HWA CHONG INSTITUTION
JC2 Preliminary Examinations
Higher 1

CANDIDATE NAME		**CT GROUP**	13S
CENTRE NUMBER		**INDEX NUMBER**	

PHYSICS **8866/02**

Paper 2 Structured Question **2 September 2014**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

INSTRUCTIONS TO CANDIDATES

Write your **Centre number**, **index number, name** and **CT class** clearly on all 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, paperclips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Section B

Answer any **two** questions.

Circle the questions attempted in the table on the cover page.

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

INFORMATION FOR CANDIDATES

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

You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
1	/ 5
2	/ 7
3	/ 10
4	/ 7
5	/11
6	/20
7	/20
8	/20
Deductions	
Total	/ 80

Data

speed of light in vacuum,

$c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge,

$e = 1.60 \times 10^{-19}$ C

the Planck constant,

$h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant,

$u = 1.66 \times 10^{-27}$ kg

rest mass of electron,

$m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton,

$m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall,

$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2 s$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + ...$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + ...$

Section A

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

1 You are provided with 2 types of resistors, one type of value 300 Ω with a percentage uncertainty of 10% and another type of value 330 Ω with a percentage uncertainty of 5%.

(a) If two of the 300 Ω resistors are placed in series, work out the value of their total resistance with its associated uncertainty.

Total resistance =………………. ± ………..…Ω **[2]**

(b) If two of the 330 Ω resistors are now connected in parallel, work out both the *maximum* and *minimum* resistance of this combination.

Maximum value = …………………..Ω

Minimum value = …………………..Ω **[3]**

2 An object is launched at a speed of 30 m s^{-1} at an angle of 30^{O} from a horizontal surface as shown in Fig. 2.1. Ignore air resistance.

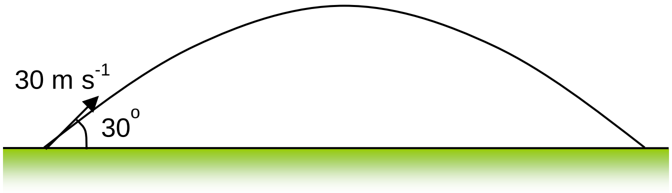

Fig. 2.1

(a) Find the time taken for the object's entire journey.

time taken = ……………..…… s **[2]**

(b) Hence, or otherwise, find the range of the launch.

range = ……………..……..….. m **[1]**

(c) State another angle with which the object can be launched such that it will travel the same range in (b).

angle = ………..…. ° **[1]**

(d) Sketch the variation of the vertical component of the velocity with time on Fig. 2.2. Label it as **A**.

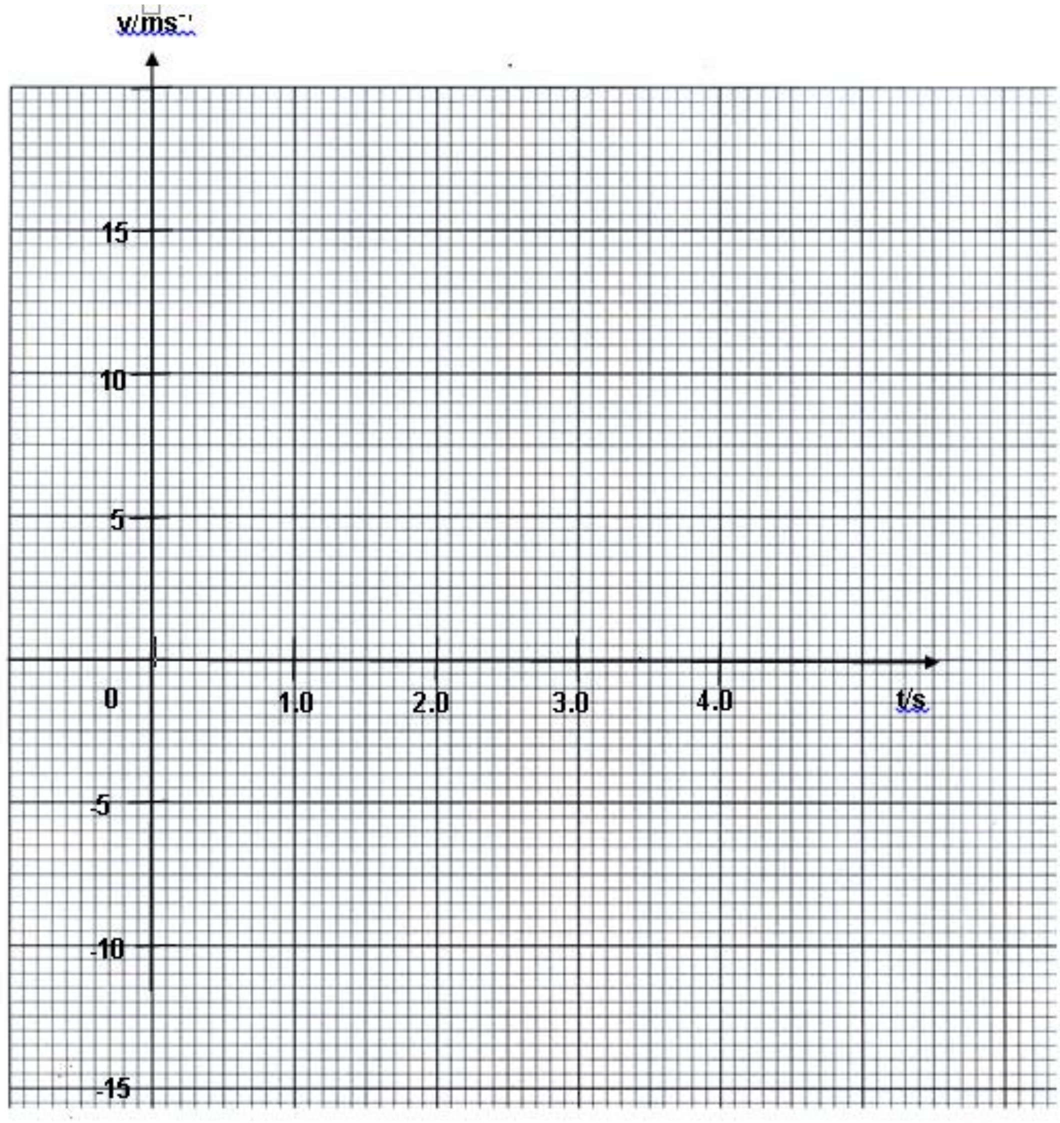

Fig. 2.2 **[1]**

(e) If air resistance is significant, sketch the variation of the vertical component of the velocity with time on Fig. 2.2. Label it as **B**. . **[2]**

3 **(a)** While Alvin drives through a long underground tunnel in Singapore, it is obvious that nothing can be seen a few metres into the tunnel without additional sources of light. However, his radio continues playing songs from Gold 90.5FM, which is broadcast at a frequency of 90.5 MHz, and his Global Positioning System (GPS) continues to display his car position. Further into the tunnel, the GPS reports that it has lost its connection with the satellites but his radio continues to play.

(i) State the type of electromagnetic waves that Alvin's GPS uses to communicate with its satellites. Explain how you come to this conclusion.

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

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

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

……………………………………………………………………………………………..

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

One particular day, the traffic was particularly heavy in the tunnel. When driving very slowly, Alvin finds that there were many points in the tunnel where the radio connection appears to be lost. Alvin decided to count those points and found there were exactly 400 points.

(ii) Assuming that the tunnel is perfectly straight, calculate the distance between the first and the last point where the radio connection is lost.

distance = ………………… m **[2]**

(b) **(i)** State two conditions that must be satisfied in order that two waves may interfere.

1. ....

2. .... **[2]**

(ii) The apparatus illustrated in Fig. 3.1 is used to demonstrate two-source interference using light.

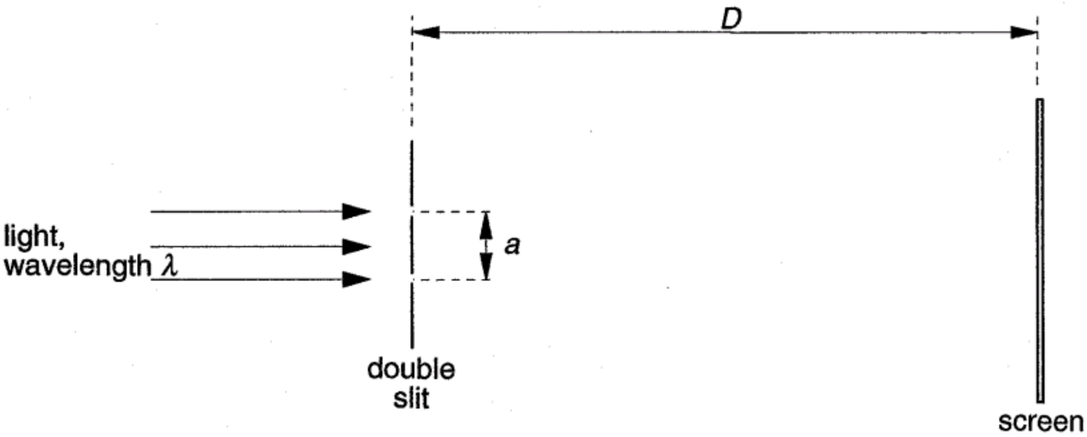

Fig. 3.1 (not to scale)

For a particular experiment, red light of λ = 690 nm is used, with a = 0.333 mm and D = 1.20 m.

1. Calculate the fringe separation.

fringe separation = ... mm **[2]**

2. The slit width of each slit is slightly increased without changing the slit separation.

Describe and briefly explain the effect of this, if any, on your answer in part 1 and any other observable changes.

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....

....

....

.... **[2]**

4 Fig. 4.1 below shows a basic setup to observe the visible absorption spectral lines of gas X.

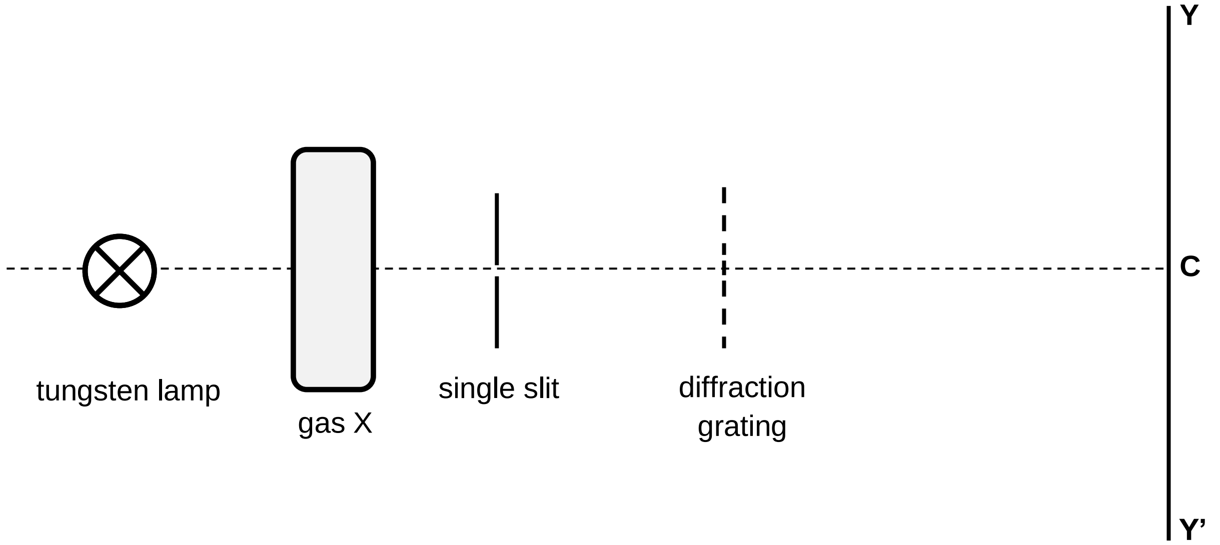

Fig. 4.1

(a) State the function of the following components in the setup.

(i) Tungsten lamp.

.... **[1]**

(ii) Single slit.

.... **[1]**

(b) Fig. 4.2 shows some of the energy levels of an atom of gas X.

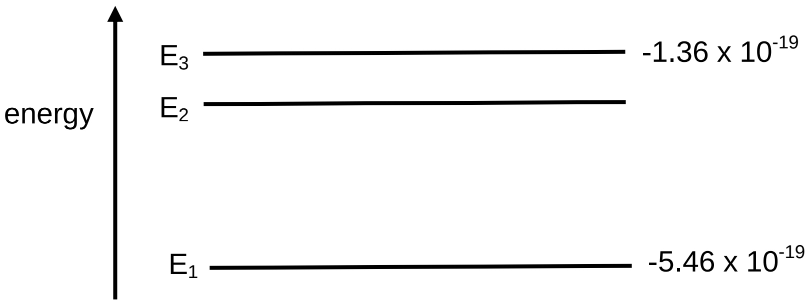

Fig. 4.2 (not to scale)

(i) Using the values of the energy levels E_3 and E_1, shown in Fig. 4.2, show that the frequency of the electromagnetic radiation emitted when an atom of gas X makes a transition between energy levels E_3 and E_1 is $f = 6.18 \times 10^{14}$ Hz.

[1]

(ii) The frequency of radiation emitted when an electron makes a transition between energy levels E_3 to E_2 is 1.6 x 10^{14} Hz. Determine the wavelength of the electromagnetic radiation when an atom of gas X makes a transition between energy levels E_2 and E_1.

wavelength = ………………………………… m **[2]**

(c) State and explain your observation of the first order spectrum on the screen, with reference to setup in Fig. 4.1.

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

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

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

[2]

5 Fig. 5.1 shows the graph of force against extension for a rubber band.

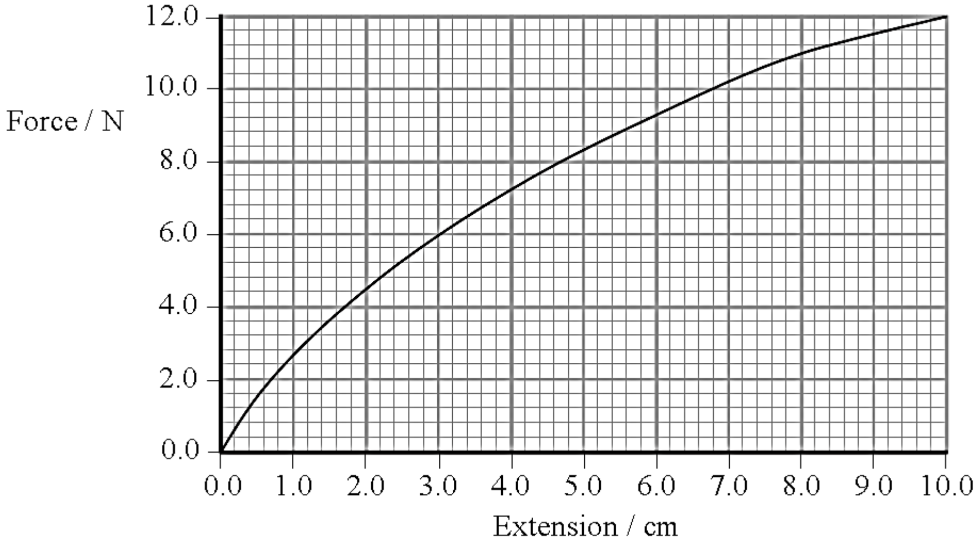

Fig. 5.1

(a) Explain whether the rubber band obeys Hooke's law.

....

....

.... **[2]**

(b) Use the graph to show that the elastic potential energy stored in the rubber band when it has an extension of 10.0 cm is less than 0.8 J.

....

.... **[2]**

(c) Fig. 5.2 shows a graph with two lines. Measurements were obtained by increasing the force on the rubber band to 12 N and then decreasing the force.

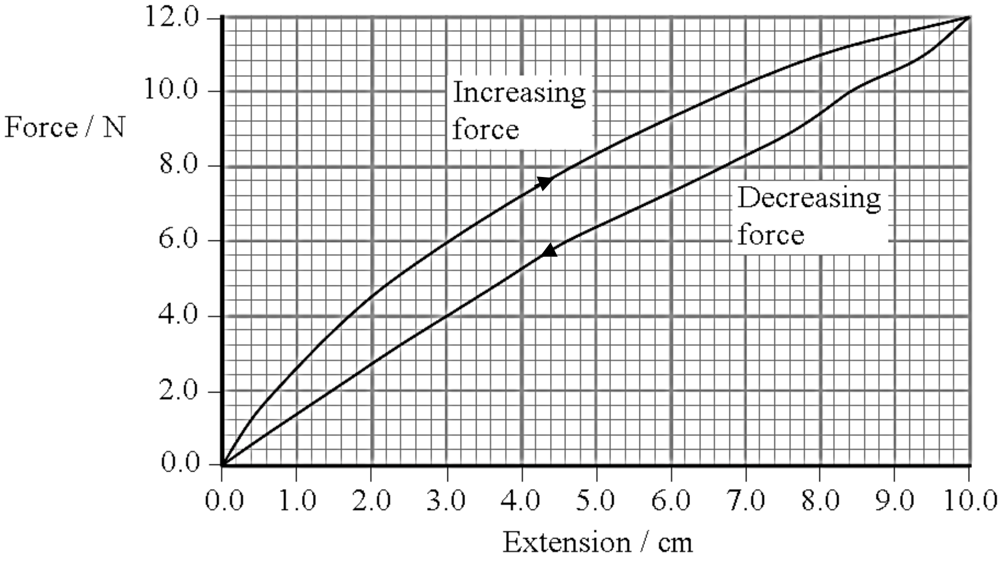

Fig. 5.2

Describe the energy transfers taking place when the force on the rubber band is increased and then decreased.

....

....

....

....

.... **[2]**

(d) Fig. 5.3 shows the rubber band being used to launch a model aeroplane.

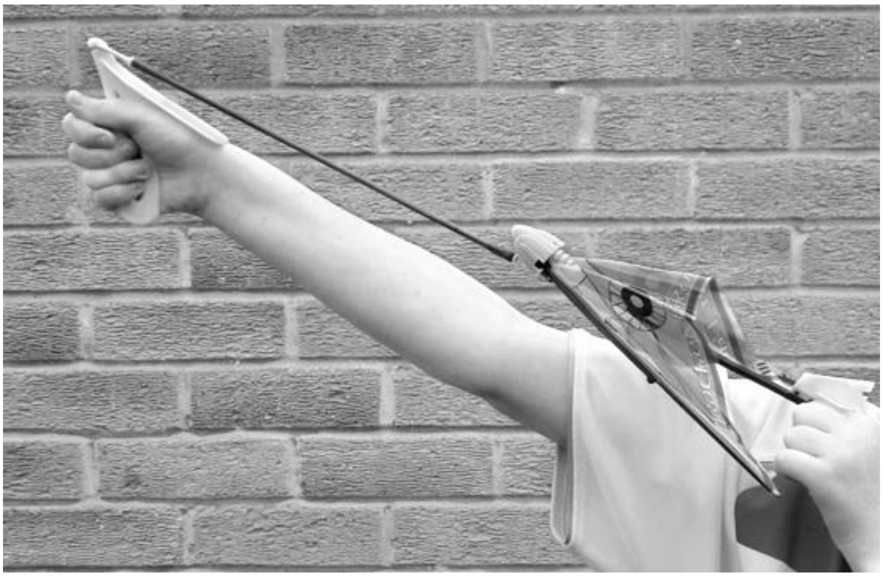

Fig. 5.3

(i) The rubber band is extended by 10.0 cm before being released to launch the aeroplane. Calculate the maximum possible initial speed of the aeroplane given that the mass of aeroplane is 0.027 kg

maximum possible initial speed of the aeroplane = ________________ $m\ s^{-1}$ **[2]**

(ii) The maximum speed of the aeroplane will be less than that calculated in **(i).** Without further calculation, suggest reasons why this is so using Fig. 5.2 as reference.

....

....

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....

....

....

....

.... **[3]**

Section B

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

6 **(a)** A uniform rigid rod of mass 30 kg is attached to a vertical wall by a hinge as shown in Fig. 6.1. The other end of the rod is held to the ceiling by a cable.

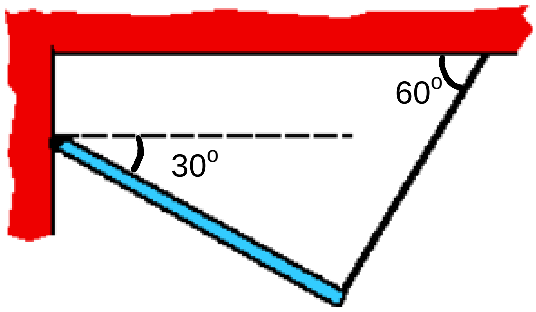

Fig. 6.1

Draw the free body diagram of the forces acting on the rod in Fig. 6.1. *Label and explain* all the forces clearly. **[3]**

(i) Show that the tension T in the cable is 127 N.

[2]

(ii) Determine the force acting on the rod by the hinge.

force = ... N **[4]**

direction = ...

(b) **(i)** State the *principle of conservation of linear momentum*.

....

....

.... **[1]**

(ii) Show how the principle of conservation of momentum can be deduced from Newton's third law.

....

....

....

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....

....

.... **[3]**

(c) A puck of mass m_1 moving on the surface of an ice rink with speed u_1 makes a perfectly elastic head-on collision with a puck of mass m_2 moving with speed u_2 as shown in Fig 6.2.

Fig. 6. 2

(i) In qualitative terms, what can be stated about the subsequent motion of the two bodies as a result of knowing that

1. The collision is head-on,

…………………………………………………………………………………………

…………………………………………………………………………………………

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

2. The collision is perfectly elastic?

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(ii) Given that the speed u_1 is 1.0 m s^{-1} and u_2 is 3.0 m s^{-1}.

1. Find the speed of separation of the two bodies after the collision.

Speed = ……………………….. m s^{-1} **[1]**

2. Immediately after the collision the puck on the left has a velocity of 2.0 m s^{-1} to the left. Calculate the velocity of the other puck immediately after the collision.

Magnitude of velocity = …………………………… m s^{-1}

Direction = ………………………………….. **[2]**

(iii) If the collision had not been head-on, discuss how the motion of the bodies would be different and state whether the velocity of the two pucks would differ from that calculated in **(d) (ii) 2.**

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

7 **(a)** Sketch the current-voltage (*I*-*V*) characteristics of

(i) a metallic conductor at a constant temperature, **[1]**

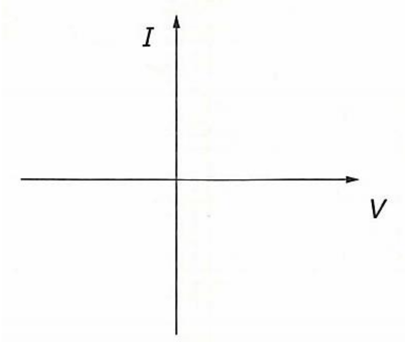

Fig 7.1

(ii) An ideal semiconductor diode. **[2]**

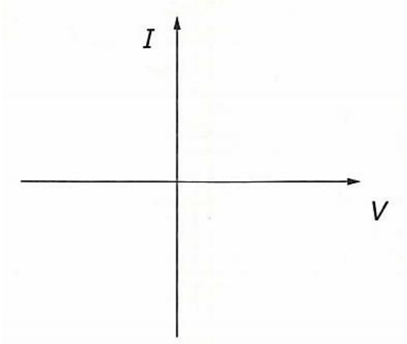

Fig 7.2

(b) **(i)** Define *potential difference*.

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

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

(ii) Distinguish between potential difference and e.m.f. in terms of energy considerations.

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

(c) A fully charged car battery has an e.m.f. of 12 V and an internal resistance of 0.026 Ω. This battery can deliver a constant current of 2.3 A for a period of 6.0 hours.

(i) Calculate the total number of electrons passing through the battery in a time of 6.0 hours.

number = …………………… **[2]**

(ii) The fully charged car battery is connected to a starter motor, four sidelights and two headlights as shown in Fig. 7.3.

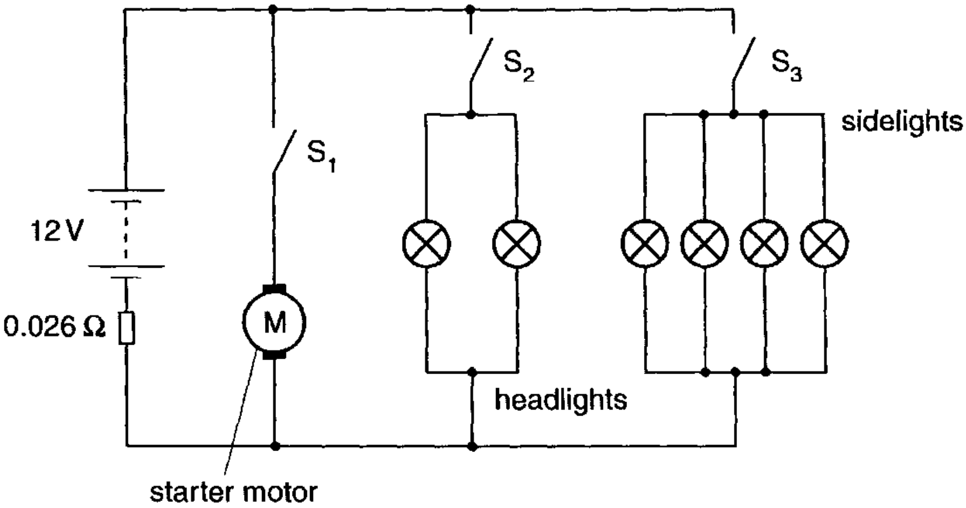

Fig. 7.3

At 12 V, the power rating of each headlight is 48 W. When operating at 12 V, the material of the filament in the headlights has a resistivity of 8.1×10^{-7} Ω m and a radius of 9.1×10^{-5} m.

1. Calculate the resistance of a single headlight.

resistance = …………….. Ω **[2]**

2. Calculate the length of the filament of the headlight.

length = ……………….. cm **[3]**

3. The resistance quoted for the filament at room temperature is very different from the working resistance of the filament lamp at 12 V. Suggest why this is so.

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

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

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

4 The resistance of each sidelight is 24 Ω.
Calculate the current in the battery and the terminal p.d. of the battery when switches S_2 and S_3 are closed and switch S_1 is open.

current = …………….. A

terminal p.d. =…………….. V **[3]**

5 The sidelights and headlights are switched on. With S_1 closed, the current in the starter motor is 120 A. Explain why all the lights become less bright when S_1 is closed.

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

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

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

8 **(a)** Define *magnetic flux density* and state its S.I. base units.

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…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

[3]

S.I. base units: ……………………………………

(b) A long straight wire, in a vacuum, carries a current I. The magnetic flux density B at a distance d from the wire is given by

$$B = \frac{\mu_o I}{2\pi d}$$

Show that the units for the permeability of free space μ_o is m kg s^{-2} A^{-2}.

[1]

(c) Two long straight parallel wires are at a distance 20.0 cm apart in a vacuum as shown in Fig. 8.1. One carries a current of 0.5 A into the plane of the paper, and the other a current of the same magnitude but out of the plane of the paper. P is a point equidistant from the two wires, such that the positions of P and the two wires form an equilateral triangle of length 20.0 cm on each side.

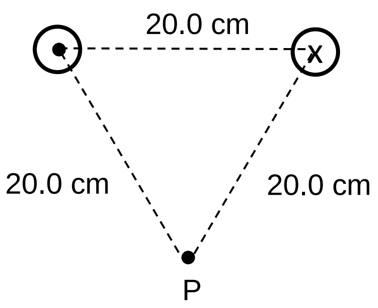

Fig. 8.1

(i) Sketch on Fig. 8.2 the magnetic flux pattern due to these two current-carrying wires.

[3]

Fig. 8.2

(ii) Determine the magnetic force per unit length and the direction of the force experienced by the wire on the left.

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

direction = …………………………………………… **[3]**

(iii) Determine the magnitude and direction of the flux density at P.

magnitude = ……………………….. T

direction = ………………………………… **[3]**

(d) Fig. 8.3 below shows a current balance. The wire frame AXYC is balanced on the pivot XY through which a current from a battery can be passed through. The wire frame is horizontal when there is no current. A magnetic force acts on the wire frame when a 3.0 A current flows through.

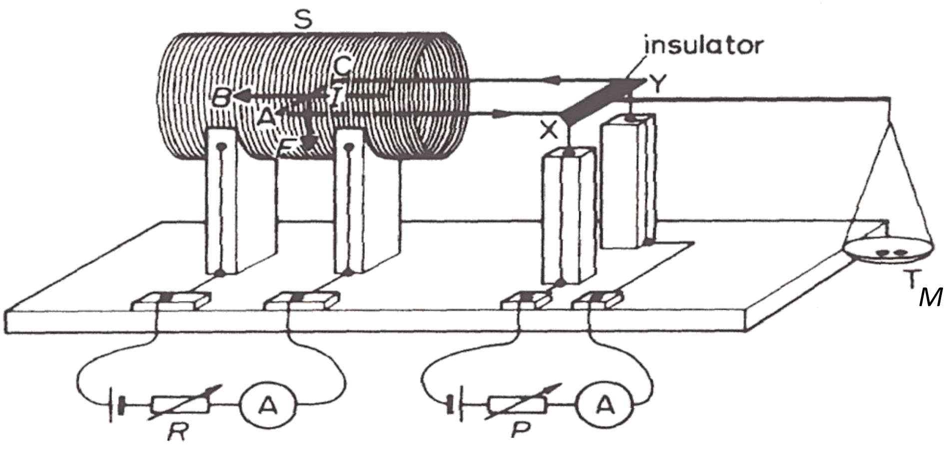

Fig. 8.3

(i) Explain why the current in the wire segment AC causes a turning effect.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………. **[3]**

(ii) Explain why the current in the wire segments AX and CY do not contribute to the turning effect.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

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

(iii) A 0.030 kg mass, *M*, is needed on the right hand side to restore the frame to its horizontal position again. The length of wire segment AX and AC are 60.0 cm and 20.0 cm respectively. The horizontal distance between load *M* and the pivot XY is 40.0 cm. Calculate the magnetic flux density in the solenoid.

magnetic flux density = ……………………….. T **[3]**

End of Paper