Cambridge Assessment International Education

# Cambridge IGCSE™

CANDIDATE NAME



CENTRE NUMBER

CANDIDATE NUMBER



**PHYSICS**



**0625/42**

Paper 4 Theory (Extended)

**February/March 2025**

**1 hour 15 minutes**

You must answer on the question paper.



No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s$^2$).



**INFORMATION**

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].



This document has **20** pages. Any blank pages are indicated.




[Turn over

**1** Fig. 1.1 shows a force–extension graph for a spring.

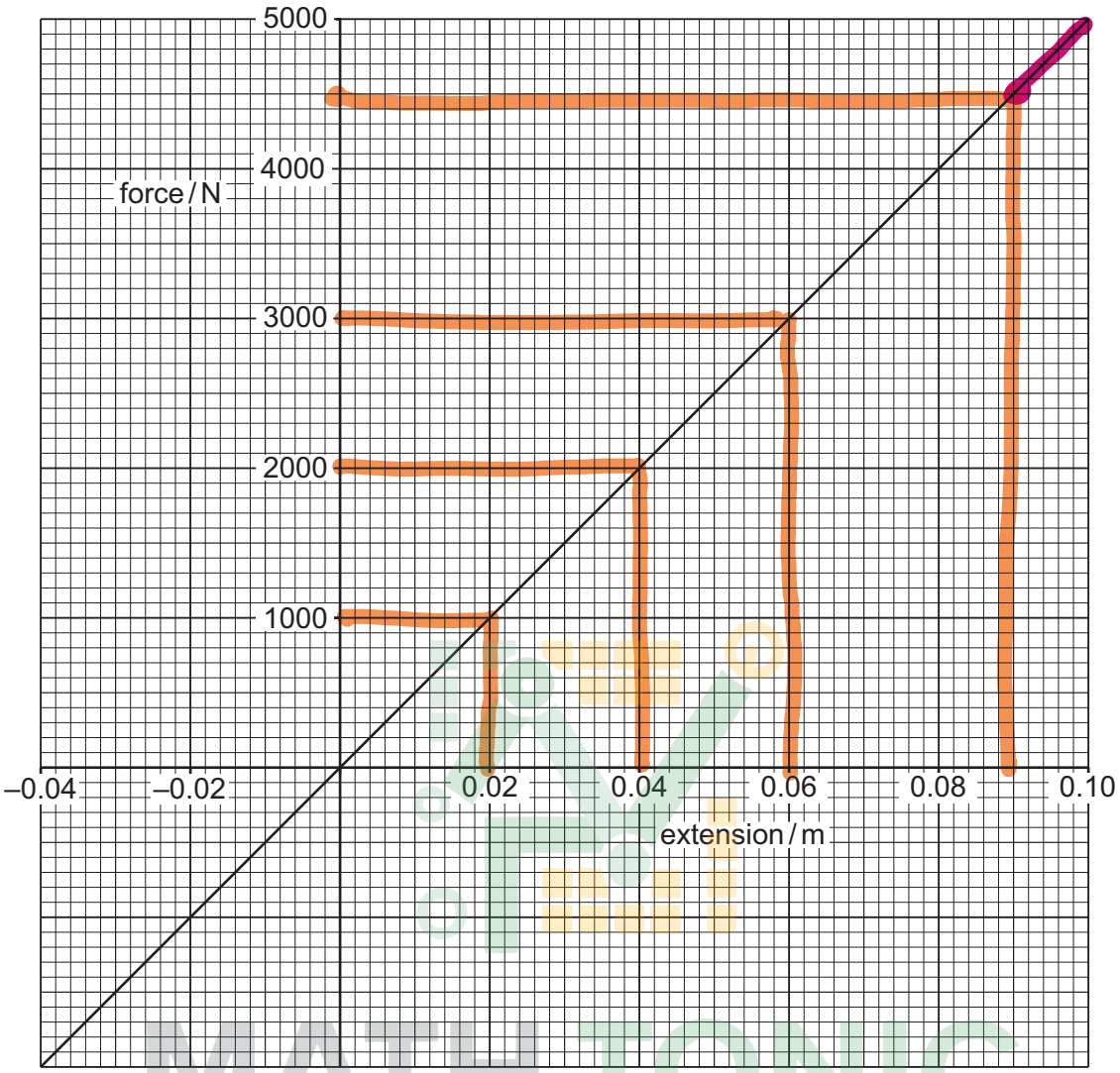



Fig. 1.1

(Hooke's law)

You can take other values
$x = 0.02$ $F = 1000$
$x = 0.06$ $F = 3000$

**(a)** Calculate the spring constant $k$ of the spring.

Force → $F = kx$ ← Extension in spring

$K = \frac{F}{x} = \frac{2000}{0.04} = 50000$

Spring Constant

$k$ = 50000 N/m [2]

**(b)** A student states that the spring has **not** reached the limit of proportionality when a force of 4500 N is applied to it.

State how the graph shows that this statement is true.

At 4500 N, x is still directly proportional to F.
It is a straight line. (obey Hooke's law) [1]

**(c)** Springs can be compressed by forces. The spring described by Fig. 1.1 is compressed by a force *F* and has an extension of –0.025 m.

Determine *F*.

$F = kx$

$F = 50000 \times (-0.025) = -1250\ N$

(Negative sign indicates you are compressing instead of pulling → moving in opposite direction.

*F* = $-1250\ N$ [2]

**(d)** State whether force is a scalar quantity or a vector quantity. Explain your answer.

Force is a vector quantity, because it has both magnitude and direction. [1]

[Total: 6]

**2** Trolley A and trolley B are on a horizontal, frictionless bench. Trolley A moves to the right with a constant velocity $u = 0.44\,m/s$. Trolley B is stationary.

Fig. 2.1 shows trolley A before it collides with trolley B.

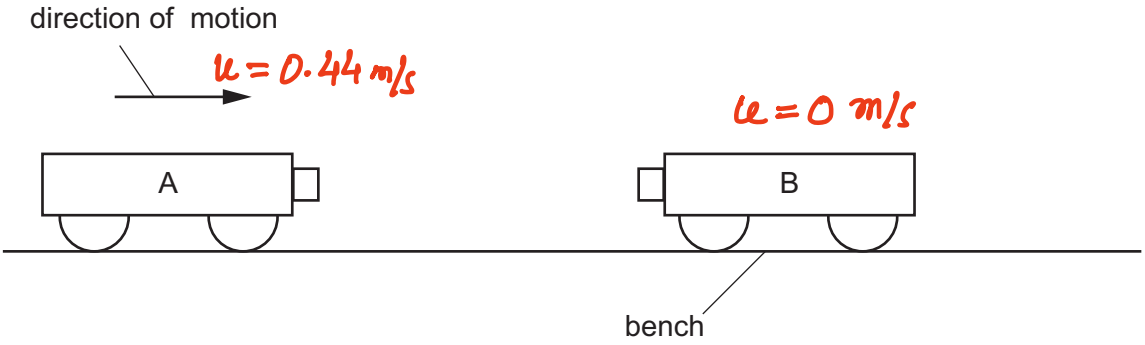



**Fig. 2.1** (not drawn to scale)

**(a)** State the momentum of trolley B before the collision. Explain your answer.

statement ..... momentum = 0 (zero) .....

explanation ..... Because, trolley B is at rest ( u = 0 ) .....

..... momentum (P) = mass x velocity .....

m x 0 = 0 [1]

**(b)** After the collision, the two trolleys are joined together and travel with a constant velocity $v = 0.18\,m/s$ to the right. The mass of trolley A is 0.75 kg.

Calculate the mass of trolley B.

Two trolleys moves in constant speed

$m_A u_A + m_B u_B = (m_A + m_B) v$

$(0.75 \times 0.44) + 0 = (0.75 + m_B) \times 0.18$

$\frac{0.33}{0.18} = 0.75 + m_B$

$1.833 - 0.75 = m_B$ $\quad m_B = 1.083\,kg$

mass of trolley B = ..... 1.08 kg ≃ 1.1 kg [3]

# Principle of Conservation of momentum

momentum before collision = momentum after collision

Impulse = F × Δt
(force, change in time)

**(c) (i)** The trolleys move onto a rough surface which exerts a constant force $F$ on the trolleys and brings them to rest in 2.6 s.

Impulse = F × Δt = Δp
Impulse is equal to change in momentum.

Calculate $F$.

$F \times \Delta t = \Delta p$
$F \times \Delta t = mv - mu = m(v-u)$ (m: Total mass)
$F \times \Delta t = mv$ (in this case two trolleys are moving in Cont. velocity after collision.)
$F = \frac{mv}{\Delta t} = \frac{(0.75+1.08)(0.18)}{2.6}$

$F =$ 0.127 ≃ 0.13 N [2]

**(ii)** A different rough surface exerts a smaller resistive force on the trolleys. State how this affects the time taken to bring the trolleys to rest. Explain your answer.

statement Time increases

explanation Due to smaller resistive force, this causes a smaller deceleration, it takes longer time to reduce velocity to become zero. [1]

[Total: 7]

$F = \frac{mv - mu}{t}$ (F ↓, t ↑)

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

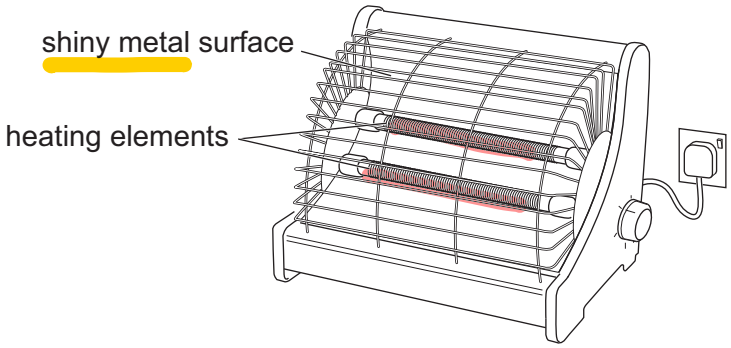



Fig. 3.1

# Notes:
INFRARED
USES: Electric grills
Remote Control
Optical fibre
Thermal imaging
Cable Tv

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

Infrared Radiation [1]

**(b)** Explain why the shiny metal surface behind the heating elements increases the thermal energy radiated into the room.

Shiny Surface are not able to absorb heat and they are best at reflecting heat. [2]

**(c)** The metal outer casing of the heater is earthed. State why this is an important safety feature.

In case of Live wire Comes in Contact with Casing, earth wire provides a low resistance path for electric Current to flow to the ground, which Causes a large current to flow and trips the fuse/ Circuit breaker. [1]

# Effect of Surface Colour:

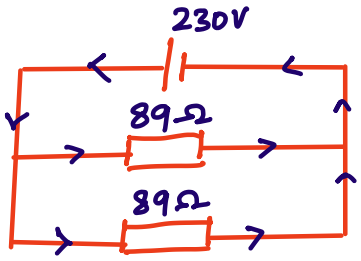
| | Matt black | white | Shiney silver |
|---|---|---|---|
| Emitting | Best | Poor | worst |
| Absorbing | Best | Poor | worst |
| Reflecting | worst | Good | Best |

# Fuse: A wire which melts if the current is too high.

# Circuit breaker: A device which stops the current flowing in a Circuit when the current is too high.

**(d)** The mains voltage is 230 V. The two identical heating elements are connected in parallel. Each heating element has a resistance of 89 Ω.

**(i)** Calculate the current in **one** heating element.




ohm's law:

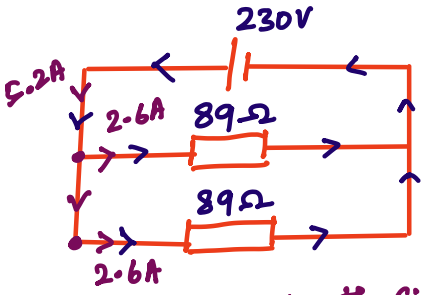
$V = I \times R$

$I = \frac{V}{R} = \frac{230V}{89\Omega}$

(voltage is always same throughout a parallel circuit)

current = ..... 2.6 A ..... [2]

**(ii)** Show that the electrical power of the heater is approximately 1200 W. State any equation you use in words or symbols.




$P = I \times V$

$P = 5.2A \times 230V$

$P = 1186.8 \simeq 1200\ W$

Total current in the circuit : $2.6A \times 2 = 5.2A$ [2]

**(iii)** The heater is 95% efficient at converting electrical work done to thermal energy.

Calculate the thermal energy emitted by the heater in **(d)(ii)** in 60 s. Give your answer to **two** significant figures.

work done = 1200 W

$= 1200\ \frac{J}{s} \times 60\ s = 72000\ J$

How much of energy is transferred per second

for 95% efficiency

$72000 \times 0.95 = 68400\ J$

thermal energy = ..... 68000 J (2sf) ..... [3]

$\simeq 6.8 \times 10^4\ J$ [Total: 11]

$u = 0$

**4** A train has a maximum speed of 200 km/h. It accelerates from rest with constant acceleration of 0.70 m/s$^2$.

**(a) (i)** Define acceleration.

change in velocity per unit time

[1]

**(ii)** Show that the maximum speed of the train is approximately 56 m/s.

$200\ \frac{km}{h} = 200 \times \frac{1000\ m}{3600\ s} = 55.55\ldots \simeq 56\ m/s$

[2]

**(iii)** Calculate the time taken for the train to reach its maximum speed.

$a = \frac{v-u}{t}$ $\quad \frac{\text{change in Speed}}{\text{Time}}$

$u = 0\ m/s$

$v = 56\ m/s$

$a = 0.7\ m/s^2$

$0.7 = \frac{56-0}{t}$

$0.7t = 56$

$t = \frac{56}{0.7} = 80\ s$

time = 80 seconds [2]

**(b) (i)** The train has a total mass of 440 000 kg. Calculate the force which causes the acceleration of the train.

force = Mass x Acceleration

$= 440000 \times 0.7$

$= 308000\ N$

force = 310 000 N [2]

**(ii)** The train travels into a headwind. The force of this headwind opposes the motion of the train. State and explain the effect of this force on the motion of the train.

statement Deceleration

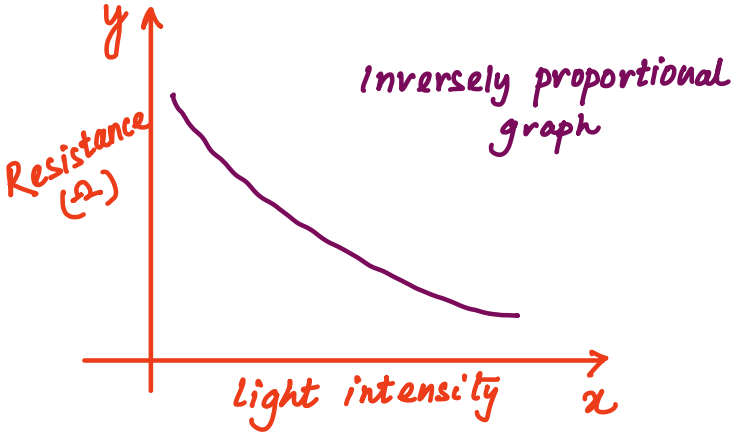
explanation The force of the headwind opposes the motion of the train. So it acts as a resistive force.

[1]

[Total: 8]

**5** A light-dependent resistor (LDR) has a low resistance in high light intensity and a high resistance in the dark.

**(a)** Sketch a graph of resistance (*y*-axis) against light intensity (*x*-axis) for an LDR.




Notes:
Type of resistors
1. Fixed Resistor Directly proportional
2. LDR Light ↑ Resistance ↓ [Inversely Proportional]
3. Thermistor Temp. ↑ Resistance ↓
4. Variable Resistor Directly proportional

[2]

**(b)** Fig. 5.1 shows part of the electric circuit used to turn on a light when it is dark.

when it is dark, LDR receives low intenstity of light which results a high resistance.
Light ↓
Resistance ↑

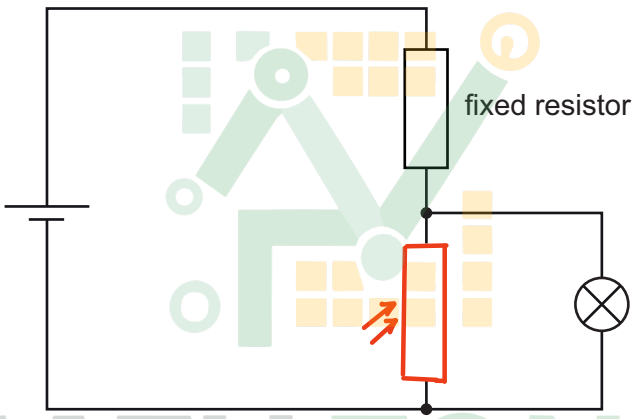



**Fig. 5.1**

**(i)** Complete the circuit in Fig. 5.1 with the symbol for a light-dependent resistor (LDR). [1]

**(ii)** Explain why the lamp is off in the light and the lamp is on in the dark. Use ideas about potential difference (p.d.) in your answer.

In the light, the resistance of the LDR is low, Most of the potential difference is across the fixed resistor. Therefore lamp gets lower potential difference, so the lamp is off. In the dark, the resistance of LDR increases, Most of Potential difference is now across LDR. The lamp get a higher P.d so it turns on. [3]

[Total: 6]

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

length between centre of lens and the focal point.

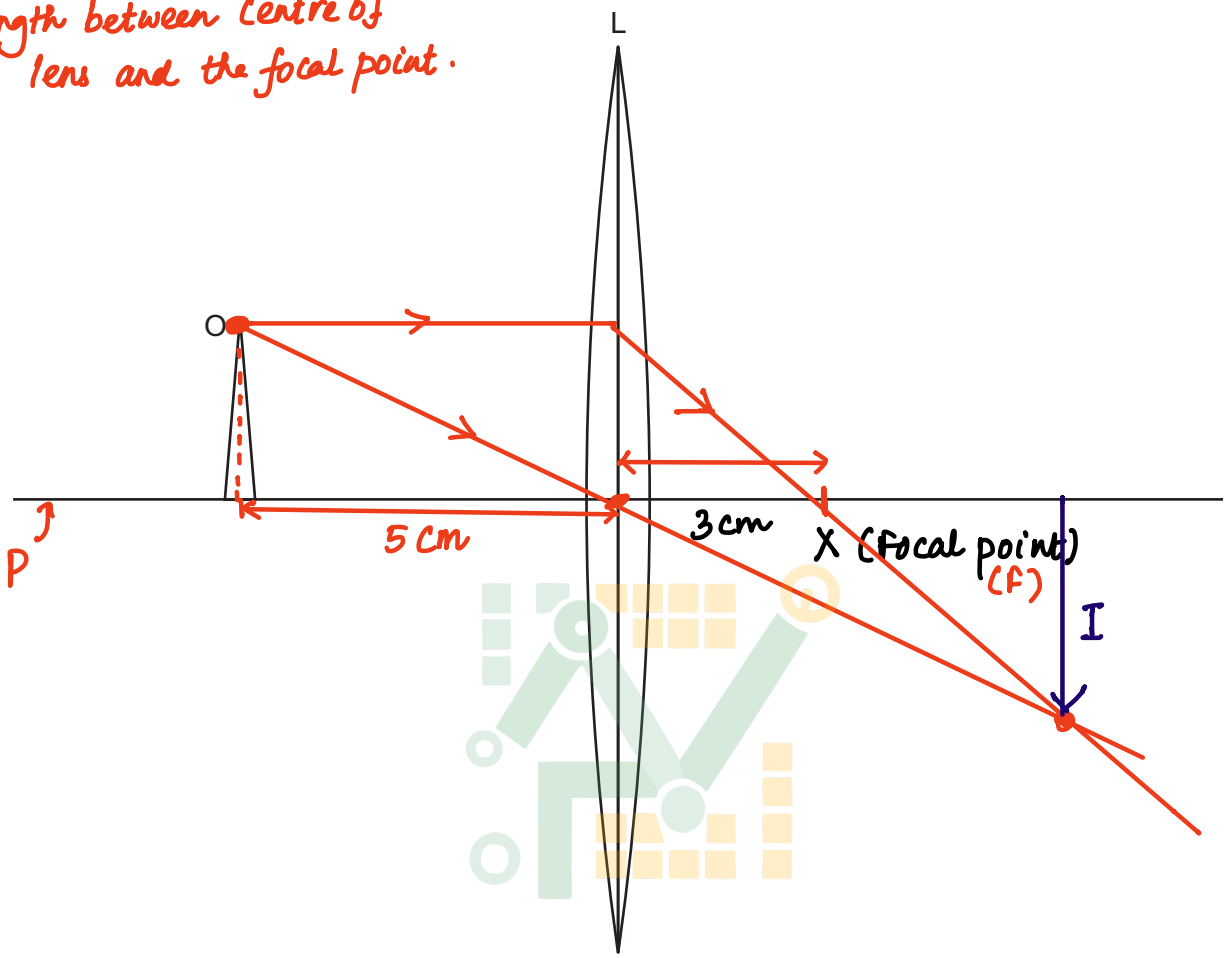



**Fig. 6.1**

**(a) (i)** On Fig. 6.1, label the principal axis with a P. [1]

**(ii)** On Fig. 6.1, place a letter X at a focal point. [1]

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

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

**Table 6.1**

| | |
|---|---|
| diminished | |
| enlarged | ✓ |
| inverted | ✓ |
| real | ✓ |
| same size | |
| upright | |
| virtual | |

[3]

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

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

Virtual , upright

[2]

[Total: 9]

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

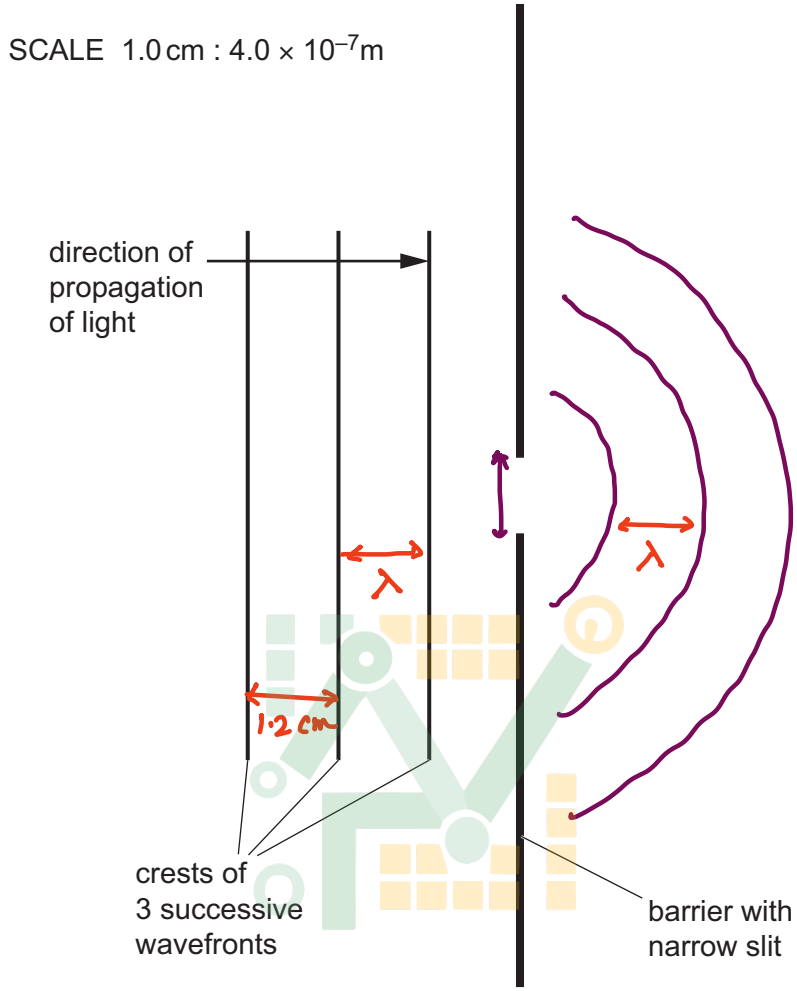





**Fig. 7.1**

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

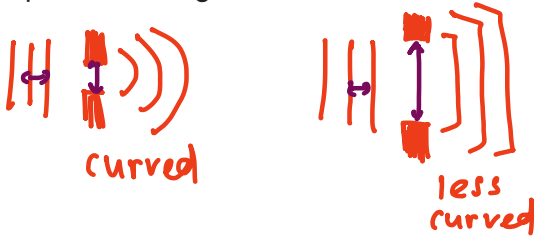
Diffraction [1]

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

1·2 cm × 4 × 10⁻⁷ m

wavelength = 4·8 × 10⁻⁷ m (2sf) [2]

**(iii)** On Fig. 7.1, draw **three** wavefronts that have passed through the narrow slit. [3]



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

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

$V = f \times \lambda$

$\lambda = \frac{V}{f} = \frac{330\ m/s}{380\ Hz} = 0.868 \simeq 0.9\ m$

[2]

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

$Time = \frac{Distance}{Speed} = \frac{2.5\ km}{330\ m/s} = \frac{2500\ m}{330\ m/s}$

7.5757...

time = 7.6 S [2]

[Total: 10]

**8** Fig. 8.1 shows a metal rod suspended in the magnetic field produced by a pair of permanent magnets. The metal rod is connected to a cell and there is a current in the metal rod.

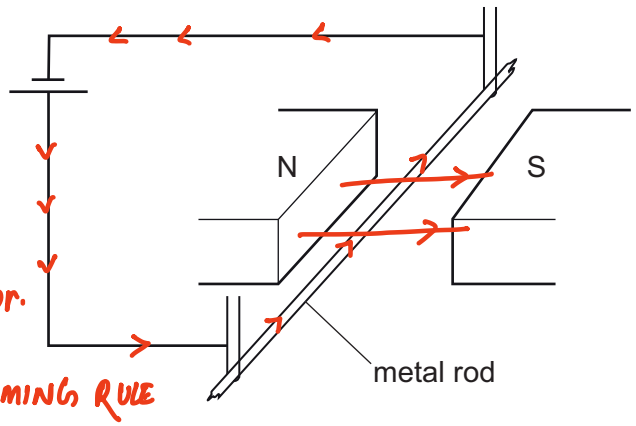


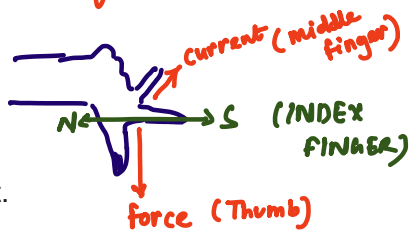

Fig. 8.1

Battery is present, which means it is a DC motor.

we use LEFT HAND FLEMING RULE for DC motor to identify the force.

# magnetic field always goes from north to south.

# Current flows from positive terminal to negative terminal.




**(a)** State the direction of the force on the metal rod due to the current.

Explain your answer.

direction of force ..... downwards .....

explanation ..... using the Fleming's Left hand Rule with magnetic field from left to right and current into the page, the thumb points downwards. .....

[3]

**(b)** The connections to the cell are reversed.

State how this change affects the force on the metal rod.

..... upwards (in opposite direction) ..... [1]

**(c)** Two magnets and a cell are used to make a simple electric motor as shown in Fig. 8.2.

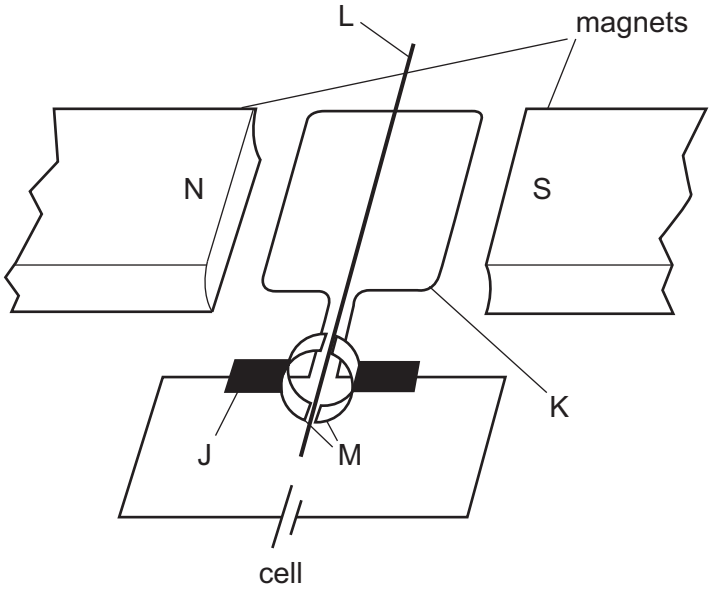



**Fig. 8.2**

Describe the function of parts J, K, L and M.

J Carbon Brush : To ensure continuous contact between external Circuit and split ring Commutator.

K Coil : A loop of wire that carries Current / Completes the Circuit.

L Shaft : Transfers the rotational motion (Mechanical energy) to external device.

M Split Ring Commutator : Reverses Direction of Current every half turn.

[4]

[Total: 8]

9 Strontium-90 is a radioactive isotope of strontium. The nuclide notation for strontium-90 is:

Nucleon Number = (Proton No. + Neutron No.)

$^{90}_{38}Sr$

Proton number in the nucleus of an atom

**(a) (i)** Explain what isotopes are.

Elements of Same proton number but different neutron number. [1]

**(ii)** Complete Table 9.1 for strontium-90.

**Table 9.1**

| particle | number in one atom | location |
|---|---|---|
| electrons | 38 | outside nucleus |
| neutron | 90 − 38 = 52 | inside nucleus |
| Proton | 38 | inside nucleus |

[2]

**(b)** Strontium-90 is used to measure the thickness of metal sheets in industry.
Strontium-90 decays by emitting beta (β) particles which pass through a metal sheet to a detector.

**(i)** One metal sheet is 0.75 mm thick. Suggest why strontium-90 is a suitable radioactive source to measure the thickness of the metal sheets.

It emits beta particles, which can pass through thin materials like metal sheets. It is less ionising than alpha particles. [2]

**(ii)** The half-life of strontium-90 is approximately 27 years. Fig. 9.1 shows the shape of a decay curve.

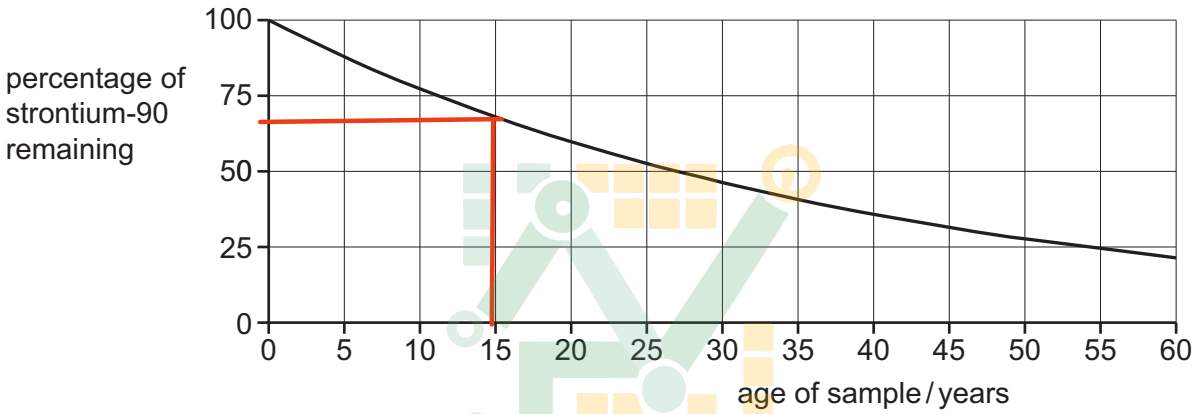



**Fig. 9.1**

The strontium-90 source is replaced with a new source after 15 years. Using Fig. 9.1, suggest why a strontium-90 source that is more than 15 years old needs to be replaced with a new source.

After 15 years, the activity of strontium-90 has decreased significantly, which means it now emits fewer beta particles, so the radiation may become too weak to accurately measure the thickness of the metal sheet. [2]

(less than 75%.)

[Total: 7]

**10** Fig. 10.1 shows the path of the Earth as it orbits the Sun. X is a position on the Earth where scientists observe the apparent motion of the Sun throughout the year.

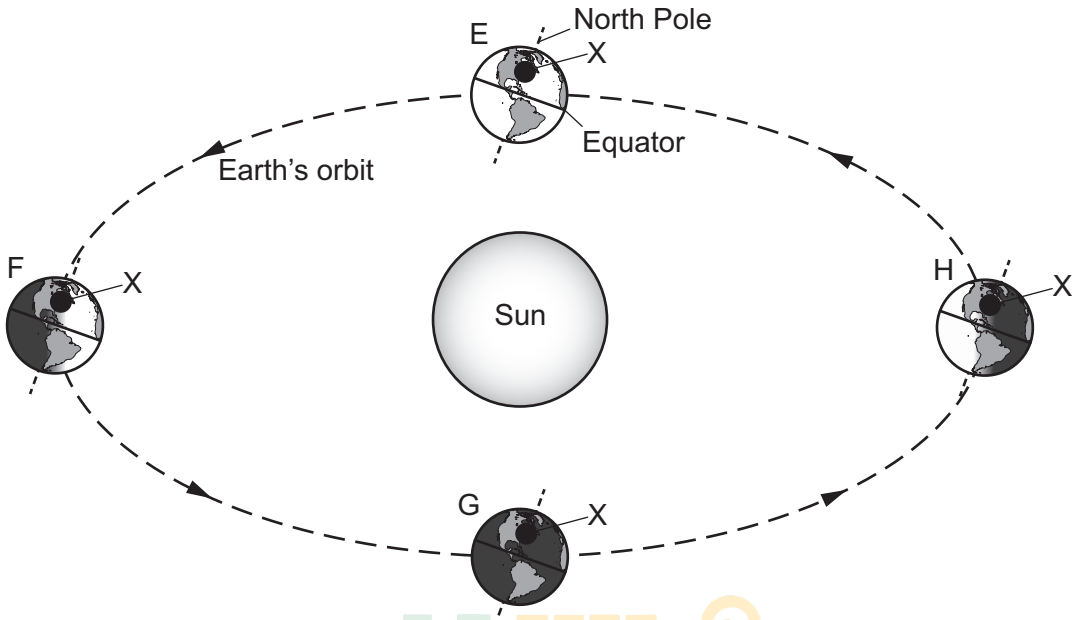



**Fig. 10.1**

**(a)** Determine how many days it takes the Earth to move around its orbit from F to G. Explain your answer.

number of days = 92 days → $\frac{1}{4} \times 365 = 92$

explanation F to G is a Quarter of a Complete Orbit of Earth around Sun which takes 365 days.

[2]

**(b)** Fig. 10.1 shows four positions E, F, G and H of the Earth in its orbit of the Sun.

**(i)** Identify the position of the Earth when it is summer at X. E (brighter) [1]

**(ii)** Identify the position of the Earth when it is winter at X. G (Darker) [1]

→ 365 days

**(c)** The orbital speed of the Earth around the Sun is approximately $3.0 \times 10^4$ m/s.

Calculate the average radius of the Earth's orbit.

Days to seconds

365 days × 24 h × 60 m × 60 s

Orbital speed: $v = \frac{2\pi r}{T}$ (seconds)

$3 \times 10^4 = \frac{2\pi r}{365 \times 24 \times 60 \times 60}$

$r = 1.5 \times 10^{11}$ m

radius = ..... $1.5 \times 10^{11}$ m ..... [3]

**(d)** Earth is a planet in the Solar System. State **one other** type of naturally occurring object that is present in the Solar System.

..... Asteroids / Comet / Moon / Stars (any one) ..... [1]

[Total: 8]

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