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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

ONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2019

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

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

1. (a) An insulated container of negligible heat capacity contains 1.5 kg of tea at a temperature of 60 °C.

(i) What mass of ice at 0 °C should be added to the tea so that the final temperature of the mixture is lowered to 10 °C ? Assume that the specific heat capacity of tea is the same as that of water. (3 marks)
Given: specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}
specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

(ii) If the heat capacity of the container is **not** negligible, explain whether more ice, less ice or the same amount of ice is needed to obtain the final temperature of 10 °C. (2 marks)

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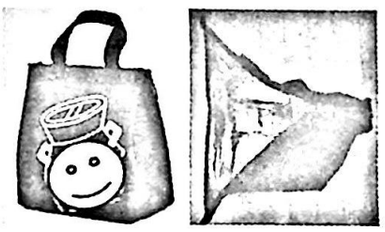
(b) Some ice cream at −10 °C is put into a 'thermal bag', of which the inner layer is made of polyethylene foam coated with aluminium foil. The bag is also equipped with a zipper at the top.



The thermal bag is then brought outdoors on a hot sunny day.

(i) Referring to the heat transfer processes, explain **ONE** feature of this bag that helps keep the ice cream at a low temperature. (1 mark)

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(ii) Suggest **ONE** modification to this bag that would enhance its ability to keep things stored inside at a low temperature. (1 mark)

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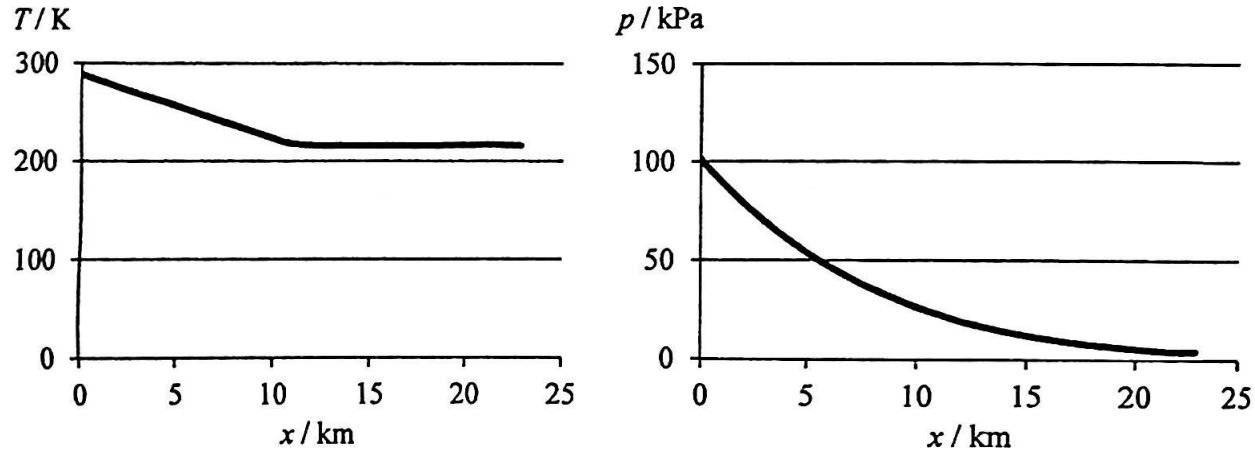
*2. A weather balloon of volume 0.52 m^3 is filled with helium gas of temperature 15 °C and pressure 100 kPa at ground level.

(a) Find the amount of helium gas (in mol) in the balloon. (2 marks)

(b) The following graphs show the variation of air temperature T and atmospheric pressure p with height x above ground level.



The weather balloon is released and rises to the upper atmosphere. Assume that the temperature and pressure of the helium gas in the balloon are the same as those of the air outside at any height x.

(i) A student believes that as the air temperature decreases in the first 10 km, the volume of the balloon decreases. Referring to the graphs above, explain qualitatively why this belief is not correct. (2 marks)

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(ii) In fact the weather balloon keeps on expanding when it rises. The air temperature becomes steady at 216 K from a height of 12 km onwards. When the balloon rises further beyond 12 km and its volume reaches 8 m^3,

(1) estimate the gas pressure in the balloon; (2 marks)

(2) hence find the corresponding height reached by the balloon. The variation of atmospheric pressure p with height x (in km) is given by

$$p = p_0 e^{-kx},$$

where p_0 is the atmospheric pressure at ground level and $k = 0.138\ km^{-1}$. (2 marks)

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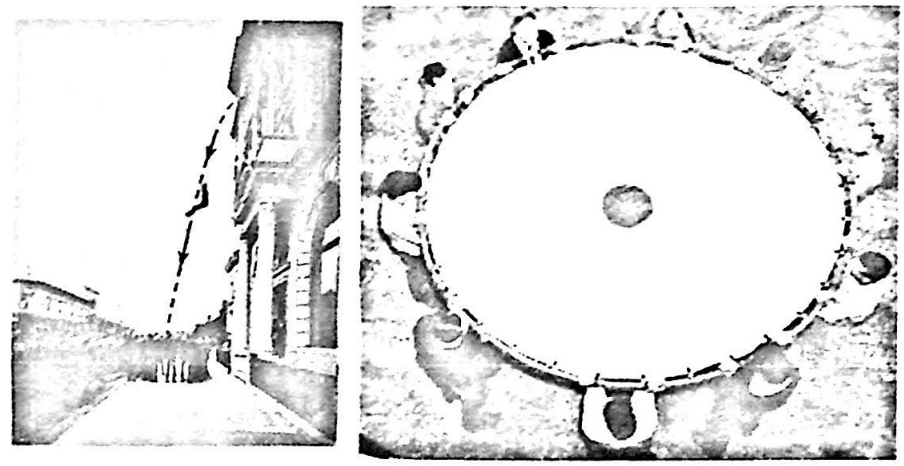
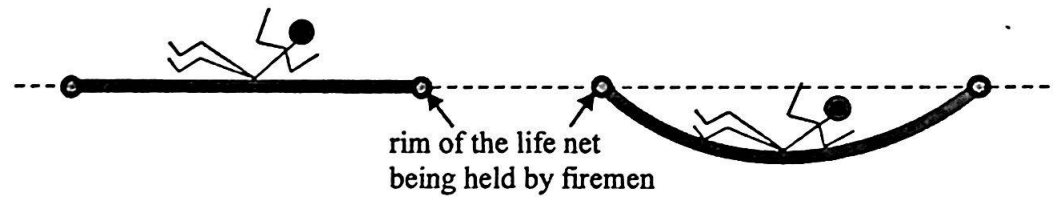
3. Read the following passage about **life nets** and answer the questions that follow.

A life net is a rescue equipment formerly used by firefighters. It gives people on the upper floors of a burning building an opportunity to jump to safety, usually to ground level. It became obsolete due to advances in firefighting technology.



The practical height limit for successful use of life nets is about six storeys, although a few people once have survived jumps from an eight-storey building into a life net with various degree of injuries. The diagrams below explain its working principle.



When a person hits the net, it deforms and puts the person to a stop in a longer time as compared to hitting the solid ground.

(a) A person falls from a height of 12 m above a life net with negligible initial speed. Neglect air resistance and the size of the person. ($g = 9.81$ m s^{-2})

(i) Estimate (1) the vertical speed v and (2) the time of fall t of the person just before hitting the life net. (4 marks)

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(ii) If this falling person of mass 70 kg is stopped in 0.3 s by the life net, estimate the average force acting on the person by the net within this time interval. (3 marks)

(iii) What form of energy is stored by the life net during the deceleration of the falling person ? (1 mark)

(b) (i) Give a reason why there exists a height limit of using life nets. (1 mark)

*(ii) The falling person might hit the rim of the net, thus the person or the firemen holding the rim would be injured. Explain why it is not easy for a person jumping from a height to reach the life net's central part. (2 marks)

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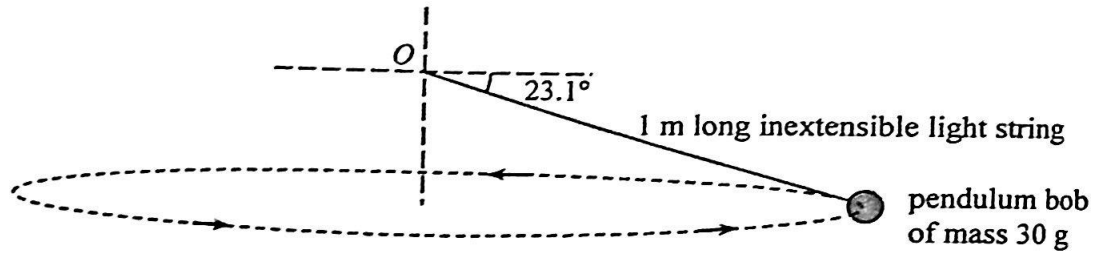
*4. (a)

Figure 4.1



A pendulum bob of mass 30 g is tied to a fixed point O by a 1 m long inextensible light string. It is swirled to describe a horizontal circle uniformly at an angular velocity of 5.0 rad s^{-1} as shown in Figure 4.1. Neglect air resistance. ($g = 9.81$ m s^{-2})

(i) What is the bob's rotation rate (in revolutions per second) ? (1 mark)

(ii) Indicate on Figure 4.1 the centripetal force F_C required for the motion of the bob. Find F_C. (3 marks)

(iii) Explain whether the magnitude of the tension in the string is greater than, equal to or smaller than the centripetal force F_C found in (a)(ii). (2 marks)

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(b) The moon is orbiting around the Earth uniformly in a circular path under the influence of the Earth's gravitational attraction.

(i) Explain why the speed of the moon remains unchanged although it is acted upon by gravitational force. (2 marks)

(ii) A student claimed that as the moon is much less massive than the Earth, it exerts negligible force on the Earth. Comment on the student's claim. (2 marks)

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5. A ripple tank has a shallow region P and a deep region Q. Straight water wave of frequency 10 Hz is travelling in the shallow region as shown in Figure 5.1 when viewed from above.

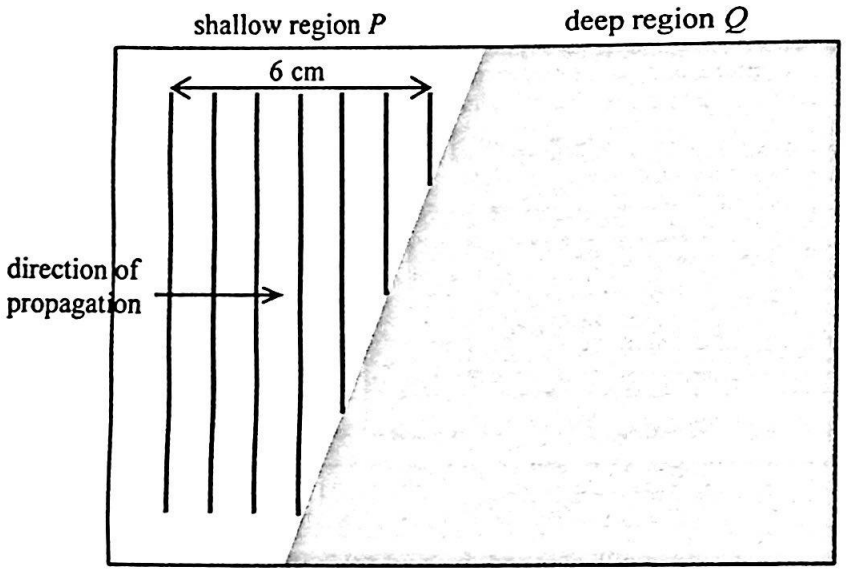

Figure 5.1 **Top view**

(a) The separation between seven crests in the shallow region is found to be 6 cm as shown.

(i) Find the wavelength of the wave in the shallow region. (1 mark)

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(ii) What is the wave speed in the shallow region ? (1 mark)

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(b) The water wave then propagates into the deep region where the wavelength of the wave is double that in the shallow region.

(i) State the frequency of the water wave in the deep region. (1 mark)

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(ii) On Figure 5.1, sketch the wave pattern in the deep region. (2 marks)

(iii) Name the phenomenon occurred across the boundary and explain its cause. (2 marks)

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6. In Figure 6.1, AB represents the virtual image of an object formed by lens L. The magnification of the image is 0.4. The horizontal scale is 1 cm to 5 cm.

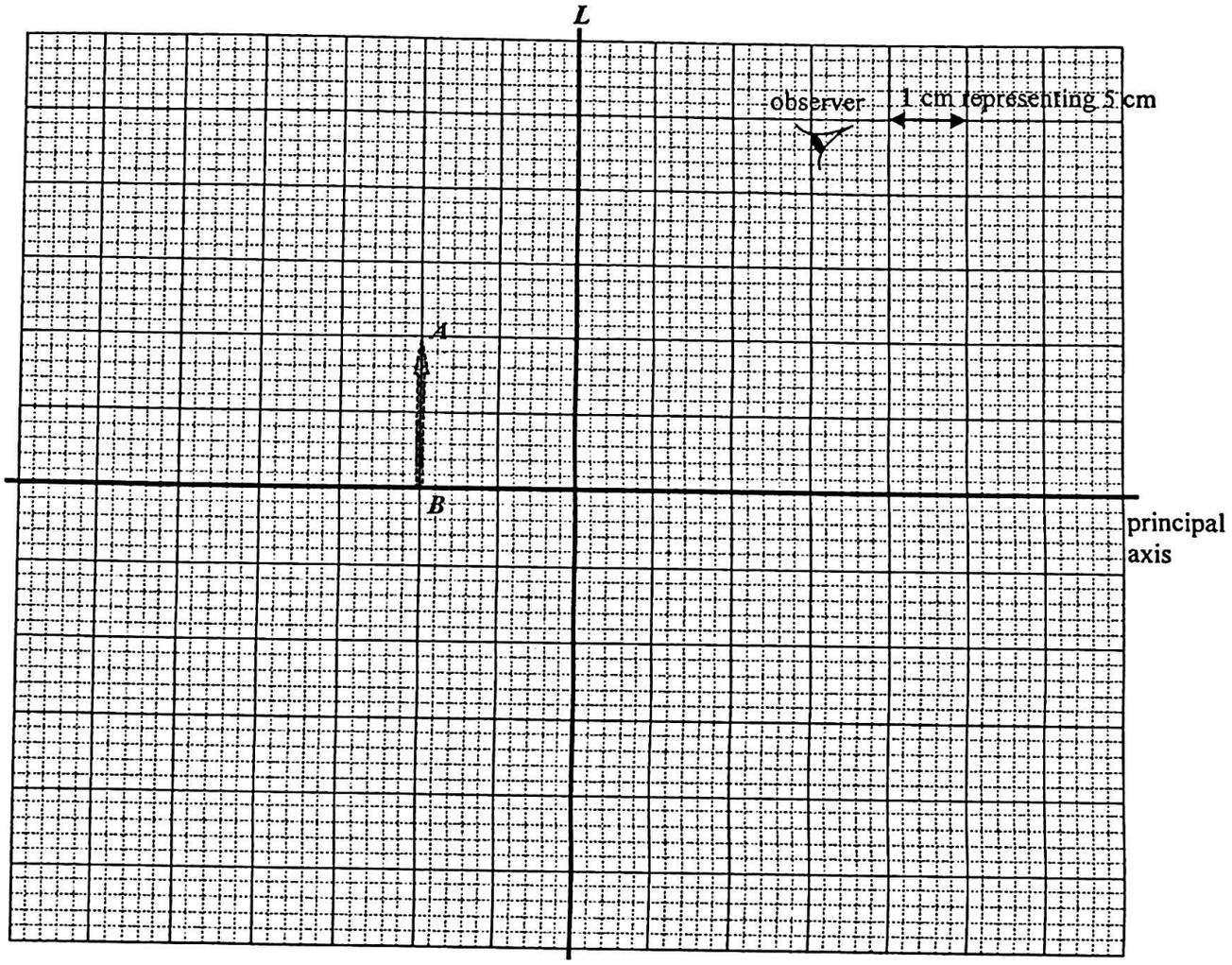

Figure 6.1

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

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(b) Indicate on Figure 6.1 the position and height of the object. (2 marks)

(c) By drawing a suitable light ray, locate and mark the position of the focus, F, of the lens. Find the focal length of the lens. (3 marks)

Focal length = ...

(d) Draw a light ray emerging from the object to illustrate how the observer in the figure can see the tip A of the image. (2 marks)

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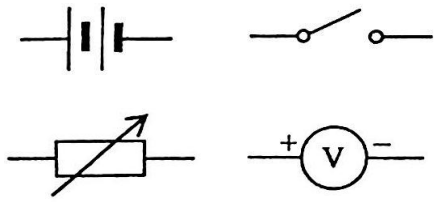
7. You are provided with a battery (of fixed e.m.f. ξ and internal resistance r), a variable resistor (with several known resistance values R to be selected), a switch, a voltmeter (assumed ideal) and a few connecting wires.



(a) With the aid of a circuit diagram, describe the procedure of an experiment to study how the terminal voltage V delivered by the battery depends on the resistance R connected to it. State **ONE** precaution of the experiment. (5 marks)

(b) Describe the variation of V with R and express V in terms of ξ, r and R. (2 marks)

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8. Figure 8.1 shows a household electrical wiring circuit. The mains cable (containing live wire L and neutral wire N) is connected to a consumer unit via a kilowatt-hour meter *M*. At the consumer unit, the wires branch out into a number of parallel circuits.

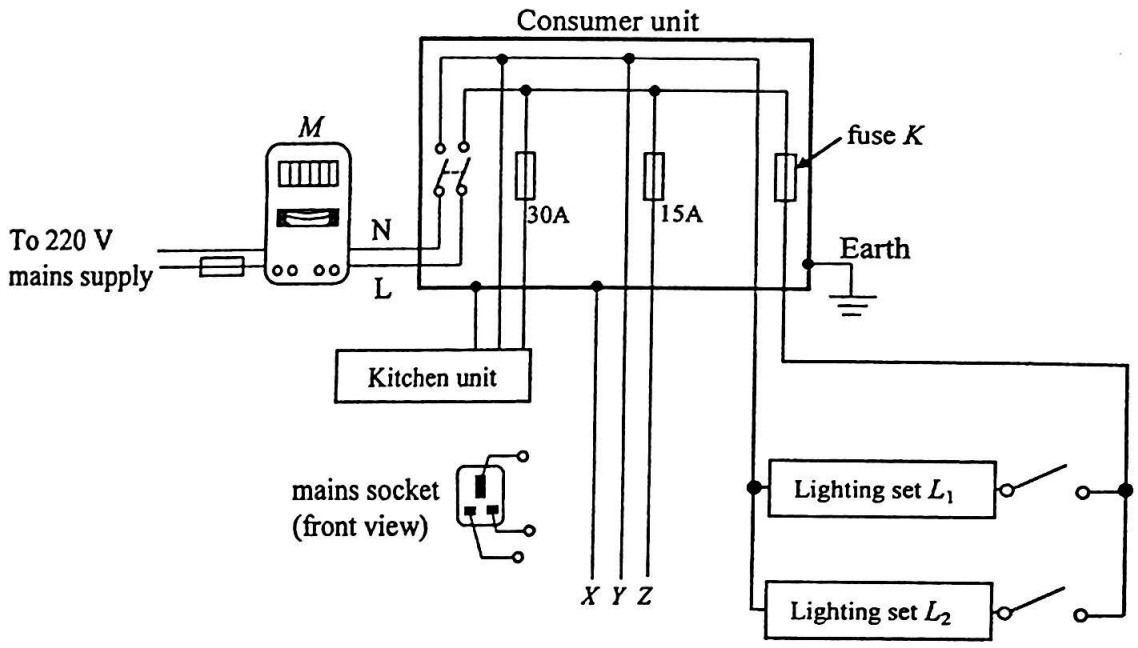

Figure 8.1

(a) Indicate on Figure 8.1 how the mains socket should be connected to wires *X*, *Y* and *Z*. (1 mark)

(b) Lighting sets L_1 and L_2 of power ratings 300 W and 450 W respectively are connected in parallel to the branch with fuse *K*.

(i) State one advantage of connecting L_1 and L_2 in parallel instead of in series to the branch. (1 mark)

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(ii) If fuses marked 3 A, 5 A, 10 A and 13 A are available, which one is the most suitable to be fuse *K*? Explain your choice. (3 marks)

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(c) The kitchen unit includes the following electrical appliances:

	rating	effective time of operation at rated value per day
a refrigerator	220 V, 500 W	8 hours
an electric kettle	220 V, 2000 W	0.5 hour
an induction cooker	220 V, 3000 W	2 hours

How much should be paid per day to run these appliances if 1 kW h of electrical energy costs \$0.9 ?
(3 marks)

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9. A rectangular coil *PQRS* of 20 turns, each having an area of 0.005 m^2, is placed in a uniform magnetic field *B* of strength 0.3 T pointing into the paper as shown in Figure 9.1.

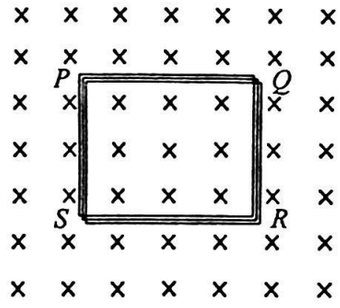

Figure 9.1

(a) The strength of the magnetic field decreases uniformly to zero within 0.5 s.

(i) Explain why a current would be induced in the coil. (2 marks)

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*(ii) Calculate the change in total magnetic flux linkage through the coil and the value of the induced e.m.f. ξ in the coil. (3 marks)

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(b) Now the coil is rotated uniformly about an axis through 180° as shown in Figures 9.2(a) and 9.2(b) within 0.5 s.

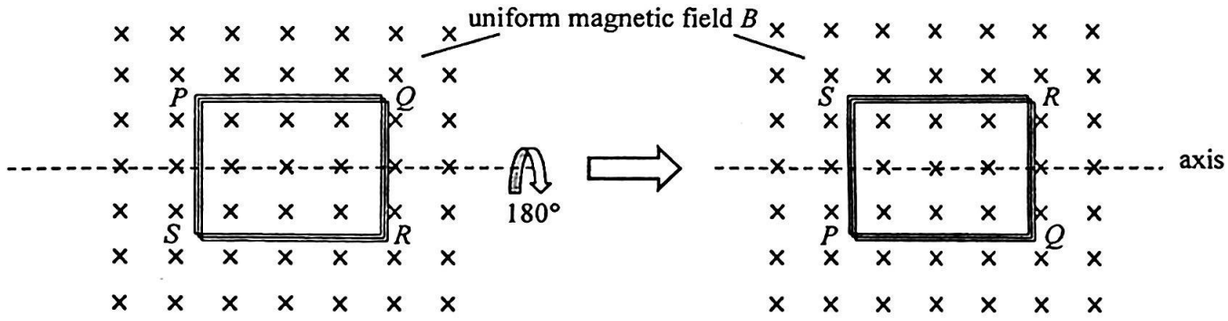


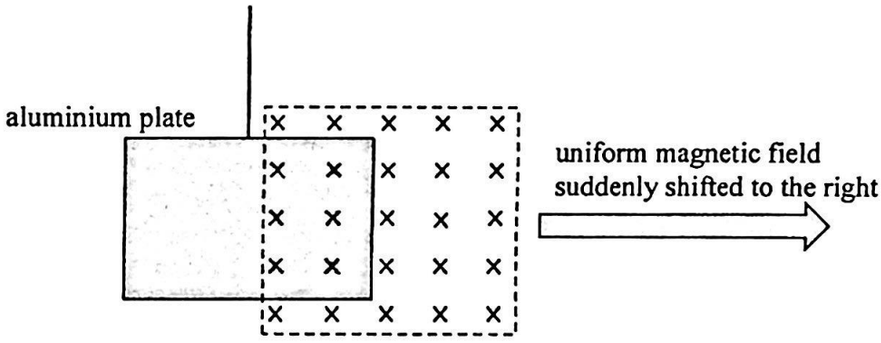
Figure 9.2(a) Figure 9.2(b)

(i) State the value of the change in total magnetic flux linkage through the coil in this case (1 mark)

(ii) At the moment when the coil rotated through 90°, would the induced current flow in the direction *PQRS*, *PSRQ* or is there no induced current in the coil ? (1 mark)

(c) Figure 9.3 shows a thin rectangular aluminium plate suspended by a long string. The plate is partly inside a uniform magnetic field provided by a strong magnet.

Figure 9.3



The magnet, which is not in contact with the plate, is suddenly shifted to the right.

(i) On Figure 9.3, draw a small circle at the location where eddy currents are induced on the aluminium plate. Use an arrow to indicate the direction of current. (2 marks)

(ii) Describe the subsequent motion of the aluminium plate, if any. (1 mark)

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10. (a) The equation below represents nuclear fission of uranium-235 (U-235).

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + x\,{}^{1}_{0}\mathrm{n} + 200\ \mathrm{MeV}$$

(i) What is the value of x ? (1 mark)

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(ii) State a necessary condition for chain reaction of fission to occur. (1 mark)

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Scientists found evidence in Oklo, Africa that natural nuclear fission occurred two billion (2×10^9) years ago. The uranium mineral ore mined from Oklo **at present** is found to have 0.6% concentration by mass of U-235 (see the table below), which is much lower than usual.

(b) The table gives the information of U-235 and U-238 in a sample of uranium mineral ore found in Oklo.
Given: half-life of U-235 = 7.04×10^8 years

	2×10^9 years ago	at present
U-235	m_0 kg	0.060 kg (i.e. 0.6% concentration by mass)
U-238	13.556 kg	9.940 kg (i.e. 99.4% concentration by mass)

*(i) Estimate the amount m_0 (in kg) of U-235 in the sample 2×10^9 years ago. (2 marks)

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(ii) Hence determine whether natural nuclear fission of U-235 was possible 2×10^9 years ago. For fission of U-235 to happen, its concentration by mass in the uranium mineral ore has to be at least 3%. (1 mark)

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There must be underground water in the vicinity of this uranium-rich mineral deposit for natural nuclear fission to be possible. Since water can slow down the fast neutrons from fission, these neutrons can easily be captured by U-235.

(c) In fact the chain reaction stopped even before the concentration by mass of U-235 dropped to 3%. Explain why this occurred. (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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