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Register/Index Number:

Class:

PRESBYTERIAN HIGH SCHOOL**PHYSICS****6091/2****Paper 2****27 August 2026****Thursday****1 hour 45 minutes**

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**2026 SECONDARY FOUR EXPRESS
 PRELIMINARY EXAMINATION**

INSTRUCTIONS TO CANDIDATES**DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO**

Write your class, register number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glues or correction fluid.

Section A

Answer **all** questions in the spaces provided.

Section B

Answer **one** question in this section.

The number of marks is given in brackets [] at the end of each question or part question.

Candidates are reminded that **all** quantitative answers should include appropriate units.

The use of an approved scientific calculator is expected, where appropriate.

Candidates are advised to show all their working in a clear and orderly manner.

At the end of the examination, submit Question 1 to 9 and
 Questions 10 to 13 separately.

For Examiner's Use	
Section A	70
Section B	10
Total	80

Section A (70 marks)

Answer **all** the questions in the spaces provided.

- 1** A piece of paper falls from 4.0 m above the ground.

Fig. 1.1 shows how the height h above the ground varies with the time t .

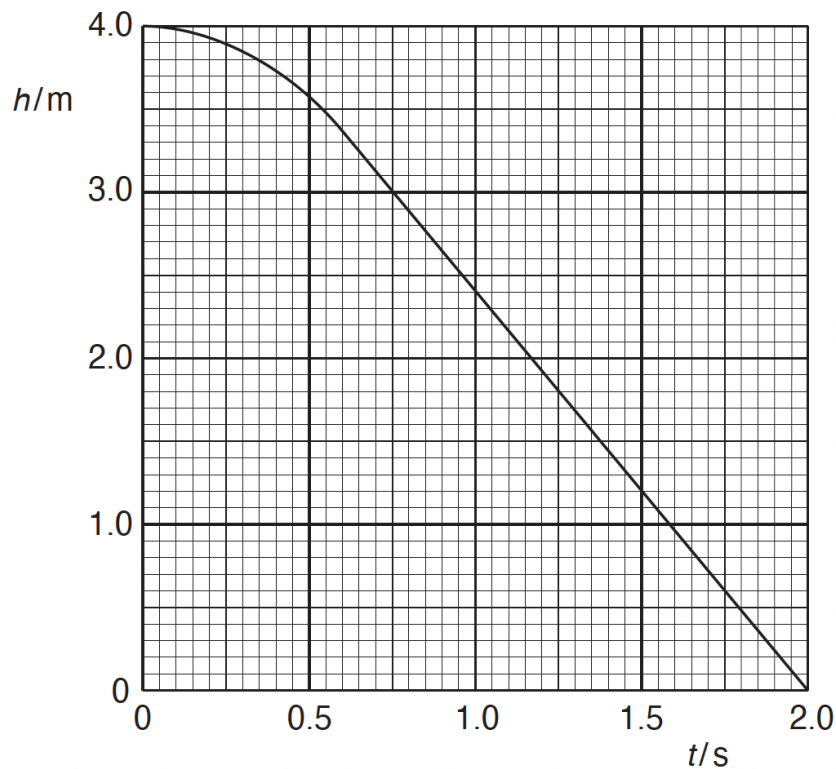


Fig. 1.1

- (a)** Calculate the speed of the paper at $t = 1.5$ s.

speed =[2]

- (b)** Determine the average speed of the paper between time $t = 0$ and $t = 1.0$ s.

average speed =[1]

- (c)** Using ideas on forces, describe and explain the motion of the paper as it falls.

.....

[3]

- 2 Fig. 2.1 shows a block of mass being hung from the ceiling using 2 different ropes.

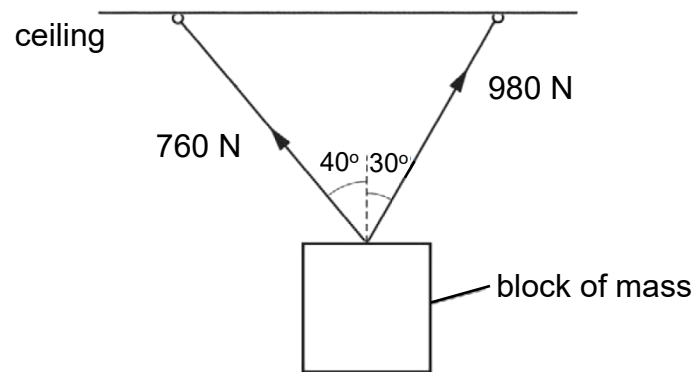


Fig. 2.1

By the use of a scale diagram of the forces acting on the block, find the weight of the block of mass.

weight =[3]

- 3 Fig. 3.1 shows a device for punching holes in a piece of paper. A person applies a force F at the end of the arm. Just before the hole is made in the paper, the arm is at rest.

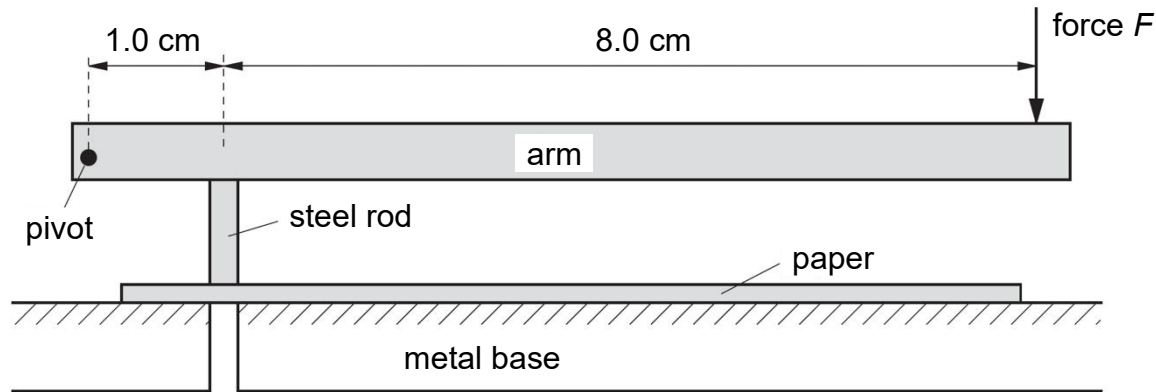


Fig. 3.1

- (a) Just before the hole is made, the force upwards on the steel rod is 7.2 N.

Calculate the value of F . Use the distances marked on Fig. 3.1.

$$F = \dots\dots\dots[2]$$

- (b) The steel rod pushes the paper into the hole in the metal base with a force of 7.2 N. The end of the steel rod has an area of 280 cm^2 .

Calculate the pressure exerted on the paper.

$$\text{pressure} = \dots\dots\dots[2]$$

- (c) In actual, the weight of the arm is not negligible.

- (i) Describe how it affects the force F required to punch a hole.

.....

[2]

- (ii) State the other force that is part of the action-reaction with the weight of the arm.

..... [1]

- 4 Fig. 4.1 shows apparatus to measure the specific latent heat of fusion of water.

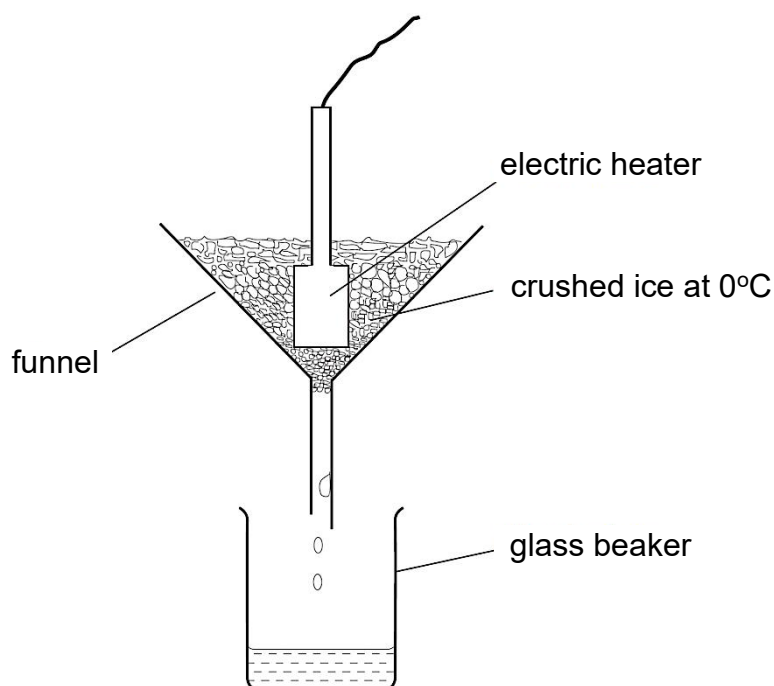


Fig. 4.1

The heater is switched on and water drips into the beaker at a constant rate.

In 2.0 minutes, 31 g of water drips into the beaker. The power of the heater is 85 W.

- (a)** Explain how thermal energy is transferred from the electric heater to the ice.

.....

.....

.....

.....

.....[2]

- (b)** Calculate the specific latent heat of fusion of water.

specific latent heat of fusion of water =[2]

5 Microwaves are waves in the electromagnetic spectrum.

- (a) State the name of waves in **one** other part of the electromagnetic spectrum that have wavelengths longer than microwaves.

.....[1]

- (b) A wave in the electromagnetic spectrum has a wavelength longer than microwaves.

Explain why the frequency of this wave is lower than the frequency of microwaves.

.....

.....

..... [2]

- (c) Microwaves are sometimes used to send telephone messages over long distances. They are sent from large dish aerials on top of high buildings or towers.

State why the aerials are placed on top of high buildings or towers.

.....

.....[1]

6 Ultrasound has many uses.

- (a) Define *ultrasound*.

.....

..... [1]

- (b) Fig. 6.1 shows how ultrasound is used to produce an image of the heart.

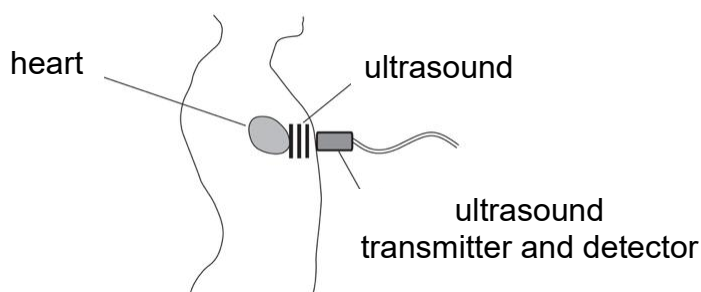


Fig. 6.1

Describe how particles in the body move as the ultrasound passes.

.....

.....

.....[2]

- (c) Ultrasound may be used to measure the depth of the sea. Fig. 6.2 shows a pulse of ultrasound sent down to the sea bed and the reflected pulse returning to the ship.

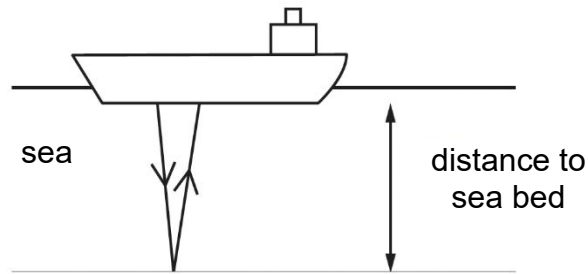


Fig. 6.2

Fig. 6.3 is a cathode-ray oscilloscope (c.r.o.) trace of the pulses of ultrasound sent from the ship and the reflected pulses.

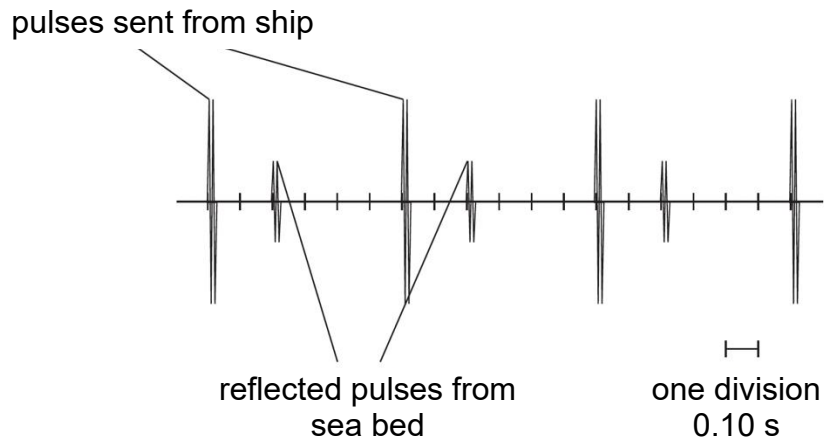


Fig. 6.3

The speed of ultrasound in water is 1500 m/s and the wavelength of the ultrasound wave is 0.030 m. The time-base setting for the x-axis on the c.r.o. is 0.10 s/division. Calculate

- (i) the frequency of the ultrasound wave,

frequency =[2]

- (ii) the time taken for the ultrasound pulse to reach the sea bed,

time =[1]

[Turn over

(iii) the distance to the sea bed.

distance =[2]

(iv) Explain why the amplitude of the reflected pulse is smaller than that of the pulse sent from the ship.

.....
[1]

7 Fig. 7.1 is a circuit used to monitor changes in room temperature.

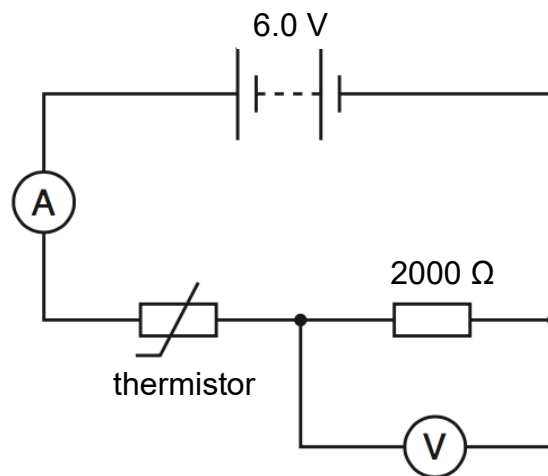


Fig. 7.1

A thermistor is connected in series with a 6.0 V battery and a 2000 Ω resistor.

(a) The temperature of the room increases. State and explain what happens to

(i) the reading on the ammeter,

.....

[2]

(ii) the reading on the voltmeter.

.....

[2]

- (b) At a certain temperature, the reading on the voltmeter is 3.8 V. Calculate the resistance of the thermistor at this temperature.

resistance =[2]

- 8 (a) Fig. 8.1 shows a coil of wire wound on a cardboard tube. There is a d.c. current in the coil. The direction of the current is shown in the key.

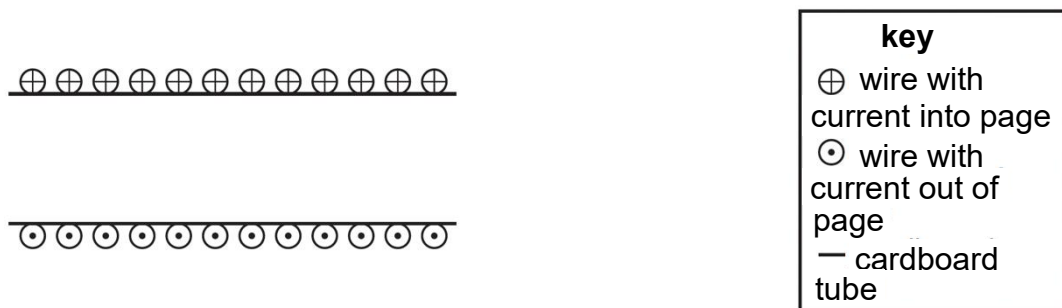


Fig. 8.1

On Fig. 8.1, draw the magnetic field produced by the coil.

[1]

- (b) Fig. 8.2 shows a simple loudspeaker that uses the coil shown in Fig. 8.1 attached to a paper cone.

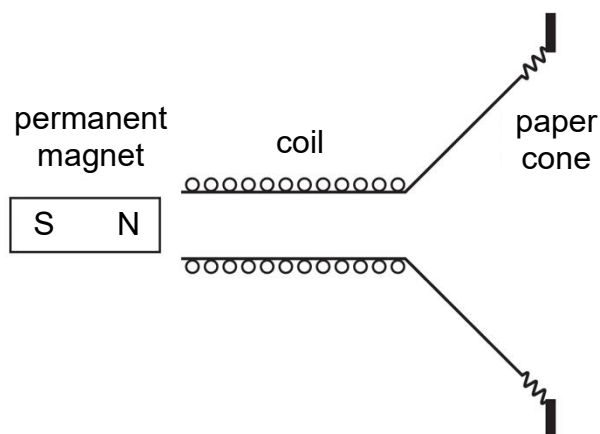


Fig. 8.2

[Turn over

The coil is connected to a signal generator. There is an alternating current in the coil.

Describe and explain the movement of the coil that creates the sound waves.

.....

[2]

- 9 Fig. 9.1 shows a rotating magnet in an alternating current generator that is used to power a lamp.

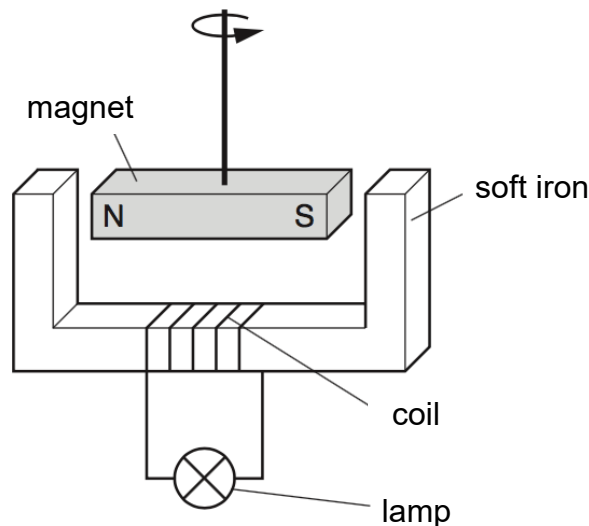


Fig. 9.1

- (a) Explain how alternating current is produced by the apparatus shown in Fig. 9.1.

.....

[2]

- (b) The generators at a power station produce a voltage of 25000 V. This voltage is stepped up to 400000 V by a transformer for long-distance transmission on overhead power lines. The voltage is later stepped down to 240 V.

- (i) Explain why the voltage is stepped up for long-distance transmission.

.....

[2]

- (ii) Calculate the ratio of the number of turns in the primary coil of the step-up transformer to the number of turns in its secondary coil.

ratio =[2]

- (iii) State **one** advantage and **one** disadvantage of using thicker wire in the overhead power lines.

advantage:
.....

disadvantage:
.....[2]

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- 10** Fig. 10.1 shows a children's ride. A carriage containing children is pulled up the slope by a motor till **A** where it stops. The carriage then runs down through **B**, **C** and **D** without further input of energy.

At **E**, brakes are applied and the carriage slows to a stop at **F**. The height of the ride is 30 m at **A** and 10 m at **C**.

Assume that friction between **A** to **E** is negligible.

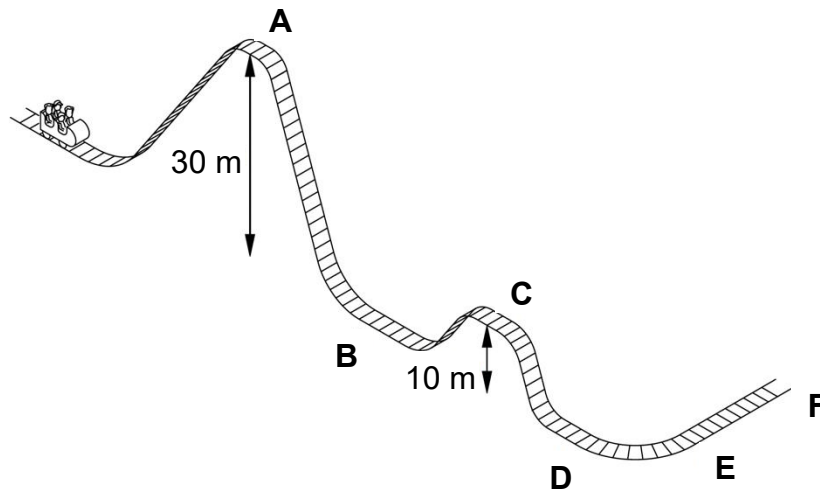


Fig. 10.1

The mass of the carriage and children is 500 kg.

Take the gravitational field strength as 10 N/kg.

- (a)** State the *Law of Conservation of Energy*.

.....

[2]

- (b) (i)** Calculate the maximum potential energy store of the carriage and children.

potential energy store =[2]

- (ii)** Determine the speed of the carriage and children at **C**.

speed =[2]

[Turn over

- (c) Fig. 10.2 shows the track between **D** and **E**. The carriage goes round part of a horizontal circle at constant speed.

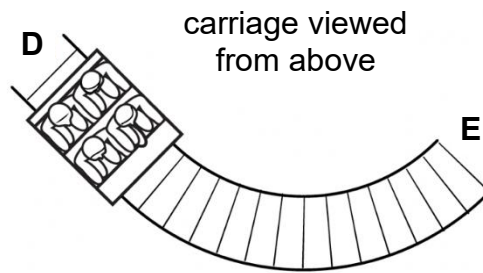


Fig. 10.2

Explain why the carriage is accelerating.

.....
[1]

- (d) State the energy transfers that occur in the ride from **E** to **F**.

.....
[1]

- (e) The average braking force is 7500 N. Find the distance between **E** and **F**.

distance between **E** and **F** =[2]

- 11** Telephone conversations are carried across the oceans of the world as brief pulses of light in cables that contain hair-thin fibre optic strands. These strands are made from glass covered by a cladding that is protected by an outer casing, as shown in Fig. 11.1. If the speed of light in the cladding is greater than in the core, total internal reflection occurs and all light is then confined to the core.

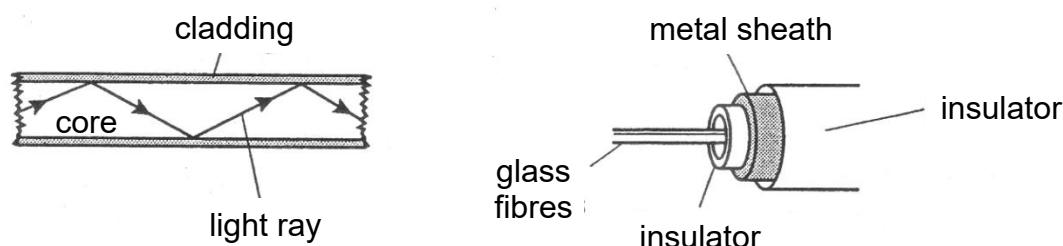


Fig. 11.1

The transmission of light is not 100% efficient as it passes down the fibre since light is absorbed by impurities in the glass. If light travels through 75 km of glass, only 10% of the signal arrives at the other end.

Over long distances, the light signal has to be boosted at the underwater repeaters, as shown in Fig. 11.2. The repeaters are powered by an electric current sent along a metal sheath inside the cable. They are connected in series with the same current of 0.80 A through each and a potential difference of 40 V across each repeater. In a typical 7500 km undersea cable there are 100 repeaters.

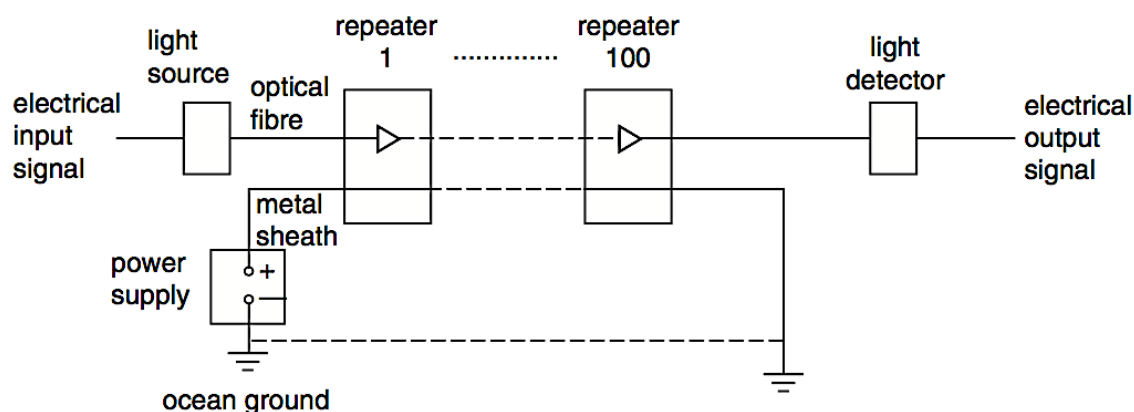


Fig. 11.2

Each kilometre of metal sheath has a resistance of $0.70 \, \Omega$ and some of the energy provided by the supply is transferred to internal energy store of the sheath.

- (a)** Calculate the energy transferred to internal energy store of sheath per second through heating, from each kilometre of metal sheath.

energy transferred per second =[2]

[Turn over

- (b) State why repeaters are necessary along an undersea cable.

.....
[1]

- (c) Explain how the difference in speed of light between glass and the cladding causes total internal reflection to occur.

.....

[3]

- (d) Calculate the refractive indexes of both glass and cladding if the speed of light in glass, cladding and vacuum is 2.1×10^8 m/s, 2.5×10^8 m/s and 3.0×10^8 m/s respectively.

refractive index of glass =[1]

refractive index of cladding =[1]

- (e) The relationship between the refractive indexes of two medium is given by $\frac{n_r}{n_i} = \frac{\sin i}{\sin r}$, where n_r represents the refractive index of the medium that contains the refracted ray and n_i represents the refractive index of the medium that contains the incident ray.

Calculate the minimal angle of incidence (to the nearest degree) for total internal reflection to take place.

angle of incidence =[2]

Section B (10 marks)

Answer **one** question from this section.

12 Fig. 12.1 shows a piece of iron being heated.

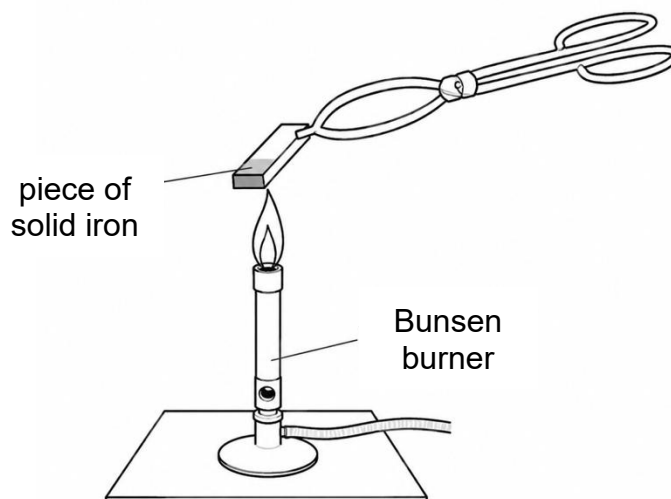


Fig. 12.1

- (a) (i)** The iron remains a solid while being heated.

Describe how the motion and arrangement of the particles changes.

.....
.....
.....[2]

- (ii)** After some time, the iron melts.

Describe what happens to the energy in the internal store of the iron and the temperature of the iron as it melts.

energy in internal store:
.....
temperature:

[3]

(b) A student:

- places a 300 g piece of iron in boiling water until the iron is at a temperature of 100 °C
- removes the iron from the water and places it immediately into 100 g of water at 25 °C.

The iron cools and the water warms until both reach the same temperature, 44 °C.

The specific heat capacity of water is 4.2 J/(g°C). No energy is lost to the surroundings.

(i) Explain what is meant by *specific heat capacity* of water.

.....

[1]

(ii) Calculate the change in energy (internal energy) of the water as it warms up.

change in energy =[2]

(iii) Calculate the specific heat capacity of iron.

specific heat capacity =[2]

13 Fig. 13.1 shows part of a smoke detector.

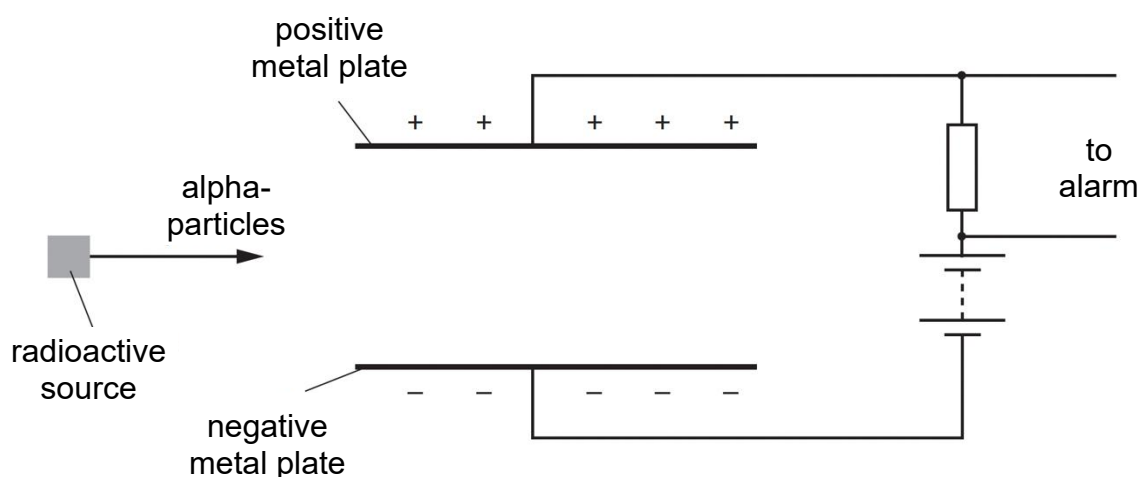


Fig. 13.1

Alpha-particles from the radioactive source ionise the air between the metal plates. There is then a small current in the resistor. When smoke enters the detector, the current changes and the alarm sounds.

- (a) Explain why a source emitting only gamma-rays is unsuitable for use in the smoke detector.

.....

[1]

- (b) There is an electric field between the metal plates.

- (i) On Fig. 13.1, draw the electric field between the plates. [1]

- (ii) The alpha-particles in Fig. 13.1 are deflected slightly as they pass through the electric field.

Explain why the alpha-particles are deflected and state the direction of the deflection.

.....

[2]

(c) The source used is the radioactive isotope americium-241, which has a half-life of 500 years.

(i) A sample of americium-241 is left for 1500 years. Determine the fraction of the original number of atoms of americium-241 left in the sample after this time.

fraction =[2]

(ii) Another isotope of the same element, americium-242, has a half-life of 16 hours.

Explain why the half-life of americium-242 makes this isotope unsuitable for use in a smoke detector.

.....
.....[1]

(d) Atoms of americium-241 and americium-242 contain protons, neutrons and electrons.

Describe the difference between an atom of americium-241 and an atom of americium-242.

.....
.....[1]

(e) When a nuclide of americium-241 ($^{241}_{95}\text{Am}$) emits an alpha particle, the atom decays into a nuclide of Neptunium (Np).

Write an equation involving nuclide notation for the decay of a nuclide of Americium-241 to Neptunium.

.....[2]

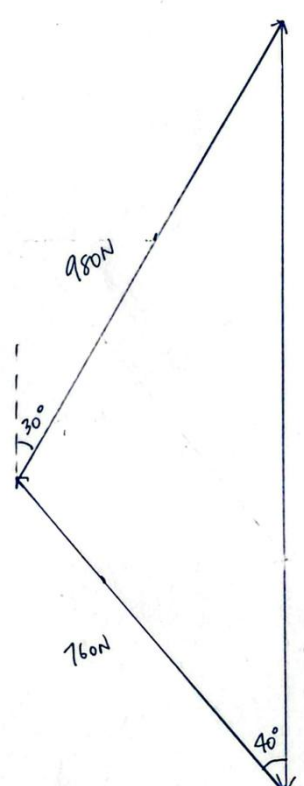
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**PRESBYTERIAN HIGH SCHOOL
SCIENCE DEPARTMENT
MARKING SCHEME**

Subject: Physics Paper 2
Setter: Mrs Zhou Meixian
Level: Sec 4 Express

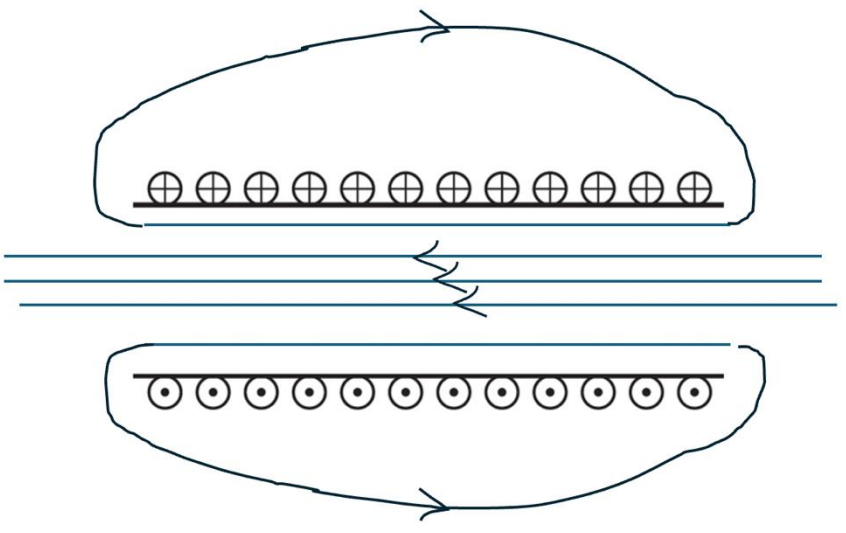
Exam: Prelim
Year: 2026

Section A (70 marks)

Q/N	Suggested Answer	Sub-total	Total
1(a)	Speed = Gradient = $(1.2 - 0)/(2.0 - 1.5)$ = 2.4 m/s	1 1	6
(b)	Average speed = total distance / total time = $(4.0 - 2.4) / 1.0$ = 1.6 m/s ²	1	
(c)	The paper starts falling from rest. Speed increases / paper accelerates due to gravity. Air resistance increases with speed. When air resistance equals to weight (at t = 0.5s), paper falls with constant speed.	1 1 1	
2	Scale 1cm: 100N  resultant force = 14.4×100 = 14400 N weight =[3]	3	3
3(a)	CW moments = ACW moments $F \times 9.0 \text{ cm} = 7.2 \times 1.0 \text{ cm}$ $F = 0.8 \text{ N}$	1 1	7
(b)	$280 \text{ cm}^2 = 280 / (100)^2$ = 0.028 m ² Pressure = Force / Area		

[Turn over

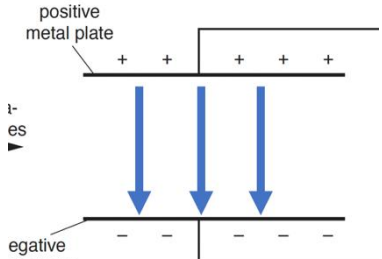
	$= 7.2 / 0.028$ $= 257 \text{ Pa}$	1 1	
(c)(i)	If the weight of the arm is not negligible, it would generate a <u>clockwise moment</u> about the pivot. Since F also generates a clockwise moment, would need a <u>smaller F</u> for clockwise moment = anticlockwise moment for equilibrium.	1 1	
(ii)	The (upward) force by arm on Earth.	1	
4(a)	The particles of the electric heater vibrate more vigorously, collide with neighbouring ice particles and transfer energy to them. The ice particles also vibrate more vigorously and all the particles eventually have greater average kinetic energy.	1 1	4
(b)	$Pt = m l_f$ $85 \times 2.0 \times 60 = 0.031 \times l_f$ $l_f = 329\,000 \text{ J/kg}$	1 1	
5(a)	Radiowaves	1	4
(b)	v, the speed of EM waves in air are the same. $v = f\lambda$; if λ higher, f will be lower	1 1	
(c)	Microwaves can be blocked by physical obstacles such as trees and buildings (accept reasonable answers)	1	
6(a)	Sound of frequency higher than 20 kHz	1	9
(b)	Particles vibrate in a direction parallel to the motion of the wave, through a series of compression and rarefactions.	1 1	
(c)(i)	$v = f\lambda$ $f = v/\lambda$ $= 1500 / 0.030$ $= 50\,000 \text{ Hz}$	1 1	
(ii)	0.1 s (1 division, since pulses hit the seabed and reflect)	1	
(iii)	Distance = speed x time $= 1500 \times 0.1$ $= 150 \text{ m}$	1 1	
(iv)	Some energy is transferred to internal store of the seabed and the sea	1	
7(a)(i)	Ammeter reading increases Total resistance decreases, so main current increase	1 1	6
(ii)	voltmeter reading increases Given potential divider principle, greater p.d across resistor or greater current through fixed/constant/2000 Ω resistor	1 1	
(b)	voltage across thermistor 2.2 V or $3.8 / 2000$ or $3.8 = 6 \times 2000 / (R + 2000)$ $R = 1160 \Omega$	1 1	

8(a)		1	3
(b)	The alternating current in the coil continuously reverses direction. This generates an alternating <u>magnetic field that interacts with the permanent magnet's field</u>, producing an oscillating force. This force pushes and pulls the coil, causing it and the attached paper cone to <u>vibrate back and forth</u> rapidly, creating sound waves	1 1	
9(a)	Coil cuts magnetic field/flux/ field lines and induces voltage/current field/flux cuts in one direction then then changes to another direction	1 1	8
(b)(i)	to reduce heat/energy/power loss (on the power lines) since for same power, higher voltage means lower current	1 1	
(ii)	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$ $\frac{N_p}{N_s} = \frac{25000}{400000}$ $N_p : N_s = 1:16$	1 1	
(iii)	Advantage: less power loss Disadvantage: costs more to install	1 1	
10(a)	In an isolated system, energy is not created or destroyed. Total energy is constant. It can be transferred to different stores.	1 1	10
(b)(i)	GPE = mgh = 500 x 10 x 30 = 150000 J	1 1	
(ii)	GPE_A + KE_A = GPE_C + KE_C 150000 = (500)(10)(10) + KE_C KE_C = 100 000 J $\frac{1}{2} (500)(v^2) = 100\ 000$ v = 6.32 m/s	1 1	

(c)	Acceleration is changing velocity. Although the speed is constant, the <u>direction keep changing</u> .	1	
(d)	Gravitational potential store and kinetic store at C transfer to internal store of rollercoaster and air at F .	1	
(e)	KE _E = GPE _A = 150000 Work done against friction = transfer of kinetic store 7500 X d = 150000 d = 20 m	1 1	
11a	P = I ² R = 0.8 ² x 0.7 = 0.448 W	1 1	
b	This is so as transmission of light is not 100% efficient as light is absorbed by impurities in the glass.	1	
c	Speed of light in cladding is higher than speed of light in glass which implies that cladding is optically less dense than glass . When light travels from glass to cladding, it will bend away from normal . When the angle of incidence is greater than critical angle , total internal reflection will occur.	1 1 1	
d	n _{glass} = 3.0 x 10 ⁸ / 2.1 x 10 ⁸ = 1.43 n _{cladding} = 3.0 x 10 ⁸ / 2.5 x 10 ⁸ = 1.20	1 1	
e	1.20 / 1.43 = sin c c = 57.1 °. Minimal angle for total internal reflection is 58 °.	1 1	

Section B (10 marks)

12(a)	Vibrate more vigorously	1	10
(i)	orderly, but slightly further apart	1	
(ii)	internal pe increase, thus internal energy increase temperature remains unchanged	1 1 1	
(b)(i)	energy needed to raise 1 kg of substance by 1 K.	1	
(ii)	E = mcΔT = (100)(4.2)(44-25) = 7980 J	1 1	
(iii)	Energy gained by water = energy lost by metal 7980 = (300)(c)(100-44) c = 0.475 J/(g°C)	1 1	
13(a)	Gamma rays have low ionising power. Not able to ionise the air between the plates.	1	10

(b)(i)		1	
(ii)	Alpha particles are positively charged (Helium nucleus) Deflection is downwards/ attracted towards negative plate.	1 1	
(c)(i)	1500 years is 3 half lives. Fraction = $(1/2)^3 = 1/8$	1 1	
(ii)	Need to replace the radioactive source often	1	
(d)	Americium-242 has 1 more neutron than americium-241	1	
(e)	${}_{95}^{241}\text{Am} \rightarrow {}_{93}^{237}\text{Np} + {}_2^4\text{He}$	2	