

HOLIDAY HOMEWORK

IGCSE Physics

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

: + °

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

Contents

1	Measurement and motion	3
2	States of matter	17
3	Waves	25
4	Magnetism and static	35
5	The atom	45
6	The Earth and the Solar System	53

1 Measurement and motion – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	Write it 3 times (English)		
length	_____	_____	_____
time	_____	_____	_____
mass	_____	_____	_____
ruler	_____	_____	_____
measuring cylinder	_____	_____	_____
meniscus	_____	_____	_____
pendulum	_____	_____	_____
speed	_____	_____	_____
acceleration	_____	_____	_____
distance–time	_____	_____	_____
gradient	_____	_____	_____
speed–time	_____	_____	_____

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** in metres, **time** in seconds, **mass** in kilograms.

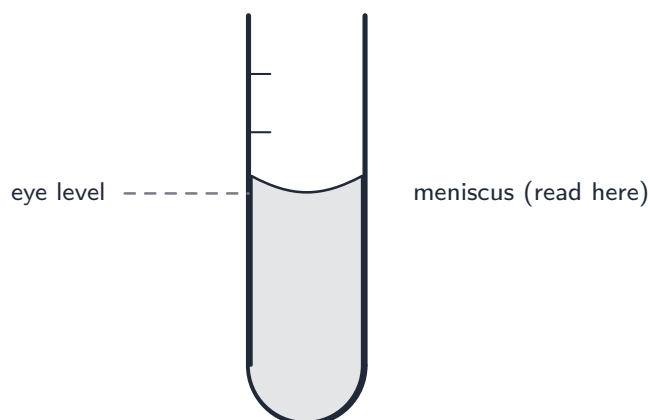
Nothing here is hard — it just lines up the basics.

New ideas

Read these first, then do the Practice.

■ 1 Measuring length and volume

- use a **ruler** for length; put your eye straight in front of the mark.
- use a **measuring cylinder** for the volume of a liquid; read the scale at the bottom of the curve (the **meniscus**), 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** → time 20 swings, divide by 20.

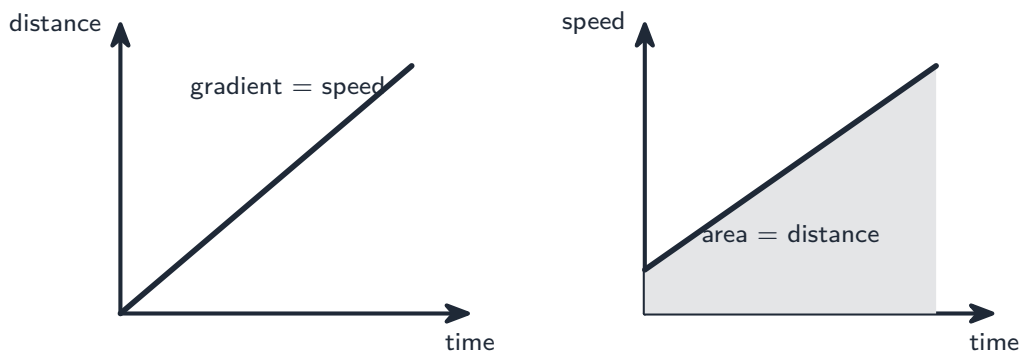
■ 3 Speed and acceleration

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

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

■ 4 Motion graphs

- **distance–time** : a flat line = at rest; a slope = constant speed (the **gradient** is the speed).
- **speed–time** : 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]

1 Which quantities are both vectors?

☐

- A** acceleration and force
- B** acceleration and pressure
- C** density and force
- D** density and pressure

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

3 Which is a vector quantity?

☐

- A** density
- B** mass
- C** pressure
- D** weight

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.

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

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

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.

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

2 Which measuring instrument is used to compare masses?

- ☐ **A** balance
B protractor
C stop-watch
D voltmeter

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

- ☐ **A** density
B mass
C volume
D weight

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

Write each word three times.

English	Write it 3 times (English)		
forces	_____	_____	_____
energy	_____	_____	_____
pressure	_____	_____	_____
mass	_____	_____	_____
weight	_____	_____	_____
density	_____	_____	_____
displacement method	_____	_____	_____
resultant force	_____	_____	_____
work done	_____	_____	_____
joules	_____	_____	_____
kinetic energy	_____	_____	_____
pascals	_____	_____	_____

Recall

From Part 1 you can measure and describe motion. Here we look at **forces**, **energy** and **pressure** — 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.

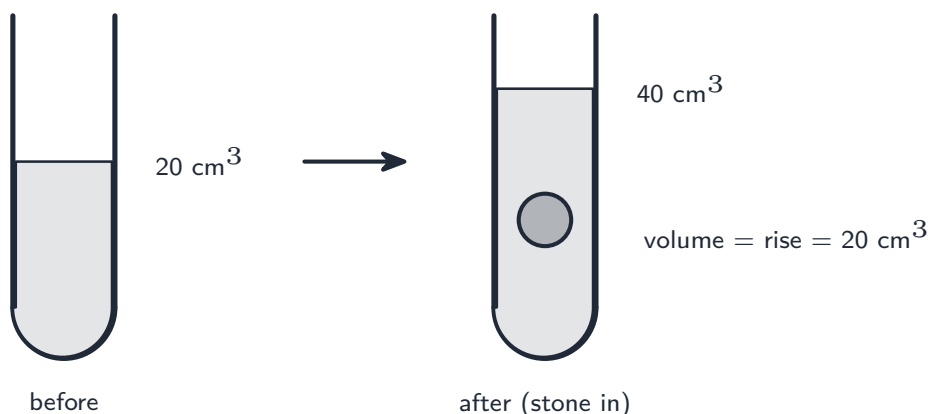
New ideas

Read these first, then do the Practice.

■ 1 Mass, weight and density

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

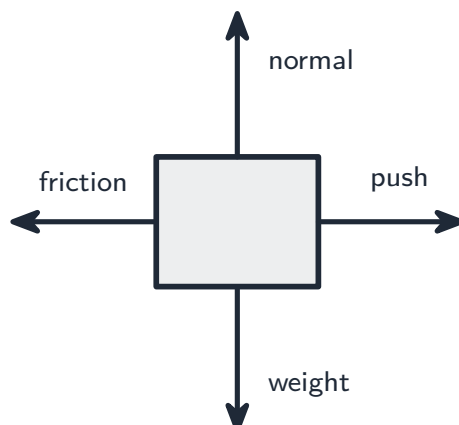
For an odd shape, find the volume by the **displacement method** — the rise in water level.



■ 2 Forces and $F = ma$

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

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



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

■ 3 Energy, work and pressure

- **work done** = energy transferred: $W = Fd$ (in **joules**, J).
- **kinetic energy** : $E_k = \frac{1}{2}mv^2$.
- **pressure** = force per area: $p = \frac{F}{A}$ (in **pascals**, 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 $g = 10 \text{ N/kg}$.

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 cm³. 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 m². 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 $5.2 \times 10^{-3} \text{ g/cm}^3$

B 5.2 g/cm^3

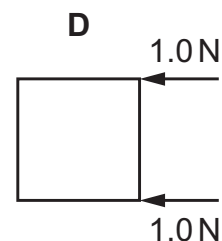
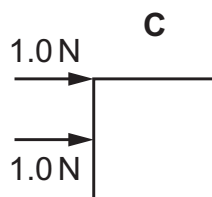
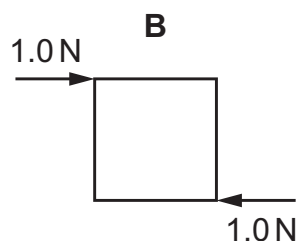
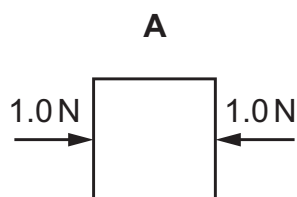
C 190 g/cm^3

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

2 Four objects each have two forces acting on them.

☐

Which object is in equilibrium?



- 1 The momentum of a car changes from $10\,000\text{ kg m/s}$ to $15\,000\text{ kg m/s}$ in a time of 8.0 s .

☐ What is the resultant force acting on the car?

- A** 630 N **B** 3100 N **C** $40\,000\text{ N}$ **D** $200\,000\text{ N}$

- 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** $m(v_2 - v_1)$

- 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?

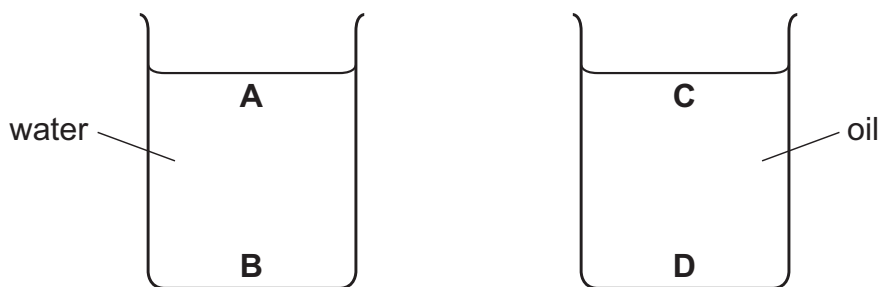
- A** 0.60 m/s in the opposite direction to Y
B 0.60 m/s in the same direction as Y
C 1.4 m/s in the opposite direction to Y
D 1.4 m/s in the same direction as Y

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

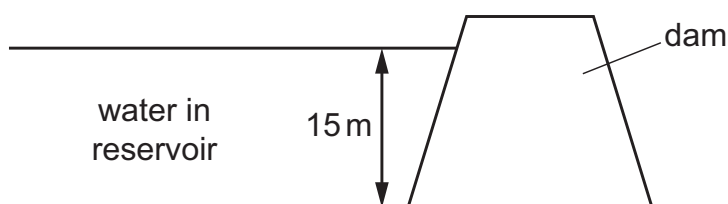
☐

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?



- 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** 15000 Pa **D** 150 000 Pa

2 States of matter – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	Write it 3 times (English)		
solid	_____	_____	_____
liquid	_____	_____	_____
gas	_____	_____	_____
particles	_____	_____	_____
vibrate	_____	_____	_____
kinetic energy	_____	_____	_____
Temperature	_____	_____	_____
absolute zero	_____	_____	_____
pressure	_____	_____	_____

Recall

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

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

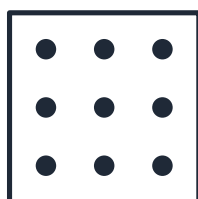
Nothing here is hard — it just adds the particle model.

New ideas

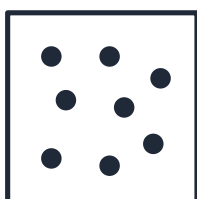
Read these first, then do the Practice.

■ 1 The three states

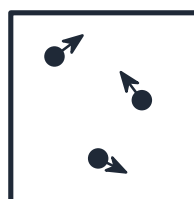
State	Shape	Particles
solid	fixed	close, in a pattern, just vibrate
liquid	takes the container's shape	close, slide past each other
gas	fills the container	far apart, fast, random



solid



liquid



gas

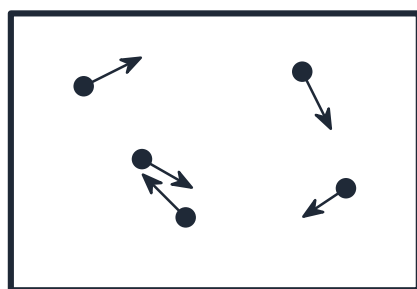
■ 2 Temperature and energy

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

The lowest possible temperature is **absolute zero** , -273°C .

■ 3 Gas pressure

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



hits = pressure

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

Write each word three times.

English	Write it 3 times (English)		
conduction	_____	_____	_____
convection	_____	_____	_____
radiation	_____	_____	_____
infrared	_____	_____	_____
Melting	_____	_____	_____
boiling	_____	_____	_____
Evaporation	_____	_____	_____

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.

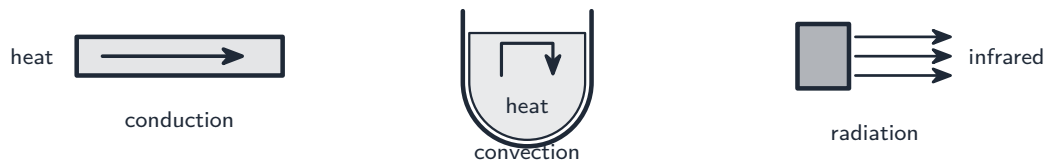
Nothing here is hard — it just names the three ways.

New ideas

Read these first, then do the Practice.

■ 1 Three ways heat moves

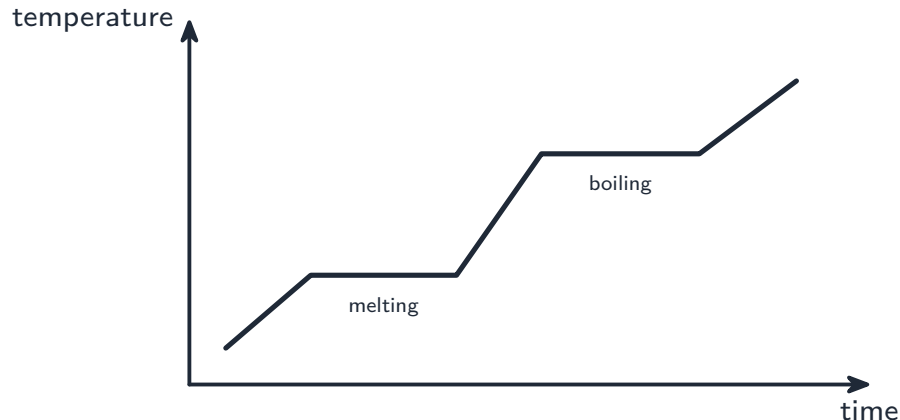
- **conduction** — through a solid; vibrating particles pass energy to their neighbours. **Metals** are good conductors (free electrons carry energy).
- **convection** — in a liquid or gas; heated fluid expands, becomes less dense and **rises**, while cooler fluid sinks (a **convection current**).
- **radiation** — by **infrared** 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 and **boiling** need energy, but the **temperature stays the same** while the state changes — the energy breaks the forces between particles.



Evaporation 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

Write each word three times.

English	Write it 3 times (English)		
wave	_____	_____	_____
energy	_____	_____	_____
wavelength	_____	_____	_____
amplitude	_____	_____	_____
frequency	_____	_____	_____
hertz	_____	_____	_____
transverse	_____	_____	_____
longitudinal	_____	_____	_____
reflection	_____	_____	_____
refraction	_____	_____	_____
diffraction	_____	_____	_____

Recall

A **wave** carries **energy** 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.

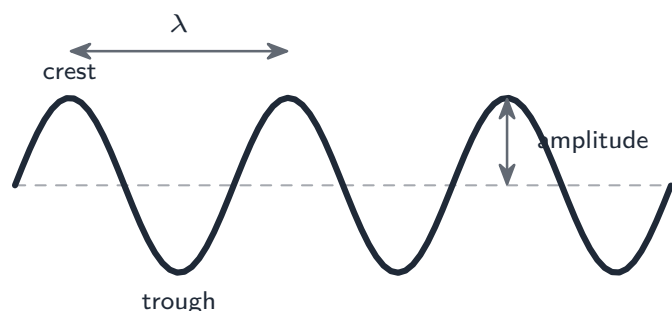
Nothing here is hard — it just adds the words and one equation.

New ideas

Read these first, then do the Practice.

■ 1 Describing a wave

- **wavelength** (λ) — the distance of one full wave (e.g. crest to crest).
- **amplitude** — the largest distance a point moves from its rest position.
- **frequency** (f) — the number of waves passing a point each second (in **hertz**, Hz).

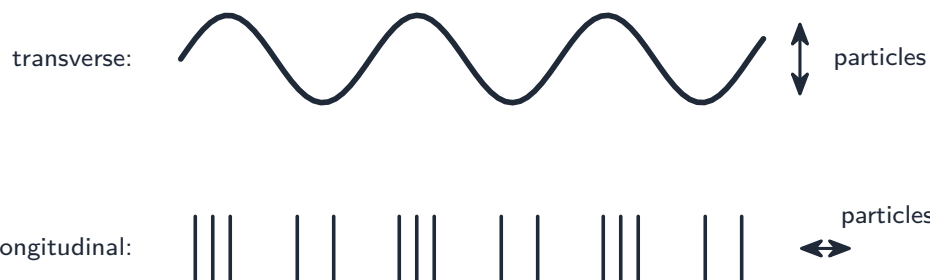


These link by the **wave equation**: $v = f\lambda$.

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



■ 3 What waves do

- **reflection** — bounces off a surface.
- **refraction** — changes speed (and bends) entering a new material.
- **diffraction** — 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]

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

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

Write each word three times.

English	Write it 3 times (English)		
Light	_____	_____	_____
sound	_____	_____	_____
electromagnetic	_____	_____	_____
normal	_____	_____	_____
angle of incidence	_____	_____	_____
angle of reflection	_____	_____	_____
total internal reflection	_____	_____	_____
optical fibres	_____	_____	_____
electromagnetic waves	_____	_____	_____
medium	_____	_____	_____

Recall

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

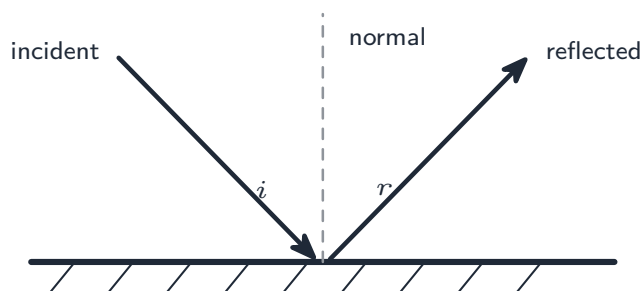
New ideas

Read these first, then do the Practice.

■ 1 Reflection

Angles are measured from the **normal of reflection**: the **angle of incidence**

(a line at 90° to the surface). The **law** equals the **angle of reflection**



■ 2 Refraction

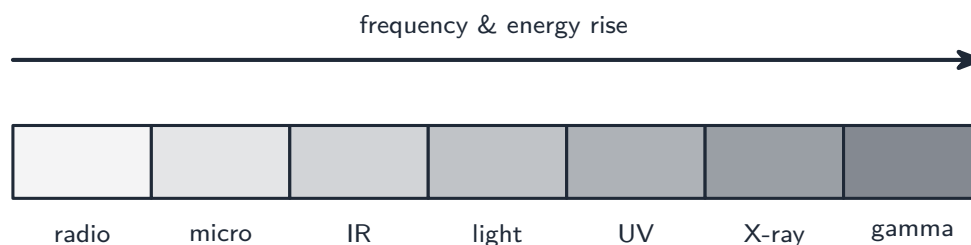
When light passes into a new material it changes **speed** and **bends**. Going from air **into** glass it slows down and bends **towards** the normal. The **refractive index** is

$$n = \frac{\sin i}{\sin r}.$$

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

■ 3 The electromagnetic spectrum

All **electromagnetic waves** 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 is a **longitudinal wave** made by a vibrating object. It needs a **medium**, 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]

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

☐

- A** radio
- B** microwaves
- C** ultraviolet
- D** X-rays

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

☐

What is the wavelength of these radio waves?

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

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

☐

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** $4.3 \times 10^{11} \text{ Hz}$ to $7.5 \times 10^{11} \text{ Hz}$
- D** $4.3 \times 10^{14} \text{ Hz}$ to $7.5 \times 10^{14} \text{ Hz}$

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.

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

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

Write each word three times.

English	Write it 3 times (English)		
magnets	_____	_____	_____
static electricity	_____	_____	_____
magnet	_____	_____	_____
poles	_____	_____	_____
repel	_____	_____	_____
attract	_____	_____	_____
magnetic materials	_____	_____	_____
magnetic field	_____	_____	_____
field lines	_____	_____	_____
charges	_____	_____	_____
electrons	_____	_____	_____
conductor	_____	_____	_____
insulator	_____	_____	_____

Recall

You have played with **magnets** and felt the spark of **static electricity**. 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** has two **poles**: north (N) and south (S). The rule:

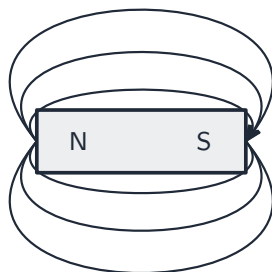
- **same** poles (N–N or S–S) **repel** (push apart).
- **different** poles (N–S) **attract** (pull together).

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



■ 2 Magnetic fields

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



■ 3 Static electricity

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

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

A **conductor** (metal) lets charge flow; an **insulator** (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]

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

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

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

Write each word three times.

English	Write it 3 times (English)		
electric current	_____	_____	_____
circuits	_____	_____	_____
amperes	_____	_____	_____
volts	_____	_____	_____
current	_____	_____	_____
ammeter	_____	_____	_____
voltage	_____	_____	_____
voltmeter	_____	_____	_____
resistance	_____	_____	_____
ohms	_____	_____	_____
Power	_____	_____	_____
watts	_____	_____	_____
series	_____	_____	_____
parallel	_____	_____	_____

Recall

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

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

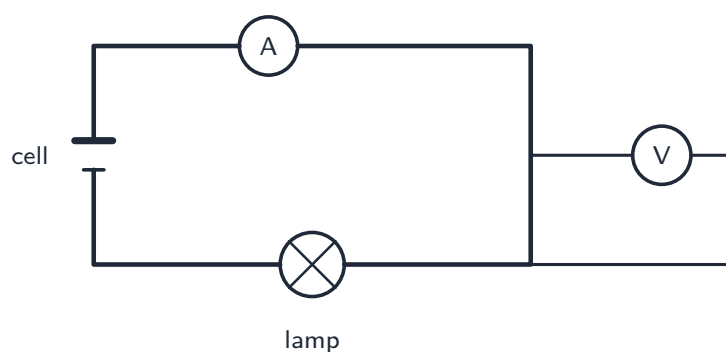
Nothing here is hard — it just adds three equations.

New ideas

Read these first, then do the Practice.

■ 1 Current, voltage and resistance

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



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

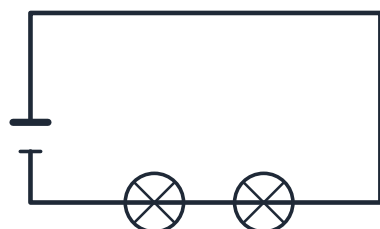
■ 2 Electrical power

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

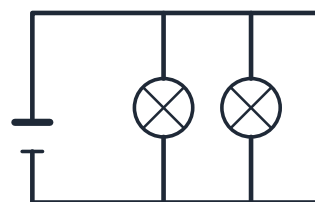
$$P = IV$$

■ 3 Series and parallel

- in a **series** circuit (one loop): the current is the **same** everywhere; the voltage is **shared**; resistances **add up**.
- in a **parallel** 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

Write each word three times.

English	Write it 3 times (English)		
atoms	_____	_____	_____
nucleus	_____	_____	_____
electrons	_____	_____	_____
neutral	_____	_____	_____
protons	_____	_____	_____
neutrons	_____	_____	_____
orbits	_____	_____	_____
mass	_____	_____	_____
proton number	_____	_____	_____
nucleon number	_____	_____	_____
ion	_____	_____	_____
Isotopes	_____	_____	_____

Recall

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

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

Nothing here is hard — it just names the parts.

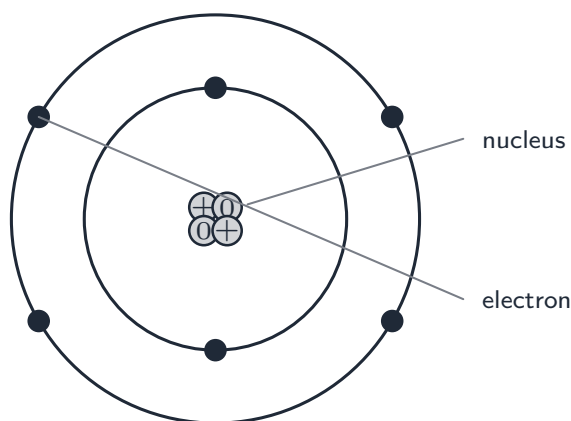
New ideas

Read these first, then do the Practice.

■ 1 Inside the atom

- the tiny central **nucleus** holds **protons** (charge +1) and **neutrons** (charge 0).
- **electrons** (charge -1) move around it in **orbits**.

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



■ 2 Proton number and nucleon number

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

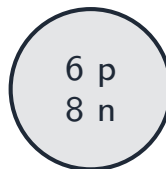
So the number of neutrons is $A - Z$. We write a nucleus as ${}^A_Z\text{X}$.

An atom can gain or lose electrons to become an **ion** (lose $\rightarrow$ positive, gain $\rightarrow$ negative).

■ 3 Isotopes

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

same protons, different neutrons



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 ${}_{11}^{23}\text{Na}$ 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

Write each word three times.

English	Write it 3 times (English)		
unstable	_____	_____	_____
radiation	_____	_____	_____
radioactive decay	_____	_____	_____
random	_____	_____	_____
spontaneous	_____	_____	_____
ionising	_____	_____	_____
paper	_____	_____	_____
aluminium	_____	_____	_____
lead	_____	_____	_____
penetrating	_____	_____	_____
half-life	_____	_____	_____
cells	_____	_____	_____
dose	_____	_____	_____
shielding	_____	_____	_____

Recall

From Part 1 you know some nuclei are **unstable** . An unstable nucleus breaks down and gives out **radiation** — this is **radioactive decay** .

- Decay is **random** and **spontaneous** (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.

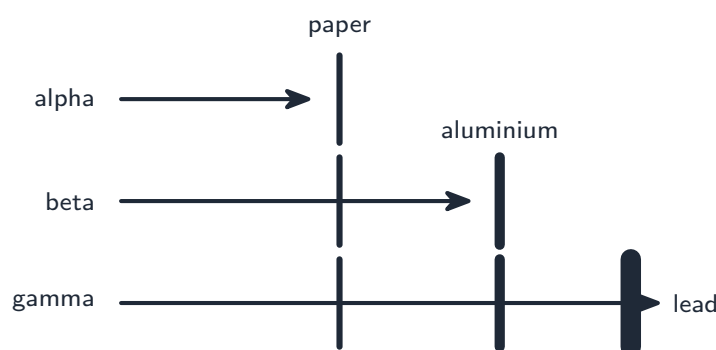
New ideas

Read these first, then do the Practice.

■ 1 Three types of radiation

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

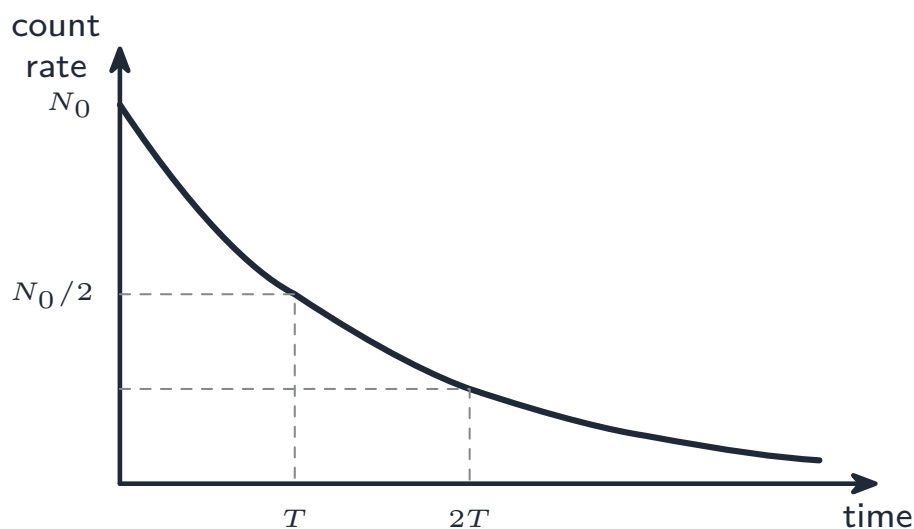
Type	What it is	Stopped by
alpha (α)	a helium nucleus (charge +2)	a sheet of paper
beta (β)	a fast electron (charge -1)	a few mm of aluminium
gamma (γ)	a high-energy wave (no charge)	thick lead (only reduced)



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

■ 2 Half-life

The **half-life** 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** . Keep the **dose** low by: **less time** near the source, **more distance**, and **shielding** (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

Write each word three times.

English

Write it 3 times (English)

Sun

Moon

orbits

rotates

tilted

seasons

phases

Solar System

eight planets

rocky

gaseous

gravity

Recall

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

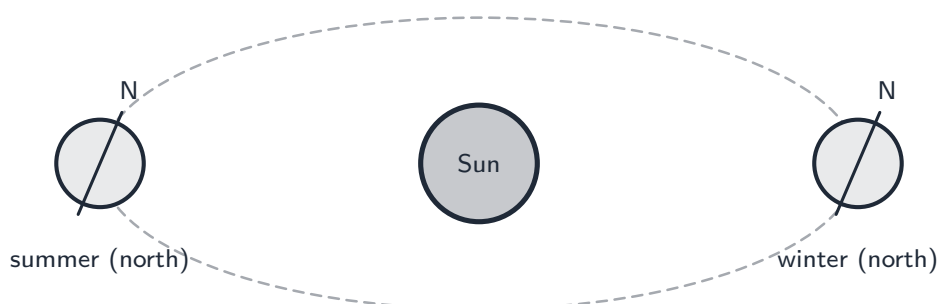
New ideas

Read these first, then do the Practice.

■ 1 Day, year and seasons

- the Earth **spins** (rotates) 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** , so each half of the Earth leans towards the Sun for part of the orbit — this gives the **seasons** (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** (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** has the Sun at its centre and **eight planets** around it (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune). The four inner ones are small and **rocky** ; the four outer ones are large and **gaseous** .



The Sun's **gravity** 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

Write each word three times.

English	Write it 3 times (English)		
Sun	_____	_____	_____
star	_____	_____	_____
Universe	_____	_____	_____
hydrogen	_____	_____	_____
helium	_____	_____	_____
nuclear fusion	_____	_____	_____
galaxy	_____	_____	_____
Milky Way	_____	_____	_____
light-years	_____	_____	_____
nebula	_____	_____	_____
mass	_____	_____	_____
red giant	_____	_____	_____
white dwarf	_____	_____	_____
supernova	_____	_____	_____
wavelength	_____	_____	_____

English**Write it 3 times** (English)

redshift

expanding

Big Bang

Recall

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

- 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**, made mostly of **hydrogen** and **helium**. Its energy comes from **nuclear fusion**: hydrogen nuclei join to make helium, releasing huge energy.

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

■ 2 The life cycle of a star

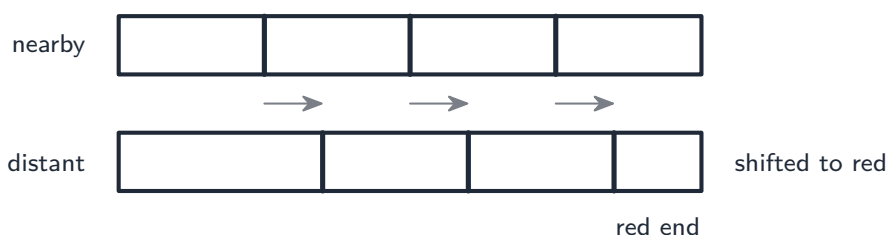
A star forms from a cloud of gas and dust (a **nebula**), then lives as a stable star, then dies. What happens at the end depends on its **mass**:



A medium star (like the Sun) becomes a **red giant** , then a **white dwarf** . A heavy star explodes as a **supernova** .

■ 3 The expanding Universe

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



Running this backwards, everything started together — the **Big Bang** 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]