2023-DSE
PHY
PAPER 1B

B

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2023

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	**8**
2	**11**
3	**12**
4	**10**
5	**8**
6	**9**
7	**8**
8	**11**
9	**7**

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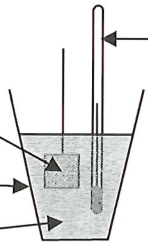
Section B: Answer **ALL** questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided.

1. An iron cube of mass 200 g is heated to a few hundred degree Celsius (say at T °C). It is then quickly transferred into a polystyrene cup containing 600 g of water. The cube is totally immersed in the water as shown in Figure 1.1. The temperature of the heated iron cube can be estimated in this experiment.

Figure 1.1



Assume that no heat is lost to the surroundings and neglect the heat capacity of the polystyrene cup.

(a) The temperature of water recorded by the thermometer rises from 25 °C to 33 °C. Estimate T.
Given: The specific heat capacities of iron and water are 450 J kg^{-1} °C^{-1} and 4200 J kg^{-1} °C^{-1} respectively. (3 marks)

(b) What would happen to the water when this iron cube of high temperature just touches the water surface ? (1 mark)

(c) Explain why the actual temperature of the iron cube should be higher than that estimated in (a). (2 marks)

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(d) (i) A mercury-in-glass thermometer is not suitable for measuring the temperature of the heated iron cube **directly**. Why ? (1 mark)

(ii) Suggest a kind of thermometer that can directly measure the temperature of this heated cube. (1 mark)

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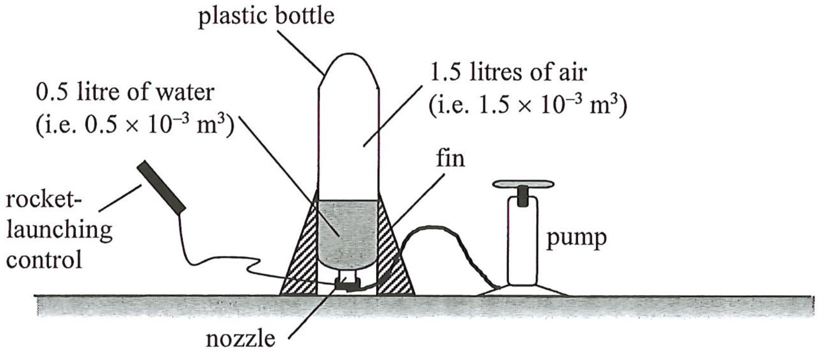
*2. Figure 2.1 shows a 'water rocket' built from a 2-litre plastic bottle with fins attached. The bottle is filled with water such that 1.5 litres of air is trapped inside.

Figure 2.1



Initially the trapped air of temperature 27 °C is at atmospheric pressure.

Given: atmospheric pressure = 1.0×10^5 Pa

density of air = 1.20 kg m^{-3}

(a) Find the mass of the trapped air m_0. (2 marks)

Air is then pumped slowly into the rocket until the total mass of trapped air inside the bottle becomes $4m_0$. Assume that the trapped air is kept at a temperature of 27°C (i.e. 300 K) and its volume remains constant.

(b) (i) Find the pressure of the trapped air. (2 marks)

(ii) Use kinetic theory to explain why the pressure of the trapped air increases. (2 marks)

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(iii) Given that the area of the water surface is 0.014 m^2. Estimate the **increase** in the force acting on the water due to the trapped air. (2 marks)

(c) Given that the mass of the plastic bottle is negligible.

(i) After the rocket-launching control is pulled and a jet of water ejects from the nozzle, explain why the rocket can go upwards using Newton's laws of motion. (2 marks)

(ii) **Just** after pulling the control, what is **most** of the energy stored in the pressurized air converted to ? (1 mark)

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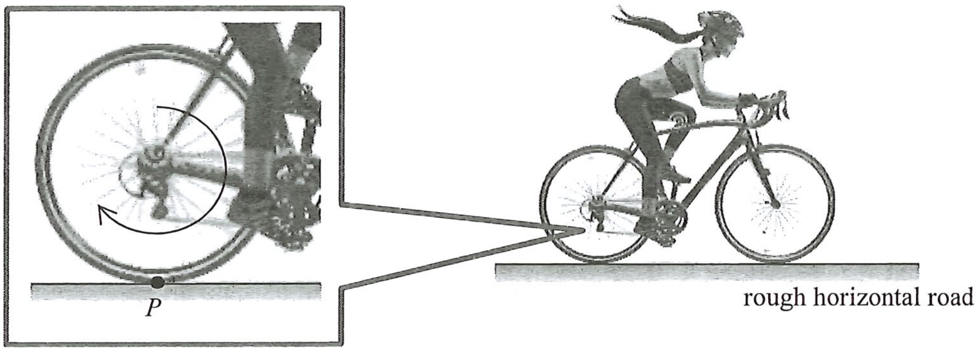
3. Figure 3.1 shows a cyclist riding on a bicycle travelling with a constant velocity of 8.0 m s^{-1} on a rough horizontal road.

Figure 3.1

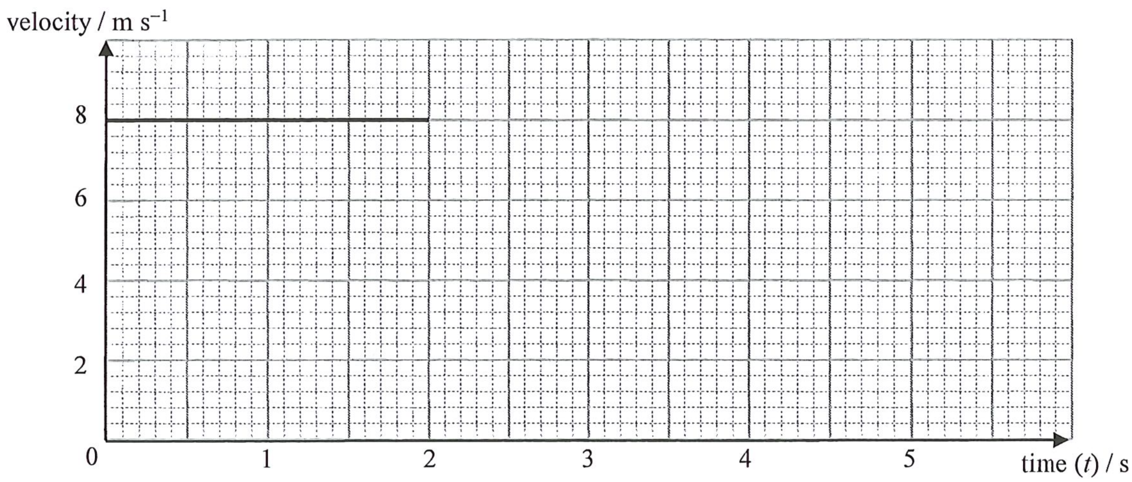


(a) The rear wheel is rotating clockwise without slipping on the ground as shown and P is the contact point with the road at that moment. Indicate in the figure the frictional force acting on the rear wheel at P. (1 mark)

(b) If the effective resistive force experienced by the cyclist and the bicycle is 17.0 N when riding at this constant velocity, estimate the mechanical power delivered by the cyclist. (2 marks)

(c) At time $t = 2.0$ s, the cyclist sees a small obstacle 9 m directly in front of the bicycle and applies the brakes as soon as possible. The reaction time of the cyclist is 0.2 s. The bicycle then decelerates uniformly and finally stops at $t = 3.8$ s.

(i) Complete the velocity-time graph below from $t = 2.0$ s to $t = 3.8$ s. (2 marks)



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(ii) The total mass of the cyclist and the bicycle is 65 kg. Calculate the resistive force for the deceleration. (2 marks)

(iii) Find the distance between the bicycle and the obstacle when the bicycle just stops. (3 marks)

(d) Figure 3.2 shows a knee pad with a padded cushion on the front to protect the cyclist in the event the knee hits the ground. Explain the working principle of this padded cushion. (2 marks)

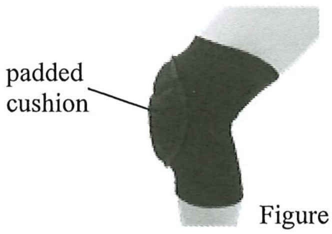

Figure 3.2

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*4. (a) Figure 4.1(a) shows a hollow cylindrical drum rotating uniformly about its central vertical axis. With a high enough rotation speed, the block shown in the figure appears 'pinned' to the wall of the drum without falling.

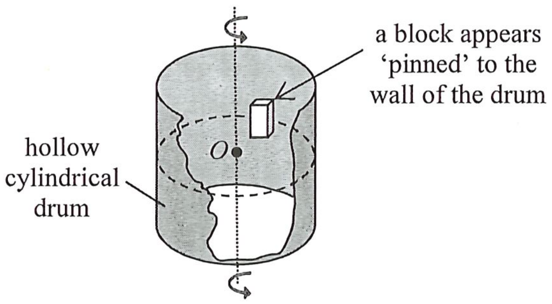


Figure 4.1 (a)

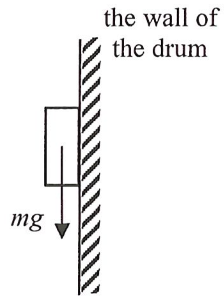


Figure 4.1 (b)

(i) Besides the block's own weight mg, there are two more forces acting on it. Indicate and label these two forces on Figure 4.1(b). (2 marks)

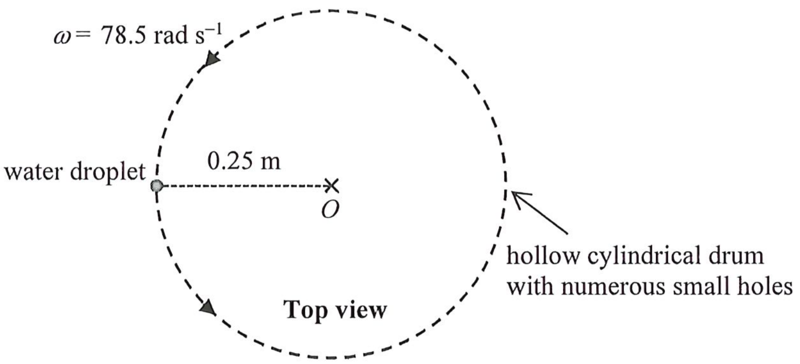
(ii) Which force provides the centripetal force for the block ? (1 mark)

(b) A washing machine has a hollow cylindrical drum with numerous small holes that allow water droplets to escape. In 'spin' mode, the drum's angular speed ω is 78.5 rad s^{-1}.

(i) What is the rotation speed of the drum in revolutions per minute ? (2 marks)

The cylindrical drum of the washing machine is of radius 0.25 m. Figure 4.2 shows the top view of the drum spinning anticlockwise about its central vertical axis through O.

Figure 4.2



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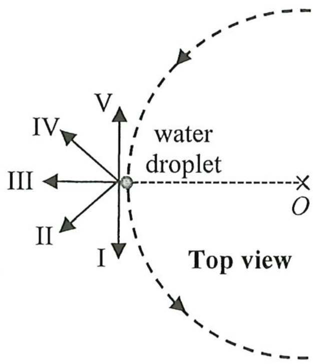
(ii) Estimate the centripetal force acting on the water droplet shown in Figure 4.2. The mass of the droplet is 2×10^{-5} kg. (2 marks)

Suppose that the water droplet is about to escape via a small hole on the wall of the drum,

(iii) estimate the speed of the water droplet. (2 marks)

(iv) along which direction (I – V) would the droplet travel just as it escapes from the drum ? (1 mark)



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5. A sound wave from a loudspeaker is propagating to the right in air. Figure 5.1(a) shows the equilibrium positions of some particles (a to u) in air. Figure 5.1(b) shows their positions at time $t = 0$.

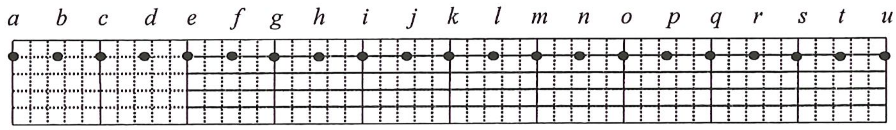

Figure 5.1(a)

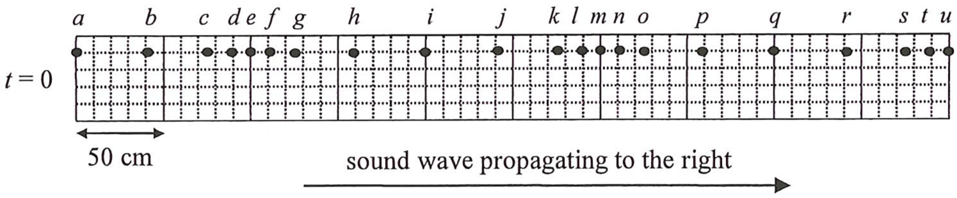

Figure 5.1(b)

(a) At time $t = 0$, state a particle which

(i) is at a centre of rarefaction. (1 mark)

(ii) has the greatest displacement to the right from its equilibrium position. (1 mark)

(b) The width of each grid is 50 cm as shown in Figure 5.1(b). The speed of sound in air is 340 m s^{-1}.

(i) What is the wavelength of the sound ? (1 mark)

(ii) Find the frequency of the sound. (2 marks)

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(iii) Figure 5.2 shows the displacement-time graph of particle a. Sketch on the same figure the corresponding graph for particle m. (2 marks)

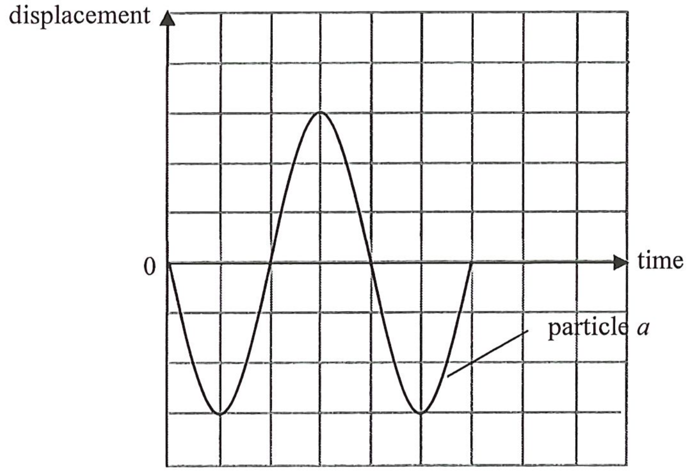

Figure 5.2

(c) State the change on the position of particle h at time $t = 0$ if the loudspeaker is turned louder. (1 mark)

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6. Read the following passage about **rainbows** and answer the questions that follow.

Rainbows are sometimes seen after a rainfall (Figure 6.1(a)). Tiny water droplets in the air each act like a prism to disperse sunlight into a spectrum of colours. The most common rainbow that we see is called a primary rainbow, in which the white light from the sun undergoes reflection once within each water droplet.

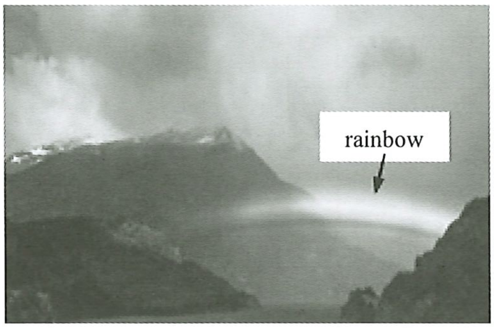

Figure 6.1(a)

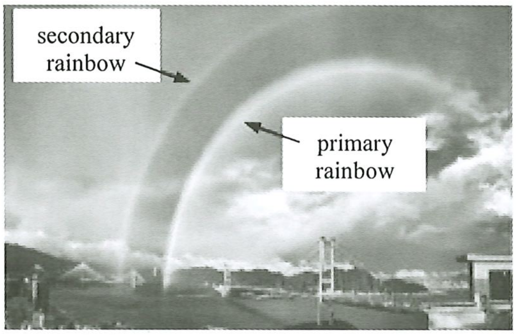

Figure 6.1(b)

Under suitable conditions, a double rainbow with an additional secondary rainbow formed above the primary rainbow can be seen (Figure 6.1(b)).

Assume that water droplets are spherical. Given: refractive index for red light in water = 1.325

(a) Figure 6.2 shows a red light ray entering a water droplet suspended in air.

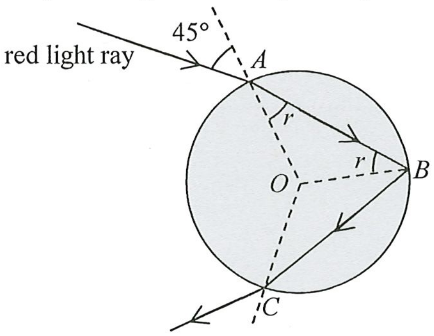

Figure 6.2

(i) When the angle of incidence is 45°, find the angle of refraction r at point A. (2 marks)

(ii) Calculate the critical angle c for red light at the water-air interface and justify whether the reflection at point B is a total internal reflection or not. (3 marks)

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(b) (i) Figure 6.3 illustrates how an observer sees a rainbow. O_1 and O_2 are the respective centres of the upper and lower water droplets suspended in air. The two paths of red light, R_1 and R_2, in the white light from the Sun are drawn for your reference, with R_1 being seen by the stationary observer.

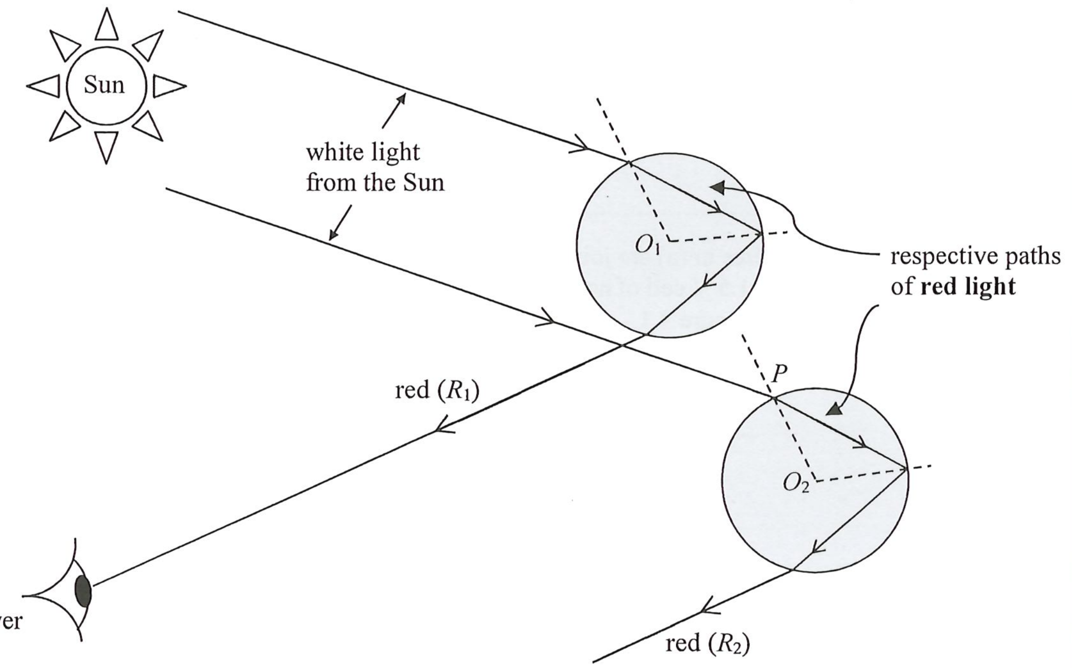

Figure 6.3

The lower water droplet enables **a violet light ray** from sunlight to be seen by the observer. Sketch the path of this violet light ray starting from point P on the lower water droplet. Given that the refractive index for violet light in water is slightly greater than that for red light. (2 marks)

(ii) For a secondary rainbow to be formed, a light ray has to undergo ***reflection twice within each of those water droplets*** situated higher above as shown in Figure 6.4.

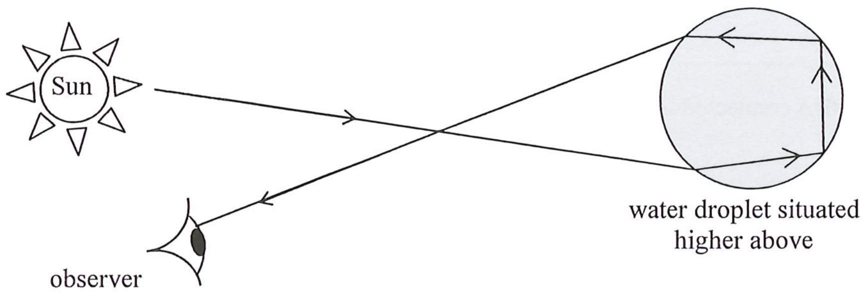

Figure 6.4

Explain why a secondary rainbow is dimmer than the primary rainbow. (2 marks)

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7. (a) A straight metallic wire of length 0.20 m and cross-sectional area 8.0×10^{-7} m^2 has a resistance of 0.50 Ω. Find the resistivity, in Ω m, of the material that the wire is made of. (2 marks)

(b) Four such metallic wires in (a) are joined together to form a square coil *CDEF*. The coil is connected to a circuit consisting of a 1.5 V cell of negligible internal resistance and two identical resistors R_1 and R_2, each of 2.0 Ω, as shown in Figure 7.1.

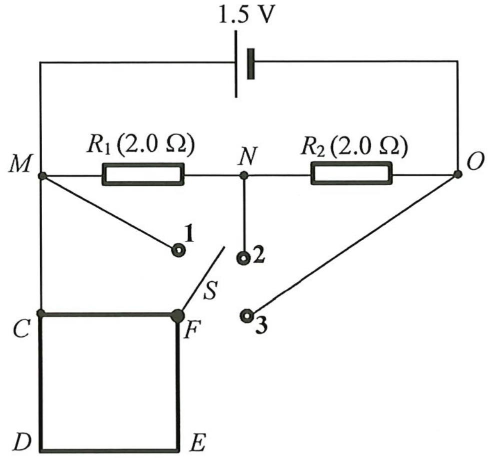

Figure 7.1

(i) To which terminal (**1**, **2** or **3**) should switch *S* be connected in order to have a maximum current flowing through side *CF* of the coil ? (1 mark)

(ii) With *S* connected to terminal **2**, find the equivalent resistance across *MN*. (2 marks)

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(iii) With S connected to terminal **2**, is the potential difference across R_2 greater than, smaller than or equal to that across R_1 ? (1 mark)

(iv) With S connected to terminal **1**, what is the power dissipated by the coil ? Give your reason. (2 marks)

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8. A student conducts an experiment to study the force on a straight current-carrying wire placed between the poles of a magnet providing a uniform magnetic field perpendicular to the wire. An adjustable power source is connected to the wire which is held horizontally by an insulated support placed on an electronic balance. The variation of the magnetic force on the wire is registered by the balance.

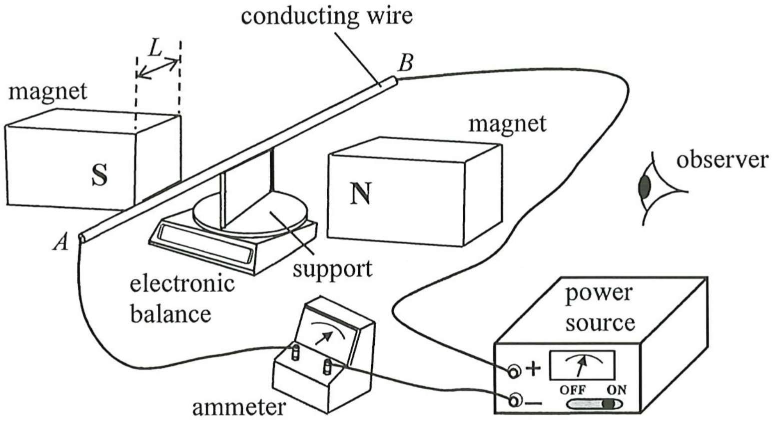

Figure 8.1

(a) On Figure 8.1, mark the positive (+) and negative (–) terminals of the ammeter. (1 mark)

(b) Figure 8.2 shows the side view of the wire AB seen by the observer. On the figure, draw the magnetic field provided by the magnet and indicate the directions of the current I and magnetic force F_B on the wire. (3 marks)

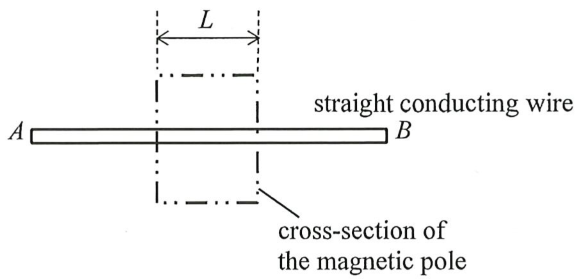

Figure 8.2

(c) Complete the table below to indicate how each of the factors listed would affect the magnitude of the magnetic force F_B (increase, decrease or unchanged). (3 marks)

	magnetic force F_B
using a stronger magnet of the same dimensions	
using another support such that the position of the horizontal wire is slightly lowered	
using a longer wire while the current is kept unchanged	

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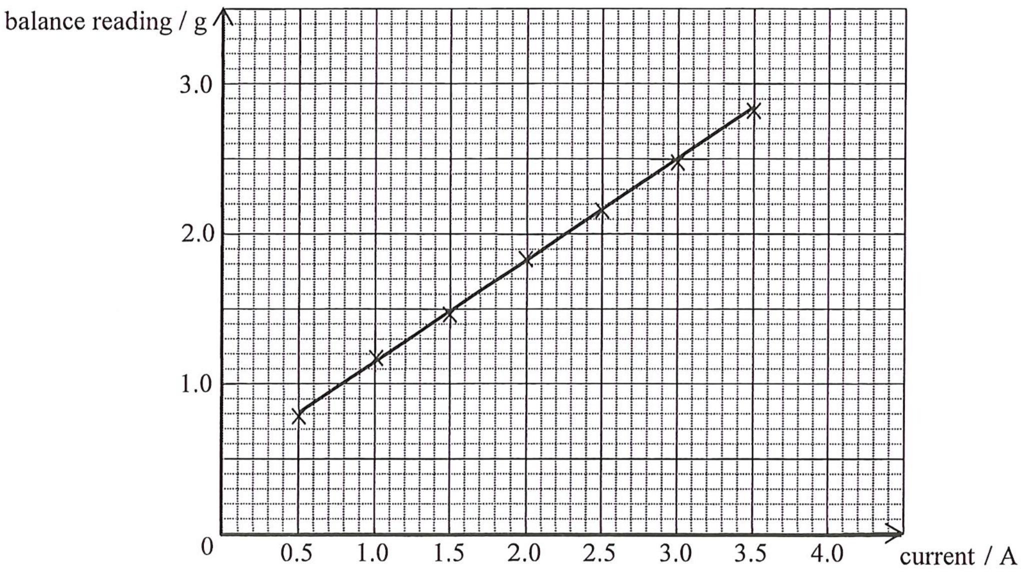
(d) The graph below is plotted by using the experimental data obtained.



(i) Describe the corresponding experimental procedures to be carried out. (2 marks)

(ii) Describe how the balance reading varies with the current as revealed by the graph. (1 mark)

(iii) Explain why the graph does not pass through the origin when the current is zero. (1 mark)

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9. Part of the decay series of thorium-232 (Th-232) is shown below. Th-232 decays to radium-228 (Ra-228) with a half-life of 1.41×10^{10} years. The end product lead-208 (Pb-208) is stable.

$$^{232}_{90}\mathrm{Th} \longrightarrow {}^{228}_{88}\mathrm{Ra} \xrightarrow{\beta} \mathrm{Ac} \rightarrow \ldots \rightarrow {}^{208}_{82}\mathrm{Pb}$$

(a) (i) State the kind of radiation emitted by Th-232. (1 mark)

(ii) How many α- and β- decay(s) has occurred before a Th-232 nucleus becomes a Pb-208 nucleus ? (2 marks)

*(b) Estimate the proportion of Th-232 decaying in 10 years. Give your answer correct to 2 significant figures. (2 marks)

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(c) By adding thorium oxide (a compound containing Th-232) to glass, thoriated glass having a higher refractive index is produced. Camera lenses manufactured before 1970 are often made from thoriated glass.

Figure 9.1

(i) Although thoriated glass is radioactive, practically it is safe to use a camera with such lenses like the one shown in Figure 9.1. Why ? (1 mark)

(ii) According to the decay series of thorium-232, thorium oxide would end up as lead oxide which is black in colour. Why is there no need to worry that a thoriated glass lens would turn black when used for several years ? (1 mark)

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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