Name: ..... Register no: ..... Class: .....

NGEE ANN SECONDARY SCHOOL O

SECONDARY 4 PRELIMINARY EXAMINATION

PHYSICS **6091/01**

PAPER 1 **27 August 2024**

1 hour

Additional Materials: Optical Answer Sheet (OAS)

Instructions to Candidates

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number at the top of this cover page.

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

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.
Where necessary, take the gravitational field strength, g, to be 10 N/kg.

Checked by student: _____ Date: _____

This document consists of **18** printed pages and **0** blank page.

Paper 1 (Multiple Choice Questions)

1 Which pair of units measure the same quantity?

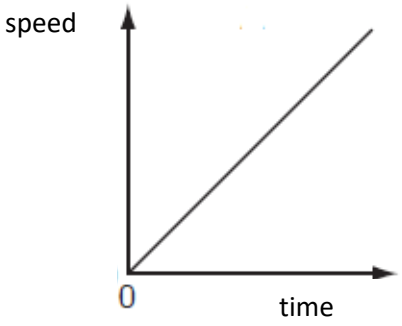
A km/h and kg/m^3 **B** N/m^3 and Pa **C** V and J/C **D** W and J

2 Which of the following gives a pair of vector quantities?

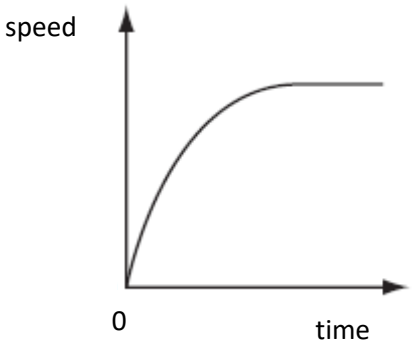
A mass, acceleration
B moment, displacement
C temperature, force
D power, energy

3 Which graph shows correctly the motion of a feather falling from a height?

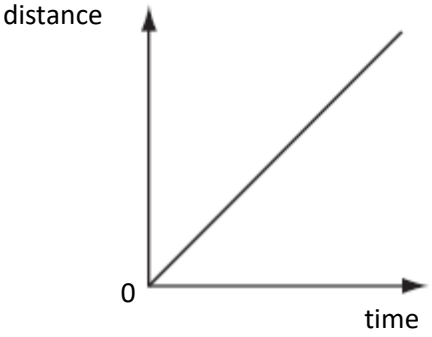
A



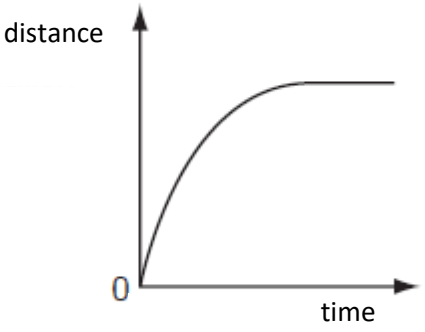
B



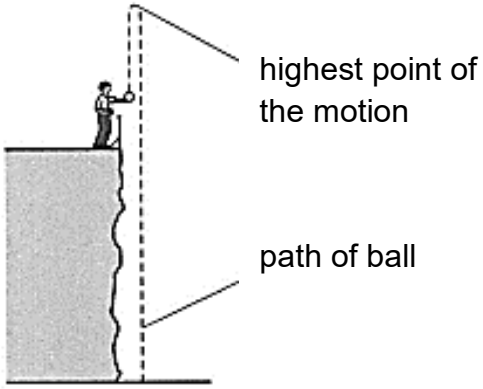
C



D



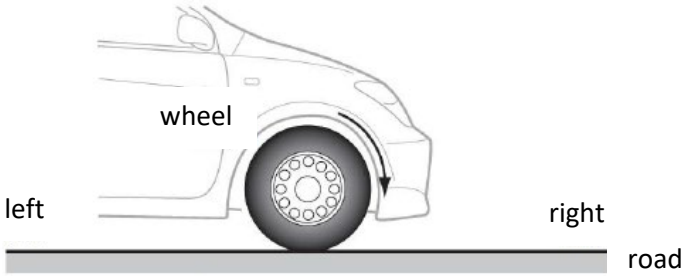
4 A student stands near the edge of a cliff. He throws the ball upwards.



What is the acceleration of the ball as the ball moves upwards and at the highest point of its motion?

	as the ball moves upwards	at the highest point of motion
A	10 m/s^2 downwards	0
B	10 m/s^2 upwards	0
C	10 m/s^2 downwards	10 m/s^2 upwards
D	10 m/s^2 downwards	10 m/s^2 downwards

5 The front wheel of a car is turned in a clockwise direction by the engine as the car moves towards the right. There is a force of friction between the wheel and the road.



What are the directions of the frictional forces on the wheel of the car and on the road?

	frictional force on wheel	frictional force on road
A	to the left	to the left
B	to the left	to the right
C	to the right	to the left
D	to the right	to the right

6 A rocket of mass 1000 kg is descending downwards upon the surface of the Moon where the gravitational field strength is 1.67 N/kg.

If the acceleration of the rocket is – 5.0 m/s^2, what is the upward force exerted by the rocket engine?

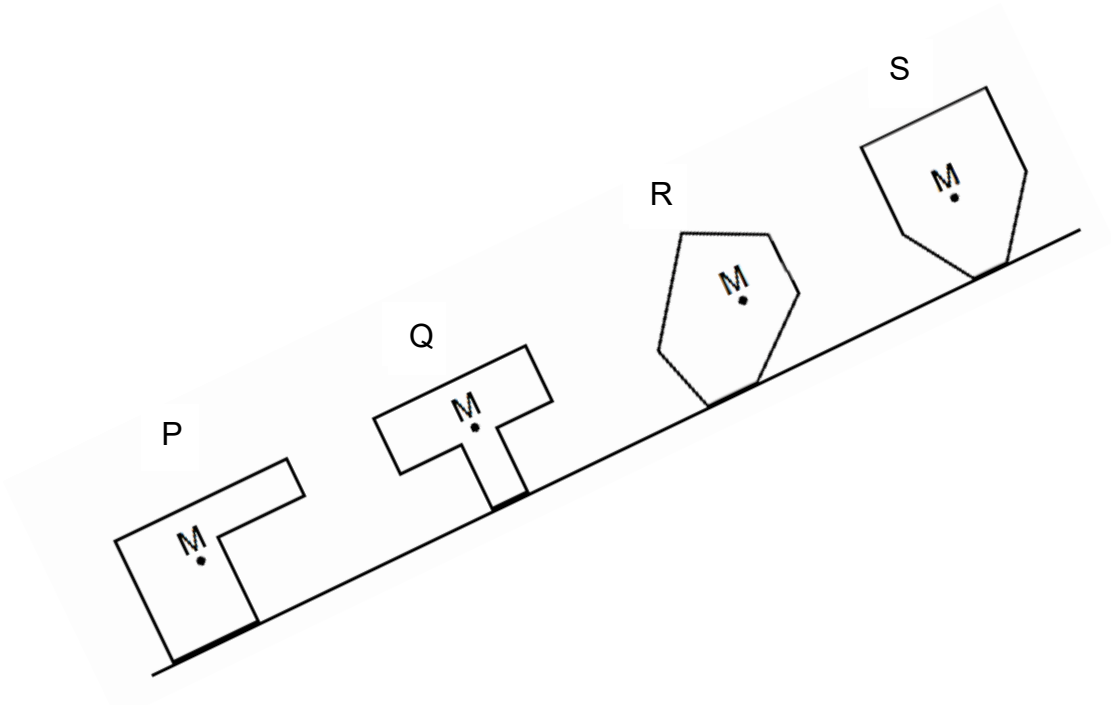
A 2500 N **B** 6670 N **C** 7500 N **D** 10 000 N

7 A thin-walled bottle of mass 20 g and volume 100 cm^3 is to be filled with sand.

What is the **maximum** mass of sand which may be **added** into the bottle so that it can float freely in seawater which has a density of 1.1 g/cm^3 ?

A 20 g **B** 30 g **C** 90 g **D** 110 g

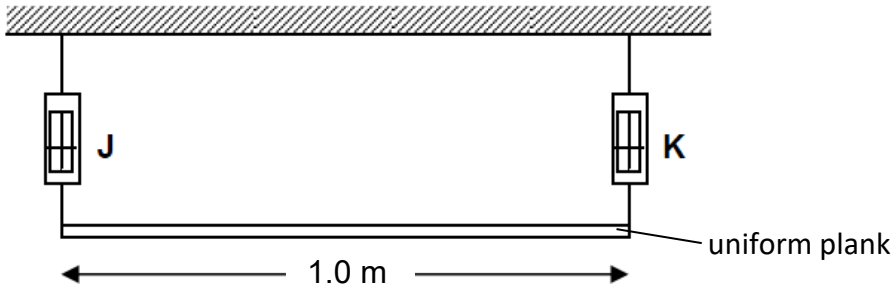
8 The diagram shows four objects P, Q, R and S placed on a sloping surface. The centre of gravity of each object is marked M.



Which of these objects will topple when placed on the slope?

A P, Q and R **B** Q, R and S **C** Q and R **D** Q and S

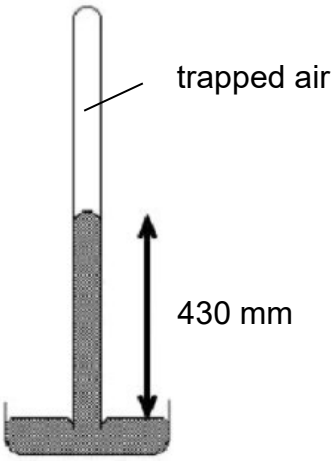
9 A uniform plank of length 1.0 m is supported by two spring balances **J** and **K**. The readings of **J** and **K** are both 150 N.



When **J** is moved 0.25 m towards **K**, what are the new readings shown on **J** and **K**?

	Reading on **J**	Reading on **K**
A	200 N	100 N
B	200 N	150 N
C	150 N	200 N
D	100 N	200 N

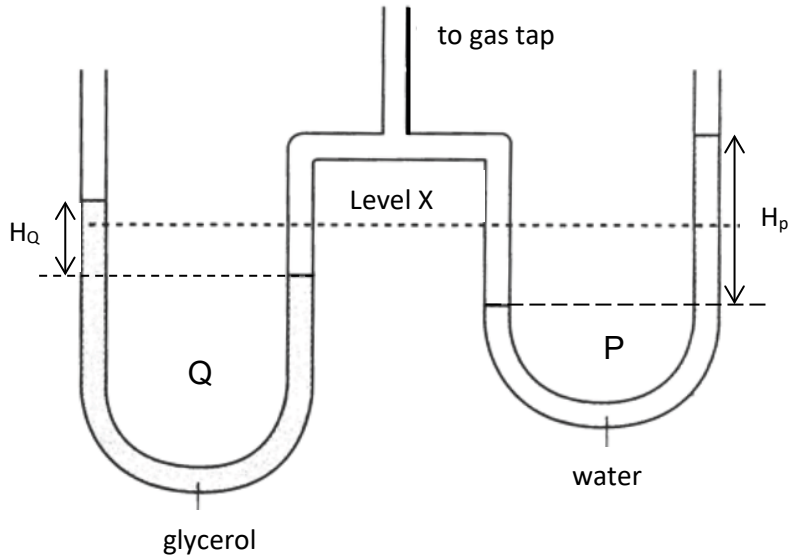
10 A barometer is incorrectly set up such that some air is trapped above the mercury column.



Given that the atmospheric pressure is equivalent to 760 mmHg, and the density of mercury is 13560 kg/m^3, what is the pressure of the trapped air?

A 14 kPa
B 45 kPa
C 58 kPa
D 103 kPa

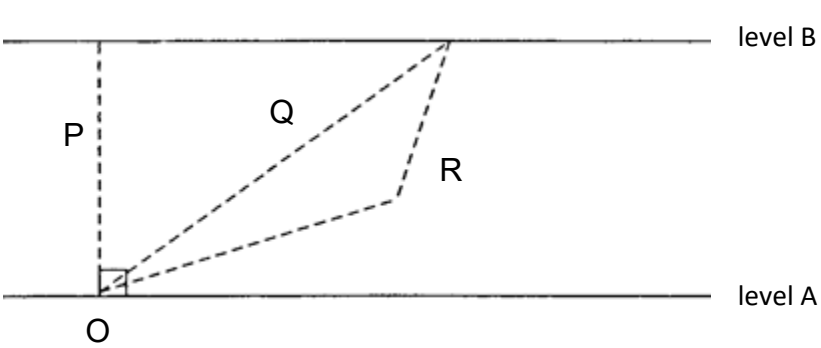
11 The diagram shows a manometer used to measure the pressure of gas. The tube P contains water and the tube Q contains glycerol. The liquid levels in the tubes were originally at X. The liquid levels in both tubes changed when the gas tap was turned on. H_Q and H_P are the height differences in tubes Q and P respectively.



What of the following explains why the height difference H_Q is less than H_P?

A There is more air flowing into tube P than tube Q.
B The liquid in Q is denser than water.
C Pressure of gas exerted in P is greater than the pressure of gas exerted in Q.
D There is more liquid in tube Q than water in tube P.

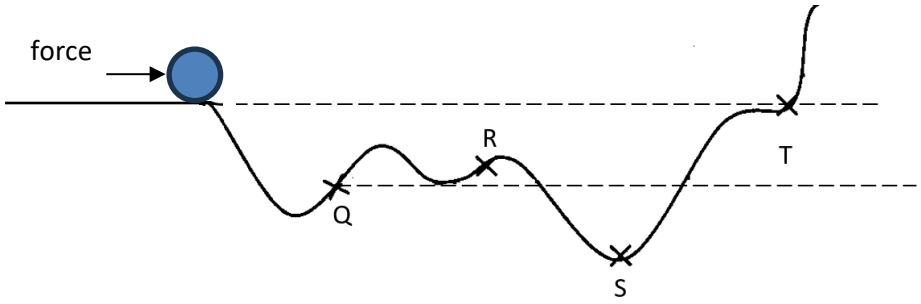
12 A box, O, can be lifted from level A to a higher level B along one of the three paths as shown in the diagram.



Which statement about the amount of work done in the vertical direction is correct?

A It is the greatest along path P.
B It is the greatest along path Q.
C It is the greatest along path R.
D It is the same along all the three paths.

13 A force is applied to a marble. The marble rolls along a frictionless path, starting from P.

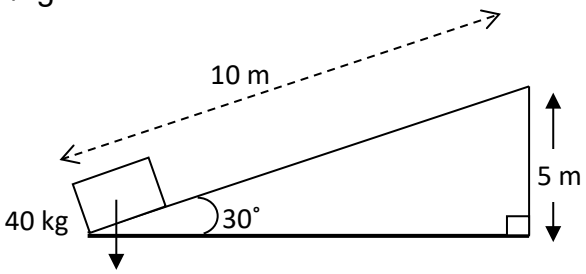


Which of the following statements is/are correct?

I The marble has maximum energy in the kinetic store at S.
II Energy is transferred mechanically through work done to the marble.
III The marble will roll up to a maximum height at T and return back to P.

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

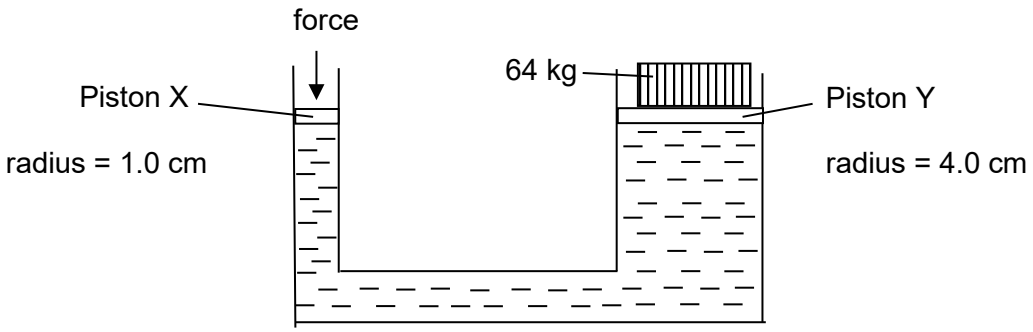
14 A girl pulls a 40 kg block up a smooth 30° inclined plane. The inclined plane is 10 m long and the block is pulled from the bottom of the inclined plane to the top in 40 s. Take *g* to be 10 N/kg.



What is the average useful power output of the girl?

A 5 W **B** 10 W **C** 50 W **D** 100 W

15 A hydraulic press consists of two circular pistons X and Y. A block of mass 64 kg is placed on Piston Y. The radius of Piston X is 1.0 cm and that of Piston Y is 4.0 cm.



What is the upward force required to raise the block?

A 5.0 N **B** 32 N **C** 40 N **D** 50 N

16 In a Brownian motion experiment involving smoke particles in air, heavy particles settle quickly but very small particles remain suspended for long periods of time.

Which statement explains why the very small smoke particles do **not** settle?

A Air pressure has a greater effect on very small smoke particles.
B The Earth's gravitational field does not act on very small smoke particles.
C Molecular bombardment by air molecules keeps the very small smoke particles suspended.
D The small smoke particles have the same density as the air.

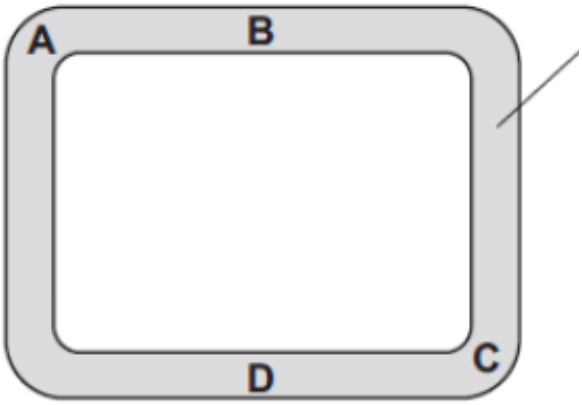
17 Which of the following statement(s) is/are true for an object being heated?

I Its temperature always increases.
II Energy in the internal store always increases.
III Energy in the internal and potential stores cannot increase at the same time.

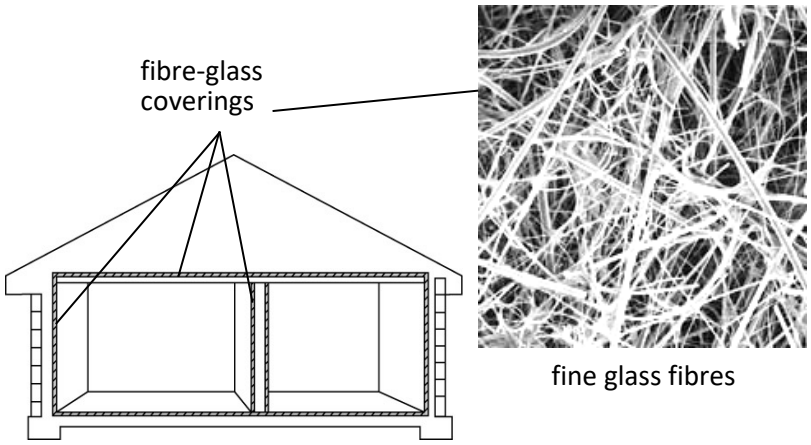
A II only **B** I and II only **C** II and III only **D** All of the above

18 A heating element is to be placed in a narrow sealed tube of liquid.

Which would be the best position, **A**, **B**, **C** or **D**, to place the heating element in order to obtain the best circulation of the liquid throughout the tube?



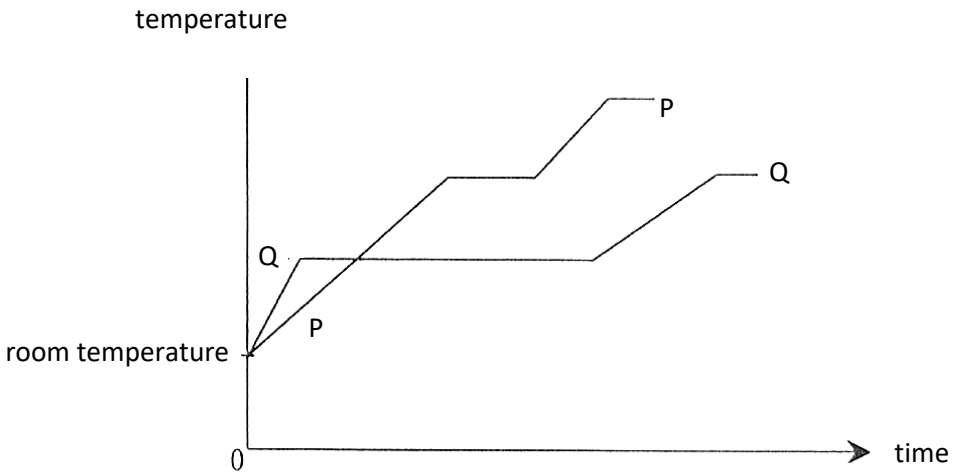
19 Fibre-glass coverings laid on the floor, walls and ceiling of a house can greatly reduce the rate of heat lost to the surroundings. Fibre-glass consists of a large amount of fine glass fibres.



Which of the following statements is not a reason why fibre-glass for thermal insulation?

A Fibre-glass reflects radiation.
B Fibre-glass reduces convection currents.
C The fibre-glass with trapped air are very poor conductors of heat.
D Fibre-glass increases surface area.

20 The graph shows the variation in temperature of two solid objects, P and Q, of equal masses when they are separately heated by identical heaters.



Which of the following deductions is correct?

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

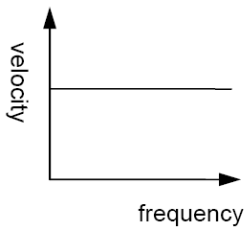
21 The table below shows some uses of electromagnetic waves.

Which of the following row is **incorrect**?

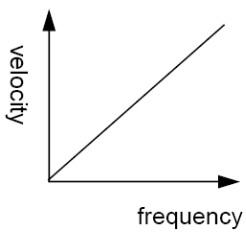
	electromagnetic waves	use
A	infrared rays	intruder alarm
B	gamma rays	treating cancer
C	radio waves	communication
D	ultraviolet radiation	scanning fetus

22 Which graph correctly shows how the velocity of electromagnetic waves is related to its frequency in a vacuum?

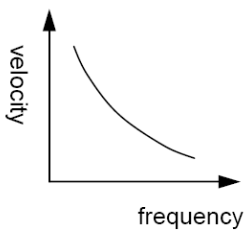
A



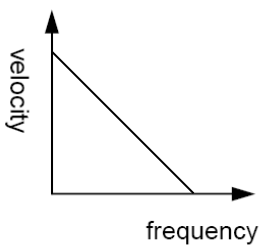
B



C

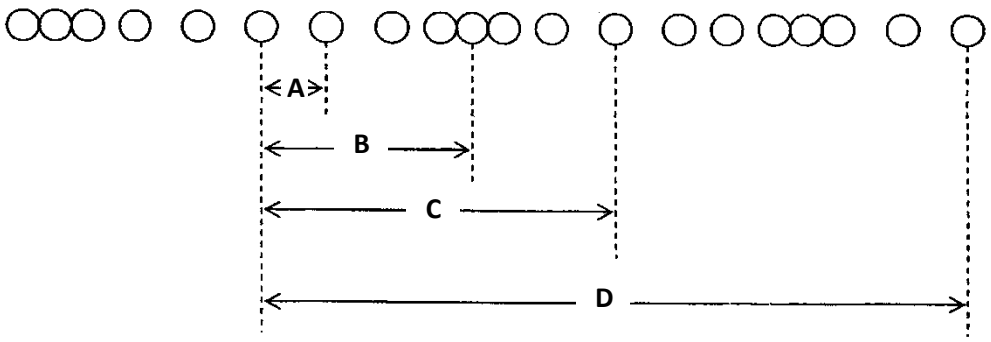


D

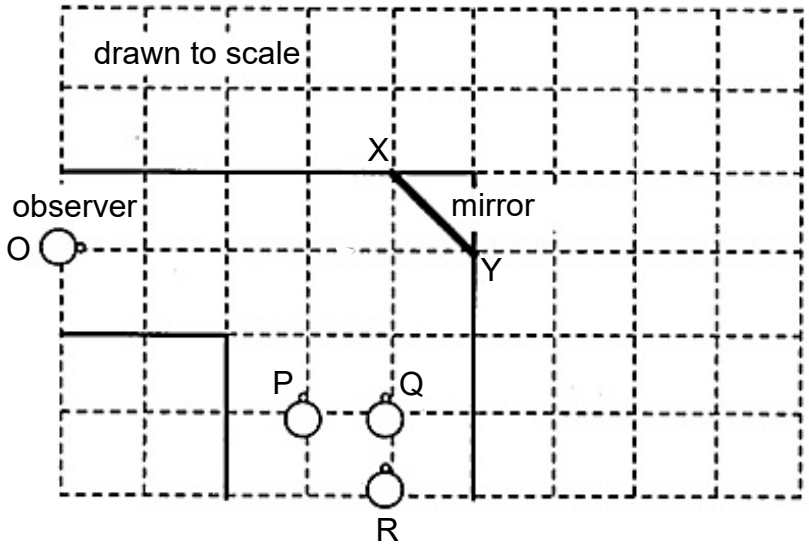


23 The diagram below represents the position of air molecules in a sound wave.

Which distance represents one wavelength of the wave?



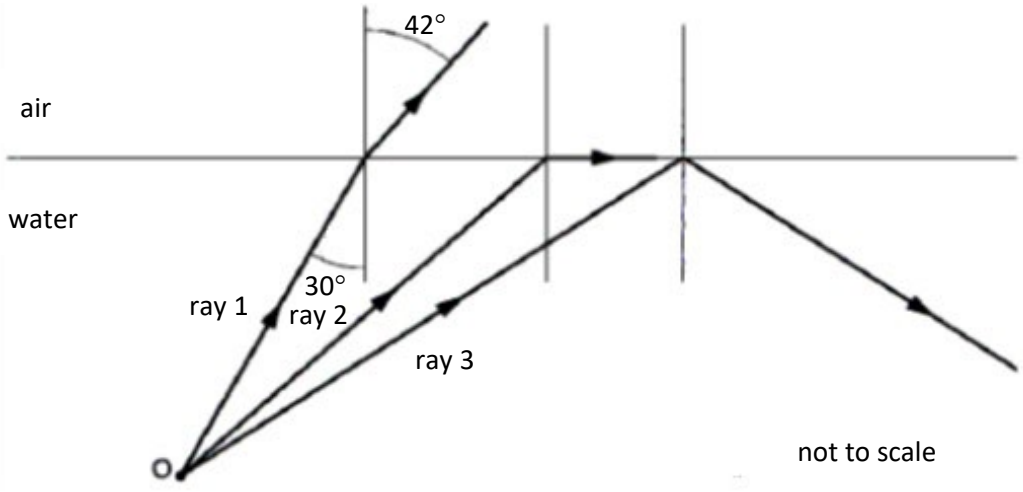
24 A plane mirror XY is positioned at the corner of a road as shown in the diagram.



Which man, P, Q or R can be seen by the observer O through the mirror?

A P and Q only **B** P and R only **C** Q and R only **D** P, Q and R

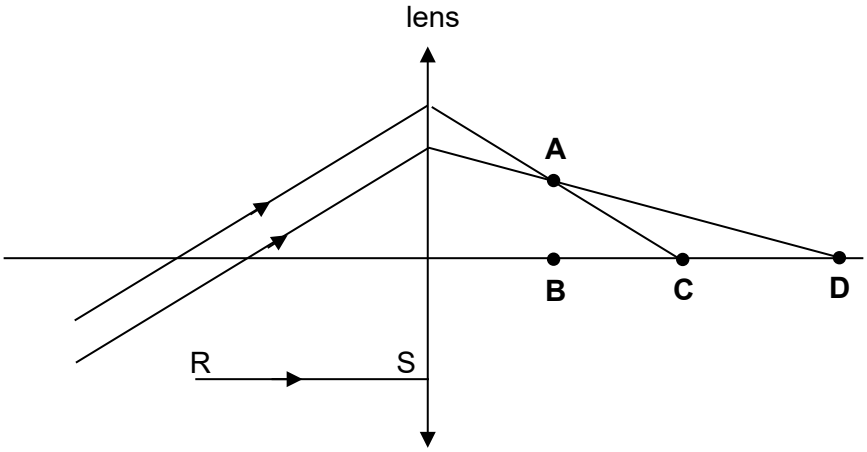
25 The diagram below shows light travelling from water and undergoing refraction.



Which the following shows correctly the angle of incidence of rays 2 and 3?

	ray 2	ray 3
A	48°	49°
B	42°	48°
C	48°	45°
D	50°	48°

26 The diagram shows two parallel rays of light passing through a converging lens. Through which point will the light ray RS pass after passing through the lens?

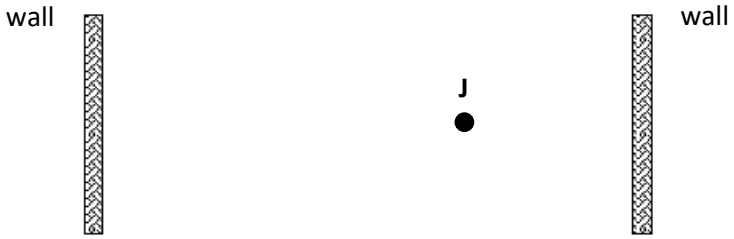


27 A ray of light passes from glass to air. In glass, the speed of light is 1.8×10^8 m/s.

What is the critical angle for light passing from glass to air?

A 18° **B** 30° **C** 37° **D** 42°

28 James stands at a point J between two parallel walls as shown in the diagram below and fires a pistol.



He hears the first echo after 0.40 s and the second echo after 1.0 s.

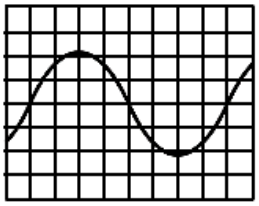
How long after firing the pistol will James hear the third echo?

A 0.80 s **B** 1.4 s **C** 2.0 s **D** 2.8 s

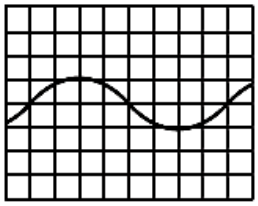
29 The diagrams show oscilloscope traces of sounds picked up by microphones.

Which trace shows the sound that is both soft and low-pitched?

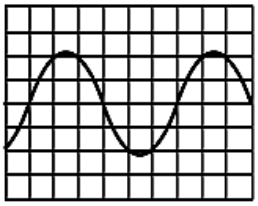
A



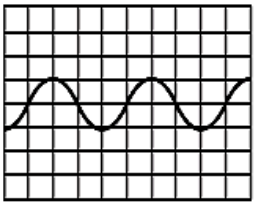
B



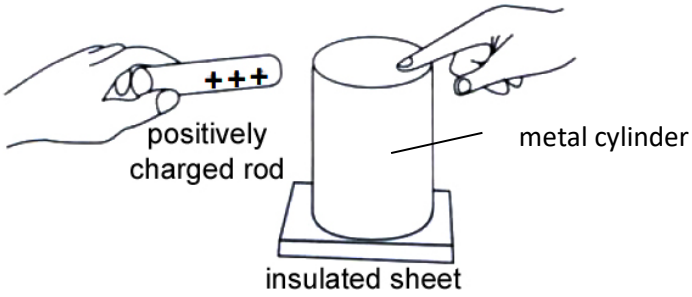
C



D



30 Jessie tries to charge a metal cylinder in the following steps:

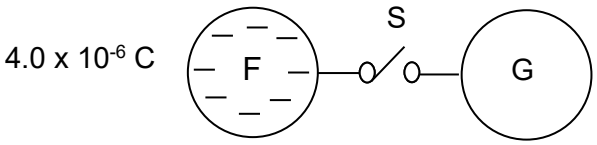


Step 1. Bring a positively charged rod near the cylinder.
Step 2. Touch the cylinder with a finger.
Step 3. Remove the positively charged rod.
Step 4. Remove the finger.

After performing these steps, what will happen to the cylinder?

A The cylinder is neutral.
B The cylinder is positively charged.
C The cylinder is negatively charged.
D The cylinder is positively charged on one side and negatively charged on the other.

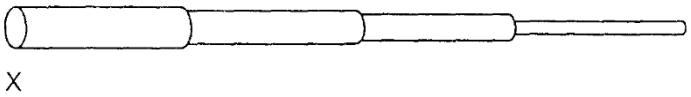
31 F and G are two identical conducting spheres. F carries a negative charge of 4.0×10^{-6} C and G is uncharged. The two spheres are linked by a switch S and conducting wires. The charges flow for 1 m s for F and G to have the same amount of negative charge.



How much is the average current in the wire when switch S is closed?

A 1.0×10^{-9} A **B** 2.0×10^{-9} A **C** 2.0×10^{-3} A **D** 4.0×10^{-3} A

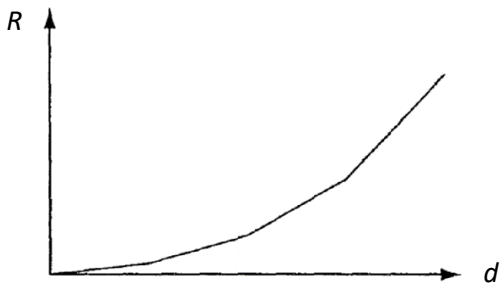
32 A composite wire is made by connecting in series four uniform wires made of the same material but having different diameters.



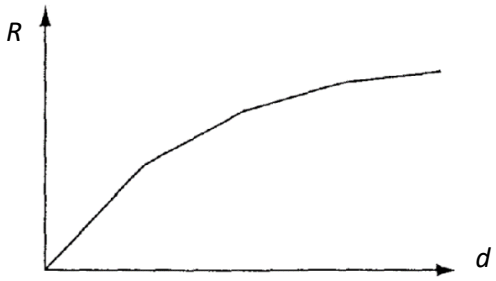
The resistance *R* of this composite wire is measured between X and other points on the wire at distances *d* from X.

Which graph best represents the relationship between *R* and *d*?

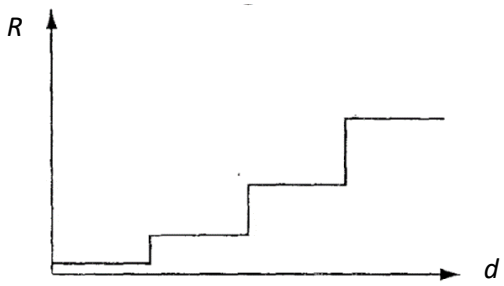
A



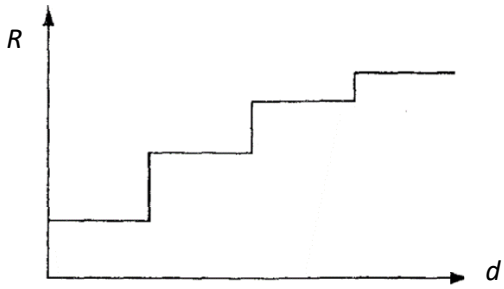
B



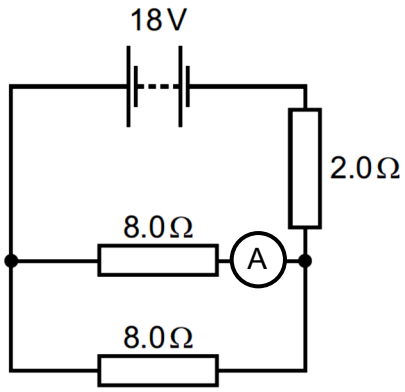
C



D



33 The following circuit is set up.



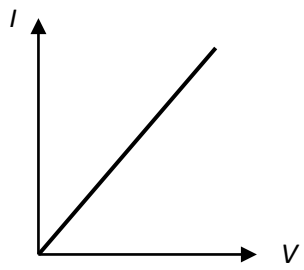
What is the reading on the ammeter?

A 0.33 A **B** 0.9 A **C** 1.5 A **D** 3.0 A

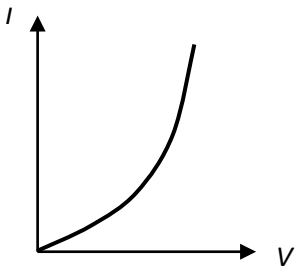
34 A filament wire gets heated when currents flow through it.

Which graph shows the correct *I*-*V* graph of a heated filament wire?

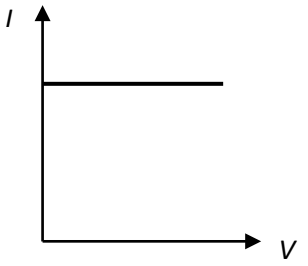
A



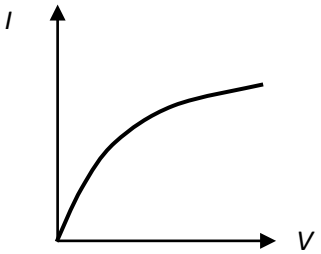
B



C



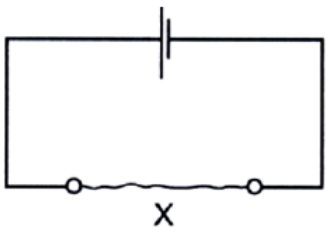
D



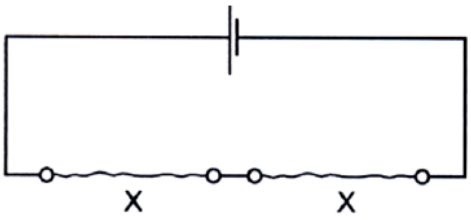
35 The circuit diagrams show identical pieces of resistance wire X connected to the same cell in different ways.

In which circuit will the cell lose its energy the fastest?

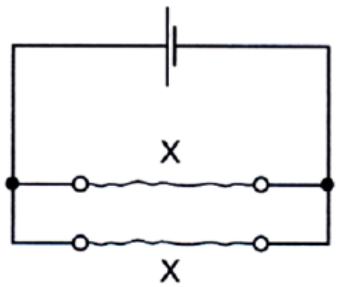
A



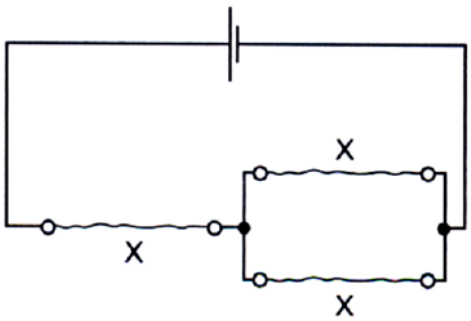
B



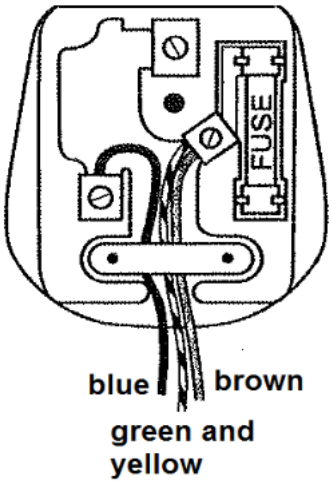
C



D



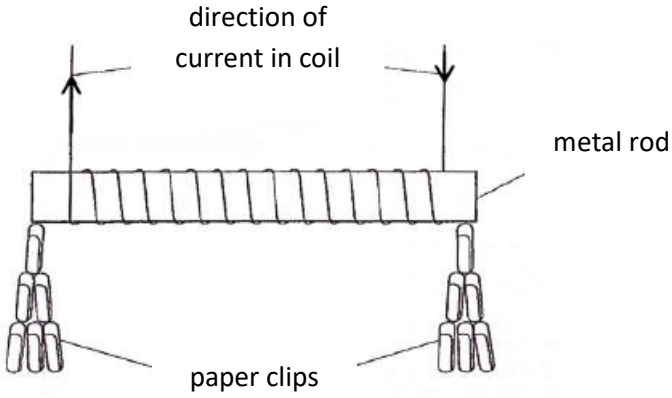
36 The diagram below shows the plug of an old electric iron wired wrongly.



What happens when the electric iron is plugged into the electrical socket?

A The metal case becomes live.
B The electric iron catches fire.
C The electric iron does not work.
D The fuse in the plug blows.

37 Four metal rods **A**, **B**, **C** and **D** are placed, in turn, inside a coil of insulated copper wire.

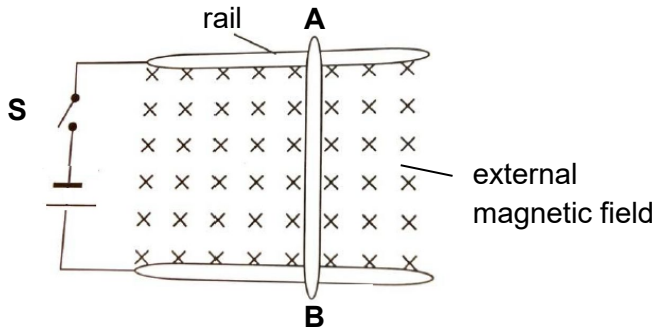


Which rod would be the most suitable to use for the core of a coil in a circuit breaker?

metal rod	number of paper clips picked up when there is a current in a coil	number of paper clips still attracted when the current in the coil is switched off
A	1	0
B	6	6
C	6	0
D	3	1

38 A metal rod **AB** is placed on two smooth horizontal metal rails on the bench.

The rail and the rod are subjected to an external magnetic field. The top view of the setup is shown below.



When switch **S** is closed, in which direction will rod **AB** move?

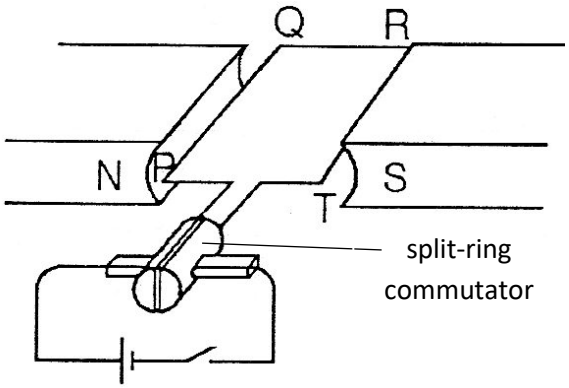
A into the page

B out the page

C to the right of the page

D to the left of the page

39 The diagram shows a simple d.c. electric motor.

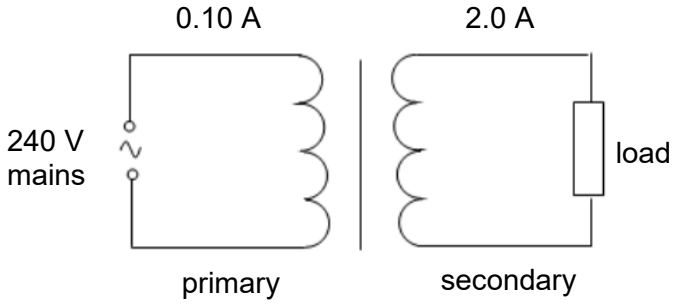


When the switch is closed, which of the following statements are correct?

I A current will flow round the coil in the direction PQRT.
II The coil will rotate in a clockwise direction when viewed from side PT.
III The split-ring commutator reverses the current after every complete cycle.

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

40 An ideal transformer supplies power to a load. In order to deliver a current of 2.0 A to the load, the primary coil draws a current of 0.10 A from the 240 V mains.



Which set of values is correct?

	number of turns on the primary coil	number of turns on secondary coil	p.d. across load / V
A	300	6000	12
B	6000	300	12
C	300	6000	4800
D	6000	300	400

END OF PAPER

Name: …….. Index no: …… Class: ……

NGEE ANN SECONDARY SCHOOL

O

PRELIMINARY EXAMINATION

PHYSICS **6091/02**

PAPER 2 **23 August 2024**

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

Section A

Answer **all** questions in the spaces provided.

Section B

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

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.

FOR EXAMINER'S USE	
Section A	/ 70
Section B	/ 10
Total	/ 80

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

Checked by student: _____ Date: _____

This document consists of **20** printed pages (including this cover page) and **0** blank page.

Section A
[70 marks]

Answer **all** the questions.

1 A police car is stationary at a junction.

At time = 0 s, a motorcycle, which is speeding at a constant speed of 25 m / s, drives past the police car. After 1.0 s, the police car starts to give chase and moves with a constant acceleration of 5.0 m / s^2. Both vehicles are travelling along a straight road.

(a) Explain what is meant by " constant acceleration of 5.0 m / s^2 ".

……

……[1]

(b) On Fig. 1.1, sketch the velocity-time graph of the **police car** for the first 10.0 s. [2]

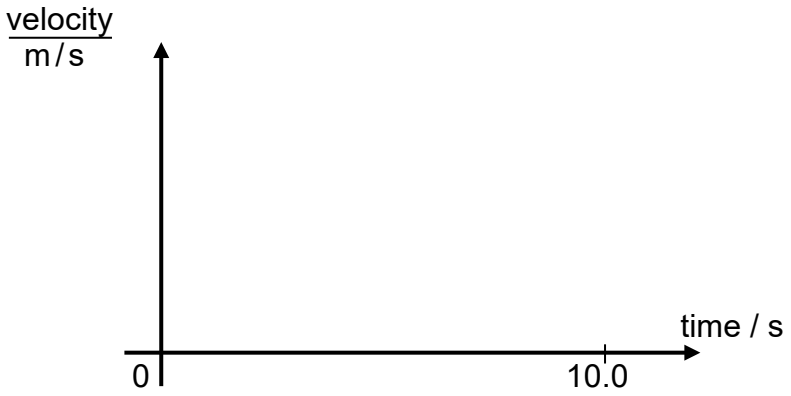


Fig. 1.1

(c) Calculate the distance travelled by the **motorcycle** for a duration of 10.0 s.

distance travelled = …… [1]

(d) Explain how Fig. 1.1 shows that the police car will not be able to overtake the motorcycle.

……

……

……

……[2]

[Total: 6]

2 Fig. 2.1 shows an archer about to shoot an arrow.

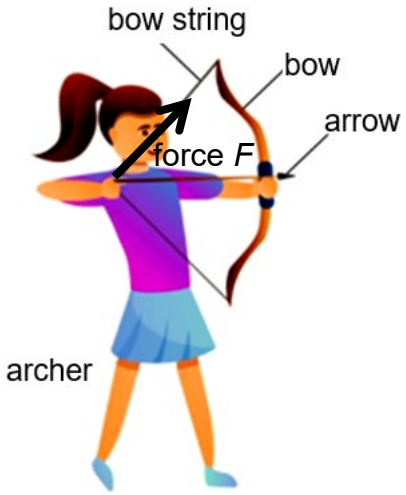


Fig. 2.1

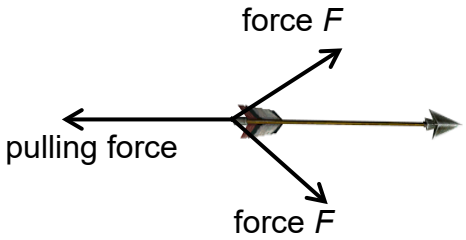


Fig. 2.2

(a) Force *F* acts along the bow string.

Name the force *F*.

Force *F* : ……..……...[1]

(b) Fig 2.2 shows the arrow at rest with forces *F* and a pulling force acting on it.

The magnitude of force *F* is 25 N and both forces *F* are making an angle to 45^{o} from the horizontal.

Using a scale drawing, determine the magnitude of the pulling force.

pulling force = …… [3]

(c) Explain, using forces, the motion of the arrow when the archer releases the arrow.

……

……

……

……

……[2]

(d) Describe fully the other force that forms a pair of action and reaction force with the pulling force.

……

……

……[2]

[Total: 8]

3 Fig. 3.1 shows the side view of a uniform table that folds upwards against a wall when not in use.

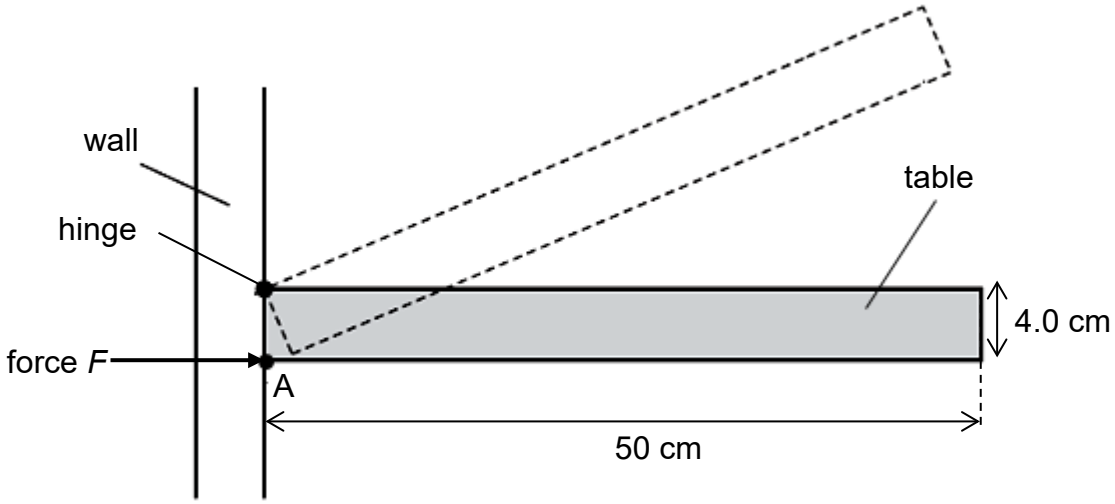


Fig. 3.1 (not to scale)

When it is horizontal, the table is supported by a hinge. The wall exerts a force *F* on the table at point A.

(a) Define *moment* due to a force.

……

……

……[1]

(b) The weight of the table is 55 N.

By taking moment about the hinge, determine the force *F* when the table is horizontal.

force *F* = …… [2]

[Total: 3]

4 Fig. 4.1 shows a filament lamp placed near to a cylinder which has a non-movable piston. The interior surface of the cylinder is coated black.

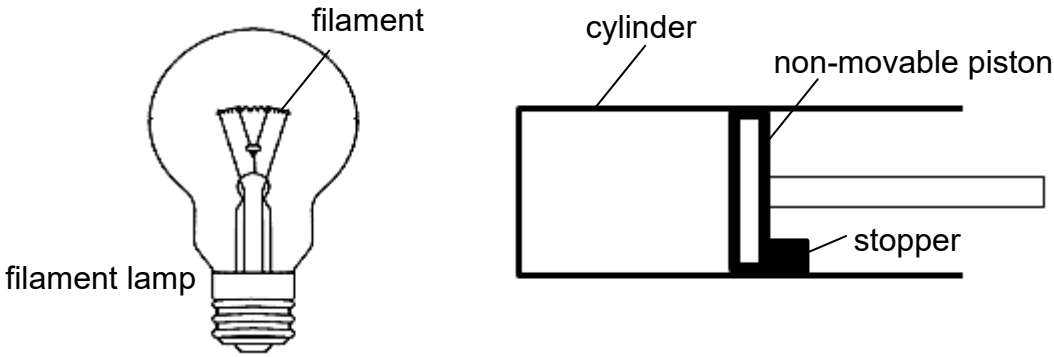


Fig. 4.1

When the filament lamp is switched on, the exterior surface of the cylinder is warmed up.

(a) State two components of electromagnetic spectrum emitted by the filament in the lamp.

……[1]

(b) Explain how the feature of the cylinder helps the transfer of energy to be more efficient.

……

……[1]

(c) Using ideas about molecules, explain what happens to the pressure of the gas in the cylinder when the lamp is switched on for a period of time.

……

……

……

……

……

……

……[3]

[Total: 5]

5 In an experiment to measure the specific heat capacity of water, an electric heater supplies energy to 72 g of water in a glass beaker at a constant rate. The temperature of the water is measured at regular intervals of time.

The surrounding temperature is kept constant at 30 °C. The energy transferred to the glass beaker can be considered as negligible.

Fig. 5.1 shows how the relationship of temperature changes with time *t*.

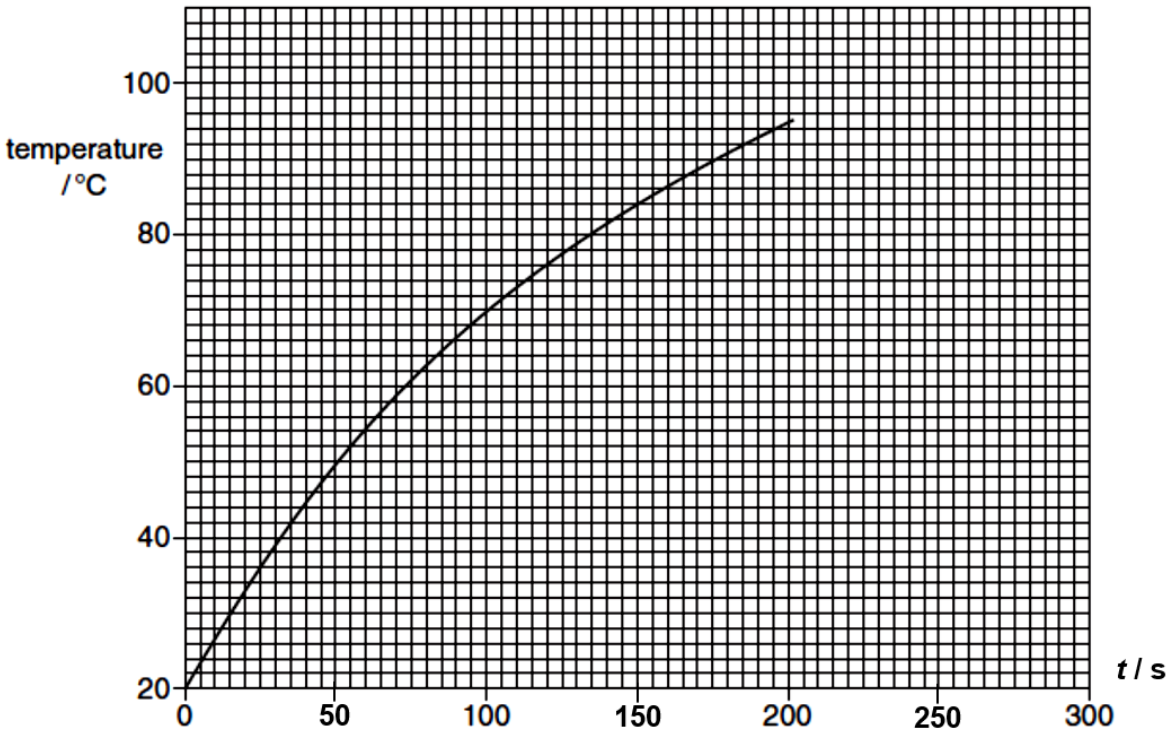


Fig. 5.1

(a) State a reason why the temperature of the water does not increase linearly with time.

……

……[1]

(b) The heater supplies 8000 J energy to the water and its temperature changes from 20 °C to 42 °C. The specific heat capacity of the water is 4.2 J / (g °C).

(i) Calculate the energy transferred to the water to change its temperature from 20 °C to 42 °C.

Leave your answer to an appropriate number of significant figures.

energy = ……[2]

(ii) Using your answer in **(b)(i)**, determine the overall efficiency of the electric heater.

efficiency = ……..[1]

(c) The temperature of water reaches 100 °C and boiling occurs.

State how the components of the internal energy of water will change, if any, **during boiling**.

component	change, if any
energy in internal kinetic store	
energy in internal potential store	

[2]

[Total: 6]

6 Fig. 6.1 shows a circuit that contains a 24 V direct current power supply, a negative temperature coefficient (NTC) thermistor, a voltmeter and a device A. The maximum resistance of device A is 90 Ω.

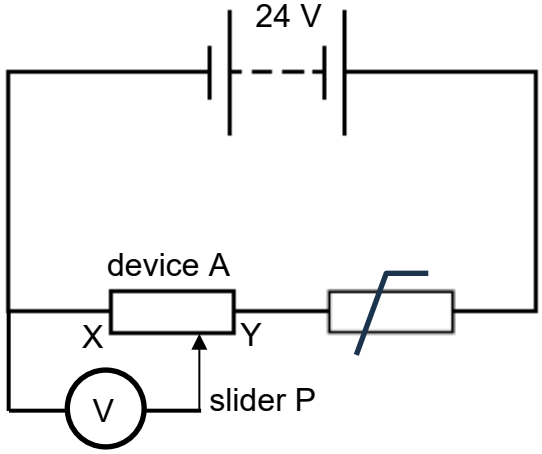


Fig. 6.1

(a) State the name of the device A.

……..[1]

(b) Explain at which position, X or Y, should slider P be for the largest voltmeter reading.

……...

……

……

……

……[2]

(c) The thermistor has a resistance ranging from 30 Ω to 60 Ω.

Slider P is at the midpoint of X and Y.

Calculate the voltmeter reading when the circuit is exposed to low temperature.

potential difference = ……[2]

[Total: 5]

7 Fig. 7.1 shows a magnetic relay that uses circuit X to switch on or off circuit Y. When switch S is closed, circuit Y will be closed. When switch S is opened, circuit Y will be opened.

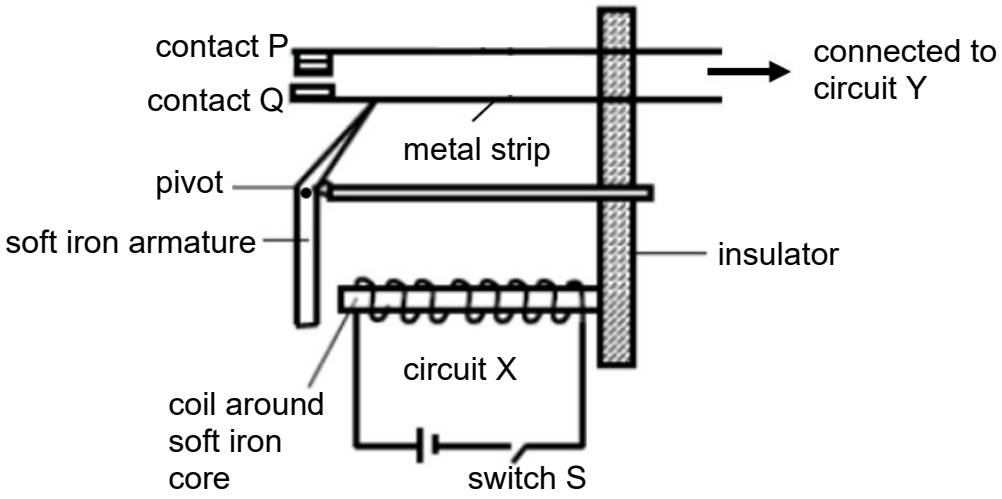


Fig 7.1

(a) Describe how circuit Y will be closed when the switch S is closed.

……

……

……

……

……

……

……

……[3]

(b) The soft iron core is replaced with a steel bar.

Explain what effect this has on the ability of circuit X to switch on and off circuit Y.

……

……

……

……

……[2]

[Total: 5]

8 Fig. 8.1 shows coils P and Q are placed near to each other. Coil P is connected to a direct current supply and a switch, and coil Q is connected to device X.

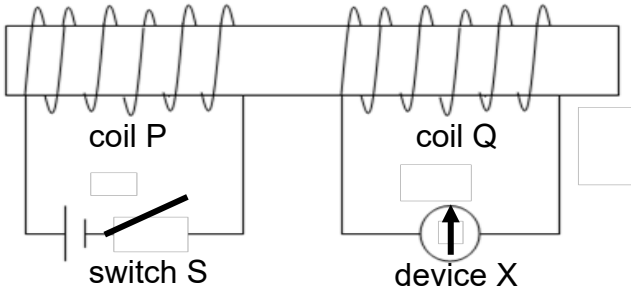


Fig 8.1

(a) Name the device X.

……,.[1]

(b) Explain how an electromotive force (e.m.f) is induced in coil Q when switch S is just closed.

……

……

……

……

……

……[2]

(c) State the polarity of the right end of coil P when the switch S is closed.

……...[1]

(d) Explain the direction of induced current flowing through device X when switch S is just closed.

……

……

……

……

……

……[2]

[Total: 6]

9 **(a)** Atoms contain protons, neutrons and electrons.

Identify the particle(s) that

(i) has a much smaller mass than the others.

……[1]

(ii) are lost from the nucleus during α-particle emission.

……[1]

(b) Fig. 9.1 shows a gamma ray entering a magnetic field.

Fig. 9.1

On Fig. 9.1, sketch the path taken by the gamma ray as it travels through the magnetic field. [1]

(c) Some atoms that undergo radioactive decay have a half-life of 6 hours. The count rate near a sample of these atoms is initially 838 counts / minute.

Background radiation near the sample is 18 counts / minute.

(i) State what is meant by *background radiation*.

……

……[1]

(ii) The equipment is left undisturbed for 12 hours.

Calculate the count rate **due to the sample of atoms alone** after this time.

count rate = ……..[2]

[Total: 6]

10 Fig. 10.1 shows a hydroelectric power station. A large reservoir of water is trapped behind a dam. When the trap opens, the water at the bottom of the reservoir rushes through the penstock and turn the turbine to generate electricity.

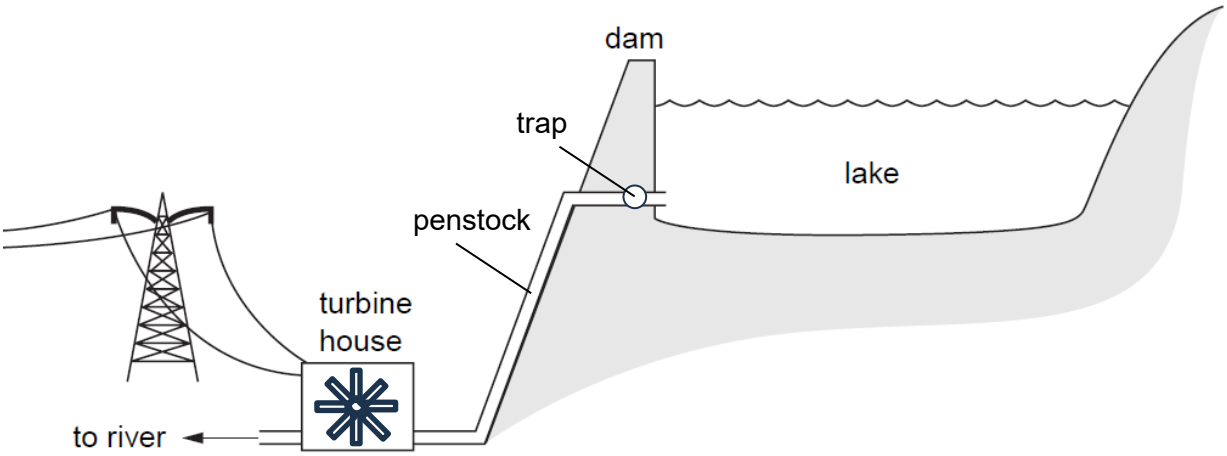


Fig. 10.1

(a) The total depth of water in the reservoir is 50.0 m. A fish is 20.0 m vertically from the base of the reservoir. The density of the water is 1010 kg / m^3. Take gravitational field strength to be 10 N / kg.

Calculate the water pressure exerted on the fish.

total pressure = ……[2]

(b) Describe the energy transfer that takes place in order to generate electricity.

……

……

……

……

……

……[3]

(c) State the electrical device that is needed to increase the voltage of the electricity before leaving the turbine house.

……[1]

Fig. 10.2 shows the relationship of the electrical power output with the speed of the water in a particular hydroelectric power station.

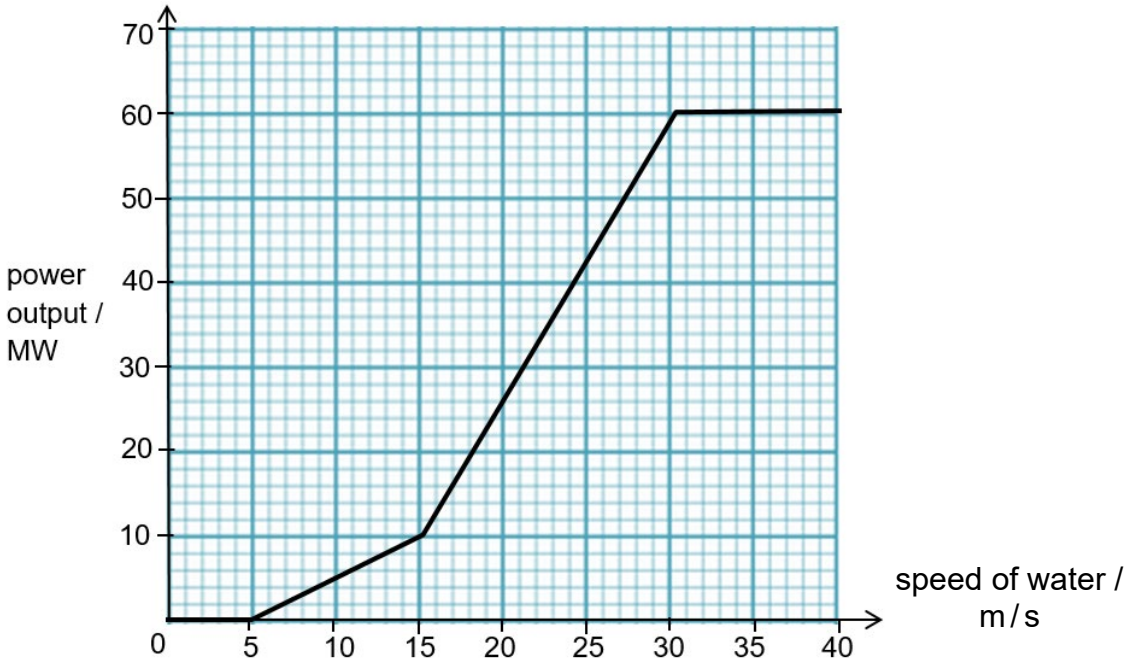


Fig. 10.2

(d) Table 10.3 shows the variation of the average water speed through the dam for a duration of two minutes.

time interval	average water speed / m / s
0 to 1.0 min	35
1.0 min to 2.0 min	20

Table 10.3

Using data from Fig. 10.2 and Table 10.3, calculate the amount of energy that can be generated by the power station for this period of 2.0 minutes. Give your answer in joules and in standard form.

energy = ……[3]

(e) Using the data in Table 10.3, suggest one possible reason to explain why the actual energy generated is less than the amount calculated in **(d)**.

……[1]

[Total: 10]

11 Fig. 11.1 shows a hand swinging a rope vertically up and down. The end of the rope is tied to a ring which can move up and down along the metal vertical pole.

P and Q are particles in the rope.

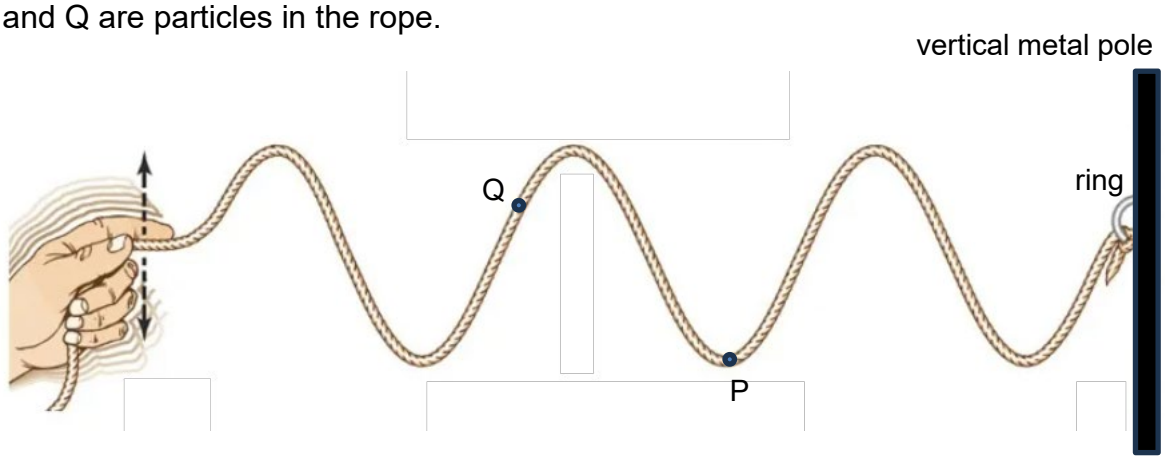


Fig. 11.1

(a) State and explain the type of the wave produced by the hand.

……

……

……

……

……[2]

(b) Describe how particle Q will move when the wave travels a distance of one wavelength.

……

……

……

……

……

……[2]

(c) Fig 11.1 shows particle P is at the lowest point.

The frequency of the wave generated by rope is 2.0 Hz.

(i) State the shortest time taken required for particle P to reach the highest point.

shortest time taken = ……[1]

(ii) The speed of the wave is 9.0 km / h.

Calculate the wavelength of the wave generated by the rope.

wavelength = ……[2]

(d) Sound is heard when the ring moves along the vertical metal pole.

Explain how the metal pole produce sound waves in the air and how these waves are transmitted through the air.

……

……

……

……

……

……

……

……[3]

[Total: 10]

Section B
[10 marks]

Answer **one** question from this section.

12 Fig. 12.1 shows an electrical kettle containing water. The kettle has a metal outer casing and is connected to a power socket.

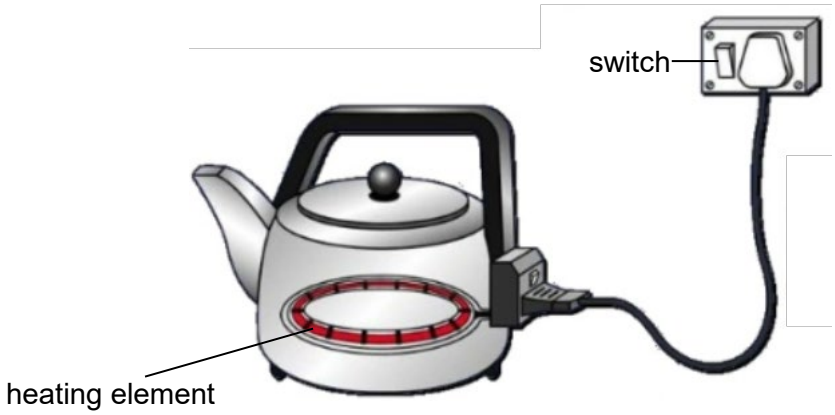


Fig. 12.1

(a) Describe, using ideas about energy transfer, how the electrical kettle heats up the water when the switch is closed.

……

……

……

……

……

……

……

……

……

……[3]

(b) Suggest a suitable material for the heating element.

State one reason to support your choice of material.

Material: ……

Reason: ……[1]

(c) State and explain which wire the switch should be placed along.

……

……

……

……

……[2]

(d) Due to some electrical fault, the metal outer casing is now at high potential.

Explain how a person can be protected from electric shock if he touches the metal outer casing.

……

……

……

……

……[2]

(e) The electrical kettle is marked “220 V, 2000 W”.

Calculate the resistance of the kettle when it is working normally.

resistance = ……[2]

[Total: 10]

13 (a) Fig. 13.1 shows an electrostatic duster that can use to attract light particles or object.

Fig. 13.1

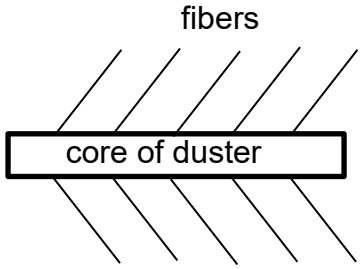


Fig. 13.2

The duster will be positively charged when it is rubbed against a piece of plastic. A charged duster will have its fibers stand on end as shown in Fig. 13.2.

(i) Explain how a duster becomes positively charged when it is rubbed against a piece of plastic.

……

……

……

……

……[2]

(ii) Explain how Fig. 13.2 shows the duster is statically charged.

……

……

……[1]

(iii) Fig. 13.3 shows a small aluminium foil is placed on the ground and the positively charged duster is placed near to the top surface of aluminium foil.

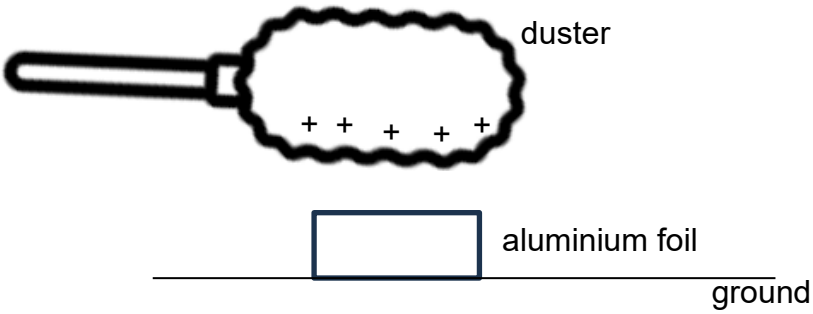


Fig. 13.3 (not drawn to scale)

1. Show, on Fig 13.3, the charge disturbution in the aluminium foil. [1]

2. The duster is brought nearer to the aluminium foil. Aluminium foil moves towards the duster.

State and explain the observation.

……...

……...

……...

……...

……...

……[2]

(b) Fig.13.4 shows a postively charged sphere and a negatively charged sphere placed near to each other.

Fig. 13.4

(i) On Fig. 13.4, draw the electric field pattern outside the spheres. [2]

(ii) State what is shown by the direction of the electric field.

……

……[1]

(c) Describe an example where electrostatic charging may be a potential harzard.

……

……[1]

[Total: 10]

*** End of Paper ***

Paper 1 Answers

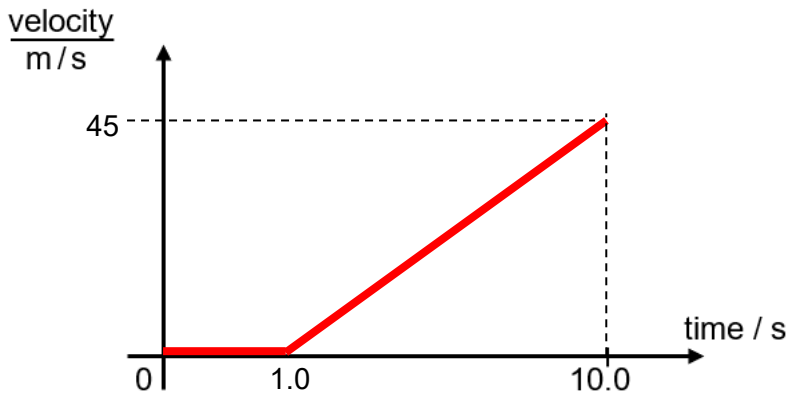
1	2	3	4	5	6	7	8	9	10
C	B	B	D	C	B	C	D	A	B
11	12	13	14	15	16	17	18	19	20
B	D	C	C	C	C	A	C	D	B
21	22	23	24	25	26	27	28	29	30
D	A	C	C	A	B	C	B	B	A
31	32	33	34	35	36	37	38	39	40
C	A	C	D	C	A	C	D	A	B

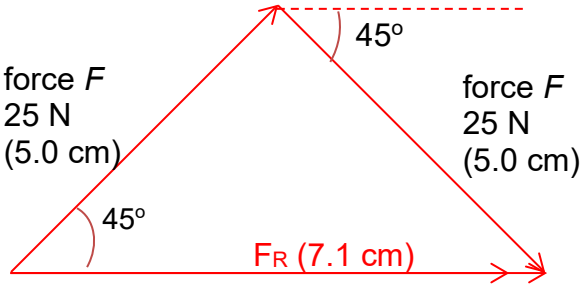
Ngee Ann Secondary School

2024 Sec 4 Physics (6091)

Prelim Paper 2 MARKING SCHEME

Section A (Answer all questions in this section)

Qn	Solution	Marking Scheme
1(a)	The velocity increases by 5.0 m / s for every 1.0 second.	B1
(b)		B1 – shape of the graph B1 – correct coordinates
(c)	Distance travelled by the motorist = speed x time taken = 25 x 10.0 = 250 m	A1
(d)	Distance travelled by the police car is given by **<u>the area under the velocity-time graph of the police car</u>** for the 1st 10.0 second and this is equal to 202.5 m (or 203 m) This value **<u>is less than</u>** the calculated value in part (c), thus showing that police car has not overtake the motorist at the end of 10.0 seconds.	M1 A1
		6 marks

2(a)	Force *F* = tension force	B1
(b)	Scale: 1.0 cm to 5.0 N  For equilibrium, pulling force = F_R = 7.1 x 5.0 = 35.5 N	M1 – Scale and the length of arrow for each force. M1 – orientation + correct drawing to illustrate tip to tail or parallelogram method A1 (also accept 2sf)
(c)	When the arrow is released, there is **no pulling force** opposing the resultant of the two forces *F*. There is a **horizontal resultant force acting on the arrow due to forces *F***. By **Newton's 2nd Law** (or F_{net} = ma), the arrow moves forward to **the right**.	B1 B1
(d)	The reaction force is the force acting **on the archer by the bow string** (or the arrow). The reaction force has the **same magitude** as the pulling force, and its **direction is horizontally to the right**.	B1 B1
		8 marks

3(a)	Moment of a force is defined as the **product** of the **force** and the **perpendicular distance between the pivot and the line of action of the force**.	B1
(b)	By principle of moment, taking moment about the hinge, sum of clockwise moment = sum of anti-clockwise moment 55 x (50 / 2) = F x 4.0 F = 344 N (3 sf)	 M1 A1
		3 marks

4(a)	Visible light and Infra-red radiation	B1
(b)	The interior of the cylinder is coated black and **black surface is a good emitter of radiation to the gas in the cylinder**. Also accept the following (assuming that the exterior of the cylinder is transparent): The cylinder is coated black and black surface is **a good absorber of radiation (or heat) from the filament**.	B1
(c)	Energy is transferred to gas particles in the cylinder and **increases the energy in the kinetic store** of the gas particles. The gas particles **move faster** and **more vigorously** and **collide with the inner walls of the cylinder with a larger force**. Since **pressure = force / area** and there is **no change in the total inner surface area**, **pressure of gas increases**.	B1 B1 B1
		5 marks

<table>
<tr><td>5(a)</td><td>Some energy from the water is transferred to the <u>internal store</u> of surrouding <u>due to temperature difference</u> (or via conduction, convection or radiation).

Does not accept if only state: Energy lost (or transferred) to surrounding.</td><td>B1</td></tr>
<tr><td>(b)
(i)</td><td>Using Q = m c Δθ,

Q = 72 x 4.2 x (42 – 20)

= 6700 J (2 s.f)

Note: All data are given in 2 s.f</td><td>

M1

A1 – only accept 2 sf.</td></tr>
<tr><td>(ii)</td><td>Overall efficiency
= 6700 / 8000 x 100%
= 84% (2 sf)</td><td>

A1 – allows ecf from (b)(i)</td></tr>
<tr><td>(b)</td><td><table><tr><th>component</th><th>change, if any</th></tr><tr><td>energy in internal kinetic store</td><td>no change</td></tr><tr><td>energy in internal potential store</td><td>increase</td></tr></table></td><td>B2 – 1 mark for each correct answer.</td></tr>
<tr><td></td><td></td><td>6 marks</td></tr>
</table>

<table>
<tr><td>6(a)</td><td>Potentiometer

Does not accept rheostat.</td><td>B1</td></tr>
<tr><td>(b)</td><td>The slider will need to move <u>towards Y</u> (or be at Y).

The <u>resistance of the potentiometer across the voltmeter will be the largest at Y</u> and hence by <u>potential divider concept</u>, the voltmeter reading will be the largest.</td><td>M1

A1</td></tr>
<tr><td>(c)</td><td>Resistance of thermistor is 60 Ω and resistance between X and slider P is ½ x 90 = 45 Ω

Using potential divider concept,

V = 45 / (90 + 60) x 24

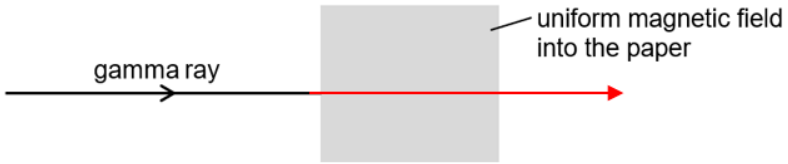
= 7.2 V</td><td>

M1

A1</td></tr>
<tr><td></td><td></td><td>5 marks</td></tr>
</table>

7(a)	When the switch is closed, **current flow through the coil** and **soft iron core is magnetised** and becomes a magnet (electromagnet). **Soft iron armature is attracted to the electromagnet** (due to induced magnetism) Soft iron armature **rotates in anti-clockwise direction about the pivot** and **the top end of the armature pushes lower metal strip** (towards the upper metal strip). **The contact P comes into contact Q** and circuit Y is closed.	B3 – have all four marking points B2 – only have two or three marking points B1 – only has one marking point B0 – otherwise
(b)	Steel bar is a hard magnetic material. When magnetised, it will **retain magnetism**. Hence, the **soft iron armature will be permanently attracted to the steel bar** even when swtich S is opened. Hence, contacts P and Q will be in contact and **circuit Y is closed even when switch S is opened**.	B2 – have all three marking points B1 – only have two marking points B0 – otherwise
		5 marks

8(a)	Galvanometer (Do not accept ammeter)	B1
(b)	**Current in coil P produces magnetic field** (which passes through coil Q). **Coil Q experience an increase in magnetic field** (or there is change in magnetic flux linkage experienced by the coil Q) By **Faraday's Law of Electromagnetic Induction**, there is an induced e.m.f in coil Q.	B2 – have all three marking points B1 – only have two marking points B0 – otherwise
(c)	South pole	B1
(d)	Left end of coil Q experiences **an increase in magnetic field** (equivalent to a south pole entering left end of coil Q). **By Lenz' Law**, the direction of induced current in coil Q will produce a **South pole at the left end of coil Q** to oppose the increase in magnetic field. **By right hand grip rule**, the direction of induced current is flowing from **left to right through device X**.	B2 – have all three marking points B1 – only have two marking points B0 – otherwise
		6 marks

9(a) (i)	electrons Note: Mass number depends only on the number of protons and neutrons. This implies that the mass of electrons is negligible.	B1
(ii)	protons and neutrons Note: α-particle is identical to a Helium nucleus. During an α-particle emission, 2 protons and 2 electrons.	B1
(b)	Gamma ray does not contain electric charge. Hence, it will not be affected by the magnetic field and will go straight to the right.  	B1
(c) (i)	Background radiation refers to nuclear radiation in an environment where no radioactive source has been **deliberately introduced**.	B1
(ii)	The original count rate due to the sample = 838 – 18 = 820 counts / minute. There are a total of 2 half-lives. Count rate due to the sample after 2 half-lives = 820 x (1/2) x (1/2) = 205 counts / minute	M1 – either stated the original count rate due to sample or with the knowledge of two half-lives. A1
		6 marks

<table>
<tr><td>10
(a)</td><td>Water pressure acting on the fish
= hρg
= (50.0 – 20.0) x 1010 x 10
= 303 000 Pa</td><td>

M1 – correct h
A1</td></tr>
<tr><td>(b)</td><td>Energy in the gravitational potential store of the water is transfer to the kinetic store of the water.

The energy is then transfer to the kinetic (or mechanical) store of the turbine.

Energy is transferred electrically by electric current and electricity is generated.</td><td>B1

B1

B1</td></tr>
<tr><td>(c)</td><td>step-up transformer</td><td>B1</td></tr>
<tr><td>(d)</td><td><table><tr><th>time interval</th><th>average water speed / m s^{-1}</th><th>Average Power / MW</th></tr><tr><td>0 to 1.0 min</td><td>35</td><td>60</td></tr><tr><td>1.0 min to 2.0 min</td><td>20</td><td>26</td></tr></table>
Total energy generated

= 60 x 10^6 x (1.0 x 60) + 26 x 10^6 x (1.0 x 60)’

= 5.16 x 10^9 J</td><td>M1 – showing understanding that E = P x t

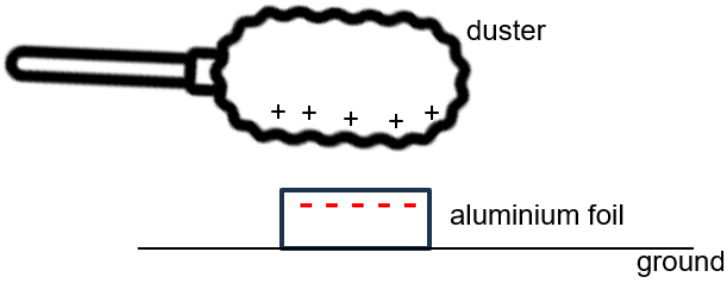
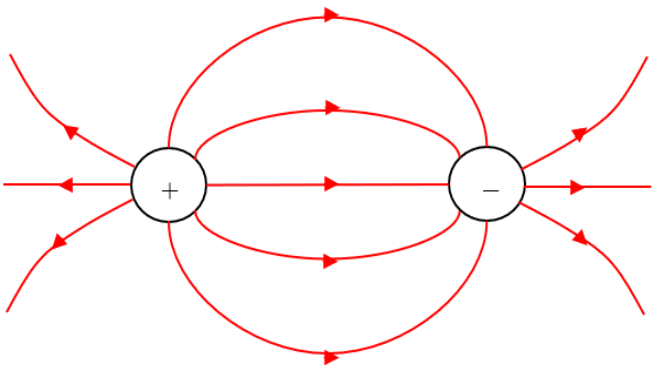
M1 – unpacking MW and express time in second

A1</td></tr>
<tr><td>(e)</td><td>Anyone of the following:
• Speed of the water varies within the time interval.
• Friction between the machinery part reduce the efficiency of the system.
• Energy transfer to the internal store of the machinery part
• Energy transfer via propagation of mechanical waves to the surrounding</td><td>B1</td></tr>
<tr><td></td><td></td><td>10 marks</td></tr>
</table>

11 (a)	Transverse wave. The direction of vibration of the source (the hand motion) is vertically and perpendicular to the direction of the wave travel (horizontally to the right).	B1 B1
(b)	Particle Q will move down to the lowest position. It will then move up to the highest position and then move down back to the original position.	B1 - able to identify that particle Q is moving downward initially. B1 – able to describe one complete movement of particle Q.
(c) (i)	Period of wave is 0.50 s. shortest time = ½ x 0.50 = 0.25 s	 B1
(ii)	9.0 km / h = 9000 / 3600 = 2.5 m / s Using v = f x λ 2.5 = 2.0 x λ λ = 1.25 Hz	M1 A1
(d)	The metal pole vibrates. This displaces the layer of air molecules adjacent to the ground and in turns displace the neighbouring air molecules. The air molecules move about their undisturbed positions, and this set up a series of compressions and rarefactions in the air. The sound wave travels in the form of longitudinal wave from the ground towards the listeners.	B3 – all marking points are present. B2 – three marking points are present. B1 – one or two marking points are present. B0 – otherwise.
		10 marks

Section B (Answer one question from this section)

Qn	Solution	Marking Scheme
12 (a)	When current flows through the heating element, the heating effect due to current heat up the heating element. Energy is transferred from the heating element to the neighbouring water via conduction. Water heats up and rises to the top of the kettle. The cold water the top of kettle sinks. and in turn heat up by the heating element. The cycle repeats and set up convection current and heat up the entire water in the kettle.	B3 – all marking points are present. B2 – three marking points are present. B1 – one or two marking points are present. B0 – otherwise.
(b)	Material: tungsten / nichrome Reason: High melting point / Relatively high resistance	B1
(c)	The switch to be placed along live wire. When the switch is correctly placed along the live wire, this will ensure that the appliance will not be at high potential when the switch is open. Hence, in the event of electrical fault and the user accidentally touch the live wire, the user will not get electric shock.	B1 B1
(d)	There is earth wire connected to the metal casing. Earth wire provides a path of no resistance for the current to flow and hence current will not flow through a person which has a high resistance. The person will not get electric shock.	B1 B1
(e)	Using $P = V^2 / R$, resistance, $R = V^2 / R$ $= 220^2 / 2000$ $= 24.2\ \Omega$ (3 sf)	 M1 A1 – also accepts $24\ \Omega$ (2 sf)
		10 marks

13 (a) (i)	Charging by friction takes place. Electrons are transferred from duster to the plastic. Since there are less electrons than protons in the duster, the duster becomes positively charged.	B2 – all three marking points are present. B1 – one or two marking points are present. B0 – otherwise.
(ii)	The fibers are not touching each other and this shows that there are repulsive electric forces between the fibers due to like charges repel.	B1
(iii) 1		B1 – shows excess electrons at the top surface of aluminium foil
2	The aluminium foil becomes negatively charged. Due to unlike charge, there is an attractive electric force. When the duster moves nearer to the aluminium foil. this attractive force is larger than weight the foil, the foil is attracted upward and touch the duster.	B1 B1
(b) (i)		B1 - correct field pattern B1 - correct direction Minus 1 if electric field lines touch or cut each other, provided students has correct field pattern.
(ii)	It is the direction of the electric force acting on a small positive electric charge when placed at that location. Can also accept: It is the direction of the motion of a positive electric charge when placed at that location.	B1
(iii)	Any one of the following: • Lightning strikes due to the discharging of excess charges in the cloud	B1

	• Accumulation of electrostatic charges on the body of trucks that transporting petrol • Accumulation of electrostatic charges on the body of petrol tank during refueling of aircraft	
		10 marks