KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2024 PRELIMINARY EXAMINATION

Secondary 4 Express

NAME

CLASS **REG. NO**

PHYSICS 6091/01

Paper 1 Multiple Choice

27 August 2024

1 hour

Additional Materials: Multiple Choice Answer Sheet

Setter: Mr. Foo Seng Hong

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

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.

This document consists of **15** printed pages including the cover page.

Multiple Choice Questions [40 marks]

Answer **all** questions and shade your answers on the OMR sheet provided.

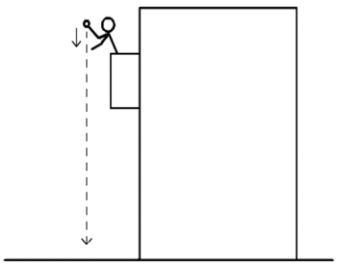
1 What is the order of magnitude of the diameter of a human hair?

A 10^{-8} m **B** 10^{-6} m
C 10^{-4} m **D** 10^{-2} m

2 Which pair contains a vector and a scalar quantity?

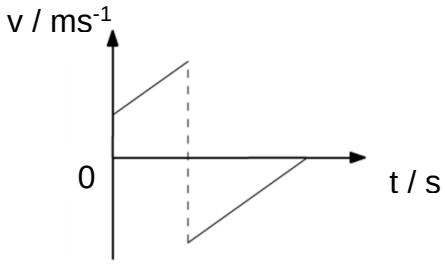
A area and displacement
B distance and volume
C temperature and pressure
D weight and velocity

3 A person drops a ball from rest vertically downwards from a height above ground as shown in the diagram. The ball hits the ground and bounces back up to a maximum height.

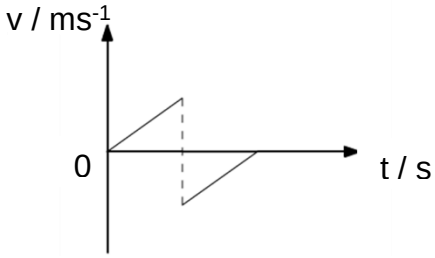


Assuming no loss of energy to the surroundings, which graph best represents the velocity-time graph of the ball?

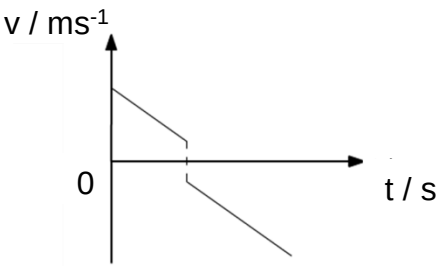
A



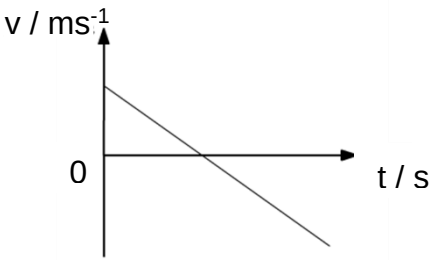
B



C



D



4 A race car is designed to change its high speed very quickly when racing on the track. It can slow down at a deceleration of 20 m/s^2.

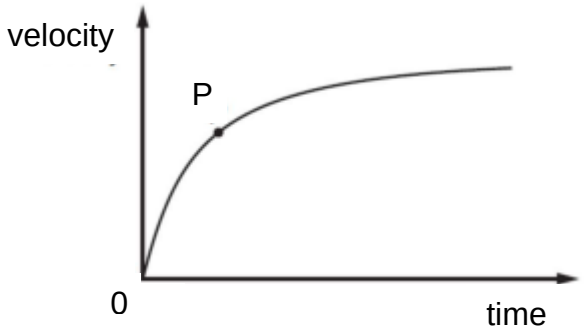
What is its displacement as it comes to a stop in 1.7 s?

A 12 m **B** 29 m
C 34 m **D** 58 m

5 Two forces, 3 N and 7 N respectively, are acting on a small ball-bearing. Which is a possible resultant force acting on the ball-bearing?

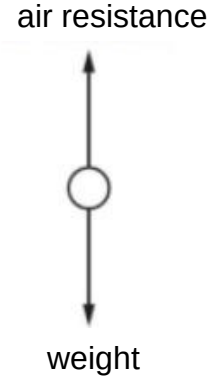
A 1 N **B** 3 N
C 8 N **D** 11 N

6 A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity with time.



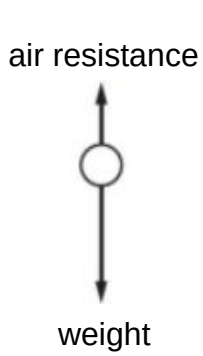
Which diagram shows the forces, drawn to scale, acting on the sphere when it is at the velocity corresponding to point P on the graph?

A

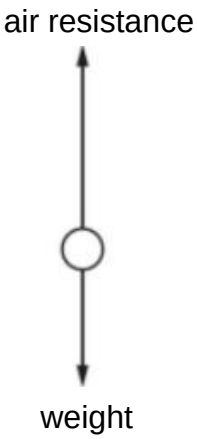


B

C



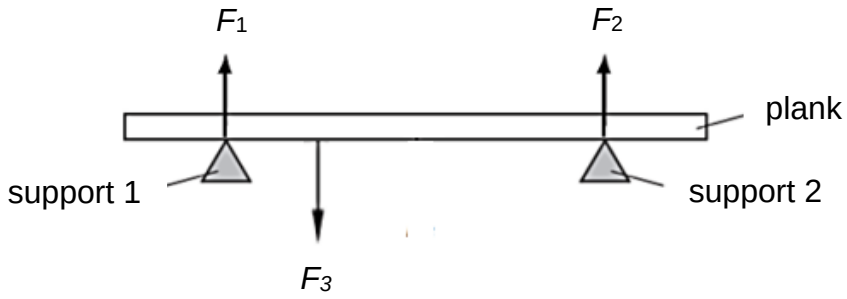
D



7 A mountaineer of weight 700 N at the bottom of Mount Everest climbs to the top. The gravitational field strength changes from 9.81 N/kg at the bottom to 9.79 N/kg at the top. What are his mass and weight at the top of Mount Everest?

	mass at top of Mount Everest / kg	weight at top of Mount Everest / N
A	71.4	699
B	71.4	700
C	71.5	699
D	71.5	700

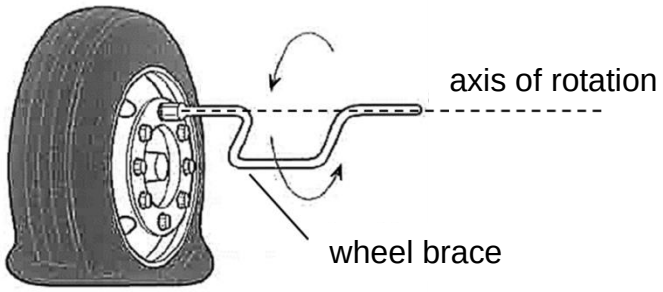
8 The diagram shows a heavy non-uniform wooden plank resting on two supports which act as pivots (not to scale). Three forces F_1, F_2 and F_3 are acting on the plank. The plank is in equilibrium.



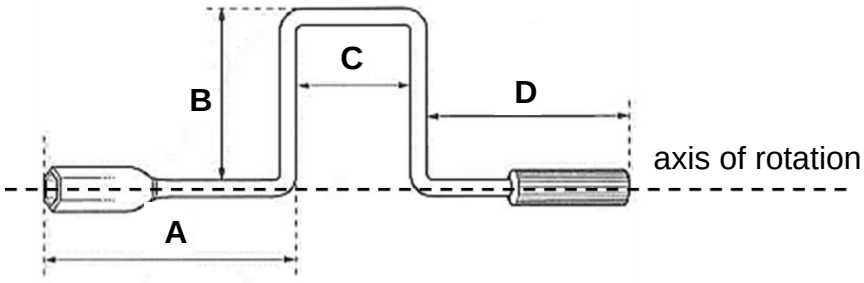
Which statement is correct?

A F_1 is larger than F_2.
B F_2 is larger than F_1.
C F_3 is larger than the sum of F_1 and F_2.
D The sum of F_1 and F_2 is twice of F_3.

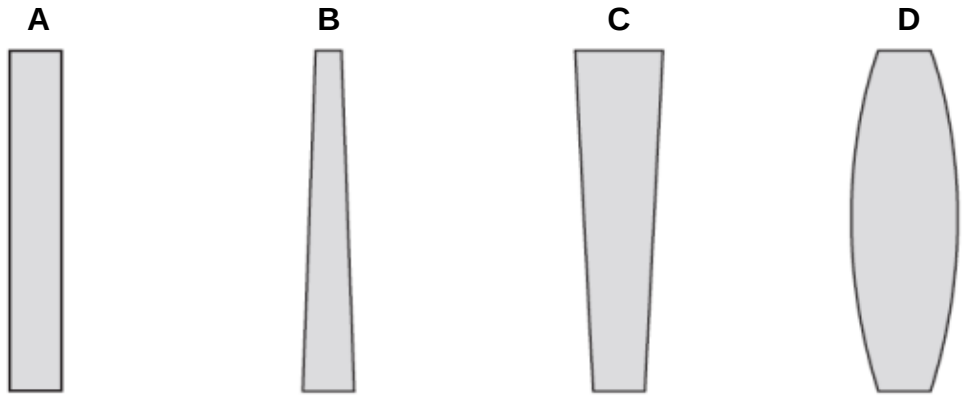
9 The diagram shows how a wheel brace is used to loosen the nuts on a wheel.



What is the dimension that should be increased so that less force is required to loosen the nuts?



10 Four glass objects have square bases of equal area. Which object is the least stable?

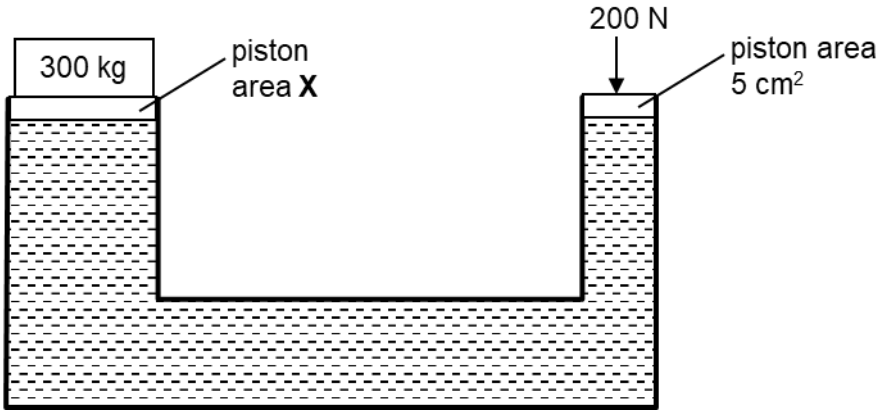


11 A builder lifts eight slabs from the ground onto the back of a lorry 1.5 m high. The total time taken is 48 s and each slab weighs 200 N. Assuming negligible air resistance.

How much useful power does the builder produce?

A 50 W
B 400 W
C 2 400 W
D 3 200 W

12 A hydraulic press is balanced by a force of 200 N and a 300 kg mass. The gravitational field strength *g* is 10 N/kg.



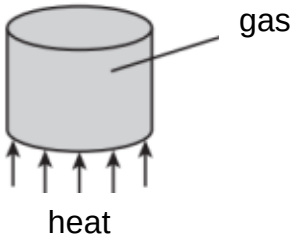
What is the area X of the larger piston?

A 0.33 cm^2
B 3.3 cm^2
C 7.5 cm^2
D 75 cm^2

13 Some pollen grains are dropped on the surface of the water in a tank. Which of the following causes the movement of the pollen grains?

A bombardment of pollen grains on water molecules
B bombardment of water molecules on pollen grains
C random motion of pollen grains
D random motion of water molecules and pollen grain

14 A gas in a sealed cylinder is heated. Which quantity does not increase as the gas is heated?



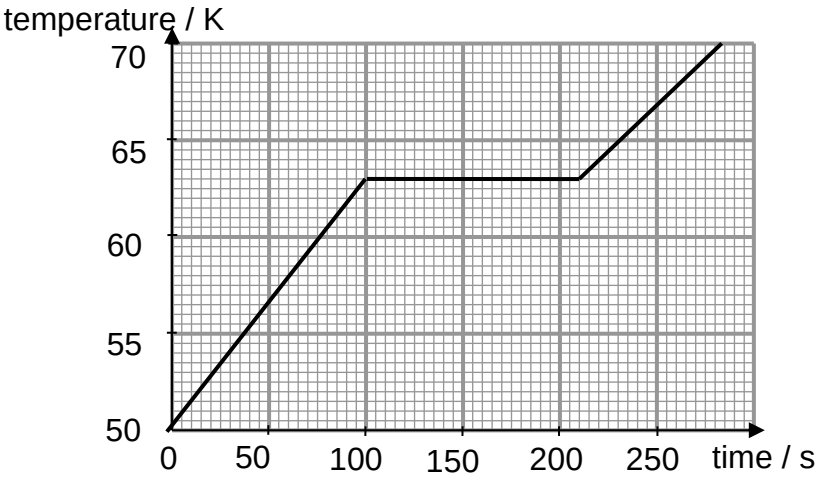
A the average distance between the gas molecules
B the average kinetic energy of the gas molecules
C The average number of gas molecules hitting the cylinder walls per second
D the average speed of the gas molecules

15 Ellie puts her hand on the wooden door of her classroom. The door feels warm. She then places her hand on the metal handle of the door and it feels cold.

Which statement about what Ellie experienced is correct?

A The door conducts internal energy more quickly to Ellie's hand than the handle.
B The door radiates infra-red heat more quickly to Ellie's hand than the handle.
C The hand conducts internal energy more quickly from the handle than from the door.
D The handle feels colder because it is at a lower temperature than the door.

16 A 400 W heater is used to heat 0.40 kg of solid. The temperature-time graph of the substance is shown below.



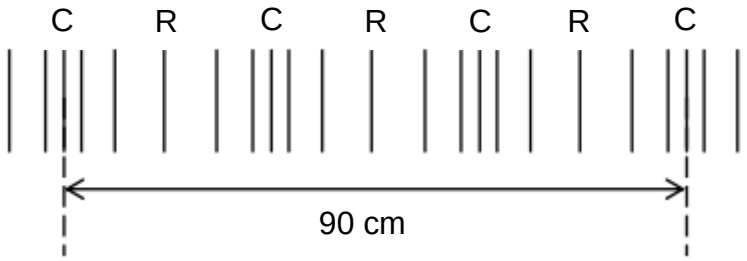
What is the specific latent heat of fusion of the substance?

A 7 690 J/kg
B 70 500 J/kg
C 100 000 J/kg
D 110 000 J/kg

17 A musical instrument produces two notes. One note of frequency *f* has a speed *v* and a wavelength 3.0 m in air. Another note has a frequency 3*f*. What are its wavelength and speed in air?

	wavelength / m	speed
A	1.0	*v*
B	1.0	3*v*
C	9.0	*v*
D	9.0	3*v*

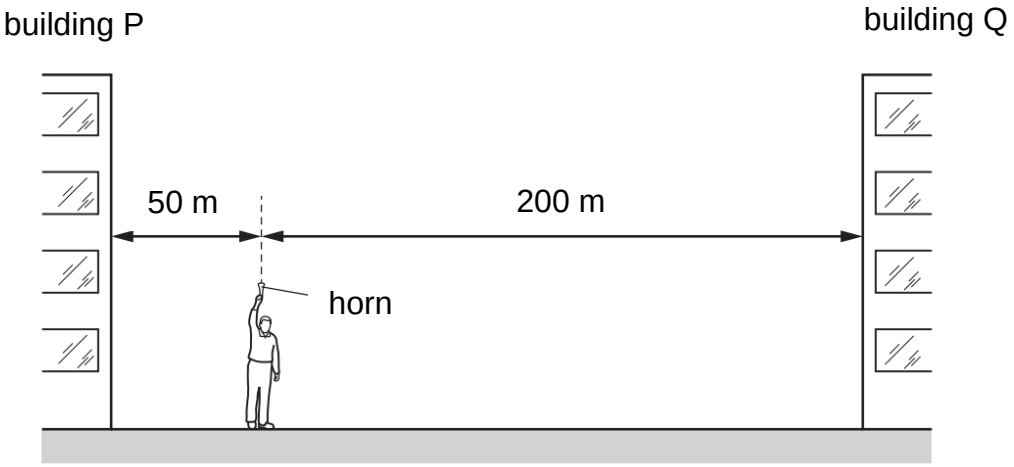
18 The diagram shows the compressions (C) and rarefactions (R) of air molecules as a sound wave travels through.



The speed of sound in air is 330 m/s. What is the frequency of this sound wave?

A 297 Hz **B** 367 Hz
C 733 Hz **D** 1100 Hz

19 A man stands between two tall buildings, P and Q. He is 50 m from P and 200 m from Q.



He sounds a horn. He hears the first echo from building P and 1.0 s later he hears the first echo from building Q.

What is the speed of sound calculated using this information?

A 250 m/s **B** 300 m/s
C 330 m/s **D** 500 m/s

20 Which type of electromagnetic radiation travels at the highest speed through a vacuum?

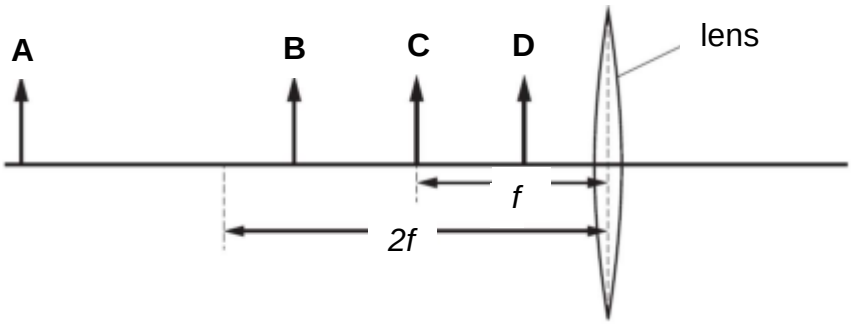
A radio waves
B visible light waves
C X-rays
D all have the same speed

21 Many devices produce electromagnetic waves when operating.

Which device produces electromagnetic waves of the highest frequency?

A mobile phone
B sunbed
C television controller
D toaster

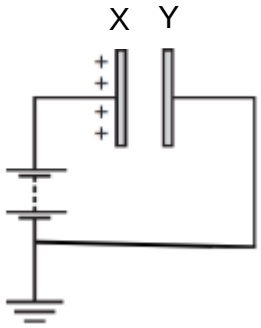
22 An object is placed in front of a converging lens. The lens has a focal length *f*. The lens produces a real, enlarged image of the object. In which position is the object placed?



23 A balloon becomes positively charged when it is rubbed with wool. What causes the balloon to be charged?

A diffusion
B induction
C transfer of negative charges
D transfer of positive charges

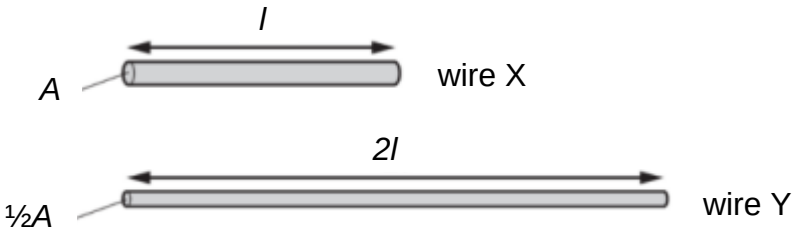
24 A metal plate X, which is positively charged, is connected to earth through a battery. A second metal plate Y is initially uncharged and connected to earth.



What happens as Y is brought closer to X?

A Electrons flow from Y to earth.
B Electrons flow to Y from earth.
C Positive charges flow from Y to earth and electrons flow to Y from earth.
D Positive charges flow to Y from earth and electrons flow from Y to earth.

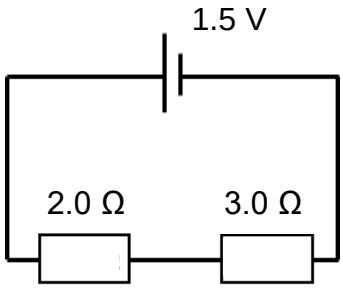
25 A copper wire X with cross sectional area *A* and length *l* has resistance R. Another copper wire Y has twice the length and half the cross-sectional area of X.



What is the resistance of Y?

A ½ R
B R
C 2 R
D 4 R

26 A 1.5 V battery is connected to a 2.0 Ω and 3.0 Ω resistor in series.

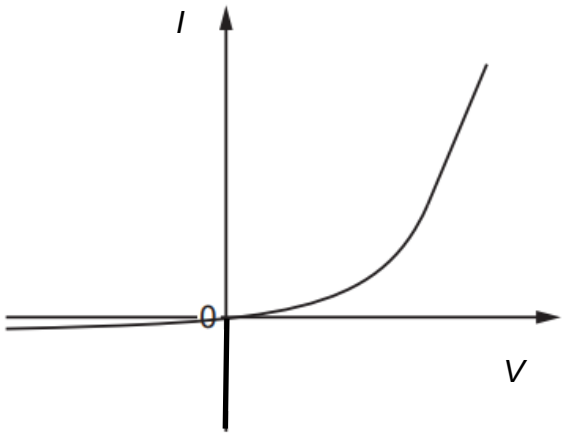


What is the work done to drive a 1.0 C charge through the 3 Ω resistor?

A 0.30 J **B** 0.60 J

C 0.90 J **D** 1.50 J

27 The graph shows the *I*–*V* characteristic for a semiconductor diode.



Which statement can be deduced from the graph?

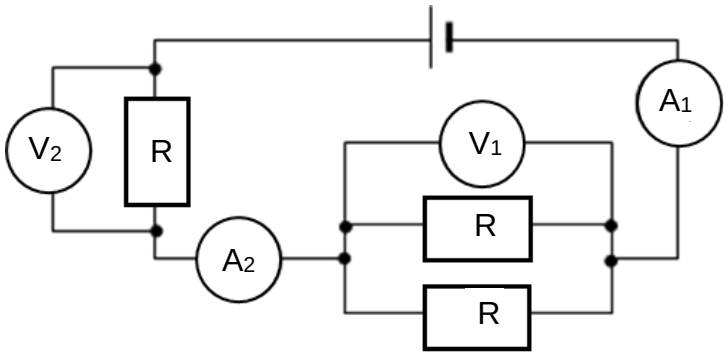
A Above a certain positive potential difference the diode obeys Ohm's law.

B 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 in the diode is in one direction.

D The resistance of the diode depends upon the potential difference across it.

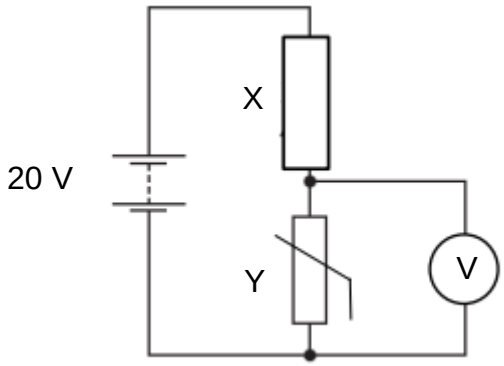
28 The circuit shows three identical resistors, R, connected to a battery, two voltmeters V_1 and V_2, and two ammeters A_1 and A_2.



Which statement is true?

A The reading of A_1 is greater than that of A_2.
B The reading of A_1 is smaller than that of A_2.
C The reading of V_1 is greater than that of V_2.
D The reading of V_1 is smaller than that of V_2.

29 The diagram shows a potential divider circuit with a fixed resistor X of resistance 1.0 kΩ and a thermistor Y. The resistance of Y varies from 600 Ω to 1200 Ω .



What is the voltmeter reading when the temperature of the surrounding is high?

A 7.5 V **B** 9.1 V
C 10.9 V **D** 12.8 V

30 A heater connected to a 230 V mains circuit has a power of 1300 W. It runs for a duration of 2 hours daily for 30 days. The cost of 1 unit of electricity is $0.25.

What is the cost of operating the heater for the 30 days?

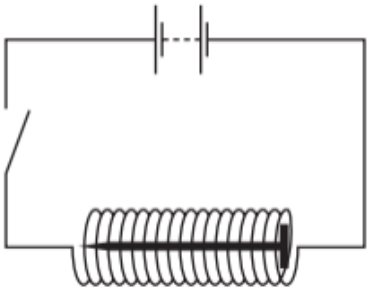
A $ 7.02 **B** $ 19.50
C $ 195.00 **D** $ 702.00

31 In which situation(s) will a fuse possibly melt?

I The fuse is fixed along the neutral wire instead of the live wire.
II The live wire touches the metal casing of the appliance.
III The neutral wire touches the live wire due to damaged insulation in the wires.

A I only
B I and II only
C II and III only
D I, II and III

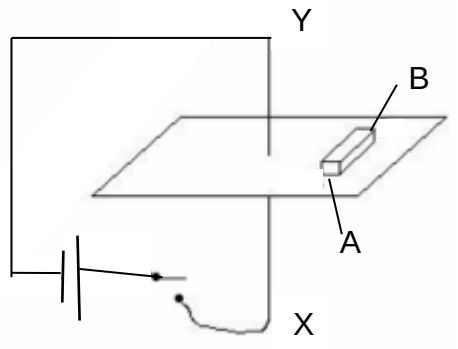
32 An iron nail can be magnetised using a coil.



How can the nail be demagnetised?

A leaving the apparatus switched on for a long time
B removing the nail from the coil after replacing the d.c supply with an a.c. supply
C using a coil with fewer turns
D using more cells

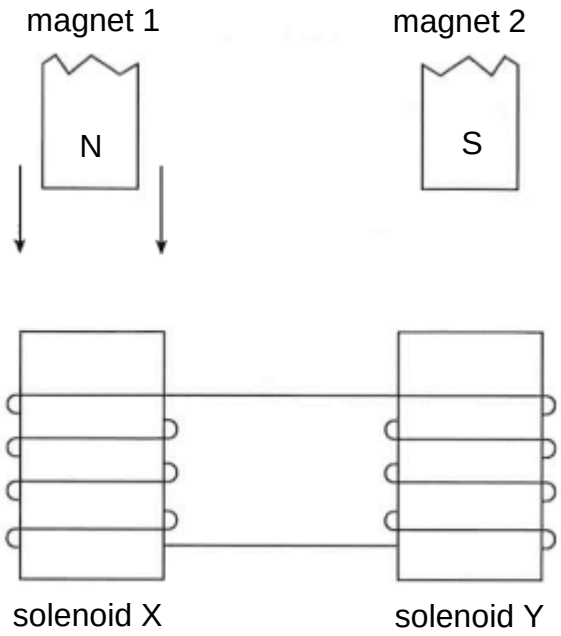
33 The diagram shows a wire XY connected to a battery and a switch. An unmagnetised soft iron AB is placed near the wire XY in a horizontal plane.



What happens to the soft iron when the switch is closed?

A End A is magnetised with a south pole.
B End B is magnetised with a south pole.
C The soft iron is attracted towards the wire.
D The soft iron is repelled away by the wire.

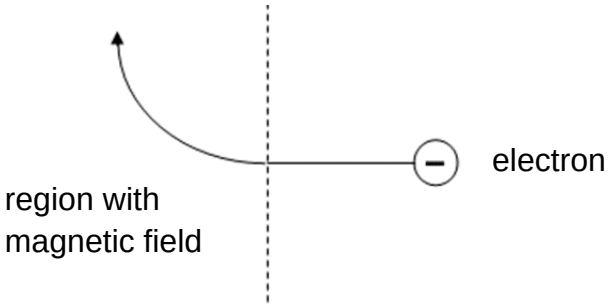
34 The diagram shows two identical magnets held above two solenoids, X and Y.



The North pole of magnet 1 is dropped through solenoid X. Which statement describes what happens to the South pole of magnet 2?

A It is attracted by a magnetic force towards solenoid Y.
B It is repelled by a magnetic force away from solenoid X.
C It is repelled by a magnetic force away from solenoid Y.
D It is unaffected by solenoid Y.

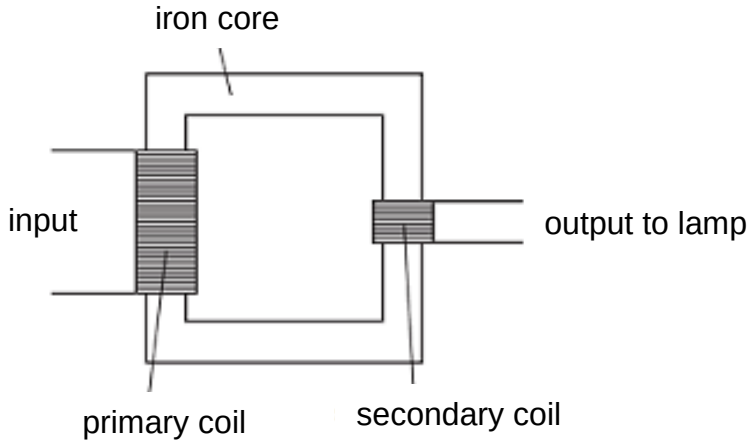
35 The diagram shows a beam of electrons entering a magnetic field.



What is the direction of the magnetic field?

A into the page
B out of the page
C towards the bottom of the page
D towards the top of the page

36 An ideal step-down transformer has a turn-ratio of 5. The secondary coil is connected to a lamp rated at 3.0 V, 0.50 A.



Which row states the type of input current and the correct magnitude, as well as the input voltage for the lamp to be lit at normal brightness?

	type of input current	magnitude of input current	input voltage / V
A	AC	0.10 A	15
B	AC	2.50 A	0.6
C	DC	0.10 A	15
D	DC	2.50 A	0.6

37 What can be done to reduce heating in a transformer without changes to the output?

A Increase the number of turns on each side of the transformer proportionally.
B Replace iron core with a steel core.
C Replace copper wires with iron wires.
D Use a laminated iron core instead of a solid iron core.

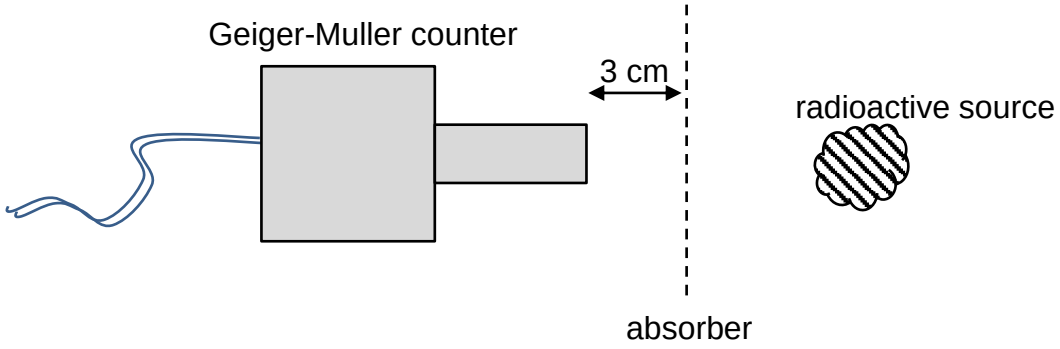
38 A nucleus is represented by $^{230}_{91}Z$. It emits one α particle and then one β particle.

What is the resulting nucleus?

A $^{226}_{88}W$ **B** $^{230}_{89}X$

C $^{226}_{90}Y$ **D** $^{230}_{91}Z$

39 Zach investigated the penetrating power of radiation from a radioactive source using a Geiger-Muller (GM) counter as shown in the diagram.



The table below shows his results.

background count	25 counts/min
count with source only	630 counts/min
count with source and paper absorber	630 counts/min
count with source and 3 mm thick aluminium absorber	180 counts/min

The source emits

A β particle only
B γ radiation only
C α and β particle only
D β particle and γ radiation only

40 In which type of nuclear reaction are the nuclei heavier after the reaction than they were before?

A α - decay
B β - decay
C nuclear fission
D nuclear fusion

END OF PAPER

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL
2024 PRELIMINARY EXAMINATION
Secondary 4 Express

NAME

CLASS **REG. NO**

PHYSICS 6091/02

Paper 2 Structured and Free Response

19 August 2024
1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

Setter: Mr. Foo Seng Hong

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an 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.

……..……..……..

Parent's signature/ Date

For Examiners' Use	
Section A	
Section B	
Total	

This document consists of **20** printed pages, including the cover page.

[Turn Over

Section A [70 marks]

Answer **all** questions.
Write your answer in the spaces provided.

1 Fig. 1.1 shows a rocket just after its launch. At its launch, the rocket and its contents have a total mass of 1.2 x 10^5 kg. Fig. 1.2 shows how the upward thrust on the rocket changes with time in the first 40 s after the launch. The gravitational field strength *g* is 10 N/kg.

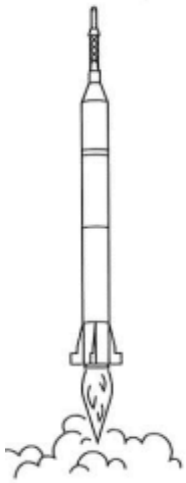


Fig. 1.1

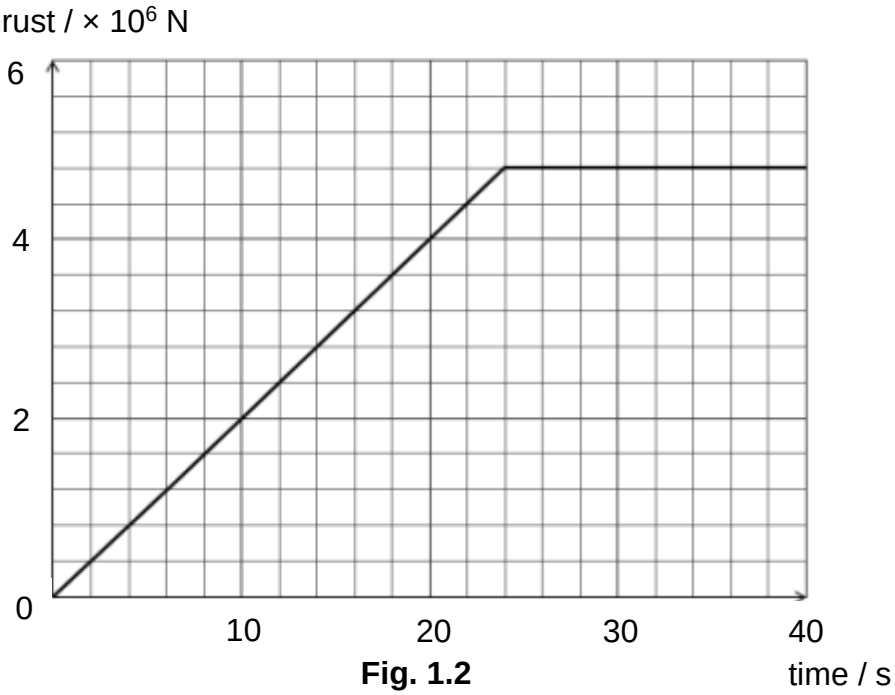


Fig. 1.2

(a) Calculate the weight of the rocket at its launch.

weight = ...[1]

(b) At the point of launching, the rocket does not take off immediately. State the time when the rocket starts to take off and explain your answer.

……..

……

……..…

……..……..[2]

(c) Assuming no change in the mass of the rocket, calculate the acceleration of the rocket at t = 30 s.

acceleration = ...…[2]

(d) 30 s after launch, the total weight of the rocket and its content decreases significantly as fuel is being burnt off while the thrust remains the same.
Describe the motion of the rocket after 30 s.

…….

…….…[1]

2 Fig. 2.1 shows a mercury barometer on a day when the atmospheric pressure is 750 mm Hg. Vessel B has a cross-sectional area 4 times that of tube A.

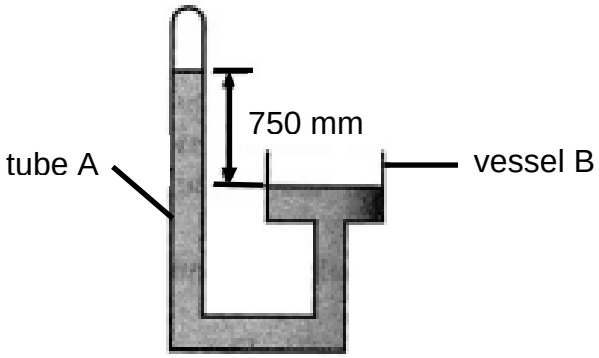


Fig. 2.1

(a) Determine the atmospheric pressure, in Pascal, given that the density of mercury i 13600 kg/m^3. (gravitational field strength *g* is 10 N/kg)

pressure = ...….....…[1]

(b) Explain what will happen to the mercury level in tube A if more mercury is added to vessel B such that the mercury level in vessel B rises by 2 cm.

……..…..…

……..…...…

……...…

…….…[2]

(c) Explain one disadvantage of using water in a barometer as compared to mercury.

……

……

……

……[2]

3 Fig. 3.1 shows a 50 kg wooden crate being pushed to the top of a slope XY at a constant speed by applying a 400 N force along the direction of the slope. The frictional force along the slope is determined to be 200 N.

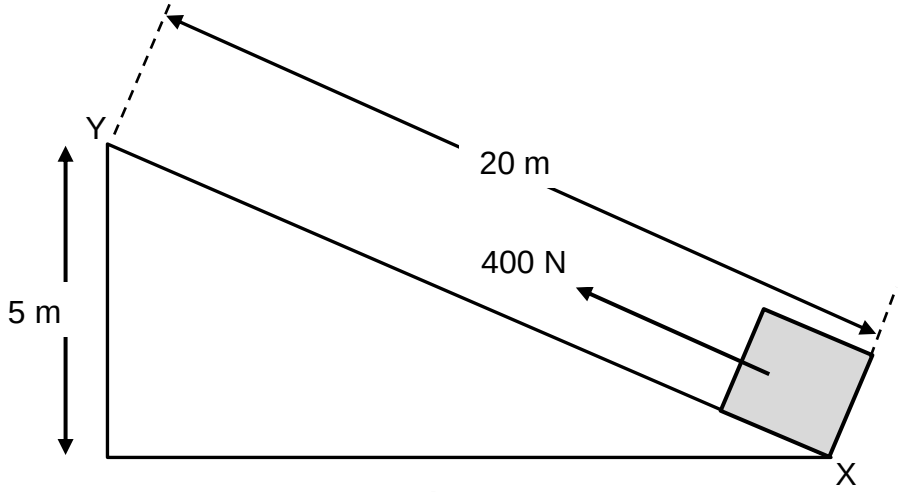


Fig. 3.1

(a) Determine the gain in energy in the gravitational potential store of the wooden crate between points X and Y. The gravitational field strength *g* is 10 N/kg.

gain in energy = ……[2]

(b) Determine the work done against friction along the slope.

work done = ……[1]

(c) If friction is successfully removed along the slope, what will be the minimum force required to push the crate to the top?

minimum force = ……[2]

(d) The weight of the crate is acting vertically downwards on the crate. Describe the other force that is an action-reaction pair with the weight of the crate and state clearly the body on which it acts.

……

……[1]

4 Fig. 4.1 shows the cross section of a cup noodle container.

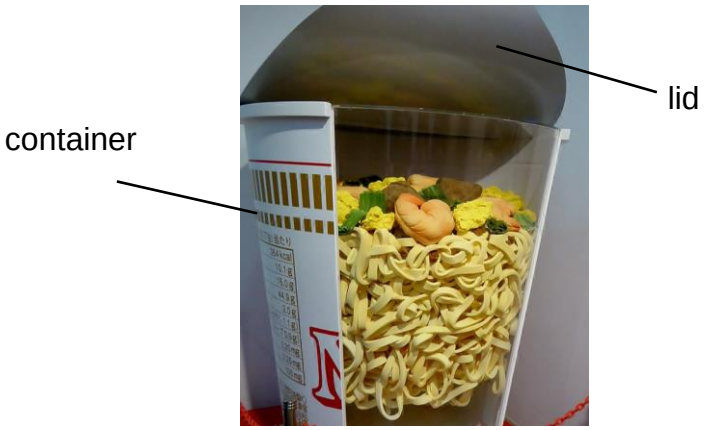


FIg. 4.1

(a) The container of the cup noodles is made of expanded polystyrene. State and explain one advantage of using such a material to make the container.

……

……

……

……[2]

(b) Explain why the inner surface of the lid is usually shiny.

……

……

……[2]

5 Fig. 5.1 shows a transverse wave travelling along a rope. The positions of the wave at the time intervals t = 0 s and t = 2.0 s are shown in Fig. 5.1.

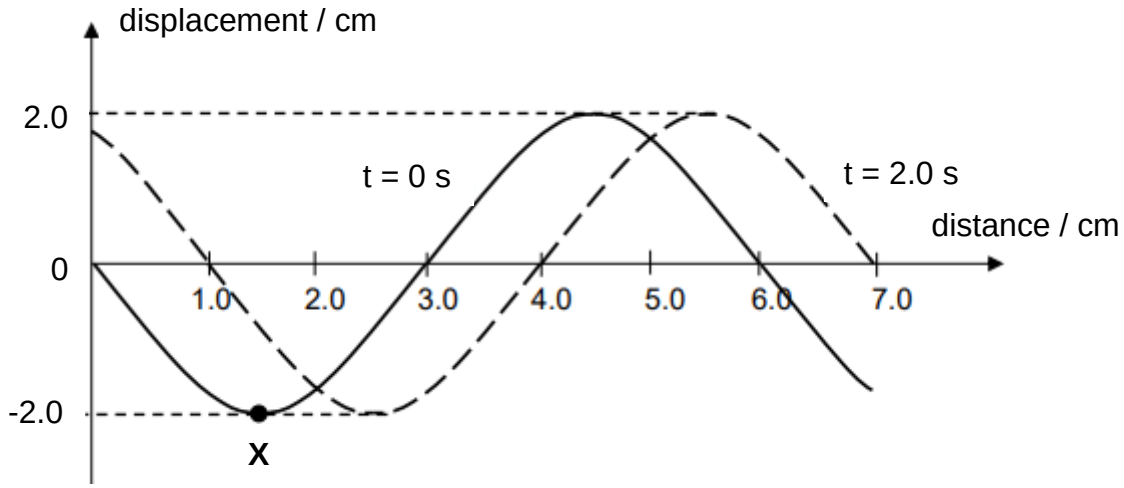


Fig. 5.1

(a) Explain what is meant by transverse wave.

……

……

……[1]

(b) Calculate the speed of the wave.

speed = ……[1]

(c) Hence, determine the period of the wave.

period = ……[2]

(d) X is a particle on the wave at t = 0 s. On Fig. 5.1, mark the new position of X at t = 6.0 s. Label this position Y.

[1]

6 **(a)** An experiment to show charging by induction uses a metal sphere mounted on an insulated support. The metal sphere X is initially uncharged and is shown in Fig. 6.1.

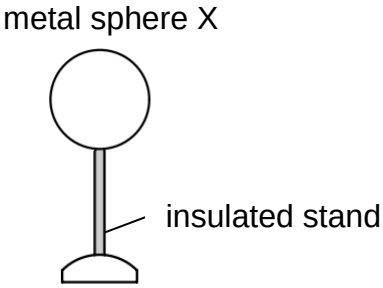


Fig. 6.1

A negatively charged rod is brought near the metal sphere X. The metal sphere is then touched at point A by a wire connected to earth, as shown in Fig. 6.2.

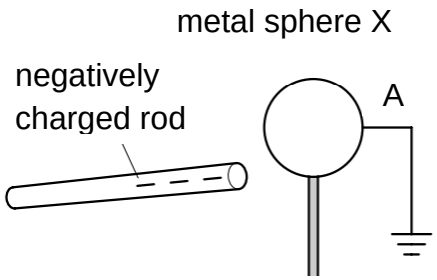


Fig. 6.2

On Fig. 6.2, draw the charges on the metal sphere. [1]

(b) Write down the steps to complete the process of charging metal sphere X.

……

……

……

……[2]

(c) The negatively charged rod is then brought near a neutral metal sphere Y, as shown in Fig. 6.3. Metal sphere Y is attached to a solenoid P, which is grounded through wire R. Solenoid Q is connected to a galvanometer and is positioned near solenoid P.

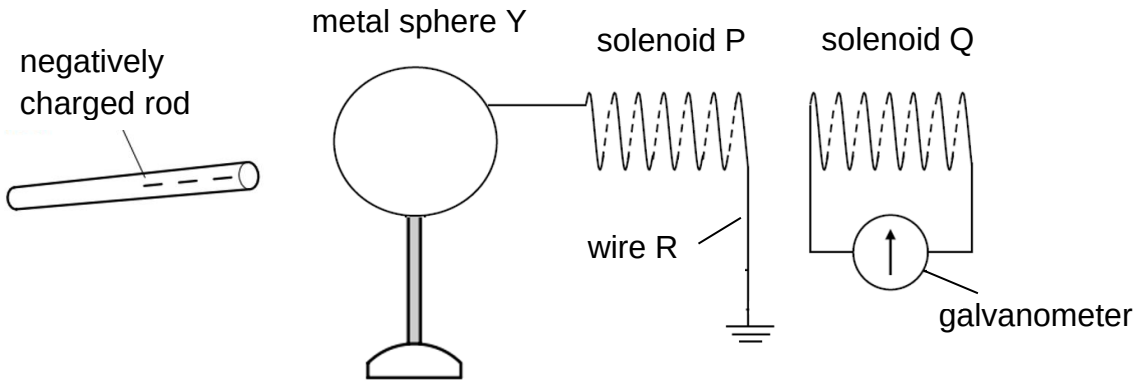


Fig. 6.3

Describe and explain the subsequent movement of charges in sphere Y and solenoid P, when the negatively charged rod is brought near to Y.

……

……

……

……[2]

(d) On Fig. 6.3, indicate with an arrow on wire R, the direction of the **current flow** during the movement of the charges.

[1]

(e) State clearly what is observed in the galvanometer during the movement of the charges.

……

……[1]

7 A student is investigating the operation of a soap dispenser. A small volume of liquid soap is dispensed when a sensor in an electronic switch detects a hand underneath the nozzle as shown in Fig 7.1. The student suggests that a light dependent resistor (LDR) could be used as a sensor in the electronic switch. The circuit is set up with a 5000 Ω resistor, an LDR and a 12 V DC supply as shown in Fig 7.2.

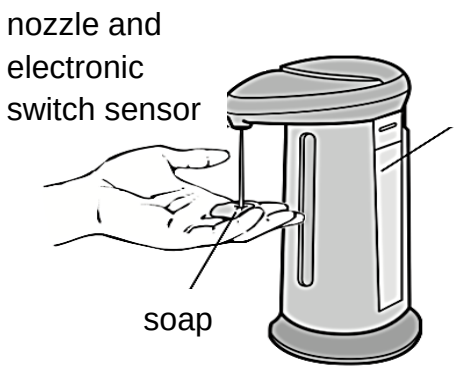


Fig. 7.1

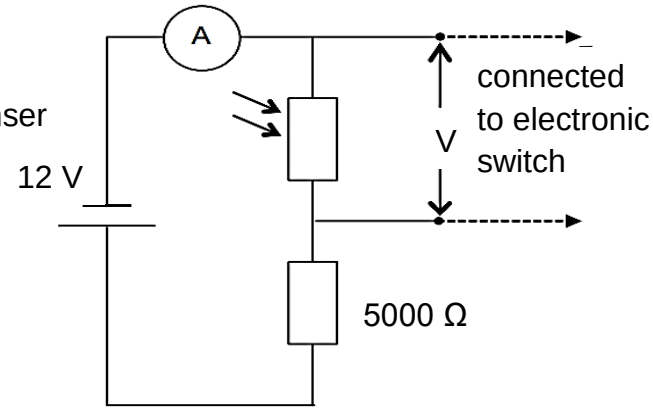


Fig. 7.2

(a) When the LDR is unblocked, the reading shown on the ammeter is 1.5 mA. Calculate,

(i) the resistance of the LDR;

resistance = ……[2]

(ii) the potential difference across the LDR.

potential difference = ……[1]

(b) The electronic switch of the nozzle is activated to dispense soap when V_{out} is larger than the calculated value in **(a)(ii).** Explain how it works.

……

……

……

……[2]

8 Fig. 8.1 shows an electric kettle and the live, neutral and earth wires of a household electricity supply. The kettle has a power rating of 2.0 kW. The supply voltage is 240 V.

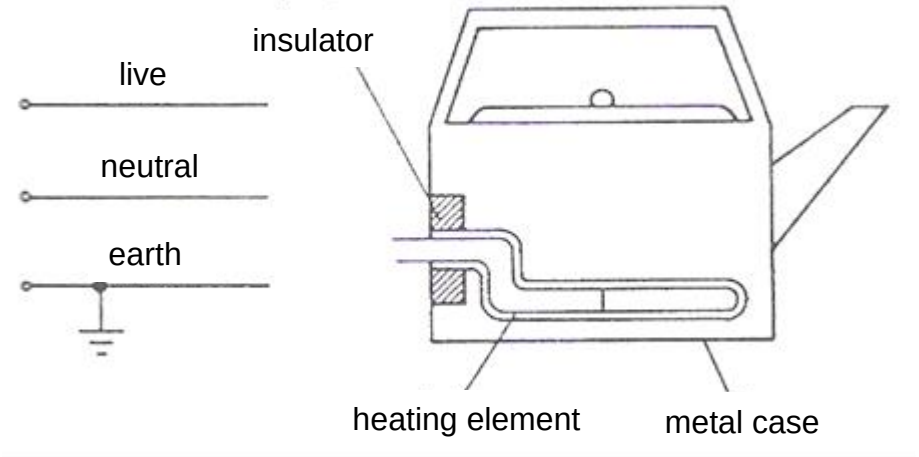


Fig. 8.1

(a) Complete Fig. 8.1 to show how the kettle should be connected to the supply. Include a switch and a fuse in your drawing. [2]

(b) The live wire becomes loose and touches the metal case. Explain why a person who later touches the case feels no shock and is not harmed.

……

……

……

……

……

……[3]

(c) Calculate the working current that flows in the live wire of the kettle.
There are 3 fuses with fuse rating of 8 A, 10 A and 12 A available. Suggest a suitable fuse rating for the kettle.

current = ……

suitable fuse rating = ……[2]

9 **(a)** A doctor uses a radioactive isotope, iodine-131, to find the volume of blood in a patient's body. Information about the iodine-131 is given in Fig. 9.1.

proton (atomic) number	53
nucleon (mass) number	131
radiation emitted	β-particles and γ-rays

Fig. 9.1

The radioactive decay equation below shows an iodine-131 nucleus decaying into a xenon nucleus (Xe) by emitting a beta particle (β).

Complete the decay equation below for this decay.

$$^{131}_{53}\mathrm{I} \longrightarrow {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{Xe} + {}^{\ldots\ldots}_{\ldots\ldots}\beta$$ [2]

(b) State what is meant by the *half-life* of a radioactive isotope.

……

……[1]

(c) Fig. 9.2 shows how the number of atoms of a radioactive isotope changes with time.

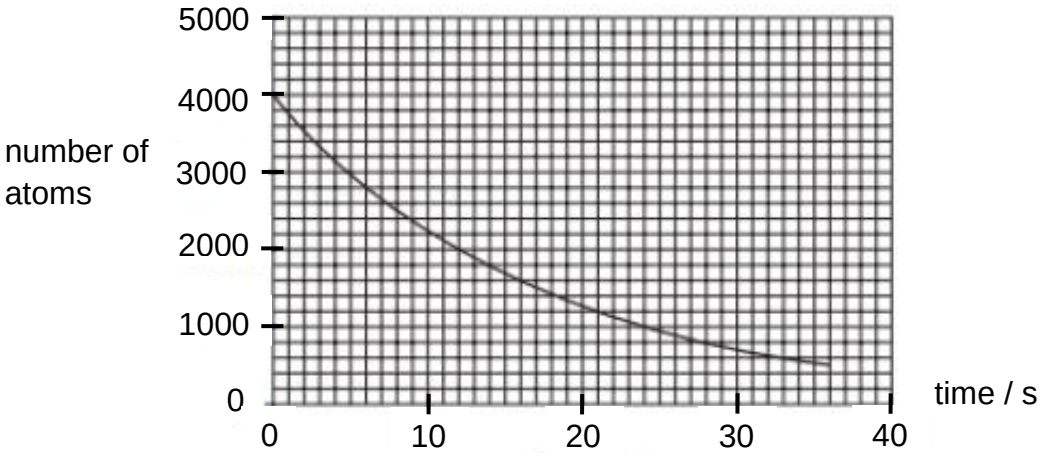


Fig. 9.2

Determine the half-life of the radioactive isotope. On Fig. 9.2, show how you obtained your result.

half-life = ……[2]

10 Jewels are commonly made of transparent materials. When light enters the material, the light either gets reflected internally or refracted out of the material. One factor that affects the shine of a jewel is the refractive index of the material. Table 10.1 shows the refractive indices of different materials used for making jewels.

Table 10.1

material of jewel	refractive index
diamond	2.42
flint glass	1.62
moissanite	2.67
quartz	1.55

Another factor which affects the shine of a jewel is the cut of the jewel. The cut of the jewel affects how light gets transmitted into the eye of an observer. The length of the pavilion of the jewel affects the path of light in the jewel when light enters the jewel from outside. A good cut is one that allows the most light to exit the top of the crown when light is shone from any angle around it.

Fig. 10.1 shows a good cut of a jewel. To test for the shine of the material, four light rays P, Q, R and S are incident on the jewel.

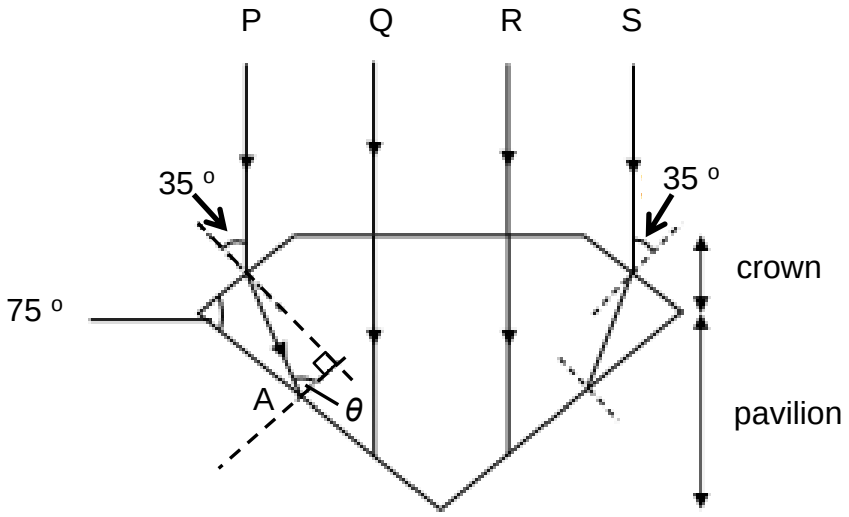


Fig. 10.1

(a) **(i)** Other than the critical angle, state another condition for total internal reflection to occur.

……....

……[1]

(ii) Determine which material in Table 10.1 has the smallest critical angle. Show your calculations clearly.

material = ……..[2]

(iii) Explain why light rays Q and R in Fig. 10.1 do not bend as they enter the jewel.

……....

……[1]

(b) Assume the jewel in Fig. 10.1 is made of diamond.

(i) Given that the angle of incidence of ray P as it enters the diamond is 35 °, calculate the angle of incidence θ of ray P as it strikes surface AB.

θ = ……[2]

(ii) On Fig. 10.1, continue ray P by drawing its next direction after it incident onto A. Show all your necessary working below.

[2]

(c) In order to check for cracks on the diamond, Issac uses a magnifying glass, to inspect the diamond. L is the thin converging lens of the magnifying glass.

Fig. 10.2 shows image I of the diamond. Complete the ray diagram in Fig. 10.2 to locate the position of the object (diamond). F is the focal point of the lens.

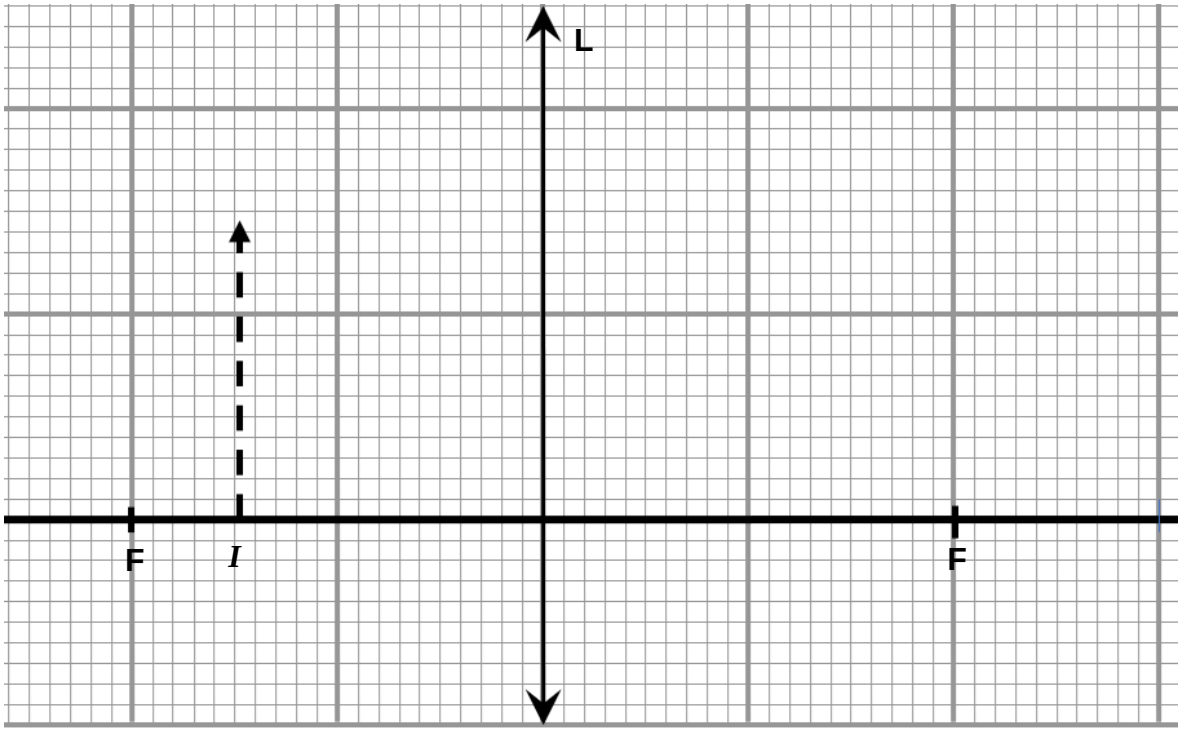


Fig. 10.2

[2]

11 Fig. 11.1 shows an a.c. generator being used to light a small filament bulb.

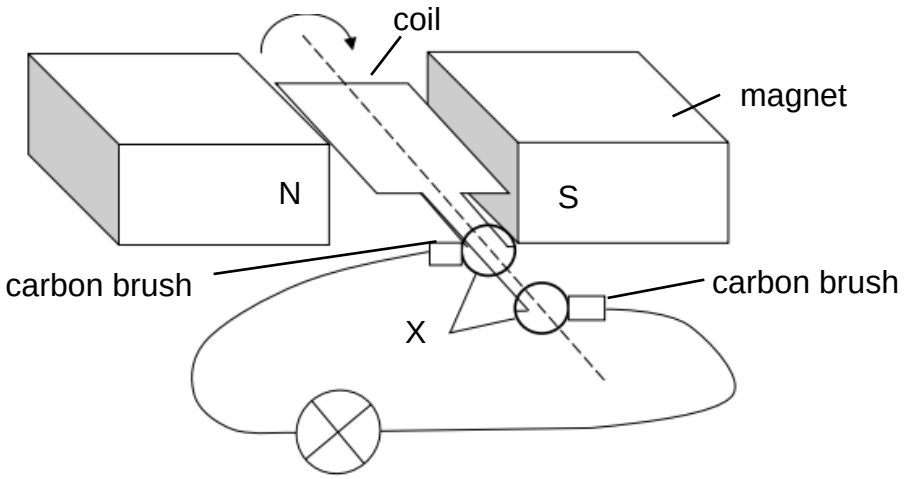


Fig. 11.1

When the coil is rotated, an electromotive force (e.m.f.) is produced in the coil.

(a) Explain why an e.m.f. is produced.

……

……

……[2]

(b) Name the components labelled X in Fig. 11.1.

……[1]

(c) State the purpose of the components labelled X in Fig. 11.1.

……

……[1]

(d) At the instant shown in Fig. 11.1, indicate clearly with an arrow on Fig. 11.1 the direction of the induced current in the coil.

[1]

(e) State two changes that could be made to the generator to make the bulb glow brighter.

……

……

……[2]

(f) In a power station, the generators produce a voltage of 25 000 V.
This voltage is stepped up to 400 000 V by a transformer for long-distance transmission on overhead power lines.

The voltage is later stepped down to 240 V.

(i) State and 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 = ……[1]

Section B

Answer **one** question from this section.

12 Fig. 12.1 shows the structure of a water cooler that supplies cold water.

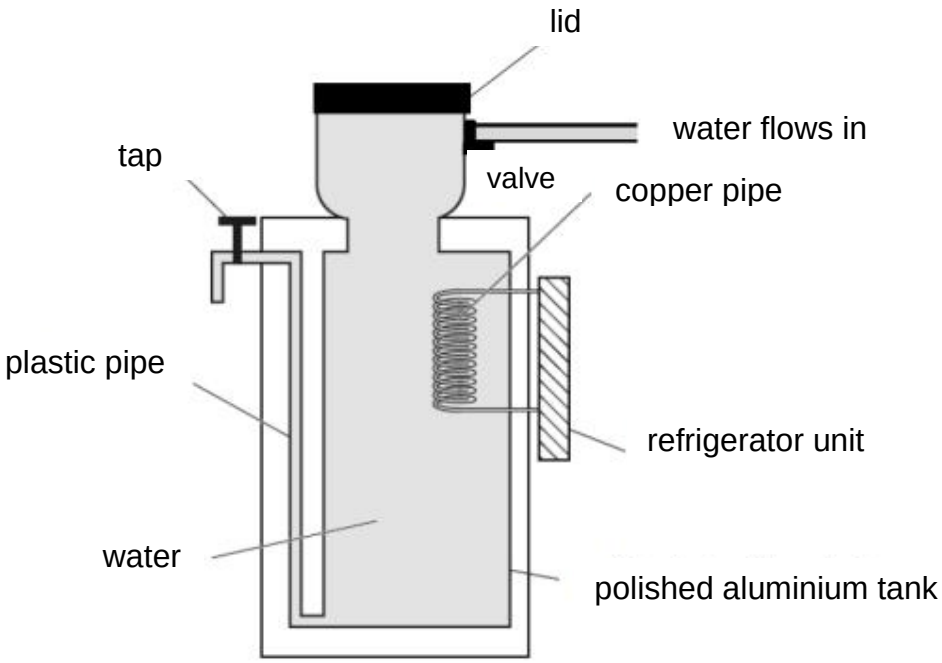


Fig. 12.1

(a) In the refrigerator unit, a coolant is pumped through the copper pipe. Heat flows from the water to the refrigerator unit.

(i) Using ideas about molecules, explain how heat is transferred through the copper pipe to the coolant.

……

……

……

……[2]

(ii) Describe and explain how water is cooled inside the tank.

……

……

……

……

……[3]

(b) Explain how the tank of the water cooler keeps the water cold.

……

……[1]

(c) With the valve closed, the tank is filled completely with 0.013 m^3 of water at 25 ^oC. The water cooler is turned on to cool down the water for 1.5 hours.

The rate at which energy in the internal store is gained by the refrigerator unit is 80 J / s.

The density of water is 1000 kg / m^3 .
The specific heat capacity of water is 4200 J / (kg °C).

(i) Calculate the gain in the energy in the internal store by the refrigerator unit at the end of 1.5 hours.

gain in energy in internal store = ……[2]

(ii) Calculate the final temperature of the water at the end of 1.5 hours.

final temperature = ……[2]

13 Fig. 13.1 shows a simple d.c. motor. A rectangular coil PQRS is connected to a power supply and is placed between two solenoids which are connected to another power supply. Each solenoid is coiled around a soft iron core.

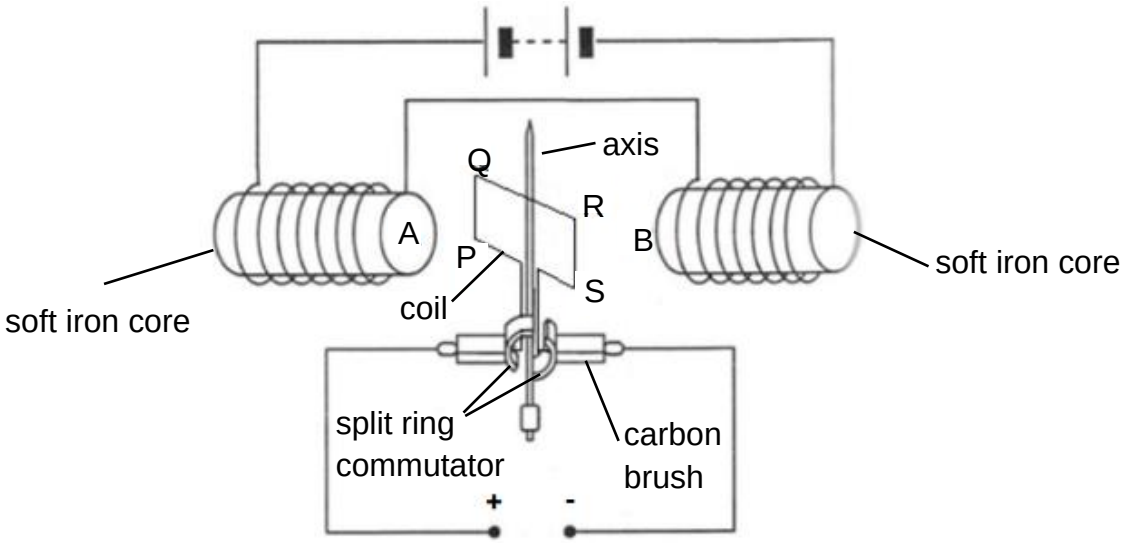


Fig. 13.1

(a) Identify the magnetic poles at A and B.

A: ……

B: …… [2]

(b) Explain why the coil turns and state the direction of its rotation.

……

……

……

……

……

……[3]

(c) Describe the purpose of having the split-ring commutator in the d.c. motor.

……

……

……[1]

(d) When the coil is vertical, the split-ring commutator is not in contact with the carbon brushes and no current flows through the coil.
Explain why the coil continues to turn even though no current is flowing.

……..……...

……..……...

……..…..[1]

(e) Fig. 13.2 shows how the turning effect acting on the coil changes with time.

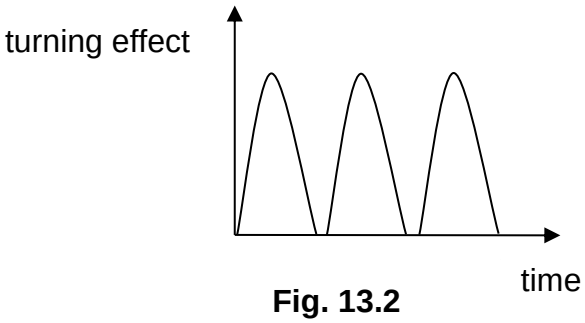


Fig. 13.2

(i) On Fig. 13.2, mark with a letter V when the coil is vertical. [1]

(ii) State 2 ways to decrease the turning effect of the coil.

……..

……..…….

……..…….

……..……[2]

END OF PAPER

6091 Sec 4 Exp Pure Physics Prelim 2024
Mark Scheme

Paper 1
Multiple Choice

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

Paper 2
Section A (70 marks)

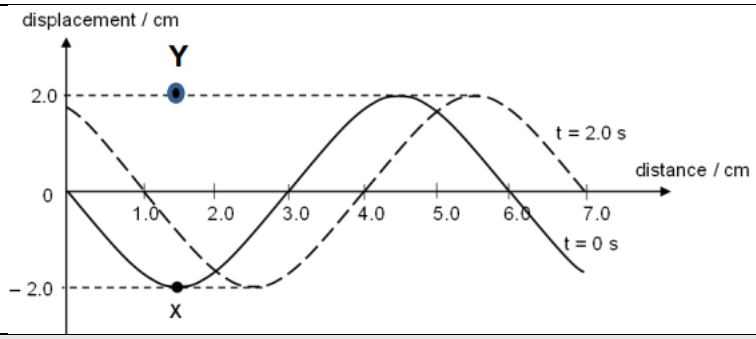
1	**(a)**		$W = mg = 1.2 \times 10^5 \times 10$ $= 1.2 \times 10^6$ N	1
	(b)		6 s. It is the time at which the **upward thrust is equal to the weight of the rocket**. From 6 s onwards thrust is greater than the weight.	1 1
	(c)		At 30 s, thrust = 4.8×10^6 N $F_{net} = ma$ $4.8 \times 10^6 - 1.2 \times 10^6 = (1.2 \times 10^5)(a)$ $a = 30$ ms^{-2}	1 1
	(d)		When the total weight decreases significantly, the upward resultant force increases. The rocket will move **with increasing acceleration**. (do not accept if student just write increasing velocity)	1
			Total	**6**

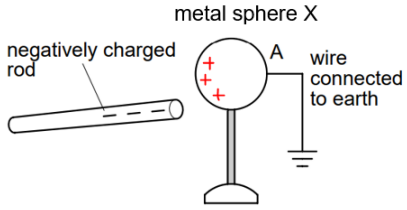
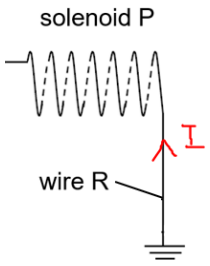
2	**(a)**		Pressure = pgh = 13 600 x 10 x 0.75 = 102 000 Pa	1
	(b)		The mercury level at A will **raise by 2 cm**.	1

			The difference in mercury level in A and B is directly proportional to the atmospheric pressure. **Since the atmospheric pressure remains the same, the height difference should remain the same** at 750 mm.	1
	(c)		Water has a **lower density**. As such, for the same pressure, a **water barometer will have a greater height**. This will make it **tougher to measure the height of the column/ harder to transport around/need to construct a very tall barometer.**	1 1
			Total	**5**

3	**(a)**		Gain in gravitational potential energy, Ep = mgh = 50 x 10 x 5 = 2500 J = 2.5 kJ	1 1
	(b)		Work done against friction = frictional force x distance = 200 x 20 = 4000 J	1
	(c)		work done = gain in energy in gravitational potential store F x d = 2500 F x 20 = 2500 F = 125 N	1 1
	(d)		It is **the force of the crate acting on the Earth** in the **upwards direction.**	1
			Total	**6**

4	**(a)**		Polystyrene has pockets of air which is a **poor conductor of heat / good insulator**. This will help to **keep the noodles hot for a longer time/ prevent cup from burning the hand.**	1 1
	(b)		Shiny surface is a **poor absorber of infrared radiation** OR **good reflector of infrared radiation**. It will **keep the noodle warm by reducing rate of energy loss by radiation.**	1 1
			Total	**4**

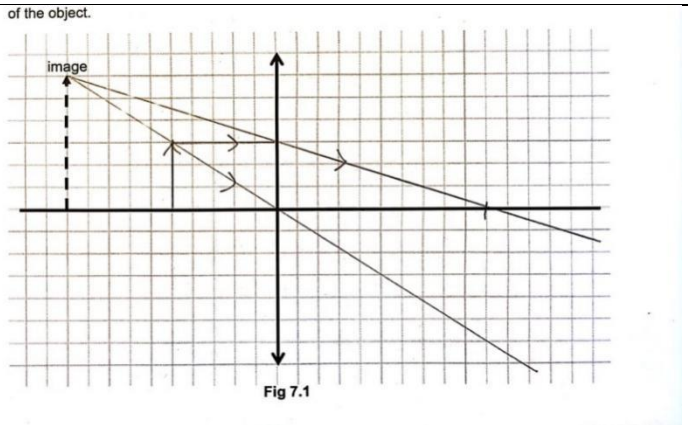
5	**(a)**		Transverse waves are **waves that move in a direction perpendicular to the direction of vibration of the particles**.	1
	(b)		Speed = Distance / time = 1 cm / 2 s = 0.5 cm/s	1
	(c)		v = λ / T 0.5 = 6 cm / T (Allow ecf from (b)) T = 12 s	1 1
	(d)			1
			Total	**5**

6	**(a)**			1
	(b)		Remove the wire connected to earth from metal sphere X. Then bring the negatively charged rod away from X.	1 1
	(c)		**Electrons in metal sphere Y are being repelled** by the negatively charged rod since **like charges repel.** Electrons will flow from **the metal sphere Y through solenoid P to Earth.**	1 1
	(d)			1
	(e)		The galvanometer will **deflect to one side momentarily,** then **deflect to the opposite side** again and **returns to zero.**	1
			Total	**7**

7	**(a)**	**(i)**	V = IR 12 = (1.5 x 10^{-3}) R R_T = 8000 Ω R_{LDR} = 8000 – 5000 = 3000 Ω	 1 1
		(ii)	V = IR_{LDR} V = 1.5 x 10^{-3} x 3000 V = 4.5 V	 1
	(b)		When the hand covers the LDR, the **light intensity decreases. Hence the resistance of the LDR will increase**. Using the potential divider concept , **the ratio of resistance of LDR to the total resistance will increase.The PD across the LDR increases. Hence V_{out} will increase** and the electronic switch of the nozzle is activated. OR When the hand covers the LDR, the **light intensity decreases. Hence the resistance of the LDR will increase**. **The effective resistance of the circuit increases. The current decreases.**The PD across the fixed resistor decreases and **hence, the PD across the LDR increases. Hence V_{out} will increase** and the electronic switch of the nozzle is activated.	1 1 1 1
			Total	**5**

8	**(a)**		Fuse and switch on live wire Live, neutral and earth wires connected correctly	1 1
	(b)		The **metal case of kettle is earthed**. When the metal casing becomes live, **a large current flows through the low resistance earth wire** instead of the user. **This causes the fuse to melt.** Thus, the **metal case is isolated from high voltage and the user does not get an electric shock** when coming into contact with the kettle.	1 1 1
	(c)		I = E /P = 2000 / 240 = 8.33 A Suitable fuse rating = 10 A	 1 1
			Total	**7**

9	**(a)**		$^{131}_{53}I \longrightarrow {}^{131}_{54}Xe + {}^{0}_{-1}\beta$ [1] for 2 correct, [2] for all correct	2
	(b)		The half-life of a radioactive isotope is the **time taken for half the nuclei/atoms/count rate** of that isotope to decay.	1
	(c)		Mark on graph at 2000 12 s	1 1
			Total	**5**

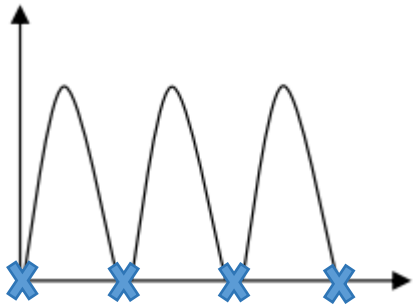
10	**(a)**	**(i)**	The light ray has to **travel from an optically denser medium to an optically less dense medium**.	1
		(ii)	Material is moissanite. $c = sin^{-1}(\frac{1}{2.67})$ $= 21.99°$ $= 22.0°$ (3sf)	1 1
		(iii)	**The angle of incidence is 0°/ The light ray is travelling along the normal,** thus the angle of refraction will also be 0°.	1
	(b)	**(i)**	$\frac{\sin 35}{\sin(r)}$=2.42 $r = 13.7°$ $\theta = 90° - 13.7°$ $= 76.3°$	1 1
		(ii)	For diamond, $n = \frac{1}{\sin c}$ $c = sin^{-1}(\frac{1}{n}) = sin^{-1}(\frac{1}{2.42})$ $c = 24.4°$ Draw a ray that shows total internal reflection at A.	 1 1
	(c)		 Fig 7.1 [1] for correct light rays	

			[1] for correct location of object minus [1] for no arrow on rays minus [1] for no dotted lines	2
			Total	**10**

11	**(a)**		As the coil rotates between the magnetic field, it **cuts the magnetic field** and experiences a changing magnetic flux. **Based on Faraday's law**, **a changing magnetic flux** induces an e.m.f. in the coil.	1 1
	(b)		Slip rings	1
	(c)		The slip rings are in continuous contact with carbon brush, **ensuring the induced current in the coil is transferred/connected to external circuit.**	1
	(d)		Current in clockwise direction (viewed from top)	1
	(e)		- increase the number of turns in the coil - increase the speed of rotation of the coil - increase the strength of the magnet - place a soft iron core in between the coil Any 2 of the above	2
	(f)	**(i)**	Since the power transmitted is a constant, when voltage is stepped up, **current in transmission wires will be reduced**. As power lost in cables is $\boldsymbol{P = I^2R}$**, power loss is reduced** when current is reduced.	1 1
		(ii)	25:400, 1:16, 0.0625 Any of the above	1
			Total	**10**

SECTION B

12	**(a)**	**(i)**	Heat is **transferred by conduction** from pipe to coolant. Molecules of the pipe **vibrate more vigorously** about their positions and **internal heat is passed through collision with neighbouring (copper) molecules** and finally to the coolant.	1 1
		(ii)	The water near the copper pipe loses energy to the coolant in the pipe, **becomes colder** and **sink** to the bottom of the tank as it is **denser.** The **warmer water** at the bottom, **being less dense** will **rise** and be cooled by the refrigerator unit. This **forms a convection current** in the tank until all the water is cooled.	1 1 1
	(b)		The polished aluminum tank is a **poor absorber / good reflector of infra-red via radiation**. It **reduces heat gain** from the surrounding by infra-red radiation.	1
	(c)	**(i)**	energy = P × t = 80 × (1.5 × 60 × 60) = 432 000 J = 432 kJ	1 1
		(ii)	Let the final temperature be T according to principle of conservation of energy, Heat gain by refrigerator unit = Heat lost by the water energy = m × c × (25 – T) 432 000 = (1000 × 0.013) × 4200 × (25 – T) final temperature, T = 17 °C	1 1
			Total	**10**
13	**(a)**		A : North B: South	1 1
	(b)		**Magnetic field of current in coil interacts with magnetic field of magnet**, producing a net force. Using Fleming Left Hand rule, **downward force acts on PQ upward force acts on RS.** Coil rotates in **anticlockwise direction.**	1 1 1
	(c)		Enable the coil to rotate continuously in the same direction by **reversing the direction of current every half a revolution.**	1

	(d)		Due to **inertia / momentum**, the coil continues to turn though current is not flowing in coil in vertical position.	1
	(e)	**(i)**	 Any of the points with X	1
		(ii)	- decrease the number of turns of the coil - decrease the strength of the magnet - decrease the magnitude of the current Any of the two above	2
			Total	**10**