2021-DSE
PHY
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2021

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	9
3	11
4	8
5	9
6	14
7	10
8	10
9	5

* 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. A 150 W immersion heater is used to keep the water in a large beaker boiling under standard atmospheric pressure. In 5 minutes, 16 g of water boils away. Neglect any heat loss to surroundings.

(a) Find the specific latent heat of vaporization of water, l. (2 marks)

A student puts a small metal sphere in the boiling water. After a few minutes, the sphere is quickly transferred to a polystyrene cup containing 100 g of water at a temperature of 20 °C. The cup of water is stirred gently and its highest temperature attained is 22 °C.
Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

(b) Estimate the heat capacity C of the metal sphere. (2 marks)

(c) In fact the sphere has carried with it some boiling water to the cup of water. Referring to this fact, explain whether the true value of C is higher or lower than the value calculated in (b). (2 marks)

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(d) In order to reduce the error contributed by the polystyrene cup, another student suggests repeating the measurements using a copper cup of similar shape and size. Explain whether the suggestion is justified.
(2 marks)

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2. A diver makes a sound by tapping a metal cylinder at sea level. Within a time of 0.04 s, the sound goes vertically to the seabed 30 m below and echoes back to the sea level.

(a) Estimate the speed of sound in sea water. (2 marks)

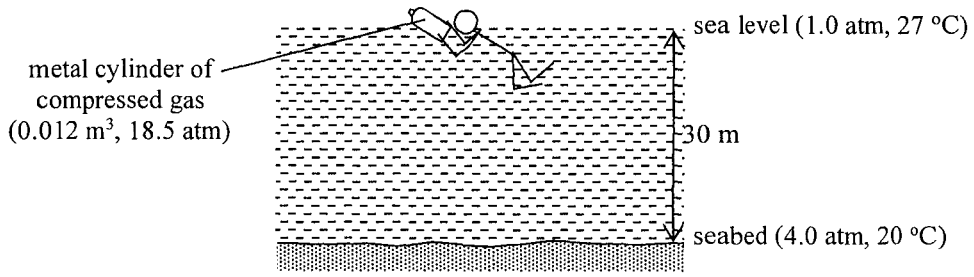

Figure 2.1

The metal cylinder of volume 0.012 m^3 contains compressed gas under a pressure of 18.5 atm is initially at sea level, where the pressure is 1.0 atm and the temperature is 27 °C. The diver then brings the cylinder to the seabed where the pressure is 4.0 atm and the temperature is 20 °C. Assume that the volume of the cylinder remains unchanged. Given: atmospheric pressure 1.0 atm = 1.01×10^5 Pa

*(b)(i) Show that at the seabed the pressure in the cylinder becomes 18.1 atm. (1 mark)

(ii) Explain the pressure drop in the cylinder using the kinetic theory. (2 marks)

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*(c) The diver then inflates identical balloons each to a volume of 0.015 m^3 by using the cylinder of compressed gas at the seabed. Assume that the balloons are inflated slowly so that the temperature of the gas remains unchanged and the final pressure in the balloon equals that at the seabed.

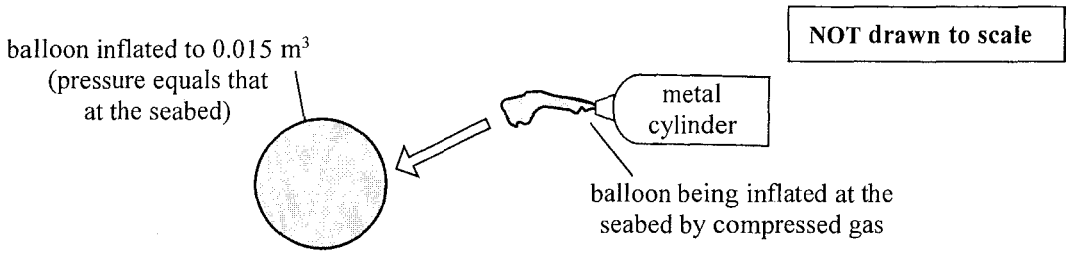

Figure 2.2

(i) Show that the gas pressure in the cylinder decreases by 5.0 atm after inflating one balloon. (2 marks)

(ii) Hence, find the total number of balloons that the diver can inflate completely. (2 marks)

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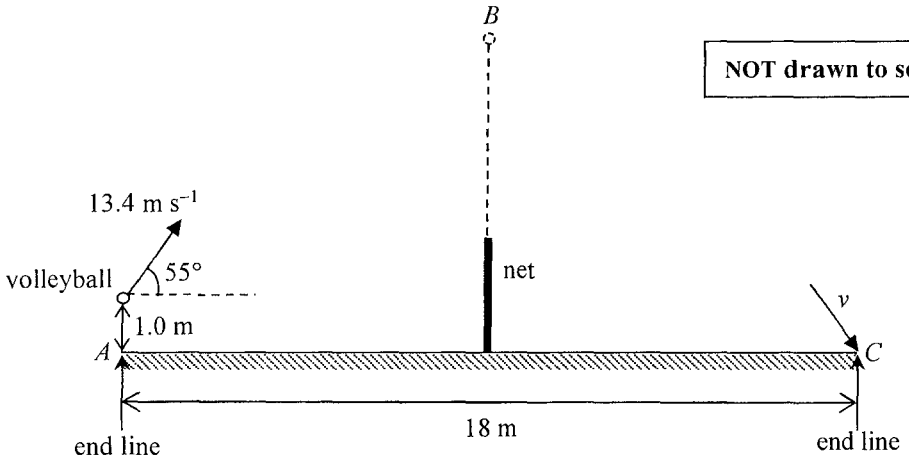
3. A volleyball player serves by hitting the ball from rest at a height of 1.0 m above the end line of the court. The initial speed of the ball is 13.4 m s^{-1} making an angle of 55° with the horizontal. It moves in a vertical plane perpendicular to the end line and finally reaches point C on the opposite end line as shown in Figure 3.1. Neglect the size of the ball and air resistance. (g = 9.81 m s^{-2})

Figure 3.1



(a) (i) The mass of the volleyball is 0.22 kg. Find the work done on the ball by the player. (2 marks)

(ii) Determine the speed v with which the ball hits point C on the ground. (2 marks)

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(b) The length of the court AC is 18 m and the net is positioned midway between A and C. It takes time t for the ball to reach point B which is vertically above the net.

(i) State whether the ball is ascending, flying horizontally or descending at B. (1 mark)

(ii) Find t. (2 marks)

(c) Another player suggests that the volleyball can reach point C in a shorter time if it is served with a similar initial speed but at a smaller angle with the horizontal (e.g. 13.2 m s^{-1} at an angle of 35°). Without doing any calculation, explain whether this suggestion is justified. (2 marks)

(d) Volleyball players have to jump and land frequently in a game. Referring to principles of mechanics, explain why volleyball courts with wood rather than concrete flooring may help to protect the players from injuries. (2 marks)

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4. A trolley is connected to a hanger of mass 20 g by a light inextensible string as shown in Figure 4.1. Four slotted weights, each of mass 20 g, are loaded onto the trolley. The experiment is designed to investigate the relationship between the net force acting on the system (trolley and slotted weights with hanger) and its acceleration. The acceleration a is measured after the trolley is released on the smooth horizontal runway.

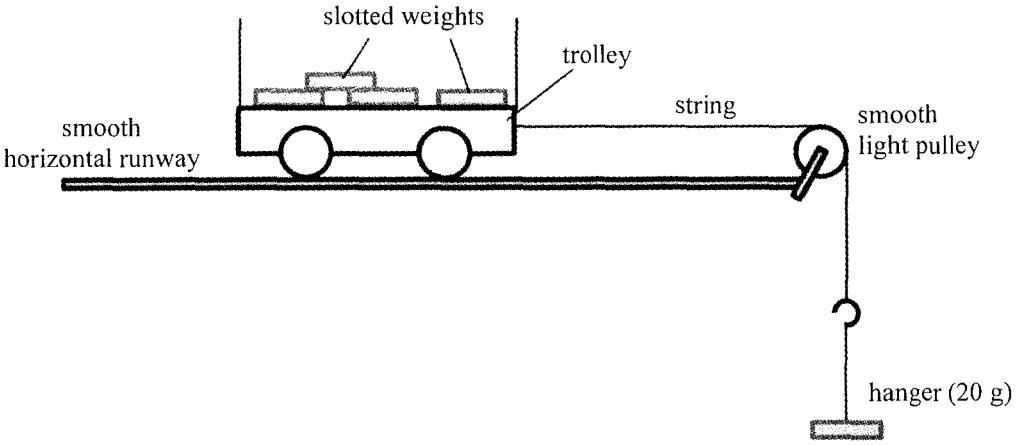
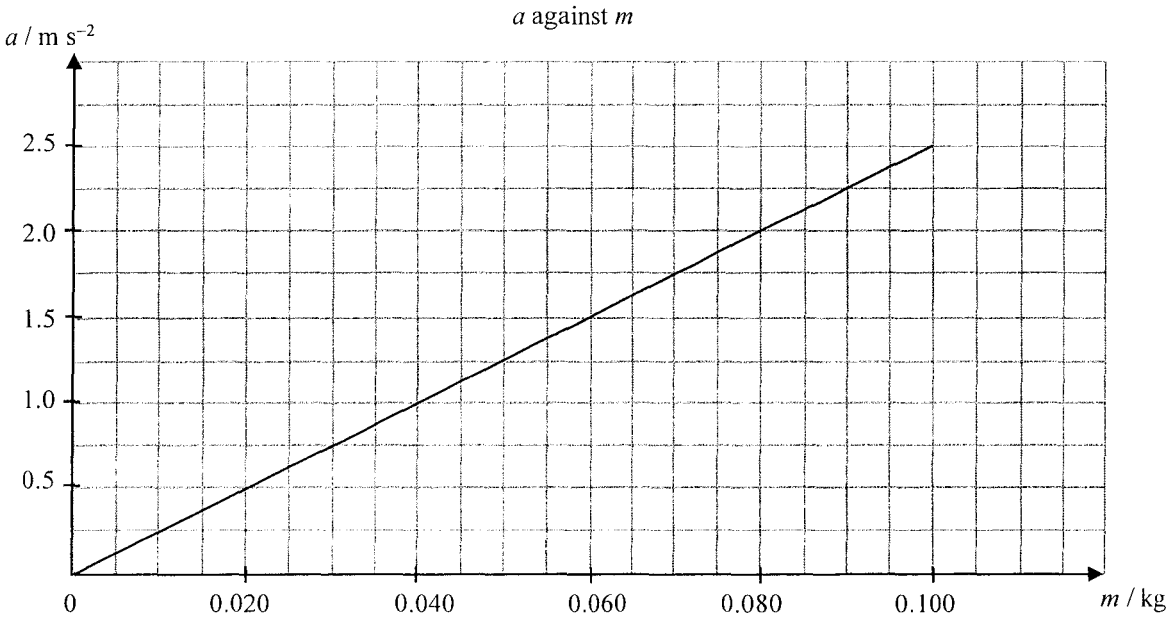


Figure 4.1

The experiment is repeated by transferring the slotted weights one by one from the trolley to the hanger so as to increase the mass hanging, m.

no. of weights transferred to the hanger	0	1	2	3	4
mass hanging m / kg	0.020	0.040	0.060	0.080	0.100

The results obtained are used for plotting a graph of a against m as shown below. Neglect both air resistance and the frictional forces acting on the trolley. ($g = 9.81$ m s^{-2})



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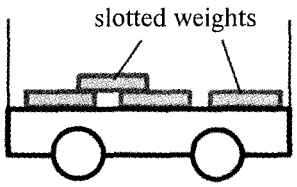
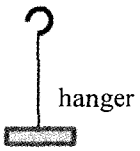
(a) (i) After the trolley is released, indicate in the figures below (1) the horizontal force(s) acting on the loaded trolley, and (2) the force(s) acting on the hanger. (2 marks)





(ii) Is the tension in the string equal to, greater than or smaller than the weight of the mass hanging when the system is released ? Explain. (2 marks)

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(iii) By considering the motion of the whole system, or otherwise, write an equation relating m, a and mass M of the trolley. (1 mark)

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(b) Calculate the slope of the graph. Hence find M using the result of (a)(iii). (3 marks)

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5. A rocket carrying an artificial satellite is launched vertically from the Earth. When the rocket is at a certain height from the Earth's surface, it expels 2.60×10^3 kg of gas per second with a certain speed v towards the Earth's centre. As a result, an average thrust of 5.20×10^6 N is produced. Neglect air resistance.

(a) (i) Assuming that the speed of the rocket is negligible, estimate v. (2 marks)

(ii) At a certain instant, the total mass of the rocket and the artificial satellite is 3.60×10^5 kg while the acceleration due to gravity at the rocket's position is 8.56 m s^{-2}. Estimate the acceleration a of the rocket at this position. (2 marks)

(iii) Suppose the rocket keeps expelling gas at the same rate for a few seconds. Would the rocket's acceleration increase, decrease or remain unchanged in that duration ? Explain. (2 marks)

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*(b) The artificial satellite is put in the geostationary orbit of radius r around the Earth. It appears to be always stationary above an observer at the equator.

(i) State the period of this satellite. (1 mark)

(ii) Show that r is approximately 42000 km. ($g = 9.81$ m s^{-2}) (2 marks)
Given: radius of the Earth = 6.37×10^6 m

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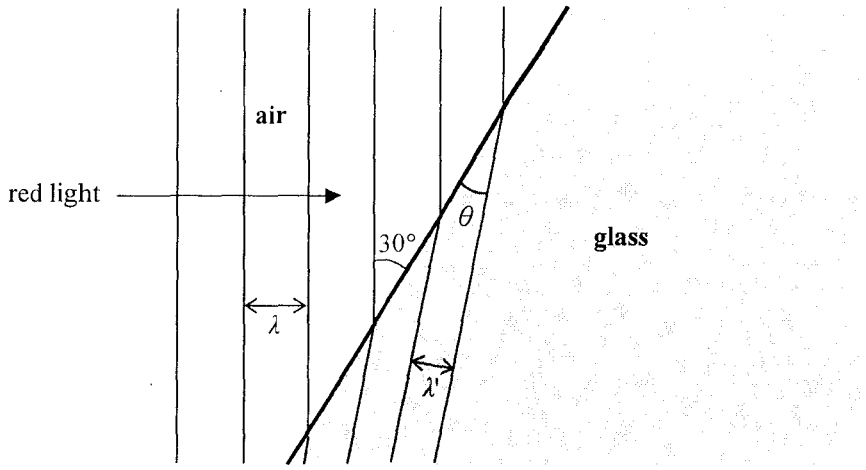
6. (a) When red light of wavelength $\lambda = 675$ nm is incident at an angle of 30° from air to glass as shown in Figure 6.1, refraction occurs such that its wavelength in glass becomes $\lambda' = 450$ nm while the angle of refraction is θ.

Figure 6.1



(i) What is the frequency of the red light in glass ? (2 marks)

(ii) Find θ. (2 marks)

(iii) If the red light is replaced by blue light, θ will decrease. Compare the refractive index of glass for the red light and blue light. (1 mark)

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6. (b) Figure 6.2 shows a system for projecting a transparent photographic slide O onto a screen. The slide and the screen are 1 m apart. A beam of white light illuminates the slide. The position of lens L is adjusted until a sharp image of O magnified linearly to 9 times is formed on the screen.

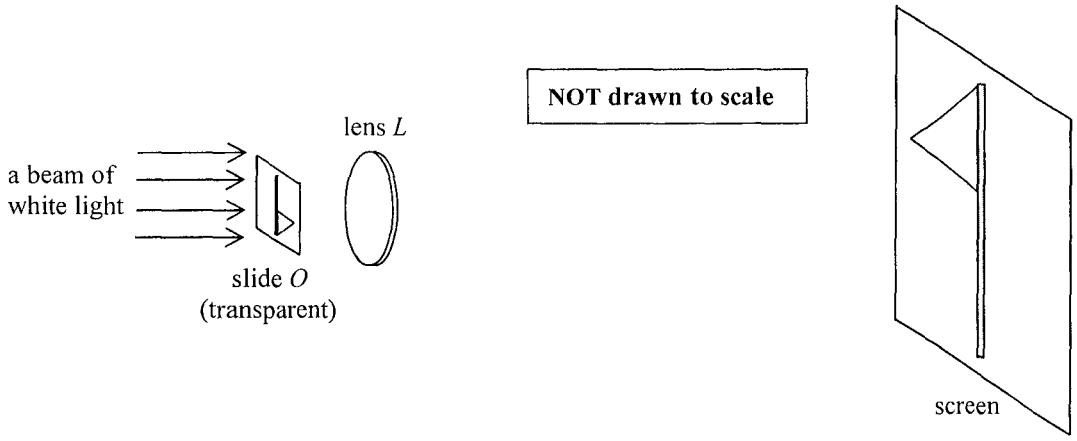
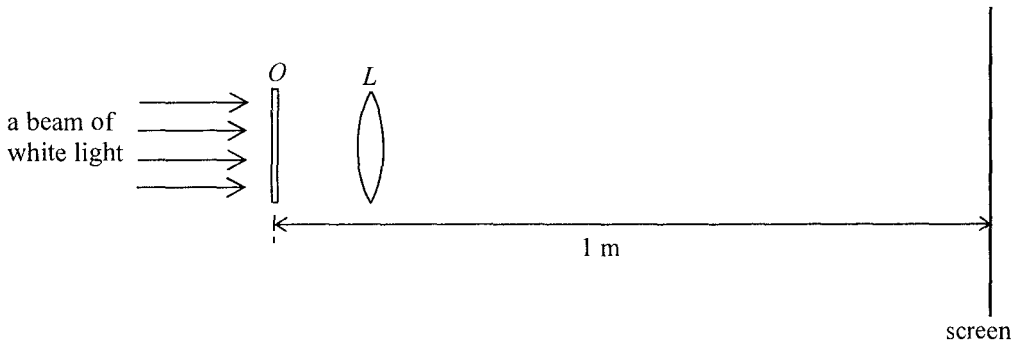


Figure 6.2



(i) State the nature of this magnified image. (1 mark)

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(ii) Find the separation between O and L. (1 mark)

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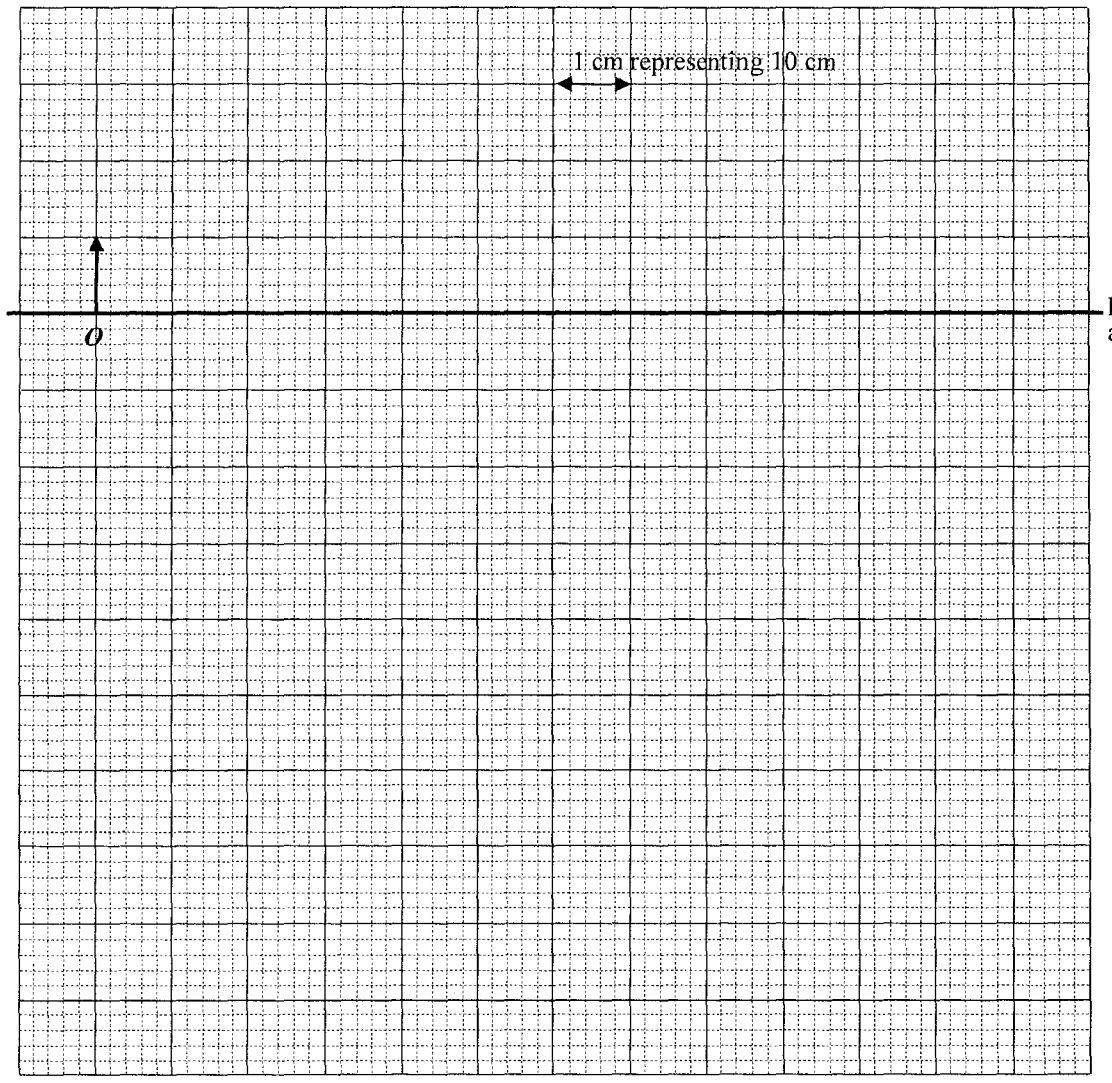
(iii) Draw a ray diagram to show how the image of slide O is formed on the screen. Locate the focus F of lens L on your diagram and find the focal length of L. (Slide O and the principal axis of the lens have been drawn for you.) (5 marks)



Focal length of L = ...

(iv) When a black-and-white slide is projected onto the screen, the image has colour edges. Explain briefly. (Hint: the lens is made of glass.) (2 marks)

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7. Read the following passage about **eddy currents** and answer the questions that follow.

> Eddy currents are induced by changing magnetic fields. They flow in closed loops in conductors like swirling eddies in a stream, perpendicular to the direction of the magnetic field. They are commonly applied in braking known as 'eddy braking'.
>
> The heating effect of eddy currents is used in induction heating devices, such as induction cookers. The resistance felt by the eddy currents in a conductor causes Joule heating. However, for applications like motors and transformers, this heat is considered as a waste of energy and as such, eddy currents need to be minimized.
>
> Eddy currents can be removed by cracks or slits in the conductor, which prevent the current loops from circulating. This means that eddy currents can be used in detecting defects in materials. The magnetic field produced by the eddy currents is measured, where a change in the field reveals the presence of an irregularity in the material.

(a) (i) In Figure 7.1, a permanent magnet with north pole facing downwards is held stationary. A metal sheet moves past the magnet (the direction of movement is not shown) and eddy currents are induced as shown. Briefly explain why eddy currents are induced and state whether the metal sheet is moving forward, backward, towards the left or towards the right. (2 marks)

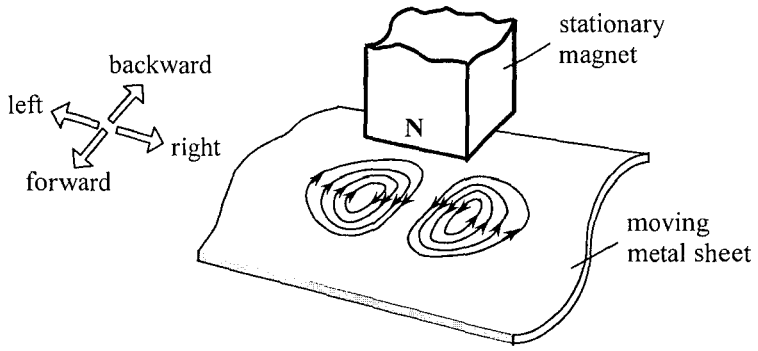

Figure 7.1

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(ii) State the energy changes in the process in which the metal sheet is slowing down to stop. (2 marks)

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(iii) Although eddy braking has the advantage of being contactless, traditional frictional braking cannot be totally replaced by eddy braking. Why ? (1 mark)

(b) An induction cooker of rating '220 V, 2000 W' operates for 15 minutes. How much should be paid if 1 kW h of electrical energy costs $1.1 ? (2 marks)

(c) State a method to minimize eddy currents produced in the iron cores of motors and transformers. (1 mark)

(d) Eddy currents can be used to detect defects in materials. When there is a crack in a material, how would the magnetic field due to eddy currents change ? Explain briefly. (2 marks)

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Figure 8.1

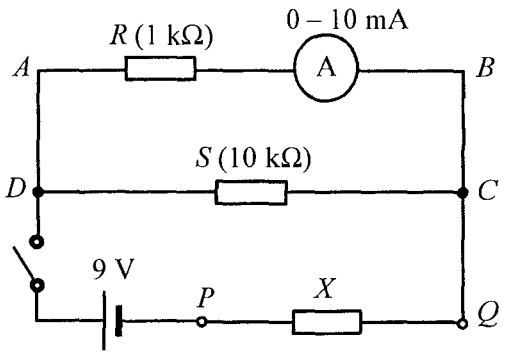

Figure 8.1 shows a circuit for measuring the resistance of resistor X connected across P and Q. The resistance of resistor S is 10 kΩ. The internal resistance of the 9 V cell and that of the ammeter are negligible.

(a) When the switch is closed, the ammeter reads 8.5 mA.

(i) What is the p.d. between A and B ? (2 marks)

(ii) Find the current passing through resistor S. (2 marks)

(iii) Indicate on Figure 8.1 the direction of current in each of the three branches via C. (2 marks)

(iv) Deduce the p.d. across resistor X. Hence, find the resistance of X. (3 marks)

(b) State the purpose of connecting resistor R in series with the ammeter. (1 mark)

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9. Potassium-40 ($^{40}_{19}K$) is a natural radioisotope of potassium.

(a) (i) What kind of decay does $^{40}_{19}K$ undergo if it decays to $^{40}_{20}Ca$? (1 mark)

(ii) As banana is rich in potassium, a student claims that the radiation emitted by $^{40}_{19}K$ after eating a few bananas can be detected outside the human body. Explain whether this claim is justified. (1 mark)

*(b) A banana typically contains 0.45 g potassium in which 0.012% by mass is $^{40}_{19}K$ while the rest is $^{39}_{19}K$.

Given: half-life of $^{40}_{19}K = 1.25 \times 10^9$ years
1 year = 3.16×10^7 seconds
molar mass of $^{40}_{19}K = 40.0$ g

(i) Estimate the number of moles of $^{40}_{19}K$ in a banana. (1 mark)

(ii) Deduce the activity, in Bq, of a banana. (2 marks)

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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