2014-15 MOCK
F.6 PHY
PAPER 1B

B

TWGHs Wong Fut Nam College
Mock Examination 2014-15

PHYSICS PAPER 1
Section B: Question-Answer Book B

8:30 am – 11:00 am (2 hours 30 minutes)
2 Feb 2015 (MON)

This paper must be answered in English

Setter: Leung Shu Kei

INSTRUCTIONS FOR SECTION B

(1) After the announcement of the start of the examination, you should first write down the information required in the spaces provided on the cover.

(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 class number and mark the question number box on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(6) No extra time will be given to candidates for filling in the question number boxes after the 'Time is up' announcement.

Student Name				
Class No.	6			

Question No.	Marks	
1		
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Script Total		

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

Question No.	1	2	3	4	5	6	7	8	9	10	11	Total
Marks	9	9	7	8	8	8	8	6	8	7	6	84

1. (a) Figure 1.1 shows electric heater mounted in the bottom of a water tank for heating up the water.

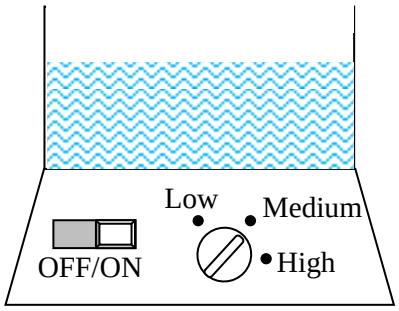

Figure 1.1

(i) Explain why the heater should be mounted at the bottom of the water tank. (1 mark)

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(ii) Given that the specific heat capacity of water is 4200 J kg^{-1} $^oC^{-1}$

the specific latent heat of vaporization of water is 2.26×10^6 J kg^{-1}

When the heater is switched to "Medium" power mode, it takes 10 minutes to heat up the water in the tank from 20 ^{o}C to 100 ^{o}C and then another 5 minutes to boil off 0.2 kg of water. Assume that the heat lost to the surroundings is negligible. Find

(1) the power of the heater in "Medium" power mode, and (2 marks)

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(2) the initial amount of water inside the tank. (2 marks)

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(b) The structure of the heater is shown in Figure 1.2. It consists of three identical heating elements of resistance 20 Ω each and a switch S. Neglect the resistance due to other parts in the circuit.

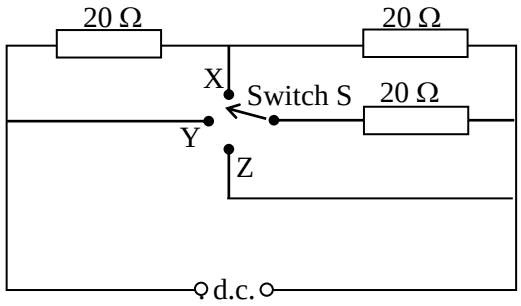

Figure 1.2

When it is operating in "Medium" mode, switch S is connected to terminal X.

(i) Find the total resistance of the heater at "Medium" mode. (1 mark)

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(ii) Find the **operating current of the heater** when it is in "Medium" mode. (2 marks)

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(iii) Should the switch S be connected to terminal X, Y, or Z when the heater is operating at "High" power mode? (1 mark)

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2. An air balloon is shown in Figure 2.1 below. The envelope of the air balloon is made from inextensible material such that its volume remains constant throughout the whole journey. The temperature and the pressure of the air inside the envelope are 87 ^{o}C and 100 kPa respectively when it is at the sea level.

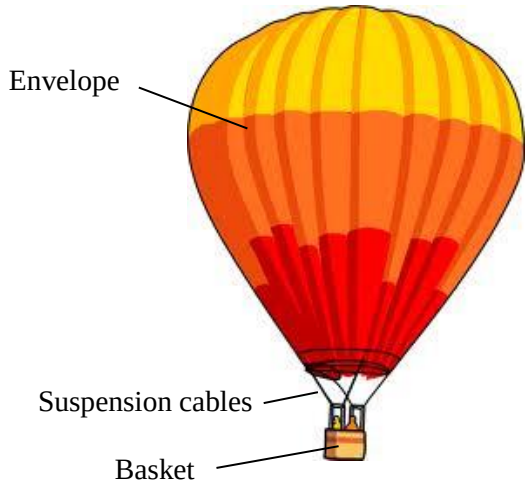

Figure 2.1

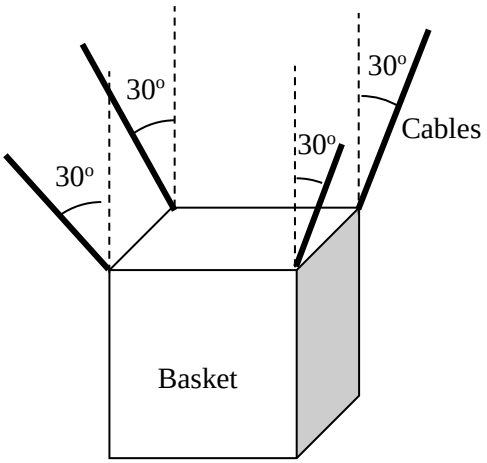

Figure 2.2

Then the air balloon rises up vertically, the temperature and pressure of the air inside the envelope becomes 47 ^{o}C and 80 kPa respectively.

*(a) (i) By using the ideal gas equation PV = nRT, find the percentage of air molecule remain in the envelope? (3 marks)

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*(ii) Use kinetic theory of an ideal gas to explain why the pressure of the gas inside the envelope decreases after the air balloon rises up vertically. (3 marks)

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(b) The basket is suspended symmetrically by four identical cables at an angle of 30^{o} with vertical as shown in Figure 2.2. The total mass of the passengers and the basket is 800 kg and the acceleration of the air balloon is 0.5 m s^{-2} throughout the whole journey.

Find the tension in each suspension cable. (3 marks)

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3. A bullet of mass 0.02 kg is fired horizontally from a toy gun as shown in Figure 3.1. It is embedded into a lump of plasticine on a stationary trolley resting on a smooth table. The trolley and the plasticine have a total mass of 1 kg. The trolley then moves a maximum distance of 5 cm up a smooth inclined plane.

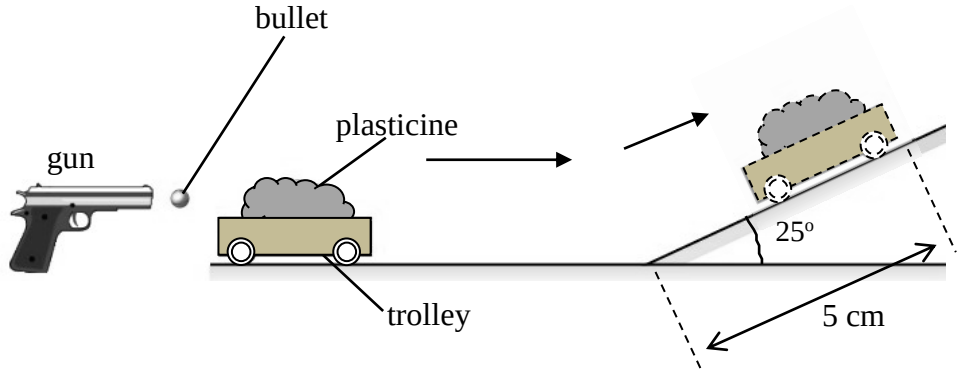

Figure 3.1

(a) Find the speed of the trolley immediately after the bullet is embedded. (2 marks)

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(b) Find the speed of the bullet immediately before hitting the plasticine. (2 marks)

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(c) Describe the energy changes of the throughout the whole motion. (2 marks)

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(d) How does the maximum vertical height reached by the trolley change if the inclination of the smooth inclined plane doubled. (1 mark)

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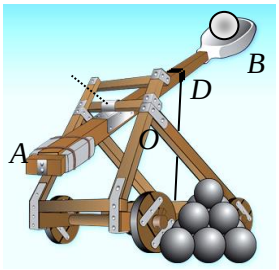
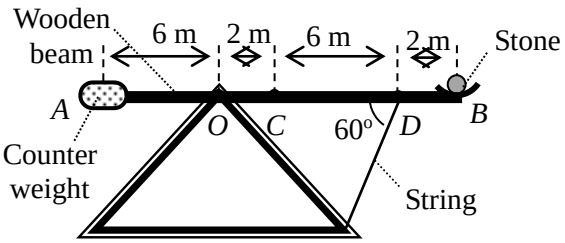
4. An ancient troop attacks a castle by projecting stones with trebuchet.

A simplified diagram showing the structure of the trebuchet is shown in figure 4.1.

Figure 4.1a





A rigid wooden beam is pivoted at point *O* and a heavy counterweight is fixed at the end *A* of the beam. A stone is placed at the other end *B* of the beam and the beam is held horizontally by a string tied at point *D*. The centre of mass of the beam is located at point *C*.

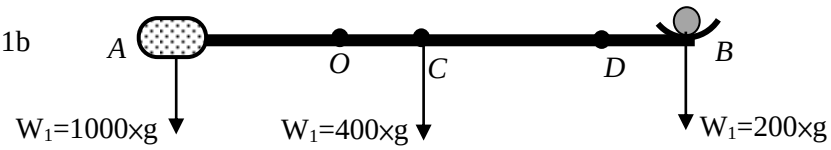
Given that the mass of the counterweight is 1000 kg

the mass of the beam is 400 kg

the mass of the stone is 200 kg

(a) (i) Complete Figure 4.1b below to show all the forces acting on the wooden beam. (1 mark)

Figure 4.1b



(ii) Find the tension in the string. (3 marks)

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*(b) When the string is cut, the stone will be thrown out from the trebuchet at point E which is 10 m from the ground as shown in Figure 4.2. The initial velocity of the stone is 40 m s^{-1} at an angle of inclination of 30° from horizontal.

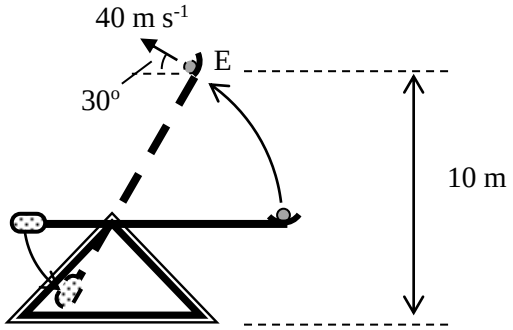

Figure 4.2

*(i) Find the time required for the stone to reach the wall of the castle which is at a horizontal distance of 100 m away from point E. (1 marks)

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*(ii) The height of the wall is 20 m. Determine whether the stone will pass over the wall of the castle. Show your calculations (3 marks)

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5. As shown in Figure 5.1, one end of the string is fixed by a clamp at P and the other end is fixed on a vibrator at Q. The vibrator is connected to a signal generator and the length of the string is 2 m. The motion of the point Q due to the vibrator is very small and can be regarded to be at rest all the time.

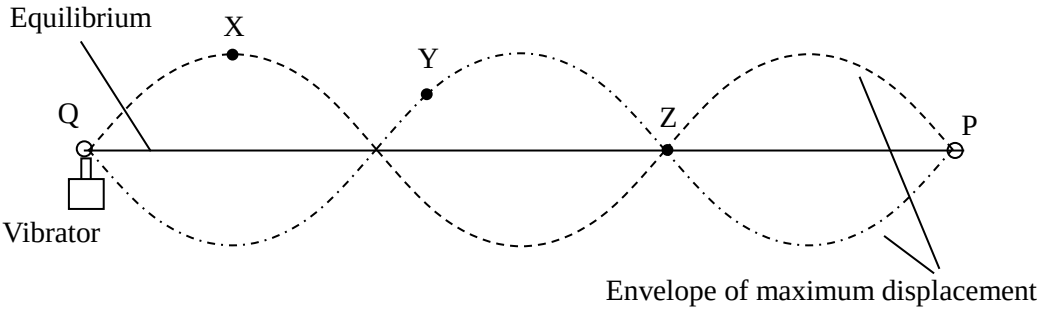

Figure 5.1

(a) (i) Name the wave formed in Figure 5.1. (1 mark)

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(ii) The frequency of the vibrator is set to be 60 Hz. Find the wavelength and the velocity of the wave travelled on the string in Figure 5.1. (2 mark)

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(iii) The motion of particle X on the string is recorded in the displacement-time graph shown in Figure 5.2. Sketch and label on Figure 5.2 to show the motion of particles Y and Z.

(2 marks)

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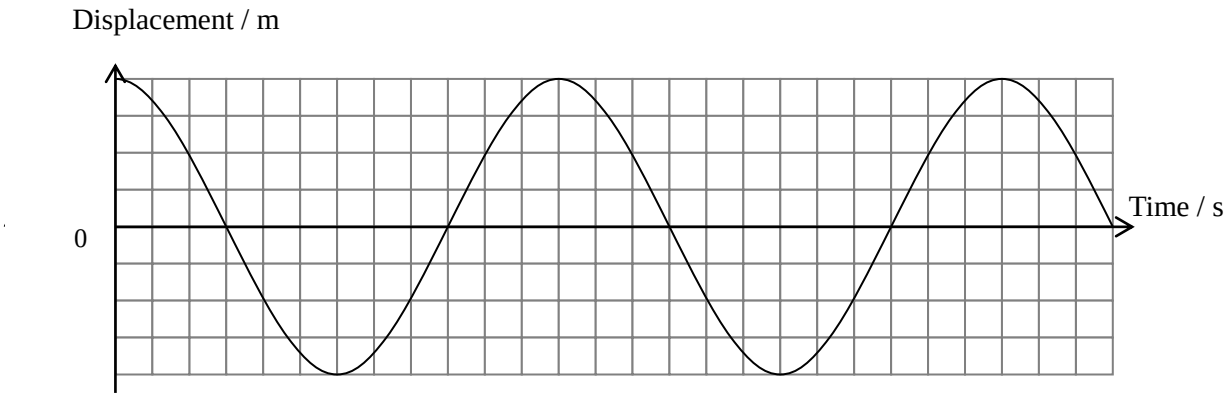

Figure 5.2

(b) State TWO differences between the wave on the string shown in Figure 5.1 and the sound wave produced by the string. (2 marks)

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(c) Sketch on Figure 5.3 below to show the new envelope of maximum displacement if the frequency of the vibrator is changed to 20 Hz. (1 mark)

Figure 5.3

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6. Mr. Leung planned to buy a mini video projector as shown in Figure 6.1 to project videos or digital images on a screen. An LCD, fixed inside the projector, acts as a luminous light source which is placed behind a lens system. The lens system can be regarded as a single lens and the position of this lens can be adjusted. The light rays passing through the lens are then projected on a screen.

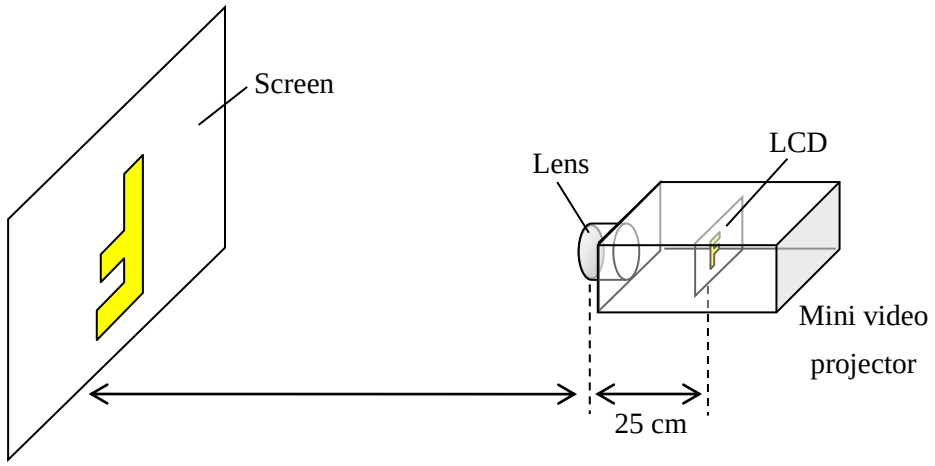

Figure 6.1

(a) What kind of lens is used in the video projector? Explain your answer. (2 marks)

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(b) In the default setting of the video projector, the distance between the LCD and the lens is assumed to be 25 cm and the clear image formed on the screen has a linear magnification of 4.

(i) What should be the distance between the screen and the lens in order to project a clear image onto the screen? (1 mark)

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(ii) Complete the ray diagram in Figure 6.2 to show the image formed on the screen and to show the path of light rays *p*, *q* and *r*, travel through the lens. (4 marks)

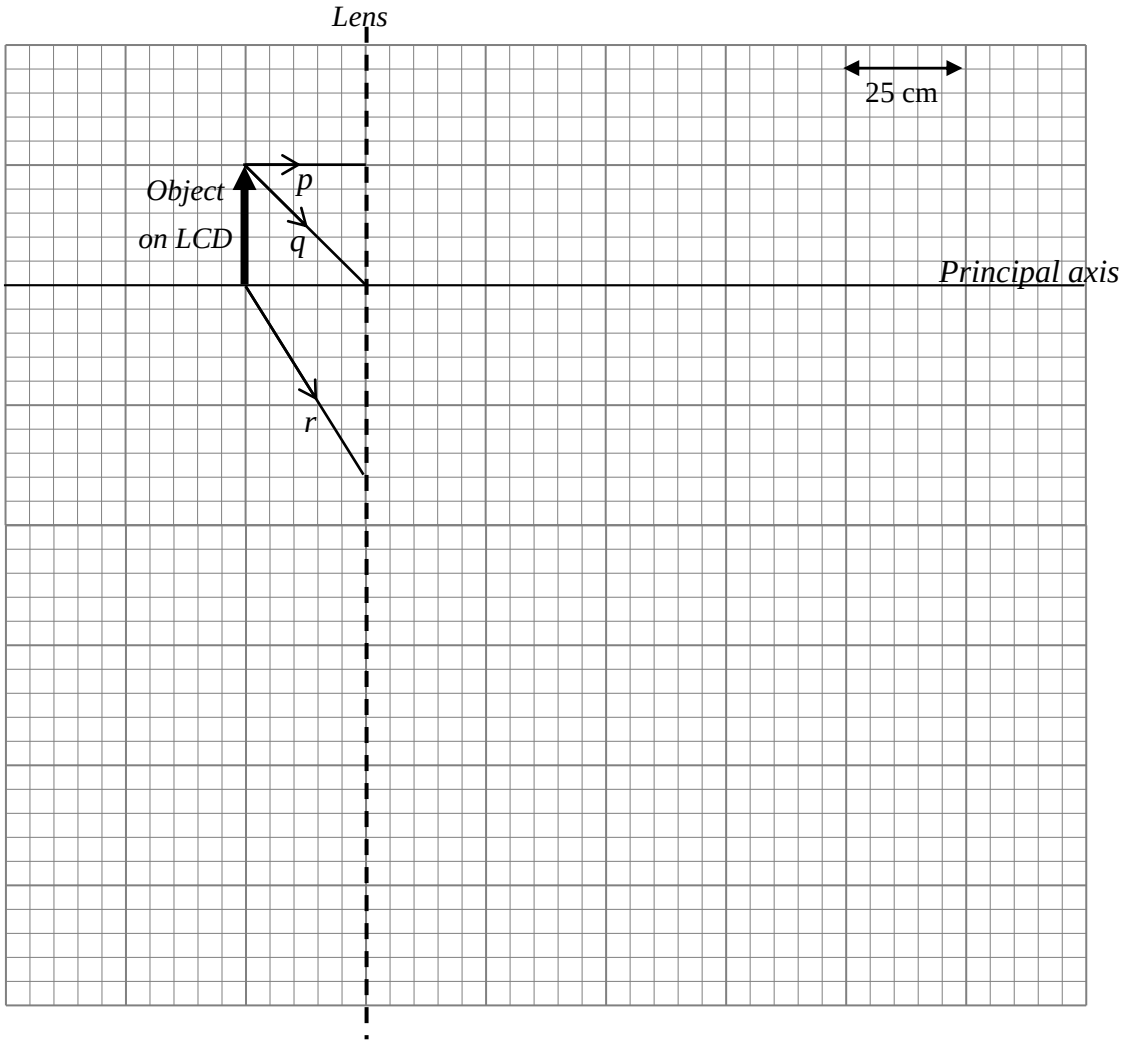

Figure 6.2

(iii) Find the focal length of the lens from the ray diagram. (1 mark)

focal length = …… cm

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7. (a) You are given a signal generator, two identical loudspeakers, a microphone and a CRO.

With the aid of a diagram, describe how to demonstrate the interference of sound.

State and explain the observations (5 marks)

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(b) Given that the speed of sound in air is 340 m s^{-1} and the frequency of the sound produced is about 300 Hz. Suggest a suitable value for the separation of the two loudspeakers. (1 mark)

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(c) Describe what would be observed if the experiment in part (a) is repeated with

(i) the frequency of the signal generator being doubled. (1 mark)

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(ii) the sounds produced by the two loudspeakers are in anti-phase. (1 mark)

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8. A charged tiny sphere of mass **m** carries – 0.02 mC of negative charge on it is hung by an insulating thread in a region of uniform electric field produced by a pair of parallel plates charged by an EHT as shown in Figure 8.1.

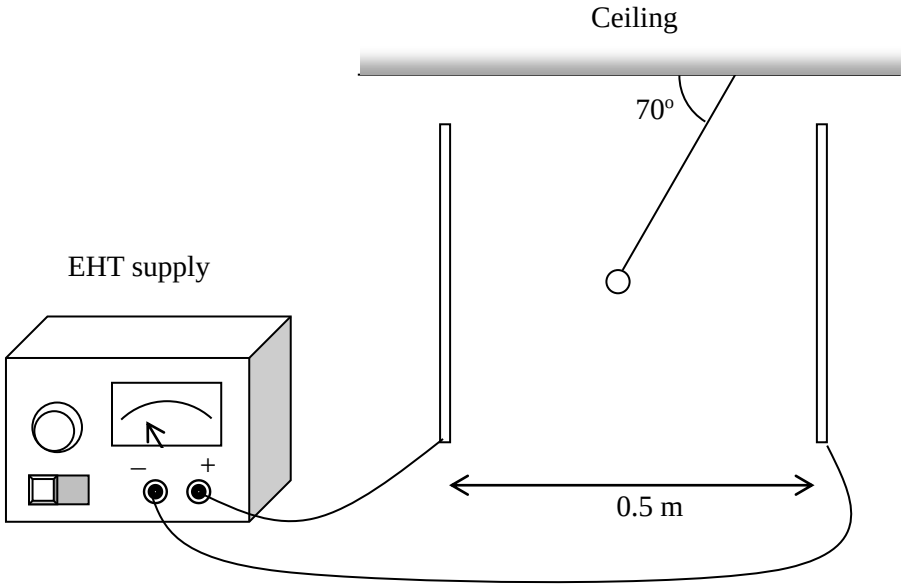

Figure 8.1

The potential difference between the two plates is 4 kV and the separation between the plates is 0.5 m. The angle between the thread and the ceiling is 70° when the charged sphere is at rest.

(a) Sketch and label on Figure 8.1 to show all the forces acting on the charged sphere. (2 marks)

(b) Find (i) the electric field strength in the region between the plates and hence, (1 mark)

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(ii) the mass of the sphere. (3 marks)

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9. Two smooth conducting parallel rails are placed in a region of uniform magnetic field and connected to a battery via a switch and a resistor. The separation between the rails is 0.4 m. An aluminium rod PQ is laid across the rails inside a uniform magnetic field of magnetic field strength of 0.6 T. The aluminium rod is connected to a 0.02 kg weight hanging below a smooth pulley by a light thread as shown in Figure 9.1a and 9.1b. When the switch is closed, a current flow through the rails and the aluminium rod and the whole system is kept at rest by the magnetic force acting on the alumimium rod.

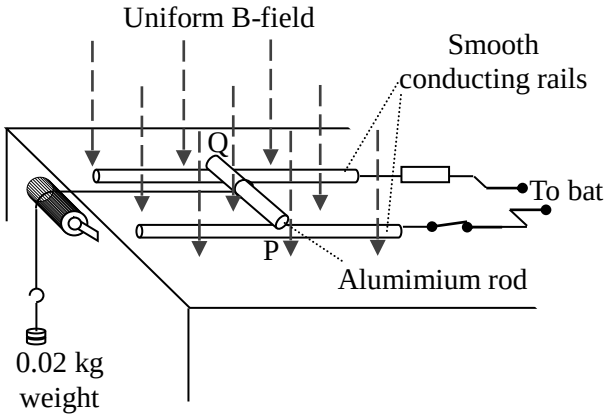

Figure 9.1a

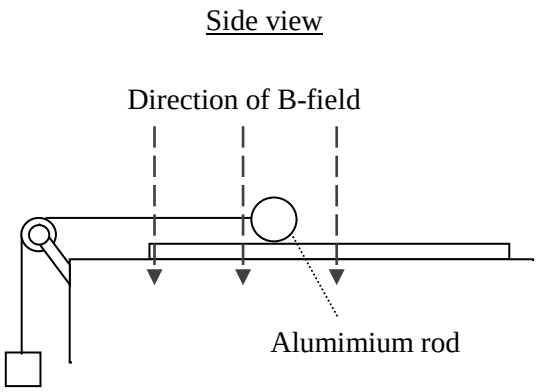

Figure 9.1b

(a) (i) Draw on Figure 9.1b to show the direction of current flow in the aluminium rod. (1 mark)

(ii) Calculate the value of the current flowing through the aluminium rod. (2 marks)

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(b) The battery is now replaced by a lamp bulb as shown in Figure 9.2

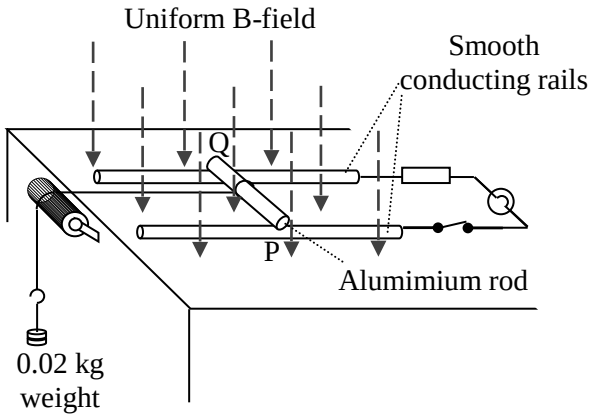

Figure 9.2

The weight falls when the switch is closed and the alumimium rod slides on the rails.

(i) Find the induced e.m.f. in the alumimium rod at the instant when the weight is falling with a velocity of 1.2 m s^{-1}. (2 marks)

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(ii) Which ends, P or Q, of the alumimium rod is now at a higher potential? (1 mark)

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(iii) Describe the change in brightness of the bulb if the weight falls faster and faster. Explain your answer briefly by the Faraday's law of electromagnetic induction. (2 marks)

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Figure 10.1 shows the structure of a bicycle speedometer.

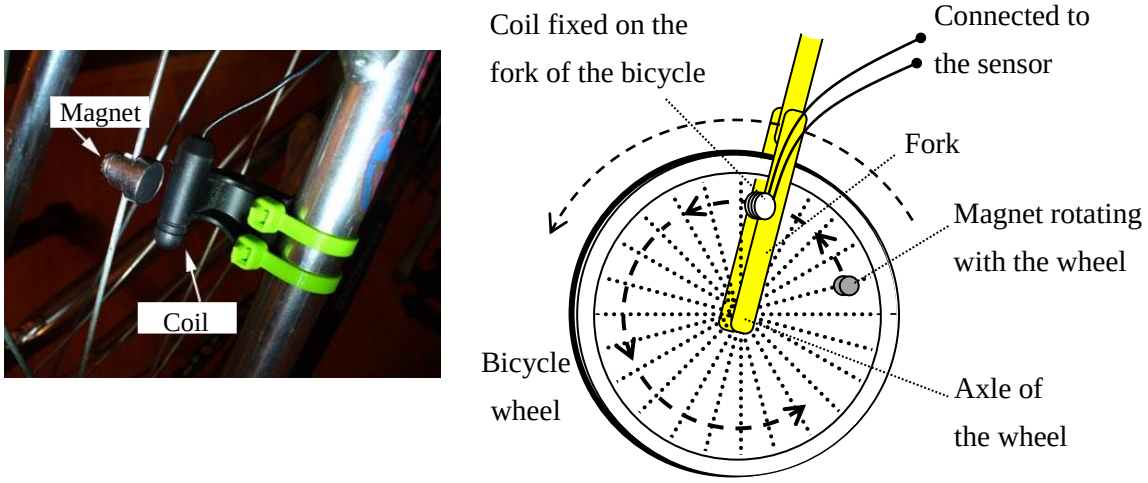

Figure 10.1

The bicycle is now moving with a constant velocity. The induced e.m.f. produced by the coil is read by the sensor and recorded in Figure 10.2.

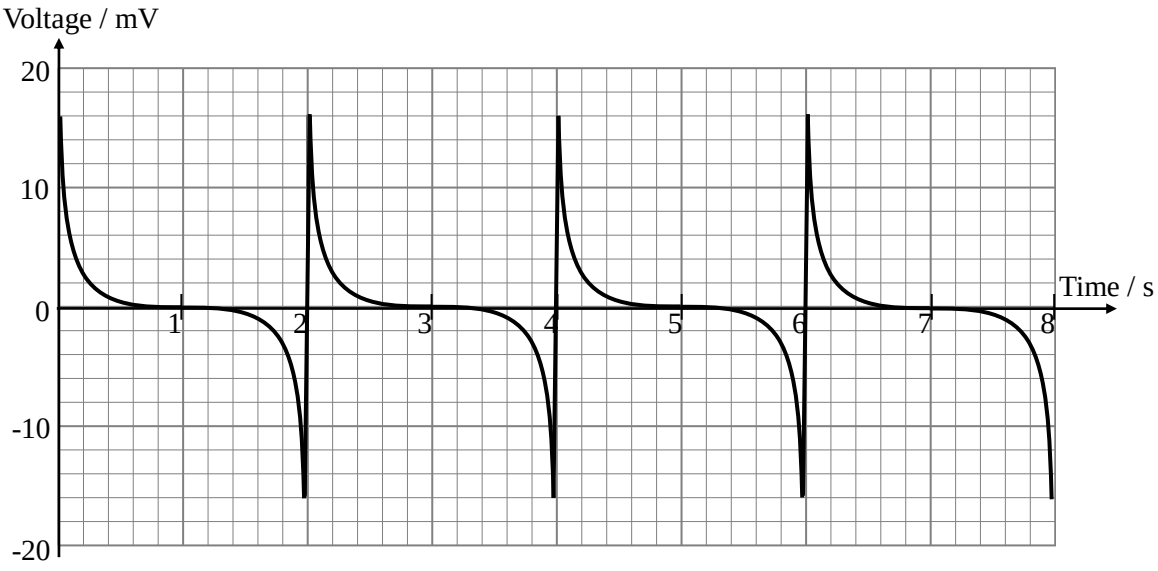

Figure 10.2

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*(a) Explain how the induced e.m.f. as shown in Figure 10.2 is produced. (3 marks)

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*(b) Estimate the angular speed of the wheel. (2 marks)

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(c) Sketch on Figure 10.2 to show the induced e.m.f. recorded if now the velocity of the bicycle is halved. (2 marks)

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10. The radiation emitted by the radioactive source ionizes the molecules of the air in the smoke detector to form ions and electrons which are attracted to a pair of charged plates as shown in Figure 11.1. When the ions and electrons hit the plates they provide a small amount of electricity (a small current). This current stays constant and is monitored by the smoke alarm.

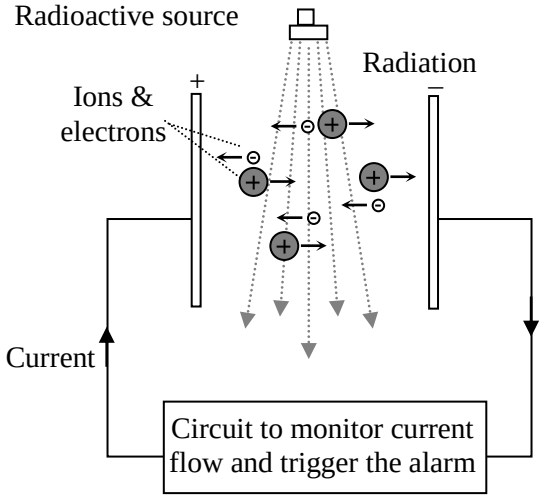

Figure 11.1

When smoke enters the smoke detector, the smoke particles near to the radioactive source absorb most of the radiation before they can ionize the air between the charged plates as shown in Figure 11.2. The number of ions and electrons between the charged plates therefore decreases and so the current which is passed between the charged plates also decreases. The smoke detector notices the decrease in current and sets off the alarm.

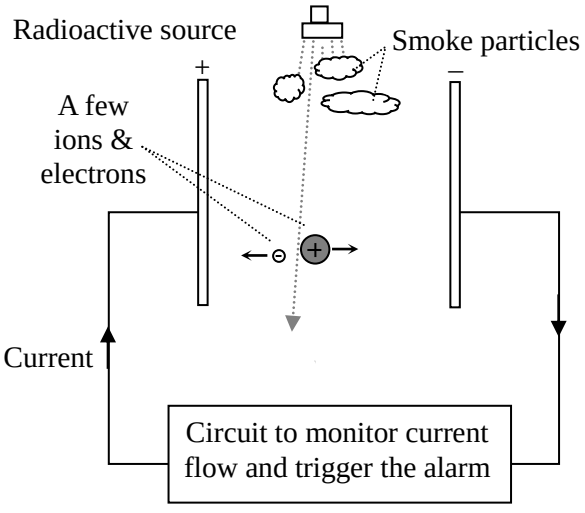

Figure 11.2

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Americium-241, an alpha emitter, has a half-life of 432 years is used as the radioactive source.

(a) Even with the radioactive source in it, it is still fine to mount the above smoke detector on the ceiling of a house. Explain briefly. (1 mark)

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(b) State TWO reasons to explain why Americium-241 is chosen to be used as the radioactive source in the smoke detector as mentioned above. (2 marks)

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*(c) For safety measures, the activity of the source should not excess 40 kBq.

*(i) Find the decay constant of the Americium-241. (take 1 year = 365days) (1 mark)

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*(ii) Estimate the maximum number of Americium-241 in the source. (2 marks)

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