Section A

2025 Phy Set 7

Answer **all** questions in this section.

1 Fig 1.1 shows an arrow about to be released. When the bowstrings are stretched to the extent shown in Fig. 1.1, the tension in each of the bowstrings is 80 N, while the angle between the bowstring and arrow is 45°.

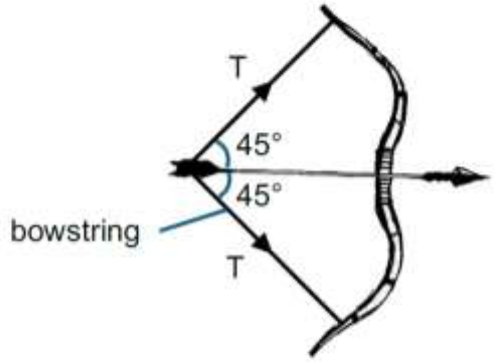

Fig 1.1

Draw a scaled vector diagram to determine the magnitude of the resultant force acting on the arrow due to the bowstrings just before it is released.

scale = ...

magnitude of resultant force = ...[4]

[Total: 4]

2 Fig. 2.1 shows a child sliding down a slope on a snow sledge.

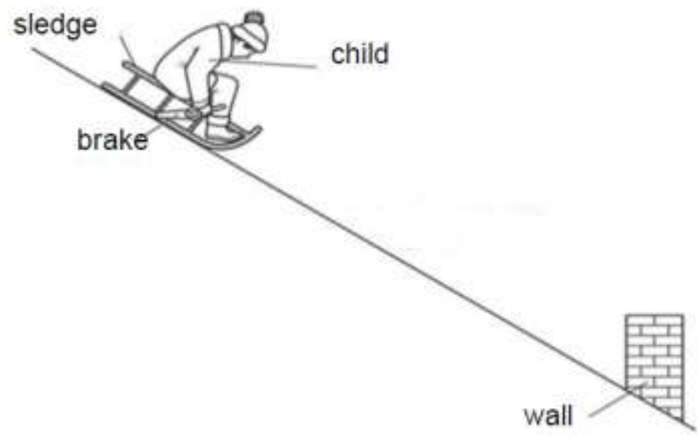

Fig 2.1

At time t = 0, the child and the sledge begin to move down the hill. When the child sees a wall ahead, he applies the brake and eventually comes to a stop.

Fig. 2.2 shows the velocity time graph of the journey.

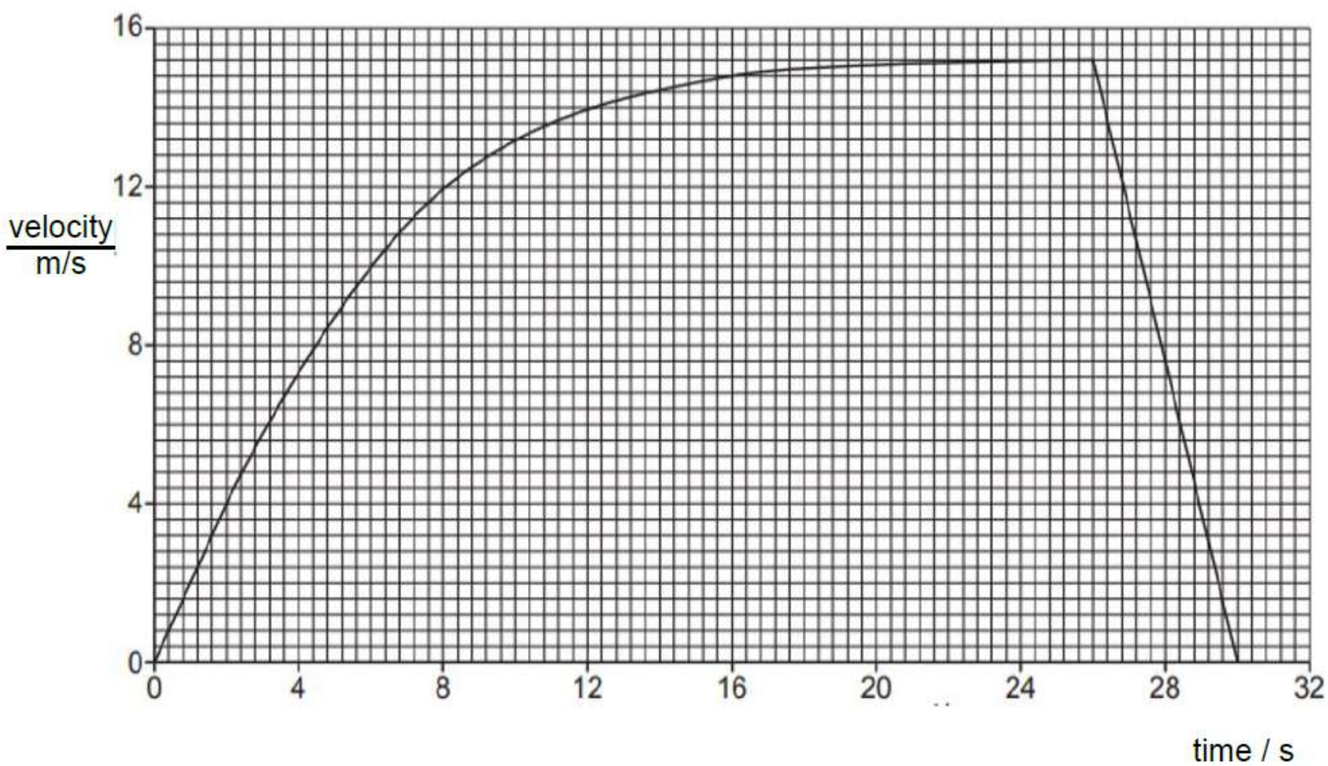

Fig 2.2

(a) Explain, using ideas of forces, why the speed varies in the way shown in Fig 2.2 between t = 0 s and t = 26 s.

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

(b) Explain how the graph shows that the child and the sledge reach terminal velocity.

………………………………………………………………………………………………

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

(c) At t = 26 s, the front of the sledge is 35 m away from the wall.

Determine if the child is able to come to a stop before hitting the wall.

………………………………………………………………………………………………

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

(d) State the main energy changes during time t = 24 s to t = 26 s.

………………………………………………………………………………………………

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

(e) At t = 26 s, when the brakes are first applied, the child jerks forward on the sledge. Explain why this happens.

………………………………………………………………………………………………

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

[Total: 8]

3 Fig 3.1 shows a crane with a boom angle of 30° used on construction sites to lift heavy loads. The length of the crane boom is 45.0 m and the perpendicular distance of the load to the pivot X is 22.0 m.

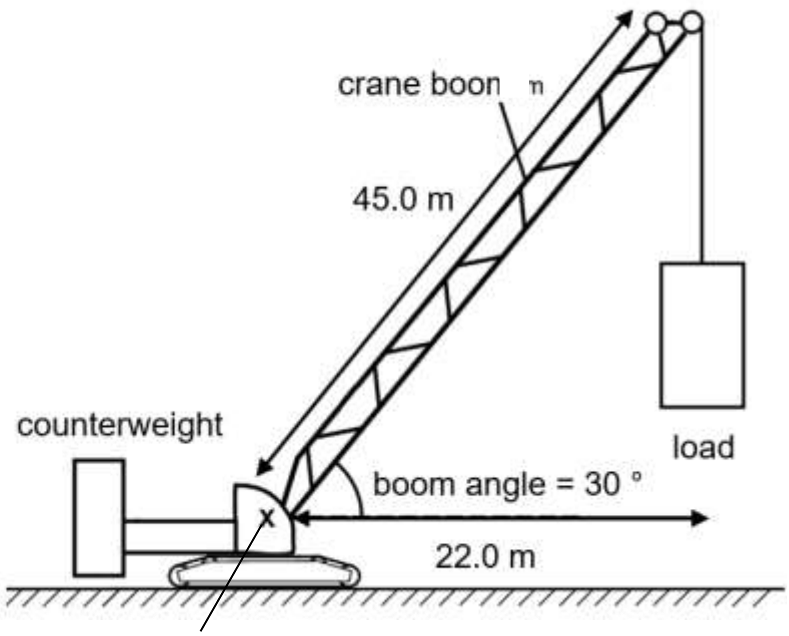

Fig 3.1

Table 3.1 shows the maximum load the crane can support at different boom angles.

Table 3.1

boom angle / °	maximum load / N
30	11 500
45	14 000
60	20 000

(a) Explain why the maximum load increases as the boom angle increases.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(b) **(i)** Calculate the maximum moment that the crane can support when the boom angle is 30^o.

maximum moment = …………………………[2]

(ii) Given that the counterweight is 5.0 m away from pivot X when the boom angle is 30^o, calculate the weight of the counterweight.

weight = ……………………[2]

Total: [6]

4 Fig. 4.1 shows a U-tube which contains mercury being used as a manometer to measure the pressure from a gas supply in a container. One end of the tube is connected to the gas supply and the other end is open.

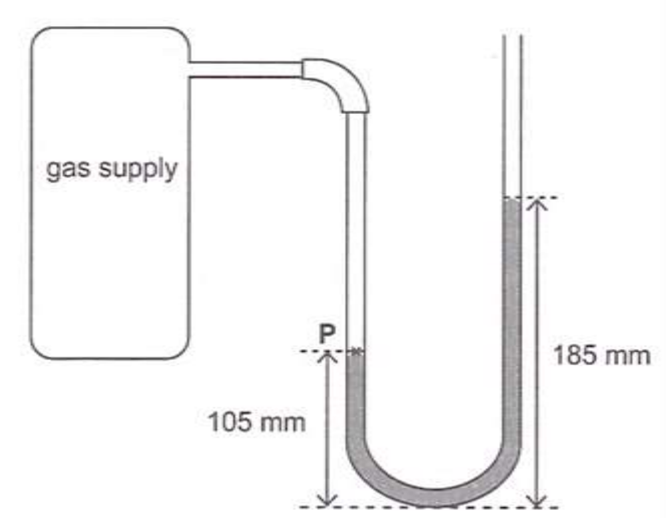

Fig. 4.1

(a) Describe how gas molecules create a pressure with the gas supply.

....

....[1]

(b) Explain why the mercury level moves down on the left side of the U-tube when the gas supply is connected.

....

....[1]

(c) Given that the density of mercury is 13 600 kg/m^3 and the atmospheric pressure is 760 mm Hg, calculate the pressure of the gas supply in pascal.

pressure = ... [2]

(d) The gas supply is made to cool down to a lower temperature. Describe and explain the effect on the difference in the mercury levels between the left and right side of the U-tube.

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

[Total: 7]

5 In a company that manufactures frying pans, a researcher wishes to select a new material that can be used for the base of the pan. Table. 5.1 shows four possible materials and their properties.

Table 5.1

material	melting point / °C	specific heat capacity / J/(kg °C)
A	2350	900
B	950	480
C	1600	480
D	7800	130

(a) The researcher carries out a series of experiments on the materials.

(i) In one of the experiments, a 2.0 kg sample of material A is heated by an electrical heater of power 450 W. The initial temperature of the sample is 25 °C.

Calculate the time taken for the temperature of the sample to rise to 100 °C.

time taken = …………………[2]

(ii) Using the data in Table 5.1, discuss which material is the most suitable to be used for the base of the frying pan. Give one reason to support your choice.

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

(b) 2.3 kg of hot water at boiling point is poured into the frying pan. 5 190 000 J was supplied to convert all the water into steam. Calculate the specific latent heat of vaporisation of water.

specific latent heat of vaporisation= ……………………[2]

[Total: 6]

6 A water wave is travelling from left to right across the water surface of a pond at a speed of 24 cm/s.

Fig 6.1 shows a snapshot of the wave at a certain instant. **R** and **S** are two water particles on the water surface. **R** makes 45 complete oscillations in one minute.

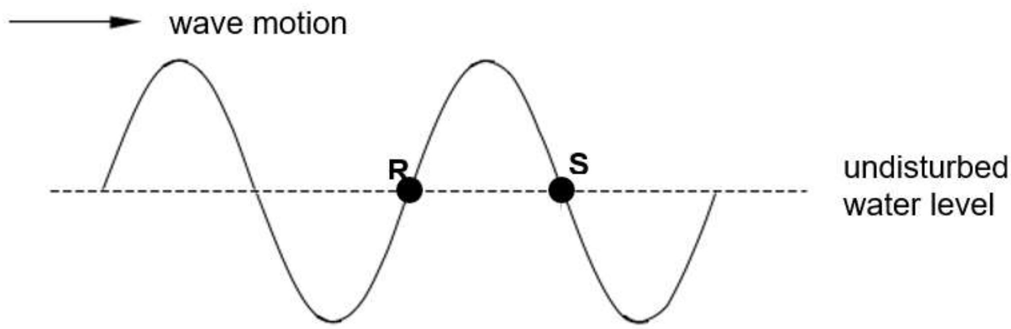

Fig 6.1

(a) State the type of wave generated. Explain your answer.

....

....

....

....[2]

(b) Calculate

(i) the time taken for **R** to reach the highest point,

time taken = ... [2]

(ii) the distance between **R** and **S**.

distance = ... [2]

[Total: 6]

7 Fig. 7.1 shows a method of producing sandpaper using static electricity.

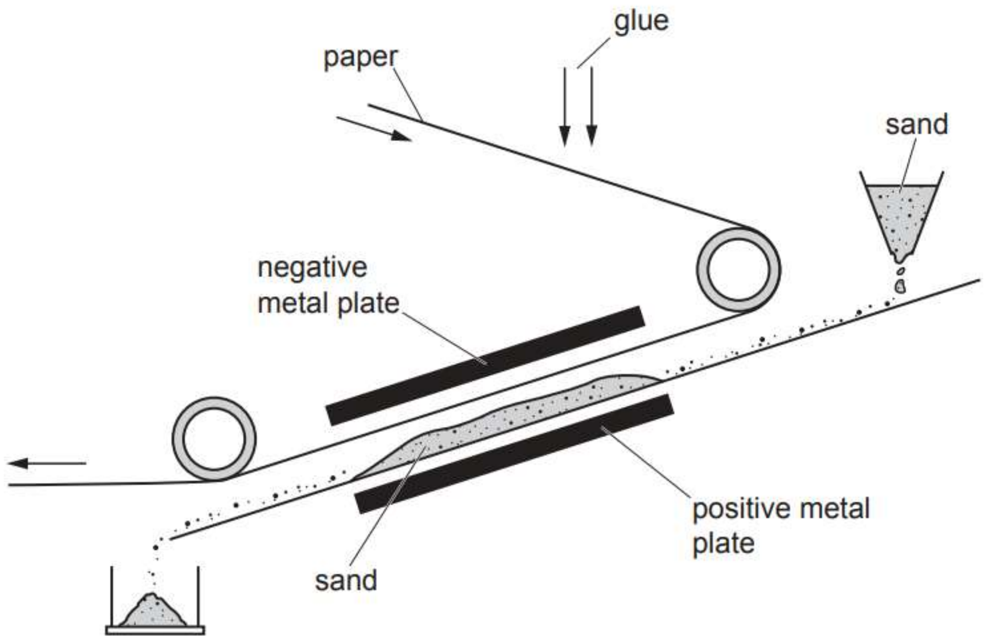

Fig. 7.1

Glue is sprayed onto moving paper. The sticky paper will then pass between two metal plates. One of the plates is positively charged and the other plate is negatively charged. There is an electric field between the plates.

(a) On Fig. 7.2, draw and show the direction of the electric field between the two metal plates. [2]

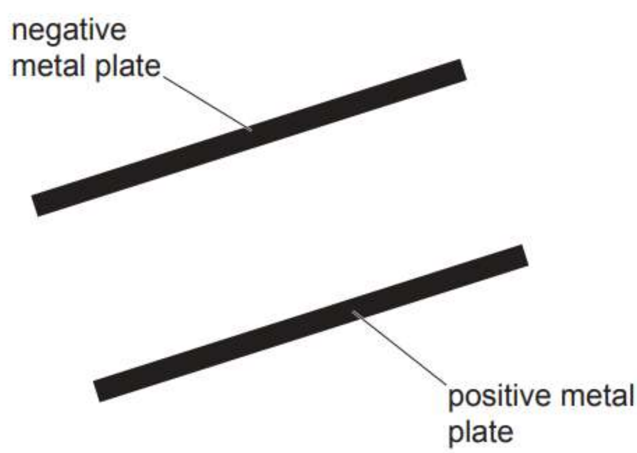

Fig. 7.2

(b) Grains of sand are present just below the sticky paper. Each grain of sand is given a charge. Fig. 7.3 shows two layers of sand grains in the space between the two plates.

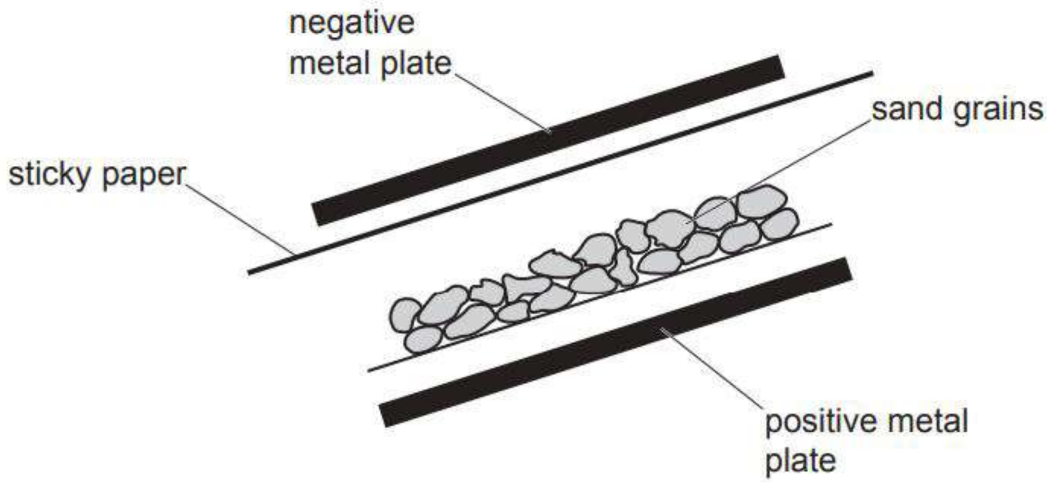

Fig 7.3

Sand grains are attracted to the negative metal plate.

State and explain whether the sand grains are positively or negatively charged.

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…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(c) A man accidentally touches the exposed part of the positive plate. The potential difference between the hand and the metal is 1500 V and the charge transferred is 4.0×10^{-4} C.

Calculate the energy transferred when the charges pass through him.

energy = …………………………. [2]

[Total: 6]

8 Fig. 8.1 shows two types of filament lamps A and B, one with its filament wire coiled and the other with its filament wire uncoiled.

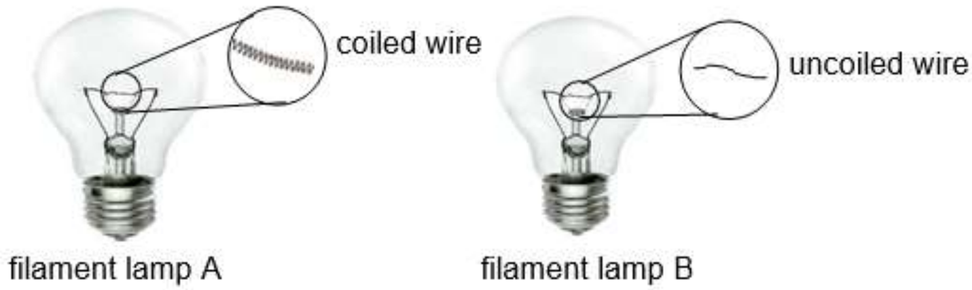

Fig. 8.1

Table 8.1 summarises the design and characteristics of the two filament lamps A and B.

Table 8.1

lamp	characteristics of filament wire		
	material	coiled / uncoiled	resistivity / Ω m
A	tungsten	coiled	5.38
B	copper	uncoiled	1.72

(a) Lamp A is observed to be brighter. Using information from Table 8.1, explain why this is so.

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…………………………………………………………………………………………………

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

(b) Lamps A and B are non-ohmic. Their resistances change with temperature due to heating.

When connected in series, the total resistance of the lamps is observed to be lower than when they are connected in parallel.

The brightness of the lamps also differs between the two circuits.

Using the relationship between power dissipation, current, and temperature, explain why the resistances of the lamps decrease in the series arrangement.

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

(c) The fuse is wrongly connected to the earth wire of the circuit. Describe what happens to the fuse, lamp and user when the live wire touches the metal surface of the filament lamp.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

[Total: 7]

9 Fig. 9.1 shows a wind turbine. When the turbine turns, part of the energy in the kinetic store of the wind is transferred mechanically to the kinetic store of the motor blades of the turbine.

The blades of the turbine are 10 m long. On average, 18 000 kg of air, moving at a speed of 12 m/s, hit the blades every second.

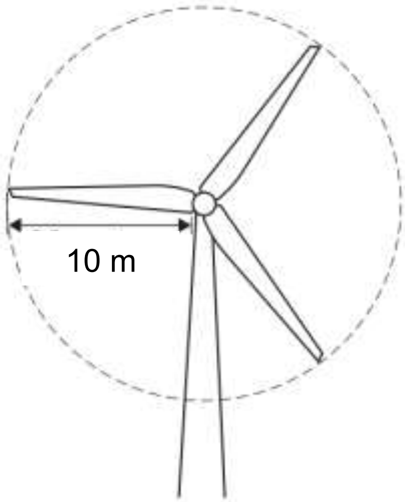


Fig 9.1

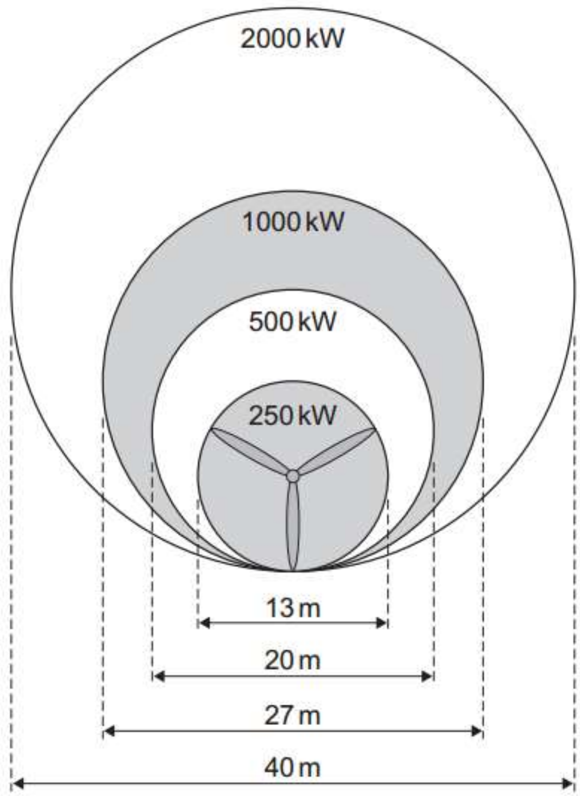


Fig 9.2

Fig. 9.2 shows that, for the same wind speed, the power output of a turbine depends on the length of the turbine blades.

(a) Calculate the energy in the kinetic store of the air hitting the blades shown in Fig. 9.1 in each second.

energy in the kinetic store = ... [2]

(b) Calculate the efficiency of the turbine with 10 metres long blades.

efficiency = …………………[1]

(c) Using the information given, show that doubling the diameter of the blades, more than doubles the power output of a turbine.

....

....

....

....[2]

(d) State a disadvantage of using wind turbines to produce electrical power.

....

....[1]

(e) The wind turbine is connected to a generator as shown in Fig. 9.3. The turbine causes the coils in the generator to rotate.

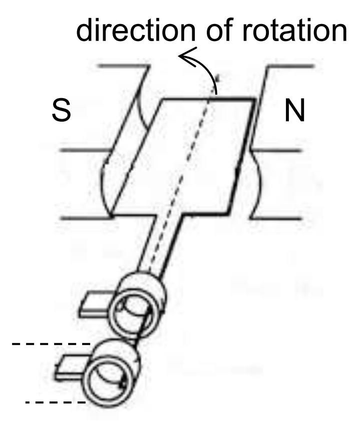


Fig. 9.3

Explain why an e.m.f is induced in the coil when it rotates between the magnets.

....

....[1]

(f) The set-up in Fig. 9.4 shows another way in which an e.m.f. is induced in a coil. Fig. 9.5 shows the result after the magnet is released from a height.

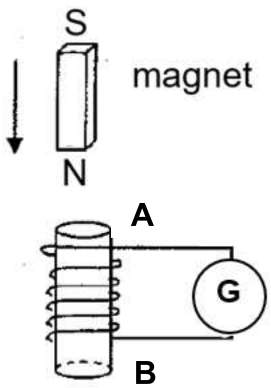


Fig. 9.4

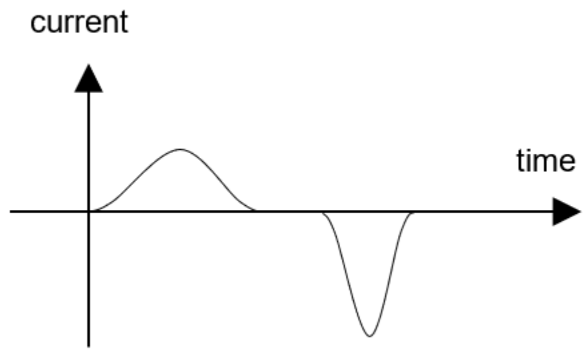


Fig 9.5

(i) State the polarity induced at end **A** of the solenoid when the magnet enters the coil.

....

....[1]

(ii) Explain why the magnitude of the 'negative peak' is greater than that of the 'positive peak'.

....

....

....

....[2]

[Total: 10]

10 A liquid containing some radioactive material is injected into the patient's blood stream. This radioactive material would be absorbed by the kidneys and then passed to the patient's bladder. A special camera is used to detect the radiation coming from the patient's kidneys.

Before the radioactive liquid is injected, background radiation must be measured to ensure accurate detection of radiation from the patient's body.

The half-life of four gamma sources W, X, Y and Z are listed in the Table 10.1.

Table 10.1

Radioactive Source	**Half- life**
W	2 min
X	5 min
Y	4 hours
Z	8 days

(a) Describe how background radiation can be measured.

....

....[1]

(b) The initial count rate of Y is 8000 counts per minute.

What is the count rate of Y after 24 hours?

activity = …………………counts per min [2]

(c) Radioactive materials that emit alpha particles are never injected into the body to obtain medical images of parts of the body.

State two reasons why alpha emitting materials are unsuitable.

....

....

....

....[2]

(d) The examination of the patient lasts for 15 minutes.

State and explain which radioactive source would be most suitable for the examination.

....

....

....

....[2]

(e) Protactinium-234 ($^{234}_{91}Pa$) is a radioactive isotope of protactinium that decays to uranium-234 ($^{234}_{92}U$).

Complete the equation below for this radioactive decay: [1]

$$^{234}_{91}Pa \rightarrow ^{234}_{92}U + \ldots\ldots\ldots\ldots\ldots\ldots$$

(f) State two different safety precautions the doctor must follow when handling the radioactive sources.

....

....

....

....[2]

[Total: 10]

Section B

Answer **one** question from this section.
Answer either **Question 11** or **Question 12**.

11 **(a)** Fig. 11.1 shows a regular hexagonal glass piece of refractive index 1.42. A light ray enters the glass piece at P, at a direction parallel to its top surface.

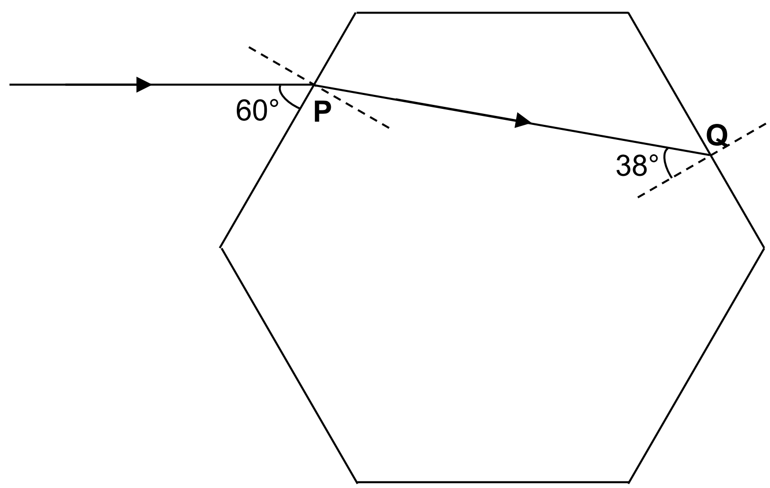


Fig. 11.1 (not drawn to scale)

(i) Determine the angle of refraction of the light ray at **P**.

angle of refraction = ……………………………….. [2]

(ii) State what is meant by *critical angle*.

....

....[1]

(iii) Determine the critical angle of the hexagonal glass piece.

critical angle = ……………………………….. [2]

(iv) On Fig. 11.1, complete the path of the light ray after it strikes the surface at **Q.** [1]

(b) Fig. 11.2 shows an object placed in front of a converging lens. The image of the object is shown on the other side of the lens.

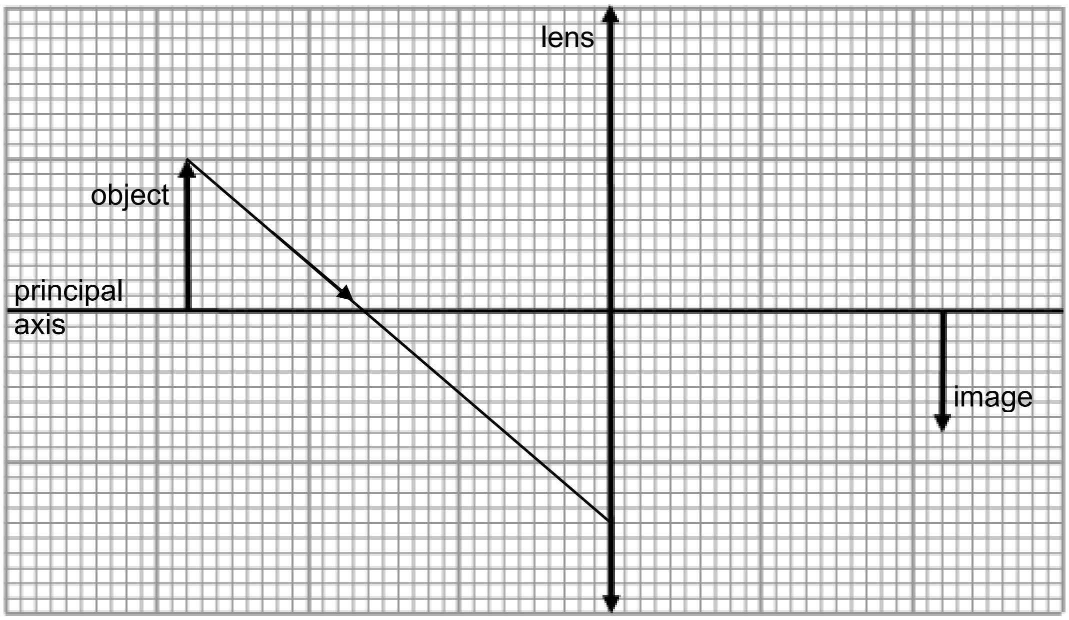


Fig. 11.2

An incomplete light ray has been given.

(i) Complete the ray diagram and determine the focal point of the lens. Mark and label the focal point with "**F**". [3]

(ii) The object is now placed at a distance nearer to the lens than the focal length of the lens.

Describe the characteristics of the image formed.

....

....[1]

[Total: 10]

12 **(a)** Fig. 12.1 shows a simple d.c. motor. A rectangular coil PQRS is connected to a power supply and is placed between two solenoids.

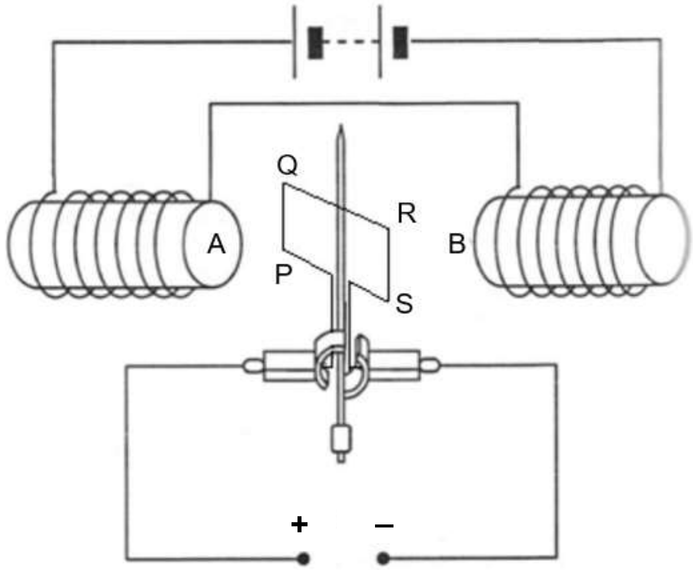


Fig. 12.1

(i) Identify the magnetic poles at A and B

A: …………………………

B: ………………………… [1]

(ii) Explain why the coil turns.

....

....

....

....[2]

(iii) Describe the action of the split-ring commutator in the d.c. motor.

....

....[1]

(iv) 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]

(b) Fig. 12.2 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

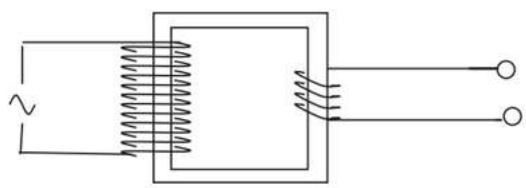


Fig. 12.2

Table 12.1

coil	number of turns
J	50
K	100
L	1 000
M	1 500

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 12.1 above.

(i) Based on Table 12.1, select the most suitable pair of coils for making the primary coil and secondary coil of the transformer.

Show your working.

primary coil: …………

secondary coil: ………… [2]

(ii) Assume that the transformer is 75 % efficient and the power output is 15 kW, calculate the current flowing in the primary coil.

current = …………………. [2]

(iii) Soft iron is used for the core of the transformer. Explain why a soft iron core is used.

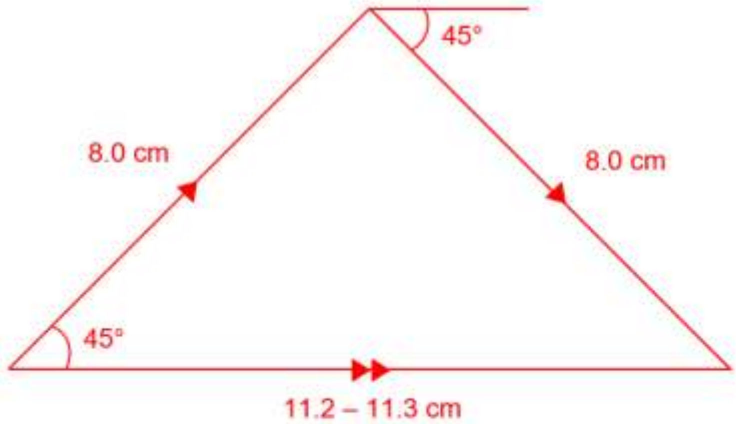
....

....[1]

[Total: 10]

Solution to 2025 Sec 4 Physics Preliminary Exam Paper 2

Section A

Qn	Solution	Mark
1	 Arrows direction [1] Shape [1] Scale 1.0 cm : 10 N [1] (can accept other reasonable scales) magnitude of resultant force =112 – 113 N [1] **Marker's Comments:** Students who did not get the full credit had one or more of the following issues: (1) Scale without unit. E.g., 1:10 instead of 1 cm rep 10 N. (2) Not indicating the resultant force with a double arrow. (3) Changing the orientation/direction of the 80 N vectors. This caused the resultant force to point in a wrong direction. Students should be mindful to keep the original direction of the vectors.	B4
2a	As the **speed increases,** the **air resistance** acting on the child and the sledge also **increases**. Hence the **resultant force decreases** and the **acceleration decreases**. [gradient is positive and decreasing] From 24 to 26s, the **forward force is equal to the backward force** and the **resultant force acting on the child and sledge is zero**. Hence, there is **no acceleration** and it **moves with a constant speed**. [gradient is zero] **1. Speed increases, air resistance increases** **2. Resultant force decrease, acceleration decreases** **3. Forward force is equal to the backward force** **4. Resultant force is zero** **5. Zero acceleration – moves at constant speed** **5 points – 3 marks** **3 points – 2 marks** **2 points with coherence – 1 mark**	B1 B1 B1

	Need to mention resultant force in each case to get the marks. **Marker's Comments:** Poorly attempted. Only a few students identified air resistance as the force opposing the motion. Almost all students cited friction instead and wrongly suggested that the magnitude of friction increases with speed.	
2b	The gradient of the graph becomes zero/ graph become horizontal from t = 24 s to t =26 s. **Need to state the time from t= 24s to 26s to get the mark.** **Marker's Comments:** Many students were able to describe the section of the graph which corresponded to terminal velocity but did not state the period when it happened.	B1
2c	Distance travelled = Area under the graph = ½ x (30-26) x 15.2 = 30.4 m Since the sledge stops in 30.4 m, **it will stop before hitting the wall** which is 35 m ahead. **Marker's Comments:** Some students tried to find the time taken for the child to stop completely and compared it with the graph. It was wrongly assumed that speed remained constant during the braking period.	M1 A1
2d	The energy in the gravitational potential store is transferred to energy in the internal store. OR Gravitational potential energy to thermal / internal energy **Note: the speed is constant, there is no changes in energy in the kinetic store. Reject any answers that mention kinetic store.** **Marker's Comments:** Poorly attempted. Almost all students included kinetic energy/store in their response. As stated in the note above, there was no change to the amount of energy in the kinetic store.	B1
2e	The child **experience inertia** where his **body mass resists a change in state of motion** / and **continue to move forward**. **Inertia + resist a change in state of motion / continue to move forward**	B1

	Marker's Comments: Generally well done.	
3a	As the **boom angle increases**, the **perpendicular distance between the load and the pivot decreases**. Since the **moment is the product of the force and the perpendicular distance**, a **decrease in the perpendicular distance allows for an increase in the force (load)** while maintaining the same moment. Hence, the maximum load the boom can support increases. **Formula of moments = F x d is needed.** **Marker's Comments:** Some students did not use the information given in the table and explained their answers based on the concept of stability instead. Others misinterpreted that the increase in boom angle meant that the perpendicular distance to the pivot increased.	B1 B1
3bi	Moment = F x d = 11 500 x 22 = 253 000 Nm **Marker's Comments:** Generally well done.	M1 A1
3bii	By taking moments about X, Clockwise moments = Anti-clockwise moments 253 000 = W x 5 W = 50 600 N (allow ecf) **Marker's Comments:** Generally well done.	 M1 A1
4a	The gas molecules collide / exert a force on the wall of the container / surface of mercury. **Marker's Comments:** Generally well done.	B1
4b	The gas pressure is higher than atmospheric pressure. **Marker's Comments:** Many students attempted the question with a similar approach as (a), missing the point that the gas pressure was higher than atmospheric pressure.	B1

4c	$P_{gas} = P_{Hg} + P_{atm}$ P_{gas} = ρ x g x h + 760mmHg P_{gas} = 13600 x 10 x 80/1000 + 13600 x 10 x 760/1000 P_{gas} = 110000 (2 sf) / 114000 Pa (3 sf) **Marker's Comments:** Poorly attempted. Most common mistake made was in converting 760mmHg to Pa. Students did not do one or more of the following: (1) divide 760mm by 1000, (2) multiply by 13600kg/m3 for the density of mercury, (3) multiply by 10 N/kg for the gravitational field strength. Students are advised to write down the mathematical statements as marks can be awarded in some contexts.	M1 A1
4d	When the gas cooled down, the average kinetic energy of the molecules decreases. The gas molecules bombard the wall of the container less frequently and less forcefully. Hence, the gas pressure decreases. This will cause the difference in the mercury level to reduce. **Marker's Comments:** Generally well done. Students were able to write down the essential points in their description.	B1 B1 B1
5ai	Q = mcΔΘ Pt = mcΔΘ 450 x t = 2.0 x 900 x (100 – 25) t = 300 s OR 5.0 mins (2 s.f) **Marker's Comments:** Generally well done. Some students who converted their answers to minutes forgot to express their answer in 2 s.f. which resulted in penalisation of 1 m. Students are advised not to make unnecessary conversion as it increases the chance of errors.	 M1 A1
5aii	D. Highest melting point so it can withstand the heat/won't melt so easily OR Smallest specific heat capacity so temperature will rise fastest for the same amount of thermal energy supplied Any 1 point – 1 mark **Marker's Comments:**	B1 B1

	Generally well done. Some students who identified A as their answer thought that a higher specific heat capacity meant more energy transferred to the food. They should note that the source of the energy is the stove so using Q= mcΔϴ, a higher specific heat capacity would cause a smaller change in temperature.	
5b	$Q = ml_v$ 5 190 000 = 2.3 x l_v l_v = 5 190 000 / 2.3 =2 256 522 J / kg = 2300 000 J/kg (2 s.f) **Marker's Comments:** Students were able to do the calculations but were not able to write down the correct unit. Many wrote J/kgºC. ºC should not appear in the unit as the process and equation does not involve change in temperature.	M1 A1
6a	Transverse wave The wave propagates in the direction perpendicular to the direction of the source of vibration. **Marker's Comments:** Generally well done. Some students were careless in their response and wrote that "The wave propagates in the direction perpendicular to the direction of the **wave motion**" which did not make sense.	B1 B1
6bi	Period = 60 / 45 = 1.33 s ¾ x 1.33 = 1.0 s (2 s.f) **Marker's Comments:** Poorly attempted. Only a handful of students were able to get the correct answer. The motion of R in the next instant is down not up. So between R and S is ¾ wave. Almost all students assumed that it was ¼ wave.	M1 A1
6bii	f = 45 /60 = 0.75 Hz V = f λ 24 = 0.75 x λ λ = 32 cm RS = 16 cm (2 s.f) **Marker's Comments:** Generally well done.	 M1 A1

7a	Straight Arrows **correctly drawn from the positive plate to the negative plate**. **Direction is consistent and correct** across all drawn field lines. Fieldlines are equally spaced. **Marker's Comments:** Many students did not get the mark for fieldlines that are equally spaced. Mark is deducted for additional and incorrectly drawn fieldlines.	B1 B1
7b	The sand grains are **positively charged**. This is because they are **attracted to the negatively charged metal plate**, and **unlike charges attract**. **Marker's Comments:** A number of students were confused. The sand grains are on the positive plate. So they become charged positive **by contact**. And then they get attacted to the negatively charged plate.	B1 B1
7c	Potential difference, V = 1500 V Charge, Q = 4.0×10^{-4} C Energy=Q×V Energy=$4.0\times10^{-4} \times 1500$=0.60 J (2 s.f) **Marker's Comments:** Students who didn not get these marks, recalled the formula worngly. Others lost the mark for s.f.	 M1 A1
8a	Tungsten wire has a **higher resistivity,** and a coil filament is **longer** compared to uncoil one, hence **resistance of lamp A is higher**. Since brightness depends on power, $P = I^2R$. Since R for Lamp A is greater, lamp A is brighter. **Marker's Comments:** There was a lot of misconception for this question. Resistivity is NOT Resistance. Resistivity is a material property. $R = \rho l/A$	B1 B1

<table>
<tr><td></td><td>Coiled means the length of the wire is longer.

Hence, Tungsten wire has a higer resistivity and is longer. Therefore, resistance is greater.

When both lamps carry the same current (e.g. in series), the power converted to heat/light in the filament is $P = I^2R$. With its larger R, A dissipates more power, reaches a higher temperature, and so glows brighter.</td><td></td></tr>
<tr><td>8b</td><td>When the non-ohmic filament lamps A and B are connected in series, their resistances decrease compared to when they are connected in parallel.

This happens because:
Lower Current in Series → Less Heating
• In a series circuit, the same current flows through both lamps, but the total resistance is higher, reducing the overall current. (Explains lower current in series → less heating → lower resistance.)
• Since the filaments are non-ohmic, their resistance depends on temperature. (Recognizes that non-ohmic resistance depends on temperature.)
• A lower current means less power dissipation ($P=I^2R$), so the filaments heat up less. Lower temperature, lower resistance.

Marker's Comments:

Many students could not make this basic connection:

Filament lamps are non-ohmic: their resistance increases with temperature (6091 outcome: I–V characteristic of a filament lamp).

In series, the same current flows through both lamps and the current is smaller than in parallel for a given supply. Hence the power in each lamp, $P= I^2R$ is lower.
⇒ Each filament runs cooler, so its resistance drops (temperature ↓ → R ↓).

In parallel, each lamp receives the same p.d., draws a larger current, so $P=VI$ (and I^2R) is higher.
⇒ Each filament runs hotter, and its resistance rises.</td><td>B1

B1

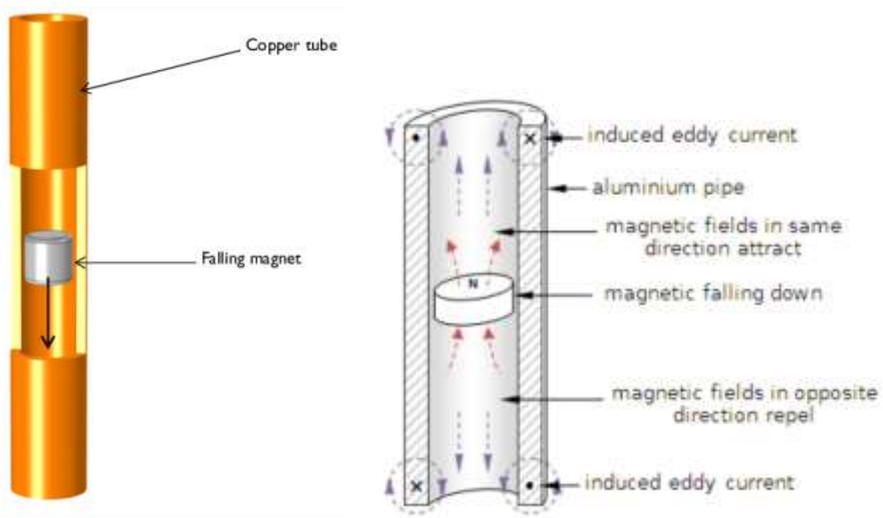
B1</td></tr>
<tr><td>8c</td><td>The fuse will still melts/blows and the lamp appears off.

However, the metal case is still live and can cause electrocution or shock

Marker's Comments:</td><td>B1

B1</td></tr>
</table>

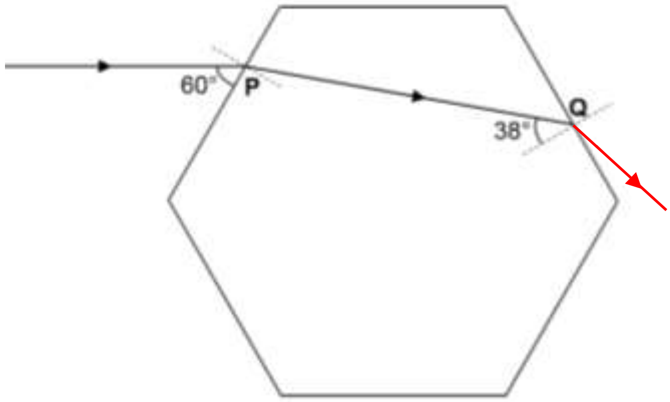
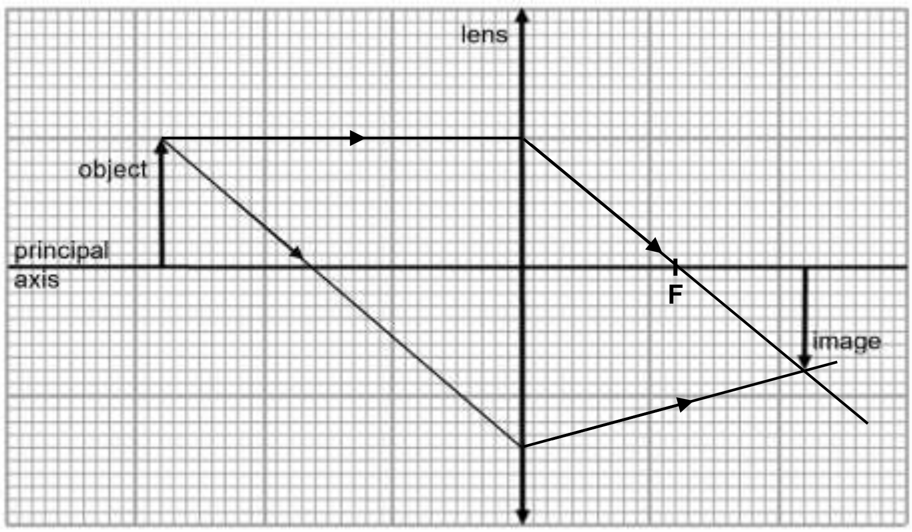
	Fuse wrongly placed in the earth wire; live wire touches the metal case Fault: live wire contacts the metal case → a large current flows from live → case → earth wire. this large current blows the fuse. Consequences: metal case remains live, if a user touches the metal case, current can pass through the body to earth, causing a severe electric shock.	
9a	Ke = ½ mv^2 = ½ x 18 000 x 12 x 12 = 1 296 000 J = 1.3 x 10^6 J (2 s.f) **Marker's Comments:** Careless.. Wrong substitution. S.f. errors. For an easy enough question.	 M1 A1
9b	(500 000 / 1 296 000) x 100% = 38.5 % = 38% or 39 % (2 or s.f) Allow ecf **Marker's Comments:** Many students did not recall the formula for efficiency. Those that did, substituted incorrectly.	 A1
9c	When the diameter is 20 m, the power is 500kW, but when the diameter is 40 m, the power is 2000 kW, which is 4 times the power. **Marker's Comments:** This question is very straightforward. Students are to read off the information provided and draw conclusions.	B1 B1
9d	Intermittent power as it is not easy to find steady wind blowing. Any other valid answer will be accepted **Marker's Comments:** Well answered. Answer in TB. Students are encouraged to know the advantages and disadvantages of all forms of energy resources stated in the syllabus.	B1

9e	As the coils rotates, there is **a change in magnetic flux linking to the coil** which induces an e.m.f. **Marker's Comments:** A recall question which was very poorly attempted. This is basically the definition of electromagnetic induction.	B1
9f(i)	North **Marker's Comments (for both 9f (i) and (ii):** This application illustrates the phenomenon of eddy current braking. A cylindrical magnet falling through a copper tube induces eddy currents on the tube walls. The eddy currents, in turn, create a magnetic field that opposes the magnetic field of the magnet and induces a braking force that opposes the motion of the magnet. This opposing force increases with increasing velocity. Thus, there is a terminal velocity at which the magnetic braking force equals the force of gravity. 	
9f(ii)	The magnitude of the induced e.m.f is **proportional to the rate of the change of the magnetic flux in the circuit**. As the magnet fall, it accelerates due to acceleration due to gravity. A **larger speed** will produce a larger rate of change of the magnetic flux in the circuit. **Marker's Comments** Very few students made this connection.	B1 B1

10a	Remove any radioactive source from the vicinity before using a radiation detector to read the radiation count **Marker's Comments:** Recall Q. Was revised in Timed Practice.	B1
10b	6 half-life – working must be shown 125 counts per min **Marker's Comments:** For a basic calculation question, students could have done it better.	B1 B1
10c	Alpha radiation cannot penetrate through the body for detection. It has high ionizing power, thus it is harmful to the body cells. **Marker's Comments:** For a basic recall question, students could have done it better.	B1 B1
10d	Source Y Able to last the examination period but not to remain in the blood for too long. **Marker's Comments:** This requires students to be realistic. There is a process to doing the examintaion of the patient which will take time. So exactly 15 mins, which is source X is incorrect.	B1 B1
10e	$_{-1}^{0}\beta$ OR $_{-1}^{0}e$ **Marker's Comments:** Some students did not know how to write this.	B1
10f	any 2 points: □ keep a distance, e.g. use tongs □ point source away (from user) □ use a barrier, e.g. wear lead apron □ use a lead container to store/transport sources □ administer within a short time or monitor with film (badge) **Marker's Comments:** There must be clarity in such recall answers. Some students confused with biological hazards.	B1 B1

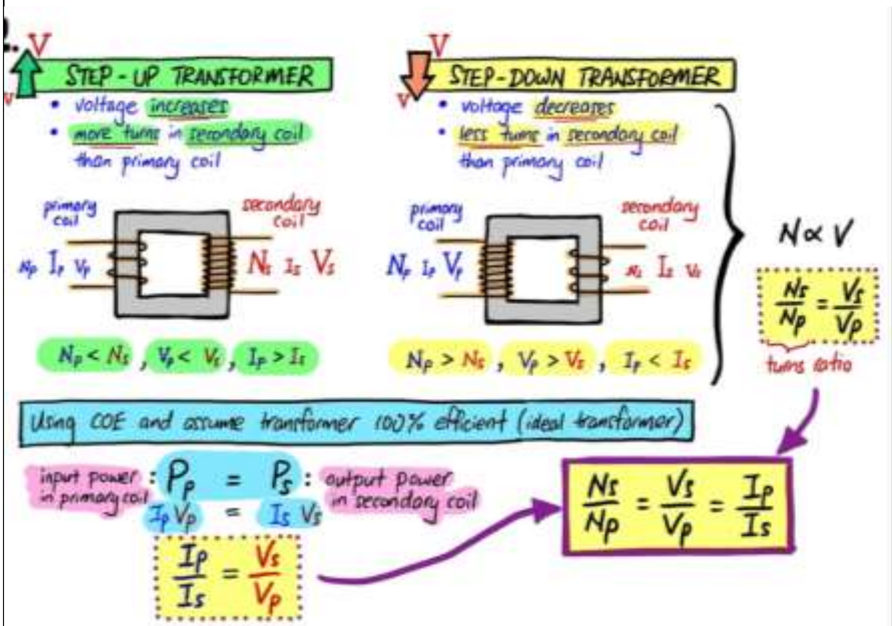
Section B

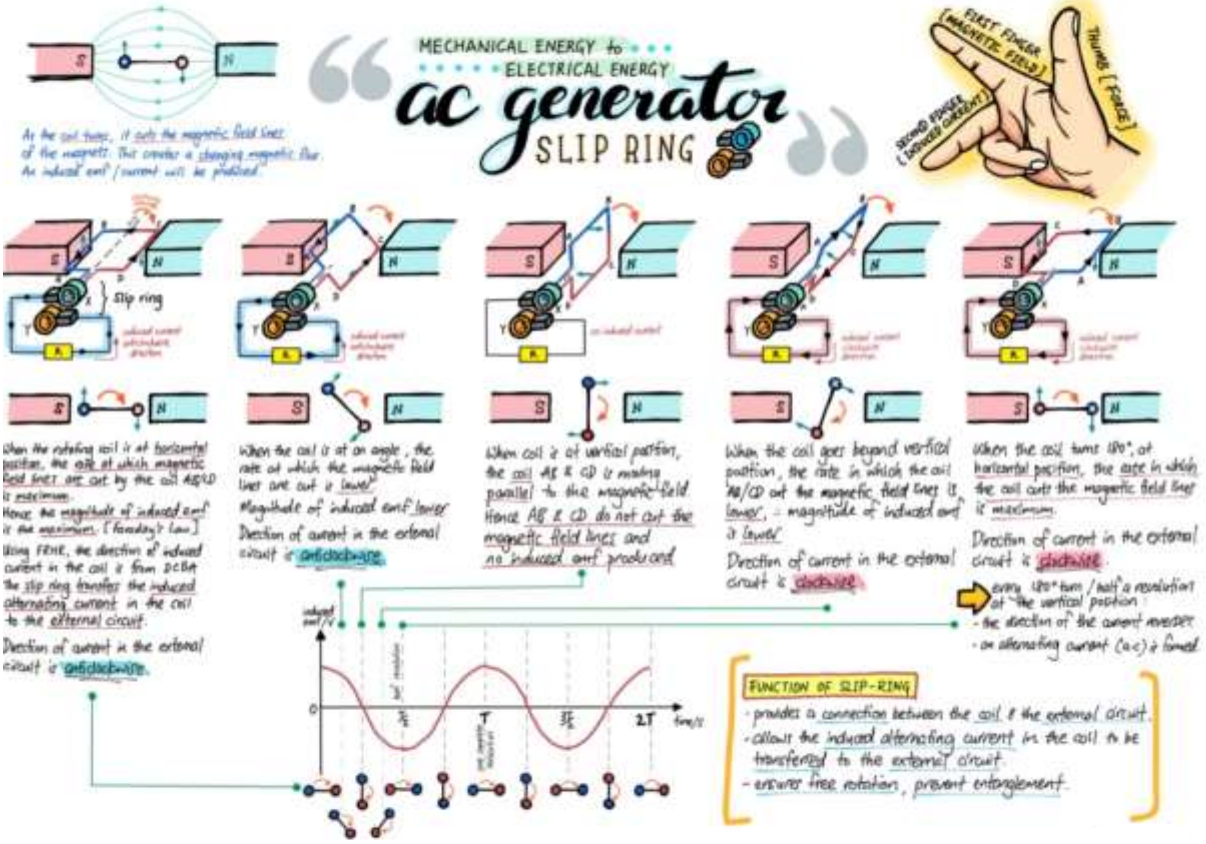
Qn	Solution	Mark
11ai	n = sin i / sin r 1.42 = sin 30° / sin r 1 x sin 30° = 1.42 x sin r r = 20.616° = 20.6° (3 sf) **Marker's Comments:** Many students wrongly identified 60° as the angle of incidence. Students should be more careful and check for the angle of incidence/refraction in diagrams.	 M1 A1
11aii	The critical angle is the angle of incidence in the optically denser medium for which the angle of refraction in the optically less dense medium is 90°. **Marker's Comments:** A significant number of students were not able to provide a satisfactory definition, omitting either the optical medium or mentioning total internal reflection.	B1
11aiii	n = 1 / sin c 1.42 = 1 / sin c c = $\sin^{-1}$ (1/1.42) = 44.766° = 44.8° (3 sf) **Marker's Comments:** Generally well done.	M1 A1

11aiv	 ray bends away from normal **Marker's Comments:** Many did not attempt this part of the question. It is likely that they did not see the question.	B1
11bi	 [1] complete given ray [1] construct rays to locate F [1] F **Marker's Comments:** Most students were able to draw the ray to locate the focal point. However, almost all were not able to complete the ray at the bottom. Students should observe that light rays originating from the tip of the object will have to converge at the tip of the image. Some students wrongly assumed that the bottom ray that passed through the principal axis was the focal point.	B1 B1 B1

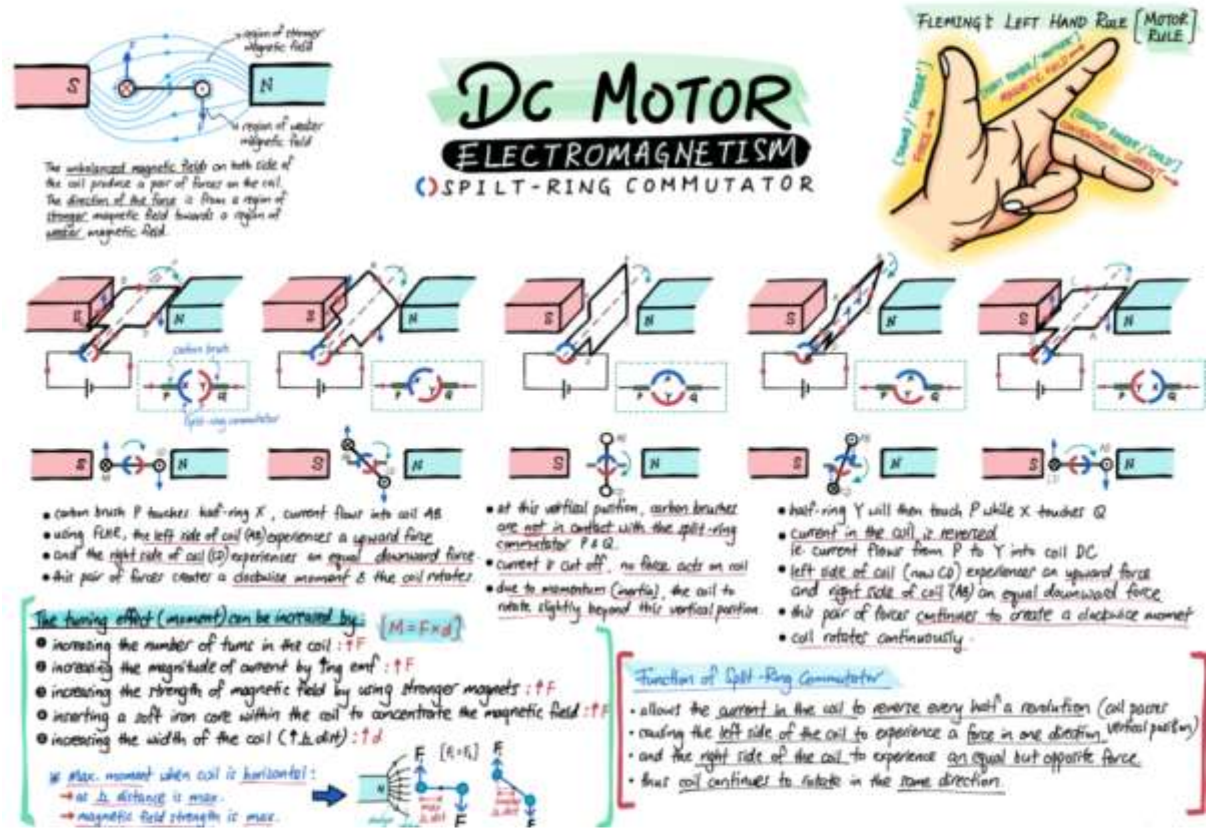
11bii	The image formed is magnified, upright and virtual **Marker's Comments:** Many students were unable to visualise the scenario and thus were not able to state the characteristics.	B1

12ai	A : North B: South **Marker's Comments:** Basic Right Hand Grip Rule	B1
12aii	Magnetic field of current interacts with magnetic field of magnet Downward force acting on PQ. Upward force acting on RS causing the coil to turn. Need to state clearly direction of force on each side of coil. (use Flemming's left hand rule to determine direction of force) **Marker's Comments** Students need to differentiate between Electromagnetism (DC Motor) and Electromagnetic Induction (AC Generator).	B1 B1
12aiii	Ensures the **current** in the circuit **reverses for every half revolution** **Marker's Comments** Recall. Poorly attempted.	B1
12aiv	Due to **inertia / momentum**, the coil continues to turn though current is not flowing in coil in vertical position. **Marker's Comments** Recall. Poorly attempted.	B1
12bi	Ratio of turns = Ratio of voltage 3300 / 220 = 15 *1500 / 100 = 15 Select M as Primary coil K as Secondary coil **Marker's Comments** Well attempted.	M1 A1
12bii	Power in Secondary = 0.75 x Power in Primary 15 000 = 0.75 x I x V 15 000 = 0.75 x I x 3300 I = 6.06 A (2 or 3 s.f) 75% efficient means output power is 75% of input power **Marker's Comments** Many students did not know how to apply the equation for efficiency. The approach is using conservation of energy.	M1 A1

		
12biii	To ensure **maximum magnetic flux linkage** of primary coil with secondary coil by **concentrating magnetic field lines**. Accept if a student is able to mention one of the two bolded ideas. **Marker's Comments** While soft iron has properties such as easily magnetized / demagnetized, etc → in this context, only these 2 points mentioned provide the advantage of using a soft iron core in a transformer.	B1



MECHANICAL ENERGY to ELECTRICAL ENERGY
ac generator
SLIP RING
FIRST FINGER (MAGNETIC FIELD)
THUMB (FORCE)
SECOND FINGER (INDUCED CURRENT)
As the coil turns, it cuts the magnetic field lines of the magnets. This creates a changing magnetic flux. An induced emf / current will be produced.
Slip ring
When the rotating coil is at horizontal position, the rate at which magnetic field lines are cut by the coil AB/CD is maximum.
Hence the magnitude of induced emf is the maximum. [Faraday's Law]
Using FRHR, the direction of induced current in the coil is from DCBA
The slip ring transfers the induced alternating current in the coil to the external circuit.
Direction of current in the external circuit is anticlockwise.
When the coil is at an angle, the rate at which the magnetic field lines are cut is lower.
Magnitude of induced emf lower
Direction of current in the external circuit is anticlockwise.
When coil is at vertical position, the coil AB & CD is moving parallel to the magnetic field.
Hence AB & CD do not cut the magnetic field lines and no induced emf produced.
When the coil goes beyond vertical position, the rate in which the coil AB/CD cut the magnetic field lines is lower, ∴ magnitude of induced emf is lower.
Direction of current in the external circuit is clockwise.
When the coil turns 180°, at horizontal position, the rate in which the coil cuts the magnetic field lines is maximum.
Direction of current in the external circuit is clockwise.
every 180° turn / half a revolution at the vertical position:
- the direction of the current reverses
- an alternating current (a.c) is formed
induced emf/V
0
T/2
T
3T/2
2T
time/s
FUNCTION OF SLIP-RING
- provides a connection between the coil & the external circuit.
- allows the induced alternating current in the coil to be transferred to the external circuit.
- ensures free rotation, prevent entanglement.



DC MOTOR
ELECTROMAGNETISM
SPILT-RING COMMUTATOR
FLEMING'S LEFT HAND RULE [MOTOR RULE]
region of stronger magnetic field
region of weaker magnetic field
The unbalanced magnetic field on both side of the coil produce a pair of forces on the coil. The direction of the force is from a region of stronger magnetic field towards a region of weaker magnetic field.
carbon brush
Split-ring commutator
• carbon brush P touches half-ring X, current flow into coil AB
• using FLHR, the left side of coil (AB) experiences a upward force
• and the right side of coil (CD) experiences an equal downward force
• this pair of forces creates a clockwise moment & the coil rotates
• at this vertical position, carbon brushes are not in contact with the split-ring commutator P & Q.
• current is cut off, no force acts on coil
• due to momentum (inertia), the coil to rotate slightly beyond this vertical position
• half-ring Y will then touch P while X touches Q
• current in the coil is reversed
ie current flows from P to Y into coil DC
• left side of coil (now CD) experiences an upward force and right side of coil (AB) an equal downward force
• this pair of forces continues to create a clockwise moment
• coil rotates continuously.
The turning effect (moment) can be increased by: [M = F×d]
• increasing the number of turns in the coil : ↑F
• increasing the magnitude of current by ↑ing emf : ↑F
• increasing the strength of magnetic field by using stronger magnets : ↑F
• inserting a soft iron core within the coil to concentrate the magnetic field : ↑F
• increasing the width of the coil (↑⊥ dist) : ↑d
* Max. moment when coil is horizontal:
→ at ⊥ distance is max.
→ magnetic field strength is max.
F
[F₁=F₂]
Function of Split-Ring Commutator
• allows the current in the coil to reverse every half a revolution (coil passes vertical position)
• causing the left side of the coil to experience a force in one direction
• and the right side of the coil to experience an equal but opposite force.
• thus coil continues to rotate in the same direction.