DUNMAN HIGH SCHOOL
Preliminary Examinations
Year 6
Higher 1

CANDIDATE NAME	

CLASS		INDEX NUMBER	

PHYSICS

8866/02

Paper 2 Structured Questions

September 2015

2 hours

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

READ THESE INSTRUCTIONS FIRST

Write your class, 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.
DO **NOT** WRITE IN ANY BARCODES.

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	**5**
2	**7**
3	**9**
4	**11**
5	**8**
Section B	
6	**20**
7	**20**
8	**20**
Total	**80**

This document consists of **23** printed pages and **1** blank page.

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,	$p = \rho g h$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

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Section A

Answer **all** the questions in this section

1 **(a)** The spacing between two atoms in a crystal is 3.8×10^{-10} m. State this distance in nm.

spacing = ... nm [1]

(b) Calculate the time of one day in ks.

time = ... ks [1]

(c) The distance from the Earth to the Sun is 150 Gm. Calculate the time in hours for light to travel from the Sun to the Earth.

time = ... hours [2]

(d) Underline all the vector quantities in the list below.

acceleration resistance momentum power work [1]

2 A golf ball is hit from point A on the ground and moves through the air to point B. The path of the ball is illustrated in Fig. 2.1.

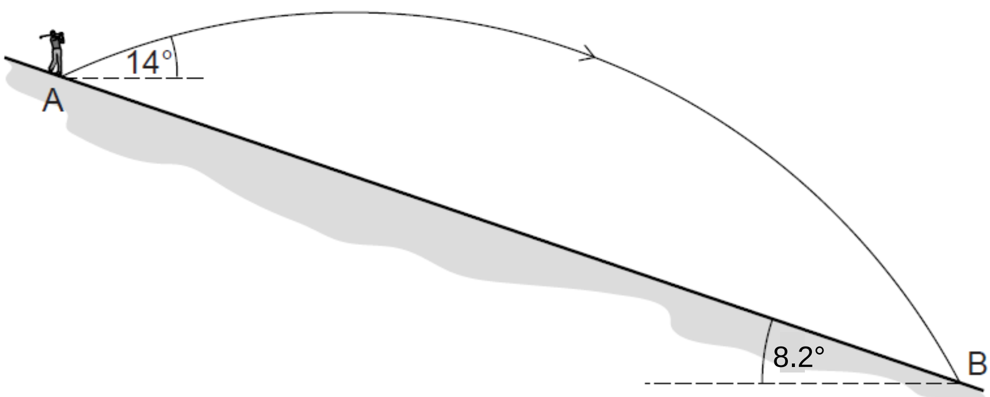

Fig. 2.1 (not to scale)

The ground slopes downhill with constant gradient of angle 8.2° to the horizontal. The ball has an initial velocity of 63 m s^{-1} at an angle of 14° to the horizontal. The acceleration due to gravity is *g* and air resistance is ignored.

(a) State the acceleration, in terms of *g*, of the ball in the direction perpendicular to the slope.

……[1]

(b) Hence determine the time taken for the ball to travel from A to B.

time = ……………………………… s [2]

(c) Calculate the displacement from A to B.

displacement = ……………………………… m [2]

(d) Describe the difference between the displacement of the ball and the distance it travels from A to B.

……

……

……[2]

3 **(a)** For a spring undergoing an elastic change, the force per unit extension of the spring is known as the force constant k.

Show that the energy E stored in the spring for an extension x of the spring is given by the expression

$$E = \frac{1}{2}kx^2$$

[2]

(b) A light helical spring is suspended vertically from a fixed point, as shown in Fig. 3.1.

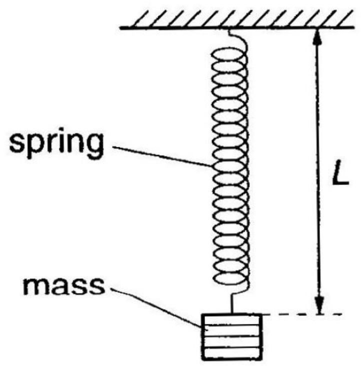

Fig. 3.1

Different masses are suspended from the spring. The weight *W* of the mass and the length *L* of the spring are noted.

The variation with weight *W* of the length *L* is shown in Fig. 3.2.

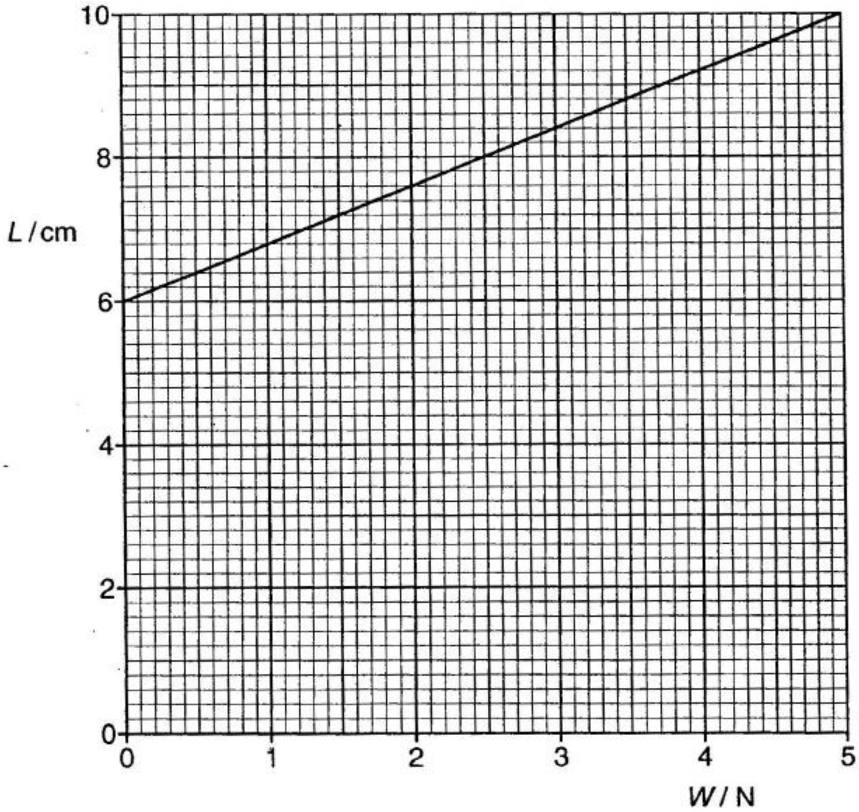

Fig. 3.2

On Fig. 3.2, show clearly the area of the graph that represents energy stored in the spring when the weight on the spring is increased from zero to 5.0 N. [1]

(c) A mass of weight 4.0 N is suspended from the spring in **(b)**.

When the mass is stationary, it is then pulled downwards a distance of 0.80 cm and held stationary.

(i) Determine the total length of the spring

length = ………………………………. cm [1]

(ii) For the increase in extension of 0.80 cm, determine the magnitude of the change in

1. the gravitational potential energy of the mass,

change = ………………………………. J [2]

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2. the elastic potential energy of the spring.

change = ………………………………. J [2]

(d) Suggest how you could check that the elastic limit of the spring in **(b)** is not exceeded when extra load is added.

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

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

4 **(a)** A long straight wire is carrying a steady current I into the page as shown in Fig. 4.1.

On Fig. 4.1, draw four field lines to represent the magnetic field due to the current in the wire. [2]

Fig. 4.1

(b) The current-carrying wire is within an external uniform magnetic field as shown in Fig. 4.2.

On Fig. 4.2, mark with the letter P a point where the magnetic field due to the current-carrying wire could be equal and opposite to that of the external field. [1]

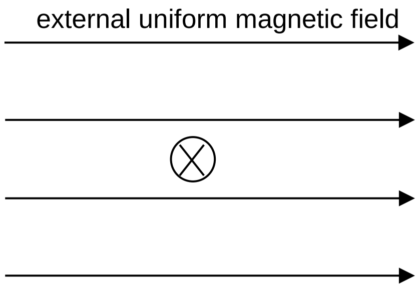


Fig. 4.2

(c) The magnetic field strength B at a perpendicular distance r from a long, straight wire carrying current I is given by

$$B = \frac{\mu_O \, I}{2\pi \, r}.$$

where $\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}.

The point P in **(b)** is found to be 15.0 cm from the centre of the wire for an external magnetic field strength of 2.0 x 10^{-5} T.

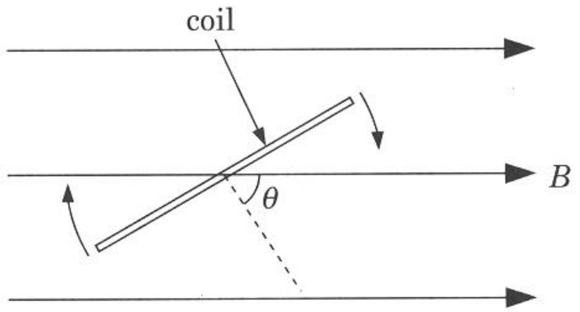
(i) Deduce the current flowing through the wire.

current = ……………… A [3]

(ii) Hence, determine the force per unit length acting on the wire.

force per unit length = ………………… N m^{-1} [2]

(d) A rectangular coil of dimensions 30 mm x 10 mm with 25 turns and carrying a current of 2.0 A is placed in a uniform magnetic field of strength 55 mT. The normal of the coil makes an angle θ to the magnetic field as shown in Fig. 4.3.



Plan (top) view

Fig. 4.3

Determine

(i) the resultant force on the coil when its plane is parallel to the magnetic field.

resultant force = …………….. N [1]

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(ii) the resultant torque on the coil when its normal is making an angle θ of 30^o to the magnetic field.

resultant torque = …………….. N m [2]

5 Fig. 5.1 below shows some of the possible energy levels of an electron orbiting inside a particular atom. The lowest possible energy level is Level 1. The diagram below is not drawn to scale.

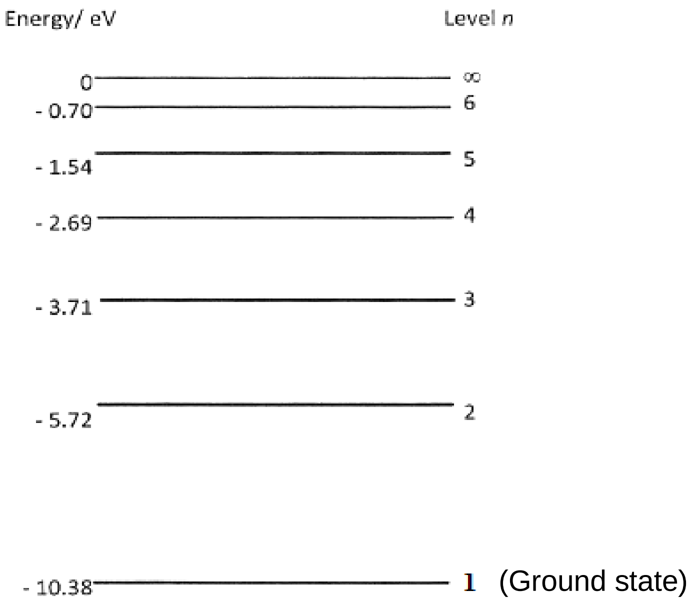

Fig. 5.1 (not to scale)

(a) Explain the significance of the energy levels having negative values.

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

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

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(b) **(i)** The electron makes a transition from level 2 to level 1. Calculate the frequency of the emitted photon.

frequency = ………………………………. Hz [1]

(ii) State and explain whether photons with frequency calculated in **(b)(i)** would be emitted if photons with energy of 4.80 eV are incident on the atoms at the ground state.

……..……………………………………………………………………………………………

……..……………………………………………………………………………………………

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

(iii) The atoms in their ground states are bombarded by electrons with energy of 7.60 eV, resulting in emission of photons. On Fig. 5.1, draw all the possible transitions that are associated with these emitted photons. [1]

(c) Determine the de Broglie wavelength λ of the electrons in **(b)(iii)**.

λ = ………………………………. m [2]

Section B

Answer **two** of the questions in this section.

6 A girl falls from rest on to the horizontal surface of a trampoline.

The graph in Fig. 6.1 shows the variation with time t of the net force F exerted on the girl before, during and after contact with the trampoline.

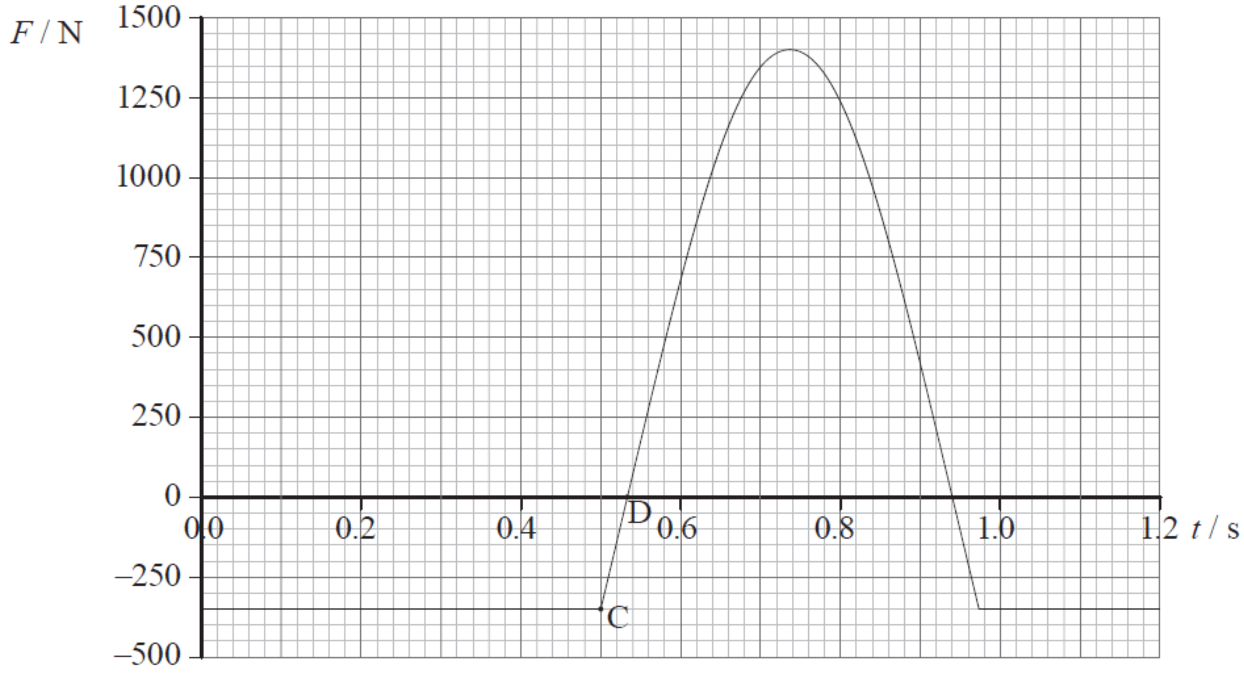

Fig. 6.1

(a) The girl first makes contact with the trampoline at point C.

Use the data from the graph to calculate

(i) the mass of the girl,

mass = ... kg [1]

(ii) the speed of the girl just before she lands on the trampoline,

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

(iii) the initial height above the surface of trampoline from which the girl falls,

height = ………………………………. m [2]

(iv) the magnitude of the maximum acceleration of the girl for the time she is in contact with the trampoline.

maximum acceleration = ………………………………. m s^{-2} [1]

(b) The girl has a maximum speed at D as shown on the graph in Fig. 6.1.

For the time between points C and D,

(i) explain why the speed of the girl is increasing.

……...…………………………………………………………………………………………

……...…………………………………………………………………………………………

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

(ii) estimate the change in momentum of the girl.

change in momentum = ………………………………. kg m s^{-1} [2]

(iii) Hence, estimate the maximum speed of the girl.

maximum speed = ………………………………. m s^{-1} [2]

(c) The girl is now driving a car of mass m with a constant velocity v. It is then brought to rest in a distance s by a constant frictional force F. Show that its initial kinetic energy is $\frac{1}{2}mv^2$. [2]

(d) The car in **(c)** of mass 850 kg travelling at a constant speed of 12.0 m s^{-1} has a power output of 1800 W.

Determine the total resistive force on the car.

force = ………………………………. N [1]

(e) The same car accelerates from 12.0 m s^{-1} with an initial acceleration of 2.50 m s^{-2}.

Calculate the driving force.

force = ………………………………. N [2]

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(f) After accelerating, the car in **(d)** reaches a constant speed of 36.0 m s^{-1}. The resistive force on the car is proportional to its speed squared.

Calculate

(i) the new resistive force on the car at 36.0 m s^{-1},

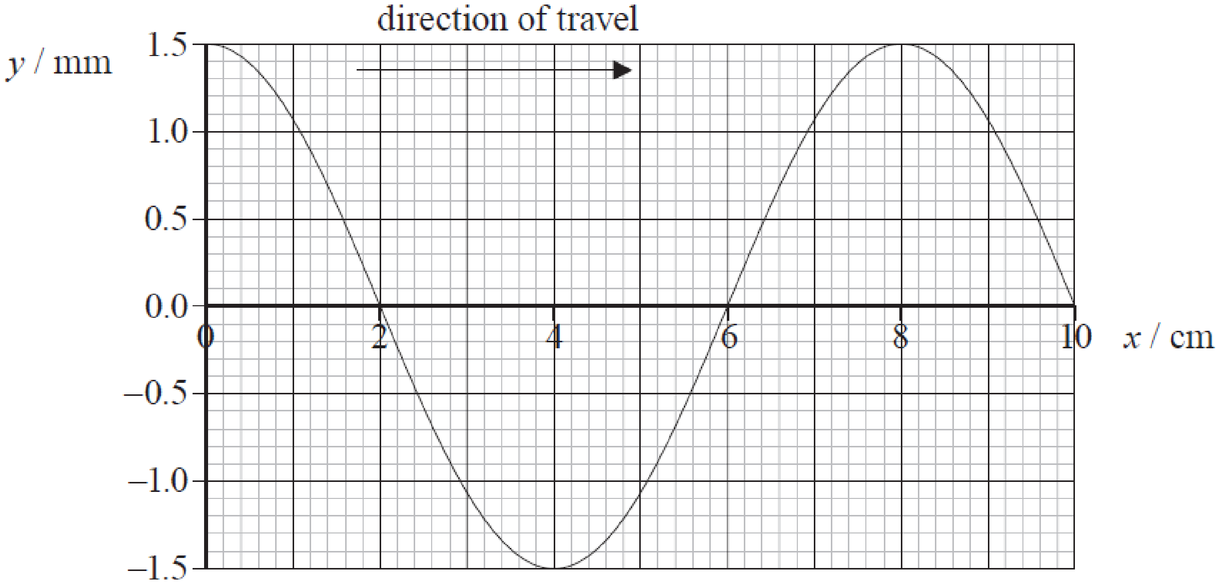
force = ………………………………… N [2]

(ii) the new power output.

power = ………………………………… W [1]

7 A progressive wave is created on a string. The wave travels in the *x* direction. The two graphs in Fig. 7.1 show the variation with distance *x* of the displacement *y* of the string. Graph 1 corresponds to time $t = 0$ and graph 2 corresponds to time $t = 0.20$ s.

Graph 1 $(t = 0)$



Graph 2 $(t = 0.20\,\text{s})$

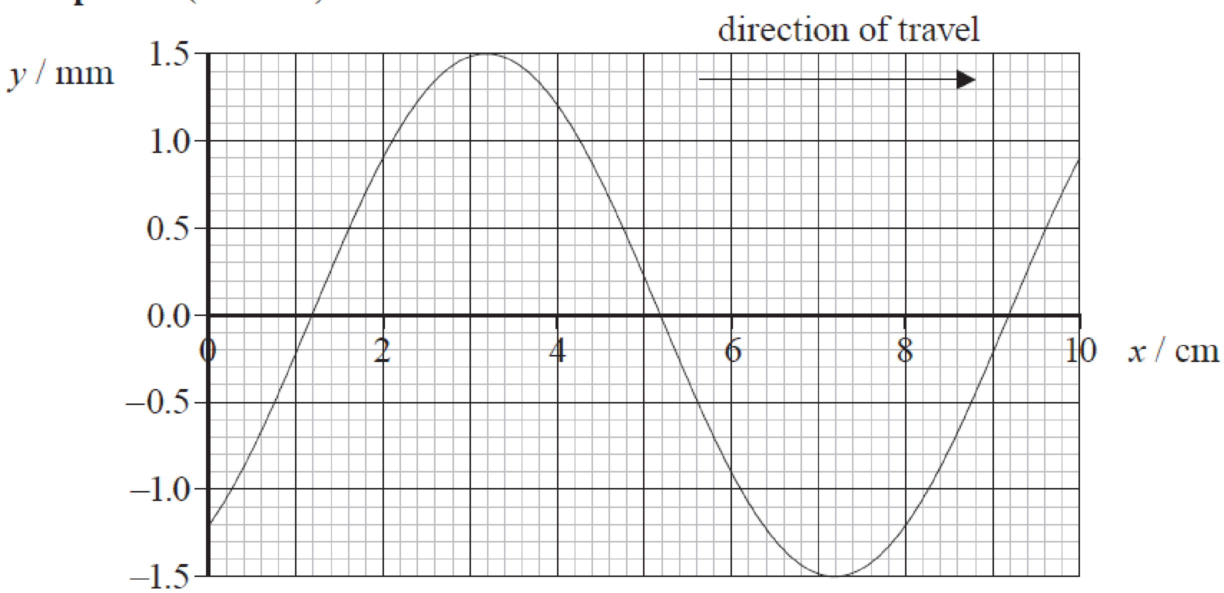


Fig. 7.1

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The period of the wave is longer than 0.20 s.

(a) Use Fig. 7.1 determine, for this wave,

(i) the amplitude,

amplitude = ………………………………. mm [1]

(ii) the wavelength,

wavelength = ………………………………. cm [1]

(iii) the speed

speed = ………………………………. m s^{-1} [2]

(b) One end of a string is then attached to a wall. A student creates a **single** pulse in the string that travels to the right as shown in Fig. 7.2.

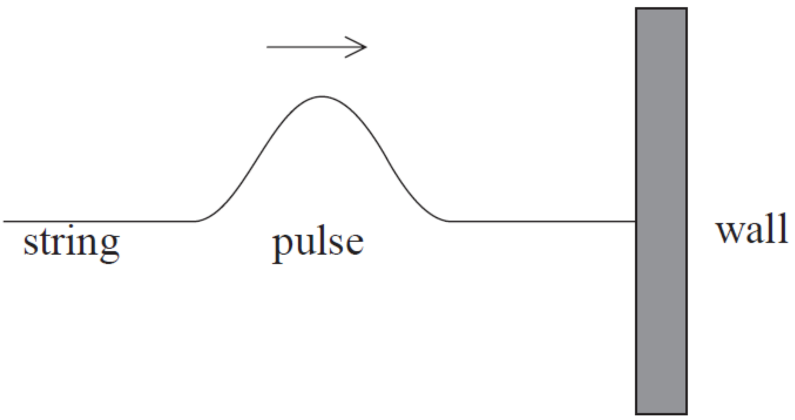

Fig. 7.2

(i) On Fig. 7.2, sketch the shape and size of the pulse after it has been reflected from the wall. [1]

(ii) By reference to Newton's third law, explain your sketch in **(b)(i)**.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(c) State two features of a standing wave that distinguish it from a progressive wave.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(d) The free end of the string in **(b)** is now made to oscillate with frequency *f* such that a standing wave is established on the string. Fig. 7.3 illustrates the standing wave.

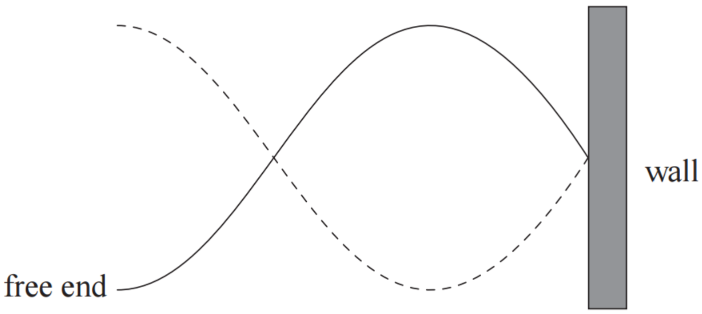

Fig. 7.3

(i) Explain, by reference to the Principle of Superposition, the formation of a standing wave.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(ii) The length of the string is 3.0 cm and the frequency of vibration of the string is 360 Hz. Calculate the speed of the wave on the string.

speed = ………………………………. m s^{-1} [2]

(e) The apparatus illustrated in Fig. 7.4 is used to demonstrate two source interference using light.

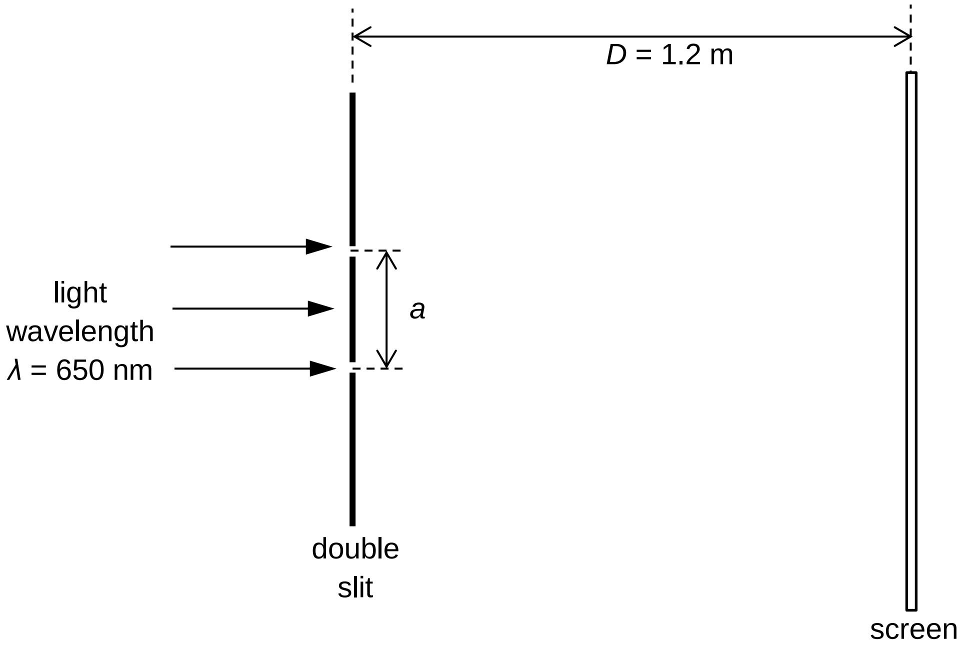

Fig. 7.4 (not to scale)

Light of wavelength λ = 650 nm is incident normally on the double slit arrangement. The interference fringes formed are viewed on a screen placed parallel to the plane of the double slit with D = 1.2 m. The slit separation is 1.1 mm.

(i) Calculate the separation of the fringes.

separation = ………………………………. mm [2]

(ii) State the effect, if any, on the separation, intensity and appearance of the fringes observed on the screen when the following changes are made, separately, to the double slit arrangement.

1. The width of each slit is increased but the slit separation remains constant.

....

....

....[3]

2. Light is incident at a small angle to the normal of plane of the double slit as shown in Fig. 7.5.

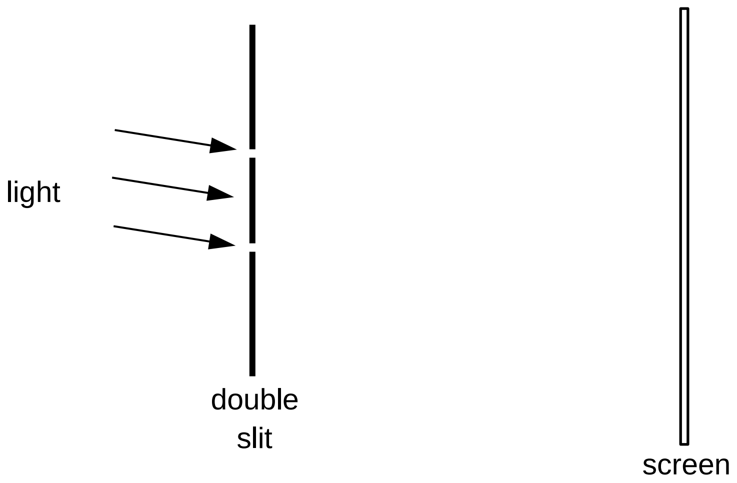

Fig. 7.5 (not to scale)

....

....

....[2]

8 (a) A wire that has resistance R is cut into two equal pieces. The two parts are joined in parallel. Determine, in terms of R, the resistance of the combination.

resistance = …………….. [2]

(b) A lamp of constant resistance operates at normal brightness when the potential difference across it is 4.0 V and the current through it is 0.20 A. To light up the lamp, a student uses the circuit shown in Fig. 8.1.

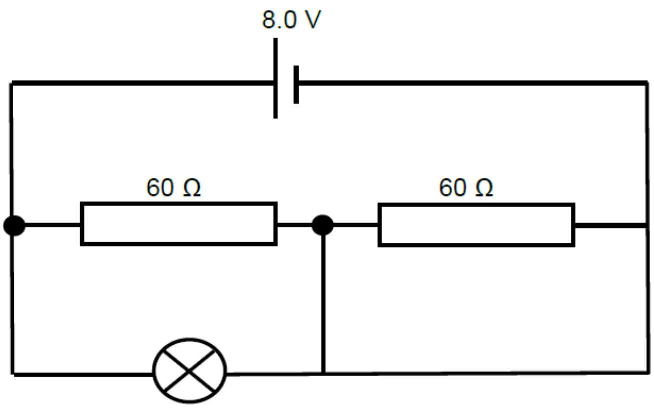

Fig. 8.1

(i) Calculate the resistance of the light bulb at normal brightness.

resistance = ………… Ω [1]

(ii) Calculate the potential difference across the light bulb.

potential difference = ………… V [2]

(iii) Calculate the current through the light bulb.

current = ………… A [1]

(iv) Hence state and explain whether the light bulb will light up.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………… [3]

(c) Explain what is meant by "*internal resistance*" of a battery.

…………………………………………………………………………………………………

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

(d) Fig 8.2 shows two circuits **X** and **Y** that were used by a student to test a battery of three identical cells. In circuit **X** there was no load resistor. In circuit **Y** a load resistor was connected. You can assume that the meters in the circuits were ideal. The meter readings are shown on each circuit.

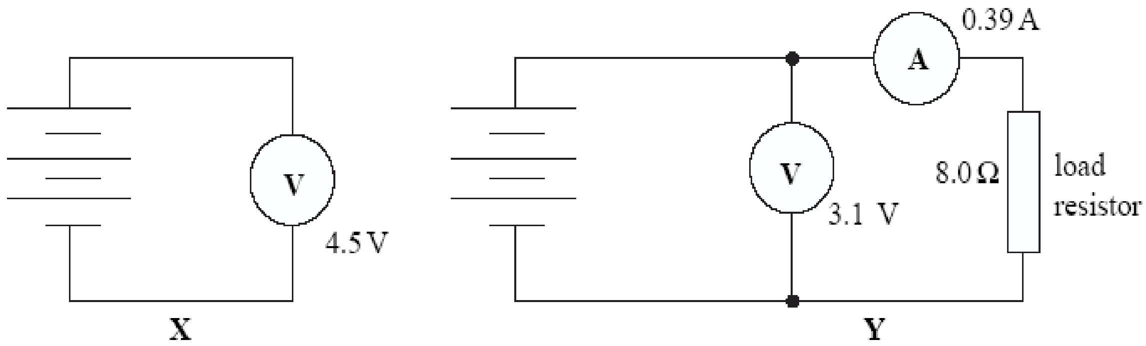

Fig 8.2

(i) Explain the difference between the voltages recorded in the two circuits.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(ii) Calculate the internal resistance of a *single* cell.

internal resistance = …………. Ω [3]

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(iii) One of the cells in the battery is reversed. Determine the new voltmeter reading in :

1. circuit **X**

voltmeter reading = ……………… V [1]

2. circuit **Y**

voltmeter reading = ……………… V [2]

(iv) The load resistor in circuit **Y** is replaced by an unknown device. The student found that the voltmeter reading decreases as the device becomes hotter. Suggest what the device is.

……………………………………………………………………………………… [1]

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