

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

Question No.	Marks
1	7
2	6
3	12
4	9
5	7
6	8
7	7
8	12
9	8
10	8



Section B: Answer ALL questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided.

1.

Figure 1.1

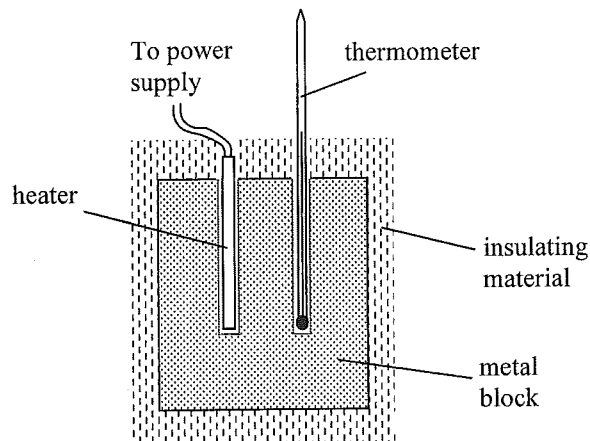
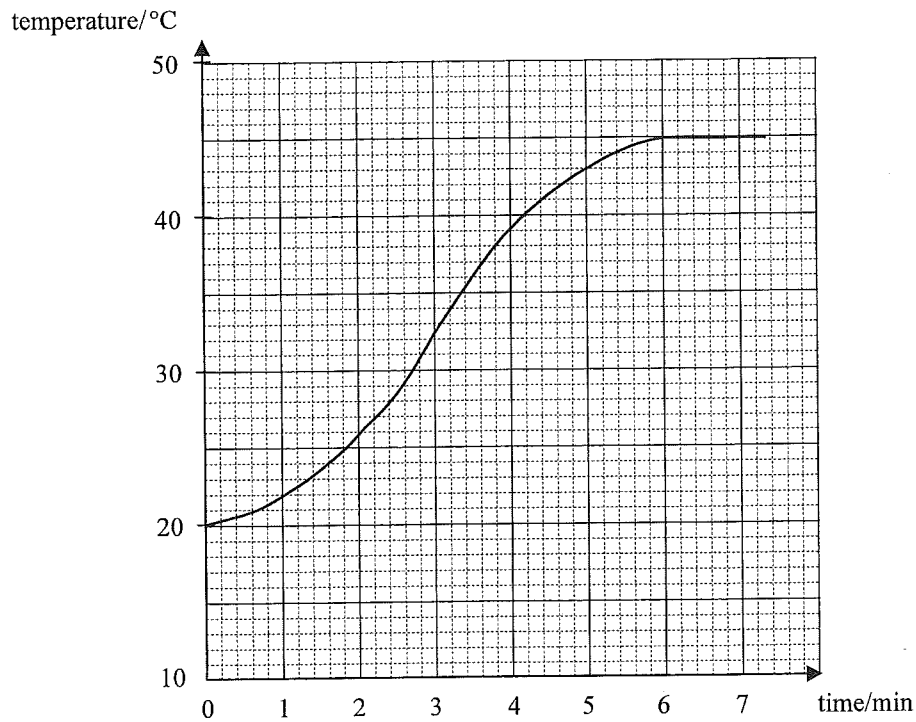


Figure 1.1 shows an experimental set-up to find the specific heat capacity of a metal. The metal block is wrapped by insulating material. A heater is connected to a power supply. It is switched on when the temperature of the metal block is 20°C and then switched off when the temperature reaches 43°C . The graph below shows the variation of the temperature of the metal block with time.



(a) Use the graph to find the duration that the heater is switched on. (1 mark)

(b) After the heater is switched off, the temperature of the metal block continues to rise for a while. Explain why. (1 mark)

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(c) Given: mass of the metal block = 0.80 kg
heater voltage = 12 V
heater current = 4.0 A

(i) By considering the maximum temperature rise of the metal block, calculate the specific heat capacity of the metal as found from the experiment. (2 marks)

(ii) Would your result be the same, higher, or lower than the actual value of the specific heat capacity of the metal? Explain. (2 marks)

(d) This method is not suitable for measuring the specific heat capacity of a glass block. Explain. (1 mark)

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- (b) Use kinetic theory of an ideal gas to explain the increase of pressure inside the basketball when air is pumped into it. (2 marks)

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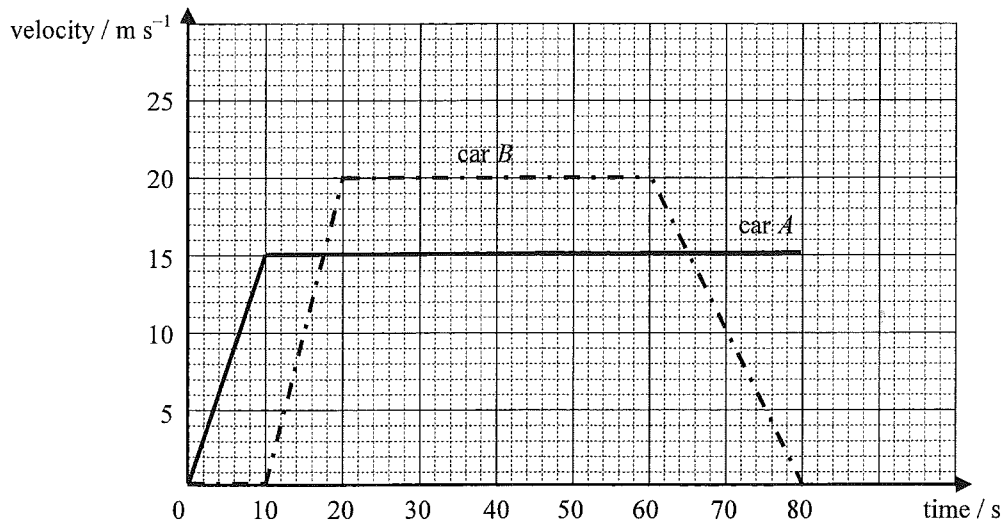
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3. Two cars *A* and *B* initially at the same position, start to travel along the same straight horizontal road. The graph below shows how their velocities vary with time.



- (a) Describe the motion of car *A* along the whole journey from $t = 0$ to $t = 80$ s. (2 marks)

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- (b) (i) Which car attained the greatest acceleration throughout the journey? Find this acceleration. (2 marks)

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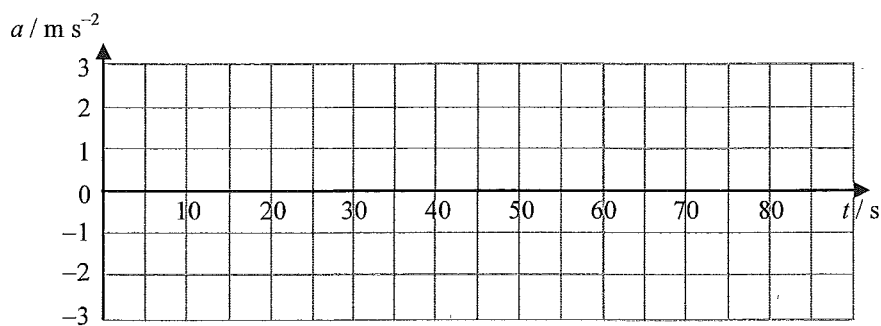
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- (ii) Sketch the acceleration-time ($a-t$) graph of car *B* from $t = 0$ to $t = 80$ s. (2 marks)



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(c) (i) At $t = 20$ s, what is the separation between cars A and B ? (2 marks)

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(ii) Deduce the time at which car B catches up with car A . (2 marks)

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(d) Both cars are of similar size and shape. It is known that the total resistive force experienced by each car is proportional to the square of its velocity. Determine the ratio of power output of the engine of car A to that of car B within the period $t = 20$ s to $t = 60$ s. (2 marks)

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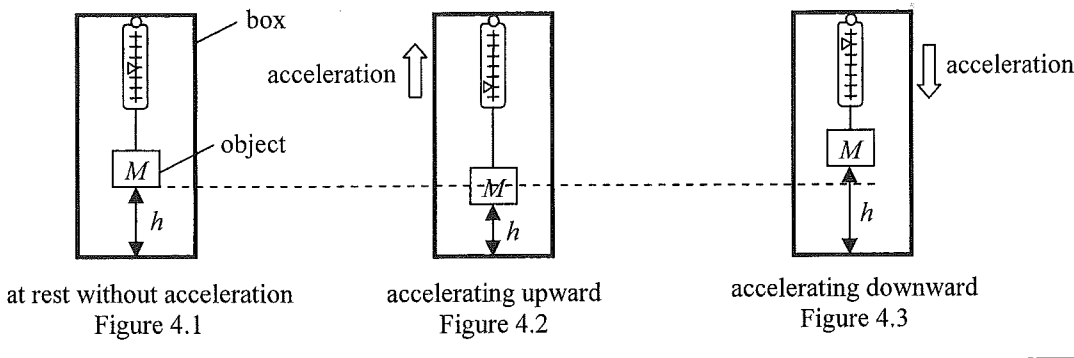
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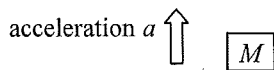
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4. Read the following description about **accelerometers** and answer the questions that follow.

An accelerometer is a device for measuring acceleration. The following example illustrates the principle of a simple accelerometer. An object of mass M is suspended by a spring balance inside a box. If the box is at rest without acceleration, the object is h above the bottom of the box (Figure 4.1). When the box accelerates upward, h decreases (Figure 4.2). Likewise, when the box accelerates downward, h increases (Figure 4.3). Since it is known that the tension of the spring balance is directly proportional to its extension, we can therefore determine the magnitude and direction of the box's acceleration by measuring h .



- (a) Draw a labelled free-body diagram in the space provided below showing the forces acting on the object when the box accelerates upward with acceleration a . Explain why h decreases in this case. (4 marks)



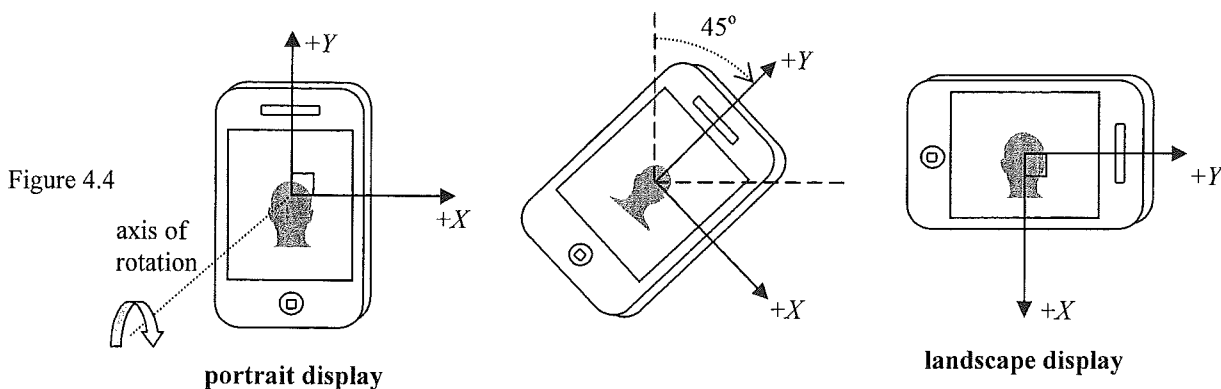
- (b) The scale of the spring balance is calibrated such that the pointer moves 1 cm for a change of 2 N of force. The weight of the object is 5 N. If h decreases by 0.5 cm compared to the situation in Figure 4.1, what is the reading of the balance? Hence find the magnitude of the corresponding acceleration of the box. (acceleration due to gravity $g = 9.81 \text{ m s}^{-2}$) (3 marks)

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Electronic accelerometers employing similar principles are widely used in smart phones. The phone's orientation is detected by a set of built-in accelerometers each detecting the acceleration due to gravity along mutually perpendicular axes of the phone. A phone in vertical orientation is shown on the left of Figure 4.4, its accelerometer along the Y axis would be sensing the acceleration due to gravity, denoted by $a_Y = -g$. When the phone is rotated about a horizontal axis perpendicular to both X and Y axes by more than 45° , 'portrait display' would change to 'landscape display' as shown on the right of Figure 4.4.



- (c) What would the kind of display be if the phone is rotated clockwise until the acceleration a_Y sensed by the accelerometer along the rotated Y axis is $-0.5 g$? Explain. (2 marks)

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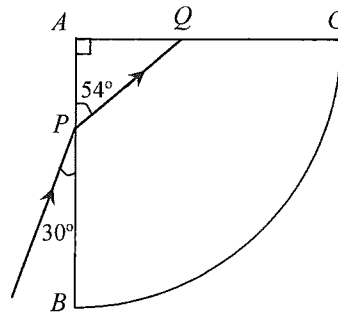


Figure 5.1

Figure 5.1 shows the cross-section of a glass block ABC . ABC is a quarter circle with its centre at A . A ray of red light is incident at P on face AB and the refracted ray strikes the face AC at Q as shown.

- (a) Calculate the refractive index of the glass for red light. (2 marks)

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- (b) Explain why the ray is totally reflected when it strikes the face AC at Q . (2 marks)

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- (c) In Figure 5.1, sketch the subsequent path of the ray until it finally emerges from the block to the air. (2 marks)

- (d) If the incident ray is a ray of white light, what can be observed when it finally emerges from the block? (1 mark)

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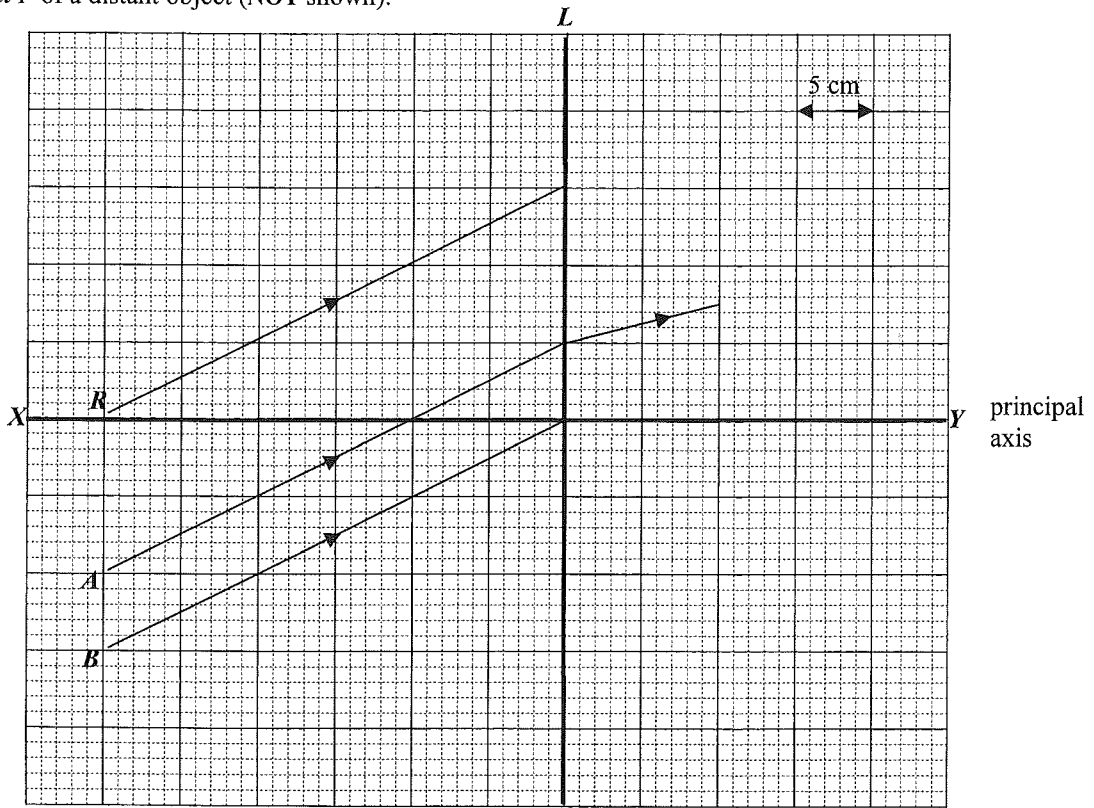
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6. In Figure 6.1, XY is the principal axis of a thin spherical lens L while A, B are two parallel rays coming from a point P of a distant object (NOT shown).

Figure 6.1



- (a) What kind of lens is L ? Explain. (2 marks)

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- (b) (i) Locate the image of P (denoted it as point P'). (2 marks)

- (ii) Hence, determine the focal length of the lens. (1 mark)

Focal length =

- (c) R is a ray coming from the same point P ; complete its path after passing through the lens. (1 mark)

- (d) Based on the situation shown in the ray diagram above, describe a simple experimental method to determine the focal length of lens L . (2 marks)

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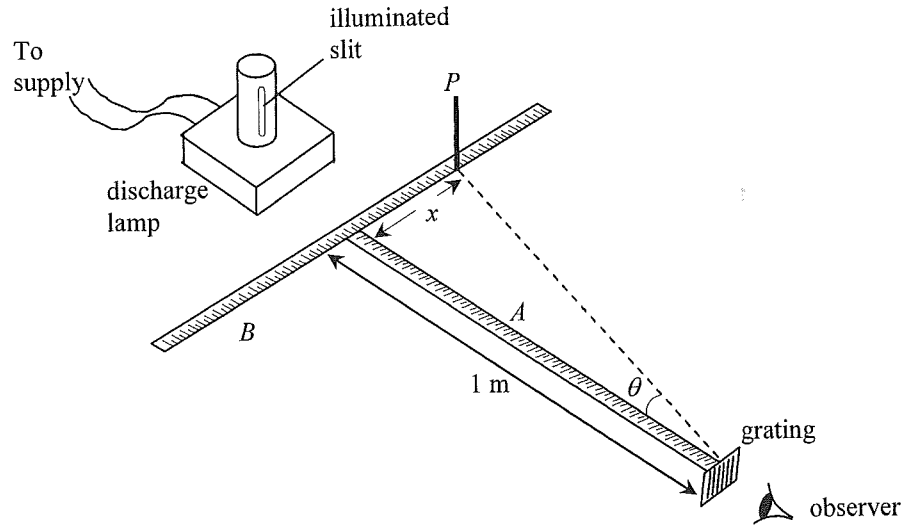
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7. Figure 7.1 shows an experimental set-up to determine the wavelength of monochromatic light emitted from the vertical narrow slit of a discharge lamp. A, B are two mutually perpendicular metre rules on the bench with rule A pointing towards the lamp. A diffraction grating with vertical lines is placed at one end of rule A . A vertically mounted pin P is moved along rule B until the pin is in line with the diffracted image of the second-order to the observer. The corresponding distance x is measured for finding the diffraction angle θ .

Figure 7.1



The grating has 300 lines per mm and x is found to be 0.38 m for the **second-order** image.

- (a) (i) Calculate the diffraction angle θ .

(1 mark)

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- *(ii) Hence find the wavelength of the light from the lamp.

(3 marks)

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- (a) (iii) Give **ONE** advantage of measuring the position of the second-order image instead of the first-order one. (1 mark)

- (b) In the experiment, the illuminated slit may not be well aligned along metre rule *A*. Suggest one way to reduce this error. (2 marks)

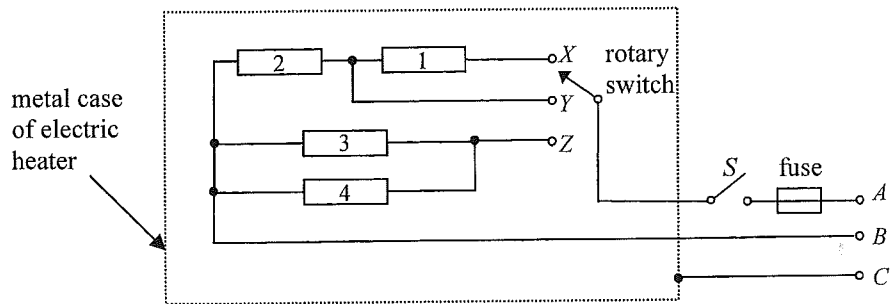
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8. Figure 8.1 shows the schematic diagram of an electric heater consisting of four identical heating elements, each having a rated value of '500 W 220 V'. A user can use the rotary switch to select one of the three modes of operation X , Y , Z . Wires A , B , C from the heater are connected to the 220 V a.c. mains via a 3-pin plug.

Figure 8.1



- (a) Find the resistance R of a heating element. (1 mark)

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- (b) What is the total power dissipation when mode X is selected? Assume that the resistance of each heating element remains unchanged. (2 marks)

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- (c) Without the need of calculations, explain which mode of operation has the largest total power dissipation. (2 marks)

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(d) (i) If fuses 3 A, 5 A and 13 A are available, determine which will be the most suitable to limit an excess current. Show your work. (3 marks)

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(ii) A student claims that since a.c. is used for the heater, the switch S can be installed in either wire A or wire B . Comment on this claim. (2 marks)

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(iii) If a fault resulted in the live wire having contact with the metal case of the heater, which wire, A , B or C , could prevent an electric shock of a person touched the case of the heater? Explain. (2 marks)

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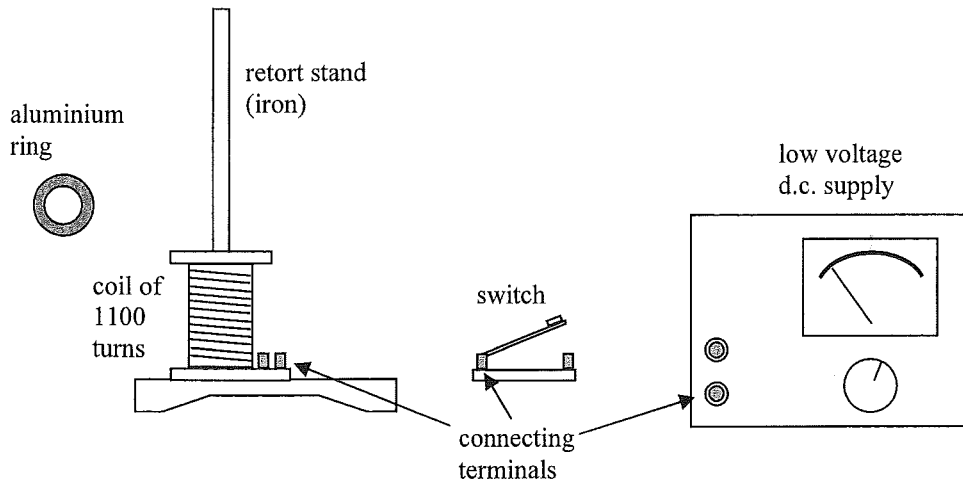
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9. (a) You are given a low voltage d.c. supply, an aluminium ring, a switch, a coil of 1100 turns and a retort stand arranged as shown. Use three connecting leads to complete the connections among the apparatus in the figure and describe how to demonstrate Lenz's law in electromagnetic induction. State and explain the observation. (6 marks)



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Area for student response with horizontal dashed lines.

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(b) Describe what would be observed if the experiment in part (a) is repeated with


(i) a low voltage a.c. supply;

(1 mark)

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(ii) a low voltage a.c. supply and an aluminium ring with a slit cut through it as shown [].

(1 mark)

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10. *Voyager I* is a space probe designed by NASA to operate for over ten years in space. It was equipped with a radioisotope thermoelectric generator (RTG) which can convert the energy released from the decay of a radioactive source into electrical power. *Voyager I* operates with a plutonium-238 radioactive source that undergoes α -decay.

- (a) The plutonium-238 source is sealed inside a thin metallic casing of the RTG. The photo shows a NASA staff handling the RTG with his bare hands. Explain why it is fine for it to be handled by the staff in this way. (1 mark)

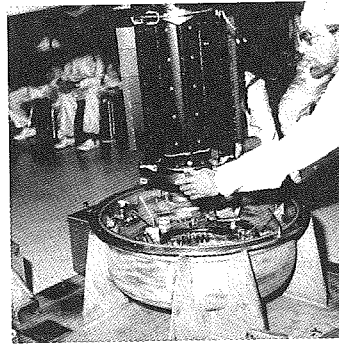


Figure 10.1

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When *Voyager I* was launched, the number of plutonium-238 atoms in the source was 3.2×10^{25} .
Given: half-life of plutonium-238 = 87.74 years.
Take 1 year = 3.16×10^7 s.

- (b) *(i) Find the activity, in Bq, of the plutonium source at the time of launch. (3 marks)

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- (b) (ii) When a plutonium-238 atom decays, it releases 5.5 MeV of energy. Estimate the power, in kW, delivered by the source at the time of launch. (2 marks)

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- *(iii) The RTG of *Voyager I* is still in operation as *Voyager I* just left the solar system in September 2013 after it was launched 36 years ago. Estimate the corresponding power delivered by the plutonium source, expressed in **percentage** of the power delivered at the time of launch. (2 marks)

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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.

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