学生手册 2026–2028

CIE IGCSE Physics 全基础题型

0625 · Core & Extended · 波

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[3] 专题 3 波

3.1 波的一般性质

题型 1：读出波的基本量（考频★★★★☆）

知识点 波在传播过程中传递_____，但不使物质随波发生整体迁移。

振幅是离开平衡位置的最大距离，波长是相邻两个同相位点之间的最短距离，二者的国际单位都是_____。

频率表示每秒完成振动的次数，单位是_____。

对于周期波，波速、频率和波长满足 $v = f\lambda$；v、f、λ 可分别用 m/s、Hz、m 表示。

答案：能量；米；赫兹

怎么认 题目出现波传递什么、波的基本量或单位时，先区分能量与物质，再按定义和单位判断。

一. 辨基本性质与单位

例题 1 Which statement about waves is correct?

A Waves do not transfer either energy or matter.

B Waves transfer both energy and matter.

C Waves transfer energy without transferring matter.

D Waves transfer matter without transferring energy.

（2024 夏季 0625/21 第16题）

解：由波的基本性质，波传递能量而不传递物质。

故选 C。

针对练习

1. Which equation enables the speed of a wave to be calculated?

A speed = amplitude × frequency

B speed = amplitude × wavelength

C speed = frequency × wavelength

D $\text{speed} = \dfrac{\text{frequency}}{\text{wavelength}}$

（2025 春季 0625/12 第21题）

2. Which statement about waves is correct?

A All waves can travel through a vacuum.

B All waves travel at the same speed.

C Seismic S-waves can be modelled as longitudinal waves.

D Waves transfer energy without transferring matter.

（2023 冬季 0625/13 第17题）

3. Which quantities relating to a wave on the surface of water can **both** be measured in metres?

A amplitude and frequency

B amplitude and wavelength

C amplitude and wave speed

D frequency and wavelength

（2023 冬季 0625/21 第18题）

二. 从波形读振幅波长

知识点 振幅是介质质点离开平衡位置的_____位移，从平衡位置量到波峰或波谷；波峰到波谷的距离等于两个振幅，单位为 m。

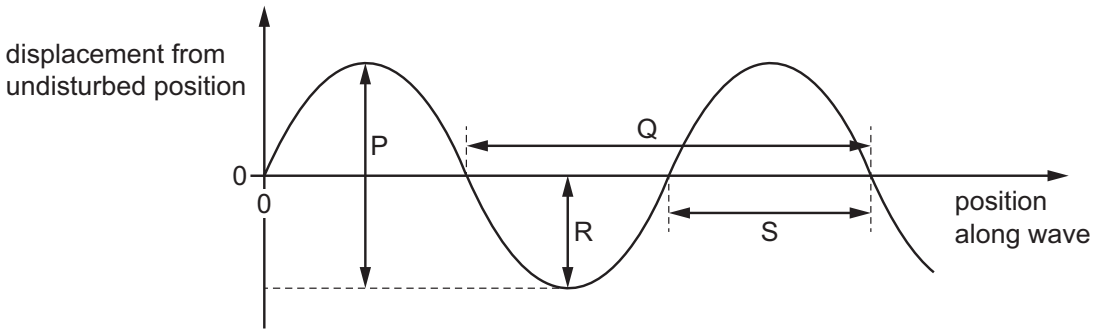
波长是沿传播方向相邻两个_____点之间的距离，可在相邻波峰、相邻波谷或相邻同向过零点之间量取，单位为 m。

若长度 L 横跨 n 个完整波形，则 $\lambda = \frac{L}{n}$；若竖直总高 H 从波峰量到波谷，则振幅 $A = \frac{H}{2}$。

答案：最大；同相位

怎么认 题目出现波形图及水平或竖直标线时，先分清传播方向和平衡位置，再数标线跨过的完整波形数。

例题 2 The diagram shows a wave.



Which dimensions describe the properties of the wave?

A P = amplitude, S = speed

B P = speed, Q = wavelength

C R = amplitude, Q = wavelength

D R = amplitude, S = wavelength

（2024 春季 0625/22 第16题）

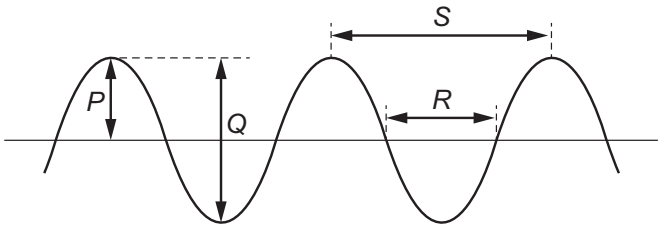
解：振幅是平衡位置到最大位移处的竖直距离，图中 R 从平衡位置量到波谷，故 R 表示振幅。

波长是相邻同相位点沿传播方向的距离，图中 Q 连接相邻同向过零点，故 Q 表示波长。

故选 C。

针对练习

4. The diagram shows a transverse wave.



Which row identifies the amplitude and the wavelength of the wave?

	amplitude	wavelength
A	*P*	*R*
B	*P*	*S*
C	*Q*	*R*
D	*Q*	*S*

（2023 冬季 0625/13 第18题）

5. **(a)** Fig. 9.1 shows a diagram of a transverse wave.

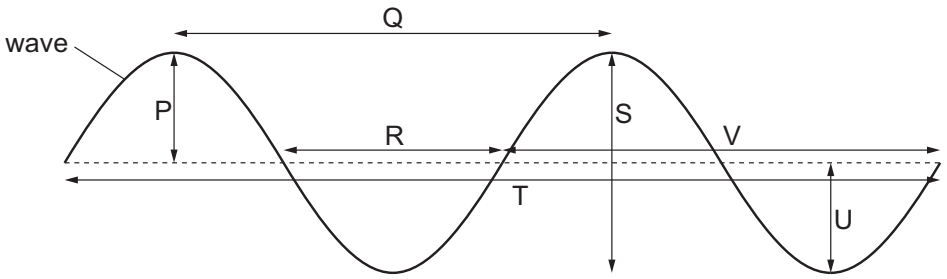
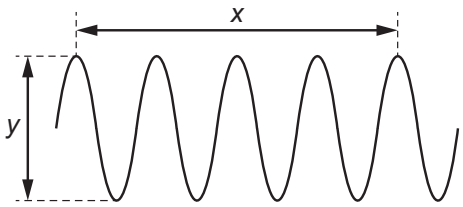


Fig. 9.1

From Fig. 9.1, identify all the lengths which represent **one** wavelength.

（2024 冬季 0625/43 第9题(a)）

6. The diagram represents a wave.



Which row gives the wavelength and the amplitude of the wave?

	wavelength	amplitude
A	x	y
B	y	x
C	x	$\frac{y}{2}$
D	$\frac{x}{4}$	$\frac{y}{2}$

（2024 夏季 0625/11 第16题）

7. A teacher demonstrates the behaviour of waves by using water waves in a ripple tank.

Fig. 5.1 shows a cross-section through part of the water waves.

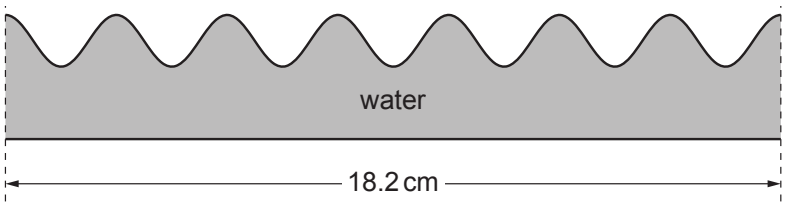


Fig. 5.1 (not to scale)

(a) Calculate the wavelength of the water waves. Use the information in Fig. 5.1.

（2023 夏季 0625/33 第5题(a)）

三. 从位移—时间图求频率

知识点 振幅是质点离开平衡位置的最大位移，从纵轴读出，单位与位移相同。

周期 T 是完成一次完整振动所需的时间，等于相邻两个同相位点的时间间隔，单位为 _____。

频率 f 是单位时间内完成的振动次数；当振动周期稳定时，$f =$ _____，单位为 _____。

答案：s；$\frac{1}{T}$；Hz

怎么认 题目出现位移–时间图并要求振幅或频率时，先读最大位移，再读相邻同相位时刻求周期。

例题 3 Fig. 6.1 shows how the displacement of a transverse wave varies with time.

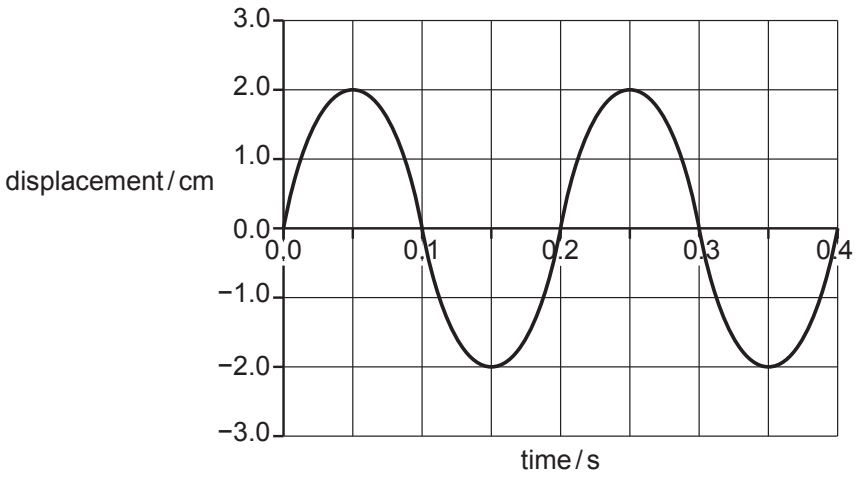


Fig. 6.1

(a) (i) Determine the amplitude of the wave in Fig. 6.1.

(ii) Determine the frequency of the wave in Fig. 6.1.

（2023 春季 0625/32 第6题(a)）

解： 由图，质点离开平衡位置的最大位移为

$A = 2.0\ \text{cm}$

相邻两个波峰对应的时刻分别为 $0.05\ \text{s}$ 和 $0.25\ \text{s}$，故

$T = 0.25\ \text{s} - 0.05\ \text{s} = 0.20\ \text{s}$

$f = \frac{1}{T} = \frac{1}{0.20\ \text{s}} = 5.0\ \text{Hz}$

答：(i) $2.0\ \text{cm}$；(ii) $5.0\ \text{Hz}$。

8. Fig. 4.1 represents a wave on the surface of water.

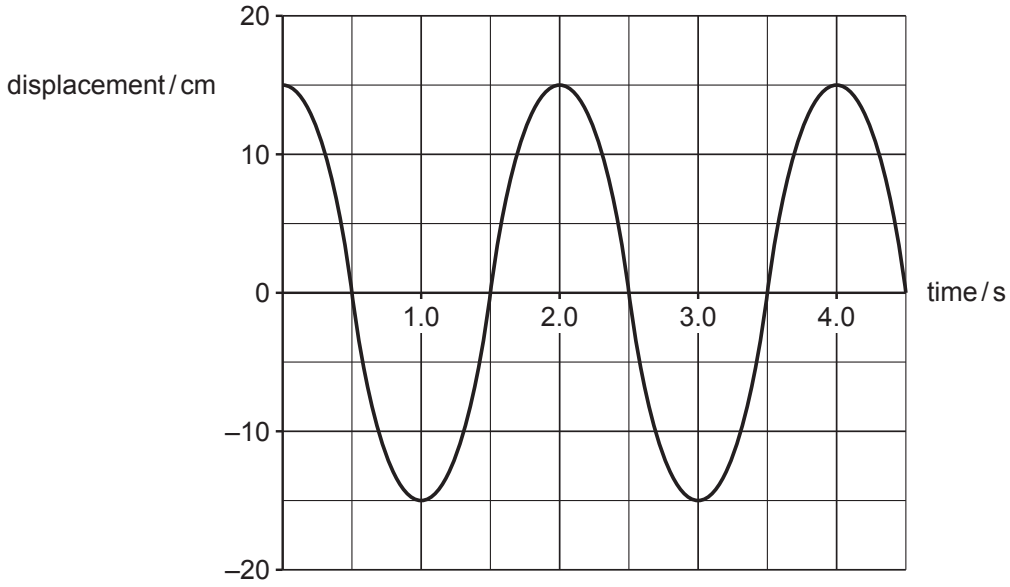


Fig. 4.1

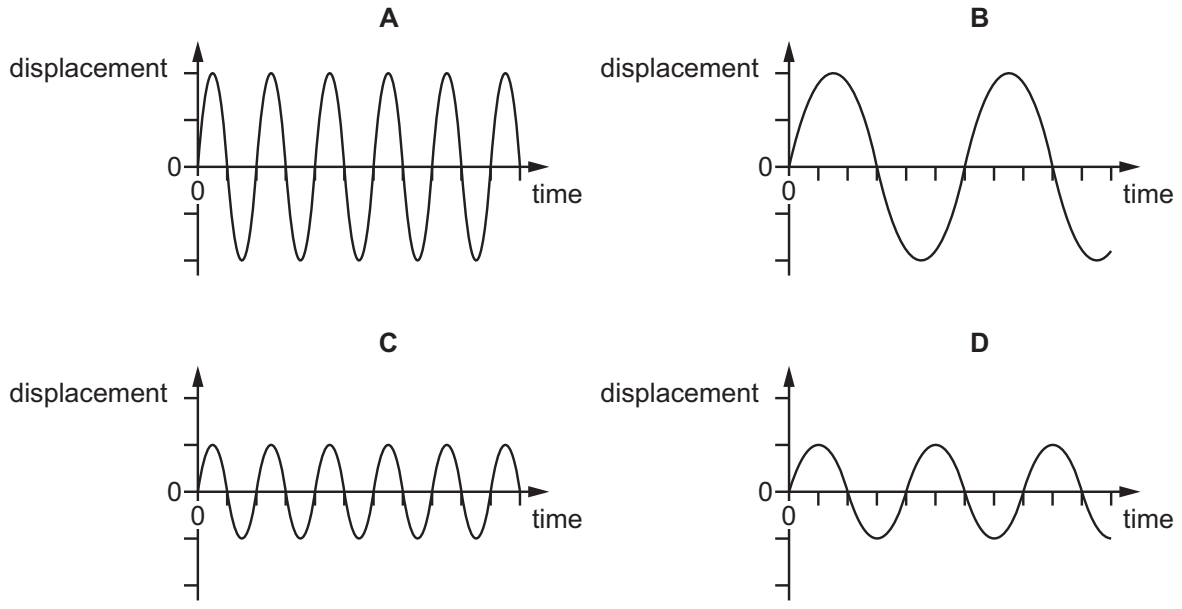
(a) (i) Determine the amplitude of the wave in Fig. 4.1.

(ii) Determine the frequency of the wave in Fig. 4.1.

（2023 冬季 0625/31 第4题(a)）

9. The diagrams show graphs of displacement against time for four waves. All the graphs are drawn to the same scale.

Which wave has the largest amplitude and the highest frequency?



（2023 夏季 0625/11 第17题）

10. **(a)** A transverse wave passes through a medium. Fig. 7.1 shows the displacement of particles in the medium.

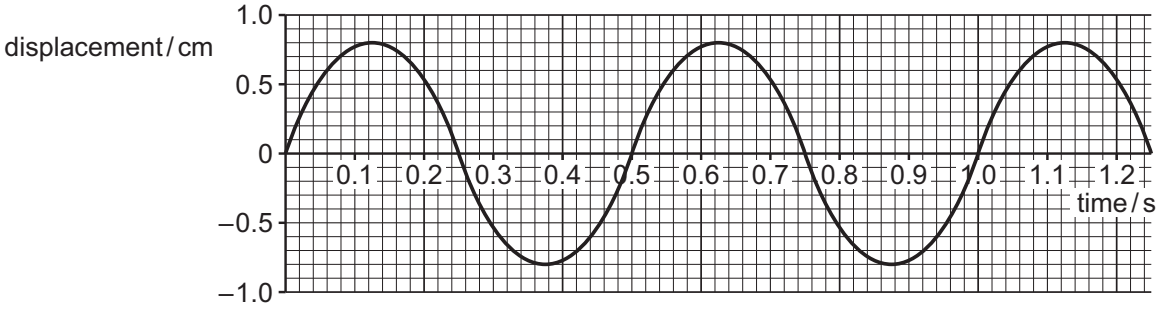


Fig. 7.1

Using the information in Fig. 7.1, determine:

(i) the amplitude of the wave

(ii) the frequency of the wave.

（2025 夏季 0625/31 第7题(a)）

11. A teacher demonstrates the behaviour of waves by using water waves in a ripple tank.

Fig. 5.1 shows a cross-section through part of the water waves.

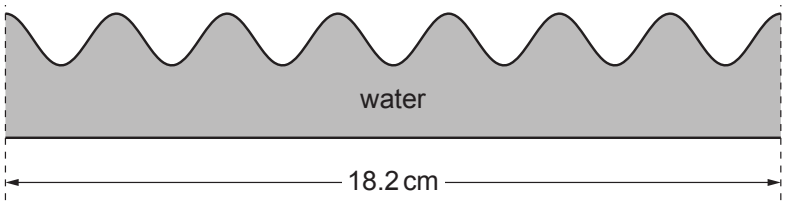


Fig. 5.1 (not to scale)

(b) The teacher places a pointer above the water waves as shown in Fig. 5.2.

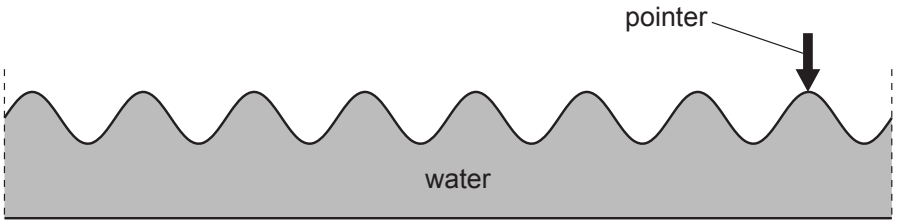


Fig. 5.2 (not to scale)

Three students use stop-watches to measure the time taken for 50 peaks to pass the pointer. Fig. 5.3 shows the measurements.



time = ... s



time = ... s



time = ... s

Fig. 5.3

(i) On the line below each stop-watch, state the time measurement, in seconds.

(ii) Calculate the average of the three time measurements in **(b)(i)**.

(iii) Calculate the frequency of the water waves using your result in **(b)(ii)**.

（2023 夏季 0625/33 第5题(b)）

四. 从波面读波长频率

知识点 波面是连接波中振动相位_____的各点所成的线或面。

对于周期波，相邻两个同相位波面之间沿传播方向的距离是_____，单位为 m。

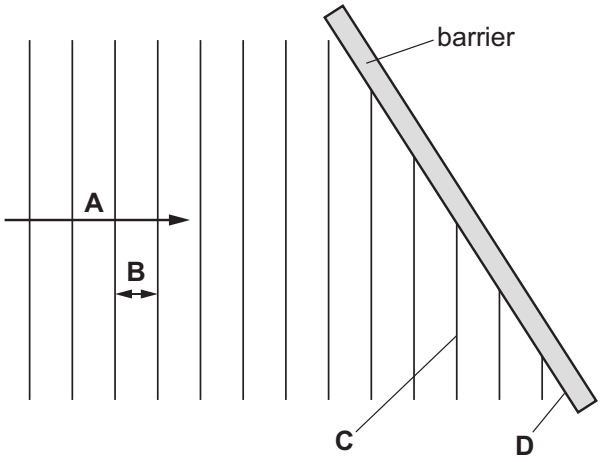
单位时间内通过固定点的波面数是_____，单位为 Hz，且 $v = f\lambda$。

答案：相同；波长；频率

怎么认 题目出现成排平行线、同心圆波纹或每秒通过的波面数时，先辨认波面及相邻波面间距。

例题 4 The diagram shows a wave before it reflects from a barrier.

Which labelled section of the diagram represents a wavefront?



（2024 冬季 0625/12 第18题）

解： 波面连接波中振动相位相同的各点。
图中各竖直线连接同相位点，C 所指为其中一条竖直线。
故选 C。

针对练习

12. What is the number of wavefronts per second that pass a fixed point?

A the amplitude of the wave

B the frequency of the wave

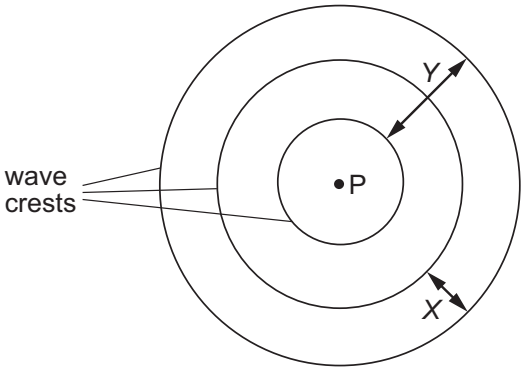
C the speed of the wave

D the wavelength of the wave

（2024 冬季 0625/22 第17题）

13. A vertical stick is dipped up and down in water at P.

In two seconds, three wave crests spread out on the surface of the water.



Which statement is correct?

A Distance *X* is the amplitude of the waves.

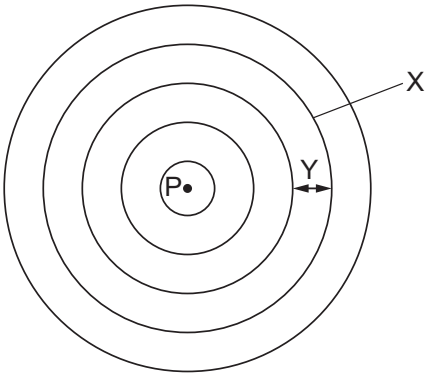
B Distance *Y* is the wavelength of the waves.

C Each circle represents a wavefront.

D The frequency of the waves is 3 Hz.

（2024 冬季 0625/23 第17题）

14. The diagram shows a view from above of waves on the surface of a pond after the water has been disturbed at point P.



What are the correct labels for X and Y?

	X	Y
A	amplitude	wavelength
B	wavefront	wavelength
C	amplitude	wavefront
D	wavefront	amplitude

（2025 夏季 0625/11 第20题）

题型 2：按振动方向辨波型（考频★★★★☆）

知识点 横波中，振动方向与传播方向互相_____；纵波中，振动方向与传播方向互相_____。判断波的类型时，应比较同一列波的振动方向与传播方向。

答案：垂直；平行

怎么认 题目出现振动方向与传播方向的比较时，先判断两方向是垂直还是平行。

一. 比较振动与传播方向

例题 1 Fig. 6.1 shows how the displacement of a transverse wave varies with time.

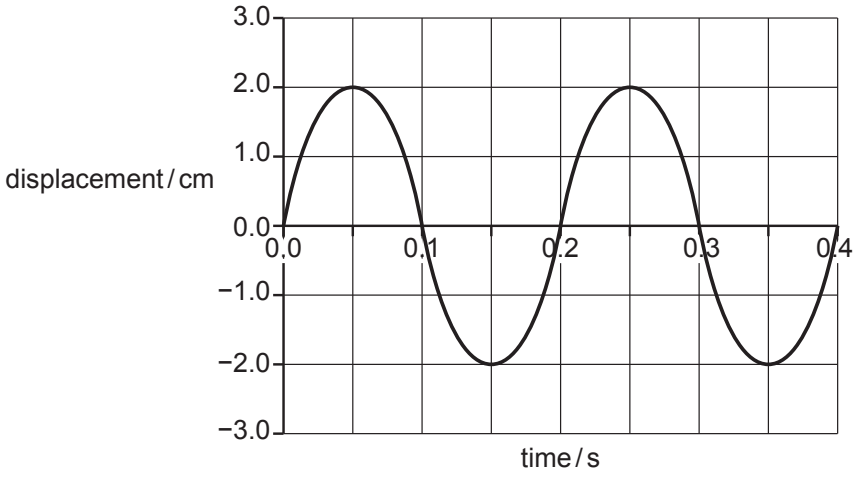


Fig. 6.1

(b) Describe the motion of particles in a transverse water wave.

（2023 春季 0625/32 第6题(b)）

解：横波的振动方向与传播方向互相垂直，因此水粒子在平衡位置附近沿垂直于波传播方向的方向往复振动。

答：水粒子的振动方向与波的传播方向垂直。

针对练习

1. **(b)** Describe the direction of vibration of particles in a transverse wave.

（2024 冬季 0625/31 第7题(b)）

2. **(b)** Describe the difference between transverse waves and longitudinal waves.

（2025 冬季 0625/43 第5题(b)）

3. In which type of wave is the direction of vibration parallel to the direction of travel?

A electromagnetic waves

B seismic P-waves

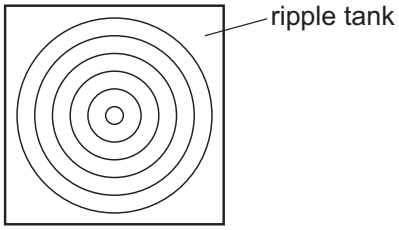
C seismic S-waves

D water waves

（2024 夏季 0625/22 第17题）

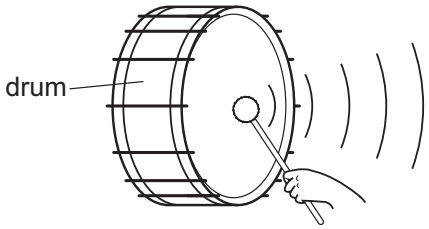
4. The diagrams show examples of wave motion.

waves on water



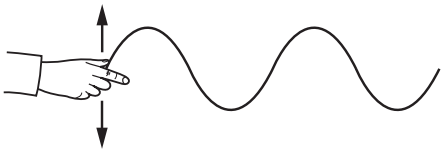
1

waves in air



2

waves on a rope



3

waves in a spring



4

Which waves are longitudinal?

A 1 only **B** 2, 3 and 4 **C** 2 and 3 only **D** 2 and 4 only

（2025 夏季 0625/12 第18题）

二. 由实例匹配横波纵波

知识点 波按振动方向与传播方向的关系分为横波和纵波。

横波的振动方向与传播方向_____；纵波的振动方向与传播方向_____。

电磁波、水波和地震 S 波按横波模型处理；声波和地震 P 波按纵波模型处理。

答案：垂直；平行

怎么认 题目出现波的实例或振动方向与传播方向时，先按实例匹配波型，再核对方向。

例题 2 Two types of seismic waves are P-waves and S-waves.

(a) State the types of wave that P-waves and S-waves can be modelled as.

（2023 夏季 0625/42 第6题(a)）

解：地震 P 波的振动方向与传播方向平行，地震 S 波的振动方向与传播方向垂直。

答：P 波可按纵波建模；S 波可按横波建模。

针对练习

5. The table gives information about seismic waves.

Which row is correct?

	seismic S-waves (secondary)	seismic P-waves (primary)
A	longitudinal	longitudinal
B	longitudinal	transverse
C	transverse	longitudinal
D	transverse	transverse

（2025 冬季 0625/12 第19题）

6. Which row shows an example of a transverse wave and an example of a longitudinal wave?

	transverse	longitudinal
A	light	radio
B	radio	sound
C	sound	water
D	water	light

（2024 冬季 0625/13 第18题）

7. Which row correctly describes the vibrations of a transverse wave and also gives a correct example of a transverse wave?

	description of vibrations	example of a transverse wave
A	at right angles to the wave direction	sound
B	at right angles to the wave direction	water wave
C	parallel to the wave direction	sound
D	parallel to the wave direction	water wave

（2025 夏季 0625/11 第19题）

8. **(c)** Fig. 7.4 lists examples of waves. **Two** of the examples are transverse waves.

☐ radio waves

☐ seismic P-waves

☐ light waves

☐ sound waves

Fig. 7.4

Indicate which of the examples are transverse waves.
Put a tick (✓) in the box next to each example of a transverse wave.

（2024 冬季 0625/31 第7题(c)）

三. 由疏密间距求纵波量

知识点 纵波中，介质粒子的振动方向与波的传播方向_____；粒子密集处称为压缩部，粒子稀疏处称为稀疏部。
相邻两个压缩中心或相邻两个稀疏中心的距离为一个_____；压缩中心到相邻稀疏中心的距离为半个波长。
若压缩中心到相邻稀疏中心的距离为 d，则 $\lambda = 2d$；波速、频率和波长满足 $v = f\lambda$。
λ 的单位为 m，f 的单位为 Hz，v 的单位为 m/s。

答案：平行；波长

怎么认 题目出现纵波的压缩、稀疏及其中心间距时，先标出疏密区并判断间距对应半波长还是一波长。

例题 3 What is a compression?

A a point in a longitudinal wave where the particles of the medium are close together

B a point in a longitudinal wave where the particles of the medium are far apart

C a point in a transverse wave where the particles of the medium are close together

D a point in a transverse wave where the particles of the medium are far apart

（2025 夏季 0625/23 第23题）

解： 纵波中粒子密集的区域为压缩部，其中介质粒子彼此靠近。
故选 A。

针对练习

9. A loudspeaker produces a sound wave in air. The distance between the centre of a compression and the centre of a neighbouring rarefaction is 0.10 m.

(a) Calculate the wavelength of the sound wave.

（2024 冬季 0625/41 第5题(a)）

题型 3：用 v=fλ 处理波（考频★★★★☆）

知识点 波的速率 v 表示波在单位时间内传播的距离；频率 f 表示每秒完成的振动次数；波长 λ 是相邻两个同相位点之间的距离。
三者满足 _____；求频率或波长时，分别变形为 _____ 和 _____。
使用 SI 单位时，v 的单位为 $\mathrm{m/s}$，f 的单位为 Hz，λ 的单位为 m；也可使用能相互约去的同类长度单位。

答案：$v = f\lambda$；$f = \frac{v}{\lambda}$；$\lambda = \frac{v}{f}$

怎么认 题目出现波的速率、频率、波长中任意两量并求第三量时，先写 $v = f\lambda$。

一. 直接变形 v=fλ

例题 1 Fig. 6.1 shows how the displacement of a transverse wave varies with time.

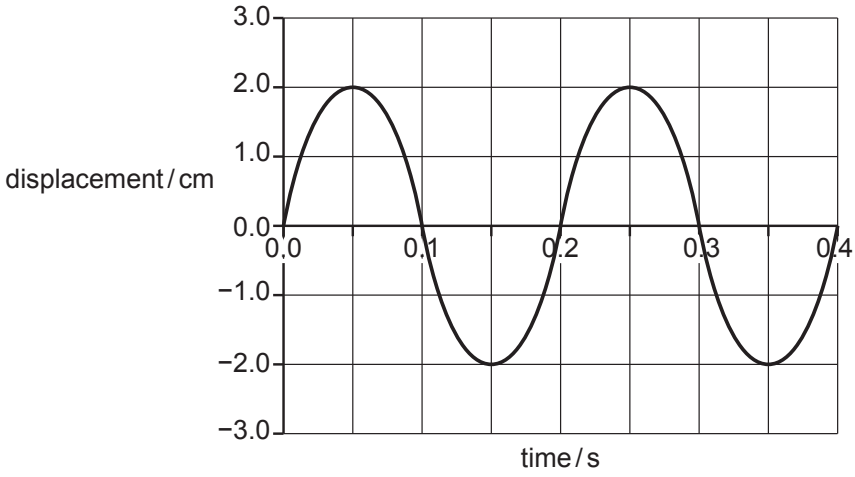


Fig. 6.1

(c) A wave has a frequency of 400 Hz and a wavelength of 0.90 m.

Calculate the velocity of the wave.

（2023 春季 0625/32 第6题(c)）

解：由 $v = f\lambda$ 得

$v = 400 \times 0.90$

$v = 360\ \mathrm{m/s}$

答：波的速度为 $360\ \mathrm{m/s}$。

针对练习

1. **(b)** The frequency of an electromagnetic wave is 2.0×10^6 Hz. The speed of the wave in a medium is 2.8×10^8 m / s.

Calculate the wavelength of the wave.

（2025 冬季 0625/31 第6题(b)）

2. **(c)** The wavelength of the wave is 4.6 cm.
The speed of the wave is 38 cm / s.
Determine the frequency of the wave.

（2024 冬季 0625/32 第7题(c)）

3. **(c)** In a different ripple tank, the wavelength of the wave is 5.1 cm.
The speed of the wave is 42 cm / s.

Determine the frequency of the wave.

（2024 夏季 0625/33 第6题(c)）

4. The frequency of a wave is doubled. The speed of the wave does **not** change.

What happens to the wavelength of the wave?

A It becomes four times as large.

B It does **not** change.

C It doubles.

D It halves.

（2025 春季 0625/22 第19题）

二. 统一单位后代入

知识点 波长 λ 是相邻两个同相位点间的距离，单位为米；频率 f 是每秒通过某点的完整波的个数，单位为赫兹；波的速率 v 的单位为米每秒。

单位统一时，波的速率、频率和波长满足 $v = f\lambda$，由此得 $\lambda = \frac{v}{f}$。

代入前应把长度统一为_____，把频率统一为_____；$1\ \text{cm} = 10^{-2}\ \text{m}$，$1\ \text{km} = 10^{3}\ \text{m}$，$1\ \text{MHz} = 10^{6}\ \text{Hz}$。

电磁波在真空中的速率为 $3.0 \times 10^{8}\ \text{m/s}$，在空气中的速率近似取此值。

答案：米；赫兹

怎么认 题目出现波的速率、频率、波长中两项并求第三项，且含非标准单位时，先统一为米、秒、赫兹。

例题 2 A student observes waves on the surface of water in a tank. The waves all have the same wavelength.

(b) The wavelength of the waves is 4.0 cm and their frequency is 6.0 Hz.

Calculate the wave speed.

（2023 夏季 0625/31 第6题(b)）

解： $\lambda = 4.0\ \text{cm} = 0.040\ \text{m}$。

由 $v = f\lambda$ 得

$v = 6.0 \times 0.040 = 0.24\ \text{m/s}$。

$0.24\ \text{m/s} = 24\ \text{cm/s}$。

答：波的速率为 $24\ \text{cm/s}$。

针对练习

5. A seismic wave has a frequency of 5.0 Hz and a speed of 10 km / s.

What is the wavelength of the wave?

A 0.20 km **B** 0.50 km **C** 2.0 km **D** 50 km

（2024 夏季 0625/23 第17题）

6. Two types of seismic waves are P-waves and S-waves.

(b) The velocity of a P-wave in the Earth's solid crust is 7.2 km / s and its frequency is 4.5 Hz.

Calculate the wavelength of this P-wave.

（2023 夏季 0625/42 第6题(b)）

7. The frequency of the microwaves used in a microwave oven is 2400 MHz.

What is the wavelength of these microwaves?

A 0.125 m **B** 8.00 m **C** 125 m **D** 7200 m

（2023 冬季 0625/22 第22题）

8. Radio waves are electromagnetic waves.

What is the wavelength of a radio wave of frequency 2.0×10^5 Hz?

A 0.00067 m **B** 0.0015 m **C** 670 m **D** 1500 m

（2024 冬季 0625/21 第22题）

三. 先求中间量再用 v=fλ

知识点 相邻两个波峰或相邻两个波谷之间的距离称为_____，符号为 λ，单位为 m。
单位时间内通过某点的完整波数称为_____，符号为 f，单位为 Hz。
波速 v 表示波传播的快慢，单位为 m/s，波速、频率和波长的关系为_____。
若距离 s 内有 N 个完整波，则 $\lambda = \frac{s}{N}$；若时间 t 内通过 N 个完整波，则 $f = \frac{N}{t}$。

答案：波长；频率；$v = f\lambda$

怎么认 题目出现波数、传播时间或传播路程时，先求频率、波长或波速，再用 $v = f\lambda$。

例题 3 The radius of a circular pond is 3.0 m.

Circular waves are made at the centre of the pond.

There are 10 whole waves between the centre and the edge of the pond and it takes 5.0 s for all 10 waves to reach the edge.

What is the wavelength and the frequency of the waves?

	wavelength / m	frequency / Hz
A	0.30	0.50
B	0.30	2.0
C	0.60	0.50
D	0.60	2.0

（2024 夏季 0625/12 第16题）

解： 池心到池边的距离为 3.0 m，其中有 10 个完整波，故
$\lambda = \frac{3.0\ \text{m}}{10} = 0.30\ \text{m}$
波传播 3.0 m 所用时间为 5.0 s，故
$v = \frac{s}{t} = \frac{3.0\ \text{m}}{5.0\ \text{s}} = 0.60\ \text{m/s}$
由 $v = f\lambda$ 得
$f = \frac{v}{\lambda} = \frac{0.60\ \text{m/s}}{0.30\ \text{m}} = 2.0\ \text{Hz}$
故选 B。

针对练习

9. **(b)** A solar cell is one way of using the solar energy resource.

Solar cells use visible light from the Sun to generate electrical power.

(i) State the property that allows visible light to travel through space from the Sun to a solar cell.

(ii) A frequency of visible light for a solar cell is 6.0×10^{14} Hz.

The speed of visible light is 3.0×10^{8} m/s.

Calculate the wavelength of this visible light.

（2025 冬季 0625/33 第5题(b)）

10. A student writes down some facts about two transverse waves.

Wave 1 has a frequency f and a velocity v.

Wave 2 has four times the frequency of wave 1 and is travelling at a velocity of $2v$.

What is the wavelength of wave 2 in terms of f and v?

A $\frac{2f}{v}$ **B** $8fv$ **C** $\frac{2v}{f}$ **D** $\frac{v}{2f}$

（2023 冬季 0625/22 第17题）

11. **(b)** A foghorn emits a sound with frequency 380 Hz. The sound is heard by a ship 2.5 km away from the foghorn. The speed of sound in air is 330 m/s.

(i) Show that the wavelength of the sound is approximately 0.9 m.
State any equation you use in words or symbols.

(ii) Calculate the time it takes for sound to travel to the ship from the foghorn.

（2025 春季 0625/42 第7题(b)）

题型 4：判断反射折射衍射（考频★★★★☆）

知识点 波遇到边界后返回原介质的现象称为_____；波跨过两种介质的界面，因传播速率改变而转向的现象称为_____。

波通过窄缝或绕过障碍物边缘后扩散的现象称为_____；波长与缝宽越接近，扩散越明显。

答案：反射；折射；衍射

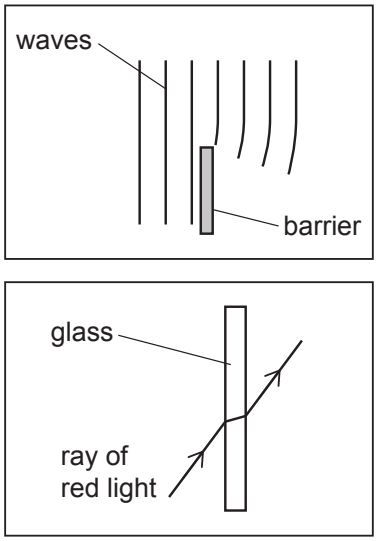
怎么认 题目出现波阵面、障碍物、窄缝或介质界面时，先看传播路径属于折回、跨界转向还是扩散。

一. 按传播路径认现象

例题 1

(a) In Fig. 8.1, each diagram illustrates a wave property.

Draw a line from each diagram to the correct wave property.



reflection

diffraction

dispersion

refraction

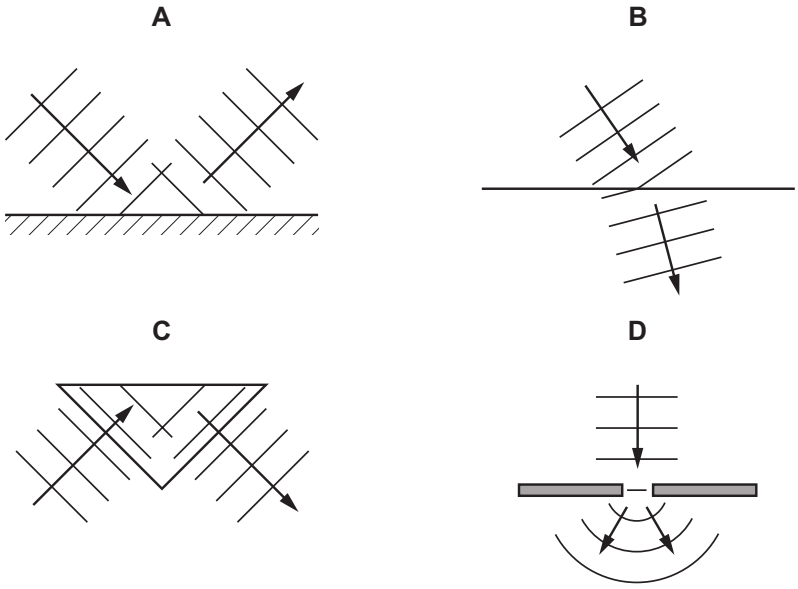
Fig. 8.1

（2023 冬季 0625/32 第8题(a)）

解：上图中，直波阵面绕过障碍物边缘后向其后方扩散，故为衍射。
下图中，红光穿过空气与玻璃的界面时传播方向改变，故为折射。
答：上图连衍射，下图连折射。

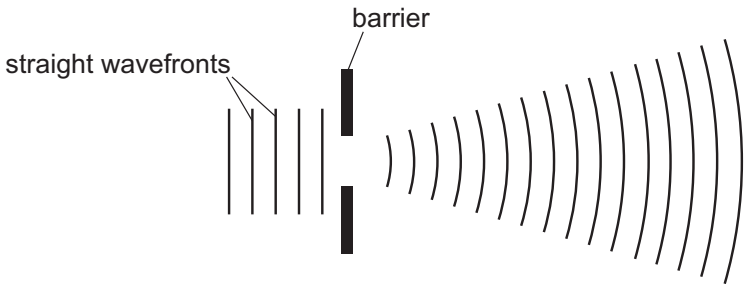
针对练习

1. Which diagram shows waves diffracting?



（2024 夏季 0625/11 第18题）

2. Straight wavefronts on the surface of a ripple tank approach a gap in a barrier. The diagram shows how the wavefronts change shape as they pass through the gap.



What is the name of this effect?

A diffraction

B propagation

C reflection

D refraction

（2023 冬季 0625/12 第18题）

3. **(b)** A teacher uses a ripple tank to demonstrate a wave property. Fig. 6.1 shows the ripple tank viewed from above. The crests of the wave are travelling from left to right.

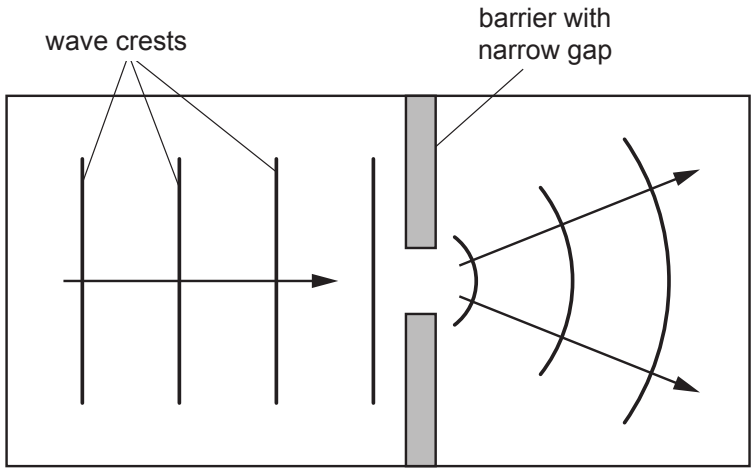


Fig. 6.1

(i) Complete the sentence about the wave property demonstrated in Fig. 6.1.

Choose **one** word from the list.

diffraction **dispersion** **reflection** **refraction**

(ii) On Fig. 6.1, indicate **one** wavelength. Label your answer with the letter ‘w’.

（2024 夏季 0625/33 第6题(b)）

4. **(a)** A student demonstrates three different processes that change the direction of water waves in a ripple tank.
Fig. 7.1, Fig. 7.2 and Fig. 7.3 illustrate the three processes.

(i)

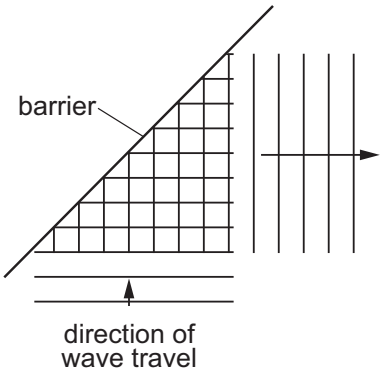


Fig. 7.1

State the name of the process shown in Fig. 7.1.

(ii)

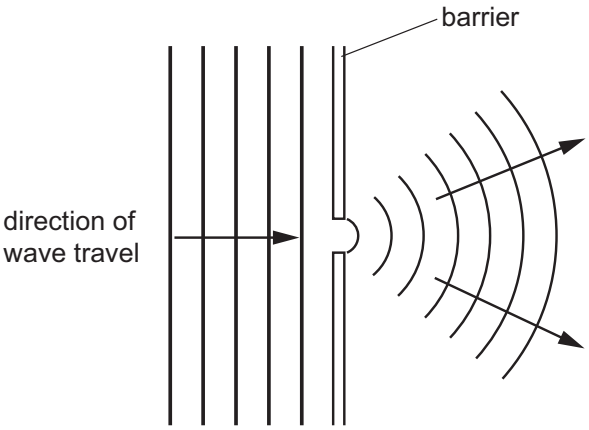


Fig. 7.2

State the name of the process shown in Fig. 7.2.

(iii)

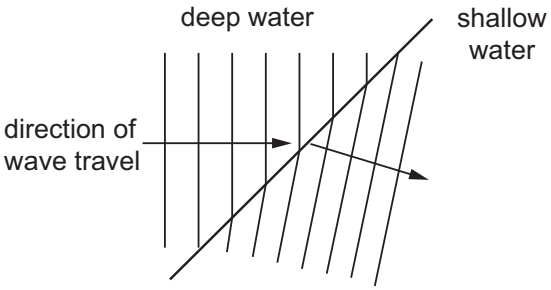


Fig. 7.3

State the name of the process shown in Fig. 7.3.

(iv) Give a reason why the waves in Fig. 7.3 change direction as they move from deep water to shallow water.

（2024 冬季 0625/31 第7题(a)）

二. 按速率变化画折射

知识点 垂直于边界的直线称为法线；水波斜着跨越传播速率不同的区域时，传播方向改变，这种现象称为_____。

水波由深水进入浅水时速率_____，传播方向向法线偏折；由浅水进入深水时，传播方向偏离法线。

跨越边界时频率_____，由 $v = f\lambda$ 可知波长与速率同向变化；v 的单位为 $\mathrm{m/s}$，f 的单位为 Hz，λ 的单位为 m。

直波的传播方向与波面垂直，相邻波面的垂直间距等于波长；画折射波面时，各波面应在边界处相接并保持互相平行。

答案：折射；减小；不变

怎么认 题目出现波跨越区域边界并给出速率变化时，先由频率不变判断波长，再画偏折方向和波面间距。

例题 2 A student observes waves on the surface of water in a tank. The waves all have the same wavelength.

(c) Fig. 6.1 shows water waves in the tank travelling from deep water to shallow water.

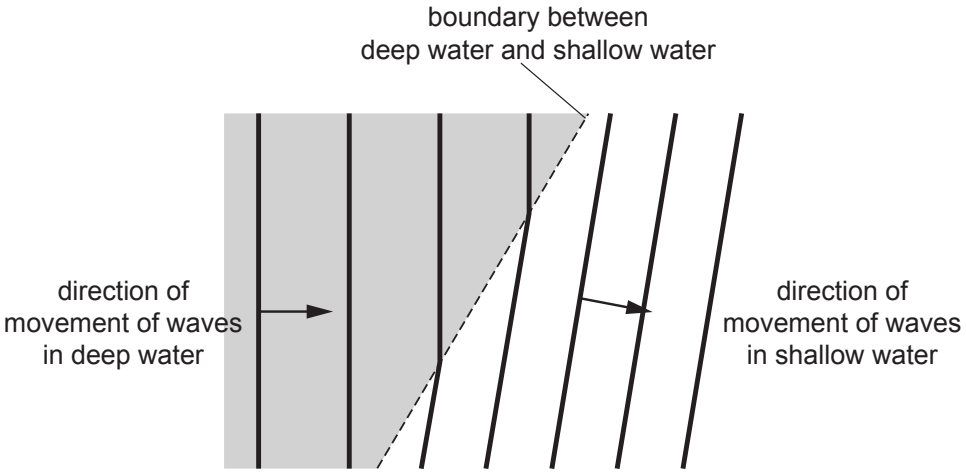


Fig. 6.1

State and explain what happens to the waves as they move from deep water to shallow water.

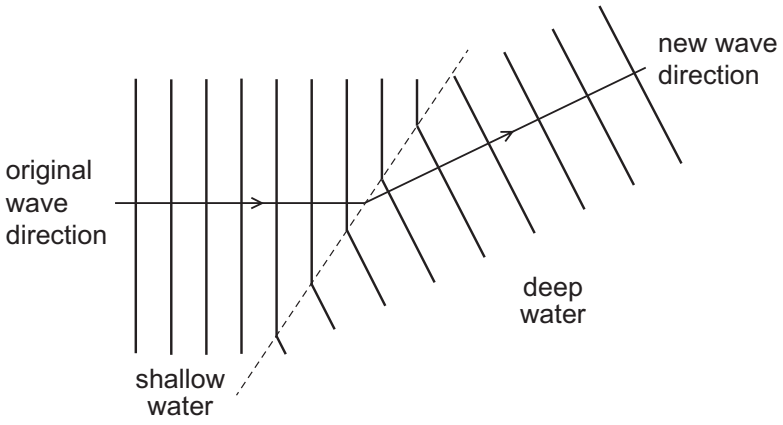
（2023 夏季 0625/31 第6题(c)）

解：水波由深水进入浅水，传播速率减小，传播方向改变，这种现象称为折射。

水波在边界处因传播速率改变而向法线偏折。

答：水波发生折射，原因是水波进入浅水后传播速率改变。

5. Water waves change direction when they move from shallow water to deep water.



What is the name of this effect?

A diffraction

B dispersion

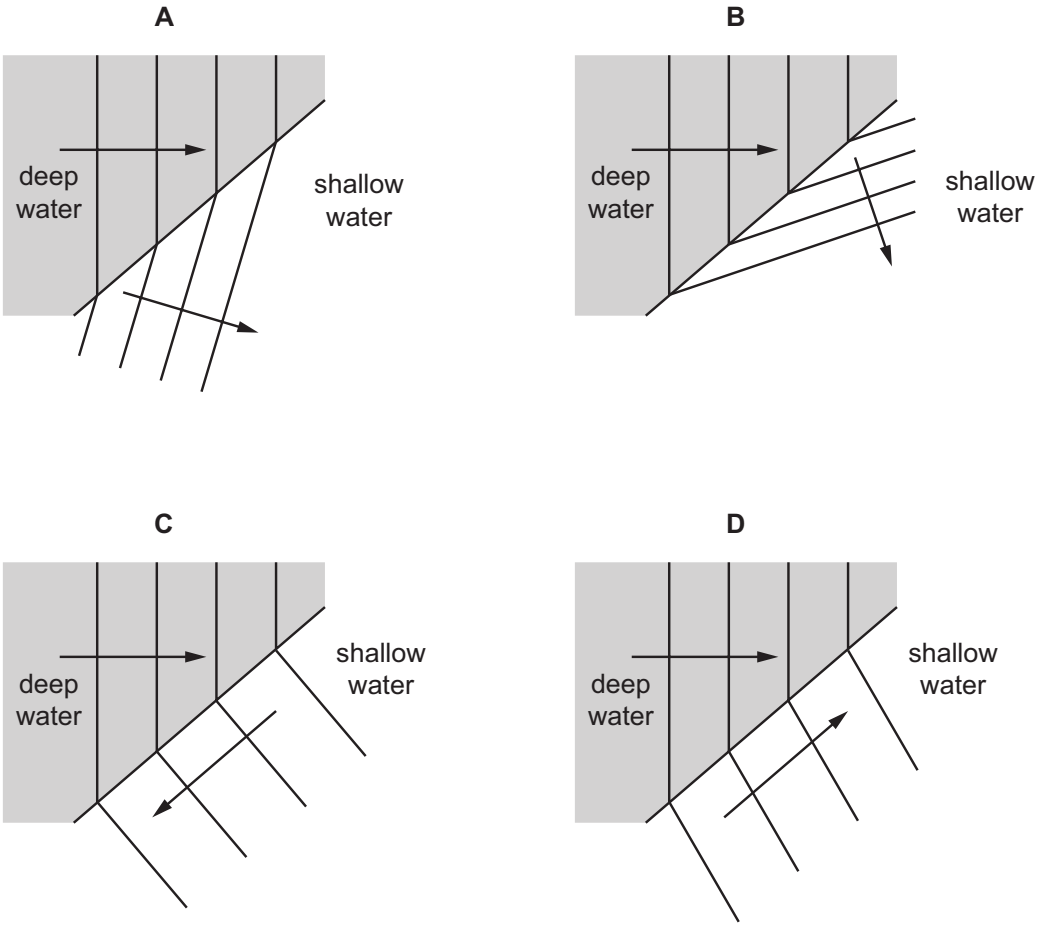
C reflection

D refraction

（2024 冬季 0625/11 第18题）

6. Waves on the surface of water travel from deep water to shallow water.

Which diagram shows the correct path of the waves in the shallow water?



（2024 夏季 0625/13 第17题）

7. **(a)** Fig. 6.1 shows successive crests of a water wave approaching a boundary.

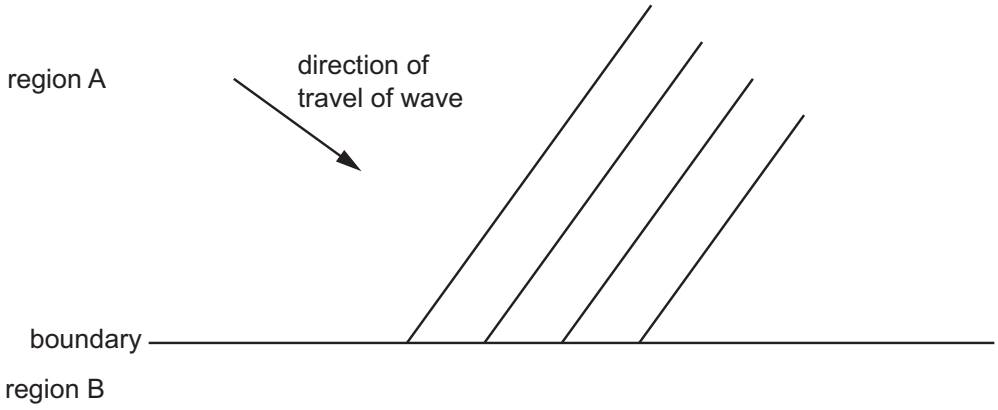


Fig. 6.1

(i) The speed of the waves in region B is lower than the speed of the waves in region A.

On Fig. 6.1, draw the crests of the waves in region B.

(ii) State the wave effect that occurs as the wave crosses the boundary between region A and region B.

（2025 冬季 0625/42 第6题(a)）

8. A teacher uses a ripple tank to demonstrate the properties of waves.

(b) The teacher demonstrates waves moving from deep water into shallow water.
Fig. 6.1 shows the crests of the waves, viewed from above. The arrows show the direction of wave travel.

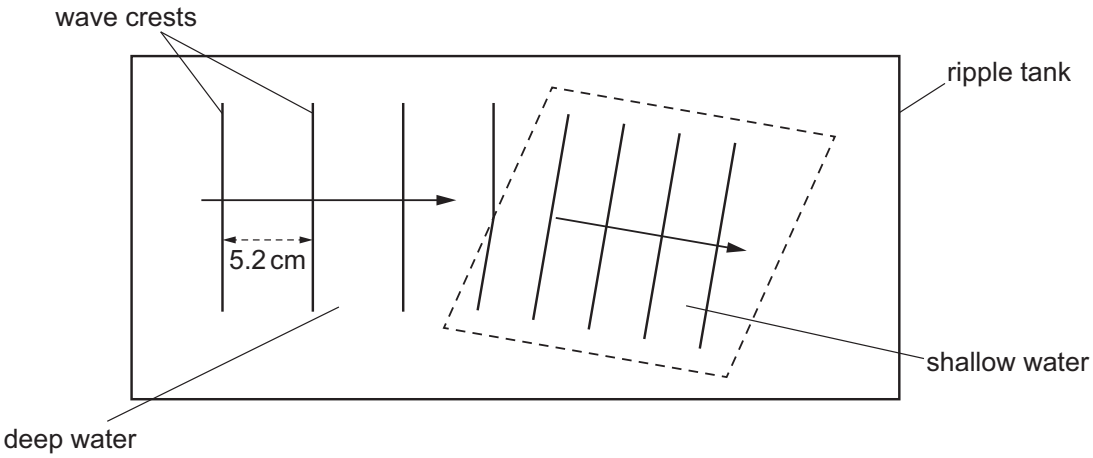


Fig. 6.1

(i) Complete the sentence about the wave property shown in Fig. 6.1.

(ii) Fig. 6.1 shows that the direction of the wave changes as the wave enters the shallow water.
State why the wave changes direction.

(iii) The speed of the wave in the deep water is 35 cm / s.
Determine the frequency of the wave. Use the information in Fig. 6.1.

（2024 冬季 0625/33 第6题(b)）

三. 比较波长缝宽判衍射

知识点 波绕过障碍物边缘或通过狭缝后向阴影区域扩展的现象称为_____。
衍射强弱取决于波长与狭缝宽度的相对大小：两者越接近，或波长相对越_____，衍射越明显；遇到尖锐边缘时，波长较长的波弯曲更明显。
波速、频率和波长满足 $v = f\lambda$；同一介质中波速不变时，频率减小，波长增大。波长和狭缝宽度的单位均为 m。

答案：衍射；大

怎么认 题目出现波通过狭缝、绕过边缘或比较弯曲程度时，先比较波长与缝宽；遇到边缘则比较波长。

例题 3 A narrow beam of light consists of two waves of different wavelengths.

The beam of light hits a sharp edge.

Which effect will be seen beyond the sharp edge?

A Both waves continue along the same straight line as before.

B Both waves bend sharply and continue along a new straight line.

C The wave of longer wavelength bends round the sharp edge more than the wave of shorter wavelength.

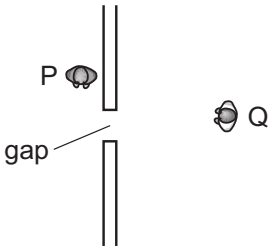
D The wave of shorter wavelength bends round the sharp edge more than the wave of longer wavelength.

（2025 夏季 0625/23 第18题）

解：光波遇到尖锐边缘会发生衍射。
波长越长，绕过边缘的衍射越明显。
故选 C。

针对练习

9. Two men, P and Q, stand close to a gap in a wall, as shown. Man P cannot see man Q but man P can hear man Q speaking.



Which statement explains this?

A Light waves do not diffract at all because they are electromagnetic waves.

B Light waves have a range of frequencies but sound has just one frequency.

C Sound waves are of a higher frequency than light waves.

D Sound waves diffract a lot because their wavelength is a similar size to the width of the gap.

（2023 冬季 0625/21 第17题）

10. Waves in a ripple tank are diffracted as they pass through a narrow gap.

What can be done to make the spreading due to diffraction greater?

A Decrease the frequency of the waves and keep the speed constant.

B Decrease the speed of the waves and keep the frequency constant.

C Increase the frequency of the waves and keep the speed constant.

D Increase the frequency of the waves and decrease the speed.

（2024 夏季 0625/22 第18题）

11. **(a)** Fig. 7.1 is a scale drawing of light waves approaching a narrow slit.

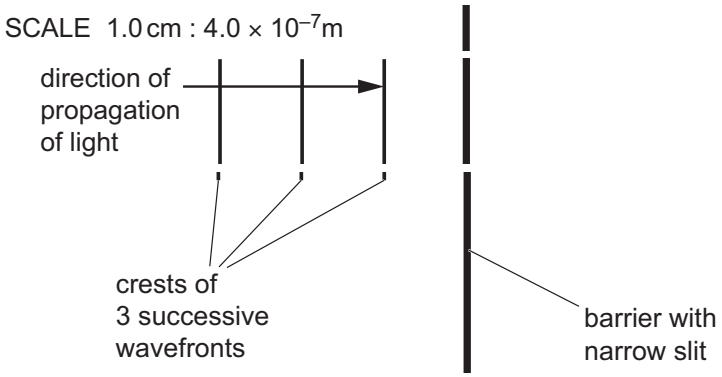


Fig. 7.1

(i) Name the wave effect produced by the narrow slit.

(ii) Using Fig. 7.1, determine the wavelength of the light. Give your answer to **two** significant figures.

(iii) On Fig. 7.1, draw **three** wavefronts that have passed through the narrow slit.

（2025 春季 0625/42 第7题(a)）

四. 以缝口为中心补波面

知识点 波通过缝口后向两侧扩展，或绕过障碍物的现象叫作_____。

缝宽与波长相近或更小时，衍射较明显；窄缝后的波面近似为以缝口中点为圆心的_____。

缝宽远大于波长时，衍射较弱，波面中央近似平直，两端弯曲。

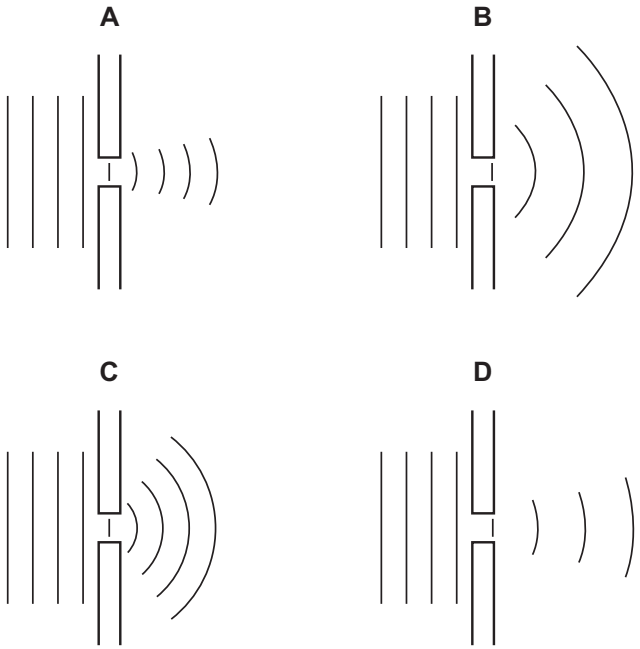
相邻波面的间距等于波长 λ；在同一介质中传播时，波长_____，单位为 m。

答案：衍射；半圆形波面；不变

怎么认 题目出现平行波面通过窄缝并要求补画缝后波面时，先保持间距不变，再以缝口中点为圆心画等距半圆弧。

例题 4 Plane water waves approach a narrow gap in a barrier.

Which diagram shows the diffraction pattern that would occur?



（2024 冬季 0625/21 第19题）

解：水波通过窄缝后发生明显衍射，缝后的波面应以缝口中点为圆心向外扩展。

同一介质中波长不变，故相邻弧形波面的间距应与缝前相同。

图 C 同时满足半圆形波面和等间距，故选 C。

12. **(a)** Fig. 5.1 is a scale diagram of wavefronts of red light approaching a gap in a barrier.

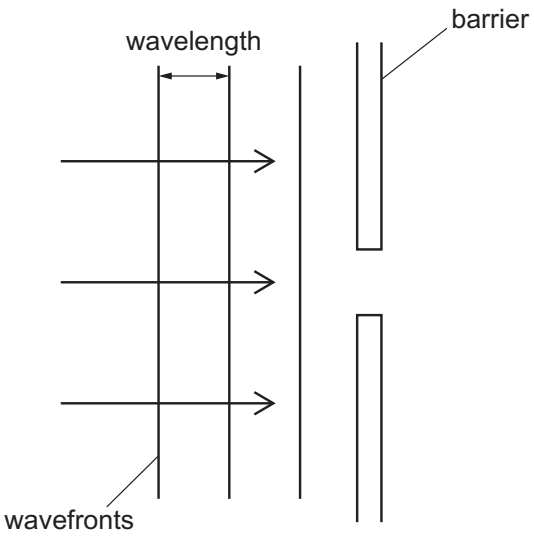


Fig. 5.1

On Fig. 5.1, draw **three** wavefronts after the wave has passed through the gap.

（2023 冬季 0625/43 第5题(a)）

13. **(b)** Fig. 7.1 represents a ripple tank showing diffraction. The ripple tank is viewed from above. The wavefronts move from left to right until they reach a barrier. They are diffracted at a gap in the barrier.

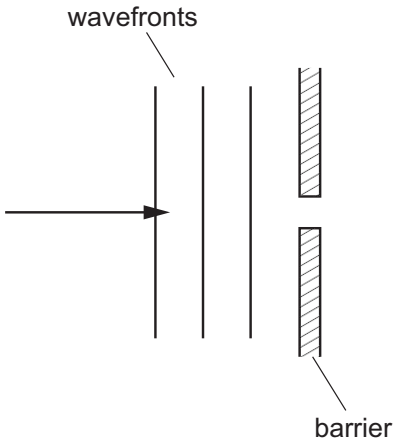


Fig. 7.1

On Fig. 7.1:

(i) draw **three** wavefronts to the right of the barrier

(ii) indicate and label **one** wavelength.

（2024 冬季 0625/32 第7题(b)）

14. **(b)** Fig. 5.1 shows successive crests of a wave after a plane wave has passed through a gap.

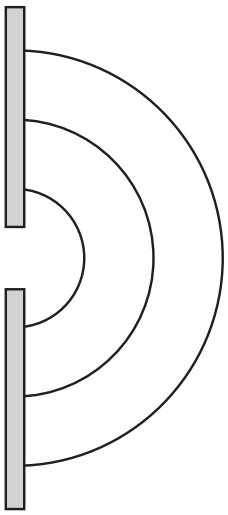


Fig. 5.1

(i) On Fig. 5.1 draw **three** successive crests before the wave reaches the gap.

(ii) Fig. 5.2 shows a much wider gap. A plane wave of the same wavelength as in **(b)(i)** is incident on the gap from the left side of the barrier.



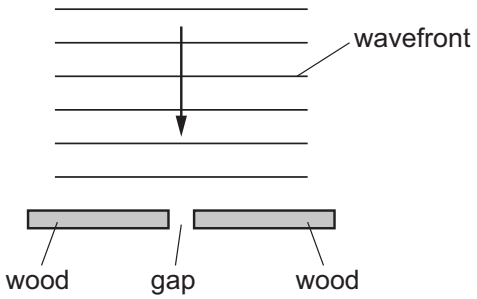
Fig. 5.2

On Fig. 5.2, draw **three** successive crests of the wave after the wave has passed thro the gap.

（2024 春季 0625/42 第5題(b)）

15. A student observes waves travelling across the surface of water. The diagram shows two pieces of wood resting in shallow water of constant depth.

Straight parallel wavefronts approach the pieces of wood, as shown.



The gap between the pieces of wood is 2.0 cm wide.

The wavefronts are 3.0 cm apart.

What is the appearance of the wavefronts after they pass through the gap?

A semicircular and 2.0 cm apart

B semicircular and 3.0 cm apart

C straight and 2.0 cm apart

D straight and 3.0 cm apart

（2025 冬季 0625/13 第18题）

3.2.1 光的反射

题型 1：找法线并用反射定律（考频★★★★☆）

知识点 入射点处与镜面垂直的直线称为_____。

射向镜面的光线为入射线，离开镜面的光线为反射线，按箭头方向区分。

入射角 i 是入射线与法线的夹角，反射角 r 是反射线与法线的夹角，单位为度。

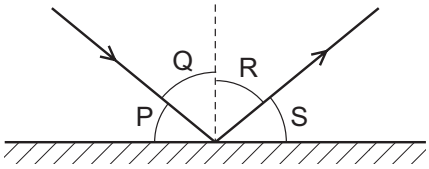
光在平面镜上发生反射时，i 与 r _____，即 $i = r$。

答案：法线；相等

怎么认 题目出现平面镜、法线和带箭头的光线并要求认角时，先从法线量角，再按箭头辨认入射线与反射线。

一. 从法线认角和光线

例题 1 A ray of light is reflected by a plane mirror.



Which row shows the angle of incidence and the angle of reflection?

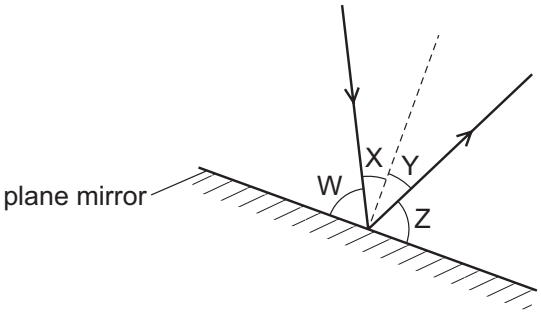
	angle of incidence	angle of reflection
A	P	Q
B	P	S
C	Q	R
D	R	S

（2023 冬季 0625/21 第20题）

解：虚线过入射点并垂直于镜面，是法线。
由箭头方向，左侧光线射向镜面，入射角为 Q；右侧光线离开镜面，反射角为 R。
故选 C。

针对练习

1. The diagram shows a ray of light being reflected from a plane mirror.

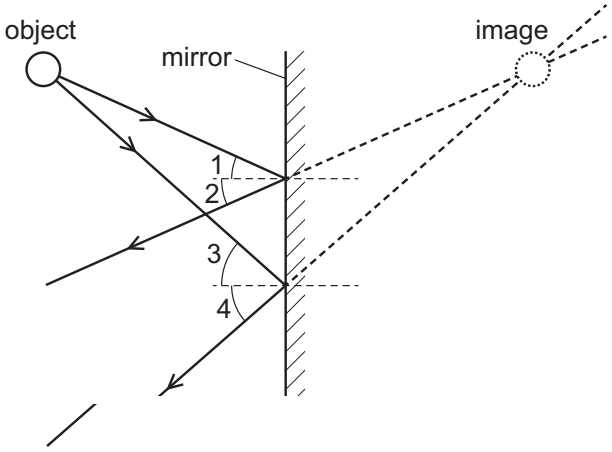


Which row identifies the angles of incidence and reflection?

	angle of incidence	angle of reflection
A	W	Y
B	W	Z
C	X	Y
D	X	Z

（2023 春季 0625/12 第19题）

2. The diagram shows a scale drawing of the formation of an image by the reflection of light from a plane mirror.



What are the relationships between the labelled angles?

A angle 1 = angle 2, and angle 3 = angle 4

B angle 1 = angle 3, and angle 2 = angle 4

C angle 1 = angle 4, and angle 3 = angle 2

D angle 1 = angle 2 = angle 3 = angle 4

（2025 冬季 0625/23 第19题）

3. A student reads the following relationship in his physics book.

$$i = r$$

What is the student reading about?

A diffraction due to a gap

B dispersion of light by a prism

C reflection in a plane mirror

D refraction as light enters glass

（2024 夏季 0625/13 第19题）

4. **(a)** Fig. 7.1 shows a ray of light striking a plane mirror. The ray is reflected as shown.

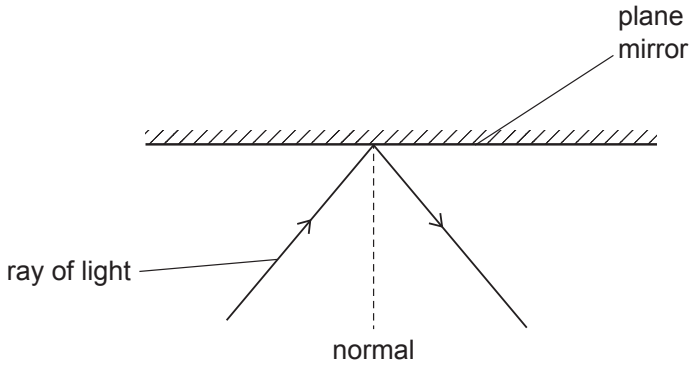


Fig. 7.1

The angle of incidence for the ray of light is 40°.

(i) Indicate the angle of reflection by drawing a letter R on Fig. 7.1.

(ii) State the size of the angle of reflection in Fig. 7.1.

（2024 夏季 0625/31 第7题(a)）

二. 把镜面角换成法线角

知识点 入射点处与镜面垂直的直线称为法线。

入射角和反射角分别是入射光线、反射光线与_____的夹角，角度单位为度。

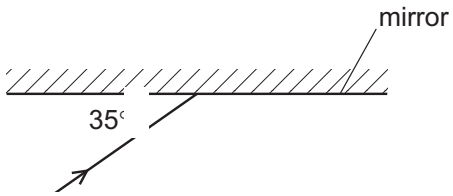
光在平面镜上发生反射时，入射角_____反射角，即 $i = r$。

若光线与镜面的夹角为 θ，则 $i =$ _____ $- \theta$；入射光线与反射光线的夹角为 $2i$。

答案：法线；等于；90°

怎么认 题目出现光线与镜面的夹角或两条光线的夹角时，先换算成光线与法线的夹角。

例题 2 The diagram shows a ray of light incident on a plane mirror.



The angle between the ray and the mirror is 35°.

The ray is reflected by the mirror.

What is the angle of reflection?

A 35° **B** 55° **C** 70° **D** 110°

（2023 冬季 0625/13 第20题）

解：法线与镜面垂直，入射角为

$i = 90° - 35° = 55°$。

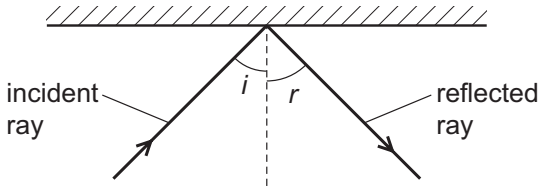
由反射定律得

$r = i = 55°$。

故选 B。

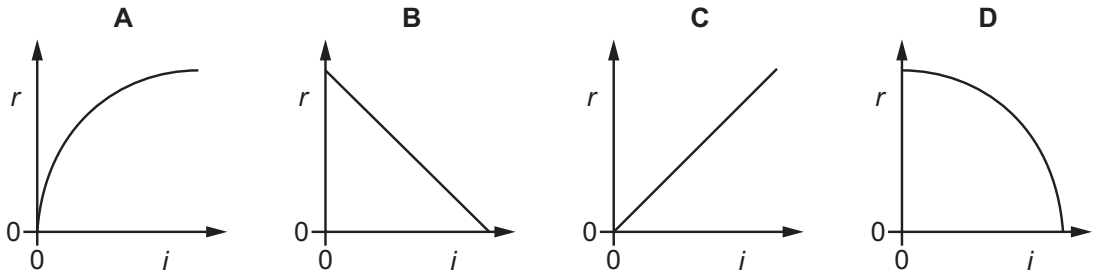
针对练习

5. A ray of light is incident on a plane mirror. A student measures the angle of incidence *i* and the angle of reflection *r*.



The student varies the angle of incidence and then plots a graph of *r* against *i*.

What does the graph look like?



（2025 冬季 0625/13 第20题）

6. Light reflects from a plane mirror.

The angle between the incident ray and the reflected ray is 68°.

What is the angle of incidence?

A 11° **B** 22° **C** 34° **D** 56°

（2025 冬季 0625/12 第20题）

7. The angle of incidence of a ray of light incident on a plane mirror is gradually increased.

To the nearest degree, what is the maximum possible angle between the incident and reflected rays?

A 0° **B** 45° **C** 90° **D** 180°

（2024 夏季 0625/21 第17题）

三. 按等角关系画反射线

知识点 法线是在入射点处与镜面_____的直线；入射光线与法线的夹角叫入射角 i，反射光线与法线的夹角叫反射角 r。

光在平面镜上发生反射时，入射光线和反射光线分居法线两侧，且 $i = r$；角的单位为_____。

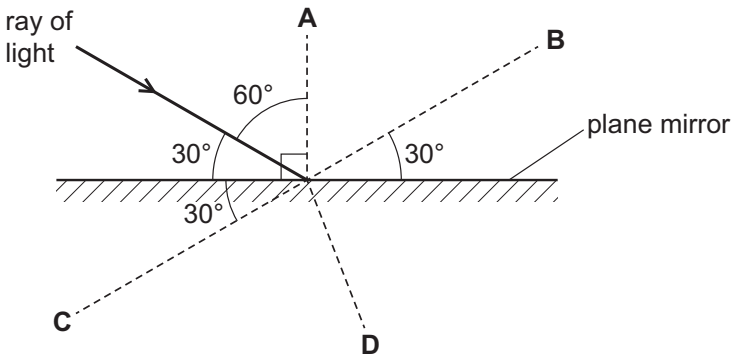
作反射光线时，先过入射点作法线，再在法线另一侧量出与入射角相等的反射角。

答案：垂直；度

怎么认 题目出现平面镜、入射光线并要求确定反射线时，先过入射点作法线。

例题 3 A ray of light is incident on the surface of a plane mirror, as shown.

In which position is the reflected ray?



（2025 春季 0625/12 第22题）

解： 过入射点作镜面的法线，入射角是入射光线与法线的夹角。

$i = 90° - 30° = 60°$

由反射定律得

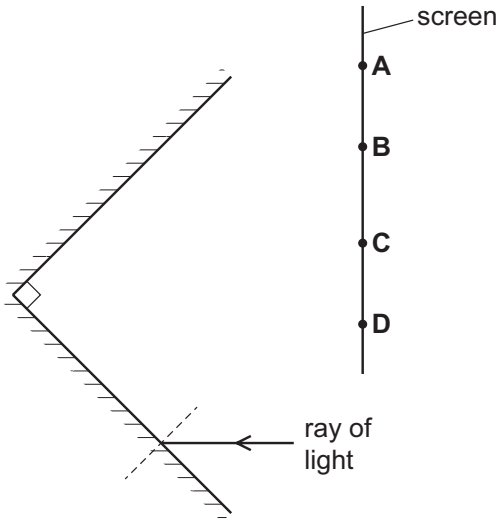
$r = i = 60°$

反射光线位于法线右侧，与镜面成 30°，对应位置 B。故选 B。

针对练习

8. The diagram shows two plane mirrors at 90° to each other. A ray of light is incident on one of the mirrors. The ray reflects off both mirrors before reaching a screen.

At which labelled point does the ray reach the screen?



（2025 夏季 0625/21 第19题）

9. A student investigates reflections in a plane mirror.

A ray-trace sheet is shown in Fig. 3.1.

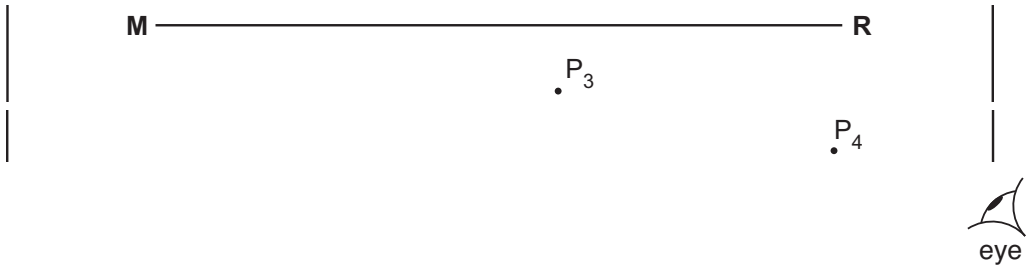


Fig. 3.1

(d) The student turns the mirror through 180°. He draws a new incident ray at an angle of incidence i = 50° to the normal above **MR** and to the left of the normal.

He labels the end of this line **C**. This line is **not** shown on Fig. 3.1. You may draw the line on Fig. 3.1.

He places two pins on the line **CB** and views the images of the two pins from near the top right-hand corner of the ray-trace sheet.

On Fig. 3.1, draw a reflected ray 10.0 cm long from **B** with an angle of reflection β equal to the angle of incidence. Label the end of the line **D**.

（2025 夏季 0625/61 第3題(d)）

10. A student investigates reflections in a plane mirror.

A ray-trace sheet is shown in Fig. 3.1.

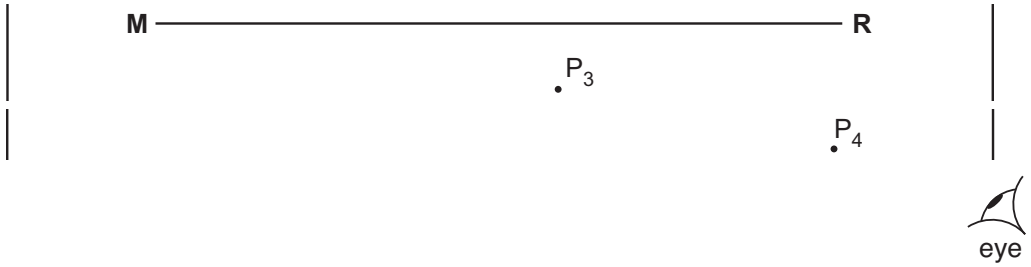


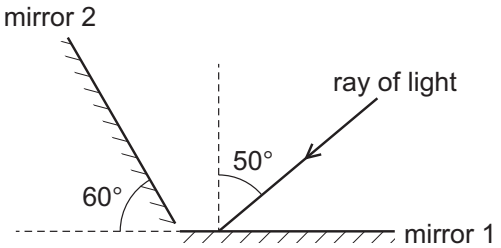
Fig. 3.1

(a)
- Draw a normal to the line **MR** that passes through the centre of **MR**. Label the normal **NL**.
- Label the point at which **NL** crosses **MR** with the letter **B**.
- Draw a line 10.0 cm long from **B** at an angle of incidence i = 40° to the normal below **MR** and to the left of the normal. Label the end of this line **A**.

（2025 夏季 0625/61 第3題(a)）

11. A single ray of light is reflected by two mirrors.

The diagram shows the ray of light incident on mirror 1.



What is the angle of reflection in mirror 2?

A 50° **B** 60° **C** 70° **D** 80°

（2024 冬季 0625/23 第20题）

题型 2：用对称关系判断镜像（考频★★★★☆）

知识点 平面镜所成的像是正立的_____像，不能用光屏承接。

像与物大小_____，且像到镜面的距离等于物到镜面的距离；像与物关于镜面对称。

答案：虚；相等

怎么认 题目出现平面镜成像的类型、大小或物像距离时，先写出平面镜成像的四个特征。

一. 说出平面镜像特征

例题 1 Which row describes some characteristics of an image formed in a plane mirror?

	image type	image size
A	real	diminished
B	real	same size as the object
C	virtual	diminished
D	virtual	same size as the object

（2024 春季 0625/22 第17题）

解： 平面镜所成的像不能用光屏承接，故为虚像。

平面镜所成的像与物体等大。

故选 D。

针对练习

1. Which row describes the image viewed in a plane mirror?

	type of image	image size
A	real	enlarged
B	real	same size
C	virtual	enlarged
D	virtual	same size

（2025 春季 0625/12 第25题）

2. **(a)** A student places a book in front of a plane mirror.

State **three** characteristics of the image of the book formed by the plane mirror.

（2023 春季 0625/32 第7题(a)）

3. The image of an object is formed by a plane mirror.

Which row gives the correct properties of the image?

	real or virtual	distance of the image from the mirror
A	real	closer to the mirror than the object
B	real	the same distance from the mirror as the object
C	virtual	closer to the mirror than the object
D	virtual	the same distance from the mirror as the object

（2025 夏季 0625/22 第20题）

4. The optical image formed by a plane mirror is the same size as the object.

Which row describes the other characteristics of the optical image formed?

	distance from the mirror	real or virtual
A	same as object	virtual
B	smaller than object	virtual
C	larger than object	real
D	same as object	real

（2023 夏季 0625/13 第18题）

二. 按等距对称定位像

知识点 平面镜所成的像是_____像，像与物体大小相同，物、像关于镜面对称。

像到镜面的垂直距离 d_i 与物体到镜面的垂直距离 d_o _____：$d_i = d_o$。

物和像的间距为 $d_o + d_i = 2d_o$；距离和速率分别用题目规定的长度单位和速率单位。

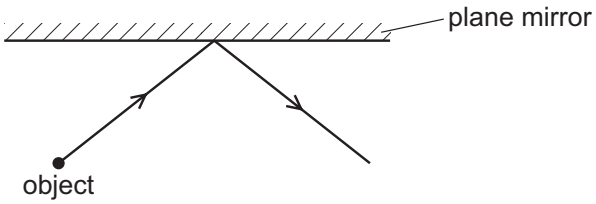
物体不动而镜面沿法线移动距离 x 时，像相对物体移动 _____；镜面静止时，物体与像沿法线运动的速率相同。

答案：虚；相等；$2x$

怎么认 题目出现平面镜、物距、物像间距或镜面移动时，先沿镜面法线把物体关于镜面对称。

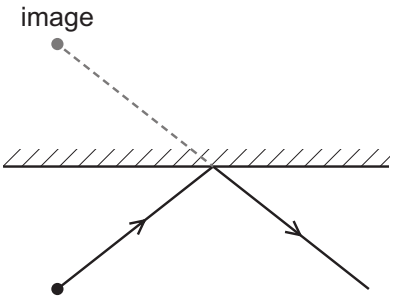
例题 2 An object is placed in front of a plane mirror.

The ray diagram shows the reflection of one ray of light from the object by the mirror.

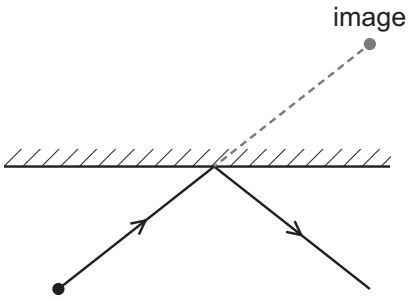


Where does the mirror form an image of the object?

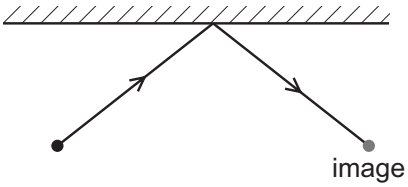
A



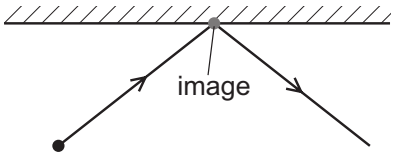
B



C



D



（2024 春季 0625/22 第19题）

解： 设物体和像到镜面的垂直距离分别为 d_o 和 d_i。

由平面镜成像关系得

$d_i = d_o$

故像位于镜后物体关于镜面的对称点，并在反射光线的反向延长线上，图 A 符合。

故选 A。

针对练习

5. An object is placed 30 cm in front of a plane mirror.

Which statement describes the image of the object?

A The image is the same size as the object and 30 cm from the object.

B The image is the same size as the object and 60 cm from the object.

C The image is smaller than the object and 30 cm from the object.

D The image is smaller than the object and 60 cm from the object.

（2025 夏季 0625/23 第19题）

6. A water droplet is falling towards a horizontal plane mirror.

At one moment, the droplet is a distance of 1.5 m above the mirror and falling at a speed of 2.0 m/s.

What is the distance between the droplet and its image and what is the speed of the image at this moment?

	distance between water droplet and its image / m	speed of image / m/s
A	1.5	2.0
B	1.5	4.0
C	3.0	2.0
D	3.0	4.0

（2025 冬季 0625/22 第19题）

7. A person stands 1.0 m in front of a plane mirror. The mirror is moved away from the person at a speed of 1.0 m/s.

Which statement is correct?

A The image moves away from the person at a speed of 1.0 m/s.

B The image moves away from the person at a speed of 2.0 m/s.

C The image moves towards the person at a speed of 1.0 m/s.

D The image moves towards the person at a speed of 2.0 m/s.

（2025 冬季 0625/11 第19题）

三. 左右翻转还原镜像

知识点 平面镜所成的像与物体大小_____，像到镜面的垂直距离等于物体到镜面的垂直距离，所成的像为_____像。

像与物关于镜面对称；镜面竖直时，图形作_____翻转，左右方向互换，上下方向不变。

物距和像距均指到镜面的垂直距离，应用同一种长度单位表示。

答案：相同；虚；左右

怎么认 题目出现竖直平面镜、字母、图形或钟面镜像时，先作左右翻转，并保持上下方向不变。

例题 3

Diagram 1 shows the page of a book in front of a plane mirror.

An eye is looking at the image of the page.

Diagram 2 shows a large letter G on the page facing the mirror.

diagram 1

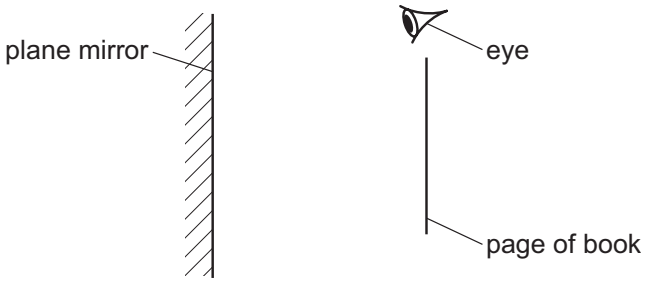


diagram 2



What is the appearance of the image of G seen by the eye?

A



B



C



D



（2024 夏季 0625/22 第19题）

解：竖直平面镜成像时，字母关于镜面左右翻转，上下方向不变。
原字母 G 的开口和内侧横线经左右翻转后与 D 图相符。
故选 D。

针对练习

8. A boy is having his eyes tested. A letter is printed on a card placed over his head. He sees the card in a plane mirror placed in front of him.

He sees the letter ‘R’ in the mirror.

How is it printed on the card?

A



B



C

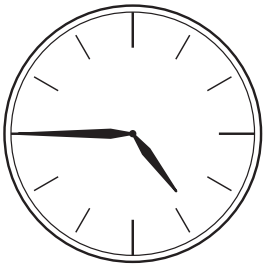


D



（2024 夏季 0625/23 第19题）

9. The diagram shows the image of a clock as seen by a person standing in front of a plane mirror.

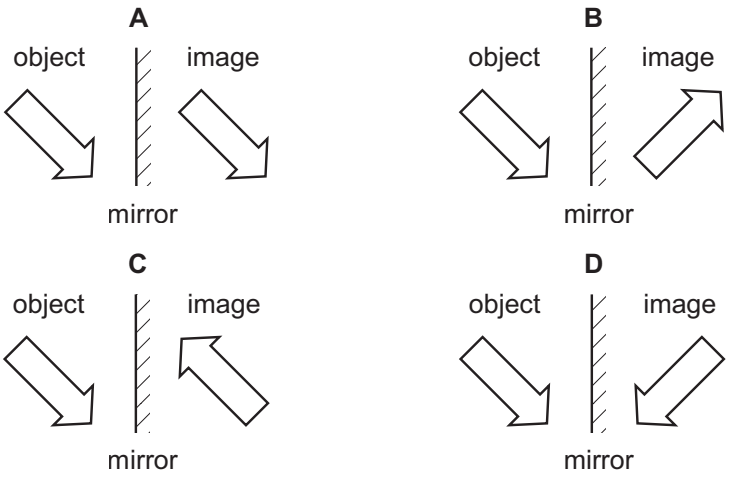


What is the actual time?

A 4:15 **B** 4:45 **C** 7:15 **D** 7:45

（2025 夏季 0625/11 第21题）

10. Which diagram shows the image correctly formed by reflection?



（2023 冬季 0625/12 第20题）

四. 由观察位置画实际光路

知识点 平面镜成像时，像与物关于镜面对称，像与物大小_____，到镜面的垂直距离_____，所成的像是虚像。

由观察位置确定光路时，先根据对称关系在镜后确定虚像，再连接眼睛与虚像；该直线与镜面的交点是反射点。

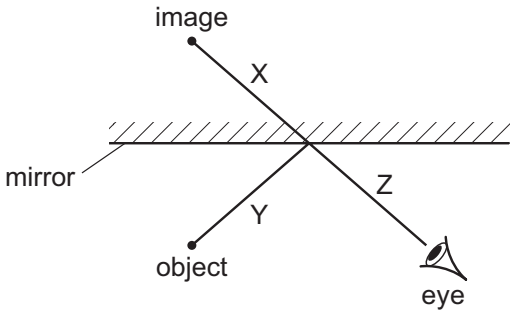
物体到反射点、反射点到眼睛的两段是_____，镜后的连线不是实际光线。

入射角 θ_i 和反射角 θ_r 均从法线量起，反射时 $\theta_i = \theta_r$，角度单位为 °。

答案：相同；相等；实际光线

怎么认 题目出现平面镜、物体、眼睛并要求画实际光路时，先作物体关于镜面的对称像，再连接眼睛与像。

例题 4 The ray diagram shows the formation of an image when light is reflected by a plane mirror.



Which lines represent light rays?

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

（2024 冬季 0625/11 第19题）

解： 平面镜后的像是物体关于镜面的对称点，眼睛接收到的反射光线反向延长后通过像。
Y 是物体射向镜面的入射光线，Z 是镜面射向眼睛的反射光线。
X 位于镜后，是反射光线的反向延长线，不是实际光线。
故选 D。

针对练习

11. A student plays the violin near the doorway to a large room. Fig. 6.1 shows a young teacher standing where he can hear the sound but cannot see the student.

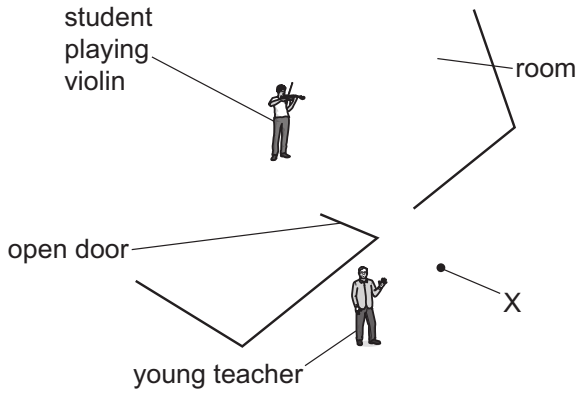


Fig. 6.1

(b) A plane mirror is placed at point X so that the teacher can see the student.
On Fig. 6.1:

- draw a light ray from the violin to point X and from point X to the teacher
- draw and label the mirror
- add an arrow to the ray to show how the teacher sees the student.

Use a ruler and sharp pencil for this drawing.

（2024 冬季 0625/42 第6题(b)）

12. Fig. 5.1 shows a road junction, a moving car and a stationary truck. The road has high walls on each side.

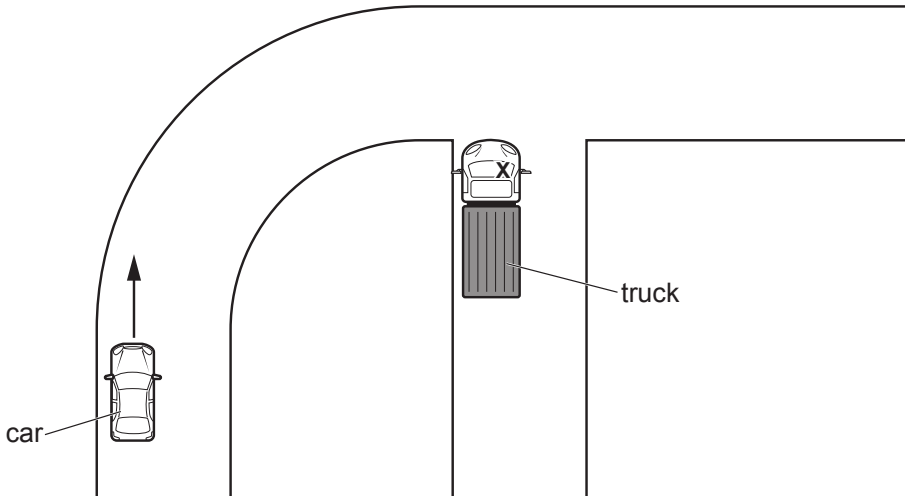


Fig. 5.1

(b) A plane mirror is placed at the road junction as shown in Fig. 5.2.

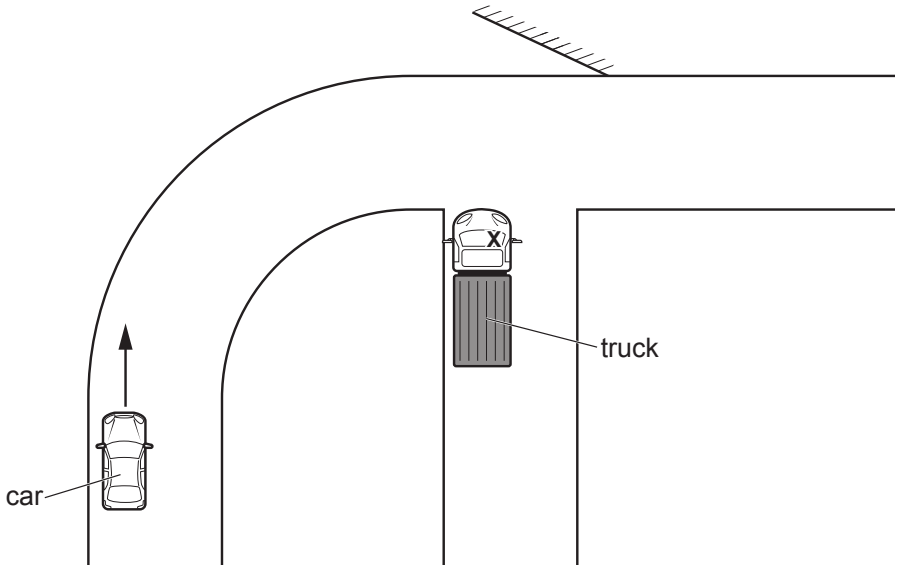


Fig. 5.2

Show how this mirror allows the driver of the truck to see the car when it is at the posit shown in Fig. 5.2.

（2023 冬季 0625/42 第5题(b)）

13. Fig. 5.1 shows a road junction, a moving car and a stationary truck. The road has high walls on each side.

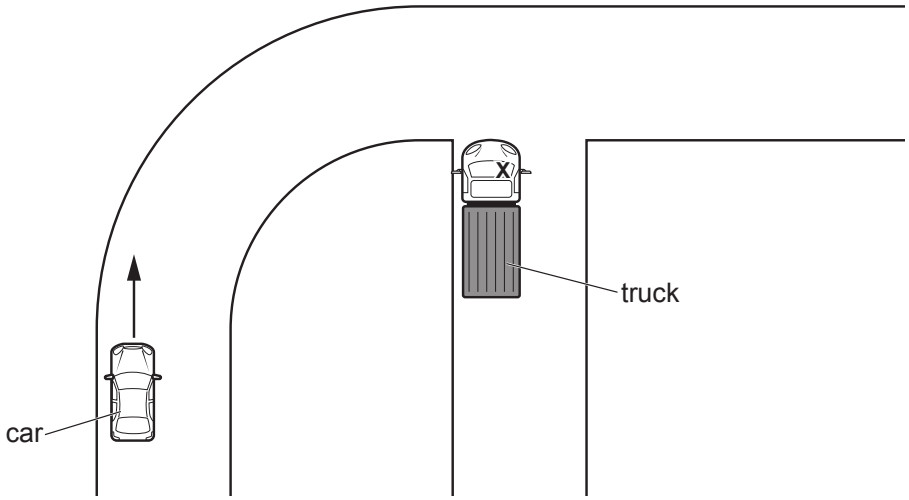


Fig. 5.1

(a) The driver of the truck is at position **X**. The car moves around the corner.

On Fig. 5.1, label a point Y on the road where the truck driver first sees the car.

（2023 冬季 0625/42 第5题(a)）

3.2.2 光的折射

题型 1：从法线画折射光路（考频★★★★☆）

知识点 法线是过入射点且与两种介质分界面_____的直线。

入射角 i 是入射光线与法线的夹角，折射角 r 是折射光线与法线的夹角；二者均从_____量起，单位为度。

若图中给出光线与界面的夹角 x，则相应的入射角或折射角为 $90\,^\circ - x$。

光从空气或真空进入折射率为 n 的介质时，$n = \frac{\sin i}{\sin r} = \frac{c}{v}$。

其中 c 为真空中的光速，v 为介质中的光速，折射率_____单位。

答案：垂直；法线；没有

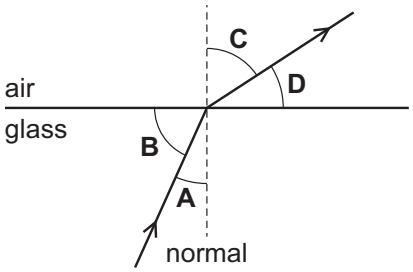
怎么认 题目出现光线、界面及所求折射角时，先过入射点作界面法线，再从法线量角。

一. 从法线认折射角

例题 1 The diagram shows a ray of light passing from glass to air.

The dotted line labelled ‘normal’ is a line drawn perpendicular to the surface of the glass.

What is the angle of refraction?

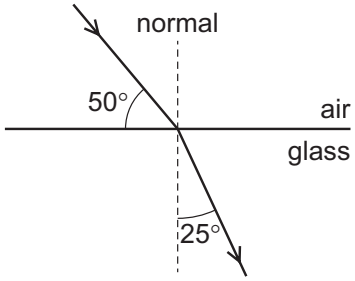


（2025 春季 0625/12 第23题）

解： 折射角是折射光线与法线在折射介质一侧的夹角。
光线由玻璃进入空气，空气一侧的折射光线与虚线法线所夹的角标为 C。
故选 C。

针对练习

1. A ray of light passes from air into glass.



What are the angles of incidence and refraction of the ray?

	angle of incidence / °	angle of refraction / °
A	40	25
B	40	65
C	50	25
D	50	65

（2024 冬季 0625/22 第20题）

2. Fig. 7.1 shows a container of oil.

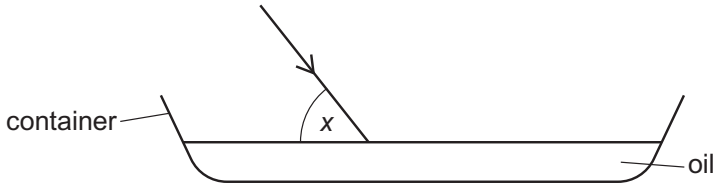


Fig. 7.1

A ray of light shines on the surface of the oil. The refractive index of the oil is 1.47.

(b) The angle *x* is 56°.

Calculate the value of the angle of refraction.

（2023 夏季 0625/42 第7题(b)）

3. A ray of light is incident on a soap film. Fig. 5.1 shows a magnified image of a small part of the soap film. The ray of light is refracted as it enters the soap film.

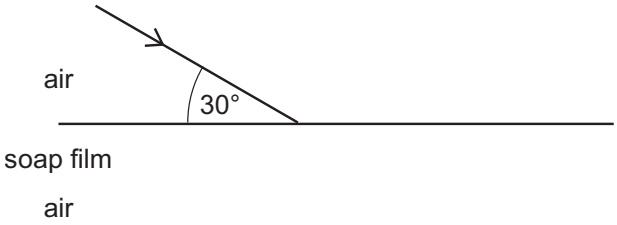


Fig. 5.1

The refractive index of the soap film is 1.28.

(b) (i) Show that the angle of refraction as the light enters the soap film is approximately 43°.

（2025 夏季 0625/41 第5题(b)）

4. The speed of light in a vacuum is 3.0×10^8 m/s.

The speed of light in glass is 2.2×10^8 m/s.

A light ray in a vacuum enters glass with an angle of incidence of 40°.

What is the angle of refraction within the glass?

A 28° **B** 29° **C** 55° **D** 61°

（2025 冬季 0625/23 第20题）

二. 按疏密关系画折射线

知识点 法线是在入射点作出的、与两种介质的分界面_____的直线。

入射角 i 是入射光线与法线的夹角，折射角 r 是折射光线与法线的夹角，角的单位为度。

光进入传播速率较小的介质时向_____偏折，即 $r < i$；进入传播速率较大的介质时背离法线偏折，即 $r > i$。

沿法线入射时 $i = 0°$，折射光线不改变方向。

临界角是光从传播速率较小的介质射向传播速率较大的介质时，折射角为_____的入射角，单位为度。

答案：垂直；法线；90 °

怎么认 题目出现光线穿过两种介质的界面并要求判断或补画光路时，先画法线，再比较两侧传播速率。

例题 2 A ray of light passes from air into a block of glass. The critical angle is 42°.

Which statement is correct?

A The angle of incidence is the angle between the ray of light and the surface of the glass block.

B The angle of incidence is always bigger than 42°.

C The angle of refraction **cannot** be less than 42°.

D The angle of refraction is smaller than the angle of incidence.

（2025 冬季 0625/13 第21题）

解：光从空气进入玻璃，传播速率减小，折射光线向法线偏折。
因此折射角 r 小于入射角 i。临界角 42 ° 适用于光从玻璃射向空气的情况。
故选 D。

针对练习

5. Fig. 5.1 shows a ray of yellow light incident on a glass prism ABC.

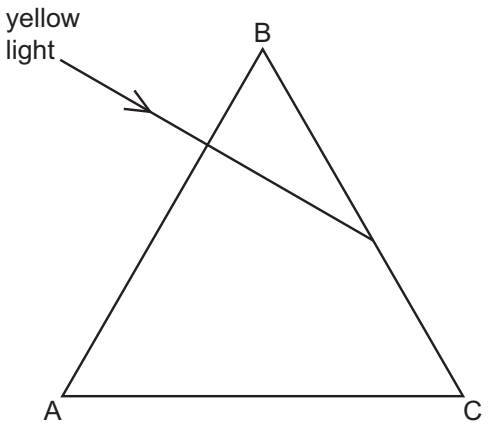


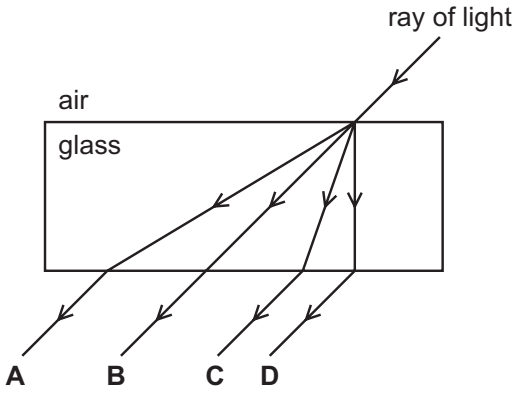
Fig. 5.1

(a) Explain why the ray does **not** change direction when it enters the prism at face AB.

（2024 夏季 0625/42 第5题(a)）

6. A ray of light passes through a glass block.

What is the path of the light?



（2025 夏季 0625/12 第19题）

7. **(a)** Fig. 7.1 represents a ray of red light entering one side of a glass block.

（2025 春季 0625/32 第7题(a)）

8. Fig. 5.1 shows a block ABCD made of glass that has a refractive index of 1.5. The block has one curved side AB and three straight sides, BC, CD and DA.

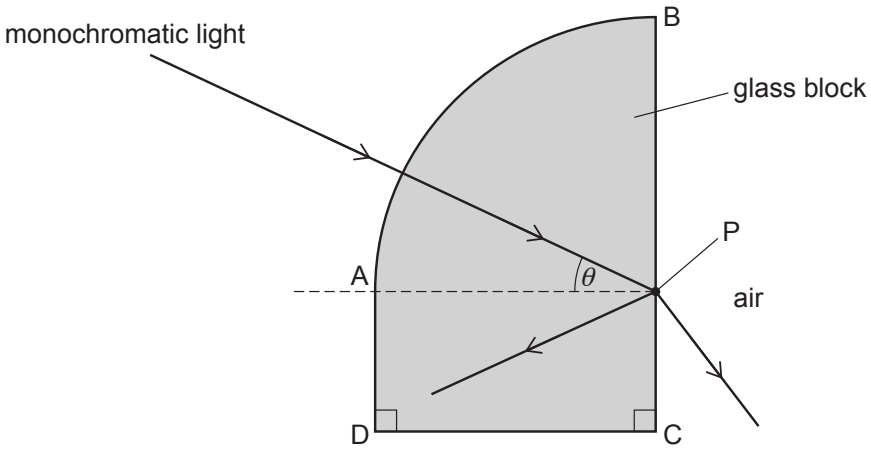


Fig. 5.1

There are right angles at C and D. The curved side AB is one quarter of the circumference of a circle that has its centre at point P.

A ray of monochromatic light enters the block through the curved side AB and strikes side BC at P. Some light emerges into the air and some is reflected.

(b) Explain why the ray of light does **not** change direction when it enters the block through side AB.

（2023 夏季 0625/41 第5题(b)）

三. 判断跨介质后的变化

知识点 过入射点且垂直于界面的直线称为_____，入射角和折射角都从这条直线量起。

光从一种介质斜射入另一种介质时，因传播速率改变而在界面处改变方向，这一现象称为_____；垂直入射时方向不变。

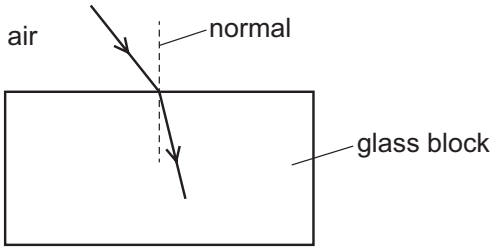
光由空气进入玻璃时，传播速率和波长均减小，频率由光源决定而保持_____；由 $v = f\lambda$ 可知，速率与波长同向改变。

传播速率 v、频率 f、波长 λ 的单位分别为 m/s、Hz、m。

答案：法线；折射；不变

怎么认 题目出现光跨介质界面，并问速率、频率或波长变化时，先写频率不变，再由 $v = f\lambda$ 判断。

例题 3 The diagram shows a ray of light travelling from air into a glass block and changing direction so that it is closer to the normal.



What is the name of this process and why does it happen?

	process	why it happens
A	diffraction	speed of the light decreases
B	diffraction	speed of the light increases
C	refraction	speed of the light increases
D	refraction	speed of the light decreases

（2024 春季 0625/12 第16题）

解： 光线由空气斜射入玻璃，在界面处向法线偏折，此过程为折射。
玻璃中光的传播速率小于空气中光的传播速率，故光的传播速率减小。
故选 D。

针对练习

9. A monochromatic ray of green light in air enters a block of glass.

Which property of the ray of light always remains the same as it moves from air to glass?

A wavelength

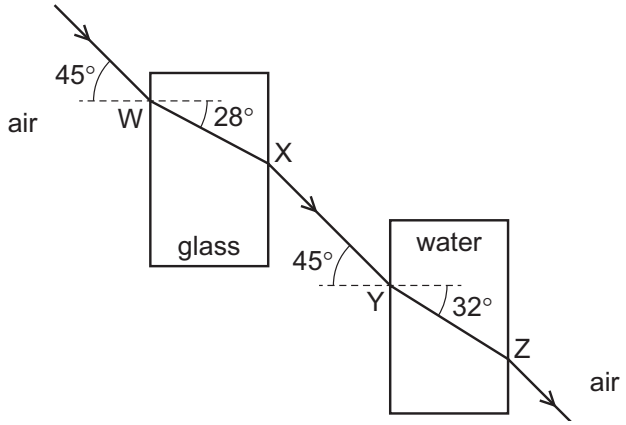
B speed

C frequency

D direction

（2023 夏季 0625/23 第19题）

10. A light ray is passed through air, glass and water.



At which points does the light speed decrease?

A W and X **B** W and Y **C** X and Z **D** Y and Z

（2024 冬季 0625/21 第18题）

11. Fig. 6.1 shows light waves passing from air into a glass block.

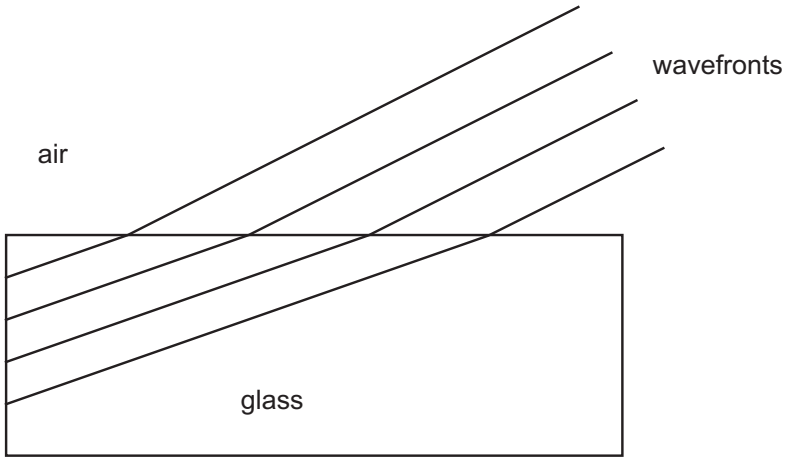


Fig. 6.1 (not to scale)

(a) (i) State the name of the process shown in Fig. 6.1 as the wavefronts enter the glass block.

(ii) State **two** changes in the light waves as they pass from air into glass.

（2023 夏季 0625/32 第6题(a)）

题型 2：用折射率关系计算（考频★★★★☆）

知识点 光从空气斜射入透明介质时，入射角 i 和折射角 r 都是光线与 _____ 的夹角。
介质相对于空气的折射率等于空气中光速与介质中光速之比，并满足 _____。
折射率是两个速率的比值，_____。

答案：法线；$n = \sin\frac{i}{\sin}r$；没有单位

怎么认 题目出现空气射入透明介质及角度或折射率时，先把角统一为相对法线的角，再写正弦比。

一. 用正弦比求折射率

例题 1 Light travels from air into glass.

What is the relationship between the refractive index n of the glass, the angle of incidence i and the angle of refraction r?

A $n = \frac{i}{r}$ **B** $n = \frac{r}{i}$ **C** $\frac{\sin i}{\sin r}$ **D** $\frac{\sin i}{\sin r}$

（2023 冬季 0625/22 第19题）

解：光从空气射入玻璃，i 与 r 均为相对法线的角，由折射定律得 $n = \sin\frac{i}{\sin}r$。
故选 C。

针对练习

1. Fig. 5.1 shows four rays of red light, P, Q, R and S, coming from a spotlight in a swimming pool.

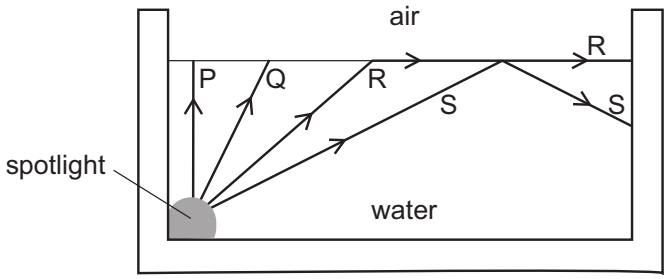


Fig. 5.1

(a) Define, in words, refractive index for a ray of light travelling from air to water.

（2025 夏季 0625/43 第5题(a)）

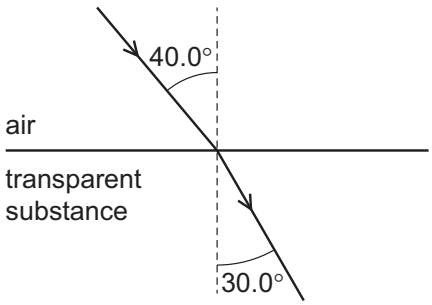
2. Light is travelling through air. It strikes a glass block at an angle of incidence of 45°. The glass has a refractive index of 1.4.

What is the angle of refraction of the light as it enters the glass?

A 29° **B** 30° **C** 32° **D** 82°

（2023 冬季 0625/23 第22题）

3. The diagram shows a ray of light passing from air into a transparent substance.

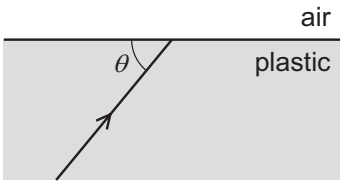


What is the refractive index of the transparent substance?

A 1.33 **B** 1.29 **C** 0.778 **D** 0.750

（2024 夏季 0625/21 第19题）

4. Light in transparent plastic meets a boundary with air. Light is transmitted into the air only if the angle marked θ in the diagram is greater than 36°.



What is the refractive index of the plastic?

A 0.59 **B** 0.81 **C** 1.2 **D** 1.7

（2023 春季 0625/22 第19题）

二. 用速率比求折射率

知识点 折射率 n 是光在两个不同区域中的传播速率之比。

光从区域 1 进入区域 2 时，区域 2 相对区域 1 的折射率为 $n = \frac{v_1}{v_2}$；由真空进入介质时，$n = \frac{c}{v}$。

其中真空中的光速 $c =$ _____，v 为光在介质中的速率；折射率_____单位。

答案：$3.0 \times 10^8 \text{m s}^{-1}$；没有

怎么认 题目出现介质的折射率和真空或空气中的光速时，先写 $n = \frac{c}{v}$。

例题 2 A ray of light is incident on a soap film. Fig. 5.1 shows a magnified image of a small part of the soap film. The ray of light is refracted as it enters the soap film.

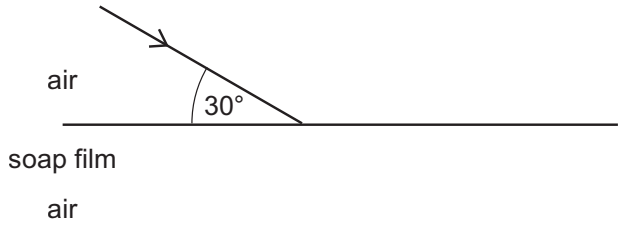


Fig. 5.1

The refractive index of the soap film is 1.28.

(a) Define refractive index in terms of the speed of light.

（2025 夏季 0625/41 第5题(a)）

解： 光从区域 1 进入区域 2 时，折射率定义为 $n = \frac{v_1}{v_2}$，其中 v_1、v_2 分别是光在区域 1、区域 2 中的传播速率。

本题中，区域 1 为空气、区域 2 为肥皂膜，因此 $n = \frac{c}{v}$。

答：折射率是光在两个不同区域中的传播速率之比。

针对练习

5. What is the speed of infrared radiation in glass with a refractive index of 1.5?

A 340 m/s

B 2.0×10^8 m/s

C 3.0×10^8 m/s

D 4.5×10^8 m/s

（2025 冬季 0625/22 第22题）

6. Fig. 7.1 shows a container of oil.

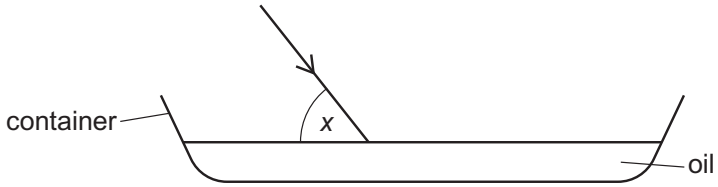


Fig. 7.1

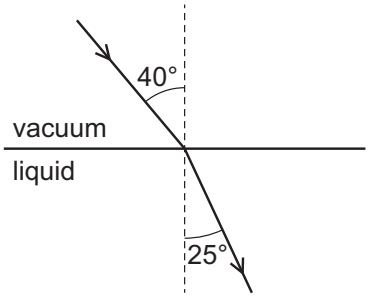
A ray of light shines on the surface of the oil. The refractive index of the oil is 1.47.

(d) Calculate the speed of light in the oil.

Give your answer to three significant figures.

（2023 夏季 0625/42 第7题(d)）

7. A beam of light passes through a vacuum and then enters a transparent liquid. The diagram shows the path it takes.



The light travels through the vacuum at a speed of 3.0×10^8 m/s.

What is the speed of light in the liquid?

A 1.9×10^8 m/s

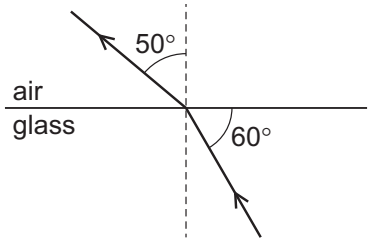
B 2.0×10^8 m/s

C 4.6×10^8 m/s

D 4.8×10^8 m/s

（2025 冬季 0625/21 第19题）

8. A ray of light is refracted as it enters air from glass, as shown.



What is the speed of light in the glass?

A 2.0×10^8 m/s

B 2.2×10^8 m/s

C 2.3×10^8 m/s

D 2.7×10^8 m/s

（2024 夏季 0625/23 第20题）

三. 用临界角关系换算

知识点 临界角 c 是光从折射率较大的介质射向折射率较小的介质时，使折射角恰为 $90°$ 的入射角。介质相对空气的折射率为 n 时，$n = \frac{1}{\sin}c$，故 $c = \sin^{-1}\left(\frac{1}{n}\right)$；折射率_____单位，角的单位为_____。入射角大于临界角时发生_____，光全部反射回原介质。

答案：没有；度；全反射

怎么认 题目出现介质折射率与临界角互求时，先确认光由介质射向空气，再写 $n = \frac{1}{\sin}c$。

例题 3 **(a)** Fig. 5.1 shows a semicircular transparent plastic block.

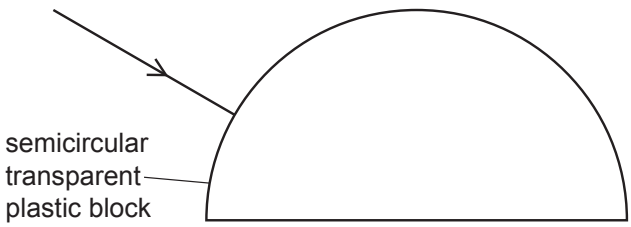


Fig. 5.1

A ray of light is incident normally on the curved surface of the block. The refractive index of the plastic is 1.5.

(i) Calculate the critical angle for the plastic.

（2023 春季 0625/42 第5题(a)）

解：塑料相对空气的折射率 $n = 1.5$，由临界角关系得

$n = \frac{1}{\sin}c$

$\sin c = \frac{1}{1.5}$

$c = \sin^{-1}\left(\frac{1}{1.5}\right) = 41.8° \approx 42°$

答：塑料的临界角为 $42°$。

9. Fig. 5.1 shows four rays of red light, P, Q, R and S, coming from a spotlight in a swimming pool.

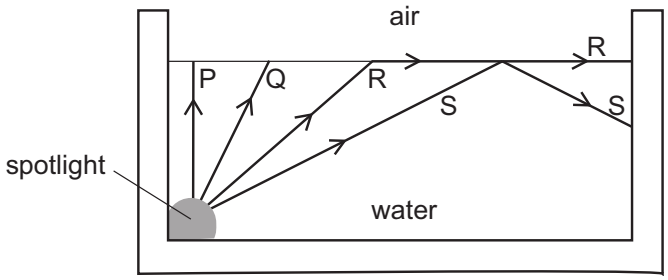


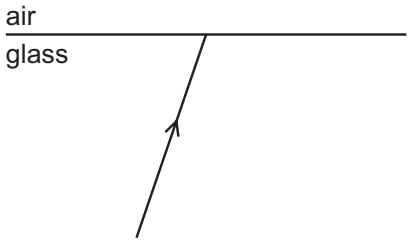
Fig. 5.1

(c) The angle of incidence for ray R is 49°.

Calculate the refractive index of the water.

（2025 夏季 0625/43 第5题(c)）

10. The diagram shows a ray of light in glass incident on the surface between the glass and air.



What happens if the angle of incidence is made larger than the critical angle for the glass?

A The angle of refraction becomes equal to 90°.

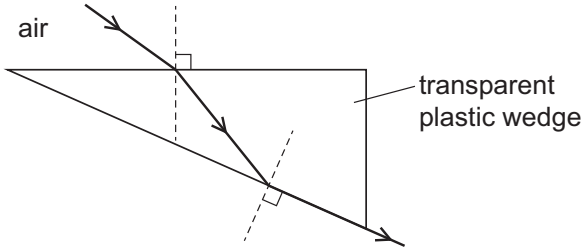
B There is a refracted ray and a ray reflected inside the glass.

C There is a refracted ray only.

D There is only a ray reflected inside the glass.

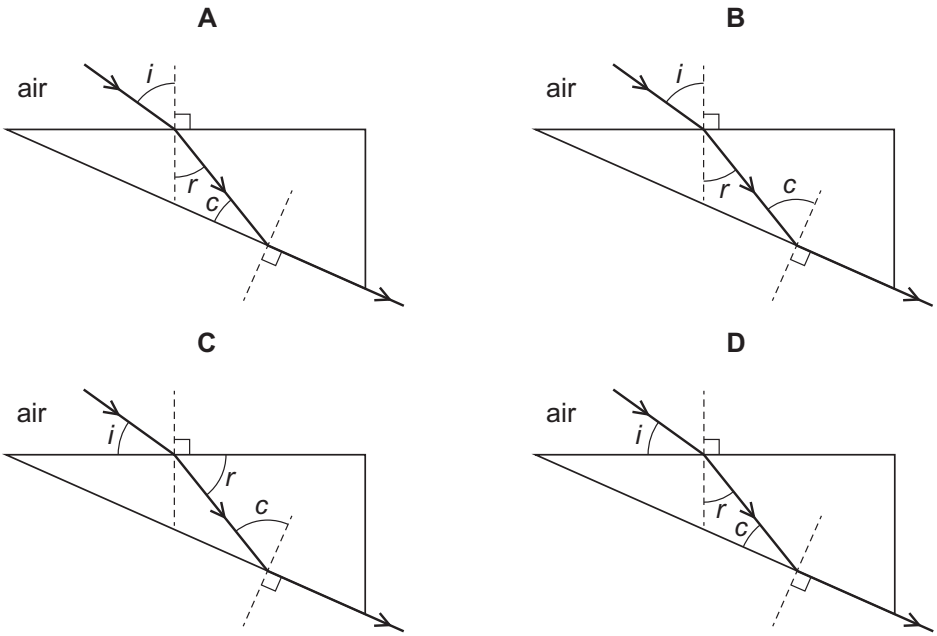
（2024 夏季 0625/11 第19题）

11. A ray of light enters a transparent plastic wedge from air and is incident on the lower surface at the critical angle, as shown.



The angle of incidence is *i*, the angle of refraction is *r*, and the critical angle is *c*.

In which ray diagram are the angles labelled correctly?



（2024 冬季 0625/21 第20题）

12. Fig. 6.1 shows part of an optical fibre used in high-speed broadband communication.

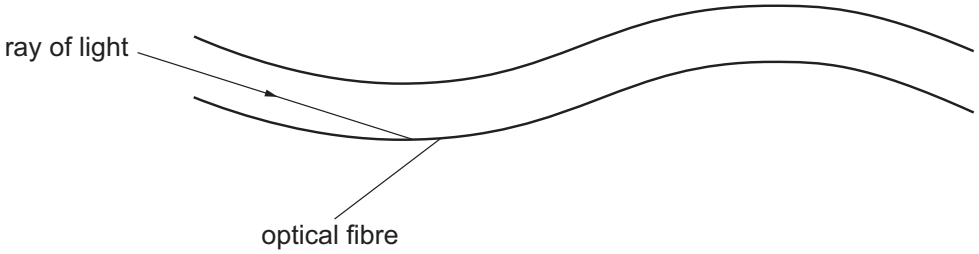


Fig. 6.1

(b) (i) The optical fibre is made of glass with a refractive index of 1.4.

Calculate the critical angle *c*.

(ii) State the meaning of critical angle.

(iii) On Fig. 6.1, label the angle of incidence of the ray of light as it hits the wall of the glass fibre. Draw the continuation of the ray until it leaves the glass fibre.

（2025 冬季 0625/41 第6题(b)）

题型 3：检查全反射与光纤（考频★★★☆☆）

知识点 全反射是光到达两种介质的分界面时，全部反射回原介质的现象。

光从_____介质射向_____介质，且入射角大于_____，才发生全反射。

临界角是折射角为 90° 时光密介质中的入射角，角度单位常用 °。

答案：光密；光疏；临界角

怎么认 题目出现全反射、临界角或光纤时，先检查光是否由光密介质射向光疏介质，再比较入射角与临界角。

一. 逐项检查全反射条件

例题 1 Which conditions are necessary for light to be totally internally reflected?

	incident light	angle of incidence
A	is in the less dense medium	less than the critical angle
B	is in the less dense medium	greater than the critical angle
C	is in the more dense medium	less than the critical angle
D	is in the more dense medium	greater than the critical angle

（2024 夏季 0625/21 第18题）

解：由全反射条件，入射光应处在光密介质中，且入射角大于临界角。

表中只有 D 同时满足这两个条件。

故选 D。

针对练习

1. **(c)** Another ray enters the glass prism and is totally internally reflected.

State **two** conditions for a ray to be totally internally reflected.

（2024 夏季 0625/33 第7题(c)）

2. A ray of light is incident on a boundary between air and water.

Under which conditions is the ray of light totally internally reflected?

A The ray, initially in the air, is incident on the air–water boundary at any angle of incidence.

B The ray, initially in the air, is incident on the air–water boundary at an angle of incidence greater than the critical angle.

C The ray, initially in the water, is incident on the water–air boundary at any angle of incidence.

D The ray, initially in the water, is incident on the water–air boundary at an angle of incidence greater than the critical angle.

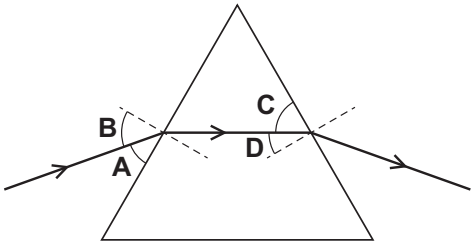
（2025 春季 0625/22 第22题）

3. The diagram shows a ray of red light travelling through a transparent prism.

Normals to the prism surfaces are marked at the points where the ray meets the prism surfaces.

The direction of the incident ray is changed until total internal reflection just occurs at one of the surfaces.

Which angle **must** now be equal to the critical angle?



（2025 冬季 0625/12 第21题）

4. Fig. 5.1 shows a block ABCD made of glass that has a refractive index of 1.5. The block has one curved side AB and three straight sides, BC, CD and DA.

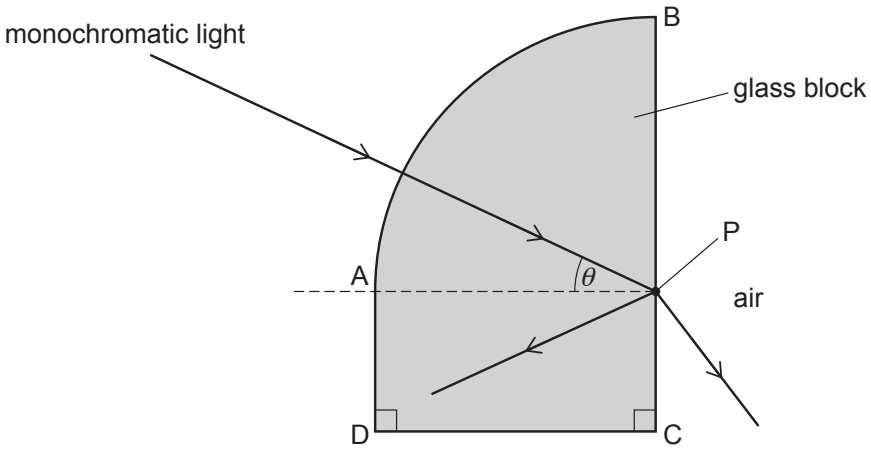


Fig. 5.1

There are right angles at C and D. The curved side AB is one quarter of the circumference of a circle that has its centre at point P.

A ray of monochromatic light enters the block through the curved side AB and strikes side BC at P. Some light emerges into the air and some is reflected.

(d) Fig. 5.1 shows that the angle between the ray of light and line AP is θ, where line AP is at right angles to side BC.

Angle θ increases to 45°.

(i) State and explain what happens to the light that strikes P.

(ii) When $\theta = 45°$, the reflected light strikes side CD.

Describe what happens when this reflected light strikes side CD.

（2023 夏季 0625/41 第5题(d)）

二. 沿光纤续画全反射

知识点 光从传播速率较小的介质射向传播速率较大的介质，且入射角大于临界角时，发生_____。
临界角是折射角为 $90°$ 时的入射角，角的单位为度；全反射时光全部返回原介质，并满足 $i = r$。
光纤利用连续全反射传输光信号，具有_____、_____等优点。

答案：全反射；信号损失小；数据传输率高

怎么认 题目出现光纤、临界角或连续反射光路时，先作法线并比较入射角与临界角。

例题 2 Fig. 6.1 shows light waves passing from air into a glass block.

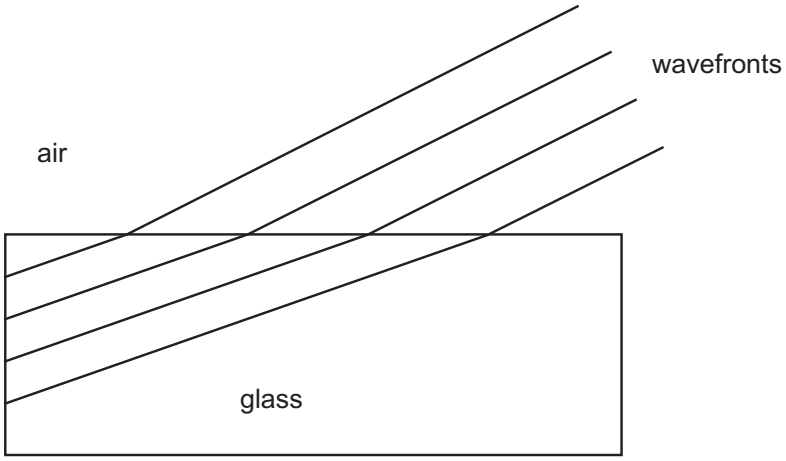


Fig. 6.1 (not to scale)

(b) Fig. 6.2 shows a ray of red light travelling through a glass fibre. The glass fibre is made of solid glass.

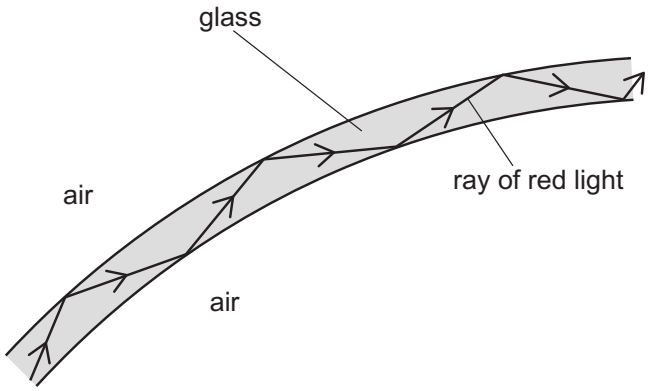


Fig. 6.2

State and explain how the ray of red light travels through the glass fibre as shown in Fig. 6.2.

（2023 夏季 0625/32 第6题(b)）

解： 红光由玻璃射向空气，光在玻璃中的传播速率小于在空气中的传播速率。
入射角大于玻璃与空气界面的临界角，故红光在边界处发生全反射。
由反射定律得
$i = r$
因此红光在光纤的内表面连续发生全反射，沿光纤传播。
答：红光由玻璃射向空气时，因入射角大于临界角而连续发生全反射。

5. Fig. 5.1 shows a ray of yellow light incident on a glass prism ABC.

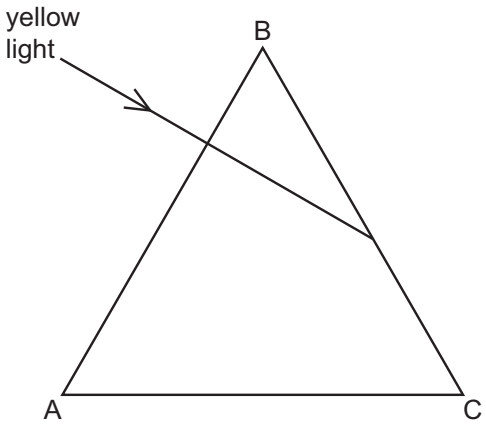


Fig. 5.1

(c) Internet data can be transferred using infrared waves in optical fibres.

State **two** advantages of using optical fibres to transmit data.

（2024 夏季 0625/42 第5题(c)）

6. **(b)** **(i)** Light can be totally internally reflected when striking the boundary between two different regions.

State **two** conditions that are necessary for total internal reflection to occur.

(ii) State **two** advantages of using optical fibres for transmitting high speed broadband.

（2025 冬季 0625/42 第6题(b)）

7. The diagram shows a ray of light in an optical fibre.



Which statement correctly explains the condition for the maximum transmission of light by the optical fibre?

A The glass must slow the light as little as possible to make the critical angle for the fibre as large as possible.

B The glass must slow the light as little as possible to make the critical angle for the fibre as small as possible.

C The glass must slow the light as much as possible to make the critical angle for the fibre as large as possible.

D The glass must slow the light as much as possible to make the critical angle for the fibre as small as possible.

（2024 夏季 0625/21 第20题）

题型 4：用插针法追迹折射（考频★★☆☆☆）

知识点 法线是过入射点且与界面_____的直线；入射角与折射角均从法线量起，单位为_____。
插针追迹前，先描出透明砖轮廓并作法线；入射侧两针应相距较远，以提高追迹精度。
从另一侧调节后两针，使后两针与前两针的像位于_____，再标记各针的位置。
移去透明砖和插针，连接相应标记点并延长，所得直线表示光线的传播路径。

答案：垂直；度（°）；同一直线上

怎么认 题目出现透明砖、四枚插针和像重合的观察要求时，先描轮廓并在入射点作法线。

例题 1 In this experiment, you will investigate the refraction of light by a transparent block.
You will determine a quantity known as the refractive index of the material of the block.

Use the separate ray-trace sheet provided.

You may refer to Fig. 3.1 for guidance.

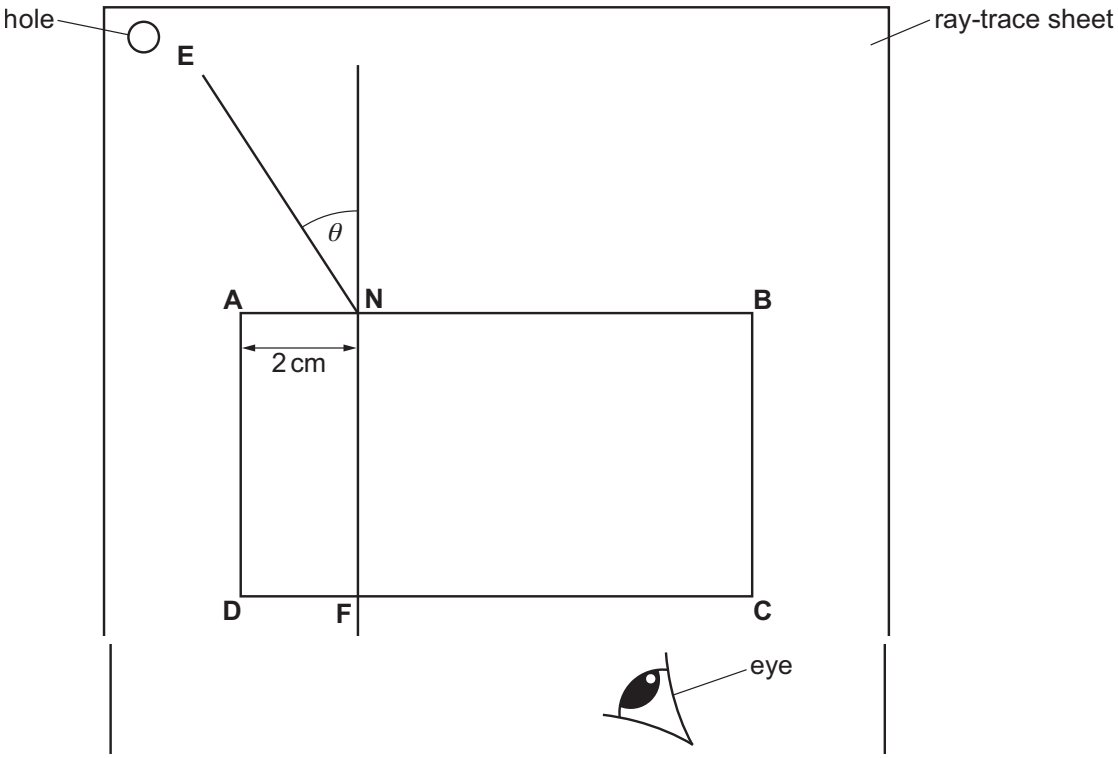


Fig. 3.1

(a) Place the transparent block approximately in the centre of the ray-trace sheet. Carefully draw round the block and label the corners **A**, **B**, **C** and **D** as indicated by Fig. 3.1.
Remove the block from the ray-trace sheet.

Draw a normal to line **AB** at a point **N**, 2 cm from **A**. Extend the normal downwards until it crosses the line **CD**. Label the point at which it crosses **CD** with the letter **F**.

Draw a line **NE**, as indicated by Fig. 3.1, 7 cm long and at an angle θ_1 = 15° to the normal.

(b) Replace the block in exactly the same position as in **(a)**.

Place two pins P_1 and P_2 on line **NE**, a suitable distance apart for accurate ray tracing.
Mark with crosses and label the positions of P_1 and P_2.

View the images of P_1 and P_2 through the block, from the direction indicated by the eye in Fig. 3.1. Place two pins P_3 and P_4 so that pins P_3 and P_4 and the images of P_1 and P_2 all appear exactly one behind the other.
Mark with crosses and label the positions of P_3 and P_4.

Remove the block and pins from the ray-trace sheet.

Draw a straight line through P_3 and P_4. Extend this line to cross **NF**.
Label the point at which this line meets **NF** with the letter **G**. Label the point at which this line crosses **CD** with the letter **H**.

（2024 冬季 0625/53 第3题(b)）

解：将透明砖放回原轮廓，在直线 NE 上插入 P_1、P_2，且两针间距不小于 5.0 cm。
从图示方向观察，调节 P_3、P_4，使两针与 P_1、P_2 的像位于同一直线上，并用叉号标记针位。
连接 P_3、P_4 并延长，直线与 NF、CD 的交点分别标为 G、H。
答：P_1、P_2 的间距不小于 5.0 cm，追迹线位置正确。

针对练习

1. In this experiment, you will investigate the refraction of light by a transparent block.

Use the separate ray-trace sheet provided.
You may refer to Fig. 3.1 for guidance.

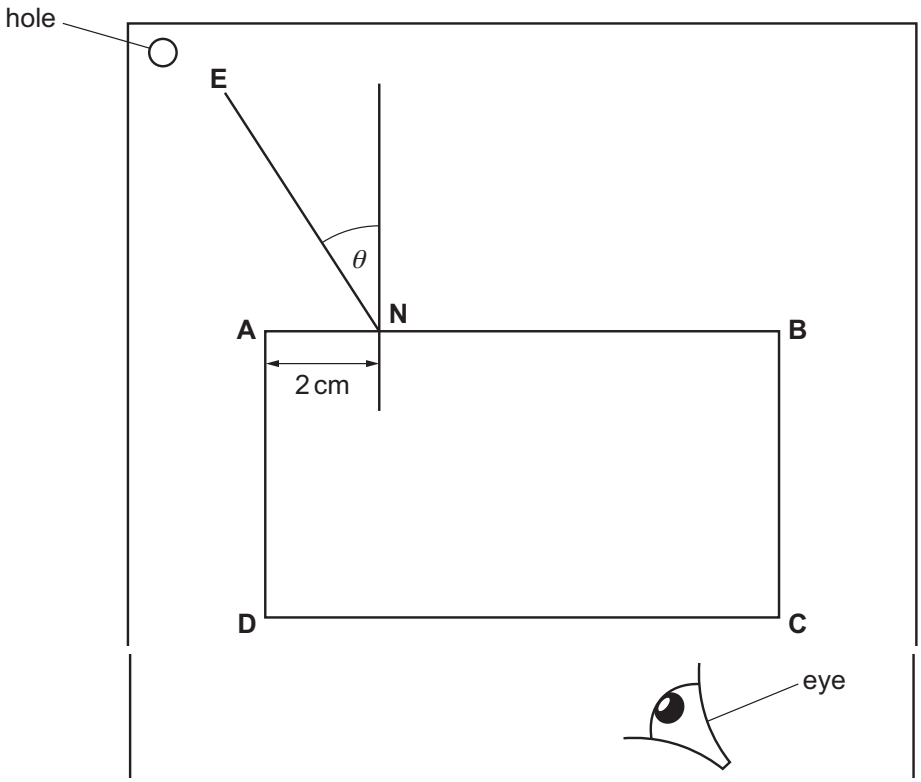


Fig. 3.1

(a) Place the transparent block approximately in the centre of the ray-trace sheet.
Carefully draw round the block and label the corners **A**, **B**, **C** and **D** as indicated by Fig. 3.1.
Remove the block from the ray-trace sheet.

Draw a normal to line **AB** at a point **N**, 2 cm from **A**.

Draw a line **EN**, as indicated by Fig. 3.1, 8 cm long and at an angle $\theta = 40°$ to the normal.

(b) Replace the block in exactly the same position as in **(a)**.

Place two pins P_1 and P_2 on line **EN**, a suitable distance apart for accurate ray tracing.
Mark with crosses and label the positions of P_1 and P_2.

View the images of P_1 and P_2 through the block, from the direction indicated by the eye in Fig. 3.1. Place two pins P_3 and P_4 so that pins P_3 and P_4 and the images of P_1 and P_2 all appear exactly one behind the other.
Mark with crosses and label the positions of P_3 and P_4.

Remove the block and pins from the ray-trace sheet.

Draw a line through P_3 and P_4. Extend this line to meet line **CD**.
Label the point at which this line meets **CD** with the letter **F**. Label the lower end of this line with the letter **G**.

Extend line **EN** to approximately 5 cm below line **CD**.
Label the point at which this line crosses **CD** with the letter **H**. Label the lower end of this line with the letter **J**.

(d) Draw a new line **EN**, as indicated by Fig. 3.1, 8 cm long and at an angle $\theta = 20°$ to the normal.

Repeat the steps in **(b)**.

（2025 春季 0625/52 第3题(d)）

2. A student investigates the refraction of light using a semicircular transparent block.

Fig. 3.1 and Fig. 3.2 show his ray-trace sheet.

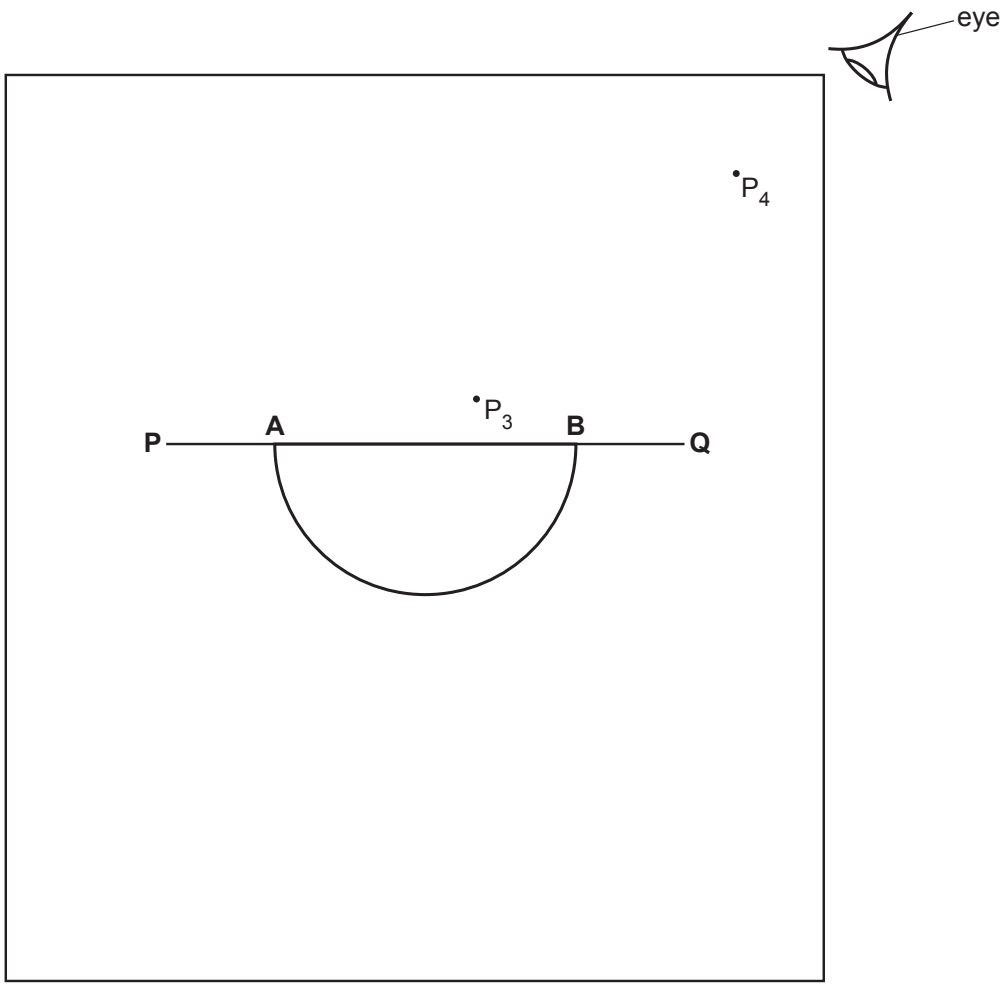


Fig. 3.1

(a)
- On Fig. 3.1, draw the normal **NL** through the centre of **AB**.
- Continue the normal so that it passes through the curved side of the block.
- Label the normal **NL**.
- Label the point **C** where the normal **NL** crosses **AB**.

（2023 夏季 0625/61 第3题(a)）

3. **(a)** A student shines a ray of red light into a rectangular glass block, as shown in Fig. 6.1.

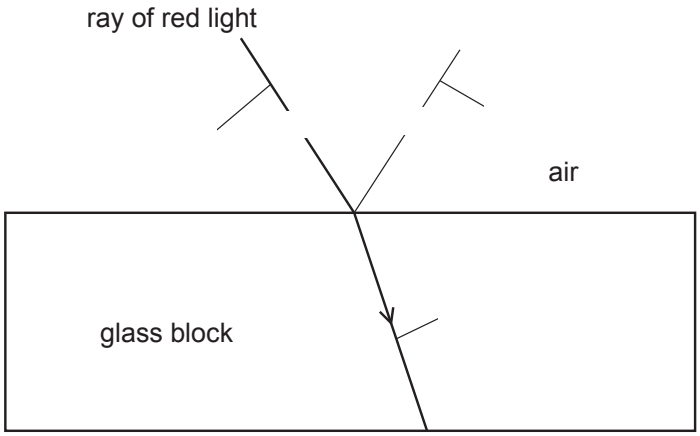


Fig. 6.1

(i) Draw the normal at the point where the ray of red light enters the glass block.

(ii) On Fig. 6.1, label each ray using words from the list.

diffracted **diffused** **dispersed** **incident** **reflected** **refracted**

（2023 冬季 0625/33 第6题(a)）

3.2.3 薄透镜

题型 1：认主轴焦点与透镜作用（考频★★☆☆☆）

知识点 穿过薄透镜光心并垂直于透镜的直线叫_____。

与主轴平行的光经薄会聚透镜折射后会聚于_____；经薄发散透镜折射后的反向延长线相交于主焦点。

光心到主焦点的距离叫焦距，用 f 表示，单位为 m 或 cm；薄透镜两侧各有一个主焦点。

答案：主轴；主焦点

怎么认 题目出现薄透镜、平行光线、主焦点或焦距时，先找穿过光心的主轴。

例题 1 Fig. 6.1 shows a thin converging lens used to produce a magnified image of an object AB.

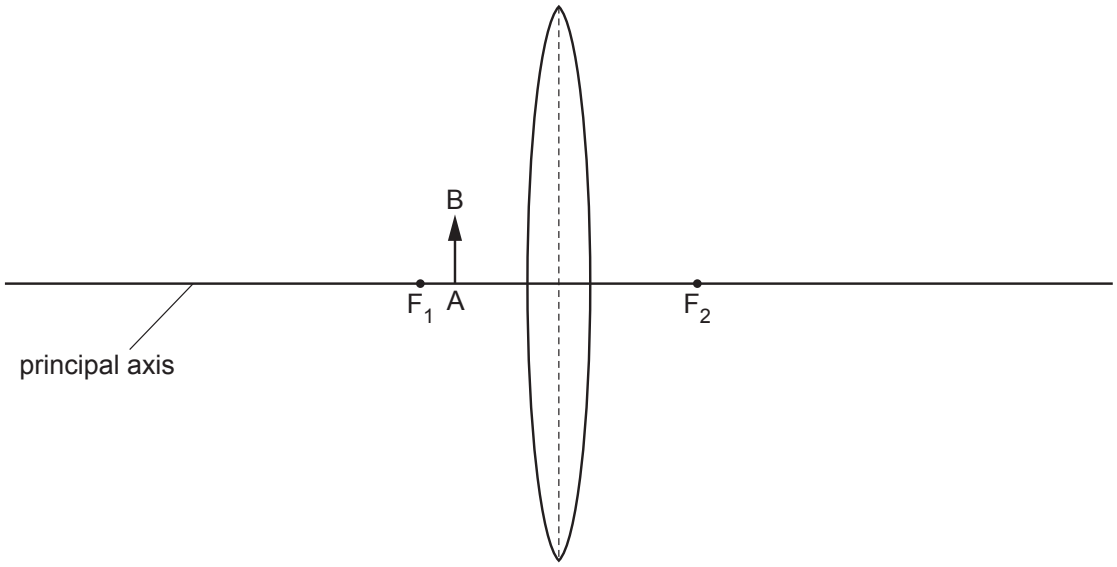


Fig. 6.1

(a) Explain the meaning of the terms principal focus and focal length.

（2024 夏季 0625/43 第6题(a)）

解：与主轴平行的光线经会聚透镜折射后相交于一点，该点为主焦点。
光心与主焦点之间的距离为焦距。
答：主焦点是平行于主轴的光经透镜后会聚的点；焦距是光心到主焦点的距离。

针对练习

1. Which statement about a thin converging lens is correct?

A All rays of light refracted by the lens pass through the principal focus.

B All rays initially parallel to the principal axis of the lens are refracted through the principal focus.

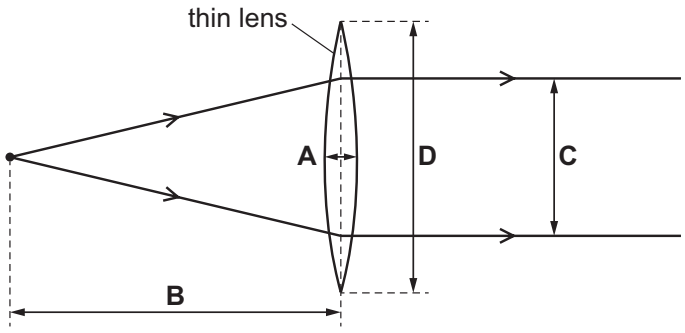
C The focal length of the lens is the distance between the image and the principal focus.

D The focal length of the lens is the distance between the object and the image.

（2025 冬季 0625/21 第20题）

2. The diagram shows two diverging rays of light passing through a lens and emerging parallel to each other.

Which labelled distance is the focal length of the lens?



（2023 夏季 0625/12 第19题）

3. Which row about converging lenses and diverging lenses is correct?

	converging lenses	diverging lenses
A	always produce inverted images	can focus a parallel beam of light
B	can be used as magnifying glasses	do not have a principal focus
C	can be used to correct short-sightedness	are usually thinner than converging lenses
D	can produce real and virtual images	can be used to correct short-sightedness

（2024 春季 0625/22 第22题）

题型 2：用两条主光线找像（考频★★★☆☆）

知识点 薄会聚透镜使平行于主轴的光线折射后会聚于主焦点；光心到主焦点的距离称为焦距 f，单位为 m，作图中也可用 cm。

从物体顶端发出的平行主轴光线，折射后通过_____；通过_____的光线传播方向不变。

两条折射光线的_____为像顶，由像顶向主轴画箭头，得到实像。

答案：透镜另一侧的主焦点；光心；实际交点

怎么认 题目出现薄会聚透镜、物体和主轴并要求定像时，先从物体顶端画两条主光线。

一. 画两条主光线定实像

例题 1

Fig. 7.1 represents an object placed close to a thin converging lens. The scale for the grid is shown.

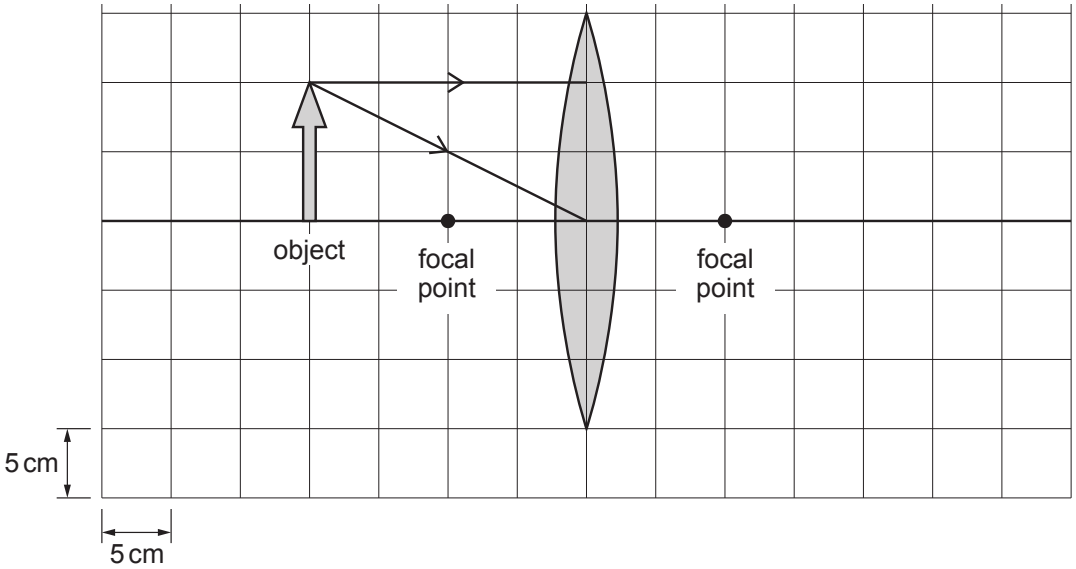


Fig. 7.1

(a) (i) Determine the focal length of the converging lens. Use the information in Fig. 7.1.

(ii) On Fig. 7.1, determine the position of the image formed by the lens, by continuing the path of each ray beyond the lens. Use an arrow to indicate the position of the image.

（2024 春季 0625/32 第7题(a)）

解： 图中光心到焦点相距 2 格，每格表示 5 cm，

$f = 2 \times 5$ cm

$= 10$ cm

将过光心的光线沿原方向延长，将平行主轴的光线折射后画向右侧焦点；两光线在透镜右侧 4 格、主轴下方 2 格处相交。

答：焦距为 10 cm；像箭头位于透镜右侧 4 格处，由主轴向下画 2 格。

针对练习

1. Fig. 6.1 shows the path of a ray of visible light travelling from the top of an object and passing through a converging lens.

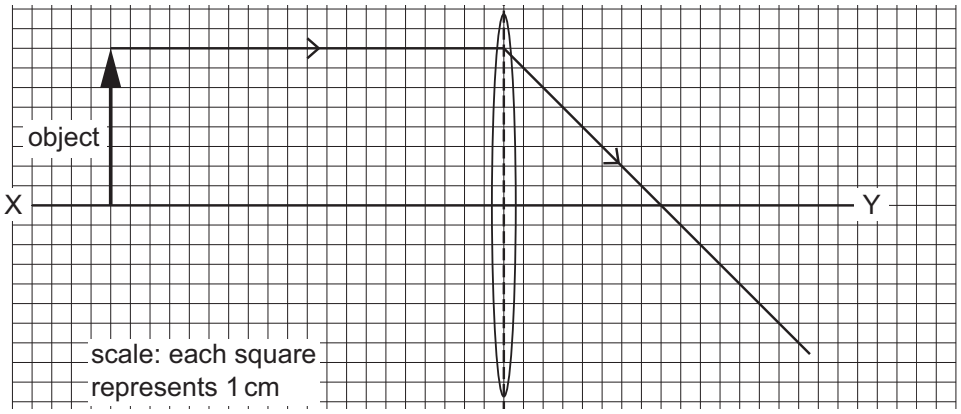


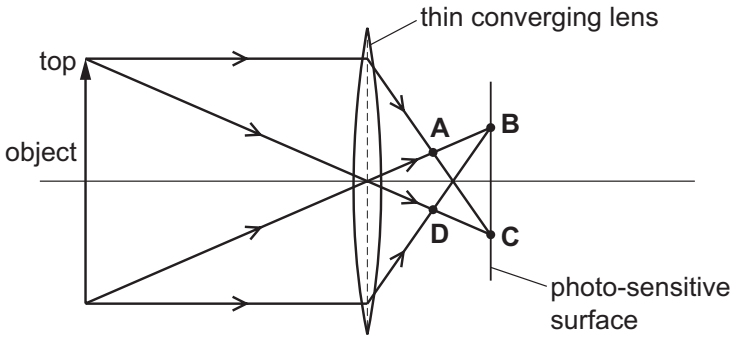
Fig. 6.1

(c) On Fig. 6.1, draw another ray from the object. Continue the path of the ray through the lens until it crosses the path of the ray shown in Fig. 6.1.

（2025 冬季 0625/33 第6题(c)）

2. A thin converging lens in a camera produces a real image on a photo-sensitive surface, as shown.

At which position is the image of the top of the object formed?



（2023 冬季 0625/13 第21题）

3. **(a)** Fig. 4.1 is an incomplete ray diagram showing an object O, a converging lens and the principal axis. The focal points of the lens are each labelled F.

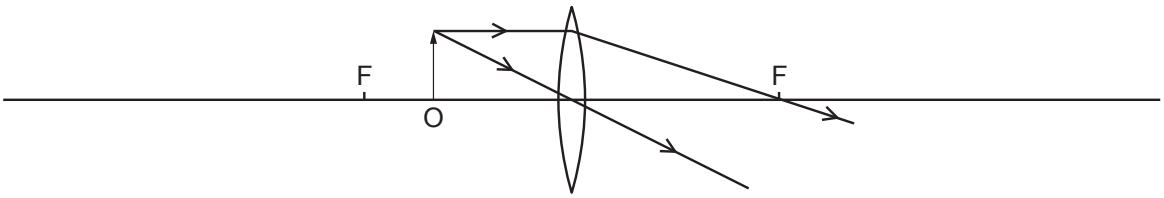


Fig. 4.1

(i) Complete the ray diagram to draw the image formed by the lens. Label your image I. [3]

(ii) Circle **three** descriptions in the list which describe the image formed in **(i)**.

diminished **enlarged** **inverted** **same size**

real **upright** **virtual**

（2023 夏季 0625/43 第4题(a)）

二. 从交点判断像的性质

知识点 主轴是通过薄透镜光心且垂直于透镜的直线；主焦点在主轴上，光心到主焦点的距离为焦距，常用单位为 cm。

平行于主轴的光线经会聚透镜折射后通过另一侧主焦点；通过光心的光线传播方向不变。

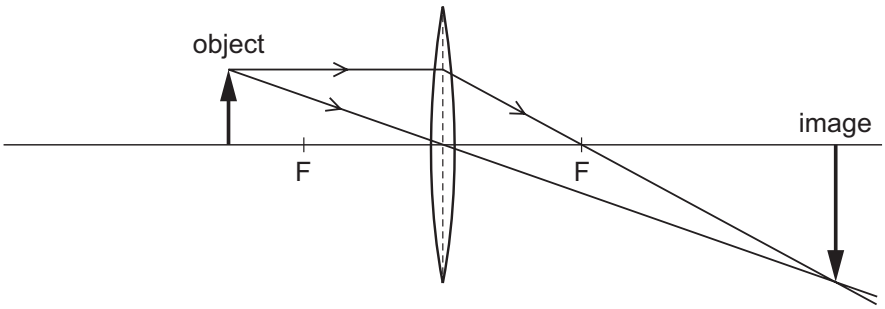
两条折射光线实际相交时形成_____像，可在屏上形成清晰像；折射光线的反向延长线相交时形成_____像，不能在屏上形成清晰像。

像与物分居主轴两侧时像为_____，位于主轴同侧时像为正立；比较像高与物高可判断像的大小。

答案：实；虚；倒立

怎么认 题目出现会聚透镜的成像光线并求像的性质时，先看实际光线是否会聚，再比较像与物的方向和高度。

例题 2 A thin converging lens forms an image.



What is the nature of this image and can it be formed on a screen?

	nature of image	can be formed on a screen
A	virtual	no
B	virtual	yes
C	real	no
D	real	yes

（2024 冬季 0625/13 第20题）

解：图中两条折射光线在透镜右侧实际相交，故所成的像为实像。
实像可在屏上形成清晰投影。
故选 D。

针对练习

4. A thin converging lens is used to produce a real image of an object.

Which statement about the real image is always correct?

A It is nearer to the lens than the object.

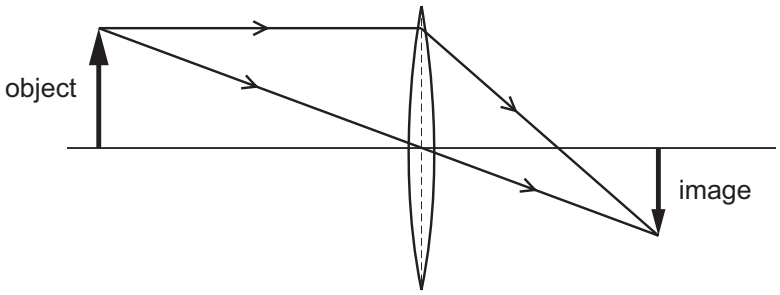
B It is on the opposite side of the lens to the object.

C It is the same size as the object.

D It is upright.

（2023 冬季 0625/11 第21题）

5. The diagram shows how a converging lens forms an image of an object.



Which description of the image formed by the lens is correct?

A real, inverted and diminished

B real, upright and enlarged

C virtual, inverted and diminished

D virtual, upright and enlarged

（2025 春季 0625/12 第24题）

6. Fig. 6.1 shows an object O which is 5.0 cm away from the centre of a thin, converging lens L. The focal length of L is 3.0 cm. Fig. 6.1 is drawn to full scale.

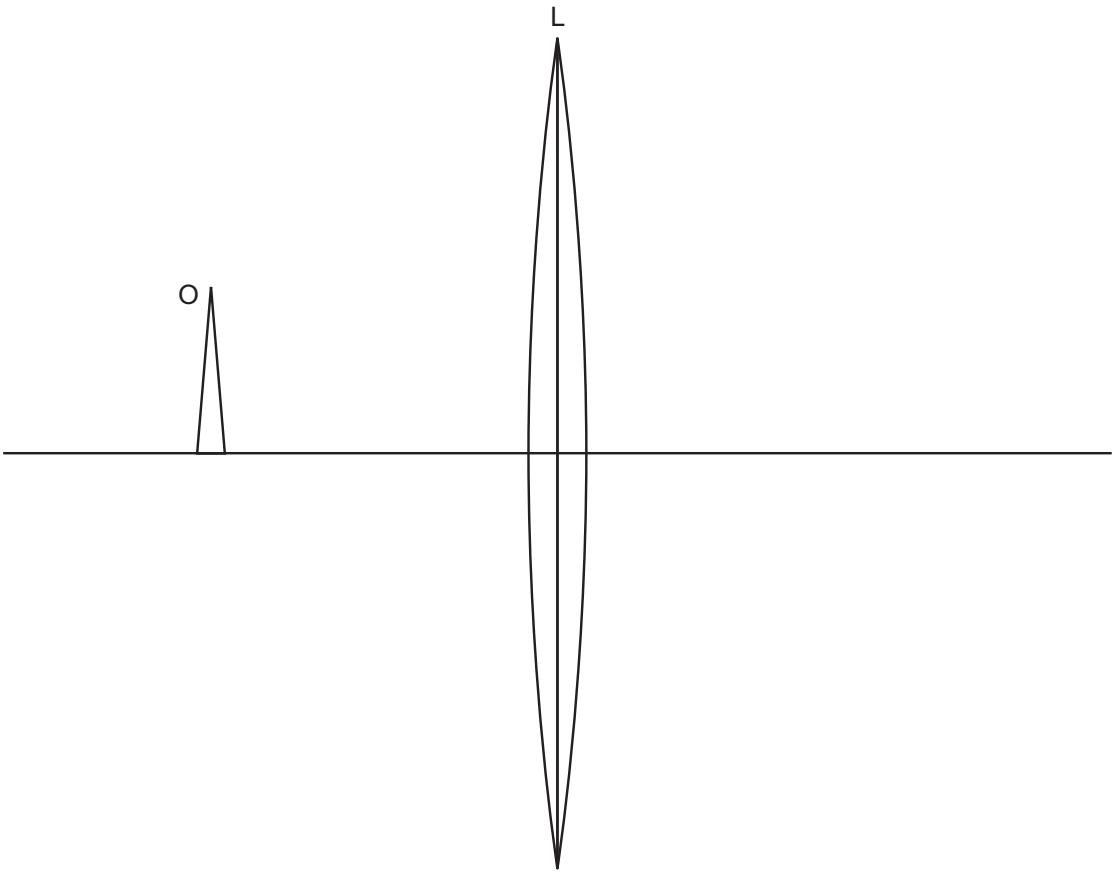


Fig. 6.1

(a) (i) On Fig. 6.1, label the principal axis with a P.

(ii) On Fig. 6.1, place a letter X at a focal point.

(iii) On Fig. 6.1, draw two rays from O to locate the tip of the image produced by the lens. [2]

(iv) In Table 6.1, place a tick in the right-hand column next to **all** the terms that describe the image in **(a)(iii)**.

Table 6.1

diminished	
enlarged	
inverted	
real	
same size	
upright	
virtual	

（2025 春季 0625/42 第6题(a)）

7. **(b)** Fig. 7.2 and Fig. 7.3 show two identical lenses, each forming an image. The images I_1 and I_2 have different characteristics.

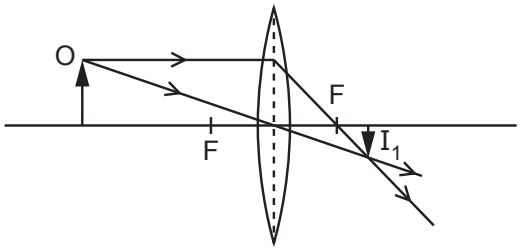


Fig. 7.2

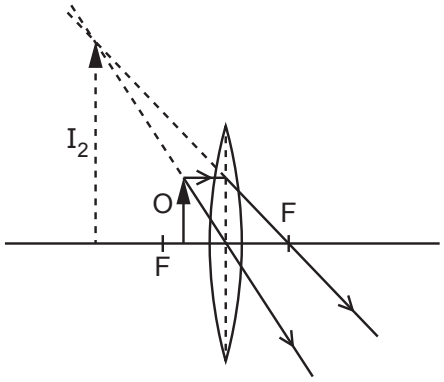


Fig. 7.3

One difference in the characteristics of the two images is:

Image I_1 is ..... diminished ..... but image I_2 is ..... enlarged ..... .

State **two** more differences in the characteristics of the images:

（2023 夏季 0625/33 第7题(b)）

题型 3：按物距判断成像（考频★★★☆☆）

知识点 物距 u 是物体到透镜光心的距离，焦距 f 是主焦点到光心的距离，二者须使用相同单位。

当 $u > 2f$ 时，像为倒立、缩小的实像；当 $u = 2f$ 时，像为倒立、等大的实像。

当 $f < u < 2f$ 时，像为放大、倒立的_____；当 $u < f$ 时，像为放大、正立的_____。

实像能呈现在屏上，虚像不能呈现在屏上。

答案：实像；虚像

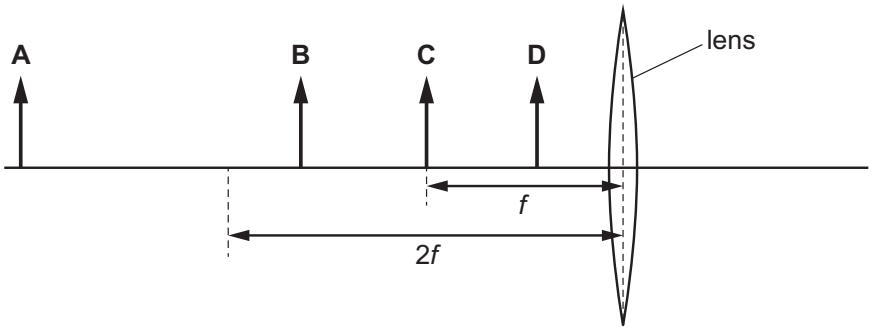
怎么认 题目出现会聚透镜、F与$2F$位置及像的性质时，先比较物距u与f、$2f$。

一. 按 F 与 2F 分区判像

例题 1 An object is placed in front of a converging lens. The lens has a focal length *f*.

The lens produces a real, enlarged image of the object.

In which labelled position is the object placed?



（2024 冬季 0625/22 第21题）

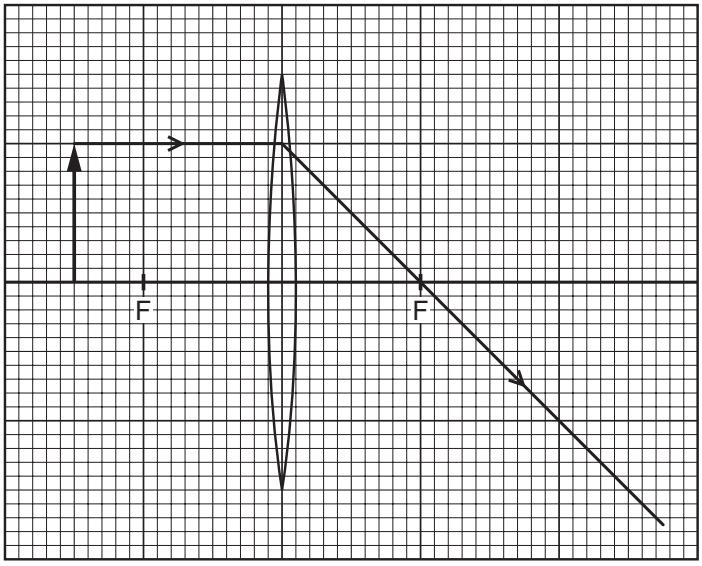
解： 由图可知，位置 B 在 F 与 $2F$ 之间，故

$f < u < 2f$

会聚透镜成放大、倒立的实像。故选 B。

针对练习

1. The diagram shows a partly completed scale drawing of an upright object placed 3 cm in front of a thin converging lens of focal length 2 cm.



What is the nature of the image formed by this lens?

A diminished, inverted and closer to the lens than the object

B diminished, upright and further from the lens than the object

C enlarged, inverted and closer to the lens than the object

D enlarged, inverted and further from the lens than the object

（2023 夏季 0625/13 第19题）

二. 焦内反向延长找虚像

知识点 物距 u 是物体到透镜光心的距离，焦距 f 是光心到主焦点的距离。

会聚透镜作放大镜时，物体位于透镜与主焦点之间，u _____ f，即 $u < f$。

折射光线彼此发散，反向延长后在物体同侧相交，形成_____、_____的虚像。

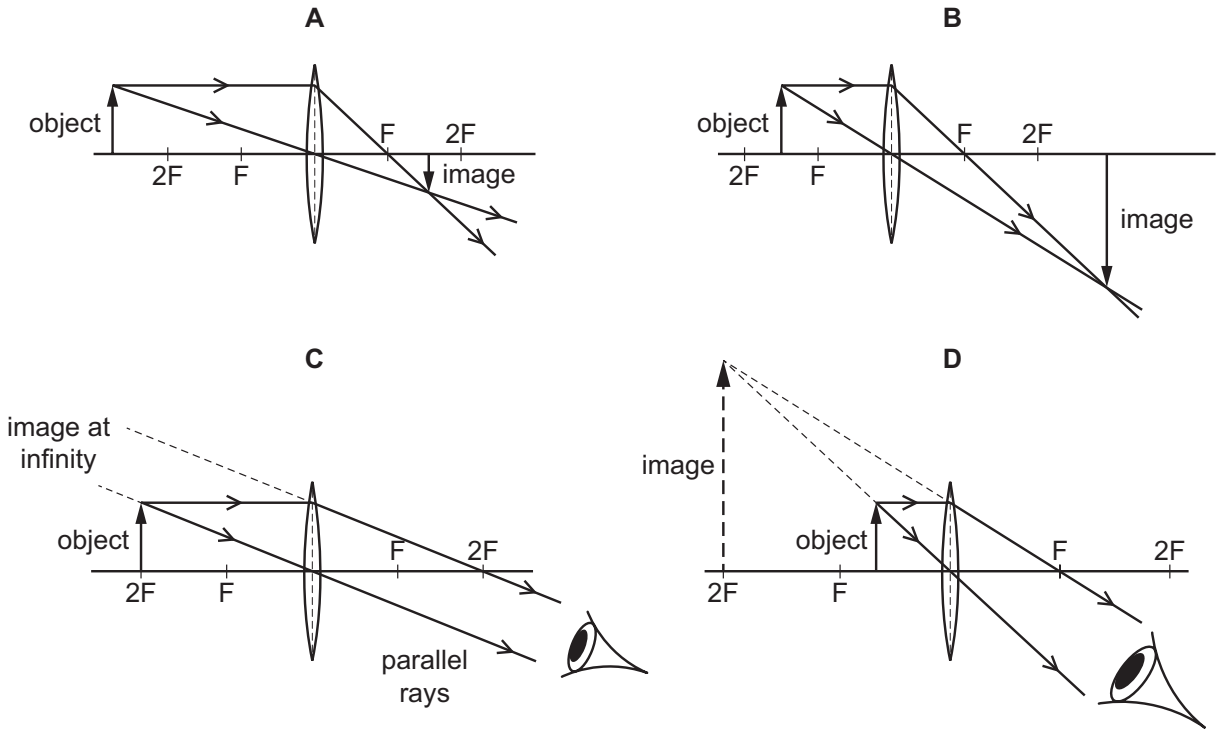
虚像不能在光屏上呈现；u 与 f 均为长度，应使用相同单位。

答案：小于；正立；放大

怎么认 题目出现会聚透镜和物体位于焦点以内时，先确认 $u < f$，再反向延长折射光线。

例题 2 Each point F is one focal length from the centre of the lens. Each point 2F is two focal lengths from the centre of the lens.

Which diagram shows a converging lens being used as a magnifying glass?



（2023 夏季 0625/23 第18题）

解：放大镜所得像应为正立、放大的虚像，物体位于会聚透镜的焦点以内。

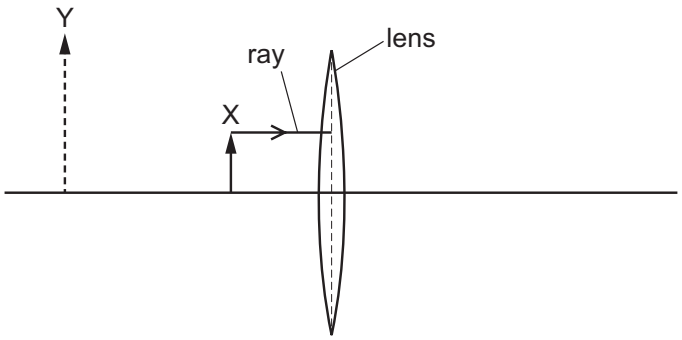
图 D 中物体位于透镜与左侧焦点 F 之间，故 $u < f$。

平行于主轴的光线折射后通过右侧焦点，经过光心的光线方向不变；两条折射光线反向延长后在物体同侧相交，形成正立、放大的虚像。

故选 D。

针对练习

2. The diagram shows part of a ray diagram that demonstrates the formation of a virtual image Y of object X by a converging lens.



One ray of light from X is shown approaching the lens.

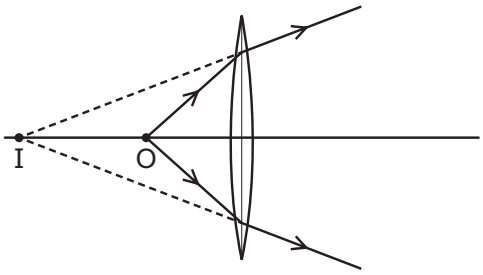
Which arrow shows the direction of this ray as it leaves the lens?

A **B** **C** **D**



（2023 冬季 0625/21 第19题）

3. A small object O is placed near a converging lens, as shown. The lens forms an image I.



Which statement is correct?

A The image I is diminished.

B The image I is inverted.

C The image I is real.

D The object O is closer to the lens than its principal focus.

（2025 夏季 0625/22 第22题）

4. Fig. 6.1 shows an object O which is 5.0 cm away from the centre of a thin, converging lens L. The focal length of L is 3.0 cm. Fig. 6.1 is drawn to full scale.

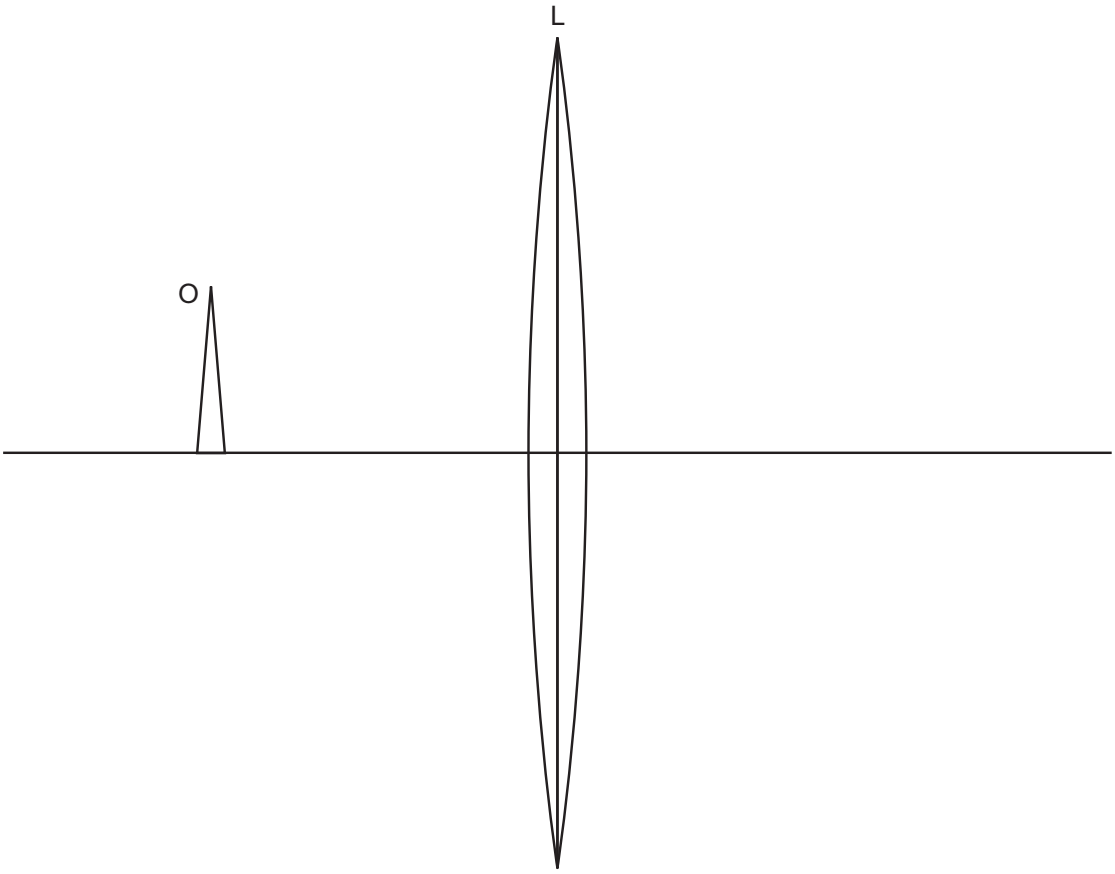


Fig. 6.1

(a) (i) On Fig. 6.1, label the principal axis with a P.

(ii) On Fig. 6.1, place a letter X at a focal point.

(iii) On Fig. 6.1, draw two rays from O to locate the tip of the image produced by the lens. [2]

(iv) In Table 6.1, place a tick in the right-hand column next to **all** the terms that describe the image in **(a)(iii)**.

Table 6.1

diminished	
enlarged	
inverted	
real	
same size	
upright	
virtual	

(b) The object moves closer to L. The new distance between L and the object is less than the focal length of L.

Describe how the new image is different from the image in **(a)(iv)**.

（2025 春季 0625/42 第6题(b)）

5. Fig. 6.1 shows a thin converging lens used to produce a magnified image of an object AB.

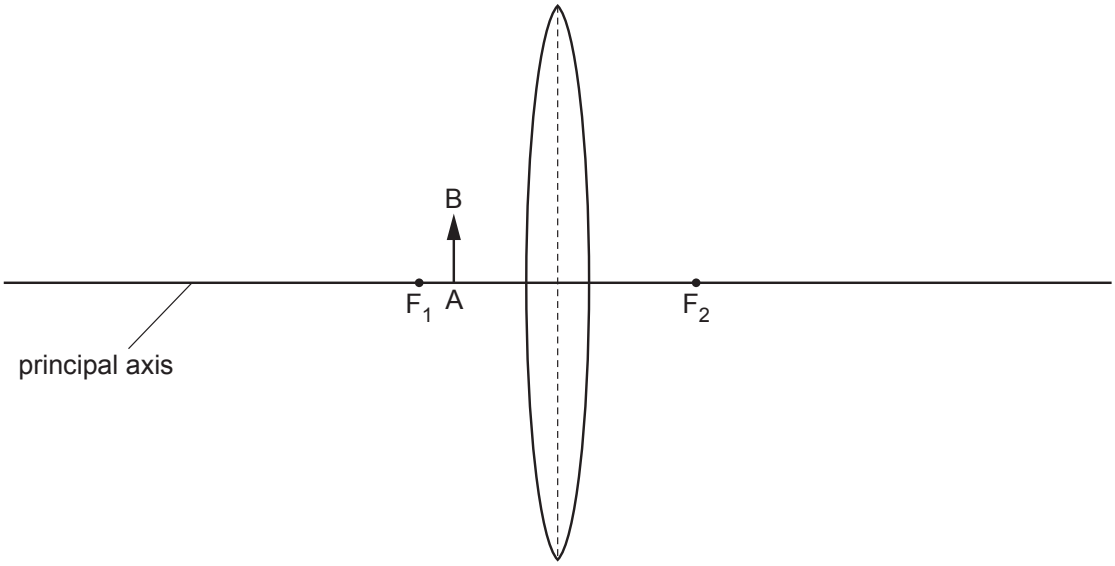


Fig. 6.1

(b) On Fig. 6.1, draw the magnified image of AB. Show your working.

（2024 夏季 0625/43 第6题(b)）

题型 4：处理矫正与透镜测量（考频★★★☆☆）

知识点 眼睛看清物体时，进入眼睛的光线应会聚在视网膜上。

近视眼观察远处物体时，像落在视网膜_____，应加_____透镜，使光线先发散。

远视眼观察近处物体时，像将落在视网膜_____，应加会聚透镜，使像前移至视网膜。

答案：前；发散；后

怎么认 题目出现近视或远视、像的位置或矫正透镜时，先判断像落在视网膜前还是后。

一. 按落像位置选矫正透镜

例题 1 A long-sighted person **cannot** see objects clearly that are a short distance away because the image is blurred.

Where is the image formed relative to the retina and which type of lens is used to correct long-sightedness?

	position of image	lens used for correction
A	behind retina	converging
B	behind retina	diverging
C	in front of retina	converging
D	in front of retina	diverging

（2025 冬季 0625/22 第21题）

解： 远视眼看近处物体时，会聚能力不足，像将形成在视网膜后。

会聚透镜使光线的会聚程度增大，使像前移至视网膜。

故选 A。

1. **(c)** Fig. 5.3 shows a simplified diagram of an eye with rays from a distant object and the path of the rays inside the eye of a person with short sight.

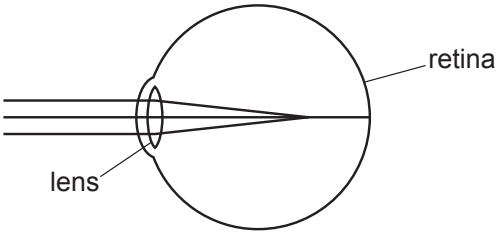


Fig. 5.3

On Fig. 5.4, draw an additional lens outside the eye to correct short-sightedness and show the path of the rays inside the eye.

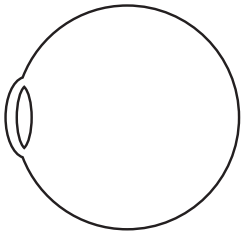
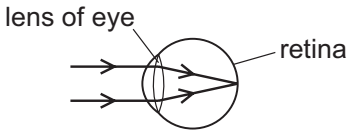


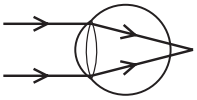
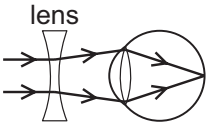
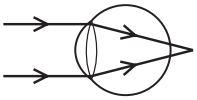
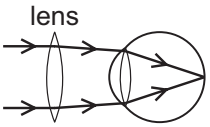
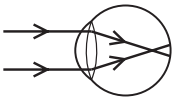
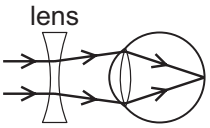
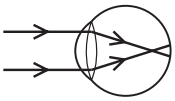
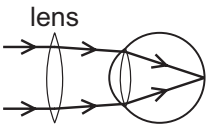
Fig. 5.4

（2023 春季 0625/42 第5题(c)）

2. The diagram shows a human eye that correctly focuses the light on the retina.



Which row shows a short-sighted eye and use of the correct lens to focus the image?

	ray diagram for short-sighted eye	corrected vision
A		
B		
C		
D		

（2025 冬季 0625/23 第21题）

3. The lens in a magnifying glass is a converging lens.

(c) Converging lenses are used in spectacles (glasses) to correct one problem with vision.

State the name of the problem and explain how a converging lens is used to correct it. You may draw a diagram.

（2024 夏季 0625/41 第4题(c)）

4. **(b)** **(i)** State the name for the defect of vision that can be corrected by a converging lens.

(ii) Describe how a converging lens corrects the defect in **(i)**.
You may find it helpful to sketch a ray diagram.

（2023 夏季 0625/43 第4题(b)）

二. 测物像距算焦距放大率

知识点 会聚透镜在光屏上形成清晰实像时，物距 u 是物体到透镜光心的距离，像距 v 是透镜光心到光屏的距离，三者须采用相同长度单位。

焦距满足 $f=\frac{uv}{u+v}$，其中 f、u、v 常用 cm。

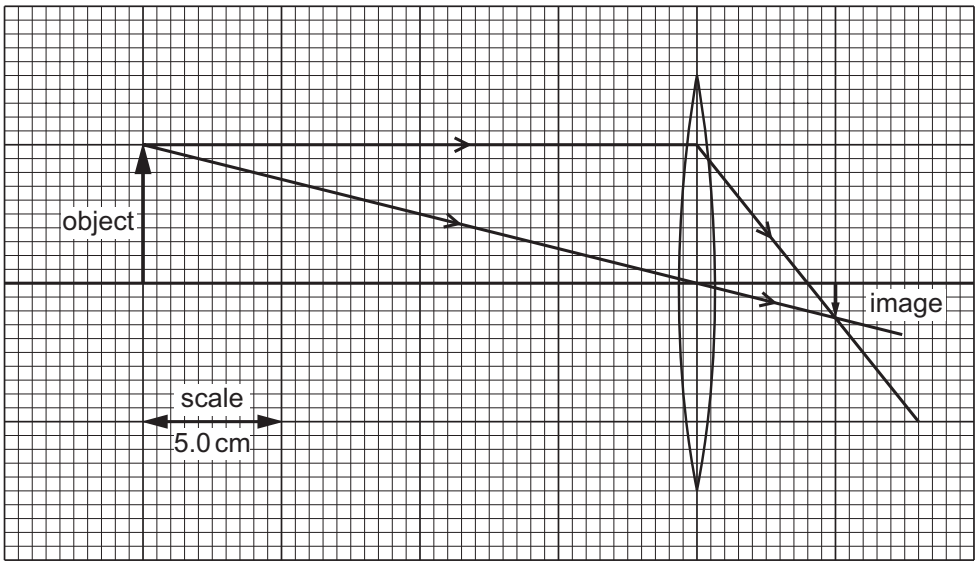
像的放大率 $m=\frac{h_i}{h_o}=\frac{v}{u}$，其中 h_i 与 h_o 分别为像高与物高，放大率_____单位。

测量时应把光屏移到像最_____的位置，并从透镜_____量取 u 和 v。

答案：没有；清晰；光心（中心）

怎么认 题目出现清晰实像、物距 u、像距 v 或比例图并求焦距、放大率时，先确定 u 与 v。

例题 2 An object is placed 20 cm in front of a thin converging lens. The scale diagram shows how the lens forms a real, inverted image.



Which row gives the focal length of the lens and the distance of the image from the lens?

	focal length of lens / cm	distance of image from lens / cm
A	4.0	5.0
B	5.0	4.0
C	8.0	10.0
D	10.0	8.0

（2024 冬季 0625/21 第21题）

解： 由比例尺读得

$v = 5.0$ cm

由会聚透镜成实像的焦距关系得

$f = \frac{uv}{u+v}$

$= \frac{20\times5.0}{20+5.0}$

$= 4.0$ cm

像距为 5.0 cm，故选 A。

5. A page of printed text is placed 18 cm from a converging lens of focal length 35 cm.

Fig. 6.1 is a scale diagram of the arrangement with each of the two principal focuses (focal points) of the lens labelled F.

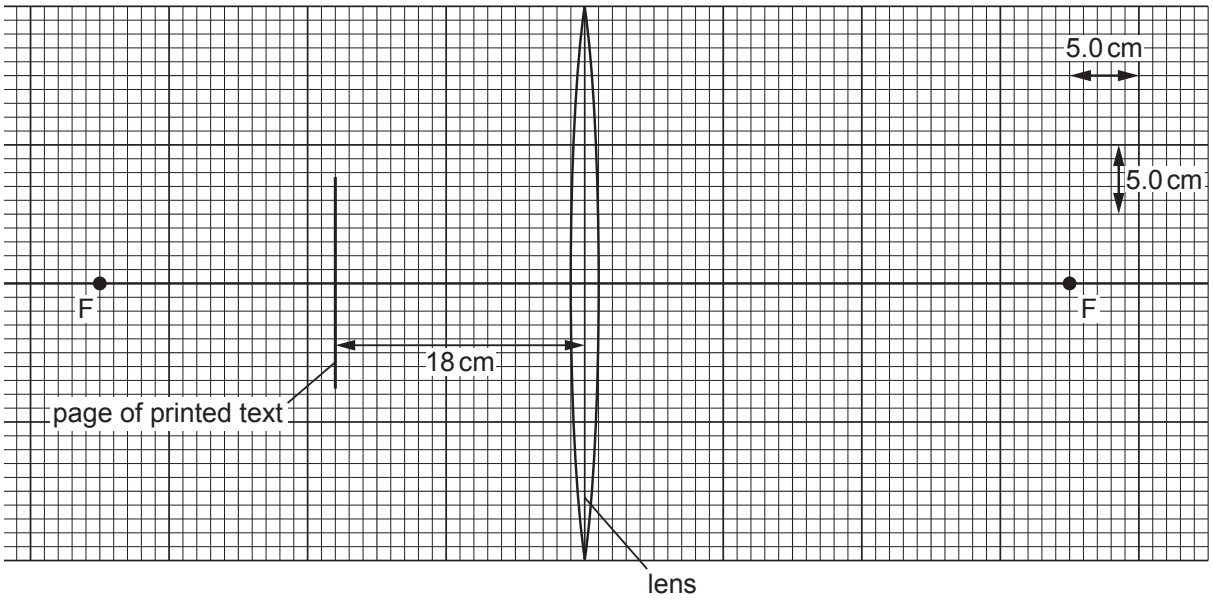


Fig. 6.1

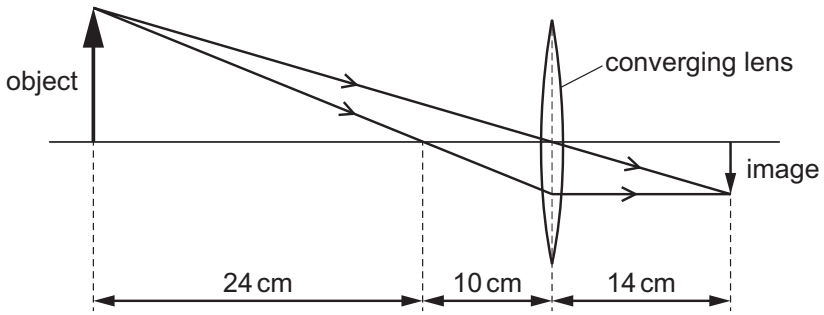
(a) A length of 1.0 cm on the scale diagram represents an actual length of 5.0 cm.

(i) By drawing on Fig. 6.1, locate the image of the page produced by the lens and label it I. [3]

(ii) Using Fig. 6.1, determine the actual distance of image I from the lens.

（2023 冬季 0625/41 第6题(a)）

6. The diagram shows a converging lens forming an image.



not to scale

What is the focal length of the converging lens?

A 10 cm **B** 14 cm **C** 24 cm **D** 34 cm

（2025 夏季 0625/12 第20题）

3.2.4 光的色散

题型 1：区分白光与单色光（考频★★★☆☆）

知识点 白光经玻璃棱镜折射后分解成不同颜色的光，这种现象称为_____。

可见光按频率由低到高，或按波长由长到短，均依次为红、橙、黄、绿、蓝、靛、紫。

频率的单位是赫兹（Hz），波长的单位是米（m）；频率越高，波长越_____。

单一频率的可见光称为_____。

答案：色散；短；单色光

怎么认 题目出现白光经棱镜分成不同颜色或形成光谱时，先判定该现象为色散。

一. 白光分色判色散

例题 1 White light can be split into different colours by passing it through a prism.

What is the name of this process?

A diffraction

B dispersion

C reflection

D refraction

（2024 夏季 0625/12 第20题）

解：白光经棱镜后分成不同颜色，这种现象称为色散。

故选 B。

针对练习

1. White light can be split into different colours by passing it through a prism.

What is the name of this process?

A diffraction

B dispersion

C reflection

D total internal reflection

（2025 冬季 0625/13 第23题）

2. A beam of white light is split into a spectrum of seven colours.

Which name is given to this process?

A diffraction

B dispersion

C reflection

D refraction

（2025 夏季 0625/21 第21题）

二. 单一频率判单色光

知识点 只含一个频率的可见光称为_____光。

白光含有多种频率，通过玻璃棱镜时，不同频率的光偏折程度不同，因而发生_____；单色光经棱镜折射后只改变传播方向，不会分成多种颜色。

光的频率用 f 表示，单位是_____（Hz）。

答案：单色；色散；赫兹

怎么认 题目出现单色光、白光或棱镜后的出射光线时，先检查光是否只含一个频率。

例题 2 Which statement describes monochromatic light?

A light of a single frequency

B light transmitted by a transparent prism

C visible light

D white light

（2023 夏季 0625/22 第19题）

解：由单色光的定义，单色光是只含一个频率的可见光。故选 A。

针对练习

3. Fig. 5.1 shows a block ABCD made of glass that has a refractive index of 1.5. The block has one curved side AB and three straight sides, BC, CD and DA.

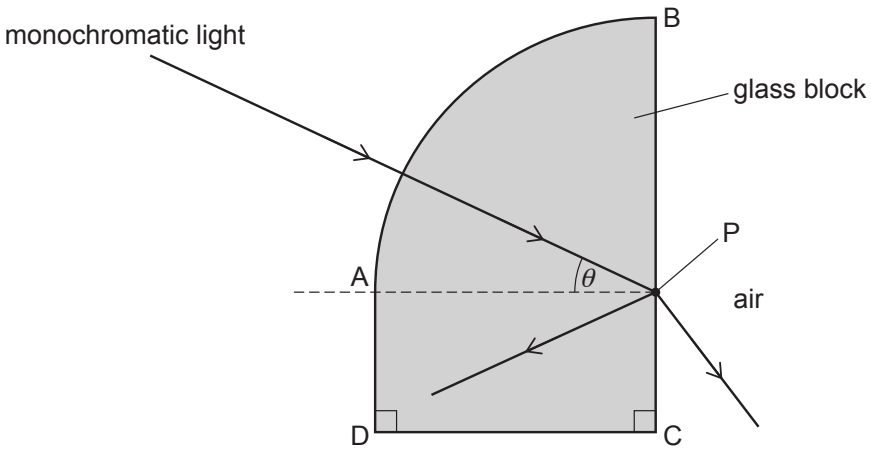


Fig. 5.1

There are right angles at C and D. The curved side AB is one quarter of the circumference of a circle that has its centre at point P.

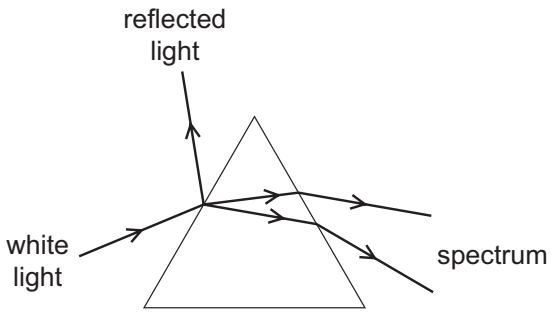
A ray of monochromatic light enters the block through the curved side AB and strikes side BC at P. Some light emerges into the air and some is reflected.

(a) State what is meant by monochromatic.

（2023 夏季 0625/41 第5题(a)）

4. The diagram shows the effect of a prism on white light.

Some light is reflected on striking the prism and some is refracted and dispersed to form a spectrum.



What happens if monochromatic light is used instead of white light?

A The light changes colour as it passes through the prism.

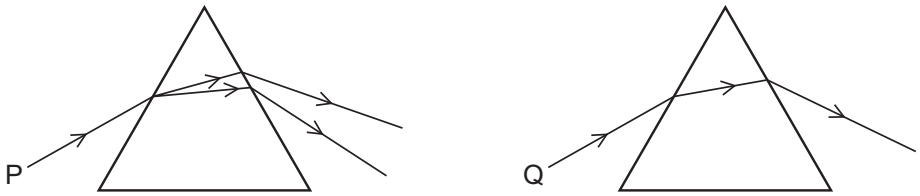
B The light forms a brighter spectrum.

C There is no reflected light.

D There is no dispersion of the emerging light.

（2023 冬季 0625/23 第19题）

5. The diagram shows two narrow beams of light, P and then Q, passing through the same prism. Beams P and Q are both incident on the same point on the prism and at the same angle.



Which row correctly compares beams P and Q?

	dispersion	nature of light
A	only Q is dispersed	P is monochromatic and Q is white light
B	only Q is dispersed	P is white light and Q is monochromatic
C	only P is dispersed	P is monochromatic and Q is white light
D	only P is dispersed	P is white light and Q is monochromatic

（2025 冬季 0625/21 第21题）

题型 2：按颜色比较频率波长（考频★★★☆☆）

知识点 白光经玻璃棱镜折射后分解成不同颜色的光，这种现象称为色散。

可见光从紫到红依次为紫、靛、蓝、绿、黄、橙、红；频率逐渐_____，波长逐渐_____。

在同一介质中，光的频率越大，波长越短；频率的单位是 Hz，波长的单位是 m。

只含单一频率的可见光称为_____光。

答案：减小；增大；单色

怎么认 题目出现可见光颜色排序、频率或波长比较时，先写出紫、靛、蓝、绿、黄、橙、红。

一. 按紫到红排频率波长

例题 1

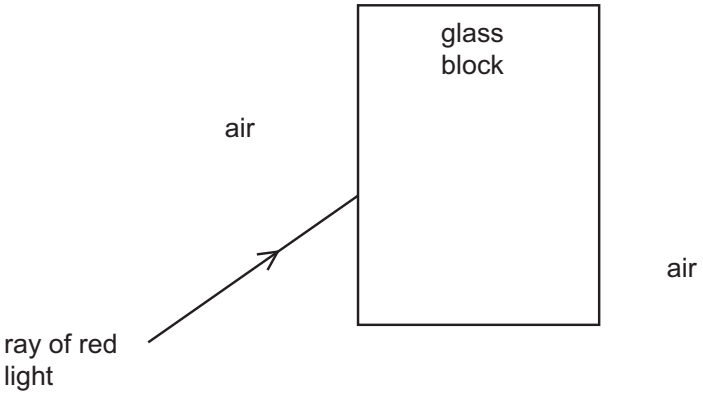


Fig. 7.1

On Fig. 7.1 draw the path of the ray of red light through the glass block and into the air.

(b) Fig. 7.2 represents the dispersion of white light by a glass prism.

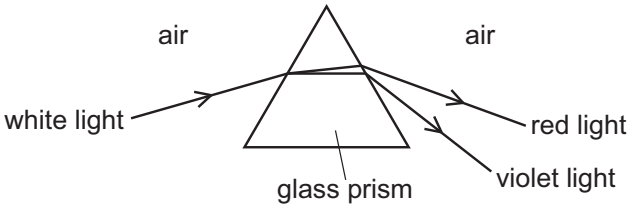


Fig. 7.2

Two of the colours of the visible spectrum are shown in Fig. 7.2.

State the other five colours of the visible spectrum in the correct order.

red

violet

（2025 春季 0625/32 第7题(b)）

解：可见光从红到紫依次为红、橙、黄、绿、蓝、靛、紫。

题图已给出红和紫，故其余五种颜色依次为橙、黄、绿、蓝、靛。

答：橙、黄、绿、蓝、靛。

针对练习

1. **(c)** State the **seven** colours of visible light. Give the colours in order of frequency.

frequency	colour
greatest ↑	
smallest	

（2023 冬季 0625/33 第6题(c)）

2. Which colours of visible light are in the correct order of increasing wavelength?

A red → yellow → blue

B orange → green → violet

C indigo → green → red

D blue → green → violet

（2024 夏季 0625/23 第22题）

3. Red, green and violet lights are part of the visible spectrum of light.

What is the order of colours from shortest to longest wavelength?

A red → green → violet

B red → violet → green

C violet → red → green

D violet → green → red

（2023 冬季 0625/12 第19题）

4. **(c)** Fig. 7.3 shows a prism producing a spectrum of colours from a narrow beam of white light.

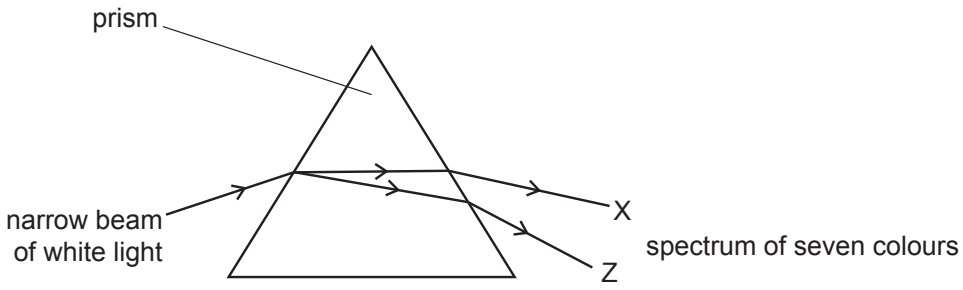


Fig. 7.3

(i) The prism refracts the white light.

State the name of the effect that produces a spectrum.

(ii) In the spectrum shown in Fig. 7.3, there are seven colours.

List the seven colours in the order they appear between X and Z.

（2024 夏季 0625/31 第7题(c)）

二. 由颜色判断大小关系

知识点 白光经玻璃棱镜折射后分成不同颜色的光，这种现象称为光的色散；红光偏折最小，紫光偏折最大。

可见光按频率由低到高、波长由长到短依次为红、橙、黄、绿、蓝、靛、紫；越靠_____端，频率越高，波长越短。

在真空中 $c = f\lambda$，空气中可近似按同一传播速率比较，故频率与波长成_____；波长单位为 m，频率单位为 Hz。

单一频率的可见光称为_____光。

答案：紫；反比；单色

怎么认 题目出现颜色或可见光谱两端，并要求比较频率、波长时，先按红橙黄绿蓝靛紫确定位置。

例题 2

Blue light has a typical wavelength of 5.0 10^{-7} m and frequency of 0.60 10^{15} Hz.

Which row gives a typical wavelength and frequency for red light?

	wavelength	frequency
A	2.4 10^{-7} m	0.40 10^{15} Hz
B	2.4 10^{-7} m	1.3 10^{15} Hz
C	6.9 10^{-7} m	0.40 10^{15} Hz
D	6.9 10^{-7} m	1.3 10^{15} Hz

（2023 春季 0625/12 第20题）

解： 红光比蓝光更靠红端，故红光的波长更长，频率更低。

$\lambda_{红} > 5.0 \times 10^{-7}$ m

$f_{红} < 0.60 \times 10^{15}$ Hz

选项 C 的波长满足

6.9×10^{-7} m $> 5.0 \times 10^{-7}$ m

频率满足

0.40×10^{15} Hz $< 0.60 \times 10^{15}$ Hz

故选 C。

针对练习

5. Red light of frequency 430 × 10^{12} Hz has a wavelength of 700 × 10^{-9} m.

What is possible for blue light?

A a frequency of 190 × 10^{12} Hz and a wavelength of 450 × 10^{-9} m

B a frequency of 190 × 10^{12} Hz and a wavelength of 950 × 10^{-9} m

C a frequency of 670 × 10^{12} Hz and a wavelength of 450 × 10^{-9} m

D a frequency of 670 × 10^{12} Hz and a wavelength of 950 × 10^{-9} m

（2024 夏季 0625/11 第20题）

6. The table shows information about different colours of light.

colour of light	frequency / Hz
violet	7.2×10^{14}
blue	6.3×10^{14}
yellow	5.2×10^{14}
red	4.5×10^{14}

Using the data, what is the frequency of orange light?

A 4.0×10^{14} Hz

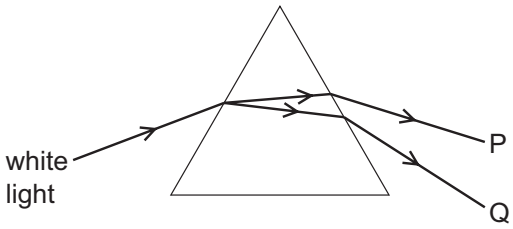
B 5.0×10^{14} Hz

C 6.0×10^{14} Hz

D 7.0×10^{14} Hz

（2024 夏季 0625/13 第20题）

7. The diagram shows a narrow beam of white light being dispersed by a glass prism to produce a visible spectrum.



Which statement describes what happens to the frequency and wavelength of the light in observing from P to Q across the spectrum?

A The frequency and the wavelength both increase.

B The frequency and the wavelength both decrease.

C The frequency decreases but the wavelength increases.

D The frequency increases but the wavelength decreases.

（2024 冬季 0625/12 第21题）

题型 3：按偏折判断棱镜光路（考频★★★☆☆）

知识点 白光经玻璃棱镜折射后分解成不同颜色的光，这种现象称为_____。

只有一种频率的可见光称为_____光（monochromatic light）。

可见光按频率由低到高依次为红、橙、黄、绿、蓝、靛、紫，波长顺序与频率顺序相反；频率单位为 Hz，波长的 SI 单位为 m。

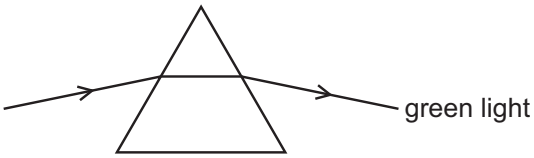
在同一种玻璃、相同入射条件下，红光偏折最小，紫光偏折最大；黄光比绿光偏折得_____。

答案：色散；单色；小

怎么认 题目出现棱镜、不同颜色光线和偏折大小时，先按红光偏折最小、紫光偏折最大排序。

一. 用红小紫大排颜色

例题 1 A ray of green light passes through a glass prism, as shown.



Which colours of light refract as shown in the table?

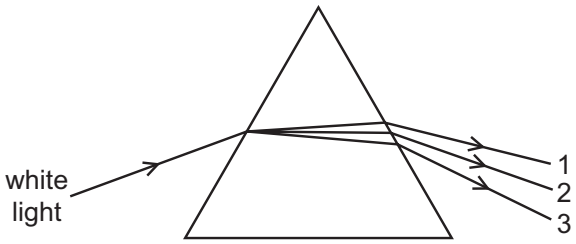
	refracts more than green	refracts less than green
A	red	blue
B	red	yellow
C	violet	blue
D	violet	yellow

（2024 春季 0625/12 第19题）

解：同一种玻璃中，可见光由红到紫频率逐渐增大，偏折程度也逐渐增大。
紫光比绿光偏折得大，黄光比绿光偏折得小。
故选 D。

针对练习

1. A narrow beam of white light passes through a prism and is dispersed into a spectrum.



Which row is correct?

	colour 1	colour 2	colour 3
A	blue	yellow	red
B	red	blue	yellow
C	red	yellow	blue
D	yellow	blue	red

（2023 夏季 0625/23 第20题）

2. **(b)** A ray of blue light replaces the ray of red light. The angle of incidence for the blue ray entering the prism is the same as in Fig. 7.1.

Describe any difference between the path of the blue ray in the prism and the path of the red ray in the prism.

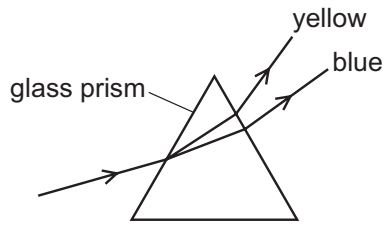
（2024 夏季 0625/33 第7题(b)）

3. A beam of light consists of yellow and blue light.

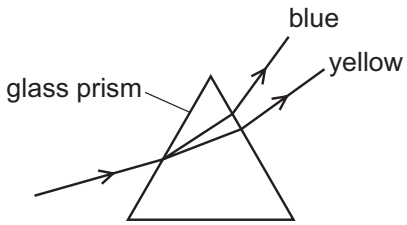
The beam of light is incident on a glass prism.

Which diagram is correct?

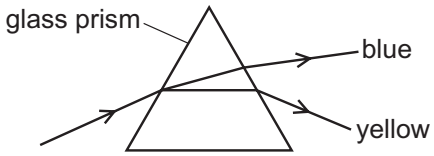
A



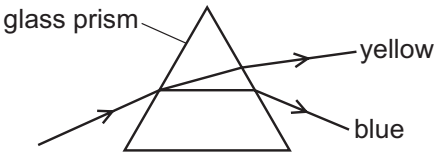
B



C

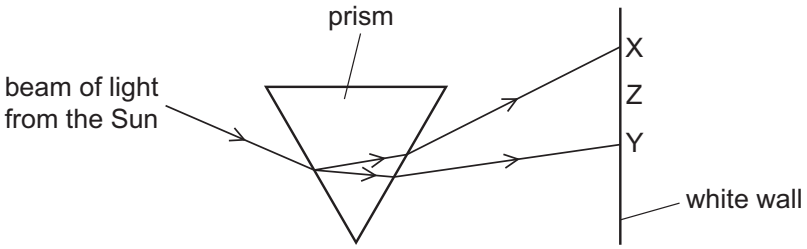


D



（2023 夏季 0625/22 第20题）

4. A beam of light from the Sun strikes a prism.



The dispersed beam is incident on a white wall between X and Y.

Which colours are seen at X, Z and Y?

	X	Z	Y
A	red	green	violet
B	red	violet	green
C	violet	green	red
D	violet	red	green

（2023 冬季 0625/13 第19题）

二. 逐界面画色散光路

知识点 白光通过玻璃棱镜时，不同频率的色光因折射程度不同而分开，这种现象称为_____。

光由空气斜射入玻璃时向法线偏折，由玻璃斜射入空气时背离法线偏折；两次折射后的光线总体向棱镜_____偏折。

玻璃对紫光的折射程度大于红光，因此紫光总偏折较大，红光总偏折较小。

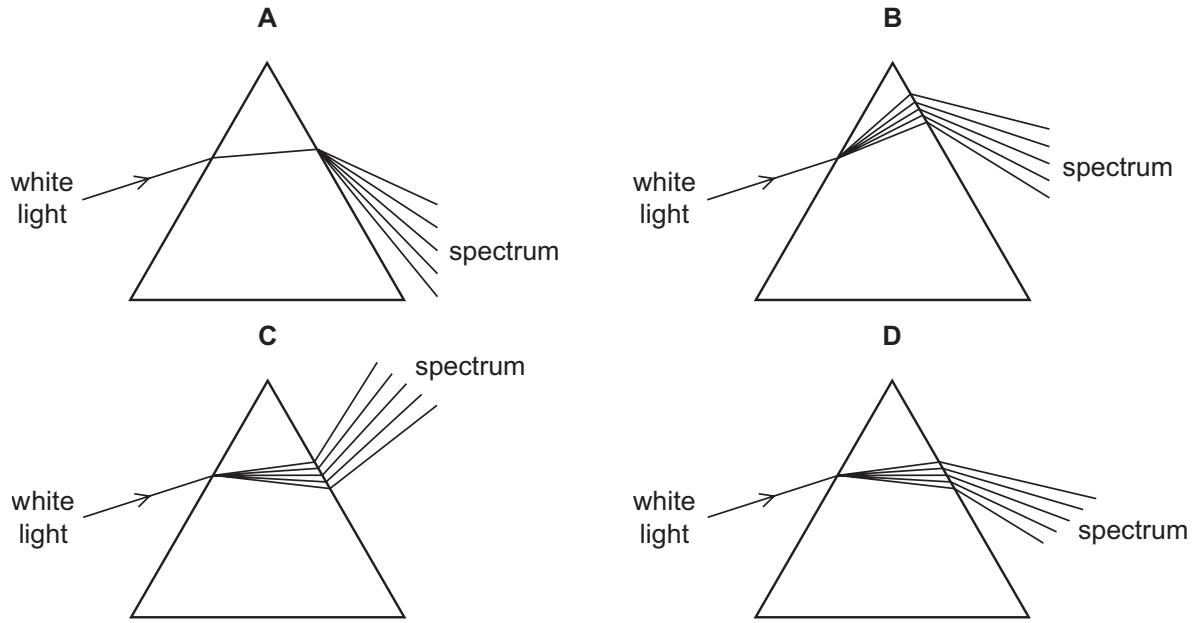
可见光按频率由低到高为红、橙、黄、绿、蓝、靛、紫，按波长由短到长的次序相反；频率单位为 Hz，波长单位为 m。

只有单一频率的可见光称为_____。

答案：色散；底边；单色光

怎么认 题目出现白光射入棱镜并要求判断或补画光路时，先判断两界面的折射方向，再比较紫光与红光的偏折大小。

例题 2 Which diagram shows what happens when a ray of white light passes through a prism?

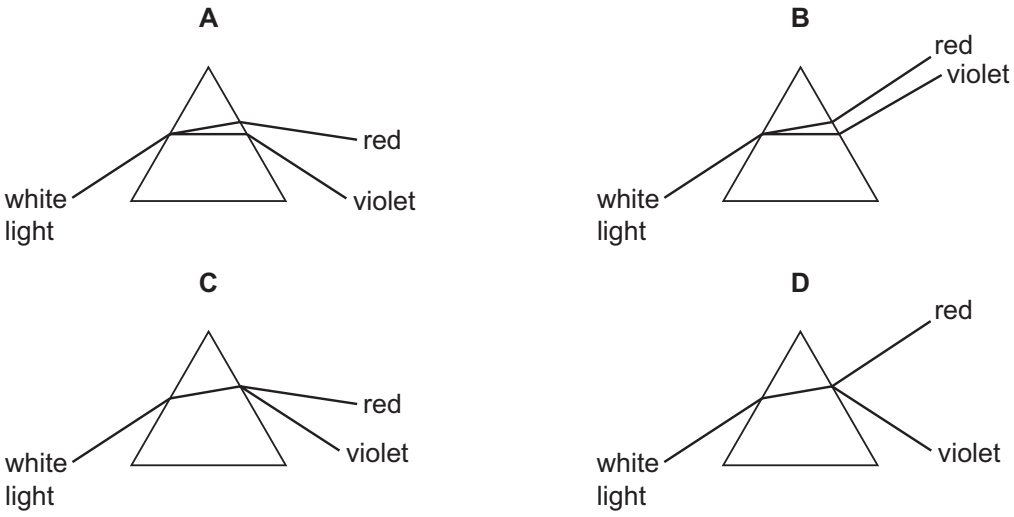


（2023 春季 0625/12 第21题）

解：光由空气进入玻璃，在入射面向法线偏折；光由玻璃进入空气，在出射面背离法线偏折。
棱镜使光线总体向底边偏折，且紫光的总偏折大于红光，出射后形成向下展开的光谱。
图 D 符合两界面的折射方向和色散方向，故选 D。

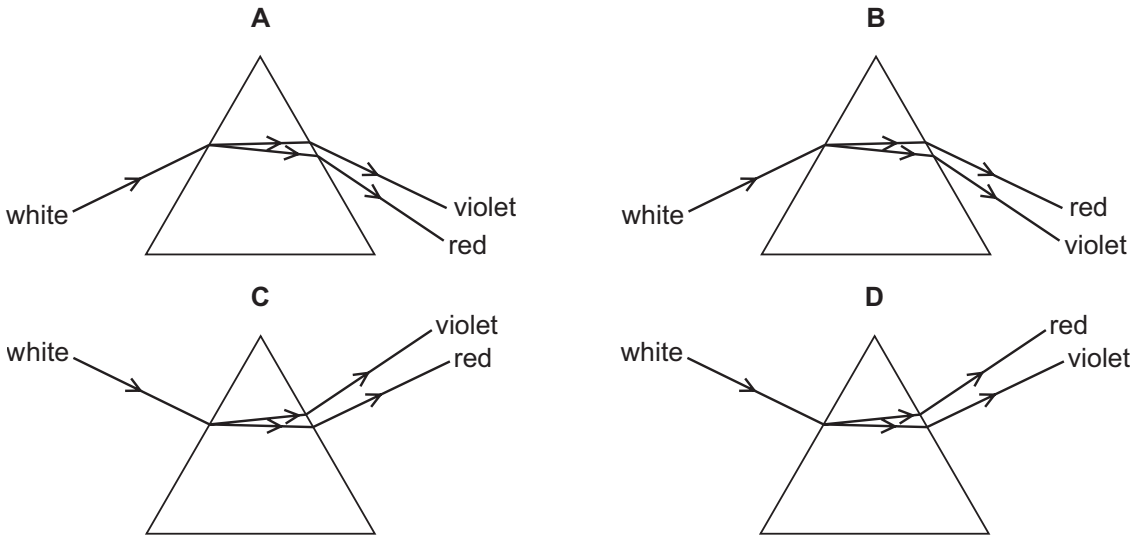
针对练习

5. Which diagram shows the dispersion of white light by a glass prism?



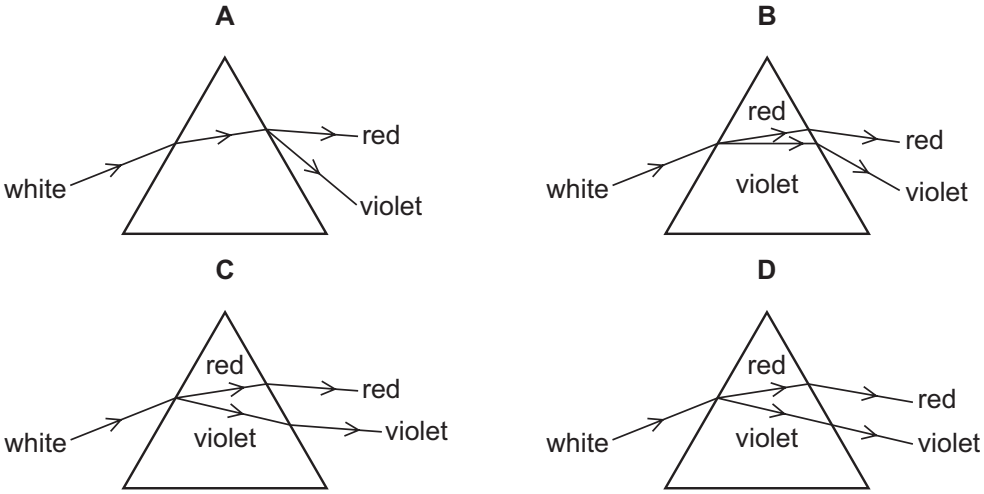
（2024 冬季 0625/11 第21题）

6. Which diagram shows the dispersion of white light by a prism?



（2024 冬季 0625/13 第21题）

7. Which diagram shows the dispersion of white light by a glass prism?



（2023 夏季 0625/21 第20题）

8. **(b)** Fig. 5.1 shows a ray of red light passing through a prism and emerging into the air.

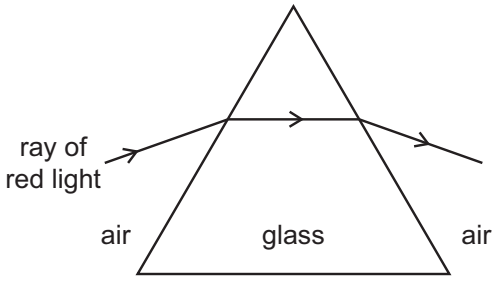


Fig. 5.1

(i) State the name of the process shown in Fig. 5.1 that occurs at the boundaries between air and glass.

(ii) A ray of **white** light replaces the ray of red light, as shown in Fig. 5.2. The ray of **white** light splits into different colours.

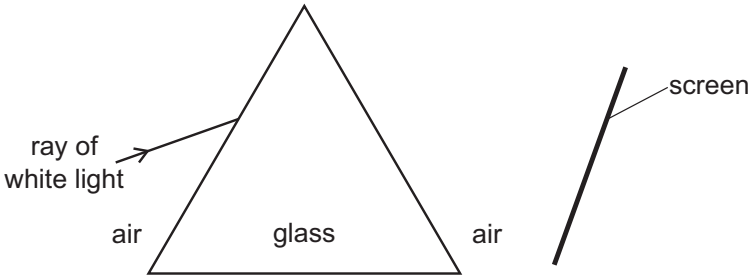


Fig. 5.2

Draw on Fig. 5.2 to show the dispersion of white light to produce a coloured spectrum on a screen. Label the red and violet (purple) parts of the spectrum.

（2025 夏季 0625/32 第5题(b)）

3.3 电磁波谱

题型 1：按顺序读电磁波谱（考频★★★☆☆）

知识点 电磁波谱按频率由低到高排列为：无线电波、微波、红外线、_____、紫外线、X 射线、γ 射线。

在真空中，所有电磁波的传播速率 c 相同，$c = 3.0 \times 10^8$ m/s，且 $c = f\lambda$；频率越高，波长越_____。

频率的单位为 Hz，波长的单位为 m。

答案：可见光；短

怎么认 题目出现波谱空格或频率、波长数据时，先写七个波段，再按频率由低到高定位。

一. 按频率顺序定位波段

例题 1 The diagram shows the electromagnetic spectrum.

γ-rays	E	ultraviolet	F	infrared	microwaves	G

Which types of wave are E, F and G?

	E	F	G
A	radio	visible light	X-rays
B	radio	X-rays	ultrasound
C	X-rays	radio	ultrasound
D	X-rays	visible light	radio

（2023 冬季 0625/13 第22题）

解： 电磁波谱按频率由低到高为
无线电波、微波、红外线、可见光、紫外线、X 射线、γ 射线。
图中从左到右频率逐渐降低，故 E 为 X 射线，F 为可见光，G 为无线电波。故选 D。

针对练习

1. The table gives the wavelengths of three electromagnetic waves.

electromagnetic wave	wavelength / m
P	3.2×10^{-3}
Q	5.0×10^{-9}
R	2.6×10^{3}

Which row correctly identifies P, Q and R?

	P	Q	R
A	microwave	radio wave	X-ray
B	microwave	X-ray	radio wave
C	radio wave	microwave	X-ray
D	radio wave	X-ray	microwave

（2024 夏季 0625/13 第21题）

2. Fig. 5.1 shows the main regions of the electromagnetic spectrum in order of increasing frequency.

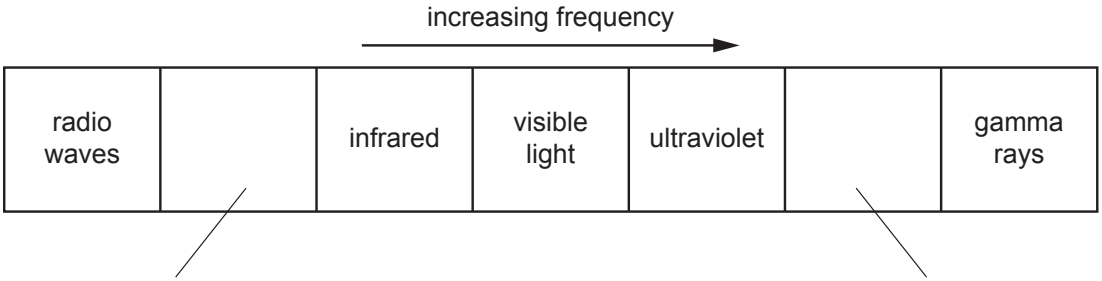


Fig. 5.1

(a) Two of the regions are unlabelled.

Add the correct label to each of the unlabelled regions in Fig. 5.1.

（2023 冬季 0625/31 第5题(a)）

3. The table gives the range of frequencies of three types of electromagnetic radiation.

type of radiation	range of frequencies / Hz
radio	3×10^4 to 3×10^9
visible light	4×10^{14} to 8×10^{14}
X-rays	3×10^{16} to 3×10^{19}

Which type of electromagnetic radiation has a frequency of 4×10^{15} Hz?

A gamma radiation

B infrared radiation

C microwave radiation

D ultraviolet radiation

（2025 春季 0625/12 第26题）

二. 比较频率波长与真空速率

知识点 电磁波谱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。

频率越高，波长越_____；按波长由长到短排列时，顺序与上述顺序相同。

电磁波都是_____波，不需要介质也能传播。

在真空中，所有电磁波的传播速率_____，均为 3.0×10^8 m/s。

卫星电视信号用微波，电视遥控器用红外线，红、绿指示灯发出可见光。

答案：短；横；相同

怎么认 题目出现电磁波谱顺序、波长比较或真空速率时，先写出各波段顺序并用同速关系判断。

例题 2 What is the speed of radio waves in a vacuum and what is the speed of gamma rays in a vacuum?

	speed of radio waves	speed of gamma rays
A	less than 3.0×10^8 m/s	less than 3.0×10^8 m/s
B	less than 3.0×10^8 m/s	more than 3.0×10^8 m/s
C	3.0×10^8 m/s	3.0×10^8 m/s
D	more than 3.0×10^8 m/s	more than 3.0×10^8 m/s

（2025 夏季 0625/23 第21题）

解： 无线电波和伽马射线都属于电磁波。
在真空中，所有电磁波的传播速率相同，
$v_{\text{无线电波}} = v_{\text{伽马射线}} = 3.0 \times 10^8\ \text{m/s}$。
故选 C。

针对练习

4. What is the speed of electromagnetic waves in a vacuum?

A 300 m/s

B 300 km/s

C 300 000 km/s

D 300 000 000 km/s

（2024 冬季 0625/22 第22题）

5. **(a)** Fig. 5.1 shows regions of the electromagnetic spectrum in order of increasing wavelength. **Two** of the regions are unlabelled.

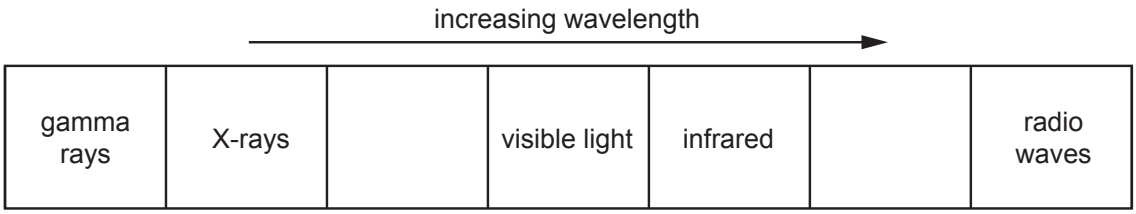


Fig. 5.1

(i) Complete Fig. 5.1 by writing the name of each unlabelled region in the correct box.

(ii) State **two** properties that are the same for all regions of the electromagnetic spectrum.

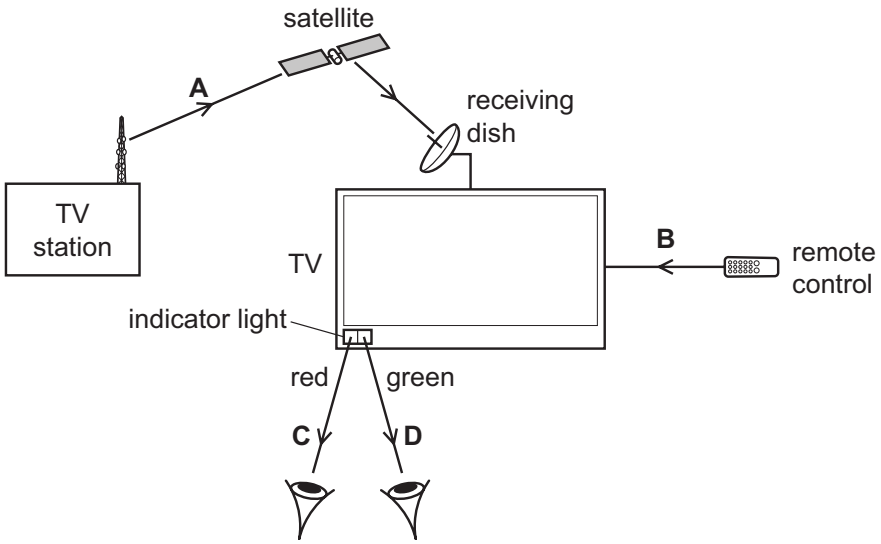
（2023 冬季 0625/33 第5题(a)）

6. A television (TV) station transmits a signal to a television receiving dish.

The television has an on / off indicator light.

The television is switched on by a remote control which changes the indicator light from red to green.

Which electromagnetic wave used in these actions has the longest wavelength?



（2023 春季 0625/12 第22题）

题型 2：由用途危害反推波段（考频★★★☆☆）

知识点 电磁波谱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 射线和伽马射线；在同一介质中，频率越高，波长越短。

无线电波用于广播和电视传输、天文观测、射频识别及蓝牙数据连接；微波用于卫星电视、手机、微波炉和无线网络。

电烤炉、电视遥控器、入侵报警器和光纤通信常用_____。

紫外线可用于水的消毒和防伪标记；伽马射线可用于癌症治疗以及食品和医疗设备的灭菌。

所有电磁波在真空中的传播速率相同，约为_____；在空气中也近似取此值。

答案：红外线；3.0×10^8 m/s

怎么认 题目出现遥控、灭菌、光纤、防伪、卫星电视等用途时，先将用途与电磁波波段逐一配对。

一. 由典型用途反推波段

例题 1 Which statement is correct?

A A remote controller emits microwave radiation.

B A remote controller emits infrared radiation.

C A remote controller emits ultrasound.

D A remote controller emits ultraviolet radiation.

（2023 夏季 0625/11 第21题）

解：电视遥控器以红外线传递控制信号，因此发出红外辐射。

故选 B。

针对练习

1. Which electromagnetic waves are used for sterilising medical equipment?

A gamma rays

B microwaves

C radio waves

D visible light

（2024 春季 0625/12 第20题）

2. **(c)** State **one** region of the electromagnetic spectrum which has a frequency lower than that of visible light. Describe a use of this region.

（2025 冬季 0625/33 第5题(c)）

3. **(a)** **(i)** Table 5.1 shows applications of regions of the electromagnetic spectrum.

Complete the second column of the table with the region of the electromagnetic spectrum used for each application.

Choose from the regions in this list:

gamma rays **infrared** **microwaves** **radio waves** **ultraviolet**

Each region may be used once, more than once or not at all.

Table 5.1

application	region of electromagnetic spectrum
cancer treatment	gamma rays
Bluetooth data connection	
optical fibres	
security marking	
sterilising food	
wireless internet	

(ii) State the approximate speed of radio waves in air.

（2024 春季 0625/42 第5题(a)）

4. Which three regions of the electromagnetic spectrum are used in the applications listed?

- sterilising water
- optical fibres
- satellite television signals
- mobile (cell) phones

A radio, infrared, visible

B ultraviolet, infrared, microwaves

C visible, radio, ultraviolet

D X-rays, visible, infrared

（2024 冬季 0625/23 第22题）

二. 按伤害部位匹配波段

知识点 电磁波谱按频率由低到高依次为无线电波、微波、红外线、可见光、_____、X 射线和 γ 射线；频率单位为 Hz，波长单位为 m。

红外线可造成皮肤灼伤，_____可使体内细胞升温；紫外线、X 射线和 γ 射线可损伤细胞或 DNA。

紫外线可用于防伪标记、检验伪钞或水的消毒，过量照射还可能导致_____。

γ 射线可用于消毒或癌症治疗；接触 X 射线时，可用铅屏、铅防护衣、缩短照射时间或增大距离进行防护。

答案：紫外线；微波；皮肤癌

怎么认 题目出现电磁波的用途、伤害部位或频率顺序时，先按用途或伤害机制匹配波段。

例题 2

(b) Visible light is one region of the electromagnetic spectrum. Another region is ultraviolet radiation.

(i) Give **one** use of ultraviolet radiation.

(ii) Give **one** possible harmful effect of excessive exposure to ultraviolet radiation.

（2023 春季 0625/32 第7题(b)）

解：紫外线可使防伪标记显现，因此可用于检验伪钞。

过量紫外线照射会损伤皮肤细胞或 DNA，可能导致皮肤癌。

答：（i）检验伪钞；（ii）可能导致皮肤癌。

针对练习

5. **(a)** Fig. 6.1 represents the main regions of the electromagnetic spectrum in order of increasing frequency.
Some of the regions have been named.

radio waves	microwaves	infrared	visible light	region 1	region 2	gamma rays

Fig. 6.1

(i) State the name of region 1 and the name of region 2.

(ii) Describe **one** use of gamma rays.

(iii) Describe **one** harmful effect on people of excessive exposure to gamma rays.

（2025 冬季 0625/31 第6题(a)）

6. Infrared is a useful type of electromagnetic radiation. However, excessive exposure to infrared can cause harmful effects.

Which row gives a use and a harmful effect for infrared?

	use	harmful effect
A	detection of cancer	mutations
B	intruder alarms	skin burns
C	detection of fake bank notes	cell damage
D	thermal imaging	internal heating of body cells

（2024 夏季 0625/11 第21题）

7. Excessive exposure to some regions of the electromagnetic spectrum can cause harmful effects to people.

Which regions cause mutation of cells in the body, skin burns and internal heating of body cells?

	mutation of cells	skin burns	internal heating of body cells
A	radio waves	infrared	visible light
B	radio waves	ultraviolet	microwaves
C	X-rays	infrared	microwaves
D	X-rays	ultraviolet	visible light

（2024 夏季 0625/12 第21题）

8. Table 6.1 shows regions of the electromagnetic (e.m.) spectrum.

Two of the regions are not labelled.

Table 6.1

gamma rays	X-rays		visible light	infrared		radio waves

(b) X-rays are used in hospitals to check for broken bones.

(i) State **one** other use for X-rays.

(ii) State **one** precaution taken by people who work with X-rays.

（2023 夏季 0625/33 第6题(b)）

题型 3：处理通信与传播计算（考频★★★☆☆）

知识点 通信系统用电磁波携带信号；卫星电视、移动电话和无线网络常用_____，Bluetooth 使用_____，光纤可传输可见光或红外线。

地球同步卫星绕地球一周的时间等于地球自转周期，并在赤道上空沿地球自转方向运行，因而相对地面保持不变。

玻璃对可见光和部分红外线透明，这两种电磁波能以很高的数据传输速率在光纤中传播。

数字信号由有限个_____值表示，模拟信号随时间连续变化。

答案：微波；无线电波；离散

怎么认 题目出现卫星、无线网络、Bluetooth 或光纤传输时，先按通信场景确定波段。

一. 按通信场景选波与信号

例题 1 Satellites are sometimes used to receive and re-transmit television signals.

Which row shows the type of satellite and the electromagnetic waves used?

	type of satellite	electromagnetic waves used
A	low orbit	infrared
B	low orbit	microwaves
C	geostationary	infrared
D	geostationary	microwaves

（2025 夏季 0625/21 第22题）

解：由地球同步卫星与地面接收站相对静止，接收天线可保持固定方向；由卫星电视使用微波传输信号，得卫星类型为地球同步卫星，所用电磁波为微波。故选 D。

针对练习

1. A radio transmitter is a very tall, thin cylinder. It is prevented from falling over by wires which have one end fixed to the transmitter and the other end fixed in the ground. The ends of the wires in the ground are a long distance from the transmitter.

Fig. 4.1 shows the transmitter and two of the wires.

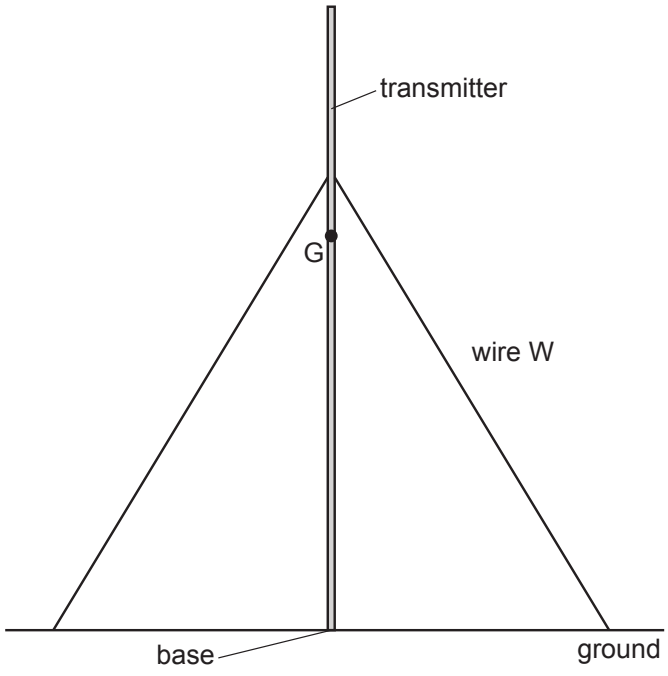


Fig. 4.1

(c) The radio transmitter uses radio waves to transmit radio and television programmes.

State **one** other use of radio waves.

（2023 冬季 0625/41 第4题(c)）

2. A student writes four statements matching a communication system to the region of the electromagnetic spectrum that it uses to transmit signals.

Which statement is correct?

A Wireless internet uses visible wavelengths.

B Mobile phones use X-rays.

C Cable television uses infrared wavelengths.

D Bluetooth uses ultraviolet wavelengths.

（2023 夏季 0625/23 第21题）

3. **(a)** Two types of electromagnetic radiation are used in glass optical fibres for high-speed broadband.

(i) State the type of electromagnetic radiation, other than visible light, which is used in glass optical fibres.

(ii) Give **two** reasons why these two types of electromagnetic radiation are used in glass optical fibres for high-speed broadband.

（2023 夏季 0625/43 第5题(a)）

4. **(a)** **(i)** Electromagnetic waves have many uses.

On Fig. 5.1 draw **one** line from each use to the region of the electromagnetic (e-m) spectrum it uses.

Use	Region of e-m spectrum
security marking	gamma rays
Bluetooth	ultraviolet
optical fibres	infrared
detection of cancer	radio waves

Fig. 5.1

(ii) State **one** advantage of using microwaves compared with radio waves to transmit mobile (cell) phone signals.

（2025 冬季 0625/43 第5题(a)）

二. 统一单位后用 c=fλ

知识点 电磁波在真空中的传播速率为 $c = 3.0 \times 10^8$ m/s，在空气中通常取相同数值。

波速、频率和波长满足 $c = f\lambda$，其中 f 的单位为 Hz，λ 的单位为 m。

计算前统一单位：1 MHz = _____ Hz，1 GHz = _____ Hz；往返信号的总路程为 $2d$。

答案：10^6；10^9

怎么认 题目出现电磁波的频率、波长或往返距离时，先统一单位并判断路程是否加倍。

例题 2 A radio station broadcasts a signal with a frequency of 89 MHz.

What is the wavelength of this signal?

A 3.7 m **B** 3.4 m **C** 3.7 km **D** 3.4 Mm

（2023 夏季 0625/22 第21题）

解：空气中电磁波的传播速率取 $c = 3.0 \times 10^8\ \text{m/s}$。

$89\ \text{MHz} = 89 \times 10^6\ \text{Hz}$

由 $c = f\lambda$ 得

$\lambda = \frac{c}{f}$

$= \frac{3.0\times10^8}{89\times10^6}\ \text{m}$

$\approx 3.4\ \text{m}$

故选 B。

针对练习

5. **(b)** Bluetooth is used to connect a mobile (cell) phone to headphones.

(i) State the name of the region of the electromagnetic spectrum used by Bluetooth.

(ii) State the speed of electromagnetic waves in air.

(iii) The frequency of a Bluetooth network is 2.48 GHz.

Calculate the wavelength of the waves used in the Bluetooth network.

（2025 夏季 0625/42 第5题(b)）

6. **(b)** Fig. 7.2 shows the regions of the electromagnetic spectrum in order of increasing frequency. Two of the regions are **not** labelled.

radio waves	microwaves		visible light		X-rays	gamma rays	

Fig. 7.2

(i) Complete the chart in Fig. 7.2 by adding the names of the missing regions.

(ii) The speed of yellow light is 3.0×10^8 m/s. The wavelength of yellow light is 5.8×10^{-7} m.

Calculate the frequency of yellow light.

（2025 夏季 0625/31 第7题(b)）

7. A remote-controlled vehicle is travelling on the surface of a planet. The vehicle senses an obstacle ahead. It sends a radio message to the control room from where it is being controlled. The control room is 2.4×10^6 km away from the vehicle. The control room sends a message back to the vehicle telling it to stop.

What is the minimum time that elapses between the vehicle sensing the obstacle and receiving the message back from the control room?

A 8.0 ms **B** 16 ms **C** 8.0 s **D** 16 s

（2024 夏季 0625/22 第24题）

3.4 声音

题型 1：认声音的产生与传播（考频★★★☆☆）

知识点 声音由声源的_____产生，声源的振动使周围介质粒子振动，形成声波。

声波是_____，介质粒子的振动方向与声波的传播方向平行。

声音传播需要_____；固体、液体和气体都能传声，真空不能传声。

答案：振动；纵波；介质

怎么认 题目出现发声物体、真空传声或粒子振动方向时，先找振动声源和传播介质，再比较两个方向。

一. 由振动和介质认声波

例题 1 A student strikes a tuning fork on a wooden block. The tuning fork is held close to the students' ear as shown in Fig. 8.1.



Fig. 8.1

(a) Describe how the tuning fork produces sound.

（2025 春季 0625/32 第8题(a)）

解：音叉受敲击后发生振动，振动使周围空气粒子振动并形成声波。

答：音叉的振动产生声音。

针对练习

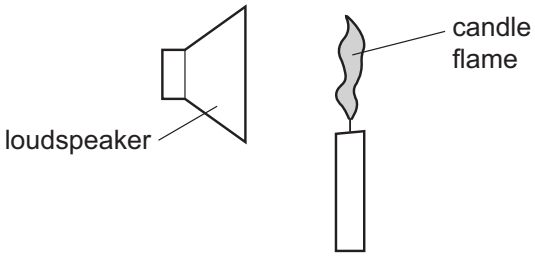
1. **(b)** We can see light from the Sun but we cannot hear any sound from it.

State the reason for this.

（2023 春季 0625/42 第6题(b)）

2. A candle flame is placed in front of a loudspeaker.

The loudspeaker produces a sound wave that causes air particles to vibrate. The vibrating air particles make the candle flame vibrate in the same direction as the air particles.



Which row shows the direction of vibration of the candle flame and the nature of sound waves?

	direction of vibration	nature of sound waves
A	↕	longitudinal
B	↕	transverse
C	↔	longitudinal
D	↔	transverse

（2024 冬季 0625/21 第23题）

3. Which statement is correct?

A Seismic S-waves are longitudinal.

B Sound waves are longitudinal.

C The amplitude is always greater than the wavelength in a longitudinal wave.

D The vibration is at right-angles to the direction of propagation in a longitudinal wave.

（2025 冬季 0625/22 第18题）

4. **(a)** Place ticks (✓) in Table 7.1 to show the properties of sound waves and of microwaves.

Table 7.1

property	sound waves	microwaves
longitudinal		
transverse		
electromagnetic		
travel in a vacuum		

（2025 夏季 0625/32 第7题(a)）

二. 从疏密或压强认纵波

知识点 声波在空气中以纵波传播，空气粒子的振动方向与声波传播方向平行。

压缩部是粒子间距比正常状态更_____、密度和压强更高的区域；稀疏部是粒子间距比正常状态更_____、密度和压强更低的区域。

在压强–时间图上，波峰表示压缩部，波谷表示稀疏部；该图不表示压强随位移的变化，不能给出波长。

相邻压缩中心与稀疏中心的距离为_____；由 $v = f\lambda$，v、f、λ 的单位分别为 m/s、Hz、m。

振幅越大，声音越响；频率越低，音调越低。

答案：小；大；$\frac{\lambda}{2}$

怎么认 题目出现粒子疏密、压强高低或压强–时间图时，先将密集或高压处认作压缩部，将稀疏或低压处认作稀疏部。

例题 2

(a) Sound waves have compressions and rarefactions.

Explain what is meant by compression and rarefaction.

（2023 春季 0625/42 第6题(a)）

解：压缩部中，空气粒子间距比正常状态小，故密度和压强较高；稀疏部中，空气粒子间距比正常状态大，故密度和压强较低。

答：压缩部是粒子较密或压强较高的区域；稀疏部是粒子较疏或压强较低的区域。

针对练习

5. Sound travels through air as a series of compressions and rarefactions.

Which statement correctly compares a compression with a rarefaction?

A In a compression, the wavelength is longer than in a rarefaction.

B In a compression, the wavelength is shorter than in a rarefaction.

C In a compression, the density of the air is greater than in a rarefaction.

D In a compression, the density of the air is lower than in a rarefaction.

（2025 冬季 0625/22 第23题）

6. A sound wave travels at 330 m / s. The distance between the centre of a compression and the centre of the nearest rarefaction in the sound wave is 2.5 cm.

What is the frequency of the sound wave?

A 66 Hz **B** 130 Hz **C** 6600 Hz **D** 13 000 Hz

（2024 夏季 0625/21 第22题）

7. **(a)** A sound wave travels through air. Fig. 6.1 shows a pressure–time graph for the air at one place.

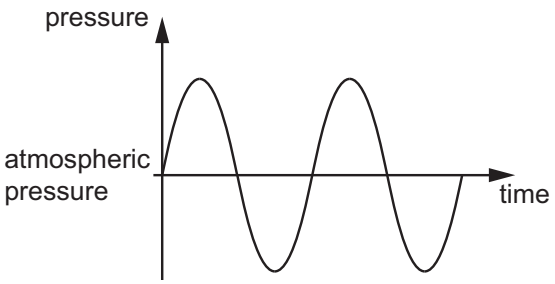


Fig. 6.1

(i) On Fig. 6.1:

- label **one** point C to indicate a compression
- label **one** point R to indicate a rarefaction.

(ii) Explain why this graph **cannot** be used to find the wavelength of the sound wave.

(iii) The sound becomes louder and of lower pitch.

State what happens to:

the amplitude of the sound

the frequency of the sound.

（2024 夏季 0625/42 第6题(a)）

题型 2：由频率振幅判断听感（考频★★★☆☆）

知识点 人耳正常可听声音的频率范围约为 _____ 至 _____，频率单位是_____（Hz）。

频率高于 20 kHz 的声音称为超声波，其中 20 kHz = 20000 Hz。

判断某个频率能否被正常人耳听到，应在单位统一后与可听范围比较。

答案：20；20000；赫兹

怎么认 题目出现听觉范围、动物发声频率或超声波时，先把频率统一为 Hz，再与人耳可听范围比较。

一. 用 20 Hz–20 kHz 判听阈

例题 1

A student strikes a tuning fork on a wooden block. The tuning fork is held close to the students' ear as shown in Fig. 8.1.



Fig. 8.1

(b) State the normal frequency range of sounds that humans can hear. Give the unit.

（2025 春季 0625/32 第8题(b)）

解：人耳正常可听声音的频率范围约为 20 Hz 至 20000 Hz。

答：20 Hz 至 20000 Hz。

针对练习

1. A healthy human ear is able to hear a range of frequencies.

What is this approximate range?

A 10 Hz to 1000 Hz

B 20 Hz to 2000 Hz

C 20 Hz to 20 000 Hz

D 200 Hz to 200 000 Hz

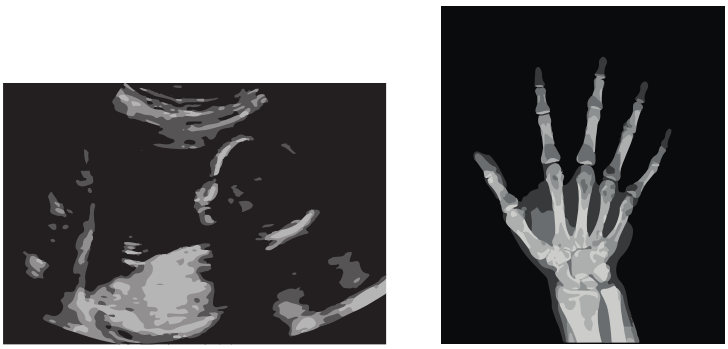
（2024 夏季 0625/13 第22题）

2. A dolphin communicates with other dolphins underwater by emitting sounds in the range 7–15 kHz.

(b) State and explain if humans with normal hearing can hear all the sounds emitted by the dolphin.

（2025 冬季 0625/41 第5题(b)）

3. Fig. 8.1 shows images produced during two different medical scanning procedures.



ultrasound scan of a fetus　　X-ray scan of a hand

Fig. 8.1

(a) (i) Define ultrasound.

(ii) State how the speed of sound in liquid compares to the speed of sound in air.

(iii) X-rays are part of the electromagnetic spectrum.

State the speed of X-rays in a vacuum.

（2024 夏季 0625/43 第8题(a)）

4. Dogs can hear sounds in the range from 100 Hz to 45 kHz.

Which statement is correct?

A Any sound a dog can hear can also be heard by a human.

B Any sound a human can hear can also be heard by a dog.

C Dogs can hear some low frequency sounds that are silent for humans.

D Dogs can hear some high frequency sounds that are silent for humans.

（2023 冬季 0625/11 第23题）

二. 由振幅频率判响度音调

知识点 在其他条件相同时，声波的振幅决定响度：振幅越大，响度越大；振幅不变，响度_____。
声波的频率决定音调：频率越高，音调越_____；频率越低，音调越低。
频率表示每秒振动的次数，单位是_____（Hz）。

答案：不变；高；赫兹

怎么认 题目出现响度、音调及振幅、频率的变化时，先对应响度与振幅、音调与频率。

例题 2 A police car with its siren sounding is stationary in heavy traffic. A pedestrian notices that, although the loudness of the sound produced does **not** change, the pitch varies.

Which row describes the amplitude and the frequency of the sound?

	amplitude	frequency
A	constant	constant
B	constant	varying
C	varying	constant
D	varying	varying

（2025 冬季 0625/21 第23题）

解：响度不变，故振幅不变。
音调变化，故频率变化。
因此应选振幅恒定、频率变化的一行。故选 B。

针对练习

5. A dolphin communicates with other dolphins underwater by emitting sounds in the range 7–15 kHz.

(c) Complete Table 5.1 to describe differences in loudness and pitch of two different dolphin sounds.

Table 5.1

Frequency / kHz	amplitude	loudness	pitch
14	large		
8	small		

（2025 冬季 0625/41 第5题(c)）

6. A drummer hits a drum harder to make a louder sound without changing the pitch of the sound.

Which statement describes the change in properties of the sound as the drummer hits the drum harder?

A Only the amplitude of the sound increases.

B Only the frequency of the sound decreases.

C Both the amplitude and the frequency of the sound increase.

D Both the amplitude and the frequency of the sound decrease.

（2025 冬季 0625/13 第25题）

7. The amplitude and the frequency of a sound wave both increase.

What happens to the loudness and what happens to the pitch of the sound?

	loudness	pitch
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2025 夏季 0625/11 第23题）

8. Both the amplitude and the frequency of a sound wave decrease.

What happens to the sound that is heard?

A The sound is louder and has a higher pitch.

B The sound is louder and has a lower pitch.

C The sound is quieter and has a higher pitch.

D The sound is quieter and has a lower pitch.

（2025 冬季 0625/23 第23题）

题型 3：由距离时间处理传播速率（考频★★★☆☆）

知识点 声音的传播需要介质，传播速率取决于介质的性质；通常在_____中最快，液体中次之，气体中最慢。

在室温空气中，声音传播速率约为_____，速率单位为 $\mathrm{m/s}$。

声波从一种介质进入另一种介质时，频率_____；由 $v = f\lambda$，传播速率增大时波长增大。

答案：固体；330–350；不变

怎么认 题目出现空气声速或不同介质中的传播速率、波长比较时，先用空气声速范围和介质次序判断。

一. 按介质比较传播速率

例题 1 The element mercury exists as a solid, a liquid or a gas.

Which row gives a possible set of values of the speeds of sound through mercury?

	speed of sound in frozen mercury / m/s	speed of sound in liquid mercury / m/s	speed of sound in mercury vapour / m/s
A	250	1500	2500
B	250	2500	1500
C	1500	250	2500
D	2500	1500	250

（2023 冬季 0625/21 第23题）

解：汞的三种状态分别为固态、液态和气态，声音传播速率通常满足

$v_{固态} > v_{液态} > v_{气态}$

表中只有 D 行满足 $2500 > 1500 > 250$。故选 D。

针对练习

1. **(c)** State the approximate speed of sound in air.

（2024 夏季 0625/42 第6题(c)）

2. A dolphin communicates with other dolphins underwater by emitting sounds in the range 7–15 kHz.

(a) State the value of the speed of sound in air and state how the speed of sound in water differs from the speed of sound in air.

（2025 冬季 0625/41 第5题(a)）

3. Which row gives the typical values of the speed of sound at room temperature in the materials stated?

	speed of sound / m/s		
	air	water	iron
A	340	1500	5100
B	340	5100	1500
C	5100	1500	340
D	3.0×10^8	3.0×10^8	3.0×10^8

（2024 夏季 0625/23 第24题）

4. A sound wave travels through the air and strikes a solid block of steel.

Some of the sound is reflected from the steel, and some is transmitted through the steel.

How does the speed and the wavelength of the sound in steel compare to the speed and the wavelength of the sound in air?

	speed in steel	wavelength in steel
A	less than in air	less than in air
B	less than in air	greater than in air
C	greater than in air	less than in air
D	greater than in air	greater than in air

（2025 夏季 0625/21 第23题）

二. 量距离时间求传播速率

知识点 声音在空气中的传播速率等于_____，即 $v = \frac{s}{t}$。

实验中应量取较长距离；发声时同时给出_____，远处观察者看到信号时开始计时，听到声音时停止计时。

多次测量后取平均时间；s 的单位为 m，t 的单位为 s，v 的单位为 m/s，空气中的声速约为 330–350 m/s。

答案：声波传播的距离与所用时间之比；可见信号

怎么认 题目出现可见信号、声音到达时间和两点间距离时，先确定传播时间，再由 $v=\frac{s}{t}$ 计算。

例题 2 A group of students are studying a topic called 'Light and Sound'.

(b) The students go to a large park to determine the speed of sound.
Describe an experiment for determining the speed of sound.
You may draw a diagram as part of your answer.

（2025 冬季 0625/32 第4题(b)）

解：让两名学生相距至少 100 m，用卷尺或测距轮测出两人之间的距离 s。
一名学生敲击两块木块，使碰撞动作清晰可见并发出响亮声音；另一名学生看到木块相碰时启动秒表，听到声音时停止秒表，记录时间 t。
重复实验多次，求出平均时间 $|t|$。
$v=\frac{s}{|t|}$
答：由测得的距离除以平均时间，得到空气中的声速。

针对练习

5. Fig. 6.1 shows some students near some rocky cliffs looking at a boat at sea. The students watch a firework display on the boat. One of the fireworks bursts and makes a loud sound.

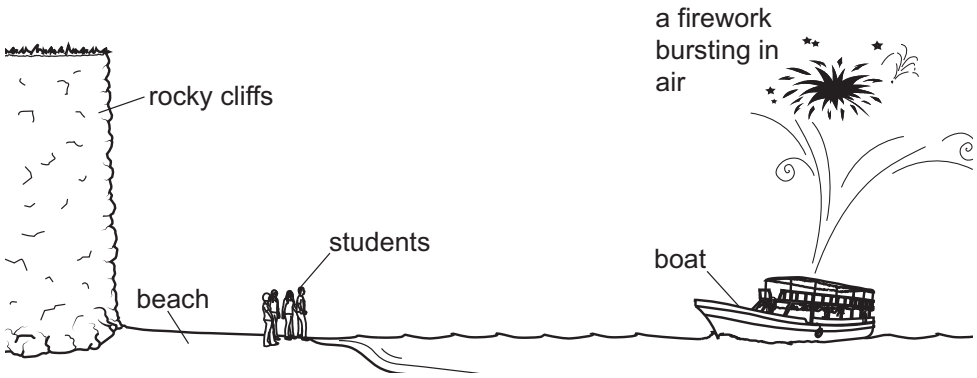


Fig. 6.1 (not to scale)

(b) The time from when the students see the firework burst to when they hear the first, loud sound is 1.3 s.

Calculate the distance from the firework to the students.

Use the speed of sound in air = 340 m / s.

（2024 冬季 0625/31 第6题(b)）

6. Student X fires a starting pistol which produces smoke and sound. Student Y is standing 100 m away and sees the smoke the instant it is produced. The speed of sound in air is 340 m / s.

What is the time delay between student Y seeing the smoke and hearing the sound?

A 0.29 s **B** 0.59 s **C** 1.7 s **D** 3.4 s

（2023 夏季 0625/21 第22题）

7. An athlete hears a starting pistol fire 1.5 seconds after she sees a puff of smoke from the pistol. The sound and the smoke are made at the same time. The starting pistol is 450 metres away from the athlete.

What is the speed of sound calculated from this observation?

A 150 m / s **B** 300 m / s **C** 330 m / s **D** 675 m / s

（2025 春季 0625/12 第27题）

8. **(a)** Describe an experiment to determine the speed of sound in air.

State the apparatus required, the measurements taken and how to calculate the speed of sound in air from the measurements.

You may draw a **labelled** diagram as part of your answer.

（2025 夏季 0625/42 第5题(a)）

题型 4：按反射处理回声超声（考频★★★★☆）

知识点 回声是声音遇到障碍物发生_____后，返回听者处形成的后到声音。

在同一介质中，反射前后声音的_____和传播速率不变；反射声的_____通常较小，听起来较弱。

声音传播的距离满足 $s = vt$，其中 s、v、t 的单位分别为 m、m/s、s。

答案：反射；频率；振幅

怎么认 题目出现先听到原声、后听到相似声音或接收到返回声波时，先判断声音是否经障碍物反射。

一. 由延迟反射认回声

例题 1 Which process causes a sound wave to produce an echo?

A diffraction

B dispersion

C reflection

D refraction

（2024 春季 0625/12 第21题）

解：回声由声波遇到障碍物反射后返回形成。故选 C。

针对练习

1. Fig. 6.1 shows some students near some rocky cliffs looking at a boat at sea. The students watch a firework display on the boat. One of the fireworks bursts and makes a loud sound.

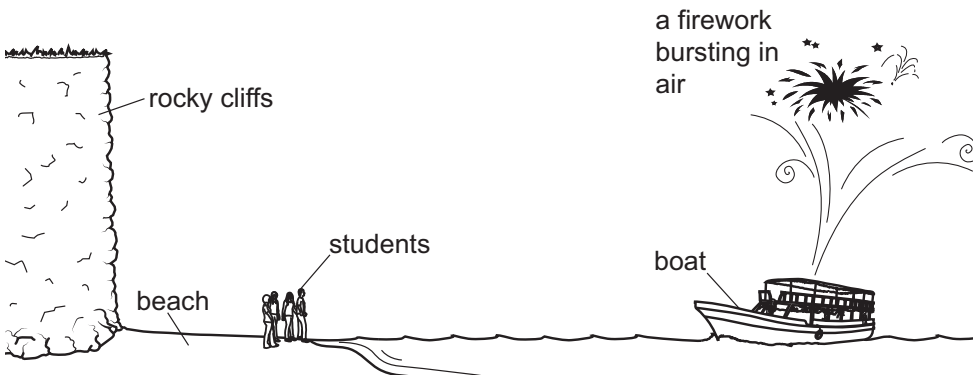


Fig. 6.1 (not to scale)

(a) The students hear a loud sound from the firework and then they hear a quieter, similar sound.

State what causes the second quieter, similar sound.

（2024 冬季 0625/31 第6题(a)）

2. A sound is produced and an echo is heard after the sound reflects off a wall.

How do the properties of the echo compare to the original sound wave?

	amplitude	frequency	speed
A	lower	lower	lower
B	lower	same	same
C	same	lower	lower
D	same	same	same

（2023 冬季 0625/13 第23题）

3. A fisherman uses high frequency sound waves to locate fish in the sea. Fig. 8.1 shows the sound waves emitted from the boat.

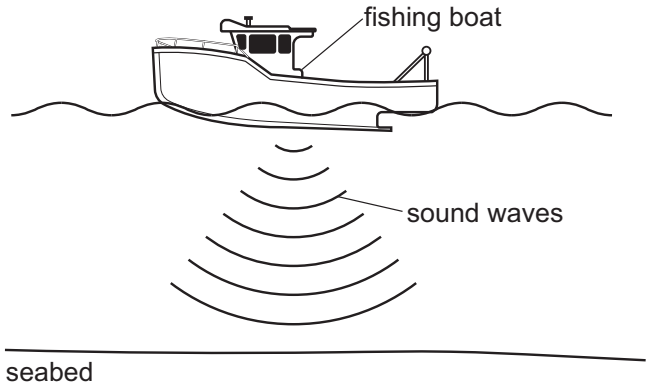


Fig. 8.1 (not to scale)

(c) Fig. 8.2 shows a fish below the boat.

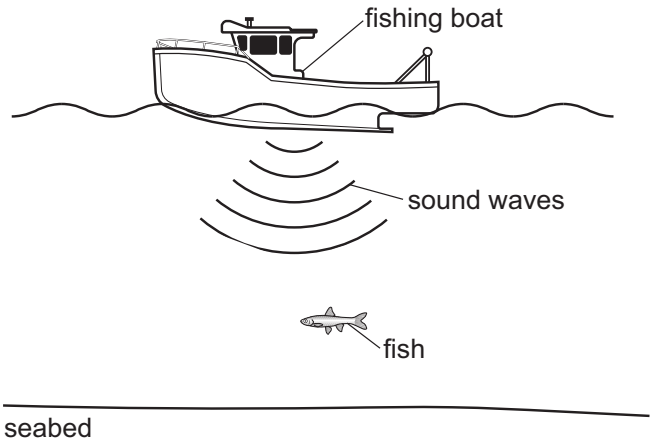


Fig. 8.2 (not to scale)

Describe and explain how the reflected sound wave received by the boat from the fish differs from the reflected sound wave received from the seabed.

（2024 冬季 0625/42 第8题(c)）

4. An observer stands at P and looks into a rock quarry. A small explosion takes place at X in the quarry.

Fig. 5.1 shows the situation.

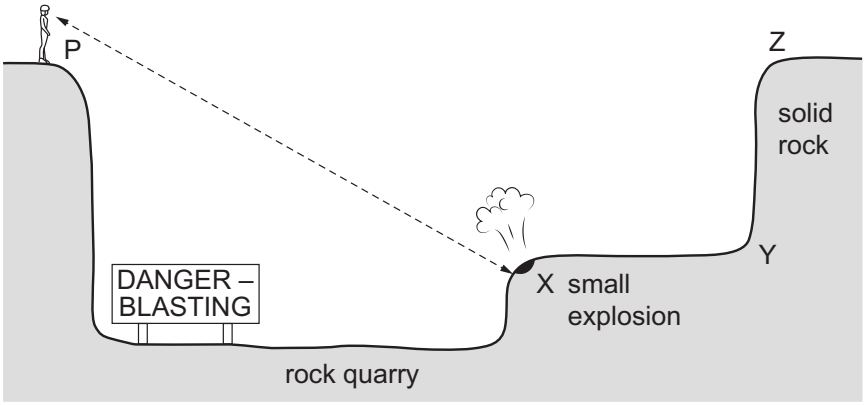


Fig. 5.1 (not to scale)

(a) The observer first hears the sound from the explosion 1.8 s after the explosion occurs. The speed of the sound is 340 m / s.

(i) Calculate the distance XP from the explosion at X to the observer at P.

(ii) The observer then hears a quieter sound from the explosion.

Suggest how the quieter sound waves reach the observer.

（2023 夏季 0625/32 第5题(a)）

二. 把往返路程写成 2d

知识点 回声是声波遇到障碍物反射后返回而再次听到的声音。

若声源到反射面的距离为 d，从发声到听见回声的时间 t 对应的总路程为 _____，故 $2d = vt$。

式中 v 为声音在介质中的传播速率，单位为 _____；d 用 m，t 用 s。

空气中的声音传播速率约为 330 m/s 至 350 m/s；声源和接收者的位置在计时过程中近似不变。

答案：$2d$；m/s

怎么认 题目出现从发声到听见回声的时间，且涉及反射面距离时，先把计时对应的总路程写成 $2d$。

例题 2 A boy shouts and hears the echo from a tall building 2.2 s later.

The speed of sound in air is 330 m / s.

How far away from the boy is the building?

A 150 m **B** 300 m **C** 360 m **D** 730 m

（2023 夏季 0625/12 第22题）

解：从发声到听见回声，声音传播的总路程为 $2d$，

$2d = vt$

$d = \frac{vt}{2}$

$= \frac{330\ \text{m/s} \times 2.2\ \text{s}}{2}$

$= 363\ \text{m} \approx 360\ \text{m}$。故选 C。

针对练习

5. A fisherman uses high frequency sound waves to locate fish in the sea. Fig. 8.1 shows the sound waves emitted from the boat.

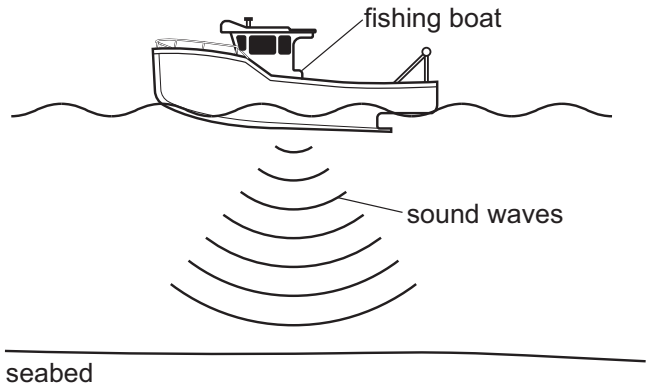


Fig. 8.1 (not to scale)

(b) High frequency sound waves travel from the boat through the sea water.
The speed of sound in water is 1500 m / s. The seabed is 22 m below the boat.

Calculate the time taken for the boat to receive the reflected wave from the seabed after the sound is emitted.

（2024 冬季 0625/42 第8题(b)）

6. A student stands 75 m from a wall and makes a short, loud sound by tapping two pieces of wood together.

What is the approximate time between making the sound and the student hearing the echo produced?

A 0.2 s **B** 0.5 s **C** 2 s **D** 5 s

（2024 春季 0625/12 第22题）

7. A student makes a sound in front of a large wall.

She hears an echo at time *t* after making the sound.

The speed of sound in air is *v*.

Which expression is used to calculate the distance between the student and the wall?

A $v \times t$ **B** $v \div t$ **C** $(v \times t) \div 2$ **D** $(v \div t) \div 2$

（2025 夏季 0625/23 第22题）

三. 按界面回波使用超声

知识点 超声波是频率高于_____的声波，属于纵波；声波传播需要_____。

超声脉冲在材料或组织的界面发生部分反射，接收回波可确定界面的位置或形成图像。

若往返时间为 t，介质中的速率为 v，则界面距离 $d =$ _____；t 用 s，v 用 m/s，d 用 m。

答案：20000 Hz；介质；$v\frac{t}{2}$

怎么认 题目出现软组织扫描、界面回波或往返时间时，先写超声反射，再用 $d = v\frac{t}{2}$。

例题 3 Which waves are used in the medical scanning of soft tissue?

A gamma rays

B infrared

C microwaves

D ultrasound

（2024 夏季 0625/21 第23题）

解：医学扫描软组织利用超声波在不同组织的界面发生反射，接收反射波可形成内部组织图像。故选 D。

针对练习

8. A student makes a list of some applications of waves.

1 medical scanning of soft tissue

2 sterilising water

3 using sonar to calculate ocean depths

Which applications use ultrasound waves?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

（2023 春季 0625/22 第23题）

9. Ultrasound is an example of a longitudinal wave.

(c) Ultrasound is used to locate objects below the surface of the sea.

(i) Describe how ultrasound is used to locate an object below the surface of the sea.

You may draw a labelled diagram as part of your answer.

(ii) State **one** other use of ultrasound.

（2025 夏季 0625/43 第6题(c)）

10. A ship sends an ultrasound pulse to the seabed to measure the depth of the sea.

The speed of ultrasound waves in sea water is 1500 m / s.

The pulse takes 4.6 seconds to travel to the seabed and back to the ship.

What is the depth of the sea?

A 330 m **B** 650 m **C** 3500 m **D** 6900 m

（2025 夏季 0625/22 第24题）

11. Fig. 8.1 shows images produced during two different medical scanning procedures.



ultrasound scan of a fetus



X-ray scan of a hand

Fig. 8.1

(b) Describe **three** similarities or differences between the use of ultrasound and X-rays in medical scanning procedures.

（2024 夏季 0625/43 第8题(b)）