RIVER VALLEY HIGH SCHOOL
YEAR 6 PRELIMINARY EXAMINATIONS II

H1 PHYSICS 8866

PAPER 2

15 SEPTEMBER 2016

2 HOURS

CANDIDATE NAME	

CENTRE NUMBER	S					**INDEX NUMBER**					

CLASS	6	

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, centre number, index number and class in the spaces at the top of this page and on all work you hand in.

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected where appropriate.

Candidates answer on the Question Paper.
No Additional Materials are required.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

You are advised to spend about one hour on each section.

FOR EXAMINERS' USE	
Section A	
1	**6**
2	**5**
3	**6**
4	**9**
5	**5**
6	**9**
Section B	
7	**20**
8	**20**
9	**20**
Deduction	
TOTAL	**80**

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **24** printed pages.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A (40 marks)

Answer **all** the questions in the spaces provided.

1 To estimate the frictional force acting on a truck, the driver puts his truck at the neutral gear (not stepping on the accelerator nor applying any brakes) while moving on a level road. He finds that the speed slows down from 24 km h^{-1} to 18 km h^{-1} over a distance of 10.5 m. The truck is of mass 1500 kg.

(a) **(i)** Show that the frictional force acting on the truck travelling on the level road is 1400 N.

[1]

(ii) Hence or otherwise, determine the power developed by the truck's engine when it is travelling at a constant speed of 12 m s^{-1} on the level road. The frictional force can be assumed to be constant.

power = ………………………… W [2]

(b) The truck then moves up a gentle slope of 1.0 ° as shown in Fig. 1.1. The frictional force acting on the truck along the slope is 800 N.

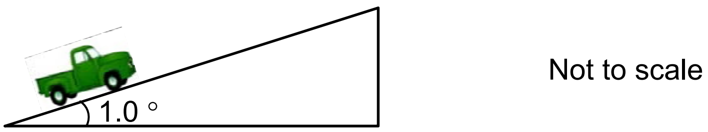


Fig. 1.1

Applying the same power from the engine as **(a)(ii)**, determine the maximum speed that the truck can attain up the slope.

speed = ………………………… m s^{-1} [3]

[Turn over

2 An air-rifle pellet of mass 2.0 g travels horizontally towards a stationary clay block of mass 56 g. The pellet reaches the block with a speed of 140 m s^{-1} and remains in the block after the collision.

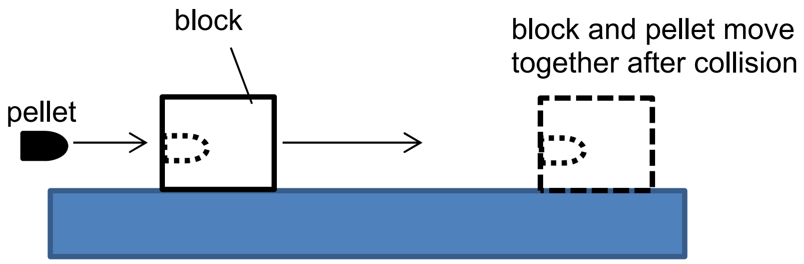


Fig. 2.1

(a) State the principle of conservation of momentum.

……………………………………………………………………………………………..

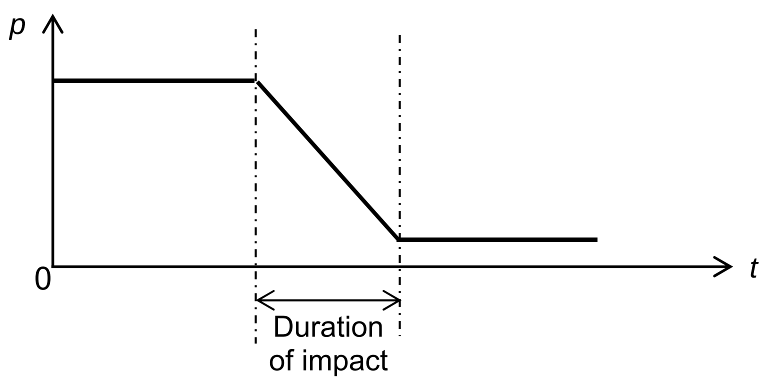
…………………………………………………………………………………………….. [1]

(b) Assuming that the total momentum of the pellet and the block is conserved during the collision, calculate the initial speed of the block and pellet after impact.

speed = …………………… m s^{-1} [2]

(c) The variation of the momentum of the pellet p with time t is shown in Fig. 2.2. below. The duration of impact (collision) is indicated in the figure.

Sketch the variation of the momentum of the **block only** with time before, during and after the collision. Values of the momentum are not needed in the sketch.



[2]

Fig.2.2

3 **(a)** Define *potential difference*.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………….. [1]

(b) For the purpose of measuring the electrical resistance of shoes through the body of the wearer to a metal ground plate, the National Standards Institute (NSI) uses the circuit shown in Fig. 3.1. The potential difference ΔV across the 1.00 MΩ resistor is measured with an ideal voltmeter.

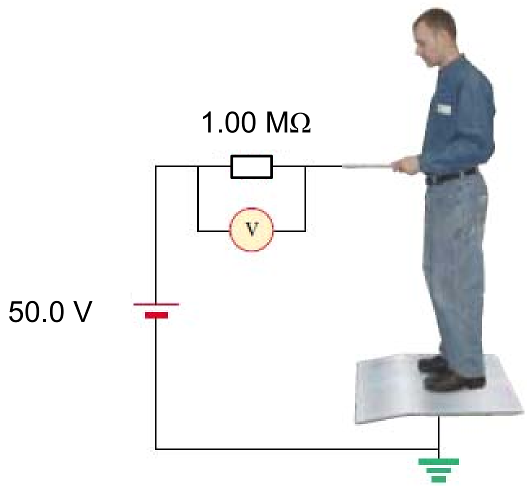


Fig. 3.1

(i) Show that the resistance of the shoes is given by

$$R_{shoes} = 1.00 \times 10^6 \left(\frac{50 - \Delta V}{\Delta V} \right)$$

[1]

[Turn over

(ii) In a medical test, a current through the human body should not exceed 150 μA.

Show with calculations, whether the current delivered by the circuit exceeds 150 μA. State any assumptions made in your calculations.

....

.... [2]

(iii) State and explain how the measured value of the resistance of the shoes will change if the voltmeter is not ideal.

....

....

.... [2]

4. The variation of current I with potential difference V across an electrical component X is shown below in Fig.4.1.

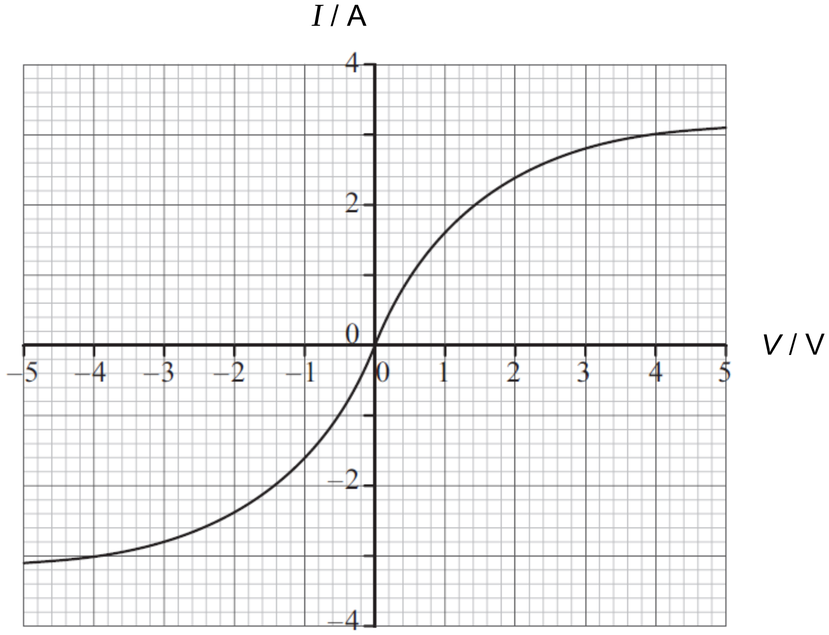


Fig. 4.1

(a) Fig. 4.2 shows a battery, a potential divider and component X.

Complete Fig. 4.2 to show a setup that can be used to obtain readings for Fig. 4.1. Include in your diagram any other relevant components and measuring instruments.

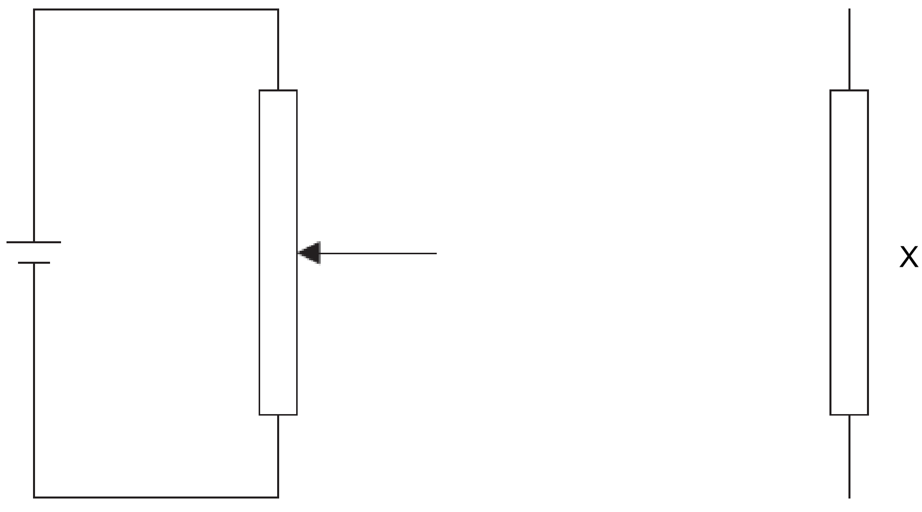


Fig. 4.2

[2]

[Turn over

(b) With reference to Fig. 4.1, describe how the resistance of X varies with the potential difference across it.

……………………………………………………………………………………………

……………………………………………………………………………………………

………………………………………………………………………………………… [2]

(c) Component X is now connected across the terminal of a cell of e.m.f. 2.0 V with negligible internal resistance.

Using Fig. 4.1, determine the resistance of X.

Resistance of X = …………… Ω [2]

(d) A fixed resistor of value 1.0 Ω is connected in series with the cell in **(c)** and X as shown in Fig. 4.3.

Using Fig. 4.1, or otherwise, determine the current in the circuit.

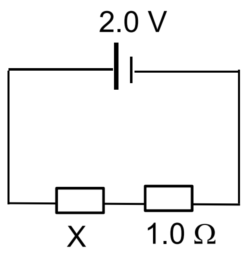


Fig. 4.3

current = …………… A [3]

5 **(a)** **(i)** Define the *tesla*.

....

....

.... [1]

(ii) Express the tesla in terms of the product of its base units.

base units = ... [1]

(b) Two long straight current-carrying conductors X and Y are placed parallel to each other. Conductor X carries a current of 2 A while conductor Y carries a current of 1 A. Both directions of currents are into the plane of the paper.

(i) Sketch the magnetic flux pattern due to X and Y in Fig. 5.1 below. [2]

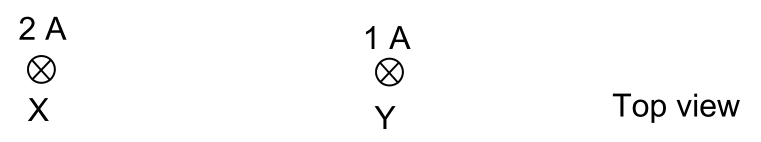


Fig. 5.1

(c) A third conductor Z with a current of 1 A into the plane of the paper is placed on the right of Y.

Y is of equal distance from X and Z.

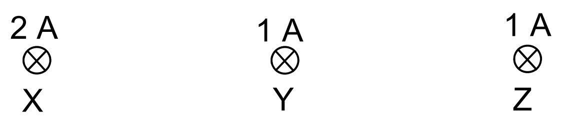


Fig. 5.2

(i) Indicate with clear labelling on Fig. 5.2 the forces acting on Y. [1]

[Turn over

6 A container used for storage of liquid is shown below in Fig. 6.1. The lower portion of the container has a uniform cross-sectional area.

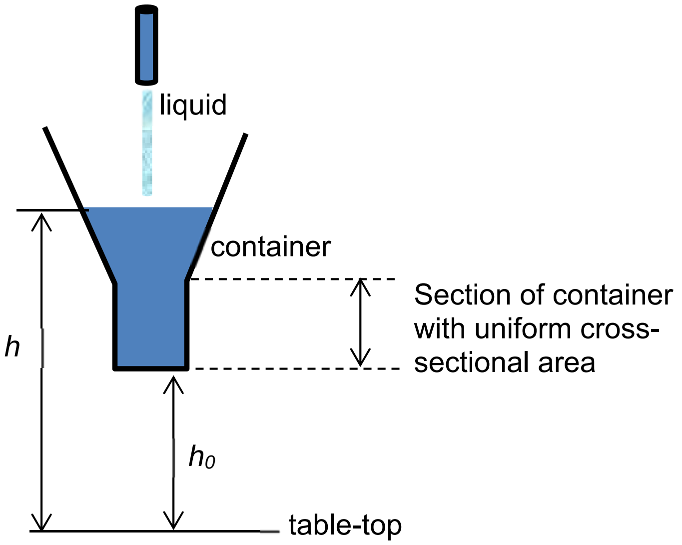


Fig. 6.1

The container, initially empty, is filled with a liquid at a constant rate from above it. The height *h* of the liquid surface above the table-top is measured as a function of time *t*. The distance between the base of the container and the table-top is h_0.

Fig. 6.2 shows the variation of *h* with *t*.

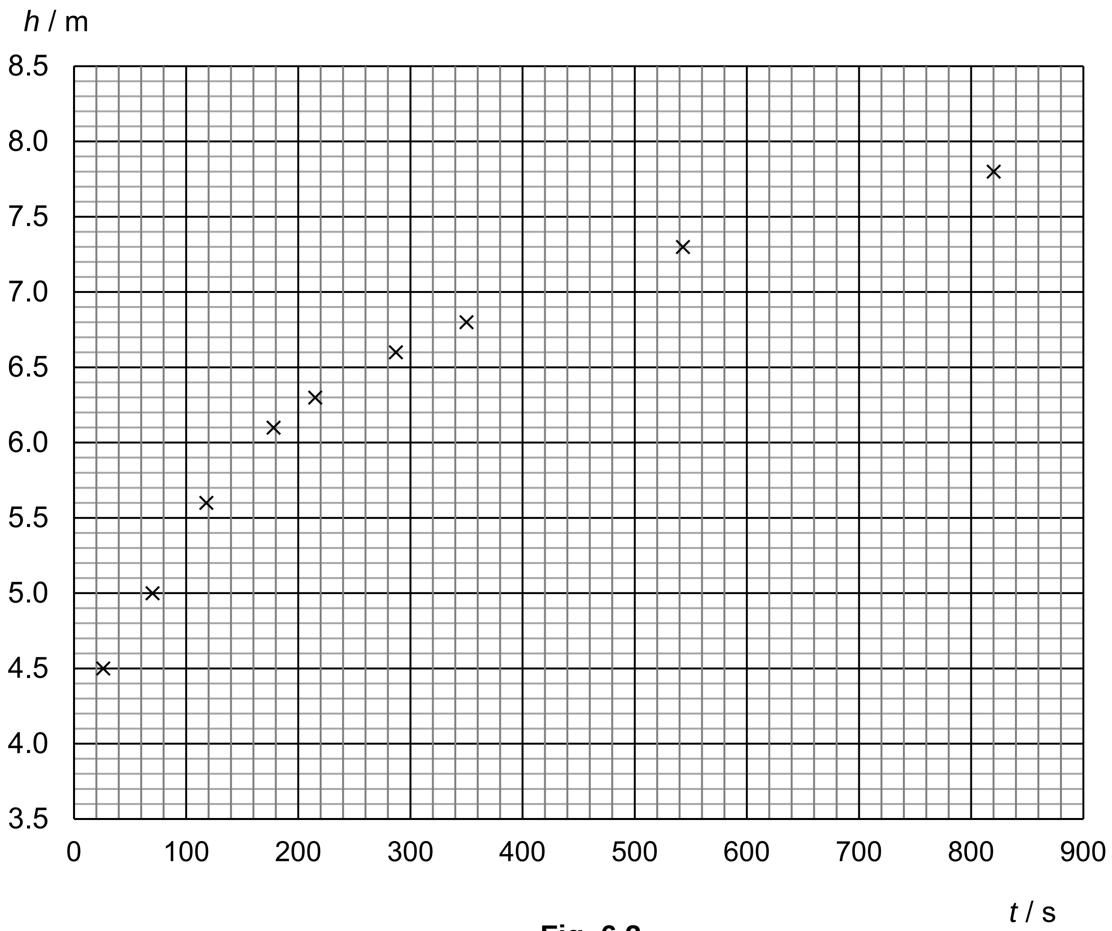


Fig. 6.2

(a) Draw a best-fit line for the graph in Fig. 6.2. [1]

(b) State and explain if any part of the graph shows that h is proportional to t.

....

....

.... [2]

(c) Determine the value of h_0 .

h_0 = …………… m [1]

(d) The base of the container has a cross-sectional area of 1.8 m^2.

Show that the volume of liquid entering the container each second is approximately 0.020 $m^3\ s^{-1}$. [2]

(e) The container is completely filled after 850 s. Calculate the total volume of the container.

volume = …………… m^3 [1]

(f) The container is emptied and is now filled at half the rate in **(d)**. Sketch another graph in Fig. 6.2 to show the new variation of h with t for time = 0 to 900 s.

Label the graph as **(f)**. [2]

[Turn over

Section B (40 marks)

Answer **two** questions from this Section in the spaces provided.

7 **(a)** **(i)** Define *acceleration*.

.... [1]

(ii) The motion of an object may be represented by the equation

$$\frac{u+v}{2}=\frac{s}{t}$$

where u : initial speed,
v : final speed,
s : distance travelled in time t.

State one assumption made in order for the above equation to be valid.

.... [1]

(iii) Using **(i)** and **(ii)**, derive an expression for s in terms of u, t and a, the acceleration of the object. [1]

(b) The shutter speed of a camera is an indication of the amount of time that the camera film is exposed to light. In order to determine the shutter speed of a camera, a metal ball is held at rest at the zero mark of a scale, as shown in **Fig. 7.1**. The ball is then released. The shutter of a camera is opened as the ball falls.

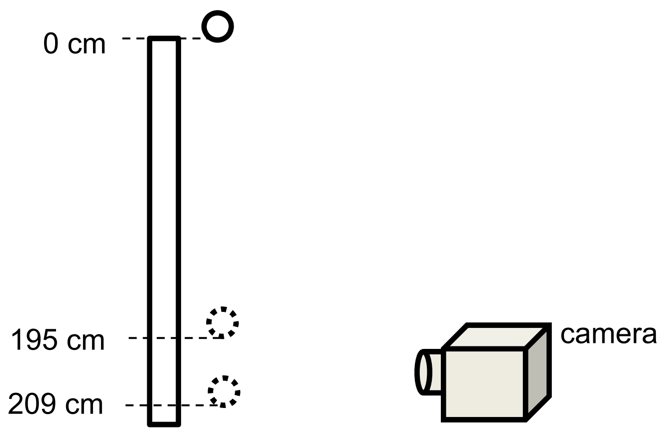


Fig. 7.1

The photograph of the ball shows that the shutter opened as the ball reached the 195 cm mark on the scale and closed as it reached the 209 cm mark.

Assume air resistance is negligible.

(i) Calculate the time the ball falls from the zero to the 195 cm mark.

time = …………….. s [2]

(ii) Determine the time duration for which the shutter is opened.

duration = …………….. s [2]

(iii) Explain why a more accurate value for the shutter speed can be obtained if the ball is allowed to fall a greater distance before the shutter is opened.

…………………………………………………………………………………………………

……………………………………………………………………………………… [2]

(iv) A student performed a similar experiment of a falling object with the help of data-loggers and obtained the following readings :

initial speed	$u = 5.0 \pm 0.1$ m s^{-1}
duration of fall	$t = 3.50 \pm 0.01$ s
acceleration of free fall	g = 9.81 m s^{-2} with no uncertainty

Determine the value of the distance of fall s using the equation in **(a)(iii)** with its associated uncertainty.

s = ………….. ± ………. m [2]

[Turn over

(c) Another experiment is conducted with a heavier ball of mass 0.50 kg. The ball is released from rest above the Earth's surface.

Fig. 7.2 shows the variation of its velocity v with time t during the fall.

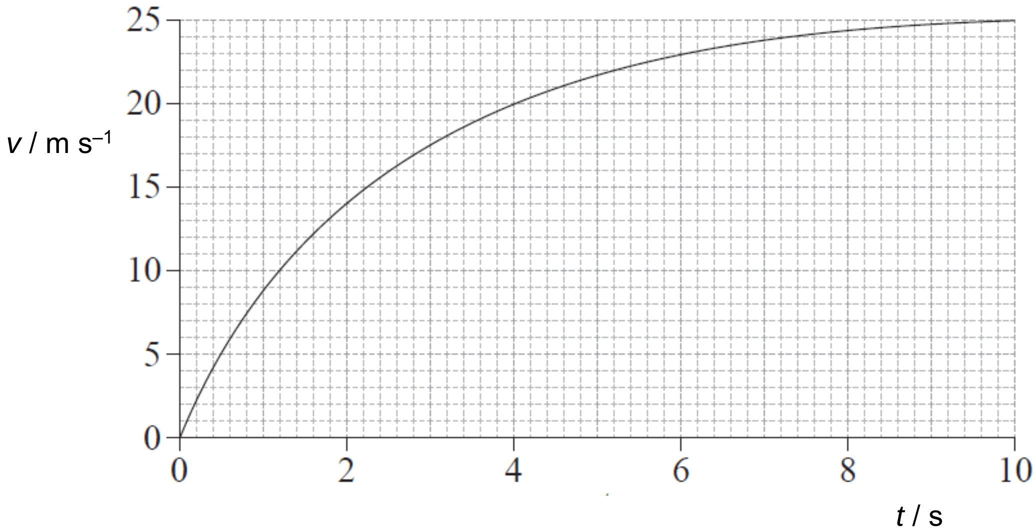


Fig. 7.2

(i) In Fig. 7.3 below, draw and label the forces acting on the ball at time t = 2.0 s. [1]

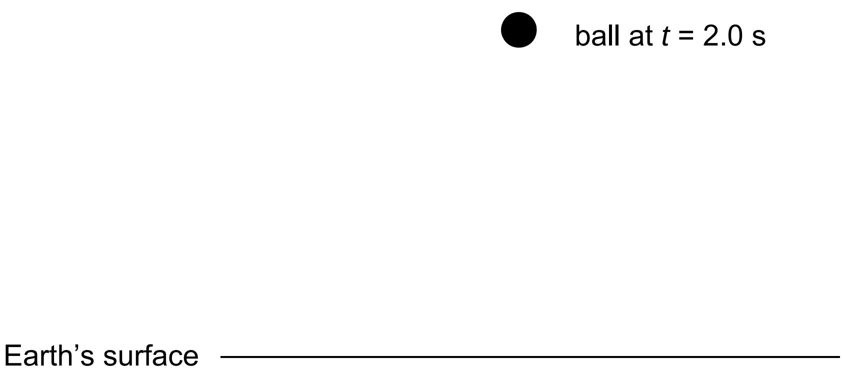


Fig. 7.3

(ii) Use Fig. 7.2 to show that the acceleration of the ball at 2.0 s is approximately 4.0 m s^{-2}. [1]

(iii) Calculate the magnitude of the resistive force on the ball at 2.0 s.

force = ………….. N [2]

(iv) With reference to Fig. 7.2, state and explain whether the resistive force on the ball at 5.0 s is smaller, equal or greater than that at 2.0 s.

………………………………………………………………………………………………

……………………………………………………………………………… [2]

(v) Determine the total work done against resistive force after it has fallen for 10 s.

work done = …………………. J [3]

[Turn over

8 **(a)** **(i)** State the principle of superposition.

....

....

.... [2]

(ii) State two conditions necessary to produce observable interference patterns between light from two sources.

....

....

.... [2]

(iii) A Young's double slit experiment is set up with a source of white light. The light is allowed to pass through a red filter before passing through a single and double slits as shown below in Fig. 8.1.

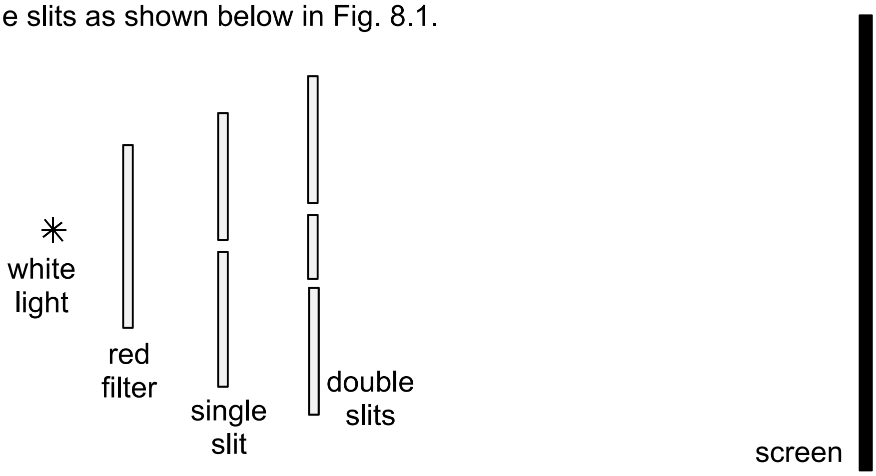


Fig. 8.1

An interference pattern of light and dark fringes is observed on the screen.

The red filter is now replaced by a blue filter.

State and explain the change in the appearance, other than the colour of the light, of the fringes on the screen.

....

....

....

.... [2]

(iv) The filter in **(iii)** is now removed. The white light passes through the slits without any filters.

State and explain the appearance of the central maximum fringe and also of fringes that are away from this central position.

You may include a diagram to help in your explanation.

....

....

....

....

.... [3]

(b) An experiment to demonstrate stationary wave formed in an open pipe is carried out. A loudspeaker is attached to the end of an open pipe. A signal generator is then connected to it. At a particular frequency, a stationary wave is formed inside the pipe.

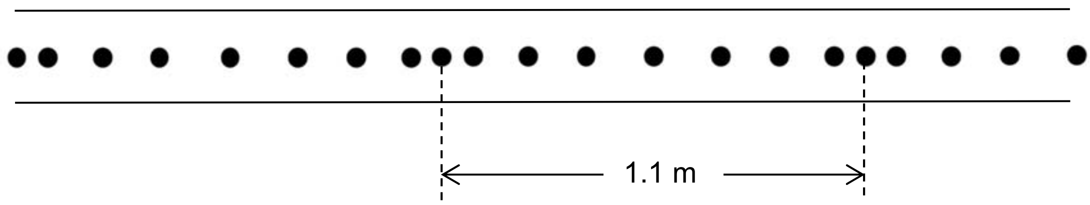


Fig. 8.2

Fig. 8.2 shows the horizontal displacement of the particles along a section of the pipe at an instant in time.

(i) Explain the formation of the stationary wave in the pipe.

....

....

.... [2]

[Turn over

(ii) Determine the node-to-node distance of the sound wave in the pipe.

distance = ………………………….. m [1]

(iii) The frequency of the sound wave produced by the loudspeaker is slowly increased from a very low value. A series of loud and soft sounds is heard in the pipe.

In Fig. 8.3, show how the amplitude of the resultant wave varies from one end to the other for the **second** instance a loud sound is heard in the pipe.

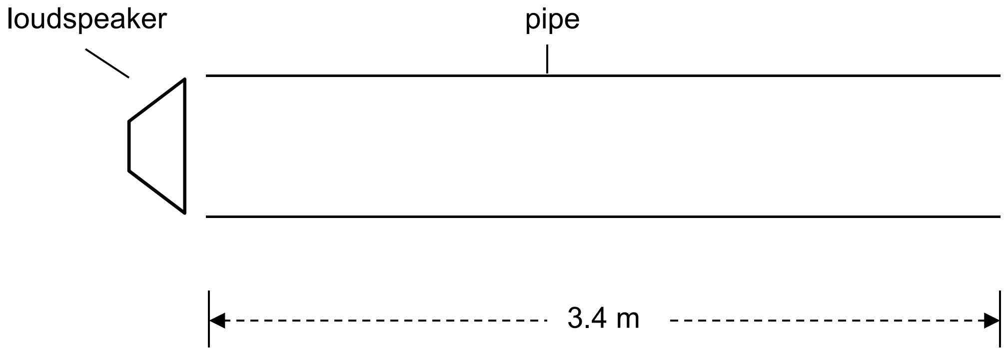


Fig. 8.3

[2]

(iv) Given that the speed of sound is 340 m s^{-1}**,** calculate the **fundamental frequency** of the pipe.

frequency = ………………………….. Hz [2]

(c) Two of the loudspeakers mentioned in **(b)** are driven by the same oscillator and are located on a vertical pole a distance of 8.0 m away from each other.

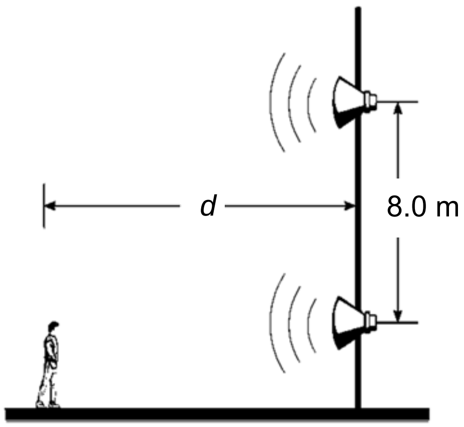


Fig. 8.4

A man walks towards the lower loudspeaker in a direction perpendicular to the pole as shown in the Fig. 8.4 while the loudspeakers are producing sound of wavelength 2.0 m. The lower speaker is at the same height as the ears of the man.

As the man walks towards the lower loudspeaker, he hears a series of maximum and minimum in sound intensities.

(i) Show that the distance *d* that the man is away from the lower loudspeaker when the intensity of the sound is a minimum, can be expressed as

$$d = \frac{63 - 4n^2 - 4n}{2(2n+1)}\text{, where } n = 0, 1, 2 \ldots$$

[2]

(ii) Hence or otherwise, find the number of times that the man will hear a minimum in sound intensity when he walks towards the lower loudspeaker from 50 m away.

no. of minimum = ………………………… [2]

[Turn over

9 **(a)** According to a wave model of electromagnetic theory of light, it is assumed that an electron on the surface of a metal absorbs all the energy of an incident radiation on the surface of the metal within a distance of 5.0×10^{-11} m.

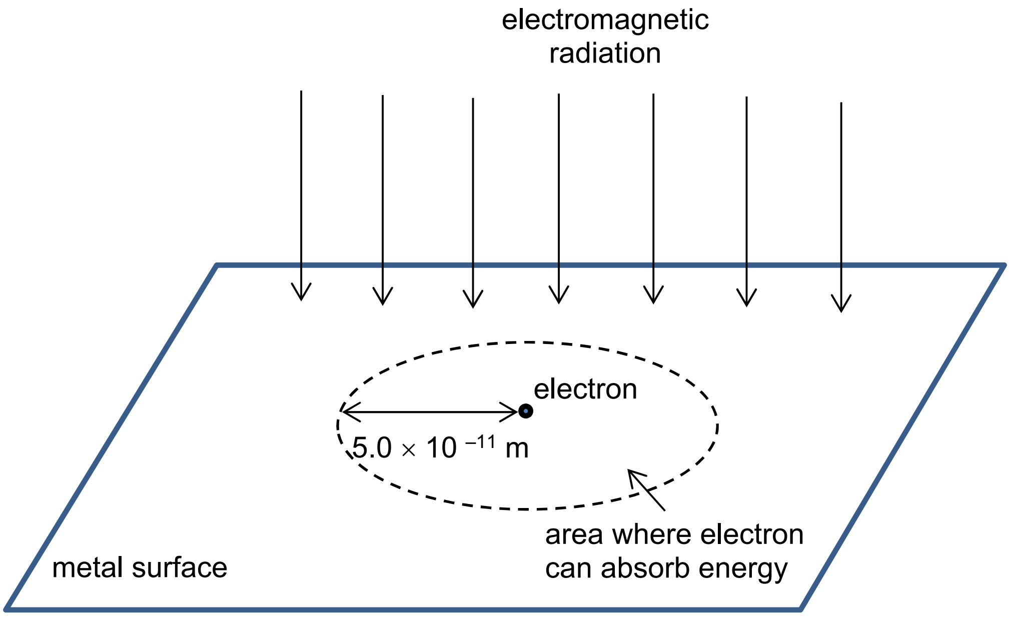


Fig. 9.1

The intensity of light incident normally on the metal surface is 1.6 W m $^{-2}$ and the energy required to remove an electron from the surface is 1.8 eV.

(i) Based on the above model, calculate the time needed for the electron to gain sufficient energy to leave the surface.

time = ……………………s [2]

(ii) Experimental observations indicate that electrons are emitted from the surface in less than 10^{-9} s.
Explain how this observation is consistent with the particle theory of light.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………… [1]

(iii) The incident light has intensity 1.6 W m^{-2}, wavelength 520 nm and 5.0 % of the incident photons cause the ejection of electrons from the surface. Using the particle theory of light, determine the number of electrons ejected from 1.0 m^2 of the surface per second.

number = ……………………s^{-1} [3]

(b) Fig. 9.2 shows an experimental setup used to investigate the photoelectric effect.

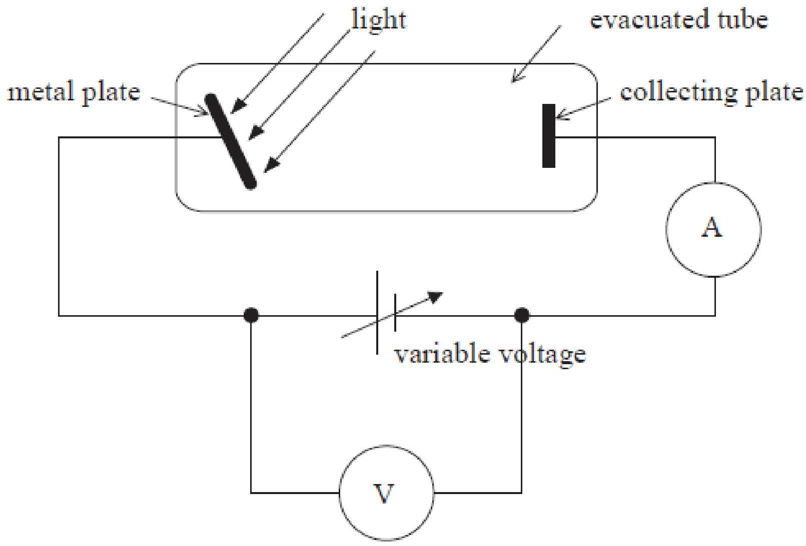


Fig. 9.2

Describe how the setup can be used to determine the maximum kinetic energy of the emitted electrons for incident light of frequency *f*.

....

....

....

....

....

.... [3]

[Turn over

(c) A student performed a photoelectric emission experiment. The graph of stopping potential against frequency of incident light falling on the metal surface is shown in Fig. 9.3.

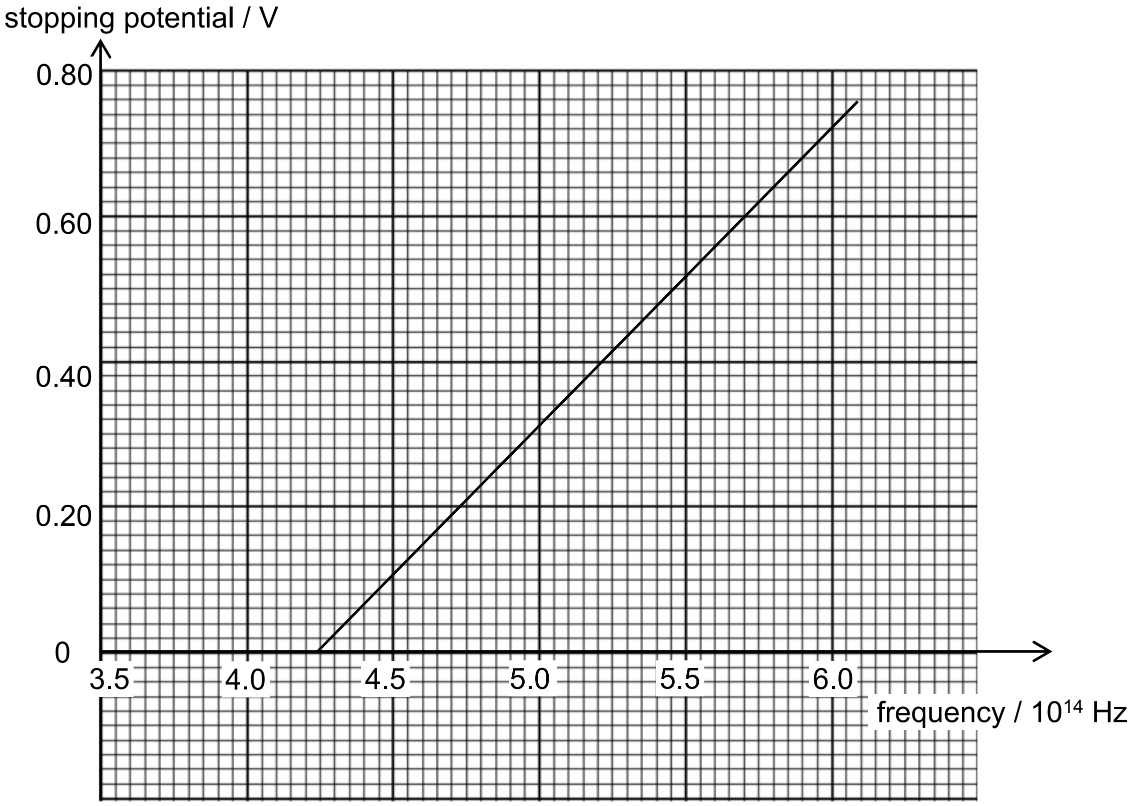


Fig. 9.3

(i) State what is meant by *stopping potential*.

....

.... [1]

(ii) Using Fig. 9.3, determine

1. the Planck's constant.

Planck's constant = ………………………… J s [2]

2. the work function for the metal.

work function = ………………………… eV [1]

(iii) Hence or otherwise, determine the stopping potential when the photons with wavelength 694 $\times 10^{-9}$ m are incident on the metal surface.

stopping potential = ………………………… V [2]

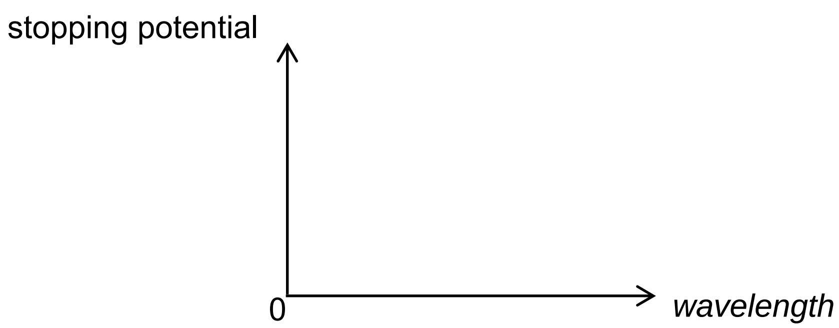
(iv) Explain why the graph does not extend below the horizontal axis.

...……………………………………………………………………………………….

...……………………………………………………………………………………….

...…………………………………………………………………………………… [1]

(v) Sketch a graph in the axes below to show the variation of stopping potential with the wavelength of the incident light for the same photoelectric experiment.



[1]

[Turn over

(d) The threshold wavelength of a photoelectric experiment is given to be λ_0. Light of wavelength ½ λ_0 and intensity I is incident on the metal surface in **(c)**. The photocurrent detected is I_p.

State and explain the effect on the current I_p for light incident on the surface

(i) of wavelength ½ λ_0 and intensity 2 I

....

....

....

....

.... [2]

(ii) of wavelength $2\lambda_0$ and intensity I .

....

.... [1]

END OF PAPER