RIVER VALLEY HIGH SCHOOL
YEAR 6 PRELIMINARY EXAMINATIONS II

H1 PHYSICS 8866

PAPER 2

23 SEP 2015

2 HOUR

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.

Candidates answer on the Question Paper.

Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

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

FOR EXAMINERS' USE	
Section A	
1	**8**
2	**6**
3	**8**
4	**18**
Section B	
5	**20**
6	**20**
7	**20**
TOTAL	**80**

This Question Paper consists of **19** 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,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

<u>**Section A (40 marks)**</u>

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

1 A student throws a ball from point S to a friend at point F. The path of the ball is shown in Fig. 1.1.

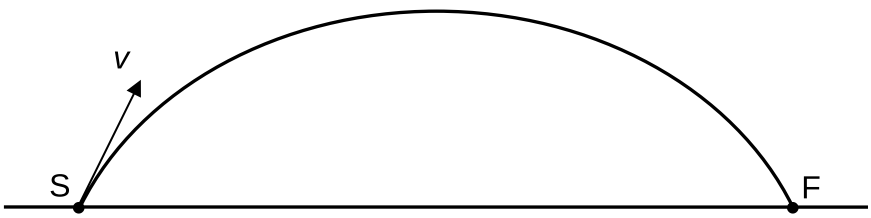

Fig. 1.1

The points S and F are on the same horizontal level. The ball is thrown from point S with velocity v, represented by the vector arrow shown on Fig. 1.1.
Air resistance is negligible.

(a) Sketch velocity-time graphs to represent the ball's vertical component of velocity v_V, and horizontal component of velocity v_H, between point S and point F.

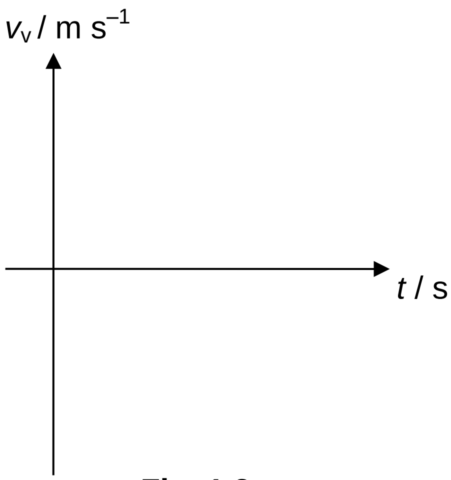

Fig. 1.2

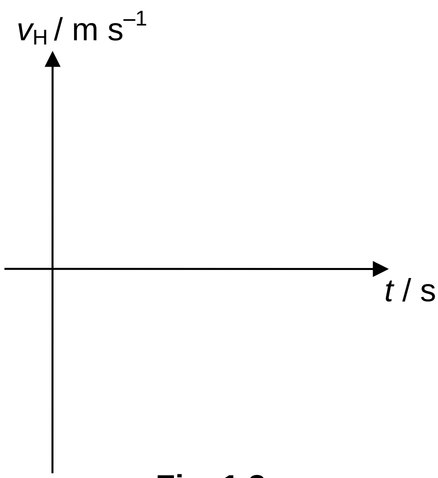

Fig. 1.3

[2]

(b) On Fig.1.2 and Fig.1.3, sketch and label clearly the velocity-time graphs to represent the ball's vertical component of velocity v_V, and horizontal component of velocity v_H, between point S and point F when air resistance is **not** negligible. [2]

(c) Explain the gradient of v_v in the presence of air resistance as compared to the case where air resistance is negligible.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(d) State and explain whether the time taken for the journey up is longer than the journey down in the presence of air resistance.

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

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

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

2 **(a)** State the conditions for a system to be in equilibrium.

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

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

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

(b) A fire engine carries a ladder of length 20.0 m and weighs 2800 N. The ladder is pivoted at one end R as shown in Fig. 2.1.

The ladder is raised into position by a force F applied by a hydraulic piston at Q. QR is 8.0 m and the force exerted by the piston makes an angle of 40° with the ladder. Assume the centre of gravity of the ladder is at its middle.

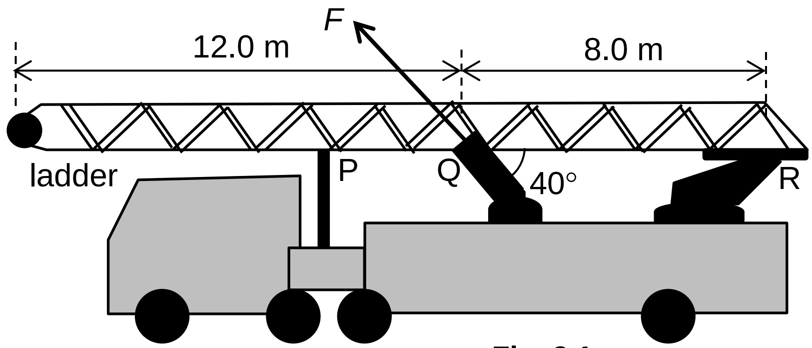

Fig. 2.1

(i) Show the forces acting on the ladder by completing the free body diagram in Fig. 2.2 when the force F is just sufficient to lift the ladder off the support bracket at P.

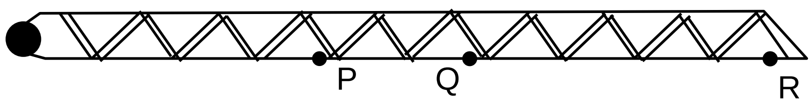

Fig. 2.2

[2]

(ii) Calculate the magnitude of F needed to just lift the ladder off the support bracket at P.

F = ……………………….. N [2]

3 A 5.0 kg ornament hangs by a wire and is 1.5 m from the ceiling. It is suddenly hit by a toy missile of mass 3.0 kg travelling horizontally at 12 m s^{-1}. The missile embeds itself in the ornament after hitting it.

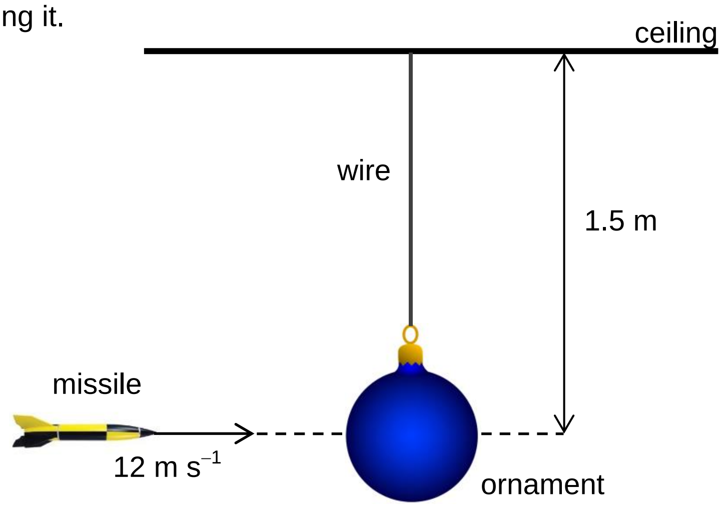

Fig. 3.1

(a) Immediately after the collision, calculate the speed of the missile and the ornament.

speed = ……………….. m s^{-1} [2]

The objects (missile and ornament) swing to a maximum height *h* at point P after the collision as shown in Fig. 3.2.

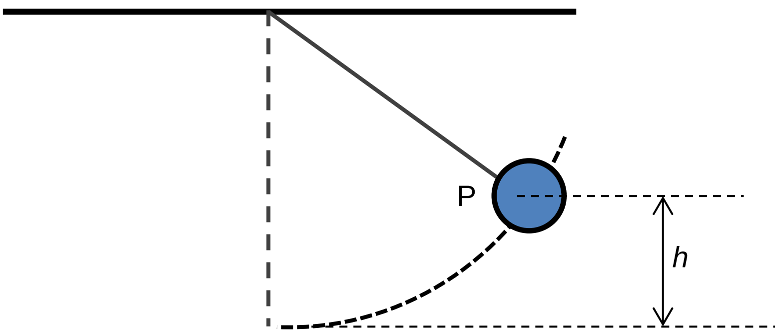

Fig. 3.2

(b) Calculate the maximum height *h*.

h = ……………….. m [2]

(c) **(i)** A student suggests that the efficiency of the system be given by the ratio $\frac{E_P}{E_K}$

where E_P is the gain in gravitational potential energy of the objects at their highest point P and E_K is the initial kinetic energy of the missile.

Suggest how the following quantities will change when the same experiment is conducted on another planet with an acceleration of free fall **half** that on Earth's surface :

1. efficiency,

....

....

2. height h.

....

.... [3]

(ii) The wire is suddenly cut when the objects are at point P.
Sketch the path of the objects on Fig. 3.2 after the wire is cut. [1]

4 **(a)** **(i)** A metal wire of constant resistance is used in an electric heater.
In order not to overload the circuit for the heater, the supply voltage to the heater is reduced from 230 V to 220 V.
Determine the percentage reduction in the power output of the heater.

reduction = ……………….. % [2]

(ii) Sketch a labelled diagram of a feasible electrical circuit which can reduce the supply voltage to the heater.
Your circuit should include the 230 V supply, the electric heater and any necessary components.

[2]

(b) A uniform wire AB of length 100 cm is connected between the terminals of a cell of e.m.f. 1.5 V and negligible internal resistance, as shown in Fig. 4.1.

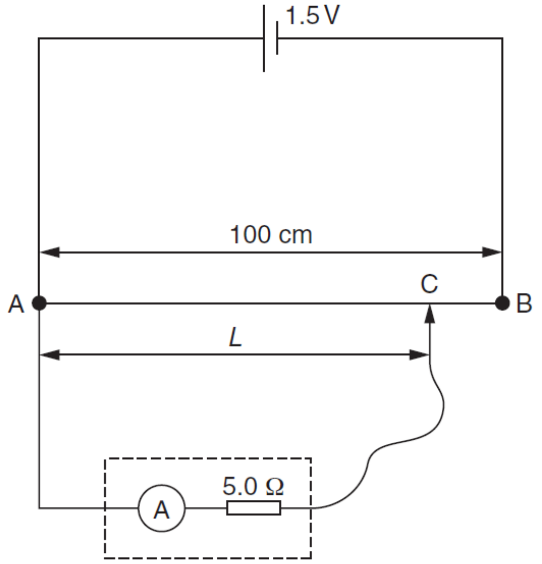

Fig. 4.1

An ammeter of internal resistance 5.0 Ω is connected to end A of the wire and to a contact C that can be moved along the wire.

Determine the reading on the ammeter for the contact C placed

(i) at A,

reading = …………………… A [1]

(ii) at B.

reading = …………………… A [1]

(c) Using the circuit in **(b)**, the ammeter reading I is recorded for different distances L of the contact C from end A of the wire. Some data points are shown on Fig. 4.2.

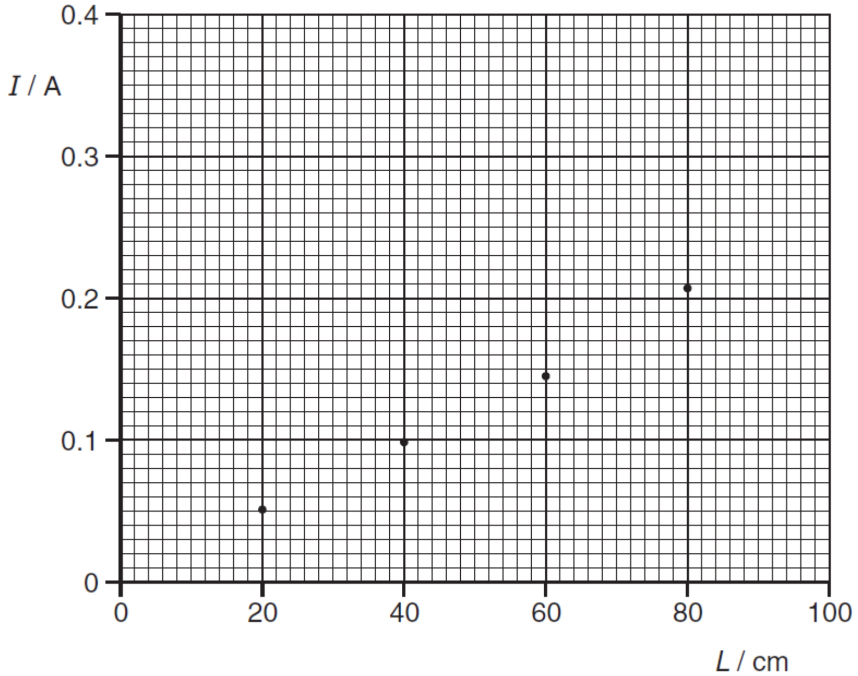

Fig. 4.2

(i) Use your answers in **(b)** to plot data points on Fig. 4.2 corresponding to the contact C placed at end A and at end B of the wire. [1]

(ii) Draw a line of best fit for all of the data points and hence determine the ammeter reading for contact C placed at the midpoint of the wire.

reading = …………………… A [2]

(iii) Explain why the ammeter reading I increases when L is increased.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………… [2]

(iv) Use your answer in **(c)(ii)** to calculate the potential difference between A and the contact C when the contact is placed at the midpoint of AB.

potential difference = …………………… V [2]

(d) Explain why, although the contact C is at the midpoint of wire AB, the answer in **(c)(iv)** is not numerically equal to one half of the e.m.f. of the cell.

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

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

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

(e) Suggest, with a reason, how the data points in Fig. 4.2 would change if the 1.5 V cell has an internal resistance.

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

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

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

(f) Using Fig. 4.2, sketch a labelled graph of potential difference across the 5.0 Ω against *L*.

[1]

Section B (40 marks)

Answer **any two** questions in this section in the spaces provided.

5 **(a)** Explain the *principle of superposition*.

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

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

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

(b) Fig. 5.1 shows the variation with time *t* of the displacement *y* of a wave W as it passes a point P. The wave has intensity I.

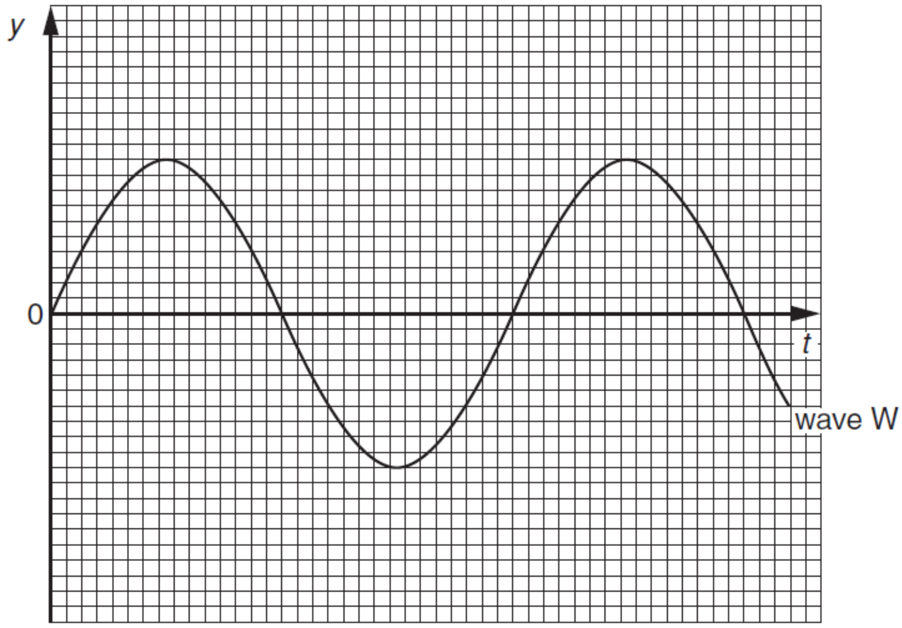

Fig. 5.1

A second wave X of the same frequency as wave W also passes point P.
This wave has intensity ¼ I. The phase difference between the two waves is 60°.

On Fig. 5.1, sketch the variation with time *t* of the displacement *y* of wave X. [2]

Hence, sketch and label clearly the resultant wave passing point P. [2]

(c) In a double-slit interference experiment using unpolarised light of wavelength 540 nm, the separation of the slits is 0.650 mm. The fringes are viewed on a screen at a distance of 2.80 m from the double slit, as illustrated in Fig. 5.2 (not to scale).

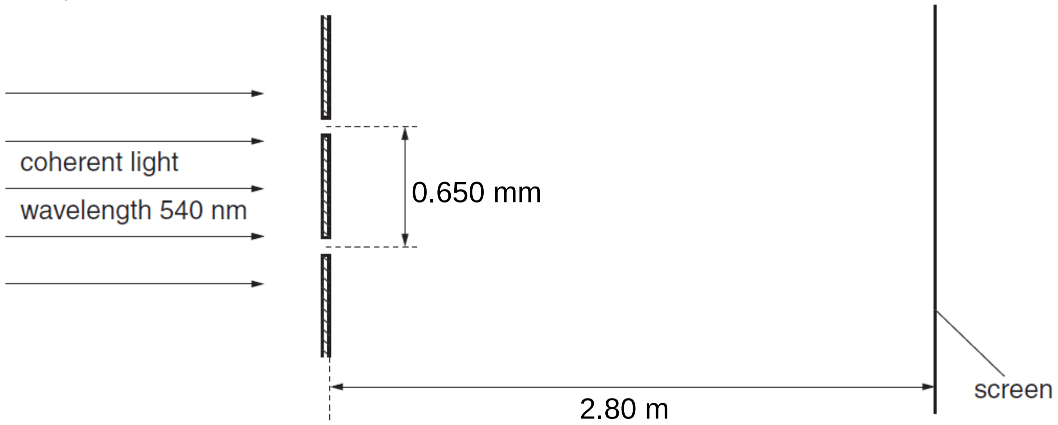

Fig. 5.2 (not drawn to scale)

(i) Calculate the separation of the fringes observed on the screen.

separation = ………………… mm [3]

(ii) State the effect, if any, on the appearance of the fringes observed on the screen when the following changes are made, separately, to the double-slit arrangement in Fig. 5.2.

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

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………………… [2]

2. One of the slits is covered with a polariser.

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………………… [2]

(d) Red light of wavelength 650 nm is incident normally on a diffraction grating having 600 lines per millimetre, as illustrated in Fig. 5.3.

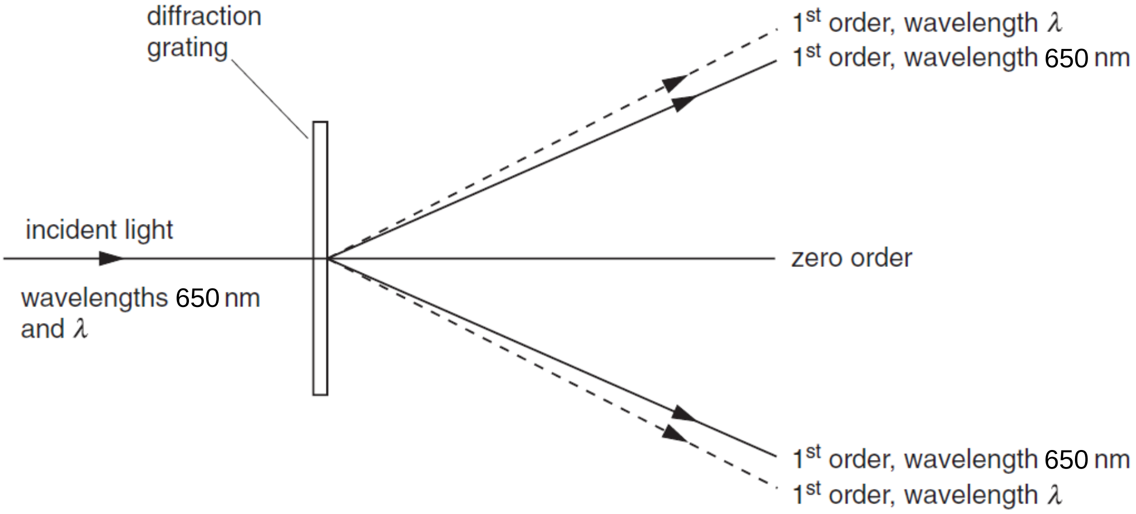

Fig. 5.3

Red light of another wavelength λ is also incident normally on the grating. The first order diffracted light of both wavelengths is illustrated in Fig. 5.3.

(i) Calculate the number of orders of diffracted light of wavelength 650 nm that are visible on each side of the zero order.

number = ………………… [4]

(ii) State and explain

1. whether λ is greater or smaller than 650 nm,

……………………………………………………………………………………..

…………………………………………………………………………………… [1]

2. in which order of diffracted light there is the greatest separation of the two wavelengths.

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………………… [2]

6 **(a)** **(i)** Define magnetic flux density.

……………………………………………………………………………………….

………………………………………………………………………………………..

……………………………………………………………………………… [2]

(ii) Using the definition of magnetic flux density in **(a)(i)**, express the unit of magnetic flux density in terms of base SI units.

base SI units of magnetic flux density = ………………………… [2]

(b) A square coil ABCD with length 10.0 cm and 200 turns is placed in a region of uniform magnetic field of 0.18 T as seen in Fig. 6.1.

The current in the coil is 5.0 A.

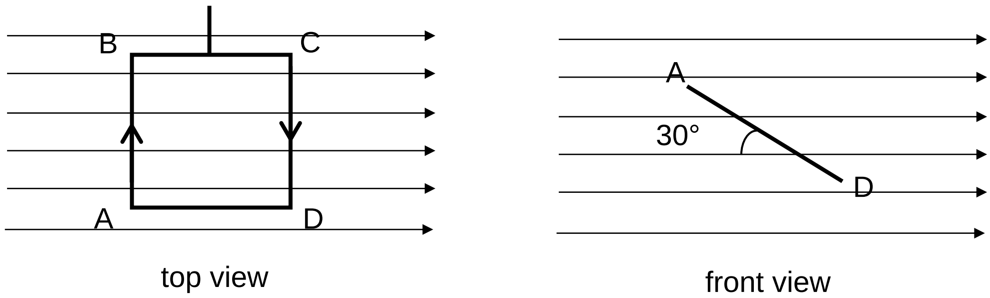

Fig. 6.1

(i) Draw two arrows on the *front* view of Fig. 6.1 to indicate the direction of the magnetic forces acting wires AB and CD. [1]

(ii) Calculate the magnetic force acting on side AB of the square loop.

magnetic force = ………………………… N [2]

(iii) Hence determine the torque of the couple acting on the coil at that instant due to the magnetic forces.

torque = ………………………… N m [2]

(c) **(i)** A simplified *front* view of Fig. 6.1 is shown below in Fig. 6.2.

On Fig. 6.2, sketch the magnetic field lines around the wires AB and CD due to the current flowing in the coil.

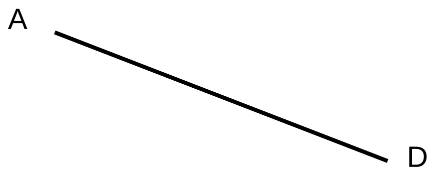

Fig. 6.2

[2]

(ii) A simplified *top* view of Fig. 6.1 is shown below in Fig. 6.3.

On Fig. 6.3, draw two arrows to indicate direction of two *other* magnetic forces acting on wires AB and CD.

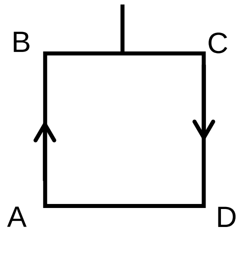

Fig. 6.3

[1]

(iii) Explain the origin and direction of these two magnetic forces.

…………………………………………………………………………………...

…………………………………………………………………………………...

……………………………………………………………………………… [2]

(d) Fig. 6.4 shows a magnified view of wire AB with an electron drifting from B to A.

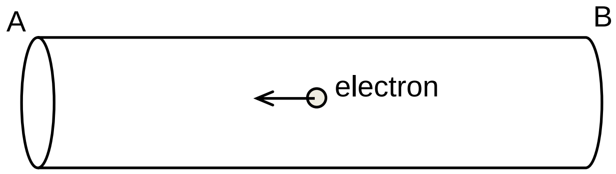

Fig. 6.4

(i) Sketch an arrow to indicate the magnetic force acting on the electron in Fig. 6.4. [1]

(ii) Derive an expression for the magnetic force acting on the electron in terms of its velocity *v*, charge *e* and the magnetic flux density *B*.

……………………………………………………………………………… [2]

(iii) An e.m.f. is induced in the wire AB due to the magnetic forces on electrons moving through AB.
Draw '+' and '–' on Fig. 6.4 to indicate the polarity of this induced e.m.f. [1]

(iv) After some time, a steady state is reached.
Suggest how the magnitude of the induced e.m.f. changes and why a steady state is reached.

…………………………………………………………………………………...

…………………………………………………………………………………...

……………………………………………………………………………… [2]

7 **(a)** By reference to the photoelectric effect, state what is meant by

(i) *a photon,*

....

.... [2]

(ii) *work function* of a surface.

....

.... [1]

(b) In an experiment to investigate the photoelectric effect, a student measures the wavelength λ of the light incident on a metal surface and the maximum kinetic energy E_{max} of the emitted electrons. The variation with E_{max} of λ is shown in Fig. 7.1.

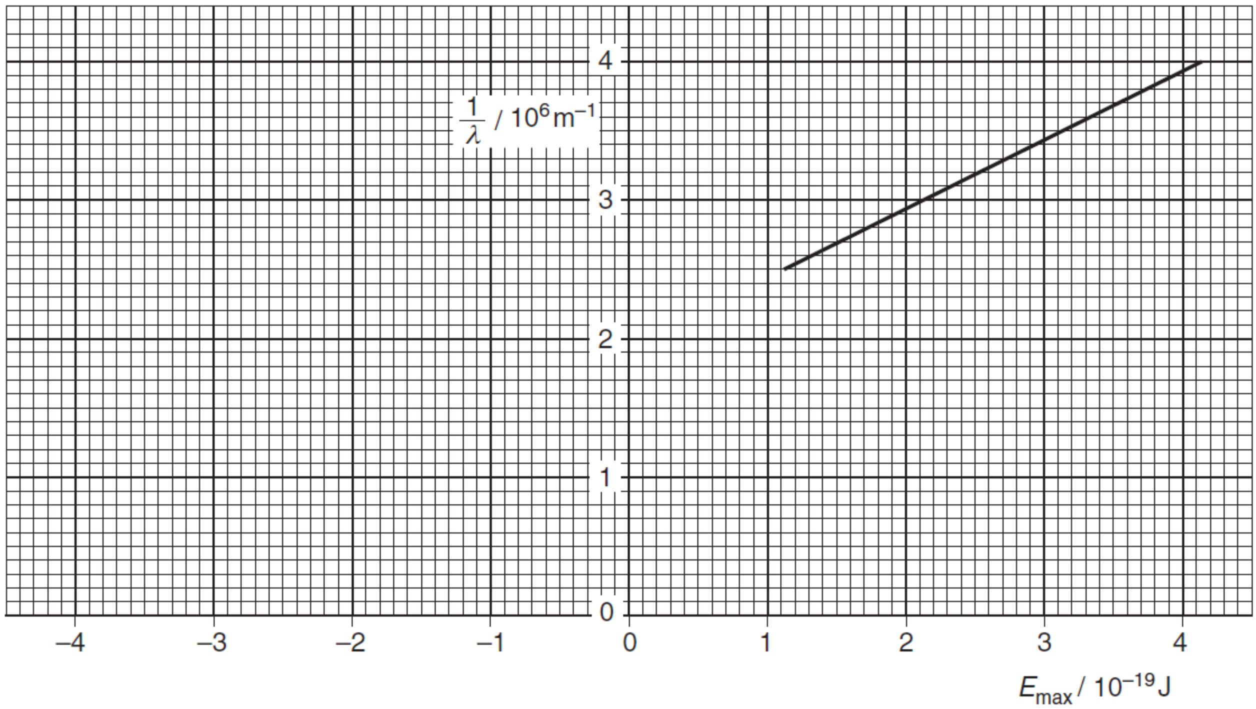

Fig. 7.1

(i) State an equation, in terms of λ, E_{max} and work function Φ, to represent conservation of energy for the photoelectric effect.
Explain any other symbols you use.

....

.... [2]

(ii) Use your answer in **(b)(i)** and Fig. 7.1 to deduce

1. the threshold frequency of the metal surface, f_0,

f_0 = ………………………… Hz [3]

2. a value for the Planck constant, expressing your answer to an appropriate number of significant figures.

Planck constant = ………………………… J s [3]

(iii) On Fig. 7.1, sketch a second graph to represent the results for an experiment using a metal plate of higher work function.
Label this graph **W**. [2]

(c) State and explain the effect on the emitted electrons if the intensity of the light is increased while keeping the frequency constant.

……………………………………………………………………………………………….

……………………………………………………………………………………………….

……………………………………………………………………………………………….

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

(d) Using Fig. 7.1 or otherwise, calculate the de Broglie wavelength of the emitted electrons when the wavelength of the incident light is 370 nm.

de Broglie wavelength = ……………………….. m [5]

END OF PAPER

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