Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS 6091/01

Paper 1 Multiple Choice

28 August 2024
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, index number and class on this paper and on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

For examiner's use only:

Total	**/ 40**

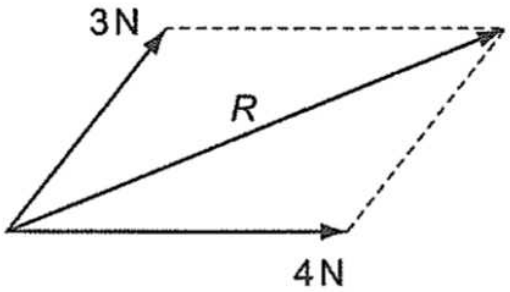
Overall	**Marks**	**%**
Paper 1	40	30%
Paper 2A	70	50%
Paper 2B	10	
Paper 3	40	20%

1 A length of copper wire is labelled: length 0.50 m and diameter 0.50 mm.

Which instrument(s) is/are **most** suitable to measure accurately the volume of the copper wire?

A measuring cylinder and digital calipers
B metre rule and digital calipers
C metre rule and digital micrometer
D tape measure and digital micrometer

2 The diagram shows how to find the resultant *R* of a 3 N and 4 N force acting at a point.



The angle between the two forces can be any value from 0° to 180°.

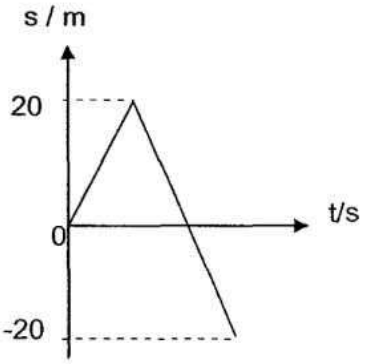
Which value of *R* is **not** possible?

A 1 N **B** 4 N **C** 7 N **D** 10 N

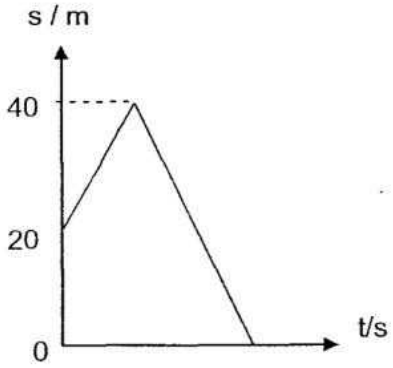
3 A ball is thrown vertically up from the top of a building 20 m high with an initial velocity of 20 m / s. The displacement of the ball is measured from the point that the ball is thrown, with an upward displacement taken as positive.

Which of the following graphs represents the displacement of the ball with time *t*?

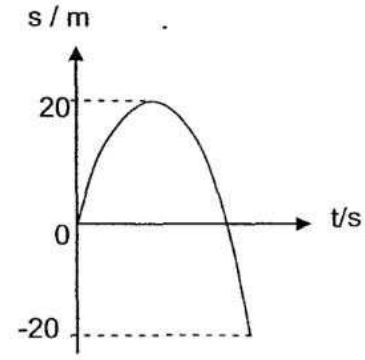
A



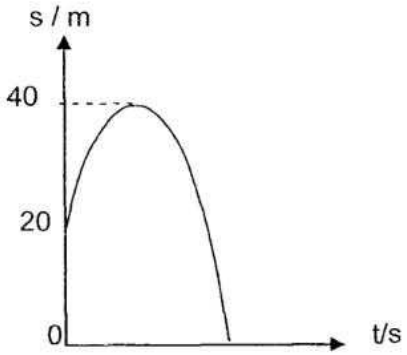
C



B



D



4 A car moving at 40 km / h speeds up with constant acceleration for 3 minutes, reaching a final speed of 80 km / h.

What is the distance travelled during this time?

A 3.0 km **B** 6.0 km **C** 180 km **D** 360 km

5 An object of mass *M* travelling to the right with velocity 2*v* collides with another object of mass 2*M* travelling to the left with velocity *v*.

It can be assumed there are no energy transfers from the objects to the surface they are moving on and to the surrounding air.

Which statement is true about both objects during the collision?

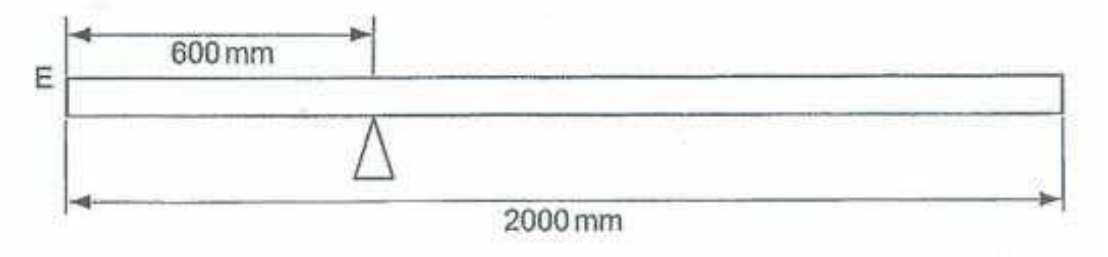
A The inertia of each object changes.
B The sum of the total energy in their stores decreases.
C They experience a deceleration of the same magnitude.
D They experience a force of the same magnitude.

6 A car is travelling on a flat road with constant velocity. It can be assumed that there is negligible air resistance acting on the car during its motion.

How many forces are acting on the car?

A 0 **B** 2 **C** 3 **D** 4

7 A uniform plank of weight 60 N is 2000 mm long. It rests on a support that is 600 mm from end E.

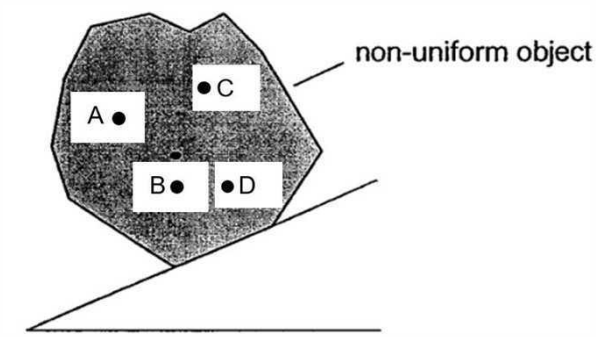


At what distance from end E must a 160 N weight be placed in order to balance the plank?

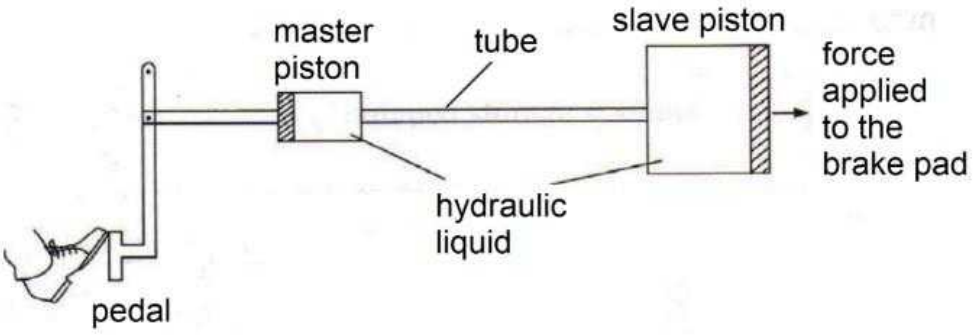
A 150 mm **B** 225 mm **C** 375 mm **D** 450 mm

8 A non-uniform object is placed on an inclined plane as shown below.

If the object is just about to topple, which position is its centre of gravity?



9 The diagram shows a hydraulic brake system used in vehicles.

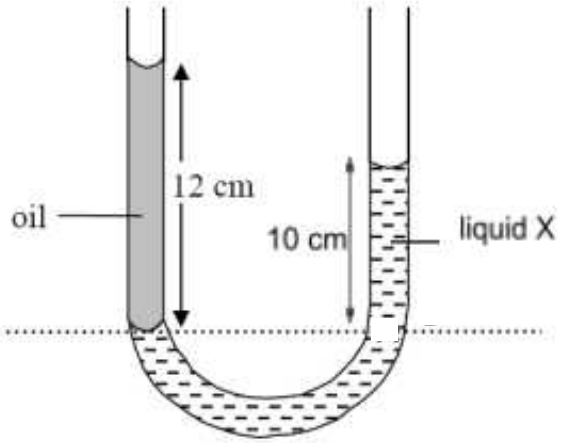


A tube links the master piston to the slave piston. Both pistons are cylindrical and the diameter of the slave piston is **twice** that of the master piston. The driver presses down on the pedal and a force of 450 N is applied on the master piston.

What is the force applied by the slave piston to the brake pad?

A 113 N **B** 225 N **C** 900 N **D** 1 800 N

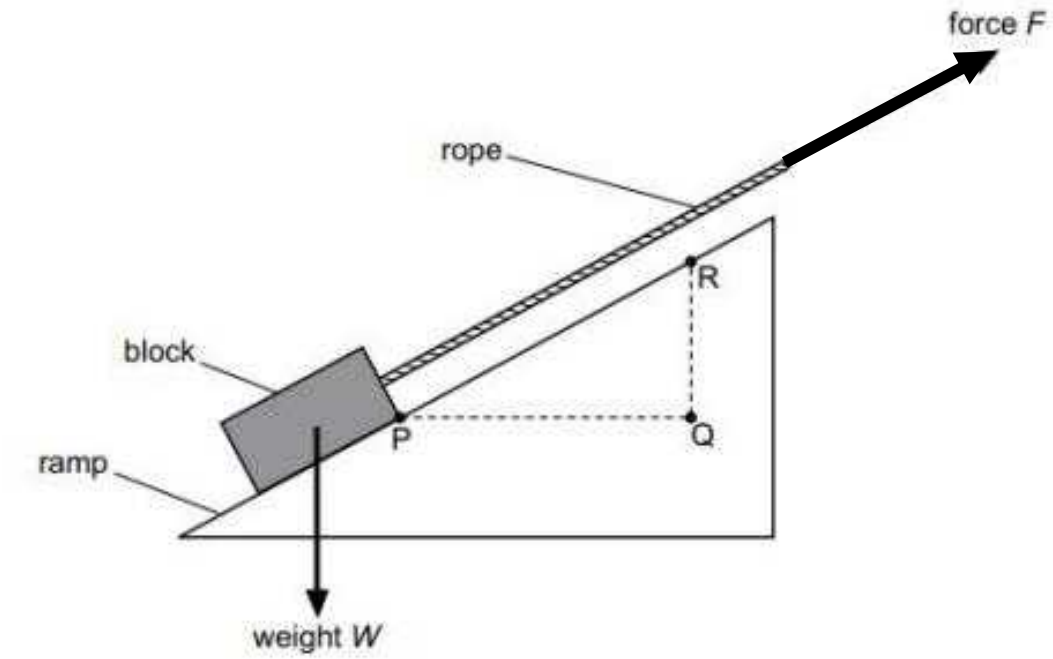
10 A U-tube containing oil and liquid X is shown in the figure below. The two liquids do not mix. The density of oil is 900 kg / m^3.



What is the density of liquid X?

A 750 kg / m^3 **B** 1 000 kg / m^3 **C** 1 080 kg / m^3 **D** 1 200 kg / m^3

11 The diagram shows a block being pulled up a **rough** ramp by a rope.
The block has weight *W* and the rope is pulled with force *F*. The block moves a distance PR along the ramp and is raised through a height QR.



What is the equation for the work done on the block by the rope?

A force *F* × distance PR
B force *F* × distance QR
C weight *W* × distance PQ
D weight *W* × distance QR

12 The diagram below shows an arrow being shot upwards, reaching its maximum height after some time. Air resistance acts on the arrow during its flight.

Which one of the following correctly states the energy transfers taking place just before the arrow reaches its maximum height?

	energy in gravitational potential store (GPE)	energy in kinetic store (KE)	GPE + KE
A	decreases	increases	decreases
B	decreases	increases	unchanged
C	increases	decreases	decreases
D	increases	decreases	unchanged

13 A student is studying Brownian motion.

Using a microscope, she observes smoke particles in a glass container, illuminated by a strong light. The smoke particles move in a zig-zag path, constantly changing speed and direction.

What happens to the smoke particles, if the air in the container is heated?

A They change direction more frequently.
B They increase in volume.
C They move faster than air molecules in the container.
D They move further apart.

14 The list below gives three properties of different states of matter.

1 They are incompressible.
2 They can flow.
3 They completely fill the container they are placed in.

Which properties are correct for liquids?

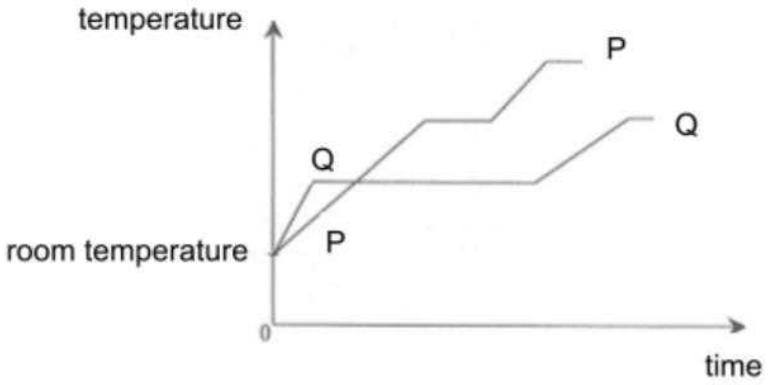
A 1 and 2 only.
B 2 and 3 only.
C 1 and 3 only.
D 1, 2 and 3.

15 Two objects, A and B, are placed in physical contact with one another. They have the same temperature. Assume there is no energy transfer to the surrounding media.

Which statement is correct?

A There is energy transfer from all molecules in A to all molecules in B.
B There is energy transfer from some molecules in A to some molecules in B, as well as from some molecules in B to some molecules in A.
C There is energy transfer from some molecules in A to some molecules in B, but no energy transfer from some molecules in B to some molecules in A.
D There is no energy transfer between any molecule in A to any molecule in B.

16 The graph shows the change in temperature of equal masses of two substances P and Q when they are heated separately by heaters of identical power.



Which of the following statements is correct?

A The energy required to raise the temperature of P from room temperature to boiling point is more than that of Q.
B The melting point of P is lower than Q.
C The specific heat capacity of P in solid state is larger than that of Q.
D The specific latent heat of fusion of P is larger than that of Q.

17 The temperature of a body increases by 1 °C. Its state remains the same.

Which other quantity of the body also increases?

A heat capacity
B internal energy
C latent heat
D potential energy of molecules

18 Which of the following quantities decreases when evaporation of water in a beaker occurs?

A average kinetic energy of water molecules
B average potential energy of water molecules
C humidity of air above water surface
D specific heat capacity of remaining water in beaker

19 Which of the following processes does **not** show that waves transfer energy without transferring matter?

A infra-red radiation emitted from the Sun to a planet with no atmosphere
B sound from a clarinet in a musical performance reaching the ear of the conductor
C transverse waves in a slinky (spring) by a person moving his hand up and down repeatedly
D water waves in the ocean due to a moving ship

20 A girl blows a whistle close to a cliff face.

The echo she hears has the same pitch as the original sound but it is quieter.

Which statement about the wave reflected from the cliff compared to the original sound is correct?

A It has the same amplitude but a lower frequency.
B It has the same frequency but a lower speed.
C It has the same speed but a lower wavelength.
D It has the same wavelength but a lower amplitude.

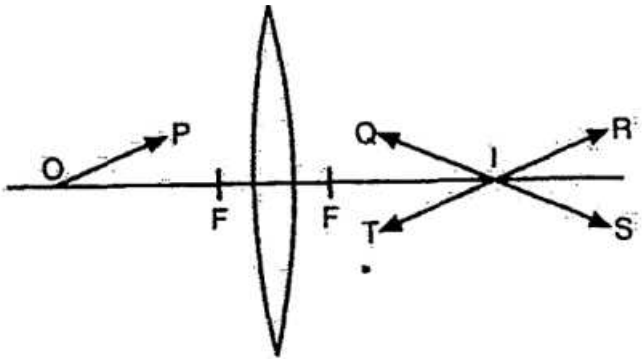
21 Which of the following, in the electromagnetic spectrum, has the shortest wavelength?

A gamma rays
B microwaves
C radio waves
D X-rays

22 Which statement applies to **both** gamma rays and X-rays?

A They are used for security screening at airports.
B They can be detected by Geiger-Muller counters.
C They can result in the growth of cancer cells.
D They travel at a faster speed in water than in vacuum.

23 A point object O moves from the principal axis of a converging lens in a direction OP as shown in the diagram.

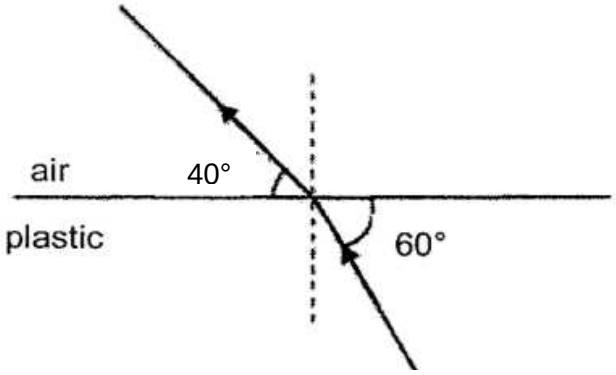


I is the image of O.

Which direction will I move subsequently?

A IQ **B** IR **C** IS **D** IT

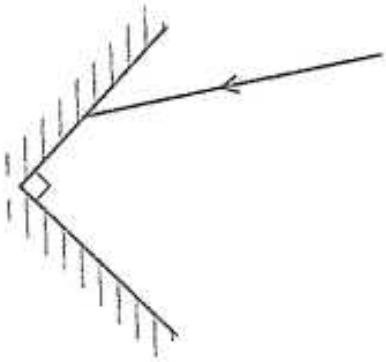
24 The diagram shows a ray of light travelling from plastic to air.



What is the refractive index of the plastic?

A 0.653 **B** 0.742 **C** 1.35 **D** 1.53

25 A ray of light hits the two mirrors placed at a right angle as shown in the diagram. The angle of incidence at the first mirror is 72°.

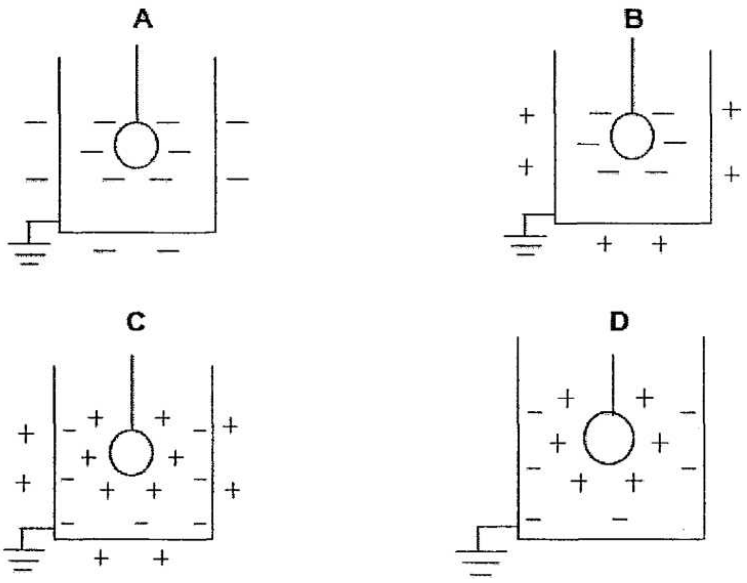


The ray is then reflected from the second mirror.

Through which angle has the direction of the ray changed due to the two reflections from both mirrors?

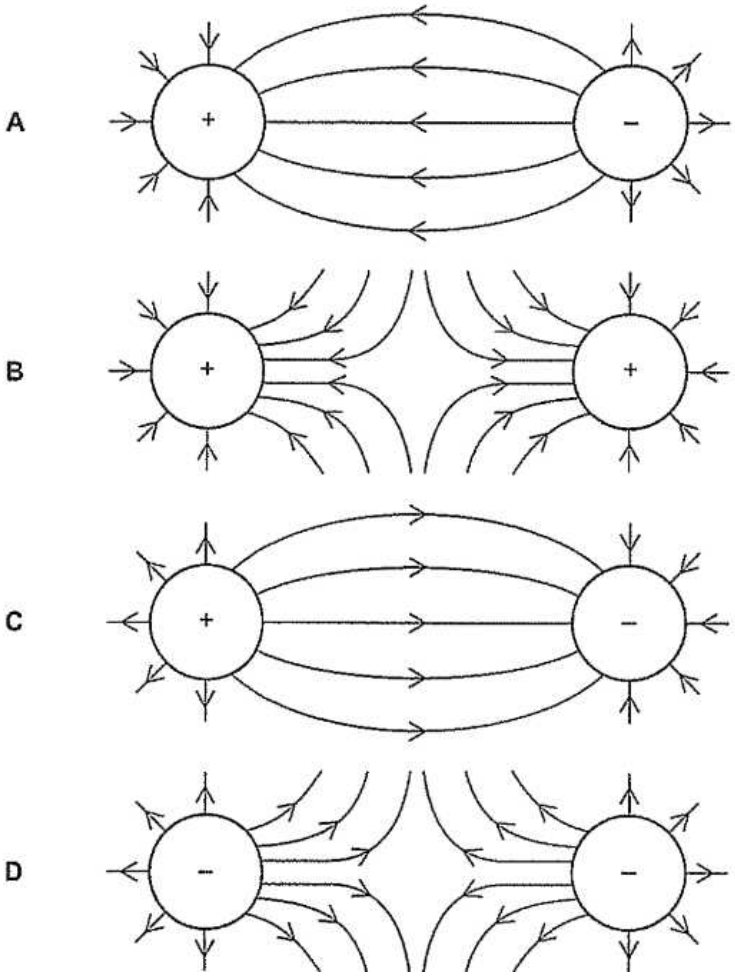
A 108° **B** 144° **C** 180° **D** 360°

26 A charged sphere is suspended by an insulating thread inside a metal can. The outside of the can is earthed.



Which diagram shows the final charges on the sphere and on the can?

27 Which diagram shows the electric field pattern between two charged spheres?

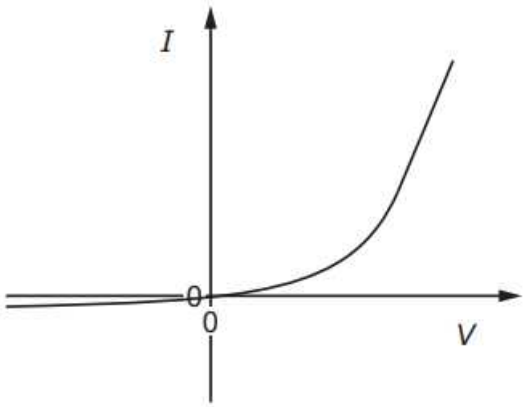


28 The potential difference between the ends of a resistance wire is 40 V. A current of 80 mA flows through the resistance wire in 350 μs.

How much energy is transferred electrically to the resistance wire?

A 0.7 μJ **B** 1.12 mJ **C** 1.12 MJ **D** 700 J

29 The graph shows the I-V characteristic for a semiconductor diode.



Which statement can be deduced from the graph?

A Above a certain positive potential difference, the diode obeys Ohm's Law.
B The current is directly proportional to potential difference when the current in the diode is in one direction.
C The diode has zero resistance when the current through the diode is in one direction.
D The resistance of the diode depends on the potential difference across it.

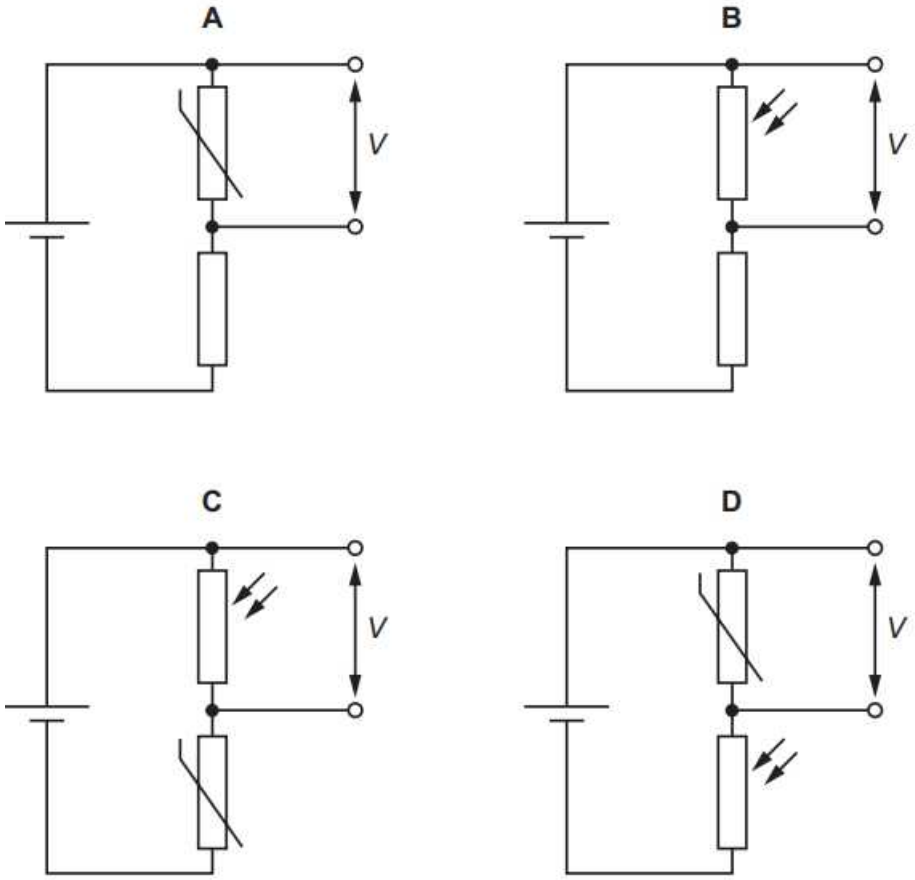
30 The sum of the currents entering a junction in an electrical circuit is always equal to the sum of the currents leaving the junction.

What is this due to?

A conservation of charge
B conservation of electromotive force
C conservation of energy
D conservation of potential difference

31 In the circuits shown, the light intensity remains constant.

In which circuit does the potential difference (p.d.) *V* increase with increasing temperature?



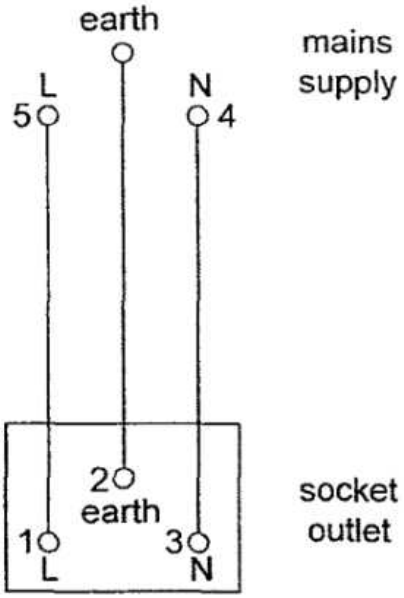
32 An electrical cable contains three wires: live, neutral and earth. The cable is correctly wired to a plug which contains a 3 A fuse. The cable insulation becomes damaged and the bare metal wires are exposed. Five possible events may occur:

- A person touches the earth wire.
- A person touches the neutral wire.
- A person touches the live wire.
- The live wire touches the neutral wire.
- The live wire touches the earth wire.

How many of these events will cause the fuse in the plug to blow?

A 2
B 3
C 4
D 5

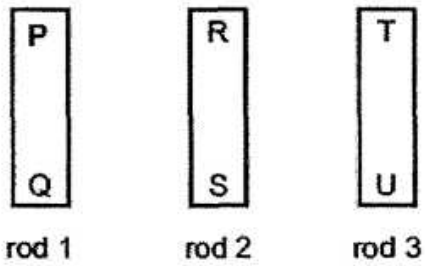
33 The wiring from a 240 V mains supply to a socket outlet in a house is shown below in the diagram.



To measure the voltage at the socket outlet, where should the voltmeter be connected?

A 1 and 3 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

34 A student conducts an experiment to find out whether there is/are magnet(s) among the metal rods 1, 2 and 3 shown below, by placing the ends of the rods close to other ends of the other rods.

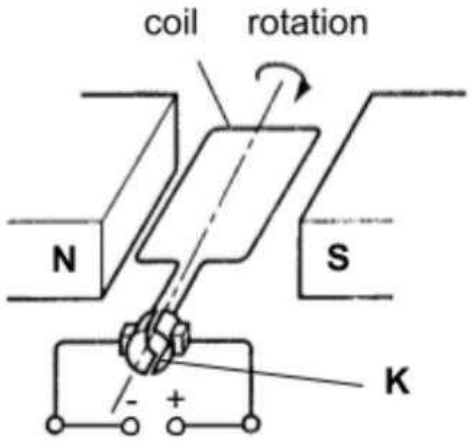


	end R	**end S**	**end T**	**end U**
end P	No observation	No observation	Attraction	Attraction

Which of the following statements is definitely correct?

A None of the rods are magnets.
B Rod 3 is a magnet.
C Rods 1 and 3 are magnets.
D The results obtained are inconclusive.

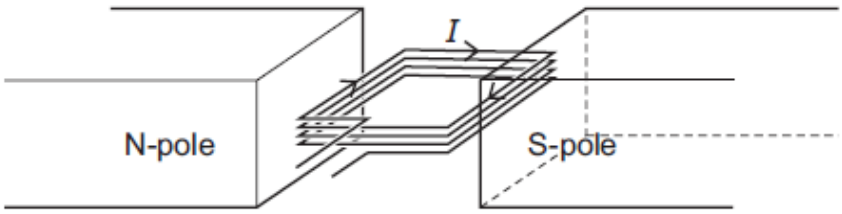
35 The diagram below shows a simple d.c. motor.



What is the main function of K?

A It acts as a contact between the coil and the connecting wires.
B It increases the strength of the magnetic flux experienced by the coil.
C It induces an e.m.f. in the coil and causes it to rotate.
D It reverses the direction of the current in the coil every half a cycle.

36 A coil P of N turns is made from a length L of wire. The coil carries a current I when between two magnetic poles.

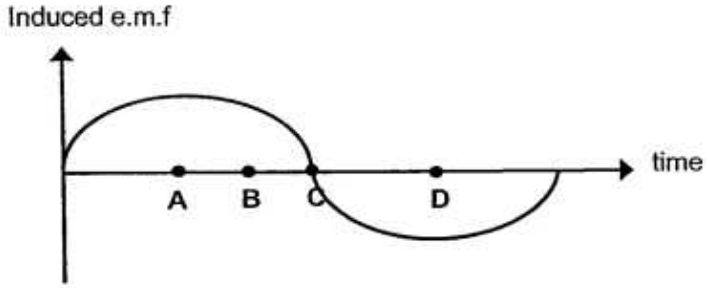


A similar coil Q of $2N$ turns is made from a length $2L$ of identical wire. It also carries the same current I when between the two magnetic poles.

Which coil has the greater resistance and which coil experiences the greater turning effect?

	greater resistance	greater turning effect
A	P	P
B	P	Q
C	Q	P
D	Q	Q

37 When an a.c. generator is rotating in a magnetic field, the induced e.m.f. changes due to the position of the coil.



Which point on the graph shows that the plane of the coil is at an angle of 45 degrees to the direction of the magnetic field?

38 A transformer has 500 turns on the primary coil and 1 500 turns on the secondary coil. The primary coil draws a current of 0.5 A from a 230 V a.c. supply. The current in the secondary coil is 0.15 A.

What is the efficiency of the transformer?

A 9%
B 10%
C 90%
D 91%

39 Three different radioactive nuclides P, Q and R each decay by three different successive emissions.

P emits α, α, β
Q emits α, β, β
R emits β, β, β

Which nuclide produces a final nucleus that has the same proton number as its starting nucleus, and which nuclide produces the same nucleon number as its starting nucleus?

	same proton number	same nucleon number
A	P	Q
B	P	R
C	Q	P
D	Q	R

40 When a nucleus of uranium-235 absorbs a neutron in a nuclear reactor it undergoes fission to form various products and release further neutrons.

In one nuclear reaction involving the fission of uranium-235, barium-144 and another element, Z are products. Two neutrons are also released when these products are formed. The reaction is shown in the equation.

$$^{235}_{92}\mathrm{U} + \mathrm{n} \rightarrow {}^{144}_{56}\mathrm{Ba} + \mathrm{Z} + 2\,\mathrm{n}$$

How many neutrons are there in the nucleus of Z?

A 34 **B** 36 **C** 53 **D** 54

END OF PAPER

Paper 2A	☐ s.f. ☐ formula	70

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS

6091/02

Paper 2 Structured and Free Response

23 August 2024
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black link.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

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, as more marks are awarded for sound use of Physics than for correct answers.

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

For examiner's use only:

Section A	/ 70
Section B	/ 10
Total	**/ 80**

Overall	Marks	%
Paper 1	40	30%
Paper 2A	70	50%
Paper 2B	10	
Paper 3	40	20%

Section A

Answer **all** the questions in this section.

1 A ball is thrown vertically upwards from ground level. Air resistance is **not** negligible. The variation with time *t* of the velocity *v* of the ball is shown in Fig. 1.1.

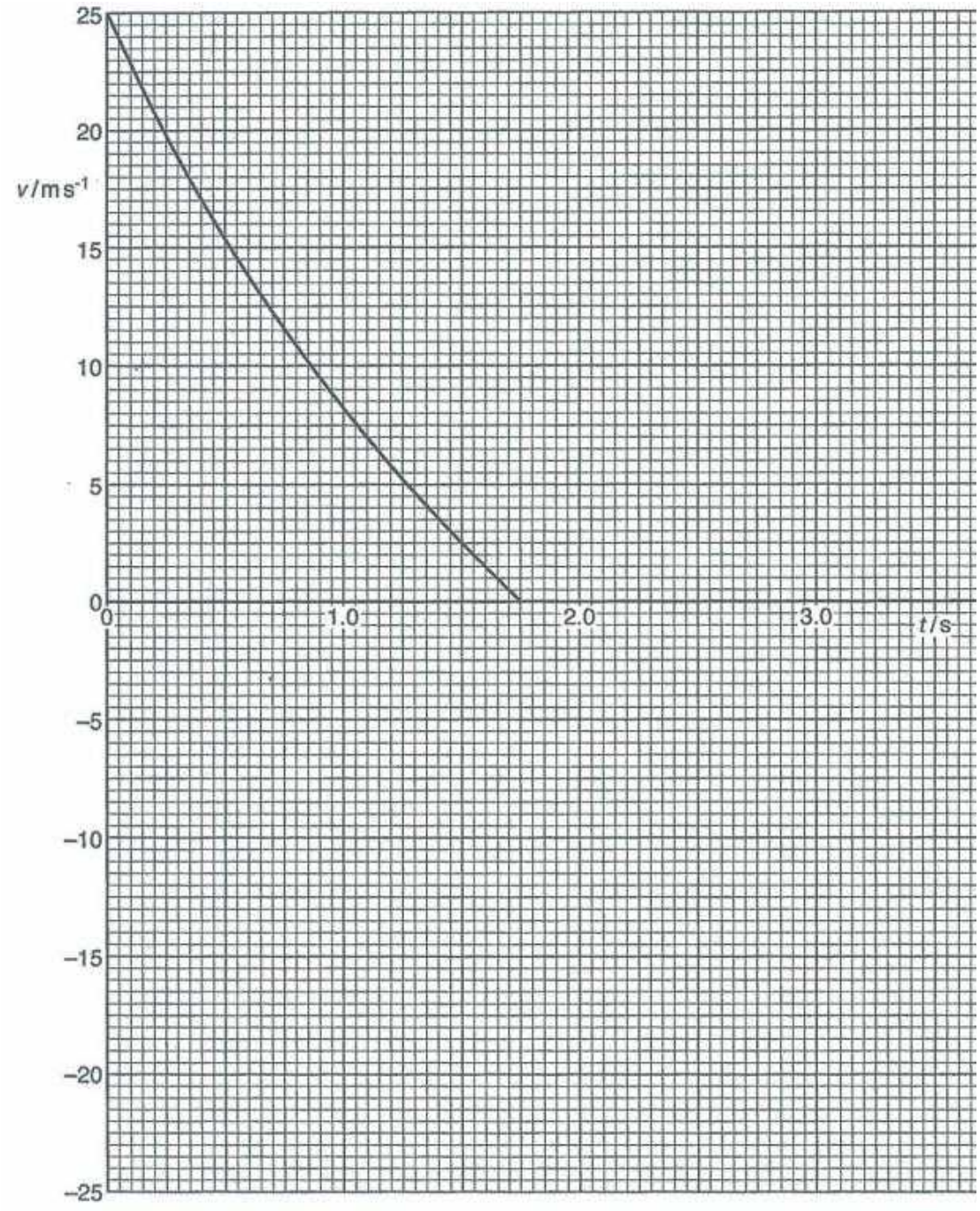


Fig. 1.1

(a) **(i)** Describe the motion of the ball from $t = 0$ s to $t = 1.75$ s.

.....

.....

..... [2]

(ii) Explain, in terms of forces acting, why the ball moves as described in **(a)(i)**.

.....

.....

.....

..... [3]

(b) State the time where the gradient of the graph is equal to the magnitude of the acceleration of free fall.

time = ... [1]

(c) The ball falls back to ground level at $t = 3.50$ s without reaching terminal velocity.

Sketch, on Fig. 1.1, the variation of the velocity of the ball with time from $t = 1.75$ s to $t = 3.50$ s.

[2]

2 Fig. 2.1 shows an electric motor and pulley wheel being used to raise a load M. The electric motor uses a belt to turn the pulley wheel.

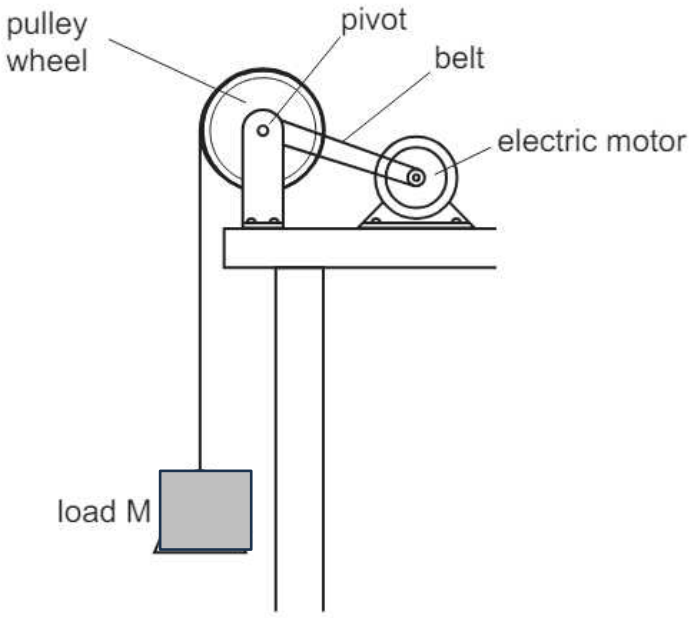


Fig. 2.1

(a) When the electric motor lifts the load, it transfers energy.

Describe the energy transfers between **the electric motor, the load M and the surrounding air**.

Assume there are no energy transfers to the belt and pulley wheel.

.....

.....

.....

.....

..... [3]

(b) Fig. 2.2 shows the force on the pulley from the load M.

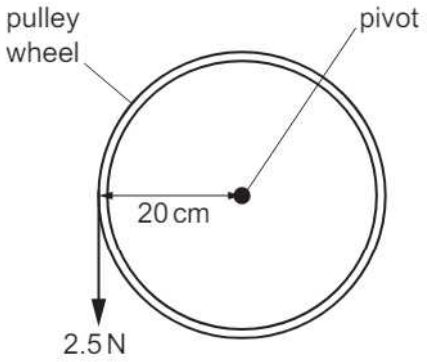


Fig. 2.2

The weight of load M is 2.5 N and the weight acts at a distance of 20 cm from the pivot of the pulley wheel.

Calculate the moment of the weight of load M about the pivot.

moment = ... [2]

(c) Fig. 2.3 shows the dimensions of load M.

The load is removed from the pulley and dropped into a tank containing an unknown liquid. It is completely submerged in the liquid and remains stationary with the same orientation shown in Fig. 2.3 without touching the base of the tank.

The gravitational field strength *g* is 10 N / kg.

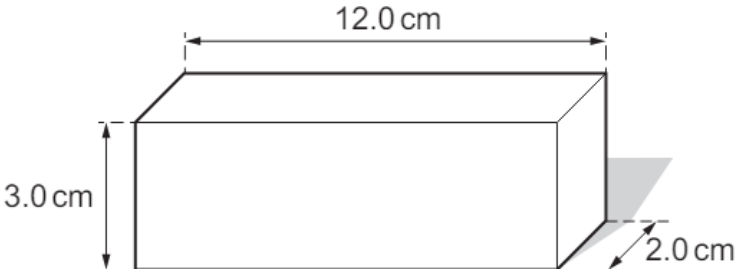


Fig. 2.3 (not to scale)

Show that the density of the unknown liquid is 3 500 kg / m^3.

[2]

3 A cylinder that contains a fixed amount of a gas is shown in Fig. 3.1.

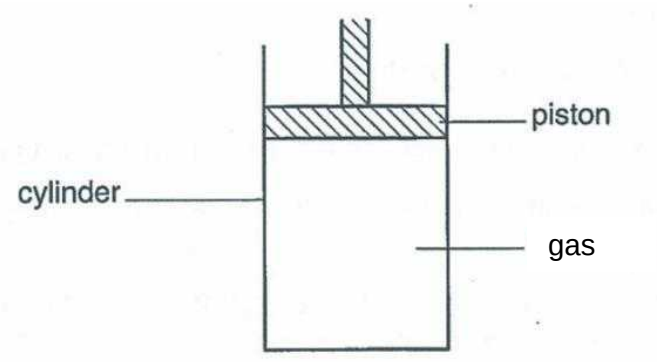


Fig. 3.1

The cylinder is fitted with a piston that moves freely.

(a) Explain how the molecules of the gas produce a pressure on the piston.

.....

.....

..... [2]

(b) The gas in the cylinder is heated.

Explain, using ideas about molecules, why a downward force needs to be applied on the piston to keep the volume of the gas constant.

.....

.....

..... [2]

(c) An engineer using the cylinder wants to minimise heat transfer from the gas to the surrounding air.

Suggest why:

(i) the piston is made of wood,

.....

..... [1]

(ii) the piston has a seal around it, which prevents the movement of air into and gas out of the cylinder,

.....

..... [1]

(iii) the outer walls of the cylinder are silver in colour.

.....

..... [1]

4 A loudspeaker emits a sound wave, which is a longitudinal wave. The variation of the air pressure with distance from the loudspeaker at a particular time is shown in Fig. 4.1.

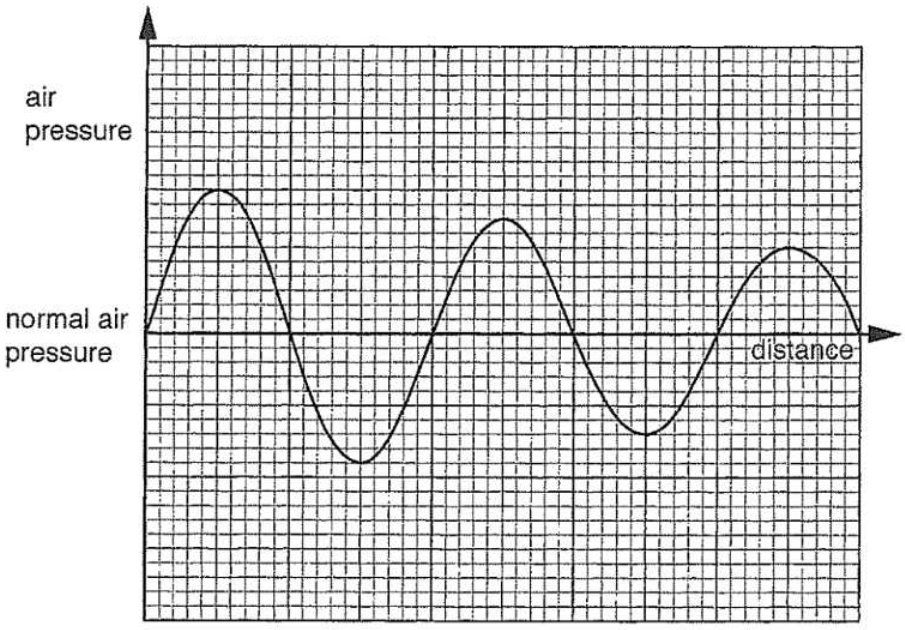


Fig. 4.1 (not to scale)

(a) State what is meant by a *longitudinal wave*.

_____

_____ [1]

(b) On Fig. 4.1,

(i) draw a line with arrows to indicate the wavelength of the wave, and label this line as **W**,

(ii) mark a point to show a centre of rarefaction, and label this point as **R**,

(iii) mark a point where the air molecules are at the maximum displacement from their rest positions, and label this point as **M**.

[3]

(c) A student is standing at point A which is at a distance of one wavelength from the loudspeaker. He moves to point B which is at a distance of two wavelengths from the loudspeaker.

He claims that as he moves from A to B, the frequency of the sound wave decreases.

State and explain whether the claim is correct.

.....

.....

..... [2]

(d) The speed of the sound wave is 330 m / s. The wavelength of the sound wave is 3.3 m.

Sketch, on Fig. 4.1, the variation of the air pressure with distance from the loudspeaker after 15 ms.

Show all relevant workings below.

[2]

5 Fig. 5.1 illustrates three ways in which different electromagnetic waves may be used to send television signals into a home.

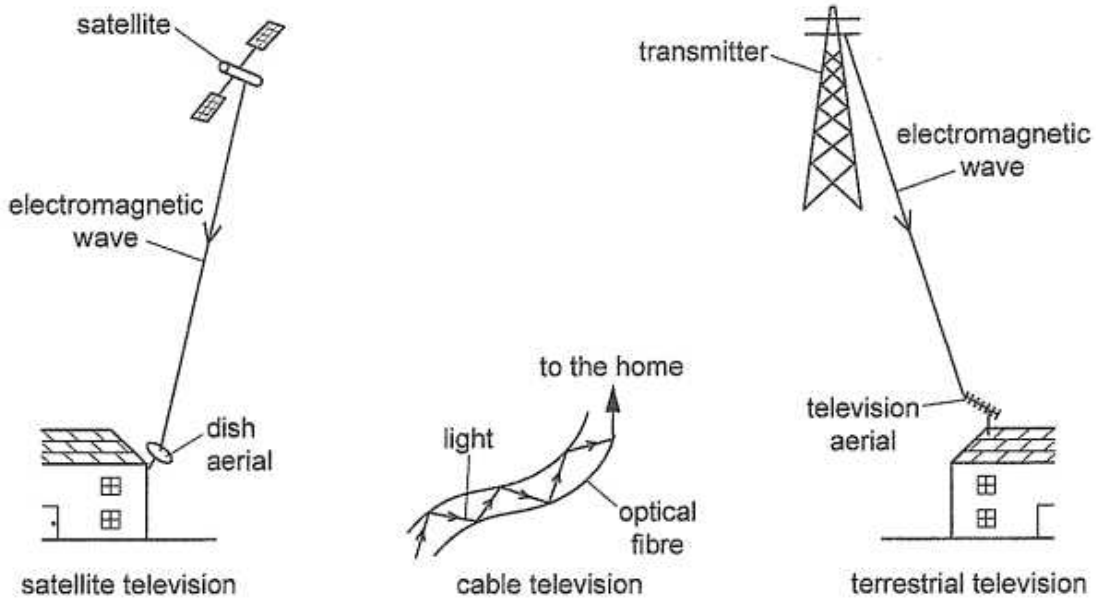


Fig. 5.1

In a satellite television, electromagnetic waves travel from a satellite in outer space to a dish aerial on the ceiling of the home.

In a cable television, light travels through optical fibres to the home.

In a terrestrial television, electromagnetic waves travel from a transmitter on Earth to a television aerial in the home.

(a) State the region of the electromagnetic spectrum used in each of these systems.

satellite .....

terrestrial .....

[2]

(b) A satellite is in orbit at a height of 36 000 km above the Earth's surface.

Calculate the time it takes for a signal to travel from the satellite to the dish aerial on Earth.

time = ... [2]

(c) In cable television, light is transmitted through an optical fibre, which is made of a core of plastic surrounded by an outer wall of glass.

(i) Explain why the light is not refracted out of the optical fibre, but stays within the walls of the optical fibre.

.....

.....

..... [2]

(ii) Hence, or otherwise, state one advantage of optical fibres over copper wires.

.....

..... [1]

6 Fig. 6.1 shows an electrical plug that is wrongly connected to an electrical heater with a metal casing.

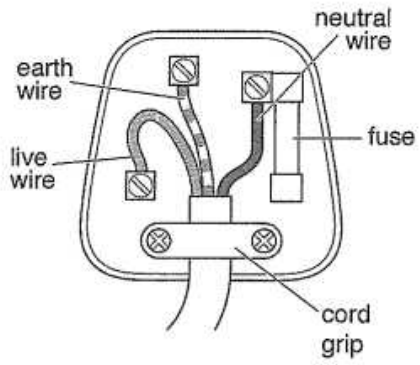


Fig. 6.1

(a) State the colours of the wires given below.

live .....

neutral .....

earth .....

[1]

(b) State two connections that are wrong with the wiring in Fig. 6.1.

.....

.....

[1]

(c) Explain why the connections described in **(b)** could be potentially dangerous.

.....

.....

.....

[2]

(d) Explain how double insulation of the electrical heater could remove the danger described in **(c)**.

.....

.....

.....

[2]

7 Fig. 7.1 shows two vertical, cylindrical tubes and a cylindrical magnet all held in a vacuum.

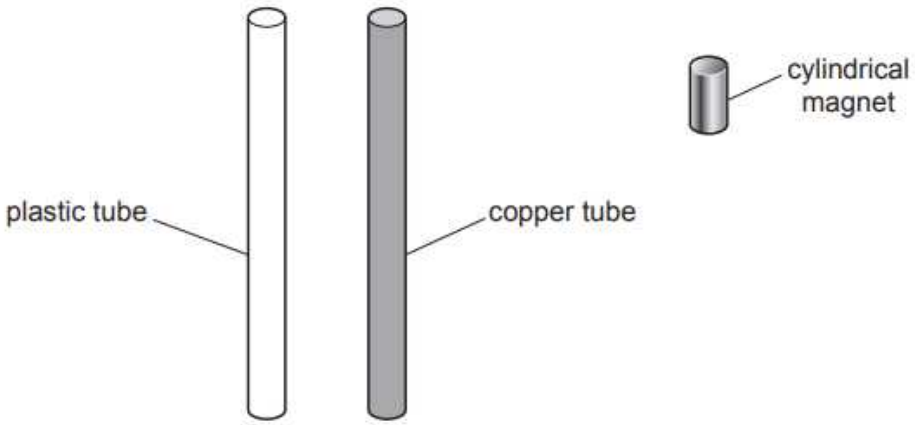


Fig. 7.1 (not to scale)

One tube is made of plastic and the other tube is made of copper. The two cylindrical tubes have identical dimensions.

The magnetic field of the cylindrical magnet is extremely strong.

The magnet is released from rest at the top of the plastic tube and copper tube respectively, and the time taken for the magnet to fall to the lower end of each tube is recorded.

(a) State which material of tube the magnet takes a longer time to fall to its lower end.

material = ... [1]

(b) Explain why there is an induced current in the tube stated in **(a)**.

.....

.....

.....

..... [3]

(c) Hence, explain, in terms of forces acting, why the magnet takes a longer time to fall to the lower end of the tube stated in **(a)**.

.....

.....

..... [2]

(d) When the magnet falls towards the top of the tube stated in **(a)**, the induced current in the tube flows in a clockwise direction when viewed from the top of the tube.

State which pole of the cylindrical magnet enters the tube first.

.....[1]

8 Plutonium-239 decays by α-emission to form the isotope uranium-X.

A sample of plutonium-239 emitting α-particles produced the following results in Table 8.1 when its emission was measured at different distances from it and at different times. The count rate from background radiation was taken and found to be 20 per minute.

Table 8.1

distance / cm	count rate / minute (t = 0)	count rate / minute (t = 12 000 years)	count rate / minute (t = 24 000 years)	count rate / minute (t = 36 000 years)
1.0	3 620	2 570	1 820	1 290
2.0	920	656	470	338
3.0	420	303	220	161

(a) State one possible source of the background radiation.

.....[1]

(b) A nuclear physicist claims that the count rate per minute due to plutonium-239 **alone** is inversely proportional to the square of the distance from it.

Using data from the column for count rate per minute at t = 0, show that the claim is true.

[2]

(c) **(i)** State the half-life of plutonium-239.

half-life = ... [1]

(ii) Hence, determine the time when the measured count rate, at a distance of 3.0 cm, will be 70 per minute.

time = ... [1]

(d) Write the nuclear equation for the alpha decay of plutonium-239 to uranium-X.

The chemical symbols for plutonium and uranium are Pu and U respectively, and the proton number of uranium is 92.

[2]

(e) Explain why α-particles are not suitable for measuring the thickness of paper, and suggest an alternative type of nuclear emission which is suitable.

.....

.....

..... [2]

(f) Suggest one precaution to control human exposure to ionising radiation.

.....

..... [1]

9 A battery with an electromotive force (e.m.f.) of 9.0 V is connected in series with a light-dependent resistor (LDR) R_L and a fixed resistor of resistance 1 800 Ω, as shown in Fig. 9.1.

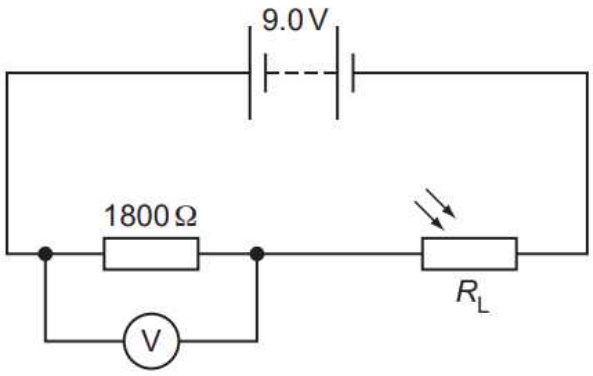


Fig. 9.1

(a) State what is meant by "an e.m.f. of 9.0 V".

.....

..... [1]

(b) A voltmeter is connected across the fixed resistor. The reading on the voltmeter is 6.3 V.

Calculate

(i) the current in the circuit,

current = ... [1]

(ii) the resistance R_L of the LDR.

resistance = ... [2]

(c) An electrical engineer wishes to connect a lamp within the circuit so that it lights up when light intensity decreases.

On Fig. 9,1, draw the lamp connected within the circuit, and explain how this connection helps the engineer to achieve his objective.

.....

.....

..... [2]

(d) At a certain low level of light intensity, the resistance of the lamp becomes four times the resistance of the LDR.

State and explain whether the lamp or the LDR dissipates more power.

.....

.....

..... [2]

(e) State two changes that can be made to the filament of the lamp in **(d)** so that its resistance will decrease to be the **same** as the resistance of the LDR. Assume that the material of the filament remains the same.

(1) .....

.....

(2) .....

..... [2]

Paper 2B	☐ s.f. ☐ formula	10

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS

6091/02

Paper 2 Structured and Free Response

23 August 2024

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

Section B

Answer only **one** of the two questions.

10 Two examples of fields in Physics are the electric field and the magnetic field.

(a) Define *electric field*.

.....

.....

..... [1]

(b) A pair of parallel charged plates of opposite charge are placed on a surface as shown in Fig. 10.1. It can be assumed that there is no flow of charge between the plates and the surface.

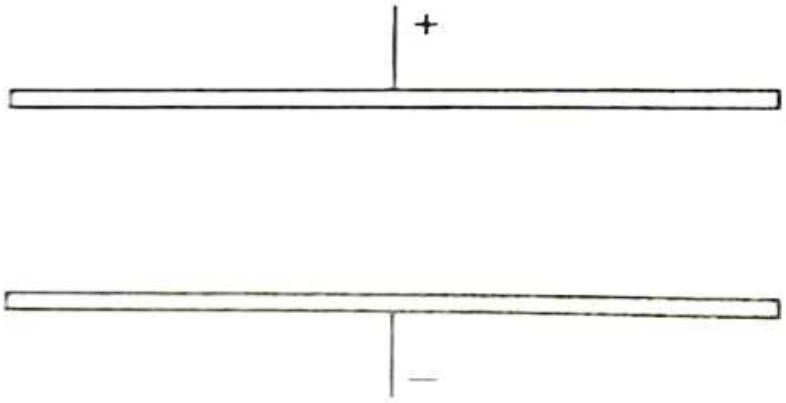


Fig. 10.1

(i) On Fig. 10.1, draw the electric field pattern in the region between the parallel plates.

[1]

(ii) The parallel plates are now placed in a region with a uniform magnetic field.

An electron is placed in between the parallel plates and immediately given a slight horizontal push to the right. The electron subsequently moves horizontally to the right with constant velocity.

By considering the **magnitudes** and **directions** of the **electrostatic and magnetic forces acting on the electron**, explain why the electron moves horizontally with constant velocity.

.....

.....

.....

..... [3]

(iii) **1.** On Fig. 10.1, draw the magnetic field pattern that causes the direction of the force on the electron stated in **(b)(ii)**.

[1]

2. Explain how you determined the direction of the magnetic field in **(b)(iii)1**.

.....

.....

..... [2]

(iv) The electron emerges out from the parallel plates to point C, and approaches an uncharged metal rod along the direction CX as shown in Fig. 10.2.

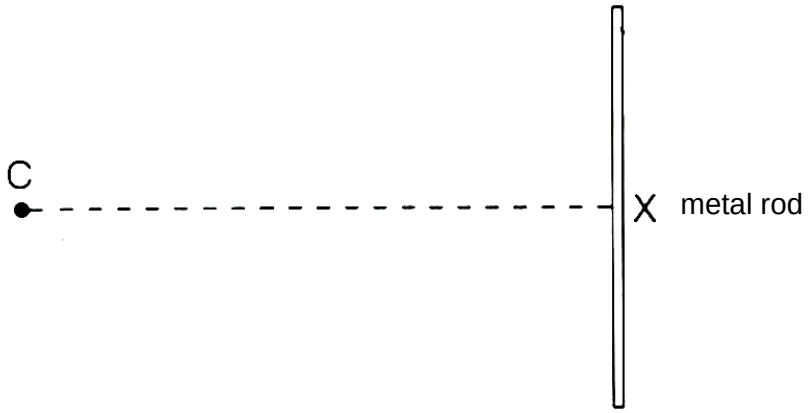


Fig. 10.2

Explain why the electron accelerates towards the metal rod.

.....

.....

..... [2]

11 Water exists in three different states, namely solid, liquid and gaseous. The same mass of water in different states has a different amount of energy in its internal store.

(a) **(i)** Define *internal energy*.

.....

.....

..... [2]

(ii) Hence, explain why steam at a temperature of 100 °C feels hotter to the touch than the same mass of water at the same temperature.

.....

.....

..... [2]

(b) 200 g of ice cubes at a temperature of 0 °C are poured into a container containing an electrical heater and 50 g of water at a temperature of 100 °C.

Ice melts at 0 °C.

The following data are provided:

- current through electrical heater = 3.0 A
- electromotive force (e.m.f.) of electrical heater = 24 V
- time electrical heater is switched on = 15 minutes
- specific heat capacity of ice = 2.1×10^3 J / (kg °C)
- specific heat capacity of liquid water = 4.2×10^3 J / (kg °C)
- specific latent heat of fusion of water = 334 J / g
- specific latent heat of vaporisation of water = 2.3×10^3 J / g

(i) Show that the energy transferred electrically by the heater is 64.8 kJ. [1]

(ii) Hence, determine the final temperature of the mixture.

final temperature = ... [3]

(iii) In reality, the actual final temperature of the mixture is different from the value in **(b)(ii)**.

State and explain whether the actual final temperature of the mixture is higher or lower than the value in **(b)(ii)**.

.....

.....

..... [2]

--- END OF PAPER ---

2024 CHS SEC 4 PHYSICS PRELIMINARY EXAMINATION

Paper 1

1	***C***	**2**	***D***	**3**	***B***	**4**	***A***	**5**	***D***
6	***D***	**7**	***D***	**8**	***B***	**9**	***D***	**10**	***C***
11	***A***	**12**	***C***	**13**	***A***	**14**	***A***	**15**	***B***
16	***C***	**17**	***B***	**18**	***A***	**19**	***A***	**20**	***D***
21	***A***	**22**	***C***	**23**	***C***	**24**	***D***	**25**	***C***
26	***D***	**27**	***C***	**28**	***B***	**29**	***D***	**30**	***A***
31	***C***	**32**	***A***	**33**	***A***	**34**	***D***	**35**	***D***
36	***D***	**37**	***B***	**38**	***C***	**39**	***D***	**40**	***D***

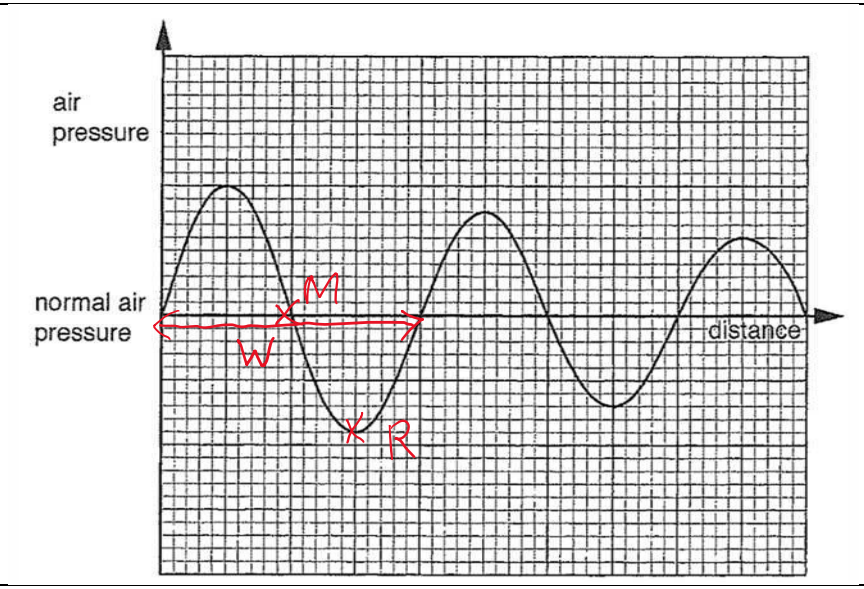
Paper 2 Section A

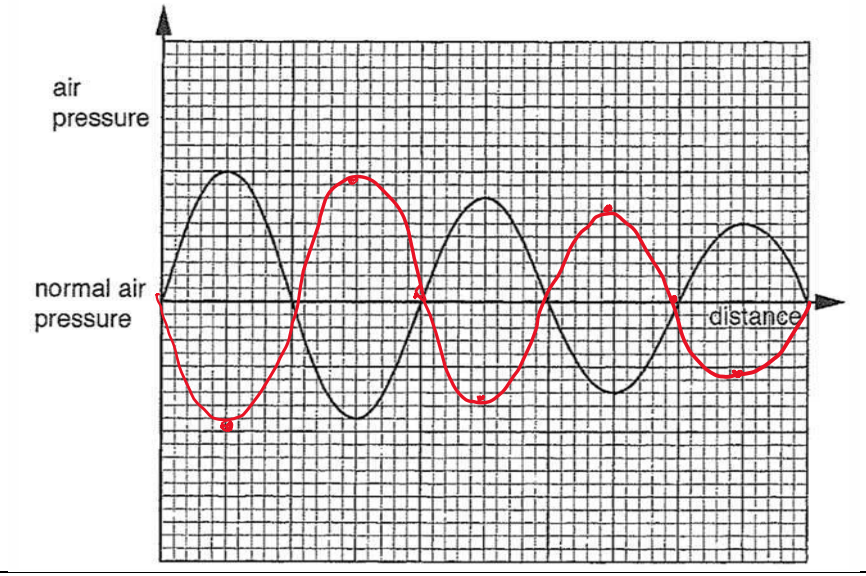
S/N	Mark Scheme	Remarks
1ai	• Ball's speed is decreasing [M1] at a decreasing rate [A1] OR • Deceleration [M1] is decreasing [A1] OR • Acceleration is decreasing [M1] and negative [A1]	1 mark awarded for "ball is decelerating at decreasing rate".
1aii	• (weight and) air resistance acts (on ball) downwards (or in opposite direction to motion/velocity) (resulting in decreasing speed) [B1] • As speed (or velocity) decreases, air resistance decreases [B1] • (downward) resultant force decreases (resulting in decreasing deceleration) [B1]	No credit is awarded for 1st mark if the answer mentions that upward force is acting on the ball as it is moving up.
1b	1.750 s [B1]	No penalty if answer in 2 d.p.
1c	• graph is below x-axis and gradient decreases smoothly without reaching 0 at 3.50 s. [B1] • final velocity, v is below x-axis and 0 m / s < v < 25 m / s [B1]	No penalty if draw past 3.50 s.

2a	• energy transferred <u>mechanically</u> to gravitational potential (and kinetic) store of load [B1]
	• (some) energy is transferred
	  ○ mechanically due to (work done against) friction (or air resistance) [B1] to the internal store of surrounding air (and load). [B1] OR
	  ○ by heating (due to temperature difference) [B1] to the internal store of surrounding air (and load). [B1] OR
	  ○ by propagation of electromagnetic waves / infra-red radiation [B1] to the internal store of surrounding air (and load). [B1] OR
	  ○ by propagation of mechanical / sound waves [B1] to the kinetic store of surrounding air. [B1]
		If student writes "store" at least once, BOD all answers without "store".
		If student does not write "store" at all, penalise 1 mark.
		
		No credit awarded for the method of energy transfer to surrounding air if the energy transfer is not from the motor.

2b	Moment = F x d [formula] = 2.5 x 0.20 [B1] = 0.50 Nm (or 50 Ncm) [B1]	

S/N	Mark Scheme	Remarks
2c	As load is stationary, Upward force due to liquid (F) = Weight of Load M = 2.5 N [B1] $F = pA$ $= (p_{bottom} - p_{top}) \times A$ $= [(h_{bottom} - h_{top}) \rho g] \times A$ $2.5 = [0.030 \times \rho \times 10] \times (0.12 \times 0.02)$ [B1] $\rho = 3\,500$ kg m^{-3}	Accept if student calculated density of load M [B1] and concluded that density of load M and the liquid are the same [B1]
3a	● molecules are in constant random motion [B1] ● collide with (inner walls of) piston, exerting a force per unit area on it [B1]	
3b	● (when gas is heated), molecules collide more frequently and forcefully with (inner walls of) piston, exerting a larger force / pressure (than that due to atmosphere) [B1] ● hence, a downward force (or pressure) is needed to balance this larger force (or pressure) / keep the piston stationary / result in no net force on piston [B1]	
3ci	● wood is a poor conductor/good insulator of heat [B1]	
3cii	● prevents hot gas rising out of the cylinder / prevents surrounding cool air sinking into the cylinder / minimising convection currents [B1]	
3ciii	● reduce heat transfer to surrounding air by infra-red radiation / silver is a poor emitter of infra-red radiation [B1]	Penalise if student writes “absorber” or “absorber and emitter” as question specifically mentions “outer walls”.
4a	● a wave that travels in a direction parallel to the direction of vibration (or oscillation) of particles [B1]	

S/N	Mark Scheme	Remarks
4bi 4bii 4biii		[B1] for W (arrow must be horizontal) [B1] for R (accept any position that is at the lowest point of first 2 cycles) [B1] for M (accept any point where graph intersects with distance axis)
4c	• Frequency of wave depends on the source of vibration, which remains the same. [M1] • Hence, claim is incorrect. [A1]	Also accepted if students say that the wavelength in the graph is constant, (hence since velocity is constant as the medium is constant), then the frequency is constant.
4d	$v = f \lambda$ $f = v / \lambda$ $= 330 / 3.3$ $= 100$ Hz $T = 1/f = 1/100 = 0.01$ s $= 10$ ms As 15 ms corresponds to 1.5 periods later, graph is as drawn below.	[B1] for obtaining T

S/N	Mark Scheme	Remarks
		[B1] for graph shape and correct values of maximum and minimum air pressures
5a	satellite: microwaves [B1] terrestrial: radio waves [B1]	
5b	v = d / t t = d / v = (36 000 x 1000) / (3.0 x 10^8) [B1] = 0.12 s [B1]	Penalise 1 mark for unit conversion error
5ci	● Plastic is an optically denser medium / has a higher refractive index than glass [B1] ● Angle of incidence (in plastic) is larger than critical angle (so total internal reflection occurs) [B1]	
5cii	● lighter (than copper wires) ● cheaper to manufacture (than copper wires) ● experience less signal loss ● carry much more information (than copper wires) ● faster rate of data transmission	[B1] for any answer
6a	live: brown neutral: blue earth: green and yellow	[B1] for all three correct answers
6b	● neutral wire connected to the live pin/fuse and live wire connected to the neutral pin [B1]	Accept “live and neutral wires are swapped in position”

S/N	Mark Scheme	Remarks
6c	● even when fuse is blown (or switch is off), appliance is live / at high potential [B1] ● user can get electrocuted [B1]	
6d	● electrical cables are insulated from (internal components which are in turn insulated from) external casing. [B1] ● user cannot get electrocuted as there is no electrical contact between the user and bare wire(s). [B1]	allow e.c.f. from (c) Also accept if students stated that "even if the first layer of insulation is worn out, there is an additional layer of insulation", or words to that effect.
7a	● copper [B1]	
7b	● When magnet falls, there is a change in magnetic flux experienced by the copper tube. [B1] ● By Faraday's Law, there is an induced electromotive force (e.m.f.) in the tube. [B1] ● As the copper tube forms a closed circuit, there is a current induced in the tube. [B1]	Allow e.c.f. from (a), except for last [B1] as plastic is not an electrical conductor
7c	● By Lenz's Law, induced current creates a magnetic field that opposes the approaching (or departing) pole(s) of the magnet. [B1] ● Magnetic force of repulsion (or attraction) is upwards (opposite to direction of weight), resulting in decreasing (downward) resultant force / acceleration. [B1]	Accept "approaching and departing poles" as well when magnet is within the tube.
7d	South [B1]	
8a	● medical X-rays ● building materials ● waste products from nuclear power stations ● rocks ● radon gas ● cosmic rays from outer space (accept the Sun) ● food high in potassium eg. bananas, carrots, salt [B1]	Any other possible answer
8b	CPM α $1/d^2$ CPM = k/d^2 $k = CPM \times d^2$ When d = 1.0, k = $(3\,620 - 20) \times (1.0)^2 = 3\,600$ When d = 2.0, k = $(920 - 20) \times (2.0)^2 = 3\,600$ When d = 3.0, k = $(420 - 20) \times (3.0)^2 = 3\,600$ Since the values of k are the same, the claim is true.	[B1] to show k is the same for 2 sets of data [B2] to show k is the same for 3 sets of data
8ci	24 000 years [B1]	
8cii	Count rate due to plutonium alone = 70 – 20 = 50 Count rate due to plutonium alone after 1 half-life = 200 Count rate after 2 half-lives = 100 Count rate after 3 half-lives = 50 Hence, t = 3 x 24 000 = 72 000 years [B1]	No working required e.c.f. from (c)(i) ie. 3 times the answer

S/N	Mark Scheme	Remarks
8d	$^{239}_{94}\mathrm{Pu} \rightarrow {}^{235}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He}$	[B1] for correct atomic numbers [B1] for correct mass numbers
8e	● alpha particles are easily absorbed by paper [B1] ● beta particles are suitable [B1]	Do not accept gamma rays as they penetrate through paper regardless of thickness.
8f	● wear lead-lined gloves / suits ● use thick concrete walls and lead-lined doors for rooms in which ionising radiation is produced ● store plutonium in a lead box	Accept “protective / radiation / hazmat suits”
9a	● 9.0 J of work is done per unit charge (by the battery) in driving charges around a complete circuit. [B1]	Accept “per 1 coulomb of charge”
9bi	I = V / R = 6.3 / 1800 = 3.5 mA [B1]	
9bii	By Potential Divider Principle [formula] 6.3 / (9.0 – 6.3) = 1800 / R_L [B1] R_L = 771 Ω [B1] OR $R_L = V_L / I$ = (9.0 – 6.3) / 0.0035 [B1] = 771 Ω [B1]	
9c	● lamp drawn (with correct circuit symbol) in parallel to LDR [B1] ● when light intensity decreases, resistance of LDR increases, causing p.d. across LDR to increase (and lamp to light up). [B1]	
9d	● same p.d. across lamp and LDR, but LDR has smaller resistance than lamp [M1] ● hence, (by $P = V^2 / R$) LDR dissipates more power. [A1]	e.c.f. if lamp is drawn in series to LDR in (c). Answer must be consistent to that of (c).
9e	● reduce length of filament to ¼ of its original length [B1] ● increase cross-sectional area of filament to 4 times its original area (or increase diameter of filament to twice its original diameter) [B1]	Penalise 1 m if both answers do not have numerical factors.

Paper 2 Section B

S/N	Mark Scheme	Remarks
10a	● a region of space in which an electric charge experiences a force. [B1]	
10bi	● (at least 3) parallel equidistant lines with arrows pointing downwards [B1]	
10bii	● force (on electron) due to electric field is (vertically) upwards [B1] ● force (on electron) due to magnetic field is (vertically) downwards (or opposite direction to electrostatic force) and of same magnitude as electrostatic force [B1] ● no net/resultant force [B1]	Award 1 mark overall if direction of electric and magnetic forces are reversed.
10biii1	● at least 1 cross in region between parallel plates [B1]	
10biii2	● using Fleming's Left-Hand Rule [B1] ● thumb representing force is (vertically) downwards and second finger representing current is to the left, (so forefinger representing magnetic field is into plane of paper) (with all three directions mutually perpendicular) [B1]	
10biv	● electron causes electrons in metal rod to move to the right side of the rod as like charges repel [B1] ● force of attraction between electron and positive charge on the left side (of rod) is larger than force of repulsion [B1]	
11ai	● an energy store that is made up of total kinetic energy associated with the random motion of the particles [B1] and the total potential energy between the particles in the system. [B1]	Accept if students say "sum of the kinetic energy and potential energy of all the particles". Penalise 1 m if student mentions "store" for potential or kinetic. Penalise 1 m if student writes "one particle" or "substance/object/body" instead of "particles". No marks awarded for "gravitational potential" instead of "potential".
11aii	● potential energy of steam molecules higher than potential energy of water molecules (while kinetic energy is the same). [B1] ● steam molecules are further apart / steam molecules can move freely in all directions / (higher potential energy) to overcome intermolecular forces of attraction (compared to water molecules) / (higher potential energy) as it has absorbed latent heat of vaporisation [B1]	

S/N	Mark Scheme	Remarks
11bi	$E = Pt$ $= IVt$ $= (3.0)(24)(15.0 \times 60)$ [B1] $= 64.8$ kJ	
11bii	Let final temperature be θ By conservation of energy, Energy transferred electrically + Loss of energy of water = Gain in energy of ice $E + m_w c_w (\Delta\theta_w) = m_i l_f + m_i c_w (\Delta\theta_i)$ $64800 + (0.050)(4200)(100 - \theta)$ [B1] $= (200)(334) + (0.200)(4200)(\theta - 0)$ [B1] $\theta = 18.1$ °C [B1]	Penalise 1 m for wrong unit conversion.
11biii	● some of the energy transferred from the heater and water is used to increase energy in internal store of container / surrounding air. [M1] ● actual temperature lower than (ii) [A1]	No need to write “store”. Accept “some energy is transferred by heating due to temperature difference from surrounding air of higher temperature, so actual temperature higher than (ii)” as long as (b)(ii) answer is lower than typical room temperature.