TEMASEK JUNIOR COLLEGE

2016 Preliminary Examination
Higher 1

CANDIDATE NAME	

CIVICS GROUP		INDEX NUMBER	

PHYSICS

8866/02

Paper 2 Structured Questions

31 August 2016

2 hours

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

READ THESE INSTRUCTION FIRST

Write your Civics group, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
Section B	
6	
7	
8	
Total	

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	=	ρgh
resistors in series,	R	=	$R_1 + R_2 + \ \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ \ldots$

Section A

Answer **all** the questions in this section.

1 A bomber, shown in Fig. 1.1, is flying horizontally at a speed of 72 m s^{-1} and at a height of 100 m above the ground. When directly flying over the origin O, bomb B is released and it strikes a truck T, which is moving along a level road with a constant speed v. At the instant the bomb is released, the truck T is at a distance x_o = 125 m from origin O.

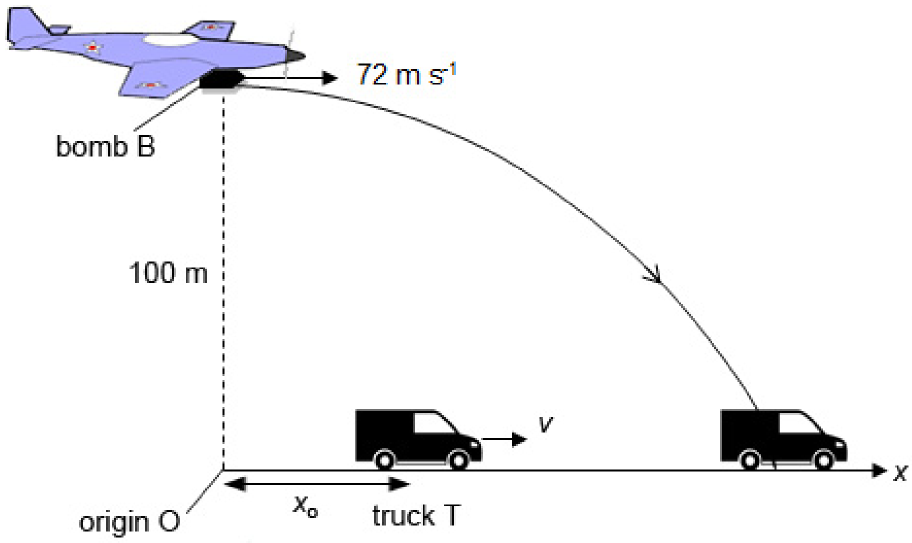


Fig. 1.1

(a) Define acceleration.

....

.... [1]

(b) Write an expression, in terms of the quantities given,

(i) the horizontal displacement x of bomb B at time t after it is dropped,

.... [1]

(ii) the vertical displacement y of bomb B at time t after it is dropped.

.... [1]

(c) Calculate the time of flight of bomb B upon striking the truck T.

time of flight = ... s [2]

(d) Determine the speed v of truck T.

v = ... m s^{-1} [2]

2 **(a)** State Newton's first law of motion.

....

.... [1]

(b) A uniform ladder of length 12.0 m and mass 40 kg rest on a wall. The lower end of the ladder is at 6.0 m from the wall as shown in Fig. 2.1. The wall is smooth while the ground is rough.

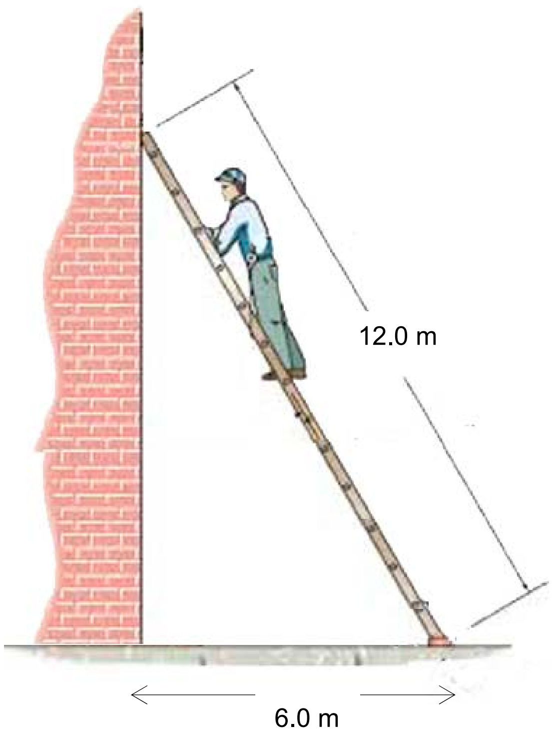


Fig. 2.1

A man of mass 72 kg starts to climb up the ladder. When the man is ¾ way up the ladder, he feels that the ladder is beginning to slip.

(i) On Fig 2.1, sketch the free-body diagram of the ladder, indicating all forces clearly.

[2]

(ii) Calculate the normal contact force by the ground on the ladder.

normal contact force = ... N [2]

(iii) Calculate the normal contact force by the wall on the ladder.

normal contact force = ... N [2]

3 **(a)** Define *electrical resistance* of a conductor.

....

.... [1]

(b) Fig. 3.1 shows a circuit containing five identical lamps A, B, C, D and E. The circuit also contains three switches S_1, S_2 and S_3.

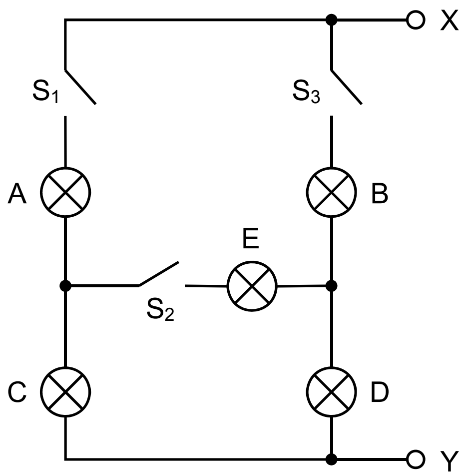


Fig. 3.1

One of the lamps is faulty. In order to detect the fault, an ohm-meter (a meter that measures resistance) is connected between terminals X and Y. When measuring resistance, the ohm-meter causes negligible current in the circuit.

Fig. 3.2 shows the readings of the ohm-meter for different switch positions. The resistance of the non-faulty lamps can be assumed to be constant.

switch S_1	switch S_2	switch S_3	metre reading / Ω
open	open	open	∞
closed	open	open	30.0
closed	closed	open	22.5
closed	closed	closed	15.0

Fig. 3.2

(i) Explain how it can be deduced from the results in the table that the resistance of each lamp is 15 Ω.

....

....

.... [1]

(ii) Identify the faulty lamp and the nature of the fault.

faulty lamp: ....

nature of fault: ....

.... [2]

(iii) Suggest why it is advisable to test the circuit using an ohm-meter that causes negligible current rather than with a power supply across terminals X and Y.

....

....

.... [1]

(iv) Each lamp is marked 12.0 V, 0.50 A.

Calculate the resistance for one of the lamps operating at normal brightness.

resistance = ... Ω [1]

(v) Explain why the resistance calculated in **(iv)** is different from the value obtained in **(i)**.

....

....

.... [1]

4 **(a)** Define *magnetic flux density*.

....

....

.... [1]

(b) **(i)** Fig. 4.1 shows the cross-section of a conductor which carries a constant current flowing out of the plane of the paper.

Sketch the magnetic field pattern due to the current.

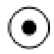


Fig. 4.1 [2]

(ii) The current-carrying conductor is placed in the region between the poles of a strong magnet as shown in Fig. 4.2.

Sketch on Fig. 4.2 the resultant magnetic field pattern in the region between the poles of a magnet.

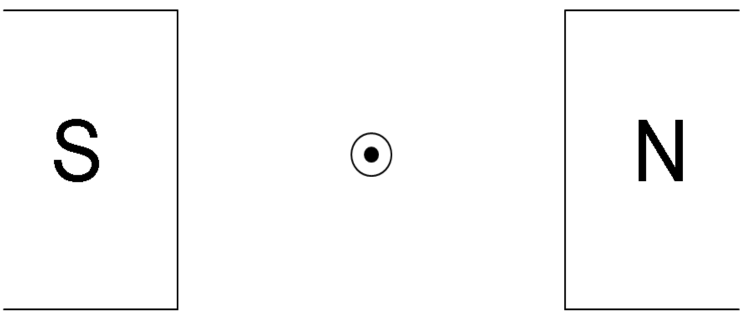


Fig. 4.2 [2]

(iii) State the direction of the magnetic force acting on the current-carrying conductor.

.... [1]

(iv) The magnetic flux density of the uniform field between the poles of the strong magnet is 0.50 T. The current in the conductor is 1.5 A and the length of the conductor that lies within the magnetic field is 0.10 m.

Calculate the magnetic force acting on the current-carrying conductor.

magnetic force = ... N [1]

5 A photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity; in other words, it exhibits photoconductivity.

An LDR is made of a high resistance semiconductor. If light falling on the device is of sufficiently high frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance. The electrons released from bonds in the material of the LDR by absorbing incident photons remain free to conduct for about 50 ms before returning to be localised in bonds again.

Fig. 5.1 shows a plot of the resistance R of the LDR against the intensity I of incident light on a logarithmic scale.

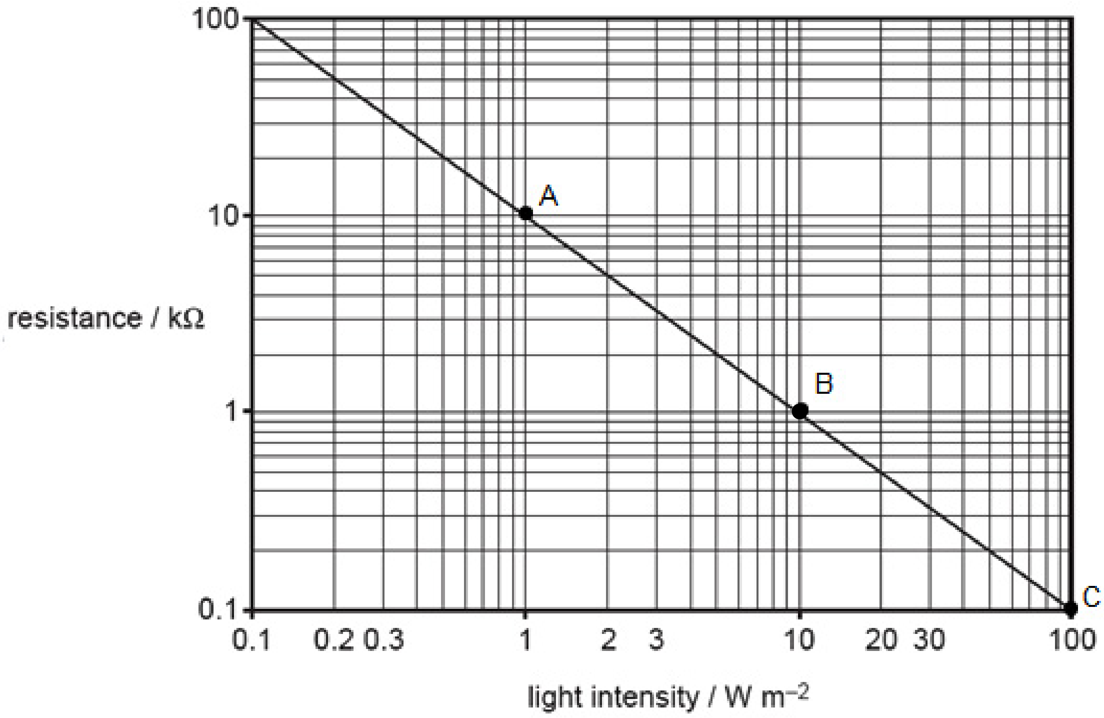


Fig. 5.1

(a) **(i)** Use Fig. 5.1 to find the resistance of the LDR at a light intensity of 50.0 W m^{-2}.

resistance of LDR = ... Ω [1]

(ii) Explain the advantage of plotting the resistance-intensity graph on the logarithmic scale.

....

....

.... [1]

(iii) It is thought that the resistance R of the LDR is related to the intensity I of incident light by a relation of the form

$$R = 10000\,I^{-1}.$$

Explain how the relation may be verified using Fig. 5.1.

....

....

....

....

.... [2]

(b) Together with the data point in **(a)(i)**, transfer the data points A, B, C in Fig. 5.1 to the grids in Fig. 5.2 to plot the graph of resistance R vs intensity I on a normal scale.

Draw a best-fit curve through the points. [2]

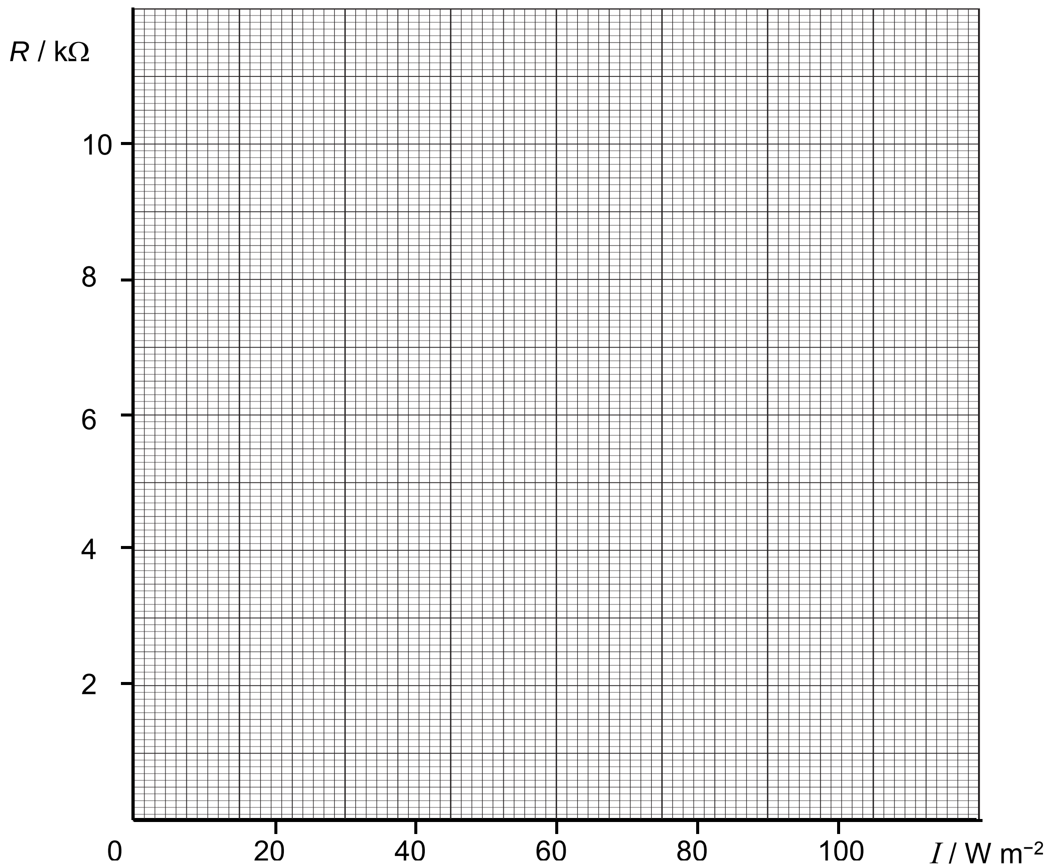


Fig. 5.2

(c) The LDR is connected in series with a variable resistor X and a 12.0 V d.c. supply. The buzzer is connected across the variable resistor X as shown in Fig. 5.3. The buzzer is set to sound if the potential difference across it is equal to or greater than 9.0 V.

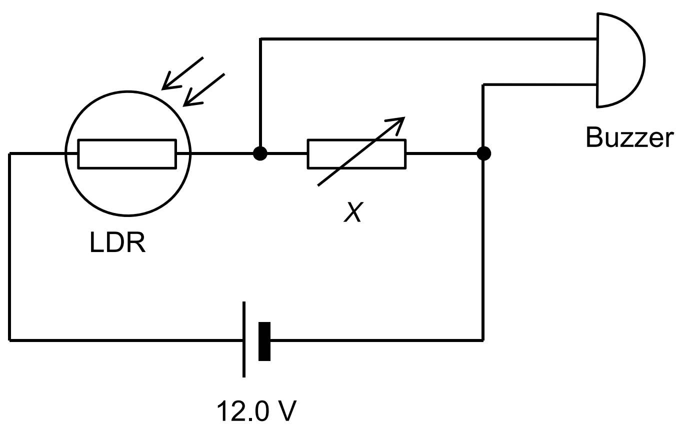


Fig. 5.3

(i) Calculate the value of the resistance of *X* if we want the buzzer to sound when the light intensity exceeds 50.0 W m^{-2}.

resistance of *X* = ... Ω [3]

(ii) Suggest an application for the circuit in Fig. 5.3.

....

.... [1]

(iii) Explain why it is impractical to use this LDR as a trigger for light intensity below 1.0 W m^{-2}.

....

....

....

.... [2]

Section B

Answer any **two** questions in this section.

6 **(a)** A body moving with a velocity u in a straight line accelerates uniformly for a time t until it reaches a velocity v, during which it travels a distance s.

(i) Sketch, with appropriate labelling, a velocity-time graph for the body in the spaces provided below.

[2]

(ii) State the significance of

1. the gradient of the graph.

.... [1]

2. the area under the graph

.... [1]

(iii) Deduce from your graph that $s = ut + ½\, at^2$, where a is the acceleration.

[2]

(b) On a building site in Fig. 6.1, a motorised hoist is used to transport bricks a distance of 32·0 m towards the top of a building. The hoist is attached to the top of the building by a supporting frame ABC. The basket, when full of bricks, has a mass of 35·0 kg.

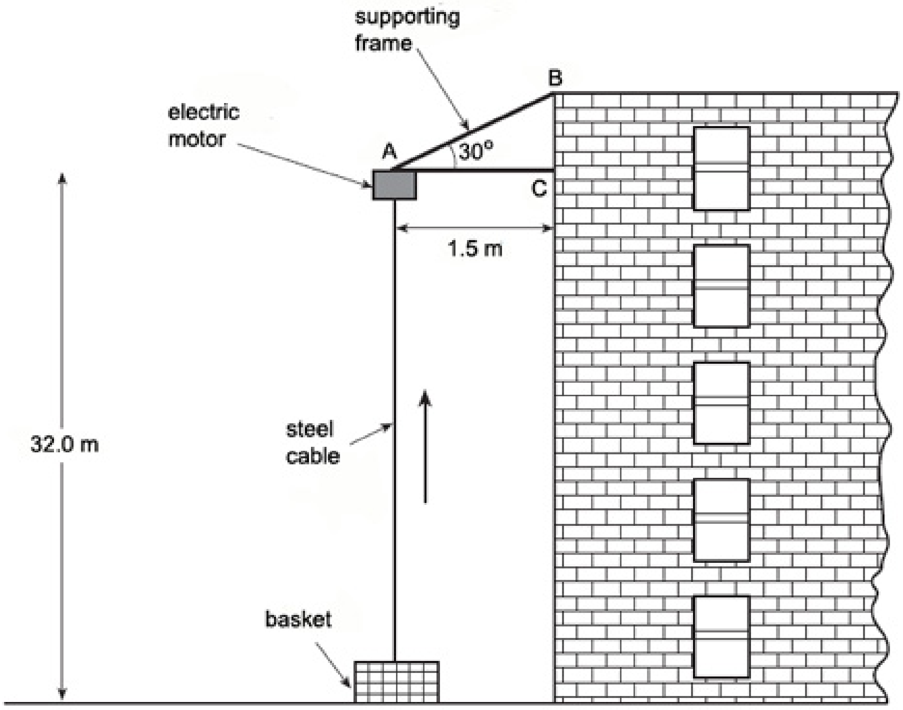


Fig. 6.1

(i) The basket is filled with bricks on the ground and the motor is switched on. Initially the basket accelerates uniformly from rest to a speed of 1·6 m s^{-1} in 2·0 s. Calculate the initial acceleration of the basket.

acceleration = ... m s^{-1} [1]

(ii) Whilst the basket is **accelerating** calculate

1. the distance travelled,

distance = ... m [2]

2. the tension in the cable.

tension = ... N [3]

(iii) After the initial acceleration (i.e. after 2·0 s) the basket continues to move with **constant speed** for the remainder of the journey.

1. Calculate the **total time** taken to reach the top.

time = ... s [2]

2. When the basket is moving with **constant speed** would you expect the tension in the cable to be more than, less than or the same as that calculated in (b)(ii)2? Justify your answer.

....

....

....

.... [2]

(iv) Fig. 6.2 is an enlarged diagram showing the supporting frame ABC.

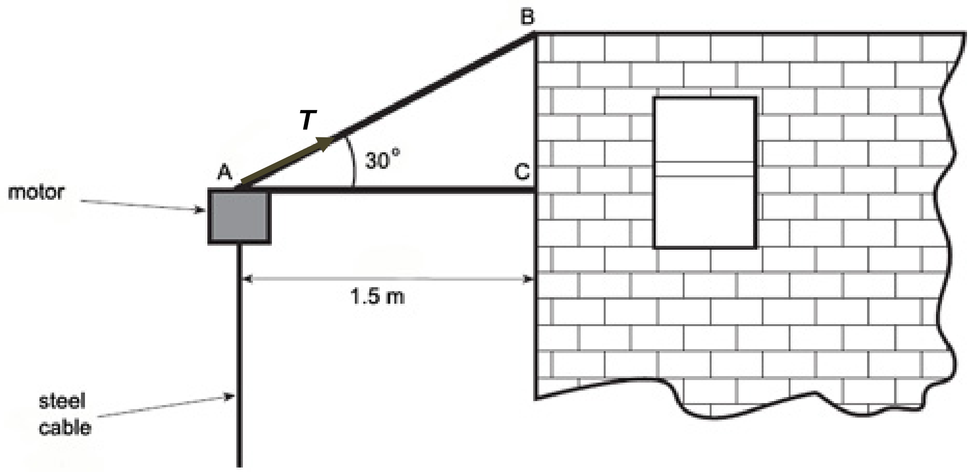


Fig. 6.2

1. Calculate the tension T in the support AB when the basket is moving at **constant speed.** Assume that the total mass of the motor and steel cable is 20 kg. You may ignore the mass of the support AC.

tension T = ... N [2]

2. Is the support AC under tension or compression? Explain your answer.

....

....

.... [2]

7 **(a)** Explain what do you understand by the *principle of superposition*.

....

....

.... [2]

(b) Two overlapping waves of the same type travel in the same direction. The variation with distance *x* of the displacement *y* of each wave is shown in Fig. 7.1.

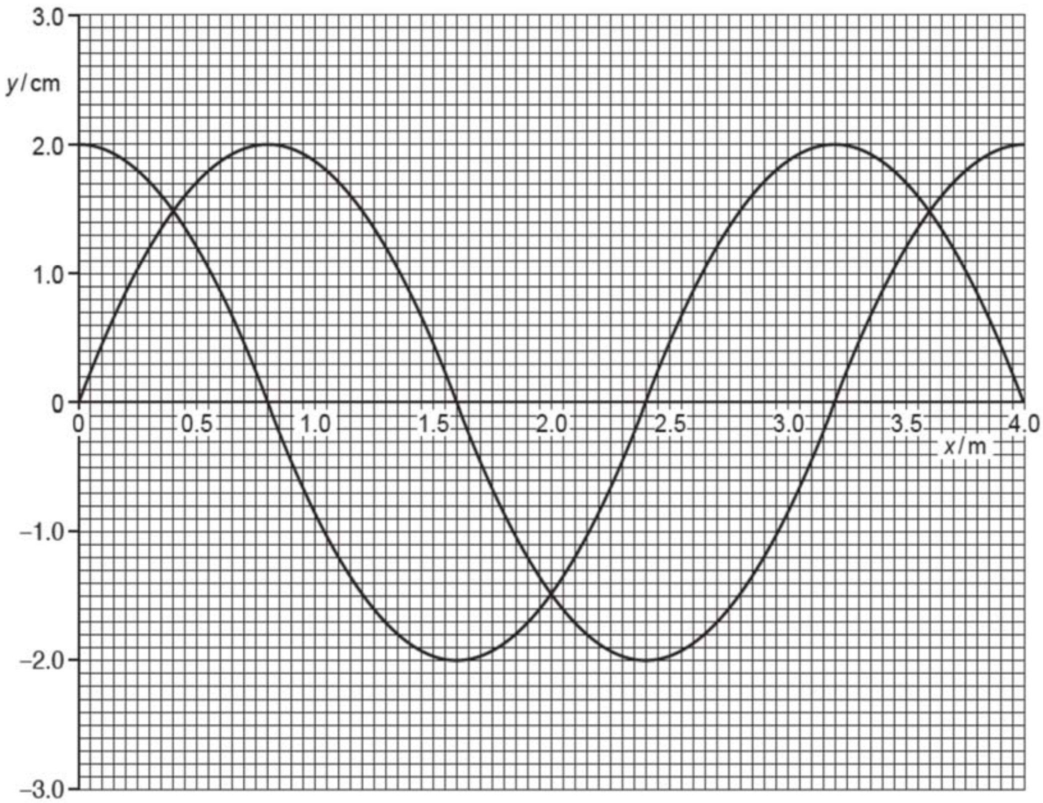


Fig. 7.1

Using the principle of superposition, sketch the resultant wave on Fig. 7.1. [2]

(c) A satellite orbits around the Earth at a fixed height above the equator as shown in Fig. 7.2.

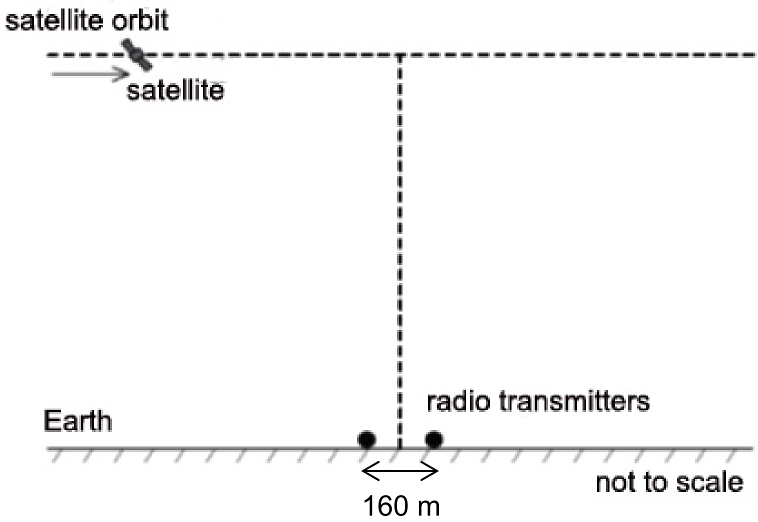


Fig. 7.2

Two coherent radio transmitters on the equator emit radio waves of equal amplitude. As the satellites flies overhead, it receives a signal that varies in intensity at regular intervals.

(i) State what is meant by the word *coherent.*

....

.... [1]

(ii) Explain why the signal received by the satellite varies in intensity.

....

....

....

.... [2]

(iii) The distance between the transmitters is 160 m and the radio waves are of wavelength 1.2 m. The signal received by the satellite varies in intensity at a frequency of 3.0 Hz. The speed of the satellite is 7.7 km s^{-1}.

1. Calculate the separation between two consecutive maximum signals.

separation = ... km [2]

2. Hence, determine the height of the satellite above the Earth's surface.

height = ... km [3]

(d) Fig. 7.3 shows an arrangement where microwaves leaves a transmitter **T** and moves in a direction **TP** which is perpendicular to a metal plate **P**.

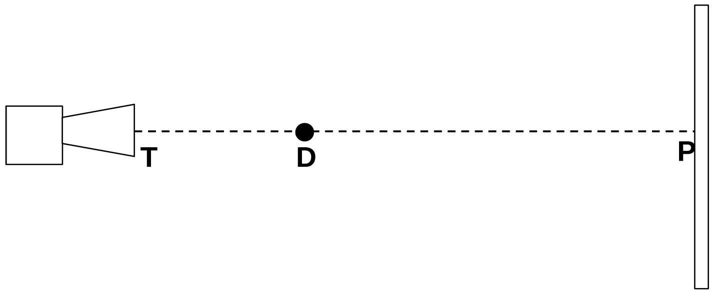


Fig. 7.3

(i) When a microwave detector **D** is slowly moved from **T** towards **P**, the intensity of the signal it receives varies through a series of maxima and minima.

Explain

1. why these maxima and minima of intensity occur ,

....

....

....

....

.... [2]

2. how you would measure the wavelength of the microwaves,

[2]

3. how you would determine the frequency of the microwaves.

[2]

(ii) Explain briefly how you would test whether the microwaves emitted by the transmitter **T** are plane-polarised.

[2]

8 **(a)** **(i)** Explain what is meant by *photoelectric effect*.

....

....

.... [2]

(ii) Experimental observations on photoelectric effect could not be explained by the wave model of light. Use the particle model of light to provide an explanation for each of the following observation:

1. Regardless of the intensity of the incident light, no photoelectrons are emitted if the frequency of the incident light is below a certain value.

....

....

....

....

....

.... [2]

2. The maximum kinetic energy of the ejected electrons is only dependent on the frequency but not the intensity of the incident light.

....

....

....

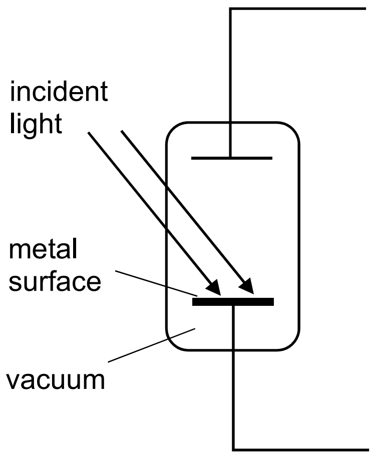
....

....

.... [2]

(b) A student wants to investigate how the stopping potential is dependent on the frequency of the incident electromagnetic radiation.

(i) Complete the circuit diagram in Fig. 8.1, showing the correct positions of the voltmeter, microammeter and variable e.m.f. source in order to determine the stopping potential. Label the positive terminal of the e.m.f. source clearly on your circuit diagram.



[3]

Fig. 8.1

(ii) Fig. 8.2 shows the results obtained by the student.

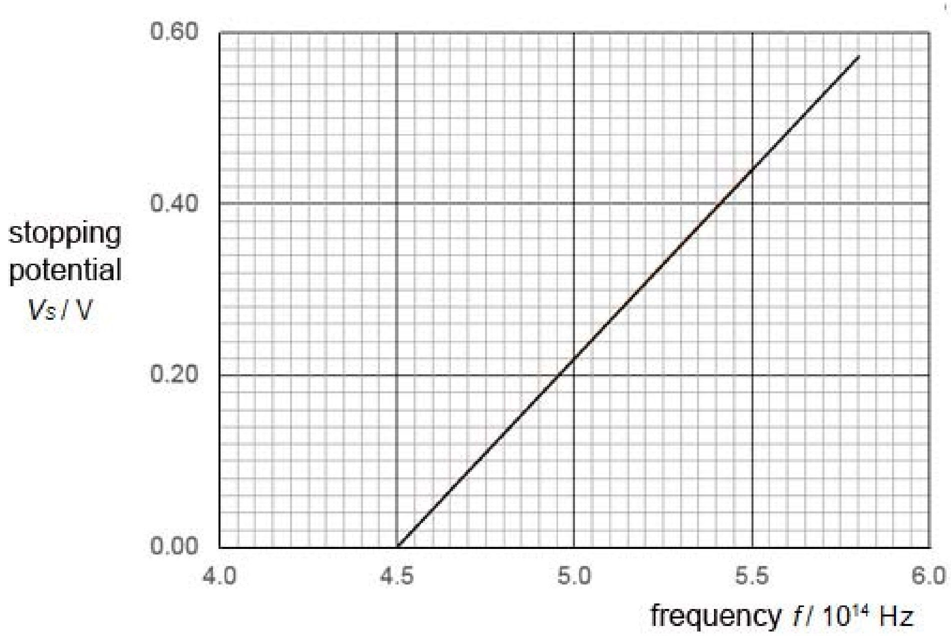


Fig. 8.2

Using information from Fig. 8.2, determine

1. a value for Planck's constant *h*,

h = ... Js [2]

2. the work function of the metal, using the value of *h* obtained in (b)(ii)1.

work function = ... J [2]

(c) Fig. 8.3 shows some of the energy levels of the mercury atom.

Level 1 represents the lowest possible energy level.

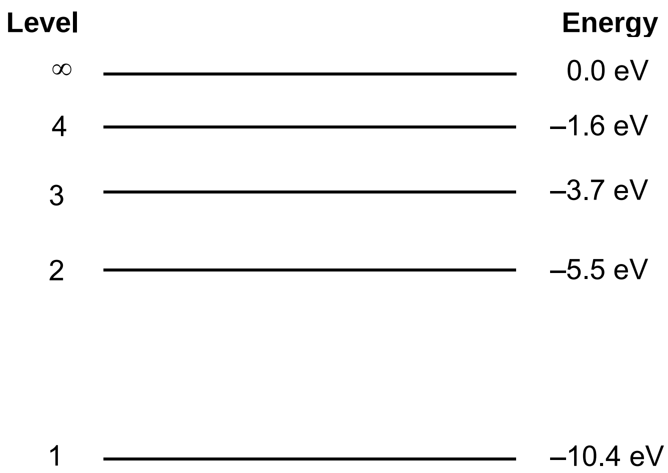


Fig. 8.3

(i) Explain clearly how an emission line spectrum could result from an atom with such energy levels.

....

....

....

....

....

.... [2]

(ii) State the possible level(s) which the mercury atom could be excited to if a moving electron of energy 7.0 eV collides with the atom in its ground state.

....

.... [1]

(iii) Determine the kinetic energy, in eV, that is retained by an incident electron after a collision with the atom and exciting it to the **highest** possible level in **(c)(ii)**.

kinetic energy = ... eV [2]

(iv) Instead of an electron, a photon of energy 7.0 eV is incident on the mercury atom in the ground state. State the transition(s), if any, that would be made by the mercury atom. Explain your answer.

....

....

....

....

.... [2]