学生手册 2026–2028

CIE IGCSE Physics 全基础题型

0625 · Core & Extended · 热学

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[2] 专题 2 热学

2.1.1 物质的状态

题型 1：辨物态与宏观性质（考频★★☆☆☆）

知识点 固体有固定形状和固定体积，不能流动；液体有固定体积而无固定形状，能流动；气体无固定形状和固定体积，能流动且容易压缩。
无固定形状的物质，其形状由容器决定，可能是_____或_____。
固体变为液体称熔化，液体变为固体称凝固；液体变为气体称汽化，气体变为液体称液化；沸腾是液体内部和表面同时发生的汽化。
质量不变时，密度$\rho = \frac{m}{V}$，单位为$\mathrm{kg\ m^{-3}}$；液体变为气体时体积显著增大，密度_____。

答案：液体；气体；显著减小

怎么认 题目出现形状由容器决定、能否流动，或密度随时间突变时，先看有无固定形状和体积，再判断物态变化。

例题 1 A sample of a substance has a shape that is determined by its container.

What are the possible states of this sample?

A gas, liquid and solid

B gas and liquid only

C gas and solid only

D solid and liquid only

（2025 夏季 0625/22 第10题）

解： 由形状由容器决定，得该物质没有固定形状。
液体和气体均没有固定形状，固体有固定形状。
故选 B。

针对练习

1. A liquid substance changes into a gas.

Which property of the substance remains the same?

A ability to flow

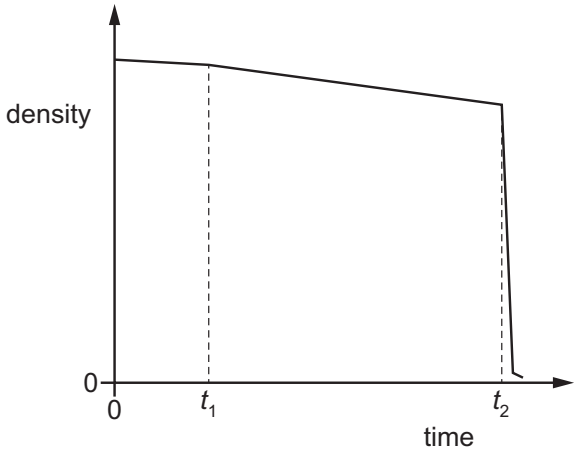
B compressibility

C shape

D volume

（2025 夏季 0625/11 第12题）

2. The graph shows what happens to the density of a substance as its temperature changes over time.



Which term describes the change of state taking place at time t_2?

A melting

B freezing

C condensation

D boiling

（2025 春季 0625/12 第19题）

题型 2：按起态终态定相变（考频★★★☆☆）

知识点 物态变化是物质由一种物态转变为另一种物态的过程；判断时先确定起始物态和最终物态。固态变为液态叫_____，液态变为固态叫_____；液态变为气态叫汽化，沸腾和蒸发都属于汽化。气态变为液态叫_____。相变名称由起始物态和最终物态决定，不以物质名称或温度数值为准，本题不涉及单位。

答案：熔化；凝固；凝结

怎么认 题目出现物质由一种物态变为另一种物态时，先写起始物态和最终物态，再对应相变名称。

一. 单段变化先写起态终态

例题 1 Which statement correctly describes a change of state?

A A gas condenses to form a liquid.

B A liquid melts to form a solid.

C A solid condenses to form a liquid.

D A solid boils to form a gas.

（2024 春季 0625/22 第9题）

解：A 对，起始物态为气态，最终物态为液态，属于凝结；
B 错，液态变为固态属于凝固；C 错，固态变为液态属于熔化；D 错，沸腾是液态变为气态。
故选 A。

针对练习

1. In which process does a gas turn into a liquid?

A boiling

B condensing

C freezing

D melting

（2024 夏季 0625/13 第9题）

2. A solid changes into a liquid.

Which term describes this change in state?

A boiling

B condensation

C freezing

D melting

（2025 夏季 0625/23 第13题）

3. Which name is given to the change of state when steam at 100 °C changes to water at 100 °C?

A boiling

B condensation

C evaporation

D melting

（2024 冬季 0625/12 第12题）

二. 多段变化逐箭头命名

知识点 物质由一种状态变为另一种状态称为物态变化，相变名称由起态和终态共同确定。

气态变液态称为_____（condensation）；液态变固态称为_____（solidification 或 freezing）；固态变液态称为_____（melting）。

液态变气态称为汽化（vaporisation）；汽化包括蒸发和沸腾，液体在沸点处内部和表面同时发生的汽化称为沸腾。

上述相变适用于起态和终态明确的过程，相变名称没有单位。

答案：凝结；凝固；熔化

怎么认 题目出现连续的状态变化或相变箭头时，先沿过程顺序逐段确认起态和终态。

例题 2 Which row gives the correct name for each change of state shown?

	gas to liquid	liquid to solid	solid to liquid
A	condensation	melting	solidification
B	condensation	solidification	melting
C	evaporation	melting	solidification
D	evaporation	solidification	melting

（2024 冬季 0625/22 第14题）

解：气态变为液态，是凝结；

液态变为固态，是凝固；

固态变为液态，是熔化。
三项依次与 B 行相符，故选 B。

针对练习

4. A scientist heats a solid substance until it turns into a liquid, and then into a gas.

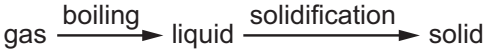
Which row describes the two changes of state of the substance as it is heated?

	change of state 1	change of state 2
A	freezing	condensing
B	freezing	boiling
C	melting	condensing
D	melting	boiling

（2025 夏季 0625/12 第10题）

5. Which diagram shows the processes happening during changes of state?

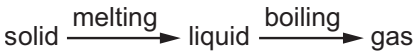
A



B



C



D



（2023 冬季 0625/12 第15题）

6. A substance is heated. The substance changes state from a liquid to a gas.

When the gas is cooled, it first becomes a liquid and finally a solid.

What is the order of changes of state for this substance?

A condensation → melting → freezing

B vaporisation → condensation → melting

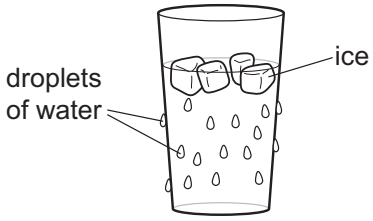
C vaporisation → condensation → freezing

D melting → vaporisation → freezing

（2025 冬季 0625/11 第11题）

7. A man puts some ice into a glass of water on a warm day.

After a short time, he notices that the ice disappears and that water droplets appear on the outside of the glass.



Which two changes of state are taking place?

A condensation and freezing

B condensation and melting

C boiling and melting

D freezing and evaporation

（2024 夏季 0625/21 第9题）

2.1.2 物质的粒子模型

题型 1：按粒子特征辨三态（考频★★★☆☆）

知识点 固体、液体和气体的粒子都不停运动，三态可按粒子的排列、间距和运动方式区分。

固体粒子排列规则、紧密相邻，只在_____附近振动；液体粒子排列不规则、彼此接近，可相互滑过。

气体粒子排列不规则、间距很大，作快速无规则运动，并不断互相碰撞及碰撞容器壁。

温度越高，粒子的平均动能越大，运动越_____；绝对零度为 −273 °C，此时粒子的动能最小。

答案：固定位置；剧烈

怎么认 题目出现物态及粒子排列、间距、运动的描述或粒子图时，先按三项特征对应物态。

一. 按排列间距运动作答

例题 1 A student warms some water in a metal container using an electric heater, as shown in Fig. 6.1.

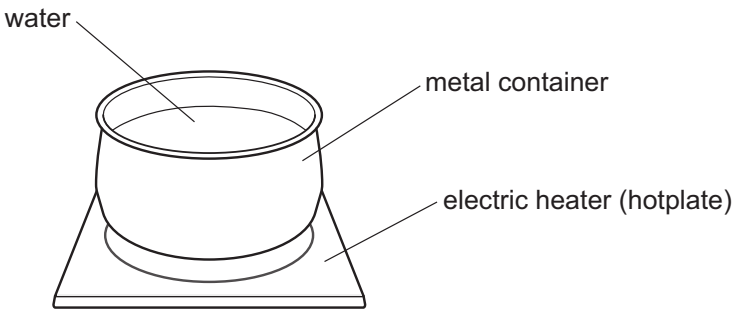


Fig. 6.1

(a) Describe the arrangement, separation and motion of the particles in liquid water.

（2025 春季 0625/32 第6题(a)）

解：由水处于液态，得其粒子排列不规则，彼此接近；粒子能相互滑过，作无规则运动，并不断相互碰撞。

答：液态水粒子排列不规则且彼此接近，能相互滑过并作无规则运动。

针对练习

1. Which row correctly describes the movement of particles in solids and liquids?

	solids	liquids
A	no movement	move around each other
B	no movement	vibration only
C	vibration only	move around each other
D	vibration only	vibration only

（2024 春季 0625/12 第9题）

2. Fig. 5.1 shows a metal box. The air in the box is at room temperature, 20 °C.
Air cannot leave or enter the box.

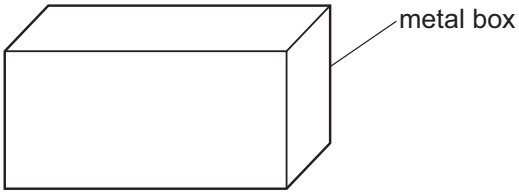


Fig. 5.1

(a) Describe the motion, separation and arrangement of the air particles in the metal box.

（2024 冬季 0625/31 第5题(a)）

3. A hot gas and a cool liquid are at the same pressure.

Which row describes the separation and the motion of the particles of a hot gas compared to those of a cool liquid?

	separation of gas particles	motion of gas particles
A	greater than a cool liquid	faster than a cool liquid
B	greater than a cool liquid	slower than a cool liquid
C	less than a cool liquid	faster than a cool liquid
D	less than a cool liquid	slower than a cool liquid

（2025 夏季 0625/21 第10题）

4. Which statement about the particles of a substance after condensation is correct?

A They are close to each other and slide over each other.

B They are close to each other and vibrate about fixed points.

C They are far apart from each other and vibrate about fixed points.

D They are far apart from each other and move freely within the container.

（2023 夏季 0625/23 第15题）

二. 用粒子间距解释压缩体积

知识点 物质由微小粒子组成；压缩物质时，粒子的数量和大小不变，体积变化来自粒子平均间距的变化。

气体粒子相距很远，粒子间有较大_____，因此容易压缩；液体粒子彼此_____，继续靠近时粒子间斥力很大，因此难以压缩。

同一质量的物质由液态变为气态时，粒子平均间距增大，体积_____。

由 $\rho = \frac{m}{V}$，质量 m 不变而体积 V 增大时，密度 ρ 减小；若 m 用 kg、V 用 m^3，则 ρ 的单位为 $\frac{\mathrm{kg}}{\mathrm{m}^3}$。

答案：空隙；靠得很近；增大

怎么认 题目出现气体与液体的压缩性差异或液态变气态时，先比较粒子间空隙。

例题 2 Gases can be compressed, but liquids cannot be compressed.

Which statement explains this difference?

A Each particle in a gas is more compressible than each particle in a liquid.

B Particles in a gas are further apart than particles in a liquid.

C Particles in a gas attract each other more strongly than particles in a liquid.

D Particles in a gas move more slowly than particles in a liquid.

（2025 夏季 0625/12 第11题）

解：气体粒子相距很远，粒子间有较大空隙；液体粒子彼此靠得很近，粒子间空隙很小。因此气体可通过缩小粒子间距而被压缩，液体难以被压缩。故选 B。

针对练习

5. Liquids are difficult to compress whereas gases can be compressed easily.

(a) Explain, in terms of particles, why it is difficult to compress liquids.

（2023 冬季 0625/41 第3题(a)）

6. Fig. 4.1 shows gas trapped in a cylinder by a piston.

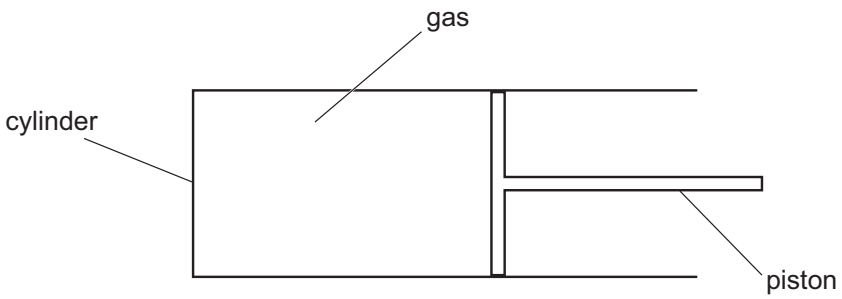


Fig. 4.1

(b) Explain, in terms of particles, why gases can be compressed but liquids cannot.

（2025 冬季 0625/42 第4题(b)）

7. Why can a gas be compressed easily into a smaller volume?

A The particles are far apart.

B The particles do not attract each other.

C The particles move randomly.

D The volume of each particle can be reduced.

（2023 冬季 0625/21 第12题）

8. A quantity of water is boiled to form the same mass of steam.

Which row shows how the volume and density of the water change?

	volume	density
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2024 冬季 0625/11 第12题）

题型 2：由温度判粒子运动（考频★★★☆☆）

知识点 气体粒子不停地做无规则运动，温度反映粒子平均动能的大小。

同种气体的温度升高时，粒子的平均动能_____，平均速率_____；温度降低时相反。

在密封、容积不变的容器内，升温后粒子与容器壁的碰撞频率_____；降温后相反。

密封且容积不变时，粒子数与容器体积均不变，粒子间平均距离不变。

温度可用摄氏度或开尔文表示；−273 °C称为绝对零度，此时粒子的动能最小。

答案：增大；增大；增加

怎么认 题目出现气体升温或降温时，先由温度变化判断粒子平均动能的变化。

一. 升降温先判平均动能

例题 1 Which statement describes what happens to air particles when the air is heated?

A The particles move more slowly.

B The particles move more quickly.

C The particles move closer together.

D The particles vibrate faster.

（2023 春季 0625/12 第15题）

解：空气受热后温度升高，粒子的平均动能增大，平均速率增大。

因此空气粒子运动得更快。故选 B。

针对练习

1. Fig. 5.1 shows a metal box. The air in the box is at room temperature, 20 °C.
Air cannot leave or enter the box.

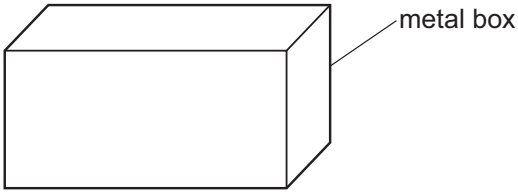


Fig. 5.1

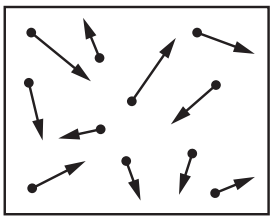
(b) A student puts the box in a freezer. The temperature of the air in the box decreases.

Describe the changes in the motion of the air particles in the box when the temperature decreases.

（2024 冬季 0625/31 第5题(b)）

2. The diagram represents gas particles moving around in a sealed container.

The gas particles collide with the walls of the container.



The temperature of the gas is increased.

What happens to the average speed of the gas particles and what happens to the number of collisions by the gas particles with the walls of the container?

	average speed of gas particles	the number of collisions with the walls of the container
A	increases	less frequent collisions
B	increases	more frequent collisions
C	stays the same	less frequent collisions
D	stays the same	more frequent collisions

（2024 冬季 0625/11 第13题）

3. A sealed bottle of constant volume contains air.

The air in the bottle is heated by the Sun.

What is the effect on the average speed of the air particles in the bottle and the average distance between them?

	average speed of air particles	average distance between air particles
A	decreases	decreases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

（2023 冬季 0625/23 第12题）

二. 最低温度对应绝对零度

知识点 绝对零度是物质所能达到的最低温度，摄氏温标中为_____ °C，开尔文温标中为_____ K。

温度越低，粒子的动能越小，运动越慢。

在绝对零度，粒子具有_____；固体粒子的振动最小。

答案：−273；0；最小的动能

怎么认 题目出现最低温度、绝对零度或粒子动能最低时，先写绝对零度，再对应 −273 °C 或 0 K。

例题 2 What is the lowest possible temperature (absolute zero) and what happens to the energy of particles at this temperature?

	lowest possible temperature / °C	particle energy
A	–273	particles have least kinetic energy
B	–273	particles have zero gravitational potential energy
C	0	particles have least kinetic energy
D	0	particles have zero gravitational potential energy

（2023 夏季 0625/13 第14题）

解： 绝对零度是最低可能温度，

$T = -273\ ^\circ\mathrm{C} = 0\ \mathrm{K}$。

此时粒子的动能最小。故选 A。

针对练习

4. **(b)** **(i)** State the value of absolute zero in °C.

(ii) Explain what is meant by the term absolute zero. Refer to particles in your answer.

（2023 夏季 0625/42 第4题(b)）

5. Four students describe the phrase ‘absolute zero’ during a lesson on the particle model.

Which student is correct?

A This is the lowest possible temperature.

B Particles in a solid start vibrating.

C Particles do not have any weight.

D Particles have the least gravitational potential energy.

（2023 夏季 0625/22 第14题）

6. Fig. 5.1 shows a metal block at room temperature on a table.

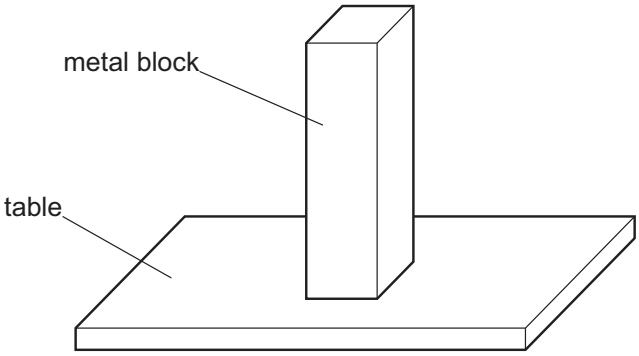


Fig. 5.1

(b) (i) The temperature of the metal block decreases.

Describe any changes in the motion and separation of the particles in the metal block.

(ii) A scientist cools the metal block until its temperature is close to absolute zero.

Describe the motion of the particles in the metal block.

（2024 夏季 0625/32 第5题(b)）

题型 3：从随机微粒认布朗运动（考频★★★☆☆）

知识点 布朗运动是悬浮在液体或气体中的微小可见粒子所作的_____运动。
它由周围分子的无规则碰撞引起，粒子的轨迹连续而曲折，运动方向频繁改变。
布朗运动可在_____和_____中观察到，不能在固体中观察到。

答案：无规则；液体；气体

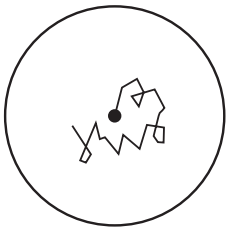
怎么认 题目出现悬浮微粒的轨迹图时，先找连续曲折且方向频繁改变的无规则轨迹。

一. 由曲折轨迹辨布朗运动

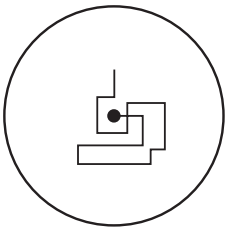
例题 1 A pollen grain in a beaker of still water is viewed through a microscope.

Which diagram shows the most likely movement of the pollen grain?

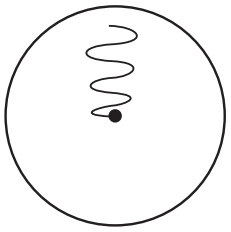
A



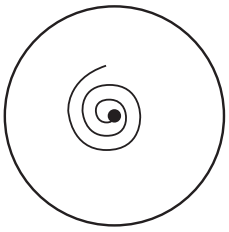
B



C



D



（2024 夏季 0625/13 第10题）

解：花粉粒悬浮在静水中，水分子从各方向对它的碰撞不均衡，使其运动方向不断改变。其轨迹应连续而曲折，且没有固定的形状和方向，符合图 A。故选 A。

针对练习

1. Brownian motion is the random motion of particles.

In which states of matter is Brownian motion observed?

A gases, liquids and solids

B gases and liquids only

C gases and solids only

D liquids and solids only

（2023 冬季 0625/12 第12题）

2. Brownian motion of particles is observed.

Which statements describe the movement of the particles?

1 The particles all travel along a curved path.

2 The particles move randomly.

3 The particles all travel in the same direction.

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

（2024 夏季 0625/23 第10题）

二. 用不均匀分子碰撞解释

知识点 布朗运动是悬浮在液体或气体中、显微镜下可见的微小颗粒所作的连续无规则运动。

液体或气体的分子处于_____运动，并从各个方向碰撞悬浮颗粒；各侧碰撞作用_____，颗粒因而不断改变运动方向。

显微镜中观察到的是悬浮颗粒，而不是液体或气体分子；该现象没有专用单位。

答案：连续、快速、无规则；不均匀

怎么认 题目出现显微镜下花粉或烟尘无规则运动时，先区分可见微粒与不可见分子，再判断各侧碰撞是否不均匀。

例题 2 When pollen grains in water are viewed through a microscope, they are seen to be in continuous, rapid, random motion.

What causes a pollen grain to move in this way?

A convection currents in the water

B bombardment by a single molecule of water

C uneven bombardment on different sides by water molecules

D collision with another pollen grain

（2024 春季 0625/22 第12题）

解： 显微镜中看到运动的是花粉粒，水分子不可见。
水分子从各个方向连续碰撞花粉粒，各侧碰撞作用不均匀，使花粉粒不断改变运动方向。
故选 C。

针对练习

3. A student uses a microscope to observe pollen moving on the surface of water.

Which statement describes the reason for this movement?

A Water molecules are moved by microscopic pollen particles.

B Water molecules are moved by pollen molecules.

C Microscopic pollen particles are moved by water molecules.

D Pollen molecules are moved by water molecules.

（2023 夏季 0625/21 第14题）

4. Diagram 1 shows apparatus being used to observe smoke particles.

Diagram 2 shows how a smoke particle moves randomly.

diagram 1

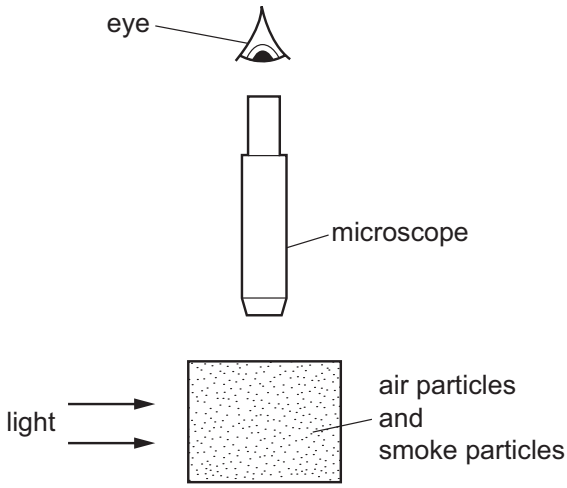
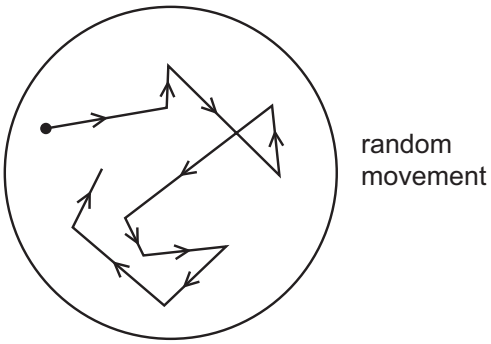


diagram 2



Why do the smoke particles move randomly?

A They are hit by air particles.

B They are less dense than air.

C They are moved by convection currents.

D They gain energy from the light.

（2024 夏季 0625/11 第10题）

5. Brownian motion is the random movement of microscopic particles in a liquid or gas.

Which statement about Brownian motion is correct?

A Brownian motion only occurs when the liquid or gas is heated.

B Much heavier fast-moving particles that **cannot** be seen collide with the microscopic particles.

C Much lighter fast-moving particles that **cannot** be seen collide with the microscopic particles.

D The microscopic particles move to avoid the fast-moving liquid or gas molecules.

（2025 冬季 0625/21 第11题）

6. A stationary smoke particle is hit by a fast-moving nitrogen molecule.

Which row describes the motion of the smoke particle and of the nitrogen molecule after the collision?

	smoke particle	nitrogen molecule
A	moves	rebounds
B	moves	stops
C	remains stationary	rebounds
D	remains stationary	stops

（2025 夏季 0625/22 第11题）

题型 4：用碰壁解释气压（考频★★☆☆☆）

知识点 气体粒子不断做无规则运动，并与容器壁碰撞；碰撞使粒子动量改变，粒子因而对器壁产生力。气体压强等于器壁单位面积所受的平均力，即 $p = \frac{F}{A}$，其中 F 为气体垂直作用在面积 A 上的平均力。在容器体积不变时，粒子数越多，单位时间内的碰撞越_____；每次碰撞的动量变化越_____，压强越大。

压强的单位为帕斯卡（Pa），$1\ \mathrm{Pa} = 1\mathrm{N\ m^{-2}}$。

答案：频繁；大

怎么认 题目出现气体、容器壁及解释压强的要求时，先写粒子不断无规则运动并碰撞器壁产生力。

例题 1 Fig. 5.1 represents some particles of a gas in a metal box. The arrows represent the directions of movement of the particles.

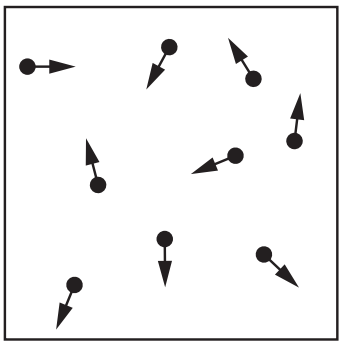


Fig. 5.1 (not to scale)

(a) Describe how the particles in Fig. 5.1 exert a pressure on the walls of the box.

（2023 夏季 0625/31 第5题(a)）

解：气体粒子不断做无规则运动，并反复碰撞金属盒的内壁。

碰撞使粒子的动量改变，粒子因而对器壁产生平均作用力。

器壁受到的压强为单位面积所受的力，即 $p = \frac{F}{A}$。

答：气体粒子不断碰撞器壁并产生作用力，从而对器壁产生压强。

针对练习

1. **(c)** Describe, in terms of particles, how a gas exerts a pressure on the walls of its container.

（2024 夏季 0625/42 第4题(c)）

2. Fig. 5.1 shows an empty metal cylinder.

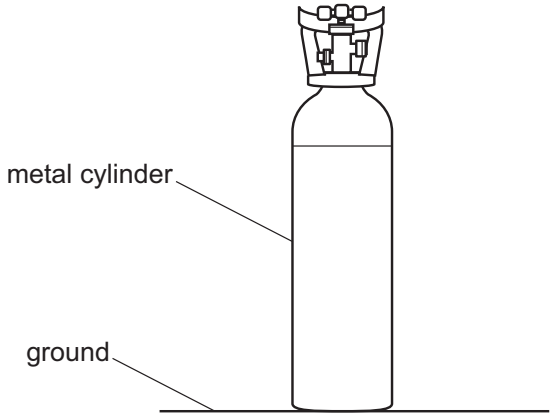


Fig. 5.1

(b) The cylinder is filled with a gas. Describe how particles of the gas exert a pressure on the inside surface of the metal cylinder.

（2025 冬季 0625/31 第5题(b)）

3. Fig. 4.1 shows some gas, at room temperature, in a cylinder with a piston that can move. The gas cannot escape from the cylinder.

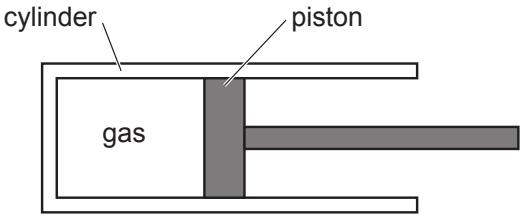


Fig. 4.1

(a) (i) Describe the movement of the gas particles.

(ii) Describe how the gas particles exert a pressure on the walls of the cylinder and piston.

（2023 春季 0625/32 第4题(a)）

4. Gas particles exert a pressure when they collide with the walls of a container.

Which statement about the gas particles is correct?

A They experience a change in force, which results in a pressure equal to momentum × area.

B They experience a change in force, which results in a pressure equal to $\frac{\text{momentum}}{\text{area}}$.

C They experience a change in momentum, which results in a pressure equal to force × area.

D They experience a change in momentum, which results in a pressure equal to $\frac{\text{force}}{\text{area}}$.

（2025 夏季 0625/23 第12题）

2.1.3 气体与绝对温度

题型 1：摄氏与开尔文换算（考频★★☆☆☆）

知识点 热力学温度 T 的单位是开尔文（K），摄氏温度 θ 的单位是摄氏度（°C）；开尔文单位前不写度数符号。

同一温度用两种温标表示时，$T=\theta+273$，故摄氏温度转为开尔文应_____ 273；反向换算为 $\theta=T-273$。

0 K 称为_____，对应 −273 °C；温差在两种温标中的数值_____。

答案：加上；绝对零度；相同

怎么认 题目出现摄氏温度与开尔文温度的换算时，先写 $T=\theta+273$ 或 $\theta=T-273$。

例题 1 How is a temperature in degrees Celsius (°C) converted to a temperature in kelvin (K)?

A Add 273 to the temperature in °C.

B Divide the temperature in °C by 273.

C Multiply the temperature in °C by 273.

D Subtract 273 from the temperature in °C.

（2024 夏季 0625/11 第11题）

解：设摄氏温度为 θ，开尔文温度为 T。

由两种温标的换算关系得

$T=\theta+273$

所以应在摄氏温度上加 273。故选 A。

针对练习

1. The temperature of an object is 37 °C.

What is the temperature of the object in kelvin?

A –236 K **B** 7.4 K **C** 236 K **D** 310 K

（2025 冬季 0625/13 第12题）

2. What is the boiling temperature of water at standard atmospheric pressure?

A –173 K **B** 100 K **C** 273 K **D** 373 K

（2024 春季 0625/12 第10题）

3. **(a)** The lowest possible temperature is zero kelvin (0 K).

(i) State the name of this lowest possible temperature.

(ii) Nitrogen boils at 77 K.

Calculate the boiling point of nitrogen on the Celsius scale.

（2023 冬季 0625/43 第4题(a)）

4. A tight-fitting lid keeps air inside a metal can.
An airtight rubber bung holds a liquid-in-glass thermometer that is inserted through a hole in the lid, as shown in Fig. 4.1.

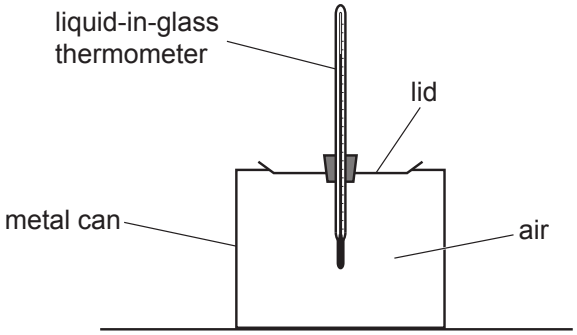


Fig. 4.1

(a) (i) State what happens to the liquid in the thermometer when the air temperature rises.

(ii) The temperature of the air in the can is 18 °C.

Calculate the temperature of the air in kelvin.

（2023 夏季 0625/33 第4题(a)）

题型 2：定容升降温判压强（考频★★★☆☆）

知识点 气体压强由气体粒子不断碰撞容器壁产生。

固定质量的气体在体积不变时，热力学温度 T 升高，压强 p _____；T 降低，p _____。

温度升高时，粒子平均动能增大，撞壁更频繁且作用更强；温度降低时情况相反。

T 的单位为 K，p 的 SI 单位为 Pa。

答案：增大；减小

怎么认 题目出现密闭气体、刚性容器或固定体积及温度变化时，先由温度变化判断压强增减。

一. 先由温变判压强增减

例题 1 The diagram shows a cylinder containing oxygen under high pressure.



The temperature of the cylinder and the oxygen decreases.

Which statement describes what happens to the pressure in the cylinder and gives the reason why the pressure changes?

A The pressure decreases because the oxygen particles move faster.

B The pressure decreases because the oxygen particles move more slowly.

C The pressure increases because the oxygen particles move faster.

D The pressure increases because the oxygen particles move more slowly.

（2025 春季 0625/12 第15题）

解： 氧气密封在气缸中，气体质量和气缸体积不变。
温度降低，氧气粒子的平均动能减小，运动变慢，对气缸壁的碰撞作用减弱，压强减小。
故选 B。

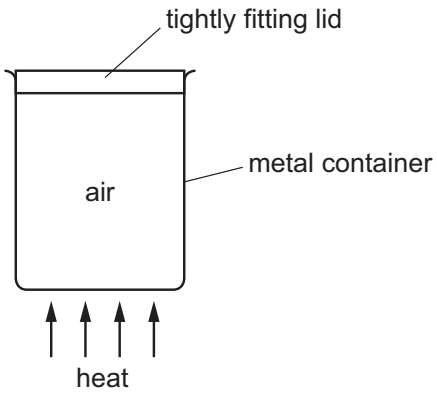
针对练习

1. **(a)** Complete the sentences about the kinetic particle model of matter.

(iv) As the temperature of a fixed volume of gas decreases, the pressure exerted by the gas

（2025 夏季 0625/32 第4题(a)）

2. Some air is trapped inside a metal container with a tightly fitting lid.



The container is heated strongly behind a safety screen. The lid is blown off by the increased pressure of the air inside the container.

What causes the increase in pressure of the air inside the container?

A Each air particle expands and takes up more room.

B The air particles move more quickly.

C The number of particles inside the container increases.

D The volume occupied by the air decreases.

（2024 冬季 0625/21 第12题）

3. A sample of gas is trapped in a rigid container. As the temperature of the gas is increased, the pressure increases.

Which statement is **not** correct?

A The gas molecules have greater kinetic energy.

B The gas molecules hit the walls of the container harder.

C The gas molecules hit the walls of the container more frequently.

D The gas molecules move further apart.

（2023 春季 0625/22 第15题）

4. A tight-fitting lid keeps air inside a metal can.
An airtight rubber bung holds a liquid-in-glass thermometer that is inserted through a hole in the lid, as shown in Fig. 4.1.

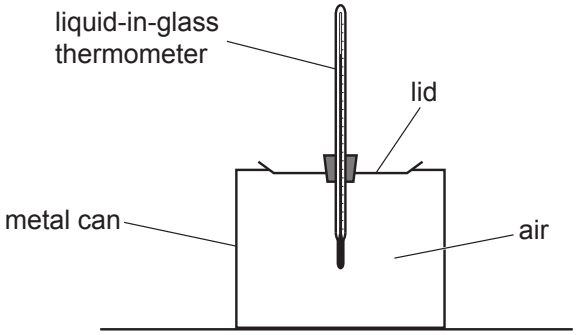


Fig. 4.1

(b) The can is placed in a refrigerator. The temperature of the air inside the can decreases.

State and explain what happens to the pressure exerted by the air in the can. Use your ideas about gas particles.

（2023 夏季 0625/33 第4题(b)）

二. 再用碰壁频率力度解释

知识点 气体压强是器壁单位面积所受粒子碰撞产生的平均作用力，单位是 Pa。

对质量一定且体积不变的气体，温度升高时，粒子平均动能增大，平均速率_____。

粒子碰撞器壁的频率_____，每次碰撞对器壁的作用增大，故气体压强_____。

温度降低时，粒子的平均速率、碰壁频率和压强均减小。

答案：增大；增大；增大

怎么认 题目出现定质量气体、体积不变并改变温度，且要求从粒子角度解释压强时，先判断粒子平均速率的变化。

例题 2

Fig. 5.1 shows a metal container used for storing petrol.
There is some petrol gas above the liquid petrol inside the metal container.

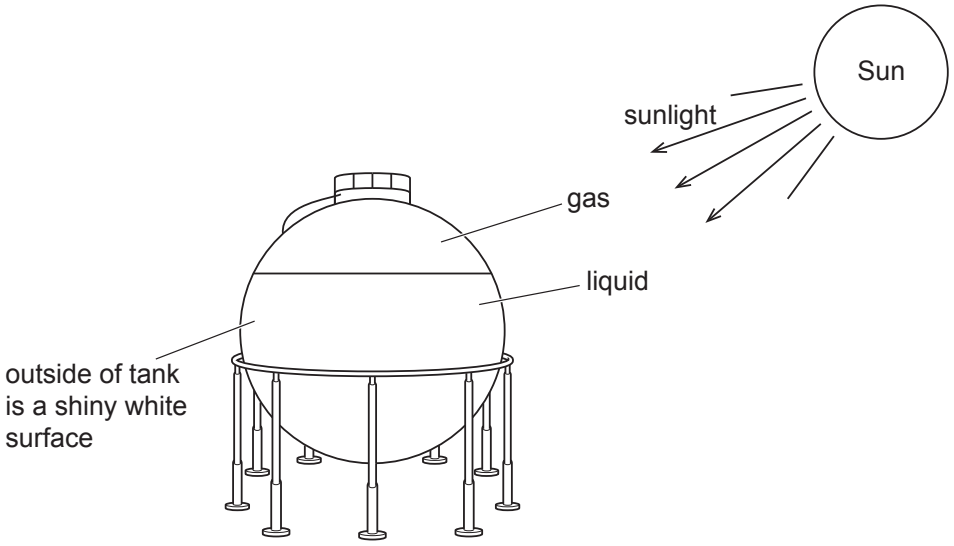


Fig. 5.1 (not to scale)

(b) The temperature of the petrol **gas** inside the metal container increases.

State and explain any change in the pressure of the petrol gas on the metal container.

（2024 春季 0625/32 第5题(b)）

解：气体温度升高，粒子的平均动能增大，平均速率增大。
粒子与容器壁碰撞更频繁，单次碰撞时的动量变化更大，对器壁的作用力更大。
故器壁单位面积所受的平均力增大，汽油气体的压强增大。
答：汽油气体的压强增大。

针对练习

5. **(a)** The temperature of a fixed mass of gas at constant volume is decreased.

State and explain, in terms of particles, how the pressure of the gas changes.

（2023 夏季 0625/42 第4题(a)）

6. **(b)** The temperature of a fixed mass of gas at constant volume changes from 300 K to 400 K.

State and explain, in terms of particles, the effect on the pressure of the gas.

（2023 冬季 0625/43 第4题(b)）

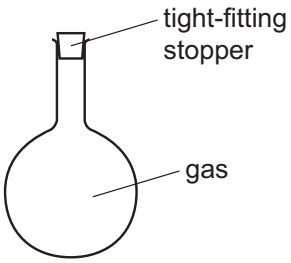
7. A football is inflated in a warm room and then taken outside where the temperature is much lower. The pressure and temperature inside the ball both decrease. The volume of the ball is unchanged.

Which row explains the decrease in pressure in terms of the movement of air particles?

	kinetic energy of air particles	frequency of collisions between air particles and inside surface of ball
A	decreased	decreased
B	decreased	unchanged
C	unchanged	decreased
D	unchanged	unchanged

（2025 冬季 0625/23 第11题）

8. A flask with a tight-fitting stopper contains a gas. The gas and flask are initially at room temperature.



The gas and flask are cooled.

Which row describes the average speed of the gas particles and the pressure of the gas as the temperature decreases?

	average speed of the gas particles	pressure of the gas
A	decreases	decreases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

（2025 冬季 0625/21 第10题）

题型 3：等温压强体积关系（考频★★★★☆）

知识点 对一定质量的气体，在温度不变时，压强 p 与体积 V 成_____比，即 $pV = \text{constant}$。

温度不变时，气体粒子的平均速率_____；体积增大，粒子与器壁碰撞的频率降低，压强减小，体积减小时则相反。

压强的国际单位为_____，体积的国际单位为 m^3。

答案：反；不变；帕斯卡（Pa）

怎么认 题目出现一定质量气体、温度不变及体积增减时，先判断粒子速率不变，再判断碰撞频率和压强。

一. 由体积增减判压强

例题 1 A fixed mass of gas at a constant temperature is trapped in a cylinder which has a movable piston.

Which row states and explains what happens to the pressure of the gas in the cylinder when the volume of the gas increases?

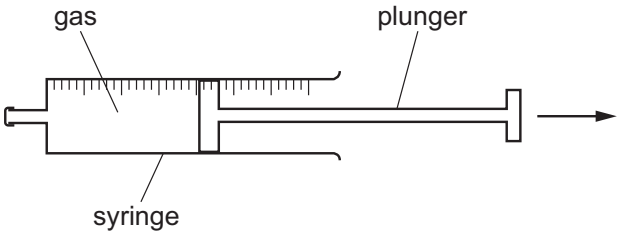
	pressure	explanation
A	decreases	gas particles collide with the cylinder at a lower speed
B	decreases	gas particles collide with the cylinder less frequently
C	increases	gas particles collide with the cylinder at a higher speed
D	increases	gas particles collide with the cylinder more frequently

（2025 夏季 0625/12 第12题）

解：温度不变，气体粒子的平均动能不变，故平均速率不变。
体积增大，粒子与器壁碰撞的频率降低，故气体压强减小。
故选 B。

针对练习

1. A teacher has a gas in a sealed syringe with a movable plunger.



The teacher slowly moves the plunger out of the syringe. The temperature of the gas remains constant.

Which row explains what happens to the pressure of the gas in the syringe?

	pressure of gas	explanation
A	decreases	gas particles collide with the syringe wall less frequently
B	decreases	gas particles collide with the syringe wall more frequently
C	increases	gas particles collide with the syringe wall less frequently
D	increases	gas particles collide with the syringe wall more frequently

（2025 夏季 0625/11 第14题）

2. A fixed mass of gas is trapped in a cylinder with a piston. The volume of the gas is slowly reduced at constant temperature without any particles of gas escaping.

Which statement is correct?

A The force exerted by the gas on the piston will decrease because the particles move more quickly.

B The force exerted by the gas on the piston will decrease because the particles move more slowly.

C The force exerted by the gas on the piston will increase because the particles are hitting the piston harder.

D The force exerted by the gas on the piston will increase because the particles are hitting the piston more frequently.

（2024 冬季 0625/13 第12题）

3. Fig. 4.1 shows some gas, at room temperature, in a cylinder with a piston that can move. The gas cannot escape from the cylinder.

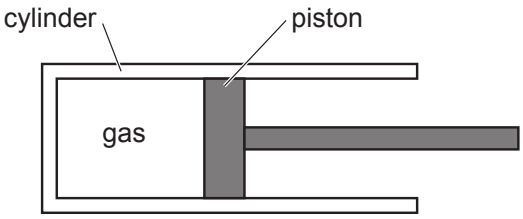


Fig. 4.1

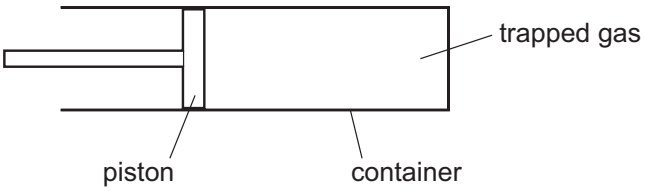
(b) The piston in Fig. 4.1 moves to the left.
The volume of the gas decreases. The temperature of the gas does not change.
State and explain any change in the pressure of the gas when the piston moves to the left.

（2023 春季 0625/32 第4题(b)）

4. Gas of volume 200 cm^3 is trapped inside a container by a piston.

The piston is pushed to the right and the volume of the gas decreases to 100 cm^3.

The temperature of the gas remains constant.



Which row states the effect that this has on the kinetic energy of the gas particles and the force per unit area exerted by the particles colliding with the inside walls of the container?

	kinetic energy	force per unit area
A	doubles	doubles
B	doubles	stays the same
C	stays the same	doubles
D	stays the same	stays the same

（2024 夏季 0625/21 第10题）

二. 列 $p_1V_1=p_2V_2$ 计算

知识点 一定质量的气体在温度不变时，压强 p 与体积 V 的乘积保持_____，即 $pV = \text{constant}$。
比较初、末状态时，有 $p_1V_1 = p_2V_2$；同一种物理量在等式两边须采用_____单位。
压强的 SI 单位是 Pa，体积的 SI 单位是 m^3；也可使用 kPa 和 cm^3。

答案：不变；相同

怎么认 题目出现固定质量气体、温度不变，并给出初末压强和体积时，先写 $p_1V_1 = p_2V_2$。

例题 2 A fixed mass of gas is contained within a sealed syringe at a pressure of 100 kPa. The plunger is slowly moved until the pressure is 80 kPa. The final volume of the gas is 50 cm^3. The temperature of the gas does **not** change.

What is the volume of the gas before the plunger is moved?

A 0.25 cm^3 **B** 40 cm^3 **C** 63 cm^3 **D** 160 cm^3

（2025 春季 0625/22 第16题）

解：温度不变，由 $p_1V_1 = p_2V_2$ 得
$100V_1 = 80 \times 50$
$V_1 = \frac{80\times50}{100} = 40\text{cm}^3$。
故选 B。

针对练习

5. **(c)** A sample of gas is at a pressure of 120 kPa. The volume of the gas is doubled at constant temperature.

Calculate the new pressure of the gas.

（2023 冬季 0625/43 第4题(c)）

6. A fixed mass of gas has a volume of 1.2 m^3 and is at a pressure of 200 kPa. The gas expands at constant temperature to a volume of 1.8 m^3.

What is the new pressure of the gas?

A 120 kPa **B** 130 kPa **C** 300 kPa **D** 600 kPa

（2025 夏季 0625/21 第11题）

7. A fixed mass of gas has a volume of 25 cm^3. The pressure of the gas is 100 kPa.

The volume of the gas is slowly decreased by 15 cm^3 at constant temperature.

What is the change in pressure of the gas?

A 67 kPa **B** 150 kPa **C** 170 kPa **D** 250 kPa

（2025 冬季 0625/23 第12题）

8. **(b)** A gas cylinder contains helium gas at a pressure of 2.0×10^6 Pa. A volume of 0.026 m^3 of the compressed gas is released from the cylinder into balloons. Each balloon contains 0.015 m^3 of helium at atmospheric pressure (1.0×10^5 Pa). The temperature remains constant.

Calculate the maximum number of balloons that can be filled.

（2024 春季 0625/42 第3题(b)）

三. 用 pV 常量认图表

知识点 对固定质量的气体，在温度不变时，压强 p 与体积 V 的乘积为_____，即 $pV = k$。

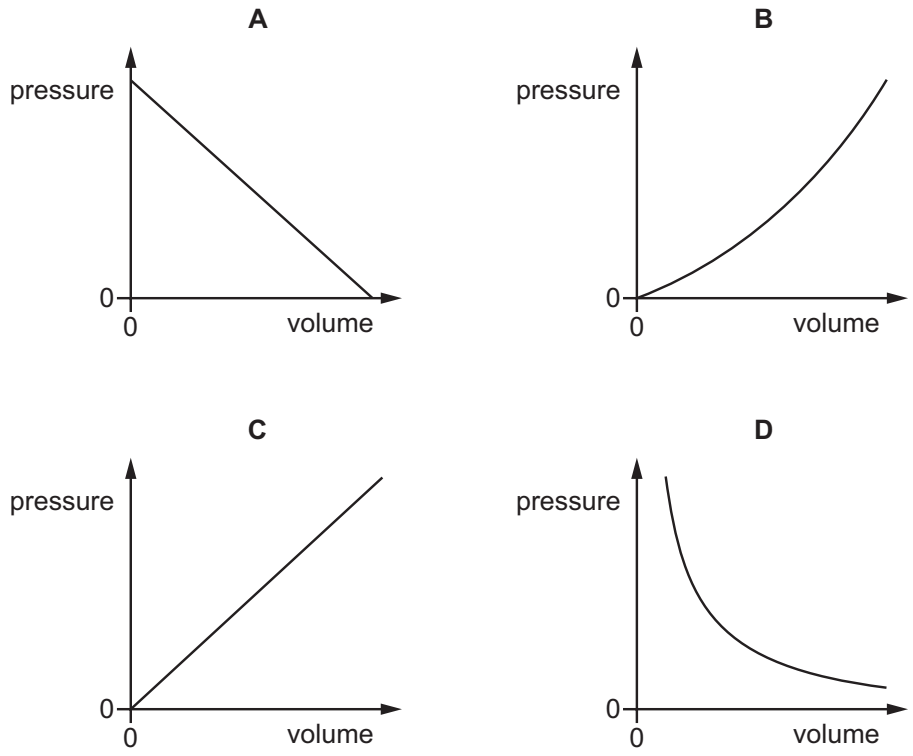
因此，压强 p 与体积 V 成_____；V 增大时，p 减小，其图像为反比例曲线。

压强单位可用 Pa 或 kPa，体积单位可用 m^3 或 cm^3；比较各组 pV 时，各组须采用同一套单位。

答案：常量；反比

怎么认 题目出现固定质量气体、温度不变及压强与体积的图表时，先写 $pV = k$。

例题 3 Which graph shows the relationship between the pressure and volume of a fixed mass of gas at constant temperature?



（2024 夏季 0625/21 第11题）

解：固定质量气体温度不变，由 $pV = k$ 得

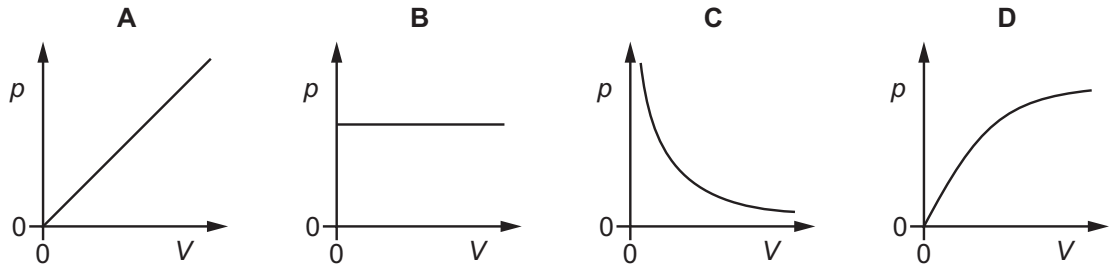
$p = \frac{k}{V}$

故压强随体积增大而减小，且二者成反比，图像为反比例曲线。

故选 D。

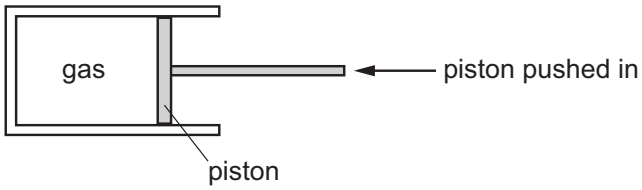
针对练习

9. Which graph shows the relationship between the pressure *p* of a fixed mass of gas and its volume *V* at a constant temperature?

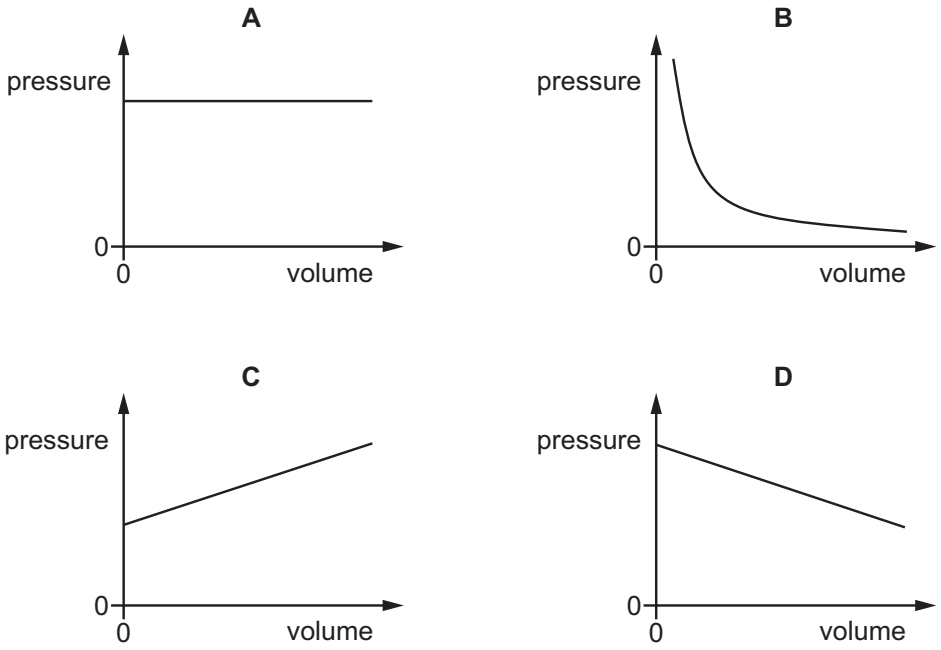


（2023 冬季 0625/13 第13题）

10. The diagram shows a quantity of gas trapped in a cylinder. The piston is pushed in slowly and the gas is compressed. The temperature of the gas does **not** change.



Which graph shows the relationship between the pressure and the volume of the gas?



（2024 夏季 0625/23 第12题）

11. A student investigates the relationship between the pressure of a gas and its volume at constant temperature. He records his results in the table.

reading	$\frac{\text{pressure}}{\text{N/cm}^2}$	volume / cm^3
1	10.0	24
2	7.4	32
3	4.0	63
4	13.0	19

What is the correct conclusion from the experiment?

A The volume decreases when the pressure increases.

B The volume increases when the pressure increases.

C The volume initially increases when the pressure increases, but then decreases.

D The volume is independent of the pressure.

（2023 冬季 0625/12 第13题）

12. A bubble of gas rises from the bottom of a lake to the top.

The table shows readings of the gas pressure inside the bubble and the volume of the bubble.

The temperature of the water in the lake is constant.

The values in three rows of the table are correct and one row is **not** correct.

Which row is **not** correct?

	pressure / kPa	volume / cm^3
A	360	2.4
B	270	3.2
C	160	4.6
D	120	7.2

（2025 夏季 0625/22 第12题）

题型 4：先辨约束处理气体过程（考频★★☆☆☆）

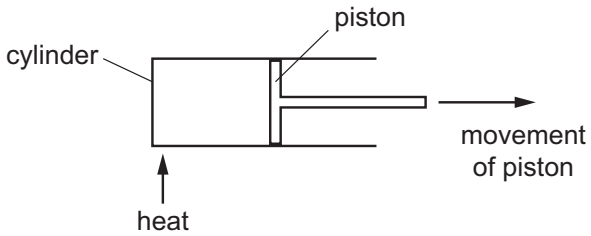
知识点 密闭容器内固定质量的气体，状态由温度、体积和压强描述。活塞无摩擦且外界压力不变时，平衡过程中气体压强保持_____；加热时温度和体积增大。
刚性容器或近似定容的轮胎内，气体体积不变；升温使粒子运动加快，压强增大。
固定质量的气体在温度不变时，$p_1V_1 = p_2V_2$，压强与体积成_____；压强单位为 Pa，体积单位为 m^3。
质量不变时，$\rho = \frac{m}{V}$；此外，$p = \frac{F}{A}$，$W = Fd$，功的单位为 J。

答案：不变；反比

怎么认 题目出现密闭气体、可动活塞及加热或推拉活塞时，先由活塞和温度条件确定不变量。

例题 1 The diagram shows a frictionless piston inside a cylinder.

The air inside the cylinder is heated. The piston moves in the direction shown.



Which statement about the air inside the cylinder is correct?

A The temperature and volume increase at constant pressure.

B The temperature and pressure increase at constant volume.

C The temperature, volume and pressure all increase.

D The volume and pressure increase at constant temperature.

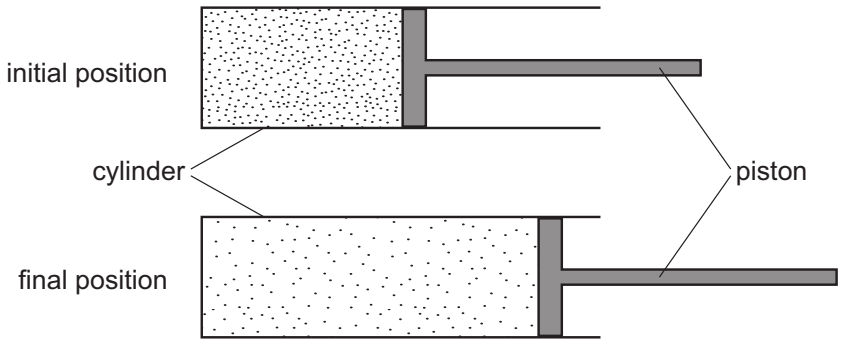
（2024 夏季 0625/11 第12题）

解： 由活塞无摩擦并能自由移动，得 $p_{内} = p_{外}$，外界压力不变，故气体压强不变。
空气受热，温度升高；活塞向外移动，空气体积增大。
故温度和体积增大而压强不变，故选 A。

针对练习

1. A piston traps a mass of gas inside a cylinder. Initially, the piston is halfway along the length of the cylinder.

The piston is now moved towards the open end of the cylinder. The temperature of the gas remains constant.



How are the density and the pressure of the gas affected by moving the piston?

	density	pressure
A	decreases	decreases
B	decreases	unchanged
C	increases	decreases
D	increases	unchanged

（2023 春季 0625/12 第14题）

2. A rubber balloon is inflated with helium and sealed so that no helium escapes.

The balloon is positioned immediately below the ceiling in a room.

Heaters are switched on and the temperature of the air in the room increases.

(b) The temperature of the helium in the balloon increases and as the rubber stretches, the volume occupied by the helium increases.

(i) State what happens to the motion of the helium particles as the temperature increases.

(ii) As the rubber stretches and the volume of the helium increases, the pressure of the helium remains constant.

Explain, in terms of the particles of helium, how the pressure of the helium remains constant.

（2023 夏季 0625/41 第3题(b)）

3. **(a)** A car has a weight of 13 000 N. The car is supported by 4 tyres. The area of each tyre in contact with the road is 0.016 m^2.

(i) Calculate the pressure on the road due to the weight of the car.

(ii) Explain, in terms of particles, why the air pressure in the tyres increases when the car travels along the road.

（2024 春季 0625/42 第3题(a)）

4. **(b)** Fig. 5.1 shows some gas in a container with a piston. The piston can move into the container.

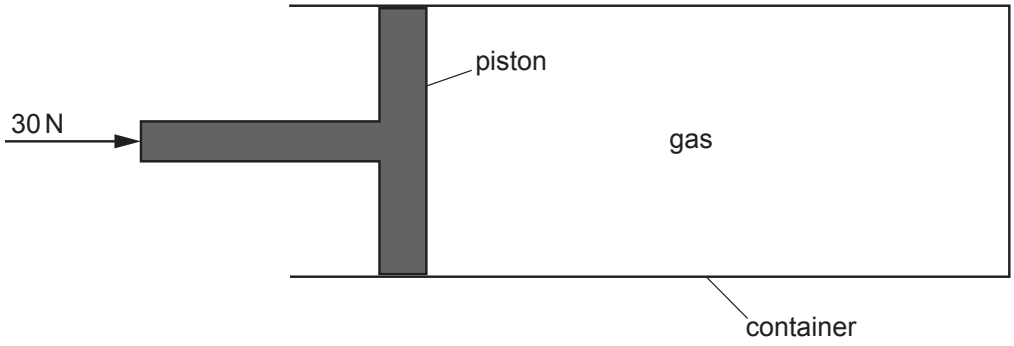


Fig. 5.1

(i) A force of 30 N pushes the piston into the container for a distance of 0.18 m.

Calculate the work done by the 30 N force.

(ii) When the piston moves into the container, the temperature of the gas does **not** change.

Describe and explain any change in the pressure on the walls of the container.

（2024 夏季 0625/31 第5题(b)）

2.2.1 热膨胀

题型 1：由升降温判热胀冷缩（考频★★★☆☆）

知识点 在压强不变且物态不变时，物体温度升高通常膨胀，体积_____；温度降低通常收缩，体积减小。

没有物质进出时，物体的_____不随温度改变，质量单位为 kg，体积单位为 m^3。

由 $\rho = \frac{m}{V}$，质量不变时，体积增大则密度_____；密度单位为 $\mathrm{kg\ m^{-3}}$。

答案：增大；质量；减小

怎么认 题目出现物体升温及体积、质量或密度变化时，先判膨胀，再由质量不变和 $\rho = \frac{m}{V}$ 判断。

一. 先判体积再守质量

例题 1 Which row describes how the volume and mass of liquid mercury change as it is heated?

	volume	mass
A	decreases	decreases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

（2024 春季 0625/12 第11题）

解：液态汞受热，温度升高，在压强不变且物态不变时发生热膨胀，故体积增大。

加热过程中没有汞进出，故质量保持不变。

故选 D。

针对练习

1. What happens when a metal block is heated?

A Its width, height and length all increase.

B Its width increases only.

C Its height increases only.

D Its length increases only.

（2023 冬季 0625/13 第14题）

2. Which quantity does **not** change when there is an increase in temperature?

A the density of a steel block

B the diameter of the hole in a metal nut

C the length of an iron rod

D the mass of a metal coin

（2025 夏季 0625/12 第13题）

3. A metal object is heated strongly in an oven.

What happens to the volume of the object and the internal energy stored in the object?

	volume	internal energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2024 冬季 0625/11 第14题）

4. A solid is heated causing it to expand.

Which effect does this have on its mass and on its density?

	mass	density
A	decreases	decreases
B	decreases	stays constant
C	stays constant	decreases
D	stays constant	stays constant

（2024 冬季 0625/23 第15题）

二. 按固液气比较膨胀

知识点 物质温度升高且压强保持不变时，体积通常_____，这种现象称为热膨胀。

在初始体积和温升相同、且不发生状态变化时，膨胀大小通常为气体_____、液体次之、固体_____。

气体粒子间距大、粒子间吸引力弱，受热后平均间距增加得较多；固体粒子排列紧密、作用力较强，平均间距增加得较少。

体积增加的百分数用 % 表示，是无量纲量。

答案：增大；最大；最小

怎么认 题目出现相同温升、无状态变化及固液气粒子图或体积增量时，先按气体、液体、固体比较膨胀大小。

例题 2 Which words complete the sentence about the expansion of solids when they are heated, relative to liquids and gases?

	1	2
A	least	greatest
B	least	smallest
C	most	greatest
D	most	smallest

（2025 春季 0625/12 第17题）

解： 固体粒子排列紧密，粒子间作用力较强，受热时粒子振动加剧，但平均间距增加最小。
因此固体相对于液体和气体膨胀最少，1 应填 least，2 应填 smallest。
故选 B。

针对练习

5. Four students are asked to state and explain the relative magnitudes of the thermal expansion of solids and gases.

Which student is correct?

A Gases expand more than solids because the molecules in a gas are in random motion.

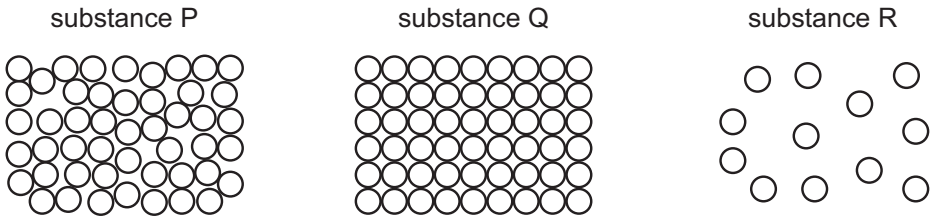
B Gases expand more than solids because the attractive forces between molecules are much weaker in gases.

C Solids expand more than gases because the molecules are closer together in solids.

D Solids expand more than gases because the molecules in a solid are in a regular pattern.

（2023 夏季 0625/22 第15题）

6. The diagram represents the particle arrangements in samples of three different substances, P, Q and R.



The samples have equal volumes and the same temperature.

The samples are heated. The temperature increase of each sample is the same and **no** changes of state take place.

Which row shows possible percentage increases in volume for the three samples?

	sample of substance P / %	sample of substance Q / %	sample of substance R / %
A	0.066	1.9	7.2
B	0.066	7.2	1.9
C	1.9	0.066	7.2
D	1.9	7.2	0.066

（2025 冬季 0625/22 第12题）

7. **(b)** Fig. 4.2 shows part of a steel railway track. There are small gaps between sections of the rail.

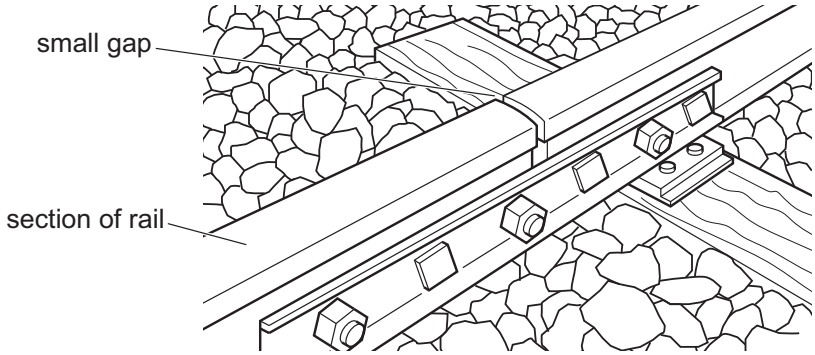


Fig. 4.2

State why gaps are needed between the sections of rail. Explain your answer in terms of particles.

（2025 冬季 0625/43 第4题(b)）

题型 2：在装置中追踪膨胀（考频★★★☆☆）

知识点 物质温度升高时，体积通常_____；温度降低时，体积通常收缩。

在相同温升下比较时，气体还需保持压强不变；膨胀程度通常是气体最大、_____次之、固体最小。

温度计中的测温液体受热膨胀，增加的体积进入细管，液柱_____；温度变化可用 °C 或 K 表示。

答案：膨胀；液体；上升

怎么认 题目出现装置受热后液柱、双金属片或气柱移动时，先找真正被加热的物质，再判断膨胀造成的动作。

一. 沿受热部件判断动作

例题 1 The liquid level in a thermometer rises when the thermometer is placed in hot water.

What causes this?

A The liquid contracts.

B The liquid evaporates.

C The liquid expands.

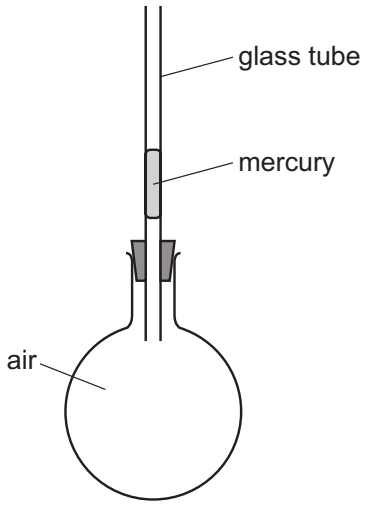
D The liquid freezes.

（2024 夏季 0625/23 第13题）

解： 温度计放入热水后，测温液体受热，温度升高。
液体受热膨胀，增加的体积进入细玻璃管，液面上升。
故选 C。

针对练习

1. The diagram shows a glass flask sealed with a small volume of mercury in a glass tube. When the flask is gently warmed, the mercury rises up the tube.



What is the main cause of the movement of the mercury?

A expansion of air in the flask

B expansion of the glass flask

C expansion of the glass tube

D expansion of the mercury

（2025 夏季 0625/22 第13题）

2. Solids expand when heated and contract when cooled.

In which example is there a useful application of expansion and **not** an unwanted effect?

A bridges

B railway lines

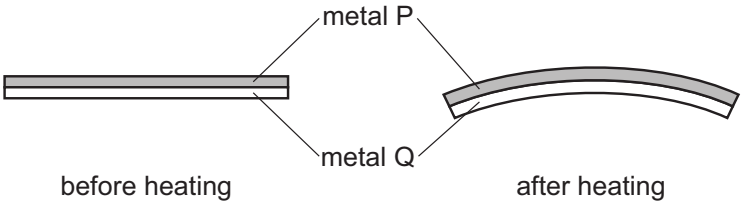
C telephone cables

D thermostats

（2024 夏季 0625/13 第13题）

3. A bimetallic strip is used to control the temperature of an electrical appliance. It is made of two different metals fixed together.

The diagram shows the shape of the bimetallic strip before and after heating.



Which statement is correct?

A Metal P contracts more than metal Q on heating.

B Metal Q contracts more than metal P on heating.

C Metal P expands more than metal Q on heating.

D Metal Q expands more than metal P on heating.

（2023 冬季 0625/11 第14题）

二. 按胀缩判断结构措施

知识点 物体温度升高时，长度或体积通常增大，称为热膨胀；温度降低时则发生热收缩。

在物质状态不变、比较气体时压强不变的条件下，升温使物体_____，降温使物体_____；温度变化可用摄氏度或开尔文表示。

升温时粒子运动加快；固体粒子的位置受约束最强，液体较弱，气体粒子可自由移动，所以膨胀程度通常为气体大于液体大于固体。

铁轨接缝和悬空电缆要留出合适的_____；套装金属环时可先加热，使其内径增大。

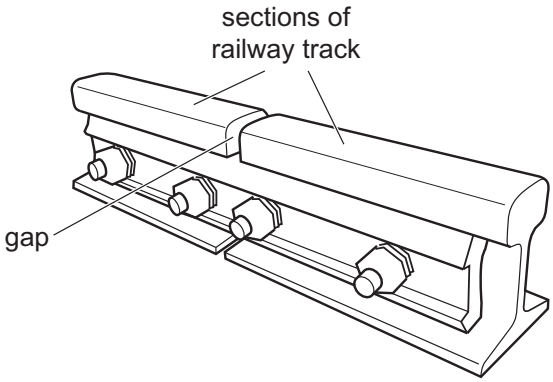
答案：膨胀；收缩；空间或余量

怎么认 题目出现铁轨缝隙、电缆松弛或金属环套装时，先判断升温膨胀或降温收缩，再判断结构后果。

例题 2

The diagram shows part of a railway track.

Each section of the railway track is separated by a gap.



Why are these gaps necessary?

A The tracks contract on cold days.

B The tracks contract on warm days.

C The tracks expand on cold days.

D The tracks expand on warm days.

（2025 冬季 0625/13 第13题）

解：温度升高时，铁轨受热膨胀，长度增大。
接缝为铁轨膨胀留出空间，可防止铁轨受挤压而弯曲。故选 D。

针对练习

4. Which effect is caused by thermal expansion?

A a metal surface heating up in direct sunlight

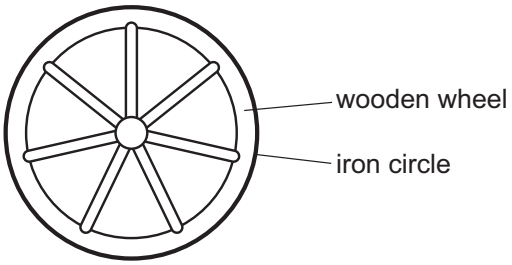
B ice-cream melting on a hot day

C a railway track buckling on a hot day

D ice forming on a pond on a cold day

（2024 夏季 0625/22 第12题）

5. A wooden wheel can be strengthened by putting a tight circle of iron around it.



Which action would make it easier to fit the circle over the wood?

A cooling the iron circle only

B heating the iron circle

C heating the wooden wheel and cooling the iron circle

D heating the wooden wheel but not heating or cooling the iron circle

（2023 冬季 0625/12 第14题）

6. The distance between two electricity pylons is 60 m. The cable that connects the two pylons is 62 m in length.

Why is the cable longer than the distance between the two pylons?

A to allow for contraction of the cable in cold weather

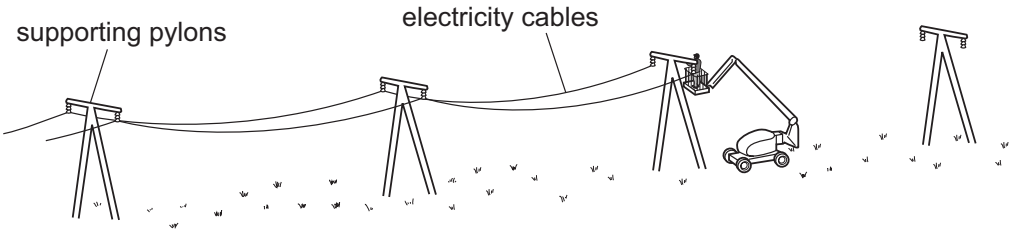
B to create a slope in the cable for electrons to flow down

C to keep the current low and the voltage high

D to reduce magnetic fields around the cable

（2025 冬季 0625/21 第12题）

7. The diagram shows electricity cables being put up on a warm day. The cables are suspended between the supporting pylons, as shown.



Why are the cables **not** tightened to make them higher above the ground?

A They will contract on cold days.

B They will contract on very warm days.

C They will expand on cold days.

D They will expand on very warm days.

（2024 冬季 0625/12 第14题）

2.2.2 比热容

题型 1：由温变判内能（考频★★☆☆☆）

知识点 物体的内能是物体内所有粒子的动能与相互作用势能的总和，单位是_____（J）。
对同一物体，温度升高时，粒子的_____增加，物体的_____增加；温度降低时，两者均减小。
能量传递或对物体做功都能改变内能；绝热条件下，搅拌做功也能使物体的内能增加。

答案：焦耳；平均动能；内能

怎么认 题目出现升温、降温或搅拌做功并问粒子或内能变化时，先判断平均动能和内能的增减。

例题 1 What increases when the temperature of a copper block increases?

A the number of copper atoms in the block

B the melting point of the block

C the internal energy of the block

D the density of the block

（2024 夏季 0625/11 第13题）

解：铜块温度升高，铜原子的平均动能增加。
因此铜块的内能增加。
故选 C。

针对练习

1. Fig. 4.1 shows a stainless-steel saucepan being heated on an electric cooker. The saucepan contains water.

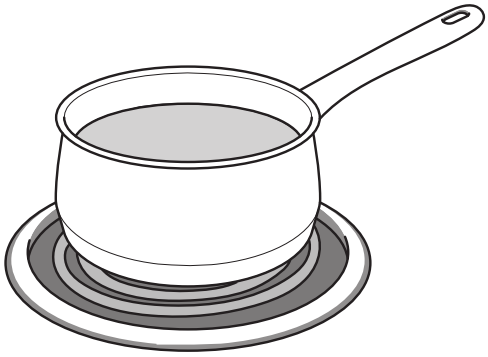


Fig. 4.1

(a) State what happens to the water particles as the water temperature increases.

（2024 夏季 0625/43 第4题(a)）

2. A metal block is left overnight in a cool, shady room. In the morning, the metal block is moved into warm surroundings.

Which statement about the metal block is correct in the morning?

A The internal energy of the metal block increases.

B The temperature of the metal block decreases.

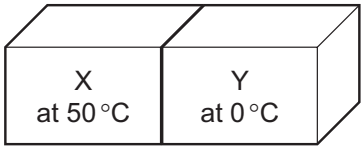
C Convection transfers energy throughout the metal block.

D The metal contracts slightly.

（2025 春季 0625/22 第15题）

3. A student has two blocks of metal, X and Y. The temperature of X is 50 °C and the temperature of Y is 0 °C.

The two blocks are placed in contact with each other, as shown.



After some time, both blocks have a temperature of 25 °C.

What has happened to the internal energy of each block?

	internal energy of X	internal energy of Y
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	unchanged	unchanged

（2023 冬季 0625/11 第15题）

4. In a famous experiment, a scientist showed that, when water in an insulated tub is stirred, its temperature increases.

What can be concluded from this experiment?

A Temperature is a store of energy.

B The water absorbs heat from the surroundings.

C Work done by stirring increases the internal energy of the water.

D Energy is not conserved.

（2024 夏季 0625/13 第12题）

题型 2：认识并测量比热容（考频★★★☆☆）

知识点 比热容表示_____的物质温度升高_____所需传递的能量。

当物质不发生状态变化时，$c = \Delta\frac{E}{m\Delta T}$，其中 ΔE 为内能增加量，m 为质量，ΔT 为温度升高量。

比热容的单位为 $\mathrm{J\ kg^{-1}{}^{\circ}C^{-1}}$。

答案：单位质量；1 °C

怎么认 题目给出内能增加量、质量和温升并求比热容时，先写 $c=\Delta\frac{E}{m\Delta T}$。

一. 从单位质量单位温升认定义

例题 1 **(a)** Define specific heat capacity.

（2024 春季 0625/42 第4题(a)）

解：由比热容的定义，

$c=\Delta\frac{E}{m\Delta T}$

答：比热容是使单位质量的物质温度升高 1 °C 所需传递的能量。

针对练习

1. In an experiment to measure specific heat capacity, a block of aluminium is heated and its rise in temperature is measured.

The internal energy gained by the block is ΔE. The mass of the block is m. The rise in temperature of the block is ΔT.

Which expression gives the specific heat capacity of aluminium?

A $\frac{m}{\Delta E\Delta T}$ **B** $\frac{m\Delta T}{\Delta E}$ **C** $\frac{\Delta E}{m\Delta T}$ **D** $\frac{\Delta E\Delta T}{m}$

（2024 冬季 0625/22 第15题）

2. Thermal energy ΔE is supplied to an object of mass m which does not change its state during the heating process. The temperature of the object rises by ΔT.

What is the specific heat capacity of the object?

A $\frac{\Delta E}{m\Delta T}$ **B** $\frac{m\Delta T}{\Delta E}$ **C** $\frac{\Delta E\Delta T}{m}$ **D** $\frac{\Delta Em}{\Delta T}$

（2023 冬季 0625/22 第15题）

3. The specific heat capacity of solid P is greater than that of solid Q.

What does this statement mean?

A Less energy is needed to raise the temperature by 1 °C of unit mass of solid P than unit mass of solid Q.

B Less energy is needed to melt unit mass of solid P than unit mass of solid Q.

C More energy is needed to raise the temperature by 1 °C of unit mass of solid P than unit mass of solid Q.

D More energy is needed to melt unit mass of solid P than unit mass of solid Q.

（2025 夏季 0625/21 第12题）

二. 按公式列实验测量量

知识点 物质的比热容 c 是使_____物质的温度升高_____所需的能量，单位为 J/(kg·K) 或 J/(kg·°C)。

物体温度升高时，内能增加；组成物体的全部粒子的平均动能增大。

由 $\Delta E=mc\Delta\theta$ 得 $c=\Delta\frac{E}{m\Delta\theta}$，其中 $\Delta\theta$ 为温度变化。

忽略向外界散失的能量时，电加热器提供 $\Delta E=VIt$，故 $c=VI\frac{t}{m\Delta\theta}$。

答案：1 kg；1 °C（或 1 K）

怎么认 题目出现电加热金属块并要求测比热容时，先由 $c = VI\frac{t}{m\Delta\theta}$ 反推各读数。

例题 2

(a) Describe an experiment to determine the specific heat capacity of aluminium. You may draw a diagram.

Include in your answer:

- the measurements made
- any equations needed.

（2024 冬季 0625/41 第4题(a)）

解：用天平测出铝块的质量 m，将电加热器和温度计插入铝块的孔中，并用隔热材料包住铝块。
记录铝块的初温 θ_1，闭合电路并开始计时，读出加热器两端的电压 V 和通过加热器的电流 I。
加热时间 t 后，记录铝块的末温 θ_2。
$\Delta\theta = \theta_2 - \theta_1$
$\Delta E = VIt$
忽略散热及其他装置吸收的能量，由 $\Delta E = mc\Delta\theta$ 得
$c = \frac{VIt}{m(\theta_2-\theta_1)}$
答：测量 m、V、I、t、θ_1 和 θ_2，代入上式可求铝的比热容。

针对练习

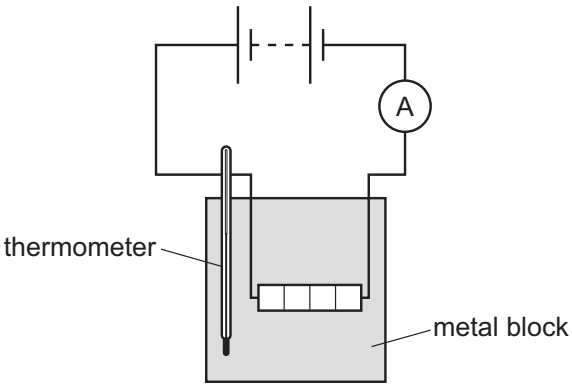
4. **(b)** **(i)** Define specific heat capacity.

(ii) A student carries out an experiment to determine the specific heat capacity of a metal. A cylinder of the metal is heated by a 12 W electrical heater.

State the readings that the student takes.

（2023 夏季 0625/43 第3题(b)）

5. The diagram shows some of the apparatus used to determine the specific heat capacity of a metal block.



Which additional pieces of apparatus are required to find the specific heat capacity?

A stop-watch, voltmeter and balance

B resistor, stop-watch and ruler

C ruler, balance and force meter

D voltmeter, thermistor and insulation

（2025 夏季 0625/23 第14题）

题型 3：用比热容式计算（考频★★★★☆）

知识点 物体温度升高时，内能增加；微观上，物体内全部粒子的平均动能_____。

比热容是单位质量的物质温度升高单位温度所需的能量，关系式为 _____。

物质不发生物态变化且比热容可视为不变时，$\Delta E = mc\Delta\theta$；比热容的单位为 _____。

答案：增加；$c = \Delta\frac{E}{m\Delta\theta}$；J/(kg °C)

怎么认 题目出现质量、比热容、温度变化和所求能量时，先统一单位并求温差。

一. 统一单位后直接代入

例题 1 **(a)** A 12 V, 50 W immersion heater is used to heat 0.15 kg of water in a beaker. The water is initially at a room temperature of 20 °C. The specific heat capacity of water is 4200 J/(kg °C).

Calculate the energy supplied to raise the temperature of the water from 20 °C to 58 °C.

（2025 冬季 0625/41 第4题(a)）

解： 水升高的温度为

$\Delta\theta = 58 - 20 = 38\ ^\circ\text{C}$

由 $\Delta E = mc\Delta\theta$ 得

$\Delta E = 0.15 \times 4200 \times 38 = 23940\ \text{J}$

$\Delta E \approx 2.4 \times 10^4\ \text{J}$

答：所需能量为 2.4×10^4 J。

针对练习

1. Fig. 4.1 shows a bottle part-filled with water. The air inside the bottle is at the same pressure as the air outside the bottle. The bottle and its contents are at room temperature.

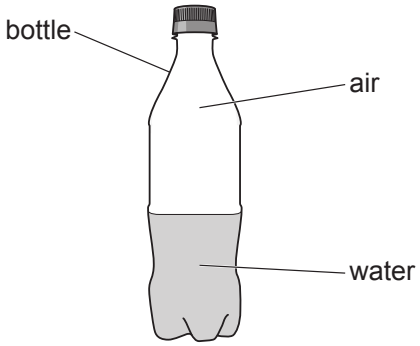


Fig. 4.1

(b) The mass of water in the bottle is 0.18 kg. The specific heat capacity of water is 4200 J/(kg °C).

Calculate the thermal energy needed to increase the temperature of the water by 20 °C.

（2023 冬季 0625/42 第4题(b)）

2. A cup contains 0.25 kg of water at 60 °C. Some time later, the water has cooled to 20 °C.

How much energy has been transferred from the water to the surroundings?

(The specific heat capacity of water is 4200 J/(kg °C).)

A 21 000 J **B** 42 000 J **C** 63 000 J **D** 84 000 J

（2025 冬季 0625/22 第13题）

3. The specific heat capacity of ice is 2000 J / kg °C.

Which thermal energy is required to raise the temperature of 100 g of ice by 5 °C?

A 40 J　　**B** 100 J　　**C** 1000 J　　**D** 4000 J

（2025 冬季 0625/23 第13题）

4. A student does an experiment to determine the specific heat capacity of a metal block.

She records the following measurements.

energy supplied = 12 kJ

initial temperature = 20 °C

final temperature = 45 °C

mass of metal block = 600 g

What is the specific heat capacity of the metal block?

A 8.0×10^{-4} J / (kg °C)

B 0.80 J / (kg °C)

C 180 J / (kg °C)

D 800 J / (kg °C)

（2025 春季 0625/22 第14题）

二. 先求质量或输入能量

知识点 物体温度升高时，内能增加；物体中全部粒子的平均动能增加。

比热容是单位质量的物质温度升高 1 °C 所需的能量，单位为 J/(kg·°C)。

物质状态不变且比热容视为恒定时，能量关系为 _____，其中 m 的单位为 kg，$\Delta\theta$ 的单位为 °C。

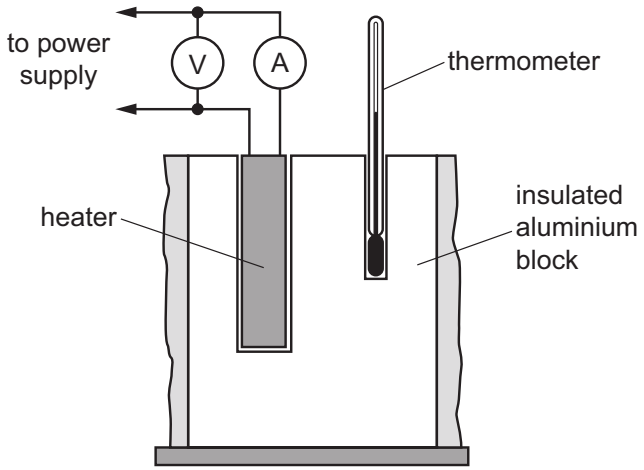
已知密度 ρ 和体积 V 时，质量为 _____，ρ 的单位为 kg/m³，V 的单位为 m³。

加热器工作时间为 t 时，输入能量为 _____；求最大温升时，取全部输入能量传给被加热物体。

答案：$\Delta E = mc\Delta\theta$；$m = \rho V$；$E_{入} = Pt = VIt$

怎么认 题目出现质量或密度、温升、比热容及加热时间或电学量时，先求质量和输入能量。

例题 2 The diagram shows the equipment used in an experiment on the heating of aluminium.



The table gives the results for the experiment.

mass of block	0.80 kg
voltmeter reading	12 V
ammeter reading	5.0 A
time	300 s

The specific heat capacity of aluminium is 900 J / (kg °C).

What is the maximum possible temperature rise in the block?

A 9 °C **B** 20 °C **C** 25 °C **D** 225 °C

（2024 春季 0625/22 第15题）

解：最大温升对应全部电能转化为铝块增加的内能，由电功得

$\Delta E = VIt = 12 \times 5.0 \times 300 = 1.8 \times 10^4$ J

由 $\Delta E = mc\Delta\theta$ 得

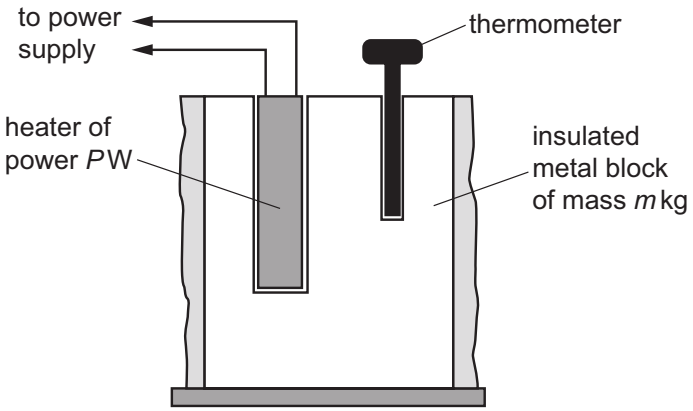
$\Delta\theta = \frac{\Delta E}{mc} = \frac{1.8\times10^4}{0.80\times900} = 25$ °C

故选 C。

针对练习

5. The diagram shows the equipment used in an experiment to determine the specific heat capacity of a metal.

In the experiment, a heater is switched on for t s and the increase in temperature $\Delta\theta$ of a block of the metal is measured in °C.



Which equation gives the specific heat capacity of the metal?

A $c = \frac{P}{tm\Delta\theta}$ **B** $c = \frac{Pt}{m\Delta\theta}$ **C** $c = \frac{tm\Delta\theta}{P}$ **D** $c = \frac{m\Delta\theta}{Pt}$

（2025 夏季 0625/22 第14题）

6. **(b)** A volume of 0.0024 m^3 of oil is heated in a pan for 7.0 min. The temperature of the oil increases from 20 °C to 180 °C.

The density of the oil is 910 kg / m^3. The specific heat capacity of the oil is 2000 J / (kg °C).

(i) Calculate the mass of oil in the pan.

(ii) Calculate the energy required to increase the temperature of the oil.

(iii) Calculate the power required to supply the energy calculated in **(b)(ii)**.

（2024 春季 0625/42 第4题(b)）

7. Fig. 3.1 shows a portable shower used on a campsite. The bag is filled with water. The water is heated using infrared radiation from the Sun.

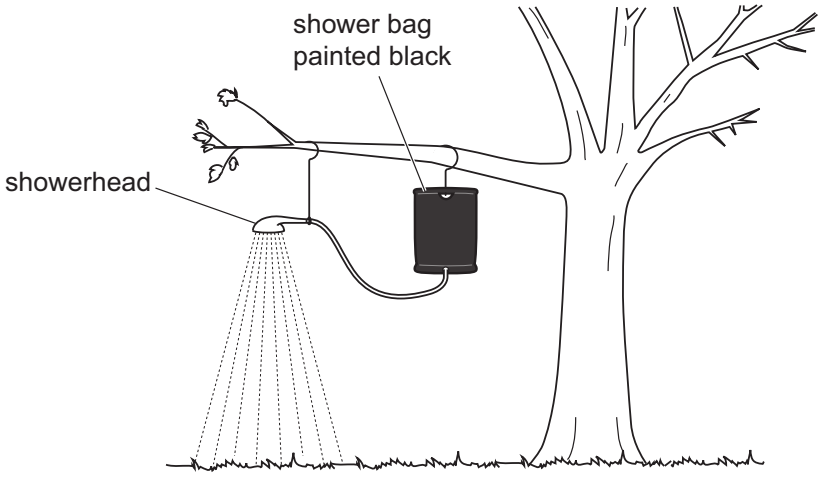


Fig. 3.1

(c) During the day, the Sun shines on the shower bag and some of the energy in the infrared radiation from the Sun transfers to the thermal energy stores of the water.

The water absorbs 60% of the energy incident on the bag. The temperature of the water rises from 10 °C to 43 °C.

The mass of the water in the bag is 40 kg. The specific heat capacity of water is 4200 J / (kg °C).

Calculate the energy incident on the shower bag during the day.

Show your working.

（2024 冬季 0625/43 第3題(c)）

8. **(a)** Fig. 5.1 shows an electric heater used to heat a room.

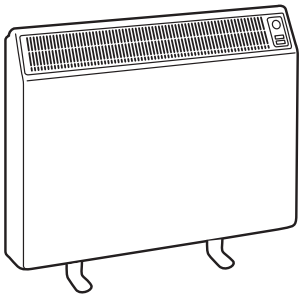


Fig. 5.1

The dimensions of the room are 4.5 m × 6.1 m × 2.4 m.
The density of air is 1.2 kg / m^3.

(i) Show that the mass of air in the room is 79 kg.

(ii) The power of the heater is 1100 W. The specific heat capacity of air is 1000 J / (kg °C).

Calculate the time taken to increase the temperature of the air in the room from 16.0 °C to 20.0 °C.

(iii) Suggest **one** reason why the time calculated in **(a)(ii)** is the **minimum** time needed to increase the temperature of the air in the room from 16.0 °C to 20.0 °C.

（2023 夏季 0625/42 第5题(a)）

三. 固定量后比较比热容

知识点 物质的比热容 c 是单位质量的物质温度升高 1° C 所需的热能，单位为 _____。
在物质不发生物态变化时，吸收的热能 ΔE、质量 m 和温升 $\Delta\theta$ 满足 _____。
质量与温升相同时，ΔE 越大，c 越_____；加热功率 P 相同时，由 $\Delta E = Pt$ 比较加热时间。
体积相同时，先由 $m = \rho V$ 比较质量，再由 $\Delta E = mc\Delta\theta$ 比较所需热能。

答案：J/(kg °C)；$\Delta E = mc\Delta\theta$；大

怎么认 题目出现相同质量、温升、体积或功率下的吸热量与加热时间比较时，先写 $\Delta E = mc\Delta\theta$。

例题 3 A 1 kg block of aluminium requires more thermal energy to raise its temperature by 1 °C than a 1 kg block of copper requires.

Why is this?

A Aluminium is a better conductor of thermal energy than copper.

B Aluminium is a poorer conductor of thermal energy than copper.

C Aluminium has a higher specific heat capacity than copper.

D Aluminium has a lower specific heat capacity than copper.

（2024 冬季 0625/21 第15题）

解：由 $\Delta E = mc\Delta\theta$ 得
$c = \Delta\frac{E}{m\Delta\theta}$。
两金属块的质量均为 1 kg，温升均为 1° C，铝块所需的 ΔE 更大，$\therefore c_{铝} > c_{铜}$。
故选 C。

针对练习

9. A chef heats some water in a pan on a hotplate.

The temperature of the water rises by 10 °C in time *t*.

She then puts the same volume of oil in an identical pan on the same hotplate.

The specific heat capacity of water is 2.5 times that of oil and water is 1.1 times denser than oil.

What is the time for the temperature of the oil to rise by 10 °C?

A 0.36*t* **B** 0.44*t* **C** 2.3*t* **D** 2.8*t*

（2023 冬季 0625/21 第15题）

10. Fig. 4.1 shows a stainless-steel saucepan being heated on an electric cooker. The saucepan contains water.

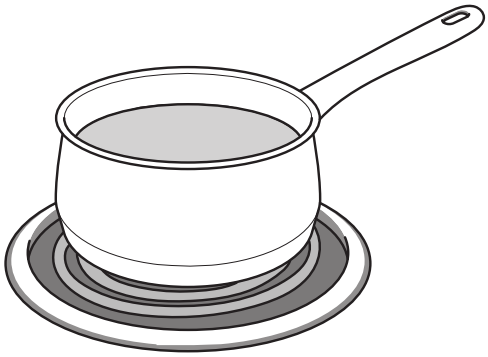


Fig. 4.1

(c) The stainless-steel saucepan is replaced with an aluminium saucepan of the same mass. It contains the same volume of water.

The specific heat capacity of stainless steel is 500 J/(kg °C).
The specific heat capacity of aluminium is 890 J/(kg °C).

Explain how using an aluminium saucepan will affect the time taken to heat the water.

（2024 夏季 0625/43 第4题(c)）

四. 列能量守恒求温度量

知识点 物体温度升高时，内能_____；从微观上看，组成物体的粒子的平均动能增大。

比热容表示单位质量的物质温度升高单位温度所需的能量，$c = \Delta\frac{E}{m\Delta\theta}$，单位为_____。

在无热量散失的热交换中，热物体减少的能量_____冷物体吸收的能量，各温度变化量均取正值。

答案：增大；J/(kg °C)；等于

怎么认 题目出现势能转化为内能，或冷热物体达到共同温度时，先列能量守恒。

例题 4 A glass beaker contains a mass of 0.20 kg of water at a temperature of 20 °C.

The specific heat capacity of water is 4200 J / (kg °C).

A brass block of mass 0.15 kg is at a temperature of 170 °C. The block is carefully lowered into the beaker of water.

The final temperature of both the water and brass is 30 °C.

What is the specific heat capacity of the brass?

(Assume that no water is lost and no thermal energy has been transferred to the beaker or the surroundings.)

A 400 J / (kg °C)

B 660 J / (kg °C)

C 1200 J / (kg °C)

D 5600 J / (kg °C)

（2025 冬季 0625/21 第13题）

解：由热交换过程无热量散失，黄铜块失去的能量等于水吸收的能量。

$0.15 \times c \times (170 - 30) = 0.20 \times 4200 \times (30 - 20)$

$c = 400 \frac{\text{J}}{\text{kg °C}}$

故选 A。

针对练习

11. Fig. 4.1 shows a pan with a copper base on a hotplate. The hotplate heats the pan and the water.

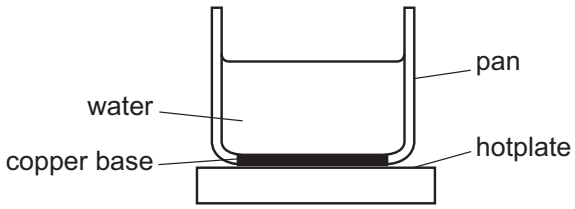


Fig. 4.1

(b) (i) Define, in words, specific heat capacity.

(ii) A student heats a metal object to 100 °C. The student places the metal object in an insulated cup containing water at 22 °C. The final temperature of the water and the metal object is 31 °C.

The specific heat capacity of water is 4.2 J / (g °C).
The mass of the water in the insulated cup is 50 g.
The mass of the metal object is 54 g.

Calculate the specific heat capacity of the metal.

（2025 夏季 0625/43 第4题(b)）

12. The temperature of the water at the bottom of a waterfall is greater than the temperature of the water at the top.

The energy in the gravitational potential store of the water at the top is transferred to the thermal store at the bottom.

The specific heat capacity of water is 4200 J / (kg °C).

What is the temperature difference for a waterfall of height 21 m?

A 0.0050 °C **B** 0.049 °C **C** 20 °C **D** 200 °C

（2024 夏季 0625/22 第13题）

13. Fig. 3.1 shows a small block of ice floating in a beaker of warm water.

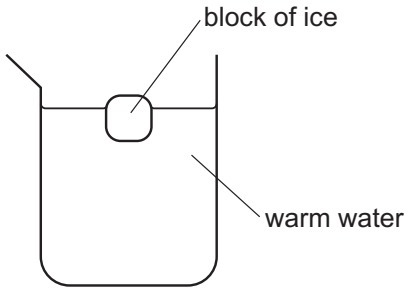


Fig. 3.1

(b) Energy is transferred from the water to the block of ice.

(i) State the name of the thermal process that transfers energy from the water to the ice.

(ii) Initially, there is 0.34 kg of water in the beaker. The specific heat capacity of water is 4200 J / (kg °C).

Calculate the energy transferred from this water as its temperature decreases from 28 °C to 10 °C.

(iii) The temperature of the water near the ice decreases first.

Explain how convection causes the temperature of all the water in the beaker to decrease.

(iv) State what happens to the internal energy of the water as the temperature of the water decreases.

Describe the change in terms of the energy of the particles.

（2024 夏季 0625/41 第3题(b)）

2.2.3 熔化、沸腾与蒸发

题型 1：按温度与平台判相变（考频★★★★☆）

知识点 标准大气压下，水的熔点为_____，沸点为_____。

温度低于熔点时，水为固态；温度在熔点与沸点之间时，水为液态；温度高于沸点时，水为气态。

水发生熔化或沸腾时，持续吸收能量而温度保持不变，直至相变完成。

答案：0 °C（273 K）；100 °C（373 K）

怎么认 题目出现水的温度或沸点图表时，先标出标准大气压下的熔点和沸点，再比较温度。

一. 先用熔沸点划分物态

例题 1 Which row correctly describes the state of water at the temperatures shown?

	250 K	300 K	350 K	400 K
A	liquid	liquid	gas	gas
B	solid	solid	liquid	liquid
C	solid	liquid	liquid	gas
D	solid	liquid	gas	gas

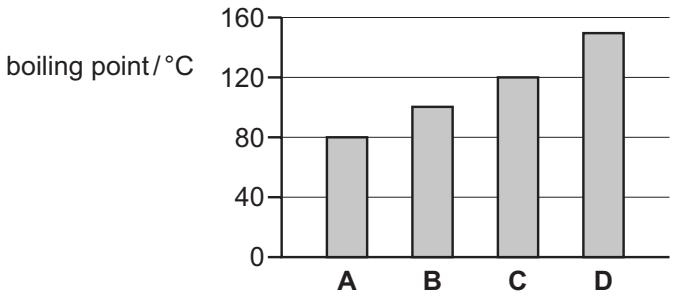
（2024 夏季 0625/12 第12题）

解： 标准大气压下，水的熔点为 273 K，沸点为 373 K。
250 K < 273 K，水为固态。
273 K < 300 K < 373 K，水为液态。
273 K < 350 K < 373 K，水为液态。
400 K > 373 K，水为气态。
故选 C。

针对练习

1. The chart shows the boiling points for four different liquids at standard atmospheric pressure.

Which liquid is water?



（2025 冬季 0625/12 第14题）

2. A student warms some water in a metal container using an electric heater, as shown in Fig. 6.1.

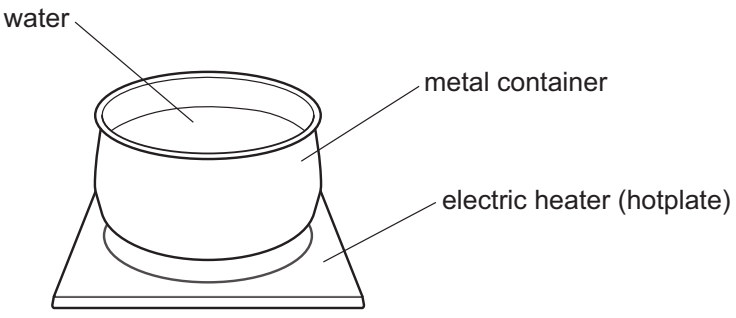


Fig. 6.1

(d) The water is heated until it is boiling. The air pressure in the room is standard atmospheric pressure.

State the temperature at which the water boils.

（2025 春季 0625/32 第6题(d)）

3. In which range of temperatures is water a liquid?

A 0 K to 100 K

B 0 K to 273 K

C 100 K to 373 K

D 273 K to 373 K

（2025 冬季 0625/22 第11题）

二. 先定相变方向与能量

知识点 物质由固态变为液态的过程叫熔化，由液态变为固态的过程叫凝固；由液态变为气态的过程包括沸腾和蒸发，由气态变为液态的过程叫凝结。

蒸发是液体表面能量较高的粒子逸出的过程，能在任何温度发生，并使剩余液体温度降低。

熔化和沸腾需要_____能量，凝固和凝结会_____能量。

在一定压强下，纯物质熔化、沸腾、凝固或凝结时温度保持不变；凝固后，粒子不能再相互移动。

标准大气压下，水的熔点为_____，沸点为100 °C；温度单位可用摄氏度°C。

答案：吸收；释放；0 °C

怎么认 题目出现物态起点、终点或相变平台时，先判定相变方向，再判断能量变化与温度是否改变。

例题 2 Which statement describes what happens as ice at 0 °C melts to become water?

A Energy is absorbed and the temperature remains constant.

B Energy is absorbed and the temperature rises.

C Energy is released and the temperature remains constant.

D Energy is released and the temperature rises.

（2024 夏季 0625/23 第14题）

解：冰由固态变为液态，发生熔化。

熔化时吸收能量，冰在0 °C熔化过程中温度保持不变。

故选 A。

针对练习

4. Which row describes the process of melting?

	initial state	final state	change in temperature
A	liquid	gas	yes
B	liquid	solid	no
C	solid	gas	yes
D	solid	liquid	no

（2024 冬季 0625/11 第15题）

5. Which statement about the temperature of the solid describes what happens when a solid is melting?

A The temperature increases and there is an input of energy.

B The temperature increases and there is no input of energy.

C The temperature remains constant and there is an input of energy.

D The temperature remains constant and there is no input of energy.

（2023 冬季 0625/13 第15题）

6. Which statement describes what happens during solidification?

A Particles begin to move around each other easily.

B Particles stop moving around each other.

C The temperature of the particles continues to decrease during solidification.

D The temperature of the particles continues to increase during solidification.

（2025 春季 0625/12 第16题）

7. Fig. 2.1 shows an electric tumble dryer used to dry wet clothes.

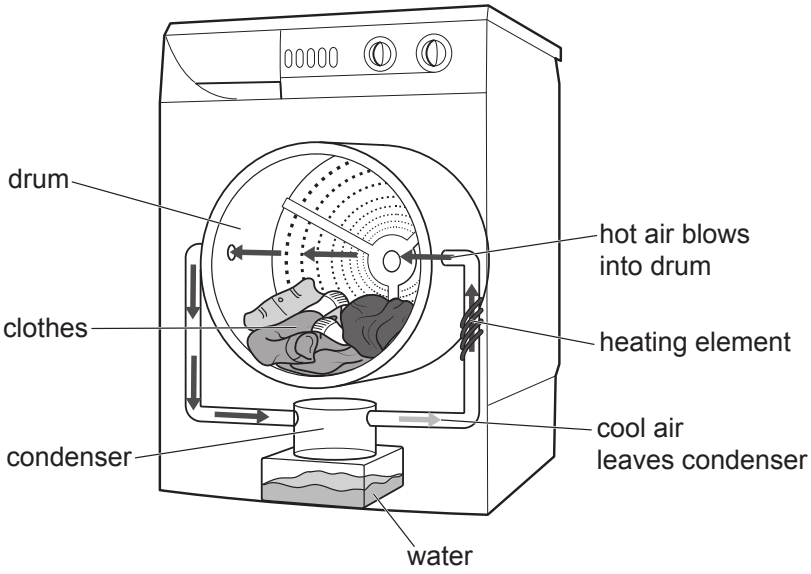


Fig. 2.1

(a) Hot air blows into the drum. The air gains water vapour from the clothes and then leaves the drum. The moist air enters the condenser. Cool air leaves the condenser, passes through the heating element and enters the drum again.

(i) State the process by which the hot air removes water from the wet clothes.

(ii) The air is cooled as it passes through the condenser.

Describe and explain **one** other way in which the air leaving the condenser is different from the air entering the condenser.

（2023 冬季 0625/42 第2题(a)）

三. 水平平台对应相变过程

知识点 纯物质由固态持续加热时，斜线段表示物质处于单一物态，吸收热能后温度_____。
水平平台表示物质正在熔化或沸腾；相变过程中继续吸收热能，而温度_____。
第一个平台温度为熔点，第二个平台温度为沸点；平台末端表示该相变_____。
熔点和沸点的常用单位为摄氏度（°C），上述平台顺序适用于物质由固态连续加热至气态的图像。

答案：升高；保持不变；完成

怎么认 题目出现持续加热的温度–时间图时，先认斜段为单一物态升温，平台为相变，平台末端为相变完成。

例题 3 **(a)** A teacher shows the class a demonstration about heat energy and states of matter.

The teacher heats a substance. A heater supplies thermal energy at a steady rate. The students measure the temperature of the substance every minute for 30 minutes.

Fig. 4.1 shows the graph of their results.

At point A, the substance is solid.

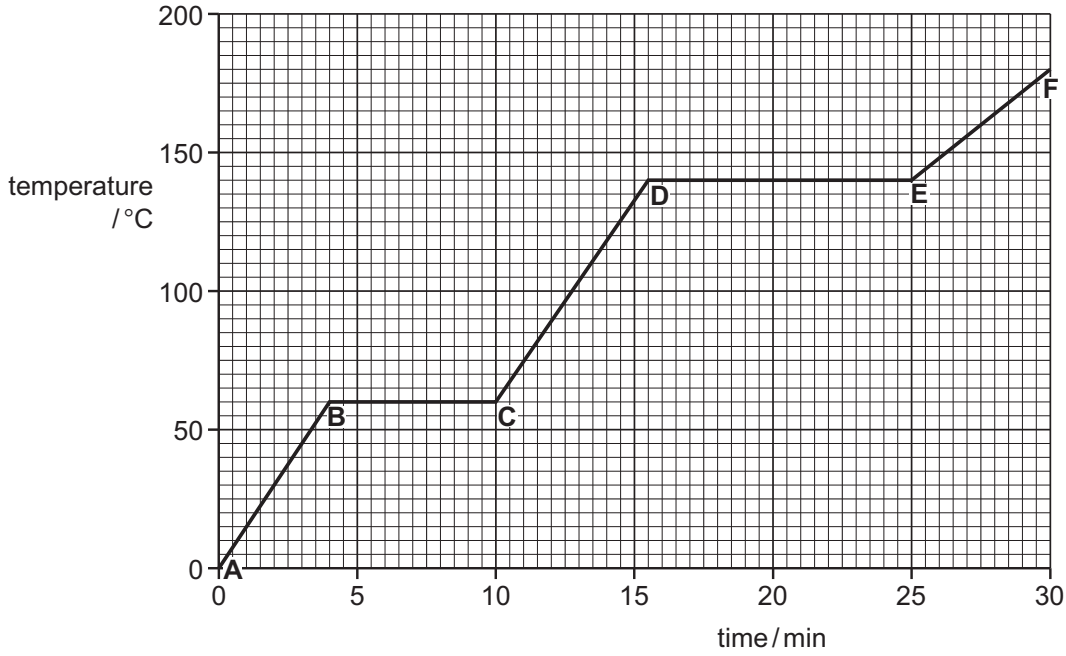


Fig. 4.1

(i) Describe the effect of the thermal energy input in section AB of the graph.

(ii) Describe the effect of the thermal energy input in section BC of the graph.

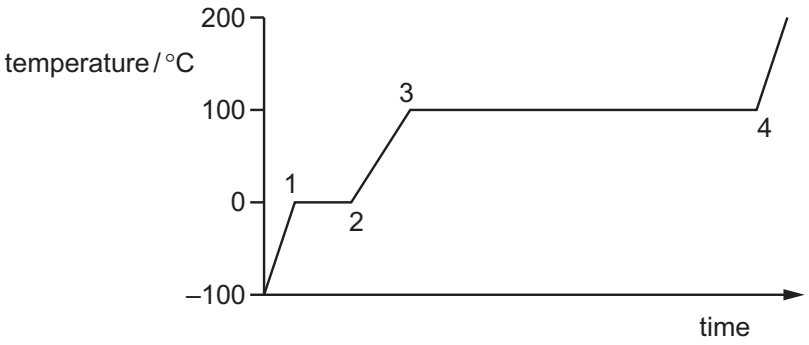
(iii) Determine the temperature at which the substance boils.

(iv) Deduce the state of matter of the substance in section EF of the graph.

（2025 冬季 0625/33 第4题(a)）

解：AB 段为上升的斜线，输入的热能使固体的温度升高，内能增大。
BC 段为第一个水平平台，物质继续吸收热能并由固态熔化为液态，温度保持不变。
DE 段为第二个水平平台，由图读得
$T = 140\ °C$
故物质的沸点为 140 °C。E 点表示沸腾完成，因此 EF 段物质为气态。
答：（i）温度升高，内能增大；（ii）物质熔化，由固态变为液态；（iii）140 °C；（iv）气态。

8. A block of ice is at a temperature of –100 °C. Energy is supplied at a constant rate. The graph shows how its temperature changes.



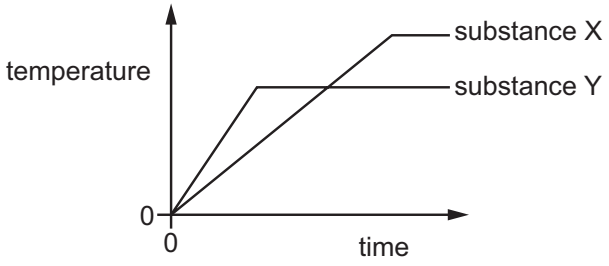
At which points have the ice completely changed state to water and all the water completely changed state to steam?

	completely changed to water	completely changed to steam
A	1	3
B	1	4
C	2	3
D	2	4

（2024 冬季 0625/21 第16题）

9. Two different pure substances, X and Y, are heated. Both substance X and substance Y are initially in the solid state.

The graph shows how the temperature of each substance changes with time.



What does the graph tell us about the substances?

A Substance X has a lower boiling point than substance Y.

B Substance X has a lower melting point than substance Y.

C Substance Y has a lower boiling point than substance X.

D Substance Y has a lower melting point than substance X.

（2025 夏季 0625/11 第11题）

题型 2：从表面逸出认蒸发（考频★★★★☆）

知识点 蒸发是液体表面能量较高的粒子逸出液体、变为气体粒子的过程。

蒸发发生在液体的_____，能够逸出的是能量较_____的粒子；蒸发可在任何温度下发生。

能量较高的粒子逸出后，液体中剩余粒子的平均动能减小，因此液体温度降低。

答案：表面；高

怎么认 题目出现液体表面、较高能量粒子逸出或液体逐渐消失时，先判断为蒸发。

一. 锁定表面高能粒子

例题 1 Which statement describes what happens to particles during the evaporation of a liquid?

A Particles become fixed in position.

B Particles escape from the surface.

C Particles move much closer together.

D Particles start to move around at random.

（2024 春季 0625/12 第13题）

解：蒸发发生在液体表面，能量较高的粒子从表面逸出。

故选 B。

针对练习

1. At the surface of a liquid, the more energetic molecules can escape from the liquid into the atmosphere.

Which name is given to this process?

A boiling

B condensation

C evaporation

D melting

（2023 夏季 0625/12 第15题）

2. When a liquid is exposed to the air, the more-energetic particles escape from the surface of the liquid.

What is the name of this process?

A boiling

B condensation

C convection

D evaporation

（2025 冬季 0625/13 第15题）

3. **(c)** Later, the floor is dry.
State the name of the process that causes the liquid to disappear.

（2025 冬季 0625/32 第5题(c)）

4. **(b)** At the beginning of a lesson, students measure the mass of water in a shallow dish.
Fig. 4.3 shows the mass of water at the beginning of the lesson.
Fig. 4.4 shows the mass of water at the end of the lesson.

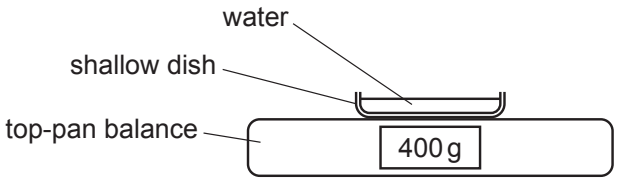


Fig. 4.3

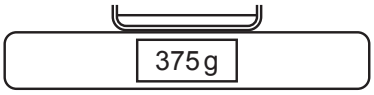


Fig. 4.4

The students find that the mass of water in the shallow dish decreases during the lesson.

(i) State the name of the process that decreases the mass of water in the shallow dish.

(ii) Describe the process that decreases the mass of water in the shallow dish. Use ideas about particles.

（2024 夏季 0625/33 第4题(b)）

二. 按位置温度区分沸腾

知识点 蒸发是液体表面能量较大的粒子逸出液体的过程，只在液体_____发生，可在_____温度发生。
沸腾是液体内部和表面同时发生的汽化，在一定压强下只在_____发生。
同一液体的沸点随压强而定；温度单位常用 °C，标准大气压下水的沸点为 100 °C。

答案：表面；任何；沸点

怎么认 题目出现蒸发与沸腾的比较，或所求为发生位置、温度时，先按表面与内部、任何温度与沸点区分。

例题 2 **(a)** State **two** ways that evaporation differs from boiling.

（2024 夏季 0625/42 第4题(a)）

解：蒸发只发生在液体表面，沸腾发生在液体内部和表面。
蒸发可在任何温度发生，沸腾在一定压强下只在沸点发生。
答：发生位置不同；发生温度不同。

针对练习

5. Fig. 4.1 shows a pressure cooker on an electric heating element. The cooker has a tight-fitting lid.

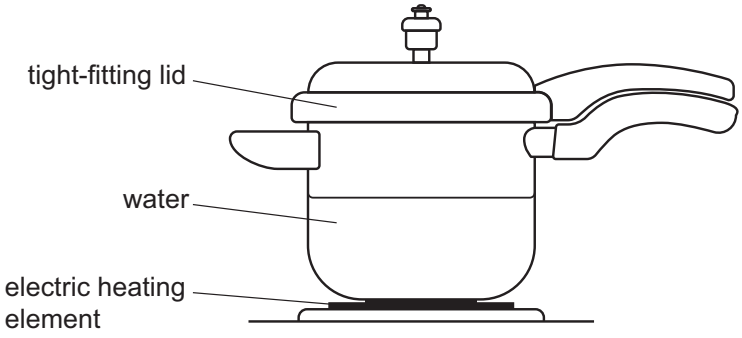


Fig. 4.1

(a) The pressure cooker is half-full of water. As the water is heated some water evaporates before the water boils.
Describe **two** differences between evaporation and boiling of the water in the cooker.

（2024 冬季 0625/42 第4题(a)）

6. Fig. 4.1 shows a metal pan on an electric hotplate. The pan contains 200 cm^3 of water.

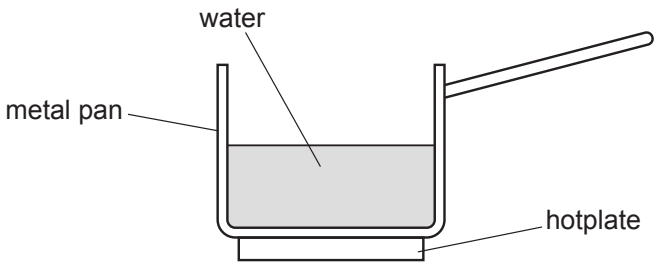


Fig. 4.1

The pan is heated. The temperature of the water in the pan increases.

(b) (i) The water boils and leaves the liquid as a gas.

Explain, in terms of forces and distances between particles, why the gas occupies a much greater volume than it does as a liquid.

(ii) State **two** ways in which boiling differs from evaporation.

（2023 春季 0625/42 第4题(b)）

三. 由高能粒子逸出判冷却

知识点 蒸发是液体表面能量较高的粒子逸出并成为气体粒子的过程，可在任何温度下发生。

逸出粒子的能量高于液体粒子的平均值，因而剩余粒子的平均动能_____，液体温度_____。

液体温度越低，能从液面逸出的粒子越少，蒸发速率越慢；温度常用摄氏度（°C）表示。

答案：减小；降低

怎么认 题目出现液体蒸发、粒子逸出位置或温度变化时，先判断高能粒子从液面逸出。

例题 3 During evaporation of a liquid, the most energetic particles escape. The temperature of the remaining liquid changes.

Which row identifies where these particles escape from and describes the temperature change?

	place from which the particles escape	temperature of remaining liquid
A	body of the liquid	decreases
B	body of the liquid	increases
C	surface of the liquid	decreases
D	surface of the liquid	increases

（2024 夏季 0625/21 第12题）

解： 蒸发时，能量较高的粒子从液体表面逸出。
逸出粒子的能量高于液体粒子的平均值，故剩余粒子的平均动能减小，液体温度降低。
故选 C。

针对练习

7. Which statement about the evaporation of a liquid is correct?

A The least energetic particles escape from the surface and the temperature of the liquid decreases.

B The least energetic particles escape from the surface and the temperature of the liquid increases.

C The most energetic particles escape from the surface and the temperature of the liquid decreases.

D The most energetic particles escape from the surface and the temperature of the liquid increases.

（2024 冬季 0625/23 第14题）

8. Which statements about evaporation of water are correct?

1 Evaporation causes the remaining liquid to cool.

2 During evaporation, the more energetic particles escape from the surface of the liquid.

3 Evaporation only happens at 100 °C.

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

（2023 夏季 0625/11 第15题）

9. **(b)** Evaporation is the name of a process that causes puddles of water to dry gradually.

(i) Describe the process of evaporation. Use your ideas about particles.

(ii) Describe another effect that evaporation has on the remaining water in the puddle.

（2025 冬季 0625/33 第4题(b)）

10. Liquid evaporates from a beaker.

What happens to the temperature of the remaining liquid and how does this temperature change affect the rate of evaporation?

	temperature	rate of evaporation
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2023 冬季 0625/22 第14题）

四. 逐项检查蒸发快慢因素

知识点 蒸发是动能较大的粒子从液体_____逸出的过程，可在任何温度下发生。

在其他条件相同时，温度越_____、液面面积越大、液面上方空气流动越快，蒸发速率越大。

蒸发带走能量，使剩余液体的平均动能减小，因而液体温度降低。

答案：表面；高

怎么认 题目出现温度、容器口径或风等条件并问蒸发快慢时，先分别判断三个因素的变化。

例题 4 A circular, flat-bottomed dish contains 100 cm^3 of water.

Students are asked how to increase the rate at which the water evaporates.

Their suggestions are listed.

student 1 Pour the water into a flat-bottomed dish of larger diameter.

student 2 Cool the dish and water.

student 3 Create a current of air over the dish with a fan.

Which suggestions will increase the rate of evaporation?

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

（2024 春季 0625/22 第13题）

解： 同体积的水倒入直径较大的平底盘后，液面面积增大，学生 1 的建议会加快蒸发；冷却使水分子的平均动能减小，学生 2 的建议不会加快蒸发；风扇使液面上方的水分子被气流带走，学生 3 的建议会加快蒸发。故选 C。

针对练习

11. Wet clothes are put out on a line to allow the water in the clothes to evaporate.

Which type of weather would cause the water to evaporate most quickly?

A a cold day with no wind

B a cold day with wind

C a hot day with no wind

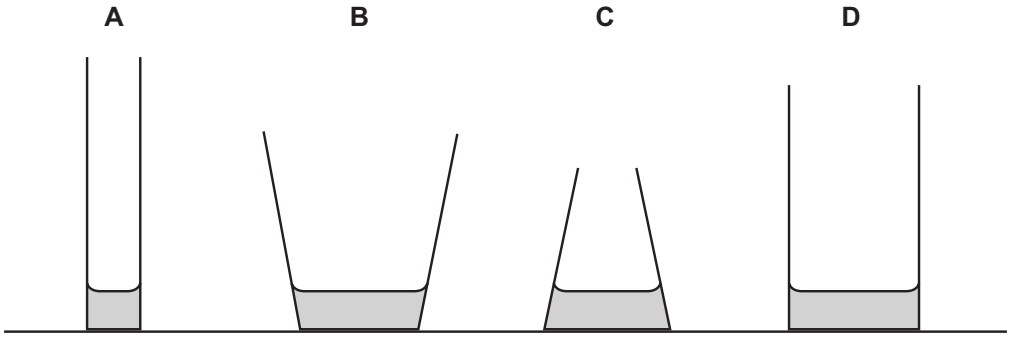
D a hot day with wind

（2024 夏季 0625/21 第13题）

12. Four containers each contain water.

More water at the same temperature is added to each container.

From which container does water now evaporate more slowly than it did before?



（2023 冬季 0625/23 第15题）

13. **(a)** There is a large puddle of water on a road. The water in the puddle evaporates.

(i) Describe how evaporation from the puddle occurs. Use ideas about particles in your answer.

(ii) State and explain **one** change in the weather that causes a faster rate of evaporation.

（2025 冬季 0625/42 第5题(a)）

14. Which row explains how increasing the surface area of a fixed volume of liquid water and blowing air over the surface speeds up evaporation?

	increasing the surface area	blowing air over the surface
A	increases the total number of water molecules present	increases the energy in the kinetic store of the liquid water
B	increases the total number of water molecules present	removes water molecules from above the surface of the water
C	increases the number of water molecules close to the surface	increases the energy in the kinetic store of the liquid water
D	increases the number of water molecules close to the surface	removes water molecules from above the surface of the water

（2024 夏季 0625/23 第15题）

2.3.1 导热

题型 1：由材料与现象判导热（考频★★★☆☆）

知识点 热传导是热能在物质内部或相互接触的物体之间，由温度较高处向温度较低处传递的过程，物质不发生整体移动。

金属通常是热的_____；木材、塑料和玻璃等通常是热的_____。

在长度、横截面积和温差等条件相同时，良导体传递热能较快，绝热体传递热能较慢；这种定性判断不写单位。

答案：良导体；不良导体（绝热体）

怎么认 题目出现两种接触冷热物体的材料，并比较手感或防烫时，先沿接触路径判断材料的导热强弱。

一. 先沿接触路径比材料

例题 1 A student stirs a hot liquid in a pan with a spoon.

Which row explains which material the spoon should be made from so that the student does **not** burn their hand?

	material of spoon	explanation
A	metal	it is a good conductor
B	metal	it is a good insulator
C	wood	it is a good conductor
D	wood	it is a good insulator

（2024 夏季 0625/12 第14题）

解：热液体与手之间的传热路径经过勺子。
为减慢热能传到手，应选热的不良导体。木材是热的不良导体。
故选 D。

针对练习

1. On a sunny day, the temperatures of a black tarmac road and the air above the road increase.

(b) State the method of thermal energy transfer from the tarmac to the air **immediately** above the road.

（2024 冬季 0625/42 第5题(b)）

2. A student warms some water in a metal container using an electric heater, as shown in Fig. 6.1.

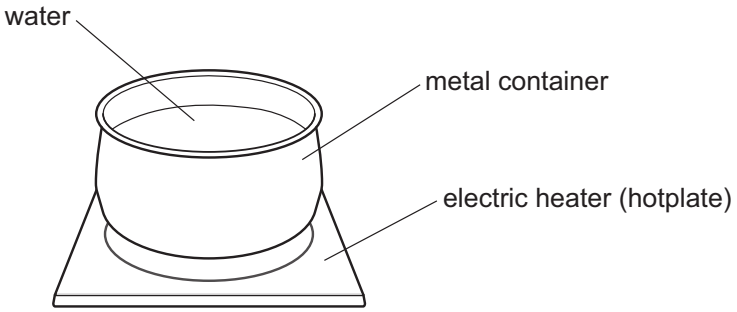


Fig. 6.1

(b) State how thermal energy moves through the metal container from the heater to the water.

（2025 春季 0625/32 第6题(b)）

3. A student has a copper rod and a wooden rod. Both rods have the same dimensions.

The student puts one end of each rod into a beaker of crushed ice.

After a few minutes, the student picks up the rods by the ends **not** in the ice.

Which statement is correct?

A The copper rod feels colder than the wooden rod because copper is a better conductor than wood.

B The copper rod feels warmer than the wooden rod because copper is a better conductor than wood.

C The wooden rod feels colder than the copper rod because wood is a better conductor than copper.

D The wooden rod feels warmer than the copper rod because wood is a better conductor than copper.

（2025 夏季 0625/21 第15题）

4. **(b)** An aluminium dish is initially at room temperature. Boiling water is poured into the aluminium dish as shown in Fig. 4.1.

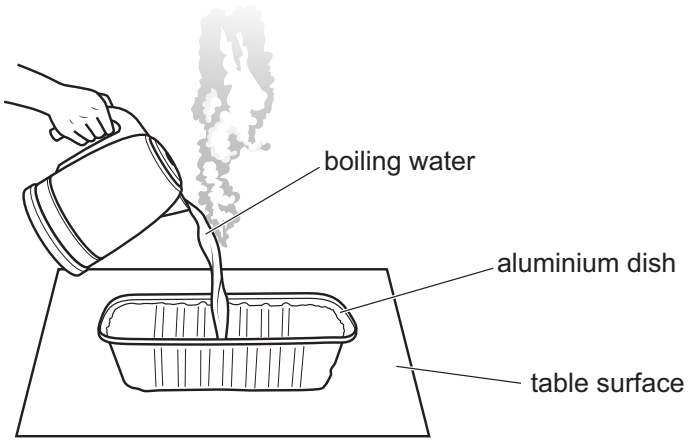


Fig. 4.1

(i) Explain why, after a short time, the dish and the water are the same temperature.

(ii) Explain, in terms of its particles, why the aluminium expands as the boiling water is poured into the dish.

(iii) The water in the dish evaporates.

Explain, in terms of the water molecules, what is meant by evaporation.

（2024 冬季 0625/41 第4题(b)）

二. 用同条件现象比导热

知识点 热能由高温处经物质内部传向低温处的过程称为_____。

比较不同材料的导热性时，应保持棒长、截面积、受热条件及测点到受热端的距离_____。

在这些条件相同时，蜡熔化得越远、图钉越早脱落或测点升温越快，材料的导热性越好。

金属中的自由电子能迅速传递能量，因此金属通常比塑料等热绝缘体导热更_____。

答案：导热；相同；快

怎么认 题目出现同尺寸材料棒、同条件加热及蜡或图钉现象时，先按熔化距离或所需时间比较导热性。

例题 2 A student wants to compare the conduction of thermal energy through rods made of iron, copper, glass and aluminium. Each rod is coated with wax.

Fig. 6.1 shows the equipment that the student uses.

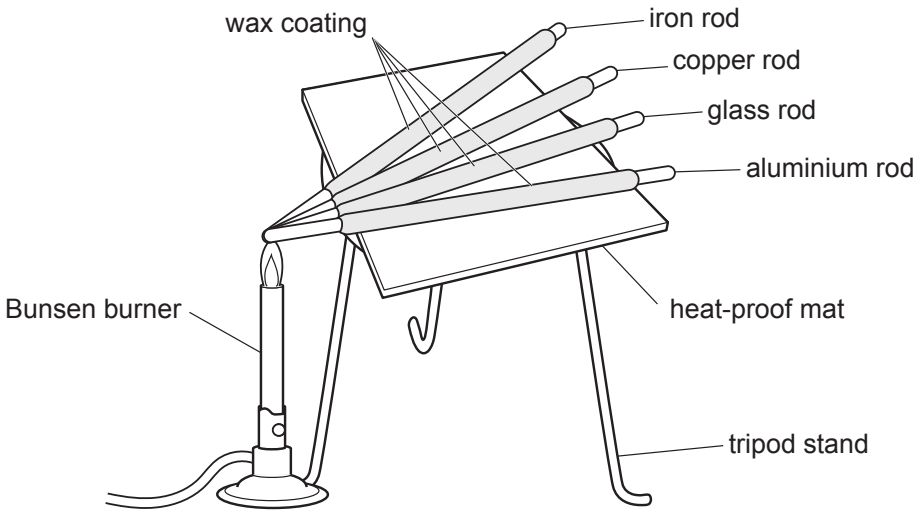


Fig. 6.1

(a) Describe how the student can compare the conduction of thermal energy through the rods in Fig. 6.1.

（2024 夏季 0625/31 第6题(a)）

解：点燃本生灯加热四根棒的一端，观察并记录同一时刻各棒上蜡熔化的长度，或记录蜡熔化到同一位置所需的时间。

由受热条件相同，蜡熔化得越远，或达到同一位置所需时间越短，说明该棒传递热能越快。

答：蜡熔化得最远或所需时间最短的材料导热性最好。

5. **(b)** A teacher demonstrates thermal energy transfer through some metal rods. Fig. 5.1 shows the arrangement.

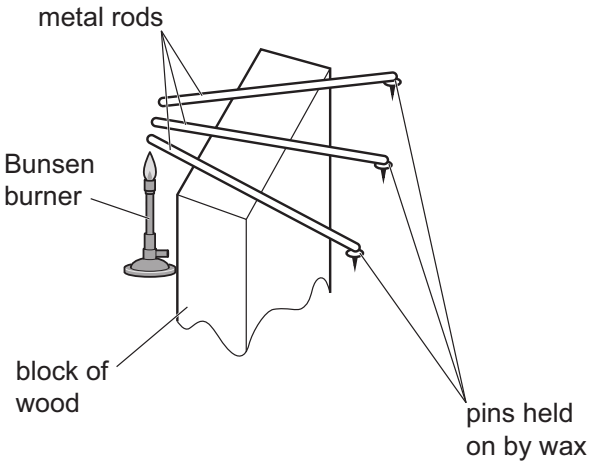


Fig. 5.1

The metal rods are placed on a block of wood.
The demonstration compares how quickly thermal energy is transferred to the wax at the end of each rod.

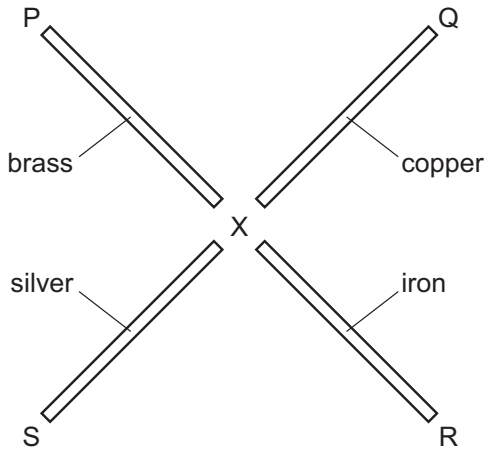
(i) State the name of the process for thermal energy transfer through the metal rods.

(ii) The rods are made from different metals. The rods have the same length and diameter. The ends of the rods in the Bunsen flame are at the same temperature.

State how the demonstration shows which metal transfers thermal energy at the greatest rate.

（2024 冬季 0625/33 第5题(b)）

6. The diagram shows four rods. Each rod is made of a different metal.



Wax is used to attach small metal balls at the rod ends P, Q, R and S.

Each rod is the same size. They are heated uniformly by a Bunsen burner at point X.

As the rods warm up, the wax melts and the balls fall off.

Why does the ball on the silver rod fall first?

A Silver is the best conductor of heat.

B Silver is the worst conductor of heat.

C Silver is the best radiator of heat.

D Silver is the worst radiator of heat.

（2025 夏季 0625/22 第15题）

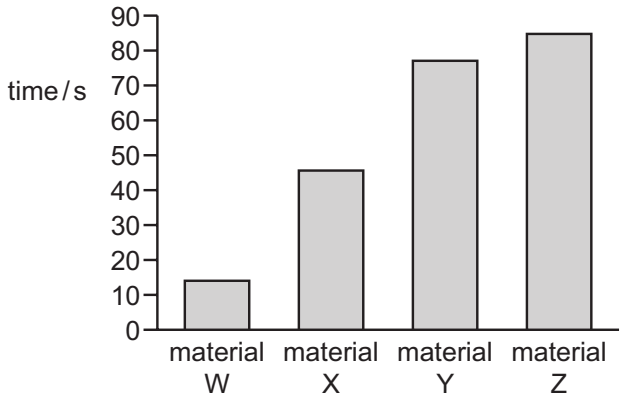
7. Students test four rods of different materials, W, X, Y and Z, to compare how well the materials conduct thermal energy.

The rods are all the same size and shape.

The students use wax to stick a pin to one end of the first rod. The wax melts when it is warm. The other end of the rod is heated and the time taken for the pin to fall is recorded.

The experiment is repeated for each rod.

The students plot a chart of the time taken for each pin to fall.



Which statement is correct?

A X is a better thermal conductor than Y.

B Y is a better thermal conductor than W.

C Z is a better thermal conductor than W.

D Z is a better thermal conductor than X.

（2025 夏季 0625/11 第16题）

8. **(b)** The immersion heater is removed from the beaker.

One metal rod and one plastic rod are placed in the beaker of hot water as shown in Fig. 4.1. The rods are at room temperature (20 °C) before they are placed into the beaker.

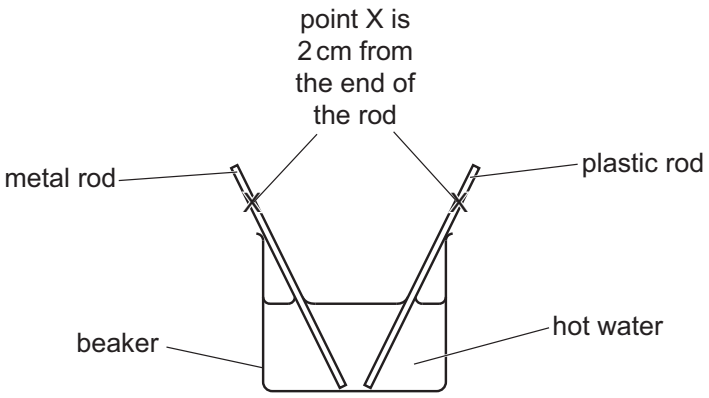


Fig. 4.1

Describe how the temperature of point X on each rod changes after the rods are placed in the beaker. Explain your answer.

（2025 冬季 0625/41 第4题(b)）

题型 2：从粒子解释导热（考频★★★☆☆）

知识点 金属中的热传导有两种微观途径：自由电子传能和晶格振动传能。

在固体金属中，受热处的_____获得动能并在金属中移动，与较远处的离子或原子碰撞而传递热能。

晶格中的正离子只能在固定位置附近振动；受热处振动加剧，并使_____粒子的振动加剧。

答案：自由电子；相邻

怎么认 题目出现金属受热并要求从粒子说明导热时，先写自由电子移动、碰撞传能，再写晶格振动传能。

一. 金属先写自由电子传能

例题 1 Fig. 4.1 shows a metal pan on an electric hotplate. The pan contains 200 cm^3 of water.

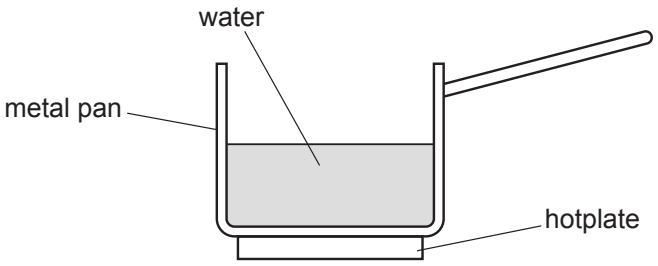


Fig. 4.1

The pan is heated. The temperature of the water in the pan increases.

(a) Thermal energy is transferred through the metal pan by conduction.

State and explain the **two** ways that thermal energy is conducted in a metal.

（2023 春季 0625/42 第4题(a)）

解：金属中有自由电子，受热处的自由电子获得动能，在金属中移动并与较远处的粒子碰撞，把热能传递到金属各处。

金属晶格中的正离子受热后振动加剧，并使相邻粒子的振动加剧，热能由此逐步传递。

答：自由电子移动、碰撞传能；晶格振动向相邻粒子传能。

针对练习

1. Fig. 5.1 shows two containers, each filled with hot water.

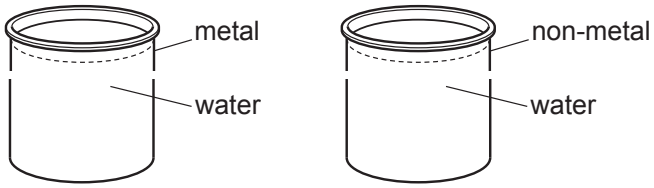


Fig. 5.1

The outer surface of the metal container is hot.

(a) Explain how electrons transfer thermal energy through the metal of the container.

（2024 夏季 0625/43 第5题(a)）

2. A bar of metal, which is a good thermal conductor, is heated at one end.

What is the main method of transfer of thermal energy along the bar?

A lattice vibration

B movement of atoms of the metal along the bar

C transfer by electrons

D vibration of atoms of the metal bar

（2023 春季 0625/22 第17题）

3. Iron is a better conductor of thermal energy than rubber.

Which statement explains this?

A Electrons in iron can move from one part of the iron to another. Electrons in rubber **cannot** move in this way.

B Electrons in iron vibrate with more energy than those in rubber.

C Positive particles in iron can move from one part of the iron to another. Positive particles in rubber **cannot** move in this way.

D Positive particles in iron vibrate with more energy than those in rubber.

（2025 冬季 0625/21 第15题）

4. Which row about the movement of electrons and ions during conduction of thermal energy through a metal is correct?

	electrons	ions
A	move through metal	vibrate about fixed points
B	vibrate about fixed points	move through metal
C	vibrate about fixed points	vibrate about fixed points
D	move through metal	move through metal

（2025 冬季 0625/23 第15题）

二. 用间距电子解释导热差异

知识点 导热是热能通过粒子间的相互作用，由高温处传向低温处的过程。

固体中，原子或分子的_____把能量传给相邻粒子；金属中的_____还能移动并传递能量。

气体粒子相距较远，碰撞较少，因而导热比非金属固体差。

多数液体和非金属没有可自由移动的电子，传导热能较慢；导热好坏的定性比较没有单位。

答案：晶格振动；自由电子

怎么认 题目出现物态、粒子间距或自由电子信息并要求比较导热时，先看粒子间距与是否有自由电子。

例题 2 Fig. 5.1 shows two containers, each filled with hot water.

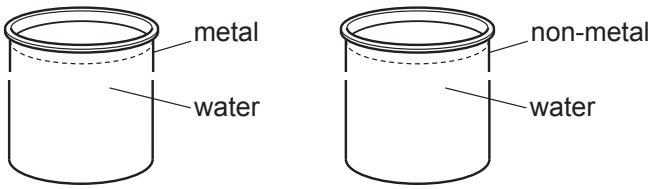


Fig. 5.1

The outer surface of the metal container is hot.

(c) Explain, in terms of particles, why gases are poor thermal conductors compared to non-metal solids.

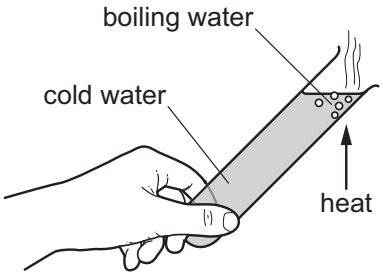
（2024 夏季 0625/43 第5题(c)）

解：气体粒子之间的距离比非金属固体中更大，粒子之间的碰撞较少，因而通过碰撞传递的热能较少。非金属固体中的粒子排列紧密，可由相邻粒子的晶格振动传递热能。
答：气体粒子相距较远，碰撞较少，所以导热比非金属固体差。

针对练习

5. A teacher puts some cold water in a test-tube.

She holds the bottom of the test-tube while heating the top.



The water at the top boils but she continues to hold the test-tube as the bottom remains cold.

Which conclusion about water is made from this experiment?

A Water is a bad conductor.

B Water is a bad convector.

C Water is a good conductor.

D Water is a good convector.

（2023 夏季 0625/12 第16题）

6. The table shows the state of materials P, Q, R and S, and whether each one contains free electrons.

	gas	liquid	solid	contains free electrons
P	✓	✗	✗	✗
Q	✗	✓	✗	✗
R	✗	✗	✓	✓
S	✗	✗	✓	✗

Using the information in the table, which comparison of the thermal conduction in the materials is correct?

A It is better in P than in Q and S.

B It is better in Q than in R and P.

C It is better in R than in Q and P.

D It is better in S than in R and Q.

（2024 夏季 0625/23 第16题）

2.3.2 热对流

题型 1：由流体升沉认对流（考频★★★★☆）

知识点 对流是液体或气体整体运动所形成的热能传递。

对流发生在_____和_____中；固体不能整体流动，不能用对流传递热能。

流体受热膨胀，质量不变而体积增大，密度减小并上升；较冷流体密度较大而下沉，由此形成对流。

答案：液体；气体

怎么认 题目出现液体或气体受热、升沉或问传热状态时，先确认介质能整体流动，再判断密度变化。

一. 先确认流体与密度变化

例题 1 In which states of matter can thermal energy be transferred by convection?

A in gases, liquids and solids

B in gases and liquids only

C in gases and solids only

D in liquids only

（2023 春季 0625/12 第17题）

解：对流需要物质整体流动。

气体和液体能够整体流动，固体不能。

∴热能可在气体和液体中通过对流传递。

故选 B。

针对练习

1. On a sunny day, the temperatures of a black tarmac road and the air above the road increase.

(c) State the main method of thermal energy transfer from the air immediately above the road to the rest of the air.

（2024 冬季 0625/42 第5题(c)）

2. A copper cooking pan contains water. Fig. 2.1 shows the pan on a hotplate of a cooker.

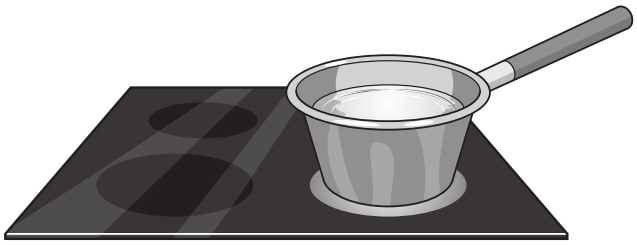


Fig. 2.1

Copper is a metal.

(c) The thermal energy passes into the water through the base of the pan.

Identify the main method by which thermal energy is transferred throughout the water.

（2023 冬季 0625/41 第2题(c)）

3. A liquid is heated and it expands.

How does this lead to the formation of a convection current?

A The density of the heated liquid decreases.

B The density of the heated liquid increases.

C The mass of the heated liquid particles decreases.

D The mass of the heated liquid particles increases.

（2025 夏季 0625/12 第15题）

4. Which statement about convection is **not** correct?

A It enables water in a pan on a cooker to get evenly heated.

B It happens in liquids and gases.

C It occurs because cooler liquids rise above warmer liquids.

D It occurs because the density of a liquid decreases when it is heated.

（2025 冬季 0625/21 第14题）

二. 按受热膨胀上升写循环

知识点 对流是液体和气体通过流体整体运动传递热能的方式。

在重力场中，流体在热源处受热膨胀，密度_____并上升；较冷、密度较大的流体下沉补位。

流体持续升沉，形成_____，热能随流体运动传遍各处。

密度的 SI 单位是 $\mathrm{kg\ m^{-3}}$。

答案：减小；对流循环

怎么认 题目出现液体或气体受热、流体升沉或热量传遍流体时，先写热源处流体受热后密度减小并上升。

例题 2 A student warms some water in a metal container using an electric heater, as shown in Fig. 6.1.

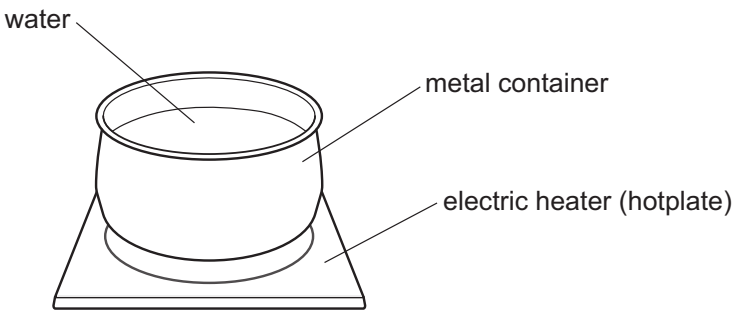


Fig. 6.1

(c) Describe how thermal energy spreads throughout the water.

（2025 春季 0625/32 第6题(c)）

解：容器底部的水先被加热，温度升高。
水受热膨胀，密度减小，密度较小的热水上升。
上方较冷、密度较大的水下沉补位，水不断循环，热能随对流传遍水中。
答：热能通过水的对流传遍各处。

针对练习

5. A beaker of water is heated and thermal energy travels through the water by convection.

What happens to the density of the water when it is heated and how does the water move?

A The density decreases and the heated water moves downwards.

B The density decreases and the heated water moves upwards.

C The density increases and the heated water moves downwards.

D The density increases and the heated water moves upwards.

（2024 冬季 0625/11 第16题）

6. A scientist measures the air temperature at different heights from the floor in a cave. The results are recorded in the table.

height / m	temperature / °C
0	10
10	11
20	13
30	14
40	16

Why does altering the height affect the temperature of the air?

A The particles in warm air have less energy than the particles in cool air.

B The particles in cool air are further apart than the particles in warm air.

C Warm air is less dense than cool air.

D Cool air rises above warm air.

（2025 冬季 0625/23 第16题）

7. Fig. 4.1 shows a heater used to warm the air in a room.

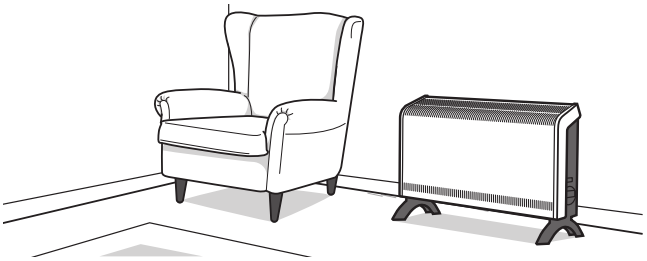


Fig. 4.1

(a) (i) State the main method of thermal energy transfer throughout the air in the room.

(ii) Explain how the heater warms **all** the air in the room.

（2025 夏季 0625/41 第4题(a)）

8. Fig. 3.1 represents the arrangement and separation of particles in a liquid. Each circle represents a particle.

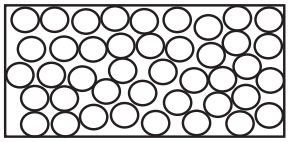


Fig. 3.1

(c) Fig. 3.3 shows a fire heating water in a metal pan.

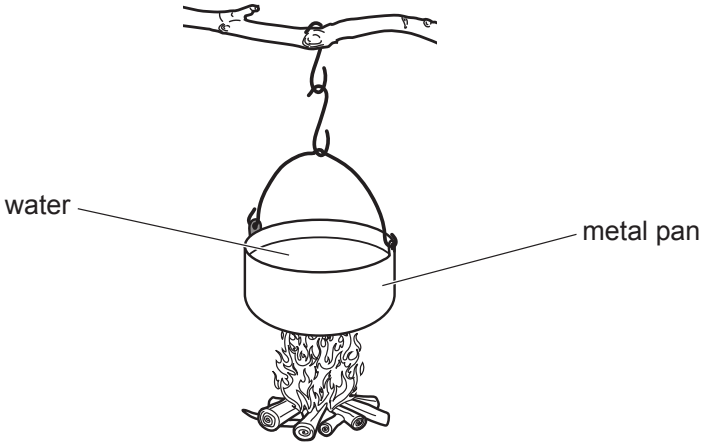


Fig. 3.3

(i) State the name of the process of thermal energy transfer through the metal of the pan.

(ii) Describe how thermal energy is transferred through the water by convection.

(iii) State the temperature at which the water boils at standard atmospheric pressure.

（2023 冬季 0625/31 第3题(c)）

三. 先定热源再画流向

知识点 对流是液体或气体因整体流动而传递热能的过程。

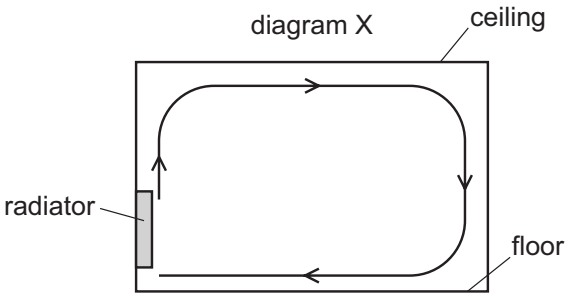
流体受热后通常膨胀，密度_____并上升；较冷流体下沉，形成_____。

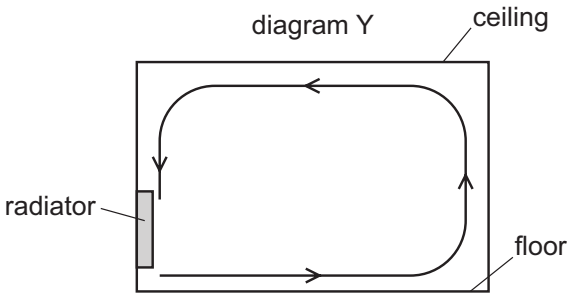
上述关系适用于能够流动且受热不均匀的液体或气体；温度单位可用 °C 或 K，密度单位为 $\mathrm{kg\ m^{-3}}$。

答案：减小；闭合的对流循环

怎么认 题目出现热源、流体升沉或环流箭头时，先标出受热区域和暖流体上升处，再沿闭合环路判断流向。

例题 3 A room is heated by a radiator. The diagrams X and Y show two possible circulations of hot air, which heat the room.





Which diagram and reason explain the heating of the room by convection?

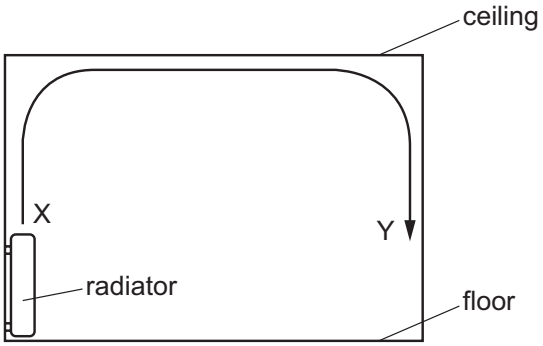
	diagram	reason
A	X	air density decreases when air is heated
B	X	air density increases when air is heated
C	Y	air density decreases when air is heated
D	Y	air density increases when air is heated

（2023 冬季 0625/12 第16题）

解： 散热器旁的空气受热，温度升高，密度减小，因而上升。
空气沿天花板向右流动，冷却后密度增大，在远离散热器的一侧下沉，再沿地板流回散热器。
故环流方向为图 X，且空气受热时密度减小。故选 A。

针对练习

9. The diagram shows the view of a room heated by a radiator. The arrowed line from X to Y is the path of the convection current in the air.

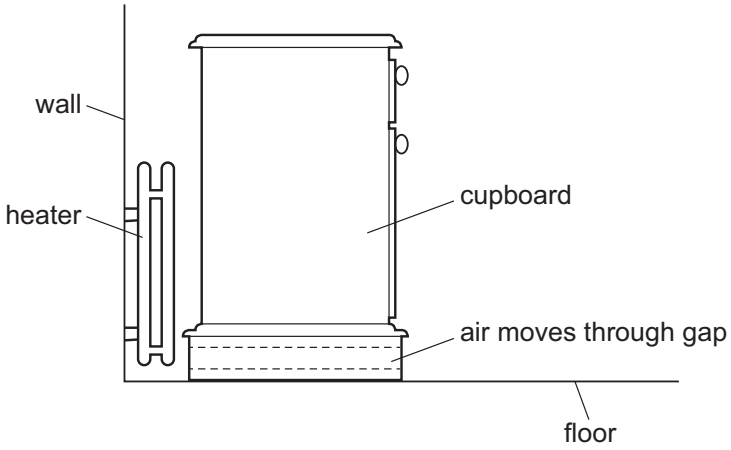


Which row about the air temperature and the air density at X and at Y is correct?

	air temperature	air density
A	higher at X	higher at X
B	higher at X	higher at Y
C	higher at Y	higher at Y
D	higher at Y	higher at X

（2023 冬季 0625/21 第16题）

10. A cupboard is placed in front of a heater. Air can move through a gap under the cupboard.



Which row describes the temperature and the direction of movement of the air in the gap?

	air temperature	air direction
A	cool	away from the heater
B	cool	towards the heater
C	warm	away from the heater
D	warm	towards the heater

（2023 冬季 0625/23 第16题）

2.3.3 热辐射

题型 1：认出红外热辐射（考频★★☆☆☆）

知识点 热辐射是以_____形式传递热能的过程，所有物体都发出热辐射。
热辐射不需要_____，能在真空中传播；传导和对流都需要物质粒子。
真空或太空中的热能传递方式为热辐射。

答案：红外辐射；介质

怎么认 题目出现真空、太空或太阳向地球传能时，先排除需要粒子介质的传导和对流。

例题 1 In which situation is radiation the **main** method by which energy is transferred?

A heating a pan of water using a gas camping stove

B energy reaching the Earth from the Sun

C heating the air in a room with a convection heater

D giving gravitational potential energy to a glider when it is lifted by thermal currents

（2024 夏季 0625/11 第15题）

解：传导和对流都需要物质粒子，太阳与地球之间近似为真空，能量由太阳传到地球不能以传导或对流为主。
热辐射是能穿过真空的红外电磁辐射，故选 B。

针对练习

1. Thermal radiation is emitted from all objects.

Which mediums can thermal radiation travel through?

	glass	water	air	vacuum
A	✓	✓	✓	✓
B	✓	✓	✓	✗
C	✗	✓	✓	✓
D	✗	✗	✗	✓

key

✓ = can travel through this medium

✗ = cannot travel through this medium

（2024 夏季 0625/12 第15题）

2. Fig. 3.1 shows a mains electric heater used to heat a small room.

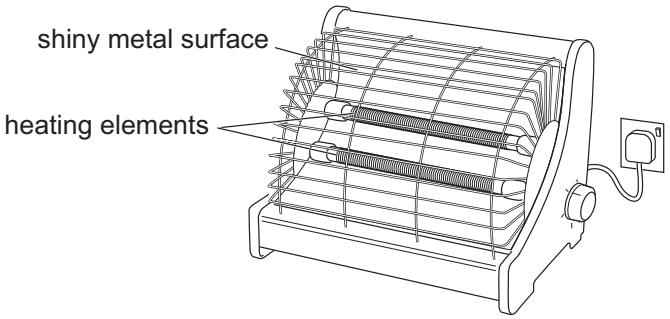
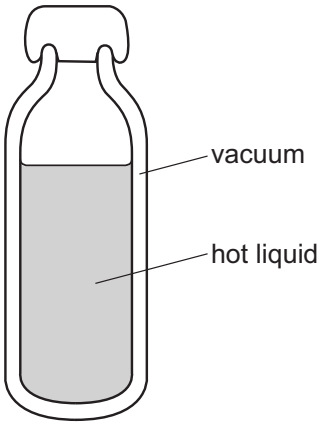


Fig. 3.1

(a) State the region of the electromagnetic spectrum which radiates thermal energy from the heater.

（2025 春季 0625/42 第3题(a)）

3. The diagram shows a vacuum flask used to keep liquid hot.



How does thermal energy pass through the vacuum?

A conduction and convection only

B conduction only

C convection only

D radiation only

（2024 冬季 0625/13 第16题）

4. Which statement about the transfer of thermal energy is correct?

A All metals conduct thermal energy equally well.

B Convection can only occur in solids or liquids.

C Convection occurs in liquids because hot liquid is more dense than cold liquid.

D The radiation that transfers thermal energy is a type of electromagnetic radiation.

（2024 冬季 0625/22 第16题）

题型 2：按表面判辐射强弱（考频★★★☆☆）

知识点 热辐射是红外辐射，所有物体都会发出热辐射；热辐射传递能量不需要介质。

表面对红外辐射的吸收和反射取决于颜色与纹理：_____表面吸收最强，_____表面反射最强。

同样照射条件下，吸收红外辐射越强，物体获得能量的速率越大，升温越快。

物体温度保持不变时，向外传递能量的速率等于接收能量的速率。

答案：黑色哑面；白色光亮面

怎么认 题目出现表面颜色、纹理及红外辐射的吸收或反射时，先区分所求是吸收强还是反射强。

一. 黑哑吸收强亮白反射强

例题 1 Solar heating panels consist of pipes carrying water that absorb radiation from the Sun.

Which texture and colour is the surface of the pipes so that the temperature of the water rises at the quickest rate?

A dull black

B dull white

C shiny black

D shiny white

（2024 春季 0625/22 第11题）

解：太阳能加热管要使水升温最快，管壁应尽可能多地吸收太阳辐射。

黑色哑面吸收红外辐射最强，因此水获得能量的速率最大。

故选 A。

针对练习

1. Which surface is the best reflector of infrared radiation?

A dull and black

B dull and white

C shiny and black

D shiny and white

（2025 冬季 0625/12 第17题）

2. **(a)** A student uses the apparatus in Fig. 5.1 to compare how different surfaces absorb infrared radiation.

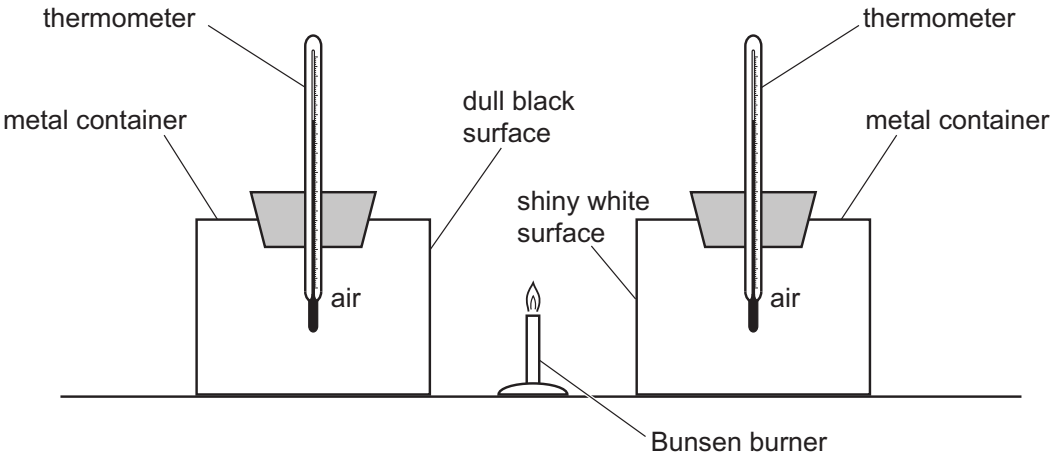


Fig. 5.1

There are two metal containers. One has a dull black surface and the other has a shiny white surface.

Before heating, the air inside the metal containers is at the same temperature.

The Bunsen burner flame is the same distance from each metal container. The Bunsen burner flame emits infrared radiation and heats the metal containers for three minutes.

Explain the difference between the temperatures of the air inside the two metal containers after heating for three minutes.

（2025 夏季 0625/31 第5题(a)）

3. Pluto is a dwarf planet. Fig. 10.1 shows the direction of motion of Pluto as it follows its elliptical orbit around the Sun.

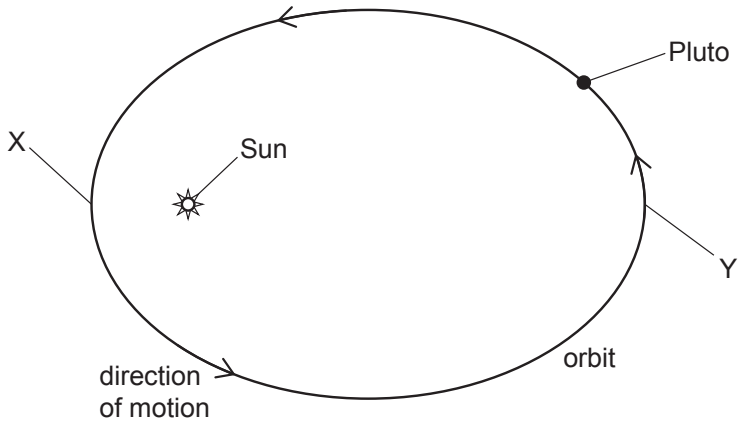


Fig. 10.1 (not to scale)

(b) The average temperature on the surface of Pluto is 43 K.

(i) Convert this temperature to a value in degrees Celsius (°C).

(ii) Pluto has a white surface, as shown in Fig. 10.2. As Pluto rotates, the white surface alternately faces towards and away from the Sun.

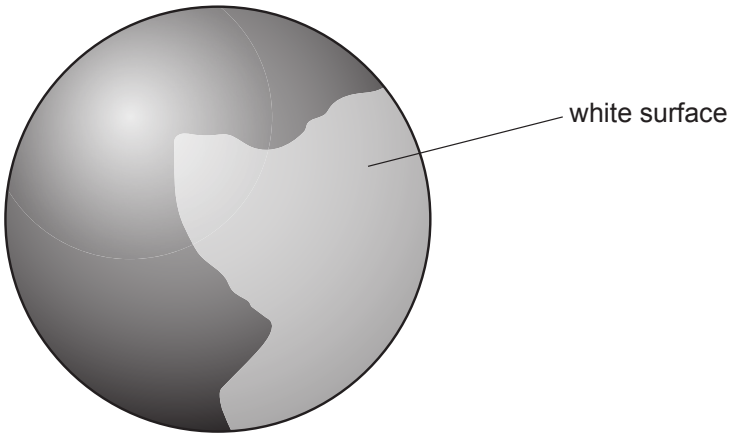


Fig. 10.2

Explain how this affects the temperature of Pluto as it rotates on its own axis.

（2023 夏季 0625/41 第10题(b)）

4. Fig. 3.1 shows a portable shower used on a campsite. The bag is filled with water. The water is heated using infrared radiation from the Sun.

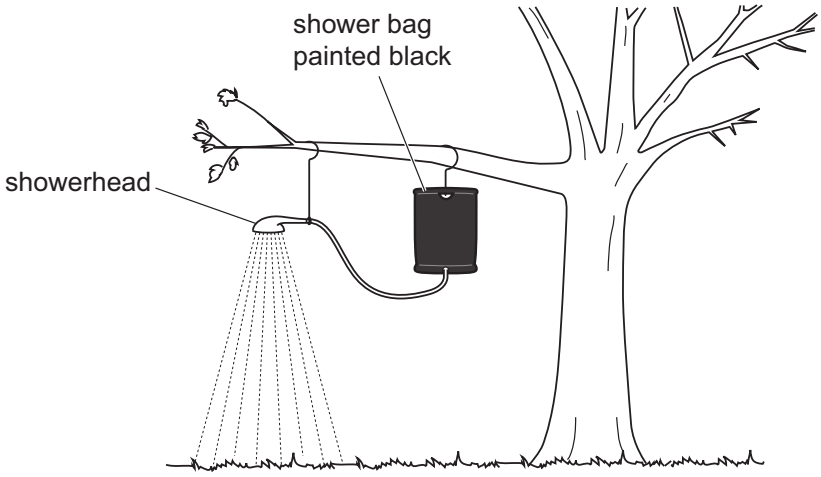


Fig. 3.1

(a) (i) Explain why the shower bag is painted black.

(ii) Explain a **disadvantage** of radiation from the Sun being the only source to heat the water.

（2024 冬季 0625/43 第3题(a)）

二. 黑哑发射强亮面发射弱

知识点 热辐射是红外辐射，所有物体都能发出热辐射，热辐射的传递不需要介质。

物体表面为_____、_____时，发射和吸收红外辐射的能力较强；白色、光亮表面的发射和吸收能力较弱。

比较表面发射能力时，物体的温度、表面积等条件应相同；热辐射发射速率的单位是 W。

物体温度保持不变时，向外传递能量的速率等于接收能量的速率。

答案：黑色；哑面（或粗糙）

怎么认 题目出现表面颜色、光亮程度不同并问发射或冷却快慢时，先比较表面发射能力。

例题 2 A student has four metal containers filled with the same volume of water at a temperature of 80 °C.

The metal containers are put in a room at a temperature of 20 °C.

The metal containers are identical except for the texture and colour of their surfaces.

Which surface will emit energy at the greatest rate?

A dull black

B shiny black

C dull white

D shiny white

（2025 夏季 0625/11 第17题）

解： 四个容器的温度、形状和大小均相同，热辐射发射速率的差异由表面性质决定。

黑色表面的发射能力比白色表面强，哑面的发射能力比光亮表面强。

因此，黑色哑面的容器发射能量的速率最大。故选 A。

针对练习

5. A student has a block of solid metal at room temperature.

(c) The metal block emits thermal radiation from its surface.

State **two** features of a surface that is a good emitter of thermal radiation.

（2023 夏季 0625/32 第4题(c)）

6. Two metal cans are identical, except that one has a shiny silver outer surface and the other has a dull black outer surface. They each have the same mass of hot water at the same temperature sealed inside them. They are both in a vacuum in the darkness of outer space.

How does the temperature of the water in each one change?

A The temperature of the water does **not** change.

B The water in the black can cools more slowly than that in the silver can.

C The water in the silver can cools more slowly than that in the black can.

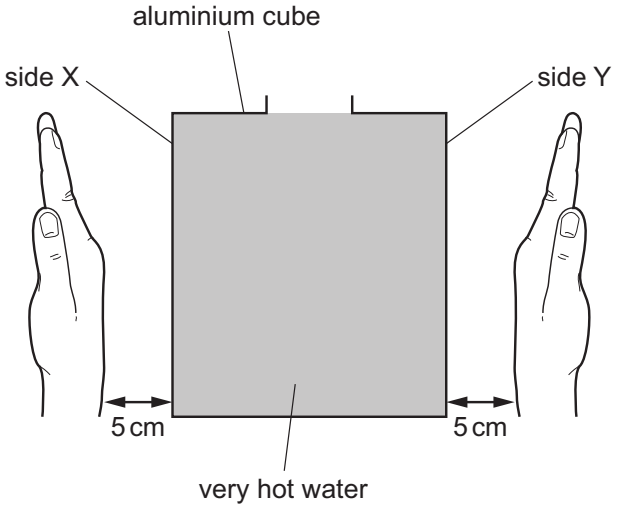
D They both cool down at the same rate.

（2025 冬季 0625/21 第16题）

7. A hollow aluminium cube is filled with very hot water.

Side X of the cube is opposite side Y of the cube. One of these two sides is black and one is white.

A student holds the back of one hand 5 cm from side X, and then immediately holds the back of the other hand 5 cm from side Y.



The hand held near side Y feels warmer than the hand held near side X.

Which row identifies the black side and correctly compares the rate of emission of thermal radiation from each side?

	black side	rate of emission of thermal radiation
A	X	greater for X
B	X	the same for X and Y
C	Y	greater for Y
D	Y	the same for X and Y

（2024 春季 0625/12 第15题）

8. A copper cooking pan contains water. Fig. 2.1 shows the pan on a hotplate of a cooker.

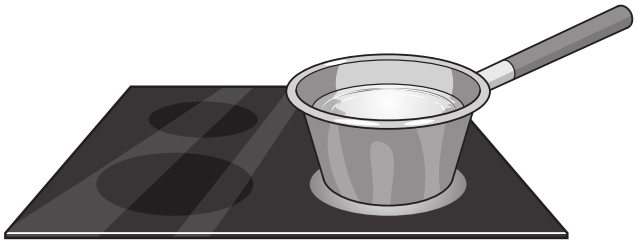


Fig. 2.1

Copper is a metal.

(b) The outside surface of the cooking pan is kept clean by regular polishing.

Explain **one** other advantage of keeping the surface of the pan shiny.

（2023 冬季 0625/41 第2题(b)）

题型 3：由辐射速率判温变（考频★★★☆☆）

知识点 所有物体都发出热辐射，热辐射是_____，传递不需要介质。

辐射发射速率表示单位时间内以辐射方式发出的能量，单位是 W。

表面颜色和质地相同时，表面温度越高、表面积越大，辐射发射速率越_____。

温度和表面积相同时，黑色、无光泽表面比白色、光亮表面的辐射发射速率大。

同质量、同材料的物体经历相同温降时，内能减少量相同；表面积越大，初始冷却速率越_____。

答案：红外辐射；大；大

怎么认 题目出现表面温度、面积与辐射发射速率的比较时，先控制表面性质，再比较温度和面积。

一. 先比温度面积再比发射

例题 1 A hot object emits thermal radiation.

Which row describes two changes that both reduce the rate of emission of radiation?

	surface area	surface temperature
A	increased	increased
B	increased	reduced
C	reduced	increased
D	reduced	reduced

（2025 春季 0625/22 第18题）

解：表面性质相同时，减小表面积可减小辐射发射速率，降低表面温度也可减小辐射发射速率。

故选 D。

针对练习

1. Four different surfaces are at the same high temperature.

Which surface emits thermal radiation at the slowest rate?

	colour of surface	texture of surface	surface area / cm^2
A	black	dull	10
B	black	dull	100
C	white	shiny	10
D	white	shiny	100

（2025 夏季 0625/23 第15题）

2. Star X has a larger diameter than star Y but they both emit radiation with the same power.

Which statement is correct?

A The surface temperature of X is less than the surface temperature of Y.

B The surface temperatures of X and Y are the same.

C The surface temperature of X is greater than the surface temperature of Y.

D The surface areas of X and Y are the same.

（2025 冬季 0625/23 第17题）

3. Two samples of the same material have the same mass but different surface areas.

Each sample is heated to the same temperature and then left to cool to room temperature.

Each sample is allowed to cool to the same final temperature.



Which row correctly compares the decrease in internal energy and the initial rate of cooling for each sample?

	decrease in internal energy	initial rate of cooling
A	X loses more internal energy than Y	X cools down faster than Y
B	Y loses more internal energy than X	Y cools down faster than X
C	X and Y lose the same quantity of energy	X cools down faster than Y
D	X and Y lose the same quantity of energy	Y cools down faster than X

（2024 夏季 0625/22 第16题）

4. Three solid copper spheres, X, Y and Z, are heated to the same temperature.

sphere	diameter	colour of surface
X	$2d$	black
Y	d	white
Z	$2d$	white

Which row gives the order for the rate of emission of radiation?

	highest rate of emission	second highest rate of emission	lowest rate of emission
A	X	Y	Z
B	X	Z	Y
C	Z	X	Y
D	Z	Y	X

（2025 夏季 0625/22 第16题）

二. 比较流入流出能量速率

知识点 设物体接收能量的速率为 $P_{入}$，向外传递能量的速率为 $P_{出}$。当 $P_{入}=P_{出}$ 时，物体的内能不变，温度保持_____。

当 $P_{入}>P_{出}$ 时，物体温度升高；当 $P_{入}<P_{出}$ 时，物体温度_____。

能量传递速率表示单位时间内传递的能量，单位是瓦特（W），$1\ \mathrm{W}=1\ \mathrm{J/s}$。

答案：不变；降低

怎么认 题目出现恒温或比较物体接收、放出能量的速率时，先比较流入与流出速率。

例题 2 An object has a constant temperature.

Which statement is correct?

A There is **no** energy transfer to or from the object.

B The rate at which the object receives energy is the same as the rate at which it transfers energy away.

C The rate at which the object receives energy is smaller than the rate at which it transfers energy away.

D The rate at which the object receives energy is greater than the rate at which it transfers energy away.

（2025 夏季 0625/23 第16题）

解：物体温度恒定，单位时间内净能量变化为零。

$P_{入} = P_{出}$

故选 B。

针对练习

5. **(a)** A teacher uses the equipment shown in Fig. 6.1.

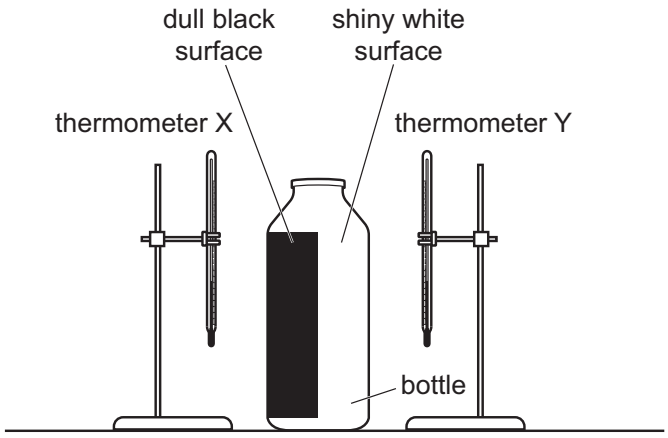


Fig. 6.1

The thermometers X and Y are the same distance from the bottle.

The room temperature is 20 °C.

The teacher pours very hot water into the bottle.

After 5 minutes, the teacher observes the reading on each thermometer.

The reading on thermometer X is 24 °C.

(i) The reading on thermometer Y is **not** 24 °C.

Explain why the readings on the two thermometers are **not** the same.

(ii) Suggest a value for the reading on thermometer Y.

（2025 夏季 0625/32 第6题(a)）

6. **(d)** The Earth's surface absorbs incoming radiation from the Sun and also emits thermal radiation from its surface.

Over the past 50 years, scientists estimate that the average temperature of the Earth's surface has increased by approximately 0.75 °C.

Explain what is causing this average temperature rise.

（2025 冬季 0625/43 第5题(d)）

2.3.4 热传递的应用

题型 1：分段判断传热路径（考频★★☆☆☆）

知识点 热传递有传导、对流和辐射三种方式。传导是在物质中由粒子的相互作用传递热能，不伴随物质整体移动。

对流是_____或_____因整体运动传递热能；辐射以红外辐射的形式传递热能，不需要介质。

沿热能传播路径分段时，固体或接触处看传导，流体整体升沉看对流，跨越空间看_____。

答案：液体；气体；辐射

怎么认 题目出现热能跨过不同物质传递的图或所求时，先沿传播路径分段判断传热方式。

例题 1

Fig. 5.1 shows a metal container used for storing petrol.
There is some petrol gas above the liquid petrol inside the metal container.

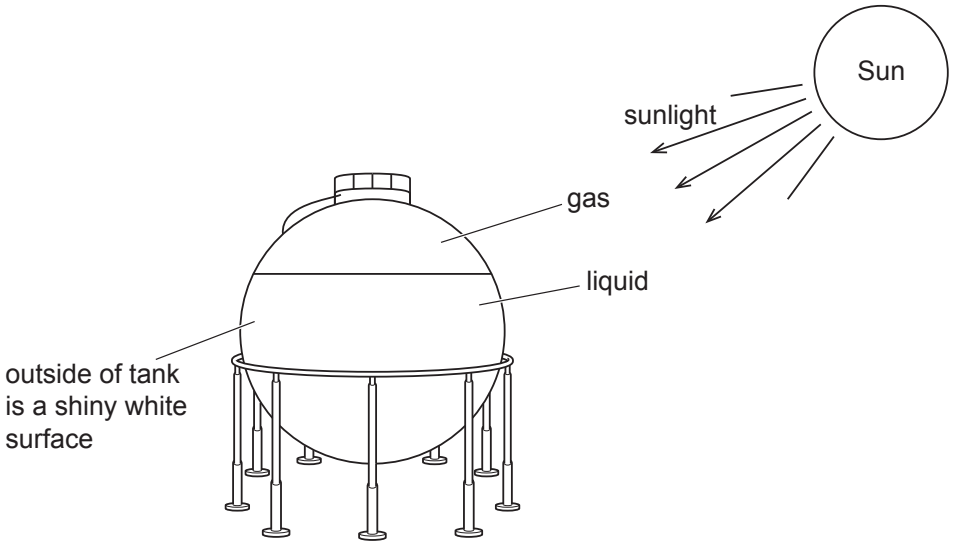


Fig. 5.1 (not to scale)

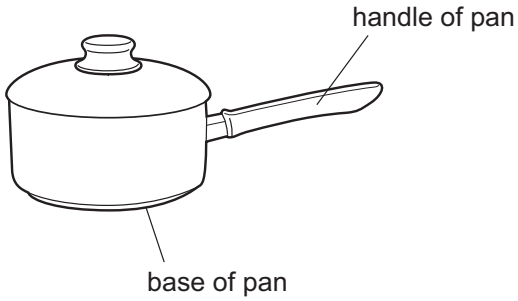
(c) Describe how thermal energy travels from the Sun to the petrol inside the metal container.

（2024 春季 0625/32 第5题(c)）

解：太阳与容器之间隔着太空和大气，热能由红外辐射传到金属容器。
热能再由传导通过容器的金属，传到容器内的汽油。
答：先由红外辐射传到容器，再由传导通过金属进入汽油。

针对练习

1. The diagram shows a pan used for cooking food.

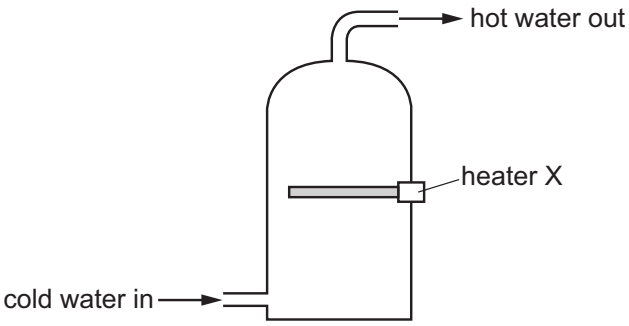


Which row is correct for the materials used to make the base of the pan and the handle of the pan?

	base of pan	handle of pan
A	good thermal conductor	good thermal conductor
B	good thermal conductor	poor thermal conductor
C	poor thermal conductor	good thermal conductor
D	poor thermal conductor	poor thermal conductor

（2024 春季 0625/22 第10题）

2. The diagram shows a hot-water tank. The tank has a heater, X, halfway up the tank.



Heater X is switched on.

Which row states the main processes by which thermal energy is transferred to the water above the heater and to the water below the heater?

	thermal energy transfer to the water above the heater	thermal energy transfer to the water below the heater
A	conduction	conduction
B	conduction	convection
C	convection	conduction
D	convection	convection

（2025 冬季 0625/13 第16题）

3. **(c)** Fig. 4.3 shows a saucepan of boiling water on the heating ring of an electric cooker.

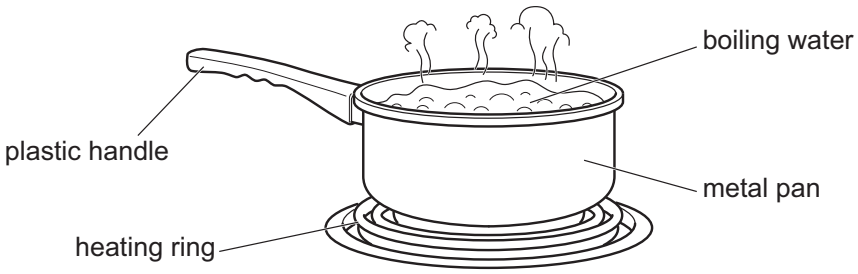


Fig. 4.3

The handle is made from plastic.
Explain why this material is suitable.

（2025 冬季 0625/43 第4题(c)）

4. Some hot water is sealed inside a metal can. The can is in a vacuum in outer space. The hot water slowly cools down.

How does the thermal energy escape into space?

A by conduction then convection

B by conduction then radiation

C by evaporation then convection

D by evaporation then radiation

（2023 夏季 0625/21 第16题）

题型 2：按散热路径改结构（考频★★★☆☆）

知识点 传导、对流和辐射是热能从高温处向低温处传递的三种过程，过程名称没有单位。

传导须有物质粒子参与；空气和塑料导热性差，能减慢_____。

对流须有液体或气体的整体流动；窄空气层或气泡中的空气难以流动，能减慢_____。

真空中没有粒子，因而阻断传导和对流，但不能阻断_____；白色或光亮表面能减弱热辐射。

答案：传导；对流；辐射

怎么认 题目出现真空、窄空气层、气泡或塑料壁时，先按传导、对流、辐射逐条判断受阻过程。

一. 逐条封住传导对流辐射

例题 1

(a) Fig. 6.1 shows a cold drink in a thermal jug. The jug reduces thermal energy transfer from the surroundings to the drink.

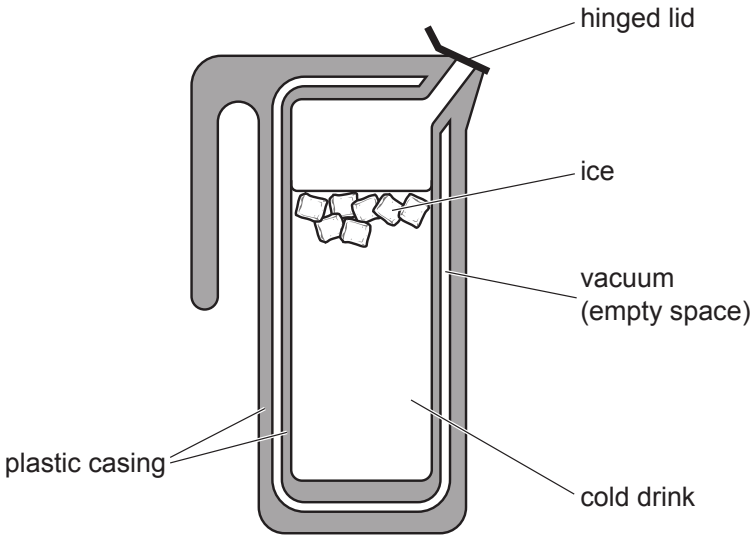


Fig. 6.1

State the names of the **two** processes of thermal energy transfer that are prevented by the vacuum.

Explain how the vacuum prevents these **two** processes of thermal energy transfer.

（2023 冬季 0625/32 第6题(a)）

解：传导和对流都需要物质粒子传递热能。
真空中没有粒子，故传导和对流均不能发生。
答：传导和对流；真空没有提供传递热能所需的粒子。

针对练习

1. **(b)** Fig. 5.2 shows a cross-section of a double-glazed window in the room.

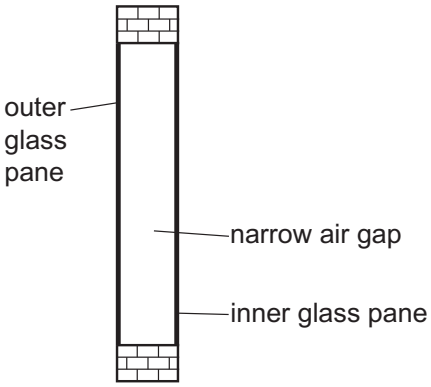


Fig. 5.2

State the main methods of thermal energy transfer from the room to outside which are reduced by this type of window.

（2023 夏季 0625/42 第5题(b)）

2. There is a vacuum between the double walls of a vacuum flask.

Which types of thermal transfer are reduced by the vacuum?

A conduction, convection and radiation

B conduction and convection only

C conduction and radiation only

D convection and radiation only

（2024 冬季 0625/12 第16题）

3. **(b)** Fig. 4.1 shows part of a container used to store a mixture of liquid and gaseous oxygen.

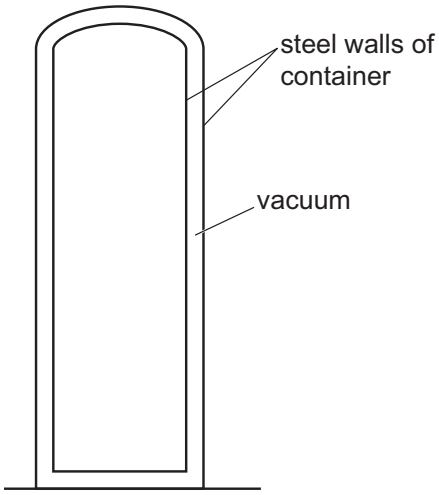


Fig. 4.1

The temperature of the liquid oxygen is –160 °C.

(i) Determine the temperature of the liquid oxygen in K.

(ii) The container is made of steel and there is a vacuum between the inner and outer walls. The outer wall of the container is at room temperature.

State **two** methods of thermal energy transfer that a vacuum prevents.

（2024 夏季 0625/42 第4题(b)）

4. A teacher shows his class a polystyrene cup. The polystyrene is a thick plastic with lots of tiny air bubbles in it.

He asks the class why the cup is so good at keeping a hot drink warm. Three suggestions are made.

1 It contains air which is a poor thermal conductor.

2 The air is trapped in tiny bubbles so very little convection is possible.

3 The plastic is a poor thermal conductor.

Which suggestions are correct?

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

（2024 夏季 0625/22 第15题）

二. 按目标改材料面积开口

知识点 热传递速率是单位时间内传递的热能，$P = \Delta\frac{E}{\Delta}t$，单位为_____。

要提高加热或冷却速率，应_____热传递；要保温，应_____热传递。

良导体可增大热传导速率，隔热体可减小热传导速率；增大接触面积或表面积通常可增大热传递速率。

移去杯盖、增大液面面积或加强空气流动可加快散热；暗色无光表面比光亮表面更善于发射红外辐射。

答案：瓦特（W）；增大；减小

怎么认 题目出现容器材料、表面积、杯盖或表面性质并要求改变散热速率时，先确定目标是加热、保温还是冷却。

例题 2 In this experiment, you will investigate the cooling of water.

Carry out the following instructions, referring to Fig. 2.1.

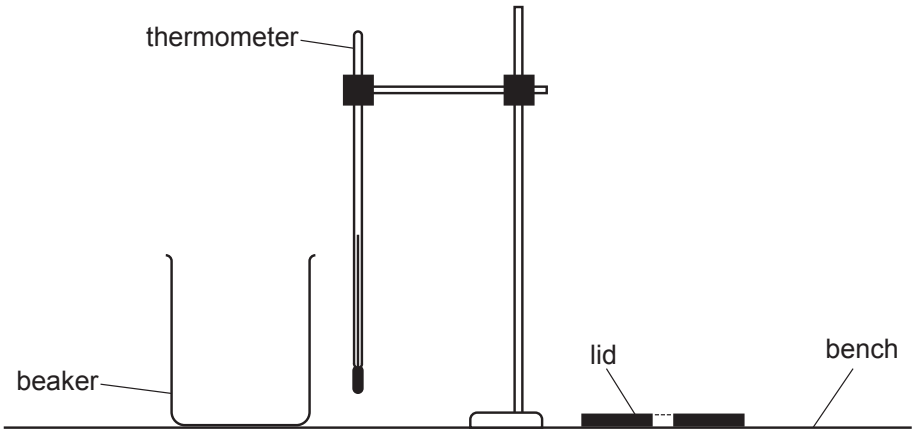


Fig. 2.1

(d) A student states that the water cools slowly.

Suggest **two** changes to the experiment that you could make to increase the rate of cooling of the hot water without changing the starting temperature of the hot water. Room temperature remains constant.

（2023 夏季 0625/52 第2题(d)）

解：移去杯盖，使水面与空气接触，对流和蒸发增强，散热加快。

改用更宽的烧杯，水面面积增大，单位时间内散失的热能增多。

答：移去杯盖；改用更宽的烧杯。

5. **(a)** Fig. 4.1 shows a pan on a hotplate. The hotplate heats the pan and the water.

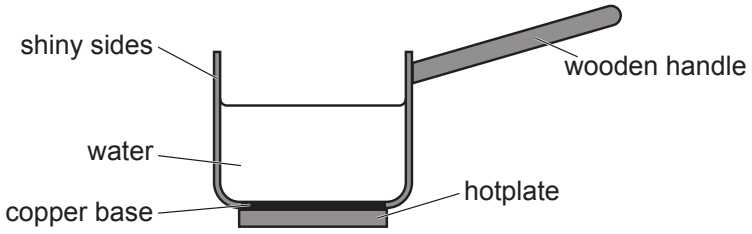


Fig. 4.1

Use your ideas about thermal energy transfer to explain why the pan has:

(i) a wooden handle

(ii) shiny sides

(iii) a copper base.

（2023 冬季 0625/33 第4题(a)）