COMMONWEALTH SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY 4 EXPRESS PHYSICS

Name: _____( ) Class: _____

Physics	**6091/01**
Paper 1 Multiple Choice	**23 August 2024**
Additional Materials: Multiple Choice Answer Sheet	**1130 h – 1230h**
	1 hour

READ THESE INSTRUCTIONS FIRST
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the Answer Sheet in the spaces.

There are **forty** questions in 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 answer in **soft pencil** on the separate answer sheet.

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.

Name of setter: Mdm Quek Lay Hong

This booklet consists of **18** printed pages including the cover page.

[Turn over

1 Which order shows units of energy in the correct order of increasing size?

A J → kJ → mJ → nJ

B mJ → nJ → J → kJ

C nJ → mJ → J → kJ

D MJ → J → kJ → GJ

2 A car travels at constant speed around a curved road.

Which of the following statements about the motion of the car is **not** correct?

A The car is accelerating.

B The displacement of the car increases.

C The distance travelled per unit time by the car is constant.

D The velocity of the car is uniform.

3 A race car is designed to change its high speed very quickly when racing on a 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

4 A van of mass 1 500 kg is moving along a level road with an acceleration of 0.60 m/s^2. The force produced by the engine is 1150 N.

What is the frictional force between the tyres and the road?

A 250 N

B 900 N

C 2100 N

D 15000 N

5 A car of mass 500 kg has an engine with a power output of 6.0 kW. The car takes 10 minutes to travel up a slope of vertical height 500 m. Air resistance and friction are negligible.

The gravitational field strength g = 10 N/kg.

What is the amount of energy in the kinetic store of the car when the car reaches the top of the hill?

A 1.1×10^6 J

B 2.5×10^6 J

C 3.6×10^6 J

D 6.1×10^6 J

6 Two blocks are connected by a light string. They move over a frictionless floor with a uniform acceleration of 1.0 m/s^2 under the action of a constant force F.

What will the acceleration of the 1.0 kg block be if the string breaks?

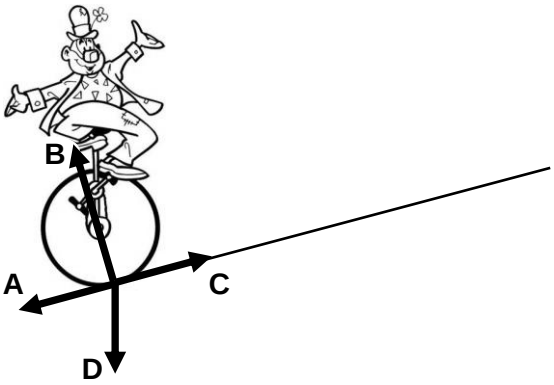
A 0 m/s^2

B 1.0 m/s^2

C 2.0 m/s^2

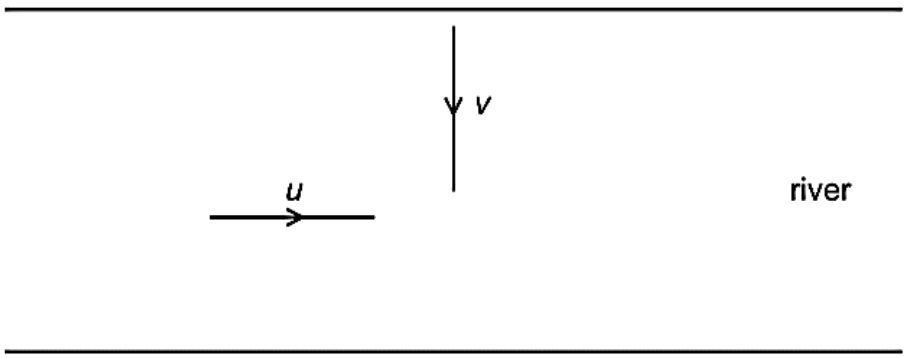
D 3.0 m/s^2

7 A clown riding a unicycle is accelerating up an inclined plane as shown in the diagram.



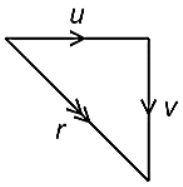
In which direction is the friction acting on the wheel of the unicycle?

8 A boat with velocity *v* travels across the river perpendicular to the river bank. The water in the river is flowing with a velocity *u* as shown.

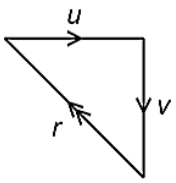


Which vector diagram correctly represents the resultant velocity *r* of the boat?

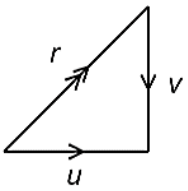
A



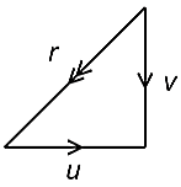
B



C



D



9 The diagram shows a tea spoon and a table spoon that are made of pure silver.

Tea spoon
weighs 20 g

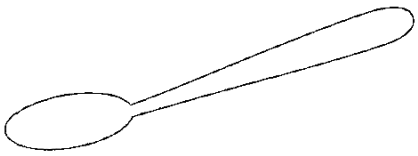


Table spoon
weighs 50 g

Which of the following statements is correct about the densities of the two types of spoons?

A The density of the tea spoon is greater than the density of the table spoon.

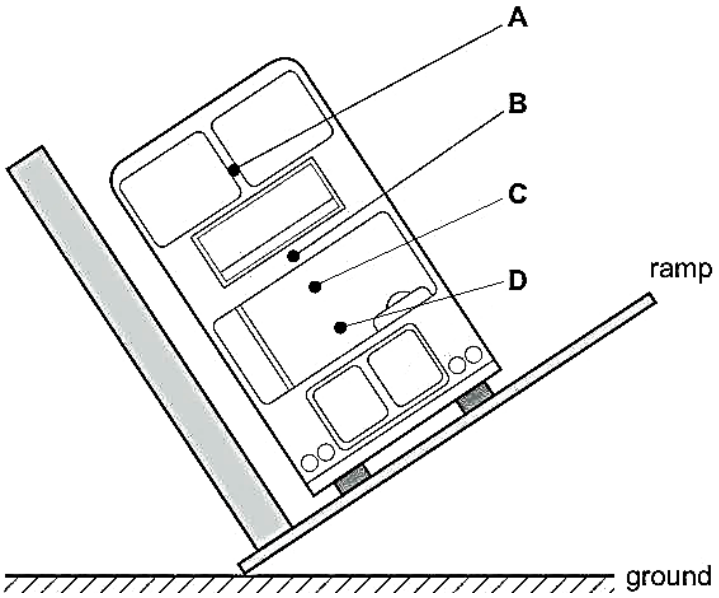
B The density of the tea spoon is less than the density of the table spoon.

C The densities of the tea spoon and the table spoon are the same.

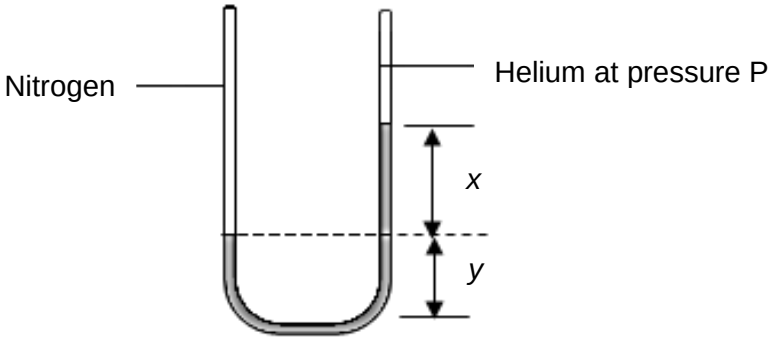
D The densities cannot be compared as information about the volume is not given.

10 A bus on a ramp is undergoing a stability test. The diagram shows the maximum angle of inclination for the bus.

Which position is likely to be its centre of gravity?



11 A sealed U-tube contains nitrogen in one arm and helium at pressure P in the other arm. The gases are separated by mercury of density ρ. The acceleration of free fall is g.



What is the pressure of nitrogen?

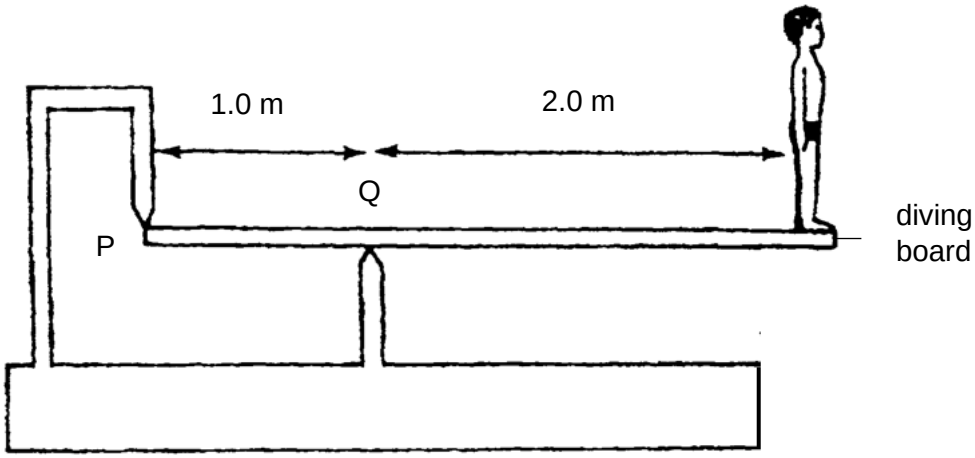
A P

B $x\rho g$

C $P - x\rho g$

D $P + x\rho g$

12 The diagram shows a man of mass 50 kg standing at the end of a diving board.



The diving board is uniform with a mass of 10 kg. It is 3.0 m long and is pivoted at points P and Q.

The gravitational field strength g = 10 N/kg.

Which would be the correct magnitude and direction for the forces at P and Q on the diving board?

	P	Q
A	950 N down	1 550 N up
B	1 050 N down	1 650 N up
C	950 N up	1 550 N down
D	1 000 N up	1 600 N down

13 A parachutist opens his parachute and falls to Earth at constant speed.

What is the principal energy transfer taking place as he falls?

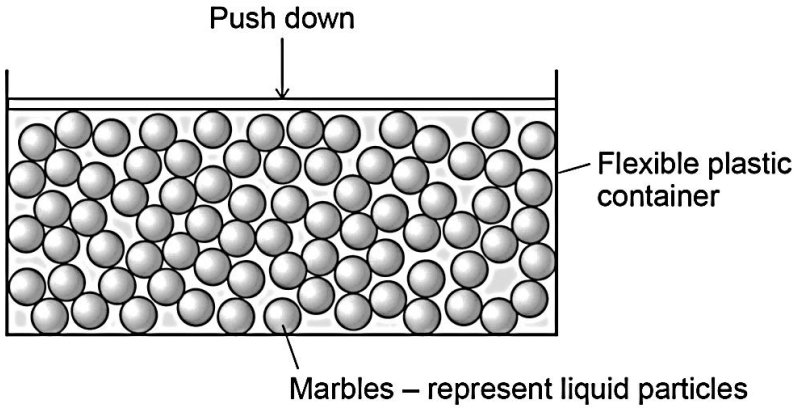
A kinetic store to gravitational potential store of energy

B kinetic store to internal store of energy

C gravitational potential store to kinetic store of energy

D gravitational potential store to internal store of energy

14 The diagram shows a simple model of a liquid. When a force pushes down on the marbles, the marbles push the sides and bottom of the container outwards.



What can be concluded from this model?

A Liquid particles are in constant and random motion.

B Liquid particles move faster under pressure.

C Pressure acts in all directions in a liquid.

D Pressure decreases the distance between the liquid particles.

15 10 g of ice-cubes at 0 °C is added to 100 g of water at 30 °C.
Specific heat capacity of water is 4.2 J/(g°C) and specific latent heat of fusion of ice is 334 J/g.

What is the final temperature of the water?

A 15 °C

B 20 °C

C 22 °C

D 27 °C

16 Which of the following increases when a liquid becomes a gas at its boiling point?

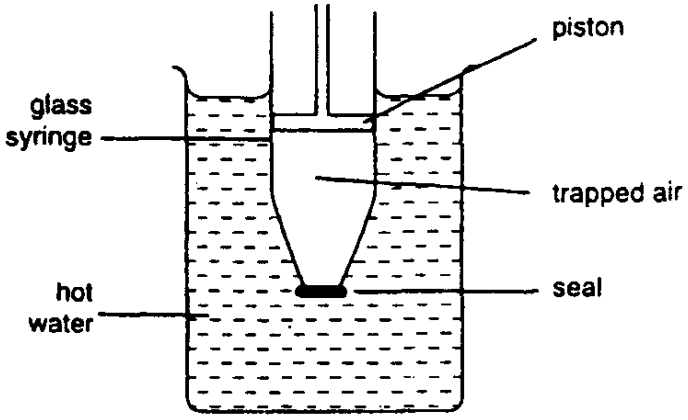
A the average kinetic energy of the molecules

B the molecular size

C the molecular spacing

D the total number of molecules

17 The outlet of a glass syringe is sealed so that air is trapped below the piston.



Which of the following explains why the piston begins to rise when the syringe is placed in hot water?

A Convection is occurring inside the syringe.

B The glass is expanding.

C The molecules of trapped air are getting bigger.

D The trapped air molecules are hitting the piston more often.

18 Which statement describes what happens when sulfur solidifies?

A There is a transfer of energy and a change in temperature.

B There is a transfer of energy but no change in temperature.

C There is no transfer of energy and no change in temperature.

D There is no transfer of energy but there is a change in temperature.

19 An electric heater of power 1.0 kW is immersed in 2.0 kg of water for 4.0 minutes. The initial temperature of the water is 20^{o}C.

The specific heat capacity of water = 4 200 J/(kg^{o}C).

What is its final temperature at the end of 4 minutes?

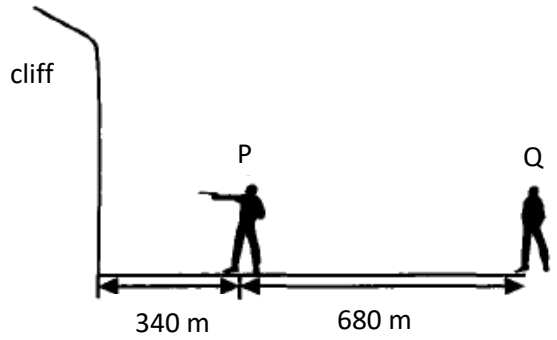
A 23 ^{o}C

B 29 ^{o}C

C 49 ^{o}C

D 51 ^{o}C

20 In the diagram, two persons P and Q stood in front of a vertical cliff.



P fired a pistol. The time for the sound to travel directly from P to Q is t_1 seconds and the time for the echo to reach Q is t_2 seconds, both times measured from the instant the pistol was fired. The speed of sound is 340 m/s.

What is value of $t_2 - t_1$?

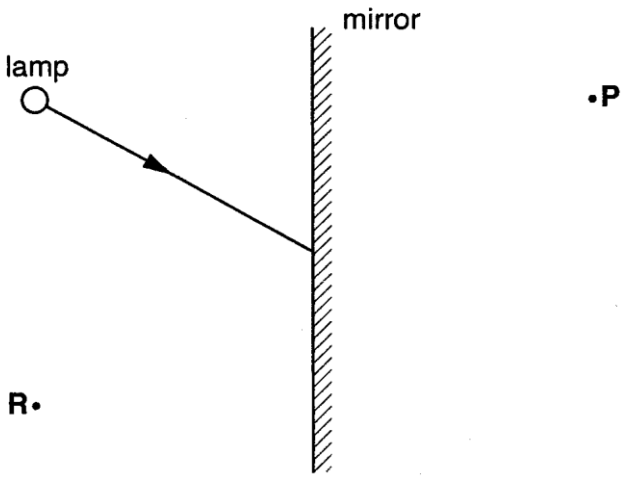
A 0.5 s

B 1.0 s

C 2.0 s

D 2.5 s

21 The diagram shows a ray of light from a small lamp striking a plane mirror.



Which of the following correctly describes the position and characteristic of the image?

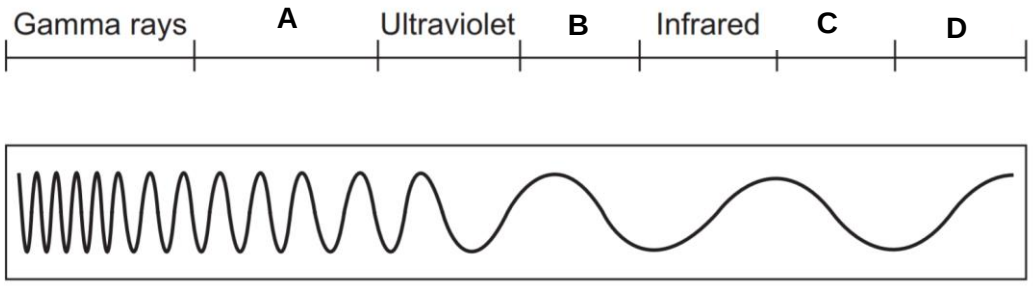
A at **P** and is real

B at **P** and is virtual

C at **R** and is real

D at **R** and is virtual

22 The figure shows the electromagnetic spectrum.

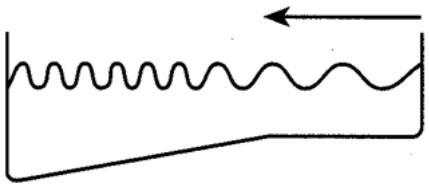


Which region, **A**, **B, C** or **D**, shows the position of a laser beam?

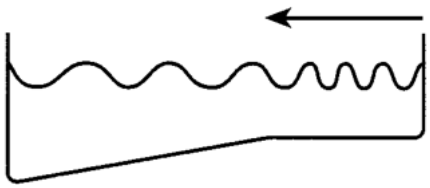
23 A ripple tank contains water of varying depths.

Which diagram correctly represents the water waves as they travel from the shallow to the deep region?

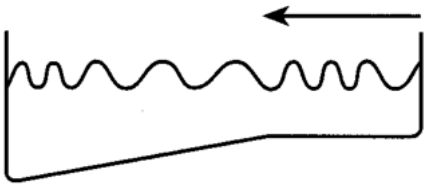
A



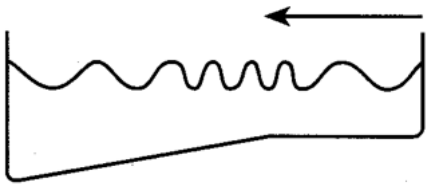
B



C



D



24 Which of the following statements is correct for light passing from air into glass?

A Its frequency increases because its speed increases.

B Its wavelength increases because its speed increases.

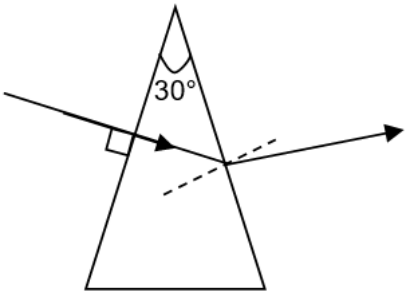
C Its frequency decreases because its speed decreases.

D Its wavelength decreases because its speed decreases.

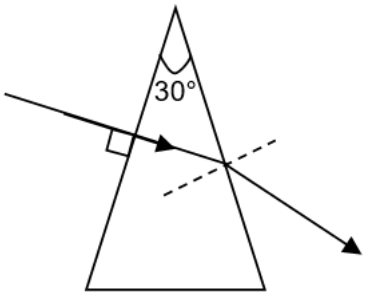
25 A ray of light falls on a glass prism which has a refractive index 1.5.

Which of the following shows the path of the light through the prism?

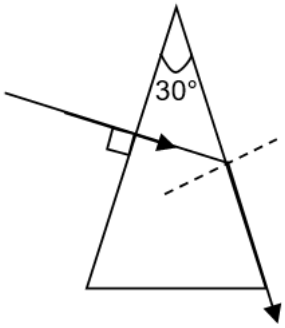
A



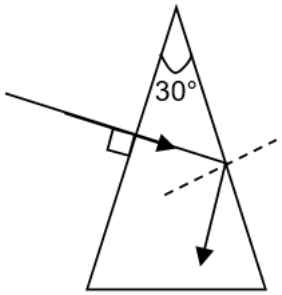
B



C



D



26 Why are humans **not** able to hear ultrasound?

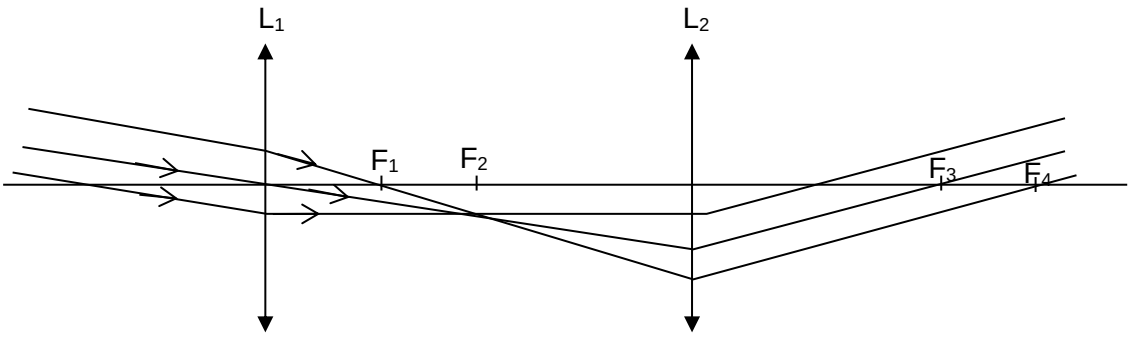
A The amplitude is too low.

B The frequency is too high.

C The speed is too low.

D The wavelength is too long.

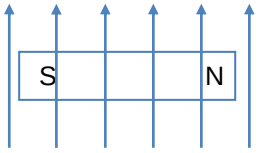
27 The diagram shows parallel rays from a distant object passing through converging lenses L_1 and L_2. The rays emerging from L_2 are parallel.



Where are the focal points of L_1 and L_2?

	focal point of L_1	focal points of L_2
A	F_1	F_3
B	F_2	F_4
C	F_1	F_4
D	F_2	F_2

28 A bar magnet is suspended freely in a uniform magnetic field as shown.



What will happen to the magnet?

A remain stationary

B turn 90° clockwise

C turn 90° anti-clockwise

D turn 180° anti-clockwise

29 Which of the following statements is correct?

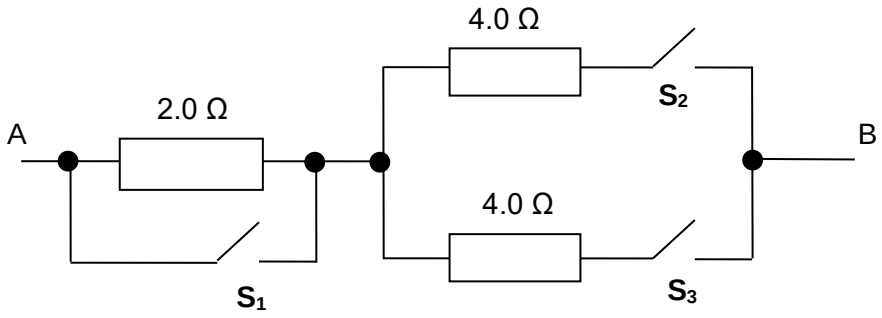
A Like charges attract.

B Unlike charges repel.

C The SI unit of electric charge is the ampere.

D The direction of the electric field is the direction of the force acting on a positive test charge placed in the field.

30 The diagram shows part of a circuit in which all the switches are open.

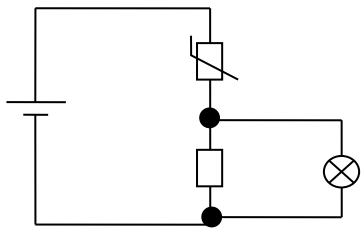


Which of the following combinations will result in a resistance of 2.0 Ω between A and B?

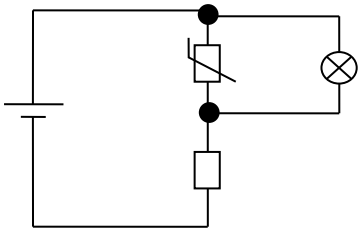
	S_1	S_2	S_3
A	Closed	Closed	Closed
B	Closed	Opened	Closed
C	Opened	Closed	Closed
D	Opened	Opened	Closed

31 In which of the circuits below will the bulb glow more brightly when less light shines on the circuit?

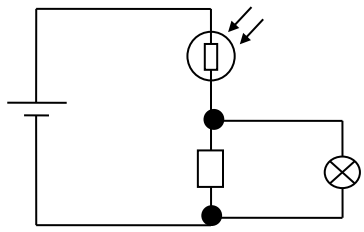
A



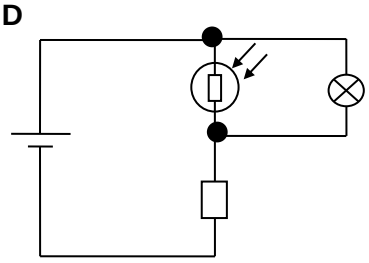
B



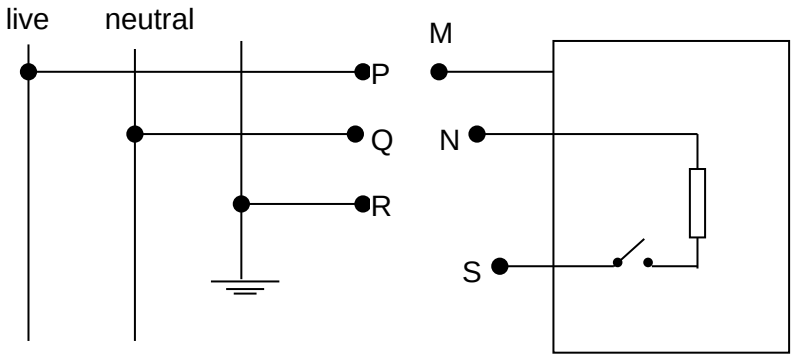
C



D



32 An electrical appliance with a metal case is to be connected to the mains supply as shown.



Which of the following shows the correct connection of the wires from P, Q and R respectively?

	P	Q	R
A	S	M	N
B	S	N	M
C	N	M	S
D	N	S	M

33 The element of an electric kettle is rated 960 W, 240V.

When the kettle is operating normally, what is the current in the element and what is its resistance?

	current / A	resistance / Ω
A	0.25	60
B	0.25	960
C	4.0	60
D	4.0	960

34 60 C of charge passes through a resistor in 120 seconds. The energy converted in the resistor is 5.0 J every second.

What is the potential difference across the resistor?

A 5.0 V

B 10 V

C 12 V

D 24 V

35 **X** and **Y** are wires carrying electric currents at right angles to this page. **P, Q** and **R** are compasses. Any effect of the Earth's magnetic field can be ignored.

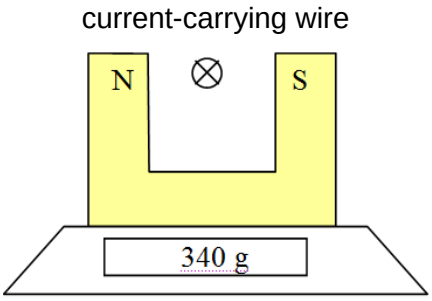
Which of the following is correct?

	direction of current in **X**	size of current
A	into the plane of the paper	larger in **X** than in **Y**
B	into the plane of the paper	smaller in **X** than in **Y**
C	out of the plane of the paper	larger in **X** than in **Y**
D	out of the plane of the paper	smaller in **X** than in **Y**

36 Which of the following changes to a wire will double its resistance?

	cross-sectional area	length
A	double	double
B	double	no change
C	no change	halve
D	halve	no change

37 A current-carrying wire is placed between the poles of the horseshoe magnet as shown. The electronic balance reads 340 g.



Which of the following could be the reading on the electronic balance when the current-carrying wire is removed?

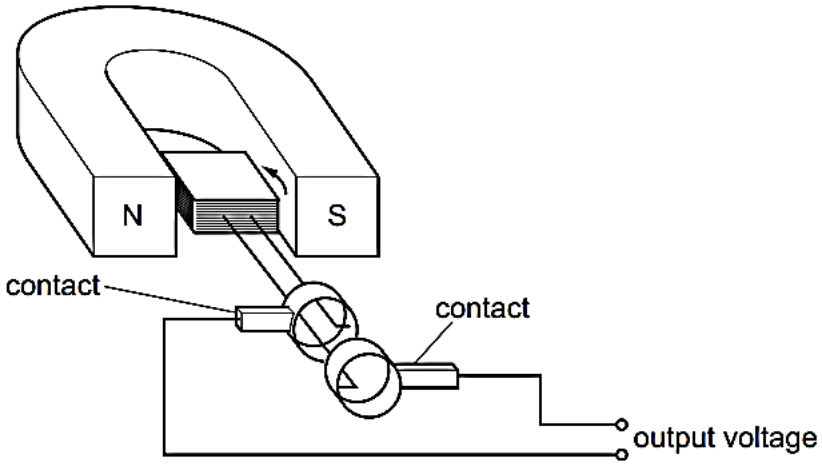
A 0 g

B 330 g

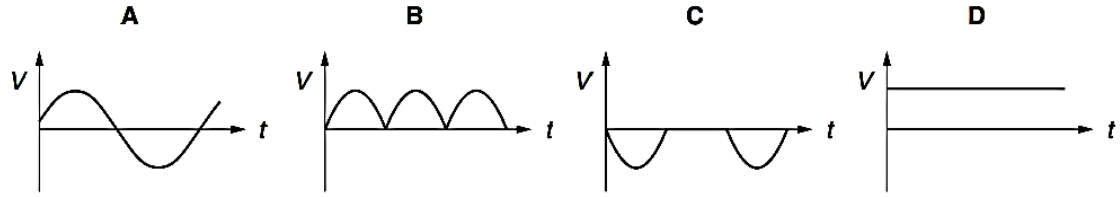
C 340 g

D 350 g

38 A coil is rotated steadily between the poles of a magnet.



Which graph shows the output voltage V against time t?



39 Which of the following statements about radioactive decay is correct?

A Gamma decay takes place only when temperature is high enough.

B Beta decay is the process in which a neutron splits into a proton and an electron.

C The chance to decay is different for each nucleus in a sample.

D The gamma radiation has a very short half-life.

40 $^{238}_{92}U$ decays by emitting 2 $\propto$-particles and 2 β-particles.

Which of the following represents the resulting nuclide?

A $^{234}_{90}Th$

B $^{234}_{92}U$

C $^{232}_{88}Ra$

D $^{230}_{90}Th$

COMMONWEALTH SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY 4 EXPRESS PHYSICS

Name: _____( ) Class: _____

Physics	**6091/02**
Paper 2 Theory	**10 Sep 2024**
	1130 h – 1315 h
Candidates answer on the Question Paper.	**1 hour 45 minutes**
No Additional Materials are required.	

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the question paper and any separate answer sheets used.

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.

Section B

Answer **one** question.

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

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

Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of physics than for correct answers.

At the end of the examination, ensure that you have submitted all your work.

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

	For Examiner's Use	
Name of setter: Mdm Quek Lay Hong	**Paper 2**	**80**
Parent's/Guardian's Signature		

This booklet consists of **23** printed pages.

SECTION A

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

1 A gun is loaded with a bullet of mass 30 g. The gun is then fired.

(a) The bullet moves with a speed of 500 m/s.

Calculate the amount of energy in the kinetic store of the bullet when it is moving.

energy = ……...…… [2]

(b) After 1.0 ms, the bullet hits a solid concrete wall, creates a 5.0 cm deep hole and is embedded in the hole. There is no energy loss to the surroundings during the flight of the bullet.

Calculate the retarding force of the concrete.

force = ……..……...…… [2]

2 Fig. 2.1 shows a device used to measure the current in a solenoid.

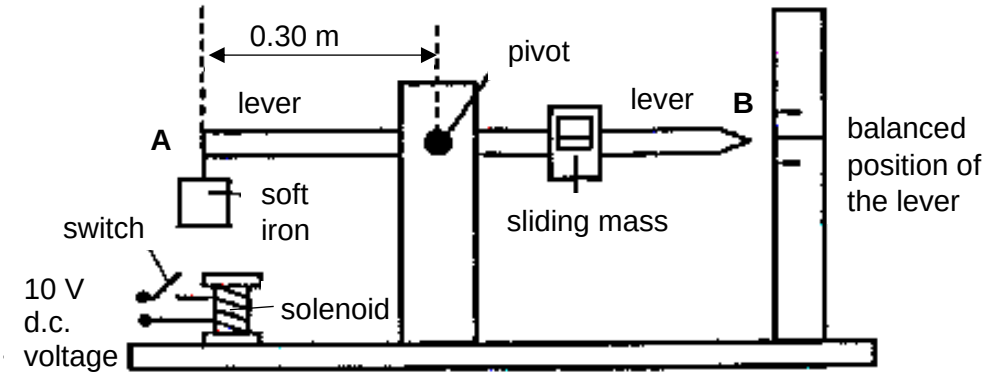


Fig. 2.1

There is no core in the solenoid. The non-uniform lever **AB** has a total length of 100 cm and mass 15 kg. It is pivoted at 0.30 m from **A**. A 5.0 kg of soft iron is attached on **A** and is balanced by a 10.0 kg sliding mass placed 0.10 m from the pivot. The pointer on the lever points to the balanced position when the switch is opened.

Gravitational field strength g = 10 N/kg.

(a) **(i)** Determine the weight of the soft iron.

weight = ... [1]

(ii) Determine the magnitude and direction of the moment due to the soft iron.

magnitude = ... [1]

direction = ... [1]

(iii) Calculate the distance of the centre of gravity of the lever from the pivot.

distance = ... [3]

(b) The switch is now closed.

State and explain what would happen to the soft iron and the position in which the pointer of the lever is pointing.

……

……

……

……

……

…… [3]

3 **(a)** Solids have fixed shape and volume, liquids have fixed volume but take the shape of the container, and gases have no fixed volume or shape.

Explain the above-mentioned physical properties of solids, liquids and gases using the kinetic particle model of matter.

……

……

……

……

……

……

…… [3]

(b) On Fig. 3.1, draw the path of a smoke particle suspended in air. [1]

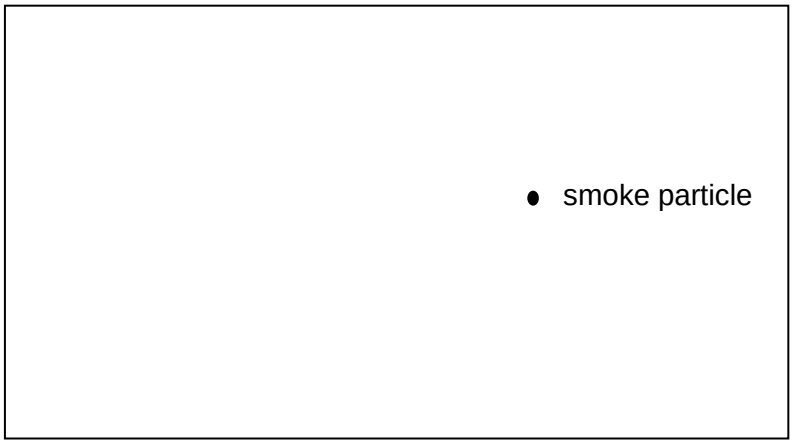


Fig. 3.1

4 **(a)** Fig. 4.1 shows the I-V characteristics of a filament lamp.

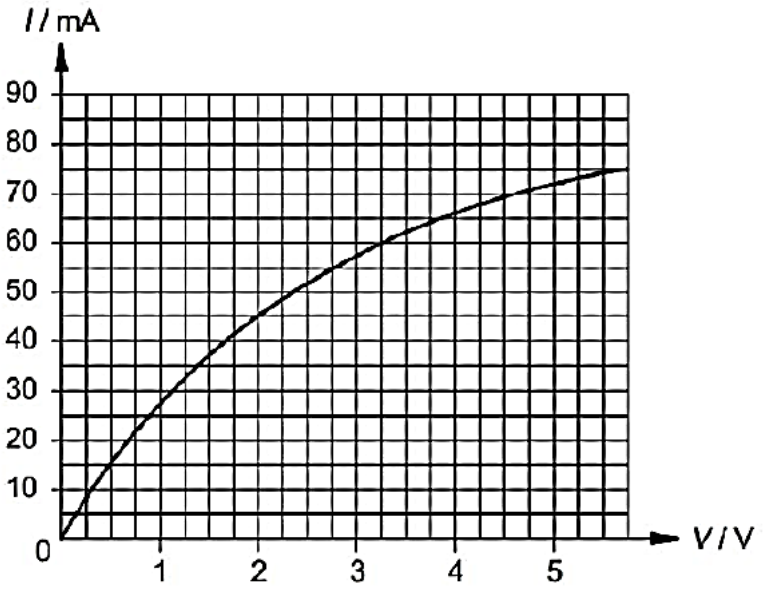


Fig. 4.1

(i) Explain why the filament lamp is a non-ohmic conductor.

……

……

…… [1]

(ii) Calculate the resistance of the lamp when V = 3.25 V

Resistance = …… [2]

(b) A thermistor is an input transducer that has a resistance which changes with temperature.

Fig. 4.2 shows the filament lamp in **(a)** connected in series with a thermistor and a 6.0 V source. The thermistor is an NTC (Negative Temperature Coefficient) type.

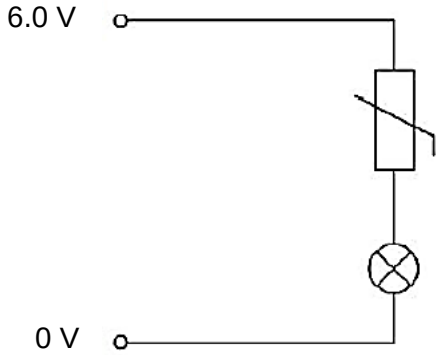


Fig. 4.2

If the surrounding temperature increases, state and explain whether the resistance of the filament lamp will increase or decrease.

……

……

……

……

……

…… [3]

5 Fig. 5.1 shows a wave travelling along a rope at time t = 0 s.

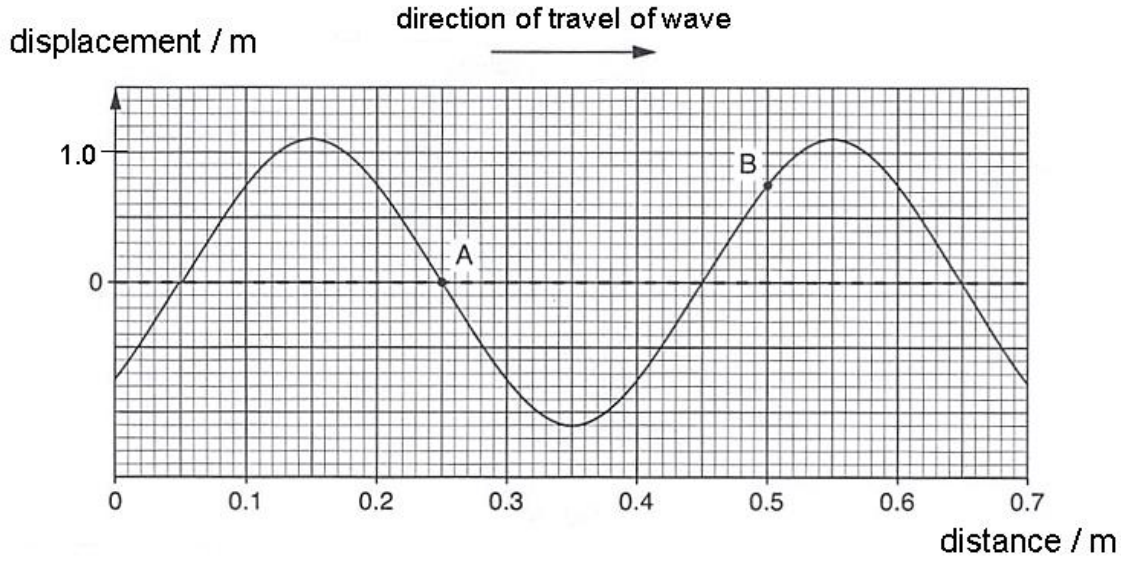


Fig. 5.1

Two points A and B are marked on the rope.

(a) **(i)** State what is meant by w*avelength*.

……..…

..…… [1]

(ii) State the wavelength of the wave in the rope.

wavelength = ……[1]

(iii) On Fig. 5.1, mark a point on the rope that has the **same** vertical speed as point A, but moves in the opposite direction to A.

Label this point C. [1]

(iv) The horizontal speed of the wave is 1.0 m/s.

On Fig. 5.1, draw the position of the wave for time t = 0.10 s. [1]

(b) Blue light, travelling in air, strikes the side of a glass block and continues in the same direction as it enters the glass block.

Fig. 5.2 shows the ray of light and the shape of the glass block.

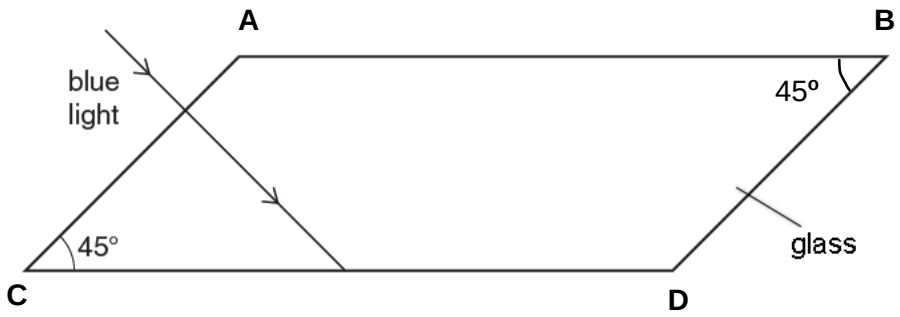


Fig. 5.2

AB is parallel to **CD**. **AC** is parallel to **BD**.

The critical angle for this glass is 42°.

(i) Explain why the light continues in the same direction as it enters the glass block.

……...

..... [1]

(ii) On Fig. 5.2, complete the path of the light until it leaves the glass. [2]

6 Fig. 6.1 shows a thin converging lens with a real image **I**. The horizontal line represents the principal axis. The focal length of the lens is 2.0 cm.

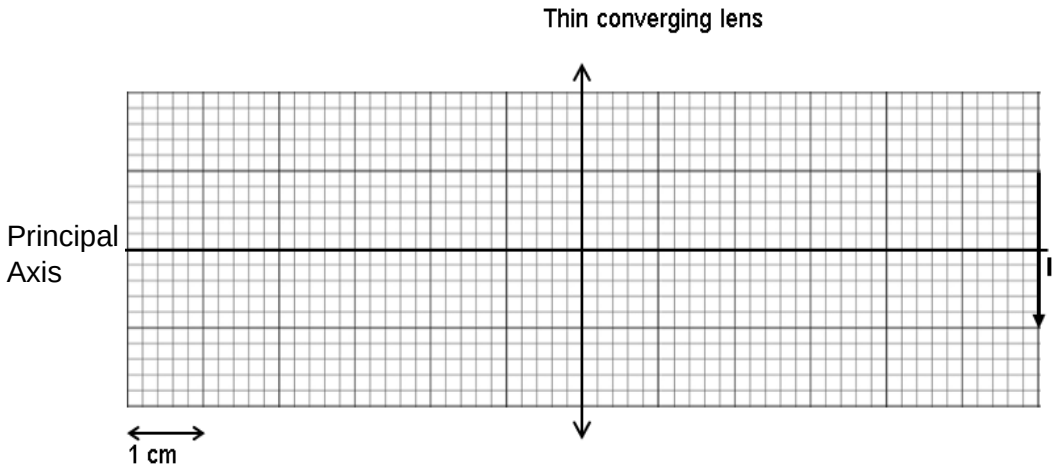


Fig. 6.1 (To scale)

(a) Using the ray diagram method, locate and draw the object in Fig. 6.1.

Label the object **O**. [3]

(b) Name a practical use of such an arrangement of the converging lens.

..... [1]

7 Electronic components can be damaged by overheating. One method of overcoming this problem is to mount the component on a heat sink as shown in Fig. 7.1.

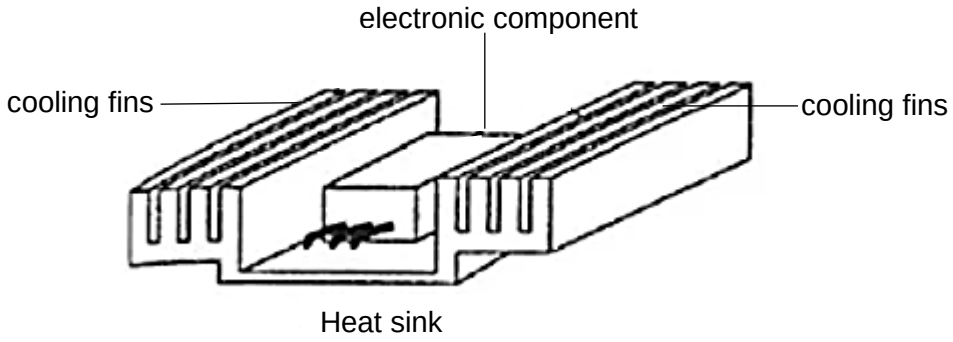


Fig. 7.1

The purpose of the heat sink is to 'soak up' surplus heat produced by the electric current in the component and transfer this heat to the surroundings. The heat sink is often in the form of a piece of aluminium of mass much greater than that of the component.

(a) List the processes by which the heat sink could transfer heat to the surroundings.

…… [1]

(b) Give a reason for

(i) making the heat sink from metal,

……
…… [1]

(ii) painting the heat sink black,

……
…… [1]

(iii) having cooling fins on the heat sink.

……
…… [1]

(c) The component produces heat continuously.

Explain why the temperature of the heat sink becomes constant after a short time.

……
…… [1]

8 Fig. 8.1 shows a transformer.

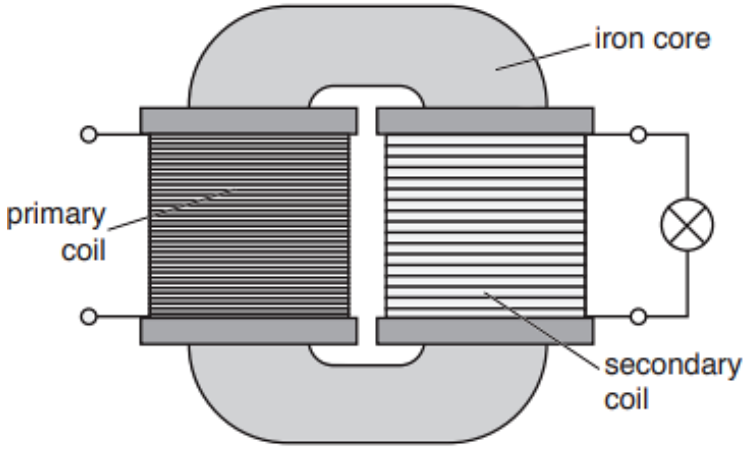


Fig. 8.1

A student tested two transformers **A** and **B**.
The primary coil of each transformer has 250 turns of copper wire. The student applies various voltages to the primary coil, V_p, of each transformer, and measures the voltages in the secondary coil, V_s.

The results are shown in Fig. 8.2.

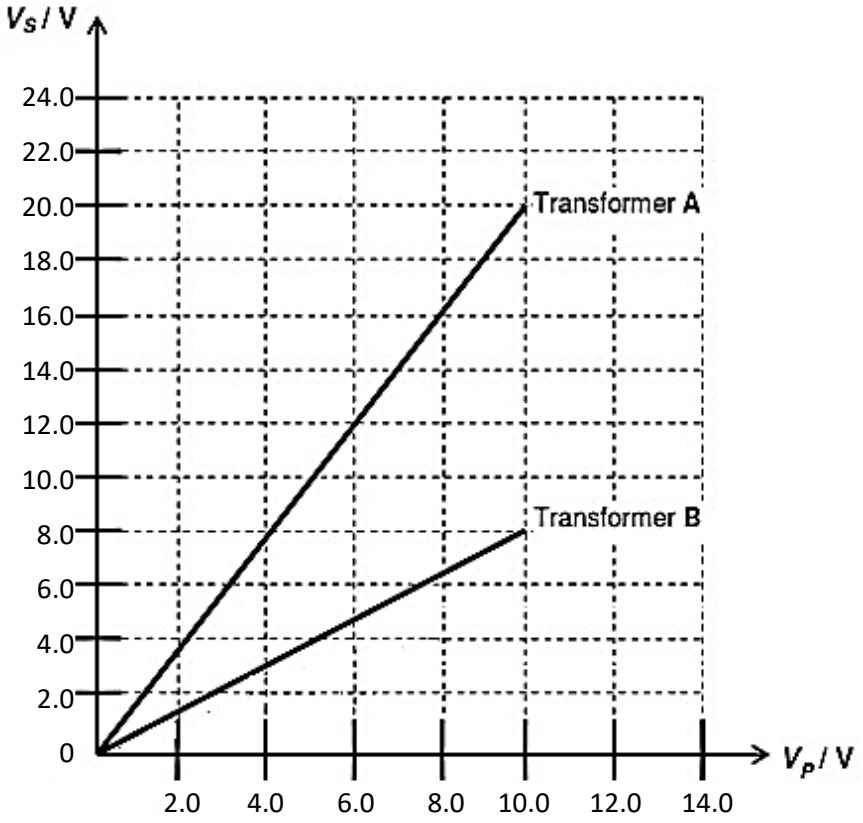


Fig. 8.2

(a) State one reason for using an iron core in the transformer.

……..

…… [1]

(b) State which transformer is a step-up transformer and which is a step-down transformer.

step-up transformer: ……..……..……..…..…

step-down transformer: ……..……
[1]

(c) The voltage in the primary coil, V_p, is 10 V.

Calculate the number of turns in the secondary coil of transformer **B**.

number of turns = ……. [2]

(d) A lamp rated 12 V and 10 W is connected to the secondary coil of Transformer **A**.

Transformer **A** has an efficiency of 75%.

Calculate the current in the primary coil of transformer **A** if it is used to light the lamp at normal brightness.

current = ……. [2]

(e) Suggest a reason why the efficiency of transformer **A** is less than 100%.

……..

…… [1]

9 A lamp is marked 12V, 25 W.

Describe an experiment to check that the electrical power supplied to the lamp is 25 W when the potential difference (p.d.) across it is 12 V.

In your account, you should:

- include a circuit diagram,
- state the readings that are taken,
- show how the result is calculated from the readings.

……..……..

……..……..

……..……..

……..……..

……..……..

……..……..

……..……..

……..……..

……..…… [4]

10 **ABCDEF** is a bare copper wire coated with a thin layer of insulation. It is bent into a coil and placed at point **P** above a 1.5 V battery as shown in Fig. 10.1.

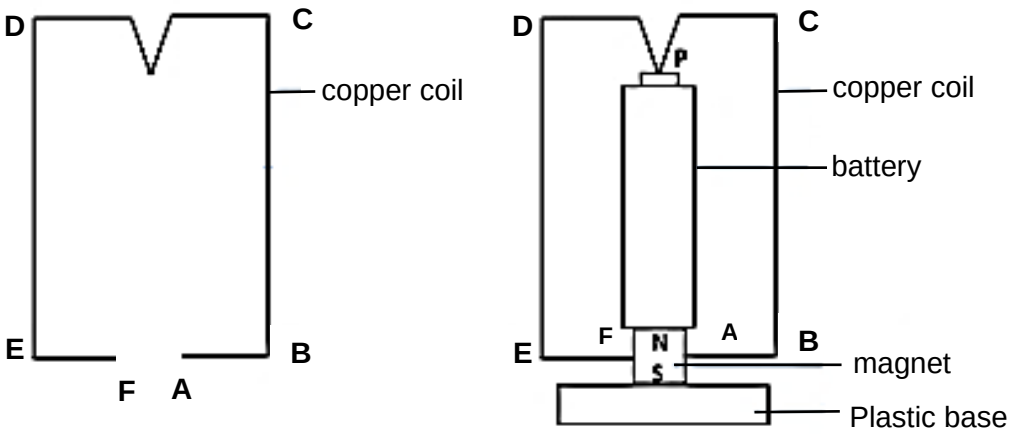


Fig. 10.1

(a) State what is meant by *centre of gravity*.

……..

…… [1]

(b) Explain why the copper coil is able to stay balanced in the position as shown in Fig. 10.1.

……..

……..

……..

…… [2]

(c) On Fig. 10.1, indicate the direction of the magnetic field on **CB** or **DE** using an arrow. [1]

(d) The insulation of the coil at **P, F** and **A** is now removed such that there is electrical contact between the coil, battery and magnet.

A current flows through the coil and the coil starts to turn about **P**.

(i) Deduce the direction of force acting on **CB** and **DE**.

force on **CB** = ……

force on **DE** = ……
[1]

(ii) Explain why **CB** and **DE** experience a force.

……..

……..

……..

……..

……..…… [2]

(e) A current flows in the coil.

The resistance of **ABCP** = the resistance of **PDEF** = 0.0022 Ω.

(i) Calculate the resistance of **ABCPDEF**.

resistance = …… [1]

(ii) Calculate the amount of thermal energy generated in the coil after 3.0 seconds.

thermal energy = …… [2]

11 An Olympic gymnast jumps off a high bar from **A**, lands on a trampoline at **B** and is in contact with the trampoline between **B** and **C**. **D** is the highest position reached by the gymnast as she rises.

Fig. 11.1 shows the velocity-time graph for the gymnast. Air resistance is negligible.

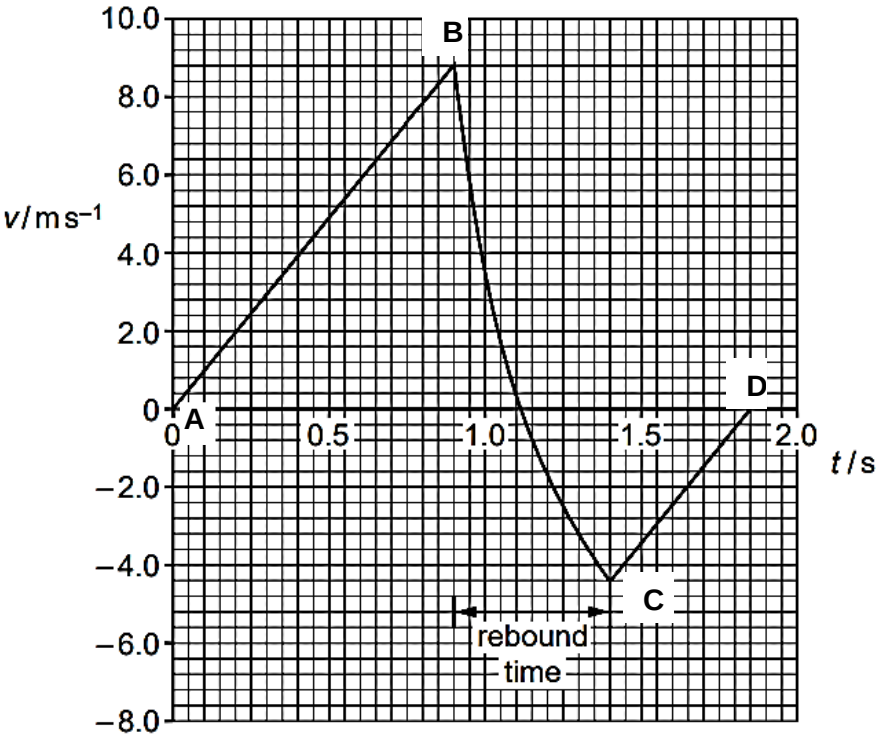


Fig. 11.1

(a) State what is meant by *uniform acceleration*.

……

…… [1]

(b) Table 11.1 shows the direction of motion of the gymnast and the direction of acceleration of the gymnast.

Complete Table 11.1. [2]

	Direction of motion of the gymnast	Direction of acceleration of the gymnast
During AB		
During CD		

Table 11.1

Do not write in this margin

(c) Using information from Fig. 11.1, describe the motion of the gymnast between **C** and **D**.

……

…… [1]

(d) Using information from Fig. 11.1, suggest and explain whether the distance covered between **A** and **B** is larger than the distance covered between **C** and **D**.

……

……

…… [2]

(e) Determine:

1. the change in speed of the gymnast between **B** and **C**:

…….. [1]

2. the change in velocity of the gymnast between **B** and **C**:

…….. [1]

(f) Calculate the average acceleration experienced by the gymnast when in contact with the trampoline.

acceleration = …….. [2]

Section B (10 Marks)

Answer **one** question from this section.

12 An electrician is replacing an old electric shower with a new one. Fig. 12.1 shows the parts of an electric shower.

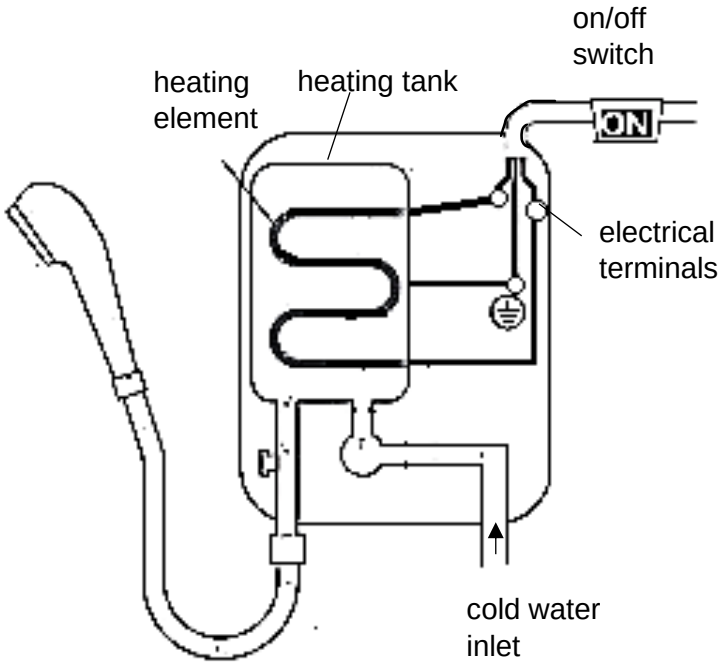


Fig. 12.1

The heating element is connected to the live and neutral conductors of the electrical mains.

(a) State what is meant by *live* and *neutral*.

live ……

……..

neutral ……

…… [1]

(b) Explain why the switch must be connected along the live wire.

……..

…… [1]

(c) Different electrical wires need to have a cross-sectional area that is suitable for the power input.

Fig. 12.2 shows the recommended maximum power input to wires of different cross-sectional areas.

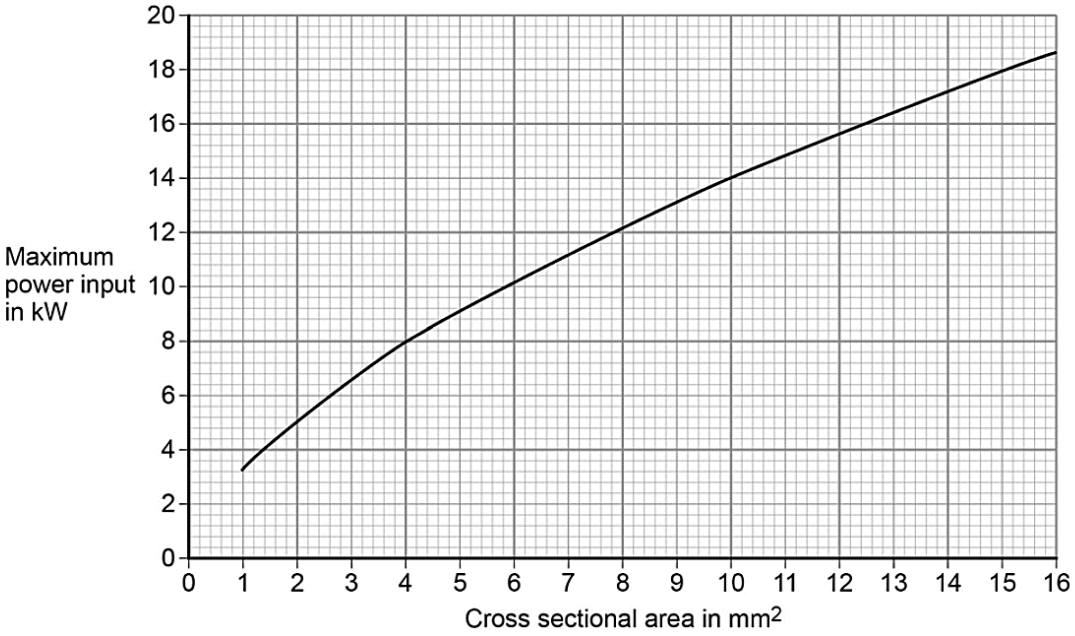


Fig. 12.2

The new electric shower has a power input of 5.0 kW.

(i) Explain what is meant by *power input of 5.0 kW*.

……..

……..

…… [1]

(ii) Determine the **minimum** cross-sectional area of wire that should be used for the new shower.

area = …… [1]

(iii) Explain why it is dangerous to use wire thinner than that in **(c)(ii)**.

……..

……..

……..

……..

…… [2]

(d) The charge that flows through the new shower in 10 minutes is 12 400 C.

The power output across the heating element in the new shower is 5.0 kW.

Calculate

(i) the current through the heating element in the new shower,

current = ... [2]

(ii) the resistance of the heating element in the new shower.

resistance = ... [2]

13 **(a)** It is found that a Geiger-Muller tube registers a count rate even though radioactive sources are not present.

Explain this observation.

……..…….

……..…….. [1]

(b) Fig. 13.1 shows an experiment to investigate the deflection of beta particles from sample Y.

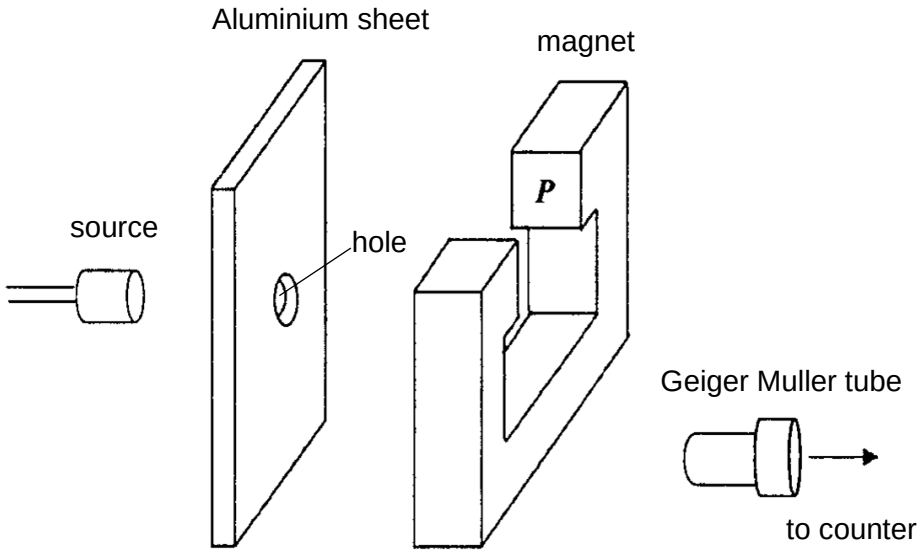


Fig. 13.1

A magnet is placed behind the aluminium sheet. A Geiger-Muller tube is connected to a counter and placed at the bottom of the entire set-up and is very near the magnet.

(i) State the nature of the beta particles.

……..……..….. [1]

(ii) The half life of the beta particles that was used is 10 days.

Determine the fraction of the mass of sample Y that will remain radioactive after 40 days.

fraction = …….. [1]

(iii) Suggest the purpose of the aluminium sheet in this experiment and a minimum thickness for the sheet.

Purpose: ……

…… [1]

Minimum thickness: ……..…… [1]

(iv) State the polarity ***P*** of the magnet for the Geiger-Muller tube to detect the deflected beam of beta particles.

…… [1]

(v) The magnet is replaced by 2 metal plates and a power source.

Describe and explain how the experiment can be modified so that the Geiger-Muller tube can detect the deflected beam of beta particles at the same position.

……

……

……

…… [2]

(vi) The source is now replaced by an alpha source and the magnet is placed back in between the aluminium sheet and the Geiger-Muller tube.

State and explain how the reading on the counter of the Geiger-Muller tube changed.

……

……

……

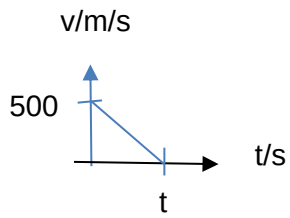
…… [2]

COMMONWEALTH SECONDARY SCHOOL
SECONDARY FOUR EXPRESS PHYSICS
PRELIMINARY EXAMINATION 2024
ANSWER KEY

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

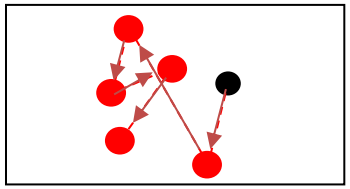
COMMONWEALTH SECONDARY SCHOOL
SECONDARY FOUR EXPRESS PHYSICS 6091
PRELIMINARY EXAMINATIONS 2024
MARK SCHEME

Section A (70 marks)
Deduct a maximum of one mark for error in sf.

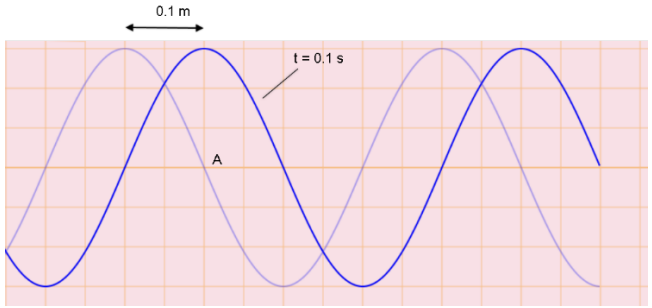
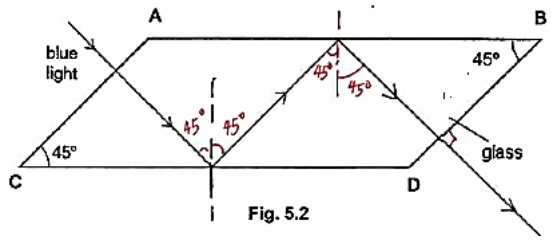
Q		Answers	Marks / Remarks
1	**(a)**	KE = ½ m v^2 **= ½ x 0.030 kg x (500 m/s)^2** = 3750 J **= 3800 J**	 [1] [1] Ans + 2sf + unit
	(b)	Loss in KE = work done by the retarding force **3750 J = Force x 0.050 m** or 3800 N = force x 0.050 m Force = **75 000 N** or 76 000 N <u>Alternative method:</u>  To find time taken for deceleration.	 [1] allow e.c.f. from (a) [1] Ans + 2sf + unit

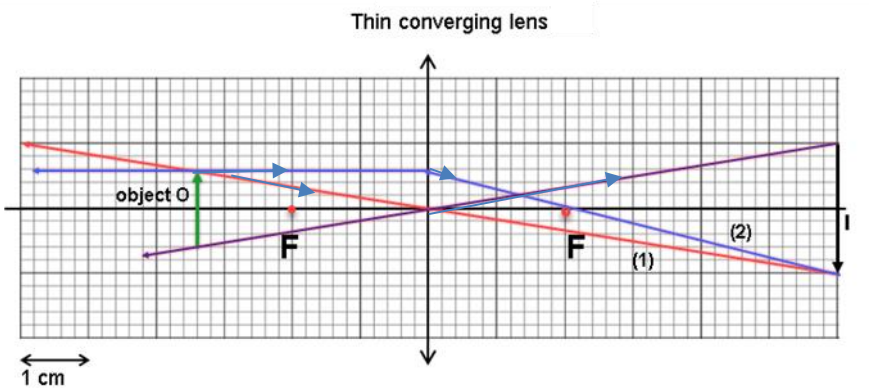
Q		Answers	Marks / Remarks
		½ x 500 m/s x t = 0.050 m t= 0.0002 s Acceleration = (-500 m/s)/0.0002s = - 2500000 m/s^2 F = ma = 0.030 kg x (-2500000 m/s^2) = 75 000 N	
		Total mark for Q 1	**[4]**

Q		Answers		Marks / Remarks
2	**(a)**	**(i)**	Weight = mg = 5.0 kg x 10 N/kg = **50 N**	[1] Ans + 2sf + unit Accept: no working
		(ii)	Moment = force x perpendicular distance = **50 N x 0.30 m** = **15 Nm** Direction: **Anti-clockwise** or counterclockwise.	[1] allow e.c.f. from (i) [1]
		(iii)	Let the distance of the CG of the lever from the pivot be d. **Add** the clockwise moments due to the lever and sliding mass. **(100 N x 0.10 m) + (150 N x d)** **Equate** the above total clockwise moment to the anti-clockwise moment in (ii). **(100 N x 0.10 m) + (150 N x d) = 15 Nm** **d = 0.033 m**	 [1] [1] allow ecf from (ii) [1] Ans + 2 sf + unit
	(b)	The soft iron would move **downwards/attracted to solenoid** and **the pointer would point up/above the balanced position marker.** The soft iron is **magnetically induced** and **attracted** by the solenoid. Or: The **magnetic field of the solenoid induces the soft iron.** The soft iron is **attracted to the solenoid.** The additional downward **force** acting on soft iron increases the **anti-clockwise moment** or**:** the lever **rotates anti-clockwise** about the pivot.		[1] [1] [1]
		Total mark for Q 2		**[9]**

Q		Answers	Marks/Remarks
3	(a)	<u>To explain volume:</u> Particles in solids and liquids are **very close to one another** / **very little space between the particles** so they cannot be compressed / have fixed volume. Particles in a gas are **very far apart** hence gas can be compressed easily / has no fixed volume. <u>To explain shape:</u> Particles in a solid are **held in fixed positions and arranged in a regular pattern / do not move about but vibrate about fixed positions**. Particles in a liquid are **are not arranged in fixed positions / are free to move about in the liquid.** The particles in gases **move freely** at high speeds. <u>Relate volume and shape to forces:</u> The particles in solids are held tightly together by very **strong attractive forces.** The particles in liquids are held together by **relatively weaker attractive forces than those in solids.** The particles in gases have **very weak / negligible attractive forces** between them.	[1] [1] [1]
	(b)		[1] accept any zigzag path Reject summetrical path.
		Total mark for Q 3	**[4]**

Q		Answers		Marks/Remarks
4	**(a)**	**(i)**	The **current** flowing through the lamp **is not directly proportional to the pd** across it. Or: the graph is **not a straight line** Or: the graph is a **curve.**	[1]
		(ii)	R = V / I **= 3.25 V / 0.060 A** **= 54.2 Ω**	 [1] Award only one mark for **3.25 / 60** [1] accept 2 or 3 sf
	(b)	The resistance of the filament lamp **increases.** As temperature increases, the **resistance of the thermistor decreases.** The **p.d. across thermistor decreases**. Since the emf is shared between the filament lamp and the thermistor, the **p.d. across the filament lamp increases.** <u>Or:</u> The resistance of the filament lamp **increases.** As temperature increases, the **resistance of the thermistor decreases.** **Current through the lamp increases.**		[1] [1] [1]
		Total mark for Q 4		**[6]**

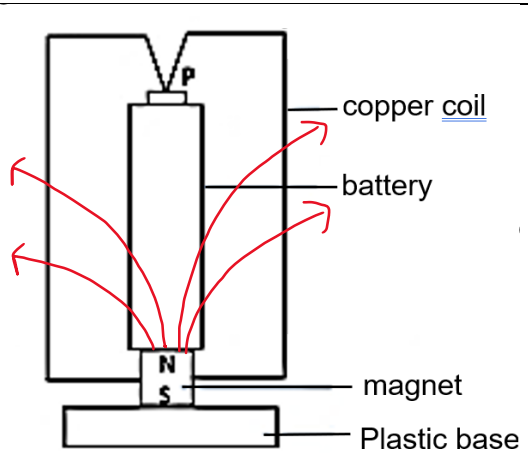
Q		Answers	Marks/Remarks
5	**(a) (i)**	The **shortest distance** between 2 points on a wave that are **in phase.** Or: the distance between successive crests of a wave	[1]
	(ii)	**wavelength =** 0.550 – 0.150 **=0.400 m (3 d.p)** Follow precision of graph paper and read to half a division.	Accept: no working [1]. No aww for d.p. because this question was tested in WA.
	(iii)	Mark the point C at **(0.050, 0)** or **(0.450, 0)**	[1]
	(iv)	 All points shifted 0.100 m to the right.	[1] Do not award mark if the **amplitude** of student's wave is **different** from original amplitude.
	(b)(i)	The **angle of incidence is 0^0** and hence no refraction.	[1]
	(ii)	 **Fig. 5.2**	[1] – reflected ray inside glass [1] – refracted ray (penalise once only; no mark if arrow is missing)
		Total mark for Q 5	[**7**]

Q		Answers	Marks/Remarks
6	(a)		[1]- - 1 ray through optical centre [1] - 1 ray through focal point. [1] - Object labelled as O and drawn with an upward arrow. Deduct one mark for missing arrows on ray
	(b)	**Projector**	[1]
		Total mark for Q 6	[**4**]

Q		Answers	Marks/Remarks
7	(a)	**Conduction, convection and radiation**	[1]
	(b)	**(i)** Metal is a **good conductor** of heat hence increasing the rate of conduction / heat transfer in the heat sink. **(ii)** Black is a **good** or **better radiator/emitter** of infra-red radiation hence increasing the rate of heat loss by radiation. **(iii)** To **increase** the **surface area** with air for losing heat by radiation and conduction, hence increasing the rate of heat loss.	One mark for each underlined phrase.
	(c)	**Rate of heat produced by/transferred** from the component to the heat sink **= the rate of heat lost/transferred** from the heat sink to the surroundings**.** Or: **Heat produced by/transferred** from the component to the heat sink **= heat lost/transferred** from the heat sink **to** surroundings. Or: **Thermal Equilibrium** is achieved.	[1]
		Total mark for Q 7	[**5**]

Q		Answers	Marks/Remarks
8	**(a)**	Any one of the following: • **Strengthen magnetic field linkages**. • **Strengthen magnetic flux** from primary to secondary coil. • **concentrate magnetic field lines**. • **Reduce leakages of magnetic field**. • Iron is a soft magnetic material, it can be **magnetised and demagnetised easily.**	[1]
	(b)	step-up transformer: **A** step-down transformer: **B**	[1] both answers must be correct.
	(c)	V_p = 10.0 V, V_s = 8.0 V $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $\frac{N_s}{250} = \frac{8}{10}$ N_s = **200**	[1] working [1] answer
	(d)	V_s = 12.0 V, V_p = 6.0 V 75% of input power = output power **75% x I_p x 6.0 = 10** I_p = **2.2 A**	[1] – working [1] ans + unit + 2sf
	(e)	Any one of the following: • **Heat loss** due to **resistance of coil** • **Leakage of magnetic flux**/ magnetic field linkages between the primary and secondary coil • **Heat loss** due to **eddy current** induces in the core	[1] *Rejected: heat loss without mentioning what causes this.*
		Total mark for Q 8	[**7**]

Q	Answers	Marks/Remarks
9	• circuit diagram showing **power supply, lamp and ammeter in series** • **voltmeter across lamp** (accept voltmeter across supply if no other resistor is drawn. Condone incorrect / old symbol for lamp) • ensure **voltage is 12 V** in some ways (e.g. power supply is 12 V) • **V x I** or **voltmeter x ammeter readings**.	[1] [1] [1] [1]
	Total mark for Q 9	[**4**]

Q		Answers	Marks/Remarks
10	(a)	A **point** through which the **whole weight of the object appears to act.**	[1]
	(b)	Its **centre of gravity is vertically below the pivot.** There is **no perpendicular distance from its line of action of weight to the pivot** or: **no moment / turning effect**.	[1] [1]
	(c)		[1] any correct line
	(d)(i)	force on CB = **out of the page /paper** force on DE = **into the page /paper**	[1] both correct Allow ecf from **(c)**
	(d) (ii)	The **current** passing through the copper wire **produces a magnetic field.** This **interacts with the magnetic field of the magnet producing an unbalanced field** and hence a force.	[1] [1]
	(e)(i)	**1/R = 1/0.0022 + 1/0.0022** R= **0.0011 Ω**	[1] ans, sf and unit

Q		Answers	Marks/Remarks
	(e)(ii)	E = $\frac{V^2}{R} \times t$ = $\frac{\mathbf{1.5^2}}{\mathbf{0.0011}}$ **x 3.0** = **6100 J** (2.s.f.) allow alternative method – calculate I = V/R, then E=VIt, E = I^2Rt	[1] – working [1] - ans + s.f. + unit Allow e.c.f from part (e)(i).
		Total mark for Q 10	[**10**]

<table>
<tr><th>Q</th><th></th><th>Answers</th><th>Marks/Remarks</th></tr>
<tr><td>11</td><td>(a)</td><td>The rate of change of velocity is constant.</td><td>[1]</td></tr>
<tr><td></td><td>(b)</td><td>Award one mark for any two correct answers.

<table><tr><td></td><td>Direction of motion of the gymnast</td><td>Direction of acceleration of the gymnast</td></tr><tr><td>During AB</td><td>Downwards</td><td>Downwards</td></tr><tr><td>During CD</td><td>Upwards</td><td>Downwards</td></tr></table></td><td>[2]</td></tr>
<tr><td></td><td>(c)</td><td>Any one:
• Velocity is decreasing at a constant rate.
• Constant deceleration
• Speed is decreasing at a constant rate and the gymnast is moving upwards.
• Constant acceleration</td><td>[1]</td></tr>
<tr><td></td><td>(d)</td><td>The distance covered between A and B is larger.
The area enclosed by the graph and t axis between A and B is larger than that between C and D.

Or: The distance travelled between A and B is 3.96 m which is greater than the distance travelled between C and D at 0.99 m.</td><td>[1]
[1]</td></tr>
<tr><td></td><td>(e)</td><td>1. – 4.4 m/s
2. – 13.2 m/s
Accept positive sign.</td><td>[1]
[1]
Answer with unit and 1 dp.</td></tr>
<tr><td></td><td>(f)</td><td>Average acceleration = (- 4.4 m/s – 8.8 m/s) / 0.50 s
= - 26 m/s^2 (2sf)</td><td>[1] for working
[1] Ans + unit & 2sf</td></tr>
<tr><td></td><td></td><td>Total mark for Q 11</td><td>[10]</td></tr>
</table>

Q		Answers	Marks/Remarks
12	**(a)**	Live is at **high potential** Neutral is at **zero potential**	[1]
	(b)	So that **when the switch is turned off**, the **appliance is disconnected from high potential** or **appliance will be at 0 V / 0 potential.**	[1]
	(c)	**(i) 5.0 kJ** of electric **energy is converted every / per second**.	[1]
		(ii) 2.0 mm^2	[1] ans + precision + unit
		(iii) Resistance of thinner wire is higher. When same current passes through, it will cause the **wire to overheat** and may results in **fire** or **P = I^{2}R. As R increases, power dissipated increases** and may result in **fire.**	[1] [1] Note: overheat itself is not a danger. It is what overheating will result in that is a danger.
	(d)	**(i)** I = $\frac{Q}{t} = \frac{\mathbf{12400}}{\mathbf{10 \times 60}}$ = **21 A** (2 s.f.)	[1] – working Award only one mark for 12400/10 [1] - ans + unit + sf
		(ii) R = $\frac{P}{I^2}$ = $\frac{5\,000}{20.7^2}$ or $\frac{5\,000}{21^2}$ = **12 Ω** or 11 Ω (2 s.f.)	[1] allow ecf from (d) (i) [1] ans + unit + sf
		Total mark for Q 12	[**10**]

Q		Answers	Marks/Remarks
13	**(a)**	The GM tube is registering **background** count from sources such as rocks, radon gas in the air, food and drink high in potassium, medical X-rays, building materials and waste product from nuclear power station.	[1] Key word: **background radiation.** No need to cite source.
	(b)(i)	**High energy / fast moving electrons**	[1]
	(b)(ii)	Number of half-lives = 40/10 = 4 Fraction = $\frac{1}{2^4}$ = $\frac{1}{16}$	 [1] Accept **0.0625**
	(b)(iii)	Purpose: **To direct the beta particles through the magnet / direct a narrow path through the magnet.** Minimum thickness: **a few mm**, e.g. 2 mm	[1] [1]
	(b)(iv)	**South** Pole	[1]
	(b)(v)	**Place the plates horizontally between the Aluminum sheet and the detector.** **The top plate is connected to negative end of d.c supply and the bottom plate connected to the positive end.**	[1] [1]
	(b)(vi)	The reading will be greatly **reduced** or **only registers the background count**. Beam of alpha particles has a **range of a few cm in air**. Or: Beam of alpha particles is **deflected upwards** as it is positively charged.	[1] [1]
		Total mark for Q 13	[**10**]