2022-DSE
PHY
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2022

Candidate Number

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.

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

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* A 1 5 0 E 0 1 B *

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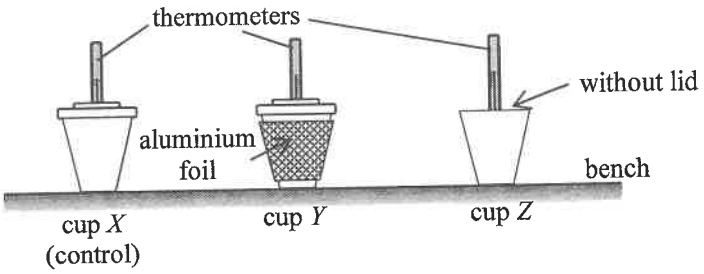
Section B: Answer ALL questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided.

1. A student conducts an experiment to study how to best retain the warmth of water by using identical paper cups *X*, *Y* and *Z* shown in Figure 1.1. Each cup is filled with 250 cm^3 of hot water and cup *X* serves as a control.

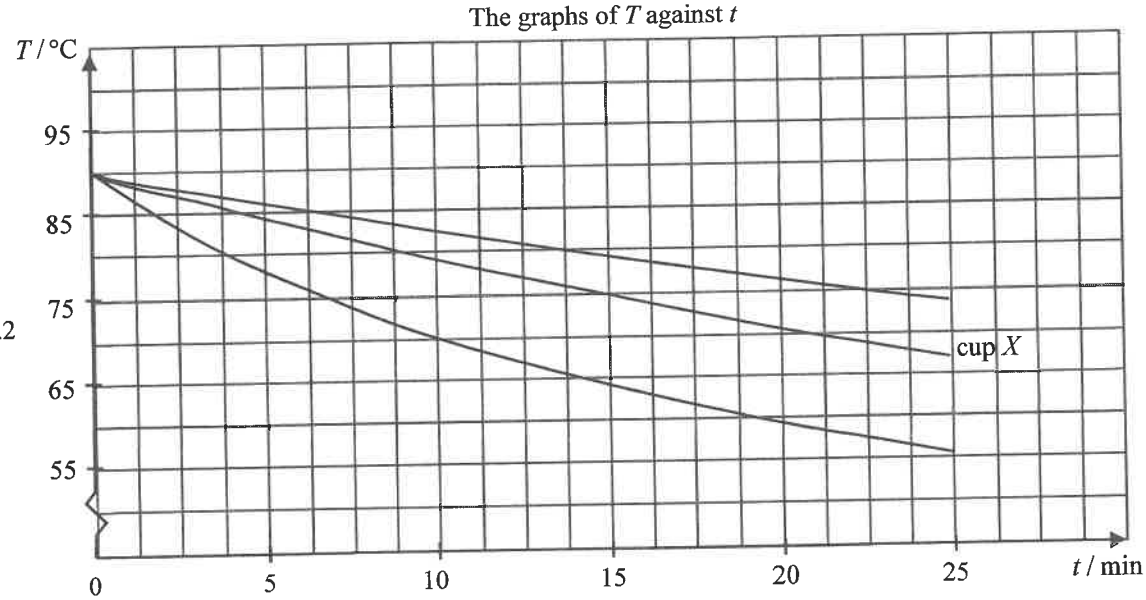
Figure 1.1



cup	wrapping	with a lid
X	no	yes
Y	aluminium wrapping	yes
Z	no	no

When the water temperature is 90 °C, the student starts taking thermometer readings every minute. Figure 1.2 shows the variation of temperature (T) of water in the cups with time (t) elapsed.

Figure 1.2



(a) Suggest a reason why this experiment begins with the **same initial water temperature** (90 °C). (1 mark)

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(b) Explain why all the curves become less steep as time elapses. (2 marks)

(c) (i) On Figure 1.2, indicate the respective curves that correspond to the results of **cup *Y*** and **cup *Z***. (1 mark)

(ii) Explain your answer by referring respectively to the main heat transfer process. (3 marks)

(d) Suggest a material for making cups so that heat loss via conduction can be reduced. (1 mark)

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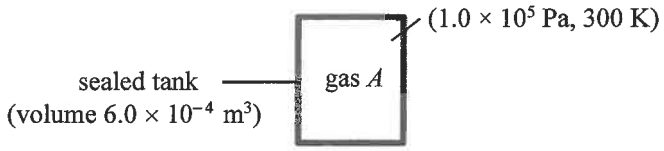
*2. (a) (i) Figure 2.1 shows a sealed tank of volume 6.0×10^{-4} m^3 containing a monatomic gas A at a pressure of 1.0×10^5 Pa and at a temperature of 300 K.

Figure 2.1

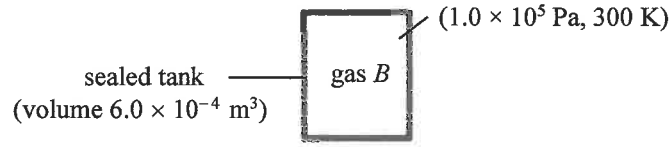


(I) Estimate the number of gas molecules in the tank, N. (2 marks)

(II) Estimate the average kinetic energy of the gas molecules, E_K. (2 marks)

(ii) Figure 2.2 shows another identical tank containing monatomic gas B under the same pressure and temperature. A molecule of gas B has $\frac{1}{5}$ the mass of a molecule of gas A.

Figure 2.2



(I) State whether N and E_K of gas B are larger than, smaller than or the same as the corresponding values of those of gas A found in (a)(i). (2 marks)

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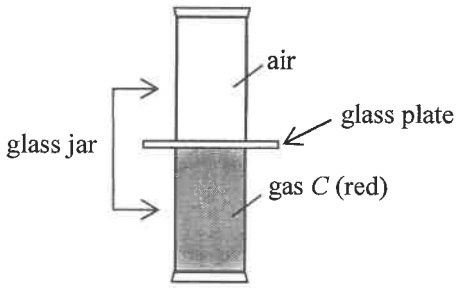
(II) Given that the root-mean-square speed ($c_{r.m.s.}$) of the molecules of gas A is 600 m s^{-1}, estimate $c_{r.m.s.}$ of the molecules of gas B. (2 marks)

(b) Figure 2.3 shows two glass jars containing air and gas C respectively and they are separated by a glass plate. Both are at the same pressure and temperature. Gas C is red in colour.

Figure 2.3



After removing the glass plate, it takes a few minutes for gas C to diffuse several centimetres into the upper jar despite its molecules having a root-mean-square speed of 200 m s^{-1}. Explain this observation. (2 marks)

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3. Figure 3.1 shows a quadcopter with four propellers.

Figure 3.1

When the four propellers are operating to propel air streams vertically downwards, the quadcopter can hover in the air in a fixed position. ($g = 9.81$ m s^{-2})

(a) Referring to Newton's laws of motion, explain why the quadcopter can hover in the air. (2 marks)

Given: mass of the quadcopter = 1.38 kg
total area swept by the **four** propellers = 0.284 m^2
density of air = 1.20 kg m^{-3}

(b) Suppose the speed of the air streams produced is v.

(i) Considering the total volume of air being propelled downwards in 1 second, express the mass of air m_a propelled by the quadcopter per second in terms of v. (2 marks)

(ii) Hence, find the speed v that enables the quadcopter to hover. (2 marks)

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(c) The quadcopter can be adjusted to tilt at an angle θ to the vertical as shown in Figure 3.2(a) and fly along a horizontal circular path of radius r (Figure 3.2(b)). Neglect the size of the quadcopter and air resistance in your calculation.

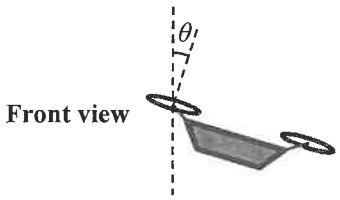

Figure 3.2(a)

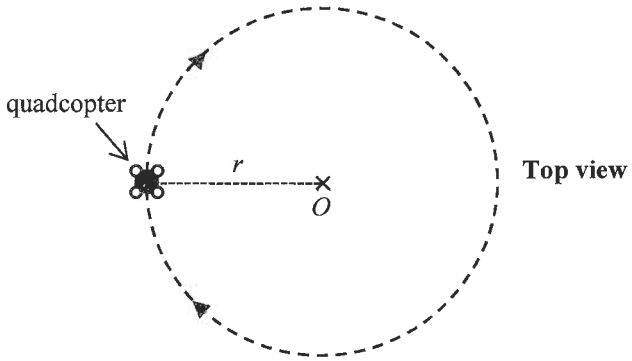

Figure 3.2(b)

(i) On Figure 3.2(a), indicate and label the force(s) acting on the quadcopter. (2 marks)

*(ii) Find the centripetal force required for the quadcopter to follow such a circular path with a radius of 50 m and a speed of 15 m s^{-1}. (2 marks)

(iii) Hence, calculate the angle θ to attain such centripetal force for the quadcopter. (2 marks)

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4.

Figure 4.1

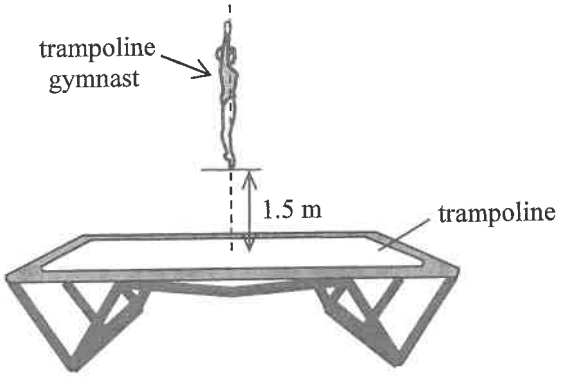

Figure 4.1 shows a trampoline gymnast of mass 50 kg performing a straight jump. Her feet are 1.5 m above the trampoline at the maximum height. Neglect air resistance and assume that the gymnast maintains this posture throughout the jump. ($g = 9.81$ m s^{-2})

(a) Find the kinetic energy of the gymnast just as her feet touch the trampoline on the way down from her jump. (2 marks)

(b) After touching the trampoline, the gymnast keeps on moving downward for 0.40 m further before she stops.

(i) Describe the energy transfer to the trampoline by the gymnast **after touching the trampoline**. (2 marks)

(ii) Estimate the average force exerted by the gymnast on the trampoline. (2 marks)

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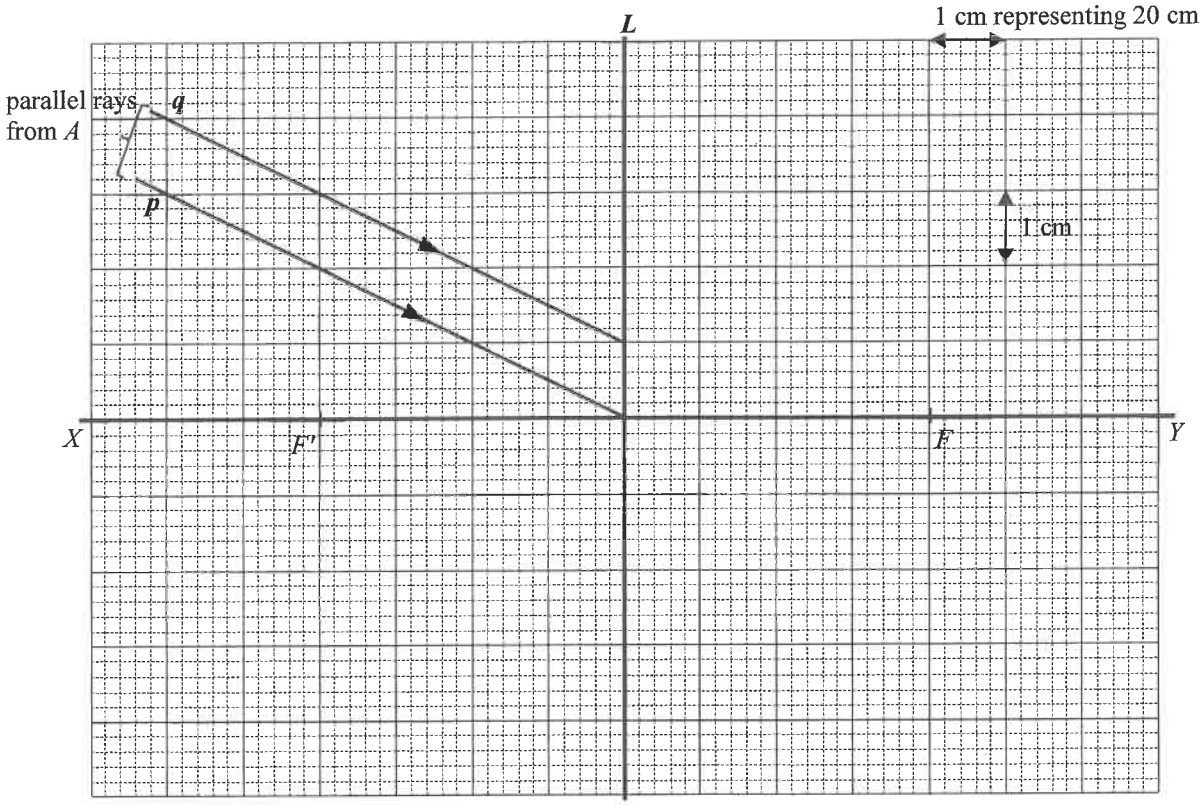
5. In the figure below, XY is the horizontal principal axis of a convex lens L with principal foci F and F'. p, q are parallel rays coming from point A of a distant object AB. (The object can be represented by a vertical arrow $\overset{A}{\underset{B}{\uparrow}}$ but it is **not** shown on the figure and its end B is on the principal axis).



(a) (i) Draw the refracted rays of p and q so as to locate the image of A (denoted as A'). Hence mark the image $A'B'$ of object AB. (3 marks)

(ii) Suggest an experiment to verify whether a real image is formed in the above situation. (2 marks)

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(b) (i) Use the ray diagram drawn to estimate the ratio $\frac{\text{height of object } AB}{\text{distance of } AB \text{ from } L}$. The horizontal and vertical scales are 1:20 and 1:1 respectively. (2 marks)

(ii) Hence, estimate the height of object AB which is a lamp post at a distance of 200 m from lens L. (1 mark)

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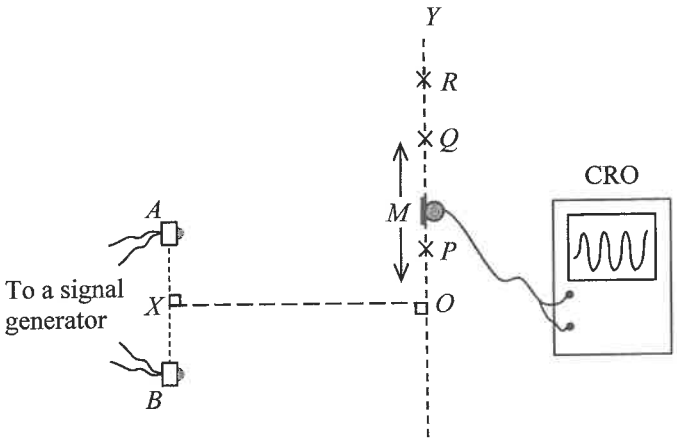
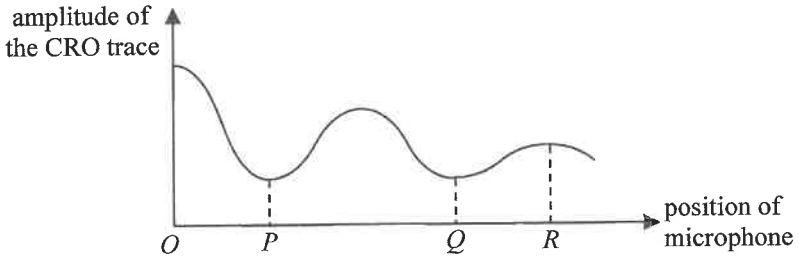
Figure 6.1



In Figure 6.1, two small identical loudspeakers A and B produce coherent sound waves. X is the mid-point of AB. A microphone M connected to a CRO is moved along OY to detect the loudness of the sound, with CRO trace of a larger amplitude representing a greater loudness. Figure 6.2 shows the result.

Figure 6.2



(a) Explain what is meant by **coherent** sound waves. (1 mark)

(b) (i) Explain why sound of alternate maximum and minimum loudness is detected along OY. (2 marks)

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(ii) The amplitude of the CRO trace at P is **not** zero. Suggest a possible reason. (1 mark)

(c) Given: $AQ = 2.17$ m, $BQ = 2.58$ m
Find the speed of sound in air if the frequency of the signal generator is 1200 Hz. (2 marks)

(d) Given that the separation of A and B is 0.80 m, explain why no more maximum can be detected when the microphone is moved beyond position R along OY. (2 marks)

(e) The microphone is now moved from O to X along the line OX. State whether the amplitude of the CRO trace increases, decreases, remains the same, or varies periodically. (1 mark)

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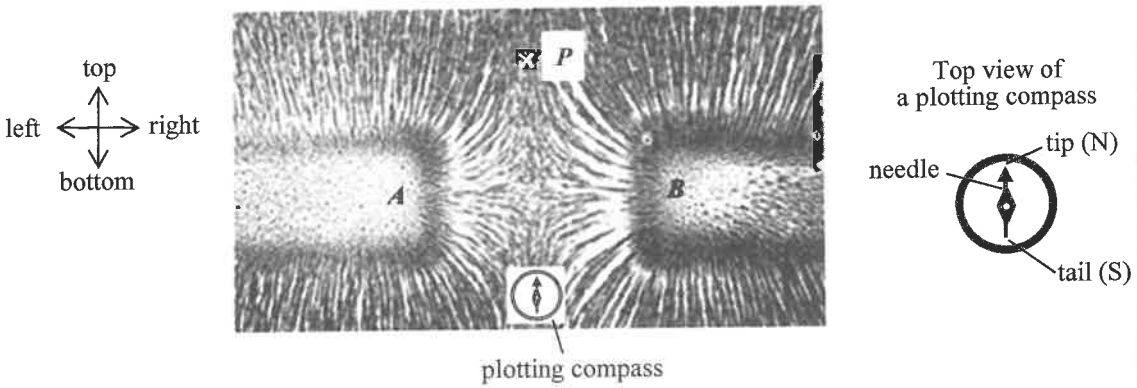
7. Read the following passage about **magnetic field patterns** and answer the questions that follow.

Iron filings are tiny pieces of iron nearly in powder form. Since iron is ferromagnetic, a magnetic field would induce each piece of iron filings to become a 'tiny bar magnet'. The south pole of each of these 'tiny bar magnets' attracts the north poles of neighbouring iron filings. The magnetic field pattern is displayed as iron filings align themselves with the field lines.

The figure below shows such a pattern displayed on a cardboard with two identical bar magnets placed underneath. A plotting compass placed at the bottom of the figure points to the top as shown.



(a) (i) State the polarity of the respective poles at *A* and *B* of the bar magnets. (1 mark)

A : .....

B : .....

(ii) If the compass is moved to *P*, towards what direction (top, bottom, left or right) would it be pointing ? (1 mark)

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(iii) In obtaining such field patterns experimentally, one is advised to place the magnets **underneath the cardboard**. Why ? (1 mark)

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(b) You are given a bar magnet (with polarities marked), 8 small plotting compasses, a pencil and a piece of white paper as shown in Figure 7.1

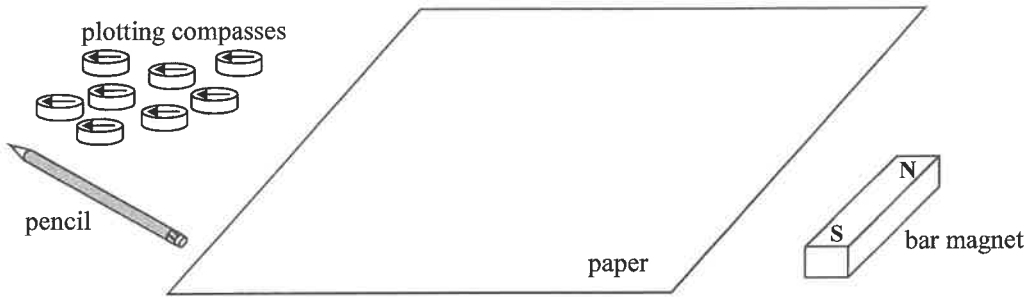
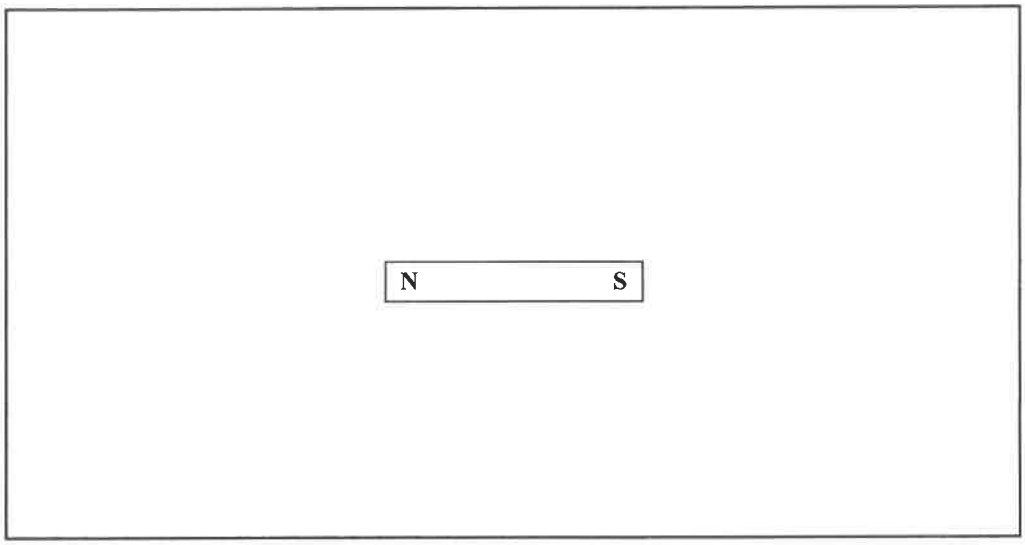


Figure 7.1

(i) Describe, with the aid of a diagram, how you would use the apparatus given to trace several field lines around the bar magnet. Neglect the Earth's magnetic field. (5 marks)

Top view



(ii) Suggest **ONE** advantage of using a plotting-compass method over an iron-filing method in studying magnetic fields. (1 mark)

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8. (a) A student sets up the circuit in Figure 8.1 to find the current-voltage (I-V) characteristic of a filament light bulb.

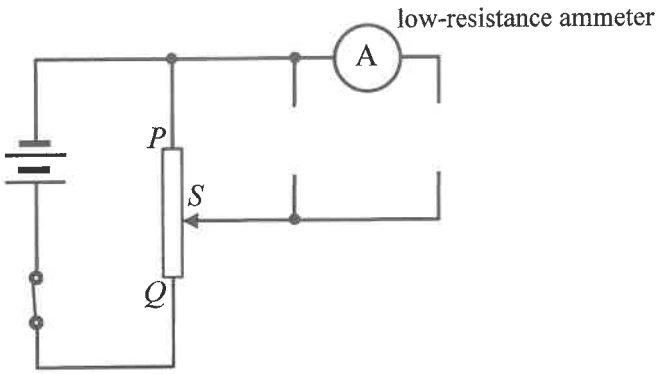

Figure 8.1

PQ is a variable resistor in the circuit with sliding contact S. The bulb and a high-resistance voltmeter are missing in the circuit.

(i) Use suitable circuit symbols to complete the circuit. (1 mark)

(ii) How would the brightness of the light bulb change when contact S is adjusted from P to Q ? (1 mark)

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(b) The graph below represents the I-V characteristic of this light bulb which has a rated voltage of 20 V.

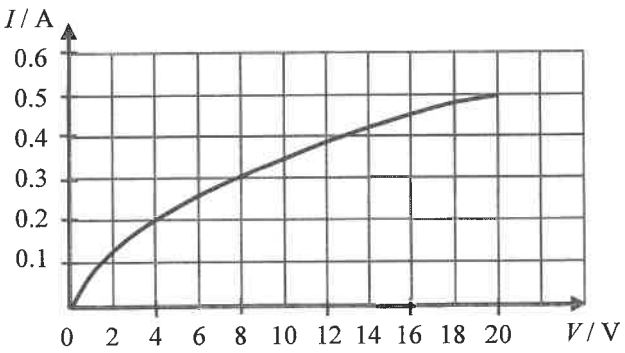

Figure 8.2

(i) Find the resistance of the bulb when working under its rated voltage. (2 marks)

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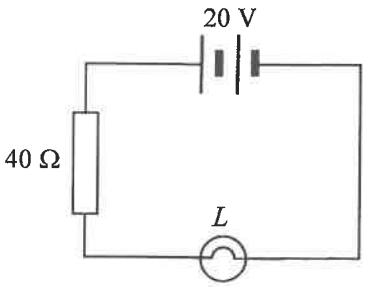
(ii) Explain why the resistance of the bulb varies with the applied voltage V. (2 marks)

(c) The bulb L in (b) and a 40 Ω resistor are connected in series with a 20 V battery of negligible internal resistance as shown in Figure 8.3.

Figure 8.3



The current I in the circuit and the voltage V across the bulb is related by $I = 0.5 - 0.025V$.

(i) Add a straight line on Figure 8.2 to determine the current I. (2 marks)

(ii) Hence estimate the power consumed by bulb L. (2 marks)

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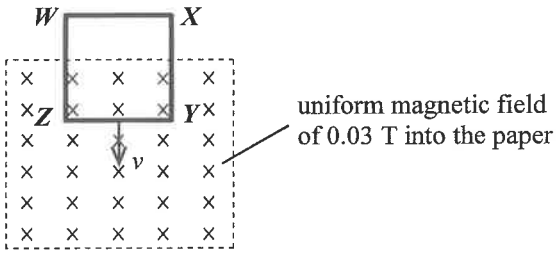
9. A square metal loop *WXYZ* of side length 0.10 m is inserted with a constant velocity v into a uniform magnetic field of flux density 0.03 T. The magnetic field is perpendicular to the plane of the loop as shown in Figure 9.1. The resistance of **each side** of the metal loop is 0.15 Ω.

Figure 9.1



When the metal loop is entering the magnetic field, a current of 0.01 A flows in the loop.

(a) On Figure 9.1, indicate the direction of this current. (1 mark)

*(b) Find v. (2 marks)

(c) (i) Find the **potential difference** V_{YZ} between Y and Z. (2 marks)

(ii) Explain whether V_{YZ} is equal to the **induced e.m.f.** across YZ. (1 mark)

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10. Deuterium (^2_1H) and tritium (^3_1H) are isotopes of hydrogen. The fusion of two deuterium nuclides can be represented by the following equation:

$$^2_1H + {}^2_1H \longrightarrow {}^3_2He + {}^1_0n$$

Given: mass of ^2_1H = 2.014102 u
mass of ^3_2He = 3.016029 u
mass of ^1_0n = 1.008665 u

*(a) 1 in 6420 atoms of hydrogen in nature is a deuterium. Estimate the maximum energy, in MeV, that could be produced from this fusion reaction with 1 mole of hydrogen nuclides. (3 marks)

(b) If conditions are altered, the fusion of two deuterium nuclides may **not** produce a helium (He) nucleus. Complete the equation below for such a possible fusion reaction. (1 mark)

$$^2_1H + {}^2_1H \longrightarrow \text{.....} + \text{.....}$$

(c) Both fission and fusion produce energy. State **TWO** advantages of using fusion as an energy source over fission. (2 marks)

END OF PAPER

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

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