



ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY 4 EXPRESS

Candidate's Name	Class	Register Number

PHYSICS

6091 /01

Paper 1

26 August 2025
1 hour

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, index number and class on the OTAS in the spaces provided.

There are **forty** 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 OTAS.

Read the instructions on the OTAS 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 booklet.

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

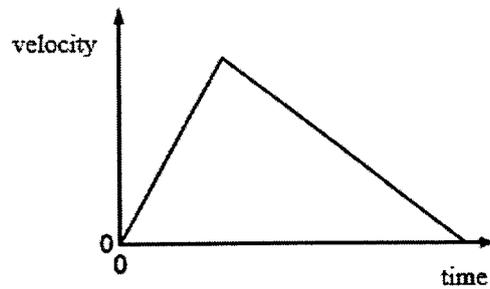
2

- 1 Velocity is given by the change in displacement divided by the change in time.

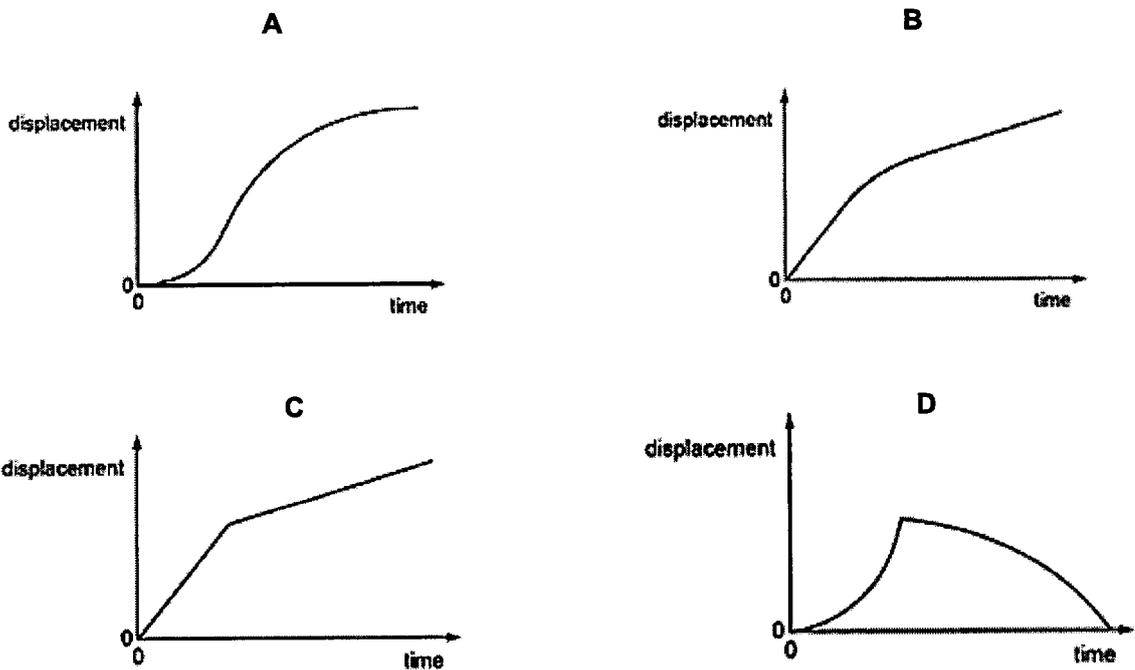
How many vector quantities appear in this statement?

- A 0 B 1 C 2 D 3

- 2 The velocity-time graph represents a short journey of an object.



Which displacement-time graph represents the same journey?



- 3 A man drives from Serangoon to Woodlands. The total distance he travels is 19 km. He started driving from Serangoon for 15 min and rested half an hour at a coffee shop. He then continued driving 20 min before he reached Woodlands.

What is the man's average driving speed?

- A 0.54 km/h B 18 km/h C 19 km/h D 33 km/h

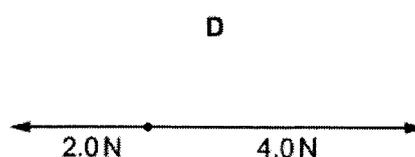
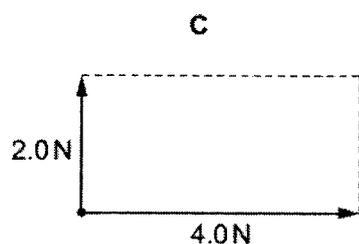
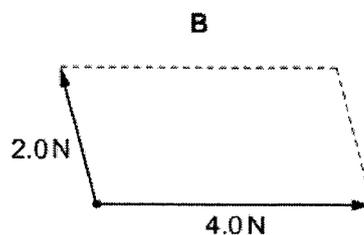
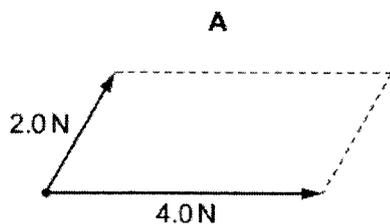
- 4 The table below shows the readings on a car speedometer at every five seconds interval.

time / s	speed / km/h
0	0
5	10
10	22
15	36
20	54

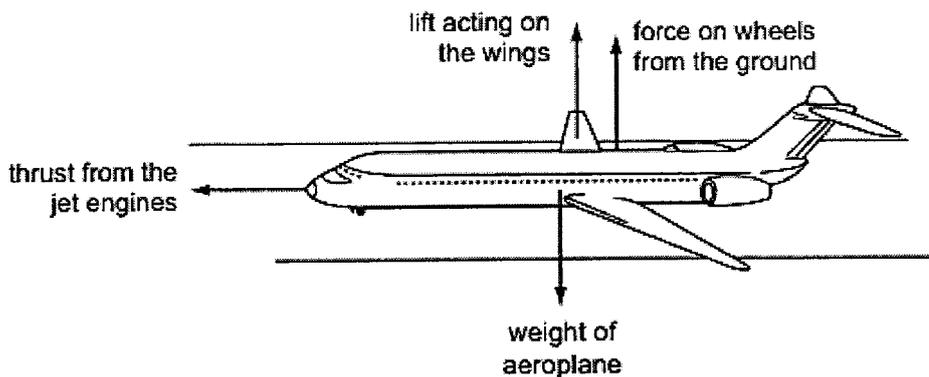
Which of the following describes the acceleration of the car?

- A constant
 - B decrease
 - C Increase
 - D zero
- 5 Forces of 4.0 N and 2.0 N act at a point.

Which scale diagram shows the forces that have a resultant of 4.0 N?



- 6 An aeroplane is half way along a runway before it takes off. The arrows show the directions of four forces acting on the aeroplane.

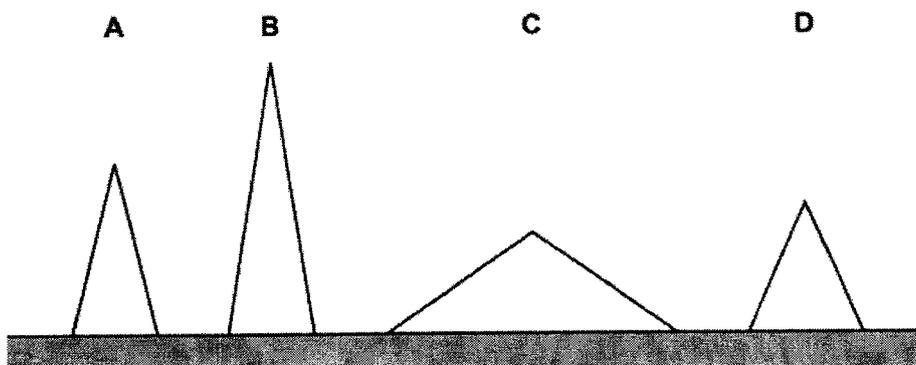


The drag forces on the aeroplane are negligible. The gravitational field strength g is 10 N/kg . The acceleration of the aeroplane is 2.0 m/s^2 .

What is the largest force?

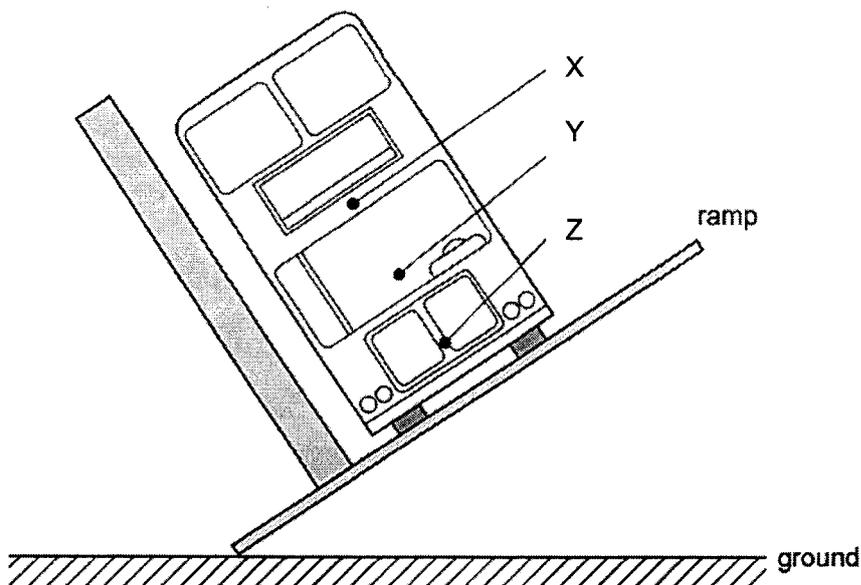
- A the force on wheels from the ground
 - B the lift acting on the wings
 - C the thrust from the jet engines
 - D the weight of the aeroplane
- 7 Four solid uniform cones have equal weight. They are placed on a bench as shown in the scale diagram.

Which cone is the most stable?



5

- 8 The stability of a bus is tested by tilting it on a ramp. The diagram shows a bus that is just about to topple over.

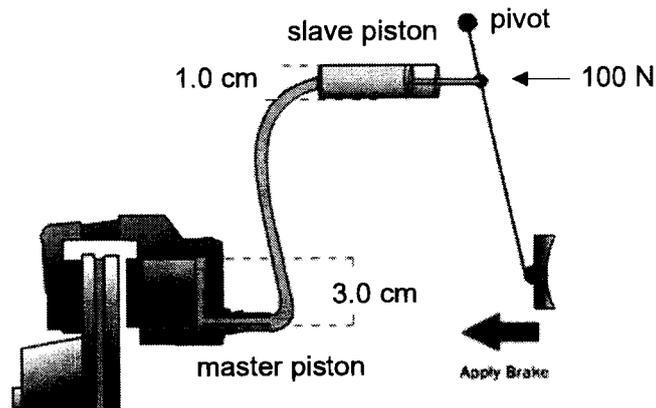


Which statement is correct?

- A** Centre of gravity is at position X and anti-clockwise moments is contributed by the weight of the bus, about the pivot.
- B** Centre of gravity is at position Y and zero moments is contributed by the weight of the bus, about the pivot.
- C** Centre of gravity is at position Z and zero moments is contributed by the weight of the bus, about the pivot.
- D** Centre of gravity is at position Z and clockwise moments is contributed by the weight of the bus, about the pivot.

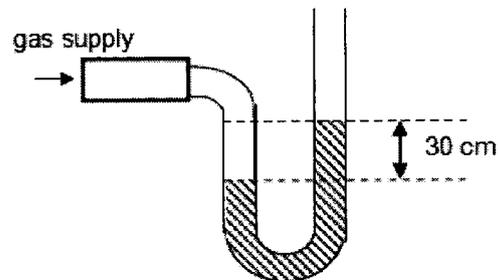
[Turn over

- 9 The diagram shows a simple car brake system. The slave piston and the master piston has a diameter of 1.0 cm and 3.0 cm respectively.



If the force exerted on the slave piston is 100 N, what is the force exerted on the master piston during braking?

- A 200 N B 300 N C 600 N D 900 N
- 10 A mercury manometer that is connected to a gas supply. Atmospheric pressure is assumed to be 0.75 mHg.



What is the pressure of the gas supply?

- A 29 cmHg B 31 cmHg C 45 cmHg D 105 cmHg
- 11 A man lifts five slabs from the ground on to the back of a lorry 1.5 m high. The total time taken is 50 s and each slab weighs 20N.
- How much useful power does the builder produce?
- A 0.60 W B 3.0 W C 30 W D 1500 W

- 12 Hydroelectric, biofuel and fossil fuel power stations generate electrical energy.

Which option shows renewable and non-renewable energy sources?

	hydroelectric	biofuel	fossil fuel
A	non-renewable	renewable	renewable
B	non-renewable	non-renewable	renewable
C	renewable	non-renewable	non-renewable
D	renewable	renewable	non-renewable

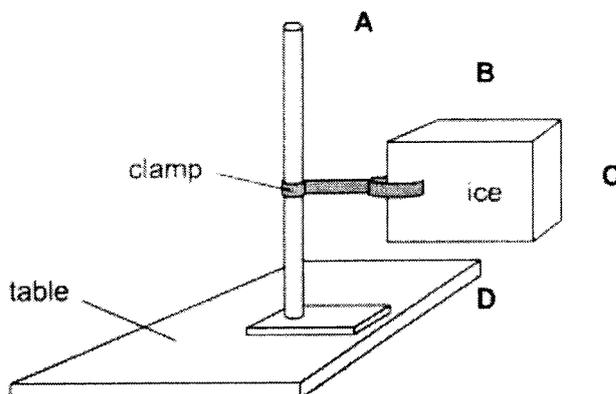
- 13 Gas in a sealed glass container is cooled.

What happens to the gas molecules?

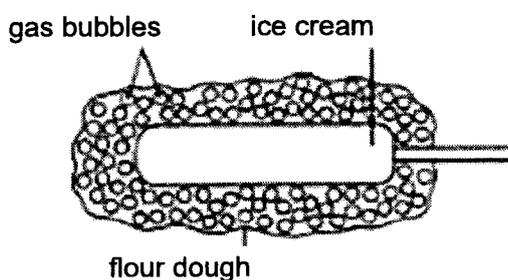
- A** They move closer together and their average speed decreases.
- B** They move closer together and their average speed increases.
- C** They move further apart and their average speed decreases.
- D** They stay the same distance apart and their average speed decreases.
- 14 When pollen grains suspended in water are viewed under the microscope, they are seen to be making small, erratic movements.
- Which statement explains the movements?
- A** There are convection currents in the water.
- B** The grains are being hit by air molecules.
- C** The grains are being hit by water molecules.
- D** The grains are moving and colliding with one another.

- 15 The diagram shows a block of ice placed in a warm room.

At which point is the temperature the lowest?



- 16 The diagram shows a stick of ice cream that is fried in hot oil. Before the ice cream was fried, it was dipped in dough mixed with bicarbonate of soda.

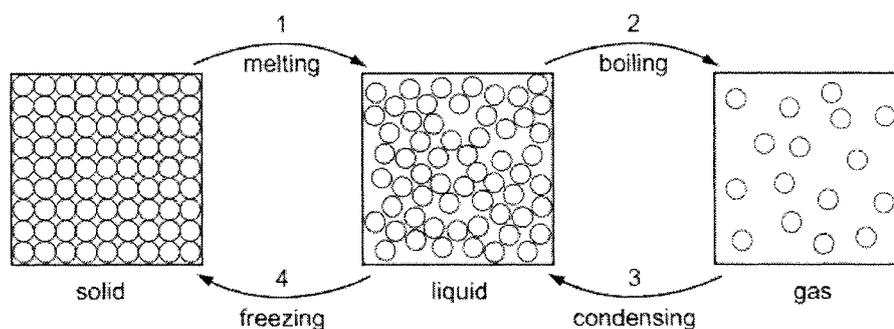


Why does the ice cream remain frozen after it has been fried?

- A** The dough contains gas bubbles which allow heat energy that is trapped in the region near the ice cream to escape to the environment via convection currents.
- B** The dough contains gas bubbles which is a poor conductor of heat energy from hot oil to cold ice cream.
- C** The heat energy from the hot oil is not able to radiate effectively to the cold ice cream.
- D** The ice cream which is removed from the freezer has a layer of ice around it and ice is a good insulator of heat energy.
- 17 What is the correct unit for latent heat of vaporisation?

- A** J **B** J/kg **C** J/kgK **D** J/kg°C

- 18 Substances can change from one state to another as shown.



For substances to change from one state to another, there is a change in the internal energy between the particles in the system.

Which option correctly shows the changes involving the energy store that is made up of the total kinetic energy and the total potential energy between the particles in the system?

	stage	change in total kinetic energy	change in total potential energy
A	1	increases	increases
B	2	increases	decreases
C	3	no change	decreases
D	4	decreases	increases

- 19 A heater with a power rating of 1000 W is used to heat water of mass 0.10 kg. The water was initially at 30 °C and started boiling. At the end of time t , the mass of water left is 0.080 kg.

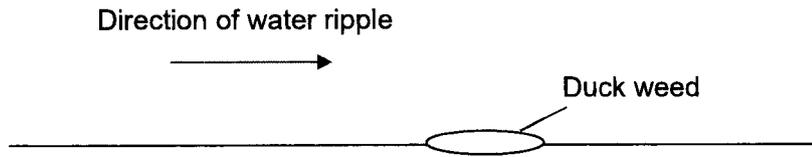
The specific heat capacity of water is 4.2 kJ/(kgK).

The specific latent heat of vaporization of water is 2.2×10^6 J/kg.

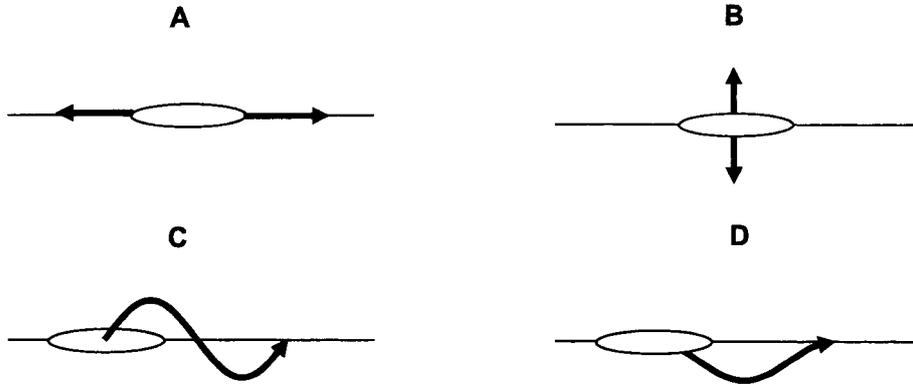
What is t ?

- A** 44 s **B** 73 s **C** 180 s **D** 210 s

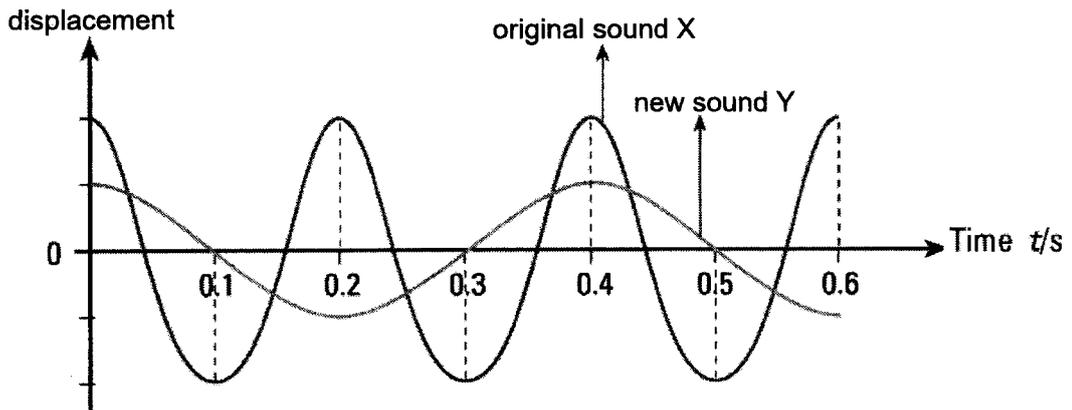
20 Diagram shows a duck weed in the way of a water ripple.



Which best describes how the duck weed will move as the water ripple passes through?



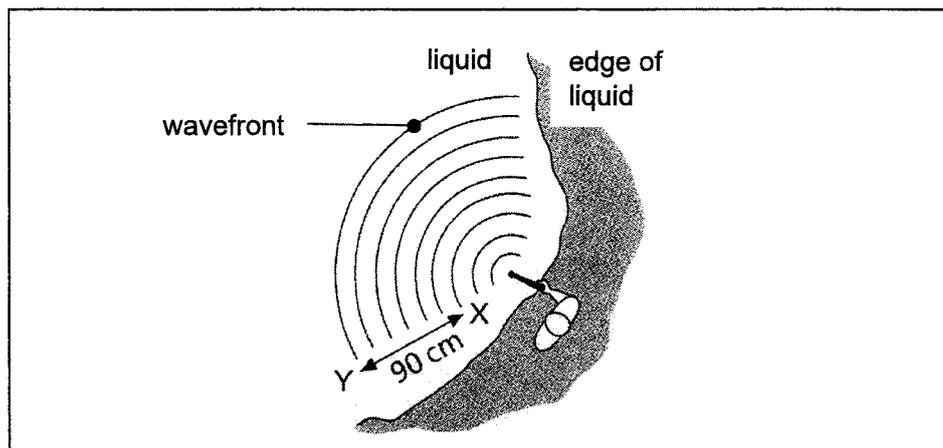
21 The displacement-time graph below represents the original, sound X and the new sound, Y, made by a violin.



Which of the following describes the change in loudness and pitch correctly?

	loudness	pitch
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

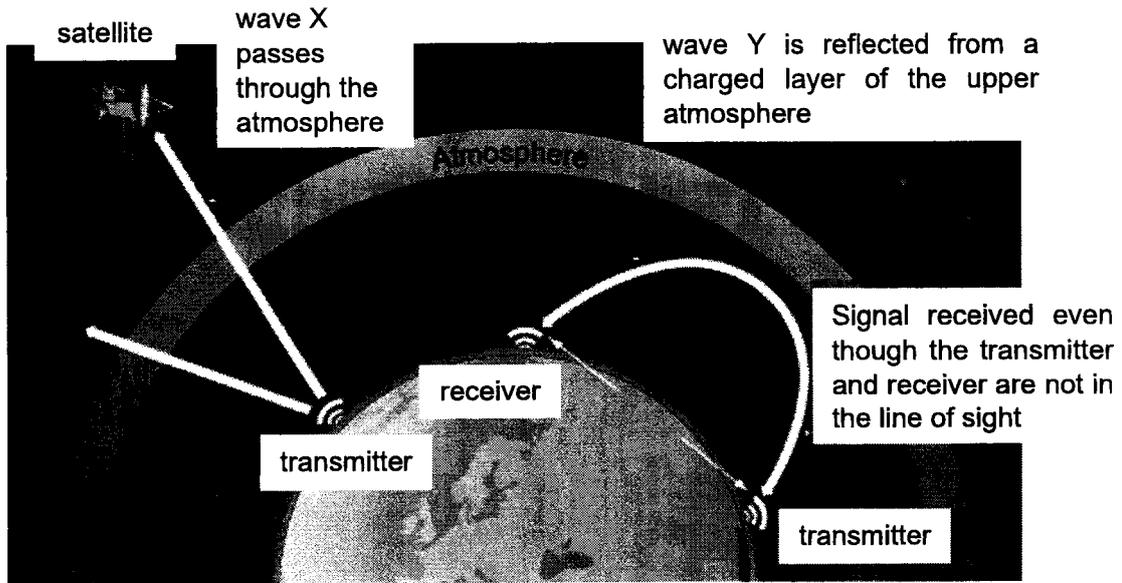
- 22 The robotic arm of a space probe is used to map the depth of the liquid body in Planet W as shown in the diagram below.



What is the wavelength of the wave and how did the frequency and speed change?

	wavelength / cm	frequency	speed
A	13	increased	increased
B	15	unchanged	unchanged
C	15	decreased	decreased
D	90	unchanged	unchanged

- 23 The diagram shows radio waves being transmitted from transmitters and received by either a receiver or a satellite.



What is electromagnetic wave X and Y?

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

- 24 A student holds a sheet of paper with letters on it facing a plane mirror. The letters on the paper are shown.

TOF

What does the student see in the mirror?

A
B
C
D

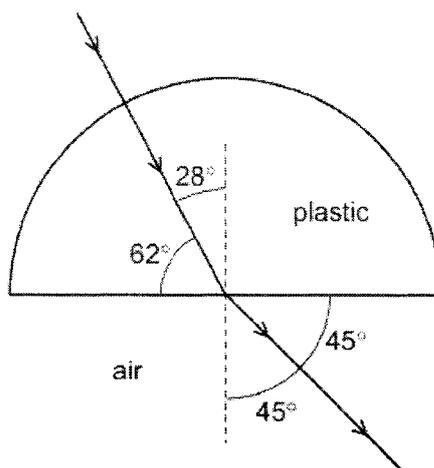
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TOF

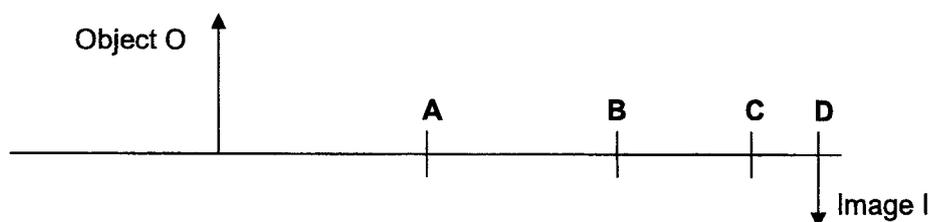
TOF

- 25 A semi-circular block is made from a plastic. A ray of light passes through it at the angles shown.



What is the refractive index of the plastic?

- A 1.3 B 1.4 C 1.5 D 1.6
- 26 Which statement correctly describes total internal reflection?
- A Light travels from optically denser to less dense medium and is total reflected within the denser medium.
- B Light travels from optically denser to less dense medium and is total reflected within the less dense medium.
- C Light travels from optically less dense to denser medium and is total reflected within the denser medium.
- D Light travels from optically less dense to denser medium and is total reflected within the less dense medium.
- 27 Diagram shows the image I formed when object O is placed in front of a thin converging lens. Which is the principal focus of the lens?



- 28 A triangular aperture of side 1.0 cm (Fig. 18A) is placed in front of a thin converging lens, as shown in Fig. 18B. When light is shone through the aperture, an image is formed on the screen placed 30.0 cm away.

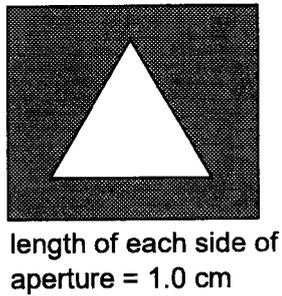


Fig. 18A

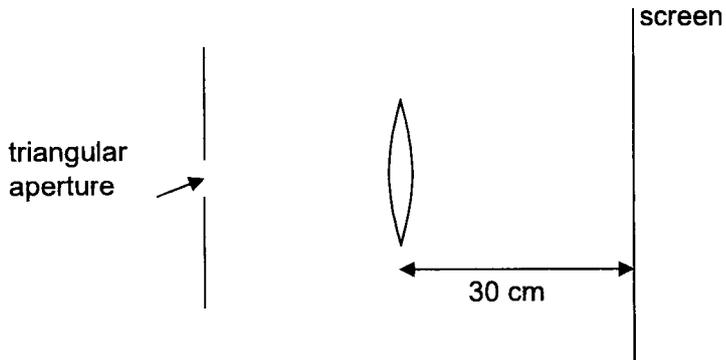
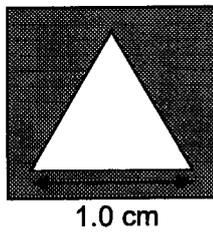


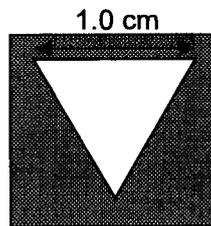
Fig. 18B

If the focal length of the lens is 15.0 cm, which is the image formed on the screen?

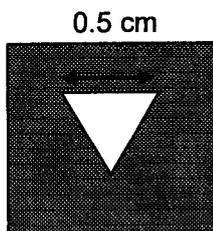
A



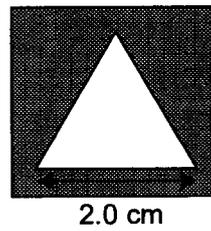
B



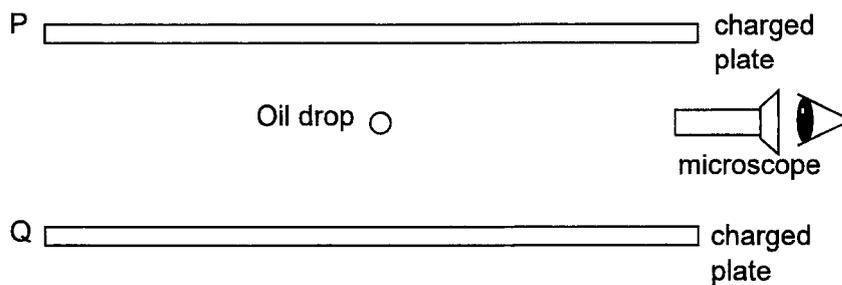
C



D



- 29 Diagram shows an experiment performed by physicist Robert Millikan in 1909.



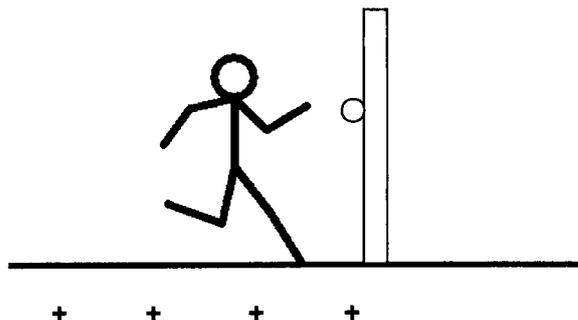
In the experiment, he placed a negatively charged oil drop between a pair of charged parallel plates. He then attempted to stop the oil drop from falling under the influence of gravity by changing the strength of the electric field between the plates.

What are the charges formed on plates P and Q, and the combined electric field pattern between the oil drop and the two plates?

	P	Q	Electric field pattern
A	Positive	Negative	
B	Positive	Negative	
C	Negative	Positive	
D	Positive	Positive	

[Turn over

- 30 A man walks bare-foot in an air-conditioned room and rubs his feet against the carpet. The carpet is then charged positively.



He then touches a wooden door knob. Which correctly describes the charges on the knob and the man?

	charge on man	charge on knob
A	negatively charged	neutral
B	negatively charged	positively charged
C	positively charged	neutral
D	positively charged	negatively charged

- 31 Sets of voltage-current readings are obtained for different electrical components.

Which set of readings is for a $100\ \Omega$ resistor?

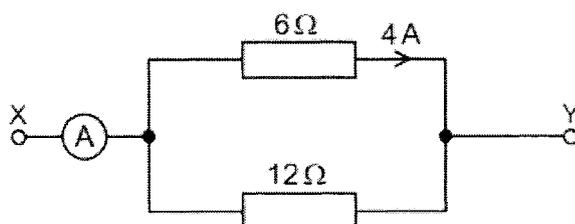
A	voltage/ V	-3	-2	-1	0	+1	+2	+3
	current/ mA	-30	-15	-5	0	+5	+15	+30
B	voltage/ V	-3	-2	-1	0	+1	+2	+3
	current/ mA	-30	-20	-10	0	+10	+20	+30
C	voltage/ V	-3	-2	-1	0	+1	+2	+3
	current/ mA	-60	-40	-20	0	+20	+40	+60
D	voltage/ V	-3	-2	-1	0	+1	+2	+3
	current/ mA	-60	-45	-30	0	+30	+45	+60

- 32 A pair of crocodile clips is inserted into a lemon and connected to a small light-bulb. The lemon carries $2.0\ \text{C}$ of charge and the charge takes $8.5 \times 10^{-3}\ \text{min}$ to travel from one end of the clip to the other.

What is the current produced by the lemon?

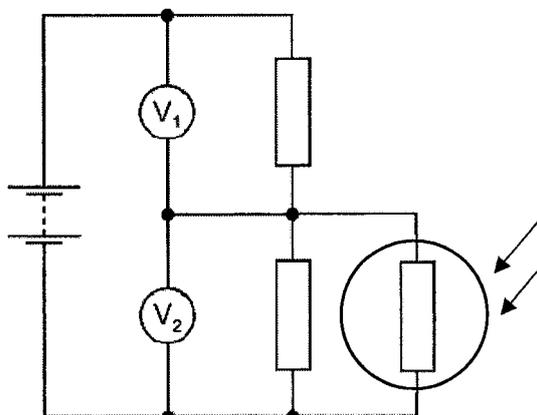
- A** 0.017 A **B** 1.0 A **C** 3.9 A **D** 240 A

- 33 Two resistors of $6\ \Omega$ and $12\ \Omega$ are arranged in parallel. A potential difference is connected across the terminals X and Y. The current in the $6\ \Omega$ resistor is $4\ \text{A}$.



What is the current in the ammeter?

- A 4 A B 6 A C 8 A D 12 A
- 34 The circuit diagram shows a light dependant resistor (L.D.R.) connected in parallel to the lower half of a potential divider.

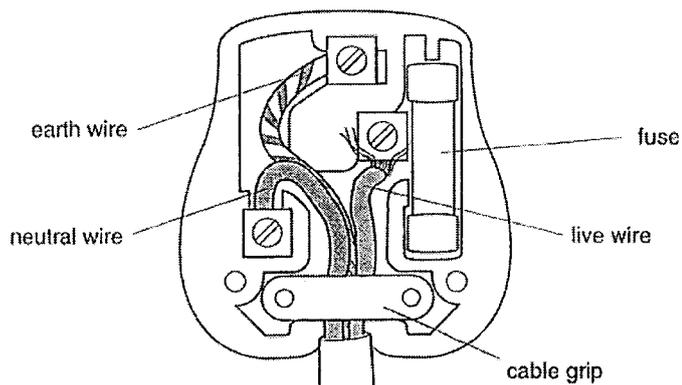


The brightness surrounding the L.D.R. decreases.

What happens to the two voltmeter readings?

	reading on V_1	reading on V_2
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 35 The following shows a three-pin plug of a kettle whose live wire has not been connected properly.

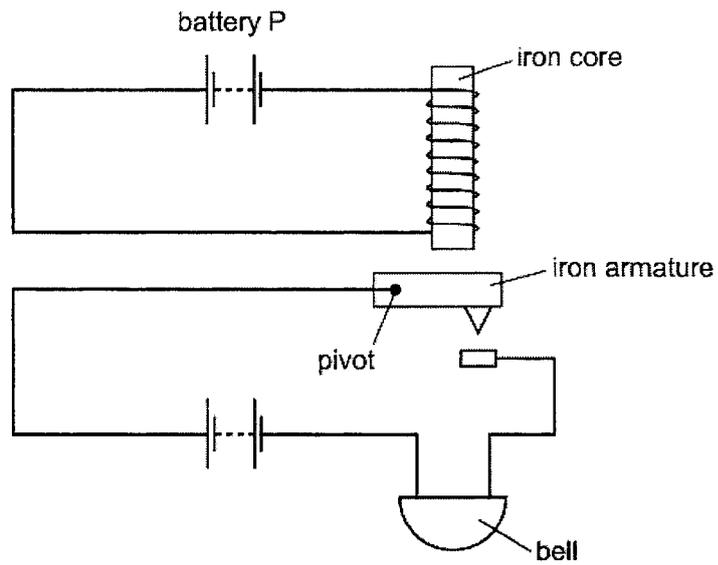


The exposed copper wires of the exposed live wire touch the neutral pin.

Which of the following will occur?

- A The current increases and the fuse will blow to prevent any electrical fire risk.
- B The earth wire will divert the high current to the ground to prevent any electrical risk.
- C The metal casing of the kettle will be at high potential and pose an electrocution risk.
- D The neutral wire will divert the high current to the ground to prevent any electrical risk.

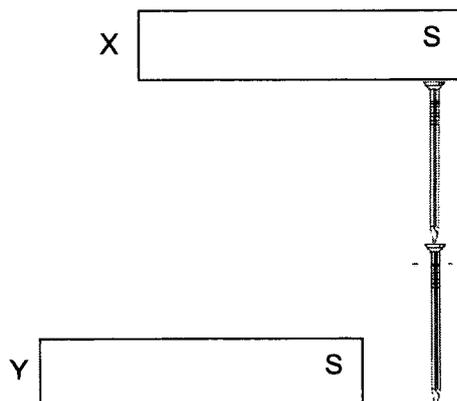
- 36 The diagram shows an alarm system.



What happens when battery P is disconnected?

	iron armature	bell
A	falls	rings
B	moves up	stop ringing
C	moves up	rings
D	stays horizontal	stop ringing

- 37 Two nails are attracted to a magnet X. A second magnet Y is held near the bottom of the nails.

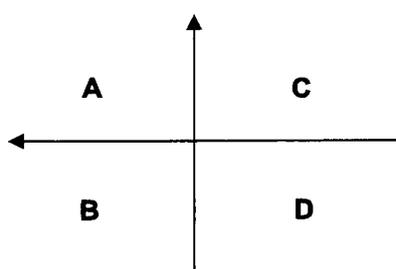


Which statement describes the motion of the nails?

The nails will

- A drop to the ground.
 - B remain stationary.
 - C swing to the left.
 - D swing to the right.
- 38 Equal amount of current is flowing in two insulated wires, perpendicular to each other as shown in the figure below.

Which segment, **A**, **B**, **C** or **D**, has the strongest magnetic field flowing into the paper?



- 39 Fig. 39.1(a) shows a simple alternating current (a.c.) generator and Fig. 39.1(b) shows the initial voltage produced against time.

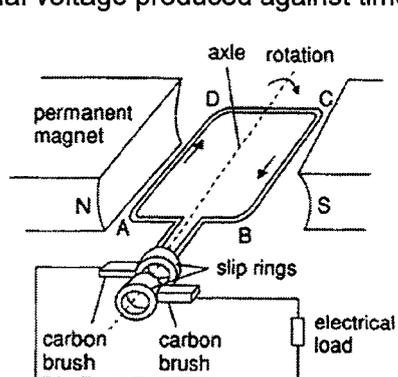


Fig. 39.1(a)

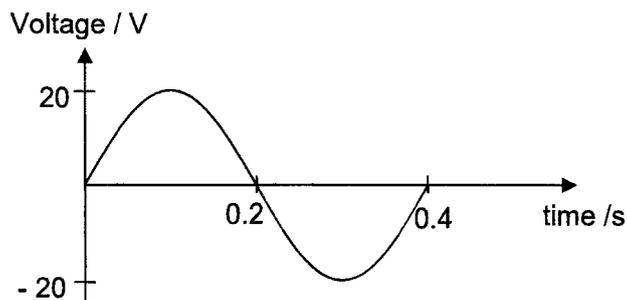


Fig. 39.1(b)

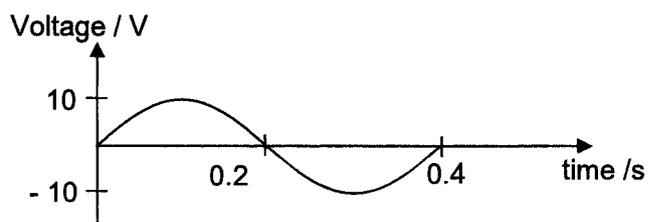


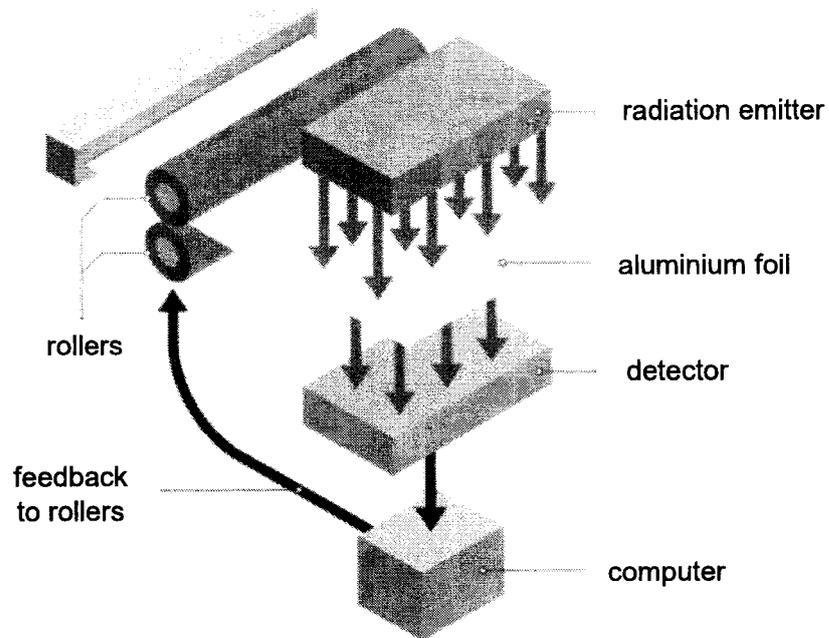
Fig. 39.2

After a certain change was made to the a.c. generator, the voltage against time waveform is as shown in Fig. 39.2.

What is likely to be the change?

- A Reduce the rotating speed.
- B Use a magnet that has a weaker strength.
- C Increase the number of turns of the coil in the generator.
- D Place a soft iron core in the centre of the coil.

- 40 The diagram shows a machine that is used to produce aluminium foil of the correct thickness. Radiation is made to pass through the foil.



If the foil is too thick, it absorbs more radiation and if the foil is too thin, it absorbs less radiation. The detector will send signals to the rollers to either increase or decrease the force on the foil.

Which type of radiation is suitable to use?

- A alpha-particles only
- B beta-particles only
- C gamma-rays only
- D either alpha-particles or beta-particles



ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY 4 EXPRESS

Candidate's Name	Class	Register Number

PHYSICS

6091 /02

Paper 2

28 August 2025
1 hour 45 minutes

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer **one** question.

Write your answers in the spaces provided on the question paper.

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

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.

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

Setter: Mr Tan Jun Hong and Mrs Ngiam-Fok Kar Yin
 Vetter: Sec 4E Pure Physics Teachers

This document consists of 21 printed pages and 1 blank page.

[Turn over

Section A

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

- 1 A drone was initially flying towards the west at a velocity of 15 m/s at time, $t = 0$ s. It then decelerated uniformly until it came to a stop at $t = 10$ s. The drone then turned and its velocity increases at a uniform rate of 2.0 m/s^2 for another 12 seconds towards the east.

- (a) Sketch, in the axes provided below in Fig. 1.1, the velocity-time graph of the drone.

velocity / ms^{-1}

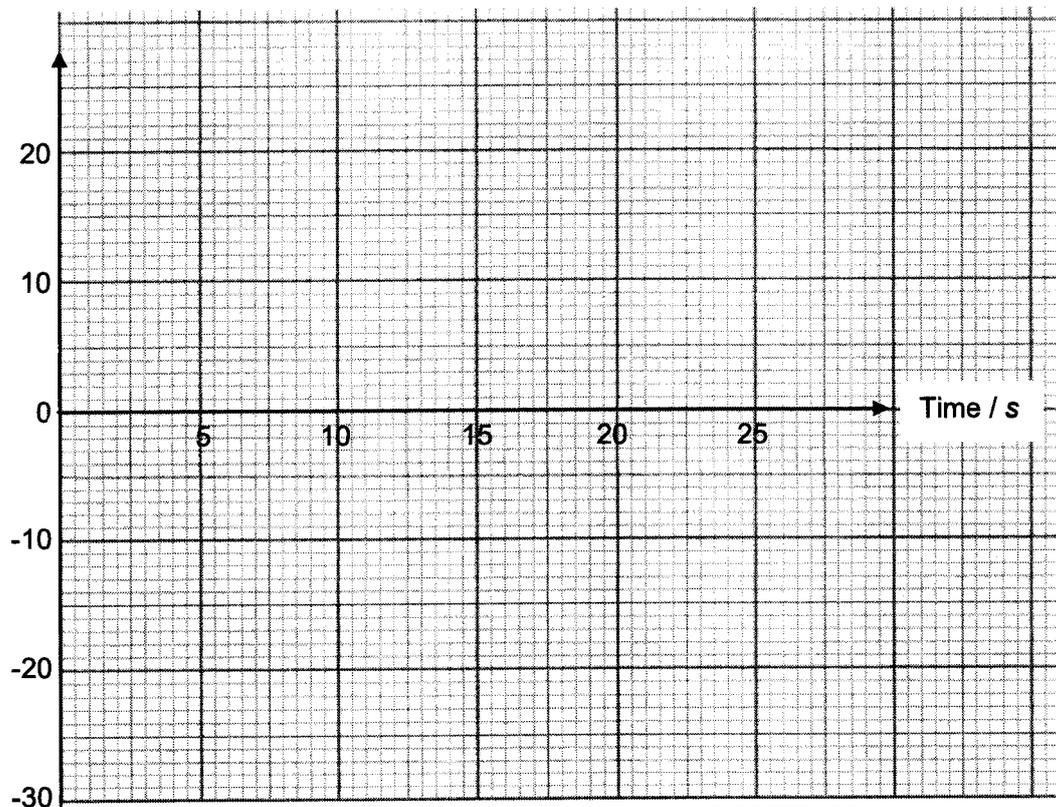


Fig. 1.1

[2]

- (b) Calculate the deceleration of the drone at $t = 0$ s.

deceleration = _____ [1]

- (c) Calculate the average speed of the drone for the entire duration of flight.

average speed = _____ [2]

- 2 Fig. 2.1 shows a toy water rocket.

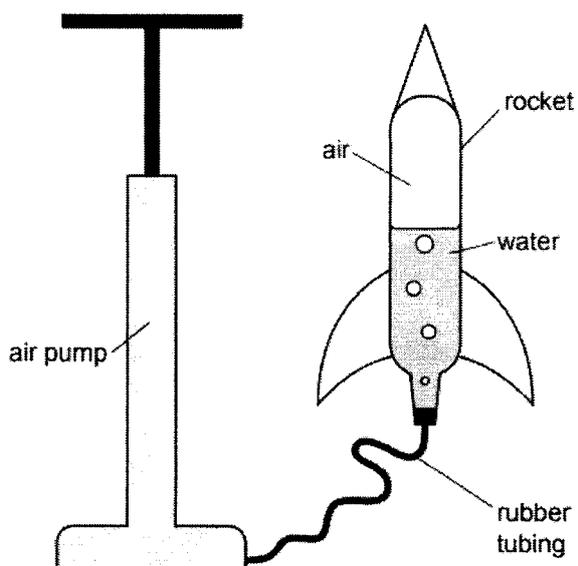


Fig. 2.1

The rocket is half-filled with water and connected by rubber tubing to a pump.

- (a) Air is then pumped into the rocket so that the pressure of the air inside the rocket increases.

Explain, in terms of particles, why the air in the rocket exerts a pressure on the walls of the rocket.

[2]

[Turn over

- (b) When the air pressure in the rocket is high, the rubber tubing is removed from the rocket. The water in the rocket is expelled downwards.

Use Newton's laws of motion to explain why the rocket begins to accelerate upwards.

.....

.....

.....

..... [2]

- (c) As the water is expelled from the rocket, the upward acceleration of the rocket decreases.

Suggest two reasons for the change in the acceleration of the rocket.

.....

.....

.....

..... [2]

- 3 A worker carries a ladder horizontally on his shoulder as shown in Fig. 3.1. His shoulder acts as a pivot.

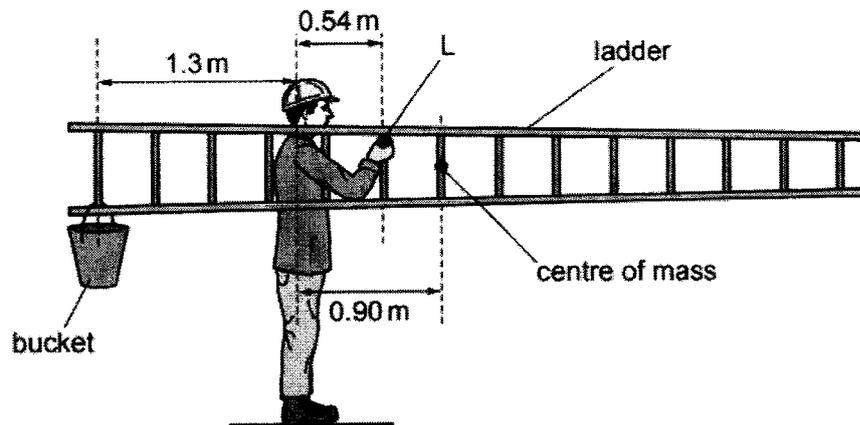


Fig. 3.1

The weight of the ladder is 80 N.

- (a) Explain what is meant by *moment of a force*.

.....

..... [1]

- (b) The centre of mass of the ladder is a horizontal distance of 0.90 m from the worker's shoulder.

Calculate the moment about the worker's shoulder of the weight of the ladder.

moment = [1]

- (c) A bucket of weight 87 N is suspended from the ladder at a horizontal distance of 1.3 m from the worker's shoulder. The worker keeps the ladder horizontal by exerting a vertical force at point L. L is a horizontal distance of 0.54 m from his shoulder.

Determine the size and direction of the force exerted at L.

size of force =

direction = [3]

[Turn over

- 4 Faith's toy consists of a flexible track and a model car as shown in Fig. 4.1.

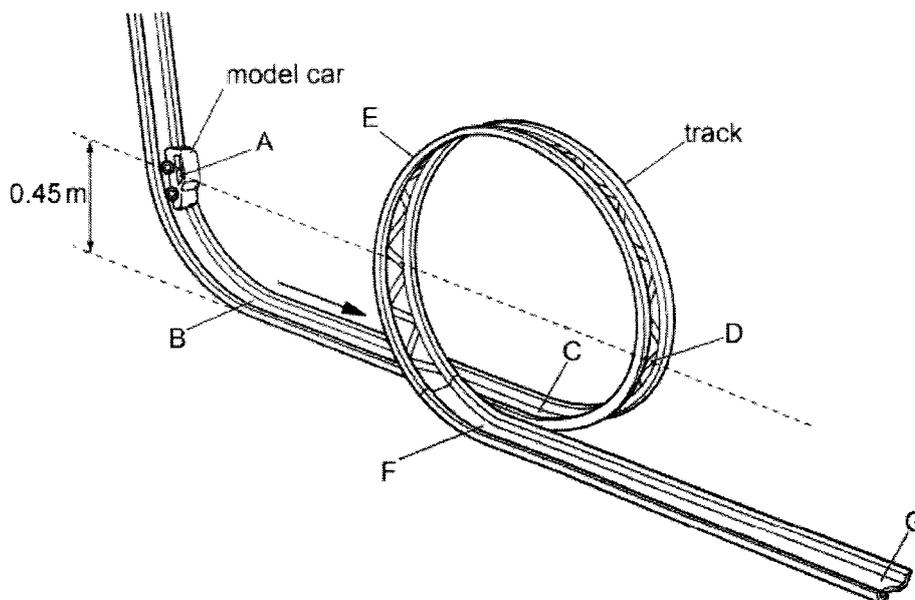


Fig. 4.1

Faith first holds the car stationary at point A which is 0.45 m above the horizontal sections of track BC and FG. She then releases the car which travels towards point B. Both air resistance and friction between the car and the track are negligible.

- (a) State the principle of the conservation of energy.

.....
 [1]

- (b) Calculate the speed of the car when it reaches B.

speed = [2]

- (c) Faith was very confident that when the car is released at A, it will follow the track along the route ABCDEFG.

Explain if she is correct.

[2]

- 5 Fig. 5.1 shows a man standing underneath an outdoor heater on a cold evening.

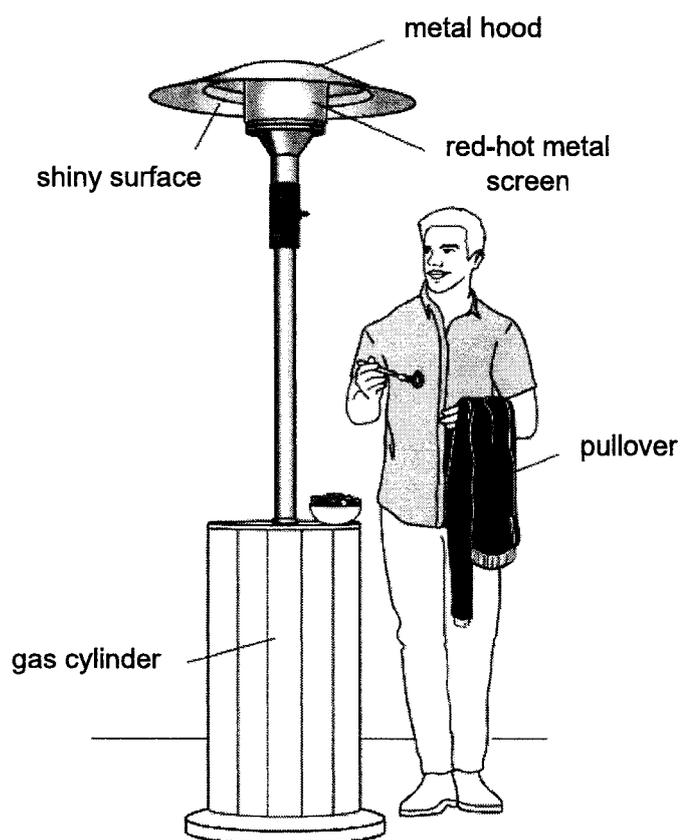


Fig. 5.1

Gas in the cylinder at the base of the heater is the fuel for the heater. When the heater is operating, the gas travels to the top of the heater where it burns.

A metal screen surrounding the burning gas is heated by the burning gas until it is red-hot. The hot metal screen warms the man who is standing underneath it.

[Turn over

- (a) Describe two possible ways how thermal energy within the red-hot metal screen is transferred to the man.

[2]

- (b) At the top of the heater is a metal hood that has a shiny lower surface. Explain why this makes the energy transfer from the metal screen more efficient.

[1]

- (c) During the evening, the temperature of the environment starts to decrease to as low as 5.0°C . The man puts on his black pullover.

Explain how the pullover keeps him warm.

[2]

- 6 A ray of blue enters a glass prism of sides XYZ as shown in Fig. 6.1. The ray is also shown incident on a different side of the prism after passing through the prism.

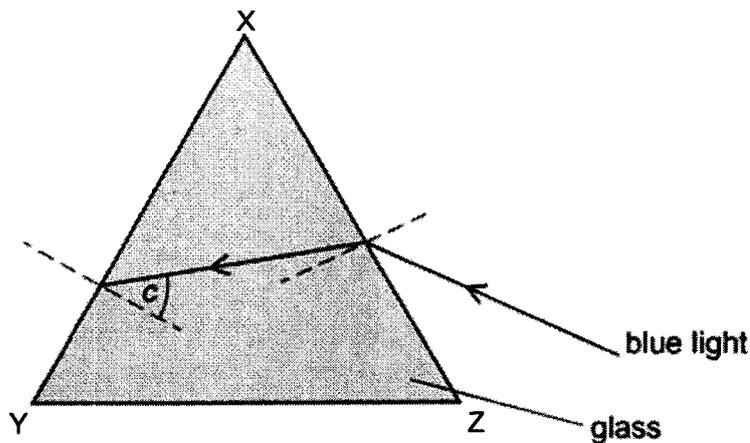


Fig. 6.1

The ray of blue light strikes the side XY of the prism at an angle equal to its critical angle c .

- (a) State what is meant by the *critical angle*.

.....
 [1]

- (b) On Fig. 6.1, mark and label the angle of incidence i and the angle of refraction r for the blue light as it enters the prism. [1]

- (c) On Fig. 6.1, continue the path of the blue light after it strikes the side XY of the prism. [1]

- (d) The glass prism is replaced by another prism which has a lower refractive index. Refraction of the blue ray now occurs at side XY.

State two reasons why this occurs.

1.

 2.
 [2]

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

- (a) The name of one of these three regions is the ultraviolet region.

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

Lowest frequency:

Intermediate frequency:

Highest frequency: [2]

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

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

Damaging effect:

.....
 Property:
 [2]

- (b) The wavelength of one of the waves emitted by the sun is 500 nm.

Calculate the frequency of this wave in space.

frequency = _____ [2]

- 8 The power supply in an electric circuit is a battery of electromotive force (e.m.f.) 12 V. Fig. 8.1 shows the circuit that includes two resistors, one thermistor, one voltmeter, one wire YZ and one open switch, S1.

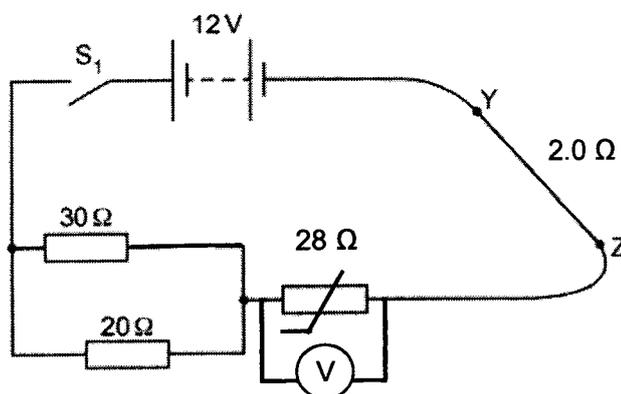


Fig. 8.1

YZ is a straight, horizontal section of connecting resistance wire of 2.0 Ω resistance. S1 is now closed.

- (a) Explain *electromotive force* (e.m.f.) 12V.

 _____ [1]

- (b) Calculate the total resistance of the circuit.

total resistance = _____ [2]

- (c) Calculate the voltmeter reading.

voltmeter reading = _____ [2]

- (d) The length of wire YZ is 100 cm and it has a diameter of 1.0 mm.

Calculate the resistivity of the wire.

resistivity = _____ [2]

- 9 Uranium-235 (${}_{92}^{235}\text{U}$) is the isotope of uranium that is used as the fuel in a nuclear power station. The isotope of uranium that is most abundant in nature is uranium-238 (${}_{92}^{238}\text{U}$).

- (a) State how a neutral atom of uranium-235 differs from a neutral atom of uranium-238.

 _____ [1]

- (b) In the reactor of a nuclear power station, a nucleus of uranium-235 absorbs a slow-moving neutron and undergoes fission.

State what happens to the nucleus of an atom during fission.

 _____ [1]

- (c) The uranium atom ${}_{92}^{238}\text{U}$ emits an α -particle to become thorium, which then emits a β -particle to become protactinium.

Calculate the proton number of protactinium.

proton number = _____ [2]

- (d) A teacher places a radiation detector beside a sample of Uranium-235 and switches it. The count rate is measured every 20s with the sample present and then corrected for background radiation.

Fig. 9.1 shows a graph of the corrected count rate against time for the Uranium-235 sample.

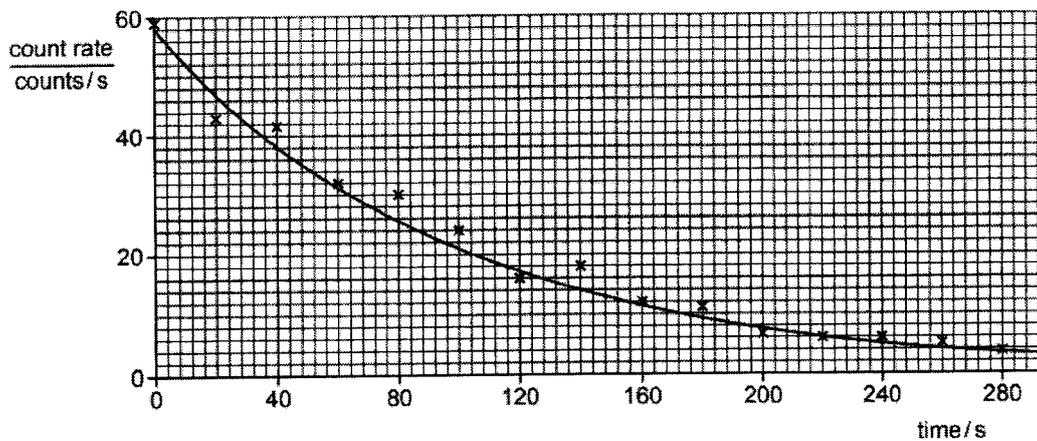


Fig. 9.1

- (i) Using Fig. 9.1, determine the half-life of Uranium-235.

Show your working.

half-life = _____ [1]

- (ii) Calculate the reading shown on the detection reader three half-lives later.

reading = _____ [1]

10 Fig. 10.1 shows a coil of wire connected by flexible leads to a switch and a battery.

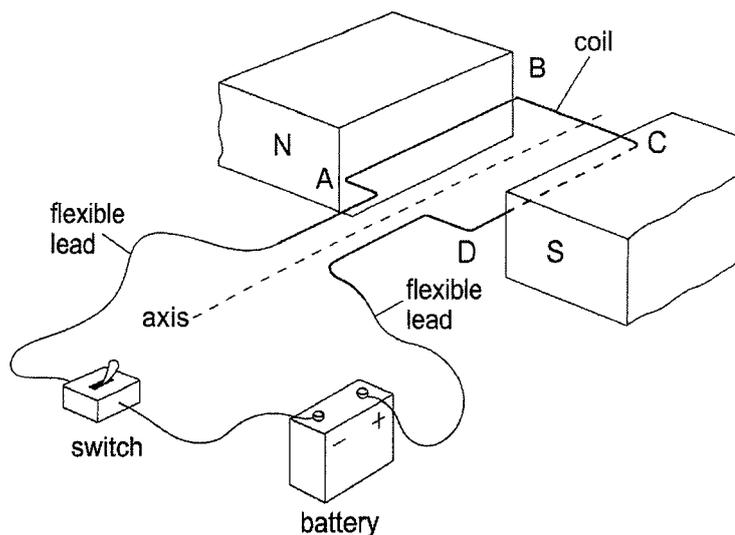


Fig. 10.1

The coil is placed between the poles of a permanent magnet and is free to turn about the axis. When the switch is closed, forces due to the current act on the sides of the coil.

- (a) On Fig. 10.1,
- (i) draw the direction of current flowing on side AB of the coil. [1]
- (ii) draw the force that acts on side AB of the coil. [1]
- (b) Describe how you determined the direction of the force on side AB.

[2]

- (c) For the coil to rotate continuously, a split-ring commutator is connected between the battery and the coil.

With reference to side AB of the coil, explain how the split-ring commutator enables the coil to rotate continuously.

[2]

[Turn over

- (d) A student suggested that increasing the horizontal distance between poles of the permanent magnet N and S will cause the coil ABCD to turn faster.

State and explain if you agree with the student.

[2]

- (e) Another student wished to demagnetize the permanent magnets.

Describe, with the aid of a well-labelled diagram, how a bar magnet can be demagnetised using an electrical method.

[2]

- 11 Fig. 11.1 shows a floorplan of a small industrial kitchen which has recently installed new equipment. The manager needs to analyse the electrical consumption and safety aspects.

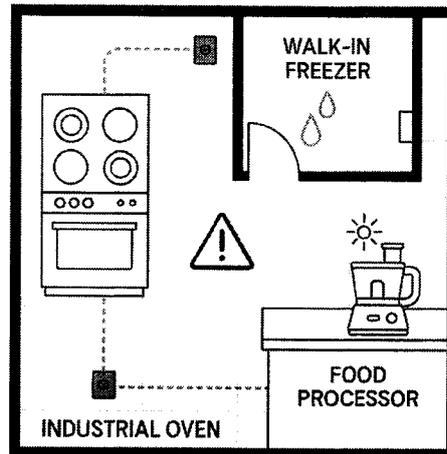


Fig. 11.1

Figure 11.2 shows the specifications of the industrial kitchen.

Voltage supply: 230 V Frequency: 50 Hz Energy cost: \$0.327/kWh Cable specifications: H07RN-F, 2.5mm ² copper conductors Plug Type: BS 1363, fitted with 13 A cartridge fuse				
Equipment	Power rating	Operating temperature	Daily usage	Maintenance log history
Industrial Oven	6000 W	50 to 280°C	4 hours	New installation
Walk-in Freezer	2800 W	-22°C to -18°C	24 hours	Shows signs of water condensation
Food Processor	1500 W	Max 60°C	2 hours	Cable feels warm during use

Fig. 11.2

- (a) The new industrial oven is protected by a 30 A Miniature Circuit Breaker (MCB). Evaluate, using appropriate calculations, whether this MCB is suitable.

[2]

- (b) The manager would like to check the monthly electrical expenditure on the kitchen.

- (i) Calculate the daily energy consumption (in kWh) for all three appliances.

daily energy consumption = _____ [1]

- (ii) Hence, calculate the kitchen's monthly electricity cost (30 days), rounded to the nearest dollar.

monthly electricity cost = \$ _____ [1]

- (c) The walk-in freezer shows signs of water condensation near its power socket.

Explain why this is a hazard.

[1]

- (d) Following reports of cable heating in the food processor, the maintenance team investigated and collected the data as shown in Fig. 11.3.

Food processor model:	FP-2000X
Rated power:	1500 W
Rated voltage:	230 V
Operating current:	6.8 A
Cable specifications:	H07RN-F, 2.5 mm ² copper conductors
Cable length:	3.0 m
Measured cable temperature (T):	62 °C
Cable resistance (R) per unit length:	0.012 Ω/m at 30 °C
Temperature coefficient of copper (α):	0.00393 Ω/°C

Fig. 11.3

- (i) Using the information in Fig. 11.3, calculate the cable resistance, R_{cold} , at the optimal operating temperature of 30 °C.

$$R_{cold} = \dots\dots\dots [1]$$

- (ii) It is given that the relationship between cable resistance and temperature can be found using the following formula:

$$R_{hot} = R_{cold} [1 + \alpha (T_{hot} - T_{cold})]$$

Calculate the actual cable resistance at 62 °C, R_{hot} .

$$R_{hot} = \dots\dots\dots [1]$$

- (iii) Using your answers from (d)(i) and (ii), explain why the temperature in the cable increases. Support your answer with calculations of power loss in the cable.

.....

.....

.....

..... [3]

Section B

Answer **one** question from this section.

- 12 Fig. 12.1 shows a long vertical tube, sealed at the base and open at the other end. The tube is 1.0 m long. The cross-sectional area of the tube is $4.0 \times 10^{-4} \text{ m}^2$. It is filled with a liquid of mass 5.6 kg.

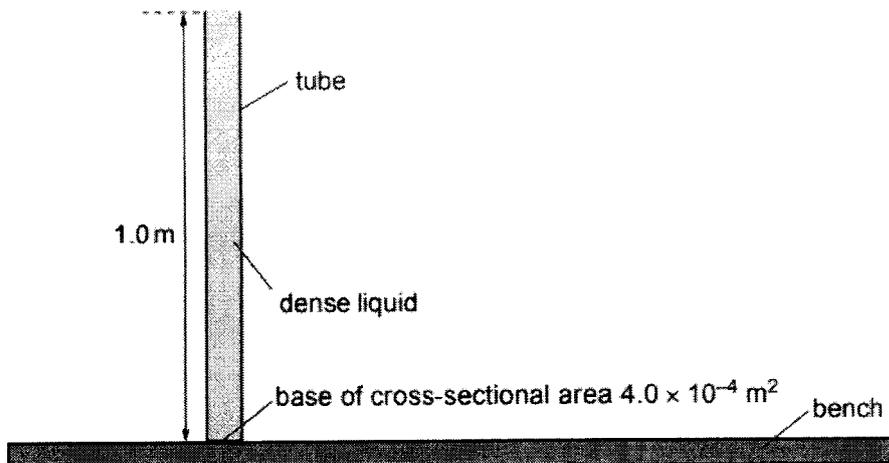


Fig. 12.1

The atmospheric pressure is L metres (dense liquid), which is equivalent to $1.0 \times 10^5 \text{ Pa}$. Gravitational field strength is 10 N/kg .

- (a) Explain *pressure is $1.0 \times 10^5 \text{ Pa}$* .

.....
 [1]

- (b) Describe the arrangement of the particles in the dense liquid.

.....

 [2]

- (c) Calculate

- (i) the density of the liquid in the tube.

density = [1]

(ii) the total pressure in the liquid at the bottom of the tube.

total pressure = [2]

(iii) the force exerted on the inside surface of the bottom of the tube.

force = [1]

- (d) A small sheet of glass is placed over the open end of the tube. The tube is inverted in a container of the dense liquid. The inverted tube also contains the same dense liquid. The open end of the tube and the sheet of glass are a short distance below the surface of the liquid. Fig. 12.2 shows the arrangement.

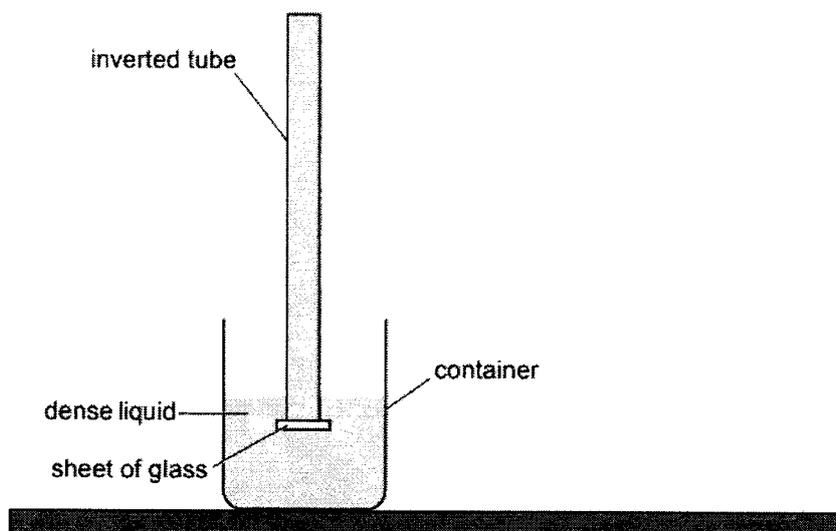


Fig. 12.2

The sheet of glass seals the open end of the inverted tube.

[Turn over

Describe what happens in the inverted tube when the sheet of glass is removed. You may draw on Fig. 12.2, if you wish.

[3]

- 13 The primary coil of a simple soft iron-cored transformer is connected to the mains supply. The voltage of the alternating current (a.c.) mains supply is 240 V.

Fig. 13.1 is a diagram of the arrangement.

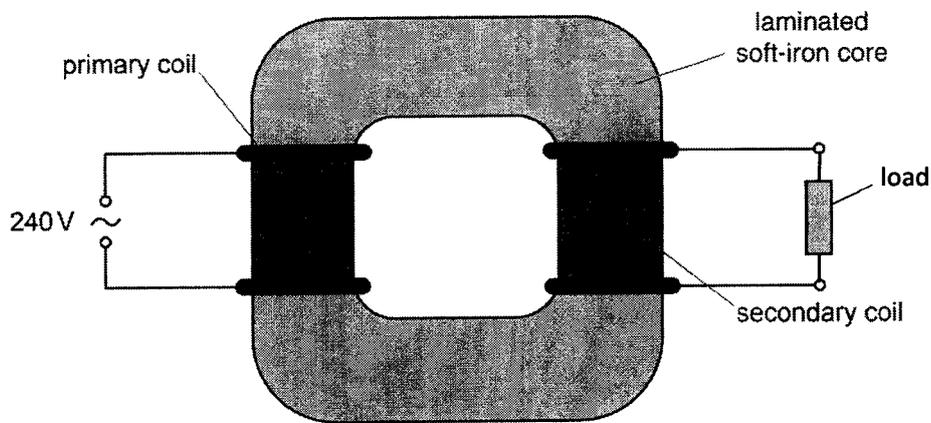


Fig. 13.1

- (a) Explain how an alternating current (a.c.) supply in the primary coil of a transformer leads to a current in the secondary coil.

[3]

- (b) State the difference between soft iron and steel and explain why soft iron is used instead of steel in the core of a transformer.

Difference:

.....

Explanation:

..... [2]

- (c) The primary coil has 1200 turns and the secondary coil has 200 turns.

- (i) Calculate the output voltage of the secondary coil.

output voltage = [1]

- (ii) If the transformer is 90% efficient and the secondary current is 3.0 A, calculate the current in the primary coil.

current = [2]

- (iii) Hence, explain why the secondary coil is often made with thicker wire than the primary coil in a step-down transformer.

.....

.....

.....

..... [2]

[Turn over

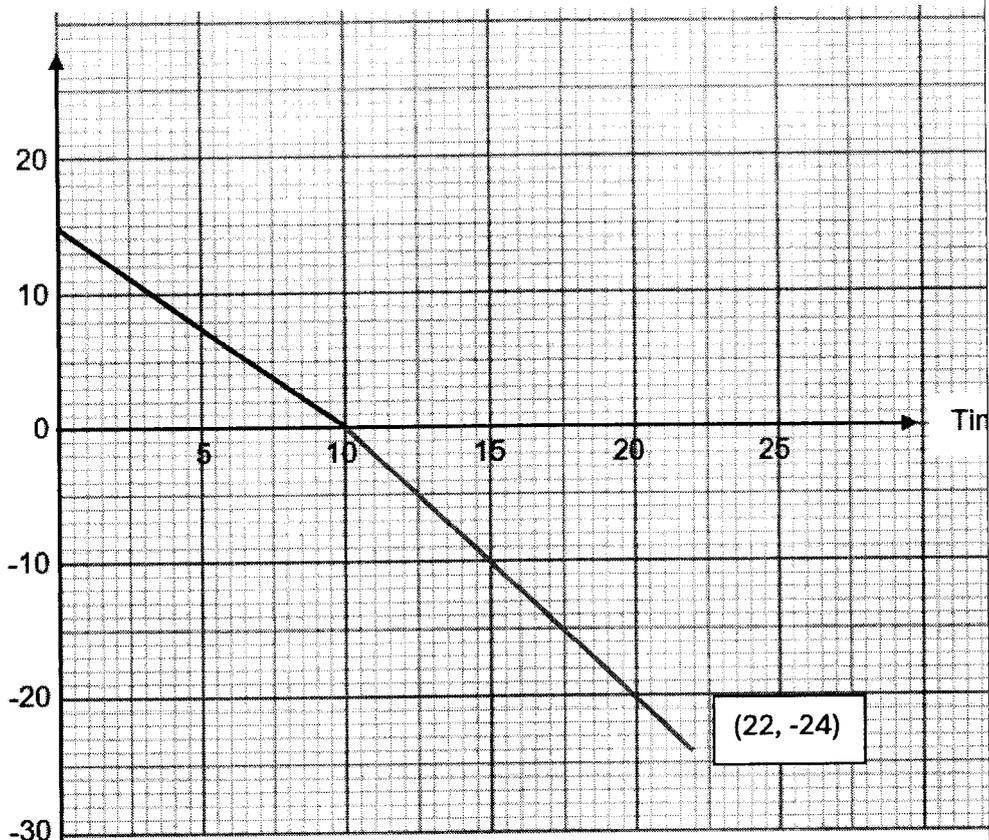
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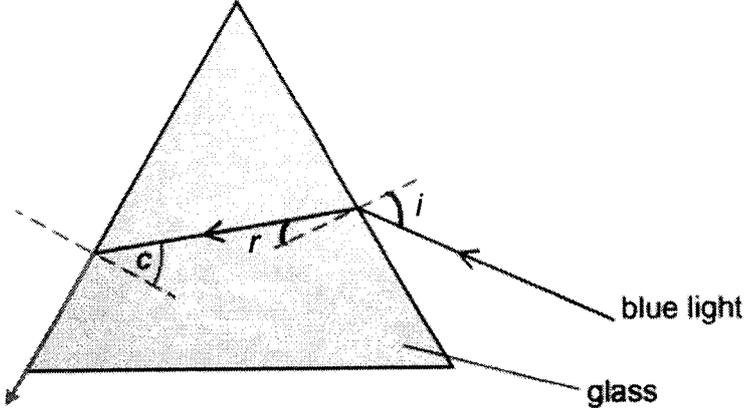
Paper 1

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

Paper 2

Section A

Question	Answers	Marks
1(a)	<p>velocity / ms⁻¹</p> 	<p>B1: $t = 0 - 10$ s</p> <p>B1: $t = 10 - 22$ s</p>
1(b)	<p>$a = (0 - 15)/10$ $= -1.5 \text{ m/s}^2$ deceleration = 1.5 m/s^2</p>	A1
1(c)	<p>Distance travelled = area under the graph $= 0.5 \times 10 \times 15 + 0.5 \times 12 \times 24$ $= 219 \text{ m}$</p> <p>Average speed = total distance / total time $= 219 / 22$ $= 10 \text{ m/s (2 s.f.)}$</p>	<p>C1: showing evidence distance = area under the graph</p> <p>A1</p>
2(a)	<ul style="list-style-type: none"> Moving air molecules collide with inner <u>wall</u> of container and exerts a <u>force</u> on it. Since <u>pressure is the force exerted per unit area</u>, the air molecules exert pressure on the surface of wall. 	<p>B1</p> <p>B1</p>

5(c)	<ul style="list-style-type: none"> Sweater is made of a material that is an insulator of heat. Sweater traps air too and air is an insulator of heat, reducing heat transfer from warm man to cooler surroundings. 	B1 B1
6(a)	Angle of incidence in the optically denser medium whereby the angle of refraction in the optically less dense medium is 90° .	
6(b), 6(c)		B1 B1
6(d)	<ul style="list-style-type: none"> At side XZ, the <u>angle of refraction (r) of the ray increases</u> since lower refractive index = constant $\sin i$ / higher $\sin r$ At side XY, the angle of incidence of the ray decreases. <u>Since angle of incidence is smaller than the larger critical angle,</u> refraction of light into the air takes place at side XZ. 	B1 B1
7(a)(i)	Smallest frequency: infra-red wave Intermediate frequency: visible light Largest frequency: ultraviolet wave	B1: correct waves in any sequence B1
7(a)(ii)	Damaging effect: (skin) cancer / cataracts Property: ultraviolet radiation is ionizing (reject high energy)	B1 B1
7(b)	$500 \text{ nm} = 500 \times 10^{-9} \text{ m}$ $v = f\lambda$ $f = (3.0 \times 10^8) / (500 \times 10^{-9})$ $= 6.0 \times 10^{14} \text{ Hz}$ (ecf)	C1 A1
8(a)	Work done by the battery to push 1 C of charge around the complete circuit is 12 J.	
8(b)	Resistance of 2 parallel resistors = $(1/30 + 1/20)^{-1}$ $= 12 \Omega$ Total resistance = $12 + 28 + 2 = 42 \Omega$	A1 A1
8(c)	$V = (28 / R_{\text{total}}) \times \text{emf}$ $= (28/42) \times 12$ $= 8.0 \text{ V}$	C1 A1

8(d)	<p>radius = 0.00050 m</p> $R = \rho l / A$ $\rho = 2.0 \times (\pi \times 0.00050^2) / 1.0$ $= 1.6 \times 10^{-6} \Omega\text{m (ecf)}$	C1 A1
9(a)	uranium-235 has (3) fewer neutrons (in the nucleus)	B1
9(b)	the nucleus splits (and releases more neutrons)	B1
9(c)	<p>Alpha particle = ${}^4_2\text{He}$ Beta particle = ${}^0_{-1}\text{e}$</p> <p>Proton number of protactinium = $92 - (2 - 1) = 91$</p>	C1 A1
9(d)(i)	<p>Half of initial count rate of 59 counts/s = $59 / 2 = 29.5$ counts/s Half life = 64 s</p> <p>OR</p> <p>Half of initial count rate of 60 counts/s = $60 / 2 = 30$ counts/s Half life = 64 s</p>	A1
9(d)(ii)	<p>59 counts/s -> 29.5 counts/s -> 14.75 counts/s -> 7.4 counts/s OR $59 \times \frac{1}{2^3} = 7.4$ counts/s</p> <p>OR</p> <p>60 counts/s -> 30 counts/s -> 15 counts/s -> 7.5 counts/s OR $60 \times \frac{1}{2^3} = 7.5$ counts/s</p>	A1
10(a)	<p>(i) from B to A (ii) top of page</p>	B1 B1
10(b)	<p>Using Fleming's left hand rule,</p> <p>point the index finger in the direction of the magnetic field and middle finger in the direction of the current. The thumb gives the direction of the force.</p> <p>OR</p> <p>Based on the direction of the magnetic field due to the current in the wire and direction of the magnetic field due to the magnets,</p> <p>we are able to determine that the force will act along the stronger magnetic field towards the weaker magnetic field.</p>	B1 B1 OR B1 B1

10(c)	The split-ring commutator ensures that the current direction changes at every half turn. After half a turn, force acts towards bottom of page because current now flows from A to B. The coil continues to rotate in a clockwise direction (about the axis).	B1 B1
10(d)	Disagree. (no marks for disagreeing without explanation) By moving the 2 solenoids further apart will bring the external magnetic field further away from the coil ABCD. This causes the external magnetic field to become weaker . A weaker magnetic field produces a weaker force on the coil and hence a weaker turning effect and thus slower rotation of the coil.	B1 B1
10(e)	Insert bar magnet into a solenoid with alternating current (a.c.) – with diagram Slowly withdraw magnet in the east west direction.	B1 B1
11 (a)	$I = P / V$ $= 6000 / 230$ $= 26 \text{ A}$ MCB is suitable as the operating current is slightly <u>lower</u> than the MCB current rating.	B1 B1
11(b)(i)	Energy consumption in kWh = power in kW x time in hour $= 6000/1000 \times 4 + 2800/1000 \times 24 + 1500/1000 \times 2$ $= 94.2 \text{ kWh or } 94 \text{ kWh}$	A1
11(b)(ii)	Cost = $94.2 \times 0.327 \times 30 \text{ days}$ $= \$924$ OR Cost = $94 \times 0.327 \times 30 \text{ days}$ $= \$922$	A1 (ecf)
11(c)	Water conductivity or damp condition could cause short circuit OR electrocution	B1
11(d)(i)	$R_{\text{cold}} = \text{resistance per unit length} \times \text{length}$ $= 0.012 \times 3.0$ $= 0.036 \Omega$	B1
11(d)(ii)	$R_{\text{hot}} = R_{\text{cold}} [1 + \alpha (T_{\text{hot}} - T_{\text{cold}})]$ $= 0.036 (1 + 0.00393 (62 - 30))$ $= 0.041 \Omega$	B1

11(d)(iii)	Higher resistance leads to higher temperature as R_{hot} is higher than R_{cold} . Power loss calculation: At 62°C: $P = (6.8)^2 \times 0.041 = 1.9 \text{ W}$ At 30°C: $P = (6.8)^2 \times 0.036 = 1.7 \text{ W}$ Higher resistance leads to higher power loss. This power loss manifests as heat, causing further temperature rise.	B1 B1 B1
12(a)	$1.0 \times 10^5 \text{ N}$ of force is acting on an unit area.	B1
12(b)	<ul style="list-style-type: none"> • Particles are slightly less closely packed than in solids • Particles are arranged in irregular pattern 	B1 B1
12(c)(i)	$\rho = m/V$ $= 5.6 / (1.0 \times 4.0 \times 10^{-4})$ $= 1.4 \times 10^4 \text{ kg / m}^3$	A1
12(c)(ii)	$P = h\rho g$ $= 1.0 \times 1.4 \times 10^4 \times 10$ $= 1.4 \times 10^5 \text{ Pa}$ Total pressure = $1.4 \times 10^5 + 1.0 \times 10^5$ $= 2.4 \times 10^5 \text{ Pa}$	C1 A1
12(c)(iii)	$F = PA$ $= (2.4 \times 10^5) \times (4.0 \times 10^{-4})$ $= 96 \text{ N}$	A1
12(d)	<ul style="list-style-type: none"> • The dense liquid level in the tube falls. • The space inside the tube, above the dense liquid, is vacuum. • The height between the dense liquid levels in the tube and the container is $L \text{ m}$ 	B1 B1 B1
13 (a)	An alternating current in the <u>primary coil</u> produces a <u>changing magnetic field</u> in the soft iron core. This changing magnetic field links to the secondary coil through the core. According to Faraday's Law of Electromagnetic Induction, <u>a changing magnetic flux through the secondary coil induces an electromotive force (e.m.f.) across it.</u> If the secondary coil is part of a <u>closed circuit</u> , this e.m.f. drives a current through the circuit.	B1 B1 B1
(b)	<u>Soft iron is easily magnetised and demagnetised</u> , while steel is harder to magnetised and retains its magnetism. Since the magnetic field in the primary coil is changing due to alternating current, the soft iron can <u>respond quickly</u> to the changing magnetic field in the transformer OR concentrates / intensifies magnetic flux	B1 B1
(c)(i)	Using $V_s/V_p = N_s/N_p$ If $V_p = 240\text{V}$ (input voltage) $V_s = (200/1200) \times 240$ $V_s = 40 \text{ V}$	A1

(ii)	<p>Using efficiency = $(V_s \times I_s)/(V_p \times I_p) \times 100$ $90 = (40 \times 3)/(240 \times I_p) \times 100$ $90 = (120/240I_p) \times 100$ $I_p = 0.56A$</p> <p><u>Alternative:</u> Power output = $V_s \times I_s = 40 \times 3 = 120W$ Power input = $120/0.9 = 133.33W$ $I_p = 133.33/240 = 0.56A$</p>	<p>B1 B1 OR B1 B1</p>
(iii)	<p>In a step-down transformer, the secondary coil provides a <u>lower voltage</u> but <u>higher current</u> than the primary coil.</p>	B1
	<p>Thicker wire is used in the secondary coil to handle the larger current without overheating or reduces heat loss</p> <p>OR</p> <p>Reduce resistance as R is inversely related to area of the cable. (Larger A leads to lower R) and therefore minimise energy loss as heat (since power loss = I^2R)</p>	B1