Paya Lebar Methodist Girls' School (Secondary)

Preliminary Examination 2024
Secondary 4 Express / G3

CANDIDATE NAME		CLASS		CLASS INDEX NUMBER	

CENTRE NUMBER					INDEX NUMBER				

PHYSICS **6091/02**

Paper 2 Structured and Free Response **20 August 2024**

1 hour 45 minutes

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

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 2B 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 their working in a clear and orderly manner, as more marks are awarded for the sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

Section A (70 marks)

Answer **all** questions.

1 Fig. 1.1 shows a satellite moving at a constant speed in a circular orbit around the Earth.

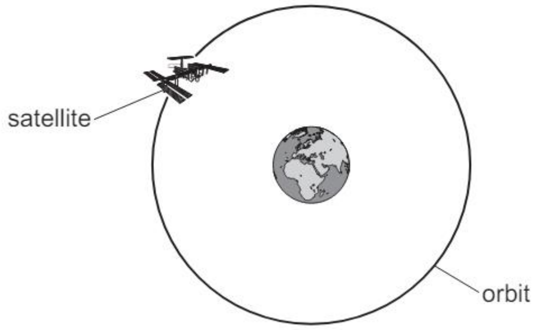

Fig. 1.1

Speed is a scalar quantity but velocity is a vector quantity.

(a) State how a scalar quantity differs from a vector quantity.

……………………………………………………………………………………….

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

(b) Underline every vector quantity in the list below.

distance displacement force length mass time

[1]

(c) There is a resultant force acting on the satellite in Fig. 1.1.

This force acts in the radial direction toward the centre of the Earth.

Explain if there is work done by the resultant force on the satellite after it travels one complete revolution.

………………………………………………………………………………………

………………………………………………………………………………………

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

2 Fig. 2.1 is the distance–time graph for a stone that is dropped from rest at t = 0 at the surface of a lake. It starts to sink thereafter and eventually reaches terminal velocity.

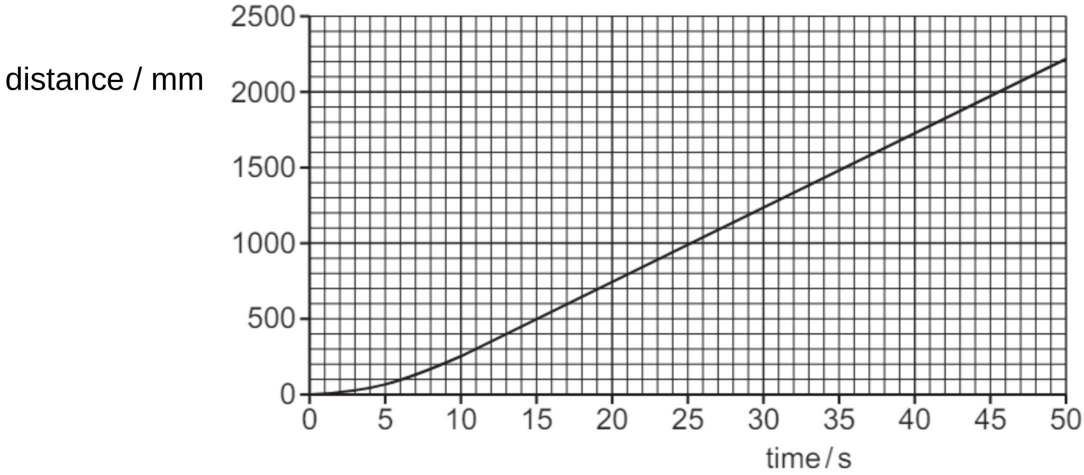

Fig. 2.1

(a) Using Fig. 2.1 and appropriate working, determine the terminal velocity of the stone.

terminal velocity = ……………….. [2]

(b) Describe how the resistive force due to water changes as the stone descends between t = 3 and t = 5 s.

……………………………………………………………………………………

……………………………………………………………………………..… [1]

(c) Acceleration of the stone decreases between t = 3 and t = 5 s.

By considering the forces acting on the stone, explain why.

……………………………………………………………………………………

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……………………………………………………………………………………

…………………………………………………………………………….... [2]

3 A 1.5 kg stone, released at **A**, falls vertically, hits a rubber mat at **B** and rebounds vertically upwards from **C** onwards.

Fig. 3.1 shows the velocity-time graph of the stone.

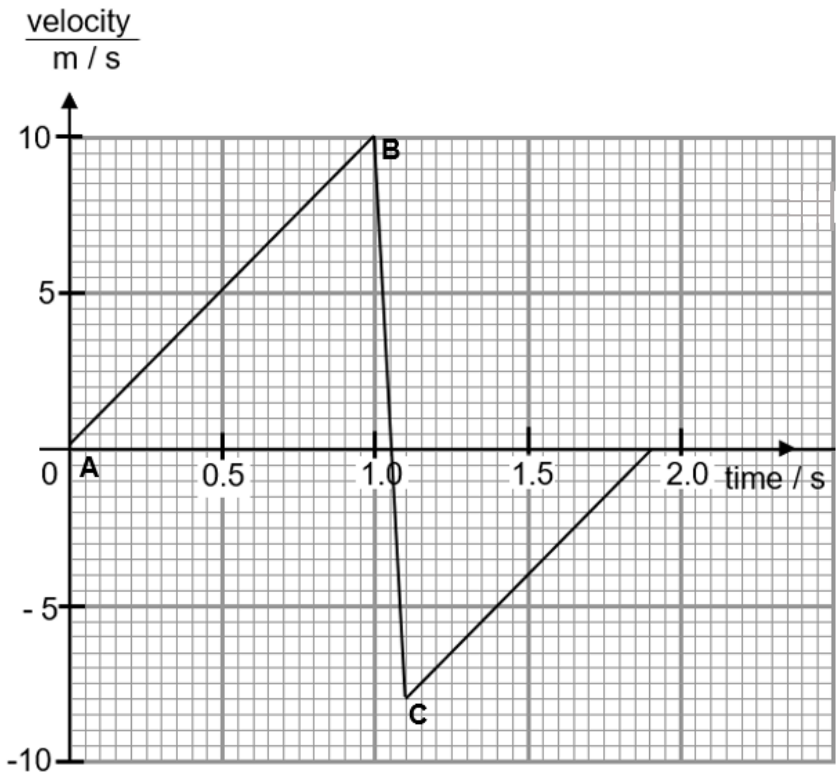

Fig. 3.1

(a) **By calculating the energy in the kinetic store and using ideas about conservation of energy,** determine the height through which the stone at **A** has fallen before it hits the rubber mat at **B**.

Take gravitational field strength g to be 10 N / kg.

height = ……………………… [2]

(b) Using Fig. 3.1 and with appropriate calculation, verify if the stone is under free fall during **AB**.

……………………………………………………………………………………… [1]

(c) Using Fig. 3.1, estimate the maximum height attained by the stone after the rebound.

maximum height = …………………… [1]

(d) The magnitude of the stone's acceleration during **BC** is 180 m / s^2.

Calculate the normal contact force acting on the stone during **BC**.

normal contact force = …………………….. [2]

4 Fig. 4.1 shows a door and an automatic door-closer viewed from above.

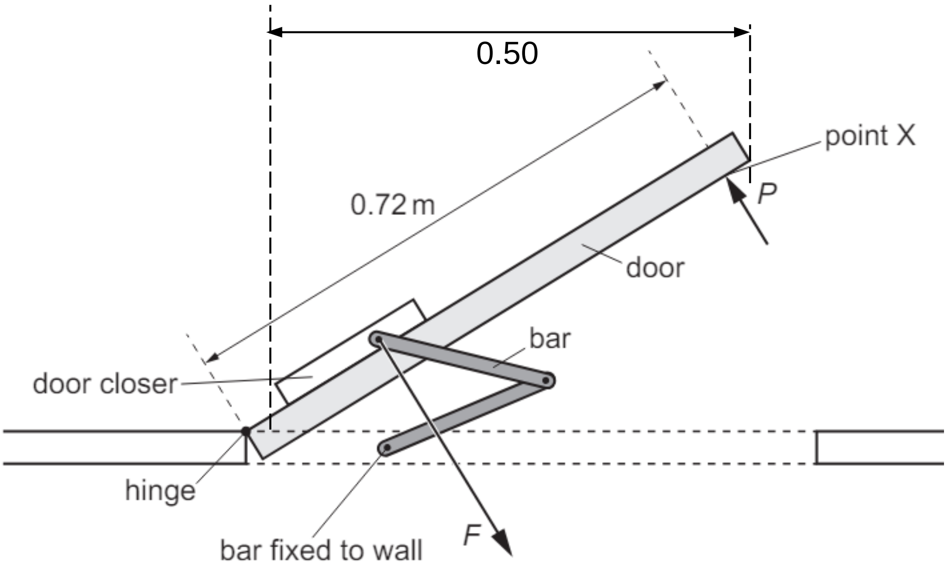

Fig. 4.1

When the door opens and closes, the hinge acts as a pivot.

A girl opens the door by exerting a force *P* at point X.

Force *P* is perpendicular to the surface of the door.

(a) Fig. 4.1 shows that point X is a distance of 0.72 m along the front of the door from the hinge. The force *P* is 25 N.

(i) Calculate the moment of force *P* about the hinge.

moment = ……………………. [1]

(ii) The door rotates about the hinge by 90°. The circumference of a circle of radius 0.72 m is 4.5 m.

Calculate the work done on the door by force *P*.

work done = ………………. [2]

(b) As the door opens, there is a force *F* on the door in the direction shown in Fig. 4.1.

Although force *F* is larger than the applied force *P*, the girl is still able to cause the door to rotate about the hinge.

Explain why.

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.... [1]

5 Object A of mass 500 g moved down a slide from a vertical height of 3.0 m as shown in Fig. 5.1.

Object A was released with an initial speed of 5.0 m/s and its speed at the lowest point **L** was 8.0 m/s.

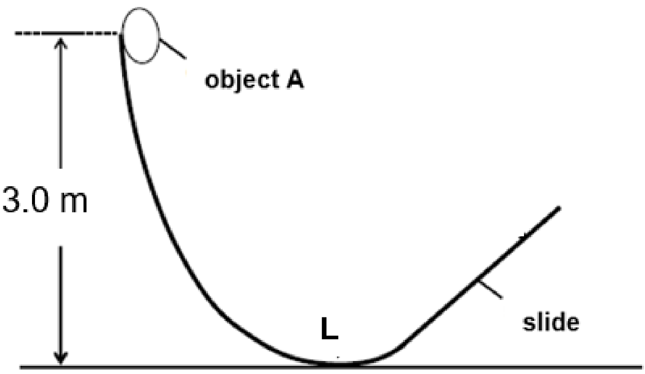

Fig. 5.1

(a) State what is meant by *work done*.

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....

.... [2]

(b) Calculate the amount of energy transferred into object A's kinetic store when object A reaches point **L**.

energy transfer = ………………….. [2]

(c) $\boxed{\text{L}}$ Determine the amount of energy transferred into the internal store when object A reaches point .

energy transfer = ………………….. [2]

6 Fig. 6.1 shows a mercury barometer. The density of mercury is 14000 kg / m^3.

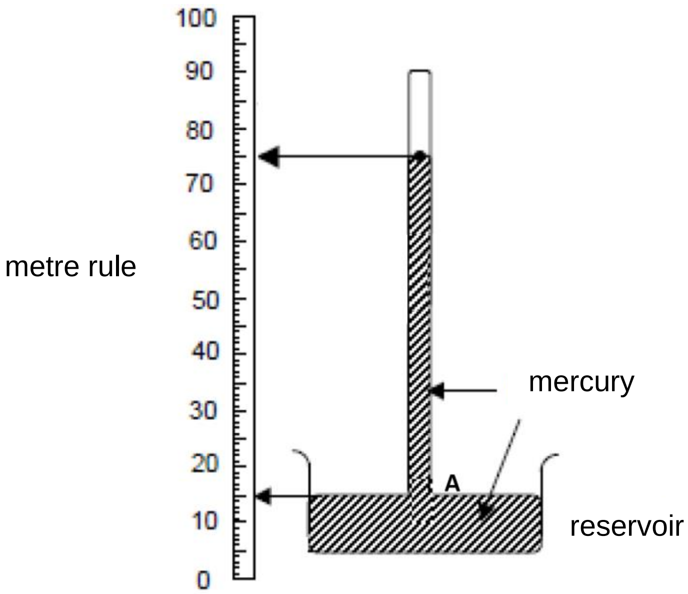

Fig. 6.1

(a) Using ideas of random motion of air particles, explain how the atmosphere exerts a pressure on the surface of the mercury at **A**.

…………………………………………………………………………………….

…………………………………………………………………………………….

……………………………………………………………………………………. [1]

(b) Determine the atmospheric pressure in Pa.

atmospheric pressure = ……………………… Pa [2]

(c) In Fig. 6.1, mark with ‘X on the metre rule where the pressure is 5 cm Hg lower than the atmospheric pressure. [1]

7 Fig. 7.1 shows the inner vessel of a double walled steel mug containing ice cold water. The double walls of the mug are sealed such that there is a vacuum between them.

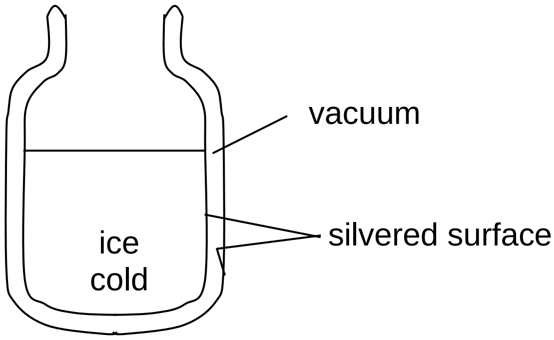

Fig. 7.1

(a) Explain how the design of the mug reduces heat gained by the ice cold water.

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……………………………………………………………………………………..

……………………………………………………………………………………… [2]

(b) A student pours hot coffee at 95 °C into the steel mug. The heat capacity of the coffee is 630 J / °C. Ignore the heat capacity of the steel mug.

(i) Explain how the design is less effective when the mug is used to keep hot beverages hot and how the design can be improved.

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…………………………………………………………………………………….

…………………………………………………………………………………….

……………………………………………………………………….…... [2]

(ii) The hot coffee loses thermal energy to the surroundings at a constant rate of 60 J / s and the optimum temperature of drinking the coffee is 80 °C. How long does it take before the student can drink it?

time taken = ………………..... [2]

8 Most of the energy emitted by the Sun is in three regions of the electromagnetic spectrum.

The name of one of these three regions is the ultraviolet radiation.

(a) State the names of all three regions in order of increasing frequency.

smallest frequency ……………………………………………

intermediate frequency ………………………………………

largest frequency …………………………………………….. [2]

(b) Some of the ultraviolet radiation emitted by the Sun reaches the surface of the Earth.

Give one possible damaging effect of ultraviolet radiation on the human body and the property of ultraviolet radiation that causes this damage.

Damaging effect ……………………….………………………………………

……………………………………………………………………………………..

property ……………………………………………………………………..

…………………………………………………………………………… [2]

9 At the substations, the voltage is transformed to 240 V for household use.

Fig. 9.1 shows an electric hairdryer and an electric heater are connected to the 240 V mains supply.

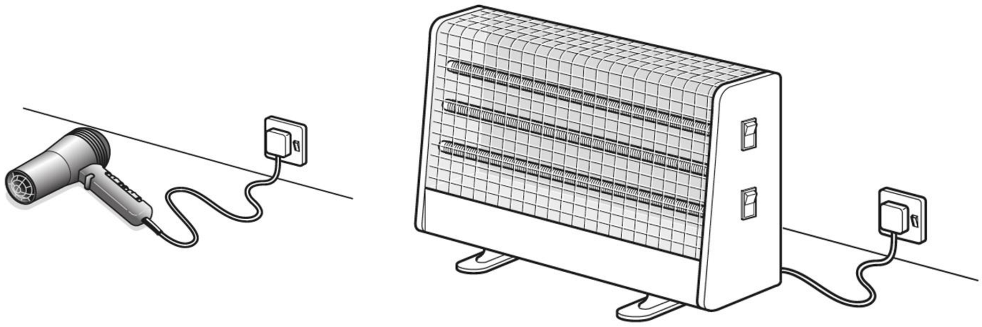

Fig. 9.1

(a) For safety, the electric heater is fitted with an earth wire.

State which part of the electric heater the earth wire should be connected to, and explain fully how it acts as a safety device.

……………………………………………………………………………………………

……………………………………………………………………………………………

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……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(b) The hairdryer does **not** have an earth wire. Explain why this hairdryer is still safe to use.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(c) A student thinks that if the hair dryer is connected to a mains supply of 120 V then the power produced is halved. Suggest why the student is incorrect.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

10 (a) The isotope plutonium-239 decays by the emission of an alpha-particle (symbol *α*) to an isotope of uranium (symbol *U*).

The half-life for this decay is 2.4×10^4 years.

(i) Complete the equation for this decay by filling in the boxes.

$$^{239}_{94}Pu \rightarrow \,^{\square}_{\square}U + \,^{\square}_{\square}\alpha$$

[2]

(ii) The count rate measured due to a pure sample of plutonium-239 is 6400 counts/second.

Calculate the count rate after a period of 1.2×10^5 years has elapsed.

count rate = …………………. [2]

(b) Fig. 10.1 shows a Geiger-Müller (G.M.) tube and counter.
A radioactive source is placed 10 cm from the G.M. tube.

The readings on the counter have been corrected for background radiation and show the count rate due to the source.

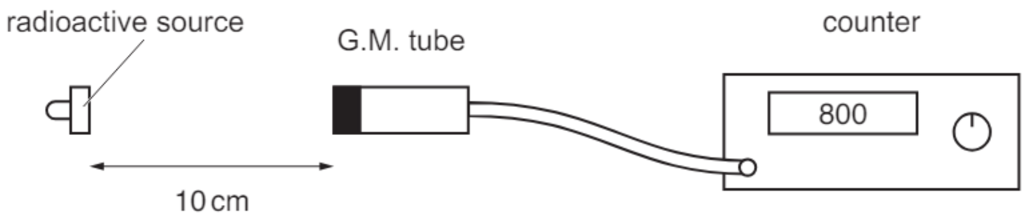

Fig. 10.1

(i) Explain if the set-up in Fig. 10.1 can be used to show that the source emits α-particles.

…………………………………………………………………………..………..

…………………………………………………………………………..…… [1]

(ii) In Fig. 10.2, a piece of metal 5 mm thick is placed between the source and the G.M. tube. The readings on the counter have been corrected for background radiation and show the count rate due to the source.

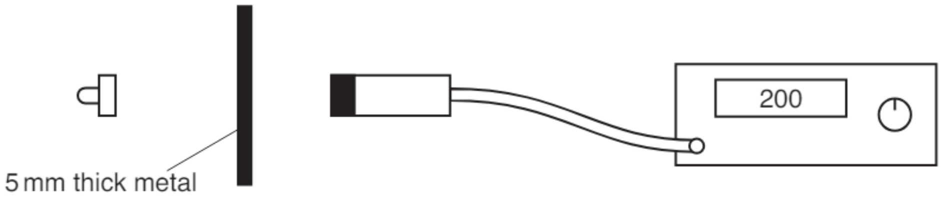

Fig. 10.2

Explain how the readings in Fig. 10.1 and 10.2 show that the source emits both β-particles and γ-radiation.

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.... [2]

11 Fig. 11.1 shows a 12.0 V battery connected in series with a 400 Ω resistor, a 600 Ω resistor, and switches S1 and S2. An ammeter and a voltmeter measure the current of the circuit and the potential difference across the 400 Ω resistor respectively.

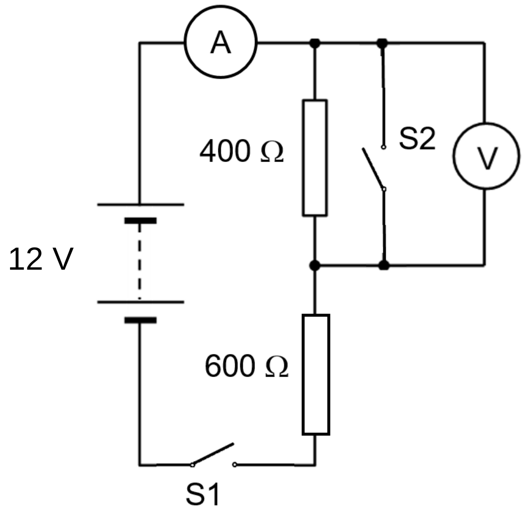

Fig. 11.1

(a) The ammeter and voltmeter readings are observed as switches S1 and S2 are opened and closed.

Determine

(i) the voltmeter reading when S1 is open and S2 is closed.

voltmeter reading = …………………………..[1]

(ii) the ammeter reading when both S1 and S2 are closed.

ammeter reading = …………………………..[1]

(b) The 600 Ω resistor is replaced with a small coil of metallic wire X. Switch S1 is closed and S2 is open.

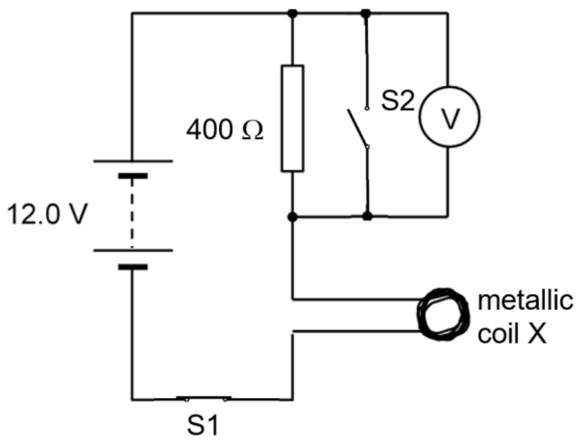

Fig. 11.2

The resistance of metallic coil X varies with temperature, as shown in Fig 11.3.

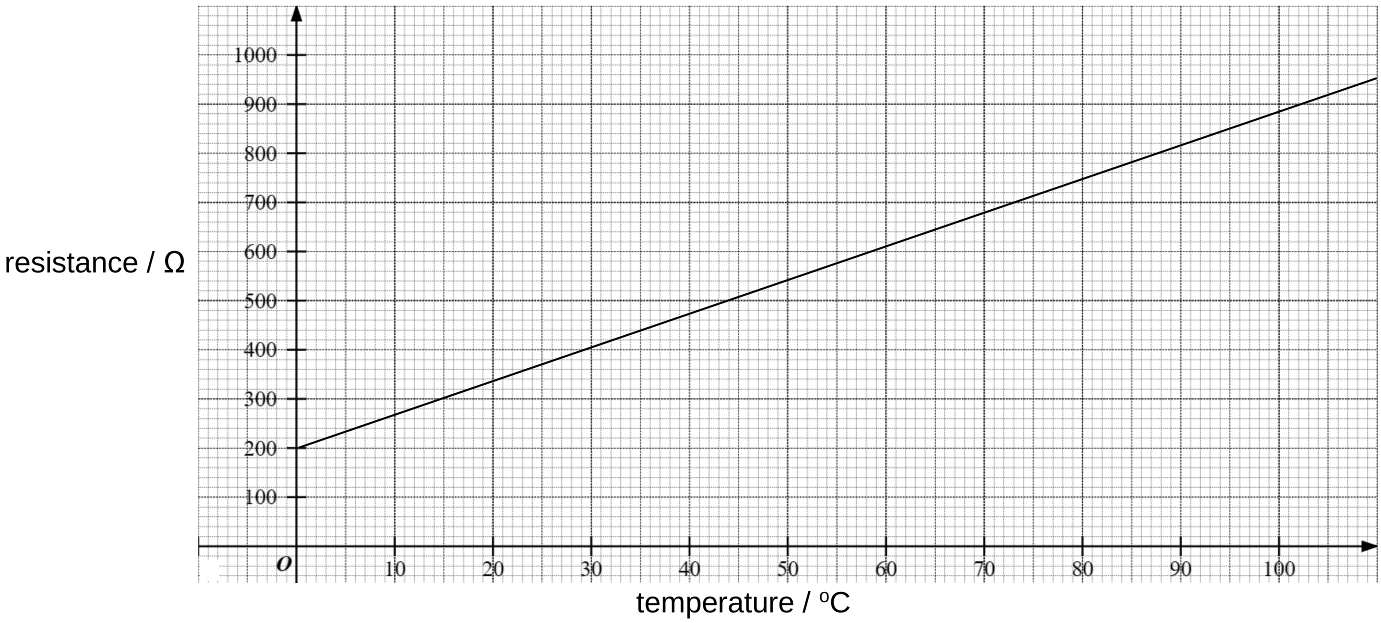

Fig. 11.3

(i) Explain in molecular terms, why the resistance of metallic coil X increases with temperature.

....

....

.... [1]

(ii) At a certain temperature, the voltmeter reads 6.4 V. By using the potential divider rule or otherwise, calculate the resistance, R, of the coil X, and hence determine the temperature.

R = …………………….. [2]

temperature = ………………….[1]

(iii) On Fig. 11.3, draw a new line to show the graph obtained if a coil of the same material X but **half** the length is used. [1]

(c) Metallic coil X is replaced with an unknown component Y.
Fig. 11.4 shows how the voltmeter readings vary with temperature.

temperature / ° C	voltmeter reading / V
0	4.60
20	5.10
40	6.70
60	8.60
80	10.75

Fig. 11.4

Suggest what component Y is. Explain your answer

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

12 (a) Fig.12.1 shows the internal structure of a motor.

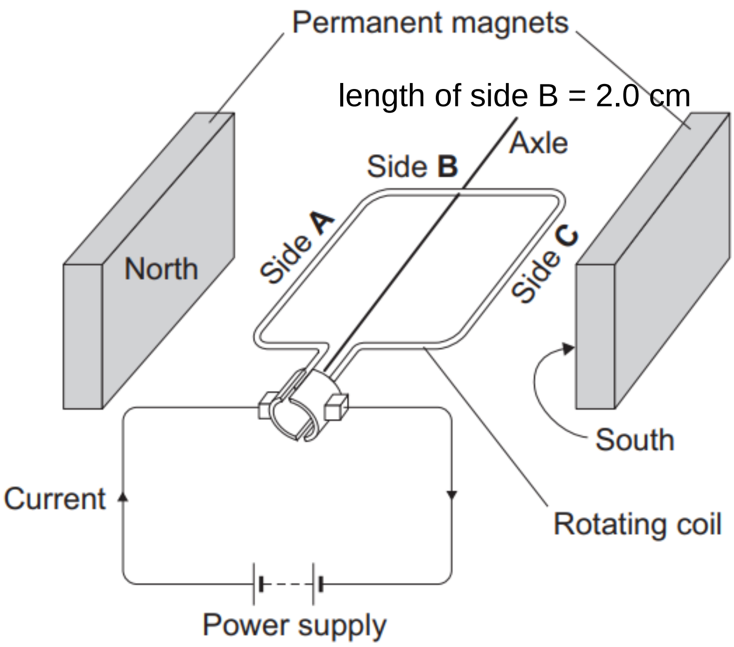

Fig. 12.1

(i) With reference to the side of the coil near to the South pole, explain how the commutator keeps the coil rotating in one direction.

…………………………………………………………………………………….

…………………………………………………………………………………….

…………………………………………………………………………………….

…………………………………………………………………………………….

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

(ii) The forces acting on side **A** and **C** of the coil is 6.0×10^{-3} N.
Side **B** is 2.0 cm.

For the instant shown in Fig. 12.1, calculate the **total** moment acting on the coil.

moment = ……………………. N cm [1]

(iii) The coil of the motor rotates at a frequency of 0.667 Hz.

Sketch the graph of the moment of the coil against time on Fig.12.2 starting from the instant shown in Fig. 12.1.

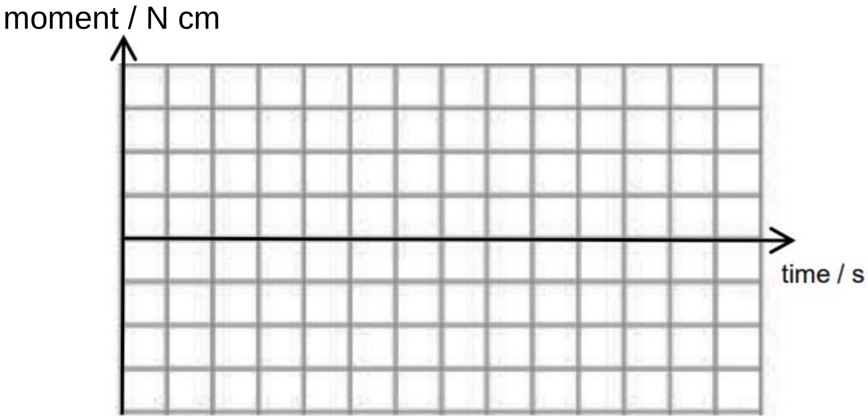

Fig. 12.2

On Fig. 12.2, indicate the time taken for one complete revolution and the value of the maximum moment. [2]

(b) This question deals with electrostatic and magnetic forces.

(i) Fig. 12.3 shows a brass ring suspended by a thread, close to a bar magnet.

When the S-pole of the magnet is moved quickly towards the brass ring, the ring swings away from the bar magnet.

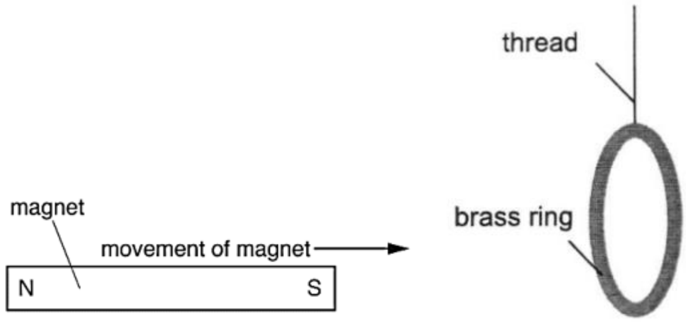

Fig. 12.3

Explain why the brass ring moves away from the magnet.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………….. [2]

(ii) In Fig. 12.4, the brass ring is replaced by an unmagnetised iron bar PQ close to the same bar magnet on a smooth laboratory bench.

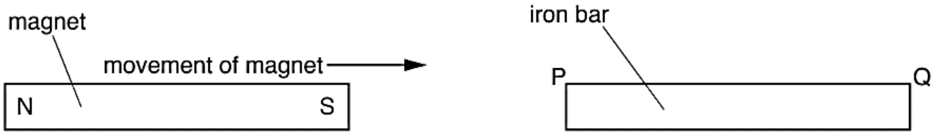

Fig. 12.4

The iron bar is initially at rest and the magnet is moved to the right very slowly. When the magnet is close enough, the iron bar moves very quickly to the left towards it.

Explain why the iron bar moves to the magnet.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………….. [2]

(iii) In Fig. 12.5, the bar magnet is replaced with a copper rod that is positively charged. It is placed near an unmagnetised iron bar PQ suspended on a piece of string.

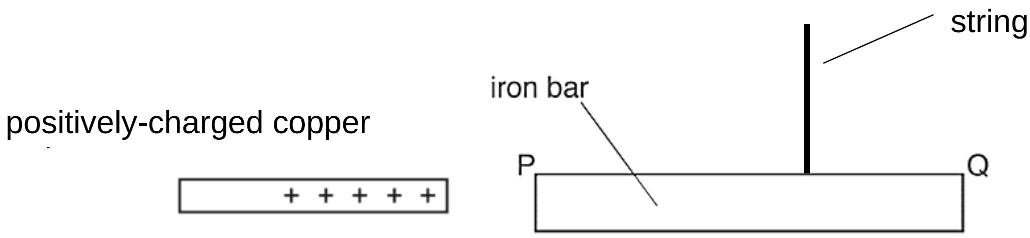

Fig. 12.5

The iron bar is initially at rest and the copper rod is moved to the right. When the copper rod is a short distance from the iron bar, the iron bar swings to the left towards it.

Explain why the iron bar swings toward the copper rod.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………….. [2]

Section B

Answer **one** question from this section.

13 (a) A positively-charged sphere S_1 is shown in Fig. 13.1.

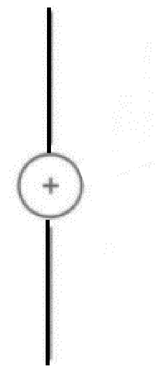

Fig. 13.1

(i) Two lines have been drawn close to S_1.

Draw an arrow on each of the lines to show the direction of the electric field near S_1. [1]

(ii) S_1 is then placed near to positively-charged S_2 and negatively-charged S_3 as shown in Fig. 13.2.

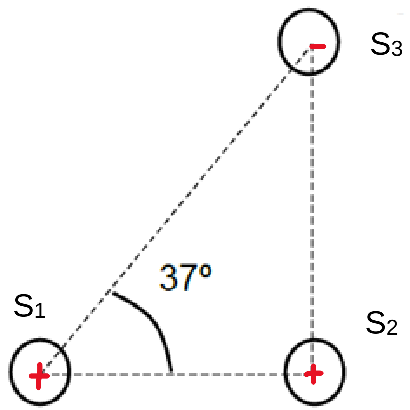

Fig. 13.2

S_1 experiences a force of 3.0 N due to S_3 and 5.0 N due to S_2.

Using the space on the next page, draw a scaled diagram to determine the resultant force of the 5.0 N and 3.0 N forces acting on S_1.

scale = ………… : ………….. [1]

resultant force = ………………….. N [2]

(b) S_1 is then suspended by a non-conducting string at point P.
It is deflected when a positively charged plate is placed nearby as shown in Fig. 13.3.

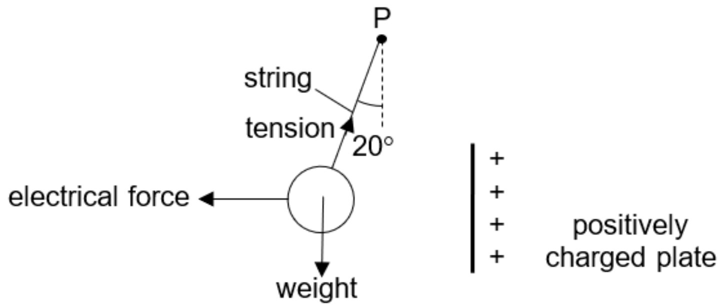

Fig. 13.3

(i) Describe the force that forms an action-reaction pair with the weight of the sphere.

…………………………………………………………………………..………

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

S_1 is then earthed with the charged plate still held near as shown in Fig. 13.4.

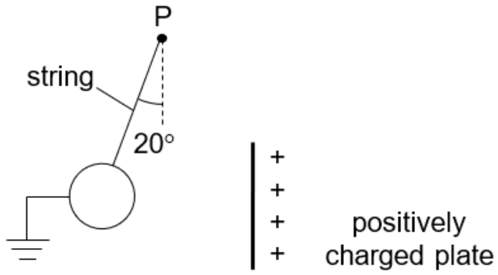

Fig. 13.4

(ii) Describe the movement of charges in S_1 when it is being earthed.

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.... [1]

(iii) The charged plate is moved far away from S_1.

On Fig. 13.5, draw how the charges will be distributed on the sphere. [1]

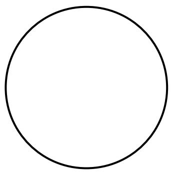

Fig. 13.5

(c) Batteries inside laptop computers are charged using laptop chargers. The laptop charger contains a traditional transformer as shown in Fig. 13.6.

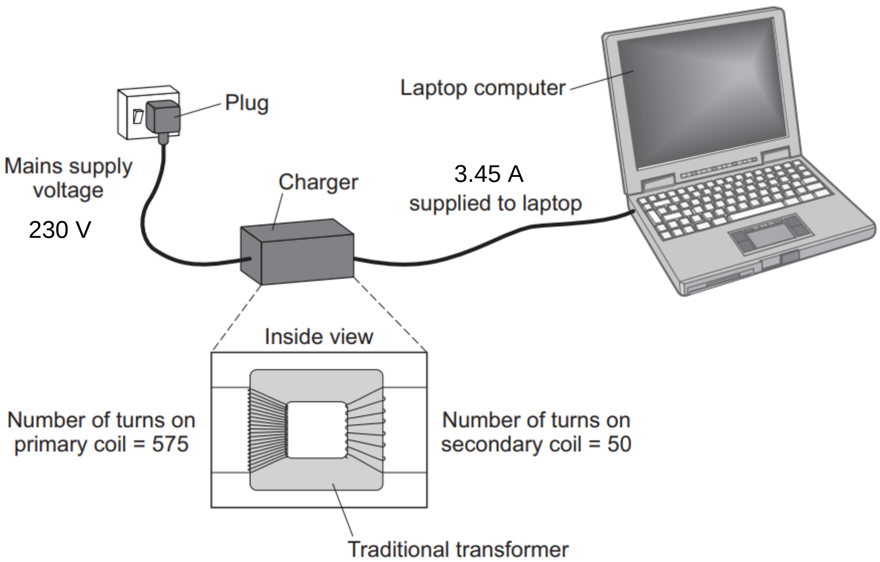

Fig. 13.6

(i) Use information from Fig. 13.6 to calculate the potential difference the charger supplies to the laptop.

potential difference = ………………….. [2]

(ii) Calculate the current in the primary coil of the transformer when the laptop is being charged. Assume the transformer is 100% efficient.

current = …………………… [1]

14 This question is about refraction.

(a) Fig. 14.1 shows a light ray entering a converging lens.

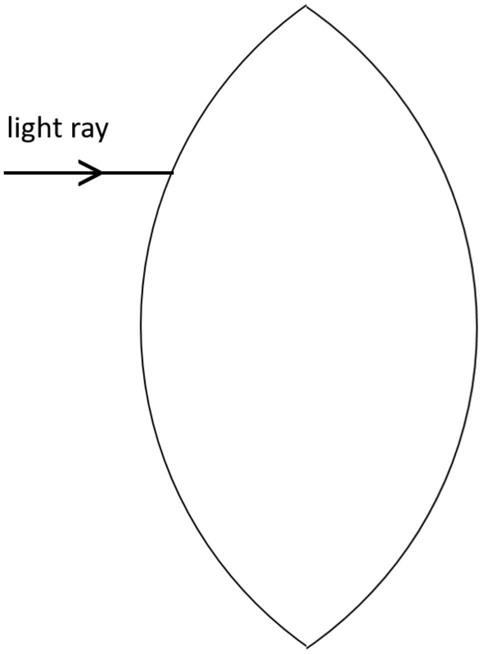

Fig. 14.1

(i) Continue the path of the light ray until it leaves the lens. Include the normal(s) in your drawing. [1]

(ii) Describe a method to find an approximate value of the focal length of the lens.

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....

....

....

....[2]

(b) Fig 14.2 shows the path of a ray of light as it passes through a glass prism.

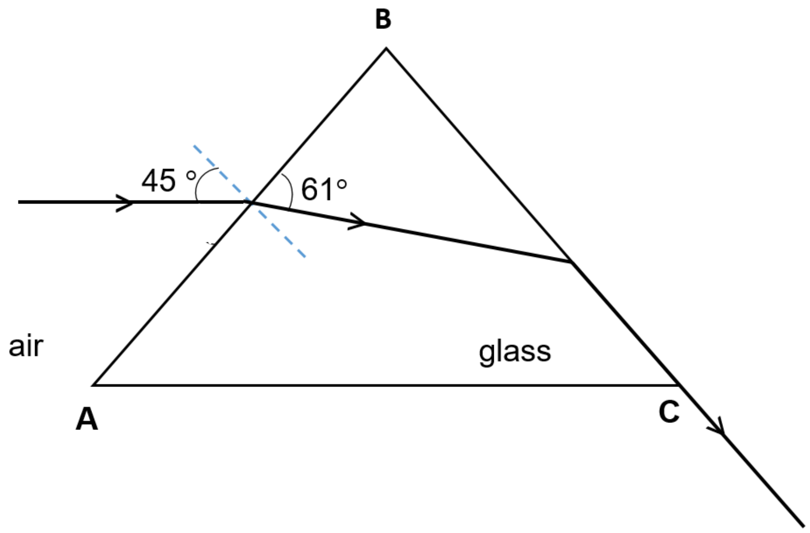


Fig. 14.2

(i) Calculate the refractive index of the glass.

refractive index = ………………………….[2]

(ii) Calculate the speed of light in the prism.

speed of light = ………………………….[1]

(c) The angle of incidence of the ray at side **AB** in Fig. 14.2 is decreased to less than 45 °.
Explain what happens when the ray reaches side **BC**.

……………………………………………………………………………………......

……………………………………………………………………………………......

……………………………………………………………………………………......

……………………………………………………………………………………......

…………………………………………………………………………………….[2]

(d) The ray of light is replaced by an ultrasound wave.
Describe what happens to the direction of the ultrasound wave at side **AB** as it enters the prism.
Using ideas of molecules, explain why.

……………………………………………………………………………………......

……………………………………………………………………………………......

……………………………………………………………………………………......

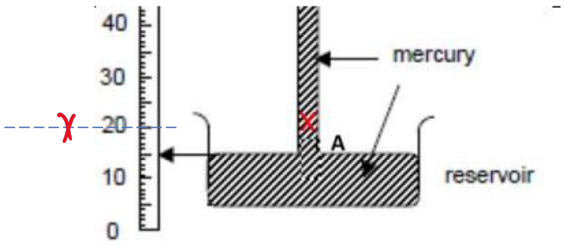
……………………………………………………………………………………......

…………………………………………………………………………………….[2]

End of Paper

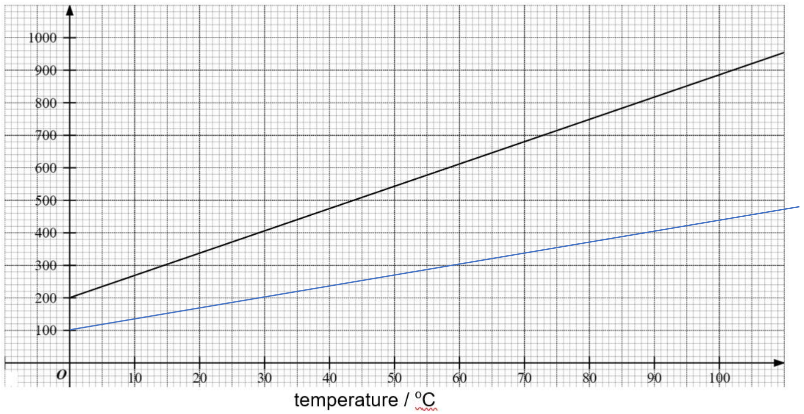
QN	SUGGESTED ANSWER	MARK
1a	A scalar quantity has only magnitude but no direction but vector quantity has both.	B1
1b	*displacement* and *force* underlined	B1
1c	Distance travelled by satellite is not in the same direction (is perpendicular to) as the resultant force. **OR** No energy is transferred since kinetic energy remains constant (speed is constant) or gravitational potential energy remains constant (at the same orbit)	C1
2a	Working shown 46 to 52 mm/s or 0.046 to 0.052 m/s	C1 A1
2b	The resistive force increases as speed of stone increases	B1
2c	Resultant force acting on the stone = weight – resistive force. Since resistive force increases as the speed increases, the resultant force decreases. Hence stone sinks with decreasing acceleration since acceleration = Fnet/mass	B1 B1
3a	KE of stone just before it hits the mat = ½ (1.5)10^2 = 75 J By COE, GPE at max height = 75 J 1.5x10xh = 75 h = 5.0 m	C1 C1
3b	Gradient of the graph during AB = 10	C1

QN	SUGGESTED ANSWER	MARK
	This means acceleration of the stone during AB is 10 m/s^2. Hence free fall.	
3c	Area under the graph = ½ (1.900-1.100)8.00 = 3.20 m <u>Accept ½ (1.9000-1.050) = 3.40 m</u>	A1
3d	F_{net} during BC = ma = 1.5 x 180 = 270 N N – mg = F_{net} N = 270 + 15 = 285 N	C1 A1
4ai	25 × 0.72 = 18 N m	A1
4aii	Work done = F x d = 25 × 4.5 / 4 = 28 J	C1 A1
4b	Anticlockwise moment due to force *P* is greater due to distance of X to hinge is greater than distance from where force *F* acts	C1
5a	Work is the product of force and the distance travelled in the direction of force. Work is the energy converted from one form to another / energy transferred from one store to another.	B1 B1
5b	Gain in KE = ½ $(0.5)(8.0)^2$ - ½ $(0.5)(5.0)^2$ = 9.75 J or 9.8 J	C1 A1
5c	Loss in GPE = gain in KE + work done against resistive force	

QN	SUGGESTED ANSWER	MARK
	0.5 x 10 x 3 = 9.75 + work done against resistive force work done against resistive force = energy transferred into internal store = 15 – 9.75 = 5.25 or 5.3 J	C1 A1
6a	Air particles in the atmosphere collide with the surface of the mercury, exerting a force. Since pressure is force per unit area, pressure is exerted on the mercury surface at A.	B1
6bi	P = hρg = (75-15)/100 x 14000 x 10 = 84 kPa or 8.4x104 Pa	C1 A1
6c		C1
7a	The vacuum between the double walls prevents thermal energy from the surroundings to be conducted into the cold water. The silvered walls reduce thermal transfer via radiation.	B1 B1

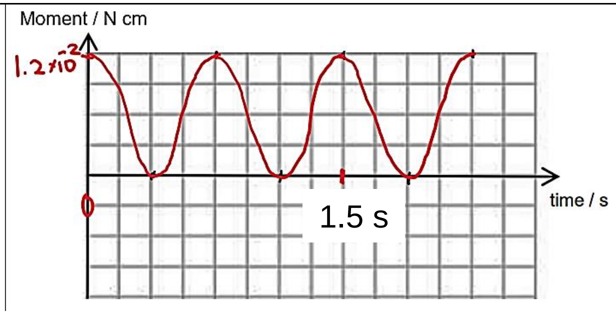
QN	SUGGESTED ANSWER	MARK
7bi	The air above the hot beverage gets heated up and rises, hence some thermal energy is transferred away from the beverage by convection. (accept evaporation) Add a lid to reduce heat loss via convection.	B1 B1
7bii	Thermal energy lost = $C\Delta\theta$ = 630 x (95-80) = 9450 J Time required = 9450/60 = 157.5 = 160 s	C1 A1
8a	infrared (radiation) and visible (light) and ultraviolet (radiation) and in this order	B1 B1
8b	Damaging effect: (skin) cancer / cataracts property: ultraviolet radiation is ionising	B1 B1
9a	Earth wire should be connected to the metal casing. Should there be a fault and the live wire touches the metal casing, the earth wire diverts the current to the ground. The current surges due to the low resistance and melts the fuse, disconnecting the appliances from the high electrical potential of the mains.	C1 B1 B1
9b	It is doubly insulated/It does not have any exterior parts that is made of conducting material.	B1
9c	$P = V^2 /R$, When V is halved, power is one-fourth.	B1

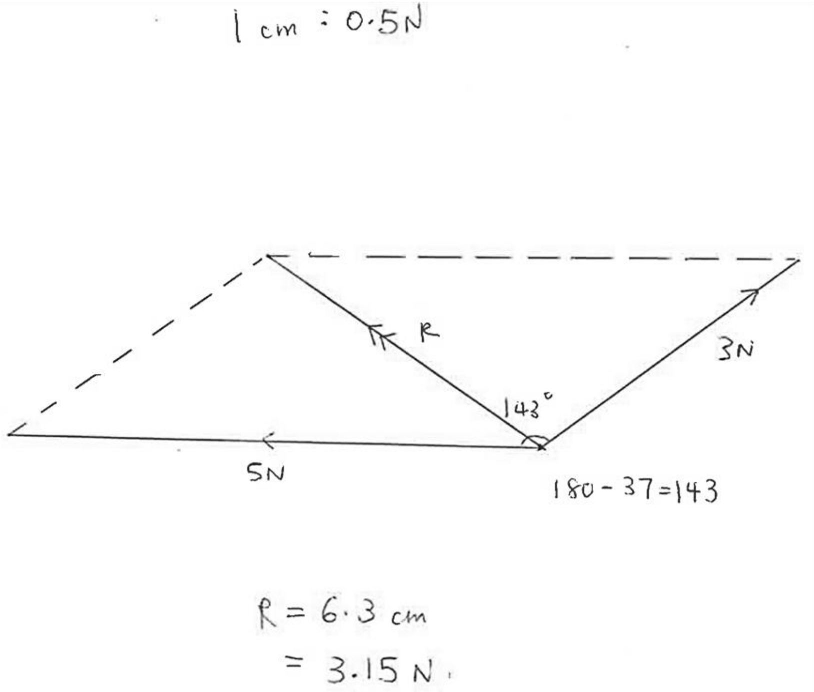
QN	SUGGESTED ANSWER	MARK
10ai	${}^{4}_{2}\alpha$ ${}^{235}_{92}\mathrm{U}$	A1 A1
10aii	1.2 × 10^5 years = 5 half lives, 6400 $(½)^5$ = 200 counts/second	C1 A1
10bi	Alpha particles have a <u>short range in air as it is very ionising and will not reach the GM tube.</u> ***If the GM counter registers a reading at 10 cm away from the source, this implies the source does not emit alpha particles.***	B1
10bii	Reading in Fig. 10.1 is due to beta and gamma radiation as both have long range in air. Fig. 10.2 shows a drop in the reading which implies the source does not emit only gamma radiation. It must also emit beta particles since they cannot penetrate a few mm thick of metal.	B1 B1
11ai	0 V	A1
11aii	12/600 = 0.020 A	A1
11bi	As temperature rises, the ions in the metallic coil <u>vibrate faster</u> and with <u>greater amplitudes</u> **and** <u>slowing down the electrons / increase in no. of colllisions between mobile electrons and metal ions / decreases rate of flow of electrons</u>	C1

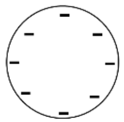
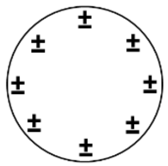
QN	SUGGESTED ANSWER	MARK
11bii	By potential divider principle, 6.4/12.0 = 400/(400+R) R = **<u>350 Ω</u>** **<u>OR</u>** I = (6.4)/400 = 0.016A R = 5.6/0.016 = **<u>350 Ω</u>** Reading from graph, temperature between 21.0 to 22.5 °C (1 d.p.) [*Allow ecf from value of R*.]	C1 C1 C1 C1 A1
11biii	Resistance is halved since length is halved. [R ∝ L] 	A1
11c	Thermistor As <u>temperature increases</u>, <u>resistance</u> of <u>thermistor</u> <u>decreases</u>, Hence the <u>pd</u> across the thermistor <u>decreases</u>.	A1 C1

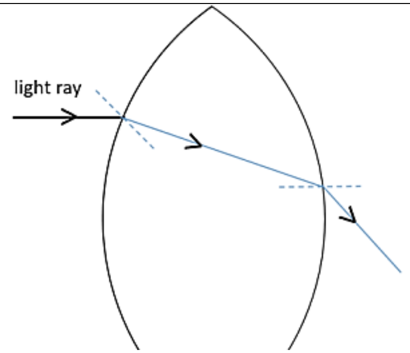
QN	SUGGESTED ANSWER	MARK
	Since pd of thermistor and the voltmeter reading adds up to 12 V, the voltmeter reading increases as temperature increases. **OR** explain using potential divider ratio: $V = 12 \times \frac{400}{400 + R_{TH}}$ As temperature increases, V increases as shown in the table. This implies that ratio $\frac{400}{400 + R_{TH}}$ increases, which means R_{TH} decreases.	
12ai	The commutator enables the current in the coil to reverse every half a revolution. Hence the force acting on the coil near the South pole will always be upward. This ensures the coil rotates continuously in the anticlockwise direction.	B1 B1
12aii	Total moment = F x d = 6.0×10^{-3} x 2.0 = 1.2×10^{-2} N cm	A1
12aiii	40 cycles in 1 min so **1 rev in 1.5 s** and **Max moment at the start** (horizontal position)	C1 for labelling C1 for shape

[Turn Over

QN	SUGGESTED ANSWER	MARK
		Ecf from 12aii
12bi	• When the magnet approaches the brass ring, the <u>increase in magnetic flux (linkage)</u> through the ring <u>induces an e.m.f</u> in the ring. • The <u>induced current</u> flows in the ring to set up a <u>S-pole</u> on the left side to <u>oppose</u> the approaching S-pole of magnet. • Since <u>like poles repel</u>, the ring swings away from the magnet.	B1 B1
12bii	The bar magnet <u>induces a north pole at end P</u> of iron bar. (or evident understanding of magnetic induction) Since <u>unlike poles attract</u>, the iron bar moves toward the bar magnet.	B1 B1
12biii	Positively charged copper rod <u>attracts the mobile electrons in iron bar toward the left side</u>. Hence end P has <u>induced net negative charge</u>. Since <u>unlike charges attract</u>, the iron bar swings toward the copper rod.	B1 B1

QN	SUGGESTED ANSWER	MARK
13ai	Arrows directed away from the sphere	C1
13aii	Appropriate scale for large vector diagram Appropriate vector diagram Answer for resultant force [between 3.1 N to 3.3 N (6.2 cm to 6.6 cm)]  	A1 C1 A1
13bi	The gravitational force by sphere on the earth	B1
13bii	<u>Electrons</u> move <u>from the earth</u> up <u>to</u> the sphere.	B1
13biii	Two possible answers:	C1

QN	SUGGESTED ANSWER	MARK
	• Answer 1: If earth connection is removed **<u>before</u>** positively charged plate is removed**,** negative charges distributed equally on the surface of the sphere.  • Answer 2: If earth connection is removed **<u>after</u>** positively charged plate is removed **OR** if earth connection remains with positively charged plate is removed, sphere becomes neutral**.** 	
13ci	$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ $\frac{V_s}{230} = \frac{50}{575}$ So V_S = 20 V	C1 A1
13cii	Since transformer is 100% efficient, input power = output power $V_P I_P = V_S I_S$ 230 x I_P = 20 x 3.45 So I_P = 0.30 A	A1

QN	SUGGESTED ANSWER	MARK
14ai		C1
14aii	Place the lens in front of a screen and adjust the distance between the lens and the screen until a focused image of a distant object is shown on the screen. The distance between the screen and centre of the lens is the focal length. (allow clearly labelled diagram)	B1 B1
14bi	n = sin 45 / sin 29 = 1.46	C1 A1
14bii	n = c/v v = 3.0×10^8 / 1.46 = 2.1×10^8 m/s	A1
14c	The angle of refraction at AB is reduced, thus increasing the angle of incidence of the ray at the side BC. This angle of incidence exceeds the critical angle and the ray experiences total internal reflection at BC.	B1 B1

[Turn Over

QN	SUGGESTED ANSWER	MARK
14d	The ultrasound wave will refract away from the normal since sound travels faster in glass than in air. Particles in glass (solid) are much more closely packed than particles in air (gas), hence energy is transferred much faster from one particle to the next / less time taken for series of compressions and rarefactions to propagate through the medium.	B1 B1

END OF MARK SCHEME