2018-DSE
PHY

PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2018

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	5
2	6
3	5
4	11
5	9
6	10
7	9
8	9
9	12
10	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. Figure 1.1 shows a domestic water heater. Tap water entering the heater is heated when it passes through the coil duct and exits as hot water at a certain temperature.

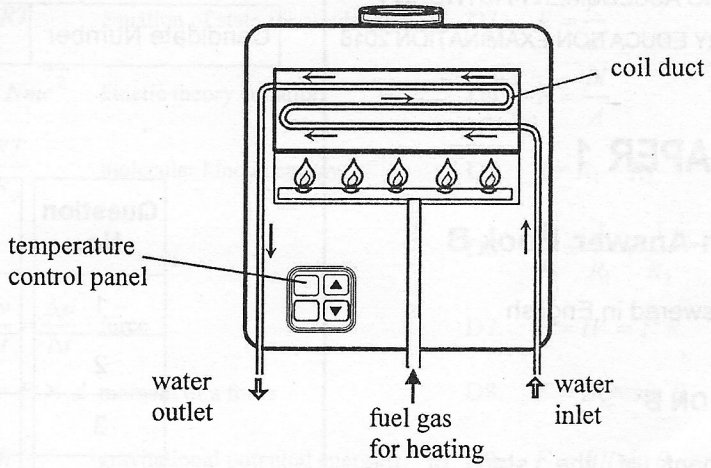

Figure 1.1

On a certain day in winter, the temperature of tap water is 15 °C. When the heater is in use, it delivers 6 kg of hot water at a temperature of 50 °C in 1 minute. Assume that there is no heat exchange between the heater and the surroundings. Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

(a) Estimate the power supplied to the tap water by the heater. (3 marks)

(b) Assuming the power estimated in (a) remains unchanged, determine the flow rate of tap water into the heater, in kg per minute, such that hot water at a temperature of 40 °C is delivered by the heater. (2 marks)

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*2. Two vessels, A and B, of volumes $3V$ and $2V$ respectively are connected by a narrow tube with a tap as shown in Figure 2.1. Initially the tap is closed and both vessels are at the same temperature. Vessel A contains helium gas at a pressure p while vessel B contains 0.8 mol helium gas at a pressure $2p$. Assume that helium gas can be taken as an ideal gas.

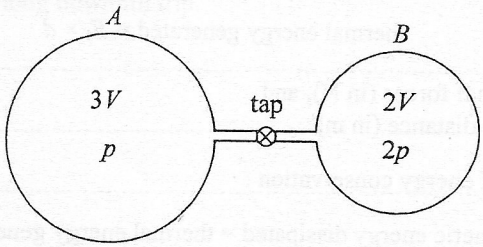

Figure 2.1

(a) Deduce the amount of helium gas (in mol) in vessel A. (2 marks)

(b) Now the tap is open and a steady state is reached. Assume that the temperature remains unchanged.

(i) Find the gas pressure inside the vessels in terms of p. (2 marks)

(ii) Account for the pressure change of the gas in vessel A using kinetic theory. (2 marks)

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3. Read the following passage about **braking in vehicles** and answer the questions that follow.

Mechanical braking is the most common braking method in vehicles. In this method, wheels of vehicles are fitted with brake pads which apply frictional forces that inhibit the motion of the wheels. Frictional braking results in a conversion of the vehicle's kinetic energy to thermal energy which then dissipates to the atmosphere in the form of waste heat.

The thermal energy (in J) generated during braking is approximately given by :

$$\text{thermal energy generated} = F_r \times d$$

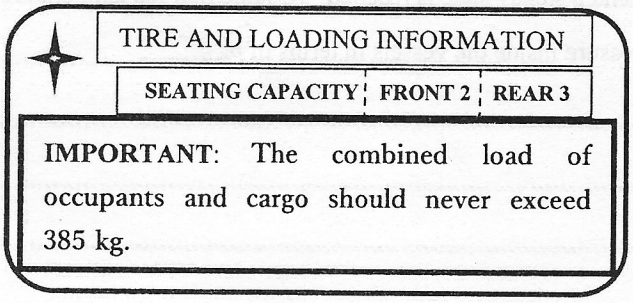
where F_r is the frictional forces (in N), and
d is the braking distance (in m).

Applying the principle of energy conservation :

$$\text{kinetic energy dissipated} = \text{thermal energy generated}$$
$$\frac{1}{2}mv^2 = F_r \times d$$

From this equation it can be seen that increasing the velocity v or mass m of an object means the applied frictional forces must be increased in order to bring the object to a stop within the same distance.

(a) Referring to the passage, explain why there should be a maximum load limit for a vehicle (see the vehicle label example below). (2 marks)



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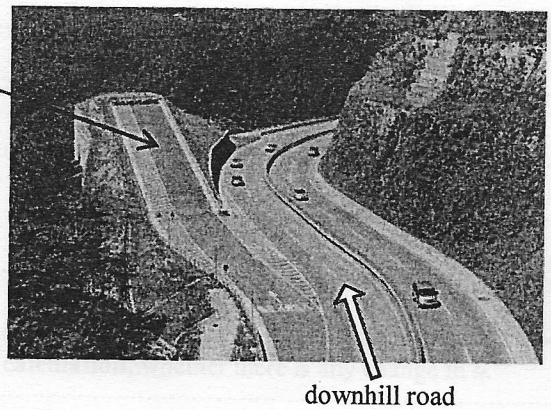
(b) (i) It is known that the brake pads would provide much smaller frictional forces or even brake failure would occur (i.e. without any friction provided) when reaching a temperature of over a few hundred degrees Celsius. Explain why it is not recommended for a vehicle driver to **apply the brakes continuously** during a long downhill trip. (1 mark)

(ii) The figure shows an emergency escape ramp (slanting upwards) built for stopping vehicles with brake failure resulting from the situation described in (b)(i). If such a ramp makes an angle of 30° with the horizontal and a vehicle with brake failure enters the bottom end of the ramp at a speed of 25 m s^{-1}, estimate how far it will travel along the ramp before it stops. Neglect air resistance and mechanical resistances within the vehicle. (g = 9.81 m s^{-2}) (2 marks)



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4. Figures 4.1 (a) and (b) show the cross-section of a fixed spring gun fitted with a small cannon ball.

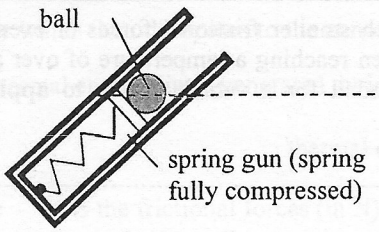

Figure 4.1(a)

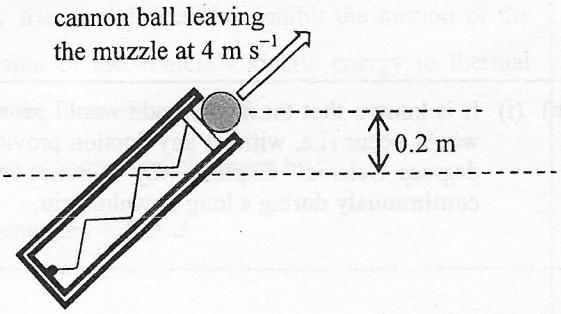

Figure 4.1(b)

The fully compressed light spring (Figure 4.1(a)) is released so that the cannon ball of mass 0.3 kg leaves the muzzle of the gun at a speed of 4 m s^{-1} (Figure 4.1(b)). Neglect air resistance. (g = 9.81 m s^{-2})

(a) During the process from the time when the spring is fully compressed till the cannon ball just leaves the muzzle,

(i) how much energy is transferred from the spring to the cannon ball ? (3 marks)

(ii) explain whether the total momentum of the spring gun and the cannon ball is conserved. (2 marks)

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*(b) The cannon ball is projected at 50° to the horizontal initially and reaches a point horizontally away from the muzzle of the gun at a distance R. Find R and the time of flight t_f of the cannon ball to that point. (4 marks)

*(c) If the projection angle is increased to slightly greater than 50° while the initial speed remains unchanged at 4 m s^{-1}, explain, **without any calculation**, whether there is any change in t_f. (2 marks)

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5. Figure 5.1 shows the use of a beam balance to measure the mass of a load. Without the load and the counter-weight, the beam with a scale pan at its left end is balanced and remains horizontal. ($g = 9.81$ m s^{-2})

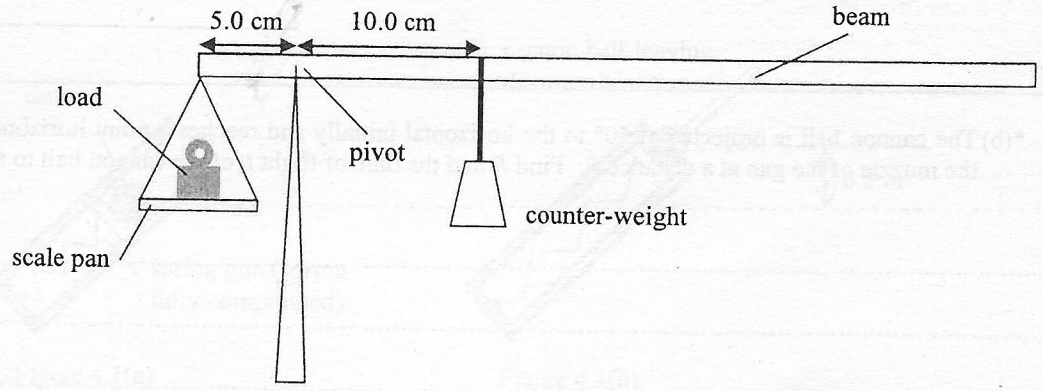

Figure 5.1

(a) A load is placed on the pan which is 5.0 cm from the pivot. The set-up is in equilibrium when the counter-weight of mass 50 g is 10.0 cm away from the pivot as shown.

(i) Find the mass of the load. (2 marks)

(ii) If the reading of the counter-weight's position on the beam carries an uncertainty of ±0.1 cm, find the maximum error that corresponds to the result found in (a)(i). (2 marks)

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(b) The weight of an identical load is now measured by a spring balance calibrated in newtons. What is the balance's reading ? (1 mark)

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(c) The beam balance set-up in Figure 5.1 and the spring balance with the load in (b) are both brought into a lift.

(i) The measurements are then repeated inside the lift which accelerates upwards uniformly. State the change, if any, in the measurements respectively. (2 marks)

counter-weight position on beam balance	spring balance reading
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(ii) A student claims that if the lift falls freely, the beam balance can still be used to measure the mass of the load. Explain whether the claim is correct or not. (2 marks)

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6. (a) You are given a ray box with a single slit (producing a fine light beam), a cylindrical concave lens, a plastic ruler, a pencil and a piece of paper as shown in Figure 6.1.

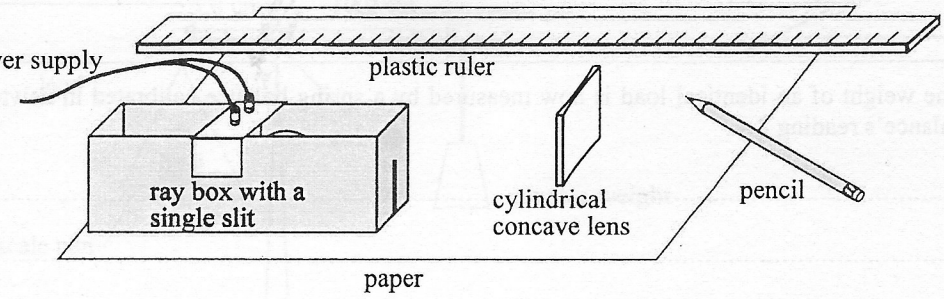

Figure 6.1

Describe how you would use the above apparatus to find the focal length of the lens and state **ONE** possible source of error in the experiment. (5 marks)

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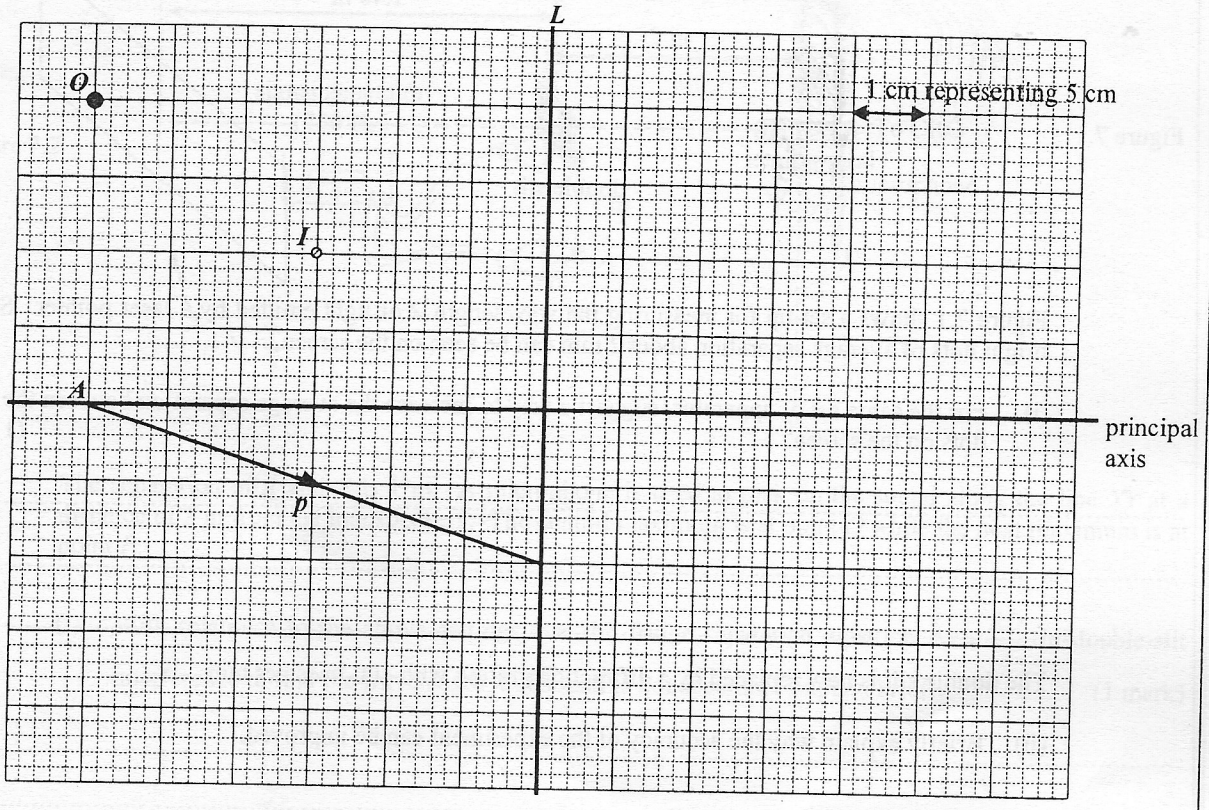
(b) In the figure below, L represents another cylindrical lens. A vertical pin used as the object is placed at O, the image is formed at I by the lens. The horizontal scale is 1 cm to 5 cm.



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

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(ii) Draw a suitable light ray to locate the principal focus F of lens L. Find its focal length.

Focal length = ... (2 marks)

(iii) Complete the path for the ray p from point A. (1 mark)

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7. *(a)

Figure 7.1

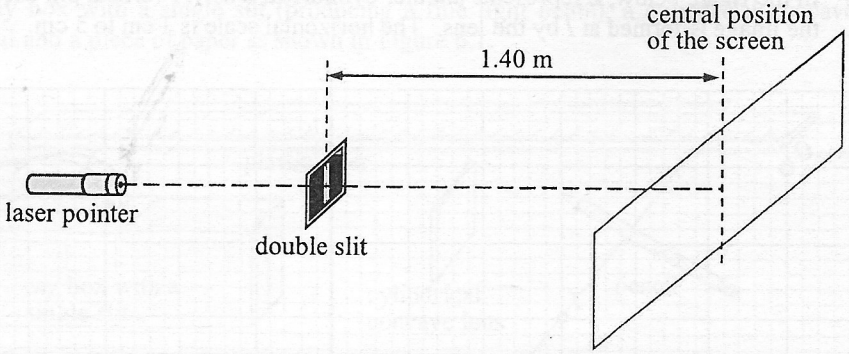

Figure 7.1 shows a set-up for measuring the wavelength λ of light emitted by a laser pointer. Several bright dots of average separation about 2 mm can be seen on the screen.

(i) For the same set of apparatus, suggest a way to increase the average separation between the bright dots on the screen. (1 mark)

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The double slit is now replaced by a diffraction grating with 400 lines per mm.

(ii) Briefly explain why the accuracy of the experiment can be improved. (1 mark)

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(iii) Only five bright dots are observed on the screen such that the separation between the 1st and 5th dots is 1.56 m. Find λ. (3 marks)

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(b) To measure the speed of sound in air, a student connects two loudspeakers, A and B, to a signal generator as shown in Figure 7.2.

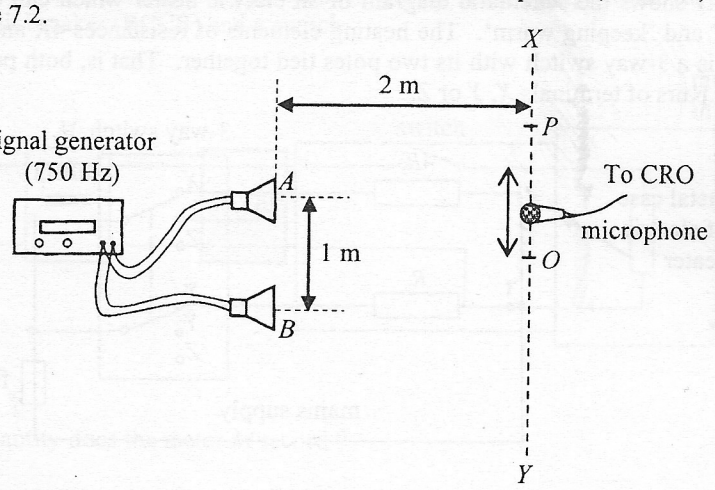

Figure 7.2

The separation of A and B is 1 m. A microphone is used to pick up the sound along the line XY at a distance of 2 m from the loudspeakers. The central maximum is at point O while the next maximum is at point P.

(i) With reference to the above settings, use the fringe separation equation $\Delta y = \frac{\lambda D}{a}$ in double-slit interference to find the wavelength λ of sound is not accurate. Explain briefly. (1 mark)

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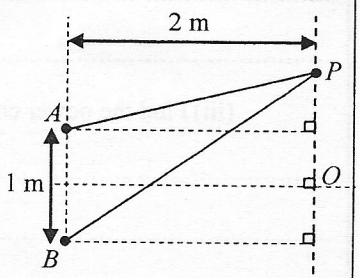
(ii) The distance between O and P is found to be 1 m when the signal generator is set at 750 Hz. By considering the path difference $PB - PA$, use the results of the experiment to find the speed of sound in air. (3 marks)



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8. (a) Figure 8.1 shows the schematic diagram of an electric heater which can operate in two modes, namely, 'heating' and 'keeping warm'. The heating elements of resistances $4R$ and R are connected to the mains supply via a 3-way switch with its two poles tied together. That is, both poles can be connected to one of the three pairs of terminals X, Y or Z.

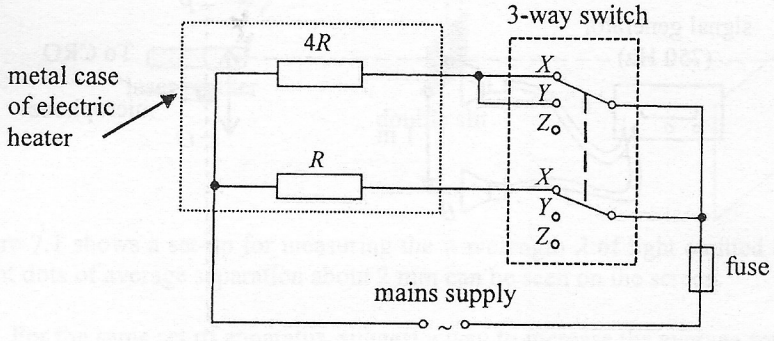

Figure 8.1

(i) To which pairs of terminals, X, Y or Z, should the switch connect to when the heater is in 'heating' mode ? (1 mark)

The power consumed by the heater in 'heating' mode is 800 W.

(ii) Calculate the current drawn from the 220 V mains supply when the heater is in 'heating' mode. (2 marks)

(iii) Find the power consumed by the heater in the mode of 'keeping warm'. (3 marks)

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(b) Figure 8.2 shows a simplified domestic circuit connected to an electrical appliance via a fuse, a meter M, a residual current circuit breaker (RCCB) and a switch.

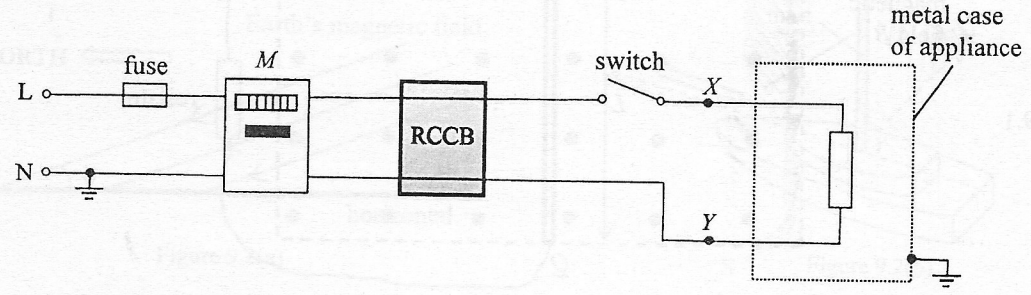

Figure 8.2

(i) What physical quantity does the meter M record ? (1 mark)

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(ii) An RCCB is a kind of safety device that cuts off the supply automatically whenever there is a small difference between the currents in the live (L) and neutral (N) wires. State, in each of the following situations, which device(s) will respond (i.e. the fuse blows and/or the RCCB cuts off the supply).

(1) A short circuit occurs between points X and Y. (1 mark)

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(2) A short circuit occurs between point Y and the metal case of the appliance. (1 mark)

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9. (a)

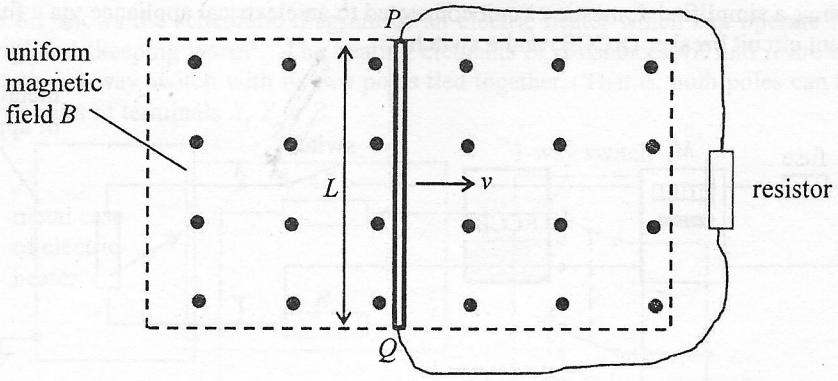

Figure 9.1

Figure 9.1 shows a metal rod PQ of length L moving with constant velocity v across a uniform magnetic field B pointing out of the paper. An e.m.f. ξ is induced across rod PQ as it cuts the field lines. When the rod is connected to a resistor outside the field, a current I flows in the circuit.

(i) Indicate the direction of I in Figure 9.1. (1 mark)

(ii) Explain why an external force F is required to maintain the uniform motion of rod PQ. Find F in terms of the physical quantities given. (3 marks)

(iii) This set-up works as a generator. By considering the mechanical power input by external force F to the set-up, show that $\xi = BLv$. (2 marks)

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(b) At a certain place the Earth's magnetic field runs along the S-N direction such that the field lines make an angle θ with the horizontal as shown in Figure 9.2(a).

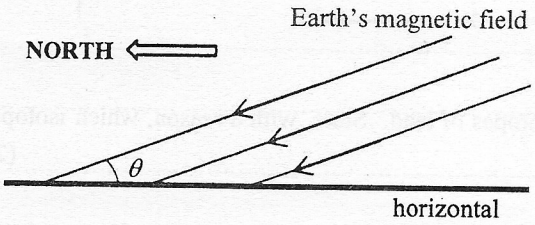

Figure 9.2(a)

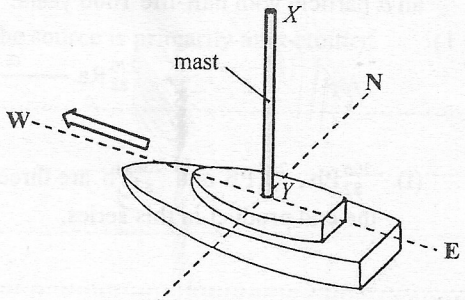

Figure 9.2(b)

A ship with a vertical aluminium mast sails at sea along a straight course to the west as shown in Figure 9.2(b). As a result, an e.m.f. is induced across the mast XY.

(i) Explain why it is **only the horizontal component** of the Earth's magnetic field that is cut by the mast which gives rise to this induced e.m.f. (1 mark)

(ii) Given: length of mast $XY = 20$ m
speed of the ship $= 6\ m\ s^{-1}$
Earth's magnetic field $= 50\ \mu T$
$\theta = 30°$

Referring to (a)(iii), calculate the e.m.f. induced across XY and state whether the distribution of free electrons along the mast is more at end X, more at end Y or uniform along XY. (3 marks)

(iii) Suppose X and Y are connected by a cable running side-by-side with the mast so that they form a complete circuit. Explain whether there will be a current passing through it. (2 marks)

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10. (a) Part of the decay series of radium-226 (Ra-226) is shown below. Ra-226 decays to radon (Rn) by emitting an α particle with half-life 1600 years. The end product in the series is lead (Pb), which is stable.

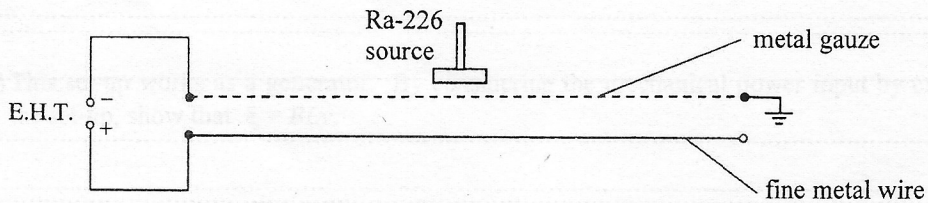
$$^{226}_{88}\text{Ra} \xrightarrow{\alpha} \text{Rn} \longrightarrow \cdots \longrightarrow \text{Pb}$$

(i) $^{206}_{82}\text{Pb}$, $^{207}_{82}\text{Pb}$ and $^{208}_{82}\text{Pb}$ are three stable isotopes of lead. State, with a reason, which isotope can be the end product in this series. (2 marks)

*(ii) In a certain laboratory, a Ra-226 source has been used for 50 years. Estimate the percentage of undecayed Ra-226 left after this period. (2 marks)

(b) Spark counters can show the ionizing power of radiations. Figure 10.1 indicates the main features of a type of spark counters in school laboratories.

Figure 10.1



A spark counter consists of a fine metal wire mounted a few mm beneath an earthed metal gauze. The wire is connected to the positive terminal of an E.H.T. (Extra High Tension) supply so that a very intense electric field is set up between the wire and the metal gauze. When a Ra-226 source is brought near the gauze, sparks giving out flashes of light and crackling sound are produced at irregular intervals.

(i) Explain why the sparks occur at **irregular** intervals. (1 mark)

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A Ra-226 source used in school laboratories is usually said to emit α, β as well as γ radiations.

(ii) Explain why β radiation is also emitted even though the source is primarily an α-emitter. (1 mark)

(iii) Why is the sparking mainly caused by α radiation rather than β or γ radiation ? Suggest a simple way to verify this. (2 marks)

END OF PAPER

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

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