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.

Contents 目录

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.

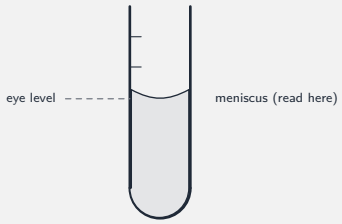
Nothing here is hard —it just lines up the basics.

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.

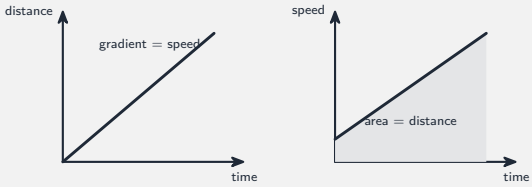
3 Speed and acceleration

- **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]

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**

1 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**

1 Which is a vector quantity?

A density

B mass

C pressure

D weight

IGCSE Physics: **w25 22**

2 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**

7 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**

2 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**

3 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**

4 Which measuring instrument is used to compare masses?

A balance

B protractor

C stop-watch

D voltmeter

IGCSE Physics: **s24 21**

2 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.

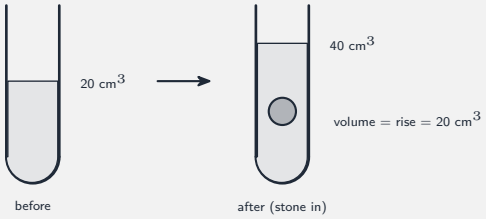
New ideas

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: $\rho = \dfrac{m}{V}$.

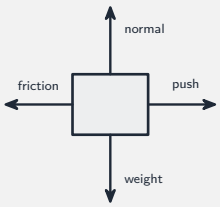
For an odd shape, find the volume by the **displacement method** 排水法—the rise in water level.



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]

4 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 $5.2\,g/cm^3$

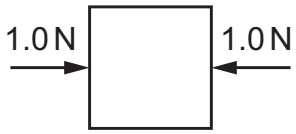
C $190\,g/cm^3$

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

5 Four objects each have two forces acting on them.

Which object is in equilibrium?

A



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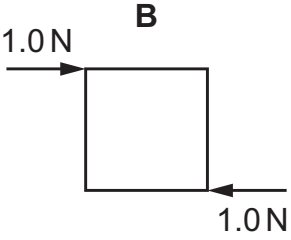

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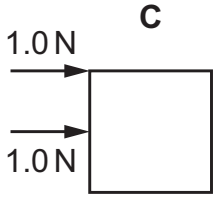
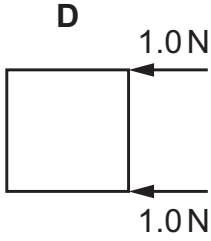


D



IGCSE Physics: **w25 21**

7 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**

6 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**

7 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

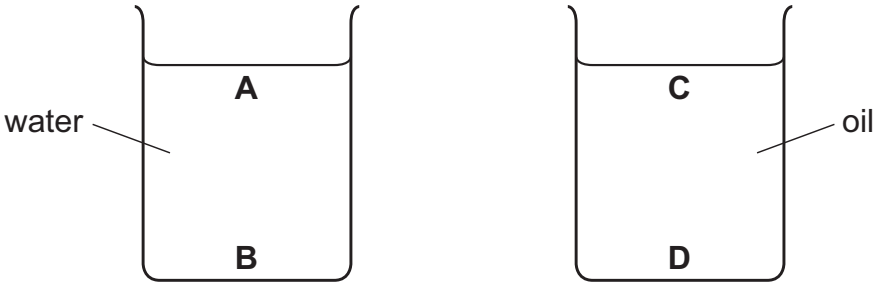
C 1.4 m / s in the opposite direction to Y

D 1.4 m / s in the same direction as Y

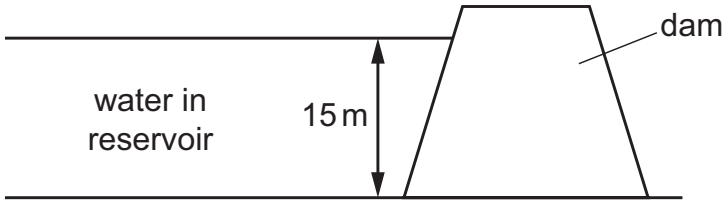
9 Two beakers are filled to the same depth, one with water and one with oil.

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?



13 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.

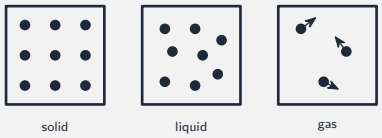
Nothing here is hard —it just adds the particle model.

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



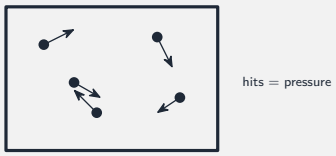
2 Temperature and energy

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.

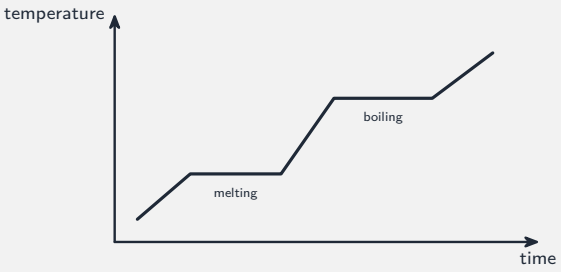
■

- **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.

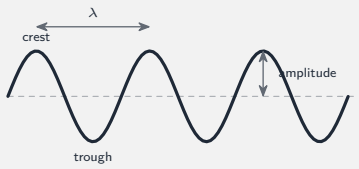
Nothing here is hard —it just adds the words and one equation.

New ideas

Read these first, then do the Practice.

1 Describing a wave

- **wavelength** 波长 (λ) —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).

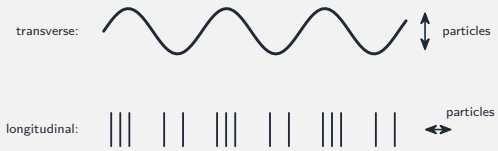


These link by the **wave equation**: $v = f\lambda$.

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]

IGCSE Physics: **w25 22**

17 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 1.3×10^{-4} m **B** 2.1×10^{-4} m **C** 4.8×10^{3} m **D** 7.5×10^{3} m

IGCSE Physics: **s24 21**

16 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**

18 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.

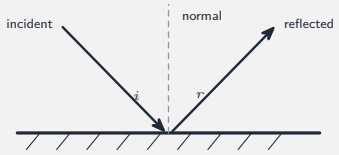
Nothing here is hard —it just adds the rules.

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.



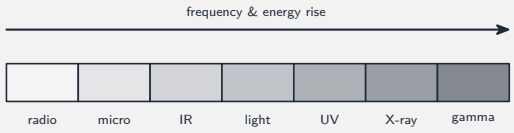
■ 2 Refraction

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 (3.0×10^8 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]

IGCSE Physics: **s24 21**

21 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**

22 A radio transmitter broadcasts at a frequency of 200 kHz.

What is the wavelength of these radio waves?

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

IGCSE Physics: **s23 21**

21 Visible light has wavelengths in the range 4.0×10^{-7} m to 7.0×10^{-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 4.3×10^{11} Hz to 7.5×10^{11} Hz

D 4.3×10^{14} Hz to 7.5×10^{14} Hz

IGCSE Physics: **w25 22**

23 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**

22 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

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

A gamma rays

B infrared

C microwaves

D ultrasound

IGCSE Physics: **s23 21**

22 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

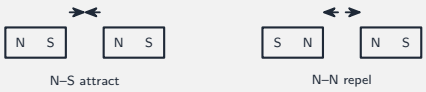
Read these first, then do the Practice.

1 Magnetic poles

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

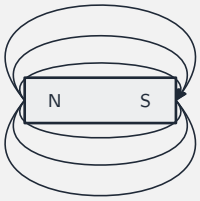
- **same** poles (N–N or S–S) **repel** 排斥 (push apart).
- **different** poles (N–S) **attract** 吸引 (pull together).

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



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]

IGCSE Physics: **w25 22**

24 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**

24 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**

24 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).

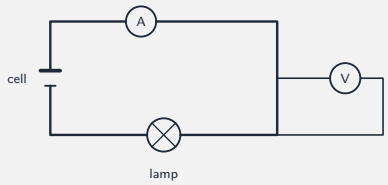
Nothing here is hard —it just adds three equations.

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: $R = V/I = 12/0.50 = 24\ \Omega$.

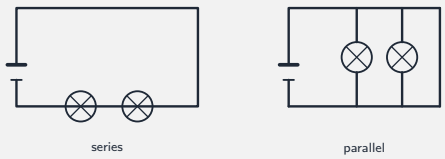
2 Electrical power

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**.



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]

29 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.

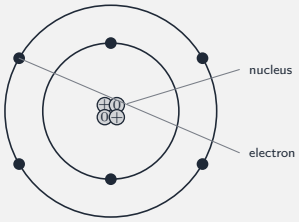
New ideas

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

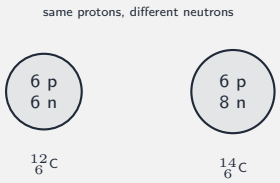
- the **proton number** 质子数 (Z) is the number of protons.
- the **nucleon number** 核子数 (A) is the number of protons **plus** neutrons.

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 $^{197}_{79}\text{Au}$. 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.

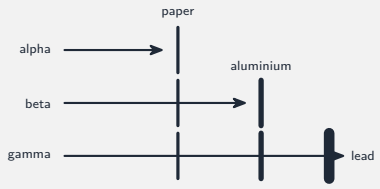
New ideas

Read these first, then do the Practice.

■ 1 Three types of radiation

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

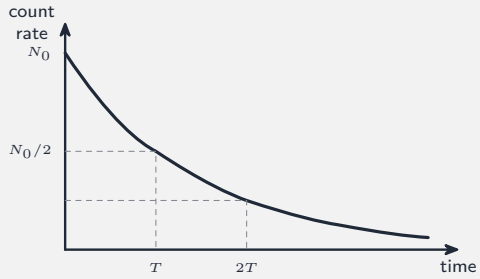
Type	What it is	Stopped by
alpha (α)	a helium nucleus (charge +2)	a sheet of **paper** 纸
beta (β)	a fast electron (charge −1)	a few mm of **aluminium** 铝
gamma (γ)	a high-energy wave (no charge)	thick **lead** 铅 (only reduced)



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.

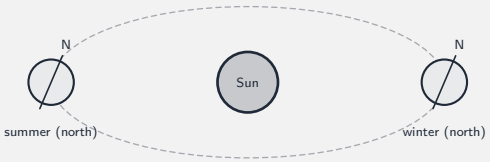
New ideas

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.

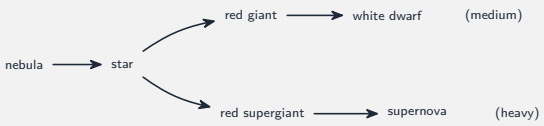
1 The Sun as a star

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

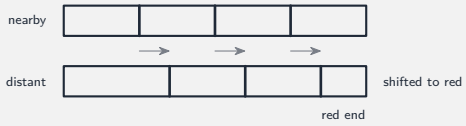
A star forms from a cloud of gas and dust (a **nebula** 星云), then lives as a stable star, then dies. What happens at the end depends on its **mass** 质量:



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]

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]