

PHYSICS PAPER 1

SECTION B: Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

- (1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.
- (2) Refer to the general instructions on the cover of the Question Paper for Section A.
- (3) Answer **ALL** questions.
- (4) Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
- (5) Graph paper and supplementary answer sheets will be provided on request. Write your Candidate Number, mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.
- (6) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Please stick the barcode label here.

Candidate Number

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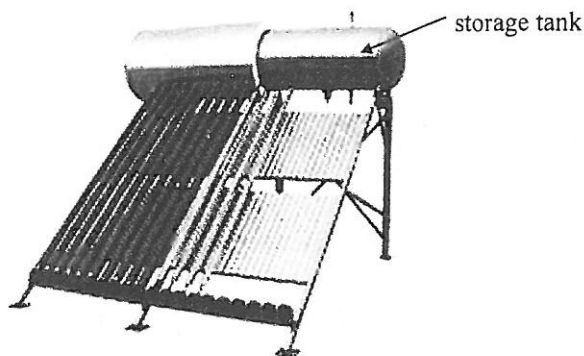
| Question No. | Marks |
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Section B: Answer ALL questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided.

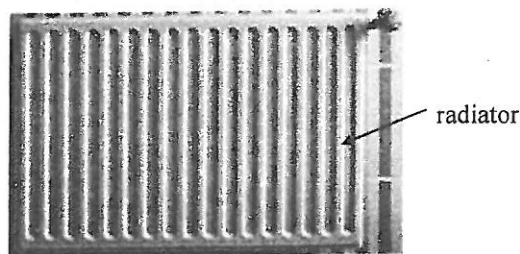
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Figure 1.1



A solar water heater shown in Figure 1.1 is installed on the rooftop of a house. During the day, the heater heats up 1.5 m^3 of water to $80 \text{ }^\circ\text{C}$. At night, the hot water in the storage tank is circulated to the radiators (see Figure 1.2) in different rooms of the house to keep the rooms warm.

Figure 1.2



Given: density of water = 1000 kg m^{-3}
specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$

- (a) Given that 15% of the energy is lost during the transfer of water, how much heat can be released from the system to the rooms when the water temperature drops to $60 \text{ }^\circ\text{C}$? (3 marks)

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- (b) Given that during night time the radiators maintain an average output power of 4.5 kW, how long can the radiators maintain this average power until the water temperature in the system drops to 60 °C ? Give your answer in hours. (2 marks)

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- (c) The rate of heat released by the solar water heating system during the time period calculated in (b) is in fact not constant and gradually drops. Explain why this is so. (1 mark)

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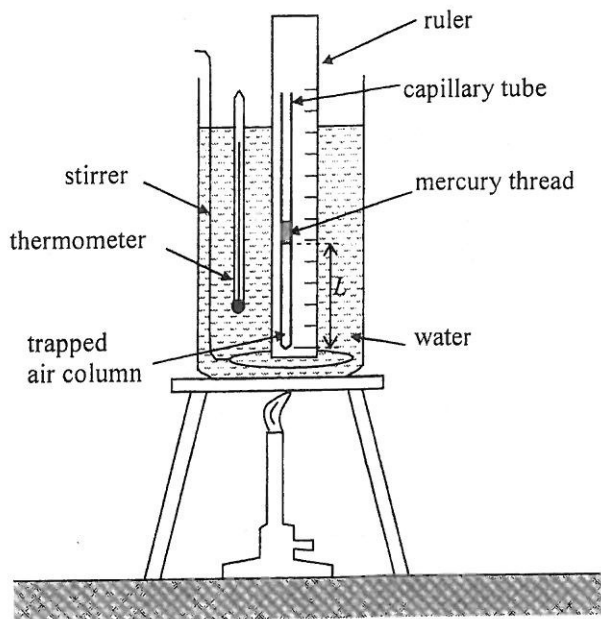


Figure 2.1

Figure 2.1 shows an air column trapped by a small mercury thread inside a uniform capillary tube. The set-up is heated by a water bath. The length of the air column L is measured at various temperature θ . Some of the results are tabulated below:

| | | | |
|---------------------------------------|----|--|----|
| Temperature $\theta / ^\circ\text{C}$ | 20 | | 92 |
| Length of air column L / mm | 64 | | 80 |

- (a) Describe the procedure(s) to be done before taking a reading in order to ensure that the trapped air reaches the same temperature as the water. (2 marks)

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(b) Assume that length L increases linearly with temperature θ throughout.

(i) Estimate the length of the air column when the temperature indicated by the thermometer is 65°C . (2 marks)

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(ii) Find the 'absolute zero' as obtained from this experiment. (2 marks)

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3. A lift car of weight 8000 N is going up with constant speed 2 m s^{-1} as shown in Figure 3.1. The upward force raising the lift car is provided by the cable wound on a drum which is driven by a motor. The other end of the cable is firmly attached to the drum at P . Neglect air resistance and the mass of the cable.

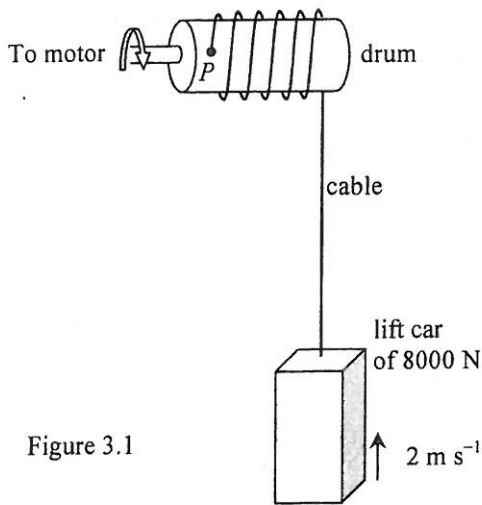


Figure 3.1

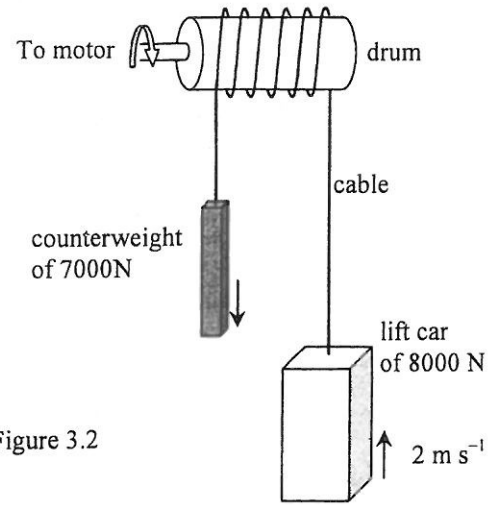


Figure 3.2

- (a) (i) Calculate the mechanical power delivered to the rising lift car by the motor. (2 marks)

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- (ii) The total mechanical power output of the motor is 20 kW . How much power is lost due to overcoming friction between the movable parts? (1 mark)

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(b) Now a 7000 N counterweight is installed at the other end of the cable as shown in Figure 3.2. The counterweight always moves in the opposite direction to the lift car which again moves up at 2 m s^{-1} . Assume that there is no slipping between the cable and the drum.

(i) Calculate the total mechanical power output of the motor required in this case, assuming the same power loss in overcoming friction between movable parts as found in (a). (2 marks)

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(ii) State the advantage of having the counterweight installed. (1 mark)

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(iii) A claim is made that as power is lost due to friction, a drum with frictionless surface can further reduce the power required from the motor. Comment on this claim. (2 marks)

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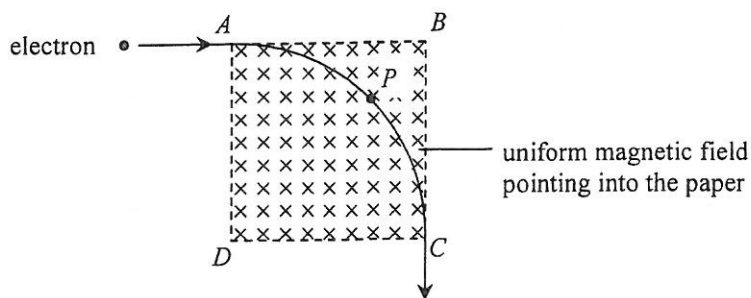
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- *4. An electron moving with speed $1.2 \times 10^7 \text{ m s}^{-1}$ enters a square region $ABCD$ with a uniform magnetic field of 0.01 T pointing into the paper as shown in Figure 4.1. The electron describes a quarter circle from A to C and it emerges from C with the same speed. Neglect the effects of gravity.

Figure 4.1



- (a) (i) Find the magnitude of the magnetic force acting on the electron at point P on its path. (2 marks)

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- (ii) Indicate in Figure 4.1 the direction of the electron's acceleration at the point P . (1 mark)

- (b) Although the electron accelerates due to the magnetic force, explain why it emerges from the magnetic field with the same speed. (2 marks)

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- (c) Deduce the speed of the electron when entering the magnetic field such that it would describe a semi-circle from A to D instead. (2 marks)

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5. Figure 5.1 shows a smooth sloping track ABC firmly fixed in a vertical plane with its horizontal part BC resting on a bench surface. You are given a toy skier, a metre rule and a long rough paper strip with adhesive tape on the bottom surface.



Figure 5.1



Using the apparatus provided, describe an experiment to study how the stopping distance of the toy skier depends on its height of release. Your description should include the physical quantities to be measured and the result expected. (5 marks)

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6. Read the following description about 'Bungee jumping' and answer the questions that follow.

Bungee jumping is an activity that involves jumping from a tall structure while the person is connected to it via a thick elastic cord. When the bungee jumper jumps, the cord stretches after falling a certain distance. The bungee jumper is momentarily at rest at the lowest point but then bounces back up into the air. The bungee jumper continues to oscillate up and down a few times before he comes to a complete stop.

ankle attachment



A simple 'ankle attachment' (as shown in the above photo) can be used to secure the player to the cord. However, due to accidents where the ankle attachment became detached from the bungee jumper, many operators now use a 'full body harness'.

full body harness



When answering the following questions, neglect the effects of air resistance.

- (a) (i) Describe the acceleration of the bungee jumper during the first downward fall to the lowest point. (3 marks)

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- (a) (ii) State the energy change during the period from the beginning of the jump to the moment when the bungee jumper is at the lowest point of his first downward fall. (2 marks)

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- (b) In terms of the net force acting on the bungee jumper, explain why the cord has to be elastic. (2 marks)

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- (c) In terms of contact area, explain why a 'full body harness' is less likely to cause injuries to or detach from the bungee jumper than a simple 'ankle attachment' during a fall. (2 marks)

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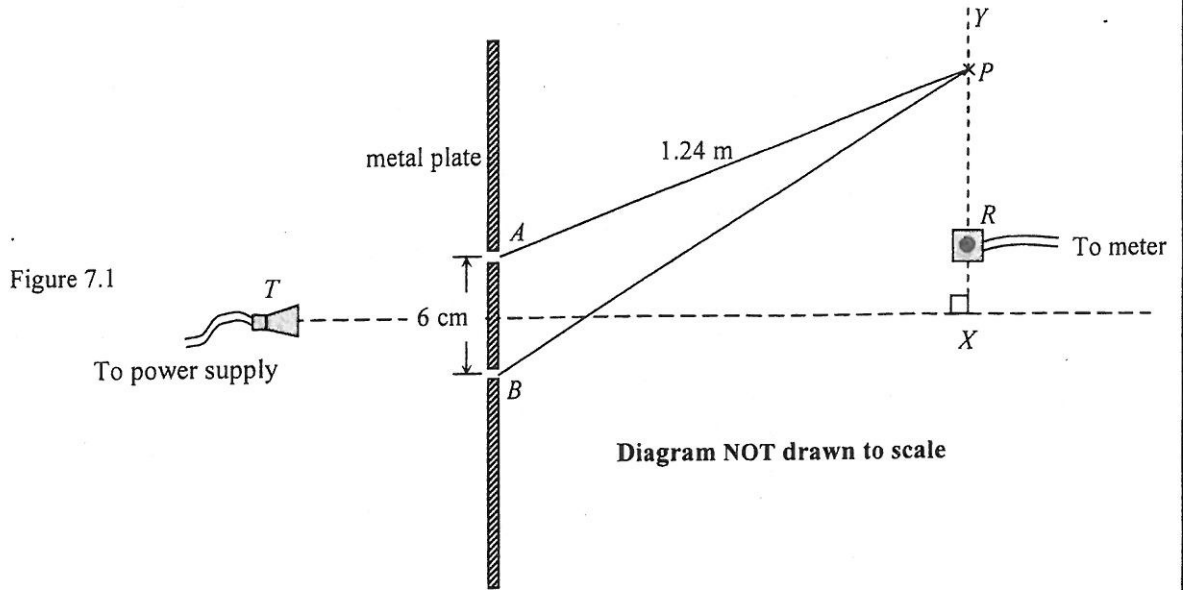


Figure 7.1 shows a set-up for the study of interference of microwaves. Microwaves of wavelength 2 cm emitted from a transmitter *T* pass through two slits *A* and *B* formed by metal plates. The slits are separated by 6 cm as shown. A probe *R* connecting to a meter is moved from *X* to *Y* to detect the intensity of microwaves received. Transmitter *T* and point *X* are equidistant from *A* and *B*.

- (a) Calculate the frequency of the microwaves. (2 marks)

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- (b) (i) The meter shows alternate maxima and minima when *R* moves along *XY*. Explain. (2 marks)

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(b) (ii) The second minimum is found at position P where $AP = 1.24$ m. Find BP . (2 marks)

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(iii) When R is moved along XY from X towards Y and beyond, explain whether or not it is possible to detect more than three maxima. (2 marks)

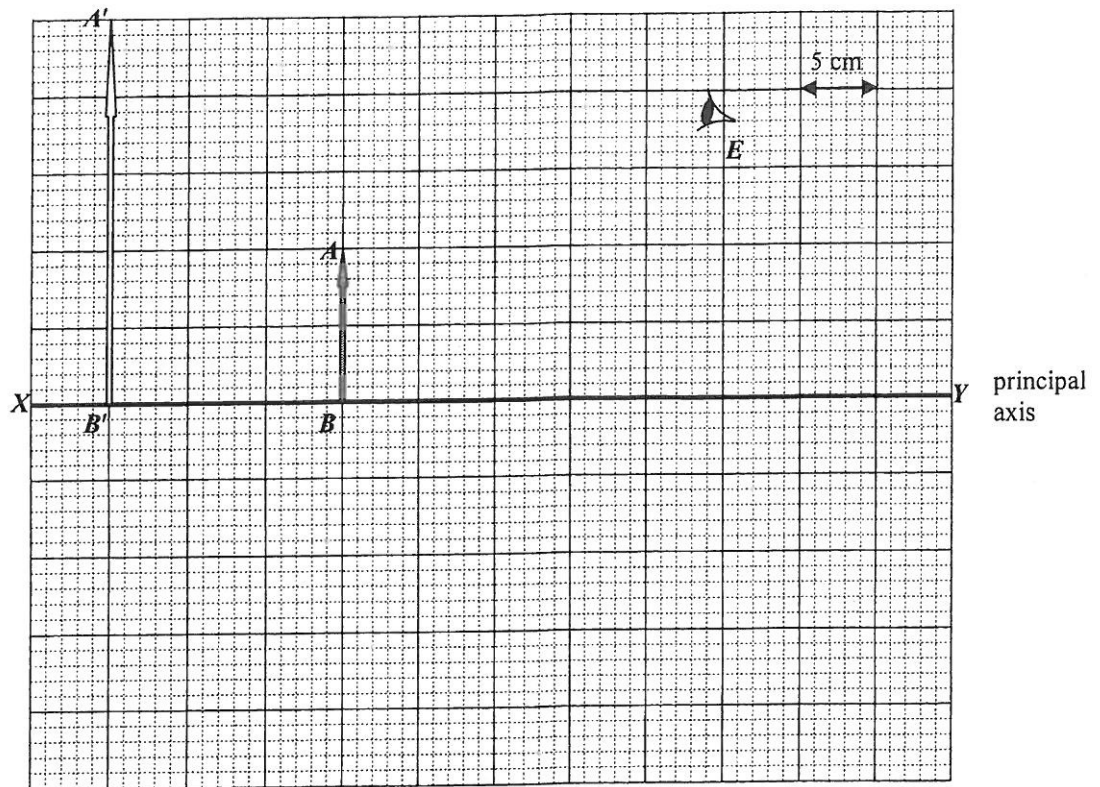
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(c) Microwaves can be used in radar. Why are radio waves of lower frequencies not suitable for use in radar? (2 marks)

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8. In Figure 8.1, $A'B'$ represents the image of an object AB formed by a lens L (not shown) where XY is the principal axis of the lens.

Figure 8.1



Answers written in the margins will not be marked.

- (a) (i) Is the image real or virtual? (1 mark)

- (ii) What kind of lens is used? Explain your answer. (2 marks)

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- (b) (i) Locate the optical centre O of lens L and draw on Figure 8.1 the position of lens L . (1 mark)

- (ii) By drawing an additional light ray, mark the principal focus F of the lens and find its focal length. The horizontal scale is 1 cm to 5 cm. (2 marks)

Focal length =

- (c) Draw a light ray to show how the eye E shown can see the image of head A through lens L . (2 marks)

- (d) State an application of lens L in the situation as shown above. (1 mark)

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9. Carbon-14 dating can be used to identify the age of some objects which have the ^{14}C isotope, as it is radioactive and decays by emitting a β -particle. A piece of wood sample is examined using carbon-14 dating and its activity is 0.2 Bq. The half-life of ^{14}C is 5730 years. Given: 1 year = 3.16×10^7 s

*(a) Calculate the decay constant of ^{14}C in s^{-1} . Hence find the number of ^{14}C nuclei in this wood sample. (3 marks)

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Assume that living organisms contain a constant proportion of carbon-14 in the ratio of $^{14}\text{C} / ^{12}\text{C} = 1.3 \times 10^{-12}$ during its life time via intake of carbon dioxide (CO_2) from the atmosphere.

(b) The carbon content of this wood sample is found to contain a total of 1×10^{23} carbon nuclei. Estimate the number of ^{14}C nuclei in the sample originally when it died. (1 mark)

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*(c) Estimate the age of this wood sample in years using the results found in (a) and (b). (2 marks)

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10. (a) In the circuit shown in Figure 10.1, a 12 V battery of negligible internal resistance is connected with a thermistor R and a resistor of resistance $120\ \Omega$. The graph shows the variation of the thermistor's resistance with temperature.

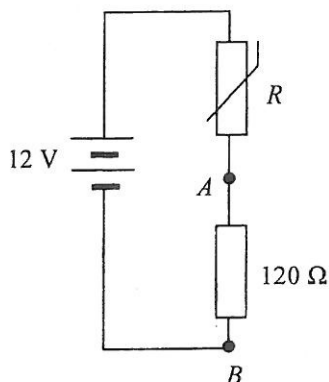
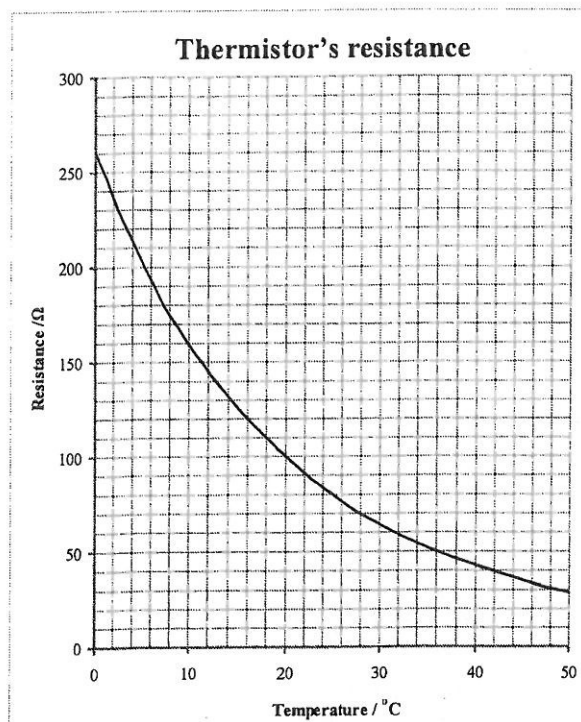


Figure 10.1



- (i) Find the resistance of the thermistor R at $25\ ^\circ\text{C}$. (1 mark)

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- (ii) What is the potential difference V_{AB} across A and B at $25\ ^\circ\text{C}$? (2 marks)

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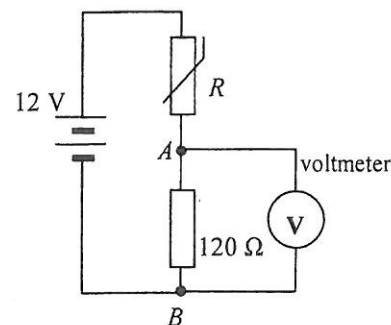
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- (b) Kelly wants to confirm the above calculation by measuring V_{AB} using a voltmeter of about $1\ \text{k}\Omega$ resistance. She finds that the reading registered is slightly different from the value found in (a) despite making careful measurements. Explain why this is so. Suggest how the accuracy of the measurement could be improved. (3 marks)



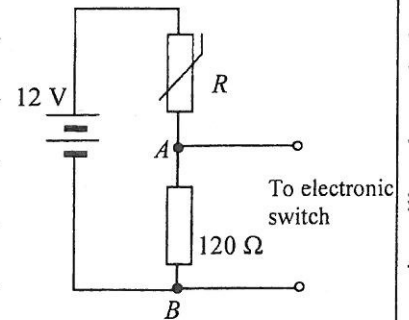
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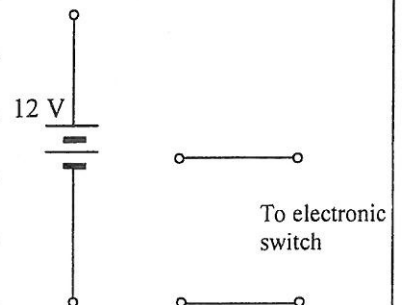
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- (c) (i) The potential difference V_{AB} is used to drive an electronic switch connected across AB to turn on a fan if temperature rises above a certain value such that V_{AB} is 6.0 V or above. Using the information provided in the graph, find the minimum temperature needed to keep the fan on. Show your working. (2 marks)



- (ii) Without using additional components, complete the new circuit diagram below to illustrate how the circuit can be modified to turn on a heating device when temperature falls below a certain value. Explain the action of the circuit. No calculation is required. (3 marks)



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11. Figure 11.1 shows two identical small metal spheres X and Y suspended by insulating threads of the same length. Each sphere has a mass of 1.0×10^{-5} kg and each carries a positive charge of 3.1 nC (1 nC = 10^{-9} C). The separation d of the spheres is 10 cm. The size of the spheres is negligible compared with their separation, therefore they can be treated as point charges.

Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$. ($g = 9.81 \text{ m s}^{-2}$)

Figure 11.1

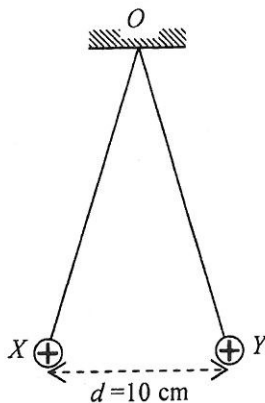


Diagram NOT drawn to scale

- (a) Find the angle between the threads.

(3 marks)

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Area for writing the answer to part (a). The area contains several horizontal dashed lines for writing.

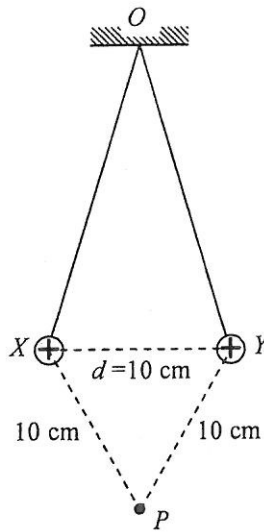
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(b) Point P is vertically below the fixed point O and it is 10 cm from each sphere.

(i) Indicate the direction of the resultant electric field at P due to these two charged spheres. (1 mark)

Figure 11.2



*(ii) Calculate the electric potential at point P . The electric potential at infinity is taken to be zero. (2 marks)

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Answers written in the margins will not be marked.

(iii) A neutral metal sphere of finite size is now placed at P . State whether the separation d would increase, decrease or remain unchanged due to the presence of this sphere. (1 mark)

Separation d

END OF PAPER

Sources of materials used in this paper will be acknowledged in the *Examination Report and Question Papers* published by the Hong Kong Examinations and Assessment Authority at a later stage.

Answers written in the margins will not be marked.