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

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.

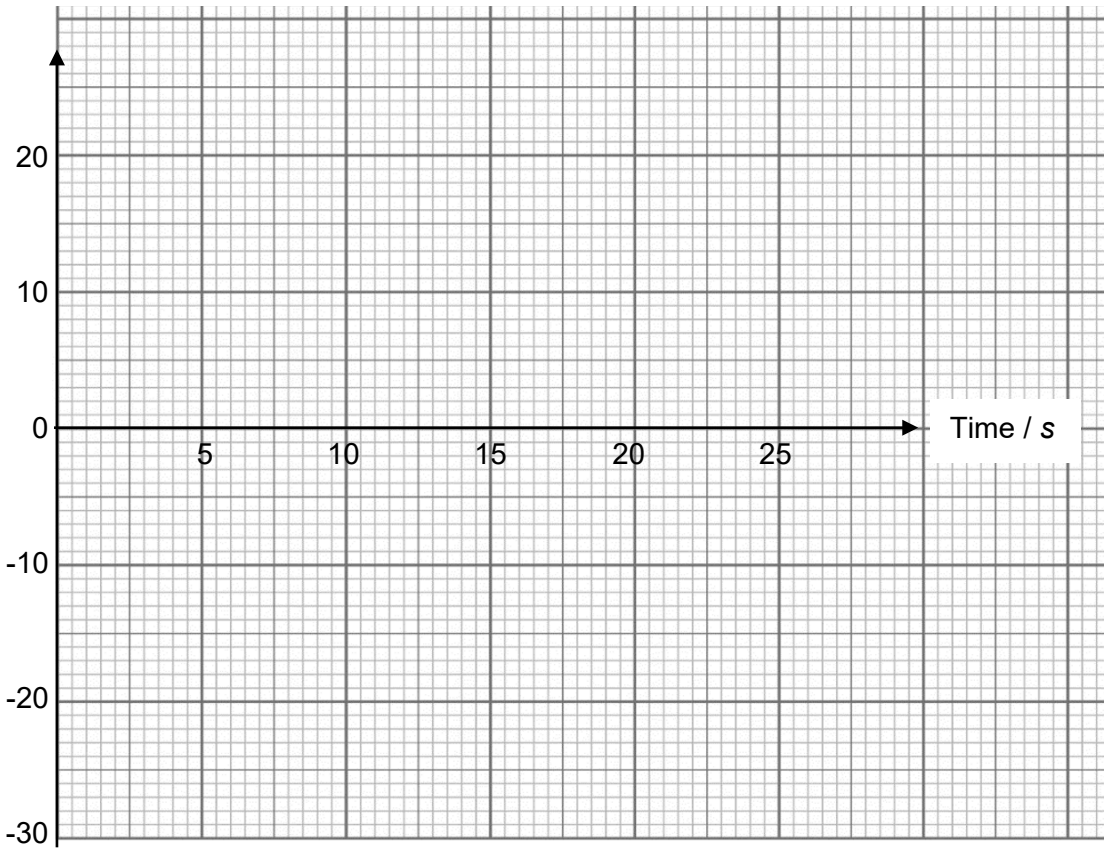

Fig. 1.1

[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.

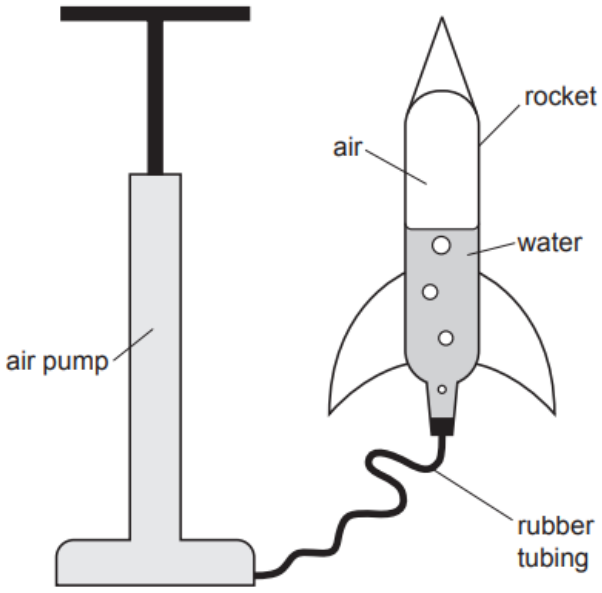

Fig. 2.1

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]

(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.

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..... [2]

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

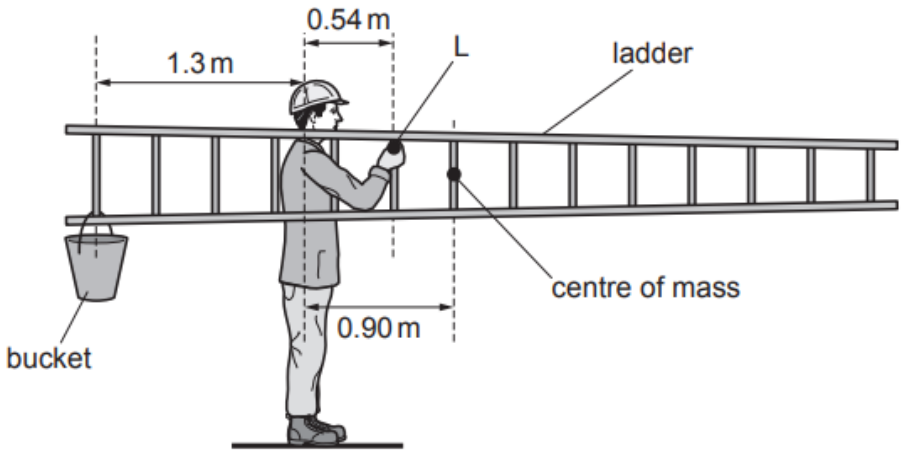

Fig. 3.1

The weight of the ladder is 80 N.

(a) Explain what is meant by m*oment 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]

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

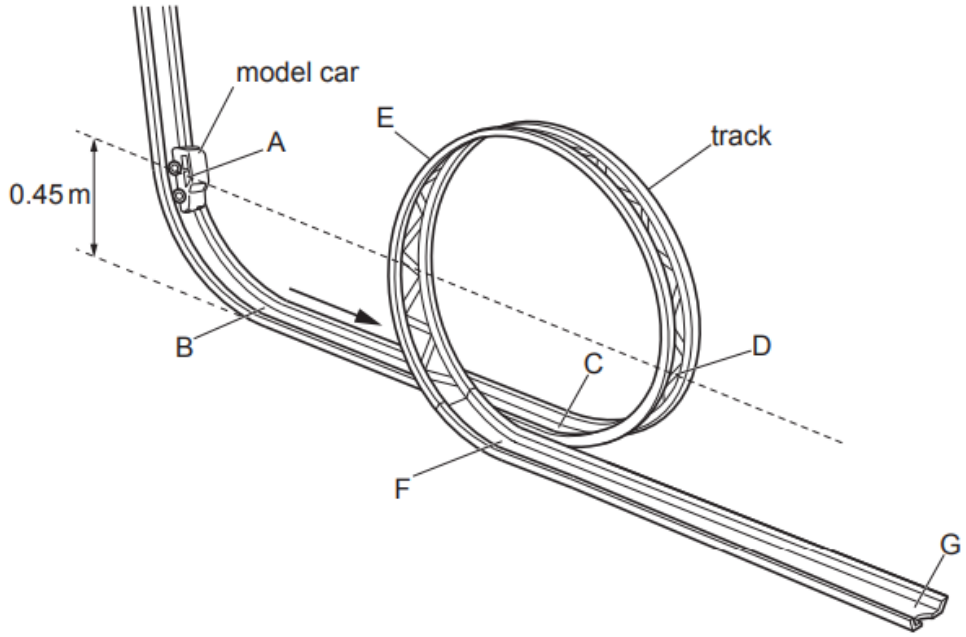

Fig. 4.1

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.

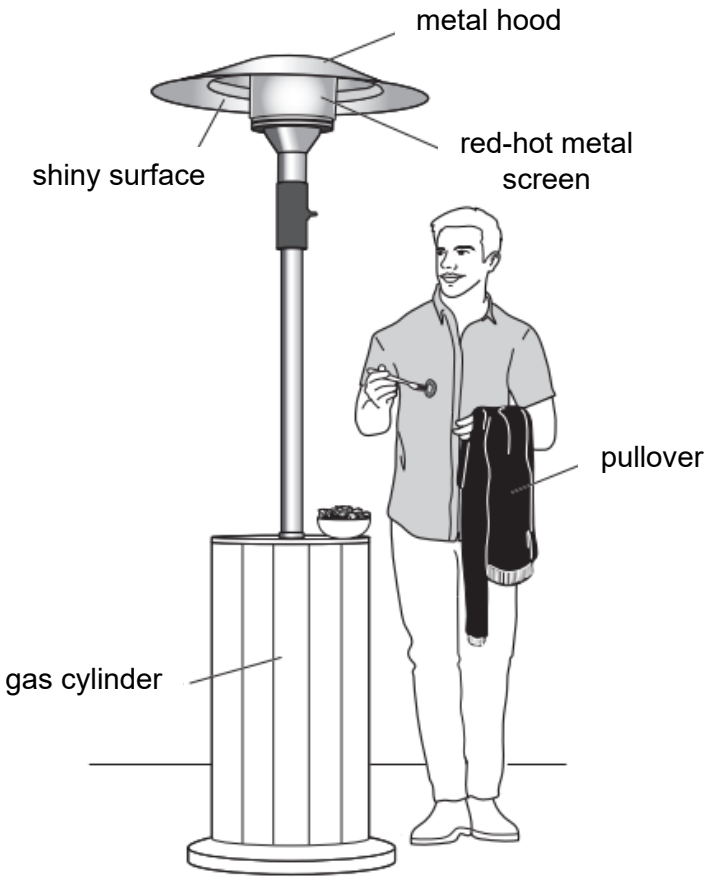

Fig. 5.1

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.

(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 ^{O}C. The man puts on his black pullover.

Explain how the pullover keeps him warm.

.....

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.....

..... [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.

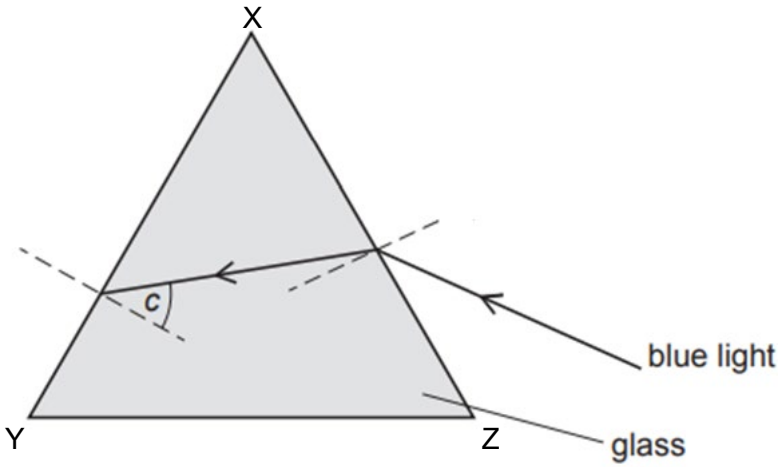

Fig. 6.1

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.

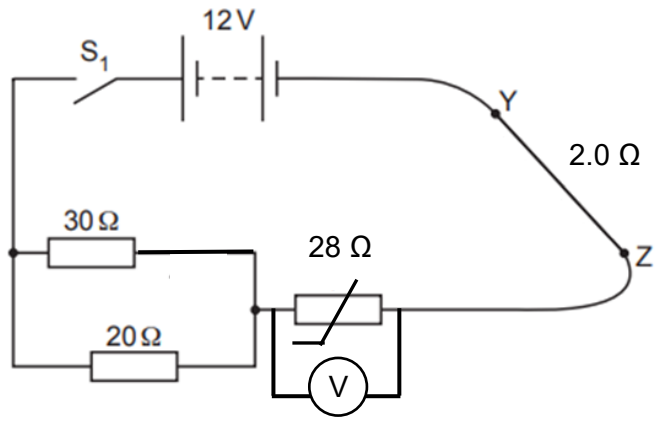

Fig. 8.1

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 ($^{235}_{92}U$) 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 ($^{238}_{92}U$).

(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 $^{238}_{92}U$ 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.

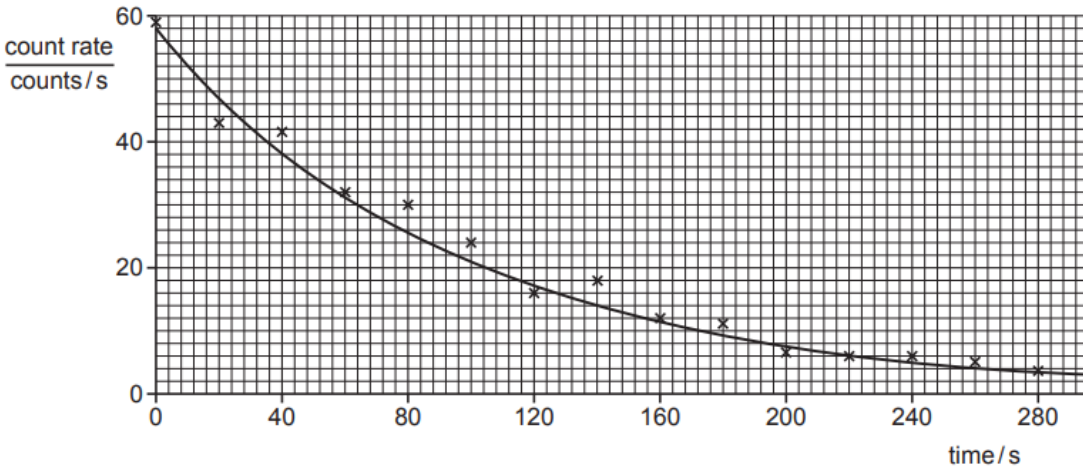

Fig. 9.1

(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.

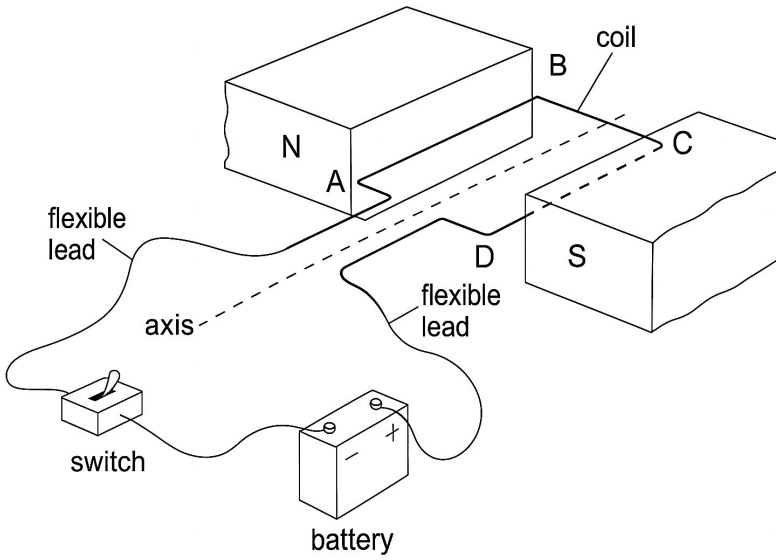

Fig. 10.1

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]

(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.

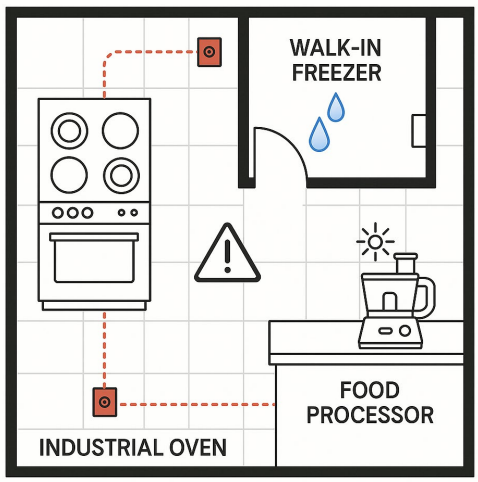

Fig. 11.1

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, 2.5mm² 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 mm² 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} = ... [1]

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

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

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

R_{hot} = ... [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.

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.....

.....

..... [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 4.0×10^{-4} m^2. It is filled with a liquid of mass 5.6 kg.

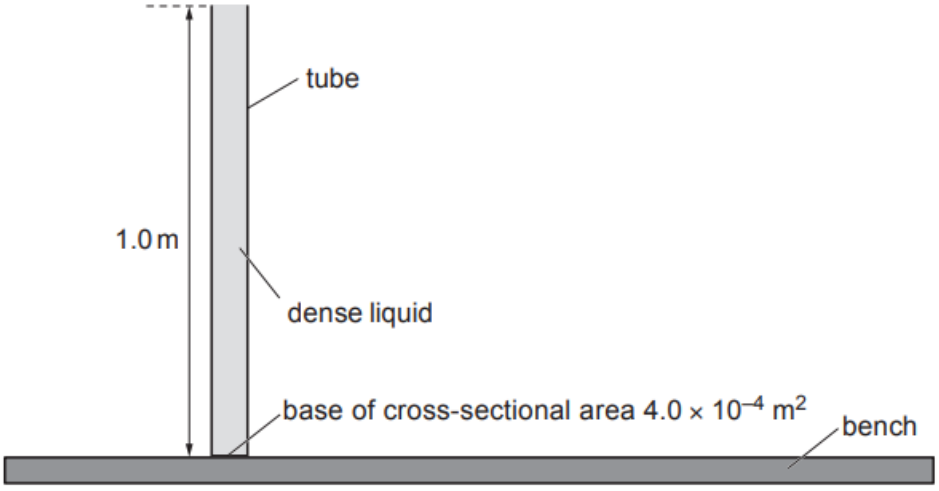

Fig. 12.1

The atmospheric pressure is L metres (dense liquid), which is equivalent to 1.0×10^5 Pa. Gravitational field strength is 10 N/kg.

(a) Explain *pressure is 1.0 × 10^5 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.

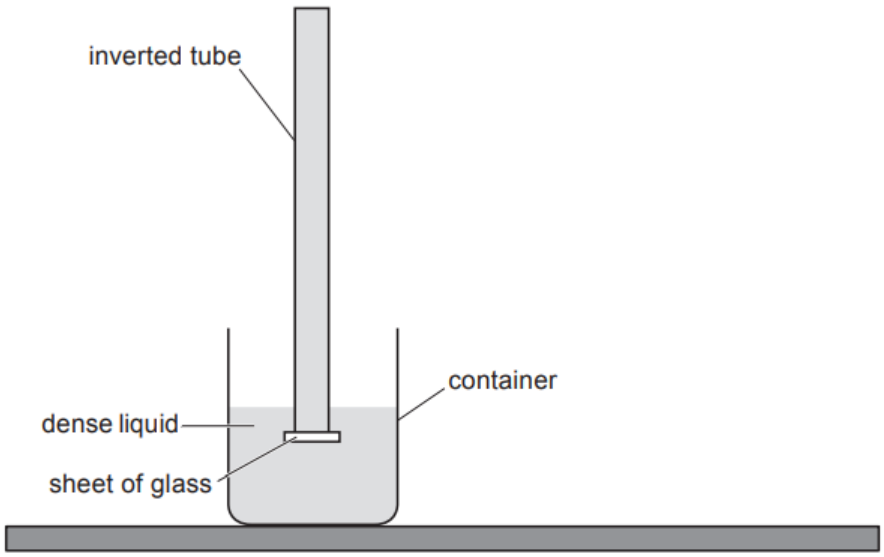

Fig. 12.2

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

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

.....

.....

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.....

.....

..... [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.

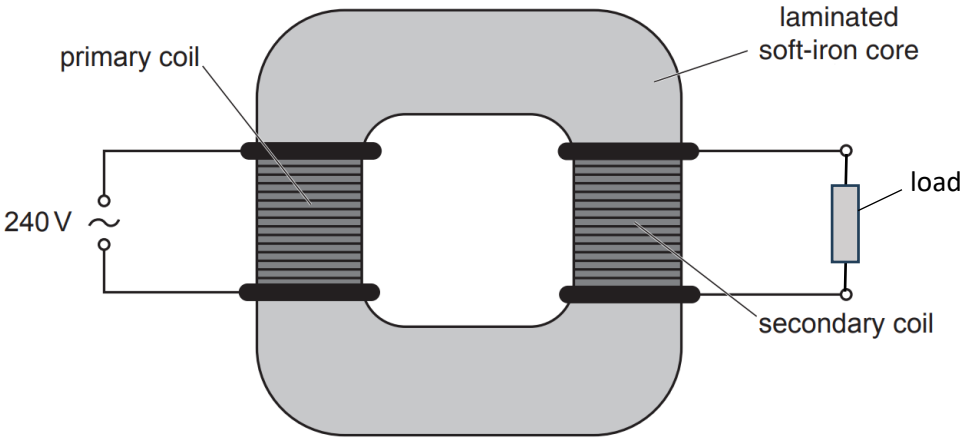

Fig. 13.1

(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.

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..... [2]

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