HWA CHONG INSTITUTION
JC2 Preliminary Examinations
Higher 1

CANDIDATE NAME		**CT GROUP**	**14S**
CENTRE NUMBER		**INDEX NUMBER**	

PHYSICS **8866/02**

Paper 2 Structured Question **27 August 2015**

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	/ 8
2	/ 7
3	/ 7
4	/ 8
5	/10
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, $R = R_1 + R_2 + \ldots$

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

Section A

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

1 A plane is flying with a velocity of 240 m s^{-1} at an angle of α = 30.0° with respect to the horizontal, as shown in Fig. 1.1. At an altitude of 3.40 km, a projectile is released from the plane. The projectile hits the target on the ground. Assume air resistance is negligible.

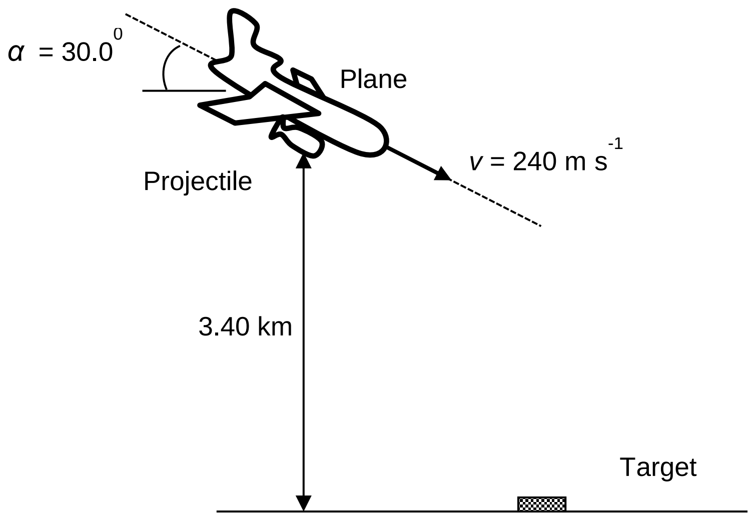


Fig. 1.1

(a) On Fig. 1.1, sketch the path of the projectile. [1]

(b) Determine the time taken for the projectile to travel from the point of release to the target.

time taken = …………………….. s [2]

(c) Find the speed attained by the projectile just before it hits the target.

speed = ……………………..m s^{-1} [2]

(d) Sketch on Fig. 1.2, the variation of the vertical velocity v_y with time t of the projectile from the time it was released to the time it hits the target. Label appropriate values on the axes.

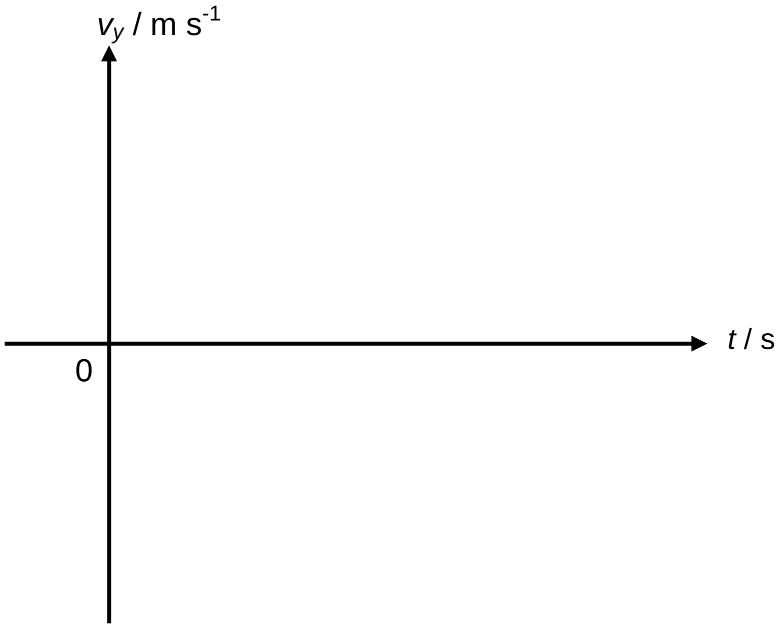


Fig. 1.2

[1]

(e) If air resistance was not negligible, sketch the variation of the vertical velocity v_y with time in Fig. 1.2 for the projectile from the time it was released to the time it hits the ground. Label this line ***T***. [2]

2 **(a)** Define the term 'moment of a force'.

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

…………………………………………………………………………………………………

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

(b) A traffic light hangs from a uniform metal pole AB, freely pivoted at point A, as shown in Fig. 2.1. The pole is 7.5 m long and has a mass of 8.0 kg. The mass of the traffic light is 12.0 kg.

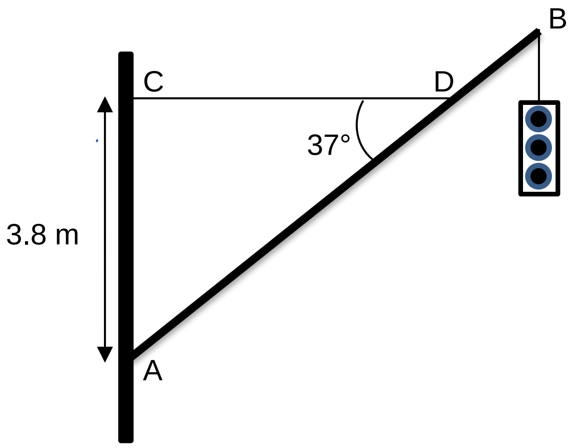


Fig. 2.1

(i) Determine the tension in the horizontal cable CD of negligible mass.

tension = …………………… N [3]

(ii) Determine the force exerted on the metal pole at pivot A.

force =…………………… N

direction: ……………………………….…………………… [3]

3 **(a)** State the principle of conservation of linear momentum.

....

....

.... [2]

(b) An object **A** of mass 120 kg traveling with velocity 25.2 m s^{-1} collides elastically with an object **B** of mass 400 kg traveling with velocity of 14.5 m s^{-1} in the opposite direction of **A** as shown in Fig. 3.1. After the collision, the velocity of **A** is $\boldsymbol{v_A}$ and the velocity of **B** is $\boldsymbol{v_B}$.

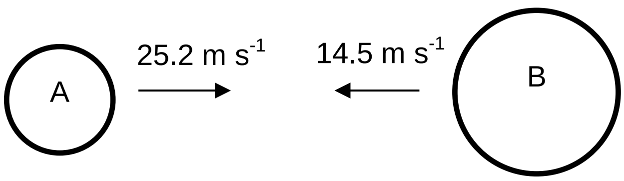


Fig. 3.1

(i) Write down the equation of conservation of linear momentum for this system. [1]

(ii) Write down an equation for the velocity of separation of **A** and **B** after the collision. [1]

(iii) Hence, determine $\boldsymbol{v_A}$ and $\boldsymbol{v_B}$. State the direction of travel of **A** and **B** after the collision.

$\boldsymbol{v_A}$ = ……………….. m s^{-1}

$\boldsymbol{v_B}$ = ……………….. m s^{-1} [2]

Direction of travel of **A**: …………………………….

Direction of travel of **B**: ……………………………. [1]

4 A 4.0 V battery with internal resistance is connected in series to a thermistor and a resistor. The cylindrical resistor has a length of 0.020 m and is made up of two materials – material A of cross-sectional area 2.0×10^{-3} m^2 surrounded by material B of cross-sectional area 1.0×10^{-3} m^2 , as shown in Fig. 4.1.

Given that
Resistivity of material A, ρ_A = 1.6 Ω m and
Resistivity of material B, ρ_B = 1.1 Ω m

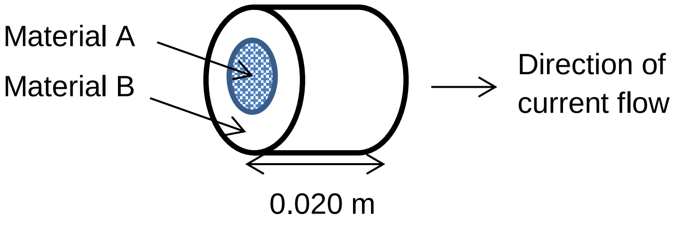
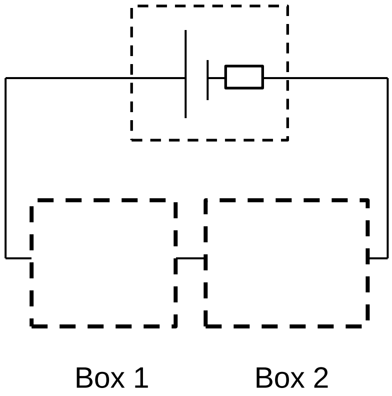


Fig. 4.1

(a) Complete the circuit diagram below by filling in the missing components, the thermistor and resistor, in the two boxes. Represent the resistor as two separate resistors, one for each material respectively.

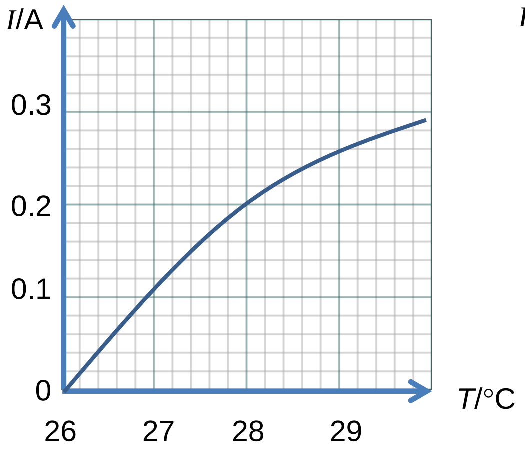


[2]

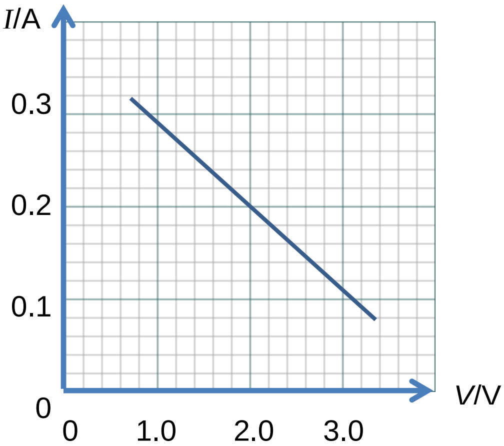
(b) Calculate the effective resistance of the resistor.

resistance = …………………… Ω [2]

(c) Graph (1) shows how the current I flowing through the thermistor varies with temperature of the thermistor T. Graph (2) shows how I flowing through the thermistor varies with voltage across the thermistor V as temperature changes . Determine the resistance of the thermistor at 28 °C.



Graph (1)



Graph (2)

[2]

resistance = …………………… Ω

(d) Describe and explain what will happen to the terminal potential difference across the battery when the temperature increases.

……………………………………………………………………………………………

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……………………………………………………………………………………………

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

5 Fig. 5.1 shows a storage container for liquids.

The container is filled from above. The distance between the base of the container and the ground is h_0.

The container is initially empty. At time t = 0 s, liquid starts flowing into the container at a **constant** rate.

Fig. 5.2 shows the variation with time t of the height h of the liquid surface above the ground from t = 25 s to t = 820 s.

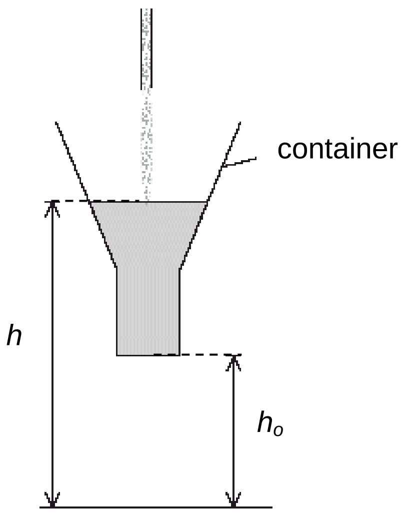

Fig. 5.1

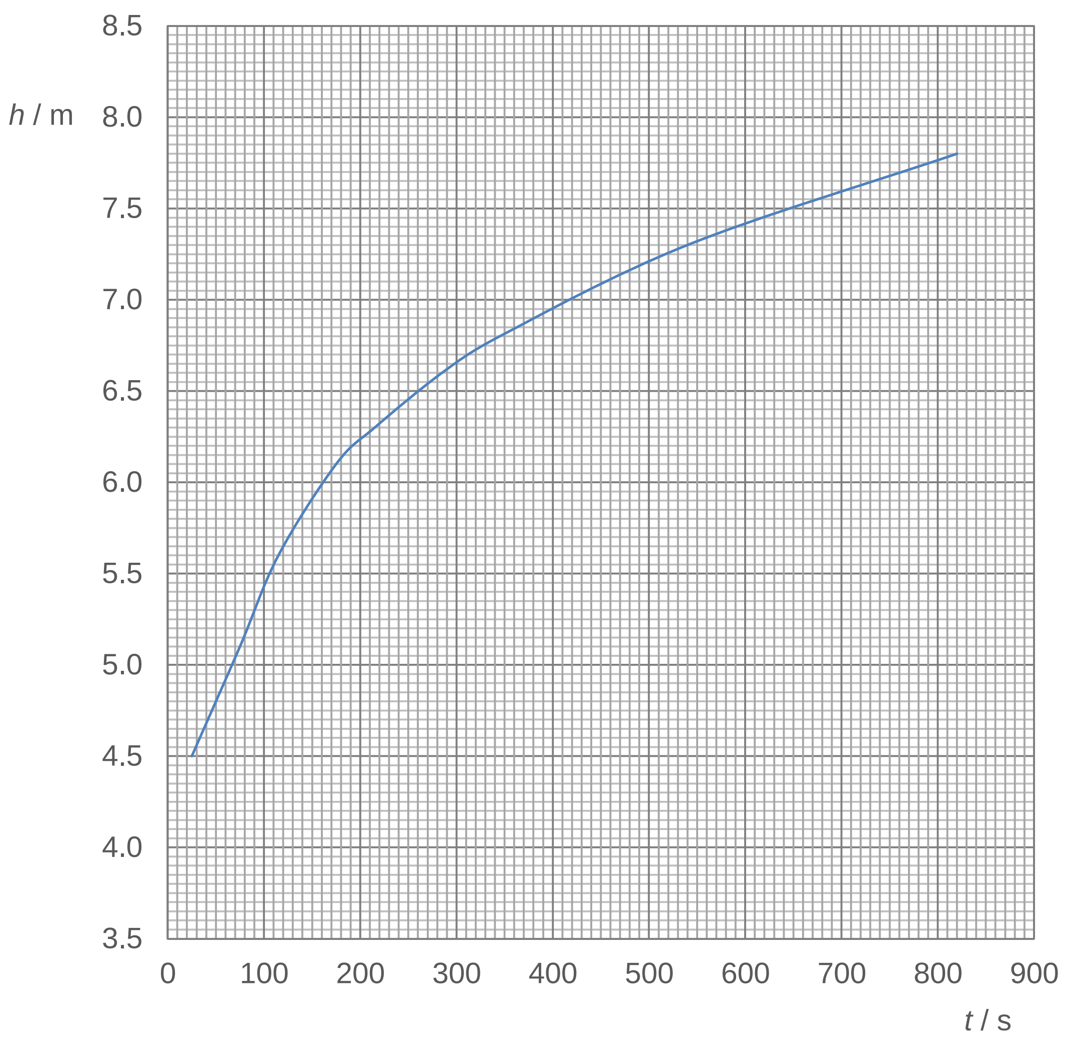

Fig. 5.2

(a) **(i)** Use data from Fig. 5.2 to determine the value of h_0.

h_0 = ………………… m [1]

(ii) The container is completely filled after 820 s.
The area of the base of the container is 1.8 m^2.

1. Deduce that the volume of liquid entering the storage container each second is approximately 0.02 $m^3 s^{-1}$. [2]

2. Hence, calculate the total volume of the container.

total volume of the container = ………………… m^3 [1]

(b) It is hypothesized that for $t > 400$ s, the relation between t and h is of the form

$$h = k\,t^n$$

where k and n are constants.

Fig. 5.3 shows the readings obtained.

t / s	h / m	lg (t / s)	lg (h / m)
460	7.10	2.66	0.851
500	7.20	2.7	0.857
540	7.30	2.73	0.863
590	7.40	2.77	0.869
640	7.50	2.81	0.875
	7.60		
760	7.70	2.88	0.886
820	7.80	2.91	0.892

Fig. 5.3

(i) Use Fig. 5.2 to complete Fig. 5.3 for h = 7.60 m. [1]

(ii) Data from Fig. 5.3 are used to obtain values for lg *h* and lg *t*. These are plotted on the graph of Fig. 5.4.

On Fig. 5.4,

1. Plot the point corresponding to h = 7.60 m ,
2. Draw the line of best fit for all the points. [1]

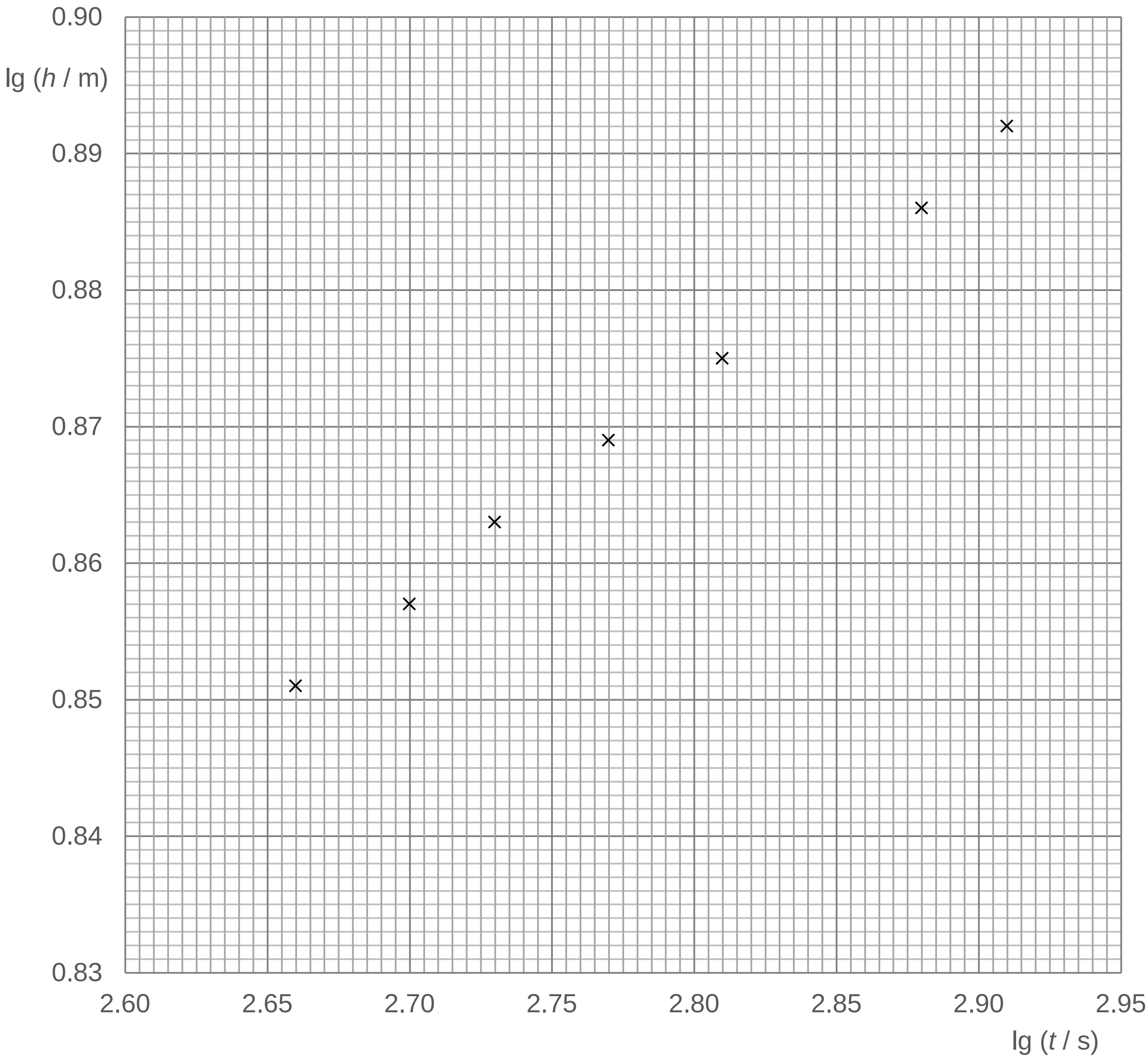

Fig. 5.4

(iii) Determine

1. the gradient of the line drawn in **(b)(ii).**

gradient = …………………….. [2]

2. the constant *k* and its unit, using your answer in **(iii)1**.

k = ……………………..

unit of *k* : …………………….. [2]

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Section B

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

6 (a) Define *wavelength, frequency and speed*, as applied to wave motion.

Wavelength: ……………………………………………………………………………………….

Frequency: ..……………………………………………………………………………………….

Speed: ………………………………………………………………………………………………. [3]

(b) Based on the definitions in (a), derive the equation for the speed of a progressive wave in terms of its wavelength and frequency. [2]

(c) Fig 6.1 shows how the amplitude of a wave varies with distance from a point source. The intensity of the wave at a distance 2.0 m from its source is 7.0 W m^{-2}.

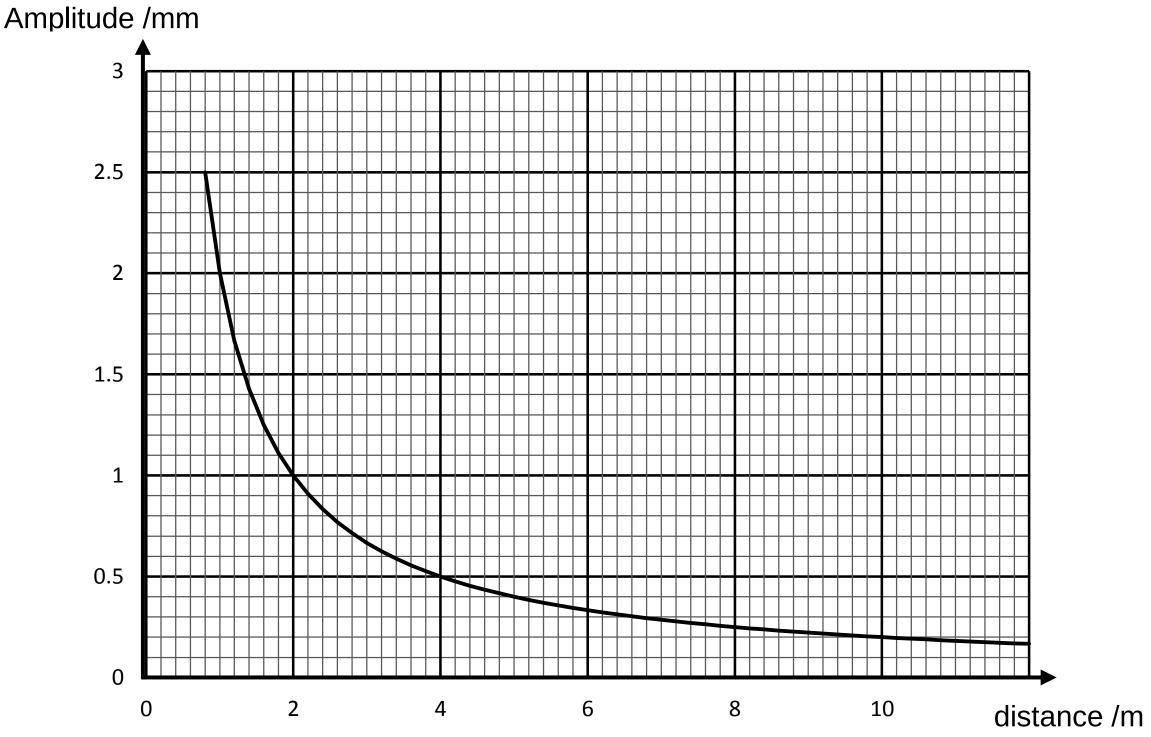


Fig. 6.1

(i) Using data from the graph, show that the amplitude is inversely proportional to the distance from source. [3]

(ii) Calculate the intensity at a distance of 5.0 m from the source. [2]

(iii) The power of the source of the wave is reduced such that the intensity of the wave at a distance 2.0 m from the source is now 3.5 W m^{-2}. Sketch on the same axes in Fig. 6.1, the variation of the amplitude of the wave with distance from the source. [1]

(d) A small loudspeaker emitting sound of constant frequency is positioned a short distance above a long glass tube containing water as shown in Fig. 6.2.

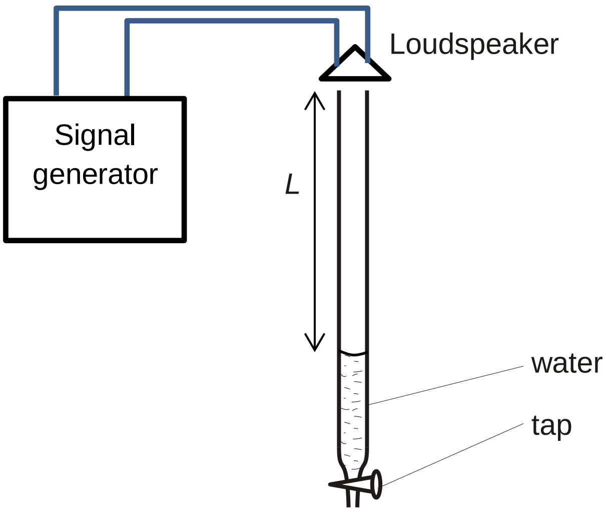


Fig. 6.2

(i) When water is released slowly from the tube via the tap, a loud sound is heard at certain length *L*. Explain this observation by reference to the superposition of waves.

....

....

....

....

....

....

.... [3]

(ii) When the loudspeaker produces sound of frequency 750 Hz, consecutive loud sounds are heard when *L* = 370 mm and when *L* = 590 mm.

1. Calculate the wavelength of the sound waves in the air column,

wavelength = ... m [2]

2. Hence, calculate the speed of the sound waves.

speed = ……………….. m s^{-1} [2]

(iii) A small microphone is inserted into the tube as shown in Fig 6.3 when *L* = 590 mm.

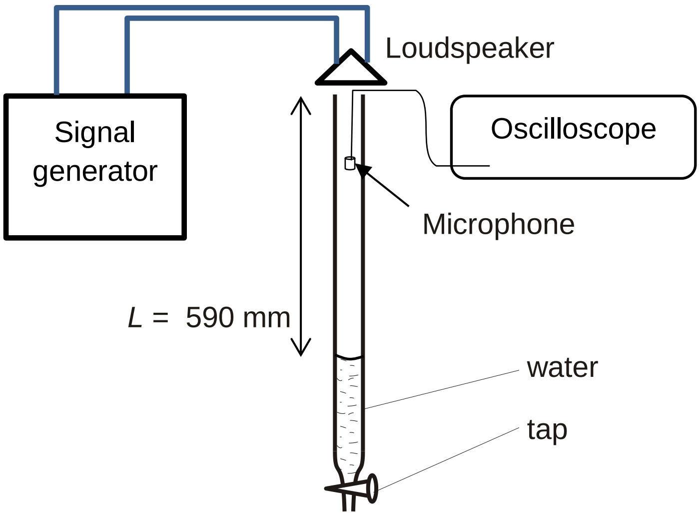


Fig. 6.3

When the microphone is close to the water level, the amplitude of the signal detected by the microphone increases to a maximum. Explain this observation.

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

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

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

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

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

7 (a) The highest magnetic flux density ever recorded on the earth is 91.4 tesla.

(i) Define magnetic flux density.

....

....

.... [1]

(ii) Explain what is meant by tesla.

....

....

.... [1]

(iii) Suggest an application where high magnetic flux density is useful.

....

....

....

.... [1]

(b) A straight conductor carrying a current I is placed in a uniform magnetic field with flux density B, as shown in Fig. 7.1. The conductor and the magnetic field are both in the same plane on the paper.

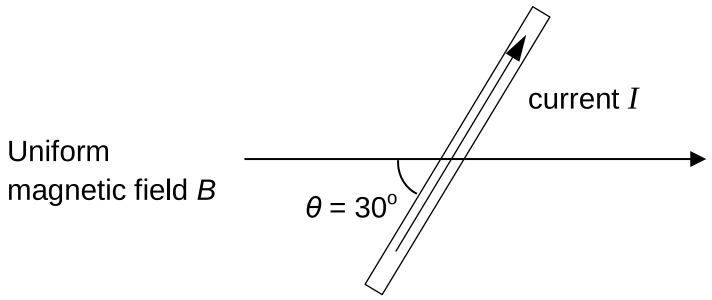


Fig. 7.1

(i) Complete Fig. 7.1 to show how a uniform magnetic field can be set up throughout the region where the conductor is to be placed. [2]

(ii) On Fig. 7.1, label the direction of the magnetic force acting on the current-carrying conductor as F_B. State clearly the direction. [1]

(iii) The magnetic flux density B is 5.7 x 10^{-2} T and the current I carried by the conductor is 10.2 A. Determine the force acting on the conductor with a length of 1.0 m.

force = ……………. N [2]

(c) Two long vertical wires X and Y pass through a horizontal card, as shown in Fig. 7.2. The current in each wire is in the upward direction.

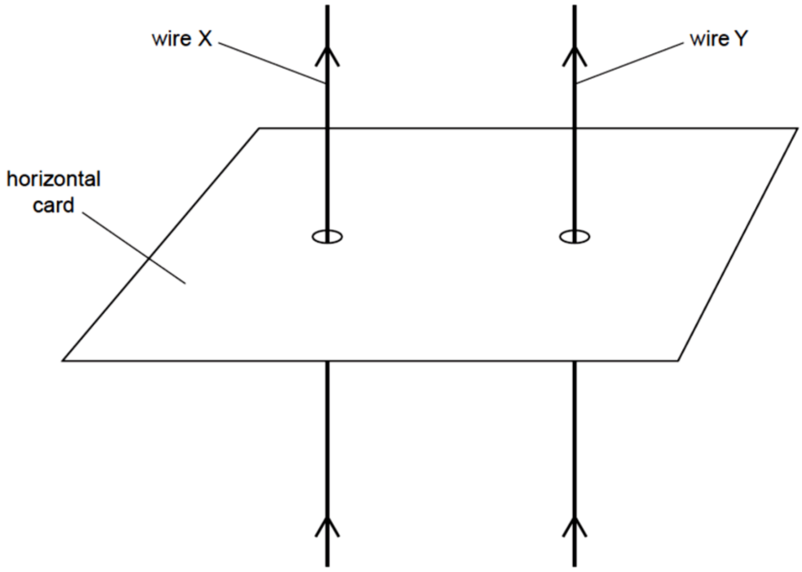
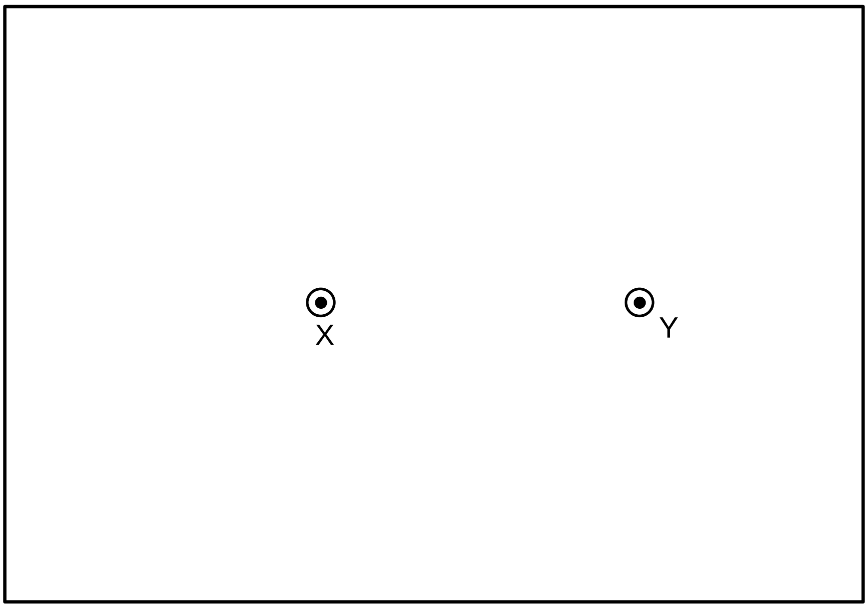


Fig. 7.2

(i) In Fig. 7.3, draw three field lines to represent the pattern of the magnetic field **due solely** to the current in wire X.



[2]

Fig. 7.3

(ii) In Fig. 7.3, draw an arrow to show the direction of the magnetic force on wire Y. [1]

(iii) The magnetic flux density *B* at a distance *r* from a long straight conductor due to a current I in the conductor is given by the expression.

$$B = \frac{\mu_0 I}{2\pi r}$$

The currents in wires X and Y are 3.0 A and 6.0 A respectively. The wires are separated by a distance of 4.0 cm.

1. Calculate the magnetic force per unit length acting on wire Y.

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

2. Without any further calculation, state and explain the magnetic force per unit length on wire X.

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

Explanation: ………………………………………………………………………………

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

(d) A proton is projected with a speed *v* horizontally into the region of uniform magnetic field *B* acting into the paper as shown in Fig. 7.4.

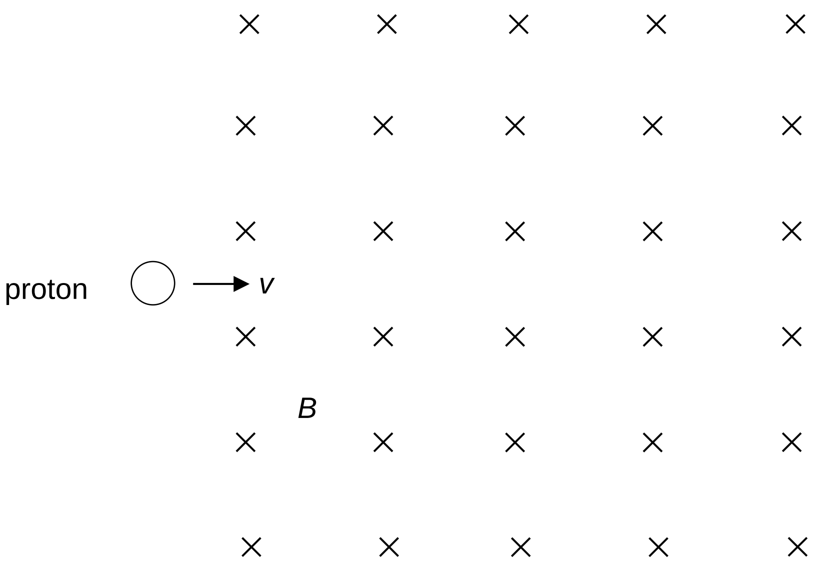


Fig. 7.4

(i) Sketch a possible path taken by the proton in magnetic field [1]

(ii) Explain your answer in **(d)i**.

....

....

....

.... [2]

(iii) If the proton is replaced with an electron traveling with the same speed, explain how the path will be different.

....

....

....

.... [2]

8 (a) Cool hydrogen gas is illuminated with electromagnetic radiation from a very hot gas as shown in Fig. 8.1.

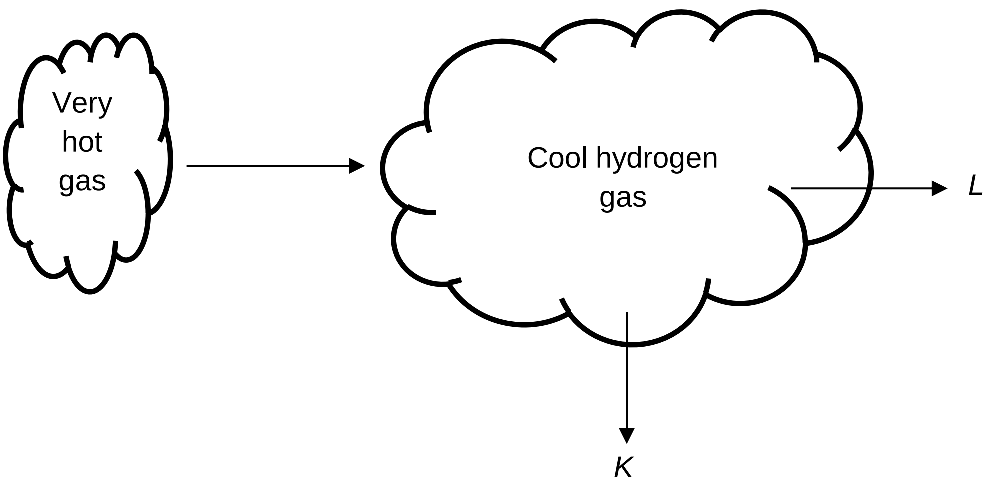


Fig. 8.1

(i) State and explain the spectrum of the radiation seen from direction *K*.

....

....

....

....

....

.... [3]

(ii) State and explain the spectrum of the radiation seen from direction *L*.

....

....

....

....

....

.... [3]

(b) The lowest energy levels for a single hydrogen atom is illustrated in Fig. 8.2.

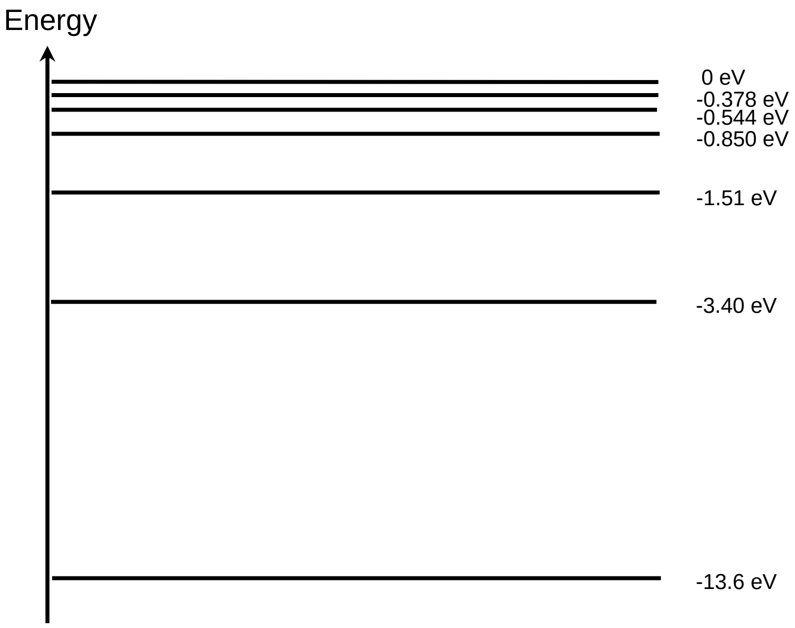


Fig. 8.2

(i) Explain why the values for the energy levels are negative.

....

....

....

.... [2]

(ii) The most energetic photon from the hot gas in Fig 8.1 has an energy of 12.75 eV.

1. Sketch on Fig. 8.2, all possible transitions which contribute photons in the direction *K*. [1]

2. Find the shortest wavelength of the photon emitted by hydrogen in the direction *K*. State the region of electromagnetic radiation for the photon.

wavelength =............................ m [2]

region of electromagnetic radiation = ... [1]

(c) Electromagnetic radiation emitted by hydrogen gas in the direction *K* in Fig. 8.1 is incident on a photoelectric tube shown in Fig. 8.3. The work function of the metal plate B in the photoelectric tube is 5.34 eV.

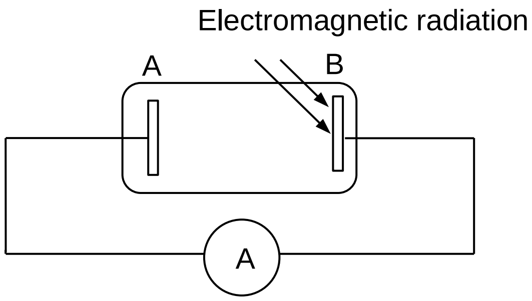


Fig. 8.3

(i) Explain why the ammeter shows a reading.

....

....

....

.... [2]

(ii) Determine the maximum initial kinetic energy of photoelectron emitted by B.

kinetic energy = ... J [2]

(iii) A variable voltage supply is connected in parallel with the photoelectric tube as shown in Fig. 8.4.

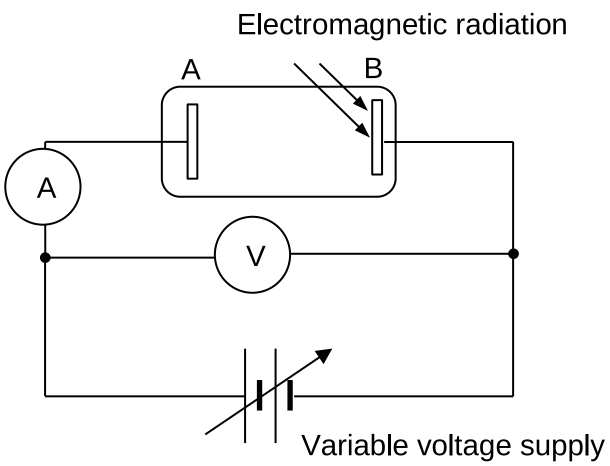
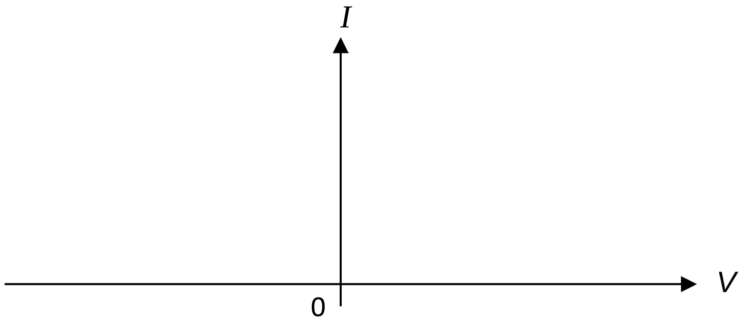


Fig. 8.4

1. Determine the minimum magnitude of potential difference *V* that would just stop the current.

potential difference = ……………. V [2]

2. On Fig. 8.5, sketch the graph to show the variation of the current *I* with potential difference *V* applied by the variable voltage supply.



[2]

Fig. 8.5

End of Paper