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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

)ING KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2020

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	13
3	6
4	10
5	8
6	6
7	9
8	11
9	8
10	5

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

1. In a restaurant, 'wontons in soup' is prepared by putting 5 pieces of cooked wonton at 4 °C into a bowl with 0.60 kg of soup at temperature 96 °C.
   Given: average mass of each piece of wonton = 0.02 kg
   specific heat capacity of wonton = 3300 J kg^{-1} $°C^{-1}$
   specific heat capacity of soup = 4200 J kg^{-1} $°C^{-1}$

   (a) Find the final temperature of the mixture. Assume that the heat capacity of the bowl and the heat loss to the surroundings are negligible. (2 marks)

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   (b) The soup in (a) is taken from a metallic container of heat capacity 2000 J $°C^{-1}$ containing 16 kg of soup maintained at 96 °C by an immersion heater.

      (i) Why does that energy have to be supplied by the heater to keep the soup at 96 °C ? (1 mark)

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(ii) A student used the following method to find the heater's operating power P: remove the heater from the container and record the temperature of the 16 kg of soup after 10 minutes. It is found that the temperature has dropped 9 °C. Estimate P. (3 marks)

(iii) If the student repeats the measurement after another 10 minutes, would the corresponding temperature drop be larger than, equal to or smaller than 9 °C ? Explain. (2 marks)

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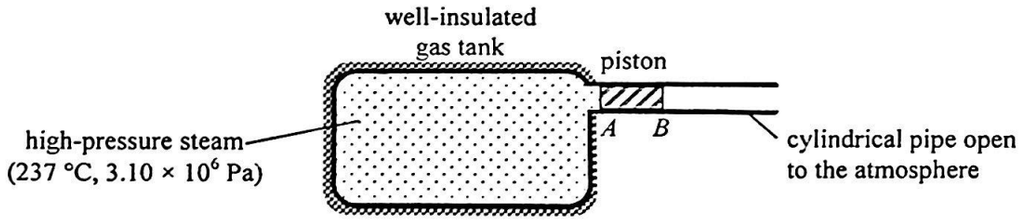
2. Figure 2.1 shows a large gas tank connected with a cylindrical pipe open to the atmosphere. The pipe is fitted with a smooth piston AB. This well-insulated gas tank is filled with high-pressure steam at a temperature of 237 °C under a pressure of 3.10×10^6 Pa while the movable piston is held stationary by a force F_p.
Given: atmospheric pressure = 1.0×10^5 Pa

Figure 2.1



(a) (i) On Figure 2.1 indicate the force F_p. (1 mark)

*(ii) By considering the force acting on the piston due to the difference in pressure, find the value of F_p. The piston has a cross-sectional area of 0.67 m^2. (2 marks)

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*(iii) Estimate the volume of the gas tank which contains 570 kg steam. You may treat the steam as an ideal gas. Given: mass of one mole of steam = 0.018 kg. (3 marks)

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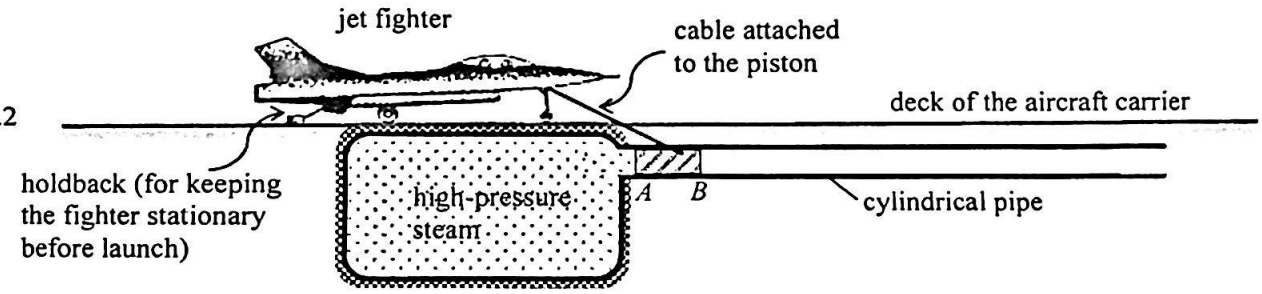
(b) This set-up can be used as a 'steam catapult' to launch jet fighters from an aircraft carrier. A jet fighter in position to be launched is connected to the piston via an inextensible cable as shown in Figure 2.2. When the holdback behind the jet fighter is released, the high-pressure steam in the gas tank expands and pushes the piston which in turn helps to accelerate the jet fighter.

Figure 2.2



In a trial run of the catapult, a jet fighter (with its engine shut down) acquires a final speed of 54 m s^{-1} in 1.5 s after running a distance horizontally on the deck. The mass of the jet fighter is 2.6×10^4 kg.

(i) Find the work done by the net force on the jet fighter during launch. (2 marks)

(ii) Calculate the average acceleration of the jet fighter during launch. (2 marks)

*(iii) State whether the acceleration of the jet fighter is increasing, decreasing or uniform during launch. Explain your answer. (3 marks)

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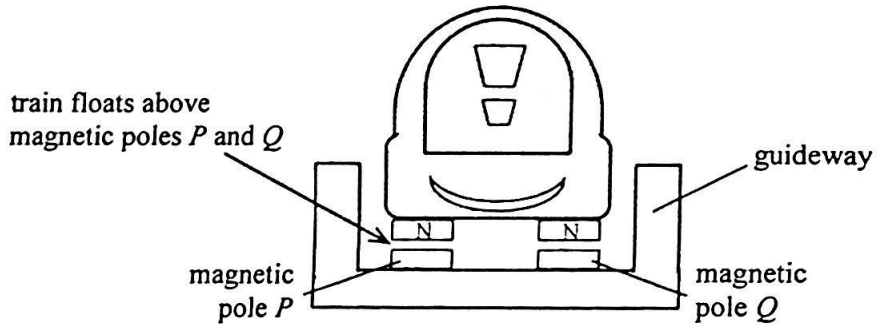
3. Read the following passage about a **magnetically levitated (maglev) train** and answer the questions that follow.

'A maglev train car is just a box with magnets on the four corners,' says Jesse Powell, the son of the maglev train inventor. The electromagnets employed have superconducting coils (i.e. coils with extremely low resistance). They therefore can generate magnetic fields 10 times stronger than ordinary electromagnets, enough to levitate and propel a train.



LEVITATION

Two sets of magnetic fields are set up for different functions. One is to make the train float a few centimetres above magnetic poles P and Q as shown while the other is a propulsion system run by an alternating current for moving the train car along the guideway by magnetic attraction and repulsion. This floating design enables a smooth movement of the train. Even when the train travels up to 600 km per hour, passengers inside experience less vibration than travelling on traditional trains.

(a) Explain why electromagnets employing superconducting coils can produce much stronger magnetic fields. (2 marks)

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(b) State the polarities of the magnetic poles P and Q and explain how this arrangement enables the train to float. (2 marks)

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(c) Referring to the resistive forces experienced by the train, explain why a maglev train ride is (i) smoother and (ii) faster. (2 marks)

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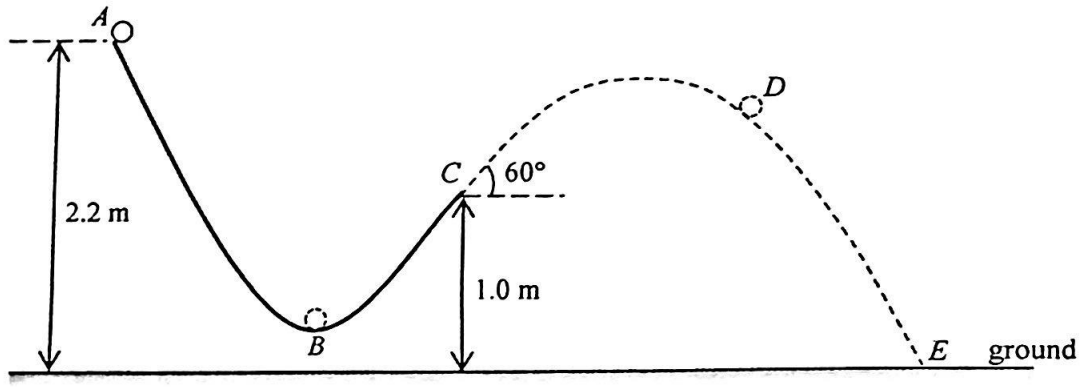
4. A small sphere is released from rest at point A and runs along a smooth track ABC as shown in Figure 4.1. The track around the lowest point B is approximately circular in shape.

Figure 4.1



The sphere leaves the track at point C where the track makes an angle of 60° with the horizontal. It finally reaches point E on the ground. Neglect air resistance. ($g = 9.81\ m\ s^{-2}$)

(a) Arrange the speeds of the sphere at points A, B, C and D respectively in descending order. (1 mark)

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*(b) On Figure 4.1, use arrows to indicate the acceleration of the sphere, if any, at point B and at point D respectively. (2 marks)

(c) (i) Describe the energy conversion of the sphere when it goes along the track ABC. (2 marks)

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(ii) Hence find the speed of the sphere at point C. (2 marks)

*(iii) If the horizontal distance between points C and E is 2.55 m, calculate the time of flight of the sphere before reaching point E. (3 marks)

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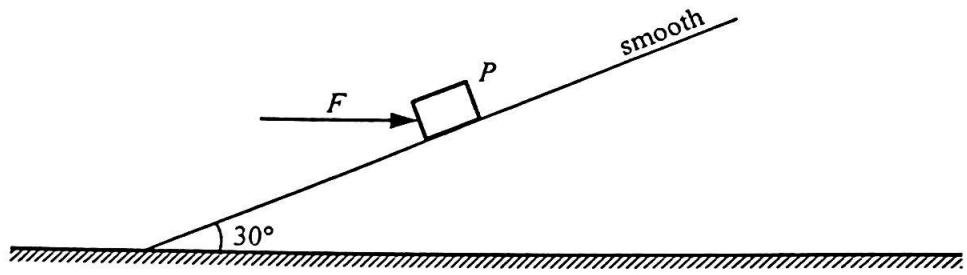
Figure 5.1



(a) A block P of mass 10 kg is kept stationary on a smooth incline by a horizontal force F as shown in Figure 5.1. The incline makes an angle of 30° with the horizontal. ($g = 9.81$ m s^{-2})

(i) On Figure 5.1, indicate and label all other forces acting on P. (2 marks)

(ii) Find the magnitudes of the force F and the force exerted by the block on the incline respectively. (3 marks)

(b) Now F is removed and neglect air resistance.

(i) What is the magnitude of the acceleration of the block ? (1 mark)

(ii) Explain whether the force exerted by the block on the incline would increase, decrease or remain unchanged when compared with that in (a)(ii). (2 marks)

Answers written in the margins will not be marked.

6. The set-up in Figure 6.1 is to find the speed of sound in air. Two identical microphones *A* and *B* are connected to a timer and placed on a bench top as shown. The timer can be triggered to 'start' and 'stop' timing using the respective microphones to feed signals to the START and STOP terminals of the timer.

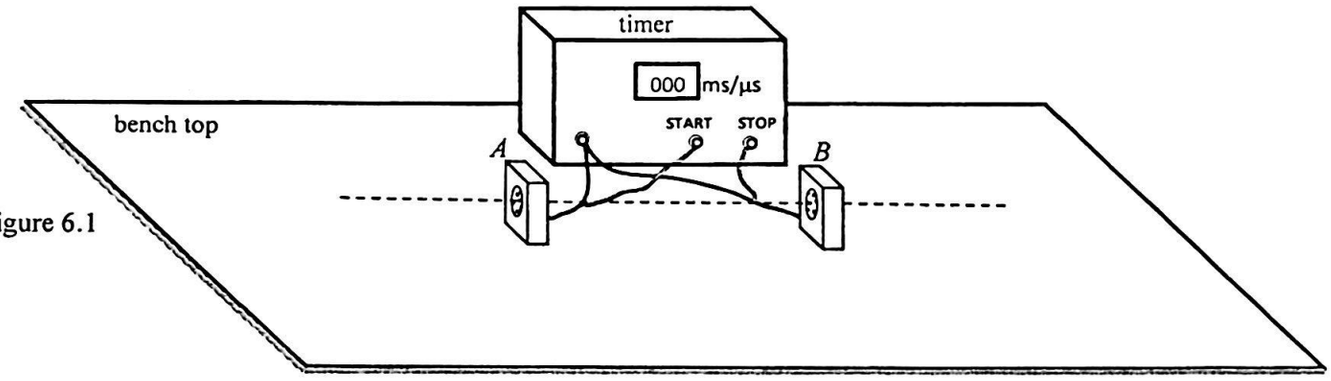
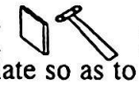


Figure 6.1

(a) You are given a hammer and a metal plate (). Use 'X' to indicate a suitable location on Figure 6.1 where the hammer should hit the plate so as to generate a sharp loud sound to be received by the microphones in this experiment. State an additional piece of apparatus needed and the measurements to be made in this experiment. (3 marks)

(b) The separation between *A* and *B* is set at 0.280 m. The experiment is repeated to obtain a few readings of the timer as follows:

801 μs, 838 μs, 539 μs, 821 μs

(i) Find the speed of sound in air. Show how you would treat the data obtained in the calculation.

(ii) Suggest one adjustment to the experimental setting so as to obtain a more accurate result.

(3 marks)

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7. Figure 7.1 shows an optical fibre which consists of a cylindrical glass core of refractive index n_g enclosed by a transparent cladding of refractive index n_c.

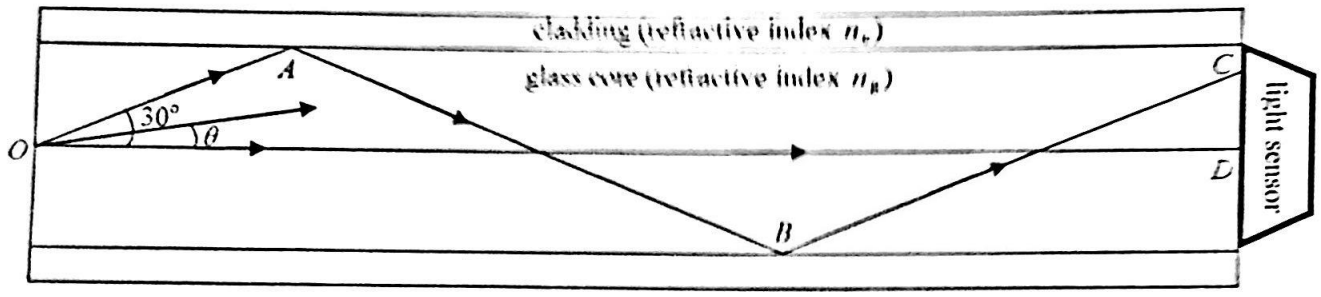


Figure 7.1

As shown in Figure 7.1, a point light source at O emits monochromatic light in all directions. Inside the fibre, light can reach the right end of the fibre through many different paths making angles θ with the axis OD. Two of these paths, OD and $OABC$, have been drawn for reference. Light ray OA makes an angle of 30° with the axis OD and is incident at the core-cladding boundary at A with an angle of incidence i_A.

(a) (i) Find i_A. (1 mark)

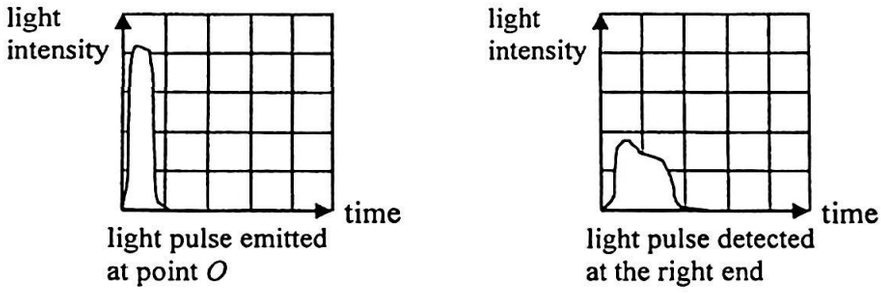
(ii) If i_A is just greater than the critical angle of that boundary, estimate $\frac{n_g}{n_c}$. (2 marks)

(iii) What phenomenon occurs at point A ? State the condition needs to be satisfied by θ such that this phenomenon fails to occur. (2 marks)

Answers written in the margins will not be marked.

(b) A narrow monochromatic light pulse (i.e. of a short duration) emitted at point O propagates with its energy within $\theta = \pm 30°$ towards a light sensor located at the right end of the optical fibre. The respective emitted and detected light pulses are represented below using the same scales.

Figure 7.2



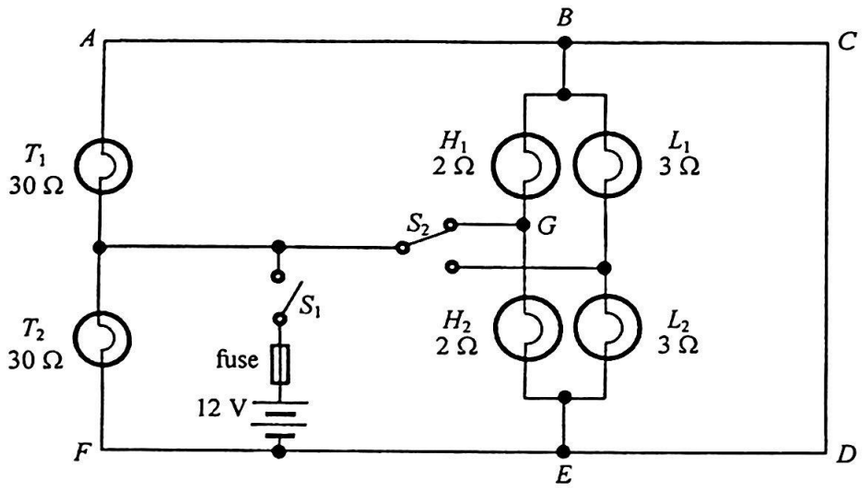
(i) Explain why the light pulse detected is **broader** (i.e. of a longer duration) and with **lower intensity**. Assume that the loss of energy of the light pulse due to absorption by glass is negligible. (2 marks)

(ii) An engineer suggests changing the refractive index n_c of the cladding in order to reduce the width of the light pulse received. Should n_c be increased or decreased ? Or, will a change in n_c have no effect on the pulse width ? Explain your choice. (2 marks)

Answers written in the margins will not be marked.

8. Figure 8.1 shows a simplified circuit of the lighting system of a car. Each of the taillights (T_1, T_2), high-beam headlights (H_1, H_2) and low-beam headlights (L_1, L_2) has resistance 30 Ω, 2 Ω and 3 Ω respectively. The internal resistance of the 12 V battery and the resistance of the fuse are negligible.

Figure 8.1



When switch S_1 is closed and switch S_2 is set at the position shown in Figure 8.1, only T_1 and T_2 as well as H_1 and H_2 are lit. The current drawn from the battery is at a maximum in this setting.

(a) Explain why L_1 and L_2 are **not lit**. (1 mark)

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(b) (i) What is the potential difference across the taillight T_2 ? (1 mark)

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(ii) Indicate on Figure 8.1 the direction of current in each of the branches *AB*, *GB* and *BC*. Which branch carries the largest current ? (3 marks)

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(c) Calculate the power delivered by the battery and show that the equivalent resistance of the circuit is slightly less than 1 Ω in this setting. (4 marks)

(d) Based on your answer in (c), explain whether a fuse rating of 15 A is suitable for this circuit or not. (2 marks)

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9. Two small metal spheres are attached to the ends of an insulating rod of length 5.0 cm. They carry charges $+Q$ and $-Q$ respectively of equal magnitude as shown in Figure 9.1. The insulating rod is suspended horizontally between two parallel metal plates, *A* and *B*, which are connected to an E.H.T. (extra high tension) supply.

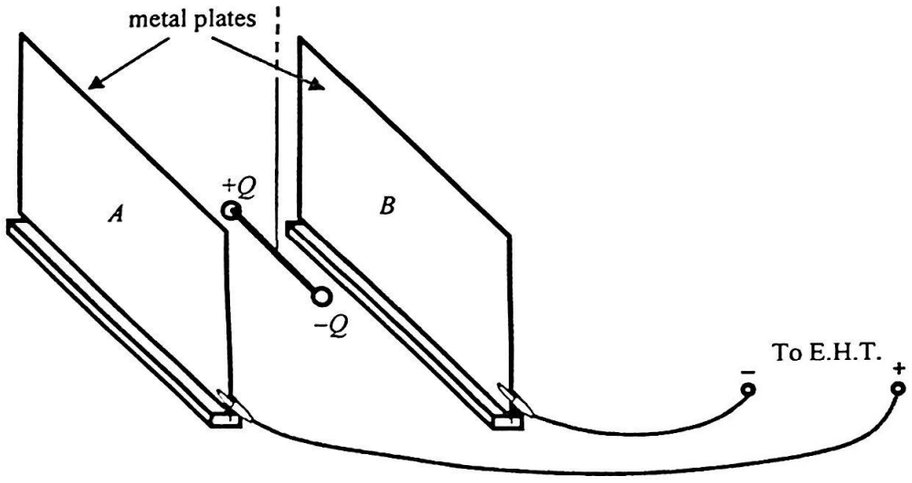

Figure 9.1

The rod is parallel to the metal plates when the E.H.T. is off. After the E.H.T. is switched on, an electric field is set up between the plates and the rod is twisted by an angle of 20° as shown in Figure 9.2.

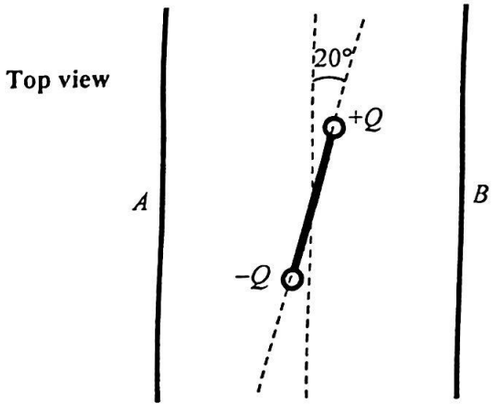

Figure 9.2

(a) On Figure 9.2, sketch the electric field lines due to the potential difference across the plates. (2 marks)

Answers written in the margins will not be marked.

(b) The potential difference across A and B is 5.0 kV and the separation between the metal plates is 10 cm. The force due to the electric field acting on each sphere is 2.0×10^{-5} N, find

(i) the moment acting on the rod as shown in Figure 9.2 due to the electric forces on the charged spheres. (2 marks)

*(ii) the strength of the electric field E due to the potential difference across the metal plates. (2 marks)

(iii) the magnitude of the charge Q on the spheres. (2 marks)

Answers written in the margins will not be marked.

10. Given: mass of proton = 1.0073 u
mass of α particle = 4.0015 u
mass of $^{14}_{7}N$ nucleus = 13.9993 u
mass of $^{17}_{8}O$ nucleus = 16.9947 u

When a stationary $^{14}_{7}N$ nucleus is bombarded by an α particle, the following nuclear reaction can be triggered with products $^{17}_{8}O$ and X fly off:

$$\alpha + {}^{14}_{7}N \longrightarrow {}^{17}_{8}O + X$$

(a) What is X?

(1 mark)

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*(b) Based on energy consideration, estimate the minimum kinetic energy, in MeV, of the α particle required for such a nuclear reaction to occur. (2 marks)

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(c) However, when conservation of momentum is also taken into account, the α particle must possess a kinetic energy greater than that found in (b) to bring about such a reaction. Explain. (2 marks)

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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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