学生手册 2026

物理分类真题与知识讲解

Cambridge IGCSE Co-ordinated Sciences · 0654 · Core / Extended · 2022–2026 真题

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专题 1 物理量、单位与测量

1.1 物理量、单位与测量

题型 1：辨认电动势和电势差共用伏特单位（考频★☆☆☆☆）

知识点 在国际单位制中，电势差表示电荷通过元件时每单位电荷转移的能量，单位为_____。
电动势表示电源向每单位电荷提供的能量，单位也为伏特；两者均满足 $1\ \mathrm{V} = 1\frac{\mathrm{J}}{\mathrm{C}}$。
电流的单位为安培，电阻的单位为_____；电势差和电动势的单位相同。

答案：伏特；欧姆

怎么认 题目出现电势差、电动势及单位配对时，先判断二者的单位是否均为伏特。

例题 1

Which two electrical quantities are measured in the same unit?

A current and potential difference (p.d.)

B current and electromotive force (e.m.f.)

C potential difference (p.d.) and electromotive force (e.m.f.)

D potential difference (p.d.) and resistance

（2023 Oct/Nov · 0654/11 · Question 37 · Core）

解：电流的单位为安培，电阻的单位为欧姆。
电势差和电动势的单位均为伏特，二者用同一单位测量。故选 C。

针对练习

1. For which quantities is the unit the volt?

A current and potential difference (p.d.)

B electromotive force (e.m.f.) and potential difference (p.d.)

C electromotive force (e.m.f.) and resistance

D potential difference (p.d.) and resistance

（2024 May/Jun · 0654/12 · Question 36 · Core；同题：2024 May/Jun · 0654/13 · Question 36 · Core）

题型 2：根据仪器能读取的量判断测量对象（考频★☆☆☆☆）

知识点 量筒是测量液体_____的仪器，刻度值表示量筒内液体所占空间的大小。
读数时量筒应竖直放在水平面上，视线与液面读数处相平；常用单位为 _____ 和 _____。

答案：体积；mL；cm^3

怎么认 题目出现仅用量筒能测量哪个量时，先看量筒刻度所表示的物理量。

例题 1

Which quantity can be measured using only a measuring cylinder?

A the density of a liquid

B the mass of a liquid

C the volume of a liquid

D the weight of a liquid

（2022 Oct/Nov · 0654/13 · Question 28 · Core）

解：量筒刻度表示液体体积，因此量筒可测液体体积。
密度需由质量和体积求得；质量与重量不能用量筒测量。
故选 C。

题型 3：累计厚度先换单位再平均（考频★☆☆☆☆）

知识点 测量很薄物体的厚度时，可测出多个相同物体的累计厚度，再除以物体的_____，得到单个物体的厚度。
计算前应将累计厚度化为所求单位；1 cm = _____ mm，纸张厚度常用 mm 表示。

答案：数量；10

怎么认 题目出现多张纸的累计厚度并求单张厚度时，先统一单位，再用累计厚度除以张数。

例题 1

The total thickness of 500 sheets of paper is 4.5 cm.

What is the thickness of 1 sheet of paper in mm?

A 0.0090 mm **B** 0.090 mm **C** 0.90 mm **D** 9.0 mm

（2025 May/Jun · 0654/11 · Question 28 · Core）

解：$4.5\ \text{cm} = 45\ \text{mm}$，
由平均厚度等于累计厚度除以纸张数，得
$t = \frac{45\ \text{mm}}{500} = 0.090\ \text{mm}$。
故选 B。

题型 4：经过平衡点次数换成完整振动次数（考频★☆☆☆☆）

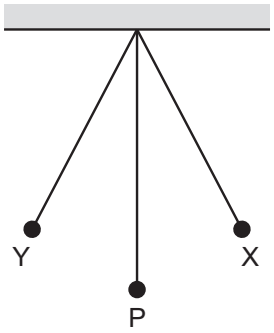
知识点 周期 T 是振动体完成一次完整振动所用的时间，单位为 _____。
同一摆球相邻两次经过平衡点的时间间隔为 _____ 个周期，成立条件是两次经过为相邻经过。
若从经过平衡点时开始计时，随后又经过平衡点 n 次，则完整振动次数为 $\frac{n}{2}$；测得总时间 t 时，$T = 2\frac{t}{n}$。

答案：s；$\frac{1}{2}$

怎么认 题目出现从摆球经过平衡点开始计时，并给出再次经过平衡点的次数时，先把次数除以 2。

例题 1

A pendulum swings backwards and forwards between point X and point Y.



A student starts a stop-watch as the pendulum first passes point P.

The student stops the stop-watch when he counts that the pendulum passes point P another 10 times.

The time on the stop-watch is 8.0 s.

What is the period of the pendulum?

A 0.40 s **B** 0.80 s **C** 1.6 s **D** 8.0 s

（2025 Oct/Nov · 0654/12 · Question 28 · Core；同题：2025 Oct/Nov · 0654/13 · Question 28 · Core）

解：摆球相邻两次经过 P 的时间为半个周期，经过 P 另 10 次对应的完整振动次数为

$N = \frac{10}{2} = 5$

由周期定义得

$T = \frac{t}{N}$

$T = 8.0\frac{\text{s}}{5}$

$T = 1.6\ \text{s}$

故选 C。

题型 5：先统一分秒再相减求时间间隔（考频★☆☆☆☆）

知识点 时间间隔等于结束读数与开始读数之_____。

在同一计时过程且读数连续递增时，$\Delta t = t_2 - t_1$。

min 与 s 混合读数相减前，应按 1 min = _____ s 统一单位；结果可用 s 或 min 与 s 表示。

答案：差；60

怎么认 题目出现计时器的开始读数、结束读数并求经过时间时，先统一为 s 再相减。

例题 1

A stop-watch is used to measure a time interval.

When the stop-watch is started, it reads 0 minutes 45 seconds.

When the stop-watch is stopped, it reads 3 minutes 25 seconds.

How much time elapses between the two readings?

A 2 minutes 40 seconds

B 3 minutes 20 seconds

C 3 minutes 40 seconds

D 4 minutes 10 seconds

（2026 May/Jun · 0654/12 · Question 28 · Core）

解： 由 $1\ \text{min} = 60\ \text{s}$，得

$t_1 = 0 \times 60 + 45 = 45\ \text{s}$

$t_2 = 3 \times 60 + 25 = 205\ \text{s}$

$\Delta t = t_2 - t_1 = 205 - 45 = 160\ \text{s}$

$160\ \text{s} = 2\ \text{min}\ 40\ \text{s}$

故选 A。

专题 2 速度、加速度与运动图像

2.1 速度、加速度与运动图像

题型 1：看速度—时间图斜率判断加速度（考频★★★☆☆）

知识点 物体沿直线且运动方向不变时，速度—时间图像的斜率表示加速度，即 $a=\frac{\Delta v}{\Delta t}$；加速度的单位为 $\mathrm{m\ s^{-2}}$。

图线为直线时，斜率不变，加速度_____；斜率为正时，加速度_____；图线水平时，加速度为零。

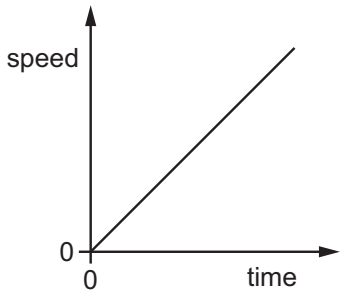
图线为曲线时，各点的斜率可能不同；斜率随时间减小，加速度随时间_____。

答案：保持不变；大于零；减小

怎么认 题目出现速度—时间图及加速度的变化或大小关系时，先看图线斜率是否变化及其正负。

例题 1

The diagram is the speed–time graph for a moving object.



What happens to the acceleration of the object during the time represented by the graph?

A It decreases.

B It increases.

C It is greater than zero and stays constant.

D It is zero and stays constant.

（2022 Oct/Nov · 0654/12 · Question 28 · Core）

解：由速度—时间图的斜率表示加速度，得

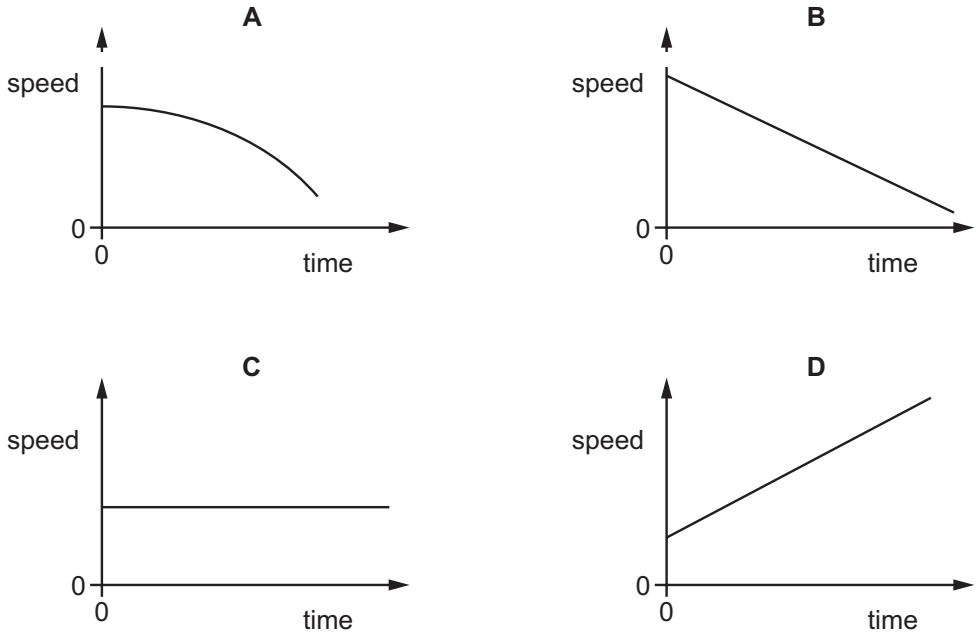
$a=\frac{\Delta v}{\Delta t}$。

图线为向上倾斜的直线，斜率大于零且保持不变，因此加速度大于零且保持不变。

故选 C。

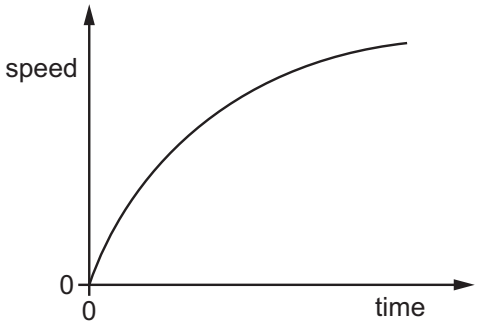
针对练习

1. In which speed–time graph is acceleration **not** constant or 0?



（2025 May/Jun · 0654/22 · Question 28 · Extended）

2. The graph shows the variation of speed with time for an object moving in a straight line.



Which statement about the motion of the object is correct?

A At time 0, the acceleration is zero.

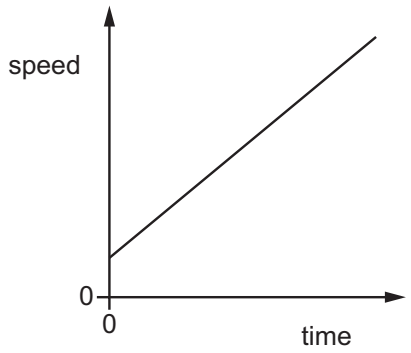
B The acceleration decreases with time.

C The gradient of the line is equal to the distance travelled.

D The velocity of the object decreases with time.

（2023 Oct/Nov · 0654/23 · Question 28 · Extended）

3. The graph shows how the speed of an object varies with time.



How is the motion of the object described during the time shown by the graph?

A moving at the start, then increasing speed with constant acceleration

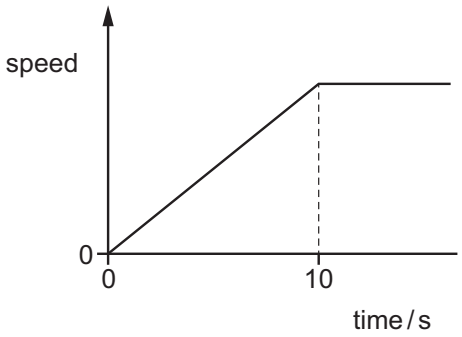
B moving at the start, then increasing speed with increasing acceleration

C starting from rest, then increasing speed with constant acceleration

D starting from rest, then moving at a constant speed

(2022 Oct/Nov · 0654/13 · Question 29 · Core)

4. The diagram shows the speed–time graph for an object moving in a straight line.



Which statement about the motion of the object is **not** correct?

A The acceleration is constant during the first 10 s.

B The acceleration steadily increases and then becomes constant.

C The rate of change of speed is constant during the first 10 s.

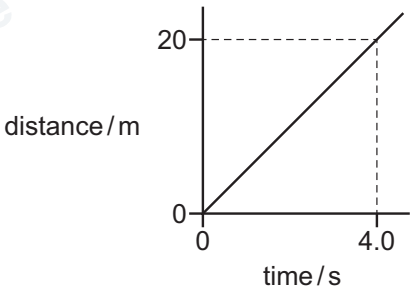
D The speed steadily increases and then becomes constant.

(2023 May/Jun · 0654/22 · Question 28 · Extended)

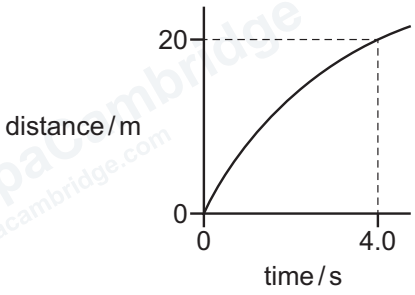
5. An object travels in a straight line with a constant acceleration of 5.0 m/s^2.

Which graph represents the motion of this object?

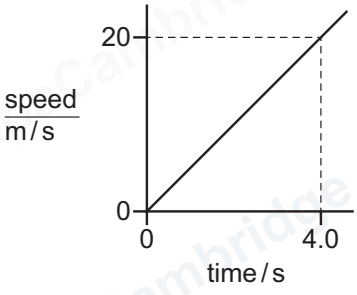
A



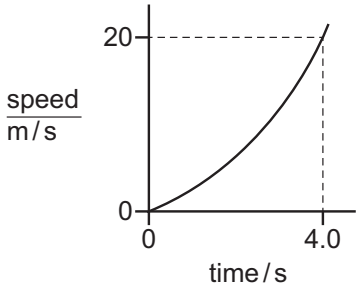
B



C



D



（2026 May/Jun · 0654/23 · Question 28 · Extended）

题型 2：用速度—时间图单个三角形或梯形面积求路程（考频★★★☆☆）

知识点 速度-时间图中，图线与时间轴在某段时间内围成的面积表示该段时间内物体通过的_____。

该关系用于速度-时间图；时间用 s，速度用 m/s 时，面积单位为_____。

图线为直线时，三角形面积为 $d=\frac{1}{2}vt$，梯形面积为 $d=\frac{1}{2}(u+v)t$，其中 u、v 分别为起、末速度。

答案：路程；m

怎么认 题目出现速度-时间图并求某段时间内的路程时，先把路程写成图线下方的面积。

例题 1

What does the area under a speed–time graph represent?

A acceleration

B average speed

C distance travelled

D total time taken

（2022 May/Jun · 0654/12 · Question 28 · Core；同题：2022 May/Jun · 0654/13 · Question 28 · Core）

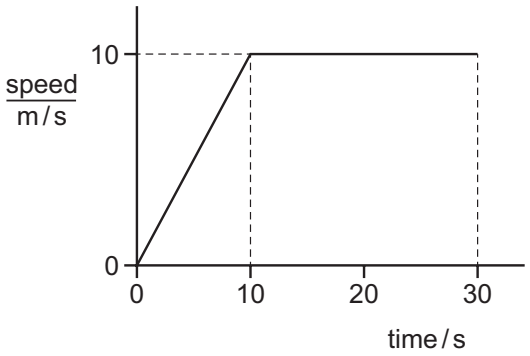
解： 由 $d=vt$ 得，速度与时间的乘积表示路程。

速度-时间图中，图线下方的面积由速度与时间的乘积累加而成，故表示路程。

故选 C。

针对练习

1. The graph shows how the speed of a car varies with time.



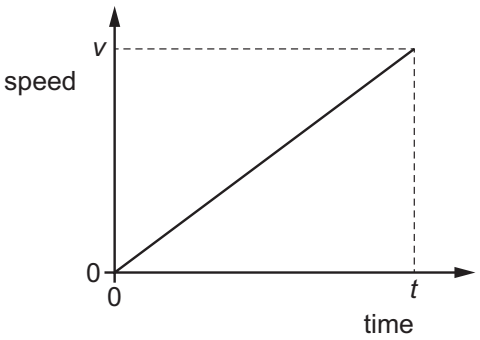
Which distance does the car travel before it reaches a constant speed?

A 10 m **B** 50 m **C** 100 m **D** 250 m

（2025 Feb/Mar · 0654/12 · Question 28 · Core）

2. The graph shows how the speed of an object varies with time.

The speed of the object is v at time t.

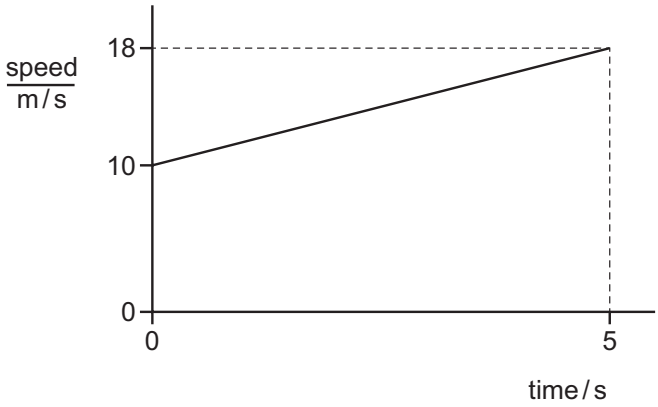


Which expression gives the distance travelled by the object in time t?

A $\frac{1}{2}\left(\frac{v}{t}\right)$ **B** $\frac{v}{t}$ **C** $\frac{1}{2}vt$ **D** vt

（2024 May/Jun · 0654/12 · Question 28 · Core；同题：2024 May/Jun · 0654/13 · Question 28 · Core）

3. The speed–time graph represents part of a car journey.

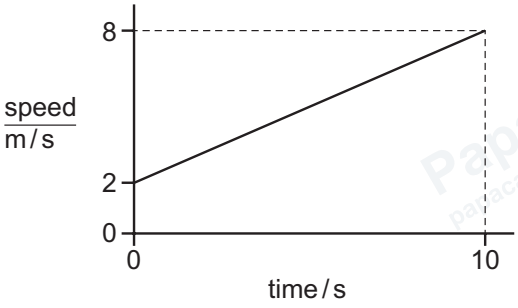


How far does the car travel in the part of the journey shown?

A 20 m **B** 45 m **C** 70 m **D** 90 m

（2023 Oct/Nov · 0654/11 · Question 28 · Core；同题：2023 Oct/Nov · 0654/21 · Question 28 · Extended）

4. The graph shows how the speed of a car varies with time.

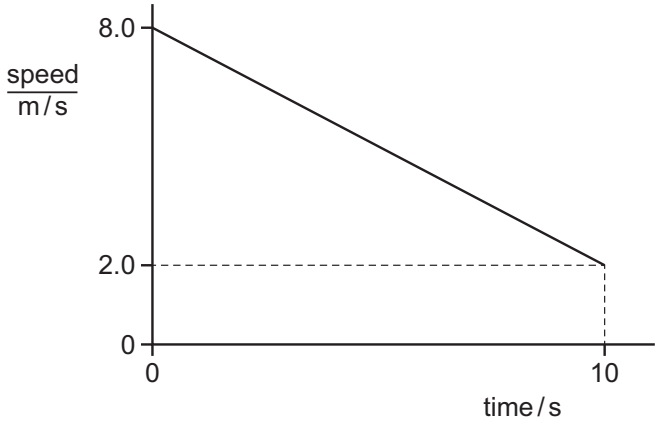


What is the distance travelled by the car?

A 30 m **B** 50 m **C** 60 m **D** 80 m

（2026 Feb/Mar · 0654/12 · Question 28 · Core）

5. The graph shows how the speed of an object varies with time.



What is the distance moved by the object between time 0 s and time 10 s?

A 30 m **B** 40 m **C** 50 m **D** 80 m

（2023 May/Jun · 0654/11 · Question 28 · Core）

题型 3：看距离—时间图斜率与速度—时间图高度（考频★★☆☆☆）

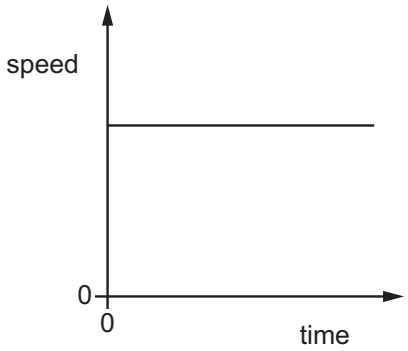
知识点 距离—时间图像的斜率表示_____，$v=\frac{\Delta s}{\Delta t}$；坐标轴刻度相同时，斜率越大，速度越大。
匀速运动中，相等时间内通过的距离相等，距离—时间图像为斜率恒定的直线。
速度—时间图像的高度表示_____；匀速运动对应水平直线，速度的国际单位为_____。
若 $t=0$ 时物体位于参考点，初始距离为 0，距离—时间图像经过原点。

答案：速度；速度；m/s

怎么认 题目出现距离—时间图、速度—时间图或匀速条件时，先看斜率是否恒定及图线高度是否不变。

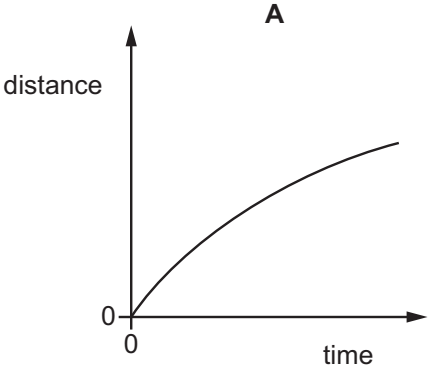
例题 1

The graph shows how the speed of an object varies with time.

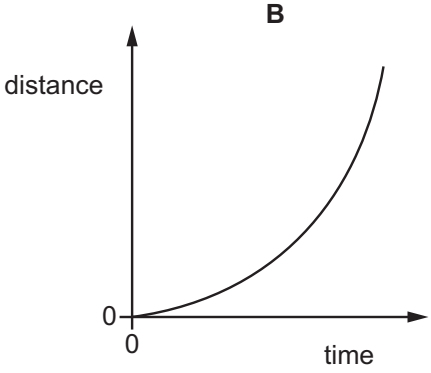


Which graph is the distance–time graph for this object?

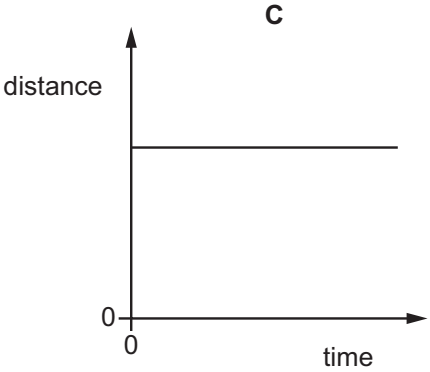
A



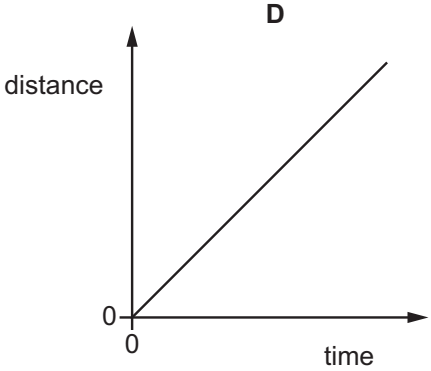
B



C



D



（2022 Oct/Nov · 0654/11 · Question 28 · Core）

解： 速度—时间图像为高于时间轴的水平直线，故物体的速度为正且保持不变。

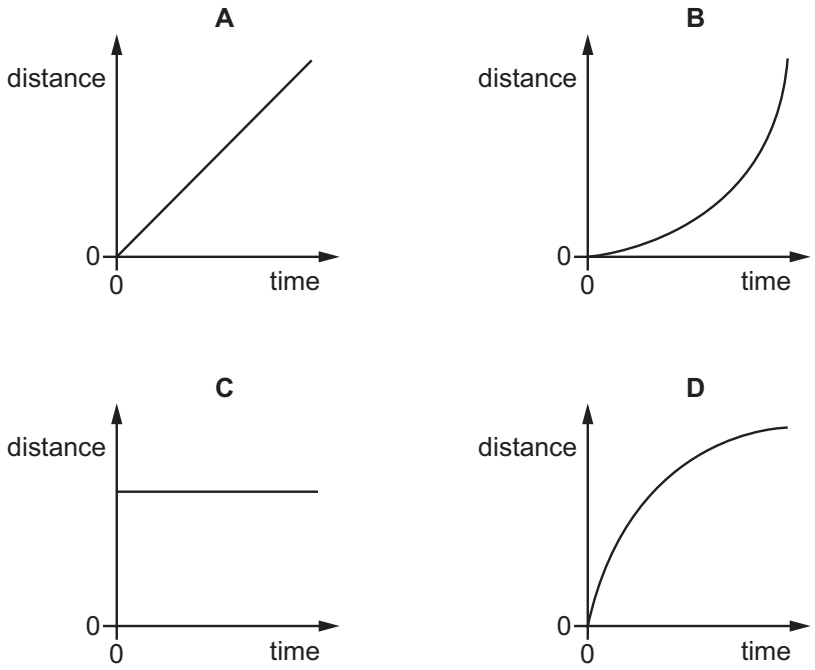
由距离—时间图像的斜率关系，

$v = \frac{\Delta s}{\Delta t}$

速度不变，故相等时间内通过的距离相等，图像为从原点出发的斜直线。故选 D。

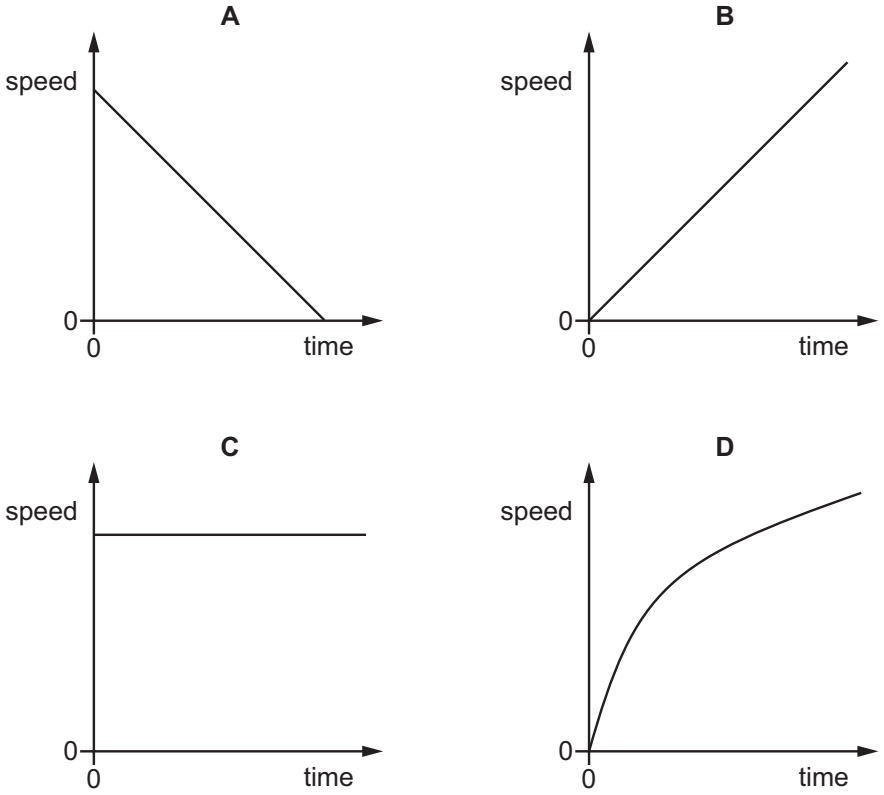
针对练习

1. Which diagram shows the distance–time graph for an object moving with constant speed?



（2023 Feb/Mar · 0654/12 · Question 28 · Core；同题：2023 Feb/Mar · 0654/22 · Question 28 · Extended）

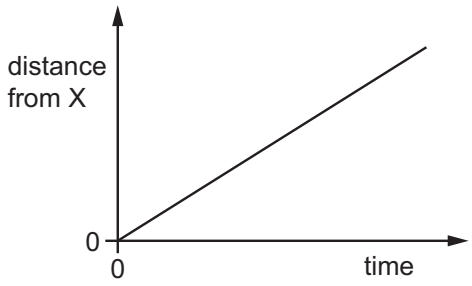
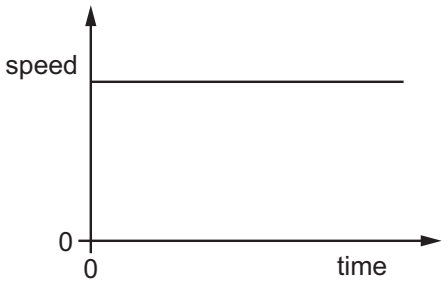
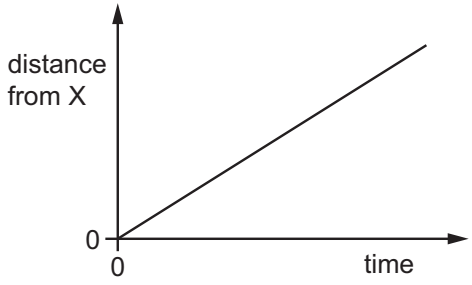
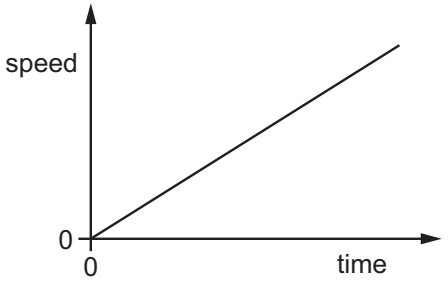
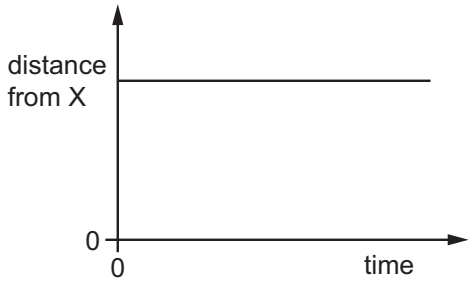
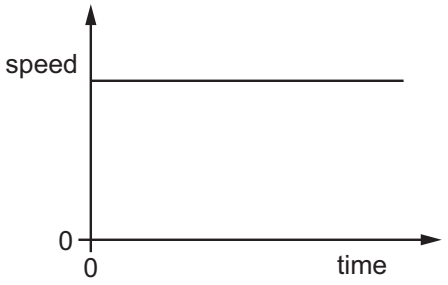
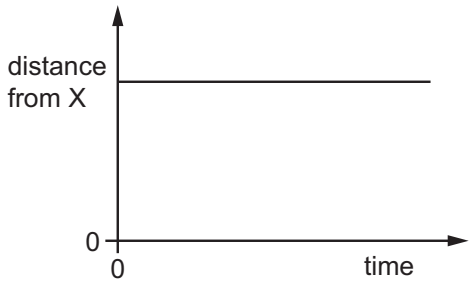
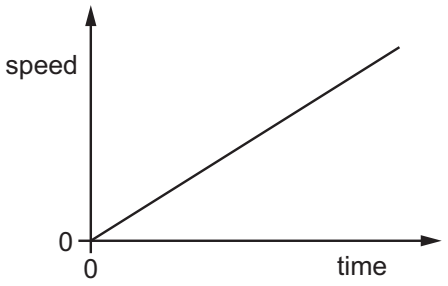
2. Which speed–time graph represents an object travelling at constant speed?



（2022 May/Jun · 0654/23 · Question 28 · Extended）

3. A car travels at constant speed. It is at point X at time = 0.

Which distance–time graph and speed–time graph represent the motion of the car?

	distance–time graph	speed–time graph
A		
B		
C		
D		

(2024 May/Jun · 0654/11 · Question 28 · Core)

题型 4：真空自由落体先认恒定重力加速度（考频★★☆☆☆）

知识点 自由落体是物体只受重力作用的运动；真空中没有空气阻力。

地球表面附近且重力场强恒定时，自由落体加速度恒为 _____，方向 _____，与物体的质量和速度无关。

速度随时间图像的斜率等于加速度；从静止开始时 $v = gt$，图像为过原点的上升直线。g 的单位是 _____。

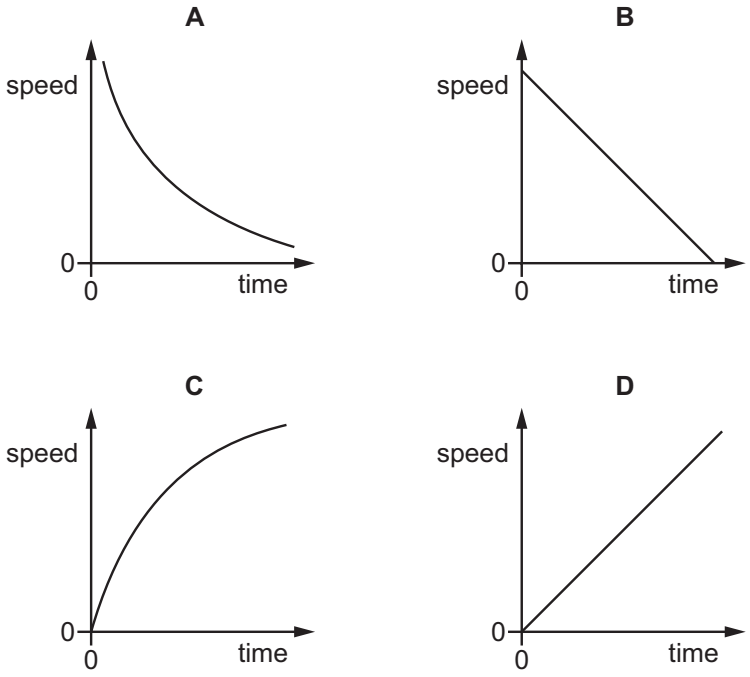
答案：g；竖直向下；$\mathrm{m\ s^{-2}}$

怎么认 题目出现真空、无空气阻力或自由落体时，先判定近地面加速度恒为 g。

例题 1

An object falls freely in a vacuum.

Which speed–time graph represents the motion of the object?



（2022 Feb/Mar · 0654/22 · Question 28 · Extended）

解：物体在真空中自由下落，所受合力为重力。

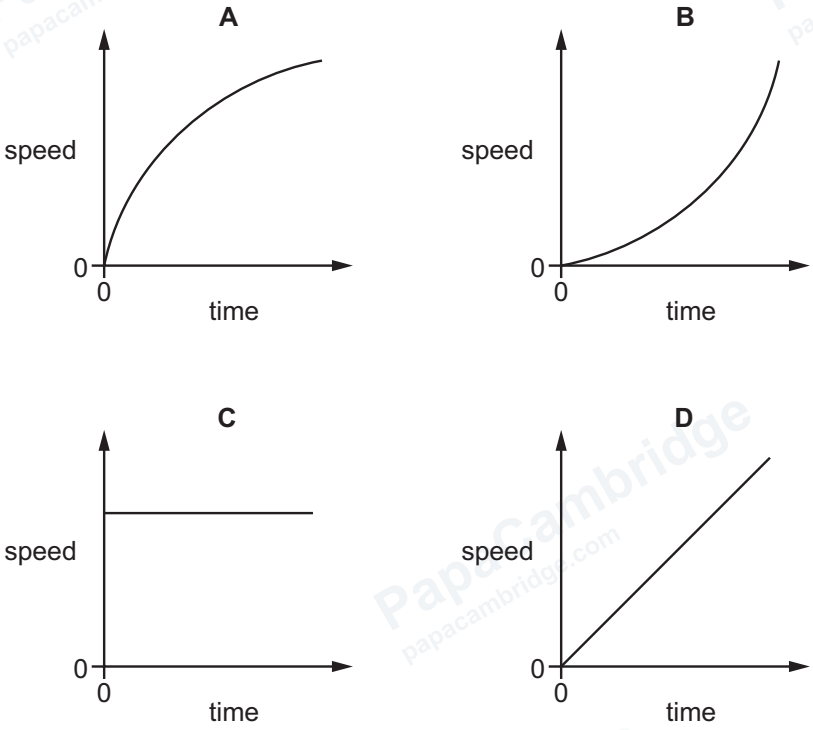
$F = mg$

$a = \frac{F}{m} = g$

$\because g$ 恒定，$\therefore v = u + gt$，速度随时间均匀增大。故选 D。

针对练习

1. Which speed–time graph shows the motion of an object in free fall with **no** air resistance?



（2026 May/Jun · 0654/22 · Question 28 · Extended）

2. An object of mass *m* falls through a vacuum. The speed of the object at one instant is *v*.

Which row shows the quantities that affect the acceleration of free fall of the object?

	m	*v*
A	no	no
B	no	yes
C	yes	no
D	yes	yes

（2025 Oct/Nov · 0654/22 · Question 28 · Extended）

3. An object near the surface of the Earth is in free fall. The gravitational field strength is constant.

Which statement about the acceleration of the object is correct?

A The acceleration is constant, but **not** zero.

B The acceleration is decreasing.

C The acceleration is increasing.

D The acceleration is zero.

（2026 May/Jun · 0654/21 · Question 28 · Extended）

题型 5：用总路程和总时间求平均速度或反求时间（考频★★☆☆☆）

知识点 平均速度等于全程的_____除以全程的_____，即 $v_{\text{avg}}=\frac{s_{总}}{t_{总}}$。

同一段行程中，$t_{总}=\frac{s_{总}}{v_{\text{avg}}}$；各段连续运动时，总路程与总时间分别_____。

路程与时间的单位须与速度单位相匹配；路程用 m、时间用 s 时，平均速度单位为 m/s。

答案：总路程；总时间；相加

怎么认 题目出现分段路程、分段时间或已知平均速度求时间时，先确定总路程与总时间。

例题 1

A car travels at an average speed of 45 km / h on a journey.

Which other information is needed to calculate the time the journey takes?

A acceleration of the car only

B acceleration of the car and distance travelled by the car

C distance travelled by the car only

D speed of the car at the end of the journey

（2026 May/Jun · 0654/11 · Question 29 · Core）

解：由平均速度关系得

$v_{\text{avg}}=\frac{s_{总}}{t_{总}}$

$t_{总}=\frac{s_{总}}{v_{\text{avg}}}$

题中已知 $v_{\text{avg}}=45\ \text{km/h}$，故还需总路程。故选 C。

针对练习

1. A car travels 100 m in the first 10 s of a journey and 300 m in the next 15 s.

What is the average speed of the car for this 25 s journey?

A 5.0 m / s **B** 8.0 m / s **C** 15 m / s **D** 16 m / s

（2024 Feb/Mar · 0654/12 · Question 28 · Core）

2. A person runs 5000 m in 1200 s and then walks a further 3000 m in 1800 s.

What is their average speed for this journey?

A 1.7 m / s **B** 2.7 m / s **C** 2.9 m / s **D** 5.8 m / s

（2024 Oct/Nov · 0654/11 · Question 28 · Core）

题型 6：由速度变化与经过时间求加速度或末速度（考频★☆☆☆☆）

知识点 加速度表示单位时间内速度的变化量，$a=\frac{v-u}{t}$，其中 u 为初速度，v 为末速度。

匀加速直线运动中，加速度为_____，并有 $v=u+at$。

速度单位为 m/s，时间单位为 s，加速度单位为_____。

答案：常量；m s^{-2}

怎么认 题目出现初速度、末速度、加速度和时间中的三个量时，先由 $a=\frac{v-u}{t}$ 建立关系。

例题 1

A motorcycle accelerates uniformly from a velocity of 20 m/s to a velocity of 35 m/s in 5.0 s.

What is its acceleration?

A $3.0\,m/s^2$ **B** $5.5\,m/s^2$ **C** $7.0\,m/s^2$ **D** $11\,m/s^2$

（2022 Oct/Nov · 0654/21 · Question 28 · Extended）

解：由加速度定义得

$a=\frac{v-u}{t}$

$=\frac{35-20}{5.0}$

$=3.0\,m\ s^{-2}$。

故选 A。

针对练习

1. A ball is moving at a speed of 3.0 m/s.

The ball now accelerates with a constant acceleration of $2.0\,m/s^2$ in the direction that it is moving.

What is the speed of the ball 5.0 s after it begins to accelerate?

A 10 m/s **B** 13 m/s **C** 17 m/s **D** 30 m/s

（2024 May/Jun · 0654/22 · Question 28 · Extended）

题型 7：用是否包含方向区别速率与速度矢量（考频★☆☆☆☆）

知识点 速率是路程与时间之比，是_____；速度是位移与时间之比，是_____。

速率只有大小，速度既有大小又有方向；同一时刻，速度的大小等于速率。

二者的国际单位均为 m/s。

答案：标量；矢量

怎么认 题目出现速率与速度的定义比较时，先判断物理量是否包含方向。

例题 1

What is the difference between speed and velocity?

A Speed has magnitude and direction; velocity has magnitude only.

B Speed has magnitude and direction; velocity has direction only.

C Speed has magnitude only; velocity has magnitude and direction.

D Speed has magnitude only; velocity has direction only.

（2022 May/Jun · 0654/21 · Question 28 · Extended）

解：由定义，速率只有大小，速度既有大小又有方向，C 符合。故选 C。

题型 8：以速度是否改变辨认加速运动（考频★☆☆☆☆）

知识点 加速度表示速度随时间的变化率，平均加速度为 $a=\frac{v-u}{t}$，单位是 m/s^2。

速度是_____；速度的大小或方向发生改变，物体就有加速度。

速度保持_____时，加速度为零；速率减小或运动方向改变时，加速度也可不为零。

答案：矢量；不变

怎么认 题目出现物体正在加速并询问运动状态时，先判断速度是否发生改变。

例题 1

An object is accelerating.

Which statement describes the motion of the object?

A It is at rest.

B It is moving at constant speed in a straight line.

C It is moving at constant velocity.

D It is moving with increasing velocity.

（2026 Feb/Mar · 0654/22 · Question 28 · Extended）

解：物体正在加速，说明其速度发生改变。
A、B、C 中速度均保持不变；D 中速度增大。
故选 D。

题型 9：把分段速度图分成面积后相加（考频★★☆☆☆）

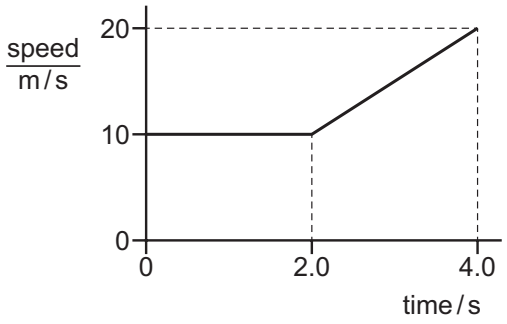
知识点 在速度—时间图像中，物体在某段时间内通过的路程等于图线与时间轴围成的_____。
图像由若干线段组成时，可把图下区域分成三角形、长方形或梯形，各部分面积应当_____。
此关系用于速度—时间图像；面积单位为纵轴单位与横轴单位的乘积，如 $(\mathrm{m/s}) \times \mathrm{s} = \mathrm{m}$。

答案：面积；相加

怎么认 题目出现分段速度—时间图像并求总路程时，先把图下区域分成基本图形并求面积之和。

例题 1

The diagram shows the speed–time graph for a moving object.



What is the distance travelled by the object in 4.0 s?

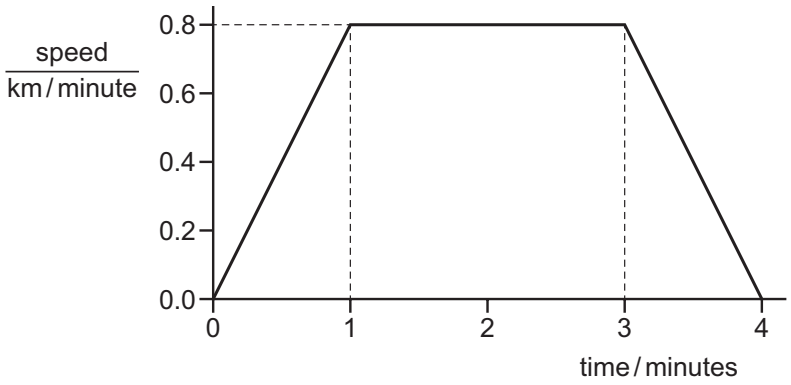
A 30 m **B** 40 m **C** 50 m **D** 80 m

（2023 May/Jun · 0654/21 · Question 28 · Extended）

解：由速度—时间图像下的面积表示路程，前 2.0 s 内的路程为
$s_1 = 10 \times 2.0 = 20\ \mathrm{m}$
后 2.0 s 内图形为梯形，
$s_2 = \frac{1}{2} \times (10 + 20) \times 2.0 = 30\ \mathrm{m}$
$s = s_1 + s_2 = 20 + 30 = 50\ \mathrm{m}$
故选 C。

针对练习

1. The speed–time graph represents the journey of a bicycle.

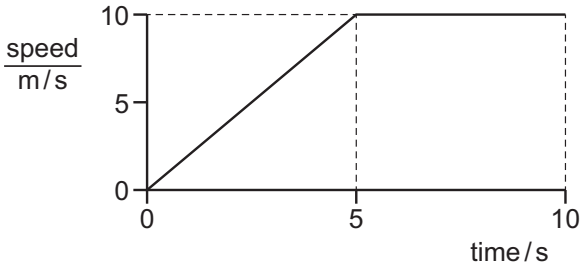


What is the total distance travelled by the bicycle?

A 1.6 km **B** 2.0 km **C** 2.4 km **D** 3.2 km

（2023 May/Jun · 0654/23 · Question 28 · Extended）

2. The speed–time graph represents the motion of a vehicle during the first 10 s of a journey.



How far does the vehicle travel during the 10 s?

A 25 m **B** 50 m **C** 75 m **D** 100 m

（2024 May/Jun · 0654/23 · Question 28 · Extended）

题型 10：由等大反向力判断匀速直线运动（考频★☆☆☆☆）

知识点 物体所受合力为 0 时，加速度为 0；运动物体的速度大小和方向均不改变，做_____运动。

同一直线上两个方向相反的力大小_____时，合力为 0。

力的单位是牛顿（N）；上述判断成立的条件是图中列出了物体所受的_____力。

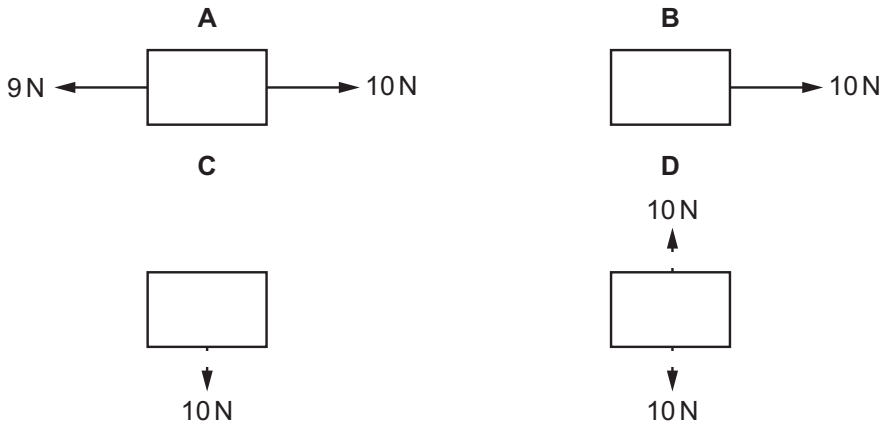
答案：匀速直线；相等；全部

怎么认 题目出现运动物体的受力图并问匀速直线运动时，先判断各力的合力是否为零。

例题 1

The diagrams show the only forces acting on four moving objects.

Which object is travelling at constant speed?



（2022 May/Jun · 0654/11 · Question 29 · Core）

解：D 中两力在同一直线上，大小均为 10 N，方向相反。

$F_{合} = 10\ \text{N} - 10\ \text{N} = 0$

由 $F_{合} = ma$ 得

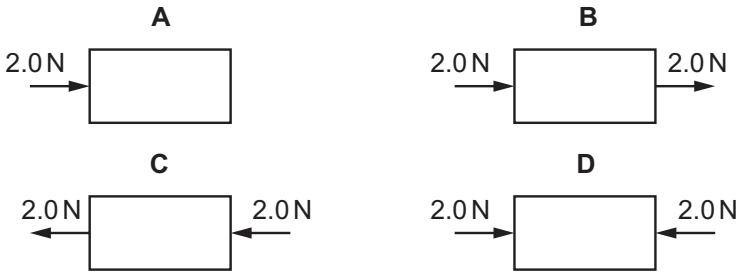
$a = 0$

物体正在运动，故速度大小和方向均不改变。故选 D。

针对练习

1. The diagrams show the only forces acting on each of four objects moving in a straight line.

Which object is moving at constant speed in a straight line?



（2025 May/Jun · 0654/12 · Question 28 · Core；同题：2025 May/Jun · 0654/13 · Question 28 · Core）

题型 11：由落差把重力势能转为动能求末速度（考频★☆☆☆☆）

知识点 物体由静止下落，若只受重力作用，则重力势能的减少量等于_____的增加量。

由机械能守恒，$mgh = \frac{1}{2}mv^2$，故$v = \sqrt{2gh}$，质量m可约去。

其中g的单位为N/kg，h的单位为m，v的单位为m/s。

答案：动能

怎么认 题目出现物体在真空中由静止下落、给出落差并求末速度时，先列机械能守恒关系。

例题 1

An object of mass 5.0 kg falls vertically from rest through a height of 13 m in a vacuum.

The gravitational field strength *g* is 10 N / kg.

What is the final speed of the object?

A 8.1 m / s **B** 10 m / s **C** 11 m / s **D** 16 m / s

（2024 May/Jun · 0654/21 · Question 30 · Extended）

解：物体在真空中下落，由机械能守恒得

$mgh = \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

$v = \sqrt{2 \times 10 \times 13}$

$v \approx 16\ \mathrm{m/s}$

故选 D。

2.2 速度、加速度与运动图像：结构题

题型 1：求速度时间图下三角形面积（考频★★☆☆☆）

知识点 速度—时间图像中，图线与时间轴在某时间段围成的面积表示该时段的路程。

图线下方为三角形时，$s = \frac{1}{2}\Delta tv$，其中底边表示_____，高表示_____。

时间单位为 s、速度单位为 m/s 时，面积单位为_____。

答案：时间间隔；速度；m

怎么认 题目出现速度—时间图和三角形区域，且求某时间段路程时，先求图线下三角形面积。

例题 1

(a) Fig. 3.1 shows a speed–time graph for a journey made by a car.

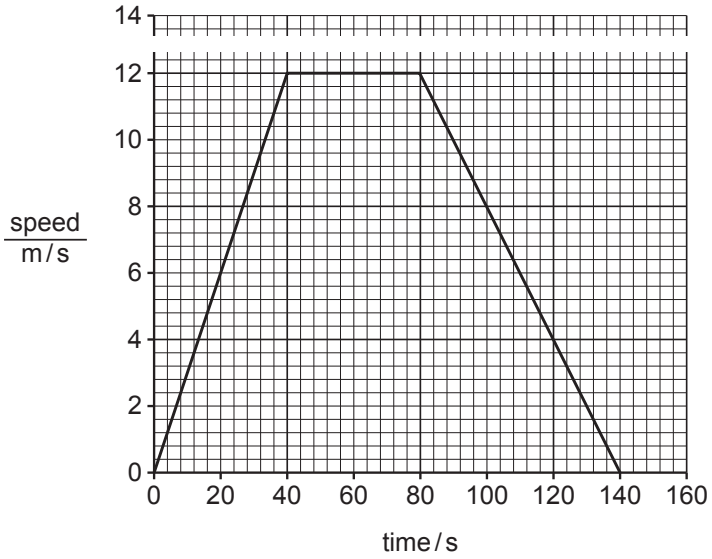


Fig. 3.1

(i) Use Fig. 3.1 to determine the distance travelled by the car during the first 40 seconds of this journey.

（2024 May/Jun 0654/43 第3题(a)(i)）

解：由图得，前 40 s 内图线下方为三角形，其底为 40 s，高为 12 m/s。

$s = \frac{1}{2} \times 40\ \text{s} \times 12\ \text{m/s}$

$s = 240\ \text{m}$

答：240 m。

针对练习

1. **(a)** A rocket travels vertically upwards.

Fig. 10.1 shows the speed–time graph for the rocket.

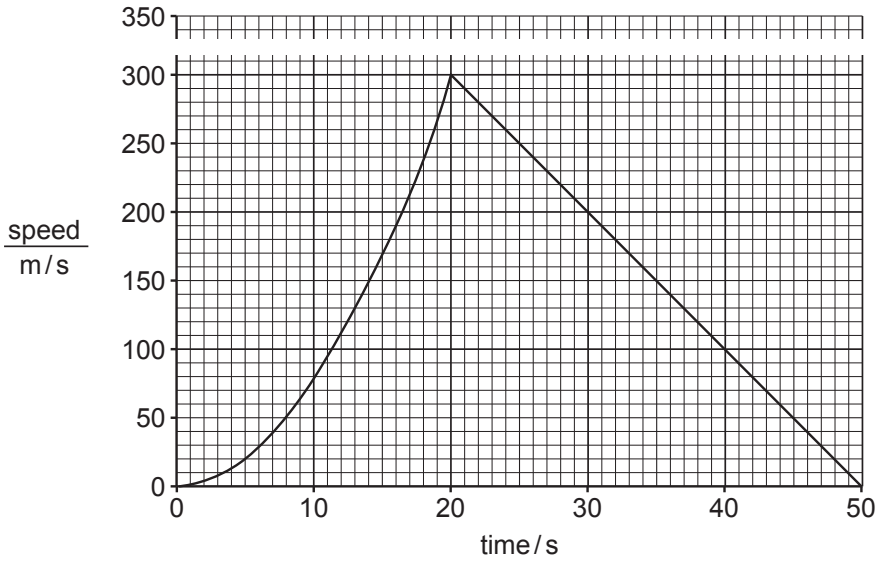


Fig. 10.1

(iii) Calculate the distance travelled by the rocket between time = 30 s and time = 50 s.

（2025 May/Jun 0654/41 第10题(a)(iii)）

2. **(d)** The farmer drives his tractor across a field.

Fig. 6.2 shows the speed-time graph for the tractor.

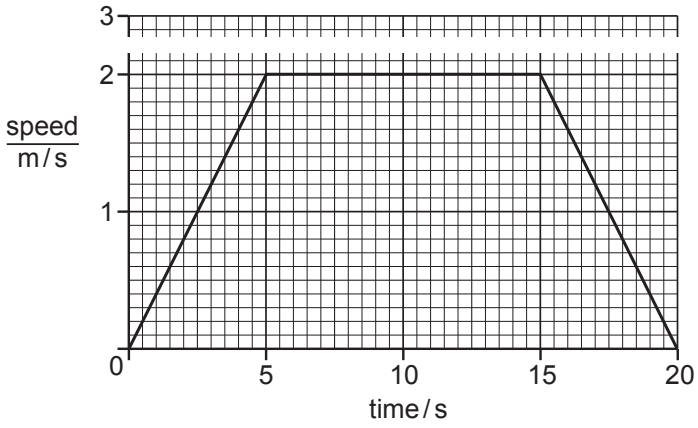


Fig. 6.2

(iii) Calculate the distance travelled by the tractor between time = 15 s and time = 20 s.

（2022 May/Jun 0654/32 第6题(d)(iii)；同题：2022 May/Jun 0654/33 第6题(d)(iii)）

专题 3 质量、重量与密度

3.1 质量、重量与密度

题型 1：量筒读弯月面或用排水体积求密度和质量（考频★★★☆☆）

知识点 密度表示单位体积物质的质量，$\rho = \frac{m}{V}$，其中 ρ 为密度，m 为质量，V 为体积；常用单位为 $\frac{\text{g}}{\text{cm}^3}$ 或 $\frac{\text{kg}}{\text{m}^3}$。

不规则固体完全浸没且不吸水、不溶于水时，其体积 $V = V_2 - V_1$，其中 V_1、V_2 分别为浸没前、后的量筒读数。

量筒竖直放置、液面静止时，视线与水面凹形弯月面的_____处相平。

小块不规则金属的质量用_____测量，体积用_____和水测量。

答案：最低；天平；量筒

怎么认 题目出现小块不规则固体的密度测量或量筒水位变化时，先确定质量及排水体积。

例题 1

Which two pieces of apparatus are used to find the density of a small, irregularly shaped piece of metal?

A balance and measuring cylinder

B balance and metre rule

C beaker and measuring cylinder

D beaker and metre rule

（2022 Oct/Nov · 0654/21 · Question 29 · Extended）

解：由 $\rho = \frac{m}{V}$，需测得金属的质量和体积。

天平测质量；量筒中水的体积变化等于完全浸没的金属体积。

故选 A。

针对练习

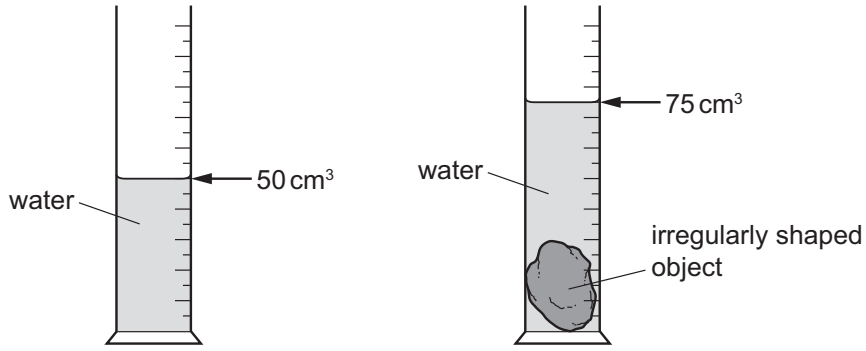
1. An irregularly shaped piece of aluminium is lowered into a measuring cylinder that contains 43 cm^3 of water. The aluminium is totally immersed in the water and the water level in the measuring cylinder rises to 51 cm^3. The density of aluminium is 2.7 g/cm^3.

What is the mass of the aluminium?

A 15.9 g　　**B** 18.9 g　　**C** 21.6 g　　**D** 127 g

（2024 May/Jun · 0654/21 · Question 29 · Extended）

2. An irregularly shaped object is lowered into a measuring cylinder of water.



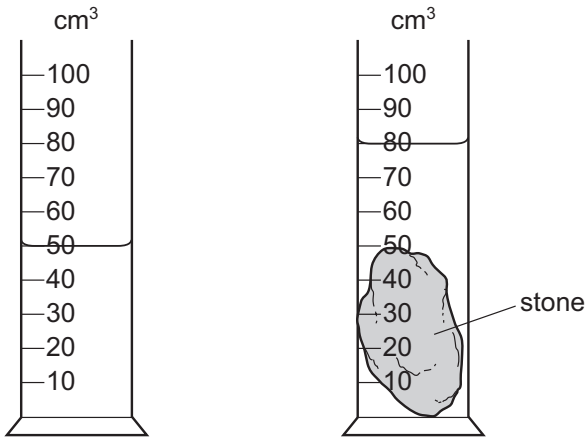
As the object is lowered into the water, the water level rises from 50 cm^3 to 75 cm^3. The object has a mass of 50 g.

What is the density of the object?

A 0.50 g / cm^3 **B** 0.67 g / cm^3 **C** 1.5 g / cm^3 **D** 2.0 g / cm^3

(2022 Feb/Mar · 0654/22 · Question 29 · Extended)

3. A stone of mass 60 g is placed in a measuring cylinder containing water. The water level in the measuring cylinder rises as shown.



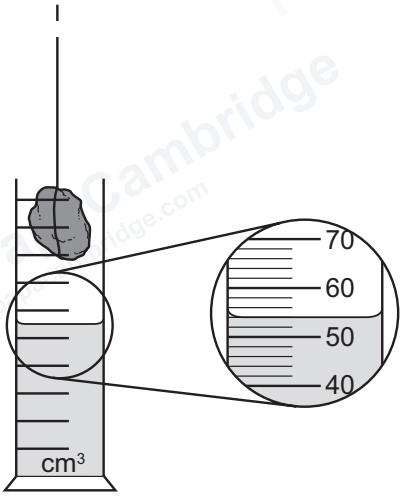
What is the density of the stone?

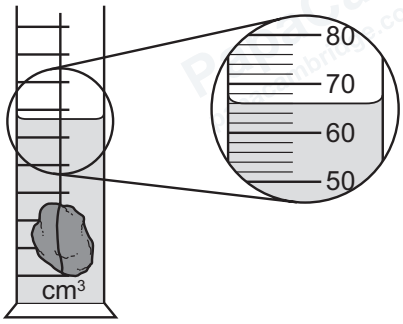
A 0.50 g / cm^3 **B** 0.75 g / cm^3 **C** 1.3 g / cm^3 **D** 2.0 g / cm^3

(2025 Oct/Nov · 0654/21 · Question 28 · Extended)

4. The volume of an irregularly shaped piece of copper is measured using a measuring cylinder and water.

The diagrams show the readings on the measuring cylinder.





The density of copper is $8.9\,g/cm^3$.

What is the mass of the piece of copper?

A 1.35 g **B** 1.80 g **C** 107 g **D** 142 g

(2026 May/Jun · 0654/22 · Question 29 · Extended)

5. A rock has a mass of 360 g.

A large measuring cylinder contains $500\,cm^3$ of water.

The rock is now lowered into the water and completely submerged. The water level in the measuring cylinder rises to $650\,cm^3$.

Which calculation gives the density of the rock?

A $\frac{360}{150}\,g/cm^3$

B $360 \times 150\,g/cm^3$

C $\frac{360}{650}\,g/cm^3$

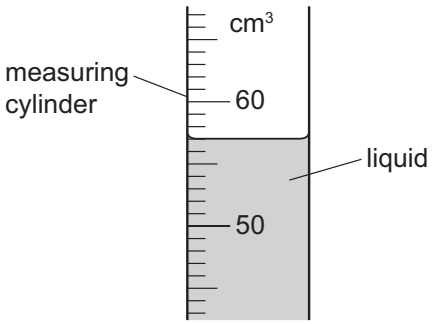
D $360 \times 650\,g/cm^3$

(2022 Oct/Nov · 0654/22 · Question 28 · Extended)

6. The mass of an empty measuring cylinder is 15 g.

Liquid is poured into it and the total mass is now 95 g.

The reading on the measuring cylinder is shown.



What is the density of the liquid?

A 1.3 g/cm³ **B** 1.4 g/cm³ **C** 1.5 g/cm³ **D** 1.7 g/cm³

（2023 Oct/Nov · 0654/11 · Question 29 · Core）

7. Five identical solid glass balls, each of mass 5.0 g, are put into a measuring cylinder containing water.

The water level in the measuring cylinder rises from the 30 cm³ mark to the 40 cm³ mark.

What is the density of the glass from which the balls are made?

A 0.50 g/cm³ **B** 1.2 g/cm³ **C** 1.6 g/cm³ **D** 2.5 g/cm³

（2022 Oct/Nov · 0654/11 · Question 29 · Core）

题型 2：区分质量、重量与重力场强并用 W=mg（考频★★★☆☆）

知识点 质量 m 表示物体所含物质的多少，不随物体所在位置改变，国际单位是 _____。

重量 W 是物体受到的重力，随所在地的重力场强改变，国际单位是 _____。

重力场强 g 表示单位质量受到的重力，单位是 _____。

在给定位置的重力场中，质量为 m 的物体所受重力满足 $W = mg$。

答案：kg；N；N/kg

怎么认 题目出现质量、重量、重力场强或位置变化时，先由 $W = mg$ 判断各量的变化。

例题 1 The gravitational field strength at the Earth's North Pole is greater than at the Equator.

An object is moved from the Equator to the North Pole.

What effect, if any, does this have on the mass and on the weight of the object?

	mass	weight
A	increases	increases
B	increases	stays the same
C	stays the same	increases
D	stays the same	stays the same

（2022 Oct/Nov · 0654/23 · Question 28 · Extended）

解：物体的位置改变，质量 m 不变。
由 $W = mg$，北极的 g 较大，故重量 W 增大。
故选 C。

针对练习

1. An object has a weight of 2.0 N.

The gravitational field strength *g* is 10 N / kg.

What is the mass of the object?

A 0.020 kg **B** 0.20 kg **C** 2.0 kg **D** 20 kg

（2024 Oct/Nov · 0654/12 · Question 28 · Core；同题：2024 Oct/Nov · 0654/13 · Question 28 · Core）

2. Which quantities are affected by gravitational field strength?

A mass and weight

B mass only

C volume and weight

D weight only

（2026 May/Jun · 0654/12 · Question 29 · Core）

3. Which row gives the units for mass *m* and gravitational field strength *g*?

	mass *m*	gravitational field strength *g*
A	kg	N / kg
B	kg	kg / N
C	N	N / kg
D	N	kg / N

（2023 Oct/Nov · 0654/12 · Question 28 · Core）

4. The weight of an object of mass *m* is given by the expression *mg*.

Which row gives the units for weight and *g*?

	weight	*g*
A	kg	kg / N
B	kg	N / kg
C	N	kg / N
D	N	N / kg

（2023 May/Jun · 0654/11 · Question 29 · Core）

5. The weight of a man on the Earth is 600 N, where the gravitational field strength is 10 N / kg.

The gravitational field strength on the Moon is 1.6 N / kg.

What is the weight of the man on the Moon?

A 60 N **B** 96 N **C** 600 N **D** 960 N

（2024 Oct/Nov · 0654/22 · Question 28 · Extended）

6. An object of mass 2.0 kg is taken from planet W to Jupiter.

The gravitational field strength on planet W is 10 N / kg.

The gravitational field strength on Jupiter is 25 N / kg.

By which factor does the weight of the object change when the object is on planet W compared to when it is on Jupiter?

A ×0.040 **B** ×2.5 **C** ×5.0 **D** ×250

（2025 May/Jun · 0654/23 · Question 28 · Extended）

题型 3：由规则形状尺寸先求体积再用密度（考频★★★☆☆）

知识点 长方体的体积等于_____，即 $V = lwh$；正方体边长为 a 时，$V = a^3$。

密度等于_____，即 $\rho = \frac{m}{V}$；由此 $m = \rho V$。

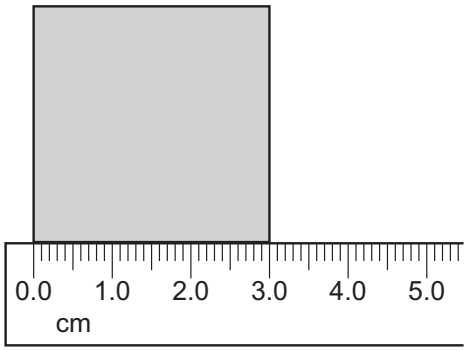
计算时长、宽、高须使用同一长度单位；质量用 g、体积用 cm^3 时，密度单位为_____；质量用 kg、体积用 m^3 时，密度单位为 kg/m^3。

答案：长、宽、高的乘积；质量与体积的比值；$\frac{g}{cm^3}$

怎么认 题目出现规则长方体或正方体的尺寸，并求体积、质量或密度时，先由尺寸求体积。

例题 1

The diagram shows a cube placed on a ruler.



What is the volume of the cube?

A 9.0 cm^2 **B** 9.0 cm^3 **C** 27 cm^2 **D** 27 cm^3

（2026 May/Jun · 0654/11 · Question 28 · Core）

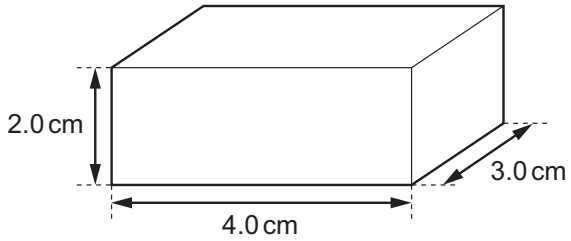
解： 由刻度尺读出正方体边长为 $a = 3.0$ cm。

正方体体积为 $V = a^3 = (3.0\ \text{cm})^3 = 27 \text{cm}^3$。

故选 D。

针对练习

1. The diagram shows a block of metal of mass 72 g.

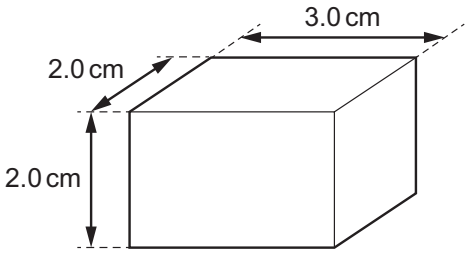


What is the density of the metal?

A $3.0\,g/cm^3$ **B** $6.0\,g/cm^3$ **C** $9.0\,g/cm^3$ **D** $12\,g/cm^3$

（2024 May/Jun · 0654/12 · Question 29 · Core；同题：2024 May/Jun · 0654/13 · Question 29 · Core）

2. The diagram shows a solid rectangular block made of material of density $2.0\,g/cm^3$.

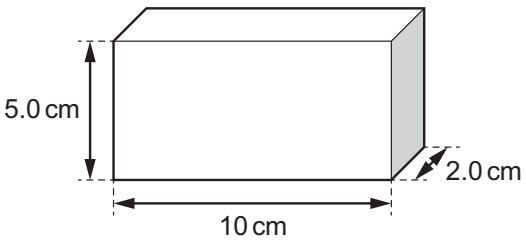


What is the mass of the block?

A 2.0 g **B** 6.0 g **C** 14 g **D** 24 g

（2025 Oct/Nov · 0654/12 · Question 29 · Core；同题：2025 Oct/Nov · 0654/13 · Question 29 · Core）

3. A metal has a density of $10\,g/cm^3$. A solid, cuboid block of this metal has the dimensions shown.



What is the mass of the block?

A 2.0 g **B** 10 g **C** 200 g **D** 1000 g

（2022 Oct/Nov · 0654/12 · Question 29 · Core）

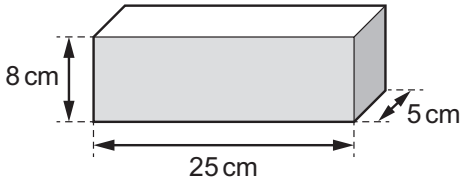
4. A solid, rectangular piece of wood measures 8.0 m × 1.0 m × 0.10 m. The block has a mass of 440 kg.

What is the density of the wood?

A $55\,kg/m^3$ **B** $352\,kg/m^3$ **C** $550\,kg/m^3$ **D** $3520\,kg/m^3$

（2023 Oct/Nov · 0654/12 · Question 29 · Core）

5. A solid, rectangular metal block has the dimensions shown.



The mass of the block is 2700 g.

What is the density of the metal?

A $\frac{25 \times 5}{2700}$ g / cm^3

B $\frac{25 \times 5 \times 8}{2700}$ g / cm^3

C $\frac{2700}{25 \times 5}$ g / cm^3

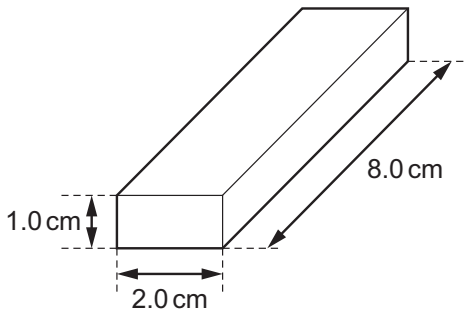
D $\frac{2700}{25 \times 5 \times 8}$ g / cm^3

(2024 Oct/Nov · 0654/21 · Question 28 · Extended)

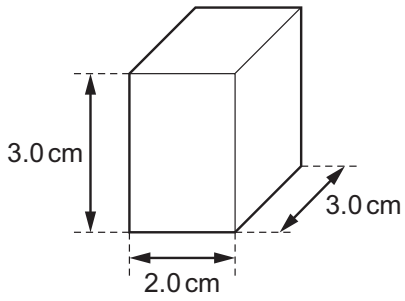
6. The diagrams show four solid blocks of equal mass.

Which block is made from the **least** dense material?

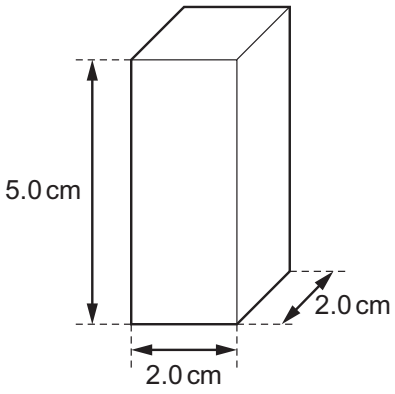
A



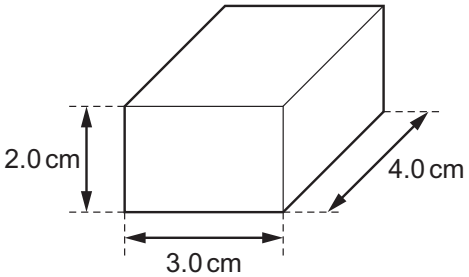
B



C



D



(2024 Oct/Nov · 0654/23 · Question 28 · Extended)

题型 4：从质量和体积读出密度或反求质量（考频★★☆☆☆）

知识点 密度表示物质单位体积的质量，定义式为 $\rho = \frac{m}{V}$，其中 m 为质量，V 为体积。

质量和体积必须对应同一物体；反求质量时，由定义式得 $m = \rho V$。

质量用 kg、体积用 m^3 时，密度单位为 _____；质量用 g、体积用 cm^3 时，密度单位为 _____。

答案：$kg\ m^{-3}$；$g\ cm^{-3}$

怎么认 题目出现质量、体积和所求密度或质量时，先写 $\rho = \frac{m}{V}$。

例题 1

Which expression is the definition of density?

A $\frac{\text{mass}}{\text{volume}}$

B $\frac{\text{volume}}{\text{mass}}$

C area × mass

D mass × volume

（2022 Feb/Mar · 0654/12 · Question 28 · Core）

解： 由密度的定义得

$\rho = \frac{m}{V}$

即密度等于质量与体积之比，故选 A。

针对练习

1. What is the density of an object that has a mass of 20 g and a volume of 5.0 cm^3?

A 4.0 g / cm^3　**B** 15 g / cm^3　**C** 25 g / cm^3　**D** 100 g / cm^3

（2025 Feb/Mar · 0654/12 · Question 29 · Core）

2. A solid metal block has a mass of 2.0×10^4 kg and a volume of 2.5 m^3.

What is the density of the metal?

A 800 kg / m^3　**B** 5000 kg / m^3　**C** 8000 kg / m^3　**D** 50 000 kg / m^3

（2026 May/Jun · 0654/23 · Question 29 · Extended）

3. The density of gold is 19 g / cm^3. The masses and volumes of four coins are given in the table.

Which coin is made of gold?

	mass / g	volume / cm^3
A	1.0	1.9
B	9.5	0.50
C	10	1.9
D	19	9.5

（2022 Oct/Nov · 0654/13 · Question 30 · Core）

4. A solid object is made from a material with density $0.60\,g/cm^3$.

The volume of the object is $4.0\,cm^3$.

What is the mass of the object?

A 0.15 g　　**B** 2.4 g　　**C** 6.7 g　　**D** 38 g

（2026 May/Jun · 0654/13 · Question 28 · Core）

题型 5：量筒读弯月面下沿并辨认每格体积（考频★☆☆☆☆）

知识点 量筒用于测量液体体积，读数时视线应与液面最低处保持水平。

透明液体形成凹形弯月面时，应读弯月面的_____。

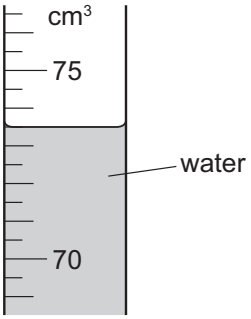
每小格体积等于相邻标数之差除以其间的_____；常用单位为 cm^3 或 mL，且 $1cm^3 = 1$ mL。

答案：下沿；小格数

怎么认 题目出现量筒刻度、弯月面和体积所求时，先求每小格体积，再读弯月面下沿。

例题 1

The diagram shows the level of water in a measuring cylinder.



What is the volume of water in the measuring cylinder?

A $73.5\,cm^3$　　**B** $74.0\,cm^3$　　**C** $76.5\,cm^3$　　**D** $77.0\,cm^3$

（2022 May/Jun · 0654/11 · Question 28 · Core）

解：从 $70cm^3$ 到 $75cm^3$ 共 10 小格，故

每小格体积 $= \frac{75-70}{10} = 0.5cm^3$

凹形弯月面下沿在 $70cm^3$ 上方 7 小格，

$V = 70 + 7 \times 0.5 = 73.5cm^3$

故选 A。

题型 6：两次称量相减消去同一个容器的质量（考频★☆☆☆☆）

知识点 密度等于物质的质量与体积之比，$\rho =$ _____，常用单位为 $\frac{g}{cm^3}$。

容器和液体的总质量满足 $m = m_0 + \rho V$，其中 m_0 为容器质量。

相同质量的容器装有同种液体时，两次称量相减可消去容器质量，得 $\rho =$ _____。

答案：$\frac{m}{V}$；$\Delta\frac{m}{\Delta}V$

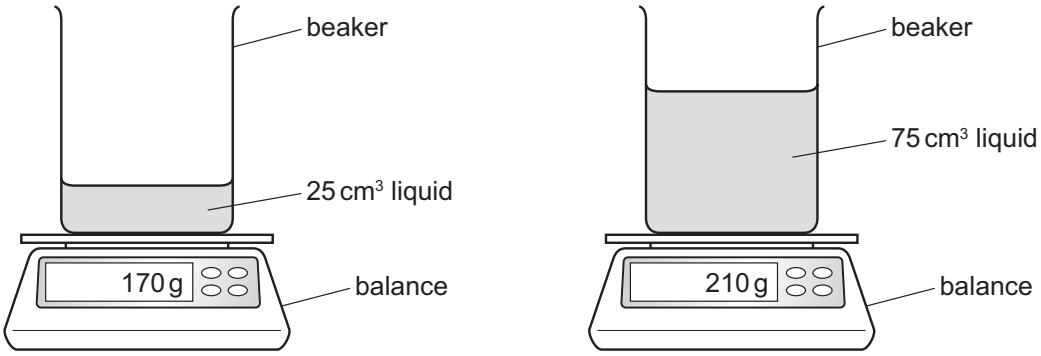
怎么认 题目出现相同容器、同种液体的两组体积和总质量时，先将两次称量相减。

例题 1

Two identical beakers each contain different volumes of the same liquid.

The mass of the beakers is measured using a balance.

The diagram shows the volume of the liquid and the reading on the balance for each beaker.



What is the density of the liquid?

A 0.53 g / cm³ **B** 0.80 g / cm³ **C** 1.3 g / cm³ **D** 2.8 g / cm³

（2025 Oct/Nov · 0654/11 · Question 28 · Core）

解：设每只烧杯的质量为 m_0，液体的密度为 ρ。

由总质量关系得

$170\ \mathrm{g} = m_0 + \rho \times 25\mathrm{cm}^3$

$210\ \mathrm{g} = m_0 + \rho \times 75\mathrm{cm}^3$

两式相减，容器质量消去，

$210\ \mathrm{g} - 170\ \mathrm{g} = \rho \times (75\mathrm{cm}^3 - 25\mathrm{cm}^3)$

$\rho = \frac{210\ \mathrm{g} - 170\ \mathrm{g}}{75\mathrm{cm}^3 - 25\mathrm{cm}^3}$

$\rho = 0.80 \frac{\mathrm{g}}{\mathrm{cm}^3}$

故选 B。

专题 4 合力、弹簧与动量

4.1 合力、弹簧与动量

题型 1：沿一条直线给力定方向后相加减（考频★★★☆☆）

知识点 合力是在作用效果上等效于多个力的一个力；沿同一直线的力可规定一个方向为正方向，各力按方向带正、负号相加。

两个同向力的合力大小等于各力大小之_____；两个反向力的合力大小等于较大力与较小力之_____，方向与较_____的力相同。

力与合力的单位均为牛顿，符号为 N；合力为零时，物体所受力平衡。

答案：和；差；大

怎么认 题目出现同一直线上的力及其方向，求合力时，先规定正方向，再将各力按方向带正、负号相加。

例题 1

Two children X and Y pull on a rope in opposite directions.

The diagram shows the size of each force and its direction.



What is the resultant force on the rope?

A 50 N towards X

B 50 N towards Y

C 950 N towards X

D 950 N towards Y

（2023 May/Jun · 0654/12 · Question 28 · Core；同题：2023 May/Jun · 0654/13 · Question 28 · Core）

解：取朝向 X 为正方向，由同一直线上的反向力相减，

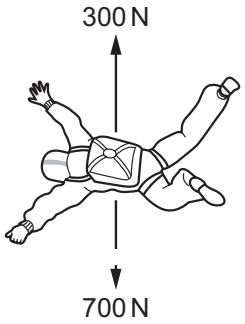
$F_{合} = 500\ \text{N} - 450\ \text{N}$

$F_{合} = 50\ \text{N}$

结果为正，方向朝向 X。故选 A。

针对练习

1. The diagram shows the two forces acting on a skydiver.



What is the resultant force on the skydiver?

A 400 N downwards

B 400 N upwards

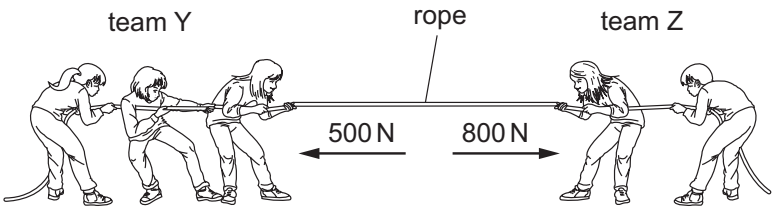
C 1000 N downwards

D 1000 N upwards

（2024 Oct/Nov · 0654/11 · Question 29 · Core）

2. The diagram shows two teams, Y and Z, pulling on a rope.

Team Y pulls with a force of 500 N to the left and team Z pulls with a force of 800 N to the right.



What is the resultant force produced by the two forces?

A 300 N to the left

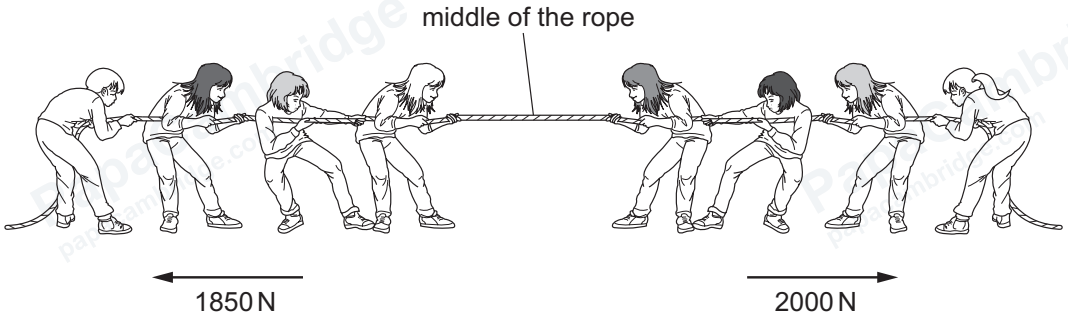
B 300 N to the right

C 1300 N to the left

D 1300 N to the right

（2025 Oct/Nov · 0654/23 · Question 29 · Extended）

3. The diagram shows two teams pulling in opposite directions on a rope. The magnitude and direction of the force exerted on the middle of the rope by each team is also shown.



What is the resultant force on the middle of the rope?

A 150 N to the left

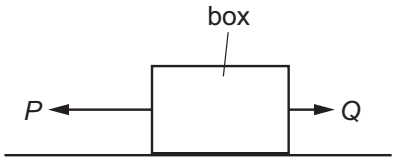
B 150 N to the right

C 3850 N to the left

D 3850 N to the right

(2026 Feb/Mar · 0654/12 · Question 29 · Core)

4. The diagram shows a large force of magnitude *P* and a small force of magnitude *Q* acting on a box.

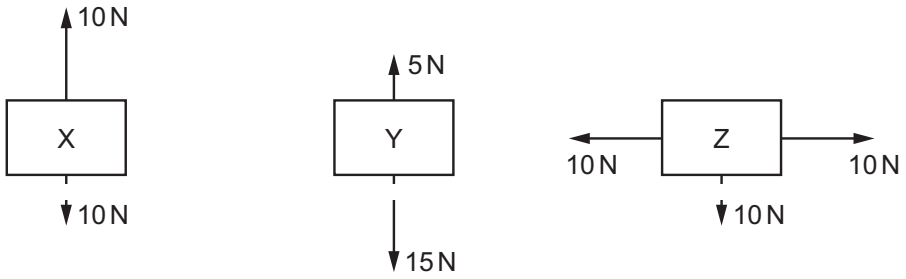


Which expression gives the magnitude of the resultant force on the box?

A $\frac{P}{Q}$ **B** $P \times Q$ **C** $P - Q$ **D** $P + Q$

(2025 May/Jun · 0654/11 · Question 30 · Core)

5. The diagrams show all the forces acting on three objects, X, Y and Z.



Which of the objects experience a resultant force?

A X, Y and Z **B** X only **C** Y and Z only **D** Y only

(2024 May/Jun · 0654/11 · Question 29 · Core)

6. The diagrams show the two forces acting on four objects P, Q, R and S.



Which two objects experience equal resultant forces acting in the same direction?

A P and Q **B** P and R **C** Q and R **D** Q and S

（2022 May/Jun · 0654/12 · Question 29 · Core；同题：2022 May/Jun · 0654/13 · Question 29 · Core）

题型 2：先从总长度扣原长再用 F=kx（考频★★★☆☆）

知识点 弹簧的伸长量是受力后长度与原长之差，即 $x = L - L_0$。

在不超过比例极限时，弹簧遵守胡克定律，$F = kx$，故 $k =$ _____。

F 用 N、x 用 m 时，k 的单位是 _____；x 用 cm 时，单位是 N/cm。

答案：$\frac{F}{x}$；N/m

怎么认 题目出现弹簧原长、受力后总长度和载荷时，先用总长度减原长求伸长量。

例题 1

A spring is extended by a force but the spring does not pass its limit of proportionality.

Which expression is equal to the spring constant?

A $\dfrac{\text{force}}{\text{extension of the spring}}$

B $\dfrac{\text{force}}{\text{length of the spring}}$

C $\dfrac{\text{extension of the spring}}{\text{force}}$

D $\dfrac{\text{length of the spring}}{\text{force}}$

（2022 May/Jun · 0654/22 · Question 28 · Extended）

解： 在比例极限内，由胡克定律得

$F = kx$

$k = \frac{F}{x}$

故选 A。

针对练习

1. Diagram 1 shows a spring with its length indicated. Diagram 2 shows the same spring with a 20 N load hung from it, and the new length of the spring.

The spring obeys Hooke's Law.

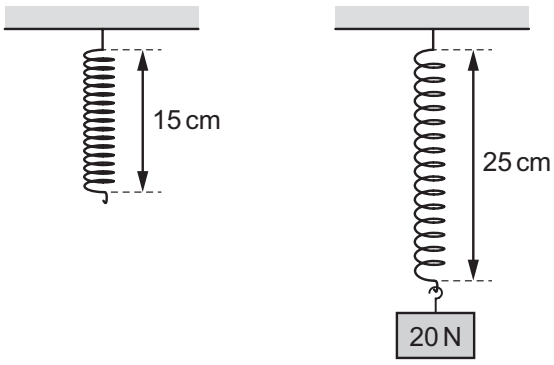
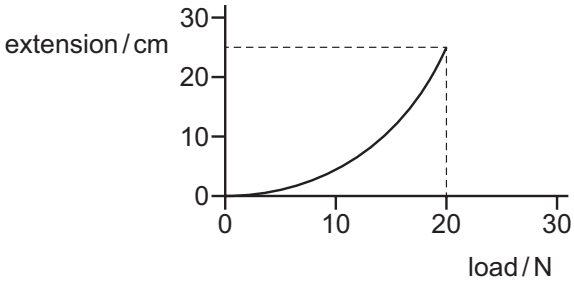


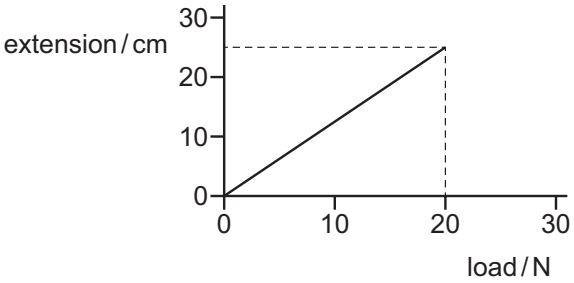
diagram 1 diagram 2

Which graph is the extension–load graph for the spring?

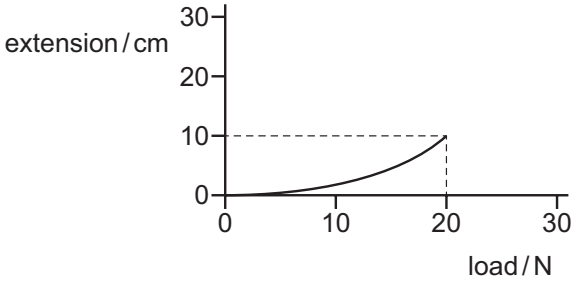
A



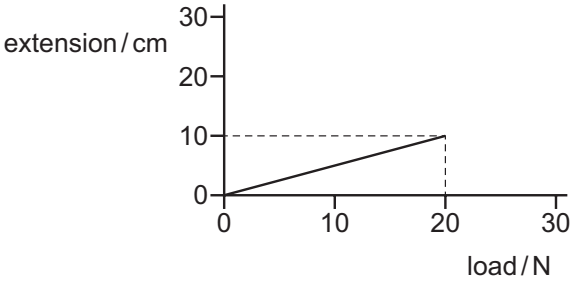
B



C



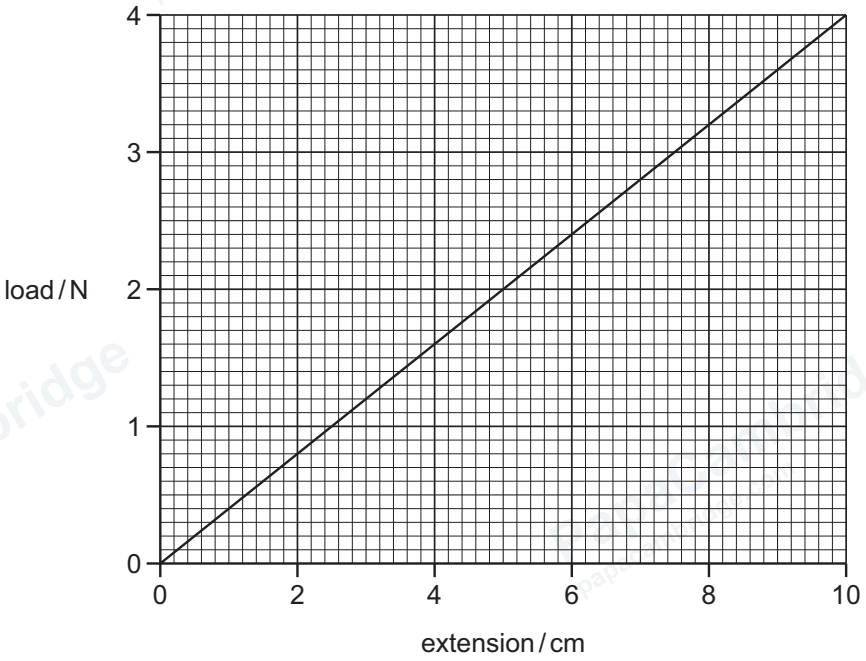
D



（2023 Oct/Nov · 0654/23 · Question 29 · Extended）

2. The load–extension graph for a spring is shown.

The unstretched length of the spring is 4.0 cm.



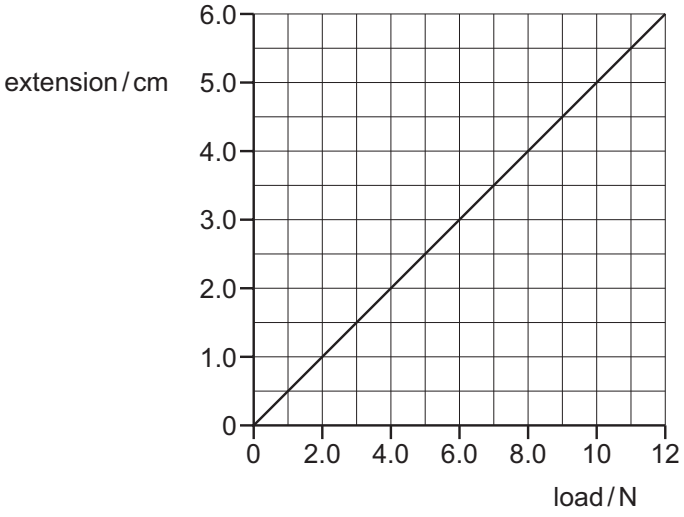
When an object is suspended from the spring, the length of the spring is 9.0 cm.

What is the weight of the object?

A 1.6 N **B** 2.0 N **C** 3.6 N **D** 10 N

(2026 May/Jun · 0654/22 · Question 30 · Extended)

3. The diagram shows the extension–load graph for a spring. The length of the unloaded spring is 4.0 cm.



A load is suspended from the spring and the length of the spring increases to 5.0 cm.

What is the value of the load?

A 0.50 N **B** 2.0 N **C** 8.0 N **D** 10 N

(2025 May/Jun · 0654/21 · Question 28 · Extended)

4. A spring is 16 cm long when it supports a load of 12 N.

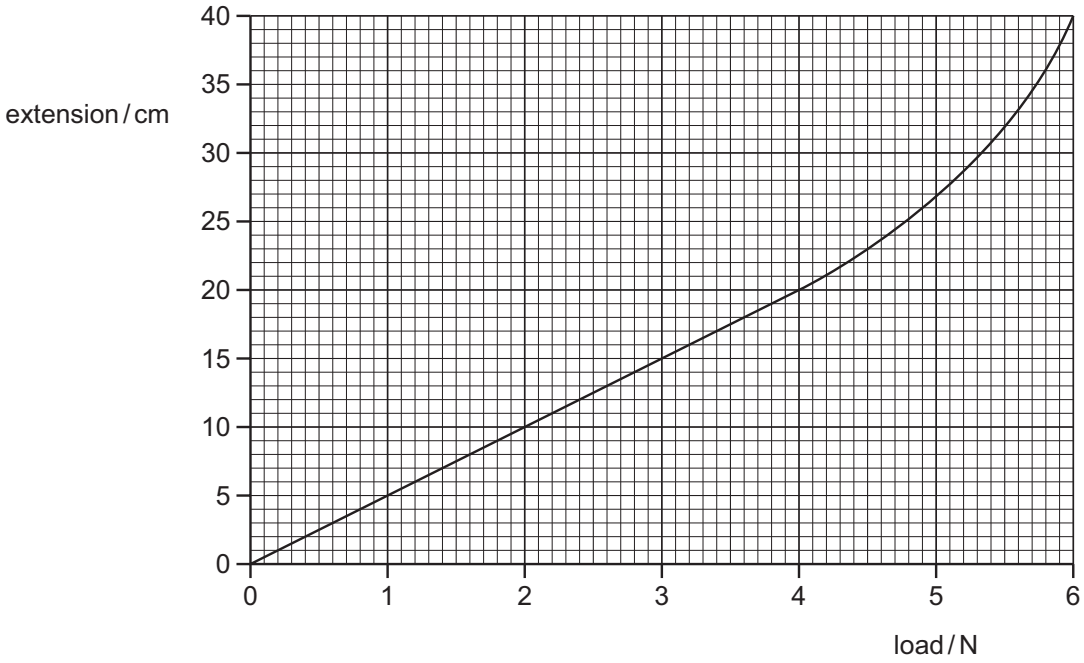
The spring is 20 cm long when it supports a load of 20 N.

What is the spring constant of the spring?

A 0.50 N / cm **B** 1.0 N / cm **C** 2.0 N / cm **D** 5.0 N / cm

(2025 Oct/Nov · 0654/23 · Question 28 · Extended)

5. The graph shows how the extension in cm of a spring changes with the load applied to it.

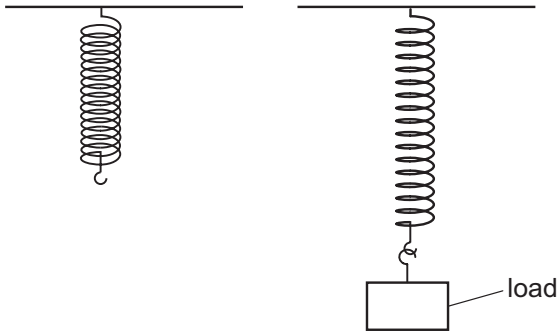


What is the spring constant of this spring in N / m?

A 0.16 N / m **B** 0.20 N / m **C** 16 N / m **D** 20 N / m

(2025 Feb/Mar · 0654/22 · Question 28 · Extended)

6. The diagram shows a spring without a load and then with a load of mass 500 g suspended from the same spring. The spring obeys Hooke's law.



The length of the unloaded spring is 30 cm.

When the 500 g load is suspended from the spring, the spring extends to a new length of 35 cm.

The gravitational field strength g is 10 N / kg.

Which calculation gives the spring constant of the spring?

A $\dfrac{0.5\times10}{35-30}$ N / cm

B $\dfrac{0.5}{10\times(35-30)}$ N / cm

C $\dfrac{10\times(35-30)}{0.5}$ N / cm

D $0.5\times10\times(35-30)$ N / cm

（2024 May/Jun · 0654/23 · Question 29 · Extended）

题型 3：由匀速直线或速度改变判断合力（考频★★☆☆☆）

知识点 合力是作用在物体上的各个力的矢量和，单位为牛顿（N），且满足 $F_{合}=ma$。

物体做匀速直线运动时，速度的大小和方向均不变，加速度为 _____，合力为 _____。

物体加速、减速或改变运动方向时，速度发生改变，$a\neq0$，合力_____。

答案：零；零；不为零

怎么认 题目出现匀速直线运动或速度改变时，先由运动状态判断合力是否为零。

例题 1

An object is travelling at constant speed in a straight line. There is no resultant force on the object.

What happens to the object?

A It continues at constant speed but changes direction.

B It continues at constant speed in the same direction.

C Its speed decreases but it continues in the same direction.

D Its speed increases but it continues in the same direction.

（2022 Oct/Nov · 0654/12 · Question 30 · Core）

解：物体沿直线做匀速运动，速度的大小和方向均不变，故 $a=0$。

由 $F_{合}=ma$ 得

$F_{合} = 0$。
物体继续以原速度沿原方向运动。故选 B。

针对练习

1. Which statement about a resultant force is correct?

A An object must have a resultant force acting on it if it is moving.

B An object must have a resultant force acting on it if it is slowing down.

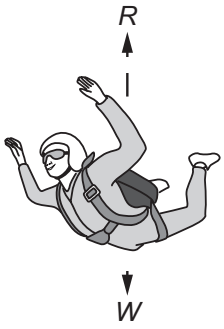
C Two forces must be in the same direction to produce a resultant force.

D Two forces must have the same magnitude to produce a resultant force.

（2024 May/Jun · 0654/12 · Question 30 · Core；同题：2024 May/Jun · 0654/13 · Question 30 · Core）

2. A parachutist and his parachute have a combined weight *W*. The parachutist falls vertically towards the Earth's surface. The force of air resistance *R* opposes his motion.

The speed of the parachutist is constant.



Which statement about the forces on the parachutist is correct?

A *W* and *R* are both equal to zero.

B *W* is equal to *R* and greater than zero.

C *W* is greater than *R*.

D *W* is less than *R*.

（2023 Feb/Mar · 0654/12 · Question 29 · Core）

3. A parachutist falls vertically at constant speed.

Which statement about the resultant force on the parachutist is correct?

A The resultant force on the parachutist acts vertically downwards.

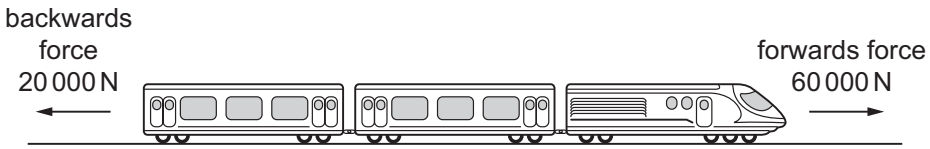
B The resultant force on the parachutist acts vertically upwards.

C The resultant force on the parachutist is equal to his weight.

D The resultant force on the parachutist is equal to zero.

（2022 May/Jun · 0654/23 · Question 29 · Extended）

4. A train travels along a horizontal track at constant speed. Two of the forces acting on the train are shown.



A force of air resistance is also acting on the train to give it a resultant force of zero.

What is this air resistance force?

A 40 000 N backwards

B 80 000 N backwards

C 40 000 N forwards

D 80 000 N forwards

（2024 Feb/Mar · 0654/12 · Question 29 · Core）

题型 4：先合力再除以质量求加速度（考频★★☆☆☆）

知识点 合力是物体所受各力的矢量和；同一直线上的力应先规定正方向，同向取同号，反向取异号。物体质量不变时，由牛顿第二定律 $F_{合}=ma$，故 $a=\frac{F_{合}}{m}$；加速度方向与_____方向相同。$F_{合}$、m、a 的单位分别为_____、kg 和 _____。

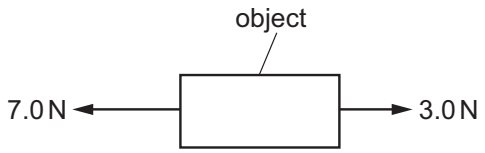
答案：合力；N；$\mathrm{m\ s^{-2}}$

怎么认 题目出现质量、同一直线上的相反力并求加速度时，先规定正方向求合力。

例题 1

An object of mass 2.0 kg is acted upon by a force of 3.0 N and a force of 7.0 N.

The directions of the forces are shown.



What is the acceleration of the object?

A $0.20\,\mathrm{m/s^2}$ **B** $0.50\,\mathrm{m/s^2}$ **C** $2.0\,\mathrm{m/s^2}$ **D** $5.0\,\mathrm{m/s^2}$

（2022 Oct/Nov · 0654/21 · Question 30 · Extended）

解：取向左为正，由同一直线上的反向力合成得

$F_{合}=7.0\ \mathrm{N}-3.0\ \mathrm{N}=4.0\ \mathrm{N}$

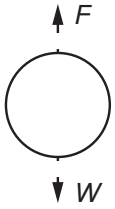
由 $F_{合}=ma$ 得

$a=\frac{F_{合}}{m}=\frac{4.0\ \mathrm{N}}{2.0\ \mathrm{kg}}=2.0\ \mathrm{m\ s^{-2}}$

故选 C。

针对练习

1. The diagram shows the two vertical forces acting on an object of mass m falling through the air.

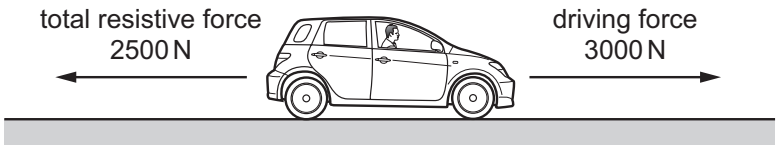


Which expression is equal to the magnitude of the vertical acceleration of the object?

A $\frac{(W-F)}{m}$ **B** $\frac{(W+F)}{m}$ **C** $\frac{m}{(W-F)}$ **D** $\frac{m}{(W+F)}$

(2025 Oct/Nov · 0654/21 · Question 29 · Extended)

2. The diagram shows a car of mass 1000 kg travelling along a straight, horizontal road. The driving force from the car's engine is 3000 N. The total resistive force acting on the car is 2500 N.



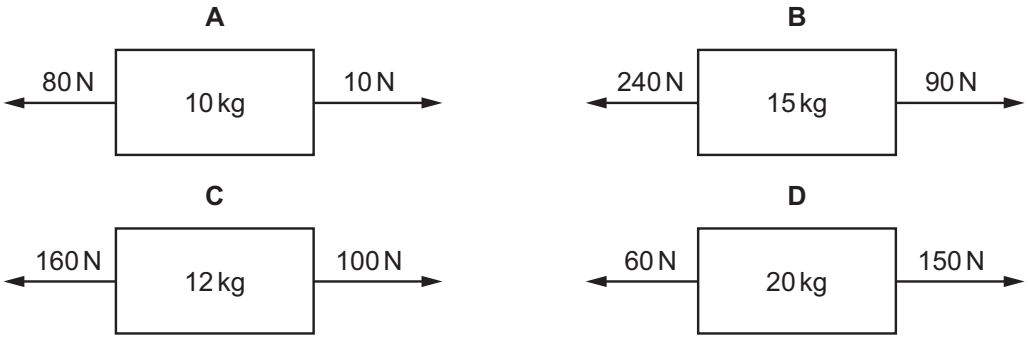
What is the acceleration of the car along the road?

A 0.50 m/s^2 **B** 2.0 m/s^2 **C** 3.0 m/s^2 **D** 5.5 m/s^2

(2022 May/Jun · 0654/21 · Question 29 · Extended)

3. Four objects with different masses have different forces applied to them, as shown.

Which object has the greatest acceleration?



(2023 Feb/Mar · 0654/22 · Question 29 · Extended)

4. A rocket has a mass of 300 kg. Its motors produce a force of 12 000 N vertically upwards.

The acceleration of free fall g is 10 m/s^2.

What is the resultant force on the rocket and what is the acceleration of the rocket?

	resultant force / N	acceleration / m/s^2
A	9 000	30
B	9 000	2.7×10^6
C	15 000	50
D	15 000	4.5×10^6

(2023 Oct/Nov · 0654/21 · Question 29 · Extended)

题型 5：找伸长与载荷开始不成正比的位置（考频★★☆☆☆）

知识点 弹簧的伸长量等于弹簧长度与原长之差，即 _____。

在比例限度内，载荷与伸长量成正比，满足 _____；F、Δx 和 k 的单位分别为 N、m 和 N m^{-1}。比例限度是载荷与伸长量开始偏离正比关系的位置；表格中比较等载荷增量对应的伸长增量，图像中找直线段开始弯曲处。

答案：$\Delta x = l - l_0$；$F = k\Delta x$

怎么认 题目出现长度或伸长量—载荷表、图及比例限度所求时，先找正比关系开始偏离处。

例题 1

The length of a spring changes when a force is applied to stretch the spring.

The table shows how the length of the spring depends on the force.

force / N	0	1.0	2.0	3.0	4.0	5.0
length of spring / cm	22	25	28	31	35	45

What is the length of the spring when the limit of proportionality is reached?

A exactly 22 cm

B between 31 cm and 35 cm

C exactly 35 cm

D between 35 cm and 45 cm

（2024 Oct/Nov · 0654/21 · Question 29 · Extended）

解：弹簧原长为 $l_0 = 22$ cm。

相邻 1.0 N 载荷对应的长度增量为

$25 - 22 = 3$ cm

$28 - 25 = 3$ cm

$31 - 28 = 3$ cm

$35 - 31 = 4$ cm

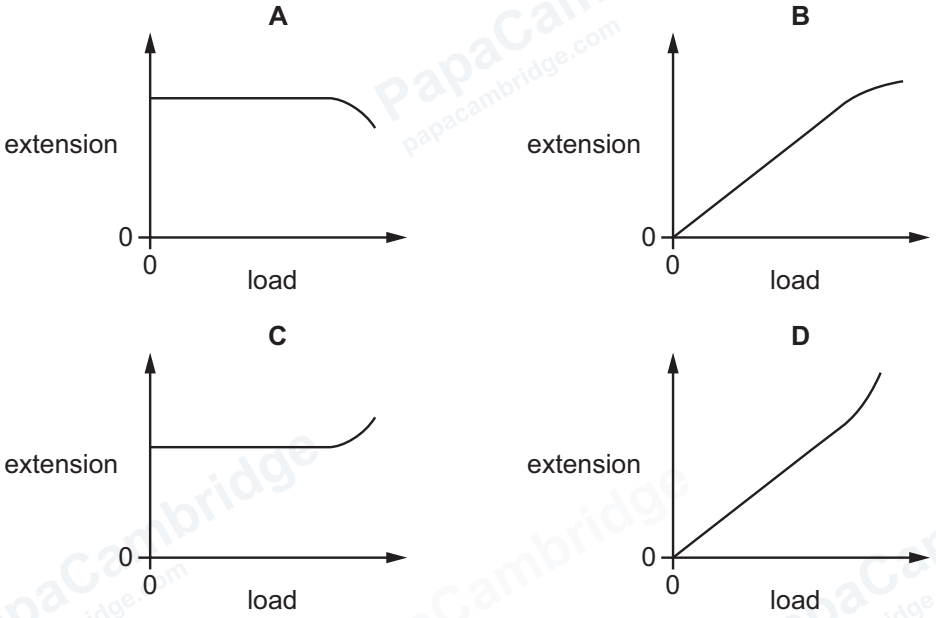
载荷由 3.0 N 增至 4.0 N 时，长度增量开始偏离原来的正比关系，比例限度对应的长度在 31 cm 与 35 cm 之间。故选 B。

针对练习

1. A solid is stretched by gradually increasing a load applied to one end of the solid. At first the extension of the solid is directly proportional to the load applied.

When the solid reaches its limit of proportionality it becomes more difficult to stretch.

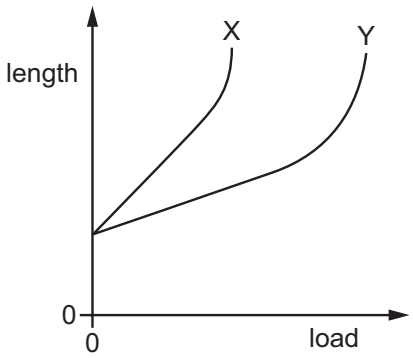
Which graph is the extension–load graph for this solid?



（2026 May/Jun · 0654/23 · Question 30 · Extended）

2. X and Y are two springs.

The graph shows how the lengths of X and Y vary with the loads suspended from them.



Which statement about X and Y is correct?

A Neither spring obeys Hooke's law for any value of load.

B The unstretched lengths of X and Y are different.

C The spring constant of X is greater than the spring constant of Y.

D Y needs a greater load than X to reach its limit of proportionality.

（2024 Feb/Mar · 0654/22 · Question 28 · Extended）

题型 6：串接弹簧各自伸长后求总伸长（考频★☆☆☆☆）

知识点 弹簧遵守胡克定律且未超过弹性限度时，伸长量 Δx 与所受拉力 F 成_____。

弹簧串联且质量可忽略、系统静止时，各弹簧所受拉力相等，均等于悬挂载荷。

串联弹簧的总伸长量等于各弹簧伸长量的_____；力的单位是 N，伸长量的单位是 cm 或 m。

答案：正比；和

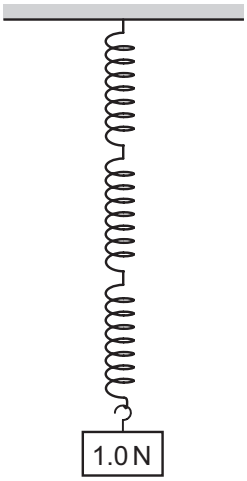
怎么认 题目出现相同弹簧串联、单个弹簧受力伸长数据及总伸长量时，先求每只弹簧的伸长量。

例题 1

A student tests three identical springs that obey Hooke's Law. Each spring stretches by 3.0 cm when a 3.0 N load is attached to one end of it.

The three springs are connected together as shown.

A 1.0 N load is placed on the end of the springs. The mass of the springs can be ignored.



What is the total extension of all the springs together?

A 1.0 cm **B** 3.0 cm **C** 6.0 cm **D** 9.0 cm

（2023 Oct/Nov · 0654/22 · Question 28 · Extended）

解： 由胡克定律，在弹性限度内有

$\Delta \frac{x}{F} = 3.0 \frac{\text{cm}}{3.0}\ \text{N} = 1.0 \frac{\text{cm}}{\text{N}}$

三只弹簧串联且质量可忽略，每只弹簧所受拉力均为 1.0 N，故

$\Delta x_1 = \Delta x_2 = \Delta x_3 = 1.0\ \text{cm}$

$\Delta x_{总} = \Delta x_1 + \Delta x_2 + \Delta x_3 = 3.0\ \text{cm}$

故选 B。

4.2 合力、弹簧与动量：结构题

题型 1：在力图中辨认竖直向下的重力（考频★★☆☆☆）

知识点 物体受到地球吸引而产生的力称为_____。

在地球表面附近，重力方向为_____，大小满足 $W = mg$，与物体的运动方向无关。

W 的单位为_____；m 的单位为 kg，g 的单位为 N/kg。

答案：重力；竖直向下；牛顿（N）

怎么认　题目出现多个带字母的力箭头并要求辨认重力时，先找竖直向下的箭头。

例题 1

(a) A farmer drives his tractor in a field.

Fig. 6.1 shows the forces **J**, **K**, **L** and **M** acting on the tractor as the tractor accelerates towards the right.

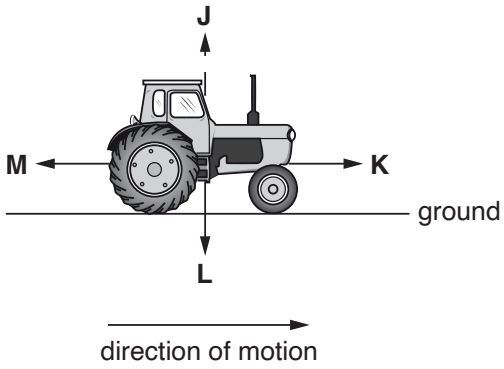


Fig. 6.1

(i) State which force **J**, **K**, **L** or **M** is the weight of the tractor.

（2024 May/Jun 0654/32 第6题(a)(i)；同题：2024 May/Jun 0654/33 第6题(a)(i)）

解：重力方向竖直向下。
图中力 L 的箭头竖直向下，故 L 表示拖拉机的重力。
答：L。

针对练习

1. **(b)** Fig. 6.1 shows the farmer driving his tractor.

Four forces, **A**, **B**, **C** and **D**, are acting on the tractor.

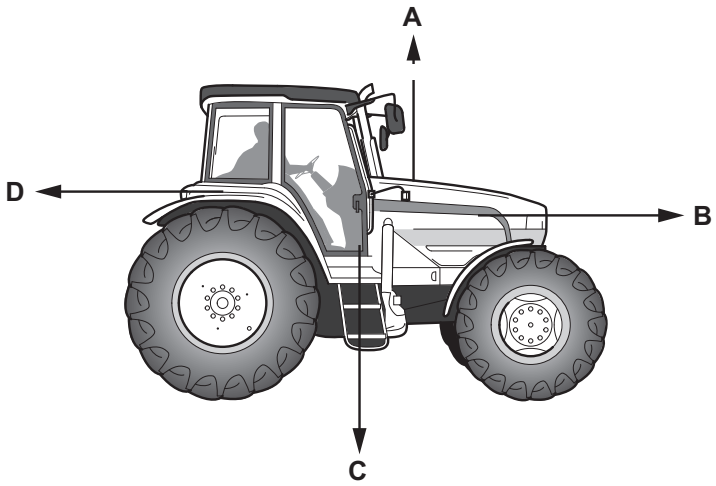


Fig. 6.1

The tractor is moving at constant speed.

The weight of the tractor is 40 000 N.

(i) State which force, **A**, **B**, **C** or **D**, is the weight of the tractor.

force

（2022 May/Jun 0654/32 第6题(b)(i)；同题：2022 May/Jun 0654/33 第6题(b)(i)）

2. **(a)** Figure 10.1 shows an aircraft moving along a runway.

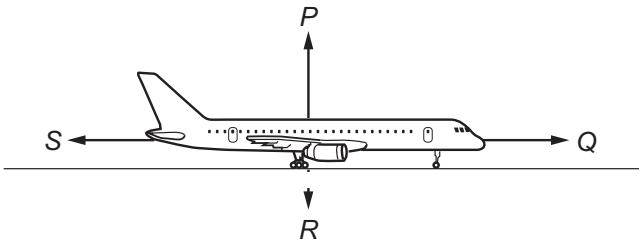


Figure 10.1

Four forces, *P*, *Q*, *R* and *S*, acting on the aircraft are shown.

(i) State which force, *P*, *Q*, *R* or *S*, is the weight of the aircraft.

force

原卷给定：1.0 kg 物体的重力为 9.8 N，即 $g = 9.8\ \text{N/kg}$（$9.8\ \text{m/s}^2$）。

（2026 May/Jun 0654/31 第10题(a)(i)）

3. **(a)** Figure 11.1 shows a gardener pushing a wheelbarrow full of soil along a straight path at constant speed.

Four forces acting on the wheelbarrow, **A**, **B**, **C** and **D**, are shown.

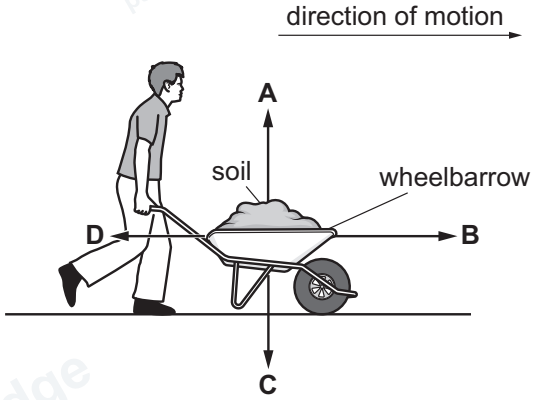


Figure 11.1

(i) State the letter, **A**, **B**, **C** or **D**, that is the weight of the wheelbarrow and soil.

原卷给定：1.0 kg 物体的重力为 9.8 N，即 $g = 9.8\ \text{N/kg}$（$9.8\ \text{m/s}^2$）。

（2026 May/Jun 0654/33 第11题(a)(i)）

专题 5 力矩、杠杆与稳定性

5.1 力矩、杠杆与稳定性

题型 1：令两侧力矩相等反求力或位置（考频★★★☆☆）

知识点 力矩是力使物体绕支点转动作用的量度，$M = Fd$，其中 d 为支点到力的作用线的垂直距离。
物体绕支点平衡时，顺时针力矩之和_____逆时针力矩之和；力矩单位为 N m。
所需力矩一定时，力臂越长，所需力越_____；均匀梁的重力作用于梁的_____。

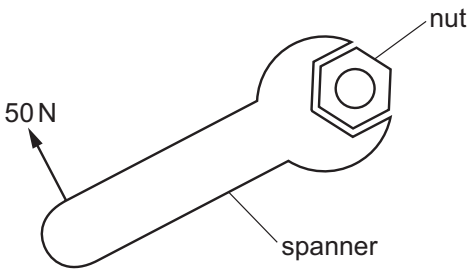
答案：等于；小；中点

怎么认 题目出现支点、两侧的力及距离，且所求为力或位置时，先令顺、逆时针力矩相等。

例题 1

A force is applied to the end of the handle of a spanner to turn a nut.

The minimum force needed to turn the nut with this spanner is 50 N.



What is an advantage of using a spanner with a longer handle to turn the nut?

A It decreases the minimum force needed to turn the nut.

B It increases the minimum force needed to turn the nut.

C It decreases the moment needed to turn the nut.

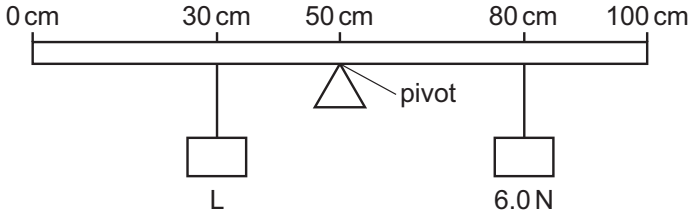
D It increases the moment needed to turn the nut.

（2026 May/Jun · 0654/21 · Question 29 · Extended）

解：设原手柄的力臂为 d，转动螺母所需的最小力矩为 M。
$M = 50d$
手柄加长后力臂为 $d' > d$，所需最小力矩不变。
$F' = \frac{M}{d'} < \frac{M}{d} = 50\ \text{N}$
故选 A。

针对练习

1. A uniform metre rule rests on a pivot at the 50 cm mark. A load L is placed at the 30 cm mark and a load of 6.0 N is placed at the 80 cm mark. The arrangement is balanced.

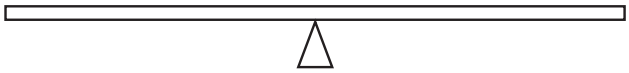


What is the weight of load L?

A 6.0 N **B** 9.0 N **C** 16 N **D** 24 N

（2023 Oct/Nov · 0654/21 · Question 30 · Extended）

2. A see-saw (teeter-totter) rests on a pivot at its centre.



A child of weight 250 N sits on one side of the see-saw at a distance of 1.6 m from the pivot.

A second child balances the see-saw by sitting on the other side of the pivot at a distance of 1.2 m from the pivot.

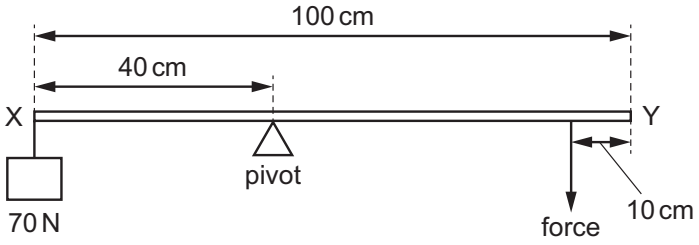
What is the weight of the second child?

A 190 N **B** 250 N **C** 330 N **D** 400 N

（2024 Oct/Nov · 0654/21 · Question 30 · Extended）

3. The diagram shows a beam XY of length 100 cm. The weight of the beam can be ignored. There is a pivot at 40 cm from end X and a load of weight 70 N is suspended at end X.

The beam is balanced by a force acting at 10 cm from end Y.



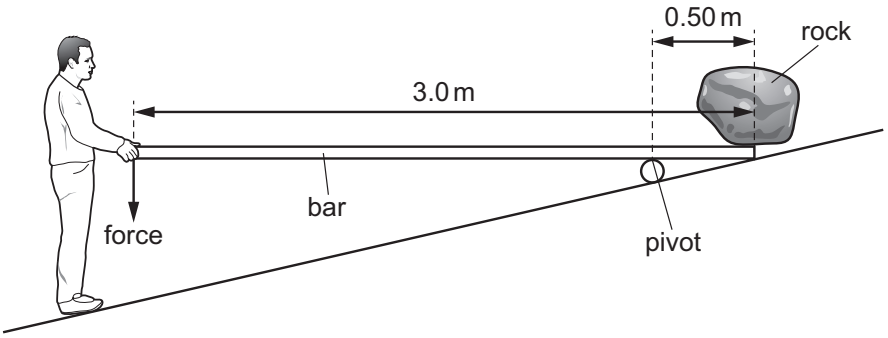
What is the magnitude of this force?

A 47 N **B** 56 N **C** 70 N **D** 280 N

（2022 Oct/Nov · 0654/22 · Question 29 · Extended）

4. A person uses a bar that is 3.0 m long to lift a rock of weight 900 N off the ground. There is a pivot under the bar at 0.50 m from the rock.

The person pushes vertically downwards on the other end of the bar from the rock, as shown.



Ignore the weight of the bar.

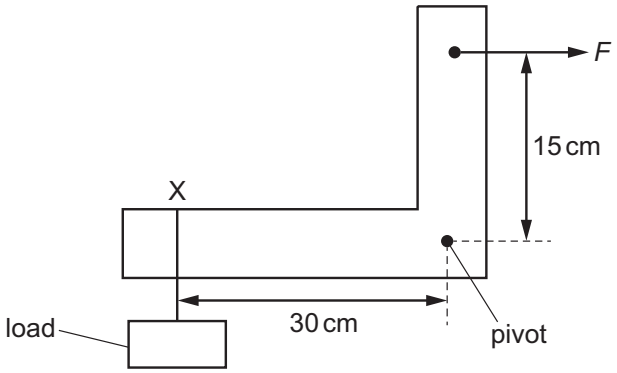
What is the minimum force needed to lift the rock off the ground?

A 150 N **B** 180 N **C** 4500 N **D** 5400 N

(2024 Oct/Nov · 0654/23 · Question 29 · Extended)

5. A weightless L-shaped beam is pivoted as shown.

A load of mass 2.4 kg is suspended from the beam at point X. The beam is held in equilibrium by a horizontal force *F* acting at the point shown.



The gravitational field strength *g* is 10 N / kg.

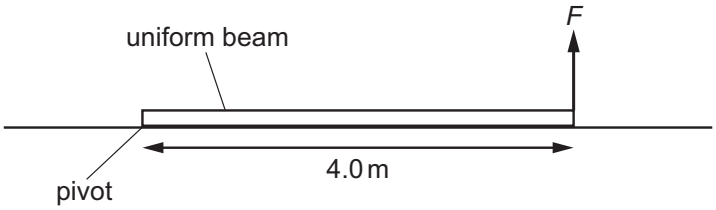
What is *F*?

A 4.8 N **B** 48 N **C** 72 N **D** 720 N

(2024 May/Jun · 0654/23 · Question 30 · Extended)

6. A uniform beam has a mass of 12 kg and a length of 4.0 m. The beam rests on horizontal ground.

One end of the beam is now raised from the ground by a vertical force *F*. The other end of the beam remains in contact with the ground and acts as a pivot.



The gravitational field strength *g* is 10 N / kg.

What is the value of *F*?

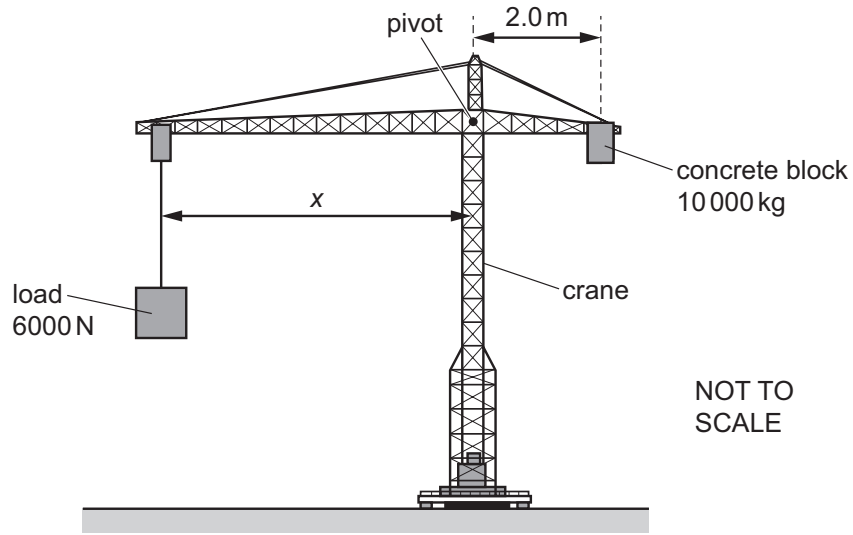
A 6.0 N **B** 24 N **C** 60 N **D** 240 N

(2023 May/Jun · 0654/22 · Question 29 · Extended)

7. The diagram shows a crane supporting a load of 6000 N. The horizontal distance between the load and the pivot is *x*.

The load is balanced about the pivot by a concrete block of mass 10 000 kg. The horizontal distance of the concrete block from the pivot is 2.0 m.

Gravitational field strength *g* is 10 N / kg.



What is the distance of *x*?

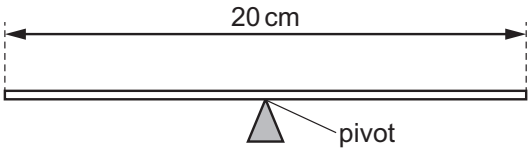
A 1.2 m **B** 3.3 m **C** 12 m **D** 33 m

(2023 Oct/Nov · 0654/22 · Question 29 · Extended)

8. A uniform beam of length 20 cm is balanced on a pivot at its centre.

A 20 N load is placed at one end of the beam and a 30 N load is placed at the other end.

A 25 N load is also placed on the beam to balance it.



How far from the pivot is the 25 N load placed?

A 4.0 cm **B** 5.0 cm **C** 8.0 cm **D** 10 cm

（2024 Oct/Nov · 0654/22 · Question 29 · Extended）

题型 2：取支点到力作用线的垂直距离求力矩（考频★★★☆☆）

知识点 力矩是力使物体绕支点转动的效应。

力对支点的力矩 $M = Fd$，其中 d 必须取支点到力的作用线的_____距离。

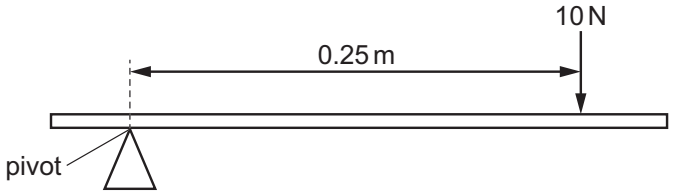
力用 N、距离用 m 时，力矩单位为_____；距离用 cm 时，单位为 N cm。

答案：垂直；N m

怎么认 题目出现支点、力的方向和长度标注并求力矩时，先取支点到力作用线的垂直距离。

例题 1

A force of 10 N is applied to a beam at a distance of 0.25 m from a pivot.



Which calculation gives the moment of the force about the pivot in N m?

A 10×0.25 **B** $\dfrac{10}{0.25}$ **C** $10 + 0.25$ **D** $10 - 0.25$

（2022 Oct/Nov · 0654/11 · Question 30 · Core）

解：支点到力作用线的垂直距离为 0.25 m，

$M = Fd$

$M = 10\ \text{N} \times 0.25\ \text{m}$

$M = 2.5\ \text{N m}$。故选 A。

针对练习

1. What is a suitable unit for the moment of a force?

A N kg **B** N/kg **C** N m **D** N/m

（2023 Feb/Mar · 0654/12 · Question 30 · Core）

2. What is meant by the moment of a force?

A the speed of an object moved by a force

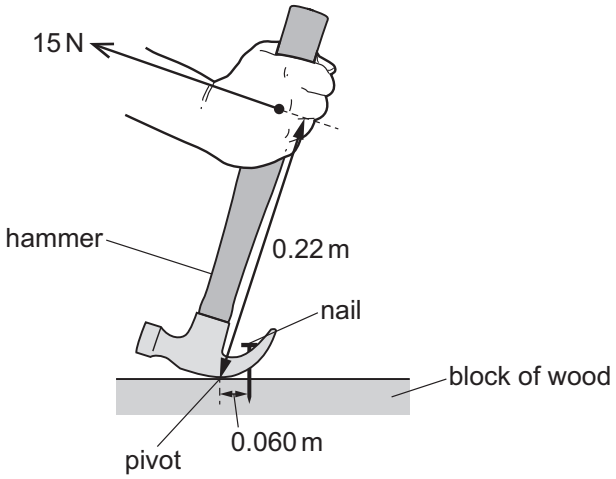
B the time taken for a force to move an object

C the turning effect of a force

D the work done by a force

（2024 May/Jun · 0654/22 · Question 29 · Extended）

3. A boy pulls a nail from a block of wood using a hammer, as shown.



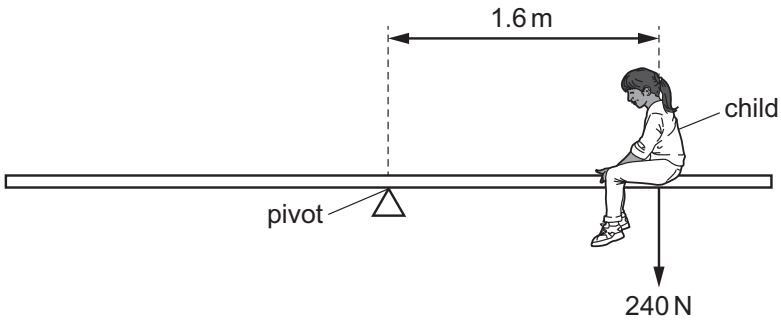
The boy pulls the hammer with a force of 15 N in the position shown.

What is the moment produced about the pivot by the boy pulling on the hammer?

A 0.90 N m **B** 2.4 N m **C** 3.3 N m **D** 4.2 N m

（2023 May/Jun · 0654/12 · Question 29 · Core；同题：2023 May/Jun · 0654/13 · Question 29 · Core）

4. The diagram shows a child of weight 240 N sitting on a see-saw (teeter-totter) at a distance of 1.6 m from the pivot.

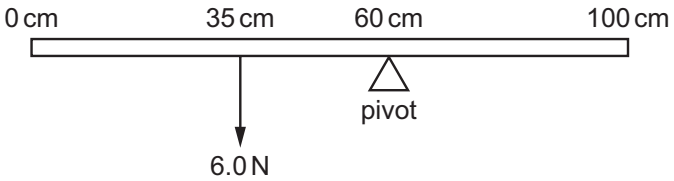


What is the moment of the weight of the child about the pivot, with the correct unit?

A 150 N m **B** 150 N / m **C** 384 N m **D** 384 N / m

（2023 Oct/Nov · 0654/11 · Question 30 · Core）

5. The diagram shows a metre rule with a pivot at the 60 cm mark. A force of 6.0 N is applied at the 35 cm mark in the direction shown.



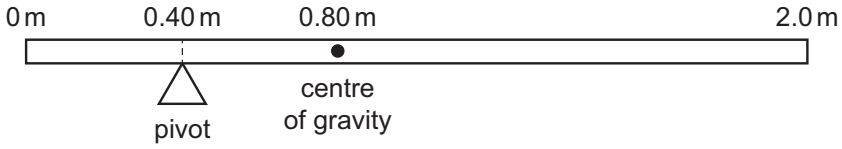
What is the moment of the 6.0 N force about the pivot?

A 150 N cm **B** 210 N cm **C** 360 N cm **D** 390 N cm

（2022 Feb/Mar · 0654/12 · Question 29 · Core）

6. A metal bar has weight 50 N and length 2.0 m. The centre of gravity of the bar is 0.80 m from the left-hand end.

The bar is placed on a pivot at a point 0.40 m from the left-hand end.

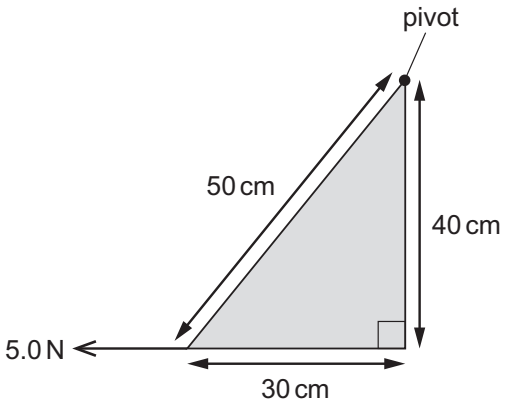


What is the moment of the weight of the bar about the pivot?

A 20 N m **B** 40 N m **C** 60 N m **D** 80 N m

（2025 May/Jun · 0654/11 · Question 29 · Core）

7. The diagram shows a triangular sheet of metal with sides of length 50 cm, 40 cm and 30 cm. The sheet is free to move about a pivot at the top corner, as shown.



A cord is attached to the bottom left corner of the sheet and pulled with a horizontal force of 5.0 N to the left.

What is the moment of the 5.0 N force about the pivot?

A 150 N cm **B** 200 N cm **C** 250 N cm **D** 600 N cm

（2023 May/Jun · 0654/11 · Question 31 · Core；同题：2023 May/Jun · 0654/21 · Question 29 · Extended）

题型 3：同时检查合力为零和总力矩为零（考频★★☆☆☆）

知识点 物体处于平衡状态时，所受_____为零，且对任一支点的_____为零。

合力为零时物体无平动加速度；总力矩为零时物体无转动加速度。

力矩满足 $M = Fd$，其中 d 为支点到力的作用线的垂直距离，单位为 N m；顺、逆时针力矩取相反符号。

答案：合力；总力矩

怎么认 题目出现物体平衡、受力图或转动效应时，先验算各方向合力为零，再验算总力矩为零。

例题 1

Which statement describes a system that is in equilibrium?

A There is a resultant force and there is a resultant turning effect on the system.

B There is a resultant force but there is no resultant turning effect on the system.

C There is no resultant force but there is a resultant turning effect on the system.

D There is no resultant force and there is no resultant turning effect on the system.

（2024 May/Jun · 0654/21 · Question 28 · Extended）

解：由平衡条件，系统应同时满足

$F_{合}=0$，

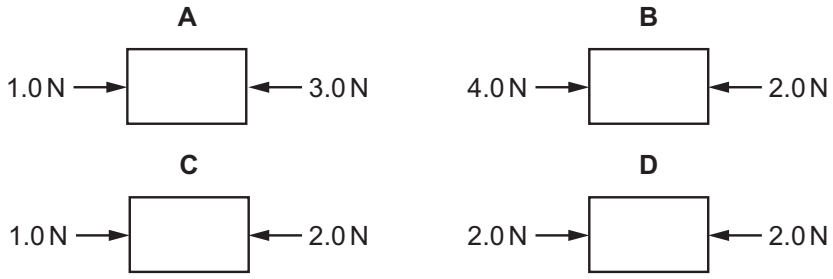
$M_{总}=0$。

故系统既无合力，也无总转动效应。故选 D。

针对练习

1. The diagrams show four objects, each acted on by only two forces.

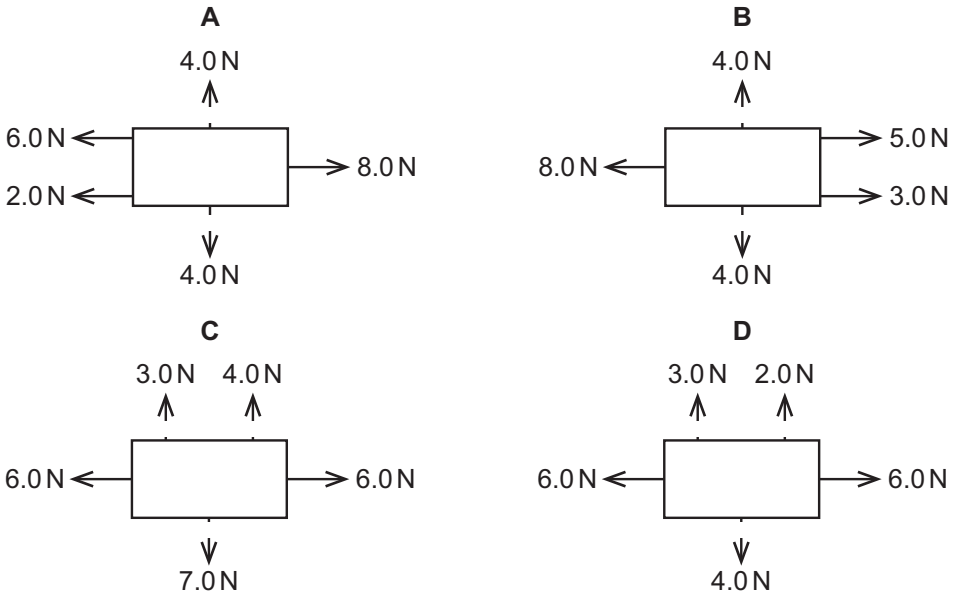
Which object is in equilibrium?



（2023 Oct/Nov · 0654/13 · Question 28 · Core）

2. The diagrams show all the forces acting on each of four objects.

Which object is **not** in equilibrium?



（2023 May/Jun · 0654/11 · Question 30 · Core）

题型 4：比较重心高低与底面宽度判断稳定（考频★★☆☆☆）

知识点 重心（centre of gravity）是物体所受重力的等效作用点；在均匀重力场中，重心与质心重合。

重力作用线是通过重心的_____线；落在支承面内时物体不翻倒，通过边缘时达到临界状态。

重心越_____、重力作用线到最近支承边缘的水平距离越_____，物体越稳定。

若重心位于底面中央，设倾倒方向底宽为 b、重心高度为 h，则 $\tan\theta_c=\frac{\frac{b}{2}}{h}$；$b$、$h$ 须同单位，θ_c 的单位为 °。

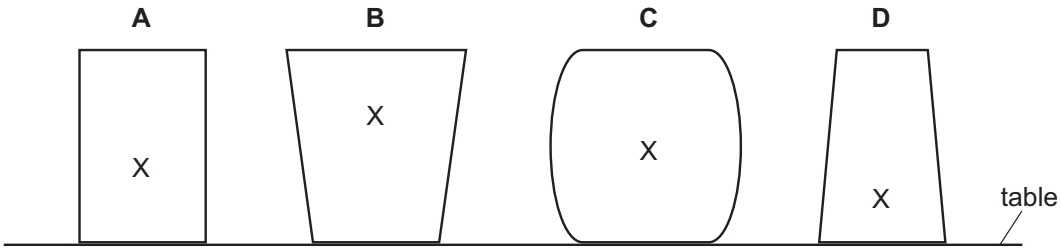
答案：竖直；低；大

怎么认 题目出现重心位置、底面宽度或倾斜至翻倒的图时，先比较重心高度与重力作用线到支承边缘的距离。

例题 1

The diagram shows four containers resting on a table. The containers have equal masses and square bases of equal areas. The centre of mass of each container is labelled X.

Which container is the most stable?



（2024 Oct/Nov · 0654/12 · Question 29 · Core；同题：2024 Oct/Nov · 0654/13 · Question 29 · Core）

解： 设方形底面沿倾倒方向的宽度为 b，重心到桌面的高度为 h。

临界翻倒时，重力作用线通过底面边缘，故

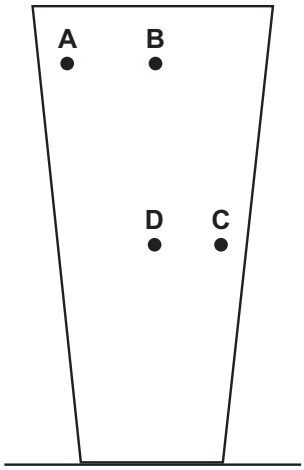
$\tan\theta_c = \frac{\frac{b}{2}}{h}$.

四个容器的 b 相同，图中 D 的 h 最小，故 D 的 θ_c 最大，稳定性最强。故选 D。

针对练习

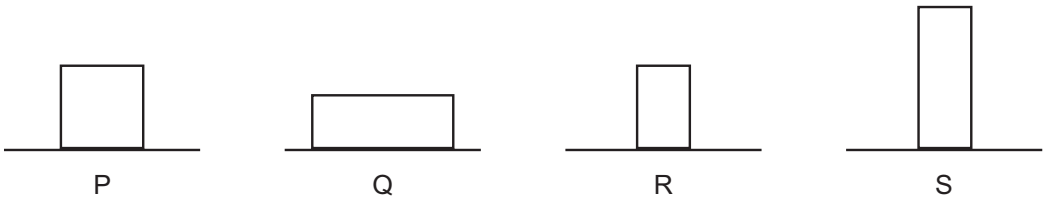
1. A student labels an object with four possible positions for the centre of gravity.

Which position for the centre of gravity makes the object the most stable?

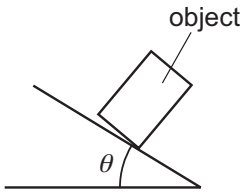


（2025 Oct/Nov · 0654/23 · Question 30 · Extended）

2. The diagram shows four objects, P, Q, R and S, with uniform density, resting on different horizontal surfaces. The objects are all drawn to the same scale.



The surfaces are slowly tilted through an angle θ until the object falls over.



For which object is the value of θ the greatest?

A object P

B object Q

C object R

D object S

（2025 May/Jun · 0654/12 · Question 30 · Core；同题：2025 May/Jun · 0654/13 · Question 30 · Core）

题型 5：比较顺时针和逆时针力矩判断转动（考频★☆☆☆☆）

知识点 力矩（moment）表示力使物体绕支点转动的作用，$M = Fd$，其中 d 是支点到力的作用线的_____距离。

力矩的国际单位是_____；作用线通过支点时，$d = 0$，该力的力矩为零。

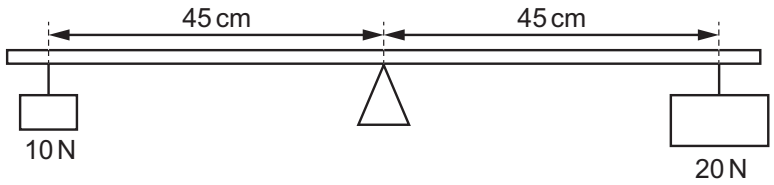
物体可绕固定支点转动时，顺时针力矩大于逆时针力矩，物体沿_____方向转动；二者相等时物体不转动。

答案：垂直；N m；顺时针

怎么认 题目出现支点、力及各力到支点的距离并求转动方向时，先分别计算顺时针和逆时针力矩。

例题 1

A uniform plank is placed on a pivot, with its centre immediately above the pivot. A load of 10 N is suspended on the left, 45 cm from the pivot, and a load of 20 N is suspended on the right, 45 cm from the pivot.



What happens to the plank?

A The left-hand side moves down, the right-hand side moves up and the plank does not return to its horizontal position.

B The left-hand side moves up, the right-hand side moves down and the plank does not return to its horizontal position.

C The plank moves down on one side then returns to its horizontal position.

D The plank remains horizontal without moving.

（2022 May/Jun · 0654/11 · Question 30 · Core）

解： 均匀木板的重力作用线通过支点，其力矩为零。

左侧载荷产生的逆时针力矩为

$M_{逆} = 10 \times 0.45 = 4.5$ N m。

右侧载荷产生的顺时针力矩为

$M_{顺} = 20 \times 0.45 = 9.0$ N m。

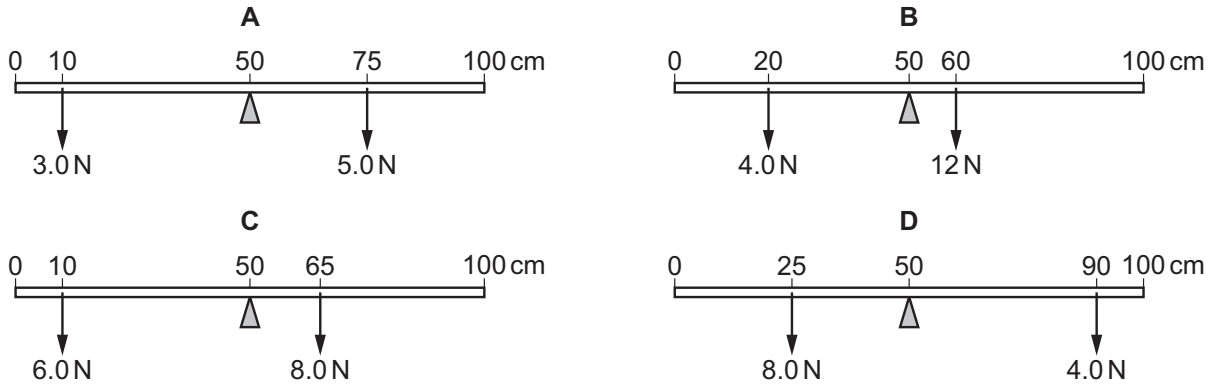
$\because 9.0 > 4.5$，$\therefore$ 木板顺时针转动，左端上升、右端下降，且不返回水平位置。

故选 B。

针对练习

1. The diagrams show uniform metre rulers each pivoted at the 50 cm mark. Different weights are placed on the rulers at different distances from the 0 cm end.

Which ruler rotates in a clockwise direction?



（2025 Feb/Mar · 0654/22 · Question 29 · Extended）

题型 6：两次悬挂的铅垂线交点找重心（考频★☆☆☆☆）

知识点 重心是物体所受重力的等效作用点。

薄片从一点自由悬挂并静止时，重心必在悬点正下方的_____线上。

从两个不同悬点分别悬挂，所画两条铅垂线的_____就是薄片的重心。

答案：铅垂；交点

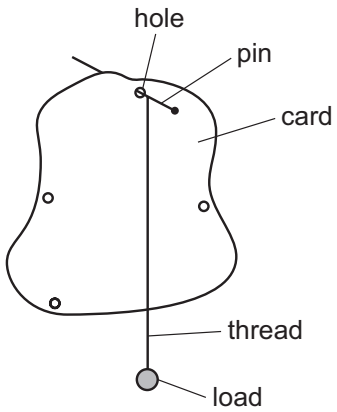
怎么认 题目出现不规则薄片、不同悬点和铅垂线时，先取两条铅垂线的交点。

例题 1

The diagram shows the apparatus that a student uses to determine the centre of gravity of a piece of card.

The student:

- makes several holes in the card
- suspends the card from a pin placed through one of the holes
- hangs a load from a thread attached to the pin
- marks the line of the thread on the card.



The student repeats the steps using a different hole each time.

What is the smallest number of lines that the student needs to draw to determine the position of the centre of gravity of the card?

A 1 **B** 2 **C** 3 **D** 4

（2025 Oct/Nov · 0654/22 · Question 29 · Extended）

解：薄片自由悬挂并静止时，重心在悬点正下方的铅垂线上。

换用另一个孔再次悬挂，所得第二条铅垂线也经过重心。

两条铅垂线的交点确定重心位置，故最少需画 2 条线。故选 B。

专题 6 能量、做功、功率与效率

6.1 能量、做功、功率与效率

题型 1：辨认燃料能否补充及发电的环境条件（考频★★★☆☆）

知识点 可再生能源可由自然过程持续补充；不可再生能源储量有限，消耗后不能在较短时间内补充。煤、石油、天然气和核裂变燃料属于_____能源；水能、潮汐能、波浪能、风能、太阳能和地热能属于_____能源。

燃烧化石燃料会释放二氧化碳；核裂变发电在燃料和设备正常时不依赖天气，可稳定供能。

风能、太阳能、波浪能和潮汐能受自然条件或周期影响，不能保证随时供能；能源的类别与供能可靠性没有单位。

答案：不可再生；可再生

怎么认 题目出现能源名称、二氧化碳排放或供能可靠性时，先按能否自然补充和是否受环境条件限制分类。

例题 1

Which source of energy is non-renewable?

A hydroelectric

B nuclear fission

C tides

D waves

（2022 Feb/Mar · 0654/12 · Question 31 · Core；同题：2022 Feb/Mar · 0654/22 · Question 30 · Extended）

解：水能、潮汐能和波浪能均可由自然过程持续补充，属于可再生能源；核裂变燃料储量有限，不能在较短时间内补充，属于不可再生能源。故选 B。

针对练习

1.

Which energy resource is non-renewable?

A geothermal

B natural gas

C tides

D wind

（2025 Feb/Mar · 0654/12 · Question 30 · Core）

2.

Which source of energy is non-renewable?

A chemical energy in a fossil fuel

B energy in tides

C geothermal energy

D wind energy

（2023 Feb/Mar · 0654/12 · Question 32 · Core；同题：2023 Feb/Mar · 0654/22 · Question 30 · Extended）

3. Electricity is generated using different sources of energy.

Which energy source is non-renewable?

A coal

B hydroelectric

C solar

D wind

（2023 May/Jun · 0654/12 · Question 30 · Core；同题：2023 May/Jun · 0654/13 · Question 30 · Core）

4. Which list of energy sources contains only **non-renewable** sources?

A coal, gas, nuclear fission

B coal, gas, geothermal

C gas, geothermal, nuclear fission

D gas, solar, wind

（2024 Feb/Mar · 0654/22 · Question 30 · Extended）

5. Which two energy sources are both non-renewable?

A oil and geothermal resources

B oil and natural gas

C tides and geothermal resources

D tides and wind

（2023 Oct/Nov · 0654/11 · Question 31 · Core）

6. Which method of generating electrical power causes carbon dioxide to be released into the atmosphere?

A combustion of fossil fuels

B nuclear fission

C use of solar cells

D use of wind turbines

（2025 Oct/Nov · 0654/11 · Question 30 · Core）

7. Electricity can be generated in different types of power station.

Which statement about geothermal power and nuclear power is correct?

A Geothermal power and nuclear power are both renewable.

B Geothermal power and nuclear power are both non-renewable.

C Geothermal power is renewable but nuclear power is not.

D Nuclear power is renewable but geothermal power is not.

（2023 May/Jun · 0654/23 · Question 30 · Extended）

8. The table shows four sources of energy used to generate electricity.

Which row about the energy source is correct?

	source	renewable	reliable at all times
A	coal	yes	no
B	nuclear fission	no	yes
C	tides	no	no
D	wind	yes	yes

（2024 May/Jun · 0654/22 · Question 31 · Extended）

题型 2：总功除以总时间并判断功率变化（考频★★★☆☆）

知识点 功率表示做功的快慢；一段过程的平均功率等于总功除以总时间。

设总功为W、总时间为t，则$P=\frac{W}{t}$；W的单位为 J，t的单位为 s。

若有用功使物体的能量增加，则$W=\Delta E$；物体匀速竖直提升时，$W=Fh$，F为重量，h为竖直高度。

功增大且时间减小时，功率一定_____；功减小且时间增大时，功率一定_____。

功率的国际单位是_____，$1\ \mathrm{W}=1\ \mathrm{J/s}$。

答案：增大；减小；瓦特（W）

怎么认 题目出现总功、能量变化、所用时间或功率变化时，先写 $P=\frac{W}{t}$。

例题 1

A student walks up some steps at constant speed.

Which two quantities provide enough information so that the useful power produced by the student can be calculated?

A the weight of the student and the time taken

B the weight of the student and the total height of the steps

C the work done by the student and the time taken

D the work done by the student and the total height of the steps

（2022 May/Jun · 0654/11 · Question 31 · Core）

解： 由功率的定义得

$P=\frac{W}{t}$。

式中必须知道学生所做的功W和所用时间t，故选 C。

针对练习

1. A student runs up some stairs.

Which quantities are used to calculate the power of the student?

A the weight of the student and the vertical distance moved

B the weight of the student and the time taken

C the work done by the student and the vertical distance moved

D the work done by the student and the time taken

（2025 Oct/Nov · 0654/12 · Question 30 · Core；同题：2025 Oct/Nov · 0654/13 · Question 30 · Core）

2. A force acting on an object increases the kinetic energy of the object from 20 J to 50 J in 5.0 s.

What is the average power produced by the force?

A 4.0 W **B** 6.0 W **C** 10 W **D** 14 W

(2022 Oct/Nov · 0654/22 · Question 30 · Extended)

3. A car accelerates uniformly from rest along a horizontal road. After 5.0 s, its kinetic energy is 400 kJ.

What is the useful power produced by the engine of the car?

A 80 W **B** 2000 W **C** 80 000 W **D** 2 000 000 W

(2022 Oct/Nov · 0654/23 · Question 31 · Extended)

4. A machine does a certain quantity of work in a certain time.

Which changes to the quantity of work done and to the time taken **both** decrease the power produced by the machine?

	work done	time taken
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

(2023 Oct/Nov · 0654/13 · Question 30 · Core)

5. A motor lifts a load vertically upwards at constant speed.

The weight of the load is known.

Which of the other quantities in the table must be known to determine the useful power output of the motor?

	height lifted	time to lift the load
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = this quantity is needed

✗ = this quantity is **not** needed

(2024 Oct/Nov · 0654/11 · Question 31 · Core)

6. A machine takes a certain time to do a certain quantity of work.

Which pair of changes **must** increase the power of the machine?

A decreasing the work done and decreasing the time taken

B decreasing the work done and increasing the time taken

C increasing the work done and decreasing the time taken

D increasing the work done and increasing the time taken

(2023 Feb/Mar · 0654/12 · Question 31 · Core)

7. Two forklift trucks P and Q lift identical loads through the same vertical height.

Truck P takes a greater time than truck Q to lift the load.

Which statement is correct?

A Truck P does more work than truck Q.

B Truck P produces more power than truck Q.

C Truck Q does more work than truck P.

D Truck Q produces more power than truck P.

（2022 Oct/Nov · 0654/12 · Question 31 · Core）

题型 3：取沿力方向位移并用功=力×位移（考频★★★☆☆）

知识点 物体在力的方向上发生位移时，力所做的功等于力的大小与沿力方向移动距离的乘积，即 _____。

式中 F 的单位是 N，s 的单位是 m，功 W 的单位是 _____，且 1 J = 1 N m。

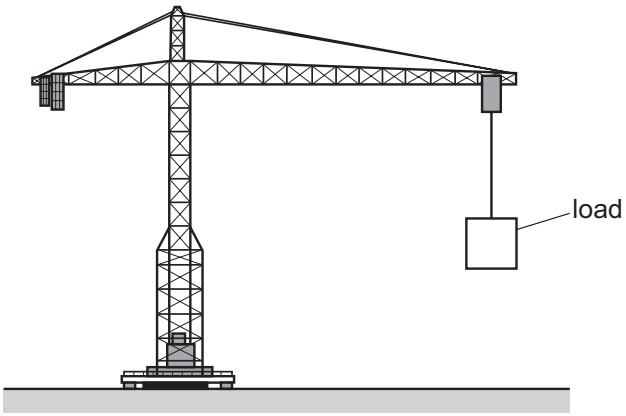
竖直提升且提升力等于物重时，$F = mg$，故 _____，其中 m 为质量，g 为重力场强度，h 为竖直高度。

答案：$W = Fs$；J；$W = mgh$

怎么认 题目出现力与沿力方向的移动距离，或物重与竖直高度时，先写 $W = Fs$。

例题 1

A crane does work on a load by lifting it vertically upwards.



Which action decreases the work done on the load?

A lifting the load higher

B lifting the load more slowly

C reducing the mass of the load

D using a more powerful crane

（2022 Feb/Mar · 0654/12 · Question 30 · Core）

解：竖直提升且提升力等于物重时，

$W = mgh$。

提高高度使 h 增大，功不会减小；减小质量使 m 减小，功随之减小。提升速度和起重机功率不改变同一质量被提升到同一高度时所做的功。故选 C。

针对练习

1. A force of 4.0 N acts on an object for 4.0 s. The object moves a distance of 8.0 m in the direction of the force.

What is the work done by the force?

A 1.0 J **B** 2.0 J **C** 16 J **D** 32 J

（2023 Oct/Nov · 0654/23 · Question 30 · Extended）

2. A worker exerts a force on a box to move it across a horizontal surface.

Which of the two quantities in the table affect the amount of work done by the force?

	magnitude of the force	distance moved by the box
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = affects the work done

✗ = does **not** affect the work done

（2024 Oct/Nov · 0654/12 · Question 30 · Core；同题：2024 Oct/Nov · 0654/13 · Question 30 · Core）

3. A student lifts a box vertically from the floor and places it on a table.

Which two quantities must be known in order to calculate the work done on the box by the student?

A the force used to lift the box and the height of the table

B the force used to lift the box and the time taken to lift the box

C the volume of the box and the height of the table

D the volume of the box and the time taken to lift the box

（2022 May/Jun · 0654/12 · Question 30 · Core；同题：2022 May/Jun · 0654/13 · Question 30 · Core）

4. A horizontal force acts on a block.

The block moves in the direction of the force.

Which two quantities affect the work done by the force on the block?

A magnitude of force and distance moved

B magnitude of force and mass of block

C magnitude of force and volume of block

D magnitude of force and weight of block

（2023 Oct/Nov · 0654/12 · Question 31 · Core）

5. Four students lift books of different total weights through different vertical heights.

Which student does the most work?

	total weight of books / N	vertical height / m
A	30	0.50
B	20	0.50
C	30	1.0
D	20	1.0

（2026 May/Jun · 0654/13 · Question 29 · Core）

题型 4：先找有用输出和总输入再求效率（考频★★★☆☆）

知识点 效率表示有用输出能量或功率占总输入能量或功率的比例，效率_____单位；用百分数表示时乘 100%。

效率 $=\frac{\text{有用输出能量}}{\text{总输入能量}}\times 100\%=\frac{\text{有用输出功率}}{\text{总输入功率}}\times 100\%$；分子与分母应属于同一过程，并采用相同单位。

总输入能量等于_____与_____之和；能量单位为 J，功率单位为 W。

答案：没有；有用输出能量；损耗能量

怎么认 题目出现有用输出、总输入或损耗及所求效率时，先确定总输入和有用输出。

例题 1

The power input to a power station is 800 MW. The useful electrical power output is 320 MW.

What is the efficiency of the power station?

A 0.40% **B** 2.5% **C** 40% **D** 250%

（2022 May/Jun · 0654/22 · Question 31 · Extended）

解：由效率定义得

效率 $=\frac{320\ \text{MW}}{800\ \text{MW}}\times 100\%$

$=40\%$

故选 C。

针对练习

1. The total energy input to an electric lamp is 20 J.

The useful energy output is 12 J.

What is the efficiency of the lamp?

A 33% **B** 40% **C** 60% **D** 66%

（2025 May/Jun · 0654/21 · Question 30 · Extended）

2. What is the definition of efficiency?

A $\frac{\text{energy input}}{\text{useful energy output}} \times 100\%$

B $\frac{\text{energy input}}{\text{wasted energy}} \times 100\%$

C $\frac{\text{useful energy output}}{\text{energy input}} \times 100\%$

D $\frac{\text{wasted energy}}{\text{energy input}} \times 100\%$

（2023 May/Jun · 0654/23 · Question 31 · Extended）

3. An electric motor transfers 4000 J of electrical energy to useful energy and 12 000 J of electrical energy is wasted.

What is the efficiency of the motor?

A 25%　　**B** 33%　　**C** 50%　　**D** 75%

（2023 Oct/Nov · 0654/23 · Question 31 · Extended）

4. A lamp produces 760 J of wasted energy for every 1000 J of energy supplied to it.

What is the efficiency of the lamp?

A 0.24%　　**B** 0.76%　　**C** 24%　　**D** 76%

（2025 May/Jun · 0654/22 · Question 29 · Extended）

5. A machine has useful output energy of 1000 J and wasted energy of 300 J.

Which expression is used to calculate the efficiency of the machine?

A $\frac{300}{1000+300} \times 100\%$

B $\frac{300}{1000} \times 100\%$

C $\frac{1000-300}{1000} \times 100\%$

D $\frac{1000}{1000+300} \times 100\%$

（2023 May/Jun · 0654/21 · Question 30 · Extended）

题型 5：沿能源来源追溯太阳、地热或月球引力（考频★★☆☆☆）

知识点　能源来源表示某种能量最初由何种过程输入，是定性关系，不设单位。

判断能源来源时，应沿形成过程追溯最初的能量输入。

太阳辐射可形成风和水循环，并通过光合作用将能量储存在木材及化石燃料中，这些能源可追溯到_____。

地热能来自_____，潮汐能主要来自_____对海水的引力作用，核裂变能来自原子核。

答案：太阳；地球内部的热能；月球

怎么认 题目出现能源名称并询问能量来自哪个天体时，先沿形成过程追溯最初输入。

例题 1

Which object is mainly responsible for the energy stored in tides in the sea?

A Mars

B the Earth

C the Moon

D the Sun

（2023 May/Jun · 0654/22 · Question 31 · Extended）

解：海水的潮汐主要由月球对海水的引力作用形成。
因此，海中潮汐储存的能量主要与月球有关。故选 C。

针对练习

1. For which energy resource is the Sun **not** the source of the energy?

A geothermal

B natural gas

C water behind a hydroelectric dam

D wind

（2024 May/Jun · 0654/21 · Question 31 · Extended）

2. For which energy resource is the Sun the source of **all** the energy stored?

A geothermal

B nuclear fission

C tidal

D wind

（2023 Oct/Nov · 0654/22 · Question 32 · Extended）

3. Which energy resource does **not** have the Sun as its source of energy?

A coal

B geothermal

C hydroelectric

D water waves

（2024 Oct/Nov · 0654/23 · Question 30 · Extended）

4. The Sun is the source of energy for most energy resources.

In which group of resources is energy input from the Sun the **only** source of energy?

A coal, geothermal, gasoline

B hydroelectric, tidal, waves

C natural gas, solar, wind

D nuclear, solar, wood

（2024 Oct/Nov · 0654/21 · Question 31 · Extended）

题型 6：从装置与过程辨认能量储存及转移链（考频★★☆☆☆）

知识点 物体因运动而具有的能量是_____；物体因位置或形变而具有的能量分别是重力势能或弹性势能。
发电装置把输入能量转移为电能：水力发电利用水的_____，风力发电利用风的动能。
物体下落时，重力势能可转移为动能；物体受阻力并停下时，动能可转移为热能。各种能量的单位均为_____。

答案：动能；重力势能；焦耳（J）

怎么认 题目出现运动物体、发电装置或高度变化并问能量种类时，先按运动、高度、形变辨认能量。

例题 1

From which type of energy is electrical energy transferred in a hydroelectric power station?

A chemical potential energy

B elastic potential (strain) energy

C gravitational potential energy

D nuclear energy

（2022 Oct/Nov · 0654/11 · Question 32 · Core；同题：2022 Oct/Nov · 0654/12 · Question 32 · Core、2022 Oct/Nov · 0654/23 · Question 32 · Extended、2022 Oct/Nov · 0654/13 · Question 31 · Core、2022 Oct/Nov · 0654/21 · Question 32 · Extended、2022 Oct/Nov · 0654/22 · Question 31 · Extended）

解：水库中的水位于高处，储存重力势能。
水下落并推动涡轮机，重力势能经动能转移为电能。
故选 C。

针对练习

1. Which type of energy does an object store due to its motion?

A elastic

B gravitational potential

C kinetic

D nuclear

（2026 May/Jun · 0654/21 · Question 30 · Extended）

2. What is the useful energy transfer in a wind turbine?

A electrical energy to thermal energy

B gravitational potential energy to kinetic energy

C kinetic energy to electrical energy

D thermal energy to gravitational potential energy

（2024 Oct/Nov · 0654/12 · Question 31 · Core；同题：2024 Oct/Nov · 0654/13 · Question 31 · Core）

3. What is the energy source for a wind turbine that is producing electricity?

A chemical potential energy of wind

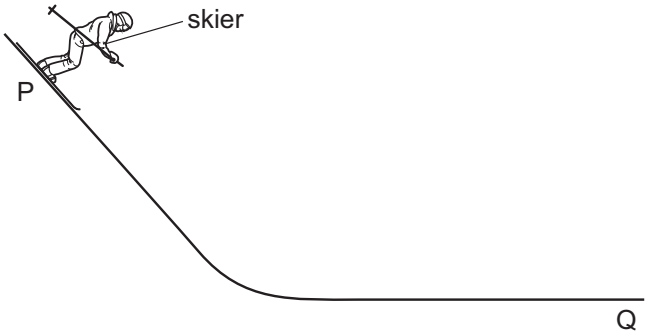
B gravitational potential energy of wind

C kinetic energy of wind

D thermal energy of wind

（2024 May/Jun · 0654/12 · Question 31 · Core；同题：2024 May/Jun · 0654/13 · Question 31 · Core）

4. A skier starts from rest at P, accelerates down a slope and then comes to rest at Q.



Which series of energy transfers takes place?

A elastic potential (strain) energy → kinetic energy → thermal energy

B gravitational potential energy → kinetic energy → thermal energy

C kinetic energy → elastic potential (strain) energy → thermal energy

D kinetic energy → gravitational potential energy → thermal energy

（2023 May/Jun · 0654/11 · Question 32 · Core）

题型 7：动能中速度先平方并按比例比较（考频★★☆☆☆）

知识点 物体因运动而具有的能量叫动能。质量为 m、速度为 v 时，动能 $E_k =$ _____。
式中的平方只作用于速度 v，不作用于质量 m。
质量不变时，动能与速度的平方成_____；速度变为原来的 k 倍，动能变为原来的 k^2 倍。
质量用 kg、速度用 m/s 时，动能单位为 J；共同运动的物体按整体计算，质量取总质量。

答案：$\frac{1}{2}mv^2$；正比

怎么认 题目出现质量、速度、动能或动能倍数时，先写 $E_k = \frac{1}{2}mv^2$，速度先平方。

例题 1

Which equation for kinetic energy (K.E.) is correct?

A K.E. = $\frac{1}{2}(mv)^2$

B K.E. = $\frac{1}{2}mv^2$

C K.E. = mv^2

D K.E. = mgh

（2022 Oct/Nov · 0654/23 · Question 30 · Extended）

解：由动能的计算式得
K.E. $= \frac{1}{2}mv^2$。
故选 B。

针对练习

1. Which expression gives the kinetic energy of an object of mass m travelling at speed v?

A $\frac{1}{2} \times m \times v$

B $\frac{1}{2} \times m \times v^2$

C $\frac{1}{2} \times (m \times v)^2$

D $(\frac{1}{2} \times m \times v)^2$

（2025 Feb/Mar · 0654/22 · Question 30 · Extended）

2. An object moving at speed v has kinetic energy E.

What is the speed of the object when its kinetic energy is $4.0E$?

A $0.25v$ **B** $2.0v$ **C** $4.0v$ **D** $16v$

（2022 May/Jun · 0654/21 · Question 30 · Extended；同题：2022 May/Jun · 0654/22 · Question 30 · Extended、2022 May/Jun · 0654/23 · Question 30 · Extended）

3. A paralympic athlete of mass 70 kg uses a wheelchair of mass 10 kg in a race.

What is the kinetic energy of the athlete and wheelchair when they are moving at 6.0 m/s?

A 240 J **B** 480 J **C** 1440 J **D** 2880 J

（2024 May/Jun · 0654/22 · Question 30 · Extended）

4. An object X with mass 2.0 kg is moving with a speed of 4.0 m/s.

Object Y has kinetic energy equal to that of object X.

Which row shows the mass and the speed of object Y?

	mass of object Y / kg	speed of object Y / m/s
A	0.50	16
B	1.0	8.0
C	8.0	2.0
D	16	1.0

（2025 May/Jun · 0654/23 · Question 29 · Extended）

题型 8：把功、能量、功率对应到单位（考频★★☆☆☆）

知识点 功表示力使物体沿力的方向发生位移时所转移的能量；当力与位移同向时，$W = Fs$。

能量和功的国际单位都是_____，符号为 J，且 1 J = 1 N m。

功率表示单位时间内完成的功，$P = \frac{W}{t}$，单位是_____，符号为 W，且 1 W = 1J s^{-1}。

答案：焦耳；瓦特

怎么认 题目出现功、能量或功率及单位选项时，先按功和能量对应焦耳、功率对应瓦特。

例题 1 What is a unit of energy?

A W **B** N **C** kg **D** J

（2025 Oct/Nov · 0654/11 · Question 29 · Core）

解：能量和功的国际单位相同，均为焦耳，符号为 J。
故选 D。

针对练习

1. Which row shows the unit of work done and the unit of power?

	work done	power
A	joule	joule
B	joule	watt
C	watt	joule
D	watt	watt

（2026 May/Jun · 0654/12 · Question 30 · Core）

2. What is the unit of work and what is an equivalent combination of units?

	unit	equivalent combination
A	joule	newton metre
B	joule	newton / metre
C	newton	joule metre
D	newton	joule / metre

（2025 May/Jun · 0654/21 · Question 29 · Extended）

题型 9：判断发电是否要转动涡轮和发电机（考频★☆☆☆☆）

知识点 涡轮是由流动的蒸汽、水或空气推动而转动的装置，发电机把转动机械能转化为_____能。当发电过程先形成转动机械能时，需要转动涡轮并带动发电机；地热能、核能和风能属于这种方式。太阳能电池利用光伏效应把光能转化为电能，不需要涡轮；能量的单位是_____。

答案：电；焦耳（J）

怎么认 题目出现能源与转动涡轮或发电机的判断时，先看发电过程是否形成转动机械能。

例题 1

Which energy resource does **not** use a turbine and generator to produce electricity?

A geothermal

B nuclear fission

C solar cells

D wind

（2022 May/Jun · 0654/11 · Question 32 · Core；同题：2022 May/Jun · 0654/12 · Question 31 · Core、2022 May/Jun · 0654/13 · Question 31 · Core）

解：地热能和核裂变放出的能量均可使蒸汽推动涡轮，风能使叶片转动，三者都用转动部件带动发电机。太阳能电池利用光伏效应把光能转化为电能，不需要涡轮和发电机。
故选 C。

针对练习

1. Some energy resources do not require a rotating turbine when used to generate electricity.

Which energy resource does **not** require a rotating turbine?

A geothermal

B nuclear

C solar

D wind

（2024 Feb/Mar · 0654/12 · Question 30 · Core）

题型 10：把提升功、照射面积或效率串成计算链（考频★★☆☆☆）

知识点 物体在近地面竖直提升高度 h 时，克服重力所做的有用功为 _____；F 为物重，m 为质量，g 为重力场强，功的单位为 J。

功率表示单位时间内传递的能量：_____；W 以 J 计，t 以 s 计，P 的单位为 W。

同一过程中，效率 $\eta = \frac{W_{\text{useful}}}{W_{\text{input}}} = \frac{P_{\text{useful}}}{P_{\text{input}}}$；效率没有单位，写成百分数时应乘 100%。

单位面积入射功率 I 均匀照到面积 A 上时，总入射功率为 _____；I 的单位为 W m^{-2}，A 的单位为 m^2。

答案：$W_{\text{useful}} = Fh = mgh$；$P = \frac{W}{t}$；$P_{\text{input}} = IA$

怎么认 题目出现提升高度、单位面积功率或效率时，先求提升功或总入射功率，再用功率与效率关系连接。

例题 1

A passenger lift (elevator) has a total weight of 4000 N, including the people inside it. The power output of the lift motor is 800 W.

How much time does it take for the lift to rise 12 m vertically?

A 2.4 s **B** 6.0 s **C** 24 s **D** 60 s

（2022 May/Jun · 0654/21 · Question 31 · Extended）

解：由提升功得

$W_{\text{useful}} = Fh = 4000 \times 12 = 4.8 \times 10^4$ J

由功率关系得

$t = \frac{W_{\text{useful}}}{P} = \frac{4.8 \times 10^4}{800} = 60$ s

故选 D。

针对练习

1. The power of sunlight falling on each m^2 of a solar panel is 200 W.

The solar panel has an area of 2.0 m^2.

The efficiency of the solar panel is 20%.

What is the useful power output of the solar panel?

A 80 W **B** 400 W **C** 500 W **D** 2000 W

（2025 Oct/Nov · 0654/21 · Question 30 · Extended）

2. A system uses a 250 W electric motor to lift a 50 N load through a height of 4.0 m in 3.0 s.

What is the efficiency of this system?

A 27% **B** 38% **C** 63% **D** 67%

（2026 Feb/Mar · 0654/22 · Question 29 · Extended）

3. A hydroelectric energy storage scheme stores energy by pumping water up a mountain into a lake behind a dam.

In 1.0 s, 10 000 kg of water is pumped into the lake and gains a height of 150 m. The efficiency of this process is 60%.

Gravitational field strength = 10 N / kg.

What is the energy input in 1.0 s?

A 9.0×10^5 J **B** 2.5×10^6 J **C** 9.0×10^6 J **D** 2.5×10^7 J

（2023 Oct/Nov · 0654/21 · Question 31 · Extended）

题型 11：以竖直高度求势能并计入动能或阻力损耗（考频★★☆☆☆）

知识点 物体在重力场中因位置而具有重力势能；升高竖直高度 Δh 时，重力势能增加量为_____。

式中 m 是质量，g 是重力场强；质量、重力场强和高度的单位分别为 kg、N/kg 和 m。

物体因运动而具有动能，动能为_____。

只有重力做功且无空气阻力时，动能与重力势能的总和_____；有阻力时，机械能的减少量等于克服阻力所做的功。

能量和功的单位均为焦耳，符号为 J。

答案：$mg\Delta h$；$\frac{1}{2}mv^2$；守恒

怎么认 题目出现竖直高度及动能或阻力损耗时，先写初、末状态的能量关系。

例题 1

A brick falls from rest at a height of 45 m above the ground.

The acceleration of free fall g is 10 m / s^2. There is no air resistance.

What is the speed of the brick as it hits the ground?

A 9.5 m / s **B** 21 m / s **C** 30 m / s **D** 450 m / s

（2023 Oct/Nov · 0654/22 · Question 31 · Extended）

解：无空气阻力，机械能守恒。

$mgh = \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

$= \sqrt{2 \times 10 \times 45}$

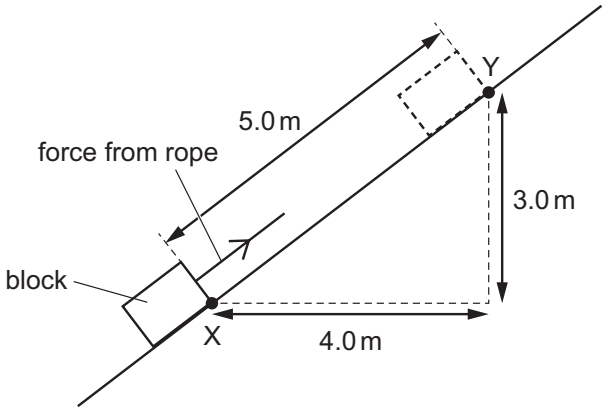
$= 30$ m/s。故选 C。

针对练习

1. A rope is used to pull a block of mass 25 kg up a slope from point X to point Y.

Three distances are shown on the diagram.

The gravitational field strength g is 10 N / kg.



What is the increase in gravitational potential energy of the block?

A 125 J **B** 750 J **C** 1000 J **D** 1250 J

（2024 Oct/Nov · 0654/22 · Question 30 · Extended）

2. When a ball is kicked vertically upwards, its initial kinetic energy is 12 J. When the ball arrives back at its starting point, its kinetic energy is 8.0 J.

Which statement explains the change in the kinetic energy of the ball?

A 4.0 J of work is done to increase the gravitational potential energy of the ball.

B 4.0 J of work is done to overcome air resistance.

C 20 J of work is done to increase the gravitational potential energy of the ball.

D 20 J of work is done to overcome air resistance.

（2024 Oct/Nov · 0654/11 · Question 30 · Core）

专题 7 压强与液体深度

7.1 压强与液体深度

题型 1：由力和面积求压强或反求一项（考频★★★☆☆）

知识点 压强表示单位面积上受到的垂直作用力，关系为 $p=\frac{F}{A}$，其中 F 为垂直作用力，A 为_____。物体静止在水平支承面上且没有其他竖直力时，垂直作用力等于物体的_____；作用力相同时，接触面积越大，压强越小。

F 用 N、A 用 $\mathrm{m^2}$ 时，p 的单位是_____，$1\ \mathrm{Pa}=1\frac{\mathrm{N}}{\mathrm{m^2}}$；计算时各量的单位必须一致。

答案：接触面积；重力；帕斯卡（Pa）

怎么认 题目出现压力、接触面积及其中一个所求量时，先写 $p=\frac{F}{A}$。

例题 1

A concrete block exerts a pressure on the ground.

Which expression is used to calculate the pressure due to the block?

A mass of block × area of contact with the ground

B $\dfrac{\text{mass of block}}{\text{area of contact with the ground}}$

C weight of block × area of contact with the ground

D $\dfrac{\text{weight of block}}{\text{area of contact with the ground}}$

（2026 May/Jun · 0654/11 · Question 30 · Core）

解：由压强的定义得

$p=\frac{F}{A}$

混凝土块静止在水平地面上，垂直作用力等于其重力，故

$F=W$

$p=\frac{W}{A}$

故选 D。

针对练习

1. Atmospheric pressure is 1.0×10^5 Pa.

A football pitch is 105 m long and 68 m wide.

What is the total weight of the air above the football pitch?

A 14 N **B** 1.7×10^7 N **C** 3.5×10^7 N **D** 7.1×10^8 N

（2025 May/Jun · 0654/22 · Question 30 · Extended）

2. A solid block of weight 14 N rests on a horizontal table. The pressure on the table due to the block is 70 Pa.

What is the area of the surface of the block in contact with the table?

A 0.20 $\mathrm{m^2}$ **B** 5.0 $\mathrm{m^2}$ **C** 98 $\mathrm{m^2}$ **D** 980 $\mathrm{m^2}$

（2023 May/Jun · 0654/22 · Question 30 · Extended）

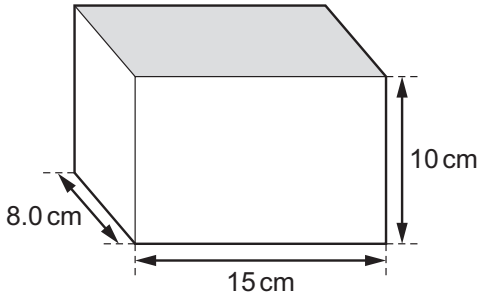
3. A chair of weight 40 N rests on four legs. Each leg has an area of contact with the floor of 10 cm^2.

What is the pressure on the floor due to the chair?

A 1.0 N / cm^2 **B** 4.0 N / cm^2 **C** 16 N / cm^2 **D** 40 000 N / cm^2

(2026 Feb/Mar · 0654/22 · Question 30 · Extended)

4. A rectangular block weighs 1200 N and has the dimensions shown.



What is the minimum pressure that the block can exert on the ground by standing on one of its faces?

A 1.0 N / cm^2 **B** 8.0 N / cm^2 **C** 10 N / cm^2 **D** 15 N / cm^2

(2023 Oct/Nov · 0654/22 · Question 30 · Extended)

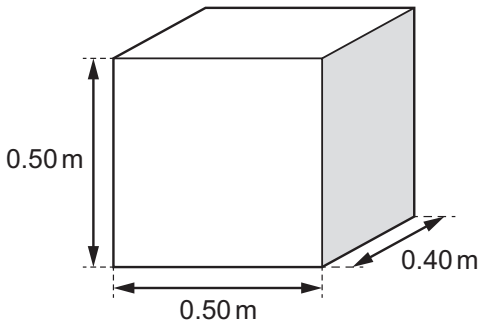
5. The table gives the weight and total area of contact with the ground for each of four animals.

Which row shows the animal that exerts the **least** pressure on the ground?

	animal	weight / N	total area of contact / cm^2
A	beaver	270	220
B	cat	41	29
C	duck	16	72
D	mouse	0.19	0.12

(2026 May/Jun · 0654/13 · Question 30 · Core)

6. The diagram shows a cuboid box resting on the ground. The dimensions of the box are shown.



The pressure on the ground due to the weight of the box is 50 Pa.

What is the weight of the box?

A 5.0 N **B** 10 N **C** 250 N **D** 500 N

(2023 May/Jun · 0654/23 · Question 29 · Extended)

题型 2：由受力与接触面积判断压强变化（考频★★☆☆☆）

知识点 物体_____所受的垂直作用力叫作压强，定义式为 $p=\frac{F}{A}$。

用 $p=\frac{F}{A}$ 求接触面的平均压强时，F 取垂直于接触面的力，A 为接触面积；压强单位是_____，$1\ \mathrm{Pa}=1\mathrm{N/m^2}$。

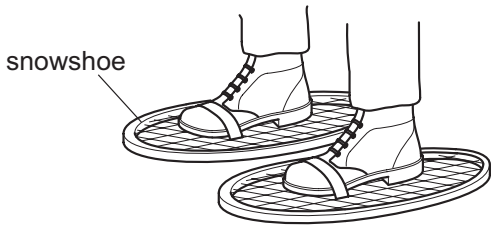
在 F 不变时，p 与 A 成_____；在 A 不变时，p 与 F 成正比。

答案：单位面积；帕斯卡；反比

怎么认 题目出现受力、重量、接触面积及压强变化时，先写 $p=\frac{F}{A}$ 比较比值。

例题 1

A person wearing snowshoes is walking on snow.



How do snowshoes decrease the pressure on the snow?

A by applying the person's weight over a larger area

B by applying the person's weight over a smaller area

C by decreasing the person's weight

D by increasing the person's weight

（2023 Oct/Nov · 0654/13 · Question 29 · Core）

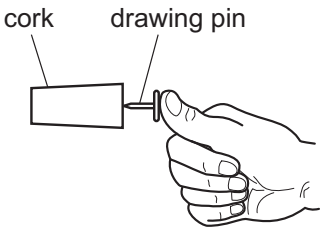
解：人的重量 F 不变，雪鞋使接触面积 A 增大。

由 $p=\frac{F}{A}$ 得，F 不变时，A 增大，p 减小。

故选 A。

针对练习

1. A person pushes a drawing pin into a cork with their thumb.



Which statement explains why the pin goes into the cork and **not** into the thumb?

A The force on the cork is greater than the force on the thumb.

B The force on the cork is less than the force on the thumb.

C The pressure on the cork is greater than the pressure on the thumb.

D The pressure on the cork is less than the pressure on the thumb.

（2025 May/Jun · 0654/12 · Question 29 · Core；同题：2025 May/Jun · 0654/13 · Question 29 · Core）

2.

Force *F* acts on area *A* and exerts pressure *p*.

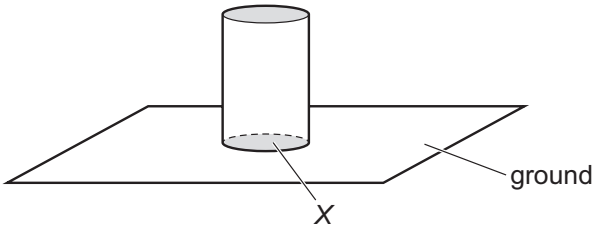
Which pressure is exerted by a force 2.0*F* that acts on an area 0.50*A*?

A 0.50*p**p*　　**B** *p*　　**C** 2.0*p*　　**D** 4.0*p*

（2026 May/Jun · 0654/22 · Question 31 · Extended）

3.

A cylinder of weight *W* and cross-sectional area *X* exerts a pressure *P* on the ground.



Some changes are made to *W* and to *X*.

Which row shows a situation that produces the same pressure *P* on the ground?

	W	*X*
A	doubled	doubled
B	doubled	halved
C	unchanged	doubled
D	unchanged	halved

（2026 Feb/Mar · 0654/12 · Question 30 · Core）

4.

The weight of a box exerts pressure on the ground.

Which pair of changes to the box **must** reduce the pressure?

A decreasing the weight and decreasing the area of the base

B decreasing the weight and increasing the area of the base

C increasing the weight and decreasing the area of the base

D increasing the weight and increasing the area of the base

（2023 Oct/Nov · 0654/12 · Question 30 · Core）

题型 3：液压两活塞以相同压强换算力（考频★☆☆☆☆）

知识点 压强表示垂直作用在单位面积上的力，$p=\frac{F}{A}$，单位为帕斯卡（Pa），其中 $1\ \mathrm{Pa}=1\mathrm{N/m^2}$。

密闭液体中的外加压强大小不变地传递，因此相连的两个活塞处压强_____。

若两活塞面积分别为 A_1、A_2，则 $\frac{F_1}{A_1}=\frac{F_2}{A_2}$，故力与活塞面积成_____，面积统一用 $\mathrm{m^2}$。

答案：相等；正比

怎么认 题目出现由液体相连的两个活塞，给出一端的力和两端面积并求另一端的力时，先写两端压强相等。

例题 1

A force of 10 N is applied to a piston of area 0.10 m^2, causing a pressure. This pressure is transmitted through a fluid to a piston of area 2.0 m^2.

What is the force on this piston?

A 2.0 N **B** 20 N **C** 200 N **D** 2000 N

（2022 May/Jun · 0654/22 · Question 29 · Extended）

解： 由 $p = \frac{F}{A}$ 得
$p = \frac{10}{0.10} = 100$ Pa。
由密闭液体传递的压强相等，
$F = pA = 100 \times 2.0 = 200$ N。
故选 C。

题型 4：先由密度体积或叠层质量求总重量再算压强（考频★☆☆☆☆）

知识点 压力是垂直作用在单位面积上的力，$p = \frac{F}{A}$，其中 F 为垂直作用力，A 为受力面积，压强单位为 _____。
物体静止在水平面上且无其他竖直力时，支持面所受压力等于物体的总重力；由 $m = \rho V$、$G = mg$ 可求压力。
相同物体叠放且接地面积不变时，n 个物体的总质量为 _____，压强为 $p = nm\frac{g}{A}$；受压强上限限制时，n 取满足条件的最大 _____。

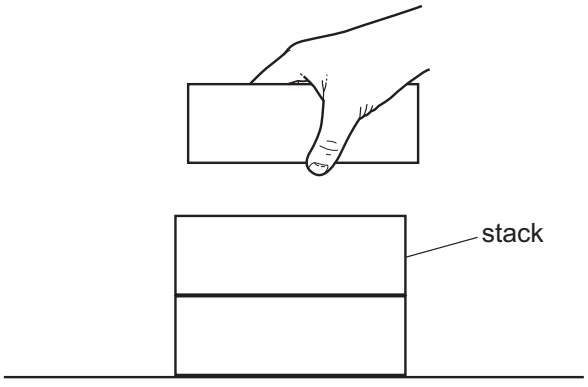
答案：帕斯卡（Pa）；nm；整数

怎么认 题目出现密度与体积或相同物体叠放，并求支持面压强时，先求总质量与总重量。

例题 1

A brick has a mass of 1.5 kg. It rests on the ground and the area of contact with the ground is 0.030 m^2.

A stack of such bricks is made by placing the bricks on top of each other, as shown.



The pressure on the ground due to the stack must **not** exceed 5700 Pa.

What is the maximum number of bricks that can be made into such a stack?

gravitational field strength = 10 N / kg

A 11 **B** 12 **C** 114 **D** 256

（2022 Oct/Nov · 0654/23 · Question 29 · Extended）

解：设可叠放 n 块砖，砖堆对地面的压力等于总重力，得

$F = nmg$

$F = n \times 1.5 \times 10$

由 $p = \frac{F}{A}$ 得

$p = \frac{n \times 1.5 \times 10}{0.030}$

因 $p \leq 5700\ \text{Pa}$，

$\frac{n \times 1.5 \times 10}{0.030} \leq 5700$

$n \leq 11.4$

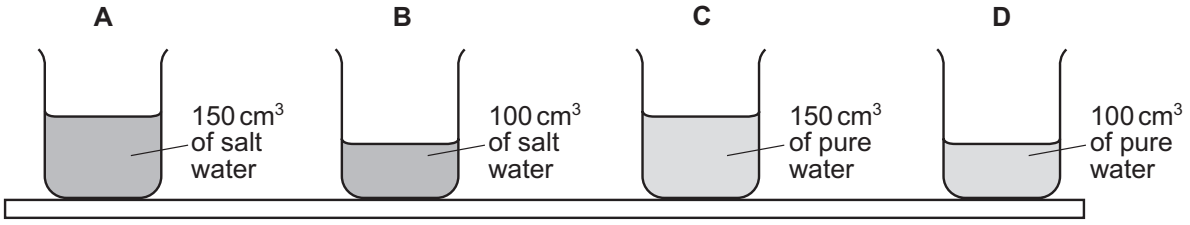
n 为正整数，故最大砖数为 11。故选 A。

针对练习

1. A student places four identical beakers on a bench.

Two beakers contain salt water of density $1.1\,\text{g/cm}^3$ and two beakers contain pure water of density $1.0\,\text{g/cm}^3$. The quantity of water in each beaker is shown.

Which beaker exerts the greatest pressure on the bench?



（2024 May/Jun · 0654/11 · Question 30 · Core）

专题 8 热运动、气体压强与状态变化

8.1 热运动、气体压强与状态变化

题型 1：认表面高能粒子逃逸及剩余液体冷却（考频★★★☆☆）

知识点 蒸发是液体_____的粒子逃逸并成为气体的过程，可在任何温度下发生。

蒸发时，能量较大的粒子先逃逸；外界补充热量不足时，剩余粒子的平均能量_____，温度降低。

粒子离开液体后，液体质量_____；蒸发吸收的能量来自液体本身或周围环境。

温度的国际单位为 K，质量的国际单位为 kg。

答案：表面；减小；减小

怎么认 题目出现液体表面粒子逃逸、液体变冷或湿物变干时，先判定为蒸发，再判断粒子能量与温度的变化。

例题 1

A bowl of water is placed on a balance outside where it is sunny and windy. The reading on the balance is recorded.

After some time, the reading on the balance is less than the original reading.

Which statement explains why the reading is less?

A The water has become cooler.

B The water has become warmer.

C The water has condensed.

D The water has evaporated.

（2022 Oct/Nov · 0654/13 · Question 32 · Core）

解：晴天和风使水蒸发加快，水分子离开碗。
碗中水的质量减小，天平示数随之减小。
故选 D。

针对练习

1. A student uses an electric hairdryer to dry wet hair.

The hairdryer blows hot air onto the wet hair.

Which process dries the hair?

A boiling

B condensation

C evaporation

D solidification

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（2026 May/Jun · 0654/11 · Question 32 · Core）

2. The more energetic molecules of a liquid are escaping from its surface, causing the liquid to cool.

What is happening to the liquid?

A It is boiling.

B It is condensing.

C It is evaporating.

D It is melting.

（2024 Feb/Mar · 0654/22 · Question 31 · Extended）

3. Which statement describes the behaviour of particles during the evaporation of a liquid?

A Only the more energetic particles escape.

B Particles bond together.

C Particles move closer together.

D The least energetic particles escape first.

（2025 Oct/Nov · 0654/12 · Question 31 · Core；同题：2025 Oct/Nov · 0654/13 · Question 31 · Core）

4. Liquid in a beaker evaporates quickly.

Which row shows what happens to the mass and to the temperature of the liquid remaining in the beaker?

	mass	temperature
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2025 May/Jun · 0654/12 · Question 31 · Core；同题：2025 May/Jun · 0654/13 · Question 31 · Core）

5. The temperature of a liquid in a beaker decreases because particles escape from the surface of the liquid.

Which row gives the name of this process and shows which particles escape from the liquid?

	name of process	particles that escape
A	condensation	less energetic
B	condensation	more energetic
C	evaporation	less energetic
D	evaporation	more energetic

（2025 Oct/Nov · 0654/22 · Question 31 · Extended）

6. When a liquid evaporates, particles escape from the surface of the liquid.

Which row shows the particles that escape and the average energy of the remaining particles?

	particles that escape	average energy of remaining particles
A	less energetic particles	decreases
B	less energetic particles	stays the same
C	more energetic particles	decreases
D	more energetic particles	stays the same

（2025 Oct/Nov · 0654/23 · Question 31 · Extended）

7. Someone wearing wet clothes can feel cold even on a warm day.

Why do they feel cold?

A Water gives out heat as it evaporates.

B Water takes in heat as it evaporates.

C Water vapour gives out heat as it condenses.

D Water vapour takes in heat as it condenses.

（2023 Oct/Nov · 0654/11 · Question 32 · Core）

8. A liquid starts to evaporate.

Which molecules escape and what happens to the temperature of the remaining liquid?

	molecules that escape	temperature of remaining liquid
A	less-energetic	decreases
B	less-energetic	increases
C	more-energetic	decreases
D	more-energetic	increases

（2024 Oct/Nov · 0654/22 · Question 31 · Extended）

题型 2：以壁面碰撞解释气体压强随温度或体积改变（考频★★★☆☆）

知识点 气体压强是气体粒子持续碰撞容器壁所产生的单位面积作用力；粒子不停地做无规则运动。

一定质量的气体体积不变时，热力学温度越高，粒子的平均动能越_____，碰壁更频繁且碰撞作用更强，压强越大。

一定质量的气体温度不变时，体积越小，粒子碰壁越_____；平均速率不变，压强越大。

热力学温度、压强和体积的 SI 单位分别为 K、Pa 和 m^3。

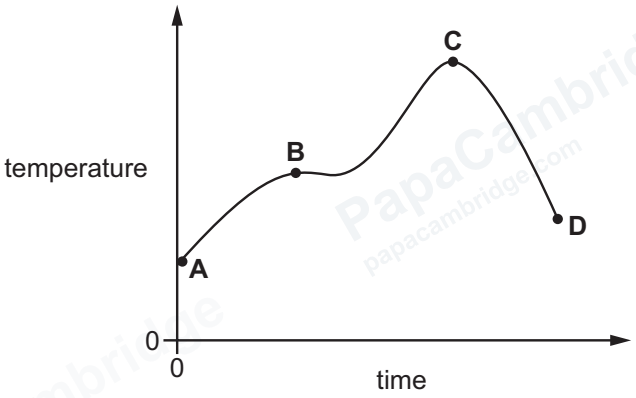
答案：大；频繁

怎么认 题目出现密闭气体的温度或体积改变，并问压强或粒子运动时，先判断碰壁频率和碰撞作用强弱。

例题 1

The graph shows the temperature of a sample of gas as it is heated and cooled over a period of time.

At which point on the graph do the particles of the gas have maximum kinetic energy?



（2026 Feb/Mar · 0654/12 · Question 31 · Core）

解：气体粒子的平均动能随温度升高而增大。
由图得 C 点温度最高，故 C 点粒子的平均动能最大。故选 C。

针对练习

1. A gas is stored in a sealed container. The particles of the gas exert a pressure on the container walls.

What causes this pressure?

A The particles are attracted by the container walls.

B The particles collide with each other.

C The particles collide with the container walls.

D The particles repel each other.

（2026 Feb/Mar · 0654/22 · Question 31 · Extended）

2. A fixed mass of gas is trapped in a container. The temperature of the gas is increased but the volume of the container does not change.

How do the kinetic energy of the molecules and the pressure of the gas change?

	kinetic energy	pressure
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2022 Oct/Nov · 0654/23 · Question 33 · Extended）

3. A sample of gas is sealed inside a container.

The volume of the container is slowly decreased. The temperature of the gas remains constant.

Which row describes and explains what happens to the pressure of the gas?

	description	explanation
A	pressure decreases	molecules collide with the container at lower speed
B	pressure decreases	molecules collide with the container less frequently
C	pressure increases	molecules collide with the container at greater speed
D	pressure increases	molecules collide with the container more frequently

(2024 Oct/Nov · 0654/23 · Question 31 · Extended)

4. Some gas is put in a sealed metal container of constant volume.

The gas is now cooled.

What happens to the average speed of the gas molecules, and what happens to the pressure of the gas?

	average speed of molecules	pressure of gas
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

(2023 Feb/Mar · 0654/22 · Question 31 · Extended)

5. Gas is trapped in a container.

The piston is moved to the right. The temperature of the gas does not change.



Which statement about the gas is correct?

A The kinetic energy of the gas particles decreases.

B The kinetic energy of the gas particles increases.

C The pressure of the gas decreases.

D The pressure of the gas increases.

(2025 Feb/Mar · 0654/22 · Question 31 · Extended)

6. A fixed mass of gas in a container is at constant temperature.

The gas is compressed into a smaller volume. This causes the pressure of the gas to change.

Which statement explains why the pressure of the gas changes?

A The gas particles collide with the walls of the container at higher speed.

B The gas particles collide with the walls of the container at lower speed.

C The gas particles collide with the walls of the container less frequently.

D The gas particles collide with the walls of the container more frequently.

（2026 May/Jun · 0654/22 · Question 32 · Extended）

7. A gas is contained in a cylinder of constant volume.

The gas is cooled.

What happens to the speed of the molecules of the gas and to the pressure of the gas?

	speed of molecules	pressure of gas
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2023 Oct/Nov · 0654/12 · Question 32 · Core）

8. The pressure of a gas in a container is caused by gas molecules colliding with the walls.

The pressure can be increased by heating the gas or by reducing its volume.

Which row explains why the pressure increases in each case?

	heating the gas	reducing the volume
A	collisions more frequent and harder	collisions more frequent and harder
B	collisions more frequent and harder	collisions more frequent only
C	collisions harder only	collisions more frequent and harder
D	collisions harder only	collisions more frequent only

（2023 Oct/Nov · 0654/23 · Question 32 · Extended）

题型 3：从起止状态或粒子排列给相变命名（考频★★★☆☆）

知识点 固体中粒子紧密且排列规则，液体中粒子紧密但排列不规则，气体中粒子相距很远。

固态变为液态称_____（melting），液态变为固态称_____（solidification）。

液态变为气态可由蒸发或沸腾发生，气态变为液态称_____（condensation）。

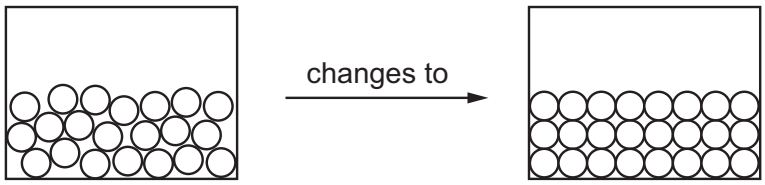
判断相变必须确定起始物态、最终物态和变化方向；温度常用 °C 表示，相变中粒子本身大小不变。

答案：熔化；凝固；凝结

怎么认 题目出现起止物态、粒子排列或相变箭头时，先判定两端物态，再按方向写相变名称。

例题 1

The diagram shows the change in the arrangement of the atoms in a substance that is changing state.



What is the change of state?

A boiling

B condensation

C melting

D solidification

（2022 Feb/Mar · 0654/12 · Question 32 · Core）

解：左图粒子紧密且排列不规则，表示液态；右图粒子紧密且排列规则，表示固态。
由液态变为固态，变化名称为凝固。故选 D。

针对练习

1. Which term describes a gas changing into a liquid?

A boiling

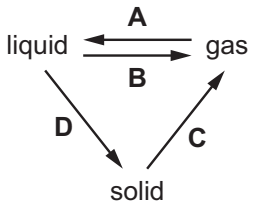
B condensation

C evaporation

D melting

（2023 May/Jun · 0654/11 · Question 33 · Core）

2. Which labelled arrow on the diagram represents condensation?



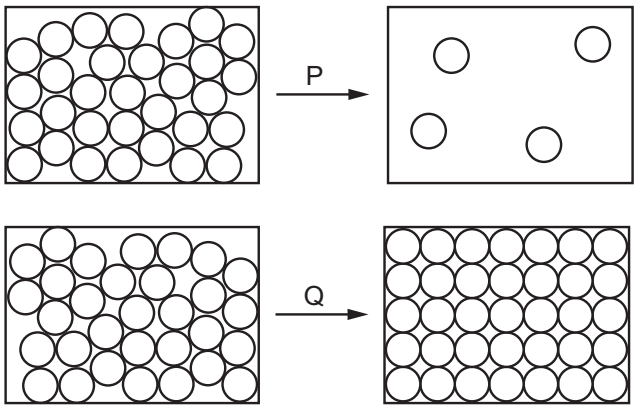
（2025 Oct/Nov · 0654/11 · Question 31 · Core）

3. What are the names for the changes of state between solids, liquids and gases?

	solid to liquid	liquid to gas
A	melting	condensation
B	melting	evaporation
C	solidification	condensation
D	solidification	evaporation

（2024 Oct/Nov · 0654/12 · Question 32 · Core；同题：2024 Oct/Nov · 0654/13 · Question 32 · Core）

4. The diagrams represent the arrangement of molecules in three states of matter. Arrows P and Q represent two changes of state.



Which row identifies the changes of state?

	P	Q
A	evaporation	condensation
B	evaporation	solidification
C	melting	condensation
D	melting	solidification

（2023 May/Jun · 0654/23 · Question 32 · Extended）

5. Liquid water boils at 100 °C to produce steam. The volume of the steam at 100 °C is much greater than the volume of the liquid water.

Which statement explains the increase in volume at 100 °C?

A The water molecules move faster in steam than in liquid water.

B The water molecules are further apart in steam than in liquid water.

C The water molecules are larger in steam than in liquid water.

D The water molecules are regularly arranged in liquid water but are randomly arranged in steam.

（2025 May/Jun · 0654/22 · Question 32 · Extended）

题型 4：比较热胀冷缩大小并处理孔或不同材料（考频★★★☆☆）

知识点 物体受热通常膨胀，遇冷通常收缩；热胀冷缩的大小指温度改变时长度、面积或体积的改变量。

在初始体积相同、温度变化相同且压强不变时，体积膨胀由小到大通常为_____。

均匀材料受热时，外形与孔洞一同_____，冷却时一同缩小；异种材料在相同温度变化下，热膨胀程度较大的材料尺寸变化_____。

温度变化量可用 °C 或 K 表示，体积变化量可用 cm^3 或 m^3 表示；同一温差用 °C 与 K 表示时数值相同。

答案：固体、液体、气体；增大；较大

怎么认 题目出现固、液、气比较、带孔物体、异种材料或定压气体加热时，先判断各部分的伸缩方向和大小。

例题 1

Equal volumes of a gas, a liquid and a solid are heated through the same temperature difference at constant pressure.

Which statement about their expansions is correct?

A The gas expands the most.

B The liquid expands the most.

C The solid expands the most.

D The gas, the liquid and the solid all expand by the same amount.

（2022 Oct/Nov · 0654/21 · Question 33 · Extended）

解： 由固体、液体、气体的相对热膨胀规律，在初始体积相同、温度变化相同且压强不变时，固体的体积增加量最小，液体其次，气体最大。
故选 A。

针对练习

1. When solids, liquids and gases are heated, they expand.

What is the order of the expansions of solids, liquids and gases, from smallest to largest?

A gas → liquid → solid

B liquid → gas → solid

C solid → gas → liquid

D solid → liquid → gas

（2024 Feb/Mar · 0654/22 · Question 32 · Extended）

2. Which statement about the relative thermal expansion of solids, liquids and gases is correct?

A Solids expand least, gases expand most.

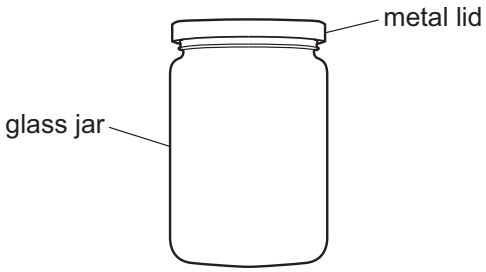
B Solids expand least, liquids expand most.

C Gases expand least, liquids expand most.

D Gases expand least, solids expand most.

（2023 Oct/Nov · 0654/12 · Question 33 · Core）

3. A glass jar in a warm room has a metal lid that is easy to remove.



The jar with the lid on is left in a refrigerator overnight.

In the morning, the lid of the jar is difficult to remove.

Which statement is an explanation of what happens when the jar is in the refrigerator?

A The glass jar contracted more than the metal lid.

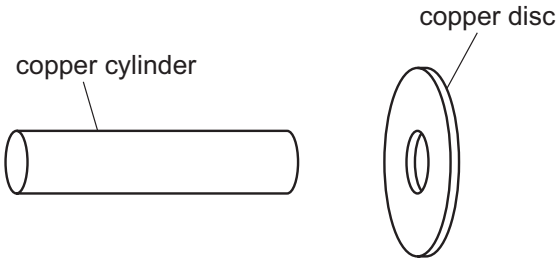
B The metal lid contracted more than the glass jar.

C The glass jar expanded more than the metal lid.

D The metal lid expanded more than the glass jar.

（2024 May/Jun · 0654/11 · Question 32 · Core）

4. A copper disc has a hole at its centre that is slightly too small to fit over a copper cylinder.



How can the disc be fitted over the cylinder?

A Cool the disc and then fit it over the cylinder.

B Cool the disc, heat the cylinder and then fit the disc over the cylinder.

C Heat the cylinder and then fit it through the hole in the disc.

D Heat the disc and then fit it over the cylinder.

（2024 May/Jun · 0654/12 · Question 32 · Core；同题：2024 May/Jun · 0654/13 · Question 32 · Core）

5. A gas in a balloon is heated at constant pressure.

What happens to the gas?

A Its density decreases.

B Its mass decreases.

C Its temperature decreases.

D Its volume decreases.

（2024 May/Jun · 0654/23 · Question 32 · Extended）

题型 5：布朗运动中分清可见颗粒与撞击它的分子（考频★★☆☆☆）

知识点 悬浮在气体中的微小烟尘颗粒所作的无规则运动称为_____运动。

这种运动由不断运动的_____分子从各方向对可见颗粒作不均匀碰撞引起，是物质的粒子运动模型的证据。

观察对象是烟尘等悬浮微粒，撞击者是不能用普通显微镜看见的气体分子；光只使烟尘颗粒便于观察。

温度升高时，气体分子的平均速率_____；布朗运动本身不是带单位的物理量。

答案：布朗；气体；增大

怎么认 题目出现烟尘微粒随机运动或布朗运动时，先分清可见颗粒是烟尘，撞击者是气体分子。

例题 1

Which statement about gas particles is **not** correct?

A Increasing the temperature of a gas makes the gas particles move more slowly.

B The gas particles are in constant random motion.

C The pressure of a gas is caused by the collision of gas particles with the container.

D Very small particles suspended in a gas are in constant random motion.

（2023 May/Jun · 0654/12 · Question 31 · Core；同题：2023 May/Jun · 0654/13 · Question 31 · Core、2023 May/Jun · 0654/22 · Question 32 · Extended）

解：温度升高，气体分子的平均速率增大，故 A 错；气体分子不断作无规则运动，B 对。

气体分子碰撞容器壁形成气体压强，C 对；悬浮微粒受气体分子不均匀碰撞而作无规则运动，D 对。

故选 A。

针对练习

1. Which statement explains why smoke particles are made to move by other particles in Brownian motion?

A The other particles are larger and move faster than smoke particles.

B The other particles are larger and move slower than smoke particles.

C The other particles are smaller and move faster than smoke particles.

D The other particles are smaller and move slower than smoke particles.

（2025 May/Jun · 0654/21 · Question 31 · Extended）

2. When a beam of light shines into a room, dust is seen in the air.

Each dust particle has a rapid and random motion.

What does this random motion provide evidence for?

A the dust particles are atoms

B the dust particles are molecules

C the kinetic particle model of matter

D the transfer of energy by light

（2026 May/Jun · 0654/12 · Question 31 · Core）

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3. A beam of light shines through a sealed transparent box.

The box contains air and smoke.

The air and smoke are viewed with a microscope.

Particles are seen moving randomly.

Which row shows the particles that are seen and describes why the particles move randomly?

	particles	why the particles move randomly
A	air	they collide with other air particles
B	air	they collide with the light
C	smoke	they collide with air particles
D	smoke	they collide with the light

（2026 May/Jun · 0654/23 · Question 31 · Extended）

题型 6：以发生位置和温度区别蒸发与沸腾（考频★★☆☆☆）

知识点 汽化是液体由液态变为气态的过程，包括蒸发和沸腾。

蒸发可在_____发生；若没有外界持续供热，蒸发使液体温度下降。

纯液体在一定压强下达到_____温度时沸腾，沸腾发生在_____，继续吸热时温度保持不变。

沸点随压强而变；温度可用 °C 或 K 表示。

答案：任意温度下且只在液体表面；确定；整个液体中

怎么认 题目出现蒸发或沸腾的发生温度、位置或温度变化时，先按两种汽化方式的特征判断。

例题 1

Boiling is a process in which a liquid changes its state to become a gas.

Which row describes the temperature at which boiling takes place and where it takes place in a pure liquid?

	temperature	where it takes place
A	at a definite temperature	only at the surface of the liquid
B	at a definite temperature	throughout the liquid
C	at any temperature	only at the surface of the liquid
D	at any temperature	throughout the liquid

（2025 Oct/Nov · 0654/21 · Question 31 · Extended）

解：纯液体在一定压强下达到确定温度时沸腾，且沸腾发生在整个液体中。故选 B。

针对练习

1. Which statement about boiling or evaporation of a liquid is correct?

A Boiling occurs at any temperature.

B Boiling occurs only at the surface of the liquid.

C Evaporation occurs only at a specific temperature.

D Evaporation occurs only at the surface of the liquid.

（2026 May/Jun · 0654/21 · Question 31 · Extended）

2. Which row describes a difference between evaporation of a liquid and boiling of a liquid?

	evaporation	boiling
A	temperature of liquid remains constant	temperature of liquid decreases
B	temperature of liquid decreases	temperature of liquid remains constant
C	occurs throughout the liquid	occurs only at the surface of the liquid
D	occurs at a fixed temperature	occurs at any temperature

（2026 May/Jun · 0654/23 · Question 32 · Extended）

题型 7：由粒子间距与固定位置解释可压缩性和流动（考频★☆☆☆☆）

知识点 物质由微小粒子组成。固体粒子排列紧密，并在固定位置附近振动；液体粒子排列紧密，但能相互滑过；气体粒子相距较远并自由运动。

物质容易被压缩，说明粒子间有较大的_____；固体和液体的粒子间距很小，不易被压缩。

物质能流动，说明粒子没有_____，可以相互移动；固体粒子的位置固定，不能流动。

可压缩性与流动性均为定性性质，不涉及单位。

答案：空隙；固定位置

怎么认 题目出现物质能否流动或是否容易压缩时，先判断粒子是否固定及粒子间距。

例题 1

A student observes that a substance X does **not** flow.

Which statement about substance X is correct?

A It can be either a gas or a liquid.

B It can only be a gas.

C It can only be a liquid.

D It can only be a solid.

（2024 Oct/Nov · 0654/21 · Question 32 · Extended）

解：物质不能流动，说明其粒子在固定位置附近振动，不能相互滑过。

具有这一粒子特征的物态是固态。

故选 D。

针对练习

1. Which states of matter are easily compressed?

A gases and liquids

B gases only

C liquids and solids

D solids only

（2026 May/Jun · 0654/11 · Question 31 · Core）

题型 8：相变过程中温度不变（考频★☆☆☆☆）

知识点 物质由固态变为液态的过程叫熔化，由液态变为气态的过程叫沸腾。

在一定压强下，纯物质熔化和沸腾时持续吸收能量，温度保持_____。

熔化时的恒定温度叫_____，沸腾时的恒定温度叫_____；温度单位可用 °C 或 K。

答案：不变；熔点；沸点

怎么认 题目出现物质正在熔化或正在沸腾并问温度变化时，先判定温度保持不变。

例题 1 What happens to the temperature of a substance as it is melting and as it is boiling?

	melting	boiling
A	decreases	increases
B	decreases	no change
C	increases	increases
D	no change	no change

（2022 May/Jun · 0654/11 · Question 33 · Core；同题：2022 May/Jun · 0654/12 · Question 33 · Core、2022 May/Jun · 0654/21 · Question 32 · Extended、2022 May/Jun · 0654/22 · Question 32 · Extended、2022 May/Jun · 0654/13 · Question 33 · Core、2022 May/Jun · 0654/23 · Question 32 · Extended）

解：熔化过程中，吸收的能量用于改变物态，温度不变；沸腾过程中，吸收的能量也用于改变物态，温度不变。

故选 D。

专题 9 温度、比热容与潜热

9.1 温度、比热容与潜热

题型 1：把测温仪器对应到物理量和测温性质（考频★★☆☆☆）

知识点 温度表示物体的冷热程度，常用单位是摄氏度（°C），热力学温度的单位是开尔文（K）。测温仪器利用随温度变化的物理性质确定温度；液体温度计利用液体的_____，热电偶利用电势差。在标准大气压下，摄氏温标的下定点是纯冰的_____，上定点是纯水的_____，分别定为 0 °C 和 100 °C。

答案：体积；熔点；沸点

怎么认 题目出现测温仪器、摄氏温标定点或测温性质时，先把仪器、被测量与随温度变化的物理性质对应。

例题 1

What are used as the fixed points on the Celsius scale of temperature?

	lower fixed point	upper fixed point
A	melting point of salt solution	boiling point of pure ethanol
B	melting point of salt solution	boiling point of pure water
C	melting point of pure ice	boiling point of pure ethanol
D	melting point of pure ice	boiling point of pure water

（2022 May/Jun · 0654/12 · Question 32 · Core；同题：2022 May/Jun · 0654/13 · Question 32 · Core）

解：在标准大气压下，摄氏温标的下定点为纯冰的熔点，上定点为纯水的沸点。
故选 D。

针对练习

1.

What is a thermocouple used to measure?

A expansion

B pressure

C resistance

D temperature

（2023 Oct/Nov · 0654/21 · Question 32 · Extended）

2.

In a liquid-in-glass thermometer, which physical property of the liquid is used to measure temperature?

A colour

B mass

C pressure

D volume

（2024 Feb/Mar · 0654/12 · Question 31 · Core）

题型 2：用液柱每度上升量比较灵敏度和量程（考频★★☆☆☆）

知识点 液体温度计的灵敏度是温度每改变 1 °C 时液柱长度的变化量，$S = \frac{\Delta l}{\Delta T}$，单位常用 mm °C^{-1}。玻璃泡容积越_____、细管内径越_____、液体受热膨胀越明显，液柱每度上升量越大，灵敏度越高。
量程是最低可测温度到最高可测温度的范围，常以 °C 表示。
在可用细管长度和起始液面相同时，灵敏度越高，液柱走完刻度对应的温度范围越_____。

答案：大；小；小

怎么认 题目出现玻璃泡大小、细管内径或液体膨胀程度，并问灵敏度或量程时，先比较液柱每度上升量。

例题 1

Which change on its own increases the sensitivity of a liquid-in-glass thermometer?

A decreasing the internal diameter of the tube

B increasing the internal diameter of the tube

C making the thermometer longer

D making the thermometer shorter

（2023 Oct/Nov · 0654/22 · Question 33 · Extended）

解：其余条件不变，温度升高相同数值时，液体的 ΔV 相同。
由液柱体积关系得
$\Delta l = \frac{\Delta V}{A}$
减小细管内径使 A 减小，因而 Δl 增大，灵敏度增大。故选 A。

针对练习

1. The liquid in a liquid-in-glass thermometer is replaced with a different liquid that expands more for the same increase in temperature.

The scale on the thermometer is changed because of the new liquid.

What happens to the sensitivity and what happens to the range of the thermometer?

	sensitivity	range
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2022 Oct/Nov · 0654/22 · Question 32 · Extended）

2. Four liquid-in-glass thermometers are made with different bulb sizes and different tube diameters.

Which thermometer is the most sensitive?

	bulb size	tube diameter
A	large	large
B	large	small
C	small	large
D	small	small

题型 3：看冷却数据有没有恒温平台判断状态（考频★☆☆☆☆）

知识点 纯物质冷却时，温度随时间降低；发生凝固时，温度保持不变，形成_____。
恒温平台对应液态与固态共存；平台结束后，物质全部变为固态，温度继续降低。
若冷却数据中的温度始终下降，则物质没有发生_____，初态为液体时仍为_____。

答案：恒温平台；凝固；液体

怎么认 题目出现冷却过程的温度—时间表格并询问某时刻状态时，先比较相邻温度是否形成恒温平台。

例题 1

A sample of liquid cools for 20 minutes. Its temperature is recorded every 2 minutes.

The results are shown.

time / minutes	0	2	4	6	8	10	12	14	16	18	20
temperature / °C	90.8	80.9	74.1	67.4	61.9	57.0	53.0	50.2	48.5	47.3	46.1

How should the sample be described at the end of 18 minutes?

A all liquid

B all solid

C in the process of boiling

D in the process of solidifying

（2023 Oct/Nov · 0654/13 · Question 31 · Core）

解：由表中数据，
$t = 16$ min时，$T = 48.5$ °C；
$t = 18$ min时，$T = 47.3$ °C；
$t = 20$ min时，$T = 46.1$ °C。
∵温度在18 min前后均继续降低，未出现恒温平台，∴样品没有凝固，仍为全部液体。故选 A。

专题 10 传导、对流与热辐射

10.1 传导、对流与热辐射

题型 1：先看是否有介质再判断传导、对流或辐射（考频★★★★☆）

知识点 传导是物质不发生整体移动时的热能传递，必须有介质，固体内部通常以_____为主。
对流是流体整体运动造成的热能转移，只发生在_____中。
热辐射以电磁波传递热能，主要涉及红外线，传播_____介质，因而能通过真空。
三者均为传热方式名称，不是物理量，没有单位。

答案：传导；液体和气体；不需要

怎么认 题目出现真空、固体传热或液体与气体流动时，先看是否有介质以及介质能否整体流动。

例题 1

How is thermal energy transferred from the Sun through the vacuum of space?

A by conduction and convection

B by convection and radiation

C by convection only

D by radiation only

（2023 Oct/Nov · 0654/11 · Question 33 · Core）

解：太阳与地球之间是真空，真空中没有可传递热能的粒子，传导和对流均不能发生。
热辐射不需要介质，能通过真空传递热能。
故选 D。

针对练习

1. What is the method of thermal energy transfer from the Sun to the Earth through the vacuum of space?

A conduction

B convection

C evaporation

D radiation

（2025 Oct/Nov · 0654/12 · Question 32 · Core；同题：2025 Oct/Nov · 0654/13 · Question 32 · Core）

2. What is a method for the transfer of thermal energy through a vacuum?

A conduction

B convection

C insulation

D radiation

（2025 Oct/Nov · 0654/11 · Question 32 · Core）

3. What is the main method of thermal energy transfer in liquid water?

A boiling

B conduction

C convection

D radiation

(2025 Oct/Nov · 0654/22 · Question 32 · Extended)

4. In which of the three states of matter is convection the main method of thermal energy transfer?

A liquids and gases

B liquids only

C solids and liquids

D solids only

(2023 Oct/Nov · 0654/13 · Question 32 · Core)

5. There is a vacuum in the space between the Sun and the Earth.

How is thermal energy transferred from the Sun to the Earth?

A by conduction only

B by convection only

C by radiation only

D by convection and radiation

(2024 Oct/Nov · 0654/23 · Question 32 · Extended)

6. In which situation is convection the main method of thermal energy transfer?

A heat from a heater on the floor of a room spreading around the room

B heat from a hot furnace reaching a factory worker standing beside it

C heat from the hot end of a metal spoon reaching a cook's hand holding the other end

D heat from the Sun reaching a worker in a field

(2025 Feb/Mar · 0654/12 · Question 32 · Core)

7. The vacuum in a vacuum flask reduces the thermal energy transfer from the contents of the flask to the surroundings.

Which methods of energy transfer **cannot** occur in a vacuum?

A conduction and convection

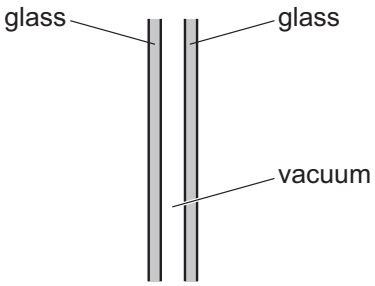
B conduction only

C convection and radiation

D radiation only

(2026 May/Jun · 0654/13 · Question 31 · Core)

8. The diagram shows a type of double glazing in a window. The double glazing consists of two sheets of glass separated by a vacuum.



Which methods of energy transfer are prevented by the vacuum?

A conduction and convection only

B conduction and radiation only

C convection and radiation only

D conduction, convection and radiation

（2025 May/Jun · 0654/12 · Question 32 · Core；同题：2025 May/Jun · 0654/13 · Question 32 · Core）

9. Water in a metal pan is heated on a gas burner.

What are the main methods by which heat is transferred through the metal pan to the water and throughout the water?

A conduction through the metal pan and convection in the water

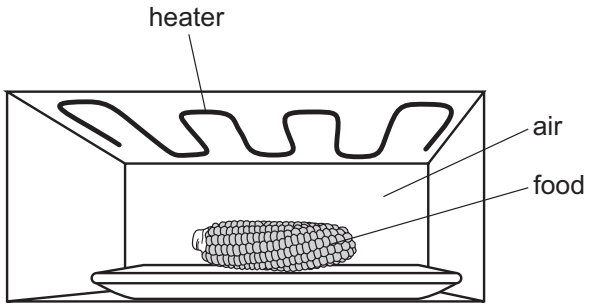
B convection through the metal pan and conduction in the water

C convection through the metal pan and radiation in the water

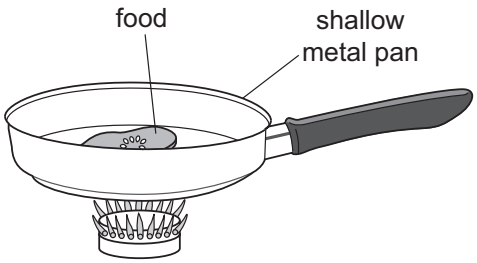
D radiation through the metal pan and conduction in the water

（2024 Oct/Nov · 0654/22 · Question 32 · Extended）

10. Two methods of cooking are grilling under a red-hot heater and frying in a shallow metal pan.



method 1: grilling



method 2: frying

How does thermal energy pass through the air to reach the food in method 1 and how does thermal energy pass through the bottom of the metal pan in method 2?

	method 1	method 2
A	convection	conduction
B	convection	radiation
C	radiation	conduction
D	radiation	radiation

（2023 May/Jun · 0654/12 · Question 32 · Core；同题：2023 May/Jun · 0654/13 · Question 32 · Core、2023 May/Jun · 0654/22 · Question 33 · Extended）

11. Which statement about the transfer of thermal energy is correct?

A Thermal energy transfer by radiation involves mainly ultraviolet radiation.

B Thermal energy transfer by radiation requires a medium to travel through.

C The main method of thermal energy transfer through gases is conduction.

D The main method of thermal energy transfer through liquids is convection.

（2025 May/Jun · 0654/11 · Question 31 · Core）

12. Which method of thermal energy transfer occurs in a vacuum and which region of the electromagnetic spectrum is mainly involved in this type of thermal energy transfer?

	method of thermal energy transfer	region of the electromagnetic spectrum
A	convection	infrared
B	convection	radio waves
C	radiation	infrared
D	radiation	radio waves

（2025 Feb/Mar · 0654/22 · Question 32 · Extended）

题型 2：按材料或远端温升判断热传导好坏（考频★★★☆☆）

知识点 热传导是热能从物体温度较高的部分向温度较低的部分传递的过程，固体中主要以这种方式传热。

金属通常是热的_____导体，木材、塑料、玻璃和空气通常是热的_____导体。

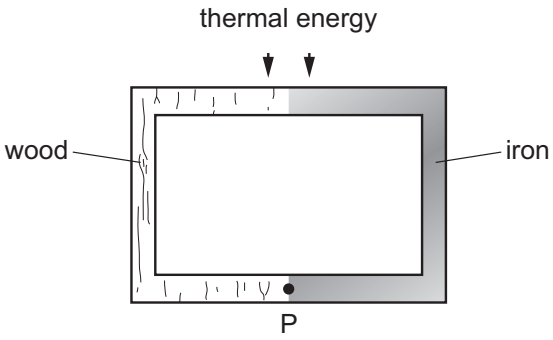
材料、长度、横截面积及加热条件相同时，规定时间内远端温度越高，表明材料的导热能力越_____；温度的常用单位为 °C。

答案：良；不良；强

怎么认 题目出现材料名称，或相同尺寸的物体同样受热并比较远端温升时，先判断材料的导热能力。

例题 1

The diagram shows an object made partly of wood and partly of iron. Thermal energy is supplied in the position shown. Point P is marked at the bottom of the object.



How does most thermal energy reach point P?

A by conduction through the iron

B by conduction through the wood

C by convection through the iron

D by convection through the wood

（2022 Feb/Mar · 0654/12 · Question 33 · Core；同题：2022 Feb/Mar · 0654/22 · Question 31 · Extended）

解：木材和铁均为固体，热能在其中通过传导传递。
铁比木材的导热能力强，热能主要沿铁制部分传至 P。故选 A。

针对练习

1. Which row shows a good thermal conductor and a bad thermal conductor?

	good conductor	bad conductor
A	copper	air
B	copper	silver
C	water	air
D	water	silver

（2025 Feb/Mar · 0654/12 · Question 31 · Core）

2. Which pair consists of one good thermal conductor and one bad thermal conductor?

A aluminium and wood

B brass and copper

C glass and plastic

D iron and steel

（2025 May/Jun · 0654/11 · Question 32 · Core）

3. Which material is a good thermal conductor?

A aluminium

B cardboard

C rubber

D wool

(2025 May/Jun · 0654/23 · Question 30 · Extended)

4. Which material is a poor thermal conductor?

A air

B aluminium

C copper

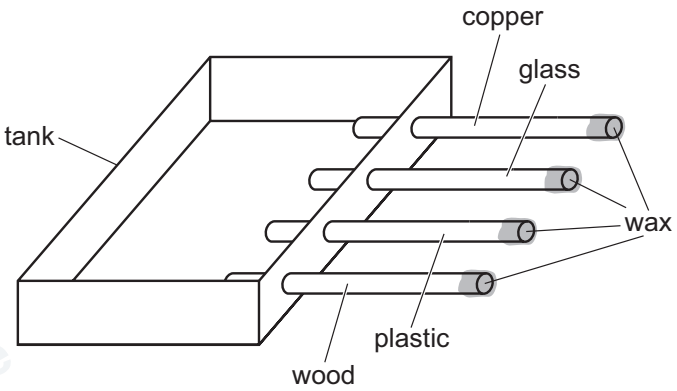
D iron

(2024 Oct/Nov · 0654/11 · Question 32 · Core)

5. The diagram shows four rods with identical dimensions. The rods are made of copper, glass, plastic and wood.

One end of each rod is inside an empty tank.

The other end of each rod is outside the tank. These ends are covered with an equal amount of wax.



The tank is filled with boiling water.

After a short time, the wax on one of the rods melts.

On which rod does the wax melt?

A copper

B glass

C plastic

D wood

(2026 May/Jun · 0654/12 · Question 32 · Core)

6. Four rods have the same dimensions. They are made of four different metals and are all at room temperature.

All the rods are heated equally at one end for the same time.

The final temperature of the other end of each rod is shown in the table.

Which rod is the worst conductor of heat?

	final temperature / °C
A	50
B	62
C	70
D	82

（2025 Feb/Mar · 0654/22 · Question 33 · Extended）

题型 3：由热流体密度较小画出上升与回流方向（考频★★★☆☆）

知识点 对流是液体或气体因温度不同而发生整体流动的传热方式。

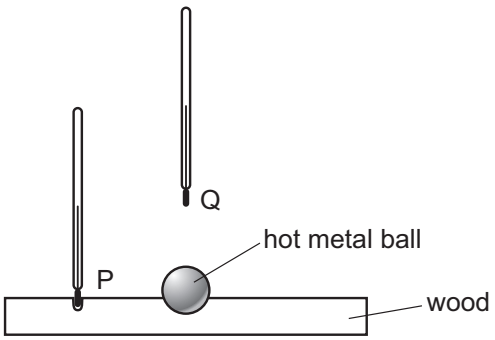
同种流体受热后密度_____并上升；较冷流体密度_____并下沉，连续运动形成对流。

对流发生在能够流动的液体或气体中，流动方向由冷热区域的位置决定，不涉及新的计量单位。

答案：较小；较大

怎么认 题目出现热源、冷热流体或流向箭头时，先标出受热处上升、较冷处下沉，再补全回流方向。

例题 1 A hot metal ball is placed in a small hollow in a piece of wood. Two thermometers are placed equal distances from the ball, one at position P and one at position Q.



Which thermometer gives the higher reading and why?

	higher reading	reason
A	thermometer at P	the air conducts heat sideways, not upwards
B	thermometer at P	the wood conducts heat sideways, not upwards
C	thermometer at Q	convection carries heat upwards, not sideways
D	thermometer at Q	infrared rays always carry heat upwards, not sideways

（2022 Oct/Nov · 0654/11 · Question 33 · Core；同题：2022 Oct/Nov · 0654/12 · Question 33 · Core、2022 Oct/Nov · 0654/13 · Question 33 · Core）

解：金属球附近的空气受热后温度升高，密度减小并上升。

Q 位于金属球上方，热空气把能量带到 Q，Q 温度计的示数较高。

故选 C。

针对练习

1. In a room, hot air above a heater rises and is replaced by cool air that falls.

What is the name of this process, and how does the density of the hot air compare with the density of the cool air?

	process	density of hot air
A	conduction	greater than cool air
B	conduction	less than cool air
C	convection	greater than cool air
D	convection	less than cool air

（2024 May/Jun · 0654/21 · Question 32 · Extended）

2. One cause of air movement in the atmosphere is convection.

Which statement describes air that rises in the atmosphere due to convection?

A It is cooler and less dense than the surrounding air.

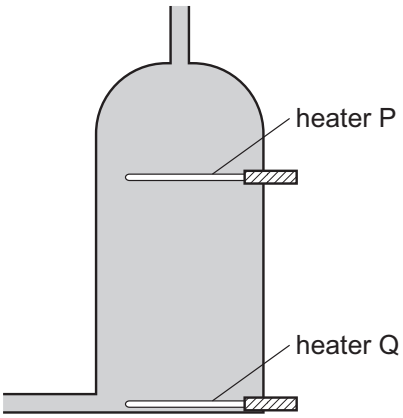
B It is cooler and more dense than the surrounding air.

C It is warmer and less dense than the surrounding air.

D It is warmer and more dense than the surrounding air.

（2022 Oct/Nov · 0654/22 · Question 33 · Extended）

3. A hot water tank is fitted with two identical heaters P and Q. Heater P is fitted above heater Q, as shown. The tank is full of cold water.



When only heater Q is switched on, it takes a long time to heat the tank of water to 60 °C.

What happens to the cold water when only heater P is switched on?

A All the water reaches 60 °C in less time.

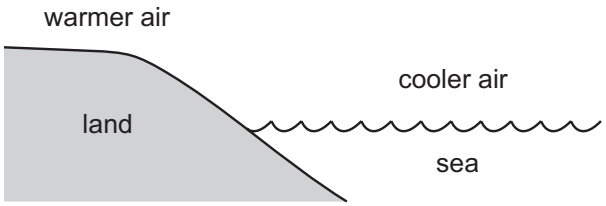
B All the water reaches 60 °C in the same time.

C The water below heater P reaches 60 °C in less time.

D The water above heater P reaches 60 °C in less time.

（2023 Feb/Mar · 0654/12 · Question 33 · Core）

4. At the coast on a hot day, the air above the land is warmer than the air above the sea. This causes a convection current. The convection current causes a gentle wind.



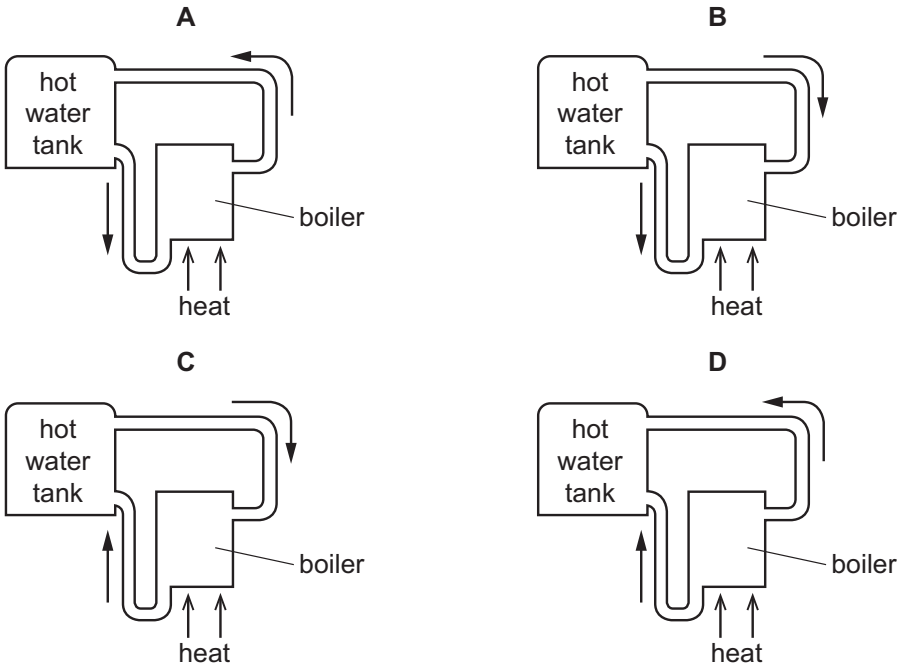
Which row describes the density of the air above the land and the direction of the wind?

	density of air above land	direction of wind
A	greater than above sea	from land to sea
B	greater than above sea	from sea to land
C	less than above sea	from land to sea
D	less than above sea	from sea to land

（2025 May/Jun · 0654/23 · Question 31 · Extended）

5. The diagrams show part of a water-heating system which is working by convection.

Which diagram shows the flow of water in the system?



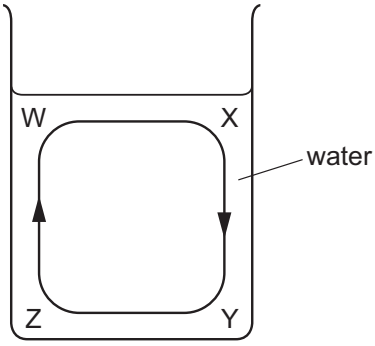
（2024 Oct/Nov · 0654/12 · Question 33 · Core；同题：2024 Oct/Nov · 0654/13 · Question 33 · Core）

6.

A beaker contains water that is all at 20 °C.

A convection current is started in the water, as shown in the diagram.

Four points are labelled W, X, Y and Z.



Which two actions can each, on their own, cause this convection current?

A cooling the water at W or heating the water at Y

B cooling the water at W or heating the water at Z

C cooling the water at X or heating the water at Y

D cooling the water at X or heating the water at Z

（2024 May/Jun · 0654/11 · Question 33 · Core）

题型 4：区分晶格振动与自由电子携带热量（考频★★☆☆☆）

知识点 存在温度差时，热传导使热能由温度较高处传向温度较低处，热能的单位是 J。

固体中的原子或分子在固定位置附近_____，并把能量传给相邻粒子；金属和塑料均可通过这种方式传热。

金属中还有能够在晶格间移动的_____，它们可携带热能；这种传热机制只存在于金属。

固体金属的热传导由_____和自由电子运动共同造成，因此金属通常比非金属导热更好。

答案：振动；自由电子（离域电子）；晶格振动

怎么认 题目出现固体金属、晶格振动和自由电子时，先分清两类粒子的运动方式。

例题 1

Solid metals transfer thermal energy by conduction.

Which conduction process occurs only in metals?

A Atoms move freely through the solid and carry energy.

B Atoms vibrate about fixed positions and pass energy to neighbouring atoms.

C Electrons move freely through the solid and carry energy.

D Electrons vibrate about fixed positions and pass energy to neighbouring electrons.

（2022 May/Jun · 0654/22 · Question 33 · Extended）

解：固体中的原子在固定位置附近振动，不能自由穿过固体；晶格振动也存在于非金属固体。
金属中的自由电子可在固体中移动并携带热能，这一传导过程只发生在金属中。
故选 C。

针对练习

1. A solid metal transfers energy by thermal conduction.

What causes this transfer?

A atomic lattice vibrations and movement of delocalised electrons

B atomic lattice vibrations only

C movement of delocalised electrons only

D change in density of the metal

（2026 May/Jun · 0654/21 · Question 32 · Extended）

2. Which statement explains why metals are better thermal conductors than non-metals?

A Atoms in metals are fixed in a lattice by bonds.

B Atoms in metals vibrate about fixed positions.

C Metals contain free electrons.

D Metals contain free protons.

（2023 Oct/Nov · 0654/23 · Question 33 · Extended）

3. Thermal energy is transferred through a solid metal by conduction.

Which row describes how the atoms and delocalised electrons in a solid metal behave during this process?

	atoms	**delocalised electrons**
A	move throughout the metal	move throughout the metal
B	move throughout the metal	vibrate about fixed positions
C	vibrate about fixed positions	move throughout the metal
D	vibrate about fixed positions	vibrate about fixed positions

（2026 May/Jun · 0654/22 · Question 33 · Extended）

4. Some materials use atomic or molecular lattice vibrations and some materials use the movement of delocalised electrons for thermal conduction.

Which row shows the correct materials?

	atomic or molecular lattice vibrations	movement of delocalised electrons
A	metals only	metals and plastics
B	plastics only	metals and plastics
C	metals and plastics	metals only
D	metals and plastics	plastics only

（2025 May/Jun · 0654/21 · Question 32 · Extended）

题型 5：按颜色与光泽比较热辐射吸收、反射和发射（考频★★☆☆☆）

知识点 物体吸收热辐射的能力与表面的颜色和光泽有关；深色、无光泽表面的吸收能力较_____，浅色、光亮表面的吸收能力较_____。

光亮表面对热辐射的反射能力较强，无光泽表面的反射能力较弱。

同温、同面积时，良好吸收体也是良好发射体，黑色、无光泽表面的发射能力较_____。

以上比较须在其他条件相同且入射辐射相同的条件下进行，属于定性判断，无单位。

答案：强；弱；强

怎么认 题目出现表面颜色、光泽及吸收、反射或发射的比较时，先判断表面是黑白、光亮还是无光泽。

例题 1

Which row shows the colour of outer clothing that helps to keep the wearer cool on a hot, sunny day and the reason why this colour is effective?

	colour	reason
A	black	it is a good absorber of radiation from the Sun
B	black	it is a bad absorber of radiation from the Sun
C	white	it is a good absorber of radiation from the Sun
D	white	it is a bad absorber of radiation from the Sun

（2025 Oct/Nov · 0654/23 · Question 32 · Extended）

解：白色表面对太阳辐射的吸收能力较弱，外衣吸收的能量较少，有助于使穿着者保持凉爽。故选 D。

针对练习

1. Which surface reflects the most thermal radiation?

A a black, dull surface

B a black, shiny surface

C a white, dull surface

D a white, shiny surface

（2025 May/Jun · 0654/22 · Question 31 · Extended）

2. Which surface is the best absorber of thermal radiation?

A dull black

B dull white

C shiny black

D shiny white

（2025 May/Jun · 0654/21 · Question 33 · Extended）

3. Which statement about thermal radiation is correct?

A A dull surface is a good absorber and a good reflector of thermal radiation.

B A dull surface is a poor absorber and a poor reflector of thermal radiation.

C A shiny surface is a good absorber but a poor reflector of thermal radiation.

D A shiny surface is a poor absorber but a good reflector of thermal radiation.

（2023 May/Jun · 0654/21 · Question 31 · Extended）

题型 6：把容器不同部位对应到各条散热途径（考频★☆☆☆☆）

知识点 热传递有传导、对流和热辐射三种方式；传导和对流都需要物质，真空能防止_____和_____。

热辐射不需要物质，温度高于周围环境的物体可通过热辐射传出内能。

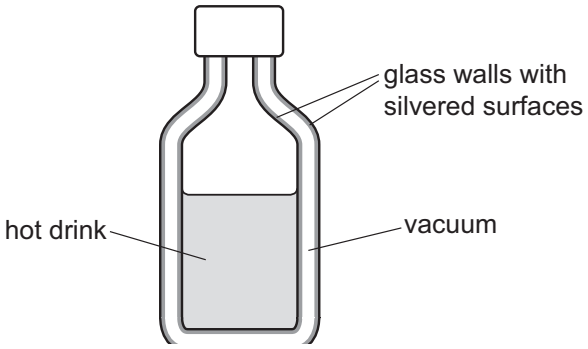
暗淡表面发射热辐射的能力强，明亮表面发射热辐射的能力弱，故镀银的明亮表面能减少_____。

盖子可减少液面上方空气的对流；在其他条件相同时，无盖且表面暗淡的容器散热较快。

答案：传导；对流；热辐射

怎么认 题目出现真空层、明亮或暗淡表面及有无盖子时，先把各部位对应到三种热传递方式。

例题 1 A vacuum flask uses a vacuum between two shiny surfaces to keep a drink hot for a long time.



How do the vacuum and the shiny surfaces help to keep the drink hot?

	vacuum	shiny surfaces
A	prevents conduction and convection	reduce conduction and radiation
B	prevents conduction and convection	reduce radiation only
C	prevents radiation	reduce conduction and convection
D	prevents radiation	reduce convection only

（2023 Oct/Nov · 0654/21 · Question 33 · Extended）

解：传导和对流都需要物质，真空中没有粒子，故真空防止传导和对流。

热辐射可通过真空，明亮的镀银表面发射和吸收热辐射的能力弱，故只减少热辐射。

故选 B。

针对练习

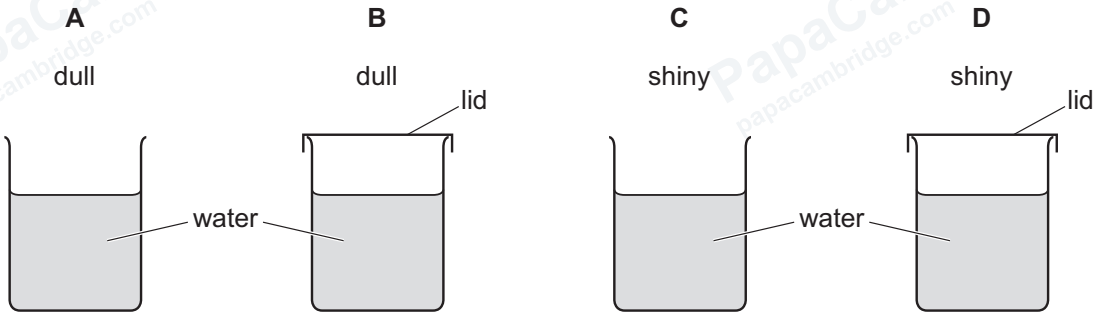
1. An equal quantity of water at 80 °C is poured into each of four identical metal containers on a laboratory bench.

The outer surfaces of two of the containers are dull and the outer surfaces of the other two containers are shiny.

Identical lids are put on two of the containers.

All the containers are allowed to cool.

Which container cools at the greatest rate?



（2026 Feb/Mar · 0654/12 · Question 32 · Core）

专题 11 波长、频率与波速

11.1 波长、频率与波速

题型 1：波形中从平衡位置量振幅、同相点量波长（考频★★★☆☆）

知识点 振幅 A 是介质中一点偏离平衡位置的最大距离；在波形图中，应从_____量到波峰或波谷。
波长 λ 是沿传播方向相邻两个_____点之间的距离，相邻波峰或相邻波谷的间距均为一个波长。
频率 f 是单位时间内通过某一点的完整波的个数，单位是赫兹（Hz）；对同一列周期波，$v = f\lambda$，相应单位可用 m s^{-1}、Hz、m。
波峰到波谷的竖直距离为_____个振幅。

答案：平衡位置；同相；2

怎么认 题目出现波峰、波谷、平衡位置或标注箭头时，先分清竖直最大位移与相邻同相点的水平距离。

例题 1

What is the name of the distance between two consecutive crests of a water wave?

A amplitude

B frequency

C speed

D wavelength

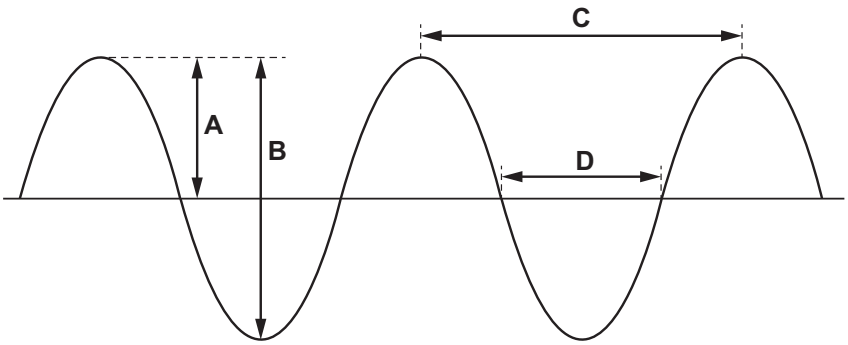
（2023 May/Jun · 0654/12 · Question 33 · Core；同题：2023 May/Jun · 0654/13 · Question 33 · Core）

解：相邻两个波峰是相邻的同相点，其间沿传播方向的距离为一个波长。
故选 D。

针对练习

1. The diagram represents a transverse wave.

Which labelled arrow represents the wavelength of the wave?



（2023 Oct/Nov · 0654/13 · Question 33 · Core）

2. A tank contains water.



A wave is produced and travels across the surface of the water.

Which feature of the wave is the maximum height of the wave above the initial level of water?

A the amplitude

B the frequency

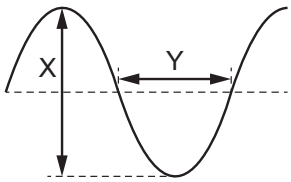
C the speed

D the wavelength

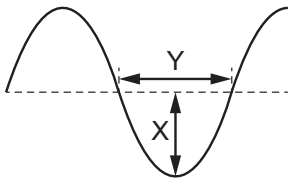
（2026 May/Jun · 0654/13 · Question 32 · Core）

3. Which wave diagram shows the amplitude X and the wavelength Y of a wave?

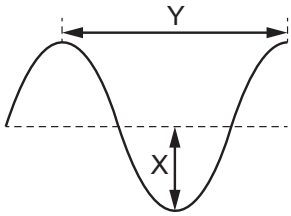
A



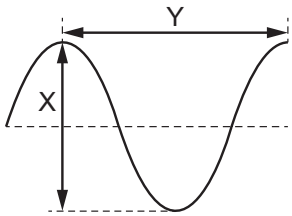
B



C

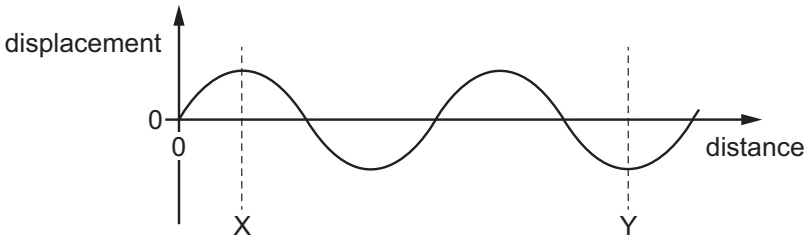


D



（2025 Oct/Nov · 0654/12 · Question 34 · Core；同题：2025 Oct/Nov · 0654/13 · Question 34 · Core）

4. The diagram represents a wave.

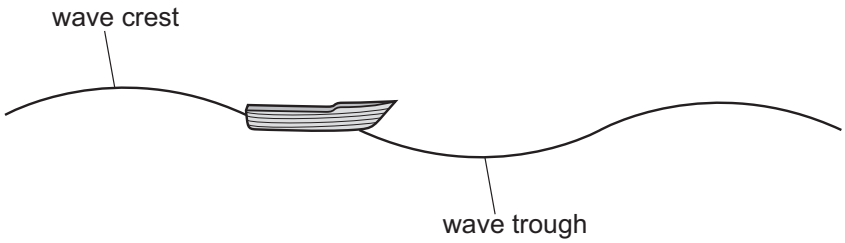


How many wavelengths are there between X and Y?

A $\frac{2}{3}$ **B** 1 **C** $1\frac{1}{2}$ **D** 3

（2024 Oct/Nov · 0654/12 · Question 34 · Core；同题：2024 Oct/Nov · 0654/13 · Question 34 · Core）

5. A boy watches a water wave passing a boat that is floating on the sea.



Which single measurement allows the boy to be able to calculate the amplitude of the wave?

A the distance between one wave crest and the next

B the time taken for a wave crest to travel the length of the boat

C the time taken for the boat to move from its lowest point to its highest point

D the vertical distance between the highest point and the lowest point of the boat

（2024 Feb/Mar · 0654/12 · Question 32 · Core）

6. A wave has an amplitude, a frequency and a wavelength.

Three definitions for these quantities are given.

1 the maximum displacement from the rest position

2 the number of wavefronts passing a point in unit time

3 the distance between two adjacent wave crests

Which definition corresponds to each quantity?

	amplitude	frequency	wavelength
A	1	2	3
B	1	3	2
C	2	3	1
D	3	1	2

（2024 May/Jun · 0654/21 · Question 33 · Extended）

题型 2：每秒通过次数求频率并接波速关系（考频★★★☆☆）

知识点 频率 f 表示单位时间内通过某一点的完整波数，若时间 t 内通过 n 个波峰，则 $f=$ _____，单位为 Hz。

相邻两波峰间的距离为波长 λ；图中 m 个波峰从第一个到最后一个含 _____ 个波长。

相邻两个波峰通过同一点的时间间隔为周期 T，频率与周期满足 $f=\frac{1}{T}$，T 的单位为 s。

波以波速 v 传播时，频率、波长与波速满足 _____；v 用 m/s 时，λ 用 m。

计算时各量的单位应相互配套，1 MHz $=10^6$ Hz。

答案：$\frac{n}{t}$；$m-1$；$v=f\lambda$

怎么认 题目出现单位时间内通过的波峰数、造峰间隔或波峰间距时，先求频率或波长，再用 $v = f\lambda$。

例题 1

A water wave passes point Y.

A student counts how many wave crests pass point Y in 30 seconds.

Using **only** this information, what can the student calculate?

A the amplitude of the wave

B the frequency of the wave

C the speed of the wave

D the wavelength of the wave

（2023 Feb/Mar · 0654/12 · Question 34 · Core；同题：2023 Feb/Mar · 0654/22 · Question 33 · Extended）

解：设 30 s 内通过 Y 点的波峰数为 n，则

$f = \frac{n}{30\ \text{s}}$

该比值表示单位时间内通过 Y 点的波峰数，即频率。故选 B。

针对练习

1. One property of a water wave is the number of crests on the surface of water that pass a particular point each second.

What is this property?

A amplitude

B frequency

C speed

D wavelength

（2025 Feb/Mar · 0654/12 · Question 33 · Core）

2. A wave passes a rock in the sea. Five complete wavelengths pass the rock in 20 s.

What is the frequency of this wave?

A 0.25 Hz **B** 4.0 Hz **C** 15 Hz **D** 100 Hz

（2025 Oct/Nov · 0654/21 · Question 32 · Extended）

3. A wave has a frequency of 3.0 MHz and a speed of 1500 m / s.

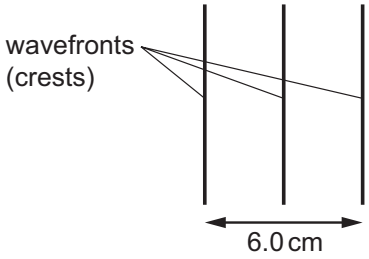
What is the wavelength of the wave?

A 5.0×10^{-4} m **B** 0.50 m **C** 500 m **D** 4500 m

（2023 May/Jun · 0654/21 · Question 33 · Extended）

4. The diagram shows a water wave seen from above.

One wavefront (crest) is made every 0.50 s.

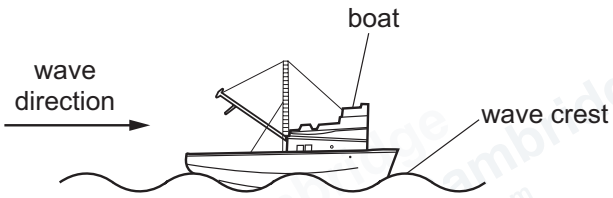


What is the frequency of the wave and what is its wavelength?

	frequency / Hz	wavelength / cm
A	0.50	3.0
B	0.50	6.0
C	2.0	3.0
D	2.0	6.0

（2022 Feb/Mar · 0654/12 · Question 34 · Core）

5. A water wave travels at a steady speed of 4.0 m / s and passes a stationary boat.



Four wave crests pass the boat every 2.0 seconds.

What is the wavelength of the wave?

A 0.5 m **B** 1.0 m **C** 2.0 m **D** 8.0 m

（2026 Feb/Mar · 0654/12 · Question 33 · Core）

题型 3：区分波的传播与漂浮颗粒的振动（考频★☆☆☆☆）

知识点 波在传播过程中传递_____，不传递物质。

对机械波，介质质点在平衡位置附近_____，不随波持续向传播方向移动。

水面波中漂浮小球随水面振动；质点位移的 SI 单位为 m。

答案：能量；振动

怎么认 题目出现波沿水面传播、漂浮小球怎样运动时，先区分波的传播方向和小球的振动方向。

例题 1

Which statement about waves is correct?

A They do not transfer energy or matter.

B They transfer energy and matter.

C They transfer energy but not matter.

D They transfer matter but not energy.

（2025 Oct/Nov · 0654/12 · Question 33 · Core；同题：2025 Oct/Nov · 0654/13 · Question 33 · Core）

解：波传播时传递能量，不传递物质。
A 错，波传递能量；B 错，波不传递物质；C 对；D 错，物质不随波传播。
故选 C。

针对练习

1. A student investigates the motion of a small ball that is floating on water in a tank. A wave passes along the water surface from left to right.

What happens to the ball?

A It does not move.

B It moves only to the left.

C It moves only to the right.

D It moves up and down.

（2025 May/Jun · 0654/12 · Question 33 · Core；同题：2025 May/Jun · 0654/13 · Question 33 · Core）

题型 4：比较振动方向与传播方向区分横纵波（考频★☆☆☆☆）

知识点 波的类型由粒子的振动方向与波的传播方向的关系判定。

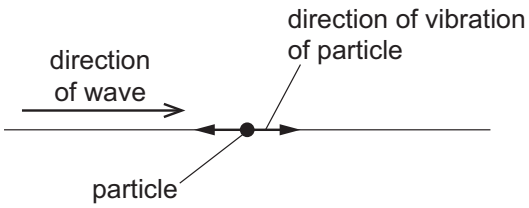
振动方向与传播方向_____的波是横波；两者_____的波是纵波。

光波、无线电波属于横波，声波属于纵波。

答案：垂直；平行

怎么认 题目出现粒子振动方向和波的传播方向时，先比较两者是否平行。

例题 1 The diagram shows the direction of a wave that passes a particle. The particle is made to vibrate by the wave. The direction of vibration of the particle is shown.



Which row states the type of wave that passes the particle and gives an example of this type of wave?

	type of wave	example
A	longitudinal	light
B	longitudinal	sound
C	transverse	light
D	transverse	sound

（2024 May/Jun · 0654/22 · Question 33 · Extended）

解：图中粒子的振动方向与波的传播方向平行，故该波为纵波。
声波是纵波，光是横波。
故选 B。

针对练习

1. Which row contains an example of a longitudinal wave and an example of a transverse wave?

	longitudinal wave	transverse wave
A	radio wave	water wave
B	sound wave	radio wave
C	water wave	radio wave
D	water wave	sound wave

（2025 Oct/Nov · 0654/22 · Question 33 · Extended）

题型 5：比较波长与缝宽判断衍射程度（考频★☆☆☆☆）

知识点 波通过狭缝后偏离原传播方向并向两侧展开的现象称为衍射。

衍射程度由波长 λ 与缝宽 w 的相对大小决定；$\frac{\lambda}{w}$ 越_____，衍射越明显。

当缝宽与波长_____时，衍射明显，出射波面近似为以狭缝为中心的圆弧；λ 与 w 应采用相同的长度单位。

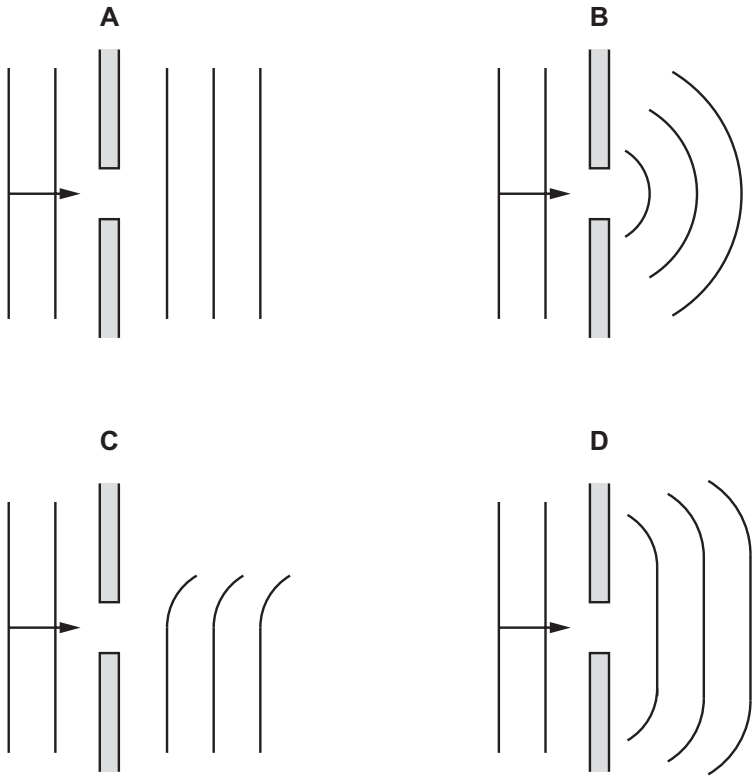
答案：大；相近

怎么认 题目出现波长、缝宽或狭缝后的波面图时，先比较 λ 与 w 的相对大小。

例题 1

A wave approaches a gap in a barrier. The gap is the same size as the wavelength of the wave. The arrow shows the direction of the wave.

Which diagram shows what happens to the wave after it passes through the gap?



（2025 May/Jun · 0654/22 · Question 33 · Extended）

解：由缝宽与波长相等得

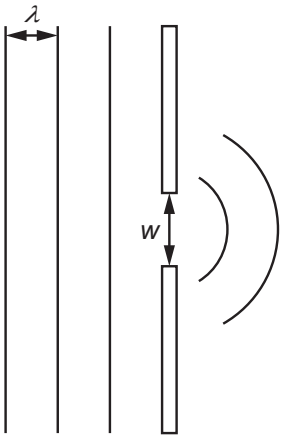
$\frac{\lambda}{w}=1$。

衍射明显，波面经过狭缝后向两侧展开并形成圆弧，图 B 符合。故选 B。

针对练习

1. The diagram shows a water wave diffracted through a gap in a barrier.

The wavelength of the wave is λ and the width of the gap is w.



Which row shows values of λ and w that produce the greatest diffraction?

	λ / cm	w / cm
A	1.0	2.0
B	1.0	4.0
C	2.0	2.0
D	2.0	4.0

（2026 May/Jun · 0654/22 · Question 35 · Extended）

题型 6：折射时频率不变、由偏折判断波长变化（考频★☆☆☆☆）

知识点 波从一种介质进入另一种介质时，频率由波源决定，波源不变，则频率_____。

波速、频率和波长满足 $v=f\lambda$；v 的单位为 $\mathrm{m\ s^{-1}}$，f 的单位为 Hz，λ 的单位为 m。

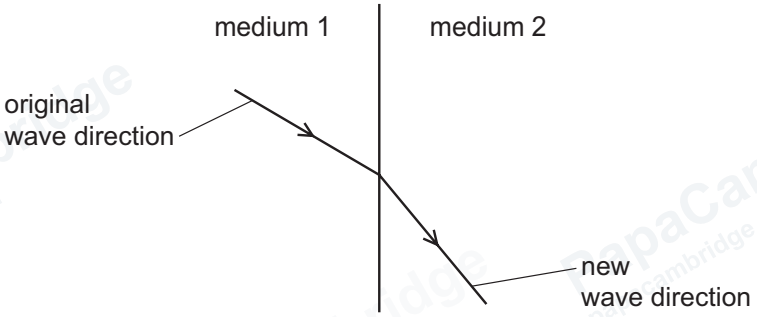
波折射后偏离法线，表明波速_____；频率不变，故波长增大。

答案：不变；增大

怎么认 题目出现波穿过介质分界面并给出偏折图时，先比较入射角和折射角，再由频率不变及 $v=f\lambda$ 判断波长。

例题 1

A wave passes from medium 1 into medium 2. The diagram shows the change in direction of the wave.



Which row describes what happens to the frequency and the wavelength of the wave as it passes from medium 1 into medium 2?

	frequency	wavelength
A	decreases	decreases
B	decreases	increases
C	no change	decreases
D	no change	increases

（2026 May/Jun · 0654/22 · Question 34 · Extended）

解： 分界面竖直，法线沿水平方向。

由图得折射角大于入射角，波进入介质 2 后偏离法线，故 $v_2>v_1$。

波源不变，故 $f_2=f_1$。

由 $v=f\lambda$ 得

$\frac{\lambda_2}{\lambda_1}=\frac{v_2}{v_1}>1$

故频率不变，波长增大。故选 D。

题型 7：把可见光颜色按波长排序（考频★☆☆☆☆）

知识点 可见光的波长约为 400 nm 至 700 nm，波长常用纳米（nm）表示，1 nm $=10^{-9}$ m。

在可见光范围内，按波长由短到长排列，各颜色依次为_____。

紫光的波长较_____，红光的波长较_____。

答案：紫、蓝、绿、黄、橙、红；短；长

怎么认 题目出现可见光的若干波长并要求判断颜色时，先按波长由短到长对应紫至红的顺序。

例题 1

Visible light contains wavelengths between approximately 400 nm and 700 nm.

Which row gives the colour of each wavelength of visible light?

	400 nm	500 nm	600 nm
A	green	orange	violet
B	green	violet	orange
C	violet	green	orange
D	violet	orange	green

（2026 May/Jun · 0654/11 · Question 34 · Core）

解：可见光的颜色按波长由短到长依次为紫、蓝、绿、黄、橙、红。
由 400 nm < 500 nm < 600 nm 得，三种光的颜色应沿紫至红的方向依次排列。
400 nm 对应紫色，500 nm 对应绿色，600 nm 对应橙色。
故选 C。

题型 8：真空中区别电磁波与声波的传播条件（考频★☆☆☆☆）

知识点 电磁波不需要介质，在真空中均以_____传播，数值为 3.0×10^8 m/s。
声波是_____波，传播必须有介质，因此不能在真空中传播。
比较真空中的波速时，应先判断波能否在真空中传播。

答案：相同速度；机械

怎么认 题目出现真空中电磁波与声波的速度比较时，先判断各波能否在真空中传播。

例题 1

Which two types of wave **cannot** travel at the same speed as each other in a vacuum?

A infrared and gamma

B ultraviolet and X-rays

C light and microwaves

D radio waves and sound

（2024 May/Jun · 0654/23 · Question 34 · Extended）

解：红外线、伽马射线、紫外线、X 射线、可见光、微波和无线电波均为电磁波，在真空中的传播速度均为 3.0×10^8 m/s。
声波是机械波，不能在真空中传播，因此无线电波与声波不能在真空中以相同速度传播。
故选 D。

专题 12 反射、折射、透镜与色散

12.1 反射、折射、透镜与色散

题型 1：用靠近或远离法线判断介质光速变化（考频★★★★☆）

知识点 光从一种介质斜射入另一种传播速度不同的介质时，传播方向改变的现象称为折射；入射角和折射角均从法线量起，单位为度。

光进入传播速度较小的介质时，折射光线_____法线；进入传播速度较大的介质时，折射光线_____法线。

折射过程中频率保持不变，由 $v = f\lambda$ 得，光速减小时波长_____；光速单位为 $\mathrm{m\ s^{-1}}$，波长单位为 m。

光从同一种介质进入并离开两平行界面的玻璃砖后，出射光线与入射光线平行，但位置发生侧移。

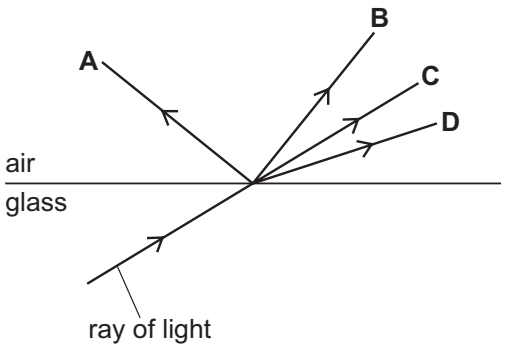
答案：偏向；偏离；减小

怎么认 题目出现光线穿过介质分界面并要求判断路径或光速时，先找出法线并比较夹角。

例题 1

The diagram shows a ray of light travelling from glass into air.

Which labelled arrow shows the path of the light in the air?



（2024 May/Jun · 0654/12 · Question 33 · Core；同题：2024 May/Jun · 0654/13 · Question 33 · Core）

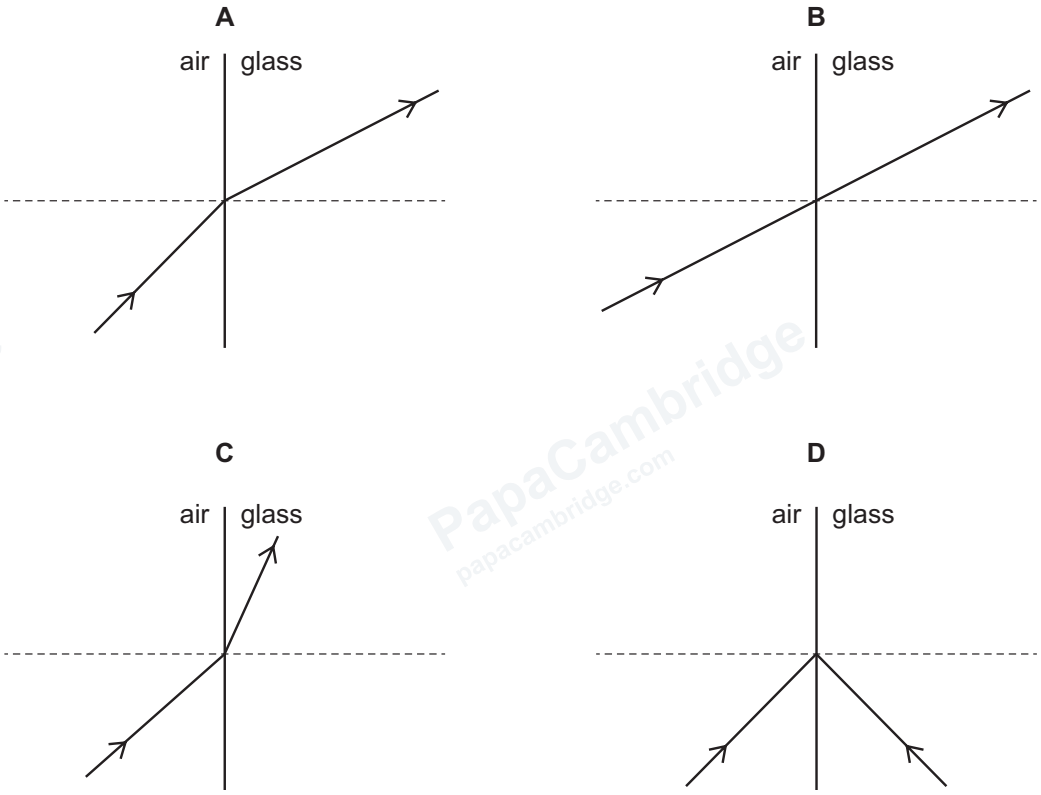
解：光由玻璃进入空气，传播速度增大，折射光线偏离法线。

折射角大于入射角，光线在空气中更靠近界面，对应 D。

故选 D。

针对练习

1. Which diagram shows the refraction of a light ray as it travels from air into glass?

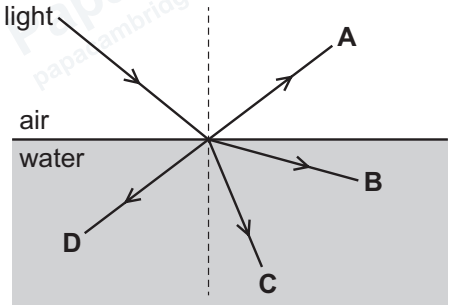


（2026 May/Jun · 0654/13 · Question 33 · Core）

2. A ray of light in air is incident on the surface of water. The ray of light is refracted.

Light travels more slowly in water than in air.

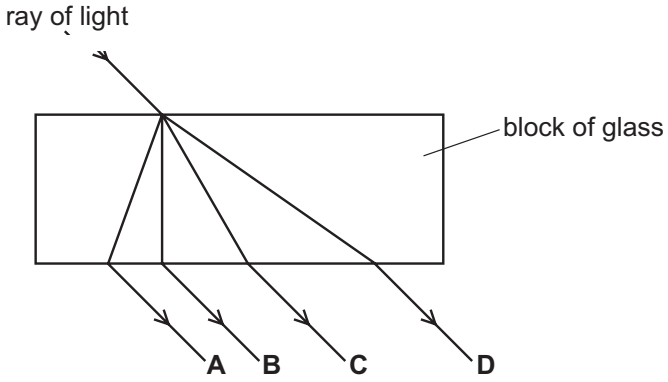
In which labelled direction is the light refracted?



（2026 May/Jun · 0654/21 · Question 33 · Extended）

3. The diagram shows a ray of light in air striking a rectangular block of glass.

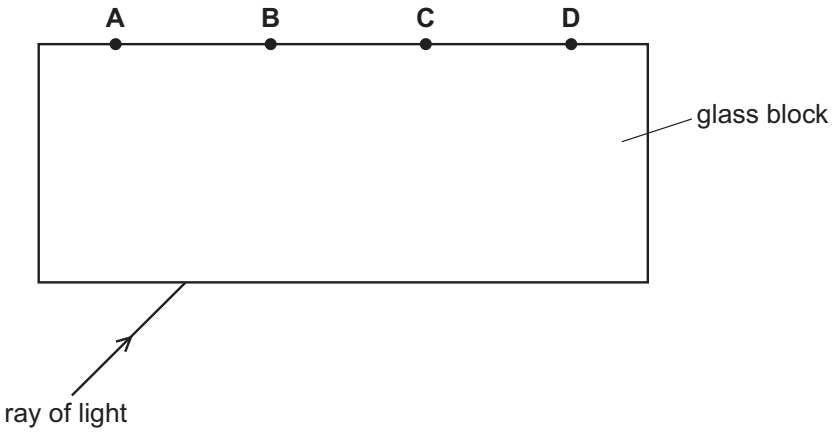
Which labelled arrow shows the path of the light into and out of the block?



(2025 Oct/Nov · 0654/11 · Question 34 · Core)

4. A ray of light enters a parallel-sided glass block.

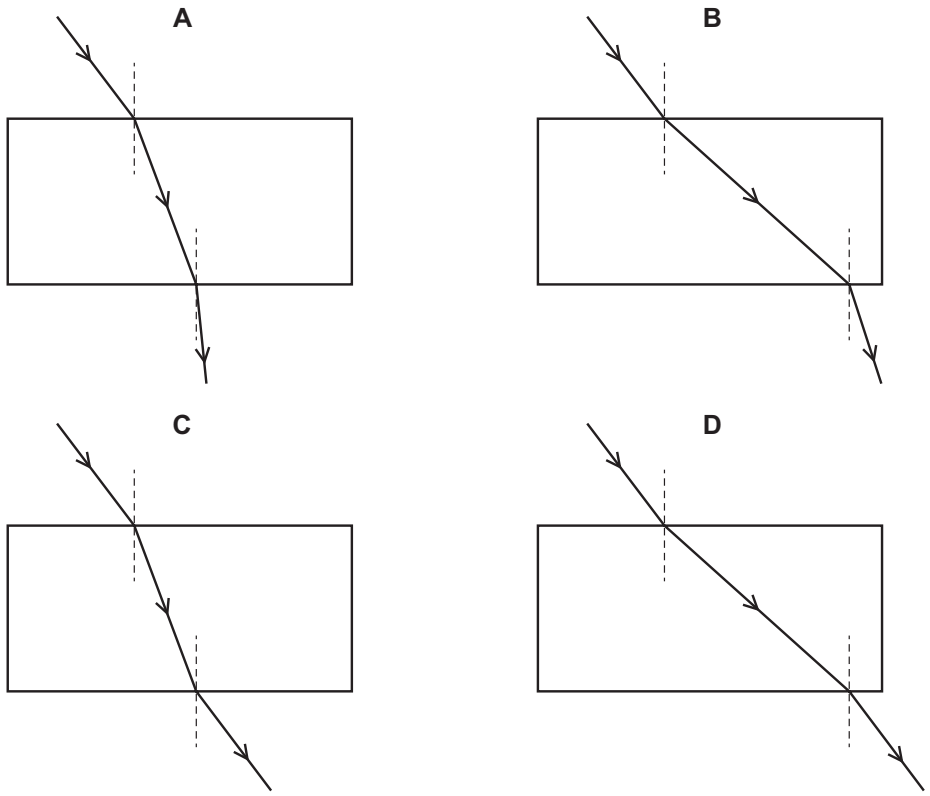
At which labelled point does the ray leave the block?



(2023 Oct/Nov · 0654/11 · Question 34 · Core)

5. A ray of light travels from air into a parallel-sided glass block and then back into air.

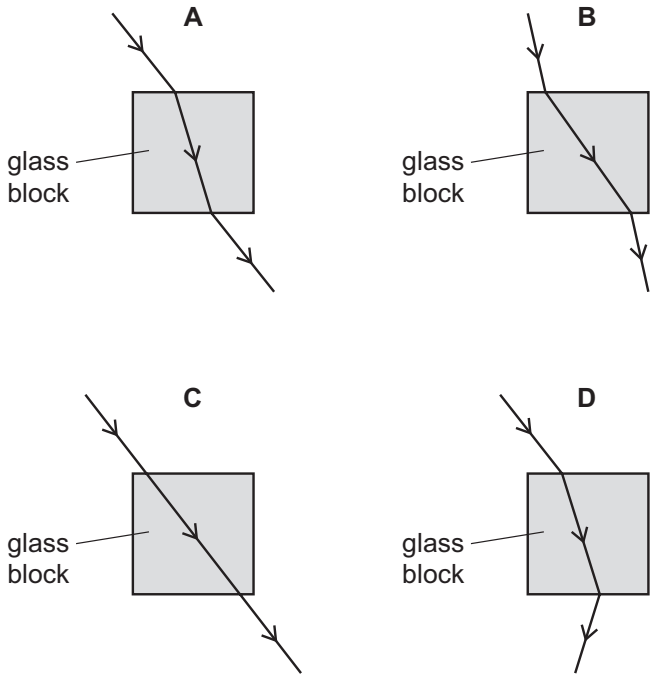
Which diagram shows the path of the light?



(2024 Oct/Nov · 0654/11 · Question 33 · Core)

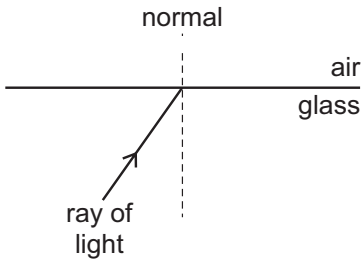
6. Light passes from air through a solid glass block and back into the air.

Which diagram shows the path of the light?



(2023 May/Jun · 0654/23 · Question 34 · Extended)

7. A ray of light travels from glass into air.



In which direction is the light refracted and how does the speed of the light change?

	direction of refracted light	speed of light
A	bends away from the normal	decreases
B	bends away from the normal	increases
C	bends towards the normal	decreases
D	bends towards the normal	increases

(2024 Oct/Nov · 0654/21 · Question 33 · Extended)

8. A light wave travelling in air is refracted as it enters a glass block.

Which row shows the effect on the speed and the wavelength of the light wave as it enters the glass?

	speed	wavelength
A	decreases	decreases
B	decreases	no change
C	increases	increases
D	increases	no change

(2024 Oct/Nov · 0654/23 · Question 33 · Extended)

9. When light passes from air into glass its speed decreases but its frequency remains constant.

Light travelling in air enters a glass block at an angle of incidence that is greater than 0°.

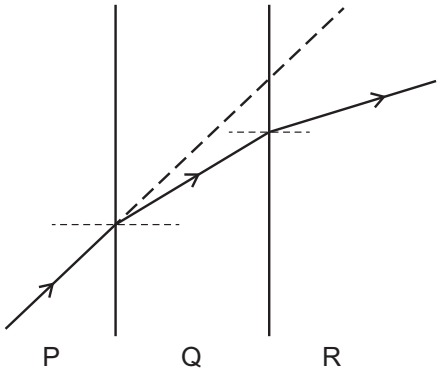
Which row describes what happens to the direction and what happens to the wavelength of the light?

	direction	wavelength
A	moves away from the normal	decreases
B	moves away from the normal	increases
C	moves towards the normal	decreases
D	moves towards the normal	increases

(2023 Oct/Nov · 0654/21 · Question 34 · Extended)

10. The diagram shows a ray of light passing from medium P to medium Q and then to medium R.

The speeds of light in each of the mediums P, Q and R are c_P, c_Q and c_R respectively.



Which list compares the speeds of light in the three mediums in order from lowest to highest?

A $c_P \rightarrow c_Q \rightarrow c_R$

B $c_P \rightarrow c_R \rightarrow c_Q$

C $c_Q \rightarrow c_P \rightarrow c_R$

D $c_R \rightarrow c_Q \rightarrow c_P$

（2025 May/Jun · 0654/21 · Question 34 · Extended）

题型 2：先认高折射率到低折射率，再与临界角比较（考频★★★☆☆）

知识点 光从折射率较高的介质射向折射率较低的介质时，折射角大于入射角；折射角增大到 90° 时对应的入射角称为_____，记为 c，角度单位为 °。

入射角 $i = c$ 时，折射光沿界面传播；$i < c$ 时，光发生折射，同时有一部分光被反射。

当光从高折射率介质射向低折射率介质，且 $i > c$ 时，发生_____，不再有折射光。

全反射时仍满足反射定律，反射角_____入射角。

答案：临界角；全反射；等于

怎么认 题目出现光由玻璃、水等射向空气及临界角时，先认传播方向，再比较入射角与临界角。

例题 1

Light undergoes total internal reflection in an optical fibre.

Which statement explains why this reflection occurs?

A The angle of incidence is equal to the angle of refraction.

B The angle of incidence is greater than the angle of reflection.

C The angle of incidence is greater than the critical angle.

D The angle of incidence is less than the critical angle.

（2022 Feb/Mar · 0654/22 · Question 32 · Extended）

解：由全反射的成立条件，光应从高折射率介质射向低折射率介质，且入射角 i 大于临界角 c，即 $i > c$。

故选 C。

针对练习

1. A ray of light strikes the boundary between water and air.

Which statement describes when the angle of incidence is equal to the critical angle?

A The light passes from air into water and **no** light is reflected.

B The light passes from air into water and the angle of refraction is 90°.

C The light passes from water into air and **no** light is reflected.

D The light passes from water into air and the angle of refraction is 90°.

（2025 Oct/Nov · 0654/21 · Question 35 · Extended）

2. Which statement describes the term critical angle?

A the largest angle of incidence in a denser medium for which refraction into a less dense medium occurs

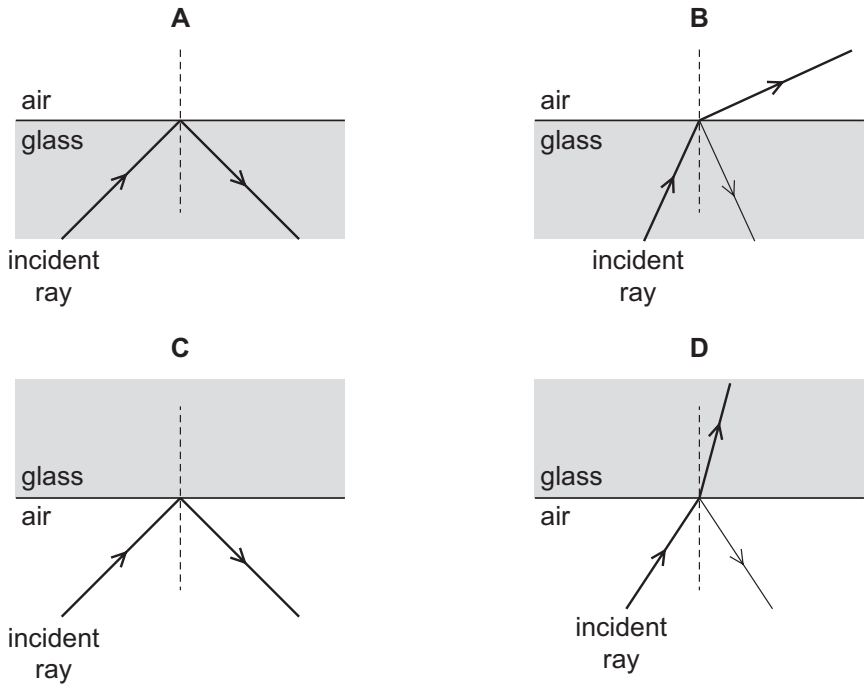
B the largest angle of incidence in a less dense medium for which refraction into a denser medium occurs

C the smallest angle of incidence in a denser medium for which refraction into a less dense medium occurs

D the smallest angle of incidence in a less dense medium for which refraction into a denser medium occurs

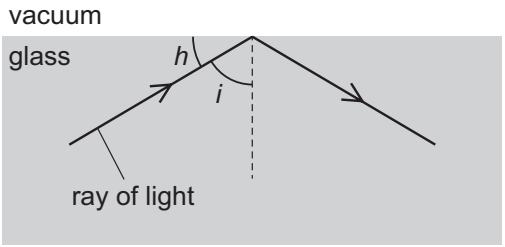
（2025 Oct/Nov · 0654/23 · Question 33 · Extended）

3. Which diagram shows a ray of light undergoing total internal reflection?



（2024 May/Jun · 0654/23 · Question 33 · Extended）

4. A glass block is surrounded by a vacuum. A ray of light strikes the inside of the glass block. The ray of light is totally reflected back into the block.



Which statement explains why this happens?

A Angle *h* is greater than the critical angle.

B Angle *i* is greater than the critical angle.

C Light **cannot** travel through a vacuum.

D The ray of light is travelling along the normal.

(2026 May/Jun · 0654/22 · Question 36 · Extended)

5. A glass block on a laboratory bench is surrounded by air. Light travels in the glass block and reaches the edge of the block. The angle of incidence at the edge is much smaller than the critical angle.

What happens to the light?

A All of the light emerges into the air.

B All of the light is reflected back into the block.

C Some of the light emerges into the air and some is reflected back into the block.

D Some of the light is reflected back into the block and some travels along the edge of the block.

(2026 Feb/Mar · 0654/22 · Question 34 · Extended)

6. The critical angle of water is 49°.

A ray of light from the bottom of a swimming pool has an angle of incidence of 50° at the surface of the water.

What happens to the ray of light?

A It is all refracted with an angle of refraction of 49°.

B It is partly reflected and partly refracted.

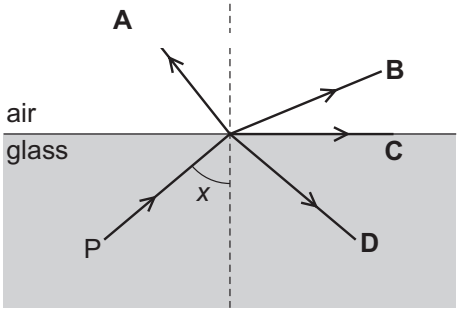
C It is totally internally reflected with an angle of reflection of 50°.

D It travels along the surface of the water.

(2024 Oct/Nov · 0654/22 · Question 33 · Extended)

7. The diagram shows a ray of light travelling in glass from point P towards a glass–air boundary. Angle *x* is greater than the critical angle.

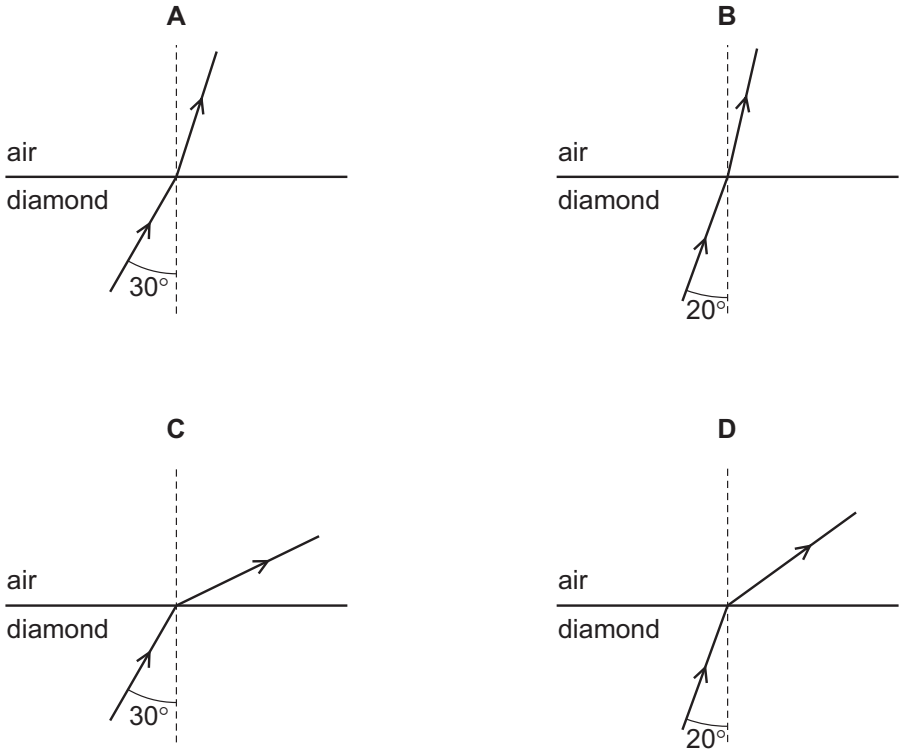
In which labelled direction does the ray continue?



（2025 May/Jun · 0654/23 · Question 33 · Extended）

8. The critical angle for diamond in air is 25°. Light travels faster in air than in diamond.

Which diagram shows the path of light passing from diamond into air?



（2022 Oct/Nov · 0654/21 · Question 34 · Extended；同题：2022 Oct/Nov · 0654/22 · Question 34 · Extended；同题：2022 Oct/Nov · 0654/23 · Question 34 · Extended）

题型 3：相对法线读入射角、反射角或折射角（考频★★★☆☆）

知识点 光线射到分界面或镜面时，过入射点且垂直于界面的直线称为_____。

入射角是入射光线与法线的夹角，反射角是反射光线与法线的夹角，折射角是折射光线与法线的夹角。

发生反射时，反射角_____入射角；角的单位为度（°）。

发生折射时，入射角与折射角分别位于分界面两侧，且都从_____量起。

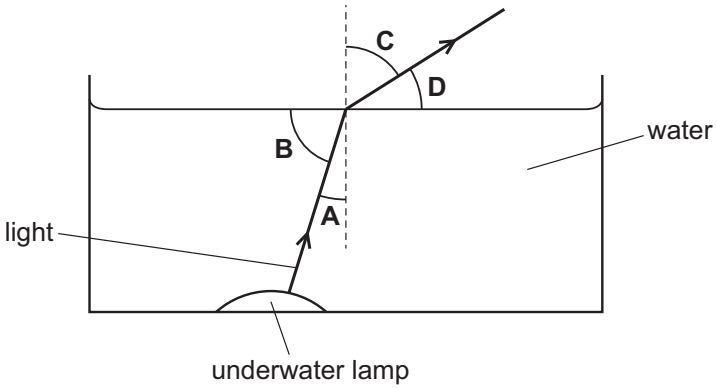
答案：法线；等于；法线

怎么认 题目出现光线、界面或镜面、法线及标角时，先确定光线方向，再从法线量角。

例题 1

Light from an underwater lamp is refracted at the surface of water.

Which labelled angle is the angle of refraction of the light?

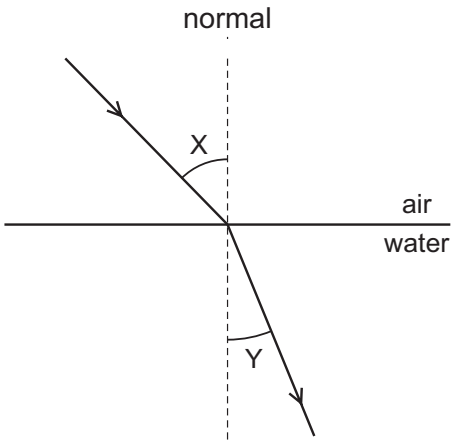


（2022 Oct/Nov · 0654/13 · Question 34 · Core）

解：光线从水中射向空气，界面上方的出射光线是折射光线。
折射角是折射光线与法线的夹角，图中标为 C。故选 C。

针对练习

1. Light travels from air into water.



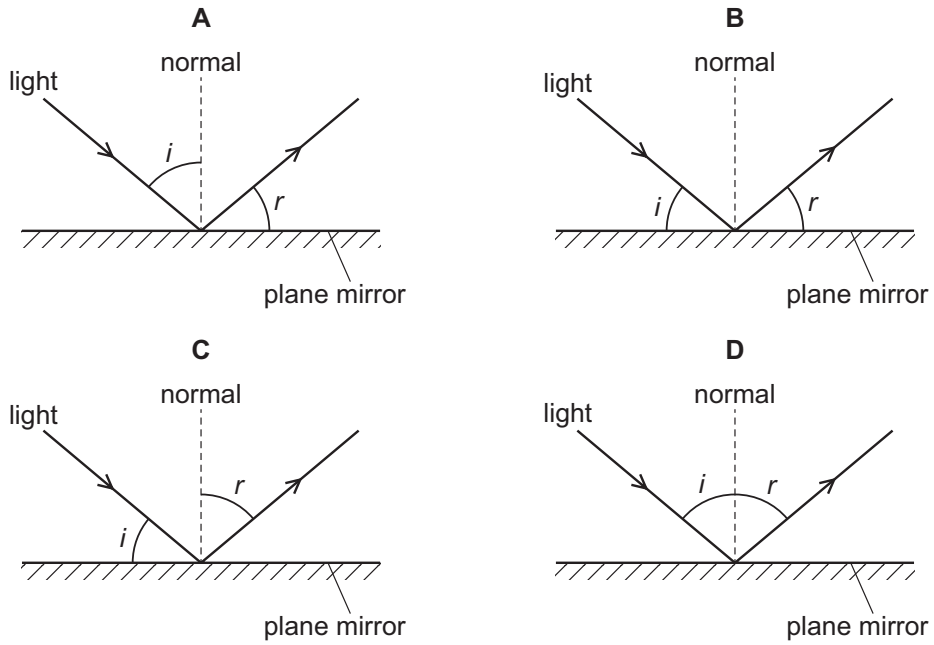
What are the names of angle X and angle Y?

	angle X	angle Y
A	angle of incidence	angle of reflection
B	angle of incidence	angle of refraction
C	angle of refraction	angle of incidence
D	angle of refraction	angle of reflection

（2025 May/Jun · 0654/12 · Question 34 · Core；同题：2025 May/Jun · 0654/13 · Question 34 · Core）

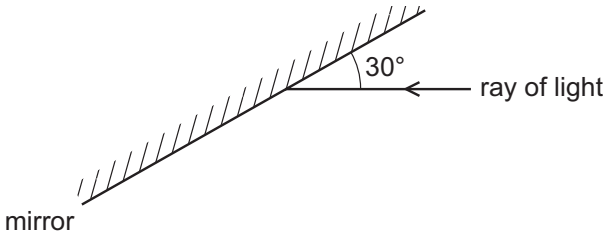
2. Light strikes a plane mirror and is reflected.

Which diagram shows the angle of incidence labelled *i* and the angle of reflection labelled *r*?



(2025 Feb/Mar · 0654/12 · Question 34 · Core)

3. A ray of light strikes a plane mirror.



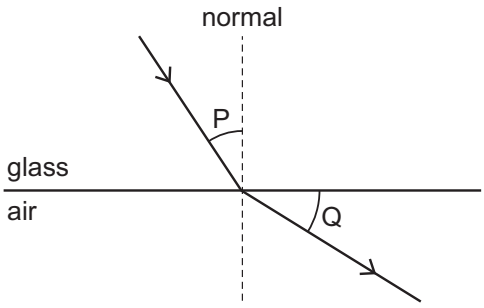
What is the angle of reflection of the ray?

A 150° **B** 90° **C** 60° **D** 30°

(2025 Oct/Nov · 0654/11 · Question 33 · Core)

4. The diagram shows a ray of light passing from glass into air.

Two angles P and Q are labelled.

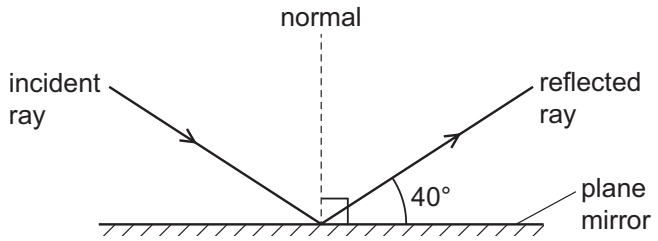


What is the angle of refraction?

A P **B** Q **C** 90° – P **D** 90° – Q

(2024 Feb/Mar · 0654/12 · Question 33 · Core)

5. The diagram shows light hitting a plane mirror.



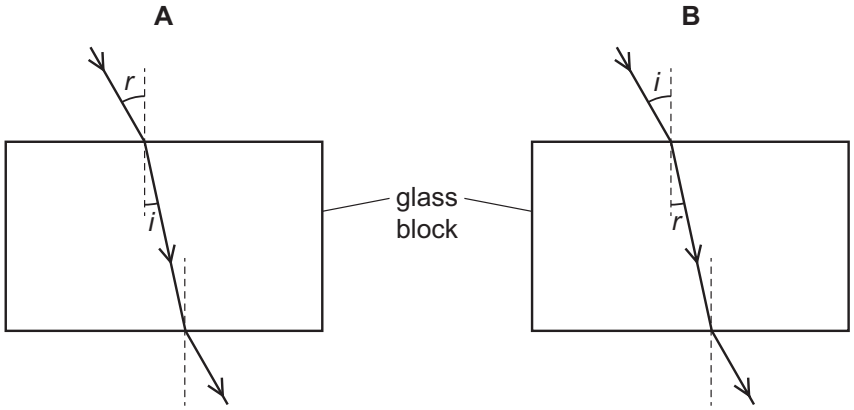
What is the angle of incidence?

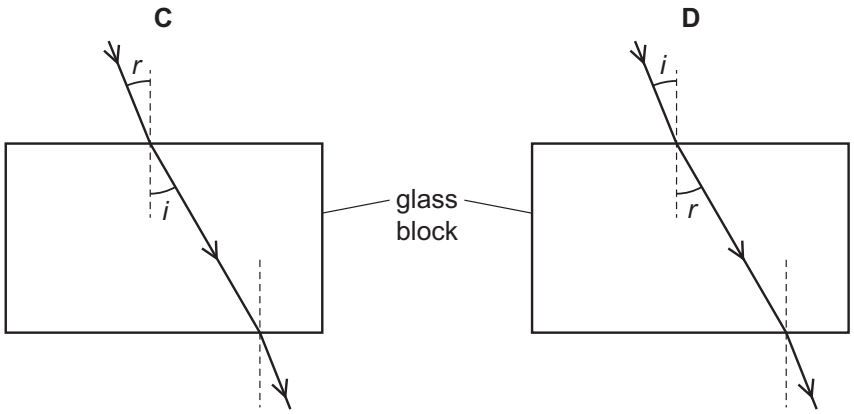
A 40° **B** 50° **C** 80° **D** 100°

（2025 May/Jun · 0654/11 · Question 35 · Core）

6. Light travelling in air passes through a glass block.

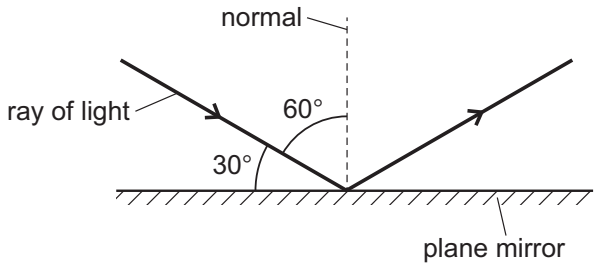
Which diagram shows the refraction of the light, with the angle of incidence labelled *i* and the angle of refraction labelled *r*?





（2025 Oct/Nov · 0654/12 · Question 35 · Core；同题：2025 Oct/Nov · 0654/13 · Question 35 · Core）

7. The diagram shows a ray of light which is reflected from a plane mirror.



What is the angle of incidence and what is the angle of reflection?

	angle of incidence / °	angle of reflection / °
A	30	30
B	30	60
C	60	30
D	60	60

（2022 Feb/Mar · 0654/12 · Question 35 · Core）

题型 4：物体在焦距之内，用反向延长线找放大虚像（考频★★★☆☆）

知识点 薄会聚透镜作放大镜时，物体应放在透镜与主焦点之间，即物距 u _____ 焦距 f。
折射光线不能在像侧会聚，其反向延长线在物侧相交，形成_____、放大、虚像。
u 与 f 均为长度，比较时应使用相同单位，如 cm。

答案：小于；正立

怎么认 题目出现会聚透镜作放大镜、物体位于焦点内或求放大虚像时，先判断 $u < f$，再反向延长出射光线。

例题 1

A thin converging lens is used as a magnifying glass to view an object.

The focal length of the lens is 15 cm.

What is a suitable distance from the lens for the object to be placed?

A 10 cm **B** 20 cm **C** 30 cm **D** 60 cm

（2026 May/Jun · 0654/23 · Question 34 · Extended）

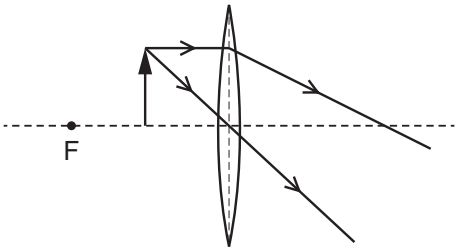
解： 由放大镜成像条件得 $u < f$。
$f = 15$ cm，四个选项中满足 $u < 15$ cm 的物距为 10 cm。故选 A。

针对练习

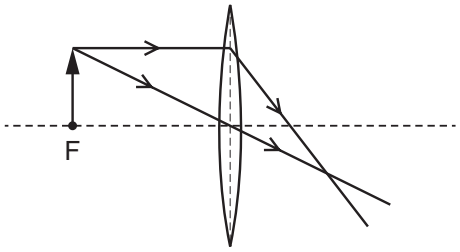
1. In the diagrams, F is one principal focus of the converging lens.

Which diagram shows the use of a lens as a magnifying glass?

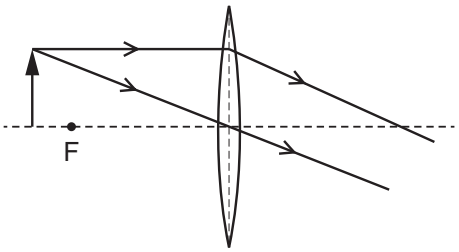
A



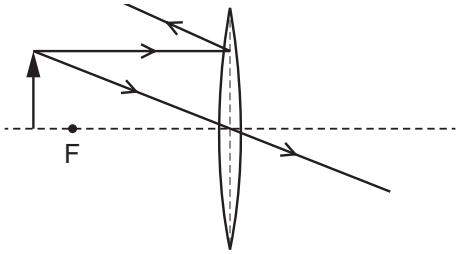
B



C



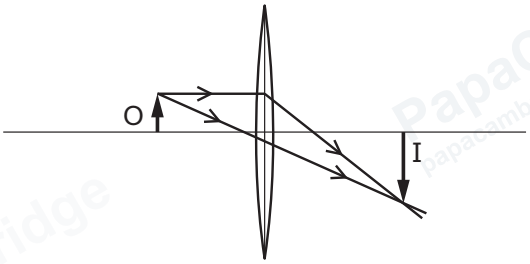
D



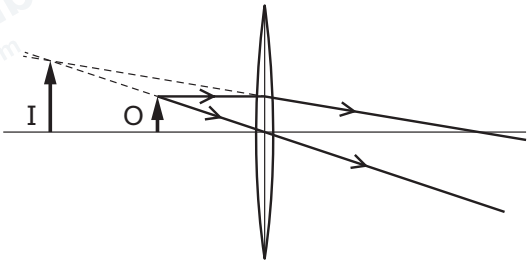
（2025 Oct/Nov · 0654/21 · Question 33 · Extended）

2. Which ray diagram represents the formation of a virtual image I of an object O by a thin converging lens?

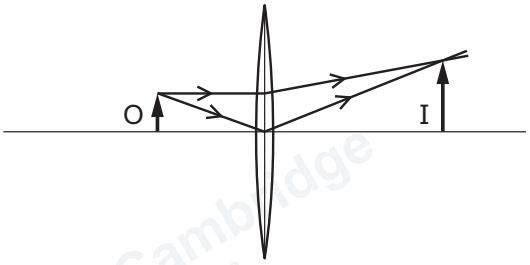
A



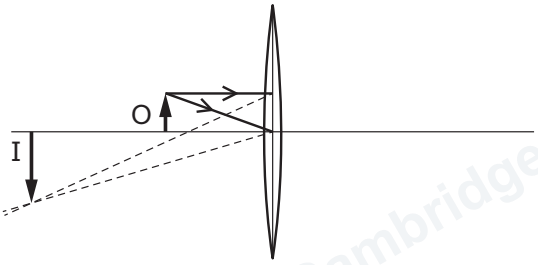
B



C



D



（2026 May/Jun · 0654/21 · Question 34 · Extended）

3. A lens is used as a magnifying glass to form a magnified image of some writing on a page.



Which statements are correct?

1 The lens is a converging lens.

2 The writing is closer to the lens than one focal length of the lens.

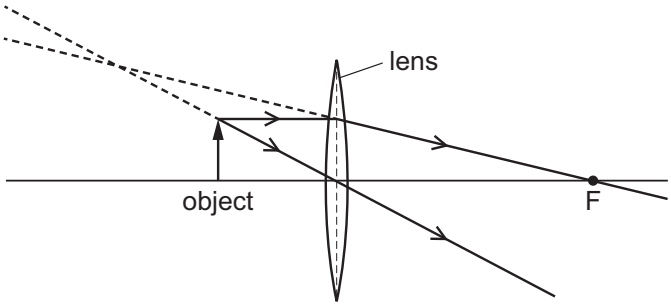
3 The magnified image is a virtual image.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

(2022 May/Jun · 0654/23 · Question 34 · Extended)

4. The diagram shows how a thin, converging lens forms an image of an object.

One principal focus of the lens is labelled F.



How is the image described?

A enlarged, upright and real

B enlarged, upright and virtual

C diminished, inverted and real

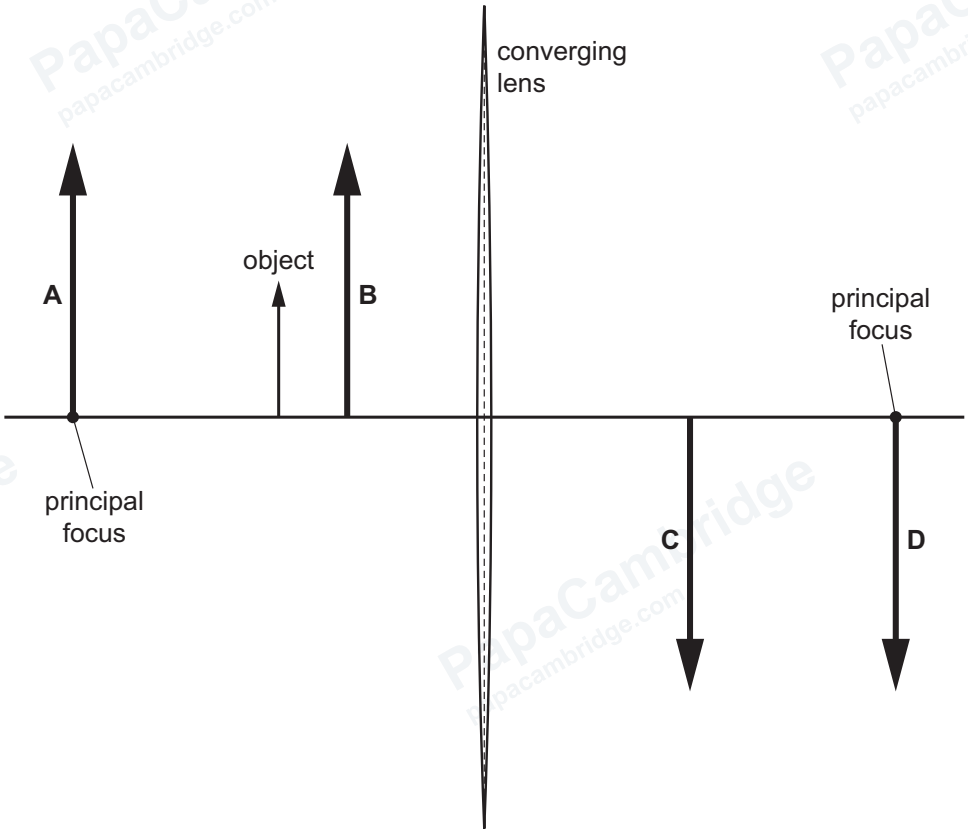
D diminished, inverted and virtual

(2022 May/Jun · 0654/21 · Question 33 · Extended)

5. A student uses a converging lens to obtain a magnified, virtual image of an object.

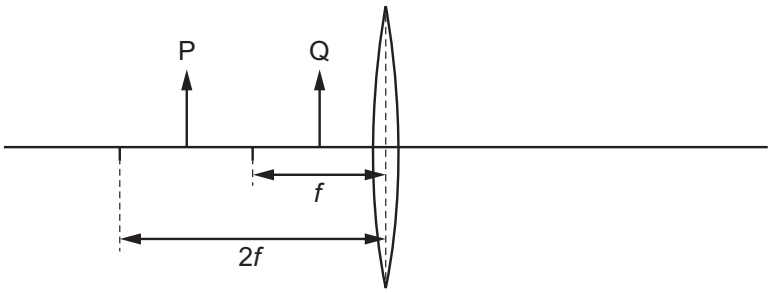
The diagram shows the position of the object and the principal focus on each side of the lens.

At which labelled position is the image formed?



(2026 Feb/Mar · 0654/22 · Question 35 · Extended)

6. The diagram shows an object at position P in front of a thin converging lens of focal length *f*. The lens produces a real image of the object.



The object is moved to position Q. The image produced is now virtual.

What happens to the image?

A It changes from a diminished image to an enlarged image.

B It changes from an enlarged image to a diminished image.

C It remains a diminished image.

D It remains an enlarged image.

(2023 May/Jun · 0654/23 · Question 35 · Extended)

题型 5：把对法线的角代入折射率关系（考频★★★☆☆）

知识点 折射率 n 表示真空中光速 c 与介质中光速 v 的比值，$n=$ _____。

光从空气或真空射入介质时，$n=\dfrac{\sin i}{\sin r}$，其中 i、r 分别是入射光、折射光与_____的夹角。

图中给出光线与界面的夹角 θ 时，相对法线的角为 $90°-\theta$；折射率没有单位。

答案：$\frac{c}{v}$；法线

怎么认 题目出现入射角、折射角或光线与界面的夹角时，先把所用角换成光线与法线的夹角。

例题 1

What is the definition of the refractive index *n* of a substance?

A $\dfrac{\text{speed of light in a vacuum}}{\text{speed of light in the substance}}$

B $\dfrac{\text{speed of light in the substance}}{\text{speed of light in a vacuum}}$

C $\dfrac{\text{frequency of light in a vacuum}}{\text{frequency of light in the substance}}$

D $\dfrac{\text{frequency of light in the substance}}{\text{frequency of light in a vacuum}}$

（2024 Feb/Mar · 0654/22 · Question 34 · Extended）

解：设真空中的光速为 c，介质中的光速为 v。

由折射率定义得

$n=\frac{c}{v}$。

故选 A。

针对练习

1. A ray of light in air enters glass at an angle of incidence of 34°.

The refractive index of glass is 1.5.

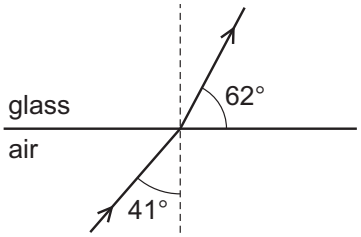
What is the angle of refraction of the ray of light in the glass?

A 22° **B** 24° **C** 56° **D** 57°

（2023 May/Jun · 0654/22 · Question 35 · Extended）

2. Light enters a glass block at an angle of incidence of 41°. The light bends toward the normal.

The angle between the refracted ray and the glass-air boundary is 62°.



Which expression is equal to the refractive index of the glass?

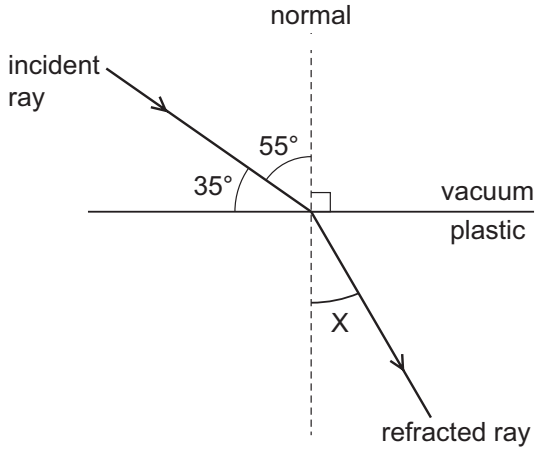
A $\dfrac{\sin 41°}{\sin 28°}$ **B** $\dfrac{\sin 41°}{\sin 62°}$ **C** $\dfrac{\sin 49°}{\sin 28°}$ **D** $\dfrac{\sin 49°}{\sin 62°}$

（2022 May/Jun · 0654/22 · Question 34 · Extended）

3. The diagram shows a ray of light that passes from a vacuum into plastic.

The plastic has a refractive index of 1.5.

An angle X is labelled on the diagram.

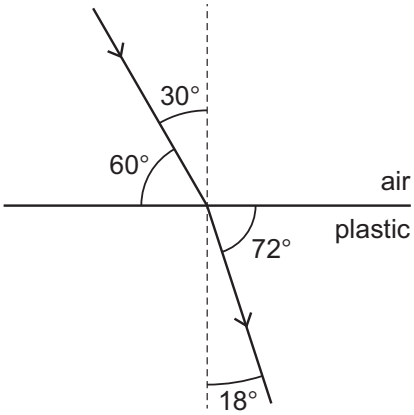


What is angle X?

A 22° **B** 23° **C** 33° **D** 37°

(2025 Oct/Nov · 0654/22 · Question 34 · Extended)

4. The diagram shows a ray of light passing from air into plastic. The sizes of four angles are given.



The table gives the value of the sine of each angle.

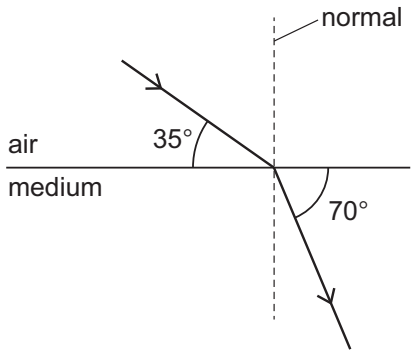
angle / °	sine
18	0.31
30	0.50
60	0.87
72	0.95

What is the refractive index of the plastic?

A 0.62 **B** 0.92 **C** 1.6 **D** 1.7

(2023 May/Jun · 0654/21 · Question 34 · Extended)

5. The diagram shows a ray of light passing from air into a transparent medium.



What is the refractive index of the medium?

A 0.50 **B** 0.61 **C** 2.4 **D** 2.8

（2023 Feb/Mar · 0654/22 · Question 34 · Extended）

题型 6：核对平面镜像等大、正立、等距及左右反转（考频★★☆☆☆）

知识点 平面镜所成的像是虚像，像与物体关于镜面对称。

像与物体的大小_____，像到镜面的垂直距离_____物体到镜面的垂直距离。

像为正立像，上下方向不变，并发生_____；比较距离时应使用相同长度单位。

以上关系适用于平面镜，与镜面竖直或水平无关。

答案：相同；等于；左右反转

怎么认 题目出现平面镜及像的大小、方向或镜面两侧距离时，先核对等大、正立、等距和左右反转。

例题 1

Which description is correct for the image of an object formed by a vertical plane mirror?

A upright and larger than the object

B upright and the same size as the object

C upside down and smaller than the object

D upside down and the same size as the object

（2022 Oct/Nov · 0654/11 · Question 34 · Core）

解：平面镜成像时，像与物体等大，且像为正立像。

故选 B。

针对练习

1. A plane mirror is fixed to a vertical wall and forms an image of an object.

What are the characteristics of the image?

A enlarged and upright

B enlarged and inverted

C same size as the object and upright

D same size as the object and inverted

（2024 May/Jun · 0654/22 · Question 34 · Extended）

2. An object is placed in front of a mirror on a wall.

Which statement about the image formed by the mirror is correct?

A The image and the object are equal distances from the mirror.

B The image is diminished (smaller than the object).

C The image is enlarged (larger than the object).

D The image is inverted (upside down).

（2024 Feb/Mar · 0654/22 · Question 33 · Extended）

3. An object is placed in front of a plane mirror on a wall.

What are the characteristics of the image formed?

A same size as object and inverted top to bottom

B same size as object and laterally inverted (left to right)

C smaller than object and inverted top to bottom

D smaller than object and laterally inverted (left to right)

（2023 May/Jun · 0654/12 · Question 34 · Core；同题：2023 May/Jun · 0654/13 · Question 34 · Core、2023 May/Jun · 0654/22 · Question 34 · Extended）

4. A student stands in front of a plane mirror on a wall.

Which statement about the image of the student is **not** correct?

A The image is laterally inverted (left to right).

B The image is smaller than the student.

C The image is upright.

D The student and the image are equal distances from the mirror.

（2023 May/Jun · 0654/11 · Question 35 · Core；同题：2023 May/Jun · 0654/21 · Question 32 · Extended）

题型 7：认平行主轴的光经会聚透镜通过主焦点（考频★★☆☆☆）

知识点 通过薄透镜光心并垂直于透镜的直线叫_____。

与主轴平行的光线射入薄会聚透镜后，折射光线通过透镜另一侧的_____。

薄会聚透镜有两个主焦点，分居透镜两侧，且到光心的距离相等。

光心到主焦点的距离叫焦距，用 f 表示，单位是_____。

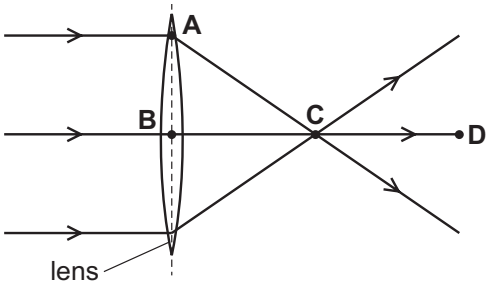
答案：主轴；主焦点；米（m）

怎么认 题目出现平行于主轴的入射光和会聚透镜时，先确定折射光线通过透镜另一侧的主焦点。

例题 1

The diagram shows light passing through a thin converging lens.

Which labelled point is the principal focus of the lens?



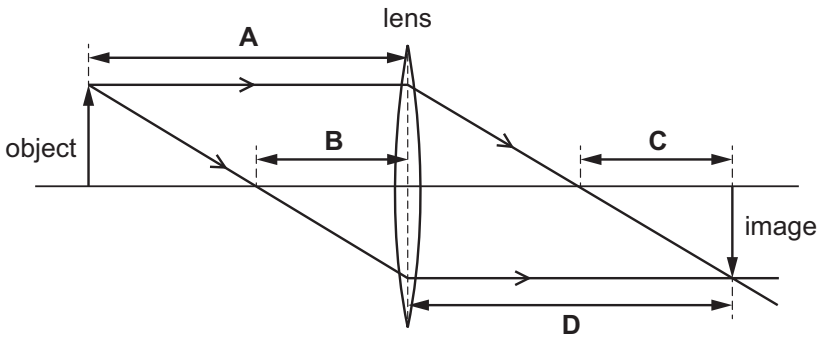
（2025 Feb/Mar · 0654/12 · Question 35 · Core）

解：入射光线平行于主轴，由会聚透镜的折射规律，折射光线通过另一侧主焦点。
图中三条折射光线在主轴上的 C 点相交，故选 C。

针对练习

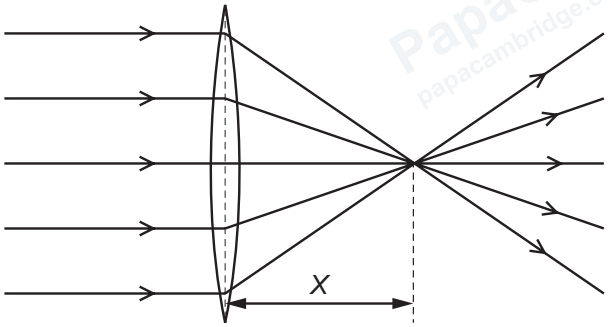
1. The diagram shows two rays of light passing through a thin converging lens to form an image of an object. Four distances are labelled.

Which labelled distance is the focal length of the lens?



（2025 May/Jun · 0654/11 · Question 34 · Core）

2. The diagram shows light passing through a thin converging lens.



What is the distance X?

A the distance from the lens to an object

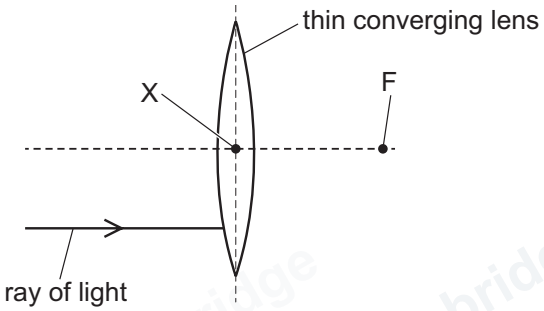
B the focal length of the lens

C the principal focus of the lens

D the wavelength of the light

（2026 Feb/Mar · 0654/12 · Question 34 · Core）

3. The diagram shows a ray of light striking a thin converging lens. The centre of the lens is marked X and the principal focus of the lens is marked F.



What happens to the ray after it passes through the lens?

A It continues in its original direction.

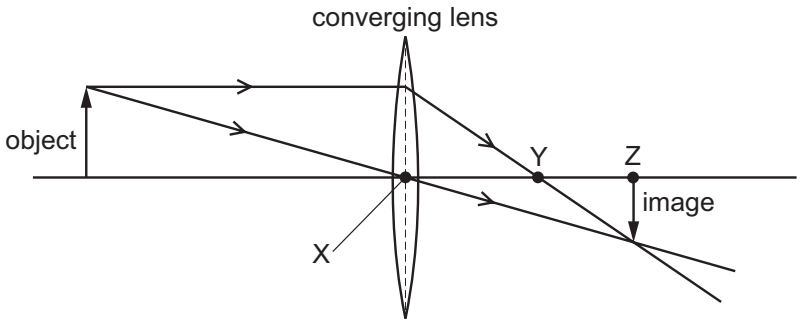
B It travels away from the principal focus F.

C It travels through the centre of the lens X.

D It travels towards the principal focus F.

（2026 May/Jun · 0654/11 · Question 33 · Core）

4. The diagram shows the formation of an image of an object by a converging lens. Three points are labelled X, Y and Z.



Which labelled point is a principal focus of the lens and which distance is the focal length?

	principal focus	focal length
A	Y	XY
B	Y	XZ
C	Z	XY
D	Z	XZ

（2024 Oct/Nov · 0654/23 · Question 34 · Extended）

题型 8：看真实光线是否相交区别实像和虚像（考频★★☆☆☆）

知识点 反射光线或折射光线实际会聚的位置形成_____，这种像能呈现在屏幕上。

光线未在像的位置相交，而是反向延长线相交时形成_____，这种像不能呈现在屏幕上。

判断像的种类，应看形成像的真实光线是否相交；像的大小和正倒不能单独作为判据。

答案：实像；虚像

怎么认 题目出现实像、虚像、屏幕或光路图时，先看真实光线是否在像的位置相交。

例题 1

Which statement about real and virtual images formed by a thin converging lens is correct?

A All real images are enlarged and inverted.

B All real images can be produced on a screen.

C All virtual images are diminished and upright.

D All virtual images can be produced on a screen.

（2025 Feb/Mar · 0654/22 · Question 35 · Extended）

解：实像由实际相交的折射光线形成，能呈现在屏幕上。
A 错，实像不一定放大；B 对；C 错，会聚透镜形成的虚像不是缩小的；D 错，虚像不能呈现在屏幕上。
故选 B。

针对练习

1. What is the difference between a real image and a virtual image?

A A real image can be shown on a screen, but a virtual image cannot.

B A real image is always formed by a magnifying glass.

C A real image is always formed by a plane mirror.

D A virtual image can be shown on a screen, but a real image cannot.

（2025 May/Jun · 0654/22 · Question 34 · Extended）

2. An image of an object is formed by a plane mirror. The image formed is virtual.

Which statement describes what is meant by a virtual image?

A The reflected rays do not meet where the image is formed.

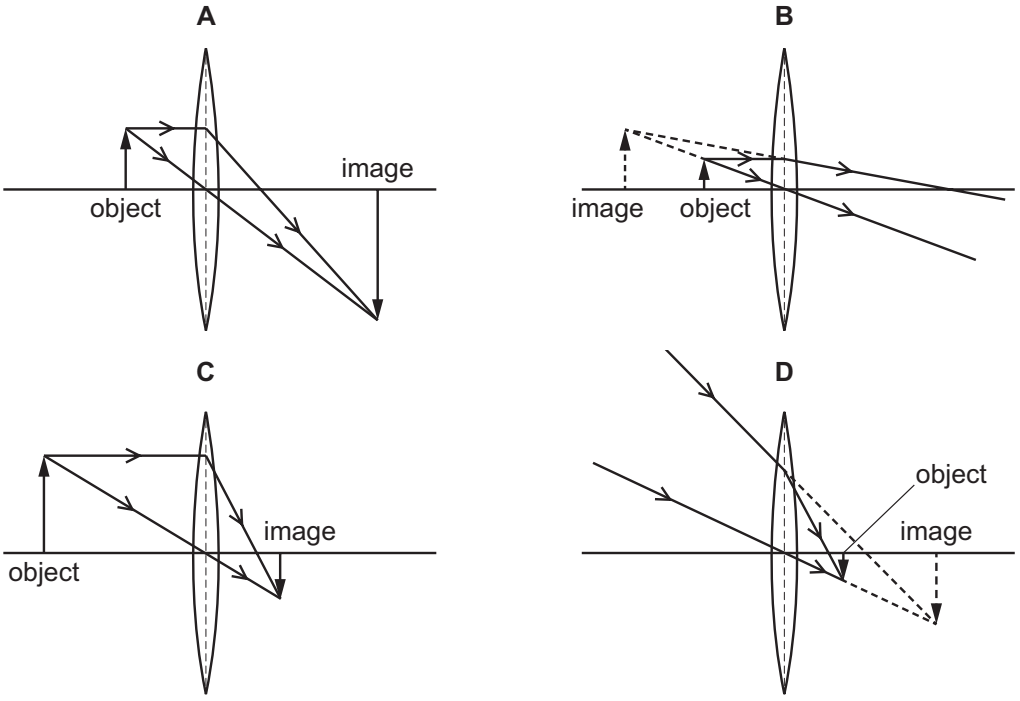
B The image is formed directly opposite the object.

C The image is the same distance from the mirror as the distance of the object from the mirror.

D The angle of incidence is equal to the angle of reflection.

（2025 May/Jun · 0654/23 · Question 32 · Extended）

3. Which ray diagram shows the formation of a virtual image?



（2025 Oct/Nov · 0654/23 · Question 34 · Extended）

题型 9：白光过棱镜分色且蓝光偏折多于红光（考频★☆☆☆☆）

知识点 白光由多种颜色的光组成，白光通过玻璃棱镜后分成不同颜色的现象叫_____（dispersion）。
当各色光通过同一玻璃棱镜时，折射程度不同，因此出射后彼此分开。
各色光总体向棱镜底边偏折，其中蓝光的偏折程度比红光_____。
色散表示一种光学现象，没有单位。

答案：色散；大

怎么认 题目出现白光射入玻璃棱镜并要求判断分色名称或出射光路时，先判定色散，再比较蓝、红光的偏折程度。

例题 1

When a beam of white light passes into a glass prism, the white light splits up into seven colours.

Which term describes the splitting up of white light into different colours?

A absorption

B dispersion

C emission

D reflection

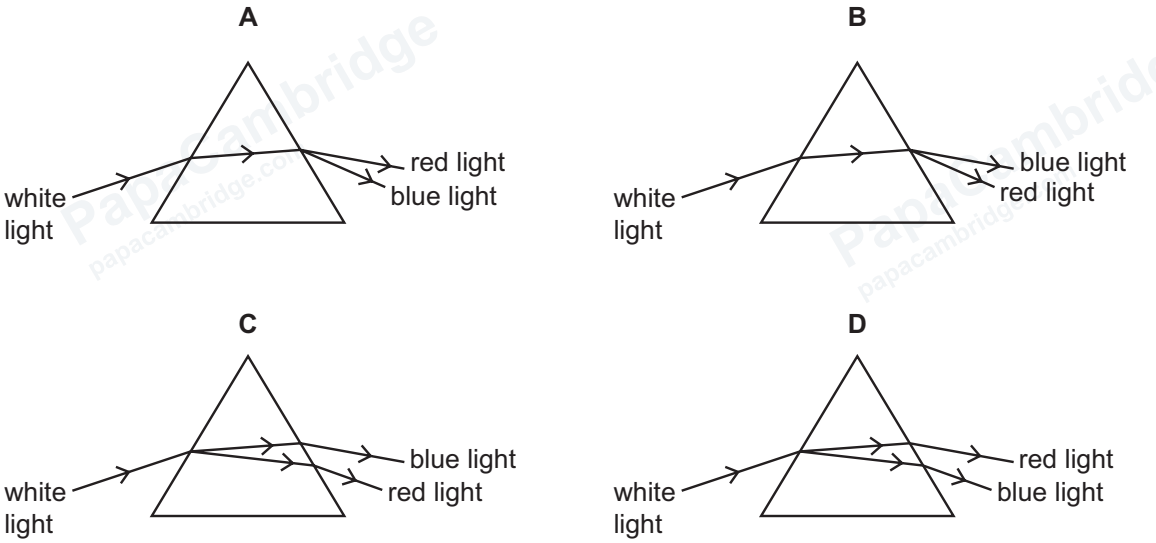
（2026 May/Jun · 0654/13 · Question 34 · Core）

解：白光通过玻璃棱镜后分成不同颜色的现象叫色散（dispersion）。故选 B。

PapaCambridge papacambridge.com

针对练习

1. Which diagram shows the dispersion of white light through a glass prism?



（2026 May/Jun · 0654/12 · Question 33 · Core）

题型 10：物体在焦距之外，追两条光线找实像（考频★★☆☆☆）

知识点 会聚透镜使平行于主轴的光线折射后通过主焦点，焦距 f 是光心到主焦点的距离。

薄透镜作图时，过光心的光线方向不变；两条折射光线的交点决定像的位置。

设物体到光心的距离为物距 u。当 $u > f$ 时，形成能承接在屏上的_____像，且像相对物体_____。

当 $f < u < 2f$ 时像放大，当 $u = 2f$ 时像等大，当 $u > 2f$ 时像_____。

物体在焦点外继续远离时，像向像方焦点移动且逐渐缩小；u、f 均为长度，常用 cm 或 m，同题须采用同一单位。

答案：实；倒立；缩小

怎么认 题目出现会聚透镜、焦点和物体位置，或给出两条光线并求像的性质时，先追平行主轴光线与过光心光线。

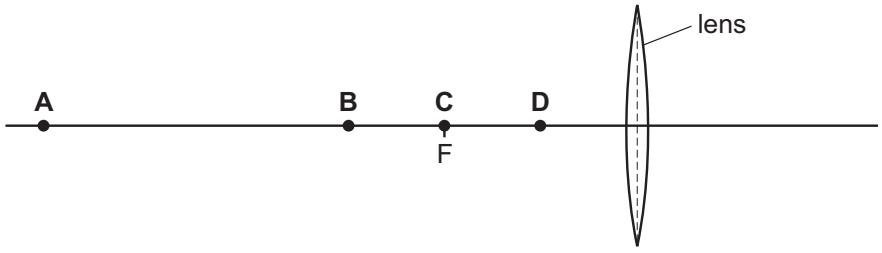
例题 1

A thin, converging lens produces an inverted, enlarged image of an object.

The image is formed on a screen.

F is a principal focus of the lens.

Which labelled point is a possible position for the object?



（2022 May/Jun · 0654/12 · Question 34 · Core；同题：2022 May/Jun · 0654/13 · Question 34 · Core）

解： 由像能成在屏上，得所成像为实像，物体位于主焦点之外。

由实像放大，得物距满足 $f < u < 2f$。

图中点 B 位于一倍焦距与二倍焦距处之间，故选 B。

针对练习

1. A thin converging lens produces a real image of an object.

What happens to the image as the object is moved away from the lens?

A It becomes larger and stays inverted.

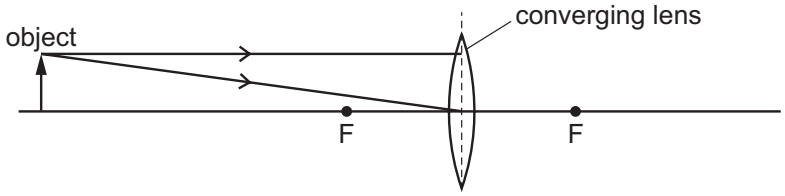
B It becomes larger and stays upright.

C It becomes smaller and stays inverted.

D It becomes smaller and stays upright.

（2024 May/Jun · 0654/21 · Question 34 · Extended）

2. An object is placed at a certain distance from a converging lens. This distance is greater than twice the focal length of the lens. The principal focus on each side of the lens is marked F and two rays from the top of the object are shown.



Which statement about the image formed is correct?

A The image is diminished and inverted.

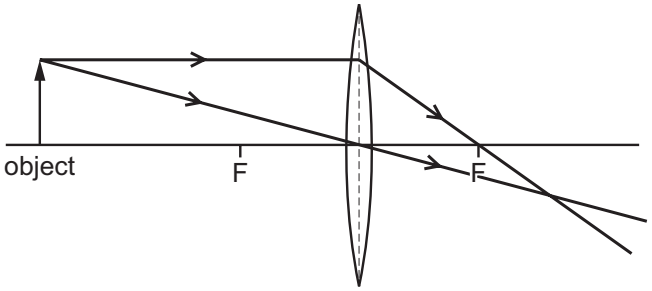
B The image is diminished and upright.

C The image is enlarged and inverted.

D The image is enlarged and upright.

（2022 Oct/Nov · 0654/12 · Question 34 · Core）

3. The diagram shows light from an object passing through a converging lens to form an image.



Which description of the image is correct?

A diminished and inverted

B diminished and upright

C enlarged and inverted

D enlarged and upright

（2022 May/Jun · 0654/11 · Question 34 · Core）

专题 13 电磁波谱与用途

13.1 电磁波谱与用途

题型 1：按频率或波长排列电磁波谱（考频★★★☆☆）

知识点 电磁波谱是按频率或波长排列的电磁波整体；按频率由低到高依次为无线电波、微波、红外线、可见光、紫外线、X 射线、伽马射线，其中频率最低的是_____，最高的是_____。

真空中所有电磁波的波速相同，满足 $c = f\lambda$；波速 c 的单位为 m/s，频率 f 的单位为 Hz，波长 λ 的单位为 m。

在波速一定时，频率越高，波长越_____；按波长由小到大排列时，顺序与按频率由低到高相同。

答案：无线电波；伽马射线；短

怎么认 题目出现若干电磁波并要求按频率或波长排列时，先写完整波谱顺序，再按所求方向截取。

例题 1

Which group shows electromagnetic waves in order of increasing frequency (lowest frequency first)?

A gamma-rays → X-rays → ultraviolet waves

B microwaves → infrared waves → gamma-rays

C ultraviolet waves → radio waves → infrared waves

D X-rays → radio waves → microwaves

（2022 Oct/Nov · 0654/12 · Question 35 · Core）

解：电磁波按频率由低到高排列为无线电波、微波、红外线、可见光、紫外线、X 射线、伽马射线。

微波、红外线、伽马射线的频率依次增大。

故选 B。

针对练习

1.

Which electromagnetic waves have the lowest frequency?

A gamma

B infrared

C ultraviolet

D radio

（2024 Oct/Nov · 0654/11 · Question 34 · Core）

2. Which list shows regions of the electromagnetic spectrum in order of increasing frequency (lowest frequency first)?

A microwaves → radio waves → ultraviolet waves

B microwaves → ultraviolet waves → radio waves

C radio waves → microwaves → ultraviolet waves

D ultraviolet waves → radio waves → microwaves

（2026 May/Jun · 0654/11 · Question 35 · Core）

3. The electromagnetic spectrum includes radio waves, infrared waves and X-rays.

What is the correct sequence of these waves in order of increasing wavelength (smallest wavelength first)?

A infrared waves, radio waves, X-rays

B infrared waves, X-rays, radio waves

C X-rays, infrared waves, radio waves

D X-rays, radio waves, infrared waves

（2024 Feb/Mar · 0654/22 · Question 35 · Extended）

4. Which statement about the electromagnetic spectrum is correct?

A Gamma-radiation has a lower frequency than visible light.

B Infrared radiation has a higher frequency than radio waves.

C Microwaves have a smaller wavelength than ultraviolet radiation.

D X-rays have a larger wavelength than visible light.

（2022 May/Jun · 0654/12 · Question 35 · Core；同题：2022 May/Jun · 0654/13 · Question 35 · Core、2022 May/Jun · 0654/22 · Question 35 · Extended）

5. Two regions of the electromagnetic spectrum are radio waves and X-rays.

Which row shows the region with the smaller wavelength and the region that is ionising radiation?

	smaller wavelength	**ionising radiation**
A	radio waves	radio waves
B	radio waves	X-rays
C	X-rays	radio waves
D	X-rays	X-rays

（2026 May/Jun · 0654/12 · Question 34 · Core）

题型 2：核对电磁波均为横波及真空共同光速（考频★★☆☆☆）

知识点 电磁波都是_____，可以在真空中传播。

所有电磁波在真空中的传播速度相同，约为_____。

在真空中，波速、频率与波长满足 $c = f\lambda$，其中 c 的单位为 m/s，f 的单位为 Hz，λ 的单位为 m。

真空中的 c 不变，因此频率越大，波长越小。

答案：横波；3.0×10^8 m/s

怎么认 题目出现电磁波类型、真空传播速度或不同波段比较时，先核对横波及共同光速。

例题 1

Which row describes all electromagnetic waves?

	type of wave	approximate speed in a vacuum / m/s
A	longitudinal	300
B	longitudinal	300 million
C	transverse	300
D	transverse	300 million

（2025 May/Jun · 0654/23 · Question 34 · Extended）

解： 所有电磁波都是横波，且在真空中的传播速度约为
$c = 3.0 \times 10^8\ \mathrm{m/s} = 300 \times 10^6\ \mathrm{m/s}.$
故选 D。

针对练习

1. What is the speed of X-rays in a vacuum?

A $3.0 \times 10^2\,\mathrm{m/s}$

B $3.0 \times 10^4\,\mathrm{m/s}$

C $3.0 \times 10^6\,\mathrm{m/s}$

D $3.0 \times 10^8\,\mathrm{m/s}$

（2025 May/Jun · 0654/21 · Question 35 · Extended）

2. Which statements about electromagnetic waves are correct?

1 The frequency of the waves increases as the wavelength increases.

2 The speed of the waves in a vacuum is 300 000 000 m/s.

3 Electromagnetic waves are transverse.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

（2025 Feb/Mar · 0654/22 · Question 34 · Extended）

3. Gamma rays and microwaves are both electromagnetic radiations.

Which statement about their frequencies and speeds in a vacuum is correct?

A Gamma rays have greater frequencies than microwaves and travel at a greater speed.

B Gamma rays have greater frequencies than microwaves and travel at the same speed.

C Gamma rays have smaller frequencies than microwaves and travel at a greater speed.

D Gamma rays have smaller frequencies than microwaves and travel at the same speed.

（2024 Oct/Nov · 0654/21 · Question 34 · Extended）

题型 3：按用途辨认红外与微波（考频★★☆☆☆）

知识点 电磁波谱可按频率分区，频率由低到高依次包括无线电波、微波、红外线、可见光、紫外线、X 射线和伽马射线；频率单位为赫兹（Hz）。
在真空中，各类电磁波的传播速度相同，约为 $3.0 \times 10^8 \text{m s}^{-1}$。
电视遥控器通常发射_____传递控制信号，热传递中的辐射常涉及红外线。
卫星电视使用_____传送信号。

答案：红外线；微波

怎么认 题目出现电视遥控器、热辐射或卫星电视等用途时，先对应红外线或微波。

例题 1

Which type of electromagnetic wave is emitted by a television remote controller?

A gamma (γ)-rays

B infrared

C ultraviolet

D X-rays

（2024 May/Jun · 0654/11 · Question 34 · Core）

解：由电视遥控器的工作用途可知，其发射红外线传递控制信号。
故选 B。

针对练习

1. Which region of the electromagnetic spectrum is often involved in heat transfer by radiation?

A infrared

B radio

C ultraviolet

D X-rays

（2024 May/Jun · 0654/22 · Question 32 · Extended）

2. Which row shows the type of electromagnetic wave used in each application?

	television remote controllers	satellite television
A	infrared	microwaves
B	infrared	ultraviolet
C	microwaves	microwaves
D	microwaves	ultraviolet

（2025 May/Jun · 0654/22 · Question 35 · Extended）

题型 4：先求电磁波波长再取指定比例天线长度（考频★☆☆☆☆）

知识点 电磁波在同一介质中传播时，波速、频率和波长满足 $c = f\lambda$，故 $\lambda =$ _____。
c 的单位为 m/s，f 的单位为 Hz，λ 的单位为 m；真空中 $c = 3.0 \times 10^8\ \text{m/s}$。
当天线长度为波长的 k 倍时，$L =$ _____；计算时各量采用相容单位。

答案：$\frac{c}{f}$；$k\lambda$

怎么认 题目出现电磁波频率、波速及天线占波长的比例时，先由 $\lambda = \frac{c}{f}$ 求波长。

例题 1

A radio transmitter emits radio waves with a frequency of 1.25×10^8 Hz. The most suitable aerial for this frequency is $\frac{1}{4}$ of a wavelength long.

The speed of radio waves is 3.0×10^8 m/s.

What is the length of the most suitable aerial?

A 0.10 m **B** 0.60 m **C** 2.4 m **D** 9.6 m

（2026 Feb/Mar · 0654/22 · Question 33 · Extended）

解： 由波速、频率和波长的关系得

$c = f\lambda$

$\lambda = \frac{c}{f}$

$= \frac{3.0\times10^8\ \text{m/s}}{1.25\times10^8\ \text{Hz}}$

$= 2.4\ \text{m}$

天线长度为四分之一波长，

$L = \frac{1}{4}\lambda$

$= \frac{1}{4} \times 2.4\ \text{m}$

$= 0.60\ \text{m}$

故选 B。

专题 14 声音、回声与人耳频率范围

14.1 声音、回声与人耳频率范围

题型 1：振幅对应响度、频率对应音调（考频★★★☆☆）

知识点 声波的振幅是介质质点偏离平衡位置的最大距离，国际单位为米（m）；其余条件相同时，振幅越大，响度越大。

频率是单位时间内完成振动的次数，单位为赫兹（Hz）；频率越大，音调越_____。

周期 T 是完成一次振动所需的时间，单位为秒（s），且 $f=\frac{1}{T}$；周期越短，频率越_____。

比较同一尺度的位移—时间图时，波峰到平衡位置的竖直距离表示_____，相同时间内的振动次数反映频率。

答案：高；大；振幅

怎么认 题目出现响度、音调或位移—时间图时，先比较振幅，再比较相同时间内的振动次数。

例题 1

Which change to a sound wave makes the sound louder?

A decreasing the amplitude

B decreasing the wavelength

C increasing the amplitude

D increasing the wavelength

（2023 Oct/Nov · 0654/11 · Question 35 · Core；同题：2023 Oct/Nov · 0654/21 · Question 35 · Extended）

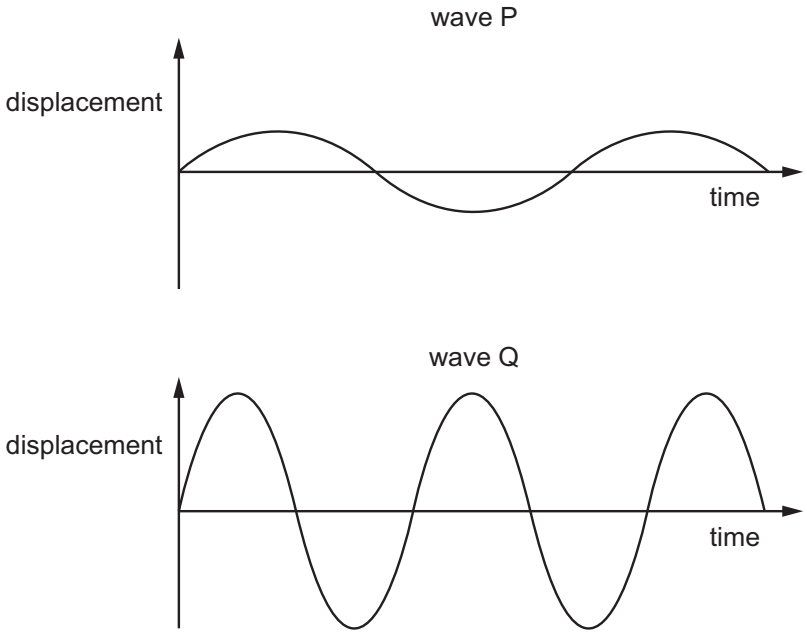
解：响度由振幅决定，振幅越大，声音越响。

增加声波的振幅会使声音变响。

故选 C。

针对练习

1. The diagrams represent two different sound waves, P and Q, drawn to the same scale.



How do the loudness and the pitch of the sounds compare?

	louder sound	higher-pitched sound
A	P	P
B	P	Q
C	Q	P
D	Q	Q

（2024 May/Jun · 0654/12 · Question 34 · Core；同题：2024 May/Jun · 0654/13 · Question 34 · Core）

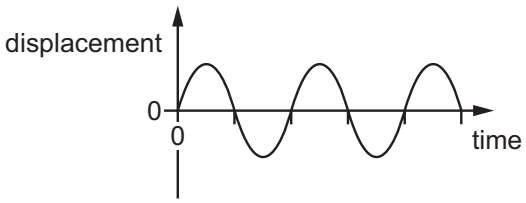
2. The amplitude of a sound wave increases, and the frequency of the wave decreases.

What is the effect on the loudness of the sound and on the pitch of the sound?

	loudness	pitch
A	greater	higher
B	greater	lower
C	less	higher
D	less	lower

（2023 Oct/Nov · 0654/12 · Question 34 · Core；同题：2023 Oct/Nov · 0654/22 · Question 34 · Extended）

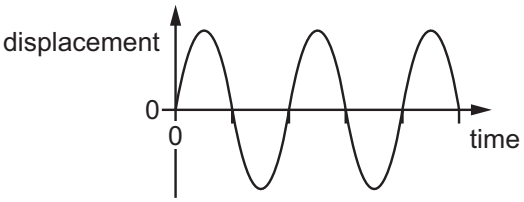
3. The diagram is a displacement–time graph for the molecules in air as a sound wave passes.



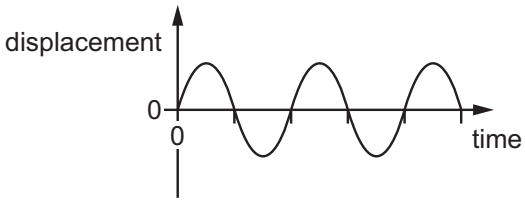
The graphs below are drawn to the same scale.

Which graph represents a quieter sound with a higher pitch?

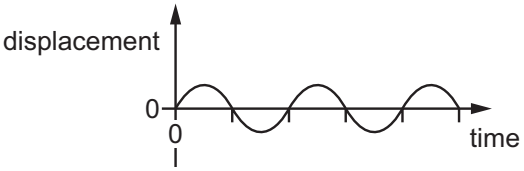
A



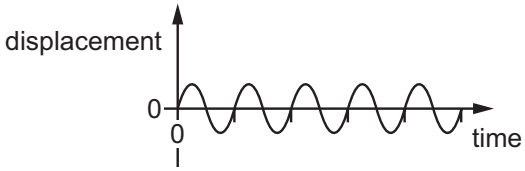
B



C



D



（2023 Feb/Mar · 0654/12 · Question 35 · Core；同题：2023 Feb/Mar · 0654/22 · Question 35 · Extended）

4. The sound heard from the siren of a police car becomes quieter and lower pitched as the car moves away from an observer.

Which row describes what happens to the amplitude and frequency of the sound wave heard by the observer?

	amplitude	frequency
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2023 Oct/Nov · 0654/13 · Question 34 · Core；同题：2023 Oct/Nov · 0654/23 · Question 34 · Extended）

5. A guitar produces a loud sound with a low pitch.

Which description of the sound wave produced by the guitar is correct?

A It has a large amplitude and a large frequency.

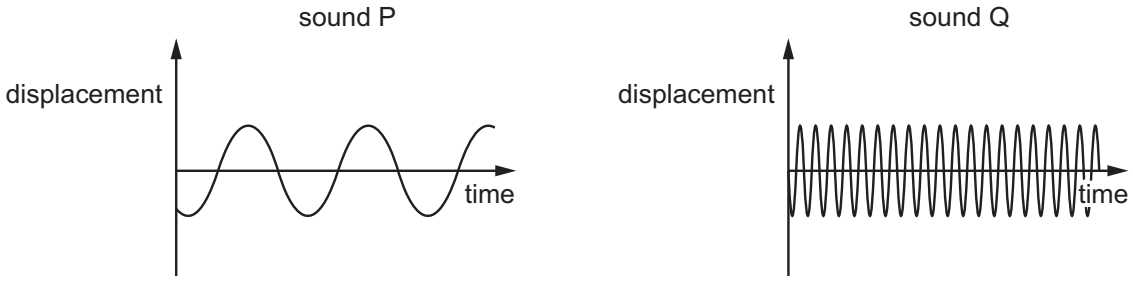
B It has a large amplitude and a small frequency.

C It has a small amplitude and a large frequency.

D It has a small amplitude and a small frequency.

（2025 Feb/Mar · 0654/22 · Question 36 · Extended）

6. The graphs represent the sound waves of sounds P and Q. The graphs are drawn to the same scale.



Which statement is correct?

A Sound P is higher pitched than sound Q.

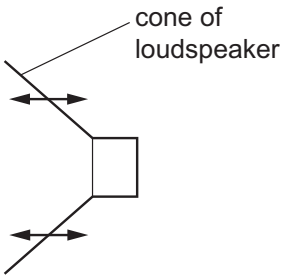
B Sound P is louder than sound Q.

C Sound P is lower pitched than sound Q.

D Sound P is quieter than sound Q.

（2025 Oct/Nov · 0654/21 · Question 34 · Extended）

7. The diagram shows a loudspeaker. The cone of the loudspeaker vibrates backwards and forwards in the direction of the arrows. These vibrations produce a sound wave in the air.



Which change results in the loudspeaker producing sound with a higher pitch?

A increasing the distance moved by the cone during each vibration

B increasing the time taken for each vibration

C decreasing the distance moved by the cone during each vibration

D decreasing the time taken for each vibration

（2025 Oct/Nov · 0654/11 · Question 35 · Core）

题型 2：从介质及疏密区判断声音传播（考频★★★☆☆）

知识点 声音由发声体的振动产生，是传递能量的_____波；介质中的粒子沿传播方向往复振动，形成压缩区和稀疏区。

声音的传播需要介质，不能通过_____；回声由声音的反射形成。

压缩区粒子较密、压强较大，稀疏区粒子较疏、压强较小。

同一物质的固态、液态、气态中，声速通常依次减小；室温下空气、水、钢中的声速约为 300 m/s、1500 m/s、4500 m/s。

答案：纵；真空

怎么认 题目出现真空、抽气装置、疏密区或不同介质中的声速时，先判断介质能否传声及粒子疏密。

例题 1

Which statement about sound waves is **not** correct?

A They are caused by vibrations.

B They are longitudinal.

C They transfer energy.

D They travel in a vacuum.

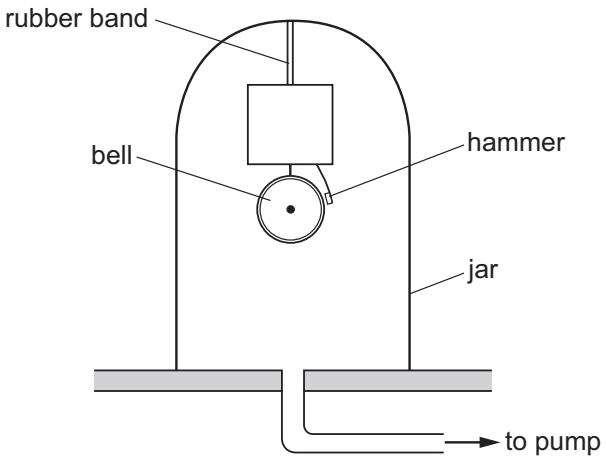
（2022 Feb/Mar · 0654/22 · Question 33 · Extended）

解：声音由振动产生，在空气中为纵波，并能传递能量。
真空中没有传声介质，声音不能传播。
故选 D。

针对练习

1.

An electric bell is suspended by a rubber band in a glass jar. The hammer hits the bell and makes it ring.



A pump removes air from the jar. The hammer still hits the bell but no sound can be heard.

Why does this happen?

A A medium is needed to transmit sound waves.

B The bell cannot vibrate in a vacuum.

C The pitch of the sound is now outside the range of human hearing.

D There cannot be an electric current in a vacuum.

（2024 May/Jun · 0654/11 · Question 35 · Core）

2.

A sound wave travels through air.

Which statement describes the behaviour of air particles as the sound wave travels?

A Air particles move backwards and forwards in a rarefaction, but up and down in a compression.

B Air particles move more slowly in a rarefaction than in a compression.

C Air particles are further apart in a rarefaction than in a compression.

D Air particles are in a region of higher pressure in a rarefaction than in a compression.

（2026 May/Jun · 0654/21 · Question 35 · Extended）

3. Massive explosions in the Sun release energy.

On Earth, humans see the light from the Sun. The humans do **not** hear the sound from the explosions.

Which statement explains this?

A Sound waves **cannot** travel through a vacuum.

B Sound waves travel slower than light waves.

C The amplitudes of the sound waves are too small.

D The frequencies of sound waves are lower than the frequencies of light waves.

(2026 May/Jun · 0654/12 · Question 35 · Core)

4. Which statement about sound waves is correct?

A An echo is caused by the refraction of sound waves.

B Sound waves are transverse waves.

C Sound waves can travel through a vacuum.

D The speed of sound waves in water is greater than the speed of sound waves in air.

(2026 May/Jun · 0654/23 · Question 35 · Extended)

5. Sound travels at different speeds in water, in steel and in air.

Each row in the table gives the three speeds at room temperature.

Which row gives the correct speeds?

	speed of sound in water / m/s	speed of sound in steel / m/s	speed of sound in air / m/s
A	300	1500	4500
B	300	4500	1500
C	1500	4500	300
D	4500	1500	300

(2025 Oct/Nov · 0654/22 · Question 35 · Extended)

6. The speeds of sound in three different states of the same substance are 480 m/s, 1500 m/s and 1800 m/s.

Which row gives the state for each of these speeds?

	480 m/s	1500 m/s	1800 m/s
A	gas	liquid	solid
B	gas	solid	liquid
C	solid	gas	liquid
D	solid	liquid	gas

(2022 Oct/Nov · 0654/22 · Question 35 · Extended)

题型 3：把频率与人耳范围比较、kHz 先换 Hz（考频★★☆☆☆）

知识点 声音是由振动产生并通过介质传播的机械波，真空中不能传播声音。

回声是声波遇到障碍物后发生_____形成的；振幅影响响度，频率影响音调。

健康人耳可听频率范围约为 _____ Hz 到 _____ kHz；频率高于此上限的声波称为超声波。

比较频率时应先统一单位，1 kHz = 1000 Hz。

答案：反射；20；20

怎么认 题目出现人耳听觉范围、动物最高可听频率或超声波时，先统一频率单位，再与 20 Hz ~ 20 kHz 比较。

例题 1

Which statement about sound is correct?

A An echo is produced by refraction of sound waves.

B The amplitude of a sound wave affects the pitch of a sound.

C The approximate range of audible frequencies for a human is 20 Hz–20 kHz.

D Sound waves travel more quickly in a vacuum than in air.

（2022 May/Jun · 0654/11 · Question 35 · Core；同题：2022 May/Jun · 0654/21 · Question 34 · Extended）

解：A 错，回声由声波反射形成；B 错，振幅影响响度，频率影响音调。

C 对，健康人耳可听频率范围约为 20 Hz 到 20 kHz；D 错，真空中不能传播声音。

故选 C。

针对练习

1. Humans can hear sounds with a range of frequencies.

Which row shows the smallest frequency and the greatest frequency that can be heard by a healthy human ear?

	smallest frequency / Hz	greatest frequency / Hz
A	20	2 000
B	20	20 000
C	200	2 000
D	200	20 000

（2024 Oct/Nov · 0654/22 · Question 34 · Extended）

2. The table shows the highest frequency of sound heard by different animals.

animal	highest frequency heard / kHz
bat	200
bird	10
cat	79

The highest frequency sound that a healthy human ear can hear is *f*.

Which animals **cannot** hear sound of frequency *f*?

A a bird only

B a bird and a cat only

C a bat, a bird and a cat

D none of the animals in the table

（2025 May/Jun · 0654/12 · Question 35 · Core；同题：2025 May/Jun · 0654/13 · Question 35 · Core）

3. Four sound waves, P, Q, R and S, have the frequencies shown.

sound wave	**frequency / kHz**
P	0.30
Q	3.0
R	30
S	300

Which sound waves are ultrasound waves?

A P, Q, R and S

B Q, R and S only

C R and S only

D S only

（2026 Feb/Mar · 0654/12 · Question 35 · Core）

题型 4：以总声程除时间，回声要计往返（考频★★☆☆☆）

知识点 声音传播的平均速度等于总声程与传播时间之比：$v = \frac{s}{t}$；当声音在空气中以稳定速度传播时适用，s、t、v 的单位分别为 m、s、m/s。

声音从声源传到接收者，单程声程等于两者间的距离；声音传到墙面后返回声源，回声声程等于声源到墙面距离的 _____ 倍。

设声源到墙面的距离为 d，则回声声程 $s =$ _____ d，传播时间 $t = \frac{s}{v}$。

若接收者先后听到原声和回声，两声到达的时间间隔等于 _____ 除以声速。

答案：2；2；两条声程之差

怎么认 题目出现两人间距、墙距、回声计时或原声与回声的时间间隔时，先确定声音实际经过的总声程。

例题 1

Two students conduct an experiment to determine the speed of sound in air.

They stand 639 m apart.

One student hits two blocks of wood together while the other uses a stop-watch to time how long it takes for the sound to reach him.

It takes 1.80 s for the sound to reach the second student.

What is the speed of sound in air, calculated using these results?

A 330 m/s **B** 355 m/s **C** 710 m/s **D** 1150 m/s

（2022 Oct/Nov · 0654/11 · Question 35 · Core）

解：声音由一名学生传到另一名学生，声程为 639 m。

$v = \frac{s}{t}$

$v = \frac{639}{1.80} = 355\ \text{m/s}$。

故选 B。

针对练习

1. A man stands 420 m away from a high wall. He bangs a drum once and starts a stop-watch at the same time. When he hears an echo from the wall, the stop-watch reads 2.4 s.

What is the speed of sound, calculated from this information?

A 87.5 m/s **B** 175 m/s **C** 330 m/s **D** 350 m/s

（2023 May/Jun · 0654/11 · Question 34 · Core）

2. A student claps his hands once when standing 100 m away from a large wall.

The speed of sound in air is 330 m/s.

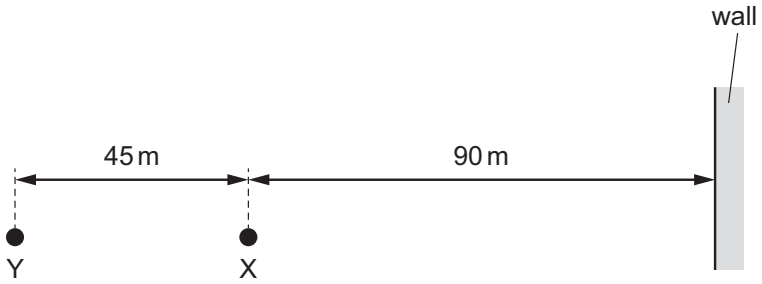
How long after clapping does the student hear an echo?

A 0.30 s **B** 0.61 s **C** 1.7 s **D** 3.3 s

（2024 Feb/Mar · 0654/12 · Question 34 · Core）

3. Person X stands facing a high wall that is 90 m away.

Person Y stands 45 m behind person X on a line perpendicular to the wall, as shown.



Person X claps loudly once.

Person Y hears the sound of this clap, then an echo of the sound from the wall.

The speed of sound in air is 330 m/s.

What is the time interval between person Y hearing the first sound and the echo?

A 0.27 s **B** 0.41 s **C** 0.55 s **D** 0.68 s

（2025 Oct/Nov · 0654/23 · Question 35 · Extended）

题型 5：用声速除频率求波长或听觉波长范围（考频★★☆☆☆）

知识点 声波的波速 v、频率 f 和波长 λ 满足 $v = f\lambda$，故 $\lambda =$ _____。

同一介质中声速不变时，频率越高，波长越_____；频率越低，波长越长。

v 以 m/s 计、f 以 Hz 计时，λ 的单位为_____；人耳可听频率通常为 20 Hz 至 20 kHz。

答案：$\frac{v}{f}$；短；m

怎么认 题目出现声速、频率并求波长或可听波长范围时，先由 $\lambda = \frac{v}{f}$ 计算。

例题 1

A loudspeaker produces a sound wave that has a frequency of 3300 Hz. The speed of sound in air is 330 m/s.

What is the wavelength of the sound wave?

A 0.10 m **B** 1.0 m **C** 11 m **D** 1.1×10^6 m

（2022 May/Jun · 0654/23 · Question 33 · Extended）

解：由 $v = f\lambda$ 得

$\lambda = \frac{v}{f}$

$= \frac{330\ \text{m/s}}{3300\ \text{Hz}}$

$= 0.10\ \text{m}$。

故选 A。

针对练习

1. A sound wave has a frequency of 16 kHz. The speed of sound is 320 m/s.

What is the wavelength of the wave?

A 0.020 m **B** 0.050 m **C** 20 m **D** 50 m

（2023 May/Jun · 0654/23 · Question 33 · Extended）

2. The speed of sound in air is 340 m/s.

What is the range of wavelengths of sound in air that is audible to humans?

A 59 mm to 59 m

B 17 mm to 17 m

C 59 m to 59 km

D 17 m to 17 km

（2026 May/Jun · 0654/23 · Question 33 · Extended）

专题 15 磁体与磁场

15.1 磁体与磁场

题型 1：靠近磁体时近端诱导异极并产生吸引（考频★★★☆☆）

知识点 未磁化的铁或软铁处在磁体的磁场中，会因磁感应成为_____。
靠近原磁极的一端感应出与其_____的磁极，远端感应出与近端_____的磁极，铁棒因此受到吸引。
移去外磁场后，软铁通常失去磁性；磁极以 N、S 表示，无单位。

答案：感应临时磁体；相异；相反

怎么认 题目出现未磁化铁棒靠近磁体，或问感应磁极与受力时，先在近端标出异极。

例题 1

An iron bar is placed within the magnetic field of a permanent magnet.

What happens to the iron bar?

A It becomes an induced permanent magnet.

B It becomes an induced temporary magnet.

C It becomes negatively charged.

D It becomes positively charged.

（2025 May/Jun · 0654/23 · Question 35 · Extended）

解：铁棒处在永久磁体的磁场中，因磁感应而磁化。
这种磁性由外磁场诱导，铁棒成为感应临时磁体。
故选 B。

针对练习

1. A magnetic material is held close to the north pole of a magnet and then close to the south pole of the same magnet.

Which statement about the magnetic material is correct?

A It is attracted to both poles.

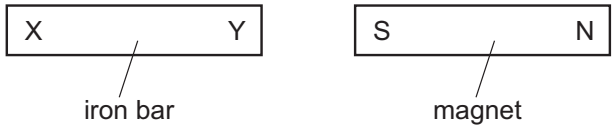
B It is attracted to the north pole but **not** to the south pole.

C It is attracted to the south pole but **not** to the north pole.

D It is **not** attracted to either pole.

（2026 May/Jun · 0654/12 · Question 36 · Core）

2. An iron bar XY is brought near to a magnet. Magnetic poles are induced in the iron bar.

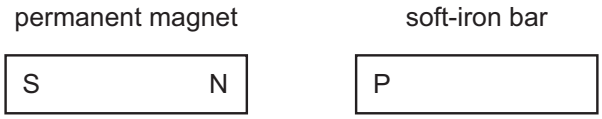


What are the magnetic poles induced at X and Y?

	pole at X	pole at Y
A	N	N
B	N	S
C	S	N
D	S	S

(2022 May/Jun · 0654/23 · Question 35 · Extended)

3. An unmagnetised soft-iron bar is brought near to the north pole of a permanent magnet.



The permanent magnet induces a magnetic pole at end P of the soft-iron bar.

Which row shows the pole induced at P and the force between the permanent magnet and the soft-iron bar?

	pole induced at P	**force**
A	north pole	repulsion
B	north pole	attraction
C	south pole	repulsion
D	south pole	attraction

(2026 May/Jun · 0654/23 · Question 36 · Extended)

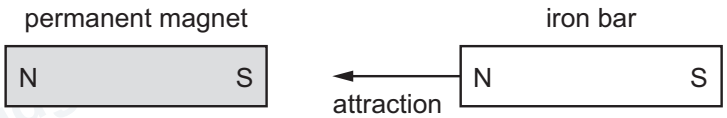
PapaCambridge
papacambridge.com

4. The diagram shows an unmagnetised iron bar placed in the magnetic field of a permanent magnet.

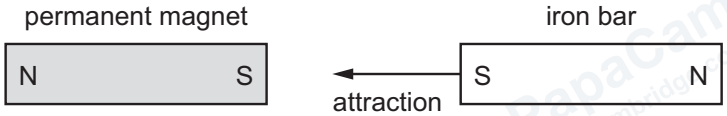


Which diagram shows what happens to the iron bar?

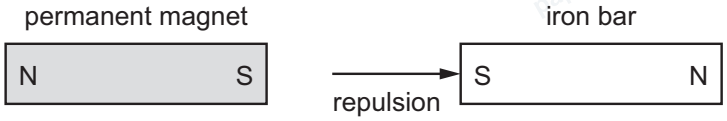
A



B



C

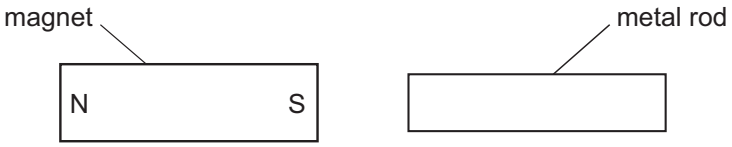


D



（2026 May/Jun · 0654/22 · Question 37 · Extended）

5. A bar magnet is brought near to a metal rod. The metal rod is attracted to the magnet.



The magnet is then turned around so that the N-pole is on the right.

The magnet is again brought near to the metal rod and is again attracted to the magnet.

What could the metal rod be?

A another bar magnet

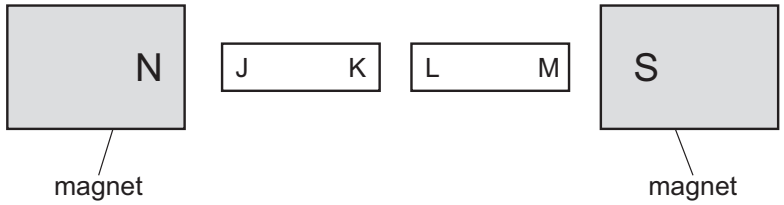
B a piece of aluminium

C a piece of copper

D a piece of iron

（2023 Oct/Nov · 0654/13 · Question 35 · Core；同题：2023 Oct/Nov · 0654/23 · Question 35 · Extended）

6. The diagram shows two soft-iron rods JK and LM placed between the poles of two magnets.



Which row shows the poles induced in the soft-iron rods?

	at J	at K	at L	at M
A	N	N	S	S
B	N	S	N	S
C	S	S	N	N
D	S	N	S	N

（2024 May/Jun · 0654/22 · Question 35 · Extended）

题型 2：看撤去外磁场后是否保磁选择铁或钢（考频★★☆☆☆）

知识点 永久磁体在撤去外加磁场后仍能保持_____。

_____的保磁性强，适合制作永久磁体。

软铁容易磁化，也容易退磁，撤去外加磁场后磁性很快减弱。

答案：磁性；钢

怎么认 题目出现永久磁体或撤去外加磁场后是否保磁时，先判断材料的保磁性。

例题 1

Which substance is used to make a permanent magnet?

A brass

B pure copper

C soft iron

D steel

（2025 Feb/Mar · 0654/12 · Question 36 · Core）

解：永久磁体在撤去外加磁场后仍能保持磁性。

钢的保磁性强，适合制作永久磁体。

故选 D。

针对练习

1. Which statement about permanent magnets is correct?

A The magnetic field of a permanent magnet can be switched off.

B Permanent magnets are made of soft iron.

C Permanent magnets attract all metals.

D Permanent magnets remain magnetised when removed from an applied magnetic field.

（2026 May/Jun · 0654/13 · Question 35 · Core）

2. A bar of soft iron and a bar of steel are held in contact with a strong magnet.

Both bars become magnetised.

The two bars are now moved away from the magnet.

Which statement about the bars is correct?

A Both bars lose their magnetism.

B Neither of the bars loses its magnetism.

C The soft iron bar loses its magnetism but the steel bar retains its magnetism.

D The steel bar loses its magnetism but the soft iron bar retains its magnetism.

（2024 May/Jun · 0654/21 · Question 35 · Extended）

题型 3：要反复通断时选择电磁铁（考频★☆☆☆☆）

知识点 电磁铁是通电后产生磁性的装置，其磁性由线圈中的_____产生。

电路接通时，电磁铁_____磁性；电路断开时，磁性_____，因此能高频反复通断。

通断快慢可用频率表示，频率的单位是 Hz；永久磁铁的磁性不能由电路控制。

答案：电流；产生；消失

怎么认 题目出现磁体需高频反复通断时，先判断磁性是否能由电流控制。

例题 1

Which type of magnet can be switched on and off many times per second?

A an electromagnet only

B a permanent magnet only

C both electromagnets and permanent magnets

D neither electromagnets or permanent magnets

（2022 Oct/Nov · 0654/11 · Question 36 · Core；同题：2022 Oct/Nov · 0654/12 · Question 36 · Core、2022 Oct/Nov · 0654/13 · Question 35 · Core、2022 Oct/Nov · 0654/23 · Question 35 · Extended、2022 Oct/Nov · 0654/21 · Question 35 · Extended、2022 Oct/Nov · 0654/22 · Question 36 · Extended）

解：由电磁铁的磁性受电流控制，电路接通时产生磁性，断开时磁性消失，故能高频反复通断。

永久磁铁不能由电路控制磁性有无。

故选 A。

题型 4：检查磁场线从 N 出、向 S 入（考频★☆☆☆☆）

知识点 磁场线表示磁场的方向和分布，箭头方向表示该处磁场的方向。

在条形磁体外部，磁场线由_____极出发，弯曲后进入_____极；磁场线越密，磁场越强。

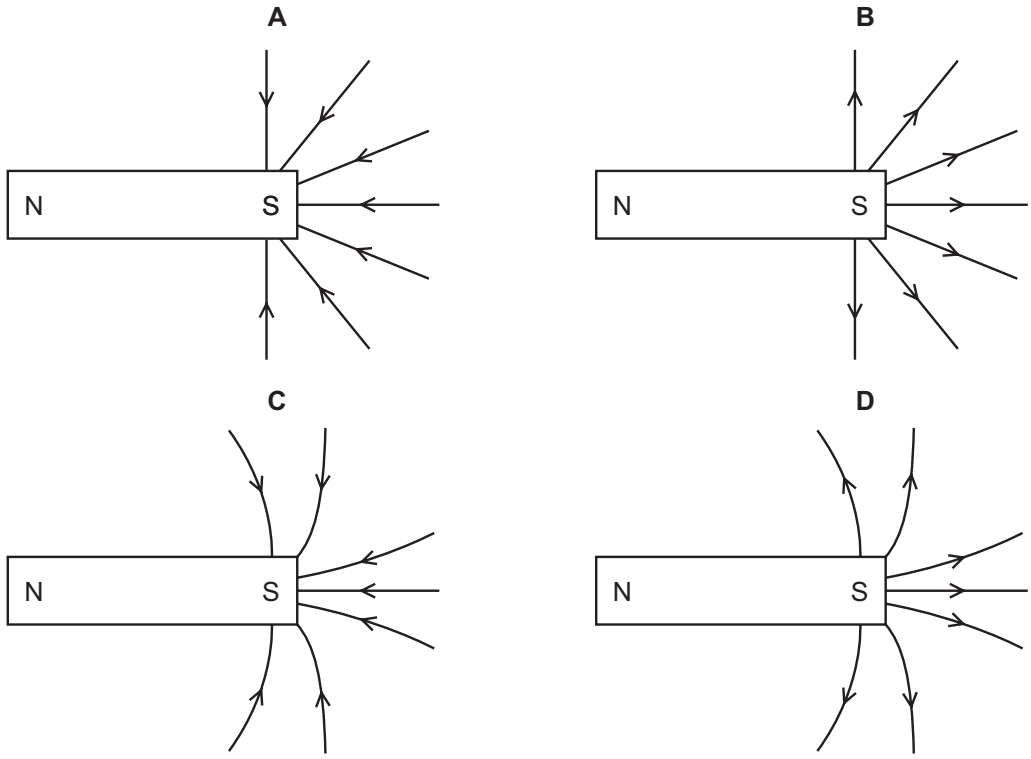
磁场线是表示磁场的辅助线，没有单位。

答案：N；S

怎么认 题目出现条形磁体的磁场线图并要求判断方向时，先检查外部磁场线是否从N极出、向S极入。

例题 1

Which diagram shows the pattern and direction of the magnetic field near the S pole of a bar magnet?



（2023 Feb/Mar · 0654/12 · Question 36 · Core）

解：条形磁体外部的磁场线由 N 极出发，进入 S 极，故 S 极附近的箭头应指向 S 极。磁场线在磁体外部弯曲分布，图 C 的形状和箭头方向均符合。故选 C。

题型 5：对面磁极异名吸引、同名排斥（考频★☆☆☆☆）

知识点 磁体上磁性最强的部位称为磁极，条形磁体两端分别为北极（N 极）和南极（S 极）。

异名磁极相互_____，同名磁极相互_____；判断时比较两磁体彼此相对的磁极。

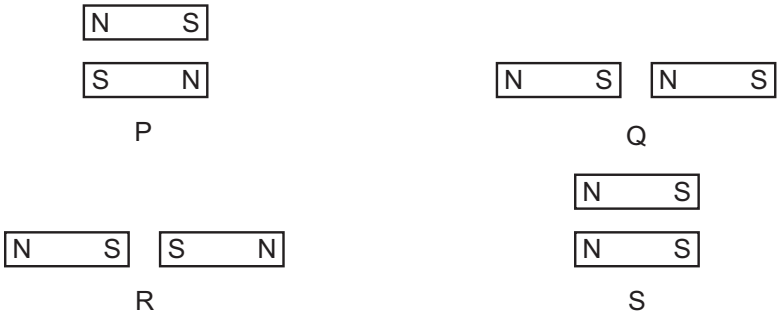
磁极间作用力属于磁力，力的国际单位是_____。

答案：吸引；排斥；牛顿（N）

怎么认 题目出现成对条形磁体的 N、S 标注并求吸引或排斥时，先比较彼此相对的磁极。

例题 1

The diagrams P, Q, R and S show four pairs of bar magnets.



For which two pairs of magnets is there a force of attraction between the magnets?

A P and Q **B** P and S **C** Q and R **D** R and S

（2025 Oct/Nov · 0654/11 · Question 36 · Core）

解：P 中上下对应的磁极分别为 N 极与 S 极、S 极与 N 极，异名磁极相吸。
Q 中相对的两端为 S 极与 N 极，异名磁极相吸。
因此有吸引力的是 P 和 Q。故选 A。

专题 16 电荷、电流、电压与电阻

16.1 电荷、电流、电压与电阻

题型 1：给出电压电流电阻两项，求或比较第三项（考频★★★★☆）

知识点 元件两端的电势差称为电压，用 V 表示；通过元件的电流用 I 表示。电阻 R 表示元件对电流的阻碍作用。

在某一工作状态下，三者满足 $R=$ _____。

变形得 $V=IR$、$I=\frac{V}{R}$；各量必须对应同一元件和同一工作状态。

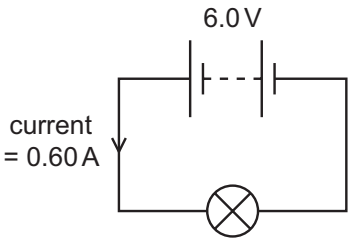
电压、电流、电阻的单位分别是伏特、安培和_____；$1\ \mathrm{A}=$ _____ mA。

答案：$\frac{V}{I}$；欧姆（Ω）；1000

怎么认 题目出现同一元件的 V、I、R 数值或比较关系时，先写 $R=\frac{V}{I}$。

例题 1

A 6.0 V battery is connected to a lamp. The current in the circuit is 0.60 A.



What is the resistance of the lamp?

A 0.10 Ω　　**B** 3.6 Ω　　**C** 10 Ω　　**D** 36 Ω

（2022 Feb/Mar · 0654/12 · Question 36 · Core）

解：由 $R=\frac{V}{I}$ 得

$R=\frac{6.0\ \mathrm{V}}{0.60\ \mathrm{A}}=10\ \Omega$。

故选 C。

针对练习

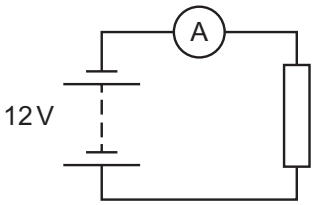
1. There is a current of 4.0 A in a resistor. The voltage across the resistor is 8.0 V.

What is the resistance of the resistor?

A 0.50 Ω　　**B** 2.0 Ω　　**C** 12 Ω　　**D** 32 Ω

（2025 Oct/Nov · 0654/11 · Question 37 · Core）

2. A resistor is connected to a 12 V battery and an ammeter as shown.



The ammeter reads 6.0 A.

What is the resistance of the resistor?

A 0.50 Ω **B** 2.0 Ω **C** 18 Ω **D** 72 Ω

(2026 May/Jun · 0654/23 · Question 38 · Extended)

3. There is a current of 4.0 A in a resistor and a potential difference (p.d.) of 12 V across it.

What is the resistance of the resistor?

A 0.33 Ω **B** 3.0 Ω **C** 8.0 Ω **D** 48 Ω

(2024 Feb/Mar · 0654/12 · Question 36 · Core)

4. There is a current of 0.60 A in a 33 Ω resistor.

What is the voltage across the resistor?

A 0.018 V **B** 12 V **C** 20 V **D** 55 V

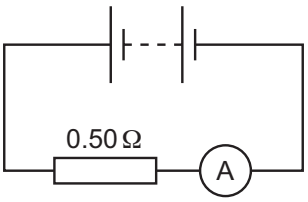
(2026 Feb/Mar · 0654/12 · Question 36 · Core)

5. Which equation relates resistance R to current I and voltage V?

A $R = I \times V$ **B** $R = \frac{I}{V}$ **C** $R = \frac{V}{I}$ **D** $R = I - V$

(2025 Feb/Mar · 0654/12 · Question 37 · Core)

6. The diagram shows a battery connected to a 0.50 Ω resistor and an ammeter. The reading on the ammeter is 0.20 A.



What is the potential difference (p.d.) across the resistor?

A 0.10 V **B** 0.40 V **C** 0.70 V **D** 2.5 V

(2024 Oct/Nov · 0654/12 · Question 35 · Core; 同题: 2024 Oct/Nov · 0654/13 · Question 35 · Core)

7. A lamp is connected to a 3.0 V battery. The resistance of the lamp is 60 Ω.

What is the current in the lamp?

A 0.050 mA **B** 20 mA **C** 50 mA **D** 180 mA

(2024 Oct/Nov · 0654/11 · Question 36 · Core)

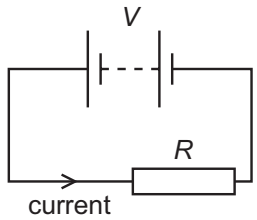
8. The table shows the voltage across and the current in four lamps.

Which lamp has the greatest resistance?

	voltage / V	current / A
A	2.0	0.40
B	4.0	0.50
C	6.0	2.0
D	12	3.0

（2025 Oct/Nov · 0654/12 · Question 37 · Core；同题：2025 Oct/Nov · 0654/13 · Question 37 · Core）

9. A battery of e.m.f. V is connected across a resistor of resistance R. There is a current in the resistor.

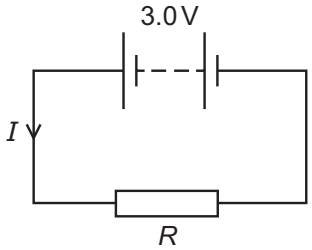


Which row shows two changes that **both** increase the current in the resistor?

	change 1	change 2
A	decrease V	decrease R
B	decrease V	increase R
C	increase V	decrease R
D	increase V	increase R

（2023 May/Jun · 0654/11 · Question 37 · Core；同题：2023 May/Jun · 0654/21 · Question 36 · Extended）

10. A 3.0 V battery is connected to a resistor of resistance R. The current in the resistor is I.



Which row gives possible values of I and of R?

	I / A	R / Ω
A	1.5	1.5
B	1.5	2.0
C	6.0	2.0
D	4.0	12

（2025 Feb/Mar · 0654/22 · Question 37 · Extended）

11. Four resistors are connected into circuits. The current in each resistor and the potential difference (p.d.) across each resistor are shown.

Which resistor has a resistance of 2.0 Ω?

	current / A	p.d. / V
A	2.0	1.0
B	4.0	2.0
C	12	6.0
D	4.0	8.0

（2023 Oct/Nov · 0654/13 · Question 36 · Core；同题：2023 Oct/Nov · 0654/23 · Question 36 · Extended）

题型 2：摩擦起电只转移电子，得电子负、失电子正（考频★★★☆☆）

知识点 两个原来不带电的绝缘体相互摩擦时，电子从一个物体转移到另一个物体，质子不发生转移。

物体_____电子后带负电，_____电子后带正电；两物体所带电荷种类相反。

电荷量用 Q 表示，单位是库仑（C）。

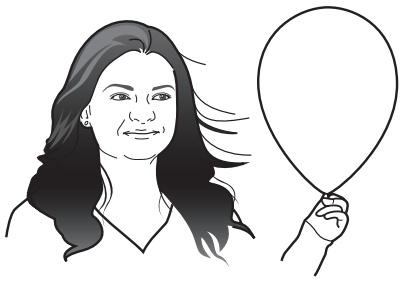
答案：得到；失去

怎么认 题目出现摩擦后物体带正电或负电时，先判断它失去还是得到电子。

例题 1

A student rubs a balloon against her hair. Electrons are transferred from the hair onto the balloon, and the hair and the balloon both become charged.

The hair is now attracted to the balloon.



Which row shows the charges on the hair and on the balloon after rubbing?

	charge on hair	charge on balloon
A	negative	negative
B	negative	positive
C	positive	negative
D	positive	positive

（2022 May/Jun · 0654/12 · Question 36 · Core；同题：2022 May/Jun · 0654/22 · Question 36 · Extended、2022 May/Jun · 0654/13 · Question 36 · Core）

解：电子从头发转移到气球，头发失去电子，带正电；气球得到电子，带负电。故选 C。

针对练习

1. A rod gains negative charge as it is rubbed with a cloth.

What happens to the cloth in this process?

A It gains electrons.

B It loses electrons.

C It gains protons.

D It loses protons.

（2026 May/Jun · 0654/13 · Question 36 · Core）

2. A plastic rod is rubbed with a cloth. The plastic rod becomes negatively charged.

Which statement explains why this happens?

A Electrons move from the cloth to the rod.

B Electrons move from the rod to the cloth.

C Protons move from the cloth to the rod.

D Protons move from the rod to the cloth.

（2026 May/Jun · 0654/11 · Question 36 · Core）

3. When two different, uncharged, insulating materials are rubbed together, one becomes positively charged and the other becomes negatively charged.

What happens to cause the materials to become charged?

	positively charged material	negatively charged material
A	gains protons	gains electrons
B	gains protons	loses protons
C	loses electrons	gains electrons
D	loses electrons	loses protons

（2024 May/Jun · 0654/12 · Question 35 · Core；同题：2024 May/Jun · 0654/13 · Question 35 · Core）

4. A plastic rod is rubbed with a cloth and the rod becomes positively charged.

What happens during this process?

A Negative charges move from the cloth to the rod.

B Negative charges move from the rod to the cloth.

C Positive charges move from the cloth to the rod.

D Positive charges move from the rod to the cloth.

（2023 May/Jun · 0654/12 · Question 35 · Core；同题：2023 May/Jun · 0654/13 · Question 35 · Core）

5. A plastic rod is rubbed with a cloth. The rod becomes positively charged.

Which statement describes why this happens?

A Electrons move from the cloth to the rod.

B Electrons move from the rod to the cloth.

C Protons move from the cloth to the rod.

D Protons move from the rod to the cloth.

（2023 Oct/Nov · 0654/12 · Question 35 · Core；同题：2023 Oct/Nov · 0654/22 · Question 35 · Extended）

6. Two rods made of different insulators are charged by friction using a cloth. One rod becomes negatively charged and the other rod becomes positively charged.

What happens during the charging process?

	positively charged rod	**negatively charged rod**
A	gains electrons	gains protons
B	gains protons	loses protons
C	loses electrons	gains electrons
D	loses electrons	gains protons

（2026 May/Jun · 0654/23 · Question 37 · Extended）

7. A plastic rod is rubbed with a cloth.

The rod becomes positively charged.

What happens to the rod and what happens to the cloth?

	rod	cloth
A	electrons are removed	electrons are added
B	electrons are removed	protons are removed
C	protons are added	electrons are added
D	protons are added	protons are removed

（2024 Oct/Nov · 0654/22 · Question 35 · Extended）

8. A plastic rod is rubbed with a cloth causing a negative charge on the rod.

Which statements are correct?

1 The rod gains electrons.

2 The cloth loses electrons.

3 The cloth becomes positively charged.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

（2022 Oct/Nov · 0654/12 · Question 37 · Core；同题：2022 Oct/Nov · 0654/22 · Question 37 · Extended）

题型 3：电源每单位电荷供能定义电动势并用伏特测量（考频★★☆☆☆）

知识点 电动势是电源使单位电荷绕完整电路一周所做的电功，$E=\frac{W}{Q}$。

式中 W 是电源提供的能量，单位为焦耳，Q 是电荷量，单位为库仑。

电池把化学能转化为电能；电动势的单位是_____，且 $1\ \mathrm{V}=1\frac{\mathrm{J}}{1}\ \mathrm{C}$。

电动势用_____测量，仪表并联在电源两端。

答案：伏特（V）；电压表

怎么认 题目出现电源每单位电荷供能、电动势定义或测量时，先写 $E=\frac{W}{Q}$，再判断单位与仪表接法。

例题 1

Which electrical device transfers chemical energy into electrical energy?

A battery

B lamp

C electric motor

D television

（2022 Oct/Nov · 0654/11 · Question 31 · Core；同题：2022 Oct/Nov · 0654/21 · Question 31 · Extended）

解：电池工作时发生化学反应，把化学能转化为电能。

故选 A。

针对练习

1. What is defined in terms of the electrical work done by a source in moving unit charge around a complete circuit?

A electromotive force (e.m.f.)

B current

C potential difference (p.d.)

D power

（2025 Oct/Nov · 0654/23 · Question 36 · Extended）

2. The electromotive force (e.m.f.) of a battery is 2.0 V.

Which statement is correct?

A The battery supplies 0.50 J of energy for every 1.0 C of charge driven around a circuit.

B The battery supplies 0.50 J of energy for every 2.0 C of charge driven around a circuit.

C The battery supplies 2.0 J of energy for every 1.0 C of charge driven around a circuit.

D The battery supplies 2.0 J of energy for every 2.0 C of charge driven around a circuit.

（2024 May/Jun · 0654/23 · Question 35 · Extended）

3. A cell is connected in a circuit.

Which statement describes how the electromotive force (e.m.f.) of the cell is measured?

A It is measured in newtons using a newton meter connected in parallel with the cell.

B It is measured in newtons using a newton meter connected in series with the cell.

C It is measured in volts using a voltmeter connected in parallel with the cell.

D It is measured in volts using a voltmeter connected in series with the cell.

（2024 May/Jun · 0654/11 · Question 36 · Core）

题型 4：电流是金属中电子流动，交流会反复改方向（考频★★☆☆☆）

知识点 电流是带电粒子的定向移动。在金属导线中，能够定向移动的带电粒子是自由电子，因此电流表现为自由电子的_____。
约定的电流方向按正电荷移动方向规定，因此与金属中电子的移动方向相反。
交流电（a.c.）中电子的移动方向会_____：先沿一个方向，再沿相反方向，周而复始。
电流 I 表示单位时间内通过导体横截面的电荷量，$I=\frac{Q}{t}$；I 的单位为安培（A）。

答案：定向移动；反复改变

怎么认 题目出现金属导线中的电流或交流时，先判断载流粒子及其流动方向是否反复改变。

例题 1

What is a current in a metal wire?

A a flow of electrons

B a flow of ions

C a flow of neutrons

D a flow of protons

（2023 Oct/Nov · 0654/12 · Question 36 · Core）

解：金属中能够定向移动的带电粒子是自由电子，电流由带电粒子的定向移动形成。
因此金属导线中的电流是电子流。故选 A。

针对练习

1. Which quantity is a flow of electrons through an electrical conductor?

A current

B power

C resistance

D voltage

（2025 Oct/Nov · 0654/12 · Question 36 · Core；同题：2025 Oct/Nov · 0654/13 · Question 36 · Core）

2. There is an alternating current (a.c.) in a metal wire.

Which statement about the current is correct?

A It is a flow of both positively and negatively charged particles.

B It is a flow of charged particles, first in one direction then in the opposite direction repeatedly.

C It is a flow of charged particles in both directions at the same time.

D It is a flow of charged particles steadily in one direction.

（2024 May/Jun · 0654/21 · Question 38 · Extended）

题型 5：以导线长度和横截面积比较电阻（考频★★★☆☆）

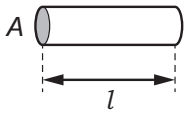
知识点 均匀导线的电阻满足 $R=\rho\frac{l}{A}$，其中 ρ 为材料的电阻率。
同种材料且温度不变时，ρ 相同；l、A、R 的单位分别为 m、m^2、ohm，ρ 的单位为 ohm m。
在这些条件下，电阻与导线长度成_____，与横截面积成_____；若横截面为圆形，则 $A=\pi\frac{d^2}{4}$。
电源电压不变时，由 $I=\frac{V}{R}$，电阻减小，电流_____。

答案：正比；反比；增大

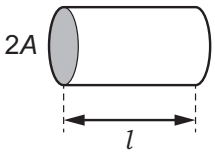
怎么认 题目出现同种材料导线的长度、横截面积或直径变化时，先由 $R=\rho\frac{l}{A}$ 比较电阻。

例题 1

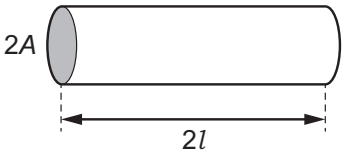
A resistance wire of cross-sectional area *A* and length l has resistance *R*.



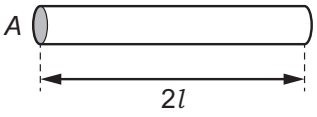
Wires X, Y and Z are made of the same material as the first wire but have different dimensions as shown.



wire X



wire Y



wire Z

Which of the wires X, Y and Z has resistance *R*?

A wire X

B wire Y

C wire Z

D none of them

（2022 Oct/Nov · 0654/21 · Question 36 · Extended）

解：同种材料，ρ 相同，由导线电阻关系得

$R_X=\rho\frac{l}{2A}=\frac{1}{2}R$

$R_Y=\rho\frac{2l}{2A}=R$

$R_Z=\rho\frac{2l}{A}=2R$

故选 B。

针对练习

1. A wire of length l and cross-sectional area *X* has resistance *R*.

Which wire has resistance 4*R*?

	length of wire	cross-sectional area of wire
A	$2l$	$2X$
B	$2l$	$\frac{1}{2}X$
C	$\frac{1}{2}l$	$2X$
D	$\frac{1}{2}l$	$\frac{1}{2}X$

（2023 Feb/Mar · 0654/22 · Question 36 · Extended）

2. A wire of a certain length has a resistance of 8.0 Ω. A second wire made of the same material has double the length and double the cross-sectional area of the first wire.

What is the resistance of the second wire?

A 4.0 Ω　　**B** 8.0 Ω　　**C** 16 Ω　　**D** 32 Ω

（2024 Oct/Nov · 0654/21 · Question 36 · Extended）

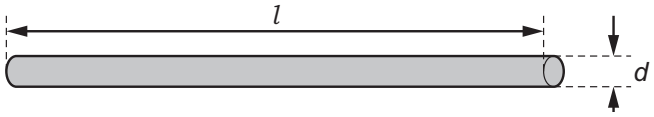
3. The resistance of a wire is 20 Ω. A second wire is made of the same material. The second wire is four times as long and has half the cross-sectional area of the first wire.

What is the resistance of the second wire?

A 10 Ω **B** 40 Ω **C** 80 Ω **D** 160 Ω

（2022 May/Jun · 0654/21 · Question 36 · Extended）

4. The diagram shows a wire of length *l* and diameter *d*.



Which pair of changes **must** increase the resistance of the wire?

A decreasing *l* and decreasing *d*

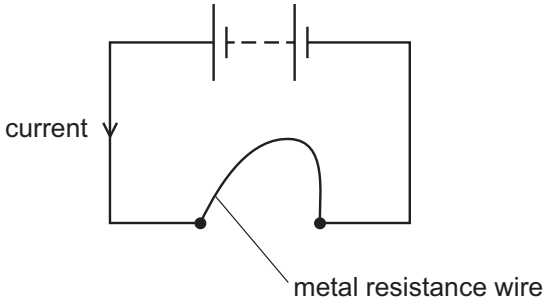
B decreasing *l* and increasing *d*

C increasing *l* and decreasing *d*

D increasing *l* and increasing *d*

（2024 Feb/Mar · 0654/22 · Question 36 · Extended）

5. A student connects a length of metal resistance wire to a battery.



Which change increases the current in the resistance wire?

A connecting a second wire in series with the first wire

B heating the wire

C making the wire shorter

D making the wire thinner

（2025 May/Jun · 0654/22 · Question 38 · Extended）

题型 6：先以吸引排斥判电荷符号，再解释电子得失（考频★★☆☆☆）

知识点 同种电荷相互_____，异种电荷相互_____；这一关系适用于两物体都带电的情况。物体得到电子后带负电，失去电子后带正电；摩擦起电时转移的是_____，质子仍束缚在原子核中。电荷量的单位为库仑，符号为 C。

答案：排斥；吸引；电子

怎么认 题目出现带电物体相互吸引或排斥，并问电荷符号或电子得失时，先由力的方向判断电荷异同。

例题 1

Two insulators are charged by rubbing them with a cloth.

After this, the charged insulators repel each other.

Which statement is a possible description of how the insulators become charged?

A One gained electrons and the other gained protons.

B One gained electrons and the other lost electrons.

C They both lost electrons.

D They both lost protons.

（2023 May/Jun · 0654/11 · Question 36 · Core；同题：2023 May/Jun · 0654/21 · Question 35 · Extended）

解：两绝缘体相互排斥，故带同种电荷。
摩擦起电时转移的是电子；两者均失去电子时都带正电，符合题意。
故选 C。

针对练习

1. Two charged rods X and Y repel each other.

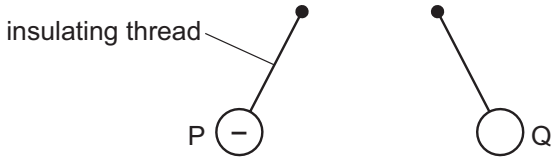
Which row gives a possible description of how the rods became charged?

	X charged by	Y charged by
A	gaining electrons	gaining electrons
B	gaining electrons	losing protons
C	losing electrons	gaining electrons
D	losing electrons	losing protons

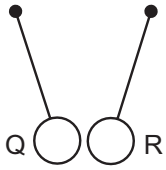
（2024 Feb/Mar · 0654/12 · Question 35 · Core）

2. Three charged balls P, Q and R are suspended by insulating threads. Ball P is negatively charged.

Ball Q is brought close to ball P. The balls move away from each other.



Ball Q is now brought close to ball R. The balls move closer to each other.



What are the signs of the charges on ball Q and ball R?

	ball Q	ball R
A	negative	negative
B	negative	positive
C	positive	negative
D	positive	positive

（2023 Oct/Nov · 0654/11 · Question 36 · Core；同题：2023 Oct/Nov · 0654/21 · Question 36 · Extended）

3. Object P is positively charged and object Q is negatively charged.

Which row describes the force between P and Q and explains how they became charged?

	force between P and Q	charge on P caused by	charge on Q caused by
A	attractive	gaining electrons	losing electrons
B	attractive	losing electrons	gaining electrons
C	repulsive	gaining electrons	losing electrons
D	repulsive	losing electrons	gaining electrons

（2024 Oct/Nov · 0654/11 · Question 35 · Core）

题型 7：灯丝发热增阻使电流—电压曲线逐渐变平（考频★★☆☆☆）

知识点 电阻定义为导体两端电压与通过导体的电流之比，$R = \frac{V}{I}$；电压、电流、电阻的单位分别为伏特、安培和_____。

金属灯丝两端电压升高时，电流增大，灯丝温度升高，电阻随之_____。

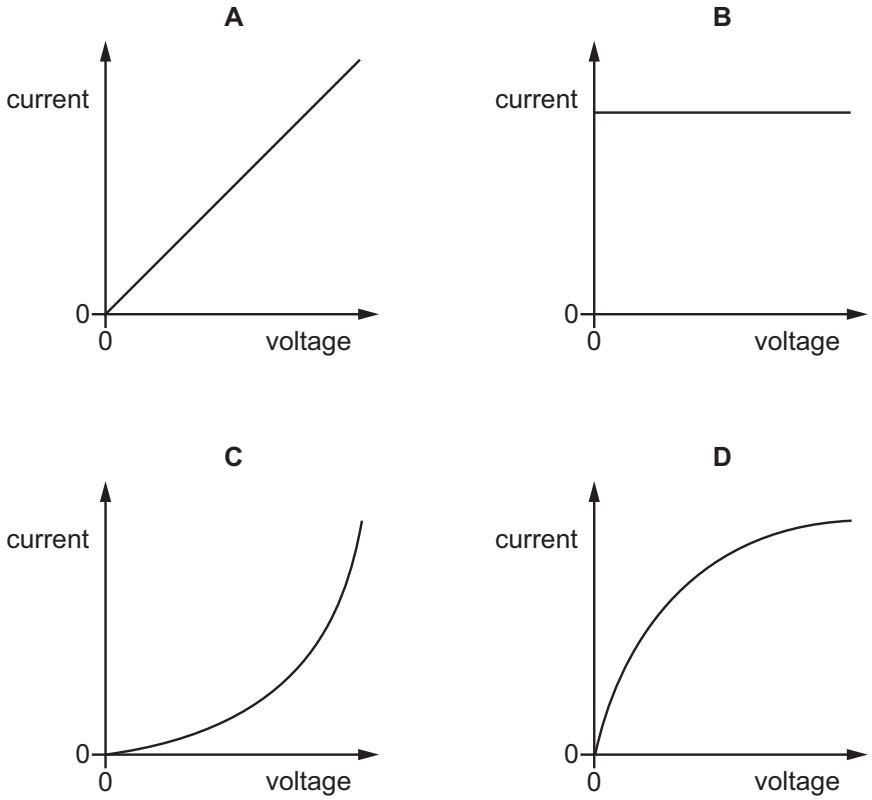
在电流-电压图像中，电阻增大时，相同电压增量引起的电流增量逐渐_____，曲线逐渐变平。

答案：欧姆；增大；减小

怎么认 题目出现灯丝灯泡的电流-电压图像或问电流增大后的温度、电阻时，先判断灯丝发热使电阻增大。

例题 1

Which graph is the current–voltage characteristic of a filament lamp?



（2023 Oct/Nov · 0654/22 · Question 36 · Extended）

解：灯丝中电流增大时，温度升高，电阻增大。

由电阻定义，

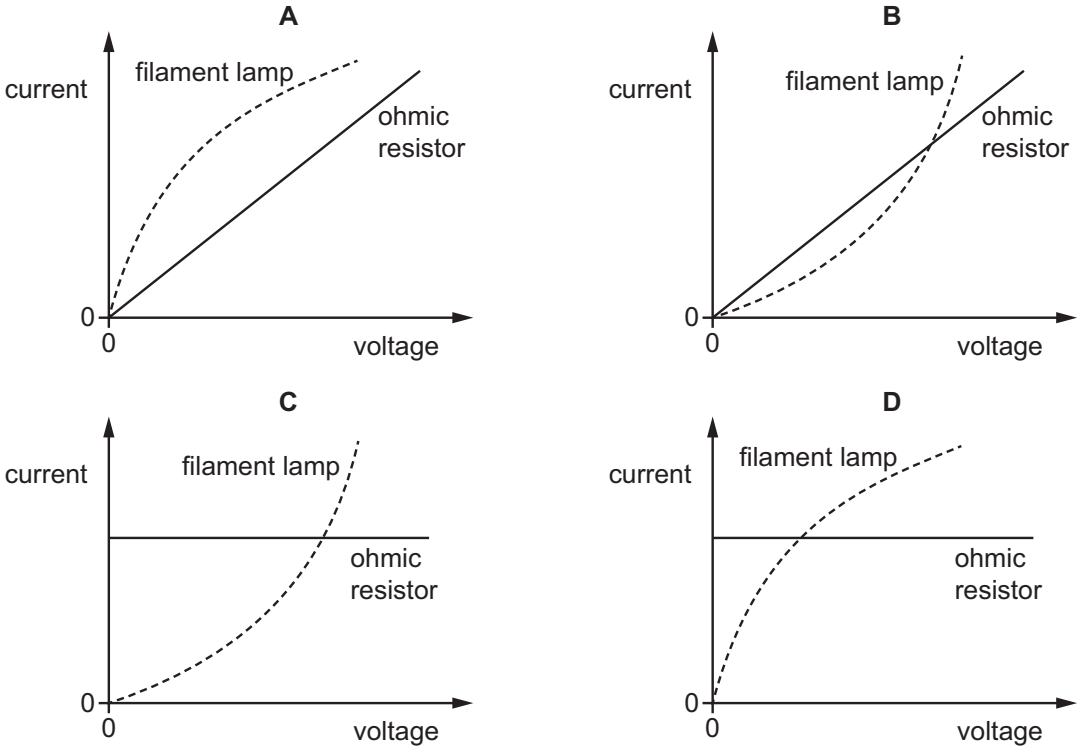
$R = \frac{V}{I}$

电阻越大，相同电压增量引起的电流增量越小，图线逐渐变平。

故选 D。

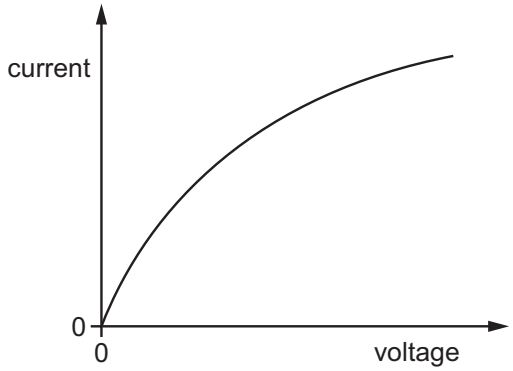
针对练习

1. Which graph shows the current–voltage characteristics of an ohmic resistor and a filament lamp?



（2023 Oct/Nov · 0654/21 · Question 37 · Extended）

2. The current–voltage characteristic for a filament lamp is shown.



As the current increases, what happens to the temperature of the lamp filament and what happens to the resistance of the lamp filament?

	temperature of lamp filament	resistance of lamp filament
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2024 Oct/Nov · 0654/23 · Question 35 · Extended）

题型 8：先秒和安培统一单位再用 Q=It（考频★★☆☆☆）

知识点 电流表示_____内通过导体横截面的电荷量，$I=\frac{Q}{t}$，变形得 $Q=It$。
式中 Q 的单位为 C，I 的单位为 A，t 的单位为 s。
当电流不变，或 I 表示该段时间内的平均电流时，上述关系成立。
计算前把分钟换成_____，把毫安换成_____；1 min = 60 s，1000 mA = 1 A。

答案：单位时间；s；A

怎么认 题目出现电荷量、电流和时间中的两个量并求第三个量时，先把时间统一为 s、电流统一为 A。

例题 1

A charge of 480 C passes through a wire in 3.0 minutes.

What is the average current in the wire?

A 2.7 A **B** 24 A **C** 160 A **D** 1440 A

（2022 Oct/Nov · 0654/23 · Question 36 · Extended）

解：由 1 min = 60 s，得
$t = 3.0 \times 60 = 180$ s
由 $I=\frac{Q}{t}$，得
$I=\frac{480}{180} \approx 2.7$ A
故选 A。

针对练习

1. The current in an ammeter is 1.5 A.

How much charge passes through the ammeter in one minute?

A 0.025 C **B** 1.5 C **C** 40 C **D** 90 C

（2024 May/Jun · 0654/21 · Question 36 · Extended）

2. There is a current of 100 mA in a circuit.

How much charge flows through the circuit in 1.5 minutes?

A 0.15 C **B** 9.0 C **C** 150 C **D** 9000 C

（2025 May/Jun · 0654/22 · Question 37 · Extended）

题型 9：比较手持导体和绝缘体能否保存摩擦电荷（考频★☆☆☆☆）

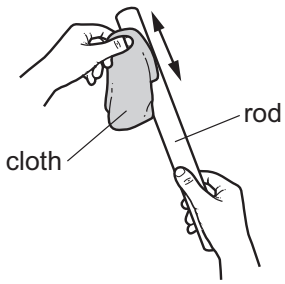
知识点 摩擦起电是电子在不同材料之间转移的现象；得到电子的物体带负电，失去电子的物体带正电。
导体内的电荷能够移动，手持导体时，电荷可经人体流向大地，不能保存摩擦产生的_____。
绝缘体内的电荷不能自由移动，在干燥条件下能保存摩擦电荷；相互摩擦的绝缘体带_____电荷而相互吸引。电荷量的单位是库仑，符号为 C。

答案：静电荷；异种

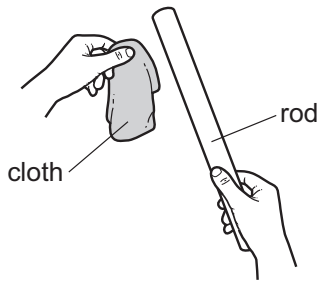
怎么认 题目出现手持金属棒或塑料棒与干布摩擦并判断作用力时，先判断棒能否保存摩擦电荷。

例题 1

A student holds an iron rod in one hand and a dry cotton cloth in the other hand. The student rubs the iron rod with the cotton cloth several times. Next the student holds the cloth close to the iron rod.



rod rubbed with cloth



cloth held close to rod

The student then repeats this procedure with an identical dry cotton cloth and a plastic rod.

Which row shows the force between the iron rod and cloth and between the plastic rod and cloth when they are held close to each other after rubbing?

	force between iron rod and cloth	force between plastic rod and cloth
A	attraction	no force
B	no force	attraction
C	no force	repulsion
D	repulsion	repulsion

（2025 Feb/Mar · 0654/12 · Question 38 · Core）

解：铁棒是导体，且由手握住，摩擦产生的电荷经人体流向大地，铁棒不能保存静电荷，故铁棒与棉布之间无静电力。
塑料棒是绝缘体，在干燥条件下能保存摩擦产生的电荷；塑料棒与棉布带异种电荷，二者相互吸引。故选B。

题型 10：选能覆盖读数的最小合适电压表量程（考频★☆☆☆☆）

知识点 电压表的量程表示能够测量的电压范围，量程上下限与被测电压必须使用相同单位。
测量时，被测电压必须_____量程范围内；多个量程均能测量时，应选量程上限最接近且_____被测电压的量程。
$1\ \text{kV} = 1000\ \text{V}$，$1\ \text{V} = 1000\ \text{mV}$。

答案：落在；不小于

怎么认 题目出现预期电压和多个量程时，先统一单位，再选能覆盖读数的最小量程。

例题 1

An electrician has a voltmeter that can be switched to different voltage ranges.

The voltmeter needs to measure a voltage of 240 V.

Which voltage range is the most suitable?

A 0–1000 mV **B** 0–200 V **C** 0–500 V **D** 5–250 kV

（2026 May/Jun · 0654/21 · Question 36 · Extended）

解：统一用 V 表示，
1000 mV = 1 V
1 V < 200 V < 240 V < 500 V < 5 kV
故 0–500 V 能覆盖 240 V，且量程上限最接近被测电压。故选 C。

题型 11：先从电压电阻求电流，再连接电荷与时间（考频★☆☆☆☆）

知识点 电流表示单位时间内通过导体横截面的电荷量，$I=\frac{Q}{t}$。
对阻值不变的电阻，$V=IR$，所以 $I=$ _____。
电流已知时，$Q=$ _____，$t=$ _____。
V、I、R、Q、t 的单位分别为 V、A、Ω、C、s。

答案：$\frac{V}{R}$；It；$\frac{Q}{I}$

怎么认 题目出现电压、电阻，并求电荷量或电荷通过所需时间时，先由 $I=\frac{V}{R}$ 求电流。

例题 1

A battery with an electromotive force (e.m.f.) of 6.0 V is connected to a 30 Ω resistor.

How much charge flows through the battery in 5.0 s?

A 1.0 C **B** 25 C **C** 36 C **D** 900 C

（2022 May/Jun · 0654/23 · Question 36 · Extended）

解：由 $V=IR$ 得
$I=\frac{V}{R}=\frac{6.0}{30}=0.20$ A。
由 $Q=It$ 得
$Q=0.20\times5.0=1.0$ C。
故选 A。

针对练习

1.

The potential difference (p.d.) across a 60 Ω resistor is 12 V.

How much time does it take for a charge of 100 C to pass through the resistor?

A 0.0020 s **B** 0.050 s **C** 20 s **D** 500 s

（2024 May/Jun · 0654/23 · Question 36 · Extended）

题型 12：先求电功率再以能量反求工作时间（考频★☆☆☆☆）

知识点 用电器传递电能的快慢用电功率表示，电功率等于单位时间内传递的能量，即 $P=\frac{E}{t}$。
用电器两端的电势差为 V、通过的电流为 I 时，电功率 $P=$ _____；在电流和电势差不变时，$E=Pt$。
P 的单位是瓦特（W），E 的单位是焦耳（J），t 的单位是 _____。

答案：IV；s

怎么认 题目出现电流、电压、传递的能量并求时间时，先由 $P=IV$ 求电功率。

例题 1

There is a current of 0.50 A in a lamp when the potential difference (p.d.) across the lamp is 12 V.

How much time does it take for the lamp to transfer 100 J of energy?

A 0.060 s **B** 4.2 s **C** 17 s **D** 600 s

（2025 May/Jun · 0654/23 · Question 37 · Extended）

解：由 $P=IV$ 得
$P=0.50\times12=6.0$ W

由 $E = Pt$ 得
$t = \frac{E}{P} = \frac{100\ \mathrm{J}}{6.0\ \mathrm{W}} \approx 17\ \mathrm{s}$
故选 C。

专题 17 串并联、电路与电功率

17.1 串并联、电路与电功率

题型 1：串联电阻相加、并联电阻小于每一支路（考频★★★☆☆）

知识点 电阻串联时，各电阻中的电流相同，总电阻等于各电阻之_____：$R_{总}=R_1+R_2+\ldots$。
电阻并联时，各支路两端电压相同，$\frac{1}{R_{总}}=\frac{1}{R_1}+\frac{1}{R_2}+\ldots$，总电阻_____任一支路电阻。
n 个相同电阻并联时，$R_{总}=\frac{R}{n}$；电阻的单位是_____，符号为 Ω。

答案：和；小于；欧姆

怎么认 题目出现电阻首尾相接、跨接同两点或求总电阻时，先判定串联或并联。

例题 1

A 12 Ω resistor is connected in parallel with a 17 Ω resistor.

Which statement about the combined resistance of the two resistors is correct?

A It must be equal to 29 Ω.

B It must be greater than 12 Ω but less than 17 Ω.

C It must be greater than 17 Ω but less than 29 Ω.

D It must be less than 12 Ω.

（2025 May/Jun · 0654/11 · Question 37 · Core）

解：两电阻并联，总电阻小于任一支路电阻。
$R_{总}<12\ \Omega$
故选 D。

针对练习

1. A 4.0 Ω resistor is connected in parallel with an 8.0 Ω resistor.

What is their combined resistance?

A less than 4.0 Ω

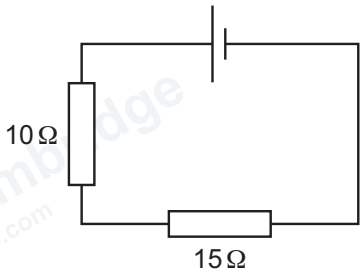
B between 4.0 Ω and 8.0 Ω

C between 8.0 Ω and 12.0 Ω

D exactly 12.0 Ω

（2025 Oct/Nov · 0654/12 · Question 38 · Core；同题：2025 Oct/Nov · 0654/13 · Question 38 · Core）

2. A student connects a circuit as shown.



What is the total resistance of the circuit?

A 5.0 Ω **B** 10 Ω **C** 15 Ω **D** 25 Ω

（2026 May/Jun · 0654/11 · Question 38 · Core）

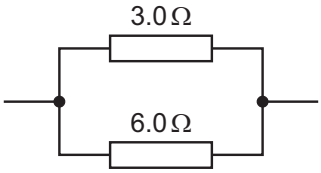
3. A 12 Ω resistor is connected in parallel with a 6.0 Ω resistor.

What is the combined resistance of the two resistors?

A 0.25 Ω **B** 4.0 Ω **C** 9.0 Ω **D** 18 Ω

（2024 Oct/Nov · 0654/23 · Question 36 · Extended）

4. The diagram shows a 3.0 Ω resistor connected to a 6.0 Ω resistor.



What is a possible combined resistance of the two resistors?

A 2.0 Ω **B** 3.0 Ω **C** 4.5 Ω **D** 9.0 Ω

（2025 May/Jun · 0654/12 · Question 38 · Core；同题：2025 May/Jun · 0654/13 · Question 38 · Core）

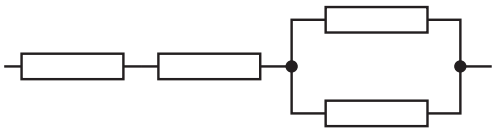
5. The diagrams show four identical resistors connected together in different arrangements.

Which arrangement has the smallest combined resistance?

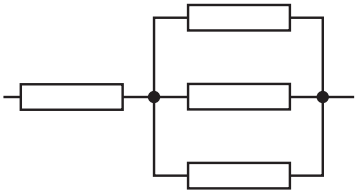
A



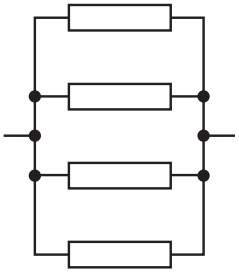
B



C



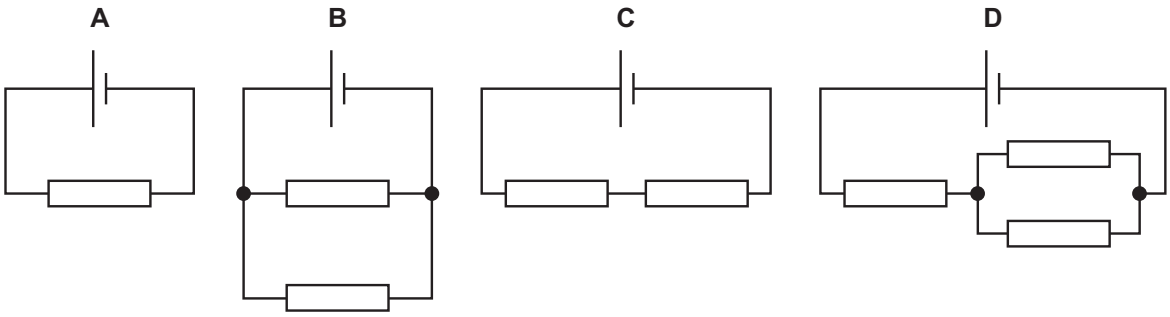
D



（2023 May/Jun · 0654/12 · Question 37 · Core；同题：2023 May/Jun · 0654/13 · Question 37 · Core）

6. In the circuits shown, all the resistors are identical.

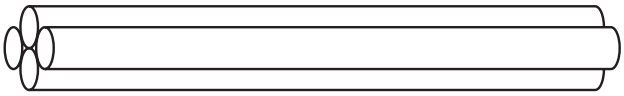
Which circuit has the smallest combined resistance?



（2024 May/Jun · 0654/11 · Question 37 · Core）

7. A copper wire has a resistance of 8.0 Ω.

Four of these wires are arranged side by side to form a cable, as shown.

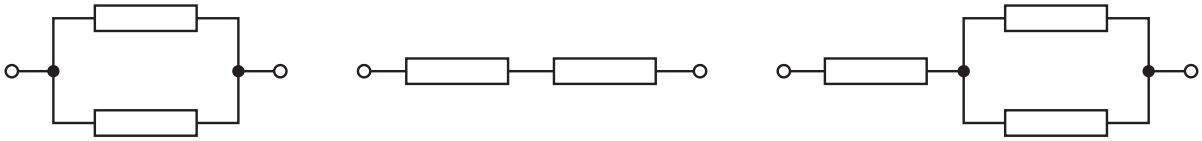


What is the resistance of this cable?

A 0.50 Ω **B** 2.0 Ω **C** 32 Ω **D** 128 Ω

（2022 Feb/Mar · 0654/22 · Question 35 · Extended）

8. X, Y and Z are combinations of identical resistors.



The combinations are put in order of decreasing resistance (largest resistance to smallest resistance).

What is this order?

A Y → X → Z **B** Y → Z → X **C** Z → X → Y **D** Z → Y → X

（2022 Oct/Nov · 0654/12 · Question 38 · Core）

题型 2：并联各灯独立通断，某支路断路不影响其余（考频★★★☆☆）

知识点 并联电路中，各用电器分别接在电源的同一对连接点之间，各支路两端的电势差_____电源电势差。

当各支路装有开关时，各用电器可以_____控制。

一条支路因灯泡损坏而断路时，其余完整支路仍有电流，用电器仍能工作。

电势差的单位为伏特（V），电流的单位为安培（A）。

答案：等于；独立

怎么认 题目出现并联灯泡、分别设开关或某灯断路时，先检查其余支路是否仍构成闭合回路。

例题 1

What is an advantage of connecting lamps in parallel in a circuit, rather than in series?

A The lamps do not use as much energy.

B The lamps last longer before failing.

C The potential difference (p.d.) across each lamp is smaller.

D When one lamp fails, all the others remain lit.

（2022 Oct/Nov · 0654/13 · Question 38 · Core；同题：2022 Oct/Nov · 0654/23 · Question 37 · Extended）

解：并联电路的各支路彼此独立，一只灯泡损坏时，所在支路断路，其余支路仍构成闭合回路，灯泡继续发光。故选 D。

针对练习

1. Which row shows how lamps are connected in a lighting circuit in a house and gives an advantage of connecting them in this way?

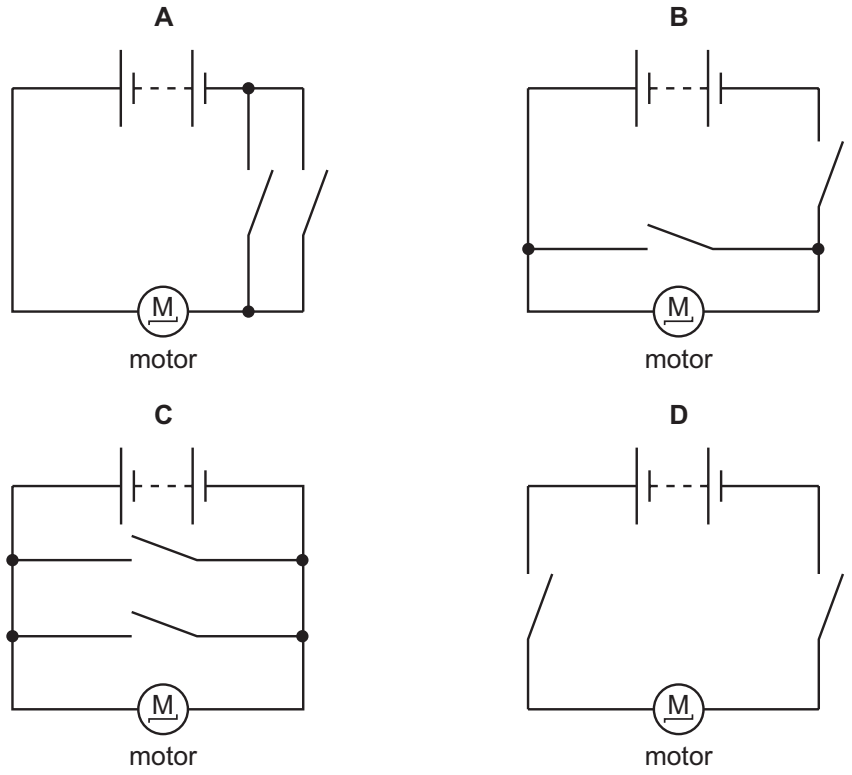
	how lamps are connected	advantage of connecting them in this way
A	in parallel	they can be switched separately
B	in parallel	they share the voltage
C	in series	they can be switched separately
D	in series	they share the voltage

（2022 May/Jun · 0654/11 · Question 37 · Core；同题：2022 May/Jun · 0654/12 · Question 38 · Core、2022 May/Jun · 0654/21 · Question 37 · Extended、2022 May/Jun · 0654/22 · Question 37 · Extended、2022 May/Jun · 0654/23 · Question 37 · Extended、2022 May/Jun · 0654/13 · Question 38 · Core）

2. The diagrams show four circuits each containing a motor and two switches. The switches are all open.

In one of the circuits, closing one of the switches on its own starts the motor turning, and closing the other switch on its own also starts the motor turning.

Which circuit is this?



（2022 Oct/Nov · 0654/13 · Question 37 · Core）

3. Two lamps can be connected to a battery either in series or in parallel.

Which statement is **not** a benefit of connecting two lamps in parallel rather than in series?

A If one lamp breaks, the other lamp stays lit.

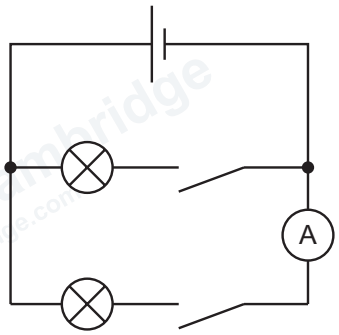
B The lamps are brighter.

C The lamps can be controlled individually using switches.

D There is a smaller current in the battery.

（2023 Oct/Nov · 0654/13 · Question 37 · Core；同题：2023 Oct/Nov · 0654/23 · Question 37 · Extended）

4. Two lamps are connected in the circuit shown.



Which statements about the circuit are correct?

1 There is a separate switch to control each lamp.

2 The ammeter measures the current in both lamps when both switches are closed.

3 The circuit is a series circuit.

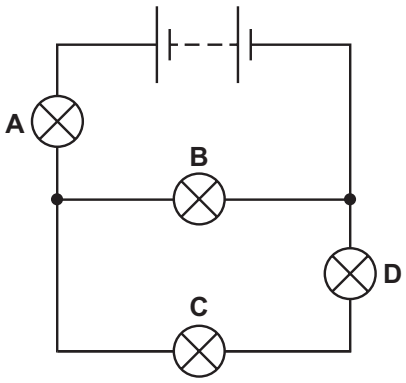
A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

（2026 May/Jun · 0654/12 · Question 37 · Core）

5. The circuit shown includes a battery and four lamps. All the lamps are on.

One lamp fails and all the lamps go off.

Which lamp failed?



（2025 May/Jun · 0654/23 · Question 38 · Extended）

题型 3：并联干路电流等于支路和、总电阻变小（考频★★★☆☆）

知识点 各支路连接在同一对节点之间，称为并联；节点处干路电流等于各支路电流之和。

两个电阻并联时，$\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}$，所以总电阻比任一支路电阻都_____。

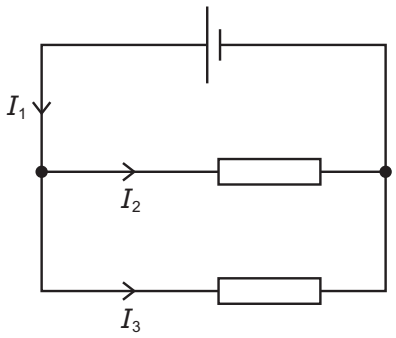
电源电压不变时，增加并联支路使总电阻_____，由 $I=\frac{V}{R_T}$ 得干路电流_____；电流、电阻和电压的单位分别为安培、欧姆和伏特。

答案：小；减小；增大

怎么认 题目出现并联支路及电流或总电阻比较时，先写节点电流关系，并判断总电阻的大小。

例题 1

A circuit contains a cell and two resistors connected in parallel. The currents in each part of the circuit are labelled I_1, I_2 and I_3.



What is the relationship between the currents?

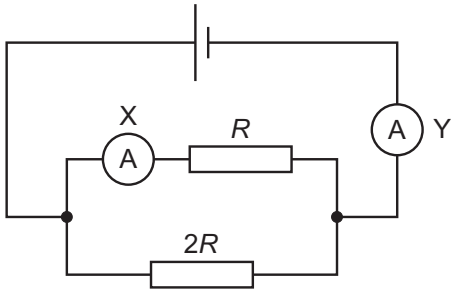
A $I_1 = I_2$ **B** $I_1 = I_3$ **C** $I_1 > I_2 + I_3$ **D** $I_1 = I_2 + I_3$

（2024 Oct/Nov · 0654/21 · Question 37 · Extended）

解：在左侧分流节点，I_1 流入，I_2 与 I_3 流出，由流入电流等于流出电流得 $I_1 = I_2 + I_3$。
故选 D。

针对练习

1. The diagram shows a circuit containing two resistors of resistance R and $2R$ and two ammeters X and Y.

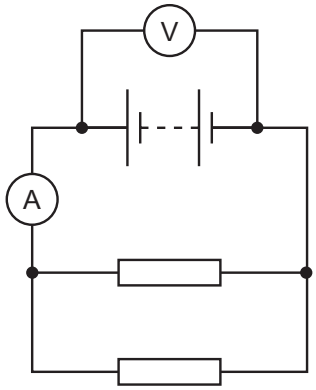


Which ammeter shows the larger reading and what is the combined resistance of the two resistors?

	ammeter with larger reading	combined resistance
A	X	less than R
B	X	more than $2R$
C	Y	less than R
D	Y	more than $2R$

（2024 Oct/Nov · 0654/12 · Question 36 · Core；同题：2024 Oct/Nov · 0654/13 · Question 36 · Core）

2. The diagram shows two resistors connected in parallel to a battery. The circuit contains a voltmeter and an ammeter.



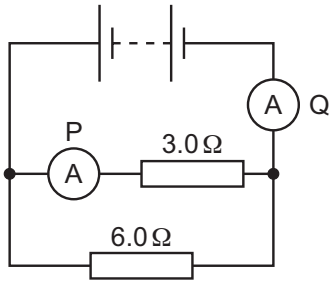
A third resistor is now connected in parallel with these two resistors.

What happens to the voltmeter reading and what happens to the ammeter reading?

	ammeter reading	voltmeter reading
A	decreases	increases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

（2024 Oct/Nov · 0654/11 · Question 37 · Core）

3. A battery is connected in a circuit to a 3.0 Ω resistor, a 6.0 Ω resistor and two ammeters P and Q.

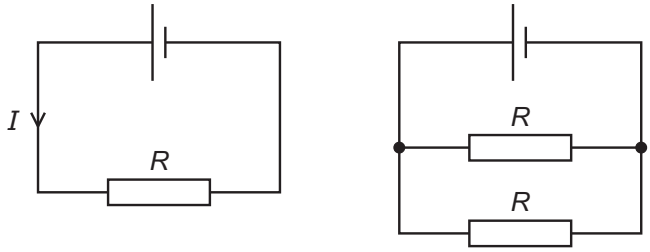


What is the combined resistance of the two resistors and which ammeter has the greater reading?

	combined resistance / Ω	ammeter with greater reading
A	less than 3.0	P
B	less than 3.0	Q
C	9.0	P
D	9.0	Q

（2023 Oct/Nov · 0654/11 · Question 38 · Core；同题：2023 Oct/Nov · 0654/21 · Question 38 · Extended）

4. Circuits 1 and 2 contain identical cells and identical resistors. Each resistor has the same resistance R. The current in the cell in circuit 1 is I.



circuit 1 circuit 2

How do the total resistance of circuit 2 and the current in the cell in circuit 2 compare with R and I?

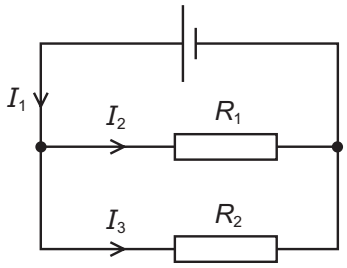
	total resistance of circuit 2	current in cell in circuit 2
A	greater than R	greater than I
B	greater than R	less than I
C	less than R	greater than I
D	less than R	less than I

(2022 Oct/Nov · 0654/11 · Question 38 · Core)

5. The diagram shows resistors of resistance R_1 and R_2 connected in parallel.

The combined resistance of the resistors is R_T.

Currents I_1, I_2 and I_3 are labelled.



Which row is correct?

	current I_1	resistance R_T
A	larger than I_3	smaller than R_2
B	larger than I_3	larger than R_1
C	smaller than I_2	smaller than R_2
D	smaller than I_2	larger than R_1

(2025 May/Jun · 0654/21 · Question 37 · Extended)

题型 4：先电压乘电流求功率，再乘时间求电能（考频★★★☆☆）

知识点 电功率表示用电器单位时间内转移的电能，电压为 V、电流为 I 时，$P=$ _____。
电压和电流在时间 t 内保持不变时，$E=Pt=VIt$；若 V 用 V、I 用 A，则 P 的单位为 _____。
计算 E 时，t 须用 _____，所得电能单位为 J。

答案：VI；W；s

怎么认 题目出现电压、电流和通电时间并求电能时，先由 $P=VI$ 求功率，再由 $E=Pt$ 求电能。

例题 1

There is a current I in a resistor when the voltage across the resistor is V.

How much energy is transferred in the resistor in time t?

A IVt　　**B** $\frac{V}{It}$　　**C** $\frac{I}{Vt}$　　**D** $\frac{VI}{t}$

（2026 Feb/Mar · 0654/12 · Question 37 · Core）

解： 由电功率关系得
$P=VI$。
由 $E=Pt$ 得
$E=VIt$。
故选 A。

针对练习

1. A kettle is connected to a 230 V mains supply. The current in the kettle is 10 A.

How much energy is transferred in 3.0 minutes?

A 12.8 J　　**B** 767 J　　**C** 6900 J　　**D** 414 000 J

（2024 May/Jun · 0654/22 · Question 37 · Extended）

2. There is a current of 3.0 A in a resistor. The potential difference across the resistor is 3.0 V.

How much electrical energy is transferred to other forms in 3.0 minutes?

A 3.0 J　　**B** 9.0 J　　**C** 540 J　　**D** 1620 J

（2023 Feb/Mar · 0654/22 · Question 37 · Extended）

3. An electric kettle is connected to a 250 V supply. The current in the heating element of the kettle is 10 A.

How much electrical energy is transferred in 3.0 minutes?

A 75 J　　**B** 4500 J　　**C** 7500 J　　**D** 450 000 J

（2023 May/Jun · 0654/21 · Question 37 · Extended）

4. An electric heater operates at 220 V.

The current in the heater is 15 A.

Which expression gives the time for the heater to transfer 1.0×10^4 J of energy?

A $\dfrac{1.0 \times 10^4 \times 220}{15}$ s

B $\dfrac{1.0 \times 10^4 \times 15}{220}$ s

C $\dfrac{1.0 \times 10^4}{220 \times 15}$ s

D $1.0 \times 10^4 \times 220 \times 15$ s

（2025 Oct/Nov · 0654/22 · Question 36 · Extended）

5. An electric kettle is rated at 3.0 kW and is connected to a 250 V supply. The kettle is switched on for 2.0 minutes.

Which row shows the current in the kettle and the energy transferred by the kettle?

	current / A	energy / J
A	12	6000
B	12	360 000
C	750	6000
D	750	360 000

（2025 May/Jun · 0654/21 · Question 36 · Extended）

题型 5：电流表串联、电压表跨待测元件并联（考频★★☆☆☆）

知识点 电流表测量通过待测元件的电流，应_____在待测元件所在支路中；电流的单位为安培（A）。

电压表测量待测元件两端的电势差，应_____在该元件两端；电势差的单位为伏特（V）。

在理想电表模型中，电流表的电阻可忽略，电压表的电阻很大，流过电压表的电流可视为零。

测定电阻时，在两表正确连接的条件下，由 $R = \frac{V}{I}$ 求电阻，单位为欧姆（Ω）。

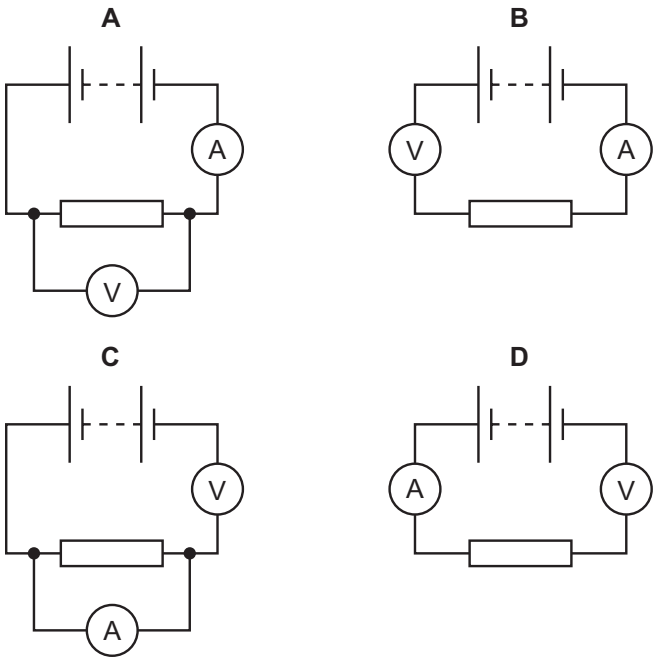
答案：串联；并联

怎么认 题目出现测某元件电流和两端电势差的电路图时，先找电流表串入该支路、电压表并接元件两端。

例题 1

A student connects a circuit to determine the resistance of a resistor.

Which circuit enables the current in the resistor and the potential difference (p.d.) across it to be measured?



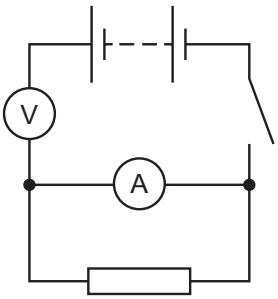
（2022 May/Jun · 0654/12 · Question 37 · Core；同题：2022 May/Jun · 0654/13 · Question 37 · Core）

解：电流表测通过电阻的电流，应串联在电阻所在支路；电压表测电阻两端的电势差，应并联在电阻两端。图 A 中两表的连接均符合要求，故选 A。

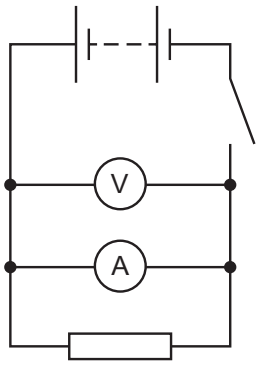
针对练习

1. Which circuit is suitable for determining the resistance of the fixed resistor?

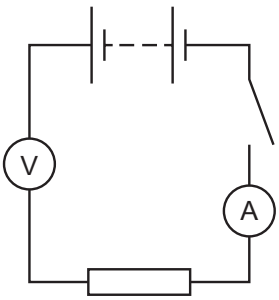
A



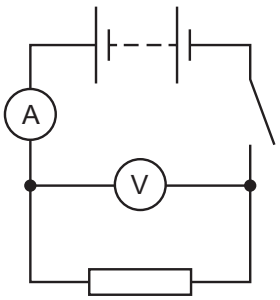
B



C



D

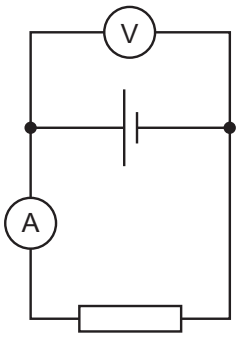


（2025 May/Jun · 0654/12 · Question 36 · Core；同题：2025 May/Jun · 0654/13 · Question 36 · Core）

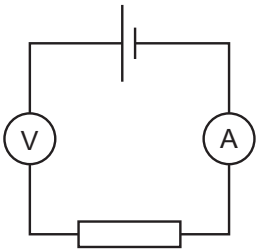
2. A student measures the current in a resistor and the potential difference (p.d.) across it.

Which circuit shows an ammeter and a voltmeter both connected correctly?

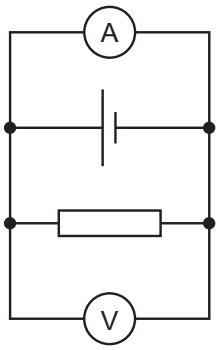
A



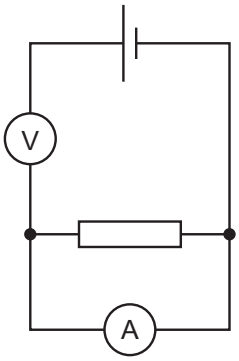
B



C



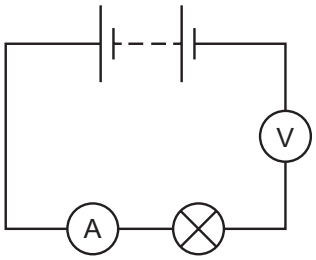
D



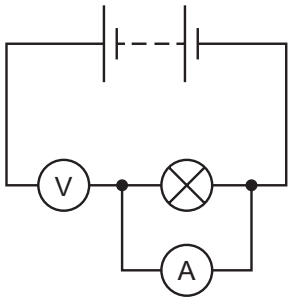
（2023 May/Jun · 0654/23 · Question 36 · Extended）

3. Which circuit shows an ammeter that measures the current in the lamp and a voltmeter that measures the potential difference (p.d.) across the lamp?

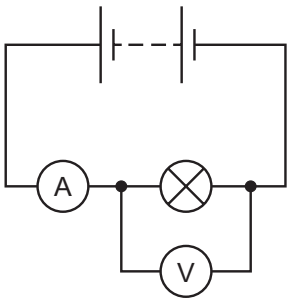
A



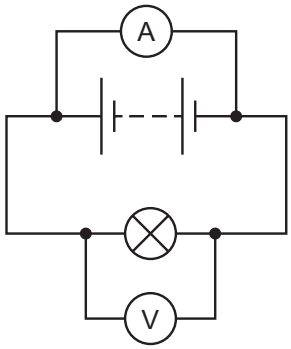
B



C



D



（2025 Oct/Nov · 0654/21 · Question 36 · Extended）

题型 6：同一条串联路径中电流处处相等（考频★★☆☆☆）

知识点 串联电路中，各元件首尾相连，电流只有一条路径。

电路闭合且电流稳定时，同一条串联路径中电流_____，即 $I_1 = I_2 = I_3$。

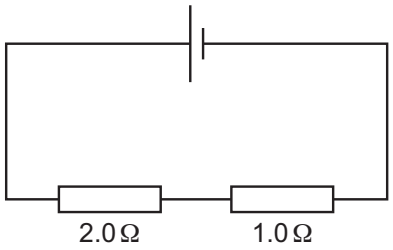
电流用 I 表示，单位是_____，符号为 A。

答案：处处相等；安培

怎么认 题目出现用电器串联或同一路径上多个电流表时，先令各处电流相等。

例题 1

A 2.0 Ω resistor and a 1.0 Ω resistor are connected in series with a cell.



Which statement about current in the circuit is correct?

A The current in the 2.0 Ω resistor is double the current in the 1.0 Ω resistor.

B The current in the 2.0 Ω resistor is equal to the current in the 1.0 Ω resistor.

C The current in the 2.0 Ω resistor is half the current in the 1.0 Ω resistor.

D The current in the cell is larger than the current in either resistor.

（2024 May/Jun · 0654/12 · Question 37 · Core；同题：2024 May/Jun · 0654/13 · Question 37 · Core）

解：两只电阻与电池位于同一条串联路径，由串联电路中电流处处相等，得

$I_{2.0\ \Omega} = I_{1.0\ \Omega}$

故选 B。

针对练习

1. Two resistors with different resistances are connected to a power supply. The resistors can be connected either in parallel or in series.

Which statement is correct?

A For resistors in parallel, the currents in the resistors are equal.

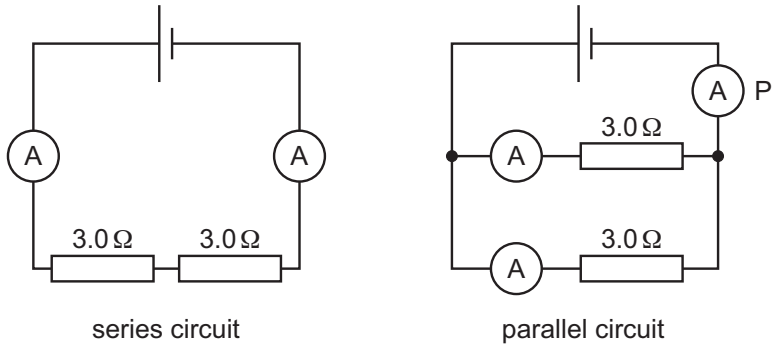
B For resistors in parallel, the potential differences (p.d.s) across the resistors are different.

C For resistors in series, the currents in the resistors are equal.

D For resistors in series, the potential differences (p.d.s) across the resistors are equal.

（2024 May/Jun · 0654/21 · Question 37 · Extended）

2. The diagrams show a series circuit and a parallel circuit. One ammeter in the parallel circuit is labelled P.



series circuit　　parallel circuit

Which statement is correct?

A The total resistance of the series circuit is 3.0 Ω.

B The total resistance of the parallel circuit is 6.0 Ω.

C In the series circuit, the readings on the ammeters are the same.

D In the parallel circuit, the reading on ammeter P is less than the reading on either of the other two ammeters.

（2022 Feb/Mar · 0654/12 · Question 37 · Core）

题型 7：额定功率是每秒能量，用 E=Pt 求总能量或时间（考频★★☆☆☆）

知识点 电功率表示用电器在单位时间内转移的_____，用 P 表示；额定功率是在规定工作条件下用电器的功率。

$P=\frac{E}{t}$，其中 E 的单位是 J，t 的单位是 s，P 的单位是 W。

功率在这段时间内保持不变时，$E=Pt$；$1\ \mathrm{W}=1\frac{\mathrm{J}}{\mathrm{s}}$，即 1 W 表示每 1 s 转移_____。

答案：能量；1 J 的能量

怎么认 题目出现额定功率的含义，或给出功率、能量、时间中的两个量时，先写 $1\ \mathrm{W}=1\frac{\mathrm{J}}{\mathrm{s}}$ 或 $E=Pt$。

例题 1

The power rating of an electric kettle is 1500 W.

What does this mean?

A The kettle requires 1500 J to boil water.

B The kettle takes 1500 s to boil water.

C The kettle transfers 1500 J of energy every second.

D The weight of the kettle is 1500 N.

（2024 May/Jun · 0654/11 · Question 31 · Core）

解：由电功率的定义，

$1500\ \mathrm{W}=1500\frac{\mathrm{J}}{\mathrm{s}}$。

故电热水壶每 1 s 转移 1500 J 的能量。故选 C。

针对练习

1. A 60 W lamp is switched on and 30 J of energy is transferred by the lamp.

How long is the lamp switched on for?

A 0.50 s　　**B** 2.0 s　　**C** 90 s　　**D** 1800 s

（2025 Oct/Nov · 0654/22 · Question 30 · Extended）

2. A 900 W oven operates for 2.0 minutes.

How much energy is transferred by the oven?

A 7.5 J　　**B** 450 J　　**C** 1.8 kJ　　**D** 108 kJ

（2024 Feb/Mar · 0654/22 · Question 29 · Extended）

题型 8：电荷绕完整回路流动而能量送往灯和环境（考频★☆☆☆☆）

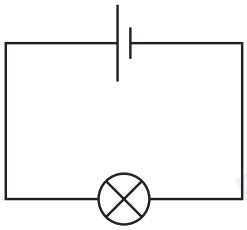
知识点 闭合电路中，电荷沿_____连续流动；电荷不会在灯中被消耗，也不会从灯进入周围环境。电池把_____传递给灯，灯再把所得能量以光和热的形式传递给周围环境。
该关系成立的条件是电路完整闭合；电荷量单位为C，能量单位为J。

答案：完整回路；能量

怎么认 题目出现电池、灯和闭合回路并判断传递对象时，先区分电荷流动与能量传递。

例题 1

The diagram shows an electric circuit that contains a cell and a lamp.



Which statement is correct?

A The electric circuit transfers charge from the cell to the lamp only.

B The electric circuit transfers charge from the cell to the lamp and then into the surroundings.

C The electric circuit transfers energy from the cell to the lamp only.

D The electric circuit transfers energy from the cell to the lamp and then into the surroundings.

（2026 May/Jun · 0654/11 · Question 37 · Core）

解：闭合电路中，电荷绕完整回路连续流动，不会在灯处停止，也不会进入周围环境。
电池把能量传给灯，灯再把能量以光和热的形式传给周围环境。
故选 D。

题型 9：先求电路总电阻，再求电流或总电压（考频★★☆☆☆）

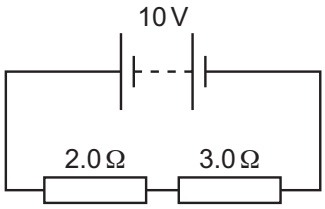
知识点 设电路的总电阻为 R_T。串联电路中各处电流相同，R_T 等于各电阻之_____；两个电阻串联时，$R_T = R_1 + R_2$。
并联电路中各支路两端电压相同，两个电阻并联时，$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$。
对温度不变的欧姆电阻，由 $V = IR$ 得 $I = \frac{V}{R_T}$ 或 $V = IR_T$；电阻、电压和电流的单位分别是_____、_____和 A。

答案：和；Ω；V

怎么认 题目出现多个电阻与电源相连，并要求总电流或总电压时，先判断连接方式并求总电阻。

例题 1

A 2.0 Ω resistor and a 3.0 Ω resistor are connected in series with a 10 V battery.



What is the current in the circuit?

A 0.50 A **B** 2.0 A **C** 5.0 A **D** 50 A

（2023 Feb/Mar · 0654/12 · Question 37 · Core）

解：两电阻串联，故

$R_T = 2.0 + 3.0 = 5.0\ \Omega$

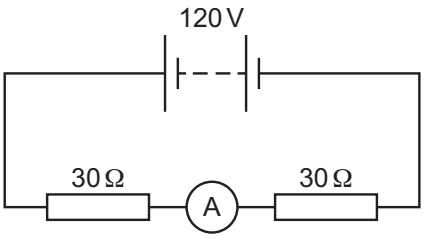
由 $I = \frac{V}{R_T}$ 得

$I = \frac{10}{5.0} = 2.0\ \text{A}$

故选 B。

针对练习

1. The diagram shows two 30 Ω resistors and an ammeter connected to a 120 V battery.

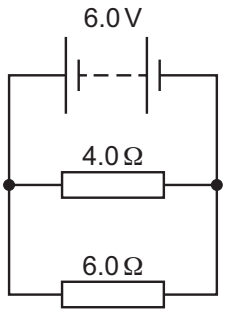


What is the reading on the ammeter?

A 0.25 A **B** 0.50 A **C** 2.0 A **D** 4.0 A

（2025 May/Jun · 0654/23 · Question 36 · Extended）

2. The diagram shows a circuit.



Which statement is correct?

A The current in the 4.0 Ω resistor is 1.0 A.

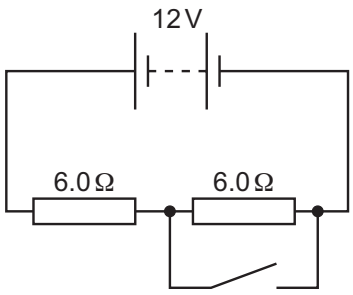
B The current in the 4.0 Ω resistor is 1.5 A.

C The current in the 6.0 Ω resistor is 1.5 A.

D The current in the 6.0 Ω resistor is 2.5 A.

（2025 Oct/Nov · 0654/23 · Question 37 · Extended）

3. The diagram shows a 12 V battery connected to two 6.0 Ω resistors and a switch.



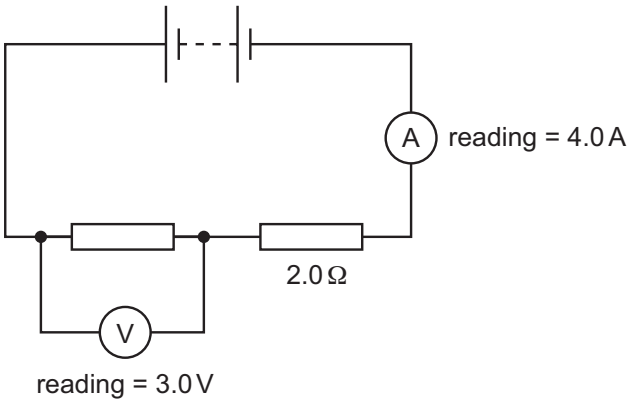
What is the current in the battery with the switch closed and what is the current with the switch open?

	current with switch closed / A	current with switch open / A
A	1.0	1.0
B	1.0	2.0
C	2.0	1.0
D	2.0	2.0

（2022 Oct/Nov · 0654/13 · Question 36 · Core）

4. The circuit shown contains a battery, two resistors, a voltmeter and an ammeter.

One of the resistors has a resistance of 2.0 Ω. The reading on each meter is shown.



What is the potential difference (p.d.) across the battery?

A 3.0 V **B** 6.0 V **C** 8.0 V **D** 11 V

（2024 Oct/Nov · 0654/22 · Question 36 · Extended）

题型 10：以电源电压和串联电阻控制灯亮度或电机速度（考频★★☆☆☆）

知识点 在串联电路中，各元件中的电流_____；电源电压升高时，电路电流通常增大。

电源电压不变时，串联电阻增大使总电阻增大，电流_____；可变电阻能使电阻连续变化。

在正常工作范围内，同一灯或电机中的电流增大时，灯通常更亮，电机通常转得更快；电功率 $P = UI$，单位为_____（W）。

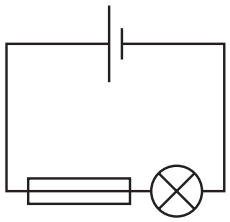
答案：相等；减小；瓦特

怎么认 题目出现电池节数、串联电阻或可变电阻，并比较灯亮度或电机速度时，先比较电源电压和总电阻。

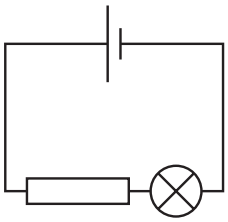
例题 1

In which circuit can the brightness of the lamp be varied continuously?

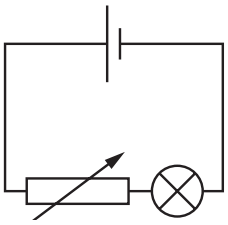
A



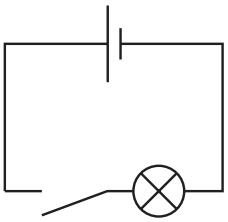
B



C



D

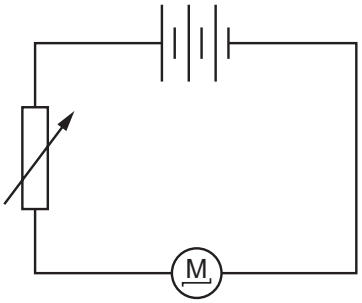


（2025 May/Jun · 0654/11 · Question 36 · Core）

解：C 中可变电阻与灯串联，调节滑片可连续改变 $R_{变}$。
由 $I=\frac{U}{R_{灯}+R_{变}}$ 得，$R_{变}$ 连续变化时，电流 I 连续变化。
灯的电功率随之改变，亮度可连续改变。故选 C。

针对练习

1. The diagram shows a circuit containing three cells, a variable resistor and an electric motor.



Which actions together **must** increase the speed of the motor?

A decreasing the number of cells and decreasing the resistance of the variable resistor

B decreasing the number of cells and increasing the resistance of the variable resistor

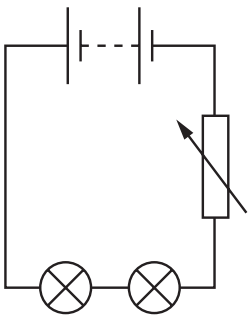
C increasing the number of cells and decreasing the resistance of the variable resistor

D increasing the number of cells and increasing the resistance of the variable resistor

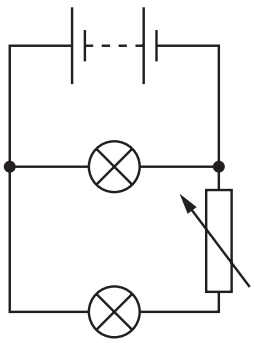
（2025 May/Jun · 0654/12 · Question 37 · Core；同题：2025 May/Jun · 0654/13 · Question 37 · Core）

2. In which circuit is it possible to change the brightness of one lamp without changing the brightness of the other lamp?

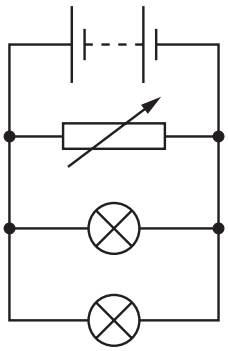
A



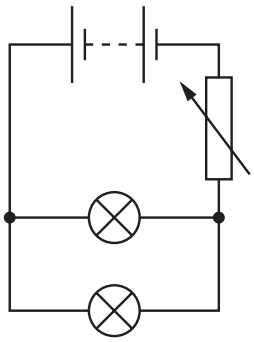
B



C



D



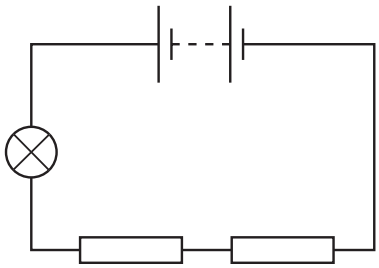
（2022 Oct/Nov · 0654/11 · Question 37 · Core）

3. A lamp is connected in four circuits in turn.

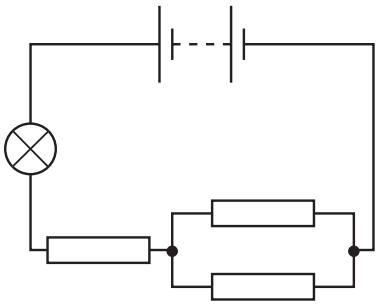
The batteries are identical and the resistors are identical.

In which circuit is the lamp the brightest?

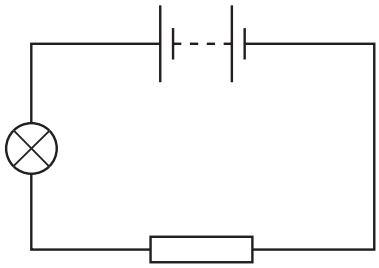
A



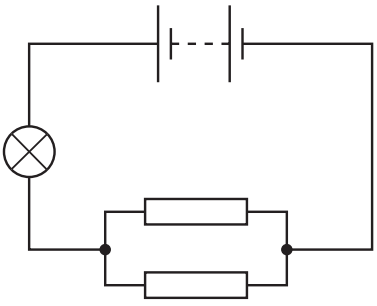
B



C



D



（2023 Oct/Nov · 0654/12 · Question 37 · Core；同题：2023 Oct/Nov · 0654/22 · Question 37 · Extended）

题型 11：先用电阻求电流，再求电能或干路电流（考频★★☆☆☆）

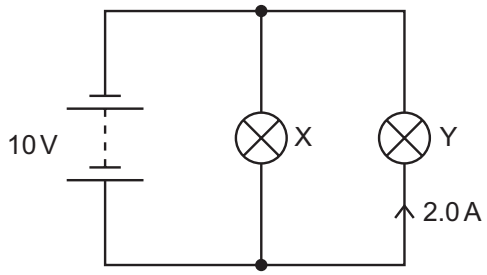
知识点 电阻为 R 的用电器两端电压为 V 时，由欧姆定律得 $I=\frac{V}{R}$，此式适用于电阻不变的用电器。电功率 $P=VI$，电能 $E=Pt=VIt$；V、I、t 分别以 V、A、s 为单位时，E 的单位为_____。并联电路各支路电压_____，干路电流等于各支路电流之和；电压相同时，功率之比等于_____之比。

答案：焦耳（J）；相等；电流

怎么认 题目出现电压、电阻、通电时间并求电能或干路电流时，先由 $I=\frac{V}{R}$ 求电流。

例题 1

A battery of electromotive force (e.m.f.) 10 V is connected to two lamps X and Y.



The current in lamp Y is 2.0 A.

The power of lamp Y is half the power of lamp X.

How much energy is transferred by the battery in 1.0 minute?

A 30 J **B** 1800 J **C** 2400 J **D** 3600 J

（2022 Oct/Nov · 0654/21 · Question 37 · Extended）

解：两灯并联，故两灯电压相等；由 $P=VI$ 得，两灯的功率之比等于电流之比。

$P_X=2P_Y$

$I_X=2I_Y=2\times 2.0\ \text{A}=4.0\ \text{A}$

$I=I_X+I_Y=4.0\ \text{A}+2.0\ \text{A}=6.0\ \text{A}$

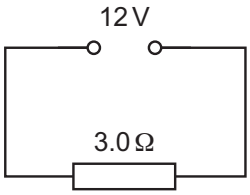
$t=1.0\ \text{min}=60\ \text{s}$

$E=VIt=10\ \text{V}\times 6.0\ \text{A}\times 60\ \text{s}=3600\ \text{J}$

故选 D。

针对练习

1. A 3.0 Ω resistor is connected to a 12 V power supply.



How much electrical energy does the resistor transfer in 10 s?

A 3.6 J **B** 4.8 J **C** 360 J **D** 480 J

（2023 May/Jun · 0654/23 · Question 37 · Extended）

2. A heating element in an electric kettle has a resistance of 24 Ω.

When the kettle is connected to a 240 V supply, it takes 2.5 minutes to boil some water.

How much energy is used to boil the water?

A 16 J **B** 960 J **C** 6000 J **D** 360 000 J

（2024 Oct/Nov · 0654/22 · Question 37 · Extended）

题型 12：热敏电阻升温减阻，再判断分压或读图电流（考频★★☆☆☆）

知识点 负温度系数（NTC）热敏电阻的温度升高时，电阻_____；温度降低时，电阻增大。

设电源电压为 V，定值电阻为 R，热敏电阻为 R_{T}；串联电路的电流为 $I=\frac{V}{R+R_{\mathrm{T}}}$。

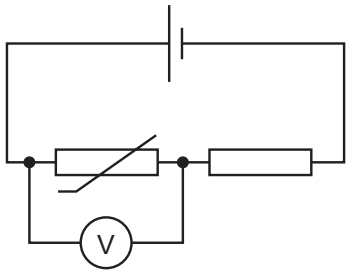
热敏电阻和定值电阻两端的电压分别为 $V_{\mathrm{T}}=V\frac{R_{\mathrm{T}}}{R+R_{\mathrm{T}}}$ 和 $V_R=V\frac{R}{R+R_{\mathrm{T}}}$。

电压表并联在哪个元件两端，就测量_____；电阻、电流和电压的单位分别为 Ω、A 和 V。

答案：减小；该元件两端的电压

怎么认 题目出现 NTC 热敏电阻升温、串联电路和电压表时，先判定其电阻减小，再看电压表并联的位置。

例题 1 The diagram shows a circuit containing a resistor and an NTC thermistor.



The temperature of the thermistor increases.

What happens to the resistance of the thermistor and what happens to the reading on the voltmeter?

	resistance of thermistor	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2022 Feb/Mar · 0654/22 · Question 36 · Extended）

解： NTC 热敏电阻的温度升高，其电阻 R_{T} 减小。

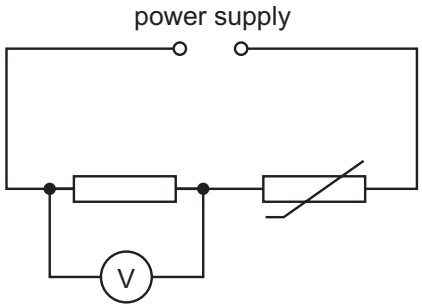
电压表并联在热敏电阻两端，由分压关系得

$V_{\mathrm{T}}=V\frac{R_{\mathrm{T}}}{R+R_{\mathrm{T}}}$

因 V 和 R 均不变，R_{T} 减小时，V_{T} 减小。故选 A。

针对练习

1. The circuit shows a resistor and an NTC thermistor connected in series with a power supply. A voltmeter is connected across the resistor.



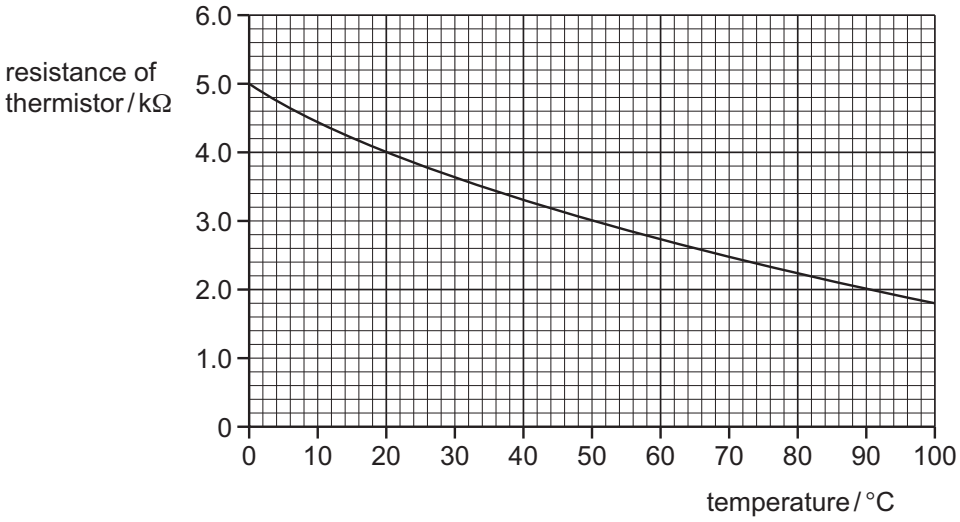
The temperature of the thermistor increases.

What happens to the resistance of the thermistor and what happens to the reading on the voltmeter?

	resistance of thermistor	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2024 Feb/Mar · 0654/22 · Question 37 · Extended）

2. The graph shows how the resistance of a thermistor changes with temperature.



There is a potential difference (p.d.) of 6.0 V across the thermistor.

What is the current in the thermistor when it is at a temperature of 50 °C?

A 0.0020 A **B** 0.50 A **C** 2.0 A **D** 500 A

（2024 May/Jun · 0654/22 · Question 36 · Extended）

题型 13：灯短暂亮后永久断路，辨认保险丝熔断（考频★☆☆☆☆）

知识点 保险丝（fuse）与被保护电路串联，其额定电流的单位是安培（A）。

当电流不超过额定值时，保险丝导通；电流过大时，保险丝因温度升高而_____，使电路形成_____。

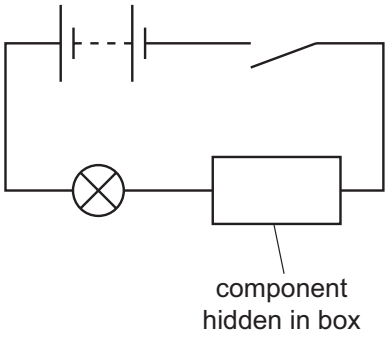
保险丝熔断后不能自行恢复，更换保险丝后电路才能重新导通。

答案：熔断；断路

怎么认 题目出现灯先短暂发光、再次闭合开关不亮时，先判断保险丝已熔断。

例题 1

The series circuit shown includes a single component hidden in a box. The switch is open.

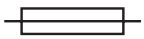


The switch is now closed and the lamp lights briefly before going off.

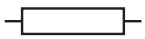
The switch is now opened, and then closed again. This time the lamp does **not** light.

Which symbol represents the component in the box?

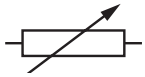
A



B



C



D



（2023 Oct/Nov · 0654/22 · Question 38 · Extended）

解：开关闭合后灯短暂发光，说明电路起初有电流。

随后灯熄灭，再次闭合开关仍不亮，说明盒内元件已使电路断开。

电流过大时保险丝熔断，熔断后不能自行恢复；A 是保险丝的电路符号。

故选 A。

题型 14：固定温升时用质量/加热时间比较有用功率（考频★☆☆☆☆）

知识点 有用功率是单位时间内转移的有用能量，$P=\frac{E}{t}$，单位为瓦特（W）。

水吸收的热量为 $E=mc\Delta T$，质量用 kg，比热容用 J/(kg °C)，温度变化用 °C。

同种水由相同初温升高到相同末温时，c 与 ΔT 相同，故 P 与_____成正比；该比值越小，有用功率越_____。

答案：$\frac{m}{t}$；小

怎么认 题目出现同种水升高相同温度，并给出质量和加热时间时，先比较 $\frac{m}{t}$。

例题 1

Four different kettles contain different masses of water.

They are used to heat the water from room temperature to boiling point.

The kettles take different times to do this.

Which kettle has the lowest useful power output?

	mass of water / g	time to heat water to boiling point / minute
A	1000	3.0
B	1000	5.0
C	2500	3.0
D	2500	5.0

（2024 May/Jun · 0654/23 · Question 31 · Extended）

解：同种水均由室温加热至沸点，c 与 ΔT 相同，由 $P=\frac{E}{t}$ 和 $E=mc\Delta T$ 得

$P=mc\Delta\frac{T}{t}$

故比较 $\frac{m}{t}$：

$\frac{m_A}{t_A}=\frac{1000}{3.0}\approx 333\text{g min}^{-1}$

$\frac{m_B}{t_B}=\frac{1000}{5.0}=200\text{g min}^{-1}$

$\frac{m_C}{t_C}=\frac{2500}{3.0}\approx 833\text{g min}^{-1}$

$\frac{m_D}{t_D}=\frac{2500}{5.0}=500\text{g min}^{-1}$

B 的比值最小，故选 B。

题型 15：给电流和时间求通过电荷量（考频★☆☆☆☆）

知识点 电流 I 表示单位时间内通过导体横截面的电荷量，关系为 $I=\frac{Q}{t}$，故 $Q=$ _____。

当电流在所求时间内保持不变时，I 用安培，t 用秒，Q 的单位为_____。

换算关系为 1 mA = _____ A。

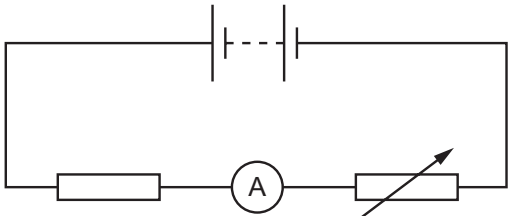
答案：It；库仑（C）；10^{-3}

怎么认 题目出现电流、通电时间并求电荷量时，先把电流换算成安培，再用 $Q=It$。

例题 1

A circuit contains a battery, a fixed resistor, an ammeter and a variable resistor.

The reading on the ammeter is 1.8 mA.



How much charge flows through the variable resistor in 30 s?

A 0.054 C　　**B** 17 C　　**C** 54 C　　**D** 17 000 C

（2022 Feb/Mar · 0654/22 · Question 34 · Extended）

解：由串联电路各处电流相等，通过可变电阻的电流为 1.8 mA。
$1.8\ \text{mA} = 1.8 \times 10^{-3}\ \text{A}$
由 $Q = It$ 得
$Q = 1.8 \times 10^{-3} \times 30 = 0.054\ \text{C}$。
故选 A。

专题 18 用电安全与保险丝

18.1 用电安全与保险丝

题型 1：保险丝过流熔断、切断火线而不稳流（考频★★★☆☆）

知识点 保险丝由熔点较低的细金属丝制成，应与被保护电路_____；当电流超过额定值时，熔丝因发热熔断，使电路断开。

家庭电路中，保险丝应接在_____线上，使其熔断后用电器与火线分离。

额定电流以安培（A）为单位；保险丝不使电流保持在额定值，也不改变电源电压。

答案：串联；火

怎么认 题目出现细丝熔化、保险元件、额定电流或家庭电路接线时，先判断保险丝是否因过流熔断并切断火线。

例题 1

A device that is designed to protect a circuit contains a thin wire. When there is a large current in the circuit, the thin wire melts and cuts off the supply.

What is the device?

A fuse

B lamp

C resistor

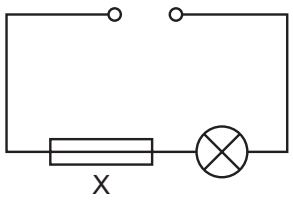
D thermistor

（2022 Oct/Nov · 0654/13 · Question 39 · Core；同题：2022 Oct/Nov · 0654/23 · Question 38 · Extended）

解：题中细丝在大电流通过时熔化并切断电源，符合保险丝的过流熔断特征，因此该装置为保险丝。故选 A。

针对练习

1. Component X protects the circuit shown in the diagram.



What is component X?

A fixed resistor

B fuse

C switch

D variable resistor

（2025 Oct/Nov · 0654/11 · Question 38 · Core）

2. A heater circuit is protected by a 10 A fuse.

How does the fuse protect the circuit?

A It cuts off the current when the current in the heater is greater than 10 A.

B It decreases the current in the heater to 10 A when the current is more than 10 A.

C It increases the current in the heater to 10 A when the current is less than 10 A.

D It maintains a constant temperature in the heater.

（2024 May/Jun · 0654/23 · Question 37 · Extended）

3. What is the purpose of a 3 A fuse in an electrical circuit?

A It keeps the current at a constant value of 3 A.

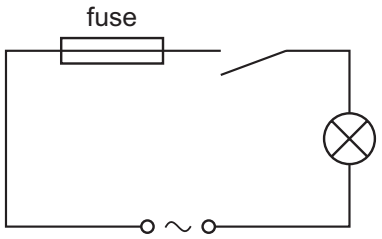
B It prevents the current increasing above 3 A.

C It reduces the resistance of the circuit.

D It varies the voltage of the supply.

（2026 May/Jun · 0654/12 · Question 38 · Core）

4. A student connects the circuit shown.



When the switch is closed, the fuse blows and stops the current.

What is a possible reason for this?

A The current rating of the fuse is too high.

B The current is too large.

C The lamp is too dim.

D The voltage is too small.

（2024 Oct/Nov · 0654/22 · Question 38 · Extended）

5. Fuses are used in domestic electric circuits.

Which statement about fuses is correct?

A A fuse is connected in the live wire.

B A fuse is connected in the neutral wire.

C A 3.0 A fuse produces a current of exactly 3.0 A in the circuit.

D A 3.0 A fuse produces a minimum current of 3.0 A in the circuit.

（2023 May/Jun · 0654/11 · Question 38 · Core；同题：2023 May/Jun · 0654/21 · Question 38 · Extended）

6. What is the function of a fuse in a circuit?

A It decreases the resistance of the circuit.

B It ensures a constant current in the circuit.

C It ensures a constant resistance in the circuit.

D It prevents the cables from overheating.

（2024 May/Jun · 0654/22 · Question 38 · Extended）

7. What is the purpose of a fuse in an electric circuit?

A to make the circuit more efficient

B to protect the circuit from damage by a large current

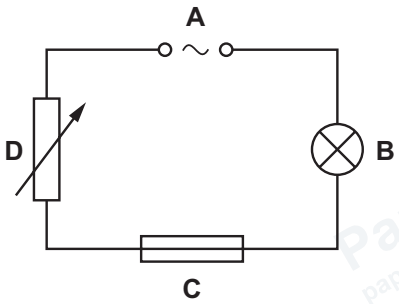
C to provide a constant current in the circuit

D to provide a constant potential difference (p.d.) across the circuit

（2023 Oct/Nov · 0654/13 · Question 38 · Core；同题：2023 Oct/Nov · 0654/23 · Question 38 · Extended）

8. The diagram shows four components in a circuit.

Which component is only used to protect the circuit?



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（2026 May/Jun · 0654/13 · Question 37 · Core）

题型 2：选略高于正常最大电流的最小合适额定值（考频★★★☆☆）

知识点 保险丝串联在电路中，电流过大时熔断并切断电路，保护电路免受过热影响。

保险丝额定电流应_____用电器正常工作时的最大电流；在可选额定值中，取符合这一条件的_____。

工作电流和保险丝额定电流均以安培为单位，单位符号为 A。

答案：略高于；最小值

怎么认 题目出现正常或最大工作电流及若干保险丝额定值时，先选略高于该电流的最小额定值。

例题 1

The current in an electric heater during normal use is 11 A.

What is an appropriate rating for a fuse to protect the heater?

A 3 A　　**B** 10 A　　**C** 13 A　　**D** 36 A

（2022 Oct/Nov · 0654/11 · Question 39 · Core；同题：2022 Oct/Nov · 0654/21 · Question 38 · Extended）

解：正常工作电流为 11 A，保险丝额定电流应略高于 11 A。

可选额定值中，满足要求的最小值为 13 A。

故选 C。

针对练习

1. The maximum current in a food mixer during normal use is 3.1 A.

What is the most suitable rating for a fuse used to protect the mixer?

A 1 A **B** 3 A **C** 5 A **D** 8 A

（2022 Oct/Nov · 0654/12 · Question 39 · Core；同题：2022 Oct/Nov · 0654/22 · Question 38 · Extended）

2. The maximum current in an electric circuit is 10 A.

What is the most appropriate rating of a fuse for this circuit?

A 5 A **B** 9 A **C** 13 A **D** 25 A

（2024 May/Jun · 0654/11 · Question 38 · Core）

3. The current in an electric kettle used to boil water is 9.0 A.

What is the most appropriate rating of fuse to use with this kettle?

A 1 A **B** 3 A **C** 8 A **D** 13 A

（2023 Oct/Nov · 0654/11 · Question 39 · Core；同题：2023 Oct/Nov · 0654/21 · Question 39 · Extended）

4. The current in an electric heater is 6.0 A when in normal use.

Four fuses with different ratings are available to protect the wire to the heater.

Which fuse is most suitable?

A 1 A **B** 5 A **C** 8 A **D** 20 A

（2024 Feb/Mar · 0654/12 · Question 37 · Core）

5. The voltage across an electric heater is 240 V and the current in the heater is 3.0 A.

The heater is connected in a circuit with a fuse.

Which fuse rating is the most suitable?

A 1 A **B** 2 A **C** 5 A **D** 240 A

（2025 May/Jun · 0654/11 · Question 38 · Core）

6. The current in an electric heater is 10 A when in normal use. The heater circuit contains a fuse.

What is the purpose of the fuse and what is a suitable rating for the fuse?

	purpose of fuse	suitable fuse rating / A
A	maintains a constant current	9
B	maintains a constant current	13
C	protects the circuit from the effects of overheating	9
D	protects the circuit from the effects of overheating	13

（2023 Feb/Mar · 0654/12 · Question 38 · Core；同题：2023 Feb/Mar · 0654/22 · Question 38 · Extended）

7. The table shows the usual current in each of four household appliances and the fuse used to protect each of them.

The only fuses available are rated at 3 A, 5 A or 13 A.

Which row shows an appliance that has been fitted with the most appropriate of the fuses available?

	appliance	current / A	fuse rating / A
A	hairdryer	5.5	5
B	kettle	7.5	13
C	lawnmower	5.0	3
D	slow cooker	1.0	5

（2024 Feb/Mar · 0654/22 · Question 38 · Extended）

题型 3：电缆承载上限先于过大额定保险丝会过热（考频★☆☆☆☆）

知识点 保险丝串联在电路中；电流过大时，保险丝会_____，从而切断电路。

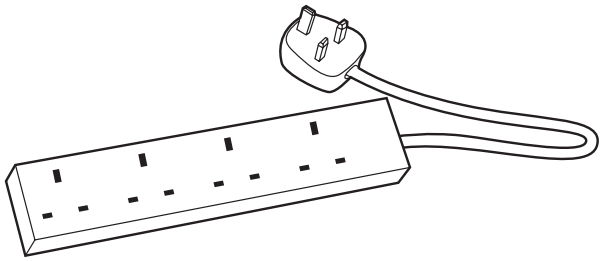
保险丝额定电流应略大于正常工作电流，且不大于导线的_____，电流单位是安培（A）。

若保险丝额定电流大于导线可安全承受的电流，导线可能先过热而保险丝尚未熔断。

答案：熔断；安全载流上限

怎么认 题目出现导线安全电流和换用更大额定电流的保险丝时，先比较两者大小。

例题 1 An electrical extension block has four sockets, a cable which can safely take a current of 6 A and a plug. It is protected by a fuse rated at 5 A.



The extension block is used with four appliances and the 5 A fuse blows. The owner replaces the 5 A fuse with a 13 A fuse.

Why is the extension block now dangerous?

A The appliances may not receive enough current.

B The cable may overheat before the fuse blows.

C The sockets may burn out before the fuse blows.

D The 13 A fuse may blow too soon.

（2022 Feb/Mar · 0654/12 · Question 38 · Core；同题：2022 Feb/Mar · 0654/22 · Question 37 · Extended）

解：电缆安全承受的电流上限为 6 A，更换后的保险丝额定电流为 13 A。

当电流大于 6 A 而尚未使 13 A 保险丝熔断时，电缆中的电流已经超过安全载流上限，电缆可能先过热。

故选 B。

针对练习

1. The instructions for a household lamp state that the plug must be fitted with a 3 A fuse.

What happens if a 13 A fuse is fitted by mistake?

A The fuse blows too easily.

B The lamp lights less brightly.

C The wires connecting the lamp to the plug overheat if a fault develops.

D Too much voltage is supplied to the lamp.

（2024 Oct/Nov · 0654/21 · Question 38 · Extended）

题型 4：识别绝缘损坏与减小导线发热的方法（考频★☆☆☆☆）

知识点 绝缘层用于隔开带电导体与人体或金属外壳；绝缘损坏和潮湿条件都会增大触电危险。

双重绝缘外壳使带电部分与使用者之间有两层绝缘保护，能_____触电危险。

电流 I 通过电阻为 R 的导线时，电热功率为 $P = I^2R$；P 的单位为瓦特，I 的单位为安培。

材料和长度相同时，导线越粗，电阻越_____；同一电流下，电热功率越小。

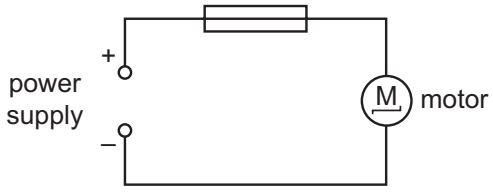
保险丝串联在电路中，电流超过额定值时熔断；额定电流的单位为安培（A）。

答案：减小；小

怎么认 题目出现导线发热、绝缘状态或市电危险判断时，先判断电阻变化和带电部分是否可能接触人体。

例题 1

An electric motor is connected to a power supply by insulated wires. The circuit is protected by a fuse, but the wires become hot.



Which change prevents the wires from becoming so hot?

A Connect a second identical fuse in the circuit.

B Use a fuse with a higher current rating.

C Use thicker connecting wires.

D Use thicker insulation on the connecting wires.

（2024 Oct/Nov · 0654/23 · Question 37 · Extended）

解：导线材料和长度相同，导线越粗，横截面积越大，电阻越小。

由电流的热效应，在电动机的工作电流相同时，

$P = I^2R$

R 减小，导线的电热功率减小，导线不易过热。

故选 C。

针对练习

1. What is **not** a hazard when using a mains supply?

A damaged insulation

B damp conditions

C excess current

D double-insulated outer casing

（2026 Feb/Mar · 0654/12 · Question 38 · Core）

题型 5：先由并联总电流或 V/R 求工作电流再选保险丝（考频★☆☆☆☆）

知识点 保险丝串联在供电线路中，其额定电流应_____电路正常工作电流，并选可用规格中最接近的较大值。

并联电路的正常工作总电流等于_____；已知电压和电阻时，由 $I = \frac{V}{R}$ 求工作电流。

V 的单位为伏特（V），R 的单位为欧姆（Ω），I 的单位为安培（A）；电流过大时，保险丝熔断并切断电路。

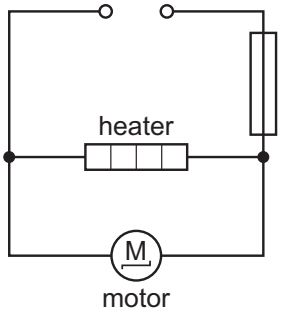
答案：略大于；各并联支路电流之和

怎么认 题目出现并联支路电流或电压与电阻，并要求选择保险丝规格时，先求正常工作总电流。

例题 1

The diagram shows a circuit containing an electric heater, a motor and a fuse.

The current in the heater is 6.0 A and the current in the motor is 2.0 A.



What is an appropriate rating for the fuse?

A 2 A **B** 4 A **C** 6 A **D** 10 A

（2022 May/Jun · 0654/12 · Question 39 · Core；同题：2022 May/Jun · 0654/13 · Question 39 · Core）

解：由并联电路电流关系得

$I_{总} = 6.0\ \text{A} + 2.0\ \text{A}$

$= 8.0\ \text{A}$

保险丝额定电流应略大于 8.0 A，可选规格中 10 A 合适。故选 D。

针对练习

1. A 240 V mains lamp operating normally has a working resistance of 480 Ω.

Which rating of fuse is most suitable to use with this lamp?

A 0.4 A **B** 1 A **C** 2 A **D** 4 A

（2022 May/Jun · 0654/11 · Question 38 · Core）

题型 6：用串联电流表与可变电阻测试熔断电流（考频★☆☆☆☆）

知识点 保险丝应_____联在被保护电路中，电流超过规定值时熔断，使电路断开。

测试熔断电流时，电流表与保险丝串联，可变电阻也应_____联，以连续调节电路中的电流。

串联电路中各处电流_____，电流表读数就是通过保险丝的电流；电流单位为安培（A）。

答案：串；串；相等

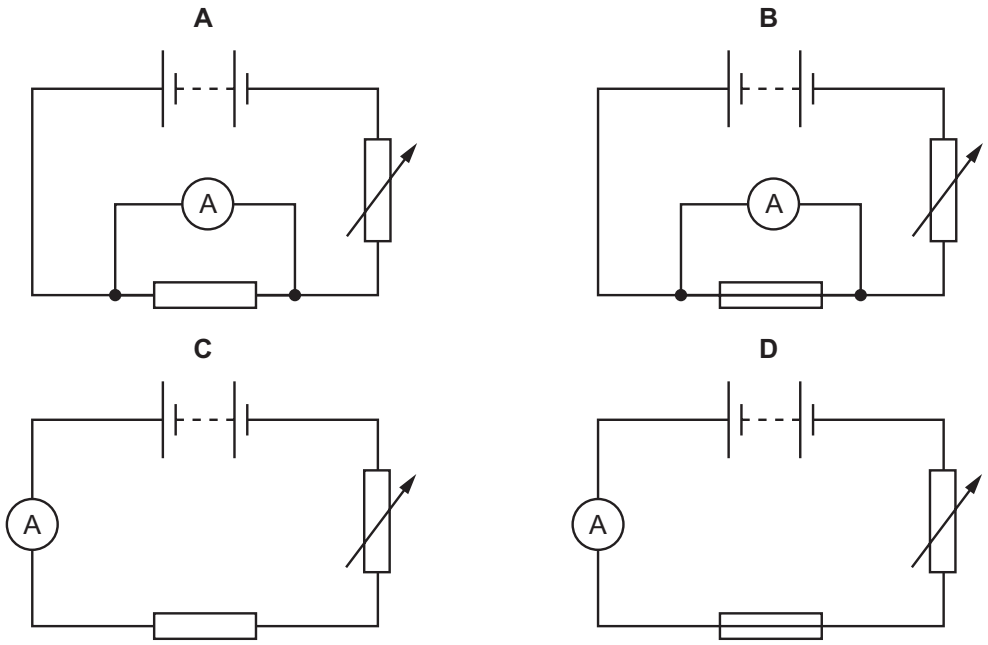
怎么认 题目出现熔断电流测试电路图时，先判断保险丝、电流表和可变电阻是否串联。

例题 1

An electrician has a box of identical fuses that do not have their rating marked on them.

They decide to test one of the fuses to determine its rating by gradually increasing the current in the fuse until it blows.

Which diagram shows a fuse connected in a suitable circuit?



（2024 Oct/Nov · 0654/12 · Question 37 · Core；同题：2024 Oct/Nov · 0654/13 · Question 37 · Core）

解： 测量熔断电流时，电流表、保险丝和可变电阻应串联。

由串联电路得

$I_{\mathrm{A}} = I_{\mathrm{fuse}}$

调节可变电阻可逐渐增大电流，图 D 中三个元件均接在同一支路。故选 D。

专题 19 电动机、感应、发电机与变压器

19.1 电动机、感应、发电机与变压器

题型 1：直导线磁场为同心圆，用右手判断环绕方向（考频★★★★☆）

知识点 通电直导线周围的磁场线位于与导线垂直的平面内，是以导线为圆心的_____。

用右手握住导线，大拇指指向_____方向，四指弯曲方向就是磁场方向。

电流垂直纸面向里时，磁场沿顺时针方向；电流垂直纸面向外时，磁场沿_____方向。

在导线可视为长直导线且电流稳定时，电流越大，磁场越强；离导线越远，磁场越弱。磁感应强度的单位为特斯拉（T）。

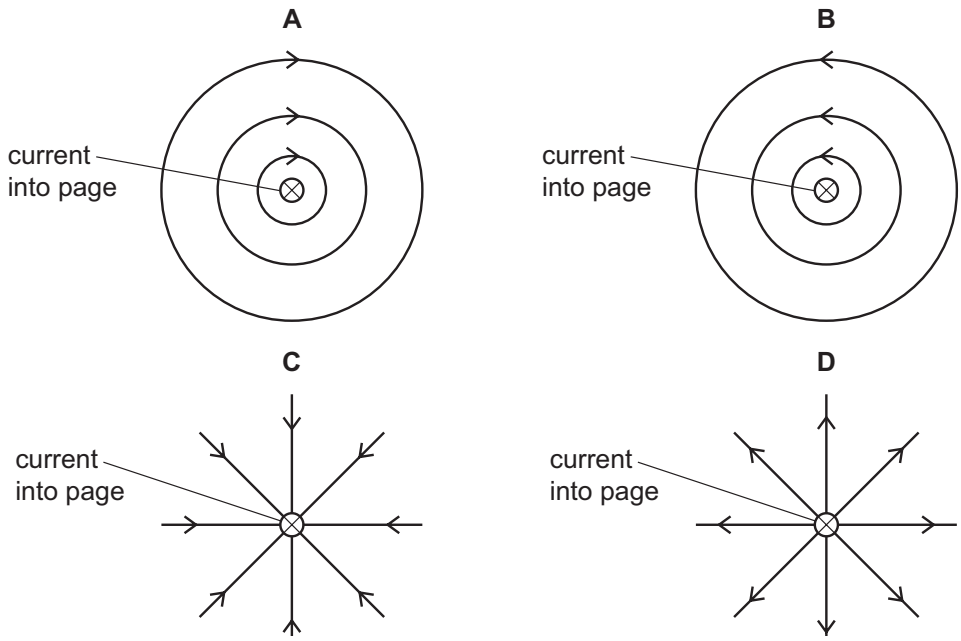
答案：同心圆；电流；逆时针

怎么认 题目出现直导线穿过纸面、叉点符号或环形选项时，先用右手螺旋定则判断环绕方向。

例题 1

A straight wire carries a current into the page.

Which diagram shows the pattern and direction of the magnetic field around the wire due to the current?



（2023 May/Jun · 0654/11 · Question 39 · Core）

解：通电直导线周围的磁场线是在垂直于导线的平面内、以导线为圆心的同心圆。

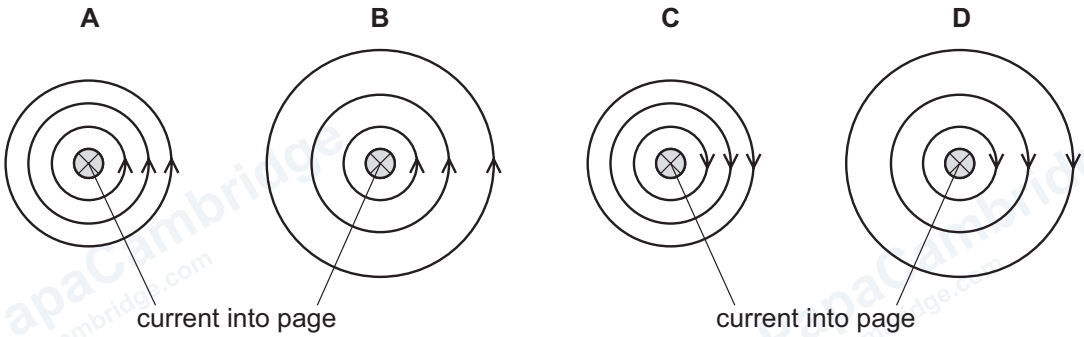
图中叉号表示电流垂直纸面向里，由右手螺旋定则，磁场方向为顺时针。

故选 A。

针对练习

1. A straight wire carries a current into the page.

Which diagram shows the pattern and the direction of the magnetic field around the wire?

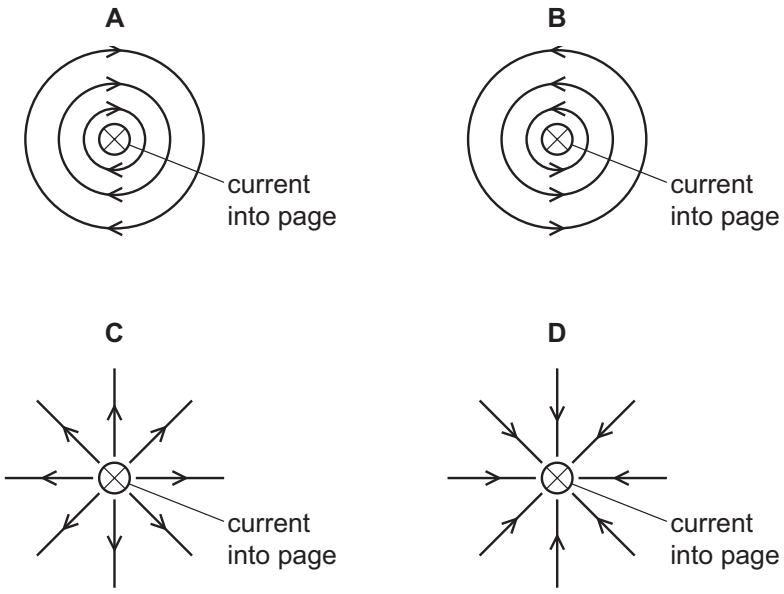


（2026 Feb/Mar · 0654/22 · Question 37 · Extended）

2. There is a current-carrying wire perpendicular to the page.

The direction of the current is into the page.

Which diagram shows the pattern and direction of the magnetic field around the wire?

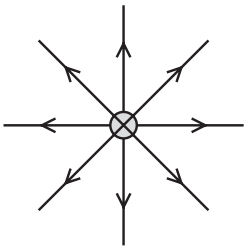


（2023 May/Jun · 0654/12 · Question 38 · Core；同题：2023 May/Jun · 0654/13 · Question 38 · Core、2023 May/Jun · 0654/22 · Question 37 · Extended）

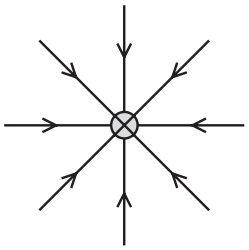
3. The diagrams show the cross-section of a straight wire carrying a current into the page.

Which diagram shows the pattern and direction of the magnetic field around the wire?

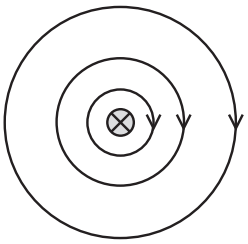
A



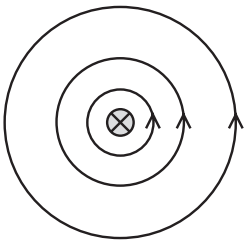
B



C



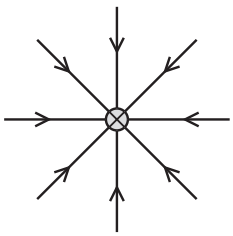
D



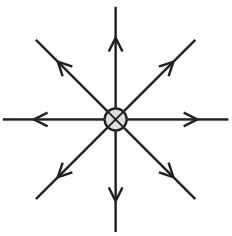
(2024 Feb/Mar · 0654/12 · Question 38 · Core)

4. Which diagram shows the pattern and the direction of the magnetic field around a straight wire that is carrying a current into the page?

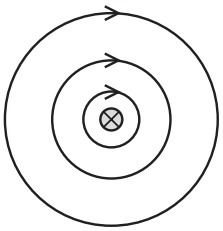
A



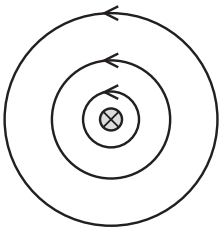
B



C

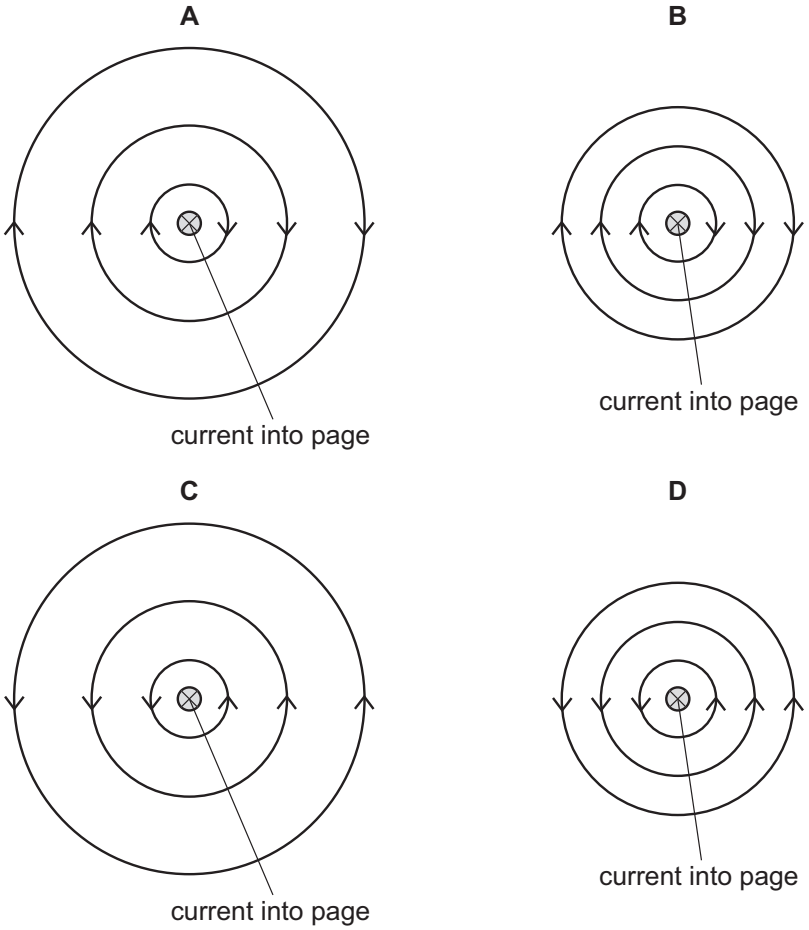


D



(2024 Oct/Nov · 0654/11 · Question 38 · Core)

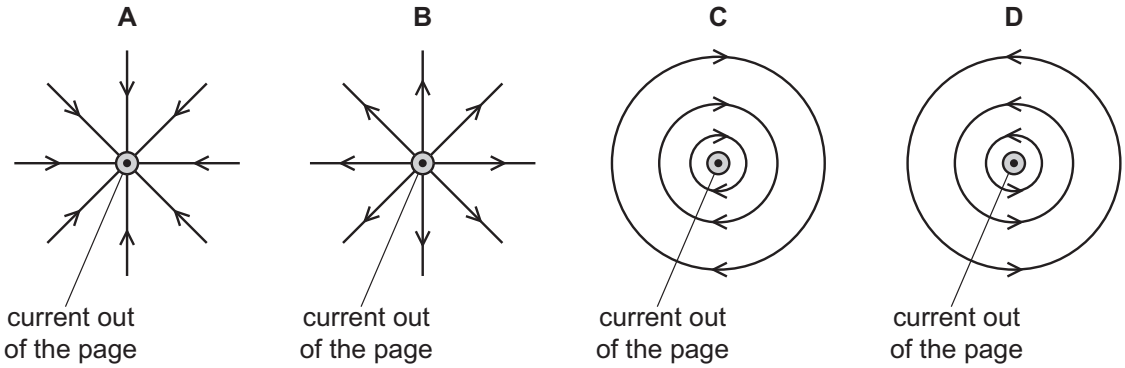
5. Which diagram shows the pattern and the direction of the magnetic field around a straight wire carrying a current into the page?



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6. The diagrams show a wire carrying a current out of the page.

Which diagram shows the pattern of magnetic field lines near the wire?

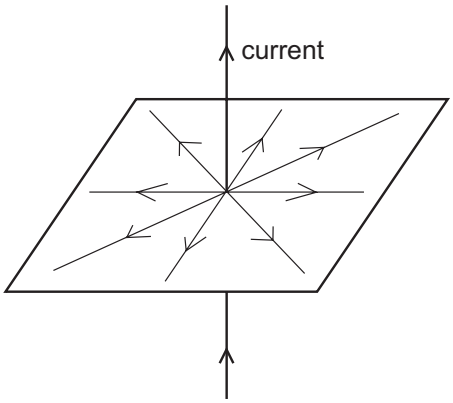


（2023 Oct/Nov · 0654/12 · Question 38 · Core；同题：2023 Oct/Nov · 0654/22 · Question 39 · Extended）

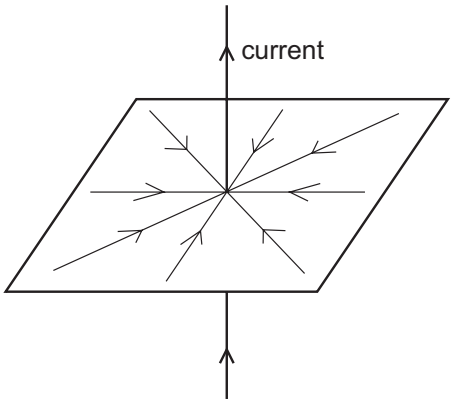
7. The diagrams show patterns around a wire that is carrying a current in the direction shown.

Which diagram shows the pattern and the direction of the magnetic field caused by the current?

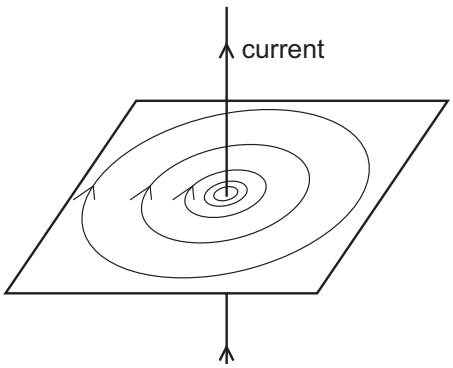
A



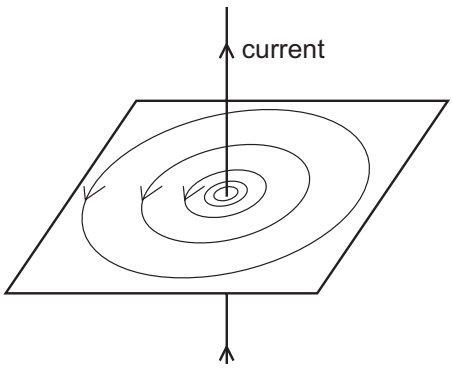
B



C



D

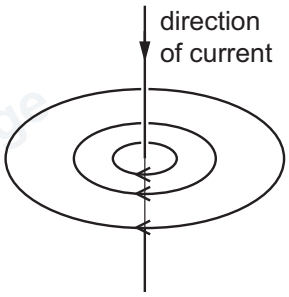


（2024 Oct/Nov · 0654/12 · Question 38 · Core；同题：2024 Oct/Nov · 0654/13 · Question 38 · Core）

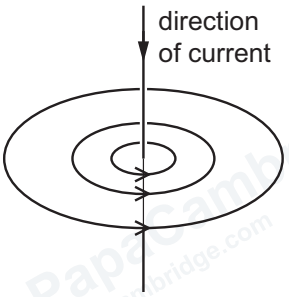
8. A straight wire carries a current. The direction of the current is shown.

Which diagram shows the pattern and direction of the magnetic field due to the current?

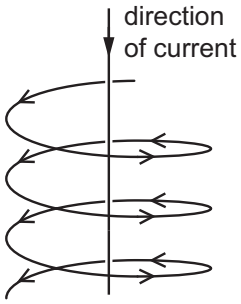
A



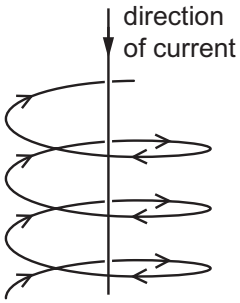
B



C



D



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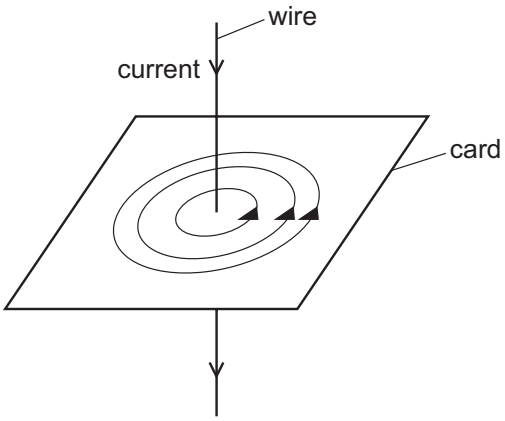
（2026 May/Jun · 0654/21 · Question 38 · Extended）

9. A current-carrying wire passes through a flat card.

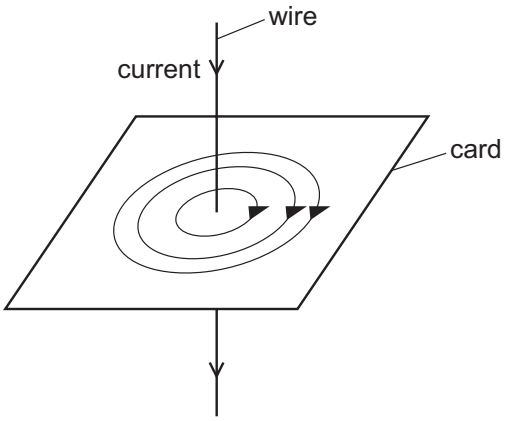
The arrow on the wire shows the direction of the current.

Which diagram shows the pattern of the magnetic field on the card and the direction of the magnetic field lines?

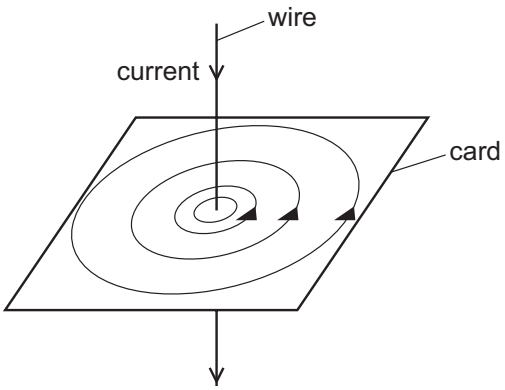
A



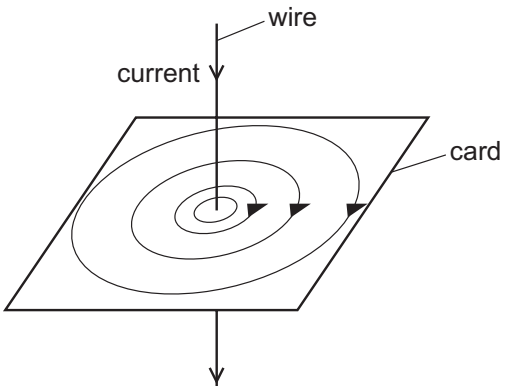
B



C



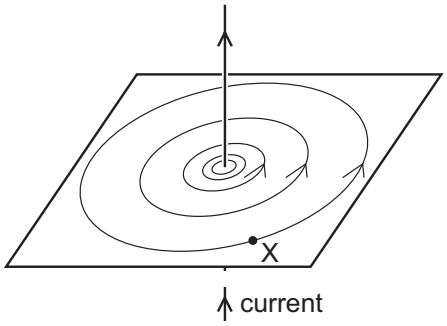
D



（2024 May/Jun · 0654/11 · Question 39 · Core）

10. The diagram shows the magnetic field around a straight current-carrying wire.

Point X lies in the magnetic field.



The current is now reduced and its direction is reversed.

Which row shows the effect on the strength and direction of the magnetic field at point X?

	strength of magnetic field	direction of magnetic field
A	decreases	reverses
B	decreases	unchanged
C	increases	reverses
D	increases	unchanged

（2025 Oct/Nov · 0654/21 · Question 37 · Extended）

题型 2：交流发电机用滑环连续连接且输出正负交替（考频★★☆☆☆）

知识点 交流发电机中，线圈在磁场内转动时产生感应电动势，其方向每半周改变一次。

两个滑环分别连接线圈的_____，并随线圈转动；碳刷固定，使线圈每一端始终与_____碳刷保持电接触。

输出电压在_____两侧周期性交替，电压的单位为伏特（V）。

答案：两端；同一块；0 V

怎么认 题目出现交流发电机、滑环或电压随时间图时，先判定输出是否在零电压两侧周期性交替。

例题 1

What is the purpose of the slip rings in an alternating current (a.c.) generator?

A to allow each end of the coil to contact each carbon brush alternately

B to allow each end of the coil to remain in contact with the same carbon brush at all times

C to maintain a constant voltage in the output circuit while the coil is rotating

D to remain stationary while the coil rotates between them

（2024 Oct/Nov · 0654/23 · Question 39 · Extended）

解： 两个滑环分别与线圈两端连接，并随线圈转动。

碳刷固定，每个滑环始终接触同一块碳刷，因此线圈每一端始终与同一块碳刷保持接触。

故选 B。

针对练习

1. What is a reason why slip rings are used in an a.c. generator?

A to connect the brushes to the external circuit as the coil turns

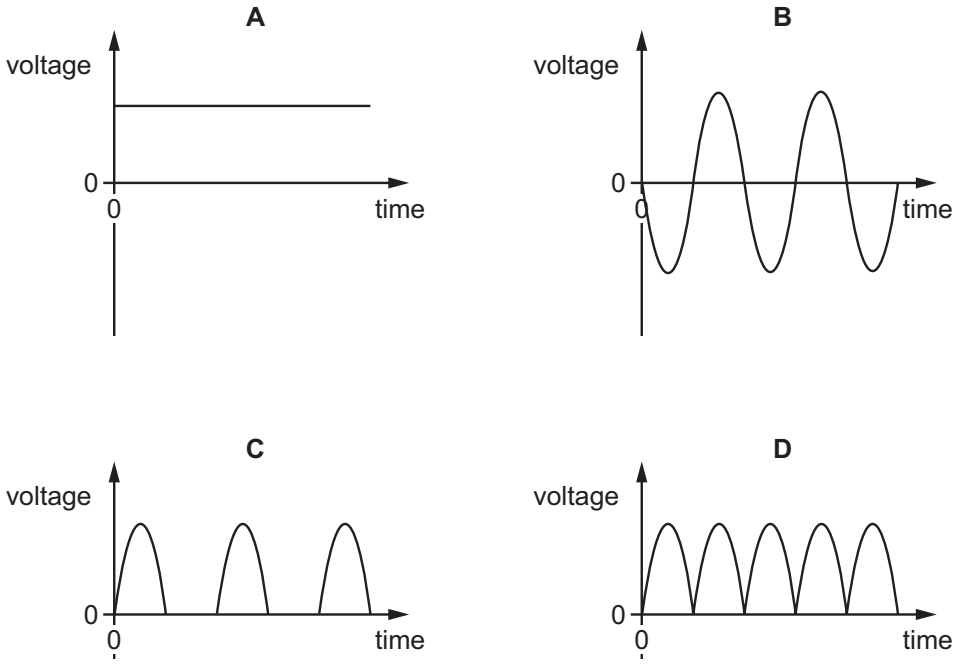
B to connect the ends of the coil to the brushes as the coil turns

C to create the magnetic field in which the coil turns

D to turn the coil in the magnetic field

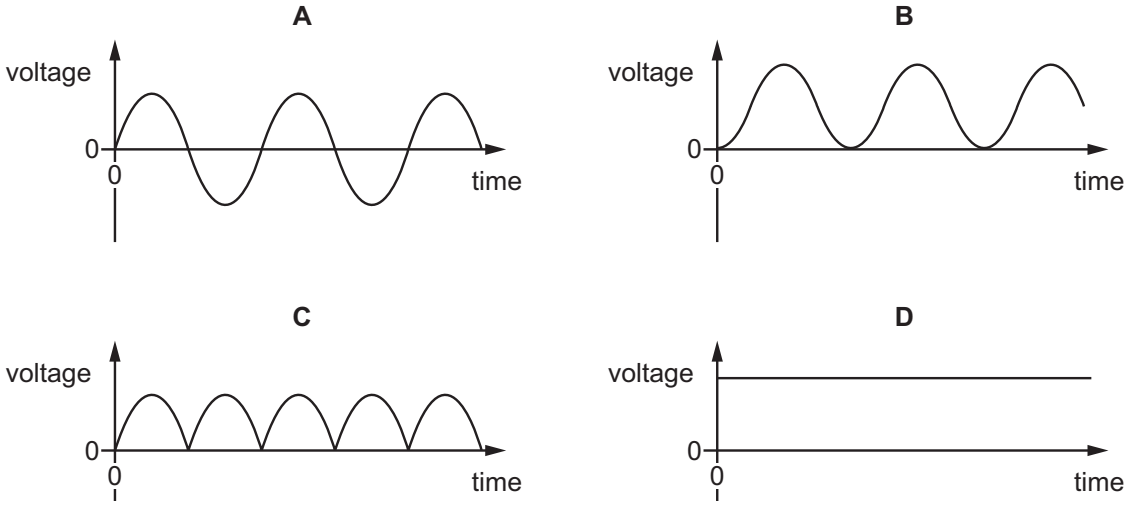
（2026 Feb/Mar · 0654/22 · Question 36 · Extended）

2. Which voltage–time graph shows the output voltage of a simple a.c. generator?



（2024 May/Jun · 0654/23 · Question 39 · Extended）

3. Which graph shows how the output electromotive force (e.m.f.) of an a.c. generator varies with time?



（2025 Oct/Nov · 0654/22 · Question 38 · Extended）

题型 3：电磁铁选软铁芯，通断时容易磁化退磁（考频★★☆☆☆）

知识点 电磁铁由通电线圈和铁芯组成；线圈通电时，铁芯被磁化，使磁场增强。

铁芯应选_____，因为它容易被_____，断电后又容易退磁。

钢不易退磁，断电后仍可能保留磁性，因此不适合作电磁铁的铁芯。

答案：软铁；磁化

怎么认 题目出现电磁铁铁芯材料或断电后的磁性状态时，先比较软铁与钢的磁化、退磁特性。

例题 1

Which material is used for the core of an electromagnet?

A aluminium

B copper

C iron

D steel

（2023 May/Jun · 0654/12 · Question 36 · Core；同题：2023 May/Jun · 0654/13 · Question 36 · Core、2023 May/Jun · 0654/22 · Question 36 · Extended）

解：电磁铁的铁芯应选容易磁化且容易退磁的软铁。

选项 C 所列的铁符合要求，故选 C。

针对练习

1. Which statement about the core of an electromagnet is correct?

A It is made of soft iron because soft iron is easy to magnetise.

B It is made of soft iron because soft iron does not lose its magnetism easily.

C It is made of steel because steel is easy to magnetise.

D It is made of steel because steel loses its magnetism easily.

（2024 Oct/Nov · 0654/21 · Question 35 · Extended）

2. A student makes an electromagnet with a steel core.

There is a problem with the electromagnet.

Which problem with the electromagnet is caused by using a steel core?

A The electromagnet does not become magnetised.

B The electromagnet has the same type of magnetic pole at each end.

C The electromagnet remains magnetised when it is switched off.

D The electromagnet repels unmagnetised magnetic materials.

（2025 May/Jun · 0654/22 · Question 36 · Extended）

题型 4：增大电流、磁场或匝数加强线圈转动（考频★★☆☆☆）

知识点 长为 L 的载流直导线处于匀强磁场中，电流方向与磁场方向的夹角为 θ 时，磁力大小为 $F = BIL\sin\theta$；F、B、I、L 的单位依次为 N、T、A、m。

线圈两侧方向相反的磁力形成转动效应；在线圈大小和位置不变时，转动效应随 B、I、N 的增大而_____，单位为 N m，匝数 N 没有单位。

电流或磁场中任一方向反向，磁力和转动方向随之_____，其大小不因反向而增大。

答案：增大；反向

怎么认 题目出现载流线圈或导线处于磁场中，所求为力或转动效应变化时，先比较 I、B、N 及方向。

例题 1

A coil lies between the poles of a magnet. There is a current in the coil and this causes a turning effect.

Which change does **not** increase the turning effect on the coil?

A changing the direction of the current

B increasing the current

C using a stronger magnet

D using more turns in the coil

（2024 May/Jun · 0654/12 · Question 38 · Core；同题：2024 May/Jun · 0654/13 · Question 38 · Core）

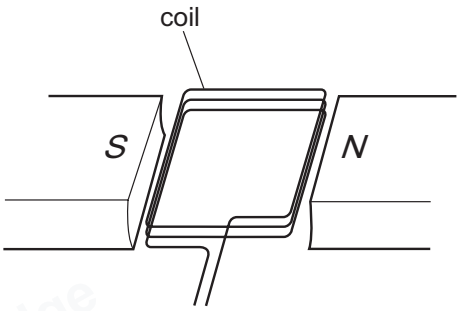
解：设转动效应大小为 M。在线圈大小和位置不变时，

$M \propto BIN$

增大 I、B 或 N 都使 M 增大；改变电流方向使转动方向反向，M 不变。故选 A。

针对练习

1. The diagram shows a coil of wire between the poles of two magnets. The coil is connected to a direct current (d.c.) power supply.



Which change increases the magnitude of the turning effect on the coil?

A decreasing the number of turns on the coil with the same current in it

B increasing the resistance of the coil with the same potential difference (p.d.) across it

C increasing the strength of the magnetic field

D reversing the direction of the magnetic field

（2026 Feb/Mar · 0654/22 · Question 38 · Extended）

2. A current-carrying conductor is in a magnetic field. This causes a force to act on the conductor.

The current is increased and the magnetic field is reversed.

Which statement describes the force after the changes to the current and the magnetic field?

A The force is greater and in the opposite direction.

B The force is greater and in the same direction.

C The force is the same and in the same direction.

D The force is the same and in the opposite direction.

（2025 Oct/Nov · 0654/23 · Question 38 · Extended）

题型 5：线圈磁通变化更快或匝数更多则感应电动势大（考频★★☆☆☆）

知识点 导体切割磁感线或穿过线圈的磁通发生变化时，导体两端产生感应电动势，单位为伏特（V）。在其他条件相同时，磁通变化越_____，感应电动势越大；线圈匝数越_____，感应电动势越大。直导体切割磁场时，场中导体越长、运动越快、磁场越强，感应电动势越大；导体电阻不影响感应电动势。

答案：快；多

怎么认 题目出现磁体进出线圈、导体在磁场中运动或比较线圈匝数时，先比较磁通变化快慢和匝数。

例题 1

When a straight conductor moves through a magnetic field, an electromotive force (e.m.f.) is induced between the ends of the conductor.

Which factor does **not** affect the magnitude of the induced e.m.f.?

A the length of conductor in the field

B the resistance of the conductor

C the speed at which the conductor moves

D the strength of the magnetic field

（2023 May/Jun · 0654/22 · Question 38 · Extended）

解：由电磁感应规律，感应电动势随场中导体长度、运动速度和磁场强度增大而增大。导体电阻不改变感应电动势的大小。故选 B。

针对练习

1. A magnet is moved in and out of a coil and an electromotive force (e.m.f.) is induced.

How can the size of the induced e.m.f. be decreased?

A Add more turns to the coil.

B Move the magnet more quickly.

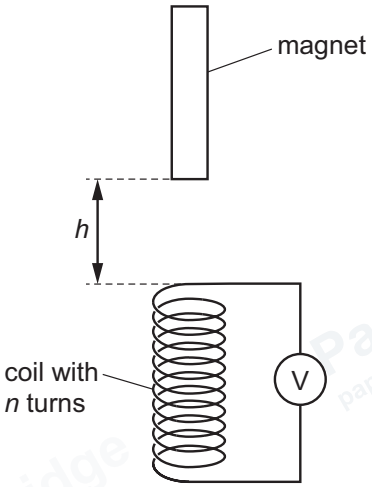
C Move the magnet more slowly.

D Turn the magnet around before moving it in and out.

（2024 Feb/Mar · 0654/22 · Question 39 · Extended）

2. A magnet is dropped through a coil from a height of *h* cm.

The coil has *n* turns and is connected to a voltmeter.



Which row gives the values of *h* and *n* that produce the greatest induced electromotive force (e.m.f.)?

	h **/ cm**	***n***
A	5	200
B	5	400
C	10	200
D	10	400

（2026 May/Jun · 0654/21 · Question 37 · Extended）

题型 6：螺线管磁场像条形磁体、反向电流翻转磁场（考频★☆☆☆☆）

知识点 通电螺线管的磁场与_____的磁场相似：内部磁感线近似平行，外部磁感线从一端弯曲到另一端。

螺线管绕线方向不变时，磁场方向由_____决定；电流方向反向，磁场方向随之反向。

电流大小的改变会改变磁场强弱，切断电流会使磁场消失；电流的单位为安培（A）。

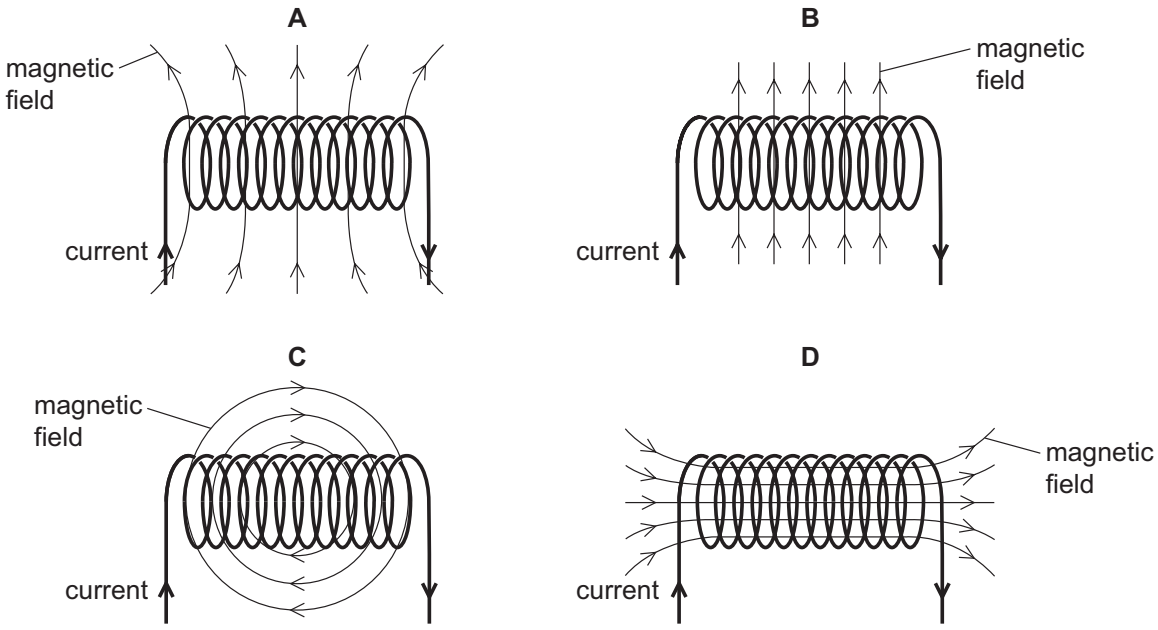
答案：条形磁体；电流方向

怎么认 题目出现通电螺线管、磁场线图或磁场反向的设问时，先按条形磁体判断分布，再看电流方向。

例题 1

A solenoid carrying a current produces a magnetic field.

Which diagram shows the magnetic field pattern?

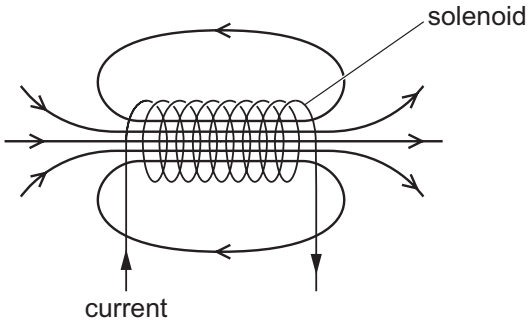


（2023 May/Jun · 0654/23 · Question 38 · Extended）

解：通电螺线管的磁场分布与条形磁体相似，内部磁感线近似平行，外部磁感线由一端弯曲到另一端。图 D 所示的磁感线符合这一分布。故选 D。

针对练习

1. The diagram shows the magnetic field due to a current in a solenoid.



Which change reverses the direction of the magnetic field?

A Change the current direction.

B Decrease the current.

C Increase the current.

D Switch off the current.

（2025 Oct/Nov · 0654/22 · Question 37 · Extended）

题型 7：换向器每半圈反向电流以维持同向旋转（考频★☆☆☆☆）

知识点 分裂环换向器（split-ring commutator）是直流电动机中与电刷接触、随线圈转动的部件。线圈每转过_____，换向器便改变线圈与电源两极的连接，使线圈中的电流方向_____，从而使转动作用保持同一方向。

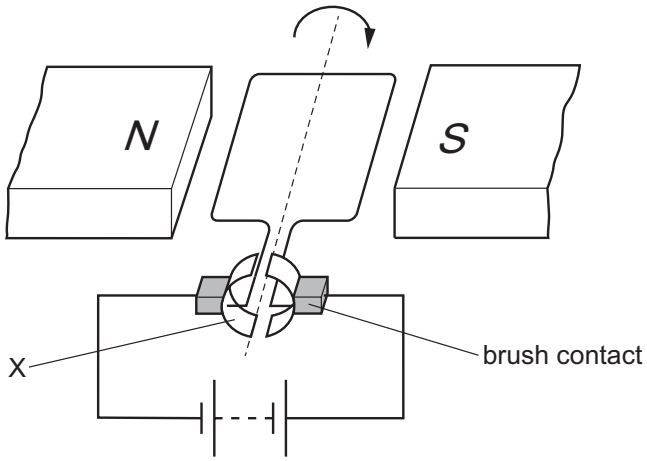
这一关系适用于由_____供电并装有分裂环换向器的电动机；换向动作不表示物理量，无单位。

答案：半圈；反向；直流电源

怎么认 题目出现直流电动机、换向器或分裂环图时，先判断其是否每半圈反向线圈电流。

例题 1

The diagram shows a motor. One part of the motor is labelled X.



What is the name of part X and how does it help the motor to work?

	name of part X	how X helps the motor to work
A	split-ring commutator	reduces the current so the coil does not overheat
B	split-ring commutator	reverses the current in the coil every half turn
C	step-down transformer	reduces the current so the coil does not overheat
D	step-down transformer	reverses the current in the coil every half turn

（2023 May/Jun · 0654/23 · Question 39 · Extended）

解： 图中 X 由两个相互绝缘的半环组成，并与两侧电刷接触，故 X 是分裂环换向器。

线圈每转过半圈，分裂环改变线圈与电源两极的连接，线圈中的电流方向随之反向，转动作用仍保持同一方向。

故选 B。

针对练习

1. What is the purpose of the commutator in a direct current (d.c.) motor?

A It reverses the direction of the current in the coil every half turn.

B It reverses the direction of rotation of the coil every complete turn.

C It reverses the direction of rotation of the coil every half turn.

D It reverses the magnetic field due to the permanent magnet every complete turn.

（2024 May/Jun · 0654/22 · Question 39 · Extended）

题型 8：降压变压器次级线圈的匝数较少（考频★☆☆☆☆）

知识点 变压器在交流电条件下工作，接电源的输入线圈叫原线圈，输出线圈叫次级线圈。
理想变压器有 $\frac{V_s}{V_p}=\frac{N_s}{N_p}$，下标 p、s 分别表示原线圈、次级线圈；电压单位为 V，匝数没有单位。
降压变压器满足 $V_s<V_p$，所以次级线圈匝数_____原线圈匝数。

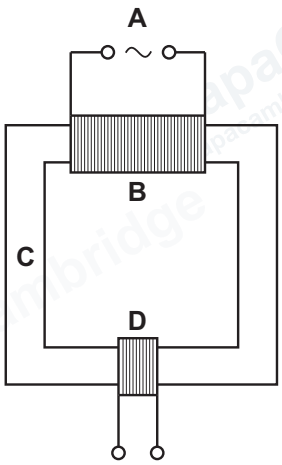
答案：少于

怎么认 题目出现降压变压器及线圈匝数图时，先找匝数较少的线圈。

例题 1

The diagram shows a step-down transformer.

Which part of the transformer is the secondary coil?



（2026 May/Jun · 0654/22 · Question 38 · Extended）

解： 降压变压器有
$V_s<V_p$
由理想变压器关系
$\frac{V_s}{V_p}=\frac{N_s}{N_p}$
得
$N_s<N_p$
图中 D 处线圈的匝数少于 B 处线圈，故 D 为次级线圈。故选 D。

题型 9：用电流与磁场两方向判断受力方向（考频★★★☆☆）

知识点 载流导线处在与电流方向不平行的磁场中会受到磁力，受力方向同时垂直于电流方向和磁场方向。

磁体外部的磁场方向由_____；判向采用_____：左手食指指向磁场，中指指向电流，拇指指向受力。

电流方向或磁场方向单独反向时，受力方向反向；两者同时反向时，受力方向_____。

导线与磁场垂直时受力最大，平行时受力为零；力的单位是牛顿（N）。

答案：N 极指向 S 极；弗莱明左手定则；不变

怎么认 题目出现载流导线、电流箭头和磁极或磁场箭头并求受力方向时，先定磁场由 N 极指向 S 极，再用左手定则。

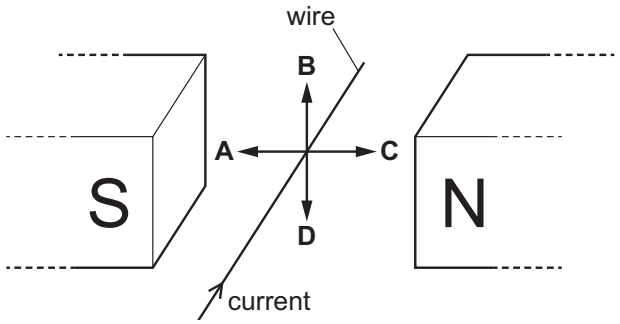
例题 1

A current-carrying wire is placed between the poles of a magnet, as shown.

The current direction in the wire is shown.

A force is produced on the wire.

In which labelled direction does the force act?



（2022 Oct/Nov · 0654/21 · Question 39 · Extended；同题：2022 Oct/Nov · 0654/22 · Question 39 · Extended、2022 Oct/Nov · 0654/23 · Question 39 · Extended）

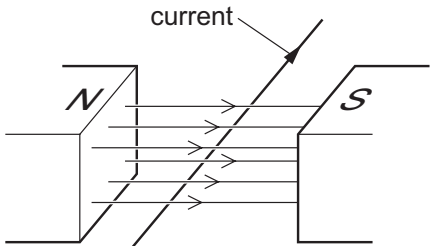
解：磁场从 N 极指向 S 极，即由右向左。

左手食指由右向左，中指沿图示电流方向，拇指指向图中 B 方向。

故选 B。

针对练习

1. The diagram shows a current-carrying conductor in a magnetic field. The direction of the current is shown.



In which direction is the force on the wire due to the magnetic field?

A downwards

B to the left

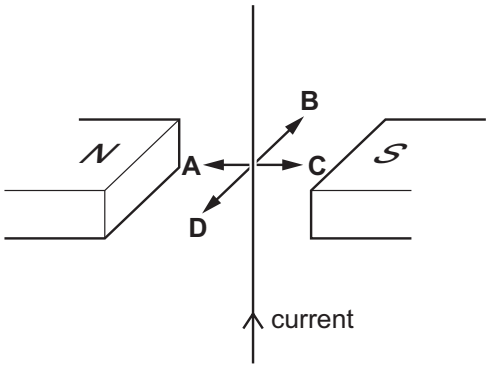
C to the right

D upwards

（2023 May/Jun · 0654/22 · Question 40 · Extended）

2. The diagram shows the direction of the current in a wire. The wire is placed between the poles of a magnet and this causes a force to act on the wire.

In which labelled direction does the force act?

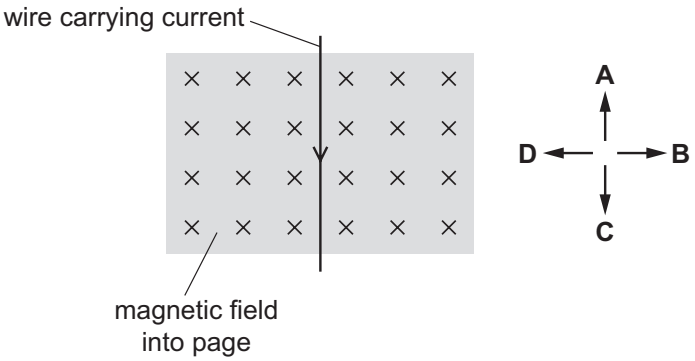


（2025 May/Jun · 0654/21 · Question 38 · Extended）

3. The diagram shows a wire carrying an electric current in the direction shown (towards the bottom of the page). The wire is at right angles to a magnetic field that is directed into the page.

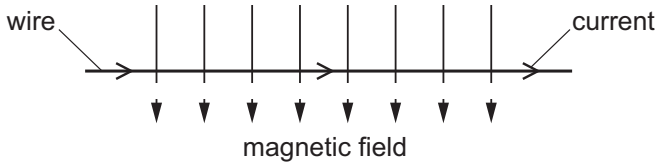
A force acts on the wire because of the current and the magnetic field.

In which labelled direction does this force act?



（2024 May/Jun · 0654/23 · Question 38 · Extended）

4. The diagram shows a wire in a magnetic field. There is a current in the wire in the direction shown. The direction of the magnetic field is also shown.



The magnetic field causes a force on the wire.

In which direction does this force act?

A into the page

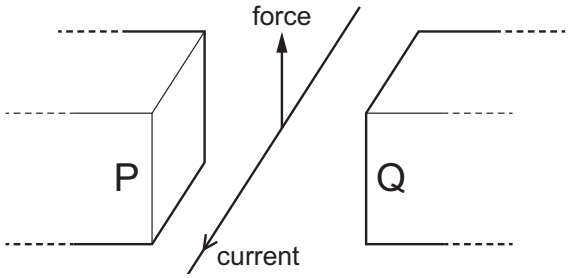
B out of the page

C towards the bottom of the page

D towards the top of the page

(2022 Feb/Mar · 0654/22 · Question 38 · Extended)

5. A current-carrying wire is placed between the poles P and Q of a magnet, as shown.



The direction of the current is shown.

A force acts on the wire upwards, as shown.

What is the direction of the magnetic field?

A from P to Q

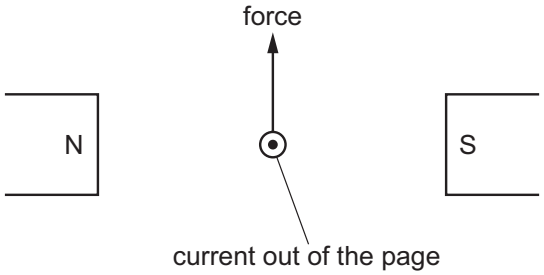
B from Q to P

C towards the bottom of the page

D towards the top of the page

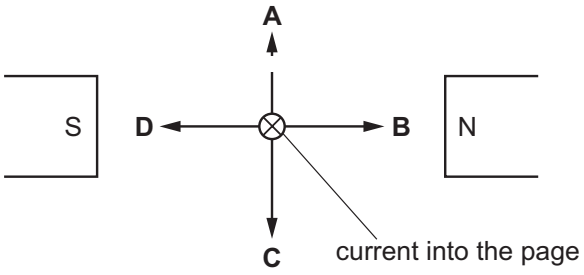
(2023 Oct/Nov · 0654/23 · Question 39 · Extended)

6. The diagram shows a current-carrying wire placed between the poles of a magnet. The direction of the current is out of the page. The direction of the force on the wire is shown by the arrow.



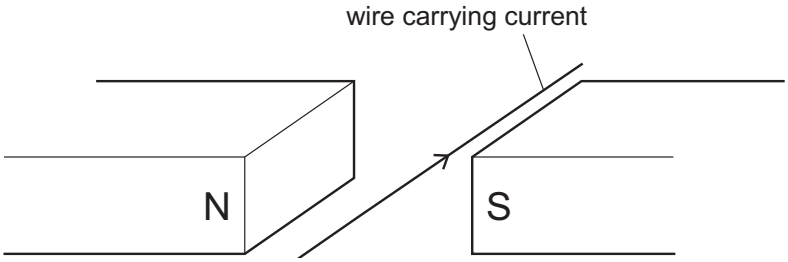
Both the direction of the current and the poles of the magnet are now reversed.

Which arrow shows the direction of the force on the wire after these changes?



(2023 Oct/Nov · 0654/13 · Question 39 · Core)

7. The diagram shows a wire carrying a current. The direction of the current is shown by the arrow. The wire lies in the magnetic field between two magnetic poles.



What is the direction of the magnetic field and what is the direction of the force on the wire?

	magnetic field	force on wire
A	to the left	downwards
B	to the left	upwards
C	to the right	downwards
D	to the right	upwards

(2023 Feb/Mar · 0654/22 · Question 39 · Extended)

题型 10：同样传输功率先升电压减电流以降低线损（考频★★☆☆☆）

知识点 电功率满足 $P=VI$，其中 P、V、I 的单位分别为瓦特（W）、伏特（V）、安培（A）。

当输送功率 P 不变时，升高输电电压 V，输电电流 I _____。

输电线电阻 R 不变时，热损耗功率 $P_{\text{loss}}=I^2R$，R 的单位为欧姆（Ω），热损耗功率的单位为瓦特（W）；电流减小，热损耗_____。

能量传输效率为有用输出能量与输入能量的比值，没有单位，通常用百分数表示；热损耗减小时，效率_____。

答案：减小；减小；提高

怎么认 题目出现传输功率不变、升高电压或减少电缆热损耗时，先由 $P=VI$ 判断电流变化。

例题 1

A transformer increases the voltage from a power station in order to transfer electricity along transmission cables.

How does increasing the voltage affect the current in the cables and how does it affect the efficiency of energy transfer?

	current	efficiency
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2022 May/Jun · 0654/21 · Question 38 · Extended；同题：2022 May/Jun · 0654/22 · Question 38 · Extended、2022 May/Jun · 0654/23 · Question 38 · Extended）

解：传输功率 P 不变，由 $P=VI$ 得

$I=\frac{P}{V}$.

电压增大，电流减小；由 $P_{\text{loss}}=I^2R$，电缆热损耗减小，能量传输效率提高。

故选 B。

针对练习

1. When electricity is generated in a power station, a step-up transformer is used before it is transmitted around the country.

Which statement explains why a step-up transformer is used?

A The current decreases, the voltage increases so more energy is transferred by heating in the transmission cables.

B The current increases, the voltage decreases so less energy is transferred by heating in the transmission cables.

C The voltage decreases, the current increases so more energy is transferred by heating in the transmission cables.

D The voltage increases, the current decreases so less energy is transferred by heating in the transmission cables.

（2025 Feb/Mar · 0654/22 · Question 38 · Extended）

2. The output from the generator in a power station is connected to a transformer before electricity is sent along a transmission cable.

What is a reason for using this transformer?

A to decrease the voltage and decrease the current

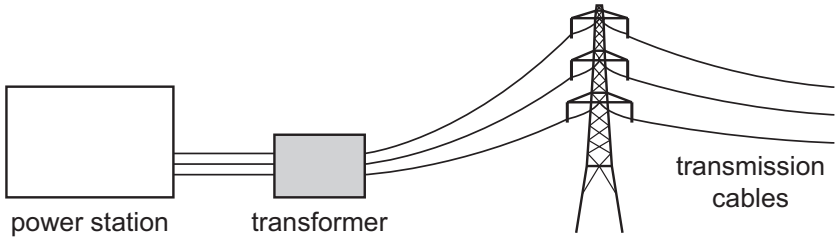
B to decrease the voltage and increase the current

C to increase the voltage and decrease the current

D to increase the voltage and increase the current

（2025 Oct/Nov · 0654/21 · Question 38 · Extended）

3. Electrical energy from a power station is transmitted over a large distance. A 100% efficient transformer is used near to the power station. This transformer reduces the energy that is wasted thermally in the transmission cables.



How does the transformer reduce the energy that is wasted?

A It decreases the power transmitted so the current and the voltage are both larger.

B It decreases the power transmitted so the current and the voltage are both smaller.

C It increases the current so the voltage is smaller.

D It increases the voltage so the current is smaller.

（2024 Oct/Nov · 0654/22 · Question 39 · Extended）

4. Cables transmit electrical power.

The power input to the cables is constant, but the voltage input is increased.

What happens to the power loss from the cables, and what happens to the current in the cables?

	power loss from cables	current in cables
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2023 May/Jun · 0654/22 · Question 39 · Extended）

题型 11：理想变压器先用匝比求电压再用功率守恒求电流（考频★☆☆☆☆）

知识点 理想变压器中，原、副线圈的电压之比等于匝数之比：$\frac{V_p}{V_s}=\frac{N_p}{N_s}$，其中 V 为电压，N 为匝数。效率为 100% 时，输入功率等于输出功率：$V_pI_p=V_sI_s$。

V、I、P 的单位分别为伏特（V）、安培（A）、瓦特（W）；降压变压器的副线圈匝数较_____，电压较_____，电流较_____。

答案：少；低；大

怎么认 题目出现 100% 效率，给出匝数比或两侧电压并求电流时，先确定两侧电压，再用功率守恒。

例题 1

A transformer with an efficiency of 100% has an input current of 10 A. The input voltage is 100 V and the output voltage is 20 V.

What is the output current?

A 2.0 A **B** 10 A **C** 50 A **D** 200 A

（2024 Oct/Nov · 0654/21 · Question 39 · Extended）

解：效率为 100%，由输入功率等于输出功率，

$V_pI_p = V_sI_s$

$100 \times 10 = 20I_s$

$I_s = 50\ \text{A}$

故选 C。

针对练习

1. A 100% efficient step-down transformer has 120 turns on its primary coil and 10 turns on its secondary coil.

A 240 V supply provides 48 W of power to the primary coil.

What is the current in the secondary coil?

A 0.017 A **B** 0.2 A **C** 2.4 A **D** 20 A

（2024 May/Jun · 0654/21 · Question 39 · Extended）

专题 20 核结构、放射性与半衰期

20.1 核结构、放射性与半衰期

题型 1：根据空气、纸、铝、铅的阻挡判断辐射种类（考频★★★☆☆）

知识点 α、β、γ 都是电离辐射；穿透能力由弱到强依次为 α、β、γ，电离能力的顺序相反。

在通常实验条件下，α 射线在空气中只能传播几厘米，并被纸挡住；β 射线能穿过纸，但被铝挡住；γ 射线能穿过纸和铝，厚铅可使其明显减弱。

被纸挡住的是 _____，穿过纸而被铝挡住的是 _____，穿过纸和铝的是 _____。

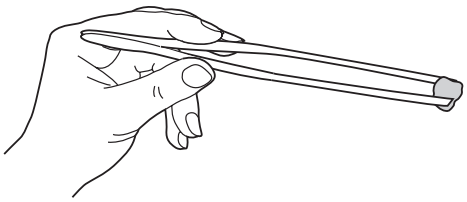
穿透能力和电离能力没有单位；材料厚度及空气距离采用题目给出的 mm 或 cm。

答案：α 射线；β 射线；γ 射线

怎么认 题目出现辐射能否穿过空气、纸、铝或铅时，先按传播距离和阻挡材料判断种类。

例题 1

A teacher handles a radioactive source with tongs that are 10 cm long.



Using the tongs protects the teacher from one type of ionising radiation.

Which type of radiation from the source is the teacher protected from?

A alpha (α)-particles

B beta (β)-particles

C gamma (γ)-rays

D X-rays

（2025 May/Jun · 0654/11 · Question 39 · Core）

解：α 射线在空气中只能传播几厘米，10 cm 长的夹钳使手与放射源的距离超过其射程。

因此夹钳能防护的是 α 粒子。故选 A。

针对练习

1. A radioactive source that emits gamma radiation is stored safely in a wooden box with a lining.

Which lining is the safest to use?

A thick aluminium

B thick copper

C thick lead

D thick paper

（2026 Feb/Mar · 0654/22 · Question 39 · Extended）

2. A radiation detector is in a box made from aluminium that is 3 cm thick.

The box is on top of a radioactive rock.

Which radiation from the rock is the detector able to detect?

A α-particles only

B β-particles only

C γ-rays only

D α-particles and γ-rays

（2026 May/Jun · 0654/11 · Question 39 · Core）

3. A gamma source in a school laboratory is stored in a box with a lid.

Which feature of the box is needed for the safe storage of the gamma source?

A The box is earthed.

B The box is lined with lead.

C The box is made of copper.

D The lid is made of wood.

（2026 May/Jun · 0654/22 · Question 39 · Extended）

4. A box is made from aluminium that is 20 mm thick.

Which statement explains why this box is **not** used to store all types of radioactive materials?

A It only prevents the escape of α-particles and β-particles.

B It only prevents the escape of α-particles.

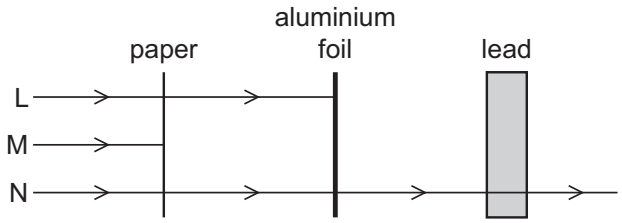
C It only prevents the escape of β-particles and γ-rays.

D It only prevents the escape of γ-rays.

（2025 Oct/Nov · 0654/12 · Question 39 · Core；同题：2025 Oct/Nov · 0654/13 · Question 39 · Core）

5. The diagram represents three types of ionising radiation L, M and N directed towards a sheet of paper, a sheet of aluminium foil and a block of lead.

The diagram shows whether each type of radiation penetrates each of the materials.



Which row identifies the radiations L, M and N?

	L	M	N
A	α	β	γ
B	α	γ	β
C	β	α	γ
D	β	γ	α

（2023 May/Jun · 0654/12 · Question 40 · Core）

6. Which row describes the relative ionising effect and the relative penetrating ability of alpha and gamma radiation?

	relative ionising effect	relative penetrating ability
A	alpha is more ionising	alpha is more penetrating
B	alpha is more ionising	gamma is more penetrating
C	gamma is more ionising	alpha is more penetrating
D	gamma is more ionising	gamma is more penetrating

（2023 Oct/Nov · 0654/12 · Question 39 · Core）

7. How do the ionising effect and the penetrating ability of alpha-emissions compare with those of beta-emissions?

	ionising effect	penetrating ability
A	alpha more ionising than beta	alpha more penetrating than beta
B	alpha more ionising than beta	alpha less penetrating than beta
C	alpha less ionising than beta	alpha more penetrating than beta
D	alpha less ionising than beta	alpha less penetrating than beta

（2022 Feb/Mar · 0654/12 · Question 39 · Core；同题：2022 Feb/Mar · 0654/22 · Question 39 · Extended）

题型 2：α 衰变前后质量数少 4、质子数少 2（考频★★★☆☆）

知识点 质量数等于原子核内质子数与中子数之和；质子数决定元素种类，二者均无单位。

一个 α 粒子由 _____ 个质子和 _____ 个中子组成，质量数为 4，质子数为 2。

原子核发射一个 α 粒子后，质量数减少 _____，质子数减少 2，中子数减少 2；此关系适用于一次 α 衰变。

答案：2；2；4

怎么认 题目出现原子核发射 α 粒子或含 α 粒子的核衰变方程时，先把质量数减 4、质子数减 2。

例题 1

The nucleus of an atom emits an α-particle.

How do the number of protons and the number of neutrons in the nucleus change?

	number of protons	number of neutrons
A	decreases by 2	decreases by 2
B	decreases by 2	decreases by 4
C	increases by 2	increases by 2
D	increases by 2	increases by 4

（2023 Oct/Nov · 0654/13 · Question 40 · Core）

解：一个 α 粒子含 2 个质子和 2 个中子，原子核发射后失去相应核子，

质子数减少 2，

中子数减少 2。

故选 A。

针对练习

1. A radioactive nucleus emits an alpha (α)-particle.

What happens to the proton number and what happens to the nucleon number of the nucleus?

	proton number	nucleon number
A	decreases by 2	decreases by 4
B	decreases by 2	does not change
C	increases by 1	decreases by 1
D	increases by 1	does not change

（2024 Feb/Mar · 0654/12 · Question 40 · Core）

2. A radioactive nucleus $^{238}_{92}\mathrm{U}$ decays into a thorium (Th) nucleus by emitting an alpha-particle.

What is the symbol for the thorium nucleus formed?

A $^{234}_{90}\mathrm{Th}$ **B** $^{234}_{92}\mathrm{Th}$ **C** $^{238}_{90}\mathrm{Th}$ **D** $^{238}_{92}\mathrm{Th}$

（2023 May/Jun · 0654/21 · Question 39 · Extended）

3. A uranium nucleus decays by emitting an alpha (α)-particle. The nuclide equation shows this decay.

$$^{X}_{92}\text{U} \rightarrow {}^{234}_{Y}\text{Th} + \alpha\text{-particle}$$

What are the numbers *X* and *Y*?

	X	*Y*
A	234	90
B	234	92
C	238	90
D	238	92

(2024 May/Jun · 0654/22 · Question 40 · Extended)

4. The isotope uranium-238 (U) decays by alpha emission to thorium (Th). The decay equation is shown.

$$^{238}_{92}\text{U} \rightarrow {}^{x}_{90}\text{Th} + {}^{y}_{2}\alpha$$

What are *x* and *y*?

	x	*y*
A	234	4
B	236	2
C	240	2
D	242	4

(2025 Feb/Mar · 0654/22 · Question 39 · Extended)

5. The decay equation for thorium-232 is shown.

$$^{232}_{90}\text{Th} \rightarrow {}^{228}_{88}\text{Ra} + {}^{x}_{y}Z$$

What are the values of *x* and *y* and what is the identity of particle *Z*?

	x	***y***	***Z***
A	1	2	beta
B	2	1	beta
C	2	4	alpha
D	4	2	alpha

(2026 May/Jun · 0654/21 · Question 39 · Extended)

6. A nucleus of $^{238}_{92}U$ undergoes radioactive decay to produce a nucleus of thorium (Th) and an alpha particle.

Which equation shows this decay?

A $^{238}_{92}U \rightarrow {}^{238}_{93}Th + {}^{0}_{-1}\alpha$

B $^{238}_{92}U \rightarrow {}^{239}_{92}Th + {}^{-1}_{0}\alpha$

C $^{238}_{92}U \rightarrow {}^{236}_{88}Th + {}^{2}_{4}\alpha$

D $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha$

（2025 May/Jun · 0654/22 · Question 39 · Extended）

题型 3：电场中 α 向负板、β−向正板、γ 不偏转（考频★★★☆☆）

知识点 α 粒子带正电，β^- 粒子带负电，γ 射线不带电。

在带电平行板间，α 粒子偏向_____板，β^- 粒子偏向_____板，γ 射线_____。

以上关系适用于射线进入静电场的定性判断；方向和相对偏转量均无单位，β^- 粒子通常比 α 粒子偏转得大。

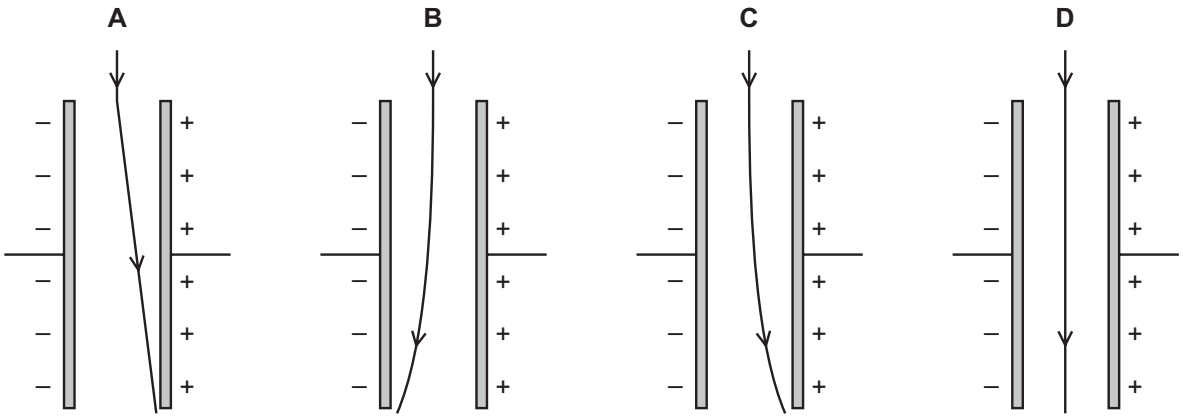
答案：带负电的；带正电的；不发生偏转

怎么认 题目出现带正、负电平行板和射线轨迹时，先按电荷正负判断偏转方向。

例题 1

A beam of γ-rays passes into an electric field between two charged plates.

Which diagram shows what happens to the γ-rays?



（2022 May/Jun · 0654/22 · Question 40 · Extended）

解： γ 射线不带电，故

$q = 0$

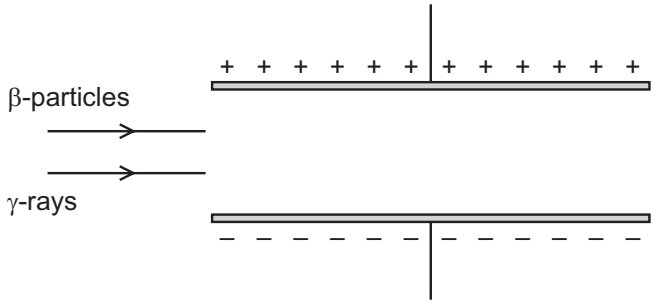
由 $F = qE$ 得

$F = 0$

射线沿原方向通过两板间。故选 D。

针对练习

1. The diagram shows a beam of β-particles and a beam of γ-rays entering the electric field between two charged plates.

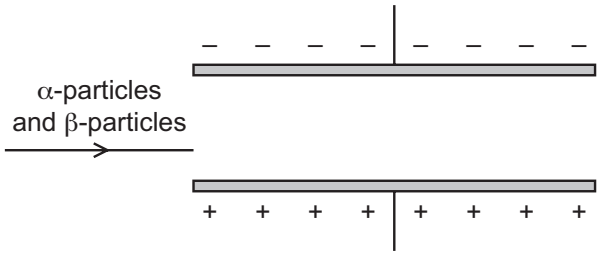


What is the effect of the electric field on each of the beams?

	β-particles	γ-rays
A	deflected to the – plate	deflected to the + plate
B	deflected to the + plate	deflected to the – plate
C	deflected to the + plate	no effect
D	no effect	deflected to the – plate

（2023 Oct/Nov · 0654/23 · Question 40 · Extended）

2. A beam of α-particles and β-particles passes into an electric field between two horizontal parallel plates in a vacuum.



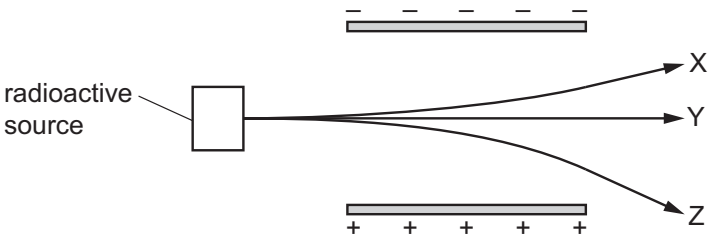
Which row shows what happens to the beam?

	α-particles	β-particles
A	deflected downwards	deflected upwards
B	deflected downwards	not deflected
C	deflected upwards	deflected downwards
D	deflected upwards	not deflected

（2022 May/Jun · 0654/21 · Question 40 · Extended）

3. The diagram shows a radioactive source emitting three types of ionising radiation, X, Y and Z.

The radiation passes through an electric field between two metal plates, as shown.

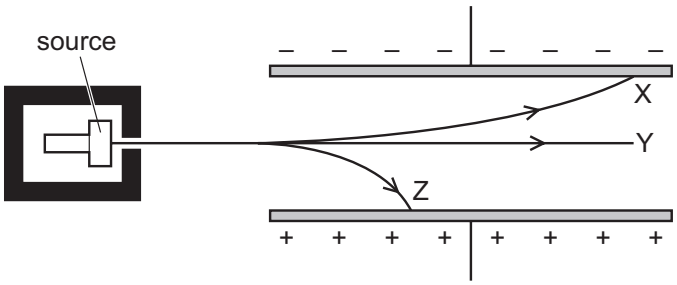


Which row identifies the three types of radiation?

	X	Y	Z
A	alpha	gamma	beta
B	beta	gamma	alpha
C	gamma	alpha	beta
D	gamma	beta	alpha

(2024 Oct/Nov · 0654/22 · Question 40 · Extended)

4. Three different types of ionising radiation X, Y and Z pass between two charged plates.

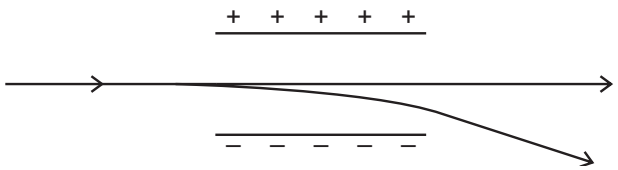


Which row identifies X, Y and Z?

	X	Y	Z
A	alpha	beta	gamma
B	alpha	gamma	beta
C	beta	alpha	gamma
D	beta	gamma	alpha

(2022 May/Jun · 0654/23 · Question 40 · Extended)

5. A beam of different types of ionising radiation passes through an electric field between two metal plates. The diagram shows the direction of each type of radiation as it passes through the field.



What does the beam contain?

A alpha (α)-particles, beta (β)-particles and gamma (γ)-rays

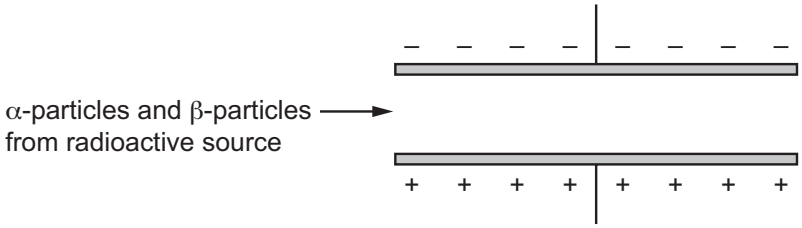
B alpha (α)-particles and beta (β)-particles only

C alpha (α)-particles and gamma (γ)-rays only

D beta (β)-particles and gamma (γ)-rays only

（2024 May/Jun · 0654/23 · Question 40 · Extended）

6. A radioactive source emits α-particles and β-particles that pass into the space between two charged plates.



In which directions are the particles deflected as they pass between the plates and which particles are deflected more?

	direction of deflection	amount of deflection
A	α towards lower plate, β towards upper plate	α-particles deflected more
B	α towards lower plate, β towards upper plate	β-particles deflected more
C	α towards upper plate, β towards lower plate	α-particles deflected more
D	α towards upper plate, β towards lower plate	β-particles deflected more

（2023 May/Jun · 0654/23 · Question 40 · Extended）

题型 4：核素左上数是总核子、左下数是质子（考频★★★☆☆）

知识点 核素符号左上角的质量数 A 表示_____，左下角的原子序数 Z 表示_____。

设中子数为 N，原子核中的核子由质子和中子组成，因此 $A = Z + N$。

由此得 $N = A - Z$；已知质子数和中子数时，质量数等于二者的_____。

A、Z、N 都是没有单位的非负整数，其中 A、Z 对实际核素为正整数。

答案：质子数与中子数的总数；质子数；和

怎么认 题目出现核素符号的左上数、左下数，或给出质子数和中子数时，先写 $A = Z + N$。

例题 1

An atom of beryllium is represented by ${}^{9}_{4}\mathrm{Be}$.

How many neutrons are in the nucleus of this type of beryllium atom?

A 4 **B** 5 **C** 9 **D** 13

（2022 May/Jun · 0654/11 · Question 39 · Core；同题：2022 May/Jun · 0654/12 · Question 40 · Core、2022 May/Jun · 0654/13 · Question 40 · Core、2022 May/Jun · 0654/21 · Question 39 · Extended、2022 May/Jun · 0654/22 · Question 39 · Extended、2022 May/Jun · 0654/23 · Question 39 · Extended）

解：核素符号左上数为质量数，故 $A=9$。
左下数为原子序数，故 $Z=4$。
$N=A-Z=9-4=5$。
故选 B。

针对练习

1. A nuclide of hydrogen is represented by $^{3}_{1}\mathrm{H}$.

Which row shows the number of protons and the number of neutrons in this nuclide?

	protons	neutrons
A	1	2
B	1	3
C	2	1
D	3	1

（2023 Oct/Nov · 0654/11 · Question 40 · Core）

2. A nucleus has atomic number *Z* and mass number *A*.

What is equal to the value of *A* – *Z*?

A the number of electrons orbiting the nucleus

B the number of neutrons in the nucleus

C the number of nucleons in the nucleus

D the number of protons in the nucleus

（2024 Oct/Nov · 0654/12 · Question 39 · Core；同题：2024 Oct/Nov · 0654/13 · Question 39 · Core）

3. An atom of an isotope of strontium (Sr) has a proton number of 38 and contains 52 neutrons.

What is the nuclide notation for this isotope?

A $^{52}_{38}\mathrm{Sr}$ **B** $^{90}_{38}\mathrm{Sr}$ **C** $^{38}_{52}\mathrm{Sr}$ **D** $^{90}_{52}\mathrm{Sr}$

（2024 May/Jun · 0654/12 · Question 39 · Core；同题：2024 May/Jun · 0654/13 · Question 39 · Core）

4. Which nuclide contains the most neutrons?

A $^{239}_{95}\mathrm{Am}$ **B** $^{234}_{91}\mathrm{Pa}$ **C** $^{239}_{94}\mathrm{Pu}$ **D** $^{238}_{92}\mathrm{U}$

（2026 May/Jun · 0654/13 · Question 38 · Core）

5. The nucleus of an isotope of gold contains 79 protons and 118 neutrons. The symbol for gold is Au.

What is the nuclide symbol for this isotope?

A $^{79}_{118}\mathrm{Au}$ **B** $^{79}_{197}\mathrm{Au}$ **C** $^{118}_{79}\mathrm{Au}$ **D** $^{197}_{79}\mathrm{Au}$

（2023 Feb/Mar · 0654/12 · Question 39 · Core）

题型 5：在衰变图上找减为一半的横向时间间隔（考频★★☆☆☆）

知识点 半衰期是放射性样品中未衰变原子数减为原来_____所经历的时间。

同一种核素的计数率或发射率也按相同规律衰减；任取一个读数及其一半，两交点的横向时间差均为_____。

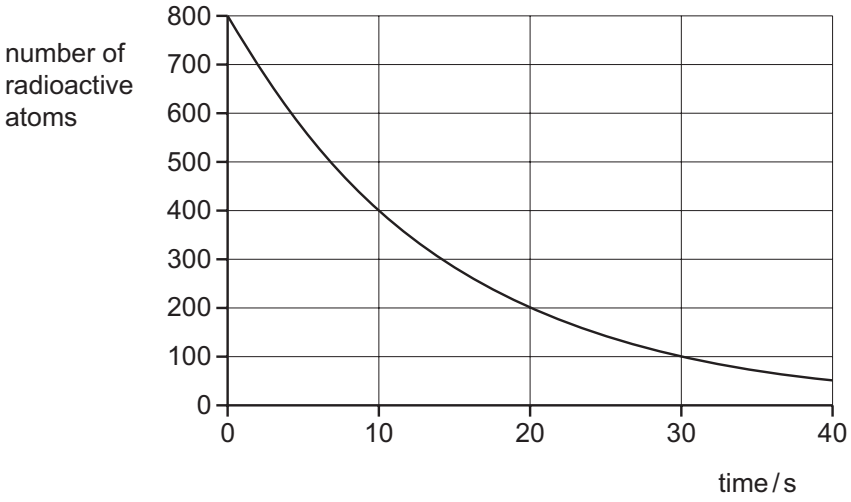
半衰期的单位与图中_____的单位相同。

答案：一半；半衰期；时间轴

怎么认 题目出现放射性衰变曲线并求半衰期时，先取一个纵轴读数及其一半，再读两交点的横向时间差。

例题 1

A pure sample of a radioactive substance decays. The graph shows how the number of these radioactive atoms in the sample changes with time.



What is the half-life of the substance?

A 10 s　　**B** 20 s　　**C** 30 s　　**D** 40 s

（2022 May/Jun · 0654/11 · Question 40 · Core）

解：由图，$t = 0$ 时原子数为 800。

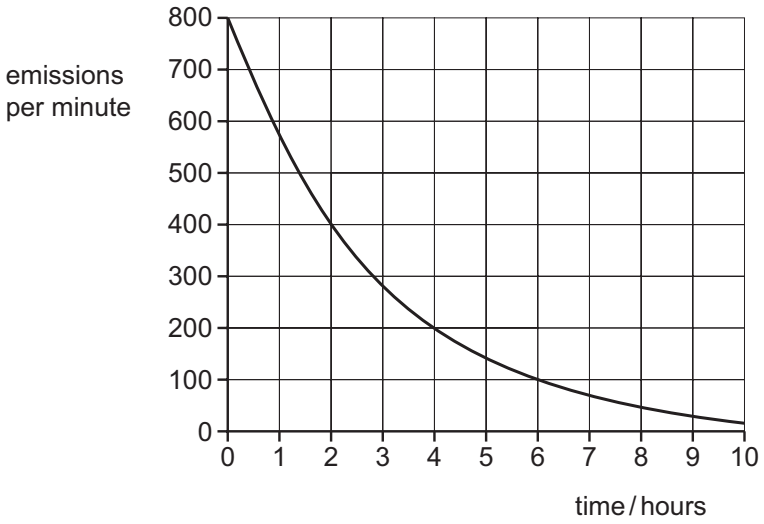
由半衰期定义，一半的原子数为

$\frac{800}{2} = 400$

曲线上原子数为 400 时，$t = 10$ s，故半衰期为 10 s。故选 A。

针对练习

1. The graph shows the decay curve for a radioactive substance.



What is the half-life of this substance?

A 2.0 hours

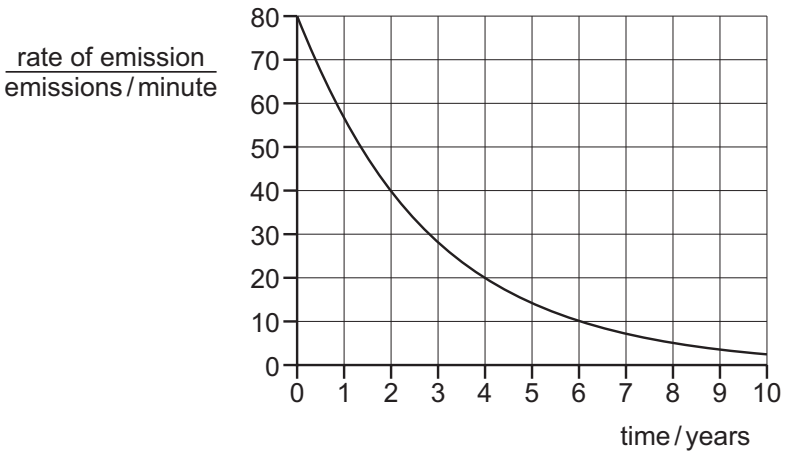
B 3.2 hours

C 5.0 hours

D 10 hours

（2024 May/Jun · 0654/12 · Question 40 · Core；同题：2024 May/Jun · 0654/13 · Question 40 · Core）

2. The graph shows how the rate of emission of radiation from a radioactive sample changes with time.



What is the half-life of this sample?

A 40 minutes

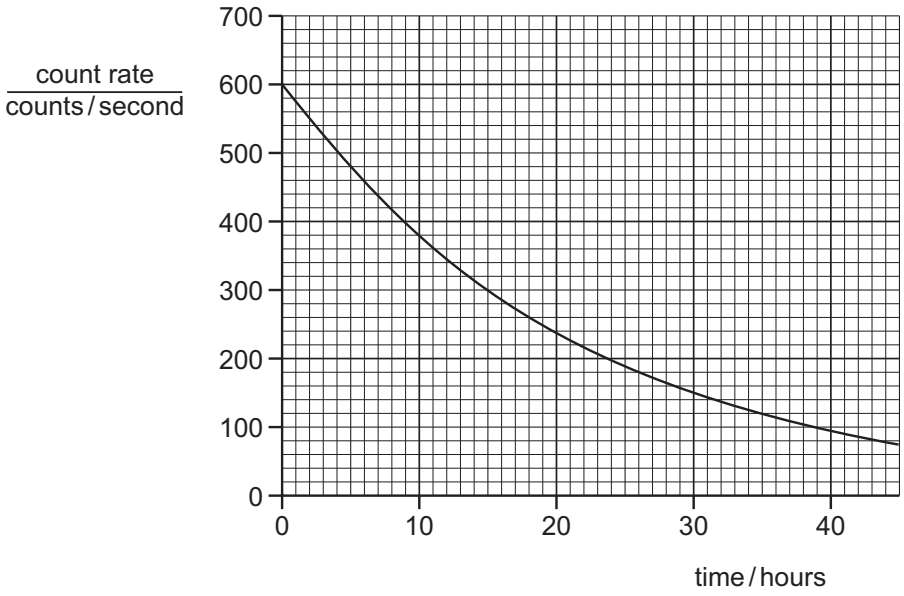
B 2.0 years

C 5.0 years

D 10 years

（2024 Oct/Nov · 0654/11 · Question 40 · Core）

3. The diagram shows how the count rate for a radioactive isotope varies with time.



How many half-lives of the isotope elapse in 45 hours?

A 1 **B** 3 **C** 45 **D** 75

（2023 May/Jun · 0654/12 · Question 39 · Core；同题：2023 May/Jun · 0654/13 · Question 39 · Core）

题型 6：用距离、屏蔽和接触时间减少辐射风险（考频★★☆☆☆）

知识点 人体受到的辐射剂量越大，辐射风险越高；在放射源种类和活度一定时，距离越大、照射时间越短，所受剂量越小。

处理放射源时，应增大与放射源的_____、缩短_____，并用合适材料进行_____；距离单位为 m，时间单位为 s。

γ 射线穿透能力强，常用铅等密度较大的材料防护；纸或铝箔不能有效屏蔽 γ 射线。

温度和夹持工具不改变放射源的半衰期；探测器用于测量辐射，不能减少人体所受辐射。

答案：距离；照射时间；屏蔽

怎么认 题目出现放射源、长柄夹具、屏蔽材料或照射时间时，先按距离、屏蔽、时间判断风险是否降低。

例题 1

Which statement explains why scientists use long tongs to move radioactive sources?

A It decreases the half-life of the source.

B It increases the distance between the source and the scientists.

C It decreases the exposure time for the scientists.

D It prevents the source from being damaged.

（2026 May/Jun · 0654/12 · Question 39 · Core）

解：使用长柄夹具时，科学家与放射源之间的距离增大。

在放射源种类和活度一定时，距离增大，人体受到的辐射剂量减小。

故选 B。

针对练习

1. Scientists use a radioactive source that emits γ-radiation.

What is a suitable safety precaution?

A Reduce the temperature of the radioactive source.

B Use aluminium foil to reflect the γ-radiation away from the scientists.

C Use a paper screen to absorb the γ-radiation.

D Use the source for the minimum time needed.

（2026 May/Jun · 0654/13 · Question 39 · Core）

2. A scientist works with a radioactive source that emits gamma (γ)-rays. The scientist takes several precautions.

Which precaution does **not** give the scientist any protection?

A Keep a lead screen between the scientist and the source.

B Use a detector to measure the count rate of the source.

C Only use the source for a short period of time.

D Have a large distance between the scientist and the source.

（2025 May/Jun · 0654/12 · Question 39 · Core；同题：2025 May/Jun · 0654/13 · Question 39 · Core）

3. A radioactive source that emits gamma radiation is a risk to people.

Which action does **not** reduce the risk to people when using the source?

A Keep the source at a very low temperature.

B Keep the time of exposure to a minimum.

C Stand a large distance from the source.

D Wear lead-lined clothing.

（2026 May/Jun · 0654/23 · Question 39 · Extended）

题型 7：α 粒子由两质子两中子构成，带正电且强电离（考频★★☆☆☆）

知识点 α 粒子由两个质子和两个中子组成。

质子带电荷 $+q$，中子不带电，因此 α 粒子的电荷为 _____。

若质子和中子的质量均为 m，则 α 粒子的质量为 _____；电荷的单位为 C，质量的单位为 kg。

α 粒子带正电，具有很强的 _____ 能力；发生 α 衰变时，原子核失去两个质子和两个中子。

答案：$2q$；$4m$；电离

怎么认 题目出现 α 粒子的组成、电荷、质量或电离能力时，先写出它由两个质子和两个中子组成。

例题 1

A radioisotope decays by the emission of an alpha (α)-particle.

What is lost by the nucleus as it decays?

A one proton and one neutron only

B one proton, one neutron and one electron

C two protons and two neutrons only

D two protons, two neutrons and two electrons

（2025 May/Jun · 0654/23 · Question 39 · Extended）

解：一个 α 粒子由两个质子和两个中子组成。
放出一个 α 粒子后，原子核失去两个质子和两个中子。
电子不属于 α 粒子的组成，故选 C。

针对练习

1. Which statement describes α-particles?

A They are negatively charged and strongly ionising.

B They are negatively charged and weakly ionising.

C They are positively charged and strongly ionising.

D They are positively charged and weakly ionising.

（2026 Feb/Mar · 0654/12 · Question 39 · Core）

2. A proton has charge *q* and mass *m*. A neutron has no charge and mass *m*.

Which row shows the charge and mass of an alpha (α)-particle?

	charge	mass
A	2*q*	2*m*
B	2*q*	4*m*
C	4*q*	2*m*
D	4*q*	4*m*

（2024 May/Jun · 0654/21 · Question 40 · Extended）

题型 8：磁场只偏转带电 α 和 β，γ 直行（考频★★☆☆☆）

知识点 磁场对运动的带电粒子产生磁力，磁力的国际单位是牛顿（N）。

α 粒子带_____电，β 粒子带_____电，γ 射线不带电。

当粒子运动方向不与磁场方向平行时，α 和 β 发生偏转，γ 沿原方向直行。

在相同运动方向和磁场方向下，α 与 β 的偏转方向_____；负电粒子的常规电流方向与运动方向相反。

答案：正；负；相反

怎么认 题目出现 α、β、γ 进入磁场并问偏转情况时，先判断辐射是否带电。

例题 1

Three types of ionising radiation enter a magnetic field at right angles to the field.

Which types of radiation are deflected?

A α and β only **B** α and γ only **C** β and γ only **D** α, β and γ

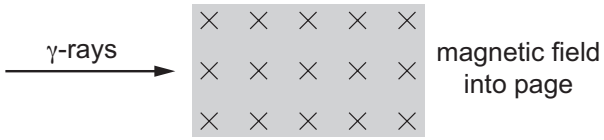
（2023 Oct/Nov · 0654/21 · Question 40 · Extended）

解：α 粒子带正电，β 粒子带负电，二者均受磁力而偏转。
γ 射线不带电，不受磁力。故选 A。

针对练习

1.

The diagram shows γ-rays travelling in the direction shown. They enter a magnetic field that is directed into the page.



In which direction are the γ-rays deflected by the magnetic field, if at all?

A They are deflected out of the page.

B They are deflected towards the bottom of the page.

C They are deflected towards the top of the page.

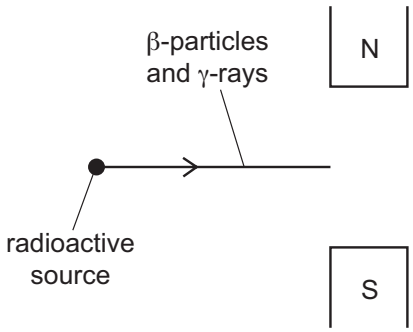
D They are not deflected.

（2023 Feb/Mar · 0654/22 · Question 40 · Extended）

2.

A radioactive source emits beta (β)-particles and gamma (γ)-rays.

Both types of radiation enter the magnetic field between the poles of a magnet, as shown.



In which direction does each type of radiation travel after entering the magnetic field?

	β-particles	γ-rays
A	into the page	into the page
B	into the page	straight on
C	out of the page	into the page
D	out of the page	straight on

（2024 Oct/Nov · 0654/23 · Question 40 · Extended）

题型 9：同位素质子数相同而中子数不同（考频★☆☆☆☆）

知识点 原子核中的粒子包括质子和中子，质子数决定元素的种类。

同一元素的不同同位素具有_____的质子数和_____的中子数。

质子数、中子数都是粒子个数，没有单位；电子位于原子核外，不用于比较原子核的组成。

答案：相同；不同

怎么认 题目出现同一元素的两种原子核或核子图时，先数质子，再比较中子。

例题 1

An element has two isotopes.

Which statement about the nuclei of atoms of these isotopes is correct?

A They have equal numbers of neutrons but different numbers of electrons.

B They have equal numbers of neutrons but different numbers of protons.

C They have equal numbers of protons but different numbers of electrons.

D They have equal numbers of protons but different numbers of neutrons.

（2024 Oct/Nov · 0654/11 · Question 39 · Core）

解：由同位素的定义，同一元素的两种同位素质子数相同，中子数不同。

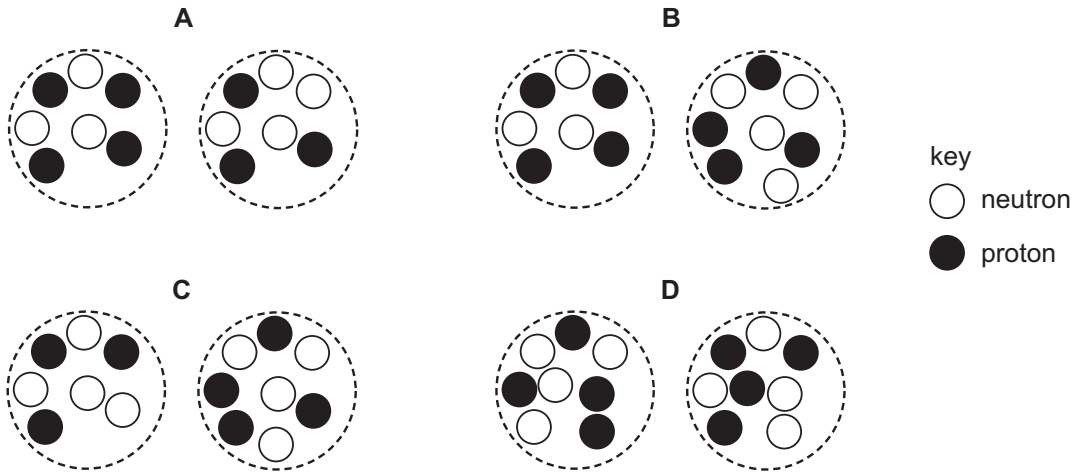
题目问原子核，电子不属于原子核。

故选 D。

针对练习

1. The diagrams represent pairs of nuclei of some atoms.

Which pair shows nuclei of different isotopes of the same element?



（2022 Oct/Nov · 0654/11 · Question 40 · Core；同题：2022 Oct/Nov · 0654/12 · Question 40 · Core、2022 Oct/Nov · 0654/13 · Question 40 · Core、2022 Oct/Nov · 0654/21 · Question 40 · Extended、2022 Oct/Nov · 0654/22 · Question 40 · Extended、2022 Oct/Nov · 0654/23 · Question 40 · Extended）

题型 10：放射性来自不稳定原子核（考频★☆☆☆☆）

知识点 放射性衰变是_____原子核自发发生变化并放出辐射的过程。

放射性辐射来自原子的_____，不来自核外电子。

稳定原子核不发生放射性衰变；本判断不涉及物理量和单位。

答案：不稳定；原子核

怎么认 题目出现放射性衰变并问辐射来自原子的哪一部分时，先确定发生变化的是不稳定原子核。

例题 1

An atom emits radiation by radioactive decay.

Which part of the atom is the radiation emitted from?

A stable orbiting electrons

B stable nucleus

C unstable orbiting electrons

D unstable nucleus

（2025 Feb/Mar · 0654/12 · Question 39 · Core）

解：放射性衰变由不稳定原子核发生，辐射从不稳定原子核发出。
题目所问为辐射发出的部位，因此应选不稳定原子核。故选 D。

题型 11：背景辐射存在多种自然来源并人人会接触（考频★☆☆☆☆）

知识点 环境中始终存在的电离辐射称为_____，所有人都会受到这种辐射。
天然背景辐射来自地面和岩石、空气中的氡、宇宙射线以及食物和饮料中的放射性物质。
不同地点的背景辐射水平可以不同；探测器计数率的单位常用_____或每分钟计数。

答案：背景辐射；每秒计数

怎么认 题目出现背景辐射的来源或接触人群时，先判断说法是否符合来源多样且人人会接触。

例题 1

Which statement about background radiation is correct?

A All of it comes from the ground.

B None of it comes from the air.

C Only people who fly long distances are exposed to it.

D Some of it comes from food and drink.

（2025 May/Jun · 0654/21 · Question 39 · Extended）

解：背景辐射来自地面和岩石、空气中的氡、宇宙射线以及食物和饮料等多种来源。
所有人都会受到背景辐射，长途飞行会使所受宇宙射线可能增多。
故食物和饮料可贡献部分背景辐射。故选 D。

题型 12：β−衰变质量数不变、质子数增加 1（考频★★☆☆☆）

知识点 核素符号 ${}^{A}_{Z}X$ 中，A 为质量数，Z 为质子数。
β^- 衰变中，核内一个中子转化为一个质子，质量数_____，质子数_____。
核反应方程两边的质量数总和、质子数总和分别相等；β^- 粒子的质量数为 0，下标为 -1。

答案：不变；增加 1

怎么认 题目出现 β^- 衰变、核素符号或衰变方程且求新核素时，先守恒质量数和质子数。

例题 1

A nucleus of carbon ${}^{14}_{6}\mathrm{C}$ decays by beta (β^-)-emission to an isotope of nitrogen N.

What is the nuclide of nitrogen formed?

A ${}^{10}_{4}\mathrm{N}$ **B** ${}^{14}_{5}\mathrm{N}$ **C** ${}^{14}_{7}\mathrm{N}$ **D** ${}^{15}_{7}\mathrm{N}$

（2024 Feb/Mar · 0654/22 · Question 40 · Extended）

解：由 β^- 衰变规律，质量数不变，质子数增加 1。

$A = 14$

$Z = 6 + 1 = 7$

所得氮核素为 $^{14}_{7}\mathrm{N}$，故选 C。

针对练习

1. A carbon-14 nucleus undergoes β^- decay and produces an isotope of nitrogen.

The decay equation is shown.

$$^{14}_{6}\mathrm{C} \rightarrow {}^{A}_{Z}\mathrm{N} + \beta^-$$

Which row gives the values of *A* and *Z*?

	A	*Z*
A	13	6
B	13	7
C	14	6
D	14	7

（2025 Oct/Nov · 0654/21 · Question 39 · Extended）

2. A decay equation for strontium-90 is shown.

$$^{90}_{38}\mathrm{Sr} \rightarrow {}^{90}_{39}\mathrm{Y} + x$$

What is *x*?

A alpha particle

B beta particle

C neutron

D proton

（2025 Oct/Nov · 0654/23 · Question 39 · Extended）

3. A carbon-14 nucleus decays to form a nitrogen-14 nucleus and one particle X of ionising radiation.

The decay equation is shown.

$$^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{Z}\mathrm{N} + {}^{0}_{-1}\mathrm{X}$$

Which row gives the value of *Z* and the identity of particle X?

	Z	particle X
A	5	β
B	7	α
C	7	β
D	8	α

（2025 Oct/Nov · 0654/22 · Question 39 · Extended）

题型 13：每过一个半衰期就把未衰变量减半（考频★★☆☆☆）

知识点 半衰期 $T_{\frac{1}{2}}$ 是放射性样品中未衰变原子数减为原来_____所需的时间；未衰变质量和计数率也按相同比例减小。

当经过时间 t 是半衰期的整数倍时，半衰期数为_____；初值为 N_0，则 $N = N_0\left(\frac{1}{2}\right)^n$。

t 与 $T_{\frac{1}{2}}$ 须用相同时间单位；N 与 N_0 可表示原子数、质量或计数率，二者单位相同。

答案：一半；$n = \frac{t}{T_{\frac{1}{2}}}$

怎么认 题目出现半衰期、经过时间和初始质量、原子数或计数率时，先求半衰期数。

例题 1

The isotope of americium used in a smoke detector has a half-life of 430 years. A sample of this isotope emits 36 000 particles per minute.

At which rate does it emit particles 1290 years later?

A 4500 counts per minute

B 9000 counts per minute

C 12 000 counts per minute

D 18 000 counts per minute

（2023 Feb/Mar · 0654/12 · Question 40 · Core）

解： 由半衰期数得

$n = \frac{1290}{430} = 3$

每经过一个半衰期，粒子发射率减半，故

$R = 36000\left(\frac{1}{2}\right)^3$

$R = 4500\ \text{counts per minute}$

故选 A。

针对练习

1. The mass of a radioactive isotope in a sample is 720 g. The half-life of the isotope is 4.0 hours.

Which mass of the isotope remains undecayed after 12 hours?

A 60 g **B** 90 g **C** 180 g **D** 240 g

（2025 Oct/Nov · 0654/11 · Question 39 · Core）

2. A radioactive isotope has a half-life of 3.0 days. A sample contains 4000 atoms of this isotope.

How many atoms of the isotope remain after 6.0 days?

A 0 **B** 500 **C** 1000 **D** 2000

（2023 May/Jun · 0654/11 · Question 40 · Core）

题型 14：先数初末量经历几次减半再反求半衰期或时间（考频★★☆☆☆）

知识点 半衰期是放射性样品中未衰变原子核数或计数率减小到原来_____所需的时间。

经过 n 个半衰期，剩余量等于初始量的 _____；已知初量和末量时，可逐次除以 2，除法次数就是半衰期次数。

对同一放射性样品且探测条件不变，计数率也按相同规律减半。

同一种放射性同位素的半衰期_____，不随样品初始量改变；单位是年、天、小时或分钟等时间单位。

答案：一半；$\left(\frac{1}{2}\right)^n$；恒定

怎么认 题目出现初始原子数或计数率、末值和总时间时，先逐次减半并数出次数。

例题 1

A radioactive isotope has a half-life of 18 years. A sample contains 80 million atoms of this isotope.

How long does it take for the number of atoms of this isotope in the sample to decrease to 10 million?

A 2.25 years

B 6.0 years

C 54 years

D 180 years

（2022 Feb/Mar · 0654/12 · Question 40 · Core；同题：2022 Feb/Mar · 0654/22 · Question 40 · Extended）

解：由每经过一个半衰期剩余量减半，得

$80\frac{\text{million atoms}}{2} = 40 \text{ million atoms}$

$40\frac{\text{million atoms}}{2} = 20 \text{ million atoms}$

$20\frac{\text{million atoms}}{2} = 10 \text{ million atoms}$

从 80 million atoms 减至 10 million atoms 共经历 3 个半衰期，

$t = 3 \times 18 \text{ years} = 54 \text{ years}$。

故选 C。

针对练习

1.

A radioactive isotope emits only alpha (α)-particles.

A sample of the isotope emits 2000 α-particles per second.

After 30 minutes, the sample emits 250 α-particles per second.

What is the half-life of the isotope?

A 7.5 minutes

B 10 minutes

C 15 minutes

D 30 minutes

（2024 Oct/Nov · 0654/12 · Question 40 · Core；同题：2024 Oct/Nov · 0654/13 · Question 40 · Core）

2.

A radioactive sample emits 1280 beta (β)-particles per second.

After 20 minutes, it emits 80 beta (β)-particles per second.

What is the half-life of the radioactive sample?

A 4.0 minutes

B 5.0 minutes

C 10 minutes

D 60 minutes

（2024 Feb/Mar · 0654/12 · Question 39 · Core）

题型 15：已知末值倒推以前的发射率逐次乘 2（考频★☆☆☆☆）

知识点 半衰期是放射性样品的发射率减小到原来 _____ 所需的时间；同一样品每经过一个半衰期，发射率均按此比例减小。
从已知末值倒推到以前，每倒推一个半衰期，发射率乘 _____；本题发射率的单位为 emissions per minute。
若时间间隔含 $n=\Delta\frac{t}{T_{\frac{1}{2}}}$ 个半衰期，则 $R_{以前}=R_{末值}\times 2^n$。

答案：$\frac{1}{2}$；2

怎么认 题目出现半衰期、末时刻发射率并求以前的发射率时，先求半衰期个数，再逐次乘 2。

例题 1

A radioactive isotope has a half-life of 4.0 days. A sample of the isotope emits radiation at a rate of 100 emissions per minute.

What was the rate of emission from the sample 8.0 days earlier?

A 25 emissions per minute

B 50 emissions per minute

C 200 emissions per minute

D 400 emissions per minute

（2023 Oct/Nov · 0654/12 · Question 40 · Core）

解：由半衰期数与时间间隔的关系，
$n=8.0\frac{\text{days}}{4.0\text{ days}}=2$。
由末值倒推，每个半衰期发射率乘 2，得
$100\times 2^2=400$ emissions per minute。
故选 D。

针对练习

1. A radioactive material has a half-life of 4.0 days. The rate of emission of radiation from a sample of the material is 32 emissions per minute.

What was the rate of emission from the sample 8.0 days **earlier**?

A 8.0 emissions per minute

B 128 emissions per minute

C 256 emissions per minute

D 1024 emissions per minute

（2024 May/Jun · 0654/11 · Question 40 · Core）

题型 16：同时核对电场吸引方向与磁场受力方向（考频★☆☆☆☆）

知识点 α 粒子带_____电，β 粒子带_____电，γ 射线_____电。
电场方向由正极板指向负极板；正电荷受力与电场同向，负电荷受力与电场反向。
磁体外部的磁场方向由 N 极指向 S 极；用左手定则判断正电荷的磁场受力方向，负电荷取反向。
在同一场中，α、β 粒子的偏转方向相反，γ 射线不偏转。
以上关系适用于粒子进入电场或垂直进入磁场时，偏转方向没有单位。

答案：正；负；不带

怎么认 题目出现带电粒子进入电场和磁场的图时，先判场的方向，再按电荷正负确定偏转方向。

例题 1

Electric and magnetic fields can cause deflection of ionising radiation.

Which statements about the deflection are correct?

1 In an electric field, α-particles and β-particles are deflected in opposite directions.

2 In a magnetic field, α-particles and β-particles are deflected in the same direction.

3 γ-rays are not deflected by electric fields or by magnetic fields.

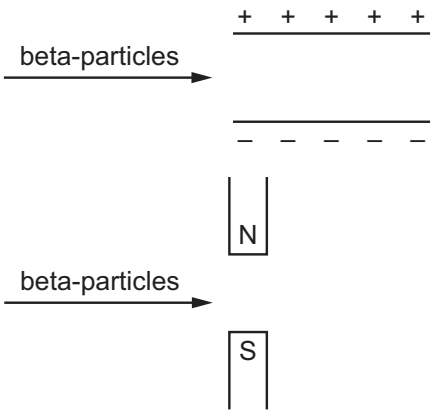
A 1 and 3 **B** 1 only **C** 2 and 3 **D** 2 only

（2023 Oct/Nov · 0654/22 · Question 40 · Extended）

解：α 粒子带正电，β 粒子带负电，在同一电场中的受力方向相反，故陈述 1 正确。
在同一磁场中，粒子运动方向相同时，异号电荷受力方向相反，故陈述 2 错误。
γ 射线不带电，不受电场力和磁场力，故陈述 3 正确。
故选 A。

针对练习

1. The diagrams show a beam of beta-particles passing into an electric field and another beam of beta-particles passing into a magnetic field.



In which direction is the beam deflected in each case?

	electric field	magnetic field
A	towards the negative plate	into the page
B	towards the negative plate	out of the page
C	towards the positive plate	into the page
D	towards the positive plate	out of the page

（2023 May/Jun · 0654/21 · Question 40 · Extended）

题型 17：连续两步衰变分别比较 A 和 Z 的改变量（考频★☆☆☆☆）

知识点 核素的质量数 A 等于质子数与中子数之和，质子数 Z 等于原子序数；二者均为计数值，没有单位。
发生 α 衰变时，A 减少 _____，Z 减少 _____。
发生 β^- 衰变时，A 不变，Z 增加 _____。

答案：4；2；1

怎么认 题目出现连续两次核素转变并询问辐射种类时，先分别比较每次衰变前后的 A 和 Z。

例题 1

A uranium nucleus decays into a thorium nucleus. The thorium nucleus then decays into a protactinium nucleus.

$$^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} \rightarrow {}^{234}_{91}\mathrm{Pa}$$

Which emissions take place during the decays?

A an alpha-particle followed by a beta-particle

B an alpha-particle followed by another alpha-particle

C a beta-particle followed by an alpha-particle

D a beta-particle followed by another beta-particle

（2024 Oct/Nov · 0654/21 · Question 40 · Extended）

解：由铀核变为钍核，

$\Delta A_1 = 234 - 238 = -4$

$\Delta Z_1 = 90 - 92 = -2$

质量数减少 4，质子数减少 2，故先发生 α 衰变。

由钍核变为镁核，

$\Delta A_2 = 234 - 234 = 0$

$\Delta Z_2 = 91 - 90 = 1$

质量数不变，质子数增加 1，故再发生 β^- 衰变。故选 A。

题型 18：太阳能源是氢核聚变而非裂变（考频★☆☆☆☆）

知识点 核聚变是两个较轻的原子核结合成较重原子核并释放能量的过程。

太阳释放的能量来自氢核的_____，而不是核裂变或化学反应。

核聚变需要_____温度和高压力等条件，释放的能量通常用焦耳（J）表示。

答案：核聚变；极高

怎么认 题目出现太阳释放能量并询问过程名称时，先判断为氢核聚变。

例题 1

What is the name of the process by which energy is released in the Sun?

A background radiation

B chemical reaction

C nuclear fission

D nuclear fusion

（2022 May/Jun · 0654/23 · Question 31 · Extended）

解：太阳内部温度和压力极高，氢核结合形成较重原子核并释放能量，此过程称为核聚变。

故选 D。

专题 21 太阳系、恒星与宇宙

21.1 太阳系、恒星与宇宙

题型 1：按太阳系轨道顺序辨认行星、小行星和卫星（考频★★★☆☆）

知识点 太阳系八大行星按距太阳由近到远依次为水星、金星、_____、火星、木星、土星、天王星、海王星。

火星与木星的轨道之间是_____；绕行星运行的天然天体称为卫星，如月球。

冥王星属于_____（minor planet），水星、天王星和海王星属于行星。

轨道顺序按天体与太阳的距离判定，以上关系不涉及物理量和单位。

答案：地球；小行星带；矮行星

怎么认 题目出现行星距太阳的顺序、小行星带位置或绕行星天体时，先写出太阳系轨道次序。

例题 1

What is between the orbits of Mars and Jupiter?

A the asteroid belt

B the orbit of Saturn

C the orbit of the Earth

D the orbit of Venus

（2025 May/Jun · 0654/11 · Question 40 · Core）

解：火星轨道外侧、木星轨道内侧分布着小行星带。

故选 A。

针对练习

1.

Which object that orbits the Sun is a minor planet?

A Mercury

B Neptune

C Pluto

D Uranus

（2026 May/Jun · 0654/22 · Question 40 · Extended）

2.

The orbit of a planet lies between the orbit of Venus and the orbit of Mars.

What is the planet?

A Saturn

B Jupiter

C Earth

D Uranus

（2025 May/Jun · 0654/12 · Question 40 · Core；同题：2025 May/Jun · 0654/13 · Question 40 · Core）

3. Which list gives the planets in order of increasing distance from the Sun?

A Earth, Mars, Venus

B Mars, Earth, Venus

C Mars, Venus, Earth

D Venus, Earth, Mars

（2026 May/Jun · 0654/13 · Question 40 · Core）

4. Which list gives the planets named in order of distance from the Sun?

A Earth, Mars, Venus, Jupiter

B Mars, Earth, Venus, Jupiter

C Venus, Earth, Jupiter, Mars

D Venus, Earth, Mars, Jupiter

（2026 Feb/Mar · 0654/12 · Question 40 · Core）

5. Which row shows a dwarf planet and an object that orbits a planet?

	dwarf planet	object that orbits a planet
A	Mercury	moon
B	Mercury	asteroid
C	Pluto	moon
D	Pluto	asteroid

（2025 Oct/Nov · 0654/11 · Question 40 · Core）

题型 2：一周圆轨道长度除以公转时间求轨道速度（考频★★☆☆☆）

知识点 物体沿半径为 r 的圆轨道运动一周，路程为 _____。

轨道速度的大小等于一周路程除以轨道周期 T，即 $v=$ _____；此关系适用于半径不变的圆轨道。

若 r 用 m、T 用 s，则 v 的单位为 m/s；1 h = _____ s，1 d = 86400 s。

答案：$2\pi r$；$2\pi\frac{r}{T}$；3600

怎么认 题目出现圆轨道半径、完成一周的周期并求轨道速度时，先用圆周长 $2\pi r$ 除以周期。

例题 1

In the Solar System, a planet orbits around the Sun. The radius of the orbit is *r* and the orbital period is *T*.

Which equation gives the orbital speed *v*?

A $v=\frac{2\pi T}{r}$ **B** $v=\frac{r}{2\pi T}$ **C** $v=\frac{2\pi r}{T}$ **D** $v=\frac{2\pi}{rT}$

（2025 Feb/Mar · 0654/22 · Question 40 · Extended）

解：圆轨道一周的路程为 $2\pi r$，由轨道速度的大小等于一周路程除以轨道周期，得 $v=\frac{2\pi r}{T}$。

故选 C。

针对练习

1. A moon that orbits a planet has an orbit radius of 1.1×10^9 m and an orbital period of 170 hours.

What is the orbital speed of this moon?

A 3.6×10^3 m/s

B 1.1×10^4 m/s

C 6.8×10^5 m/s

D 4.2×10^{15} m/s

（2025 Oct/Nov · 0654/21 · Question 40 · Extended）

2. A moon that orbits a planet has an orbit radius of 9.4×10^6 m and an orbital period of 7.7 hours.

What is the orbital speed of this moon?

A 6.8×10^2 m/s

B 2.1×10^3 m/s

C 1.3×10^5 m/s

D 1.6×10^{12} m/s

（2025 Oct/Nov · 0654/22 · Question 40 · Extended）

3. A planet orbits the Sun once every 225 days. The radius of the orbit of the planet is 110 million km.

What is the orbital speed of the planet?

A 36 m/s **B** 85 m/s **C** 36 000 m/s **D** 85 000 m/s

（2026 May/Jun · 0654/21 · Question 40 · Extended）

题型 3：把光年当距离并识银河系尺寸量级（考频★☆☆☆☆）

知识点 光年是光在真空中一年内传播的距离，是_____单位；$1\ \text{ly} \approx 9.5 \times 10^{12}$ km。
银河系的直径约为_____光年，即约为10^5 ly。
若某恒星距地球d光年，则其光到达地球约需d年；这一关系以光在真空中传播为条件。

答案：长度；十万（10^5）

怎么认 题目出现光年、恒星距离或银河系直径量级时，先按光年的定义判断。

例题 1

What is the approximate diameter of the Milky Way galaxy?

A 10^5 km

B 10^8 km

C 10^5 light-years

D 10^8 light-years

（2026 May/Jun · 0654/11 · Question 40 · Core）

解： 银河系的直径约为十万光年，
$100000\ \text{ly} = 10^5\ \text{ly}$
故选 C。

针对练习

1. The nearest star to the Earth after the Sun is Proxima Centauri.

Proxima Centauri is 4.2 light-years from the Earth.

Which statement about Proxima Centauri is correct?

A It takes 4.2 years for light from Proxima Centauri to reach the Earth.

B It takes 4.2 years for Proxima Centauri to orbit the Sun.

C It would take 4.2 years for humans to travel to Proxima Centauri from the Earth.

D It takes 4.2 years for the Earth to orbit Proxima Centauri.

（2026 May/Jun · 0654/12 · Question 40 · Core）

题型 4：重力维持轨道并让气体尘埃聚成原恒星（考频★☆☆☆☆）

知识点 有质量的物体之间存在_____，方向沿两物体的连线。

太阳对天体的重力提供指向太阳的向心力，使天体保持绕日轨道。

星际气体和尘埃在重力作用下聚集，形成_____；力的 SI 单位是_____。

答案：重力；原恒星；牛顿（N）

怎么认 题目出现绕日轨道或气体尘埃聚集成星体时，先判断作用力是否为重力。

例题 1 Which type of force keeps an object in orbit around the Sun and which type of force forms a protostar?

	force keeping an object in orbit around the Sun	force that forms a protostar
A	gravitational	magnetic
B	gravitational	gravitational
C	magnetic	magnetic
D	magnetic	gravitational

（2025 Oct/Nov · 0654/12 · Question 40 · Core；同题：2025 Oct/Nov · 0654/13 · Question 40 · Core）

解：太阳对绕日物体的重力指向太阳，该力提供维持轨道所需的向心力。

星际气体和尘埃在重力作用下相互吸引并聚集，形成原恒星。

因此两处均为重力，故选 B。

针对练习

1. An early phase of star forms from interstellar clouds of dust and gas due to gravitational attraction.

What is the name of the star formed?

A protostar

B red giant

C supernova

D white dwarf

（2026 Feb/Mar · 0654/22 · Question 40 · Extended）

题型 5：稳定恒星氢聚变为氦释放能量（考频★☆☆☆☆）

知识点 核聚变是两个或多个轻原子核结合成较重原子核并释放能量的过程。

稳定恒星内部温度和压强足够高时，氢核发生核_____，形成氦核。

随着反应持续，氢含量逐渐_____，氦含量逐渐增加。

答案：聚变；减少

怎么认 题目出现稳定恒星、核反应或氢氦含量变化时，先判定氢核聚变形成氦核。

例题 1

Which process describes how energy is released from a stable star?

A fission of helium into hydrogen

B fission of hydrogen into helium

C fusion of helium into hydrogen

D fusion of hydrogen into helium

（2025 May/Jun · 0654/22 · Question 40 · Extended）

解： 稳定恒星内部发生核聚变。

聚变过程中，氢核结合形成氦核并释放能量。

故选 D。

针对练习

1. A stable star is powered by nuclear reactions. Over time the composition of the star changes.

Which row shows the type of nuclear reaction that powers the star and how the composition of the star changes over time?

	nuclear reaction	composition
A	fission	hydrogen decreases and helium increases
B	fission	hydrogen increases and helium decreases
C	fusion	hydrogen decreases and helium increases
D	fusion	hydrogen increases and helium decreases

（2026 May/Jun · 0654/23 · Question 40 · Extended）

题型 6：核对宇宙起始为高温高密并持续膨胀（考频★☆☆☆☆）

知识点 大爆炸理论认为，宇宙起始于一个_____，起始状态的温度_____、密度_____，此后宇宙持续膨胀。
宇宙膨胀过程中，整体温度逐渐降低，物质分布的尺度不断增大。
宇宙年龄约为138亿年，年龄通常以年为单位；相关陈述的起始状态和膨胀方向应符合上述关系。

答案：单一的点；极高；极大

怎么认 题目出现宇宙起始状态或膨胀方向的陈述时，先与高温、高密、持续膨胀核对。

例题 1

Which statement about the Universe is included in the Big Bang Theory?

A The Universe is approximately 13.8 thousand years old.

B The Universe is contracting.

C The Universe started as a single point.

D The Universe started at a low temperature and a low density.

（2025 Oct/Nov · 0654/23 · Question 40 · Extended）

解：由大爆炸理论，宇宙起始于温度极高、密度极大的单一点，并持续膨胀。
题目中 C 所述的起始状态与该理论相符。
故选 C。

题型 7：按恒星质量区分最终星体阶段（考频★☆☆☆☆）

知识点 恒星的演化终点取决于质量：小质量恒星最终形成_____，大质量恒星在超新星爆发后形成_____，超大质量恒星最终形成_____。
超新星是恒星演化中的爆发现象，不是最终留下的星体阶段。

答案：白矮星；中子星；黑洞

怎么认 题目出现恒星质量类别并求最终阶段时，先按质量判断对应的星体。

例题 1

The life cycle of a star depends on whether it has a small mass, a large mass or a very large mass.

What is the final stage of the life cycle of a large mass star?

A black hole

B planetary nebula

C neutron star

D supernova

（2025 Feb/Mar · 0654/12 · Question 40 · Core）

解：大质量恒星发生超新星爆发后，最终形成中子星。故选 C。

题型 8：识别太阳主要气体及主要辐射波段（考频★☆☆☆☆）

知识点 太阳主要由_____和_____两种气体组成。
太阳辐射的能量主要分布在_____波段；这是定性关系，不涉及单位。

答案：氢；氦；红外线、可见光和紫外线

怎么认 题目出现太阳的主要气体和主要辐射波段时，先确定氢、氦，再确定红外线、可见光和紫外线。

例题 1

Which gases make up most of the Sun and in which regions of the electromagnetic spectrum does the Sun mostly radiate its energy?

	gases	electromagnetic regions
A	hydrogen and helium	infrared, visible, ultraviolet
B	hydrogen and helium	visible, ultraviolet, X-rays
C	methane and helium	infrared, visible, ultraviolet
D	methane and helium	visible, ultraviolet, X-rays

（2025 May/Jun · 0654/23 · Question 40 · Extended）

解：太阳主要由氢和氦组成。
太阳辐射的能量主要分布在红外线、可见光和紫外线波段。
故选 A。

题型 9：更强太阳引力对应更近轨道与更快公转（考频★☆☆☆☆）

知识点 重力场强 g 表示单位质量的物体在该处所受的引力，单位为 N/kg。

距太阳中心 r 处，$g = G\frac{M}{r^2}$，其中 G 为引力常量，M 为太阳质量；同一太阳周围，g 越大，r 越_____。

行星绕同一太阳作近似圆周运动时，万有引力提供向心力，$v = \sqrt{G\frac{M}{r}}$，v 的单位为 m/s。

因此，轨道半径越小，公转速度越_____。

答案：小；大

怎么认 题目出现太阳在某行星处的重力场强更大，并要求比较轨道距离和公转速度时，先判断该行星离太阳更近。

例题 1

Planet X and planet Y orbit the Sun and are at different distances from the Sun.

The gravitational field strength of the Sun is greater at the position of planet X than it is at the position of planet Y.

Which row compares the distances from the Sun and the orbital speeds of planet X and planet Y?

	distance from the Sun	orbital speed
A	greater for planet X	greater for planet X
B	greater for planet X	less for planet X
C	less for planet X	greater for planet X
D	less for planet X	less for planet X

（2025 May/Jun · 0654/21 · Question 40 · Extended）

解： 设行星 X、Y 到太阳中心的距离分别为 r_X、r_Y。

由 $g = G\frac{M}{r^2}$，且 $g_X > g_Y$，得

$r_X < r_Y$。

行星绕太阳作近似圆周运动，由万有引力提供向心力，得

$GM\frac{m}{r^2} = m\frac{v^2}{r}$，

$v = \sqrt{G\frac{M}{r}}$。

$\because r_X < r_Y$，$\therefore v_X > v_Y$。

故行星 X 离太阳较近，公转速度较大。故选 C。

题型 10：吸收辐射多于发射则地球储能升温（考频★☆☆☆☆）

知识点 物体吸收辐射时获得能量，发射辐射时失去能量。

在同一段时间内，只考虑辐射传能且物体不发生显著相变时，若吸收的辐射能大于发射的辐射能，物体储存的能量_____，温度_____。

辐射能的单位是_____，辐射功率的单位是 W。

答案：增加；升高；J

怎么认 题目出现地球温度随时间升高并比较吸收与发射辐射时，先由温度变化判断能量收支。

例题 1

Over a period of time, it is observed that the temperature of the Earth increases slightly.

Which statement about the Earth explains this observation?

A No radiation is absorbed or emitted.

B More radiation is absorbed than is emitted.

C More radiation is emitted than is absorbed.

D Radiation is emitted and absorbed at the same rate.

（2026 Feb/Mar · 0654/22 · Question 32 · Extended）

解： 设同一段时间内地球吸收、发射的辐射能分别为 $E_{吸}$、$E_{发}$。

地球温度升高，说明地球储存的能量增加，由能量守恒得

$\Delta E = E_{吸} - E_{发} > 0$

$E_{吸} > E_{发}$

故选 B。