CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE NAME			
CLASS	2T	**INDEX NUMBER**	

PHYSICS
Paper 2

8866/02
28 August 2015
2 hours

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST
Write your index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper. **[PILOT FRIXION ERASABLE PENS ARE NOT ALLOWED]**
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions. **Circle the 2 questions** that you answered in the table below.

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

FOR EXAMINER'S USE	
SECTION A (40 MARKS)	
1	**/6**
2	**/ 8**
3	**/7**
4	**/9**
5	**/3**
6	**/7**
SECTION B (40 MARKS)	
7	**/ 20**
8	**/ 20**
9	**/ 20**
TOTAL	**/80**

This document consists of **24** printed pages

PHYSICS DATA:

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ H m^{-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}

PHYSICS FORMULAE:

uniformly accelerated motion,	s	=	$u\,t + \frac{1}{2} a\,t^2$
	v^2	=	$u^2 + 2\,a\,s$
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,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots$

SECTION A (40 marks)

Answer all questions in Section A.

1 A car of mass 1380 kg, travelling at 31.1 m s^{-1}, is brought to rest by applying the brakes. The average braking force is estimated to be 1.38×10^4 N.

(a) Calculate

(i) the initial kinetic energy of the car,

kinetic energy = ………………………..J **[1]**

(ii) the average deceleration of the car,

deceleration = ……………………… m s^{-2} **[1]**

(iii) the distance travelled before it comes to rest.

braking force = …………………………N **[2]**

(b) Suggest whether the answer in (a)(iii) is an over-estimation or under-estimation.

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2 **(a)** State what is meant by the equilibrium of a body.

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.... **[2]**

(b) Fig. 2 shows a girl supported by two ropes. She is in equilibrium. She has a weight of 392 N.

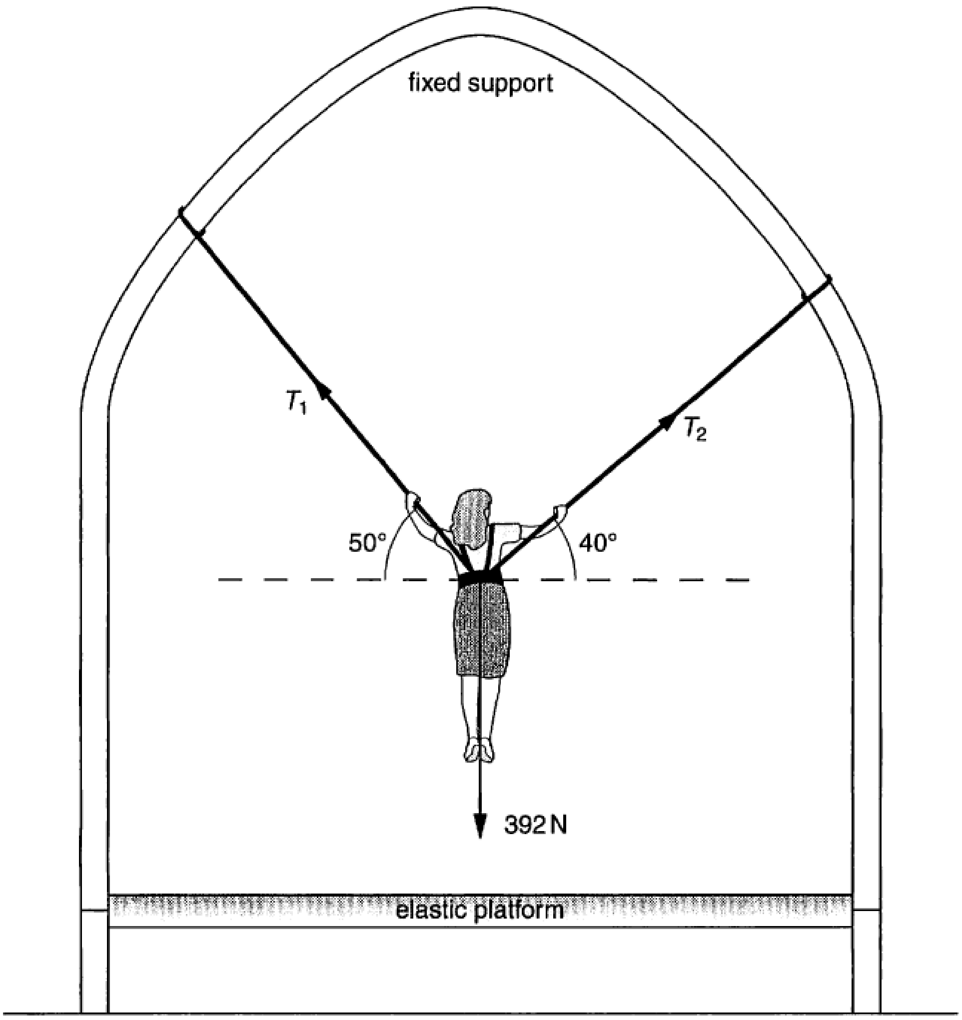

Fig.2

(i) Calculate the tension T_1 and T_2 in the ropes.

tension T_1 = ………………N

tension T_2 = ………………N **[4]**

(ii) The girl is pulled vertically downwards so the ropes stretch. She is then released. Explain why the method you used in (i) could not be used to determine the tensions in the ropes immediately after she is released without additional information.

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

3 A long-jumper leaps off the starting block at a speed 8.6 m s^{-1} at an angle θ to the horizontal and lands on a level pit.

(a) Explain why the longer-jumper needs to have an upwards component of velocity at take-off, as well as forward velocity component to reach a good horizontal distance.

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(b) (i) Suppose that the angle $\theta = 35^o$, calculate the time to reach the maximum height and the horizontal distance of the long jumper. In your calculations, you should neglect the presence of air resistance.

time = …………………s

horizontal distance =………………………m **[4]**

(ii) Why does his horizontal distance is less than the answer to (b)(i) when air resistance is taken into consideration.

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

4 A glass tube of Helium gas atoms are excited when a potential difference is applied across it. When the emitted light is viewed through a spectrometer, three emission lines of blue, green and yellow colours are observed. Fig. 4.1 shows the spectral lines, together with the associated photon wavelengths of each colour.

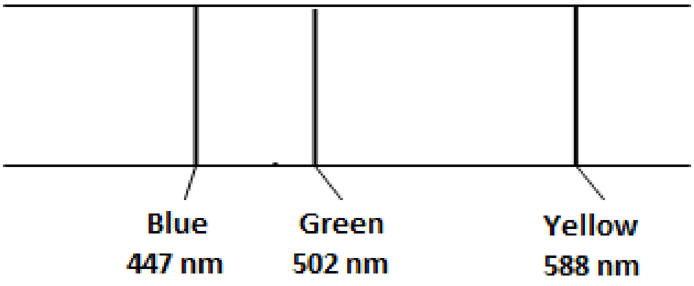

Fig. 4.1

Light from the gas is incident on the surface of a metal plate **X**. The electrons liberated from the plate are attracted to the anode as shown in Fig. 4.2

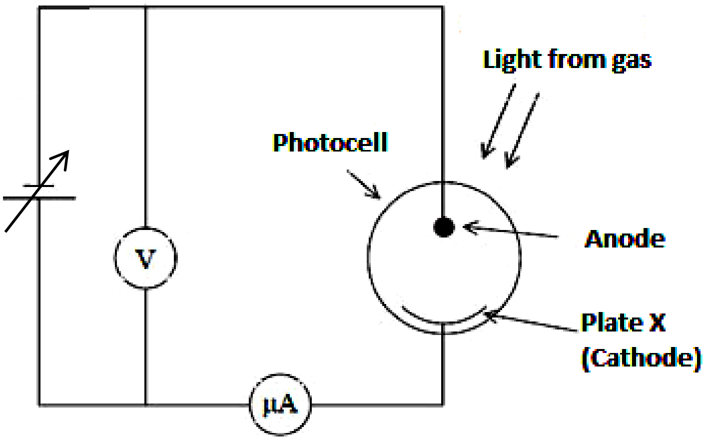

Fig 4.2

The experiment is then repeated using two other metal plates **Y** and **Z** of different work function energies. The table below shows the work function energies of the different plates.

Plate	Work Function Energy / eV
X	1.58
Y	2.42
Z	3.17

(a) What is meant by the term *work function energy* of a metal?

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.... **[1]**

(b) The figure below shows the variation of current I in the circuit with applied potential difference V between the metal plate and anode when the blue light from the gas is allowed to incident on plate X.

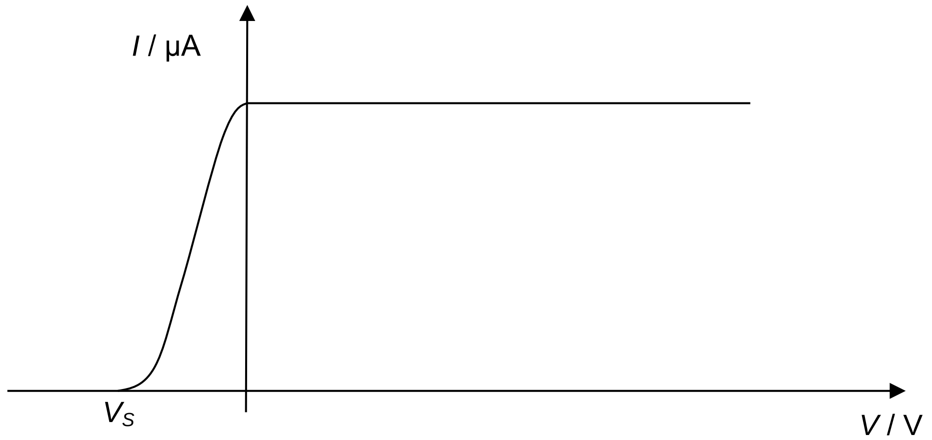

Fig. 4.3

(i) Calculate the stopping potential $V_{s.}$

stopping potential V_s = ………………..V **[3]**

(ii) On Fig. 4.3, sketch the variation of current I with applied potential difference V when the blue light from the gas is incident on plate **Y**. Assuming the intensity of the blue light remained constant. Explain your answers.

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(iii) State with a reason, which of the plates used for the photoelectric effect experiments will a zero reading be registered in the micro-ammeter when all the 3 wavelengths are allowed to incident on the plates ?

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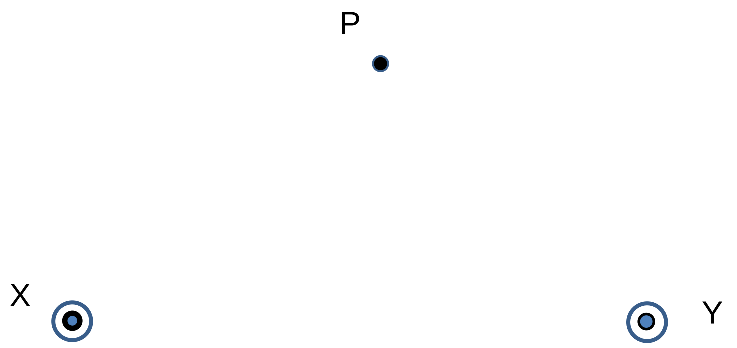
.... **[2]**

5 Two wires X and Y, which are at right angles to the plane of the paper, carrying current I and 2I out of the plane of the paper as shown in Fig.5. A point P is at equal distance from the wires. On Fig. 5, draw an accurate vector diagram to show how you can determine the magnitude and direction of the resultant field at P.



[3]

Fig. 5

6 In the 16th century, Kepler conducted observations of the planetary positions and deduced that for a circular orbit of a planet around the Sun, if T is the period of rotation and r is the radius of the orbit, then

$T^2 = 4\pi^2r^3 / GM$ where G is the gravitational constant which has a value of 6.67×10^{-11} N m^2 kg^{-2}
M is the mass of the Sun.

The relation $T^2 = 4\pi^2r^3 / GM$ is also true for the moons of the planet Jupiter.

Data for some of the moons of Jupiter is given in Fig.6.1

Moon of Jupiter	Period T/days	Mean distance from centre of Jupiter, r / 10^9 m	log (T/days)	log (r/m)
Sinope	758	23.7	2.88	10.37
Leda	239	11.1		
Callisto	16.7	1.88	1.22	9.27
Lo	1.77	0.422	0.248	8.63
Metis	0.295	0.128	-0.53	8.11

Fig.6.1

(a) (i) Complete Fig.6.1 by calculating the values for log (T/days) and log (r/m) and plot the data for moon Leda on Fig.6.2. On the axes of Fig.6.2, draw the line of best fit of log (T/days) against log (r/m) **[1]**

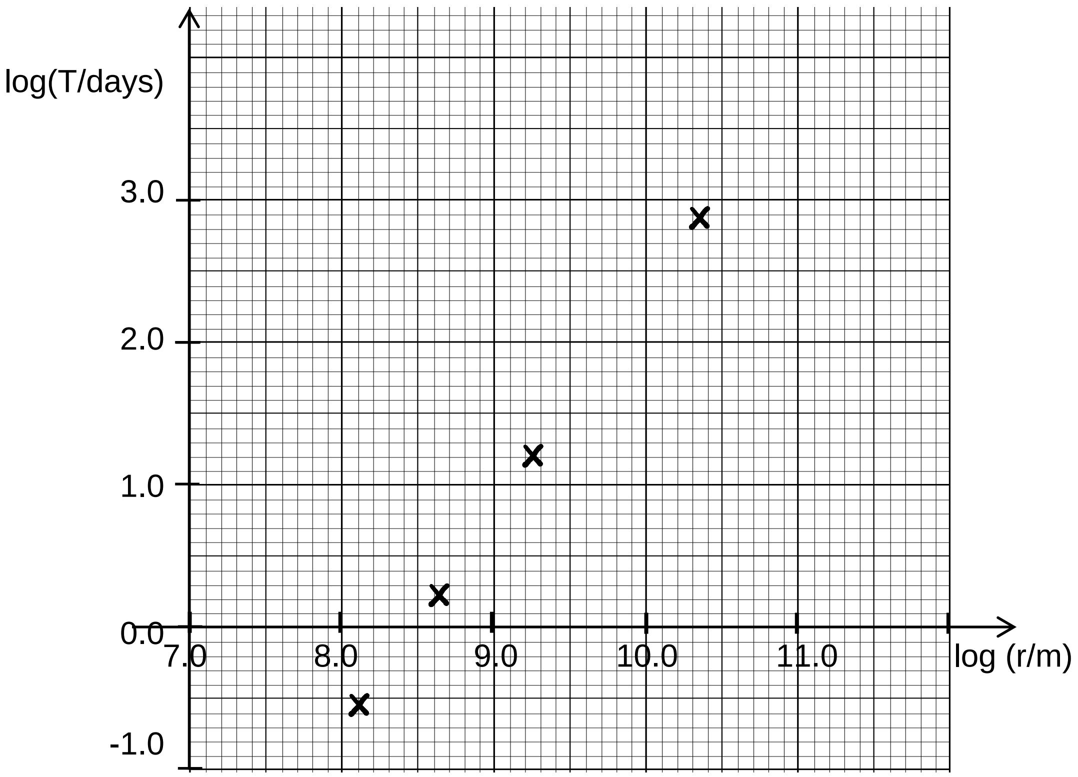


Fig.6.2

(ii) Determine the gradient of the graph in Fig.6.2

gradient = ………………. **[1]**

(iii) Discuss whether the data Fig.6.1 support the relation $T^2 = 4\pi^2 r^3 / GM$

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(b) Observation shows that the moon Ganymede orbits Jupiter with a period of 7.16 days. Use the graphs of Fig.6.2 to estimate the orbital radius of Ganymede

orbital radius = ……………………m **[2]**

(c) Explain how you can use the graph on Fig.6.2 to determine the mass of Jupiter.

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SECTION B (40 marks)

Answer only 2 out of 3 questions.

7 **(a)** Assume that the helicopter's main rotor blades give a vertical velocity v to a cylinder of air of cross-sectional area equal to that swept out by the blades as shown in Fig.7

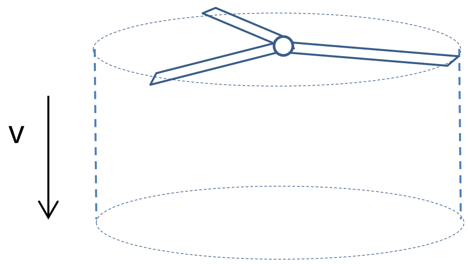

Fig.7

(i) Explain how the helicopter is able to hover in flight.

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

(ii)(1) Show that the weight of the helicopter while hovering is given by $\pi r^2 \rho v^2$ where ρ is the density of the air and r is the length of the rotor blades. **[3]**

(2) By what factor must the power increase for the helicopter to hold up a load equal to its own weight?

power increase by = ………………times **[3]**

(b) Use the Newton's laws of motions to derive the principle of conservation of momentum applied to the collision of two bodies.

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(c) Fig. 7.1 shows a container of mass 45 kg floating in deep space where the effect of gravity is negligible. An astronaut, looking into it, observes an object of mass 15 kg, floating inside the container, explode into two fragments A and B of mass 5.0 kg and 10 kg respectively. The two fragments apart in the direction shown in Fig. 7.1. The fragments adhere to the walls of the container on impact. Initially, the astronaut, container and object have no relative motion.

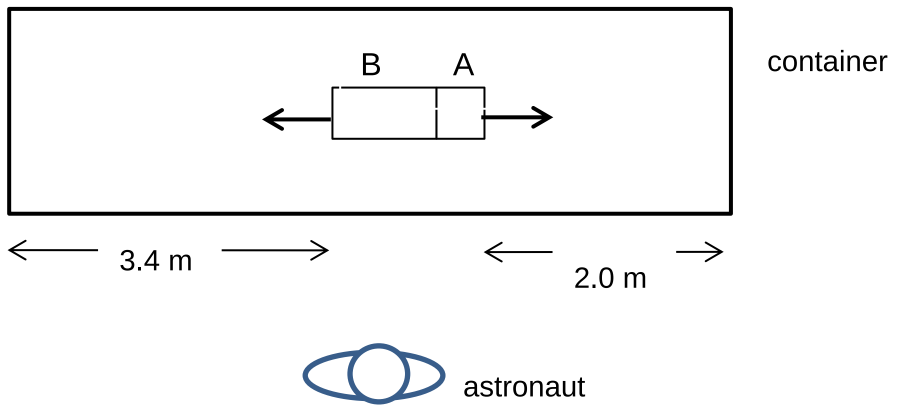

Fig. 7.1

(i) The impulse from the explosion on A is 10 kg m s^{-1}. Calculate the speeds of the fragments after explosion.

speed of A =………………………m s^{-1}

speed of B =…………………….m s^{-1} **[3]**

(iii) Sketch the graphs of velocity and horizontal position of the container, relative to the astronaut, against time for the first 5 seconds after the explosion.

[4]

(iv) Energy is generated during the explosion. State the energy conversion during the first 5 seconds during and after explosion.

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.... **[2]**

8 Fig.8.1 shows the variation with time *t* of the displacement y of the air at a point **P** in front of a loudspeaker emitting a sound wave of a single frequency.

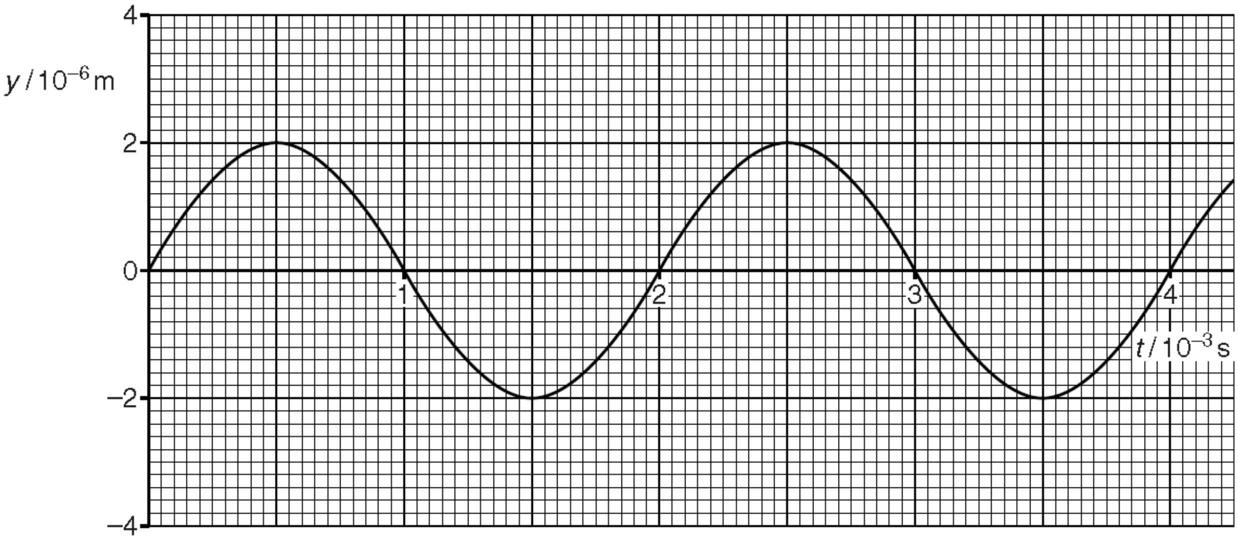

Fig. 8.1

(a) Calculate

(i) the frequency *f* of oscillations of the air at **P**

frequency = …………Hz **[1]**

(ii) the wavelength λ of the wave which is travelling at 340 m s^{-1}.

Wavelength = ……………..m **[1]**

(b) **(i)** Draw on Fig. 8.1 the variation with time of the displacement of the air at a point **Q** a distance of one quarter of a wavelength $\lambda/4$ beyond **P**. Label this curve **Q**. **[2]**

(ii) Explain the meaning of the term *phase difference*. Illustrate your answer by stating the phase difference between the displacements of the air at the points **P** and **Q**.

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

(c) An open tube is placed in front of the loudspeaker such that its far end is at point Q, as shown in Fig. 8.2.

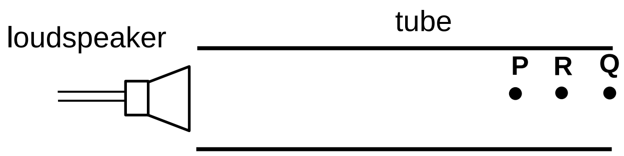

Fig. 8.2

(i) Explain why the frequency of the loudspeaker has to be adjusted to a particular value for a stationary sound wave to be formed in the tube.

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.... **[2]**

(ii) A stationary wave is set up in the tube. The distance between the points P and Q is $\lambda/4$.
Compare and contrast the motion of the air particles at P, Q and R.

P & Q

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P & R

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.... **[4]**

(iii) A student attempts to determine the speed of the sound in the tube by calculating the wavelength of the waves by measuring the distance between P and Q and using the expression λ = 4 x distance PQ. Give a reason why his measurement of the speed is unlikely to be accurate and suggest the improvement to reduce the uncertainty.

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.... **[3]**

(d) Light can be polarised using a polarizer, such as a sheet of Polaroid. A polariser has an axis for the 'easy' transmission of light (the easy axis). It transmits the component of the electric field (E-field) of light which is parallel to this axis. In a perfect polariser, this component is transmitted without absorption. The component perpendicular to the easy axis is completely absorbed.
Fig.8.3 shows a perfect polarizer A with its easy axis vertical.

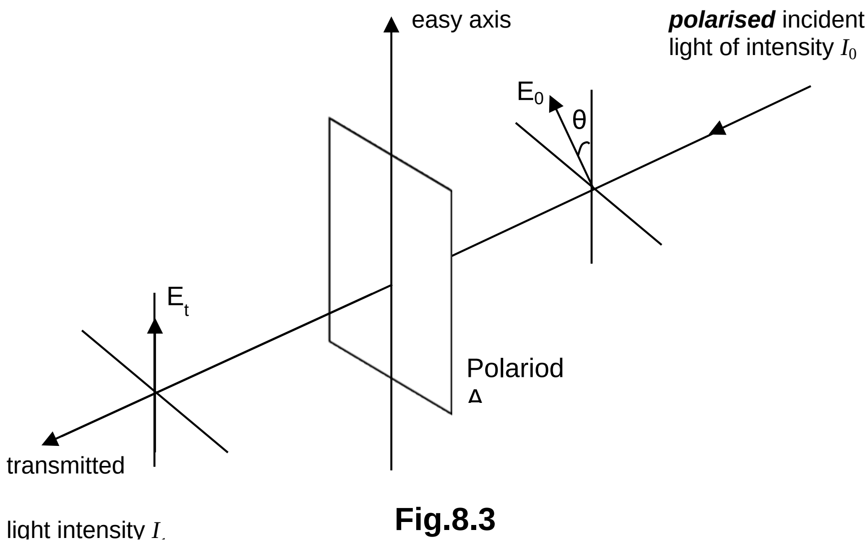

Fig.8.3

A parallel beam of polarised light of intensity I_0 is incident on the polarizer A with its E-field, of amplitude E_0, at an angle θ to the vertical. The transmitted light has amplitude E_t.

(i) Show that I_1 is given by $I_t = I_0 \cos^2 \theta$

[3]

(ii) The polarised light of intensity I_0 is now incident on A with its E-field parallel to the easy axis (i.e. the angle θ is set at 0^o). A second polarizer B is now placed in front of A, with its easy axis parallel to that of A. Keeping the polarizer A fixed, polarizer B is then rotated so that its easy axis makes an increasing angle ϕ with the easy axis of Polaroid A.
On Fig.8.4, sketch a graph to show how the intensity I_t of the light transmitted by the polariser combination varies with the angle ϕ, for values of ϕ between 0 and 2π rad. Label the axes with appropriate values.

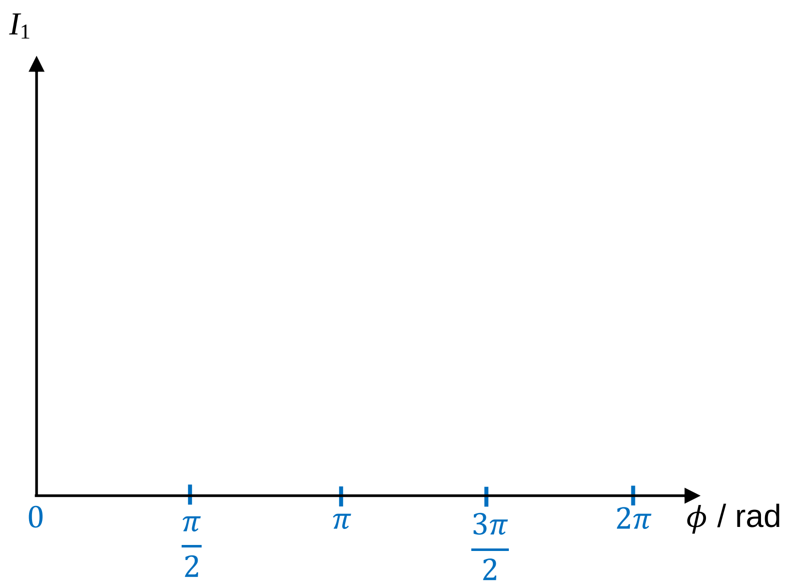

Fig.8.4

[2]

9 **(a)** Fig. 9.1 shows the I-V characteristic of a *light-emitting* diode (LED).

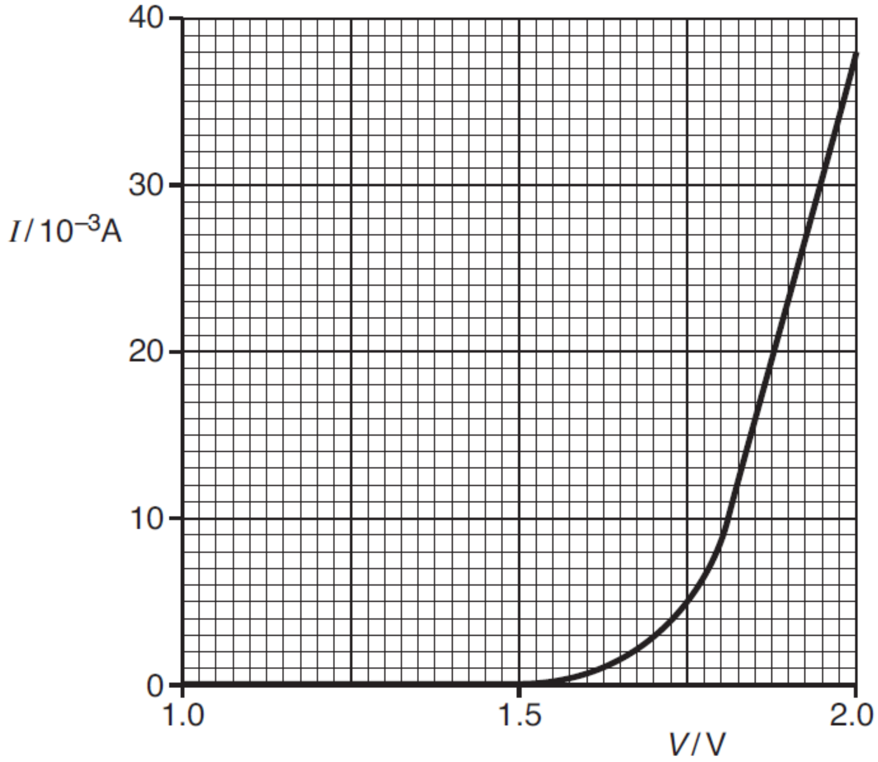

Fig. 9.1

(i) Describe the significant features of the graph in terms of current, voltage and resistance.

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.... **[4]**

(ii) Calculate the resistance of the LED at 1.9 V

Resistance = ………………..Ω **[2]**

(b) In order to carry out an investigation to determine the I-V characteristic of an LED a student connects the circuit as shown in Fig. 9.2.

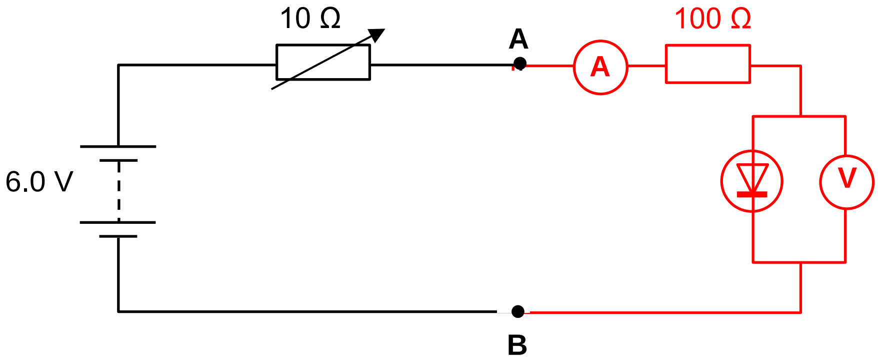

Fig. 9.2

Explain why the circuit in Fig. 9.2 is not suitable to obtain the graph in Fig 9.1.

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.... **[2]**

(c) Another student uses the 10 Ω variable resistor as a potential divider as shown in Fig. 9.3. The rest of the circuit is then completed between terminals **A** and **B** as for Fig. 9.2 in **(b)**.

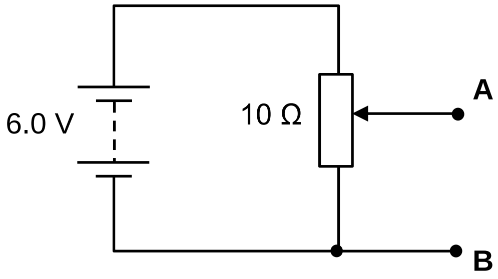

Fig. 9.3

Explain why the circuit of Fig. 9.3 is more suitable for obtaining the I-V characteristic of the LED than the circuit of Fig. 9.2.

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.... **[2]**

(d) Fig. 9.4 shows a battery of e.m.f E and internal resistance r is connected to a variable resistor of resistance R.

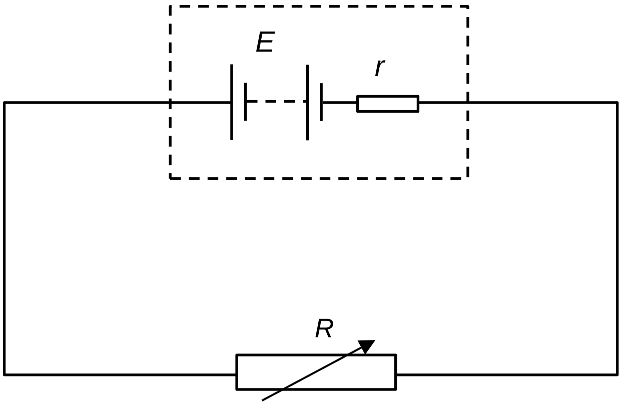

Fig. 9.4

The total power produced in the battery is P_T. The power dissipated in the variable resistor is P_R.

The variation of P_T and of P_R with resistance R of the variable resistor are show in Fig. 9.5.

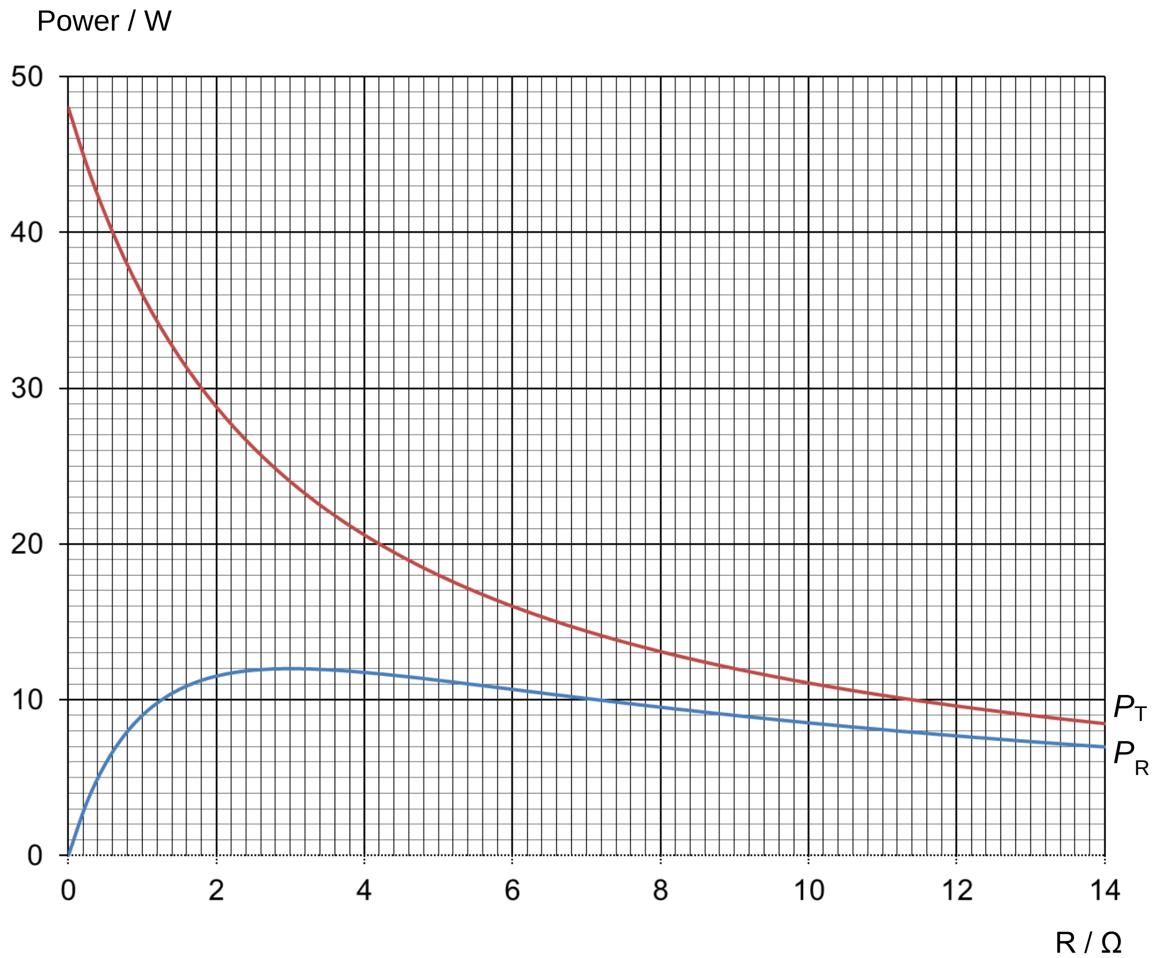

Fig. 9.5

(i) For resistance R = 6.0 Ω, use Fig. 9.5

1. to show that the current in the circuit is 1.3 A

[2]

2. to determine the e.m.f. E of the battery.

e.m.f. = ………………V **[2]**

(ii) For any value of R, the value of P_T is greater than that of P_R.

1. Suggest what is represented by the quantity ($P_T - P_R$)

[1]

2. Use your values of P_T and P_R at R = 6.0 Ω and you answer to **(i)(1)** to determine the internal resistance r of the battery.

[2]

internal resistance = ………………………….Ω

(iii) 1. Use Fig 9.5 to determine the efficiency of power transfer from the battery to the variable resistor when R = 3.0 **Ω**.

[1]

efficiency = ……………………..

2. Discuss, based on Fig 9.5 but without mathematical calculations, how the efficiency changes with R.

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