**HOLIDAY HOMEWORK 假期作业**

# IGCSE Physics

Exercise sheets and past-paper practice, topic by topic.

每个单元：练习卷 + 历年真题。

For class or self-study • no answer keys included.

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# 1 Measurement and motion – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| length | 长度 | | | |
| time | 时间 | | | |
| mass | 质量 | | | |
| ruler | 直尺 | | | |
| measuring cylinder | 量筒 | | | |
| meniscus | 弯月面 | | | |
| pendulum | 摆 | | | |
| speed | 速率 | | | |
| acceleration | 加速度 | | | |
| distance–time | 距离时间图 | | | |
| gradient | 斜率 | | | |
| speed–time | 速度时间图 | | | |

## Recall

You measure things every day – length, time, how fast something moves. This sheet gets you ready for the IGCSE Physics course.

- A measurement is always a **number** with a **unit** (5 means nothing; 5 m is a length).
- We measure **length** 长度 in metres, **time** 时间 in seconds, **mass** 质量 in kilograms.

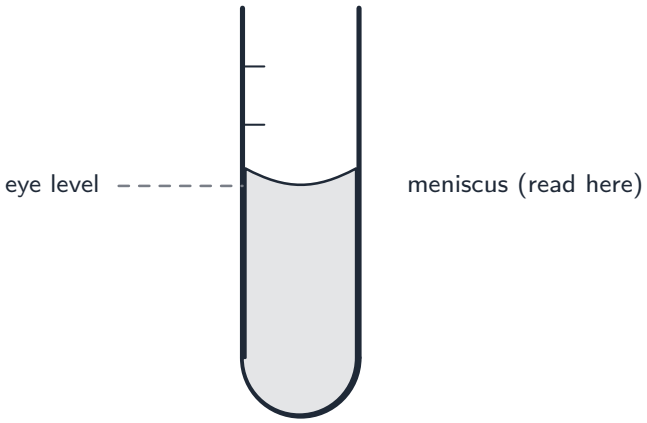
Nothing here is hard – it just lines up the basics.

## New ideas

Read these first, then do the Practice.

### ■ 1 Measuring length and volume

- use a **ruler** 直尺 for length; put your eye straight in front of the mark.
- use a **measuring cylinder** 量筒 for the volume of a liquid; read the scale at the bottom of the curve (the **meniscus** 弯月面), with your eye level.




### ■ 2 Measuring small amounts

A single small length or short time is hard to measure. The trick is **measure many and divide**:

- thickness of one page → measure 100 pages, divide by 100.
- time for one swing of a **pendulum** 摆 → time 20 swings, divide by 20.

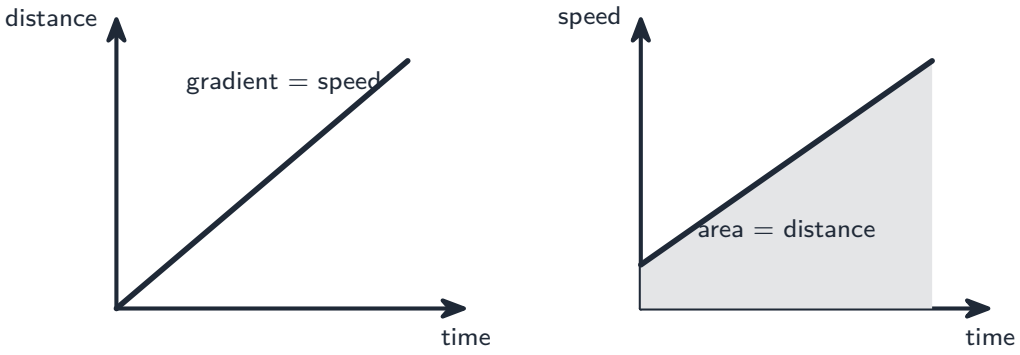
### ■ 3 Speed and acceleration

- **speed** 速率 is distance per time: $v = \dfrac{s}{t}$.
- **acceleration** 加速度 is the change in velocity per time: $a = \dfrac{\Delta v}{\Delta t}$.

*Worked example.* A car speeds up from 8 to 20 m/s in 4.0 s: $a = \dfrac{20 - 8}{4.0} = 3.0\ \text{m/s}^2$.

## 4 Motion graphs

- **distance–time** 距离时间图: a flat line = at rest; a slope = constant speed (the **gradient** 斜率 is the speed).
- **speed–time** 速度时间图: a slope = constant acceleration; the **area under the line** is the distance.




**Watch out:** on a **distance–time** graph the gradient is the *speed*; on a **speed–time** graph the gradient is the *acceleration* and the *area* under the line is the distance – don't read the two graphs the same way. Always read a measuring cylinder at the bottom of the meniscus, with your eye level.

## Practice

Try these in order.

**1.1** What two parts must every measurement have? [1]

**1.2** To find the thickness of one sheet of paper, you measure 100 sheets as 9 mm. What is the thickness of one sheet? [2]

**1.3** Write the equation linking speed, distance and time. [1]

**1.4** A runner travels 100 m in 20 s. Calculate the speed. [2]

**1.5** On a distance–time graph, what does a flat (horizontal) line mean? [1]

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**1.6** A car speeds up from 5 m/s to 15 m/s in 2.0 s. Calculate its acceleration. [2]

**1.7 Challenge.** A cyclist rides 60 m in 5 s, rests for 3 s, then rides another 40 m in 5 s. Calculate the average speed for the **whole** journey. [2]

Name:

IGCSE Physics: **w25 22**

**1** Which quantities are both vectors?

**A** acceleration and force

**B** acceleration and pressure

**C** density and force

**D** density and pressure

IGCSE Physics: **w25 23**

**2** When a pendulum passes a marker, a timer displays 1 minute 30 seconds.

The pendulum passes the marker 12 more times from the same direction.

On the final pass, the timer displays a time of 2 minutes 18 seconds.

What is the time period of oscillation of the pendulum?

**A** 4.0 s **B** 4.4 s **C** 7.5 s **D** 12 s

IGCSE Physics: **w23 21**

**3** Which is a vector quantity?

**A** density

**B** mass

**C** pressure

**D** weight

Name:

IGCSE Physics: **w25 22**

**1** How is the deceleration of an object calculated from a speed–time graph?

**A** It is the area under the graph.

**B** It is the gradient of the graph.

**C** It is the difference between two readings on the horizontal ($x$) axis.

**D** It is the difference between two readings on the vertical ($y$) axis.

IGCSE Physics: **w25 23**

**2** A car driver applies the brakes to bring a car to rest with a constant deceleration of $4.0\,m/s^2$ in a time of 8.0 s.

What is the average speed of the car during this time?

**A** 4.0 m/s **B** 8.0 m/s **C** 16 m/s **D** 32 m/s

IGCSE Physics: **s24 21**

**3** A stone is dropped from a tall tower and falls a distance of 50 m to the ground.

The stone has a mass of 3.0 kg.

At which speed does the stone hit the ground?

**A** 17 m/s **B** 31 m/s **C** 54 m/s **D** 150 m/s

IGCSE Physics: **s23 21**

**4** An object falls towards the surface of the Earth.

The object is falling at its terminal velocity.

Which statement is correct?

**A** There is air resistance and the acceleration of the object is negative.

**B** There is air resistance and the acceleration of the object is zero.

**C** There is no air resistance and the acceleration of the object is negative.

**D** There is no air resistance and the acceleration of the object is zero.

Name:

IGCSE Physics: **w25 22**

**1** A space probe that has a mass of 600 kg is on the planet Mars.

The acceleration of free fall on Mars is $4.0\,m/s^2$.

What is the weight of the space probe on Mars?

**A** 60 N **B** 150 N **C** 2400 N **D** 6000 N

IGCSE Physics: **w25 23**

**2** Which measuring instrument is used to compare masses?

**A** balance

**B** protractor

**C** stop-watch

**D** voltmeter

IGCSE Physics: **s24 21**

**3** Which name is given to the quantity of matter in an object?

**A** density

**B** mass

**C** volume

**D** weight

IGCSE Physics: **s23 21**

**4** On the Earth, a spring stretches by 5.0 cm when a mass of 3.0 kg is suspended from one end.

The gravitational field strength on the Moon is $\frac{1}{6}$ of that on the Earth.

Which mass, on the Moon, would stretch the spring by the same extension?

**A** 0.50 kg **B** 3.0 kg **C** 5.0 kg **D** 18 kg

# 1 Forces, energy and pressure – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| forces | 力 | | | |
| energy | 能量 | | | |
| pressure | 压强 | | | |
| mass | 质量 | | | |
| weight | 重力 | | | |
| density | 密度 | | | |
| displacement method | 排水法 | | | |
| resultant force | 合力 | | | |
| work done | 做功 | | | |
| joules | 焦耳 | | | |
| kinetic energy | 动能 | | | |
| pascals | 帕斯卡 | | | |

## Recall

From Part 1 you can measure and describe motion. Here we look at **forces** 力, **energy** 能量 and **pressure** 压强 – the rest of the mechanics you start IGCSE with.

- A **force** is a push or a pull.
- Energy is never made or destroyed – it only moves between stores.

Nothing here is hard – it just adds the key equations.

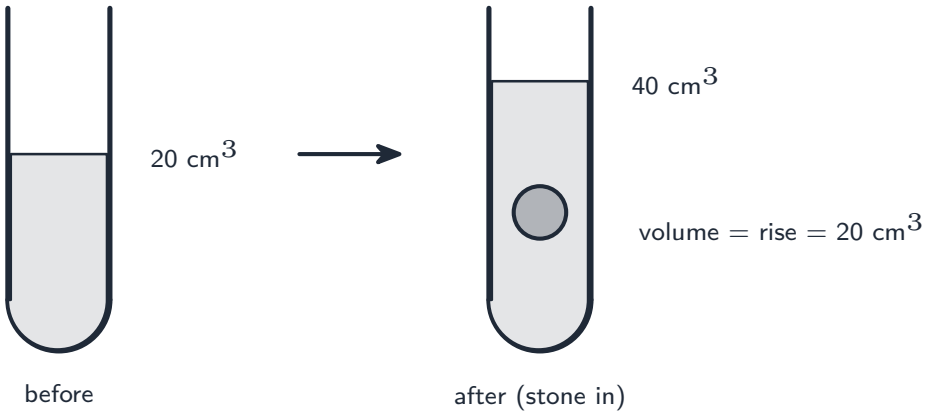
## New ideas

Read these first, then do the Practice.

### ■ 1 Mass, weight and density

- **mass** 质量 is the amount of matter (in kg); it does not change.
- **weight** 重力 is the force of gravity on a mass (in N); $W = mg$ (with $g \approx 10$ N/kg).
- **density** 密度 is mass per volume: $\rho = \dfrac{m}{V}$.

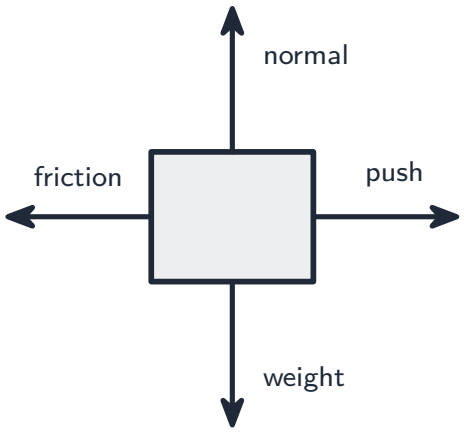
For an odd shape, find the volume by the **displacement method** 排水法 – the rise in water level.




### ■ 2 Forces and F = ma

Add the forces on a line to get the **resultant force** 合力:

- resultant force **zero** → at rest or constant speed.
- resultant force **not zero** → it accelerates: $F = ma$.




*Worked example.* A 1200 kg car has 3000 N driving force and 600 N friction: resultant = 2400 N, so $a = F/m = 2400/1200 = 2.0$ m/s$^2$.

### 3 Energy, work and pressure

- **work done** 做功 = energy transferred: $W = Fd$ (in **joules** 焦耳, J).
- **kinetic energy** 动能: $E_k = \frac{1}{2}mv^2$.
- **pressure** 压强 = force per area: $p = \dfrac{F}{A}$ (in **pascals** 帕斯卡, Pa). A small area gives a large pressure.

**Watch out:** mass (kg) never changes, but weight (N) depends on $g$. In $F = ma$ use the **resultant** force – subtract friction first. And because $p = F/A$, a **smaller** area gives a **larger** pressure.

## Practice

Try these in order. Take $g = 10$ N/kg.

**1.1** State the difference between *mass* and *weight*. [2]

**1.2** Calculate the weight of a 5.0 kg bag. [2]

**1.3** A block has mass 54 g and volume 20 $cm^3$. Calculate its density. [2]

**1.4** A resultant force of 20 N acts on a 4.0 kg trolley. Calculate its acceleration. [2]

**1.5** Write the equation for pressure, and its unit. [2]

**1.6** Why does a sharp knife cut better than a blunt one? [1]

**1.7 Challenge.** A 6.0 kg block rests on a face of area 0.02 $m^2$. Calculate the pressure it exerts on the floor. (Take $g = 10$ N/kg.) [3]

**1** The mass of an object is 2.5 kg. The volume of the object is 480 $cm^3$.

What is the density of the object?

**A** $5.2 \times 10^{-3}\,g/cm^3$

**B** $5.2\,g/cm^3$

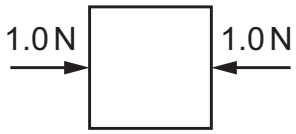
**C** $190\,g/cm^3$

**D** $1.2 \times 10^{3}\,g/cm^3$

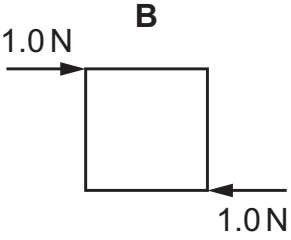
**2** Four objects each have two forces acting on them.

Which object is in equilibrium?

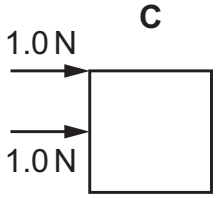
**A**



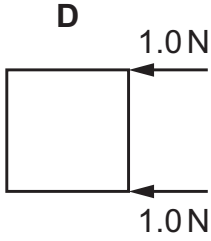

**B**




**C**




**D**



Name:

IGCSE Physics: **w25 21**

**1** The momentum of a car changes from 10 000 kg m / s to 15 000 kg m / s in a time of 8.0 s.

What is the resultant force acting on the car?

**A** 630 N **B** 3100 N **C** 40 000 N **D** 200 000 N

IGCSE Physics: **s24 21**

**2** A ball of mass $m$ falls vertically and hits a hard surface.

Its speed on hitting the surface is $v_1$.

It rebounds vertically upwards with speed $v_2$.

What is the change in momentum of the ball?

**A** $mv_1$ **B** $mv_2$ **C** $m(v_1 + v_2)$ **D** $m(v_2 - v_1)$

IGCSE Physics: **w23 21**

**3** A sphere X collides head on with a second identical sphere Y which is stationary.

The mass of each sphere is 0.15 kg.

Sphere X is travelling at a velocity of 2.0 m / s before the collision and produces an impulse of 0.21 N s on sphere Y.

What is the velocity of sphere X after collision?

**A** 0.60 m / s in the opposite direction to Y

**B** 0.60 m / s in the same direction as Y

**C** 1.4 m / s in the opposite direction to Y

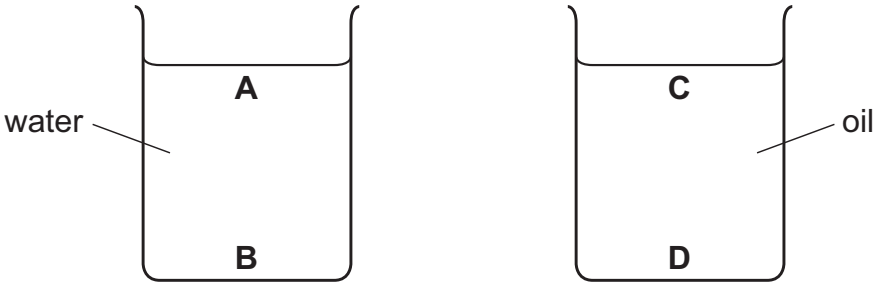
**D** 1.4 m / s in the same direction as Y

IGCSE Physics: **w25 22**

**1** Two beakers are filled to the same depth, one with water and one with oil.

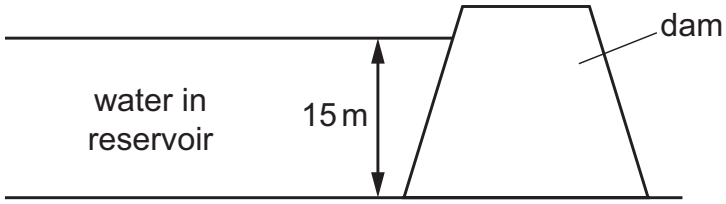
The density of water is 1000 kg / $m^3$. The density of oil is 920 kg / $m^3$.

In which position is the pressure the greatest?




IGCSE Physics: **s23 21**

**2** A dam holds water in a reservoir. The height of the water in the reservoir is 15 m.




The density of water is 1000 kg / $m^3$.

What is the pressure due to the water at the bottom of the dam?

**A** 6.8 Pa **B** 1500 Pa **C** 15 000 Pa **D** 150 000 Pa

# 2 States of matter – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| solid | 固体 | | | |
| liquid | 液体 | | | |
| gas | 气体 | | | |
| particles | 粒子 | | | |
| vibrate | 振动 | | | |
| kinetic energy | 动能 | | | |
| Temperature | 温度 | | | |
| absolute zero | 绝对零度 | | | |
| pressure | 压强 | | | |

## Recall

You know that matter can be a **solid** 固体, a **liquid** 液体 or a **gas** 气体. The IGCSE course explains this with the idea that everything is made of tiny moving **particles** 粒子.

- The particles are always moving.
- How they move and how close they are decides the state.

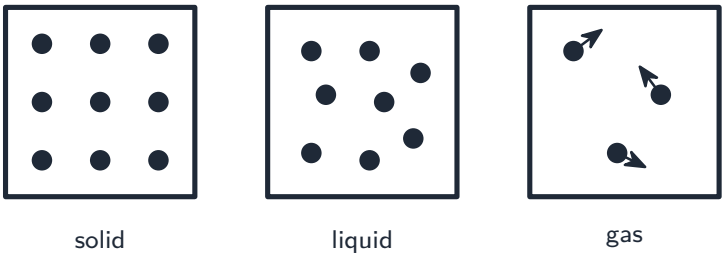
Nothing here is hard – it just adds the particle model.

## New ideas

Read these first, then do the Practice.

### ■ 1 The three states

| State | Shape | Particles |
|---|---|---|
| **solid** 固体 | fixed | close, in a pattern, just **vibrate** 振动 |
| **liquid** 液体 | takes the container's shape | close, slide past each other |
| **gas** 气体 | fills the container | far apart, fast, random |



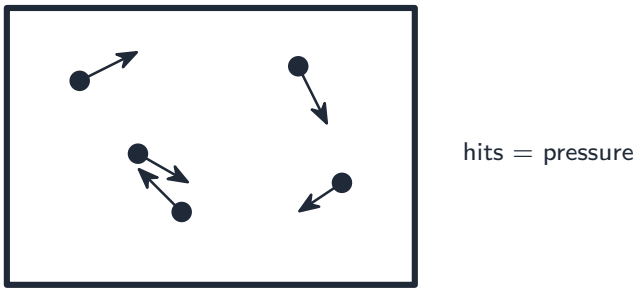

### ■ 2 Temperature and energy

Heating a substance makes its particles move **faster** (more **kinetic energy** 动能). **Temperature** 温度 measures the average kinetic energy of the particles.

The lowest possible temperature is **absolute zero** 绝对零度, $-273\,^{\circ}\mathrm{C}$.

### ■ 3 Gas pressure

Gas particles hit the walls of their container. Each hit is a tiny push. The **pressure** 压强 is the total force of all these hits per unit area.




- heat a gas → faster particles hit harder and more often → pressure rises.
- squeeze a gas smaller → more hits per second on each area → pressure rises.

> **Watch out:** temperature measures the **average** kinetic energy of the particles, not the total. When a gas is squeezed at constant temperature the particles do **not** speed up – there are simply more wall-hits per second on each unit of area.

## Practice

Try these in order.

**2.1** In which state are the particles (a) far apart and fast, (b) fixed in a pattern? [2]

**2.2** What does *temperature* measure, in terms of particles? [1]

**2.3** State the value of absolute zero in °C. [1]

**2.4** Explain, in terms of particles, how a gas exerts pressure on its container. [2]

**2.5** A gas is squeezed into a smaller volume at constant temperature. Explain why its pressure rises. [2]

**2.6 Challenge.** A sealed jar of gas is **heated** (its volume fixed). Explain, in terms of particles, why the pressure rises – give **two** reasons. [2]

# 2 Thermal energy – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) |
|---|---|---|
| conduction | 热传导 | |
| convection | 对流 | |
| radiation | 热辐射 | |
| infrared | 红外线 | |
| Melting | 熔化 | |
| boiling | 沸腾 | |
| Evaporation | 蒸发 | |

## Recall

From Part 1 you know heating makes particles move faster. Here we see how thermal energy **moves** from hot to cold, and what happens during a **change of state**.

- Thermal energy always flows from hotter to colder.
- It moves in three ways: conduction, convection and radiation.

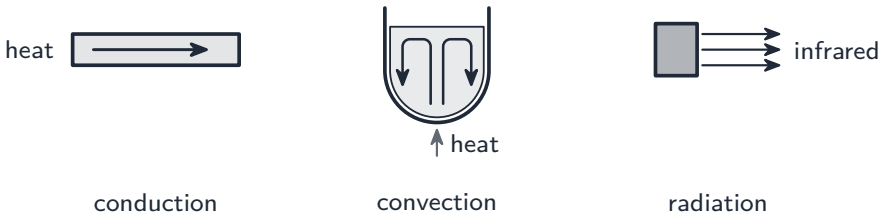
Nothing here is hard – it just names the three ways.

## New ideas

Read these first, then do the Practice.

## 1 Three ways heat moves

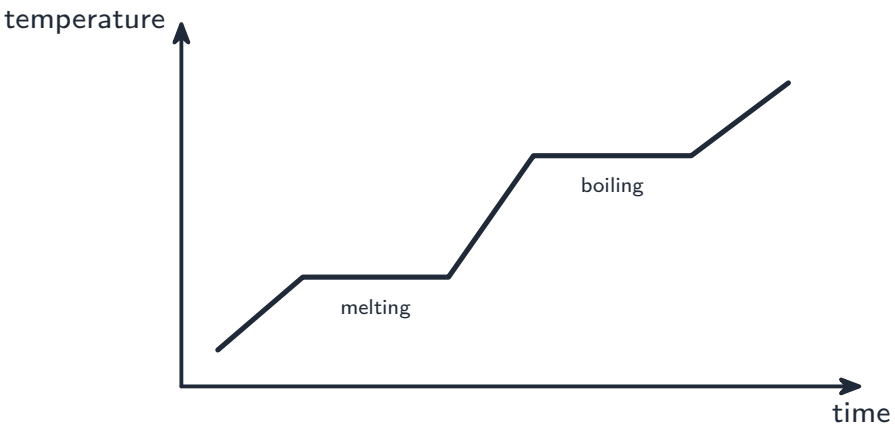
- **conduction** 热传导 – through a solid; vibrating particles pass energy to their neighbours. **Metals** are good conductors (free electrons carry energy).
- **convection** 对流 – in a liquid or gas; heated fluid expands, becomes less dense and **rises**, while cooler fluid sinks (a **convection current**).
- **radiation** 热辐射 – by **infrared** 红外线 waves; needs no material, so it can cross empty space (this is how the Sun's energy reaches us).




A **dull black** surface is a good emitter and absorber of infrared; a **shiny white** surface is a poor emitter and a good reflector.

## 2 Changes of state

**Melting** 熔化 and **boiling** 沸腾 need energy, but the **temperature stays the same** while the state changes – the energy breaks the forces between particles.




**Evaporation** 蒸发 happens at the **surface**, below boiling point. The fastest particles escape, so the average energy of those left falls – the liquid **cools**.

**Watch out:** while a substance is melting or boiling its temperature stays **constant**, even though energy is still added – the energy breaks the forces between particles. A dull black surface is the best emitter *and* absorber of infrared; a shiny surface is the best reflector.

## Practice

Try these in order.

**2.1** Name the three ways thermal energy is transferred. [3]

**2.2** Why are metals good conductors of heat? [1]

**2.3** Explain how a convection current forms when water is heated from below. [3]

**2.4** Which type of heat transfer can travel through empty space? [1]

**2.5** What happens to the temperature while a solid is melting, even though energy is still added? [1]

**2.6** Explain why evaporation cools a liquid. [2]

**2.7 Challenge.** A vacuum flask keeps a drink hot. Explain how (a) the vacuum gap and (b) the shiny silvered walls each reduce heat loss. [3]

# 3 Waves – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| wave | 波 | | | |
| energy | 能量 | | | |
| wavelength | 波长 | | | |
| amplitude | 振幅 | | | |
| frequency | 频率 | | | |
| hertz | 赫兹 | | | |
| transverse | 横波 | | | |
| longitudinal | 纵波 | | | |
| reflection | 反射 | | | |
| refraction | 折射 | | | |
| diffraction | 衍射 | | | |

## Recall

A **wave** 波 carries **energy** 能量 from place to place **without** carrying matter. A water wave makes a cork bob up and down, but the cork does not travel along with it.

- Waves are how light, sound and ripples carry energy.
- We describe every wave with the same few words.

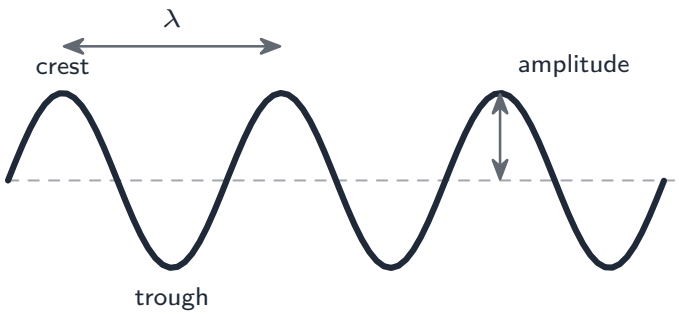
Nothing here is hard – it just adds the words and one equation.

## New ideas

Read these first, then do the Practice.

### 1 Describing a wave

- **wavelength** 波长 ($\lambda$) – the distance of one full wave (e.g. crest to crest).
- **amplitude** 振幅 – the largest distance a point moves from its rest position.
- **frequency** 频率 ($f$) – the number of waves passing a point each second (in **hertz** 赫兹, Hz).

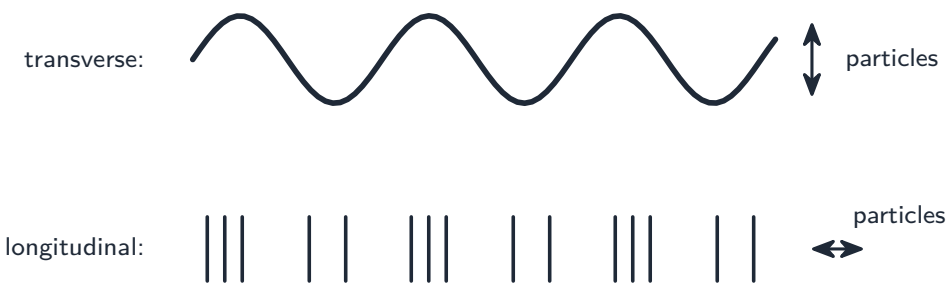



These link by the **wave equation**: $v = f\lambda$.

*Worked example.* A sound wave with $v = 340$ m/s and $f = 170$ Hz: $\lambda = v/f = 340/170 = 2.0$ m.

### 2 Two types of wave

- **transverse** 横波 – particles vibrate at **right angles** to the travel direction (light, water).
- **longitudinal** 纵波 – particles vibrate **along** the travel direction (sound).



### ■ 3 What waves do

- **reflection** 反射 – bounces off a surface.
- **refraction** 折射 – changes speed (and bends) entering a new material.
- **diffraction** 衍射 – spreads out through a gap or round an edge.

**Watch out:** in $v = f\lambda$, frequency is waves per second (Hz) and wavelength is a distance (m) – keep the units apart. Amplitude is measured from the **rest** position to a crest, not from crest to trough.

## Practice

Try these in order.

**3.1** What does a wave carry from place to place, without carrying matter? [1]

**3.2** Define the *wavelength* of a wave. [1]

**3.3** Write the wave equation. [1]

**3.4** A wave has frequency 50 Hz and wavelength 6 m. Calculate its speed. [2]

**3.5** State whether each is transverse or longitudinal: (a) light, (b) sound. [2]

**3.6** Name the wave behaviour where a wave spreads out after passing through a gap. [1]

**3.7 Challenge.** A water wave has a wavelength of 0.5 m and travels at 2 m/s. Calculate its frequency. [2]

Name:

IGCSE Physics: **w25 22**

**1** An earthquake-monitoring station records the arrival of 16 complete wavelengths of an earthquake wave in a time of 20 s.

The speed of the earthquake wave is 6.0 km / s.

What is the wavelength of the earthquake wave?

**A** $1.3 \times 10^{-4}$ m **B** $2.1 \times 10^{-4}$ m **C** $4.8 \times 10^{3}$ m **D** $7.5 \times 10^{3}$ m

IGCSE Physics: **s24 21**

**2** Which statement about waves is correct?

**A** Waves do not transfer either energy or matter.

**B** Waves transfer both energy and matter.

**C** Waves transfer energy without transferring matter.

**D** Waves transfer matter without transferring energy.

IGCSE Physics: **w23 21**

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

**A** amplitude and frequency

**B** amplitude and wavelength

**C** amplitude and wave speed

**D** frequency and wavelength

# 3 Light and sound – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| Light | 光 | | | |
| sound | 声音 | | | |
| electromagnetic | 电磁 | | | |
| normal | 法线 | | | |
| angle of incidence | 入射角 | | | |
| angle of reflection | 反射角 | | | |
| total internal reflection | 全反射 | | | |
| optical fibres | 光纤 | | | |
| electromagnetic waves | 电磁波 | | | |
| medium | 介质 | | | |

## Recall

From Part 1 you can describe a wave. **Light** 光 and **sound** 声音 are waves too. Here we look at how light reflects and bends, and at the family of **electromagnetic** 电磁 waves.

- Light reflects off mirrors and bends through glass.
- Light is one member of a big family of waves.

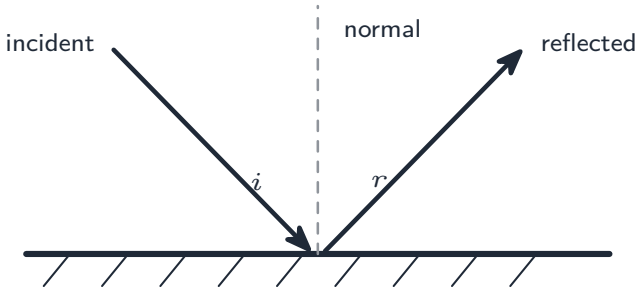
Nothing here is hard – it just adds the rules.

## New ideas

Read these first, then do the Practice.

### ■ 1 Reflection

Angles are measured from the **normal** 法线 (a line at 90° to the surface). The **law of reflection**: the **angle of incidence** 入射角 equals the **angle of reflection** 反射角.



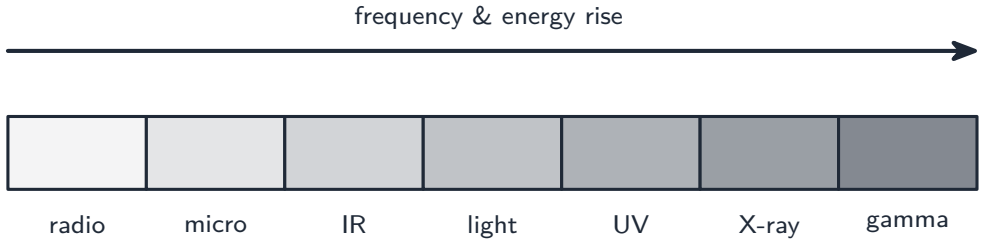

### ■ 2 Refraction

When light passes into a new material it changes **speed** and **bends**. Going from air **into** glass it slows down and bends **towards** the normal. The **refractive index** is $n = \dfrac{\sin i}{\sin r}$.

When light tries to leave glass at too steep an angle, it cannot get out and reflects completely – **total internal reflection** 全反射. This is how **optical fibres** 光纤 carry light signals.

### ■ 3 The electromagnetic spectrum

All **electromagnetic waves** 电磁波 travel at the same speed in a vacuum ($3.0 \times 10^8$ m/s). In order of rising frequency:




From radio waves to gamma rays, the **wavelength falls** while the **frequency and energy rise**.

### ■ 4 Sound

**Sound** 声音 is a **longitudinal wave** made by a vibrating object. It needs a **medium** 介质, so it cannot travel through a vacuum.

**Watch out:** angles are always measured from the **normal** (the 90° line), not from the surface. All electromagnetic waves travel at the **same** speed in a vacuum – what changes across the spectrum is the wavelength and frequency.

## Practice

Try these in order.

**3.1** State the law of reflection. [1]

**3.2** From which line are angles of incidence and reflection measured? [1]

**3.3** Going from air into glass, does light bend towards or away from the normal? [1]

**3.4** Name the effect used in optical fibres to keep light inside. [1]

**3.5** List, in order of **rising frequency**: infrared, radio waves, X-rays, visible light. [2]

**3.6** Why can sound not travel through a vacuum? [1]

**3.7 Challenge.** Light hits a mirror with an angle of incidence of 35°. State (a) the angle of reflection and (b) the angle between the incident and reflected rays. [2]

Name:

IGCSE Physics: **s24 21**

**1** Which region of the electromagnetic spectrum is used for detecting fake bank notes?

**A** radio

**B** microwaves

**C** ultraviolet

**D** X-rays

IGCSE Physics: **w23 21**

**2** A radio transmitter broadcasts at a frequency of 200 kHz.

What is the wavelength of these radio waves?

**A** $6.7 \times 10^{-4}$ m **B** 1.5 m **C** $1.5 \times 10^{3}$ m **D** $1.5 \times 10^{6}$ m

IGCSE Physics: **s23 21**

**3** Visible light has wavelengths in the range $4.0 \times 10^{-7}$ m to $7.0 \times 10^{-7}$ m.

What is the range of the frequencies of visible light?

**A** 0.12 Hz to 0.21 Hz

**B** 120 Hz to 210 Hz

**C** $4.3 \times 10^{11}$ Hz to $7.5 \times 10^{11}$ Hz

**D** $4.3 \times 10^{14}$ Hz to $7.5 \times 10^{14}$ Hz

Name:

IGCSE Physics: **w25 22**

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

Which statement correctly compares a compression with a rarefaction?

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

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

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

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

IGCSE Physics: **s24 21**

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

What is the frequency of the sound wave?

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

**3** Which waves are used in the medical scanning of soft tissue?

**A** gamma rays

**B** infrared

**C** microwaves

**D** ultrasound

IGCSE Physics: **s23 21**

**4** Student X fires a starting pistol which produces smoke and sound. Student Y is standing 100 m away and sees the smoke the instant it is produced. The speed of sound in air is 340 m / s.

What is the time delay between student Y seeing the smoke and hearing the sound?

**A** 0.29 s **B** 0.59 s **C** 1.7 s **D** 3.4 s

# 4 Magnetism and static – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) |
|---|---|---|
| magnets | 磁体 | |
| static electricity | 静电 | |
| magnet | 磁体 | |
| poles | 磁极 | |
| repel | 排斥 | |
| attract | 吸引 | |
| magnetic materials | 磁性材料 | |
| magnetic field | 磁场 | |
| field lines | 磁场线 | |
| charges | 电荷 | |
| electrons | 电子 | |
| conductor | 导体 | |
| insulator | 绝缘体 | |

## Recall

You have played with **magnets** 磁体 and felt the spark of **static electricity** 静电. The IGCSE course explains both with simple rules.

- Every magnet has a **north** and a **south** pole.
- Electric charge comes in two kinds: positive and negative.

Nothing here is hard – it just adds the rules.

## New ideas

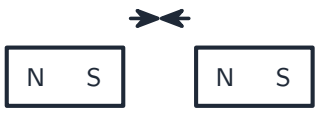
Read these first, then do the Practice.

### ■ 1 Magnetic poles

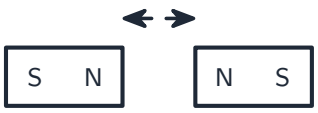
Every **magnet** 磁体 has two **poles** 磁极: north (N) and south (S). The rule:

- **same** poles (N–N or S–S) **repel** 排斥 (push apart).
- **different** poles (N–S) **attract** 吸引 (pull together).

A magnet attracts **magnetic materials** 磁性材料 – iron, steel, cobalt, nickel – but not copper, plastic or wood.



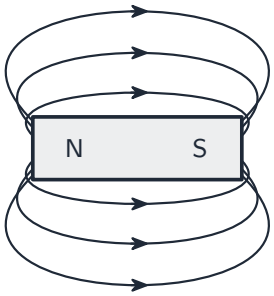
N–S attract



N–N repel

### ■ 2 Magnetic fields

A **magnetic field** 磁场 is a region where a pole feels a force. We draw **field lines** 磁场线 that come **out of N** and go **into S**. Closer lines = stronger field.



### ■ 3 Static electricity

There are two **charges** 电荷: positive and negative (same rule – like repel, unlike attract). Rubbing two materials moves tiny negative **electrons** 电子 from one to the other:

- the material that **gains** electrons becomes **negative**.
- the material that **loses** electrons becomes **positive**.

A **conductor** 导体 (metal) lets charge flow; an **insulator** 绝缘体 (plastic) does not.

**Watch out:** field lines always run **out of N and into S** – never the other way. Rubbing only ever moves **electrons** (negative): the material that *gains* electrons becomes negative, the one that *loses* them becomes positive.

## Practice

Try these in order.

**4.1** State the rule for two magnetic poles. [2]

**4.2** Name two magnetic materials. [1]

**4.3** Which way do magnetic field lines point – out of which pole, into which? [1]

**4.4** A plastic rod is rubbed with a cloth and becomes negative. Explain what happened to the electrons. [2]

**4.5** State the difference between a conductor and an insulator. [2]

**4.6 Challenge.** Two plastic rods are each rubbed with a cloth and both become negatively charged. State and explain what happens when they are brought close together. [2]

Name:

IGCSE Physics: **w25 22**

**1** Which statements about magnets are correct?

1 Permanent magnets are made of steel.

2 Electromagnets are temporary magnets.

3 A magnet can be used to induce magnetism in an iron bar.

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

IGCSE Physics: **s24 21**

**2** Which row describes suitable materials for use in a temporary magnet and in a permanent magnet?

| | temporary magnet | permanent magnet |
|---|---|---|
| **A** | soft iron | soft iron |
| **B** | soft iron | steel |
| **C** | steel | soft iron |
| **D** | steel | steel |

IGCSE Physics: **w23 21**

**3** Which metal could be used for a permanent magnet and which metal could be used for the core of an electromagnet?

| | permanent magnet | core of electromagnet |
|---|---|---|
| **A** | iron | copper |
| **B** | iron | steel |
| **C** | steel | copper |
| **D** | steel | iron |

# 4 Electric circuits – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| English | 中文 | Write it 3 times (English) | | |
|---|---|---|---|---|
| electric current | 电流 | | | |
| circuits | 电路 | | | |
| amperes | 安培 | | | |
| volts | 伏特 | | | |
| current | 电流 | | | |
| ammeter | 电流表 | | | |
| voltage | 电压 | | | |
| voltmeter | 电压表 | | | |
| resistance | 电阻 | | | |
| ohms | 欧姆 | | | |
| Power | 功率 | | | |
| watts | 瓦特 | | | |
| series | 串联 | | | |
| parallel | 并联 | | | |

## Recall

From Part 1 you know charge can flow through a conductor. A flow of charge is an **electric current** 电流. Here we look at simple **circuits** 电路 and the key electrical quantities.

- Current is measured in **amperes** 安培 (A).
- Voltage is measured in **volts** 伏特 (V).

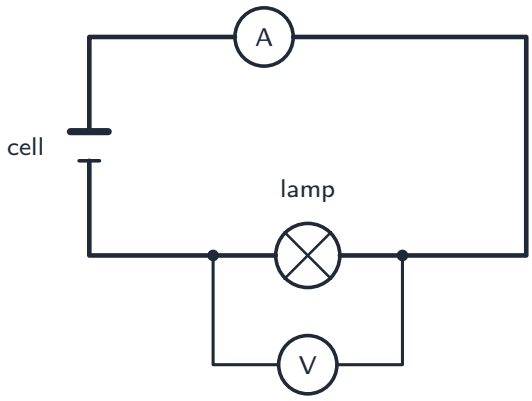
Nothing here is hard – it just adds three equations.

## New ideas

Read these first, then do the Practice.

### 1 Current, voltage and resistance

- **current** 电流 ($I$) is the charge that passes each second: $I = \dfrac{Q}{t}$. Measured with an **ammeter** 电流表 (in series).
- **voltage** 电压 ($V$) is the energy given to each unit of charge. Measured with a **voltmeter** 电压表 (in parallel).
- **resistance** 电阻 ($R$) is how hard it is for current to flow: $R = \dfrac{V}{I}$ (in **ohms** 欧姆, Ω).




*Worked example.* A 12 V battery drives 0.50 A through a lamp: $R = V/I = 12/0.50 = 24\ \Omega$.

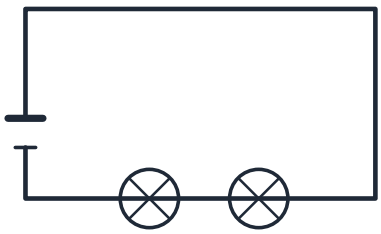
### 2 Electrical power

**Power** 功率 is the energy transferred each second (in **watts** 瓦特, W):

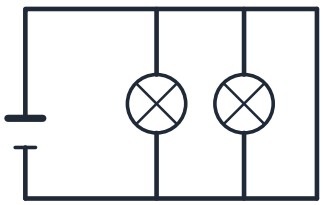
$$P = IV$$

### ■ 3 Series and parallel

- in a **series** 串联 circuit (one loop): the current is the **same** everywhere; the voltage is **shared**; resistances **add up**.
- in a **parallel** 并联 circuit (separate branches): each branch gets the **full** voltage; the current **splits**.



series



parallel

Home lamps are wired in **parallel**, so each gets full voltage and one can fail without the others going off.

**Watch out:** an **ammeter** goes *in series* (it measures the current passing through); a **voltmeter** goes *in parallel*, across the component. In a series circuit the current is the same everywhere – it only **splits** in parallel.

## Practice

Try these in order.

**4.1** Write the equation linking current, charge and time. [1]

**4.2** A current of 3.0 A flows for 20 s. Calculate the charge that passes. [2]

**4.3** A 6.0 V supply drives 0.30 A through a resistor. Calculate its resistance. [2]

**4.4** A lamp runs at 12 V and 2.0 A. Calculate its power. [2]

**4.5** In a series circuit, what is true about the current at every point? [1]

---

**4.6** Why are the lamps in a house wired in parallel? [2]

**4.7 Challenge.** A 230 V hairdryer has a power of 1150 W. Calculate the current it draws. [2]

**1** An electrical appliance has a symbol on it to indicate it is double-insulated.

Which statement is correct?

**A** A two-core, flexible cable with **no** earth wire is used to connect it to the mains supply.

**B** It needs an earth wire that is connected to a fuse.

**C** **No** fuse or circuit breaker is needed.

**D** The cable should be connected to the live and earth connectors of the plug but **not** the neutral.

# 5 The atom – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| atoms | 原子 | | | |
| nucleus | 原子核 | | | |
| electrons | 电子 | | | |
| neutral | 中性 | | | |
| protons | 质子 | | | |
| neutrons | 中子 | | | |
| orbits | 轨道 | | | |
| mass | 质量 | | | |
| proton number | 质子数 | | | |
| nucleon number | 核子数 | | | |
| ion | 离子 | | | |
| Isotopes | 同位素 | | | |

## Recall

Everything is made of **atoms** 原子. The IGCSE course looks inside the atom – at its tiny **nucleus** 原子核 and the **electrons** 电子 around it.

- The nucleus is positive; the electrons are negative.
- The whole atom is **neutral** 中性 (the charges balance).

Nothing here is hard – it just names the parts.

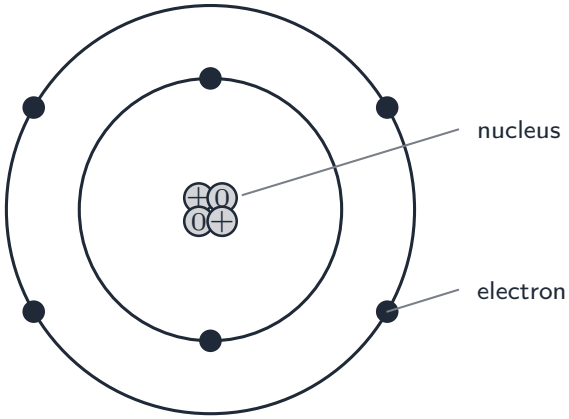
## New ideas

Read these first, then do the Practice.

### 1 Inside the atom

- the tiny central **nucleus** 原子核 holds **protons** 质子 (charge +1) and **neutrons** 中子 (charge 0).
- **electrons** 电子 (charge −1) move around it in **orbits** 轨道.

Almost all the **mass** 质量 is in the nucleus, but the atom is mostly empty space.




### 2 Proton number and nucleon number

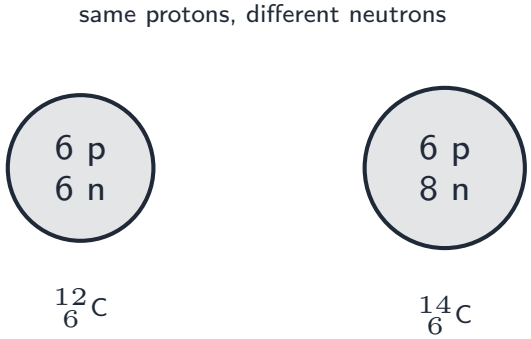
- the **proton number** 质子数 ($Z$) is the number of protons.
- the **nucleon number** 核子数 ($A$) is the number of protons **plus** neutrons.

So the number of neutrons is $A - Z$. We write a nucleus as ${}^{A}_{Z}\mathrm{X}$.

An atom can gain or lose electrons to become an **ion** 离子 (lose → positive, gain → negative).

### 3 Isotopes

**Isotopes** 同位素 are atoms of the **same** element (same $Z$) with **different** numbers of neutrons (different $A$).




**Watch out:** the proton number $Z$ counts only protons; the nucleon number $A$ counts protons **plus** neutrons – so neutrons $= A - Z$, never just $A$. Isotopes share $Z$ (same element) but differ in $A$.

## Practice

Try these in order.

**5.1** Name the two particles found in the nucleus. [2]

**5.2** What is the charge on (a) a proton, (b) an electron? [2]

**5.3** A nucleus is written $^{197}_{79}$Au. How many (a) protons, (b) neutrons does it have? [2]

**5.4** An atom loses an electron. What kind of ion does it become? [1]

**5.5** What is meant by *isotopes*? [2]

**5.6 Challenge.** An atom of $^{23}_{11}\text{Na}$ loses one electron to become an ion. State the number of (a) protons, (b) neutrons and (c) electrons in this ion. [3]

# 5 Radioactivity – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| unstable | 不稳定 | | | |
| radiation | 辐射 | | | |
| radioactive decay | 放射性衰变 | | | |
| random | 随机 | | | |
| spontaneous | 自发 | | | |
| ionising | 电离 | | | |
| paper | 纸 | | | |
| aluminium | 铝 | | | |
| lead | 铅 | | | |
| penetrating | 穿透 | | | |
| half-life | 半衰期 | | | |
| cells | 细胞 | | | |
| dose | 剂量 | | | |
| shielding | 屏蔽 | | | |

## Recall

From Part 1 you know some nuclei are **unstable** 不稳定. An unstable nucleus breaks down and gives out **radiation** 辐射 – this is **radioactive decay** 放射性衰变.

- Decay is **random** 随机 and **spontaneous** 自发 (you cannot speed it up or slow it down).
- There are three types of radiation.

Nothing here is hard – it just compares the three types.

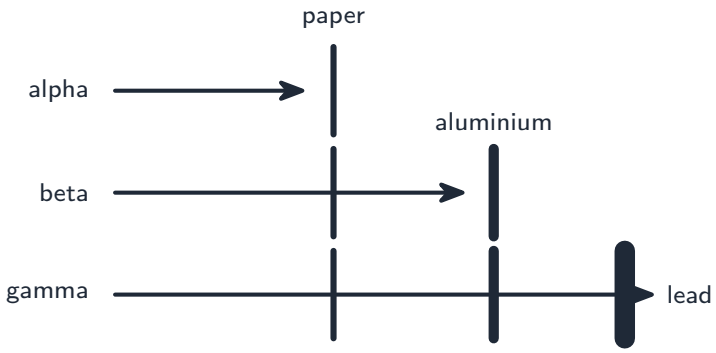
## New ideas

Read these first, then do the Practice.

### ■ 1 Three types of radiation

All three are **ionising** 电离 (they knock electrons off atoms):

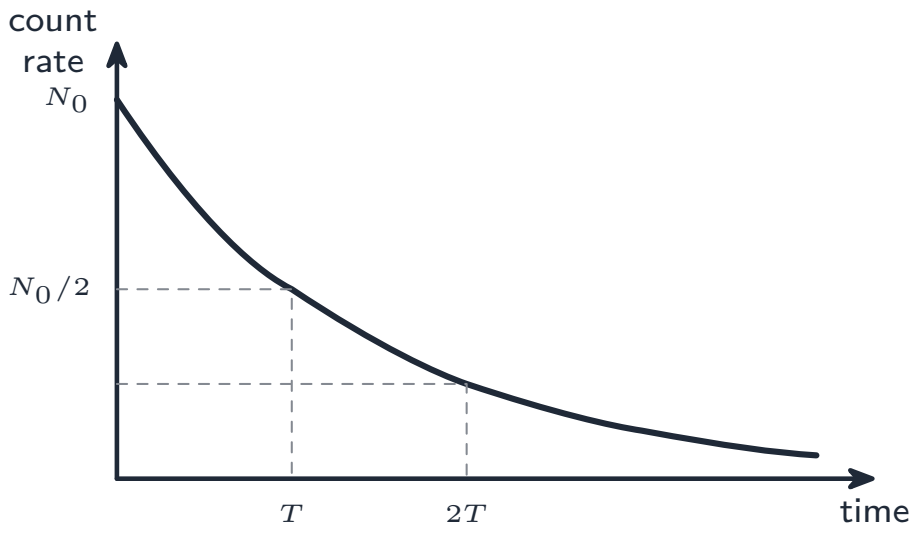
| Type | What it is | Stopped by |
|---|---|---|
| alpha ($\alpha$) | a helium nucleus (charge +2) | a sheet of **paper** 纸 |
| beta ($\beta$) | a fast electron (charge −1) | a few mm of **aluminium** 铝 |
| gamma ($\gamma$) | a high-energy wave (no charge) | thick **lead** 铅 (only reduced) |




So alpha is the most **ionising** but least **penetrating** 穿透; gamma is the least ionising but most penetrating.

### ■ 2 Half-life

The **half-life** 半衰期 is the time for **half** the unstable nuclei in a sample to decay. After each half-life the count rate falls to half.




### 3 Safety

Radiation harms living **cells** 细胞. Keep the **dose** 剂量 low by: **less time** near the source, **more distance**, and **shielding** 屏蔽 (such as lead).

**Watch out:** alpha is the most **ionising** but the *least* **penetrating**; gamma is the opposite. A half-life **halves** the count rate – after two half-lives the rate is a *quarter*, not zero.

## Practice

Try these in order.

**5.1** Name the three types of radiation. [3]

**5.2** Which type is stopped by a sheet of paper? [1]

**5.3** Which type is the most penetrating? [1]

**5.4** Define the *half-life* of a radioactive isotope. [1]

**5.5** A source has a count rate of 800 counts/min and a half-life of 3 hours. What is the count rate after 6 hours? [2]

**5.6** State two ways to reduce the radiation dose you receive. [2]

**5.7 Challenge.** A sample starts at 1600 counts/min and has a half-life of 2 hours. After how many hours will the count rate fall to 200 counts/min? [3]

# 6 The Earth and the Solar System – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| Sun | 太阳 | | | |
| Moon | 月球 | | | |
| orbits | 轨道 | | | |
| rotates | 自转 | | | |
| tilted | 倾斜 | | | |
| seasons | 季节 | | | |
| phases | 月相 | | | |
| Solar System | 太阳系 | | | |
| eight planets | 行星 | | | |
| rocky | 岩石 | | | |
| gaseous | 气态 | | | |
| gravity | 引力 | | | |

## Recall

You see the **Sun** 太阳 cross the sky each day and the **Moon** 月球 change shape each month. The IGCSE course explains these with **orbits** 轨道 and spinning.

- The Earth **spins** on its axis and **orbits** the Sun.
- The Moon orbits the Earth.

Nothing here is hard – it just lines up the motions.

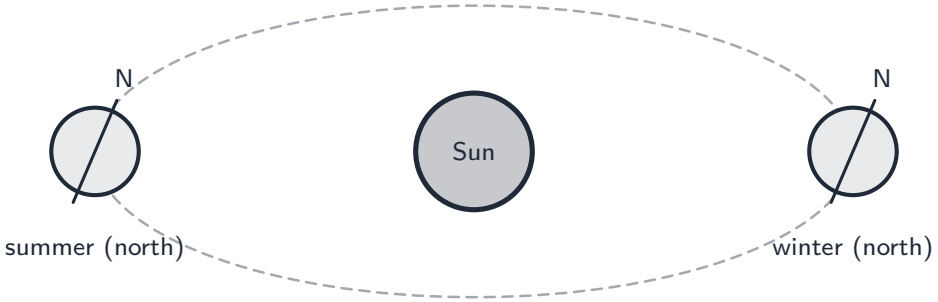
## New ideas

Read these first, then do the Practice.

### 1 Day, year and seasons

- the Earth **spins** (**rotates** 自转) once in about **24 hours** → this gives **day and night**.
- the Earth **orbits** the Sun once in about **365 days** → this is one **year**.

The Earth's axis is **tilted** 倾斜, so each half of the Earth leans towards the Sun for part of the orbit – this gives the **seasons** 季节 (summer when it leans towards the Sun).




### 2 The Moon and its phases

The Moon orbits the Earth once in about a **month**. Its lit half always faces the Sun, so as it goes round we see different amounts – the **phases** 月相 (new moon, half moon, full moon).

So, shortest to longest: **day** (Earth spin) < **month** (Moon orbit) < **year** (Earth orbit).

### 3 The Solar System

The **Solar System** 太阳系 has the Sun at its centre and **eight planets** 行星 around it (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune). The four inner ones are small and **rocky** 岩石; the four outer ones are large and **gaseous** 气态.




The Sun's **gravity** 引力 reaches out and keeps the planets in their orbits.

**Watch out:** the Earth **spinning** gives day and night (24 h); the Earth **orbiting** gives the year (365 days) – two different motions. The seasons come from the *tilt* of the axis, not from the Earth being closer to the Sun.

## Practice

Try these in order.

**6.1** What causes day and night? [1]

**6.2** About how long does the Earth take to orbit the Sun once? [1]

**6.3** Why does the Earth have seasons? [2]

**6.4** Put these in order from shortest to longest: a year, a day, a month. [1]

**6.5** What holds the planets in their orbits around the Sun? [1]

**6.6** State one difference between the inner and the outer planets. [1]

**6.7 Challenge.** It is summer in the northern hemisphere. State the season in the southern hemisphere at the same time, and explain why. [2]

# 6 Stars and the Universe – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary 词汇

*Write each word three times.* 把每个单词抄写三遍。

| **English** | **中文** | **Write it 3 times** (English) |
|---|---|---|
| Sun | 太阳 | |
| star | 恒星 | |
| Universe | 宇宙 | |
| hydrogen | 氢 | |
| helium | 氦 | |
| nuclear fusion | 核聚变 | |
| galaxy | 星系 | |
| Milky Way | 银河系 | |
| light-years | 光年 | |
| nebula | 星云 | |
| mass | 质量 | |
| red giant | 红巨星 | |
| white dwarf | 白矮星 | |
| supernova | 超新星 | |
| wavelength | 波长 | |

| English | 中文 | **Write it 3 times** (English) | | |
|---|---|---|---|---|
| redshift | 红移 | | | |
| expanding | 膨胀 | | | |
| Big Bang | 大爆炸 | | | |

## Recall

From Part 1 you know the Sun is at the centre of the Solar System. The **Sun** 太阳 is a **star** 恒星 – and there are billions more. Here we look at stars and the whole **Universe** 宇宙.

- A star makes energy by joining nuclei together.
- Stars are born, live and die.

Nothing here is hard – it just tells the story.

## New ideas

Read these first, then do the Practice.

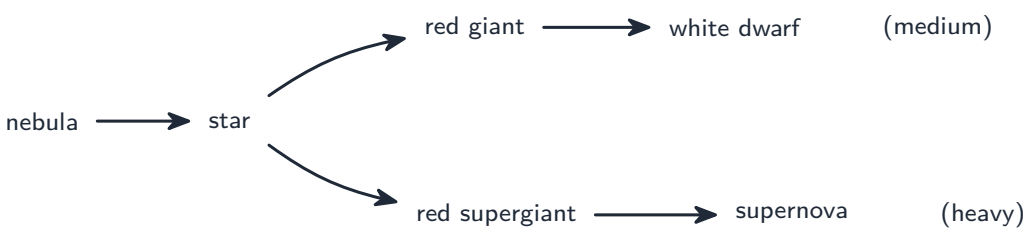
### 1 The Sun as a star

The Sun is a medium **star** 恒星, made mostly of **hydrogen** 氢 and **helium** 氦. Its energy comes from **nuclear fusion** 核聚变: hydrogen nuclei join to make helium, releasing huge energy.

A **galaxy** 星系 is billions of stars held together by gravity. Our Sun is one star in the **Milky Way** 银河系. Distances between stars are measured in **light-years** 光年 (the distance light travels in a year).

### 2 The life cycle of a star

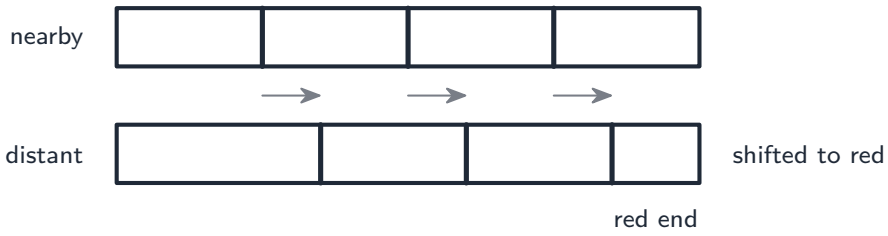
A star forms from a cloud of gas and dust (a **nebula** 星云), then lives as a stable star, then dies. What happens at the end depends on its **mass** 质量:



A medium star (like the Sun) becomes a **red giant** 红巨星, then a **white dwarf** 白矮星. A heavy star explodes as a **supernova** 超新星.

### ■ 3 The expanding Universe

Light from distant galaxies is shifted to a longer **wavelength** 波长 (towards red) – this is **redshift** 红移. The further a galaxy, the bigger its redshift, so galaxies are moving apart: the **Universe** 宇宙 is **expanding** 膨胀.




Running this backwards, everything started together – the **Big Bang** 大爆炸 theory.

**Watch out:** a star's energy comes from **nuclear fusion** (small nuclei *joining*), not from burning. Redshift means a galaxy's light is stretched to **longer** wavelengths as it moves *away* – the bigger the redshift, the faster and further the galaxy.

## Practice

Try these in order.

**6.1** What is the Sun mostly made of? [1]

**6.2** Name the process that makes the Sun's energy. [1]

**6.3** What is a *galaxy*? [1]

**6.4** Name the stage a medium star (like the Sun) swells into near the end of its life. [1]

**6.5** What is *redshift*, and what does it tell us about the galaxies? [2]

**6.6** Name the theory that says the Universe started from a single point. [1]

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**6.7 Challenge.** The light from a distant galaxy shows a **large** redshift. State what this tells you about (a) the galaxy's motion and (b) its distance compared with a galaxy of small redshift. [2]