Name: **Register Number:** **Class:**

For Marker's Use
80

Parent's Signature:

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS

PHYSICS **6091/02**

Paper 2 **22 August 2024 Thursday**
1 hour 45 mins

Candidates answer on the Question Paper.
No additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided on the question paper.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid or tape.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question from this section.
Write your answers in the spaces provided.

Students are reminded that all quantitative answers should include appropriate units.
The use of an approved calculator is expected, where appropriate.
Students 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.

Section A

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

1 A microphone has a weight W of 6.0 N. It is suspended by wire X from the ceiling in a radio studio. Fig. 1.1 shows the microphone held in the correct position by a horizontal wire Y.

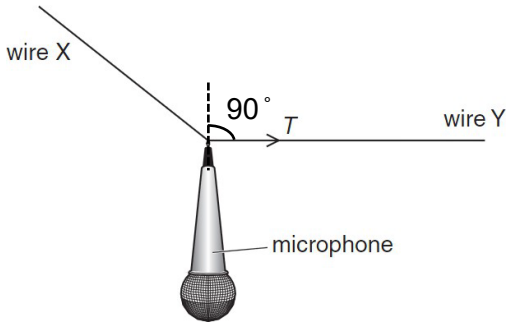

Fig. 1.1

(a) The tension T in wire Y is 8.0 N. Use a vector diagram to determine the magnitude and the direction of the resultant of W and T. [3]

scale = ……..

magnitude = ……..

direction = ……..

(b) The microphone is at rest. State the tension in wire X. [1]

tension in x = ……..

2 Fig. 2.1 shows a man pushing a heavy box with a force P. A frictional force F acts in a horizontal direction. When P = 150 N and F = 75 N, the box accelerates.

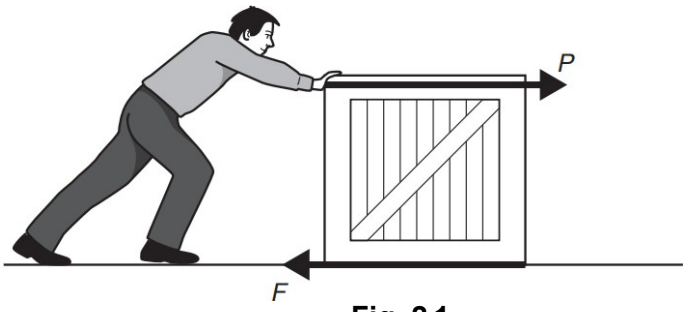

Fig. 2.1

(a) Fig. 2.1 does not show an action-reaction pair of forces.

(i) State one way in which P and F are not an action-reaction pair. [1]

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(ii) Name the other force in the action-reaction pair for force P. [1]

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(b) The mass of the box is 20 kg. Calculate the acceleration of the box. [2]

acceleration = ……..

3 Fig. 3.1 shows an air descender that controls the rate at which a climber drops from a platform at the top of a climbing wall.

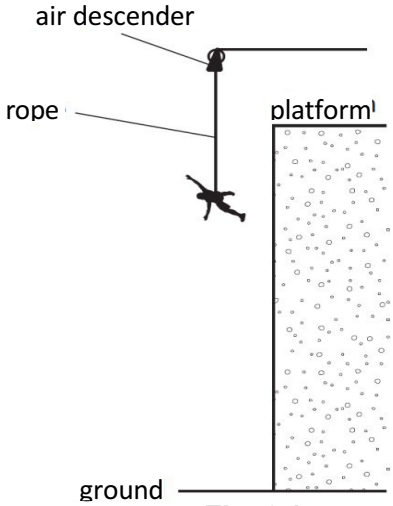

Fig. 3.1

The following sequence describes the motion of a climber, attached to the air descender by a rope, as he steps off the platform, drops towards the ground and lands safely.

1. The climber starts from rest at t = 0 s and accelerates uniformly to 3.7 ms^{-1} at t = 3.0 s.
2. From t = 3.0 s to t= 5.0 s, he maintains this constant velocity of 3.7 ms^{-1}.
3. From t = 5.0 s to t = 7.4 s, he experiences decreasing deceleration to 0 ms^{-1}.

(a) On Fig. 3.2, sketch the velocity-time graph of the climber from 0.0 s to 7.4 s. [3]

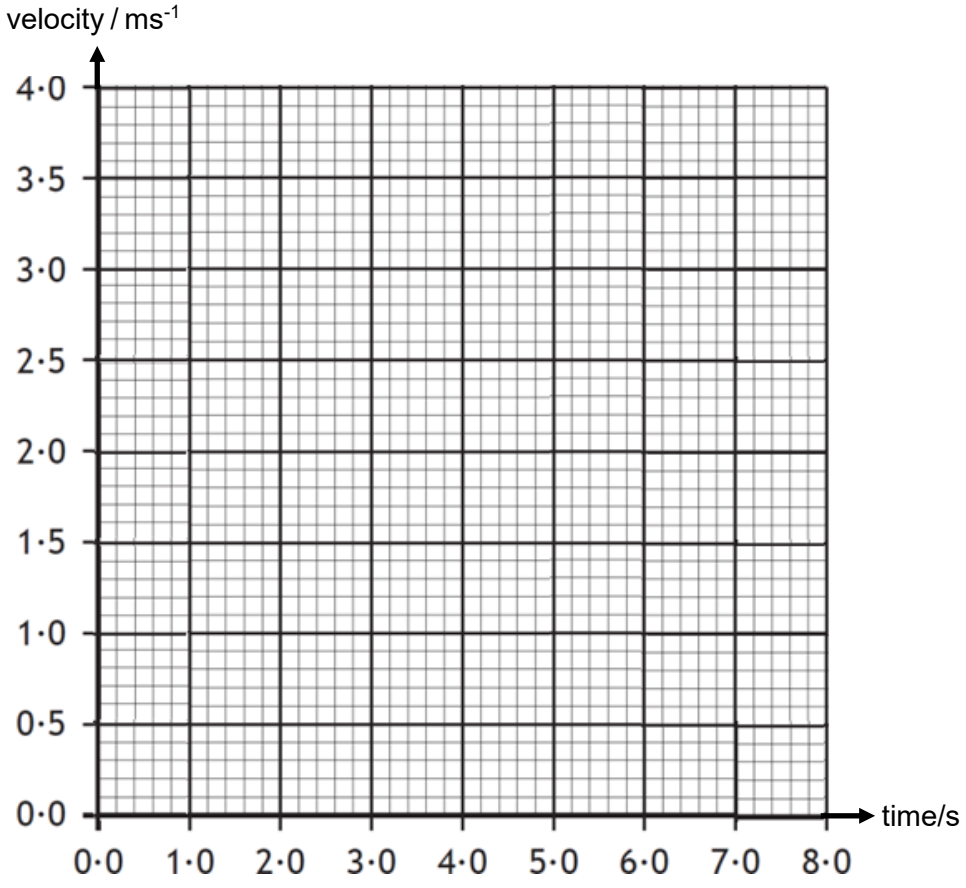

Fig. 3.2

(b) From Fig. 3.2, calculate the acceleration of the climber during the first 3.0 s. [1]

acceleration = ……..

(c) From Fig 3.2, calculate the distance the climber drops during the first 3.0 s. [1]

distance = ……..

(d) State and explain the time interval when the forces acting on the climber are balanced while he is descending. [2]

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4 In a bicycle shop, two wheels hang from a horizontal uniform rod AC, as shown in Fig. 4.1.

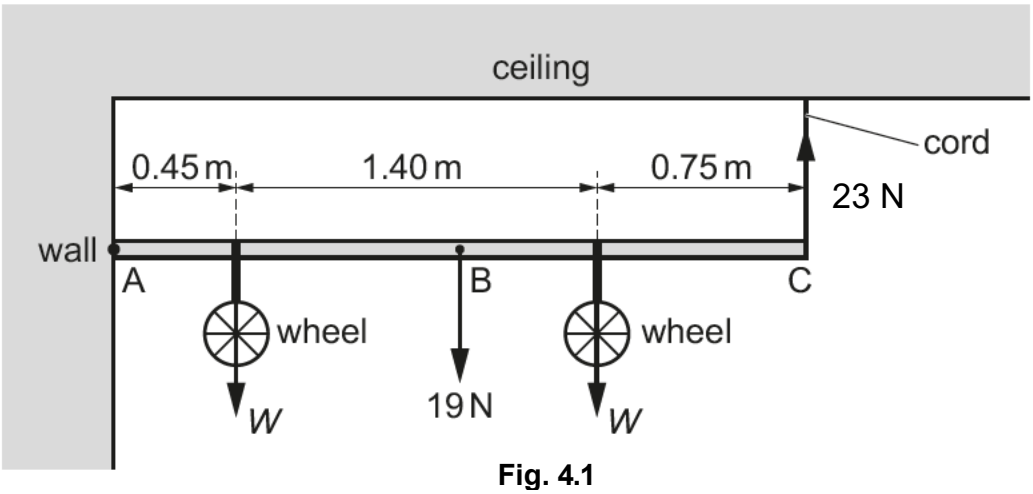

Fig. 4.1

The rod weighs 19 N and is freely hinged to a wall at end A. End C of the rod is attached by a vertical elastic cord to the ceiling. The centre of gravity of the rod is at point B.

(a) The weight of each wheel is W and the tension in the cord is 23 N.
Show that the weight W of each wheel is 15 N. [2]

(b) Determine the magnitude of the vertical force acting on the rod at end A. [2]

force = ……..

5 Fig. 5.1 shows a piston in a cylinder that is connected to a manometer. The atmospheric pressure is 100 kPa.

The density of mercury in the manometer is 13 600 kgm^{-3}.

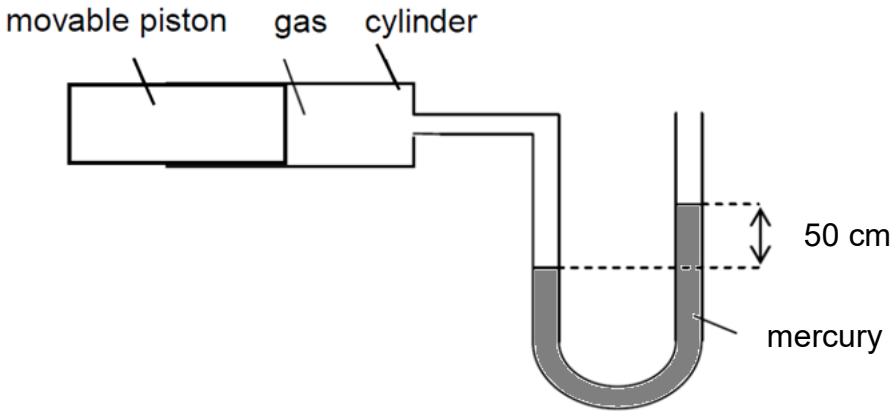

Fig. 5.1

(a) Calculate the pressure of the gas in the cylinder. [2]

pressure = ……..

(b) Describe and explain what will be observed in Fig. 5.1 if more mercury is poured into the manometer. [2]

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6 A diver of mass 80 kg climbs up a flight of stairs to reach the springboard.
The springboard is 3.0 m above the water surface in a swimming pool as shown in Fig. 6.1.
The gravitational field strength is 10 Nkg^{-1} and air resistance is negligible.

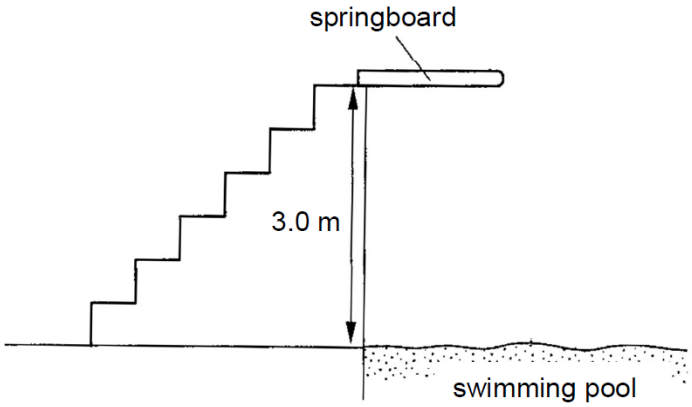

Fig. 6.1

(a) Calculate the energy gain in gravitational potential store of the diver. [1]

energy gain in gravitational potential store = ……..

(b) The diver jumps off the springboard with an initial speed u and hits the water with a speed of 8.0 ms^{-1}. By applying the principle of conservation of energy, calculate his initial speed u. [2]

u = ……..

(c) The diver enters the water with no splash and decelerates until he is momentarily at rest near to the bottom of the pool. Describe the energy transfers of the diver that has taken place in terms of energy stores and transfer pathways. [2]

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7 A young boy is lying on his back at the bottom of a swimming pool. He is holding his breath and his eyes are open. A mobile red lamp is positioned on a step above the ground at Q.

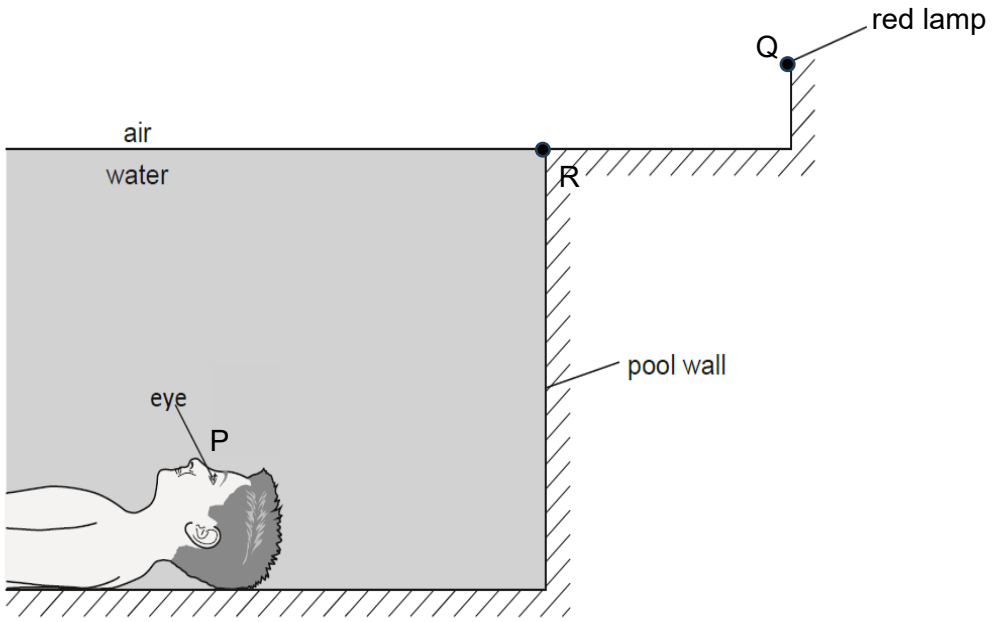

Fig. 7.1

(a) On Fig. 7.1, draw the ray from the red lamp travelling from Q to R to the eye at P. Indicate the angle of incidence, i and angle of refraction, r. [2]

(b) From Fig. 7.1, calculate the refractive index of water. [1]

refractive index = ……..

(c) From **(b)**, calculate the critical angle. [1]

critical angle = ……..

8 **(a)** Fig. 8.1 shows a light ray from a distant luminous object O (not shown) hitting a converging lens. The focal point of the lens is marked as F.

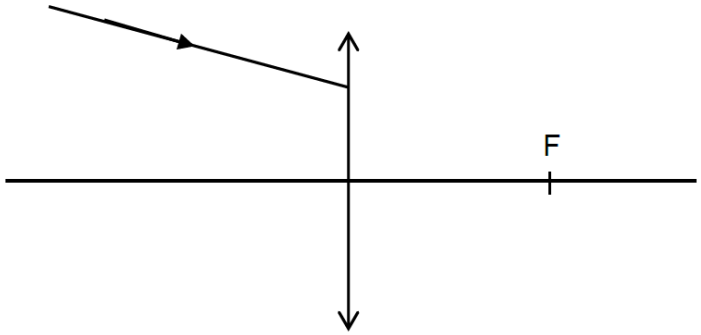

Fig. 8.1

(i) In Fig. 8.1, draw light rays to show the position of the image I of object O. [2]

(ii) State any two characteristics of image I. [1]

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(b) A student investigates how the magnification of an object changes at different distances from a converging lens. He places the object in front of the lens as shown in Fig. 8.2.

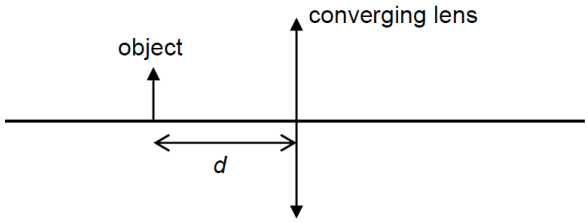

Fig. 8.2

Table 8.3 shows the set of data that he has collected for the distance d and the magnification produced.

d / cm	magnification
5.0	1.2
10.0	1.5
15.0	2.0
20.0	3.0
25.0	6.0

Table 8.3

He observed from the table that when the distance d doubles from 10 cm to 20 cm, the magnification also doubles from 1.5 to 3.0. He then concludes that the magnification is directly proportional to the distance, d of the object from the lens.

Explain if his conclusion is accurate. [2]

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9 Fig. 9.1 shows part of the electrical circuit in a house, where the mains supply is at 230 V. The lamps in the circuit are identical and each is rated at 50 W, 230 V. The water heater is rated at 2.5 kW, 230 V.

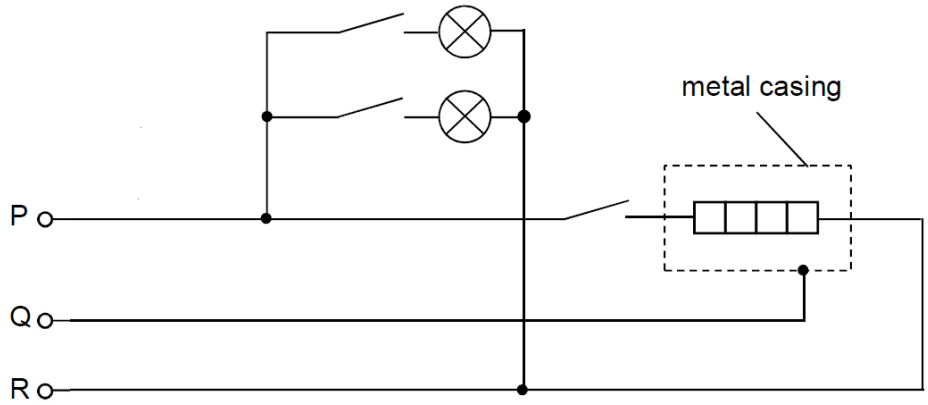

Fig. 9.1

(a) In Fig. 9.1, draw a fuse in the electrical circuit to protect the lamps and water heater from excessive current flow. [1]

(b) State which wire is the earth wire and describe the function of the earth wire. [2]

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(c) In a day, each lamp is switched on for 3.0 hours and the water heater is switched on for 0.40 hours. The cost of electricity is 30 cents for one kWh.
Calculate the cost of using the appliances for a week. [2]

cost = ……

10 Fig 10.1 shows a waveform generated by a long rope fixed to a post. The wave moves at a rate of 10 times every 4.0 seconds. The rope moves to a high of 15 cm and a low of 15 cm from its original rest position.

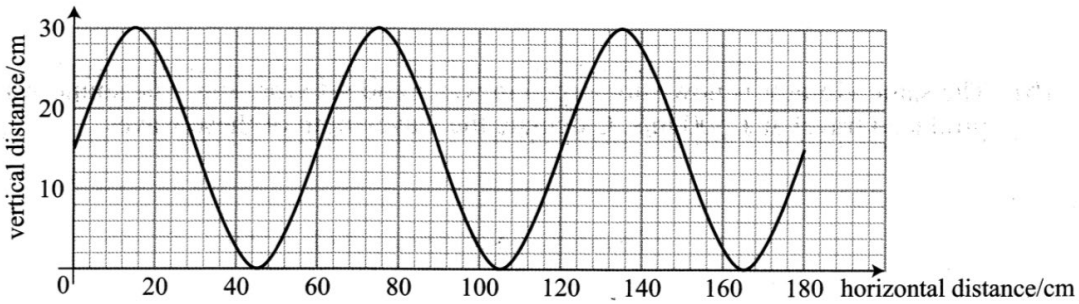

Fig.

(a) Calculate the velocity of the wave. [2]

velocity = ……..

(b) On Fig. 10.1, sketch the waveform of the rope after 25 s. [2]

11 Californium-241 decays by giving out an alpha particle. The half-life of Californium-241 is 4.0 minutes.

(a) If the sample of Californium-241 had an initial count rate of 1200 counts/min, what is the count rate of the sample after 20 minutes? [2]

count rate = ……..

(b) Explain why Californium-241 is not suitable for use in a smoke detector. [2]

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12 Thermal conduction is the transfer of thermal energy through a substance with no overall movement of the substance.

(a) Fig. 12.1 shows a solid metal rod of length about 30 cm that has one end maintained at a temperature of 100 °C using a bath of water.

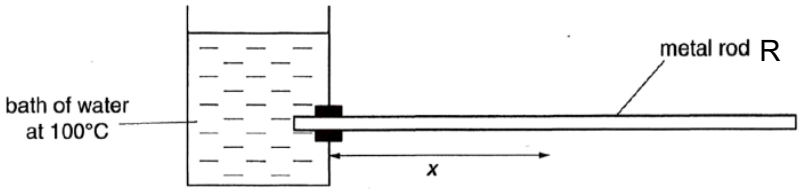

Fig.

The rod is in a room free of moving air currents. The apparatus is left until the temperature at any point along the rod does not change.
Fig. 12.2 shows the variation of the temperature θ of the rod R with distance x from the bath of water until it reaches room temperature of 31 °C.

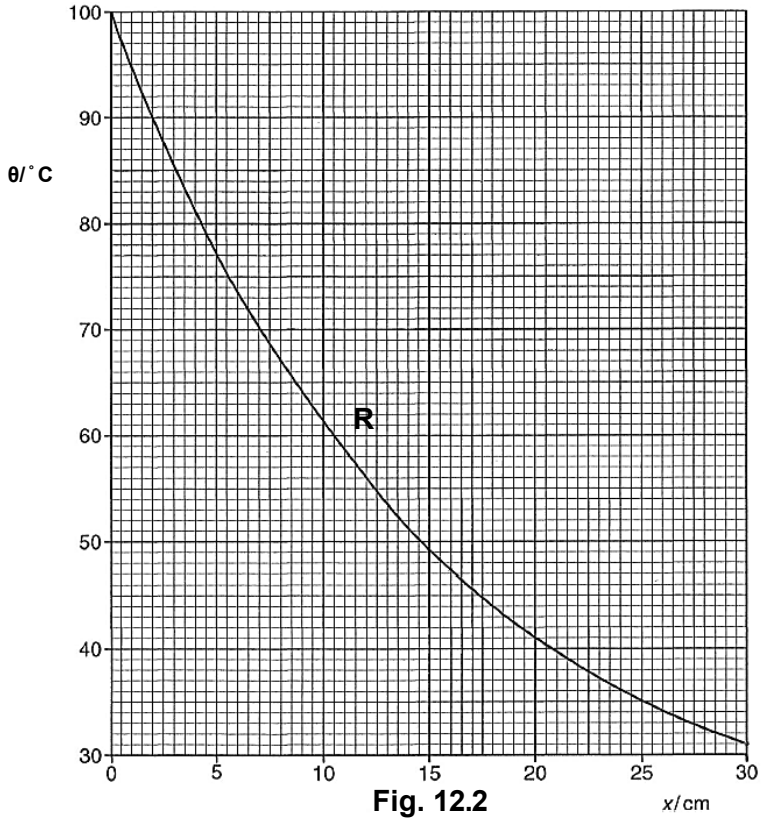

Fig. 12.2

The metal rod R is replaced with a similar rod S made of wood under the same conditions.

(i) On Fig. 12.2, **sketch and label graph S** to show a possible variation with distance x of the temperature θ of wood rod S. [2]

(ii) Explain your answer to **(a)(i)**. [2]

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(b) The rod in **(a)** is shortened and placed between two baths of water, as shown in Fig. 12.3.

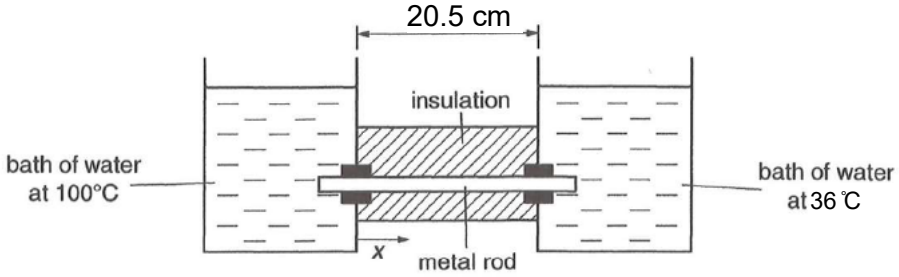

Fig.

The baths of water are maintained at temperatures of 100 °C and 36 °C. The length of the rod between the baths of water is 20.5 cm and the rod is surrounded by insulation. The apparatus is left until the temperature at any point along the rod does not change. Fig. 12.4 shows the variation of the temperature θ of the rod with the distance x from the hotter bath of water.

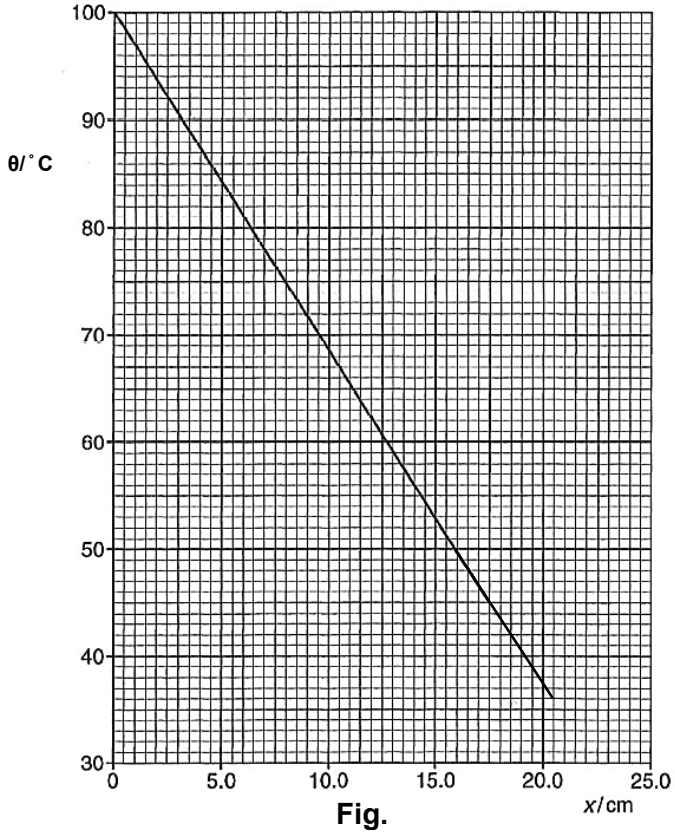

Fig.

(i) The insulation on the rod is perfect. State the relation between the rate at which thermal energy enters the rod at 100 °C and the rate at which it leaves the rod at 36 °C. [1]

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(ii) State why, for any value of x between 0.5 cm and 20 cm, the temperature, as shown in Fig. 12.4, is higher than that shown in Fig. 12.2. [1]

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(iii) The temperature change per unit length of the rod, which is also known as the temperature gradient, is constant.
Use Fig. 12.4 to determine the temperature gradient of the rod. [2]

temperature gradient = ……..

(c) It was found that the rate of heat flow *H* through the rod in **(b)** is directly proportional to the cross-sectional area *A* of the rod and its temperature gradient, where *k* is the thermal conductivity of the rod.

$$H = -kA \times \text{temperature gradient}$$

Fig. 12.5 shows the thermal conductivities of some substances.

substance	thermal conductivities / W m^{-1} $°C^{-1}$
copper	385
brass	109
steel	50
concrete	0.80
wood	0.12
Styrofoam	0.027

Fig.

The study of heat conduction in different substances enables the efficient design of buildings, as well as household products. Fig. 12.6 shows a Styrofoam cooler with a total wall area of 0.80 m^2 and wall thickness of 5.0 cm. It is filled with ice at 0 °C.

Fig.

(i) Determine the rate of heat flow into the cooler if the temperature of the outside wall is 35 °C. [2]

rate of heat flow = …….. W

(ii) The specific latent heat of fusion of ice is 3.34 x 10^5 J kg^{-1}. Calculate the mass of ice that will melt in 2 hours. [2]

mass = ……..

13 **(a)** Fig. 13.1 shows a circuit containing a 4.0 V filament lamp and a 4.0 V power supply.

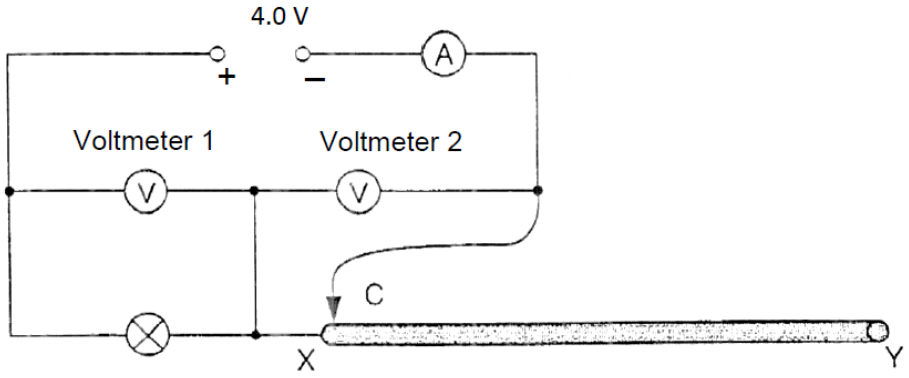

Fig.

The variable resistor XY is made from a long resistance wire. The sliding contact C moves along the wire from X to Y.

(i) State what happens to the readings of the two voltmeters and the ammeter as C moves from X to Y. Give numerical values where possible. [3]

Voltmeter 1

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Voltmeter 2

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Ammeter

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(ii) Fig. 13.2 shows the I-V characteristic graph of the filament lamp.

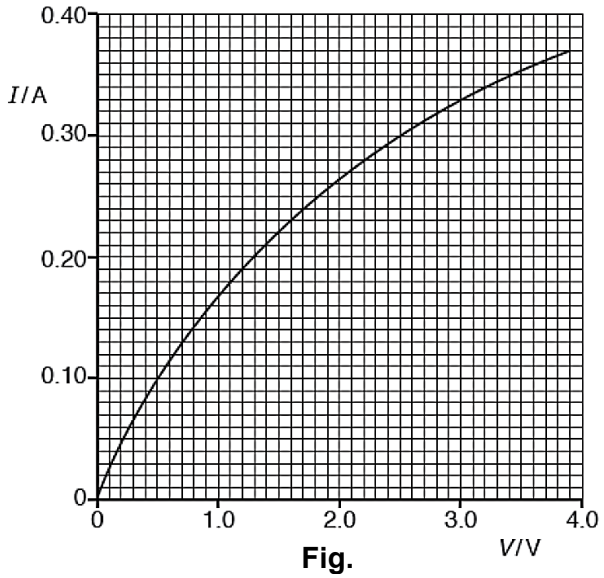

Fig.

Describe and explain how the brightness and resistance of the lamp varies as the voltage across it increases. [2]

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(b) The wire XY has a length of 2.2 m and a diameter of 1.5 mm. When the potential difference of 0.50 V is applied across the wire, the current flowing in the wire is 0.40 A.

Calculate

(i) the resistance, and [1]

resistance = ……..

(ii) the resistivity of the wire. [2]

resistivity = ……..

Section B

Answer **one** question from this section.

14 Fig. 14.1 shows a simple experimental set up to study the motion of a motor. AB and CD are solenoids connected to a battery. F and G are connected to an external voltage supply. It is observed that the coil makes 5.0 rotations every minute.

The graph of the external voltage supplied is as shown in Fig. 14.2. Positive voltage indicates that the potential of F is higher than of G.

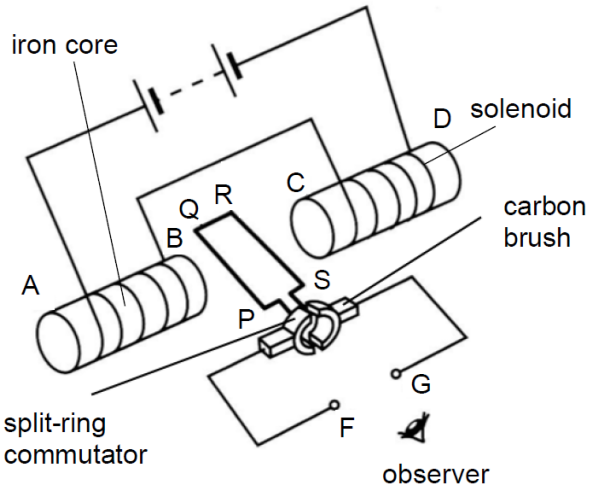

Fig.

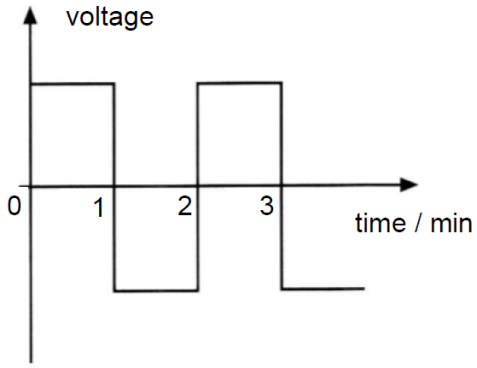

Fig.

(a) Identify the magnetic poles at B and C. [1]

B ……..

C ……..

(b) Fig. 14.3 shows the solenoids and the coil PQRS from the observer's point of view.

Fig.

On Fig. 14.3, draw the resulting magnetic field due to the set up. [2]

(c) State whether the coil PQRS turns (clockwise or anticlockwise direction) in the first minute. [1]

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(d) Explain your answer in **(c)**. [2]

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(e) Explain why the coil rotates continuously for the first minute when the split-ring commutator is used. [2]

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(f) State the change in the movement of the coil between the first and second minute. [1]

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(g) Suggest one improvement to increase the speed of rotation of the coil. [1]

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15 Fig. 15.1 shows a flowmeter that measures the volume of oil passing through a pipe.

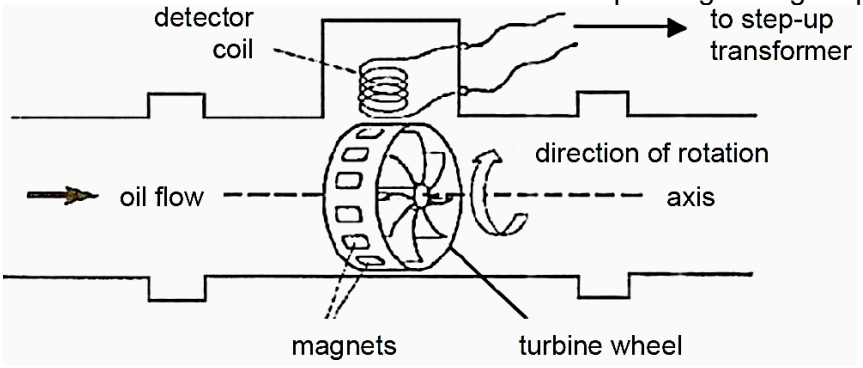

Fig.

Twenty identical magnets are spaced equally around a turbine wheel. As oil flows, the turbine wheel rotates about the axis as shown in Fig. 15.1. The detector coil is connected to the primary coil of a step-up transformer as shown in Fig. 15.2 to amplify the voltage signal, which is then displayed on a computer display.

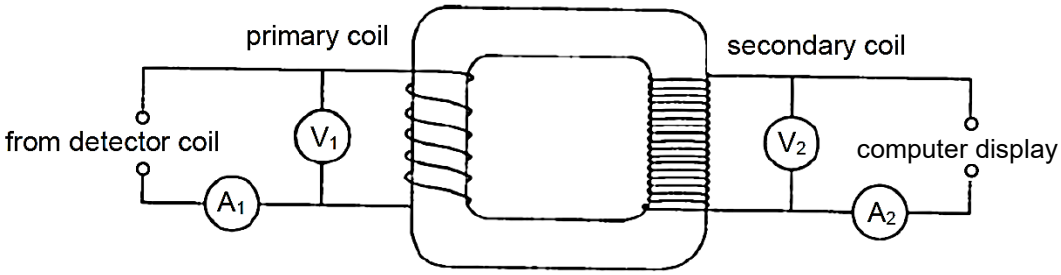

Fig.

Table 15.3 shows the data for two different oil flow rates with some missing values.

oil flow rate / $cm^3\ s^{-1}$	period of induced e.m.f. / s	transformer			
		A_1 / A	V_1 / V	A_2 / A	V_2 / V
15	2.0	1.8	6.0	0.80	12
32	1.0	3.6		1.60	

Table 15.3

(a) Explain why an alternating e.m.f. is induced in the detector coil. [3]

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(b) On Fig. 15.4, sketch how the induced e.m.f. in the primary coil varies with time for a flow rate of 15 $cm^3\ s^{-1}$. [2]

Fig. 15.4

(c) Calculate the efficiency of the transformer. [2]

efficiency = ……..

(d) Calculate the turns ratio of the transformer shown in Fig. 15.2. [2]

turns ratio = ……..

(e) Calculate the missing values for V_1 and V_2. [1]

V_1 = ……..

V_2 = ……..

[End of Paper]