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DUNEARN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023

PHYSICS 6091 / 01
SECONDARY 4 EXPRESS

12 September 2023 (Tuesday) **0815 - 0915** **Paper 1** **1 hour**

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and register number on the Question Paper and Answer Sheet in the spaces provided unless this has already been done for you.

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 choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this paper.

Setter: Ms Yvonne Tan

This question paper consists of **17** printed pages including the cover page.

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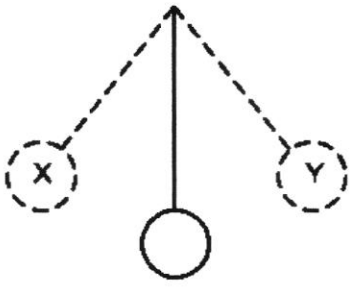
1 Which of the quantities are classified correctly under scalar and vector?

	scalar	vector
A	acceleration	time
B	friction	speed
C	latent heat	velocity
D	velocity	displacement

2 What is the order of magnitude of the diameter of an atom?

A 10^{-7} cm **B** 10^{-7} mm **C** 10^{-7} μm **D** 10^{-7} ns

3 A pendulum swings from **X** to **Y** and back to **X** again twenty times in 37.4 s.



What is the period of the pendulum?

A 0.534 s **B** 0.935 s **C** 1.87 s **D** 3.74 s

4 An object X of mass *m* is released from a height *h*. Above object X, another object Y of mass 2*m* is released from a height 2*h* simultaneously.

If both objects fall freely, which statement is correct?

A The distance between them decreases and Y overtakes X.
B The distance between them increases as X falls faster.
C The distance between them remains constant.
D The velocities of both objects are constant.

5 Which of the following will experience the **largest** inertia?

A A bowling ball that is rolling at 20 m/s.
B A leaf that is free falling with an acceleration of 10 m/s^2.
C A car that is travelling at 100 km/h.
D An airplane that is at rest.

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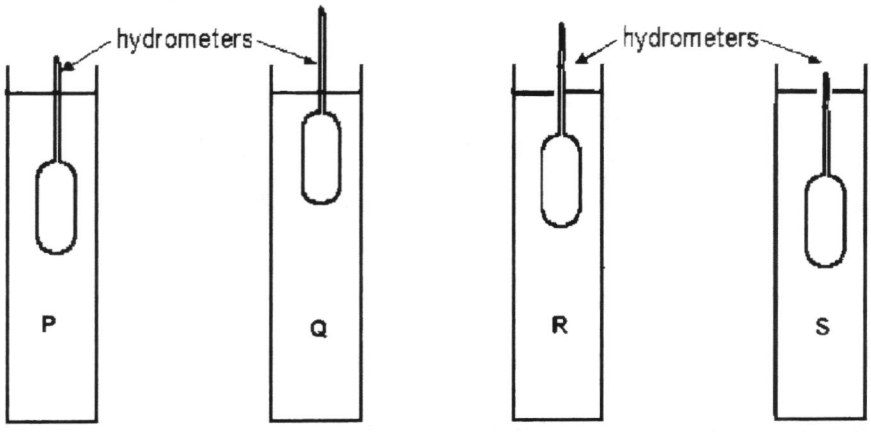
6 A block of iron is brought from Earth to the surface of the Moon with gravitational field strengths of 10 N/kg and 1.6 N/kg respectively.

statement	
1	Its mass decreases.
2	Its weight decreases.
3	Its density remains unchanged.

Which of the following statements is/are true about the iron block when it is on the Moon?

A 1 only
B 1 and 3
C 2 and 3
D 1, 2 and 3

7 Hydrometers are used to measure the density of four different liquids, P, Q, R and S as shown.

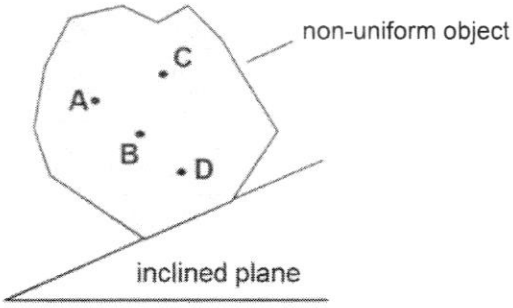


Which arrangement correctly shows the **increasing** density of the four liquids?

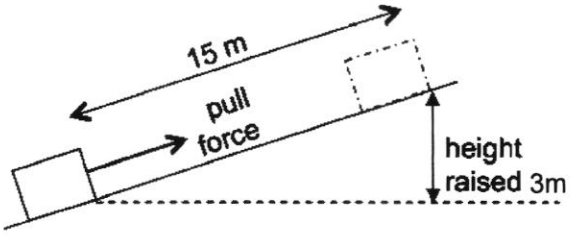
A S, P, R, Q
B S, P, Q, R
C Q, R, P, S
D Q, R, S, P

8 A non-uniform object is placed on an inclined plane. The object is just about to topple.

Which position is the centre of gravity?



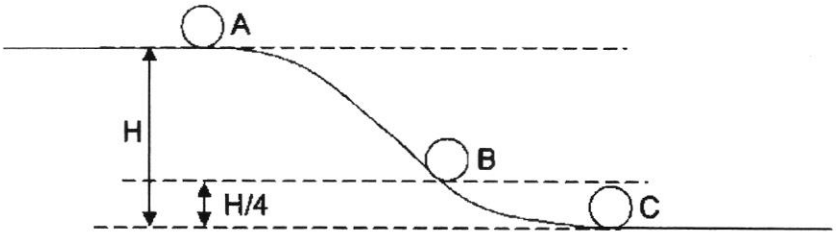
9 An object of mass 20 kg is pulled up a slope of 15 m. The object is raised by a vertical height raised of 3 m. The frictional force between the object and the slope is 30 N.



What is the minimum work done by the pulling force?

A 150 J **B** 450 J **C** 510 J **D** 1050 J

10 A ball, initially at rest at A, rolls down a smooth slope as shown in the figure below. Air resistance can be ignored. Assume that the gravitational potential energy of the object is zero at C.



What is the ratio $\frac{\text{gravitational potential energy}}{\text{kinetic energy}}$ at B?

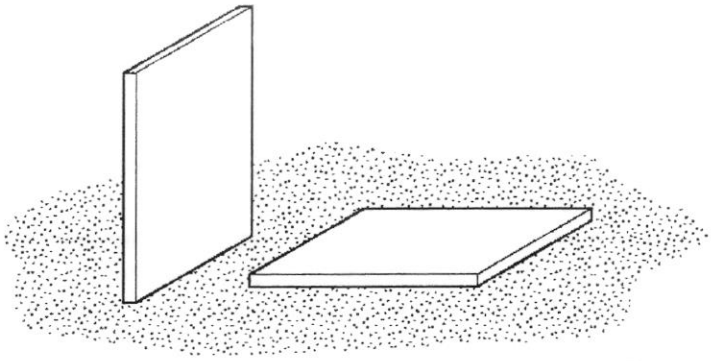
A 0.25 **B** 0.33 **C** 2.0 **D** 3.0

11 A small emergency generator supplies 432 MJ of electrical energy in 24 hours.

What is the average power output of the generator?

A 5000 W **B** 300 000 W **C** 18 000 000 W **D** 432 000 000 W

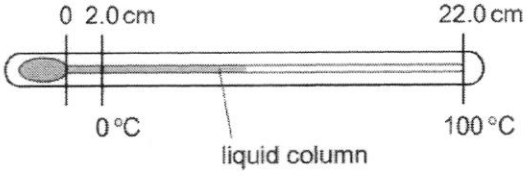
12 A builder leaves two identical, heavy, stone tiles resting on soft earth. One is vertical and the other is horizontal.



Which row correctly compares the forces and the pressures that the tiles exert on the earth?

	forces	pressures
A	different	different
B	different	same
C	same	different
D	same	same

13 The diagram shows a liquid-in-glass thermometer.



At 0 °C, the length of the liquid column is 2.0 cm. At 100 °C, the length of the liquid column is 22.0 cm.

What is the length of the liquid column at 60 °C?

A 12.0 cm **B** 13.2 cm **C** 14.0 cm **D** 14.4 cm

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14 A gas in a sealed cylinder with fixed volume is heated.

Which of the following does **not** increase as the gas is heated?

A the average distance between the gas molecules
B the average kinetic energy of the gas molecules
C the average number of collisions between gas molecules
D the frequency of gas molecules hitting the cylinder walls

15 Cooling fins are used in many devices such as refrigerators and car radiators.

Below are three statements about cooling fins.

statement	
1	The cooling fins are made of metal to ensure that thermal energy is being radiated quickly to the environment.
2	The cooling fins have a large surface area for heat to be dissipated quickly to the environment through convection and radiation.
3	Cooling fins are usually painted white to increase the rate of radiation to the surroundings.

Which statement(s) about the cooling fins is/are correct?

A 1 and 2
B 2 only
C 2 and 3
D 1, 2 and 3

16 Containers A and B are filled with equal amounts of hot water at the same temperature. The temperature of the water in the containers are measured with a thermometer sometime later. It is observed that container A has a much lower temperature than container B.

Which of the following is a possible reason?

A Container A is made of ceramic and container B is made of metal.
B Container A has a lid over it and container B is not covered.
C Container B is made of steel and container A is made of plastic.
D Container B has a smooth and shiny surface and container A has a rough and dull surface.

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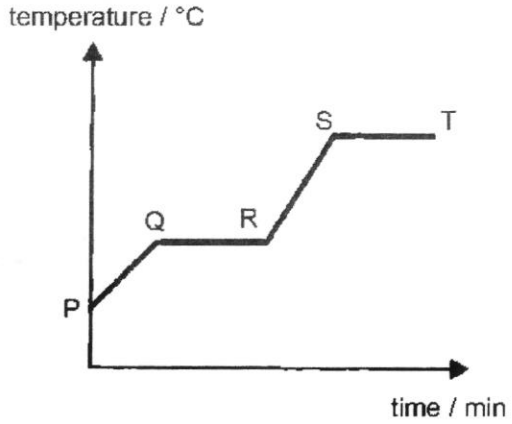
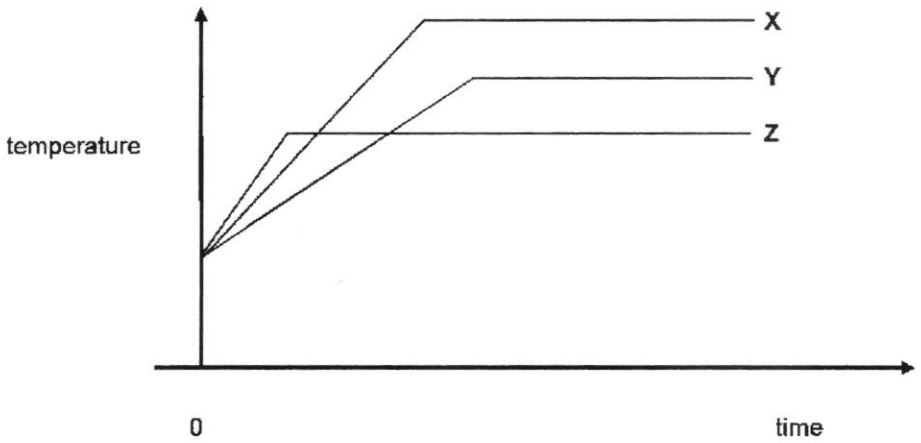
17 A solid substance is placed in a boiling tube and heated steadily. The temperature-time graph of the substance is shown below.



At which region(s) do the substance gain internal kinetic energy?

A PQ and RS
B QR and ST
C PQ, QR and RS
D All regions

18 Equal masses of three liquids X, Y and Z are heated from room temperature. Energy is supplied by heating at the same rate to each liquid. The graph shows how the temperature of each liquid varies with time after heating starts.



What can be deduced from the graph?

A X has the largest latent heat of vaporisation.
B Y has the smallest specific heat capacity.
C Z has the smallest latent heat of vaporisation.
D Z has the smallest specific heat capacity.

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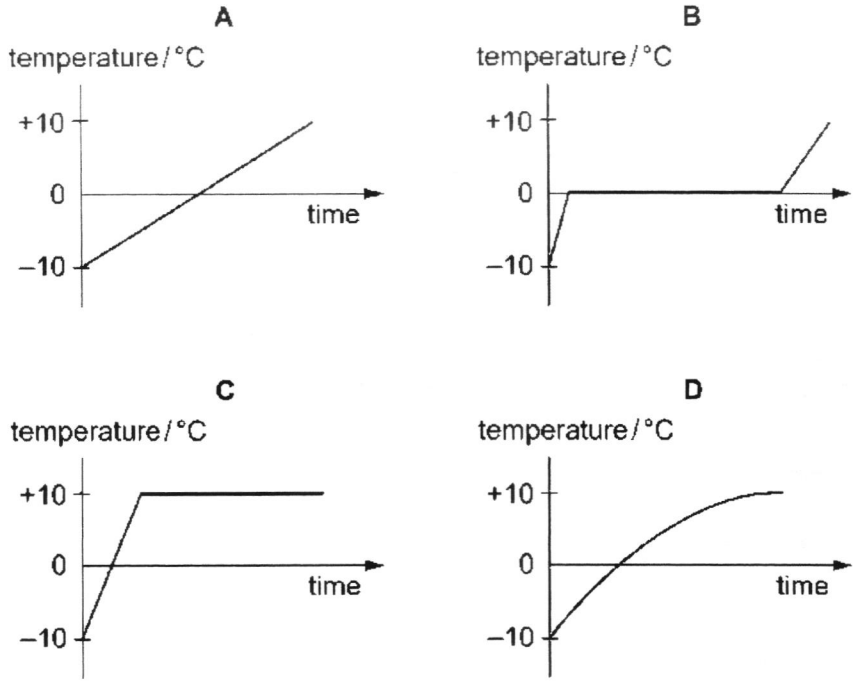
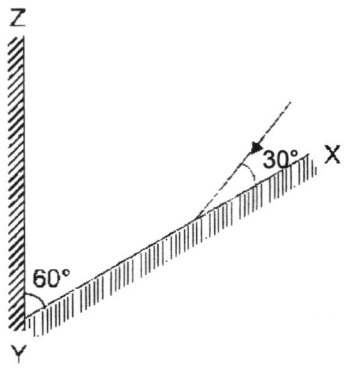
19 Ice at –10 °C is heated at a constant rate until it is water at +10 °C.

Which graph shows how the temperature changes with time?



20 A ray of light is incident at an angle of 30° to a mirror XY. Another mirror YZ is arranged at an angle of 60° to XY as shown in the diagram below.

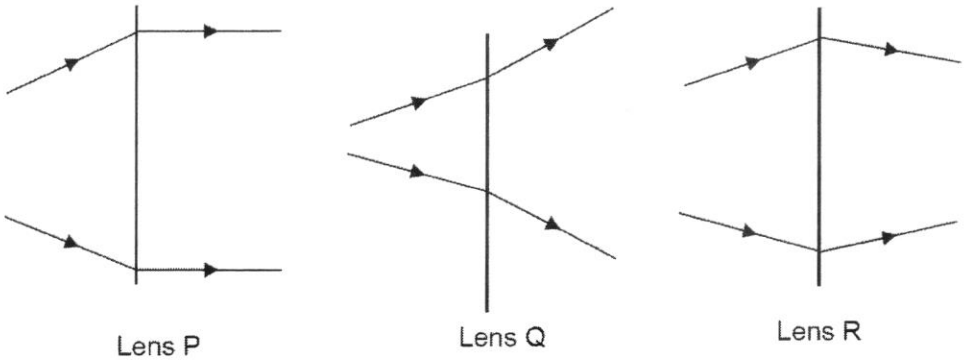


After reflection from XY, the ray is incident on YZ.

What is the angle of incidence of the ray at the mirror YZ?

A 0° **B** 10° **C** 30° **D** 60°

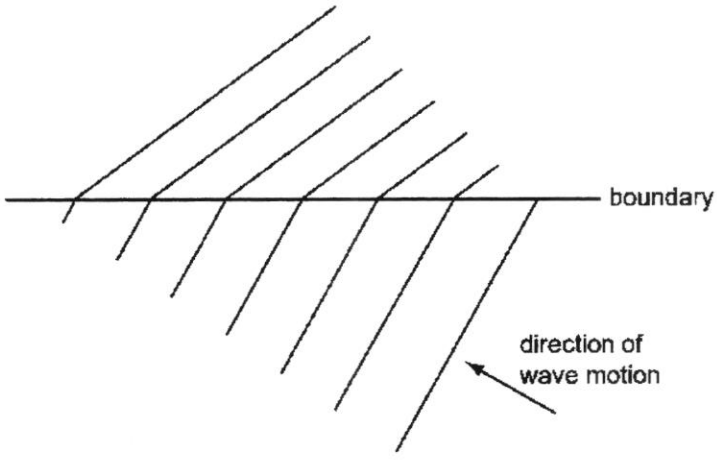
21 Rays of light pass through three lenses.



Which len(s) is/are **not** a converging lens?

A Lens Q only
B Lens R only
C Lens P and R
D Lens Q and R

22 The diagram shows the refraction of water waves as they cross a boundary in a ripple tank.



What causes this refraction?

A a change in frequency due to a change in depth
B a change in frequency due to a change in wavelength
C a change in speed due to a change in depth
D a change in speed due to a change in frequency

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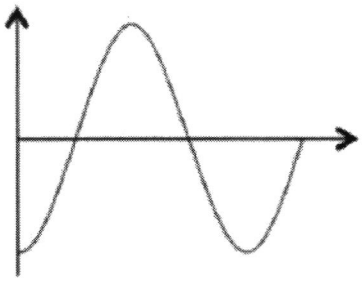
23 Which waves consist of compressions and rarefactions?

A gamma rays
B infrared waves
C water waves
D ultrasound

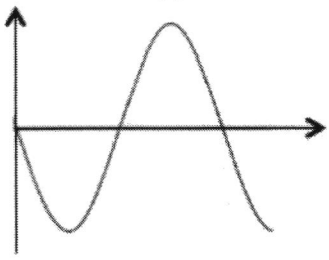
24 A student generates a transverse wave in a long rope, as shown in the diagram below. The waves move from left to right.

He makes 1.25 oscillations in 1.0 s.

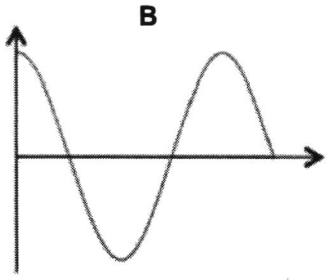


What is the shape of the rope 2.2 s later?

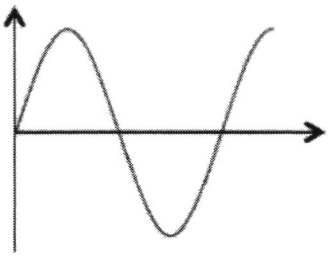
A



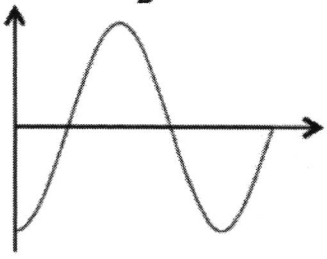
B



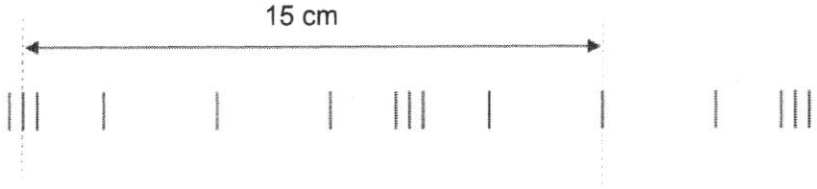
C



D



25 A longitudinal wave of period 2.0 s passes along a spring. The diagram below shows the position of coils at a particular time.



Which of the following shows the wavelength of the wave above and the speed of the wave?

	wavelength / cm	speed of wave / cm s^{-1}
A	7.5	7.5
B	7.5	10
C	10	5
D	10	7.5

26 Different parts of the electromagnetic spectrum are used for different purposes.

Below are four statements about parts of the spectrum.

statement	
1	Infra-red waves are used in television remote controllers.
2	Radio waves are used to sterilize hospital equipment.
3	Ultra-violet waves are used for intruder alarms.
4	X-rays are used for security checks.

Which statements are correct?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

27 Which of the following shows the correct arrangement of electromagnetic waves in **decreasing** order of wavelength?

A radio wave, infra-red, X-ray, microwave, gamma ray
B radio wave, microwave, infra-red, X-ray, gamma ray
C gamma ray, infra-red, X-ray, microwave, radio wave
D gamma ray, X-ray, infra-red, microwave, radio wave

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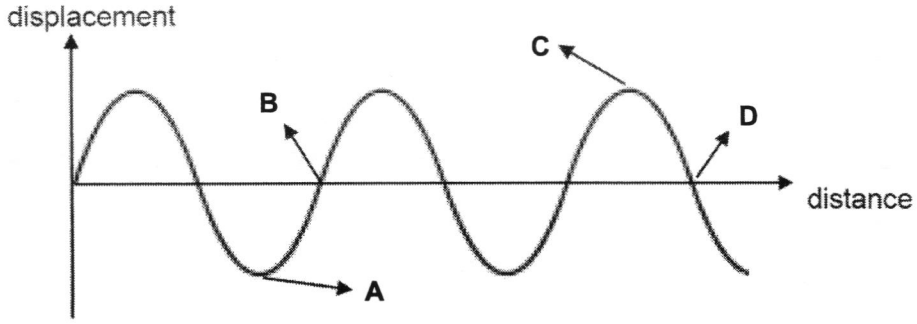
28 The diagram below shows a displacement-distance graph of a longitudinal wave. Displacement to the right is taken to be positive.

Which point indicates a centre of compression?

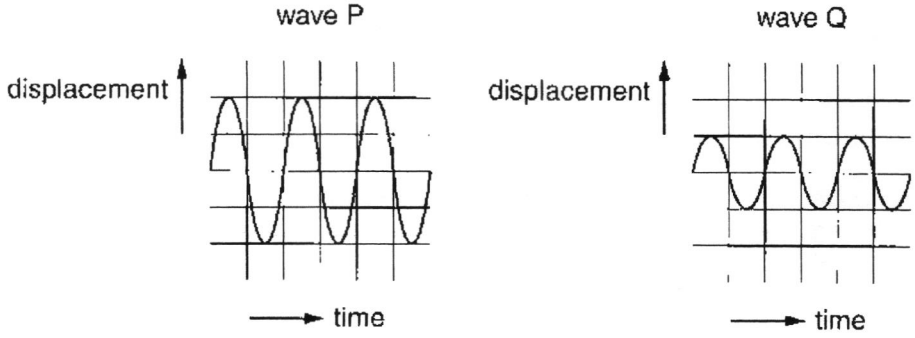


29 A flash of lightning and the corresponding thunderclap are detected 6 s apart. It is calculated that the lightning struck about 1800 m away.

On which assumption is the calculation based?

A Light reaches us almost instantaneously, but sound travels at 300 m/s.
B Light travels 300 m/s faster than sound.
C Sound reaches us almost instantaneously, but light travels at 300 m/s.
D The sound of the thunder was emitted 6 s after the flash.

30 The diagrams represent two different sound waves.



How do the frequency and pitch of P compare with the frequency and pitch of Q?

	frequency of P	pitch of P
A	greater than Q	higher than Q
B	greater than Q	same as Q
C	same as Q	higher than Q
D	same as Q	same as Q

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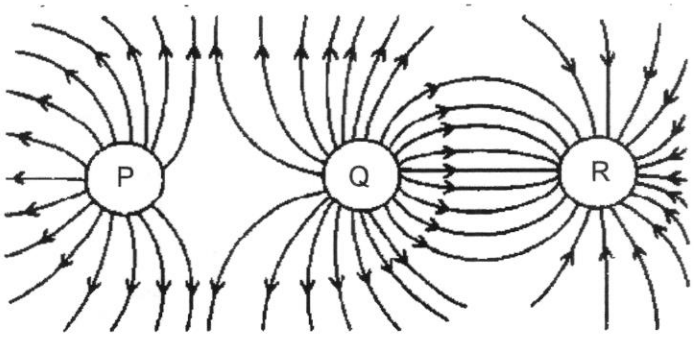
31 The electric field pattern between three spheres P, Q and R is shown.



Which is the correct charge on each sphere?

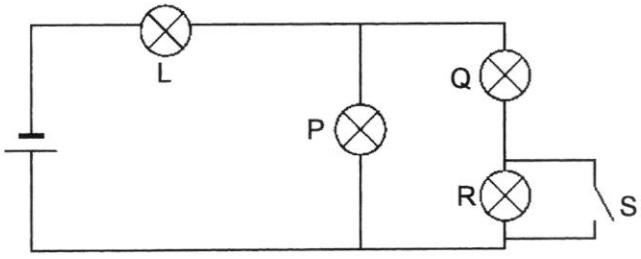
	P	Q	R
A	+	+	+
B	+	+	-
C	-	-	+
D	-	-	-

32 A charged cloud carrying a charge of 150 C passes all its charge to the earth through lightning. The lightning lasts for 0.5 ms.

What is the current of the lightning?

A 75 A **B** 300 A **C** 75 000 A **D** 300 000 A

33 The diagram shows a circuit with four identical light bulbs L, P, Q and R.



Which option describes the changes in brightness of the bulbs L and P when switch S is closed?

	L	P
A	brighter	brighter
B	brighter	dimmer
C	dimmer	brighter
D	dimmer	dimmer

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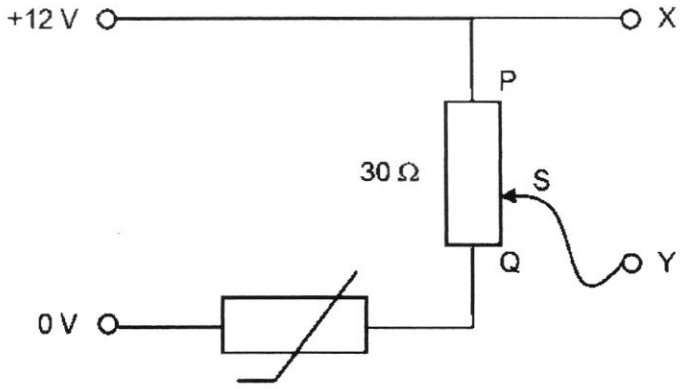
34 A variable potential divider has a sliding contact S that can be moved between end P and end Q of a 1.0 m long resistance wire of 30 Ω. The potential divider is connected in series to a constant 12 V power supply and a thermistor. The resistance of the thermistor can vary from 10 Ω to 90 Ω.



If the temperature of the thermistor is high, which of the following is a possible description of the potential difference between X and Y as S moves from P to Q?

A It decreases from 12.0 V to 9.0 V.
B It decreases from 12.0 V to 3.0 V.
C It increases from 0 V to 3.0 V.
D It increases from 0 V to 9.0 V.

35 The metal case of an electric heater is earthed. The plug to the heater contains a 5 A fuse. There is a current of 4 A when the heater works normally.

The cable to the heater becomes so worn that the live wire makes electrical contact with the case.

What happens?

A The current flows to earth and the fuse is not affected.
B The fuse melts and switches off the circuit.
C The metal case becomes live and dangerous.
D The metal case becomes very hot.

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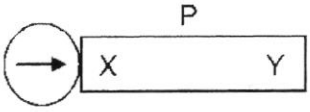
36 Energy is represented by the letter E, current by I, power by P, charge by Q, potential difference by V and time by t.

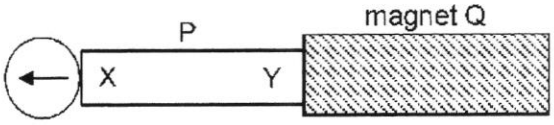
Which pair of equations is correct?

	equations	
A	E = It	P = VIt
B	E = VI/t	P = VI
C	E = VIt	P = VI
D	E = VQ	P = VI/t

37 A compass placed at end X of a metal bar P points to the right.



When Y, the opposite end of bar P is next to a magnet Q, P is attracted to Q. The compass at X points to the left.

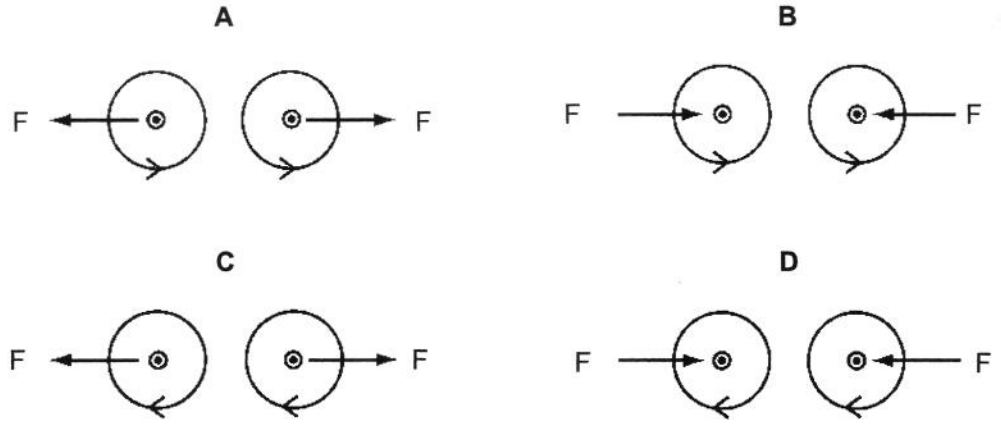


What can be deduced about P?

A It is made of a material such as aluminium.
B It is made of a material such as iron.
C It is a magnet with X as the North pole.
D It is a magnet with X as the South pole.

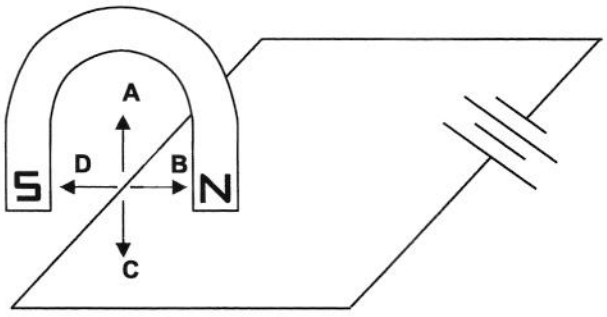
38 The diagrams show the forces F between two wires carrying currents out of the page. The magnetic fields close to the wires are also shown.

Which diagram is correct?

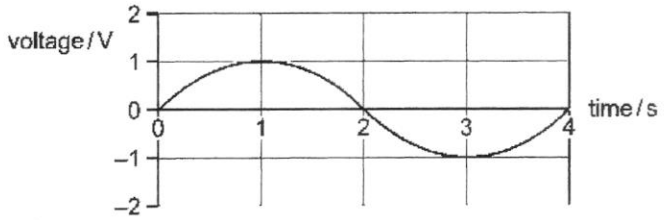


39 A current-carrying wire is placed between the poles of magnet.

Which direction will the wire move when the current flows?

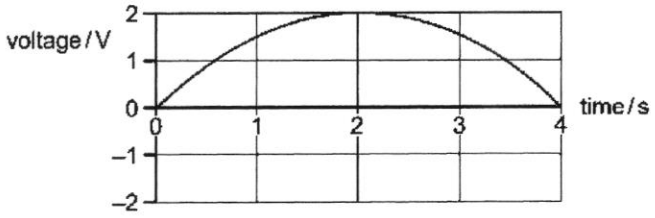


40 A simple a.c. generator produces a voltage that varies with time as shown.

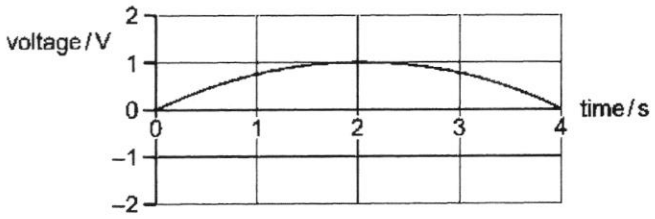


Which graph shows how the voltage varies with time when the generator rotates at twice the original speed?

A



B



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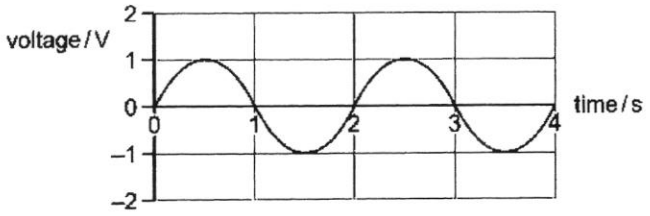

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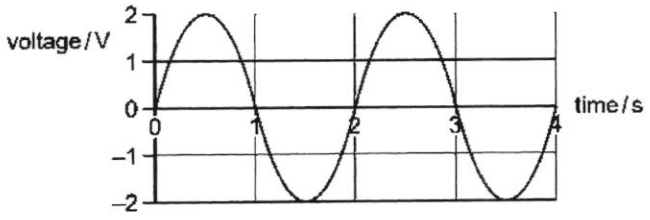

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DUNEARN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023

PHYSICS 6091 / 02
SECONDARY 4 EXPRESS

28 August 2023 (Monday) **1115-1300** **Paper 2** **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions.
Question 11 has a choice of parts to answer.

You are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
You are advised to show all 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 exam, fasten all your work securely together. The number of marks is given in brackets [ ] at the end of each question or part question.

Paper 1	**Paper 2**						Sub-total for P2 Section A	/50
	A1	A2	A3	A4	A5	A6	Sub-total for P2 Section B	/30
/40	A7	A8	B9	B10	B11(E)	B11(O)	**Total marks for Paper 2**	/80
							Overall marks	**/ 120**

Setter: Ms Yvonne Tan

Parent's Signature: .....

This question paper consists of **21** printed pages.

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Section A (50 marks)

Answer all questions in this section in the spaces provided.

1 Fig. 1.1 shows a block moving at a constant speed down a slope.

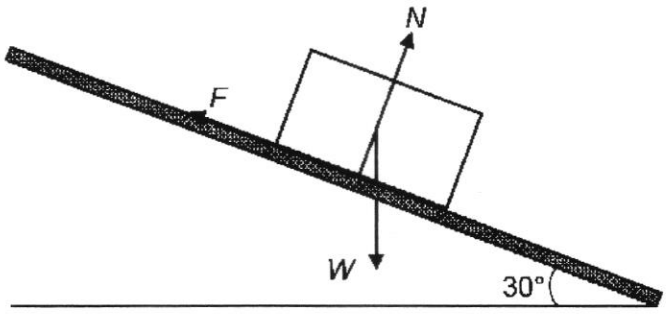

Fig. 1.1

The forces acting on the block are the weight *W* of the block, the normal reaction force *N* exerted by the slope and the friction *F* between the block and the slope.

F is 20.0 N and *W* is 40.0 N.

(a) In the space below, draw a labelled diagram to show the **resultant** of F and *W*. Determine the size of the resultant force and the direction between the resultant force and the horizontal ground. State the scale that you used.

resultant force = ...

direction = ... [3]

(b) Hence, determine the magnitude of the normal reaction force *N*.

normal reaction force *N* = ... [1]

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2 Fig. 2.1 is the speed-time graph for a rocket from the moment that the fuel starts to burn at time $t = 0$.

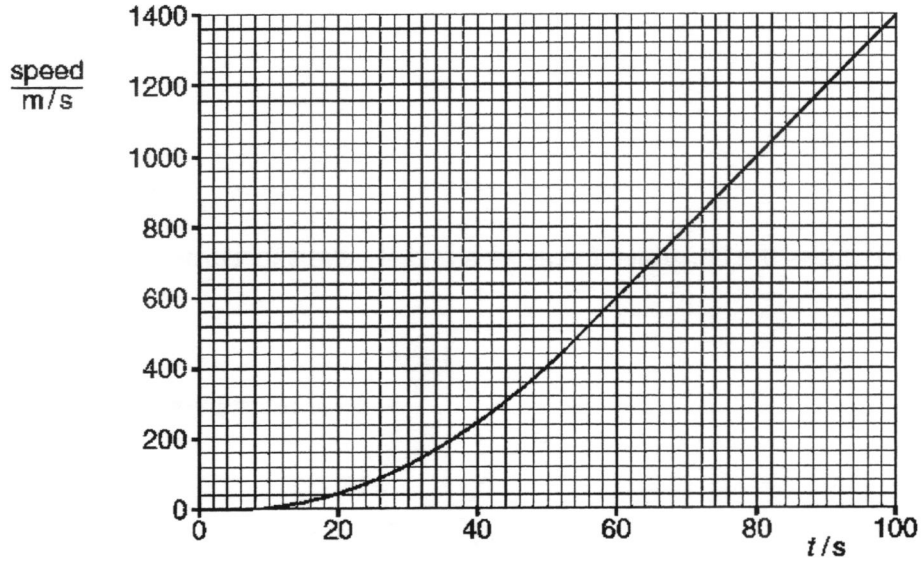

Fig. 2.1

(a) State the principal energy changes taking place as the rocket accelerates upwards.

.....

..... [2]

(b) **(i)** State the size of the acceleration of the rocket at $t = 0$.

acceleration = ... [1]

(ii) State what happens to the acceleration of the rocket between $t = 5$ s and $t = 80$ s.

.....

..... [2]

(iii) Calculate the acceleration of the rocket at $t = 90$ s.

acceleration = ... [2]

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(c) As the rocket burns fuel, it ejects hot gas downwards.

Explain how Newton's third law of motion applies to the upward force on the rocket and to the force on the hot gas.

.....

.....

..... [1]

3 Fig. 3.1 shows the horizontal forces as a cyclist travels forwards.

Fig. 3.1

The cyclist produces the driving force that acts on the back wheel.
In this question, you may ignore any frictional force acting on the front wheel.

(a) The bicycle accelerates until a constant speed is reached.
Explain, in terms of the forces acting, why the acceleration changes.

.....

.....

.....

..... [2]

(b) The total mass of the bicycle and the cyclist is 75 kg. At one instant, the speed of the bicycle is 4.0 m/s, the driving force is 30 N and the air resistance is 20 N.

Calculate

(i) the total kinetic energy of the bicycle and the cyclist,

kinetic energy = ... [2]

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(ii) the acceleration of the bicycle and the cyclist.

acceleration = ... [2]

(c) As the bicycle moves, energy is transmitted from the pedals to the back wheel. Fig. 3.2 shows what happens to the energy input to the pedals.

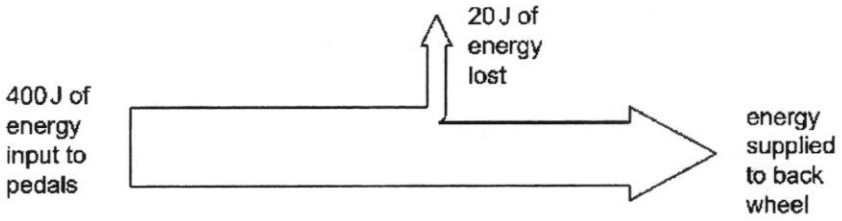

Fig. 3.2

Calculate the efficiency of the bicycle in transmitting energy from the pedals to the back wheel.

efficiency = ... [1]

4 Fig. 4.1 shows a rectangular concrete slab of weight 120 000 N. It rests on a brick wall and is the roof of a bus shelter. The concrete slab is 15.0 m long, 3.0 m wide and 0.10 m in thickness.

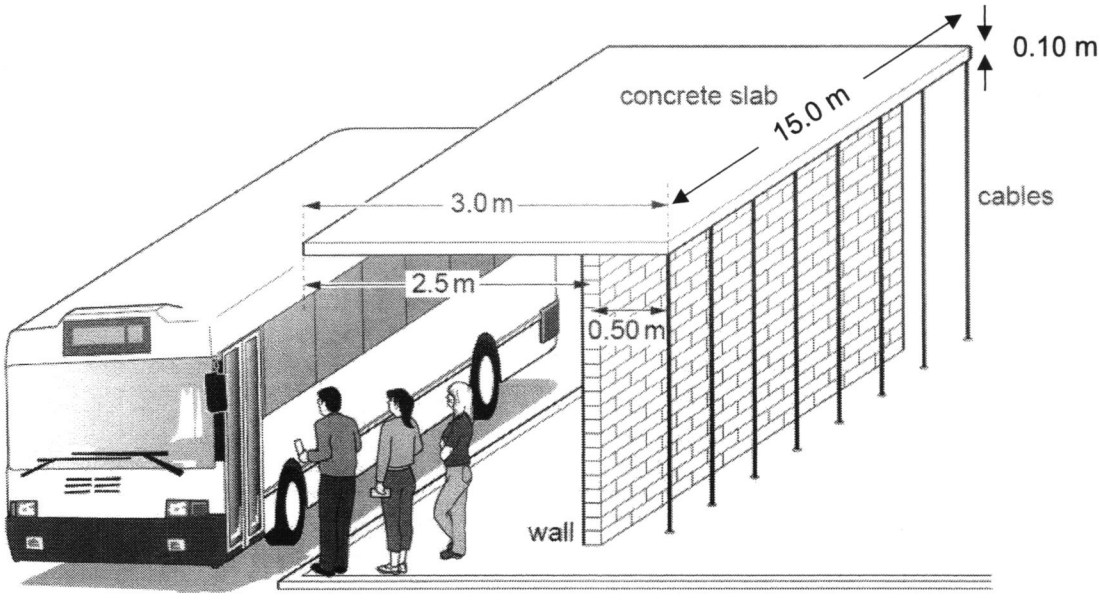

Fig. 4.1

The wall is 2.5 m from the front of the concrete slab and 0.50 m from the back. The cables behind the shelter pull downwards and stop the slab toppling forwards.

(a) Calculate the density of the concrete slab.

density = ... [2]

(b) The concrete slab is of uniform thickness and density. Determine the perpendicular distance between the wall and the centre of mass of the slab.

perpendicular distance = ... [1]

(c) **(i)** State the principle of moments.

.....

.....

..... [2]

(ii) Calculate the total downward force exerted by the cables on the slab.

force = ... [2]

5 Fig. 5.1 shows a water manometer used to measure the pressure inside a gas pipe.

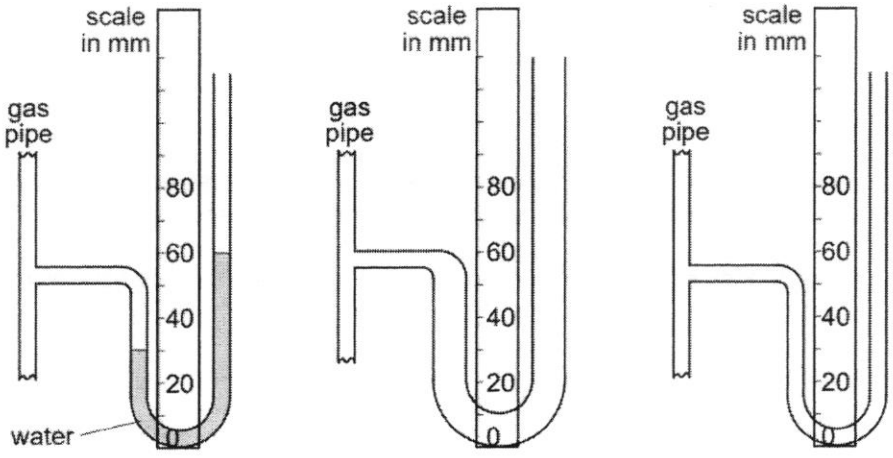

Fig. 5.1 **Fig. 5.2** **Fig. 5.3**

(a) State whether the pressure inside the gas pipe in Fig. 5.1 is larger than or smaller than atmospheric pressure.

..... [1]

(b) The manometers shown in Figs. 5.2 and 5.3 are connected to the same gas pipe at the same pressure as shown in Fig. 5.1.

On Figs. 5.2 and 5.3, draw the levels of the water in each manometer if

(i) the manometer in Fig. 5.2 contains water and has tubes with twice the diameter of Fig. 5.1, [1]

(ii) the manometer in Fig. 5.3 contains a liquid with density twice that of water. [1]

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(c) The manometer shown in Fig. 5.4 has its top end sealed.

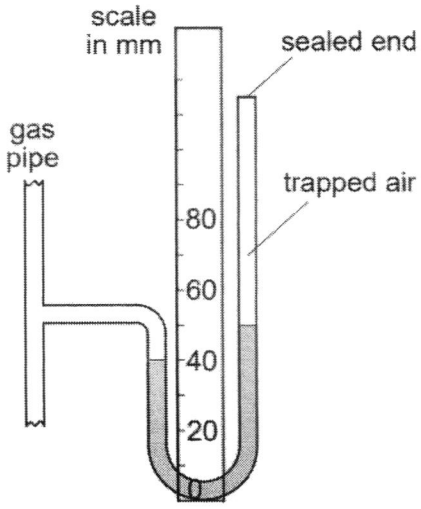

Fig. 5.4

Using Figs. 5.1 and 5.4, calculate the difference in pressure between the trapped air and atmospheric pressure. Leave your answer in Pascals.

Take density of water = 1000 kg / m^3 and gravitational field strength = 10 N / kg.

pressure difference = ... [2]

6 Fig. 6.1 shows a helium balloon that is used to bring weather apparatus up to a great height to take measurements.

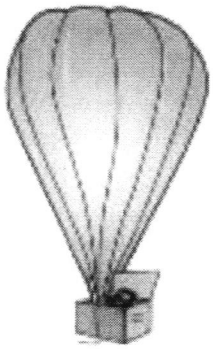

Fig. 6.1

(a) Using ideas about the motion of particles, explain how the atoms of helium produce a pressure in the balloon.

.....

.....

.....

..... [2]

(b) As the balloon rises, the atmospheric pressure experienced decreases and the balloon expands. With reference to the motion of helium atoms inside the balloon, state and explain how the pressure in the helium balloon changes.

.....

.....

.....

.....

.....

..... [3]

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7 **(a)** An experiment to show charging by induction uses a metal sphere mounted on an insulated support. The metal sphere X is initially uncharged and is shown in Fig. 7.1.

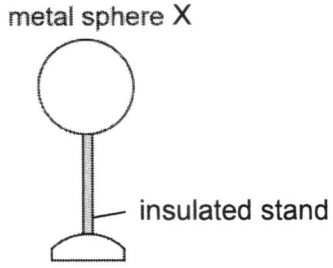

Fig. 7.1

A negatively charged rod is brought near the metal sphere X. The metal sphere is then touched at point A by a wire connected to earth, as shown in Fig. 7.2.

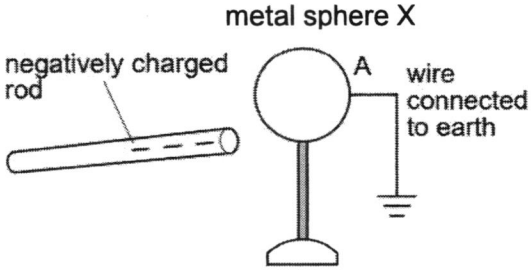

Fig. 7.2

On Fig. 7.2, draw the charges on the metal sphere. [1]

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

.....

.....

.....

..... [2]

(c) On Fig. 7.3, draw the resulting charges on the metal sphere X from the induction process. [1]

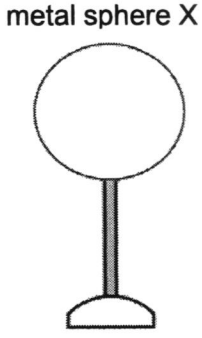

Fig. 7.3

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(d) The negatively charged rod is then brought near a neutral metal sphere Y, as shown in Fig. 7.4. Metal sphere Y is attached to a solenoid P, which is grounded through wire R. Solenoid Q is connected to a galvanometer and is positioned near solenoid P.

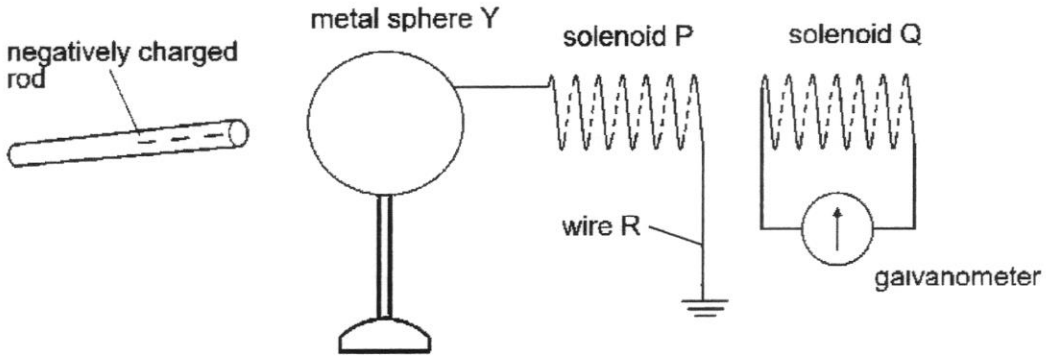

Fig. 7.4

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

.....

.....

..... [2]

(e) On Fig. 7.4, indicate with an arrow on wire R, the direction of the **current flow** during the movement of the charges. [1]

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

.....

.....

..... [1]

8 **(a)** Fig. 8.1 shows the current-potential difference (p.d.) graphs for a resistor and a thermistor.

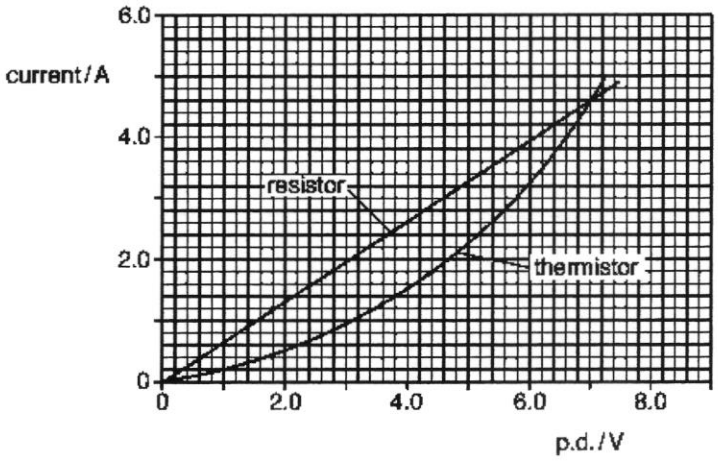

Fig. 8.1

State the effect on the resistance of the resistor and the thermistor when the p.d. across each component is increased from 0 V to 7.0 V.

effect on resistor.....

effect on thermistor.....[2]

(b) Fig. 8.2 shows a design for a simple circuit breaker in a household circuit.

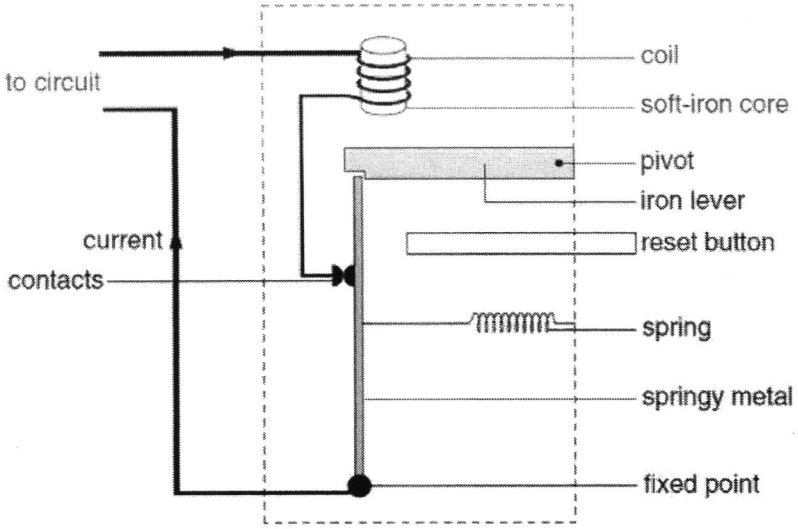

Fig. 8.2

The circuit breaker opens the circuit when the current gets too high. Explain how the circuit breaker works as a safety device in the household circuit.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

Section B (30 marks)

Answer **all** the questions in this section in the spaces provided.
Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows the arrangement used to measure the temperature rise of a piece of lead struck by an air-gun lead pellet.

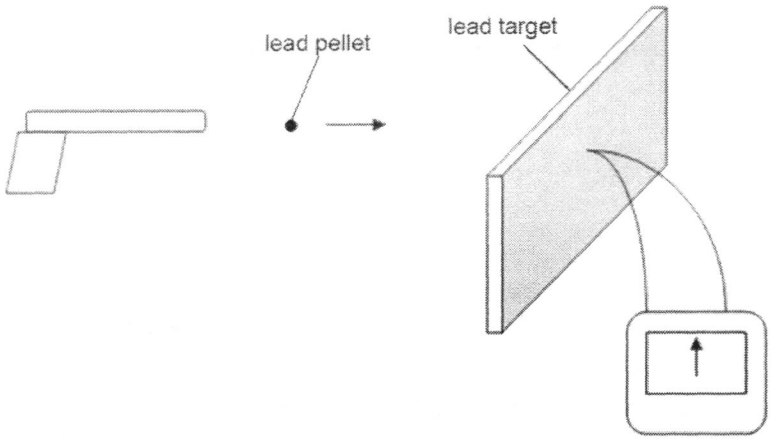

Fig. 9.1

The thermometer consists of a thermocouple whose junction is embedded in the lead. When the temperature of the junction is raised, a deflection is observed on the galvanometer.

After the lead pellet is fired into the lead target, the results and data are given below.

Mass of lead target = 35.5 g Mass of lead pellet = 0.5 g Deflection on galvanometer = 4 divisions Specific heat capacity of lead = 130 J / (kg °C) Galvanometer sensitivity = 5 divisions / °C

(a) Write down the thermometric property of the thermometer and state an assumption on using this property with respect to temperature measurements.

Thermometric property:.....

Assumption:.....

..... [2]

(b) Explain what is meant by *specific heat capacity of lead is 130 J / (kg °C)*.

.....

.....

..... [1]

(c) Determine the temperature rise of the lead target.

temperature rise = ... [1]

(d) Hence, calculate the thermal energy gained by the lead target.

thermal energy gained = ... [2]

(e) The lead target with the lead pellet embedded, is then detached from the thermometer and immersed into mixture of ice and water with 20 g of ice at 0 °C and 100 g of water at 25.0 °C. The initial temperature of the lead target and the lead pellet is 35.0 °C.

The specific heat capacity of water is 4200 J / (kg °C).
The specific latent heat of fusion of ice is 3.4×10^5 J / kg.

(i) Assuming all the ice melted in the process, calculate the final temperature of the lead target with the pellet embedded.

temperature = ... [3]

(ii) State an assumption you made in the above calculation.

.....

..... [1]

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10 **(a)** Fig. 10.1 shows a young boy lying on his back on the bottom of a swimming pool. He is holding his breath and his eyes are open. A red light is positioned on the ground at Q. At first the boy's head is touching the pool wall. He notices that, as he slides away from the pool wall, his eye reaches a point P where he first sees the light at Q. Fig. 10.1 shows the boy in this position.

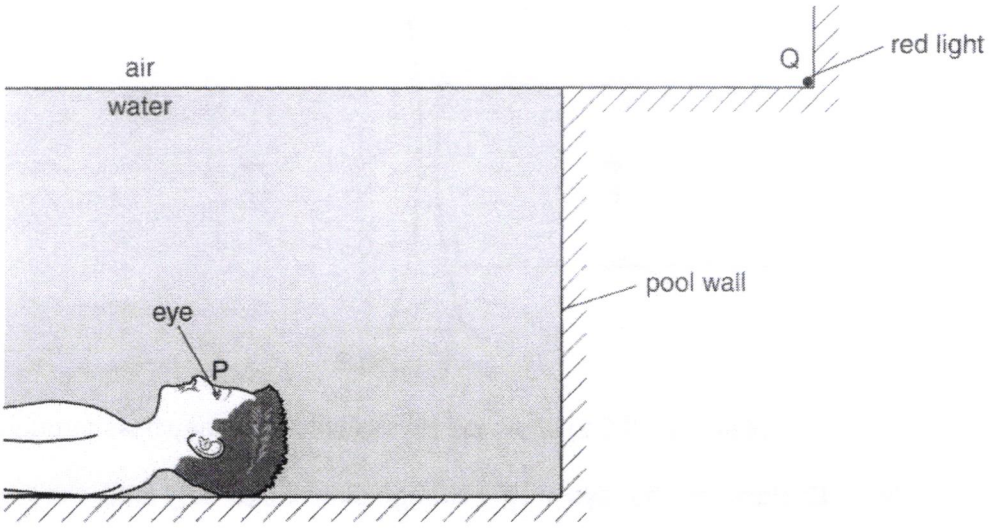

Fig. 10.1

(i) Define *critical angle*.

.....

.....

..... [1]

(ii) On Fig. 10.1, draw the ray of light travelling from Q to P. Mark the critical angle for light in water and label it C. [2]

(iii) Explain why the boy is **unable** to see the red light at Q when his eye is closer to the pool wall than P.

.....

.....

..... [1]

(iv) The critical angle is 49°. Calculate the refractive index of water.

refractive index = ... [2]

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(b) Fig. 10.2 shows parallel rays of light incident on a thin diverging lens.
The points labelled F show the principal focus on each side of the lens.

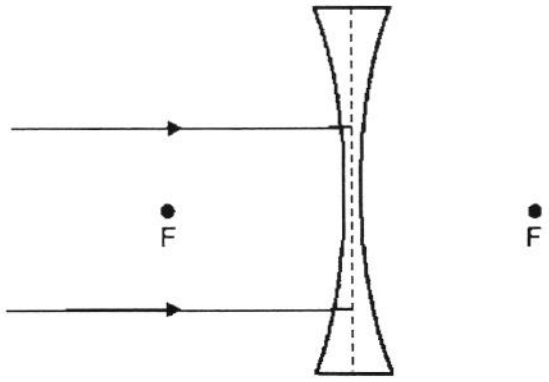

Fig. 10.2

(i) Complete Fig 10.2 to show the rays of light after they pass through the lens. [2]

(ii) Explain how the rays of light change direction as they enter the lens.

.....

.....

.....

..... [2]

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EITHER

11 **(a)** Fig. 11.1 shows a transformer.

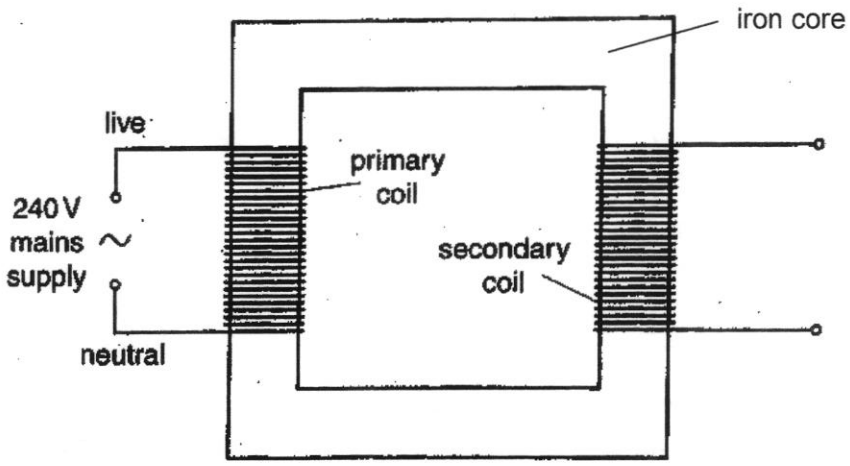

Fig. 11.1

(i) Explain why a soft iron core is used in a transformer instead of a steel core.

.....

.....

..... [1]

(ii) Explain how a current in the primary coil produces an output voltage in the secondary coil.

.....

.....

.....

.....

.....

..... [2]

(b) A student wants to test three transformers, A, B and C.

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. 11.2.

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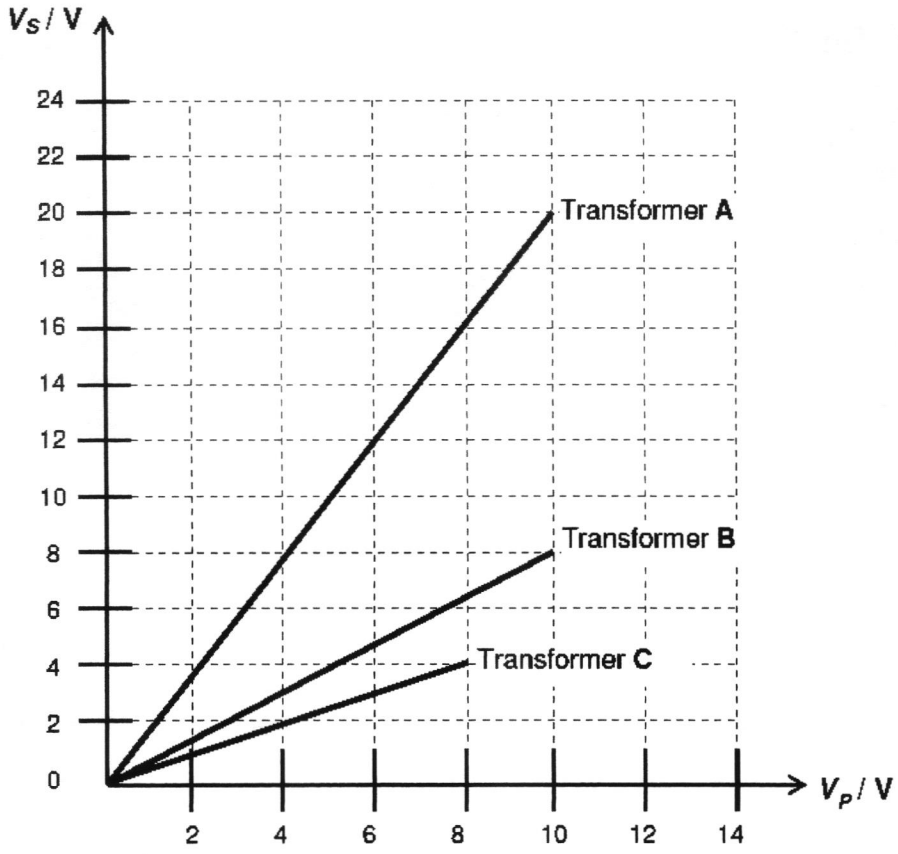

Fig. 11.2

(i) Using data from Fig. 11.2, describe the relationship between V_s and V_p.

.....

..... [1]

(ii) State which transformer(s) is/are step-up transformer(s) and which is/are step-down transformer(s).

Step-up transformer(s).....

Step-down transformer(s)..... [1]

(iii) The voltage in the primary coil, V_p, in transformer A is 10.0 V.

Determine the number of turns in the secondary coil.

number of turns = ... [2]

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(c) The output from the generator in the power station is connected to a step-up transformer. The transformer is connected to transmission lines as shown in Fig. 11.3.

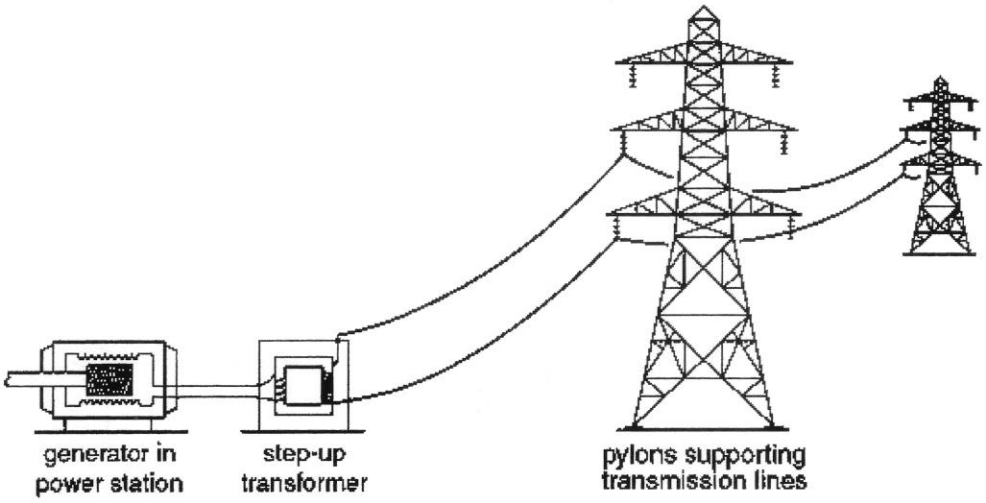


Fig. 11.3

(i) Explain why a step-up transformer is needed.

.....

.....

.....

.....

..... [2]

(ii) State one physical property that is considered in the choice of transmission lines. Explain your answer.

.....

..... [1]

OR

11 A man makes an anemometer, a device for measuring wind speed, out of apparatus shown below in Fig.11.4. When the wind blows, the spindle rotates, and the centre-zero voltmeter is deflected to give a reading.

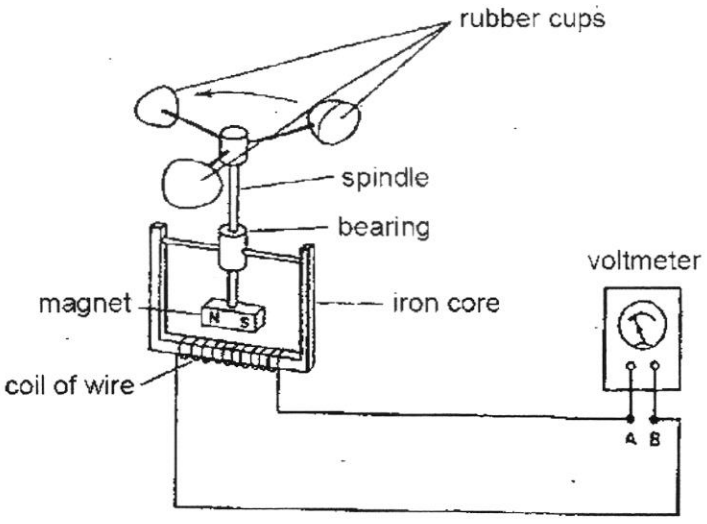


Fig. 11.4

(a) Explain how the rotating spindle causes the voltmeter pointer to be deflected.

.....

.....

.....

.....

.....

.....

..... [3]

(b) When the wind speed increases, the voltmeter shows a larger reading. Explain this observation.

.....

.....

..... [1]

(c) Suggest two ways in which the apparatus could be modified so as to obtain a bigger reading on the voltmeter.

.....

.....

..... [2]

(d) Using the oscilloscope with a time-base setting of 2.0 ms / cm and a Y-gain setting of 0.5 V / cm, the e.m.f. produced by the anemometer is displayed as shown in Fig. 11.5.

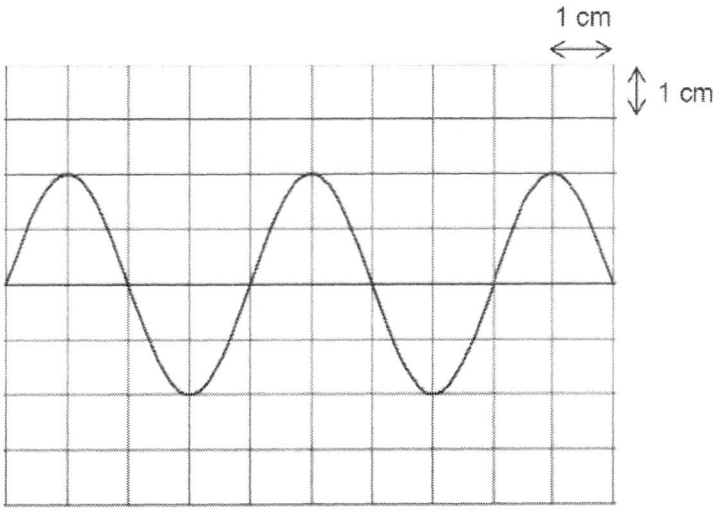


Fig. 11.5

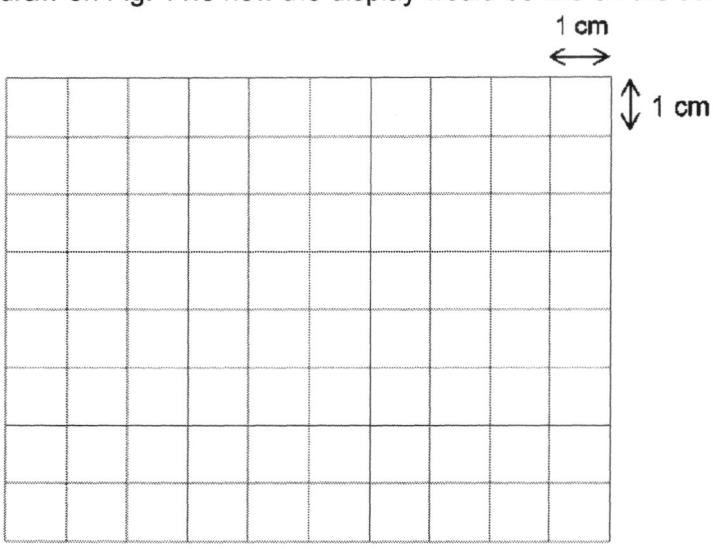
(i) Determine the peak voltage of the e.m.f.

peak voltage = ... [1]

(ii) Determine the frequency of the e.m.f.

frequency = ... [2]

(iii) If the time-base setting is switched off and the Y-gain setting is changed to 0.25 V / cm, draw on Fig. 11.6 how the display would be like on the screen.



[1]

Fig. 11.6

END OF PAPER

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DUNEARN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023
PHYSICS 6091/02 Secondary 4E

Paper 1 MCQ

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

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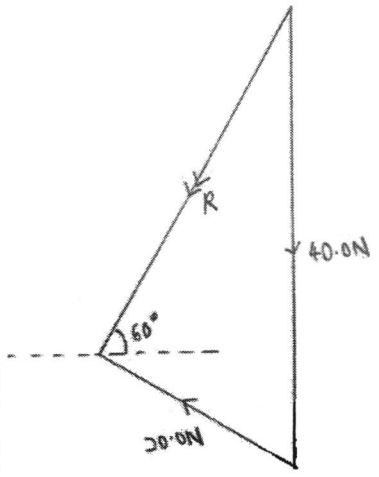
Section A

1a	 Scale = 1 cm : 5.0 N and correct method Resultant force = 6.9 cm x 5.0 = 34.5 N Direction = 60° with respect to the horizontal ground	1 1 Accept: 6.8 cm to 7.0 cm (34.0 N to 35.0N) 1
1b	34.5 N	1 Allow ecf from 1a
		4 marks
2a	Chemical potential energy → kinetic energy + gravitational potential energy + thermal energy + (sound energy)	1 1
2bi	0 m/s^2	1
2bii	From t = 5 s to t = 50 s, acceleration increases. From t = 50 s to t = 80 s, acceleration is constant.	1 1
2biii	Using (60, 600) and (100, 1400) a = (1400 – 600) / (100 – 60) = 20 m/s^2	1 1
2c	The downward force rocket exerts on gas is equal and opposite to the upward force the hot gas exerts on the rocket.	1
		8 marks
3a	The driving force is larger than the air resistance, hence there is a resultant force forward, causing the cyclist to accelerate. Air resistance will increase due to the increase in speed (acceleration), and will become equal to the driving force. Hence the resultant force is zero and the cyclist travels at constant speed.	1 1
3bi	½ x 75 x 4.0^2 = 600 J	1 1
3bii	Resultant force = 30 – 20 = 10 N 10 = 75 x a	1

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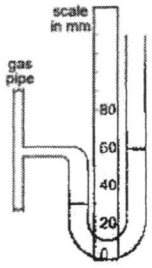
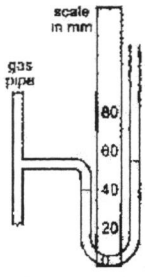
	a = 0.13 m/s^2	1
3c	Efficiency = (400 – 20)/400 = 95%	 1
		7 marks
4a	Volume = 15.0 x 3.0 x 0.10 = 4.5 m^3 Density = 12000 / 4.5 = 2666.66 = 2700 kg/m^3	1 1
4b	1.0 m	1
4ci	For an object in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anti-clockwise moments about the same pivot.	1 1
4cii	ACM = CM 120 000 x 1.0 = F x 0.50 F = 240 kN	 1 1
5a	Larger	1
5bi		1 Difference is 30 mm
5bii		1 Difference is 15 mm
5c	Difference between trapped air and gas pipe = 10 mm of water Difference between atmospheric pressure and gas pipe = 30 mm of water Difference between trapped air and atmospheric pressure = 20 mm of water Pressure = 0.02 x 1000 x 10 = 200 Pa	 1 1
		5 marks

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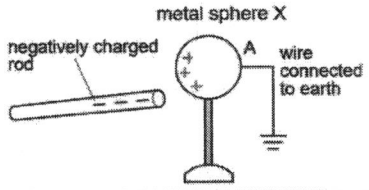
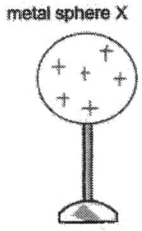
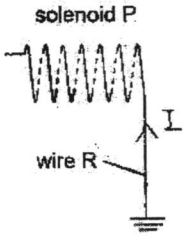
6a	Atoms of helium travel at high speeds and collide with the inner walls of the balloon. Each collision exerts a force, and multiple collisions take place over the surface area of the balloon, creating a pressure.	1 1
6b	As atmospheric pressure decreases, the pressure inside the balloon becomes greater than the pressure outside relatively. The volume increases, causing frequency of collisions to decrease. The pressure in the balloon decreases and the balloon stops expanding once it is equal to atmospheric pressure.	1 1 1
		5 marks
7a		1
7b	Remove the wire connected to earth from X. Then bring the negatively charged rod away from X.	1 1
7c		1
7d	Electrons are repelled by the negatively charged rod since like charges repel. Electrons will flow from the left side of metal sphere Y through solenoid P to Earth.	1 1
7e		1
7f	The galvanometer will deflect to one side momentarily, deflect to the other side momentarily again and returns to zero.	1
		8 marks
8a	Effect on resistor: Remains constant Effect on thermistor: Decreases	1 1
8b	When a high current passes through, the iron core is magnetized (or becomes a stronger electromagnet) because a magnetic field is set up in the coil.	1

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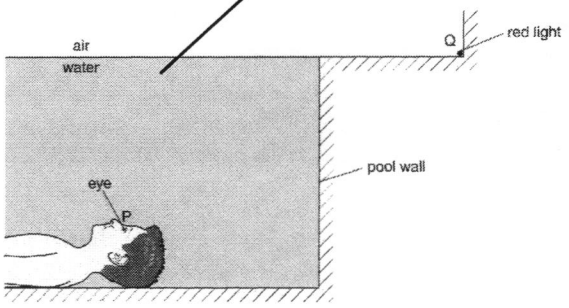
	The magnetized core then induces magnetism in the iron lever and attracts it, rotating it about the pivot and lifting it up. This causes the springy metal to be released as it is pulled by the spring and this causes the contacts to be opened. The spring also pulls the springy metal towards the reset button thereby pushing it outwards. (or any mention of how the reset button can be used)	1 1 1
		6 marks

Section B

9a	Themometric property: Electrical voltage or electromotive force (e.m.f.) Assumption: The e.m.f. varies linearly with temperature.	1 1
9b	130 J of thermal energy is required to raise the temperature of 1 kg of lead by 1 °C.	1
9c	Temperature rise = 4/5 = 0.8 °C	1
9d	Q = (35.5/1000) x 130 x 0.8 = 3.692 J = 3.7 J	1 1
9ei	Heat gained by ice = 0.02 x 3.4 x 10^5 + 0.02 x 4200 x (T – 0) Heat lost by water = 0.1 x 4200 x (25 – T) Heat lost by lead = (35.5 + 0.5)/1000 x 130 x (35.0 – T) Heat gained by ice = Heat lost by water + Heat lost by lead T = 7.595 = 7.6 °C	1 1 Award for heat lost by water or lead 1
9eii	No thermal energy is lost/gained to the surroundings.	1
		10 marks
10ai	Critical angle is the angle of incidence in the optically denser medium in which the angle of refraction in the optically less dense medium is 90°.	1
10aii	 Horizontal way from Q to pool edge and on to P from corner. Critical angle marked C.	1 1
10aiii	For a horizontal ray of light, or when the angle of incidence is 90°, the angle of refraction in water cannot be less than the critical angle (or can only be equal to the critical angle).	1
10aiv	n = 1/sin 49°	1

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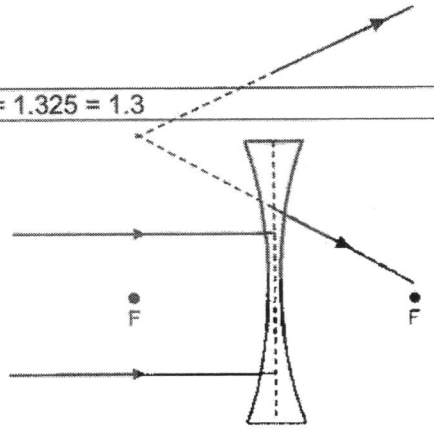
	n = 1.325 = 1.3	1
10bi	 1m for each correctly drawn ray Deduct 1m if there is ray is not dotted	2
10bii	As light travels from a less optically dense medium (air) to the optically denser medium, (glass), it will bend towards the normal, as the speed of light decreases.	1 1
		10 marks
E 11ai	Soft iron is more permeable to magnetic field lines and does not retain magnetism after the magnet is removed.	1
11aii	The current in the primary coil will set up a changing magnetic field in the primary coil and the iron core, which links to the secondary coil. By Faraday's law of electromagnetic induction, the rate of change in magnetic flux cutting the secondary coil produces an induced emf/voltage in the secondary coil.	1 1
11bi	V_P is directly proportional to V_S.	1
11bii	Step-up: A Step-down: B and C	1
11biii	From graph, V_S = 20 V 250 / 10 = N_S / 20 N_S = 500 turns	1 1
11ci	Electricity needs to be transmitted at high voltages to reduce the current flowing in the cables. This is to reduce the loss of power due to Joule heating in the cables as $P = I^2R$.	1 1
11cii	Lightweight / Good conductor of electricity / Low resistivity	1
		10 marks

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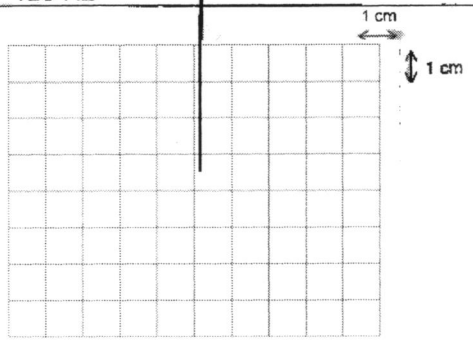
O 11a	When the rotating spindle rotates, the magnet rotates. This causes a rate of change of magnetic flux cutting the coil of wire through the iron core. By Faraday's law of electromagnetic induction, the rate of change of magnetic flux cutting the coil of wire produces an emf in the coil, causing the voltmeter pointer to be deflected.	1 1 1
11b	The spindle spins faster when wind speed increases, causing a greater rate of change of magnetic flux cutting the coil of wire.	1
11c	Larger rubber cups to catch more wind Increase the number of turns of coil of wire Use a stronger magnet Lubricate the bearing to reduce friction	Any 2
11di	1.0 V	1
11dii	1 / (8.0 x 10^{-3}) = 125 Hz	1 1
11diii		1
		10 marks

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