2016-DSE
PHY
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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

* A 1 5 0 E 0 1 B *

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

1. The following experimental items are provided for estimating the specific heat capacity of bronze c_b:

   a bronze sphere of mass 0.80 kg hung with a thread at room temperature T_0
   a polystyrene cup containing 0.50 kg of water at room temperature T_0
   a water bath maintained at 80 °C
   a thermometer
   a stirrer
   a towel

   (a) Describe the procedures of the experiment and state **TWO** experimental precautions to be taken. Write down an equation for finding c_b.
   Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$ (6 marks)

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(b) The value of c_b found in the experiment in (a) is lower than the actual value. Explain. (2 marks)

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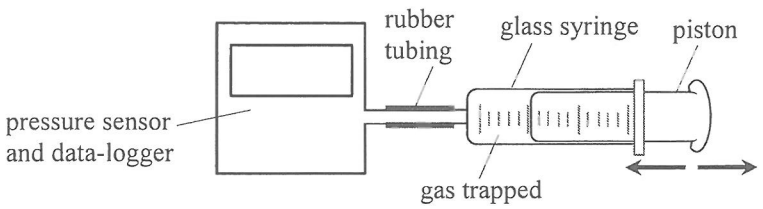
*2.

Figure 2.1



Judy uses the set-up shown in Figure 2.1 to study the relationship between the pressure and volume of a fixed mass of gas at constant temperature. The volume V of the gas trapped is read directly from the syringe and the corresponding pressure p is measured by a data-logger via a pressure sensor.

(a) The initial volume and pressure of the gas are 6.0×10^{-5} m^3 and 1.0×10^5 Pa respectively at a room temperature of 25 °C. Estimate the number of gas molecules trapped in the syringe. (3 marks)

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(b) The piston is then pushed in or pulled out to vary V and p such that several pairs of readings are recorded. Figure 2.2 shows the graph of V against $\frac{1}{p}$ plotted.

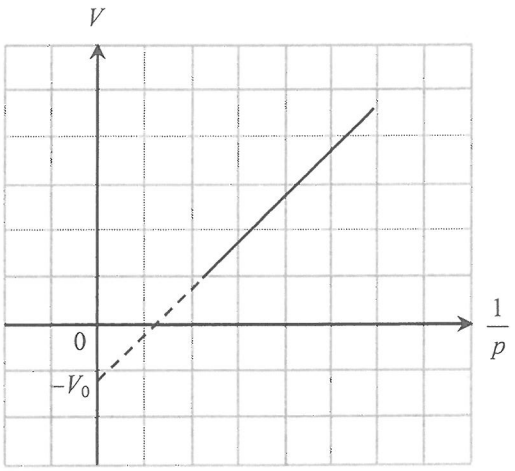

Figure 2.2

(i) State **ONE** experimental precaution for keeping the gas temperature constant. (1 mark)

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(ii) The straight line graph does not pass through the origin but cuts the vertical axis at $-V_0$ instead. Suggest what V_0 stands for. (1 mark)

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(iii) If the experiment is repeated at a higher room temperature using this set-up with the same mass of the same gas, sketch the expected graph in Figure 2.2. (2 marks)

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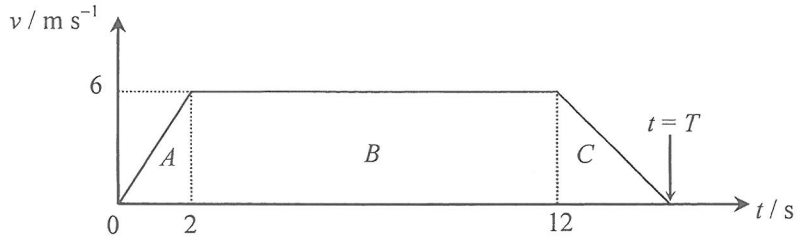
3. A person of mass m stands on a balance inside a lift. The lift goes down from the top of a building at time $t = 0$ and it reaches the ground at $t = T$. The velocity-time (v-t) graph of the lift is shown in Figure 3.1. ($g = 9.81$ m s^{-2})

Figure 3.1



(a) Calculate the acceleration of the lift from $t = 0$ to $t = 2$ s. (2 marks)

The reading of the balance changes during the person's ride on the lift and the readings registered are 685 N, 569 N and 395 N.

(b) Match these readings with the three stages, A, B and C, of the ride (shown in Figure 3.1). Hence deduce the mass of the person. (3 marks)

A:_____ B:_____ C: _____

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(c) (i) Show that $T = 15$ s. (2 marks)

(ii) Hence estimate the height of the building. (2 marks)

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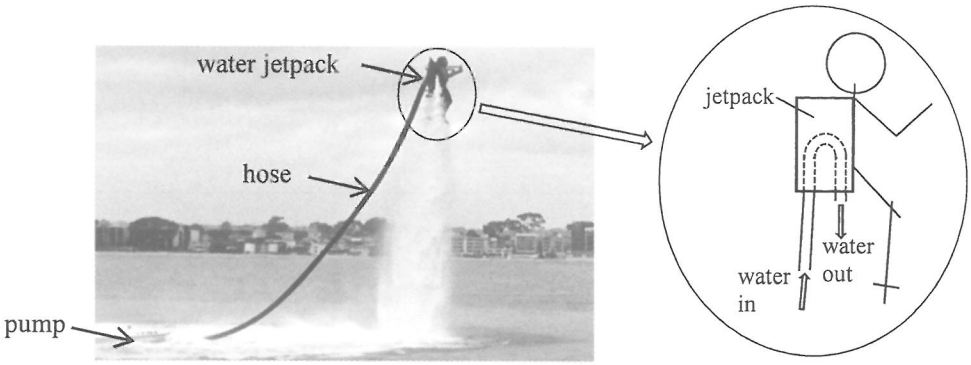
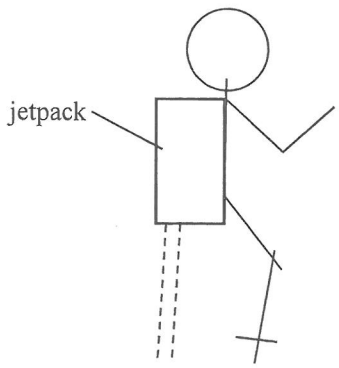
Figure 4.1



A person wears a water jetpack which enables him to stay 'afloat' in equilibrium in the air as shown in Figure 4.1. A pump on the sea surface continuously pumps water to the jetpack via a hose and the water is then ejected downwards.

(a) Referring to Figure 4.1, water enters the U-shape hose inside the jetpack with a certain speed and is then ejected out vertically downwards. Use Newton's law(s) of motion to explain why a lifting force acting on the person is produced. (3 marks)

(b) Draw and label all the forces acting on the person wearing the jetpack as a whole in the free-body diagram below. Neglect the pulling force due to the hose connected to the jetpack. (1 mark)



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(c) Suppose that water enters the jetpack with a speed of 10 m s^{-1} vertically upwards and is then ejected out at the same speed vertically downwards. (g = 9.81 m s^{-2})

(i) **Just by considering the change of momentum of the water**, estimate how much water, in kg, has to be ejected per second to provide a lifting force of 1000 N needed. (2 marks)

(ii) Water is pumped to the water jetpack at a height of 7.5 m above sea surface and then ejected from it. By considering the gain in mechanical energy of the water, estimate the minimum output power of the pump. (3 marks)

(d) The person changes to staying 'afloat' in equilibrium at a higher position. If the speed by which water enters and is ejected from the jetpack remains the same, would the amount of water ejected per second be greater than, equal to or smaller than the result found in (c)(i) ? Explain. (Neglect the weight of the hose.) (2 marks)

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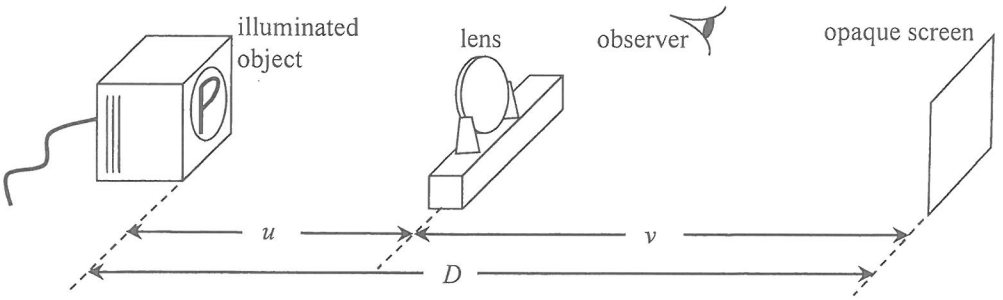

Figure 5.1

Kitty uses the set-up in Figure 5.1 to study the image formation of a lens. The lens is placed at a distance u from an illuminated object (letter 'P'). An opaque screen is placed at a distance D from the object so as to capture the image.

(a) (i) State the kind of lens used. Explain your answer. (2 marks)

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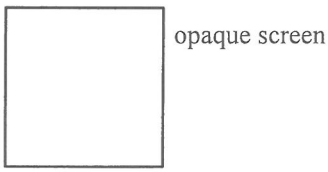
(ii) Sketch the image on the screen seen by the observer. (1 mark)



(b) The separation D is varied while the position of the lens is adjusted to form an image once again on the screen. The corresponding object distance u is obtained for plotting a graph of D against u (Figure 5.2).

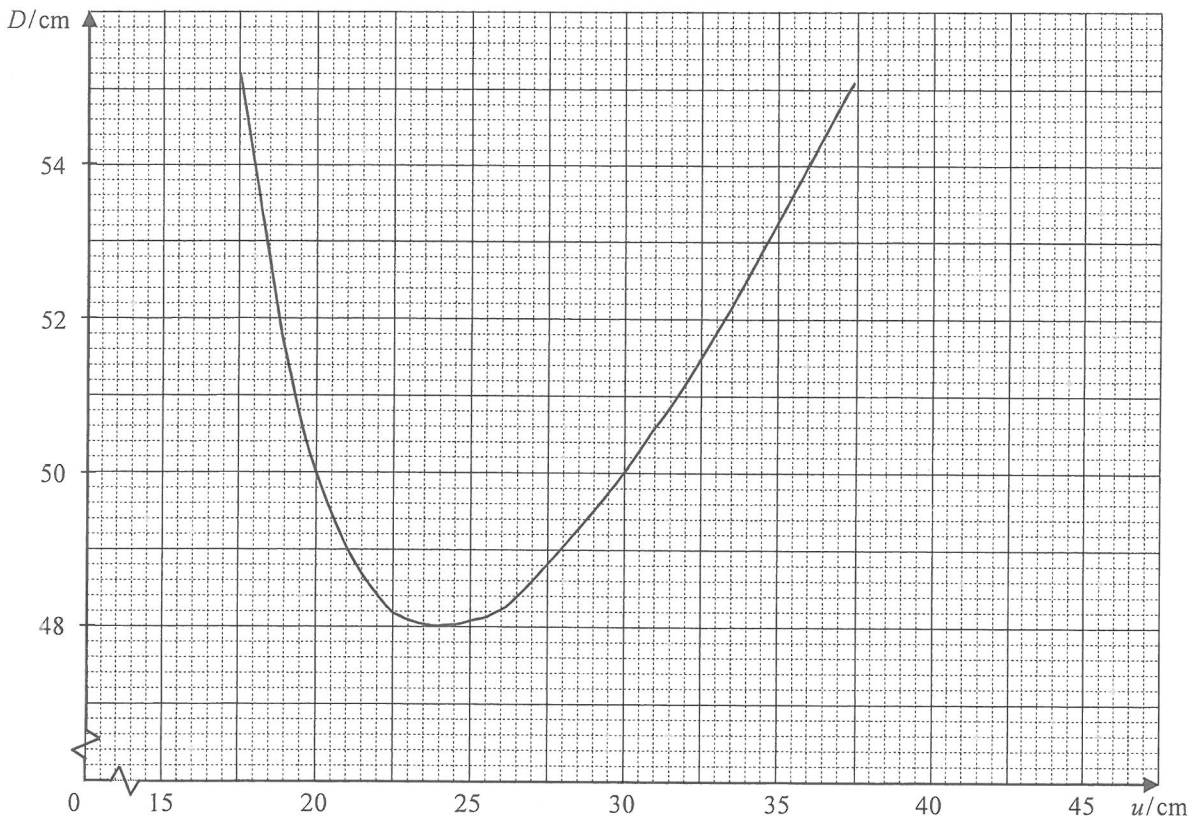


Figure 5.2

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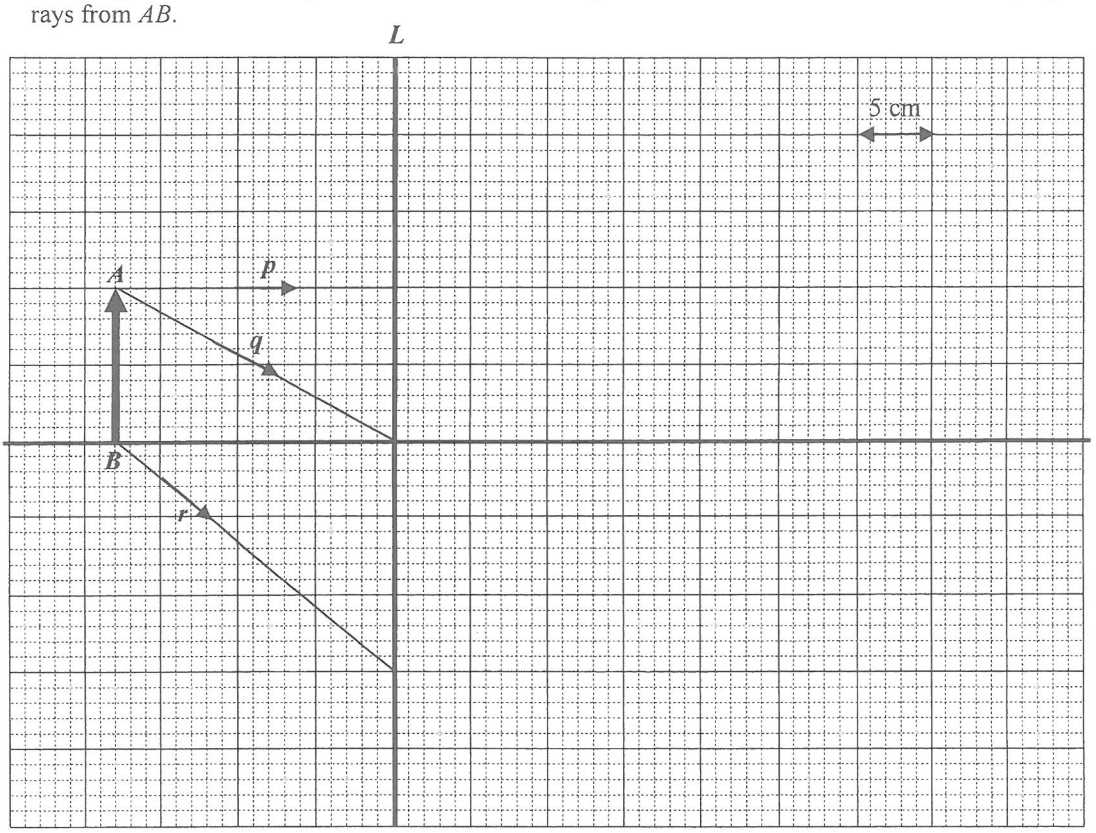
(i) When the lens is placed at 18 cm from the object, use the graph to find the corresponding separation between the lens and the screen. Hence calculate the magnification of the image. (2 marks)

In the figure below, AB represents the illuminated object which is at 18 cm from the lens L. p, q and r are light rays from AB.



(ii) Indicate the image formed by AB (denote it as I) and draw the refracted rays of p, q and r. (3 marks)

(iii) Hence find the focal length of the lens. The horizontal scale is 1 cm to 5 cm. (1 mark)

Focal length = ...

(iv) Keeping the object and screen fixed in position, suggest where Kitty should move the lens to such that an image can be formed again on the screen. State the ratio $\frac{\text{height of this new image}}{\text{height of the original image}}$. (2 marks)

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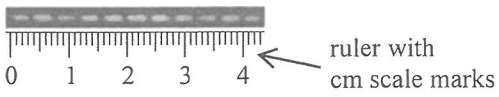
*6. (a) A laser beam is directed perpendicularly towards a double slit of separation $a = 0.3$ mm. The pattern of bright spots projected on a screen 1.8 m away from the slits is shown in Figure 6.1.

Figure 6.1



(i) Find the wavelength of the laser beam. (3 marks)

(ii) Explain why the slit width has to be very narrow in order for the above pattern to be observed. (2 marks)

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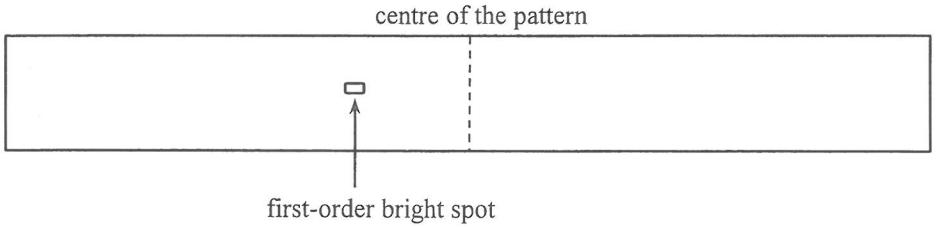
(b) The double slit is now replaced by a diffraction grating of 500 lines per mm.

(i) Find the separation between the central bright spot and first-order bright spot of the pattern on the screen for the same experimental settings. (3 marks)

(ii) Sketch the pattern, up to the second-order, that you would expect to see on the screen when using this diffraction grating. A first-order bright spot has already been drawn for you. (2 marks)



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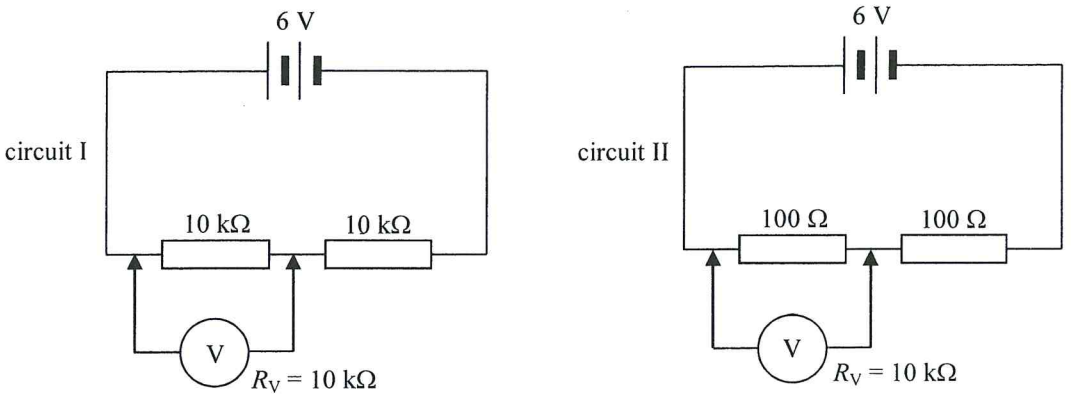
7. (a) The circuits in Figure 7.1 each contains two resistors connected in series with a 6 V battery of negligible internal resistance. The resistors in circuit I are 10 kΩ each while those in circuit II are 100 Ω each.

Figure 7.1



A voltmeter of internal resistance R_V = 10 kΩ is used to measure the potential difference across one of the resistors as shown.

(i) What would be the respective voltmeter readings ? (3 marks)

(ii) In fact, the potential difference across each resistor *before connecting the voltmeter* is 3 V in both circuits. Explain why this voltmeter gives a relatively inaccurate value for circuit I. Hence state the general principle of selecting a suitable voltmeter for such measurement. (2 marks)

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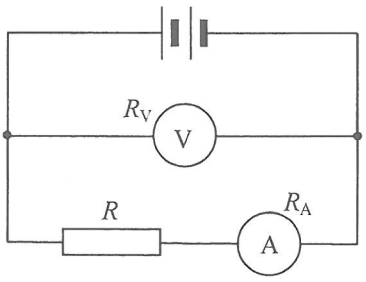
(b) Circuit III shows a possible method for measuring resistance using a voltmeter and an ammeter. The internal resistances of the voltmeter and the ammeter are R_V and R_A respectively and their readings V_m and I_m give the measured resistance $R_m = \frac{V_m}{I_m}$. The true resistance value of the resistor is R.

Figure 7.2

circuit III



(i) State which reading(s), V_m, I_m or both, do(es) **NOT** give the *true voltage* across the resistor and/or the *true current* passing through the resistor. Hence write down an equation relating R_A, R_m and R. (2 marks)

(ii) Find the percentage error associated with R_m when measuring the resistance of this resistor. Given: R_V =10 kΩ, R_A = 1 Ω and R = 10 Ω. (2 marks)

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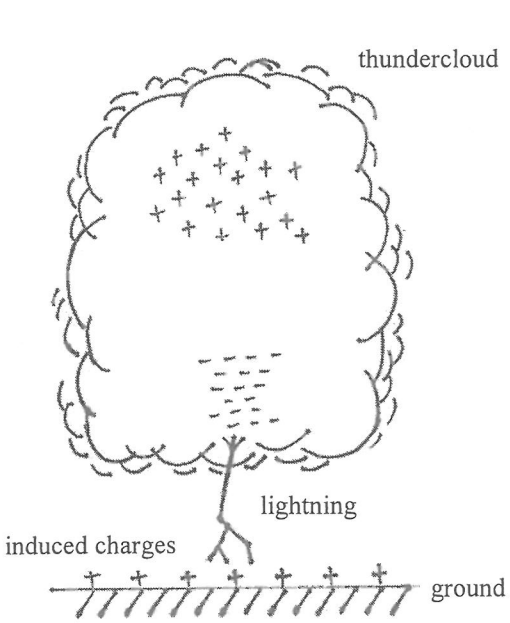
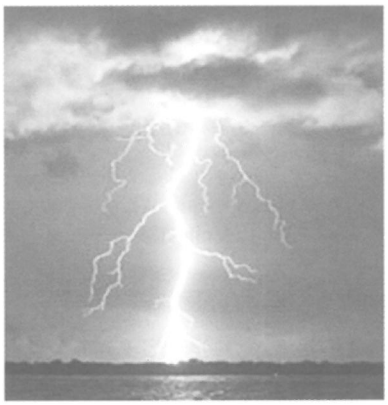
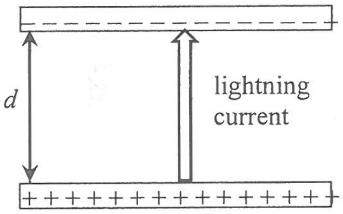
8. Read the following passage about **lightning** and answer the questions that follow.







Lightning occurs when charges accumulate in the clouds to such an extent that the electric field in the atmosphere is strong enough to cause the air to lose its insulating properties. The threshold electric field for 'breakdown' to occur is about 3×10^5 V m^{-1} above which electrons or ions in the atmosphere can pass through the air between clouds and the ground or between clouds and clouds. The peak current of a typical lightning bolt can reach about 30000 A. How the charges are separated and accumulated in the clouds is not fully understood yet. In most cases, negative charges are at the base of the cloud and positive charges are induced on the ground.

(a) (i) What is the meaning of 'breakdown' in the passage ? (1 mark)

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*(ii) The thundercloud's base and the ground can be modeled as two parallel plates with opposite charges. If the negative charges distributed at the cloud's base are about $d = 2$ km from the ground, find the potential difference between the cloud and the ground when the electric field in the atmosphere just reaches the threshold of 'breakdown'. (2 marks)

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A lightning detector having a small square coil inside is placed at point O which is 1.5 km from the lightning bolt. The coil and the lightning's direction are in the same vertical plane as shown. Assume that the lightning current flows vertically upwards to the thundercloud from the ground.

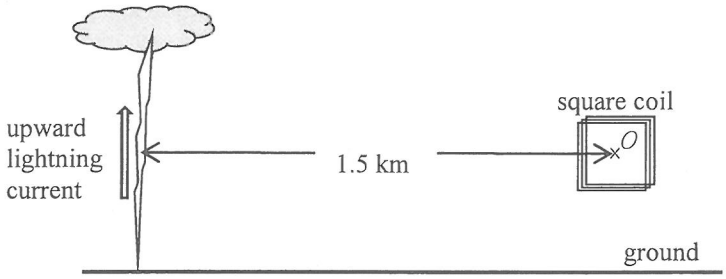

Diagram **NOT** drawn to scale

(b) (i) State the direction of the magnetic field (to the left / to the right / into paper / out of paper) produced at point O by the lightning current. Estimate the magnetic field strength's peak value at O. (3 marks)

(ii) Explain why within the very short duration of lightning an induced current first flows in the coil in a certain direction and then reverses. Your answer should include the directions of the induced current in the coil. (3 marks)

(iii) Among the physical quantities related to lightning, **electric field in the atmosphere**, **lightning current** and **magnetic field due to lightning**, suggest which one can be monitored so as to give fore-warning of lightning. Explain your choice. (2 marks)

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9. Part of the decay series of uranium-238 (U-238) is shown below. The end product lead-206 (Pb-206) is stable.

$$^{238}_{92}\mathrm{U} \xrightarrow[4.5\times10^{9}\ \text{years}]{\alpha} \mathrm{Th} \xrightarrow[21\ \text{days}]{\beta} \mathrm{Pa} \rightarrow \ldots \rightarrow {}^{206}_{82}\mathrm{Pb}$$

(a) When a U-238 nucleus decays to a Pb-206 nucleus, how many α-particle(s) and β-particle(s) are emitted ?
(2 marks)

(b) As the first decay in the above chain from U to Th has a half-life much longer than those of subsequent decays, the decay from U-238 to Pb-206 can be simplified to *a single decay* with half-life 4.5×10^9 years:

$$^{238}_{92}\mathrm{U} \xrightarrow[4.5\times10^{9}\ \text{years}]{} {}^{206}_{82}\mathrm{Pb}$$

Suppose that a uranium-bearing rock contains only U-238 and no Pb-206 at the time when it was formed long ago by solidification of molten material. In a particular sample of the rock, it is found that the ratio $\dfrac{\text{number of Pb-206 atoms}}{\text{number of U-238 atoms}}$ is $\dfrac{2}{3}$ *at present*.

(i) Estimate the age of the rock. Assume that all Pb-206 atoms come from the decay of U-238 originally present in the sample and ignore the small number of U-238 atoms which have decayed but have not yet become Pb-206.
(2 marks)

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(ii) State, with a reason, whether the answer in (b)(i) is an overestimate or an underestimate of the age of the rock if some Pb-206 atoms have actually been lost. (2 marks)

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(iii) The graph in Figure 9.1 shows how the number of U-238 atoms in the sample varies with time t subsequently while $t = 0$ denotes *the present time*. On Figure 9.1, sketch a graph to show the variation of the number of Pb-206 atoms in the sample with time. (2 marks)

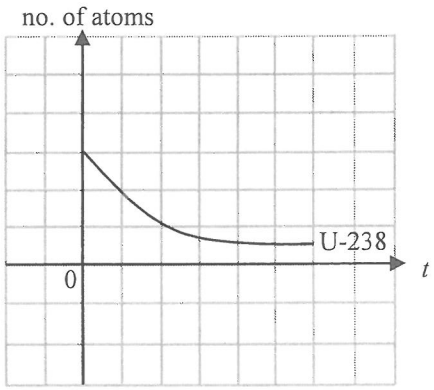

Figure 9.1

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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