#

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME

CLASS | INDEX NUMBER

PHYSICS 8866/02

Paper 2 Structured Questions **15 September 2015**

2 hours

Candidates answer on the Question Paper

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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 the brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	5
2	4
3	5
4	5
5	10
6	6
7	5
Section B	
8	20
9	20
10	20
Penalty	
Total	80

#

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,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots$

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Section A

Answer **all** questions in this section.

1 The energy per unit time, P radiated by an object with a surface area A at thermodynamic temperature T is given by

$$P = e\sigma AT^4$$

where e is the emissivity of the surface and σ is the Stefan-Boltzmann constant.

(a) Given that the emissivity, e has no unit, use the equation to find the base units of Stefan-Boltzmann constant, σ.

base units of σ = ……………………. [2]

(b) In an experiment to determine the Stefan-Boltzmann constant, σ, a circular surface of diameter d with an emissivity of 0.431 was used and the following measurements were taken:

P = (3.0 ± 0.2) W
d = (5.0 ± 0.1) cm
T = (500 ± 1) K

Calculate a value for the Stefan-Boltzmann constant, σ and express it with its associated uncertainty.

σ = ……………………………………………. [3]

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2 A ball is thrown from a point P, which is at ground level, as illustrated in Fig. 2.1.

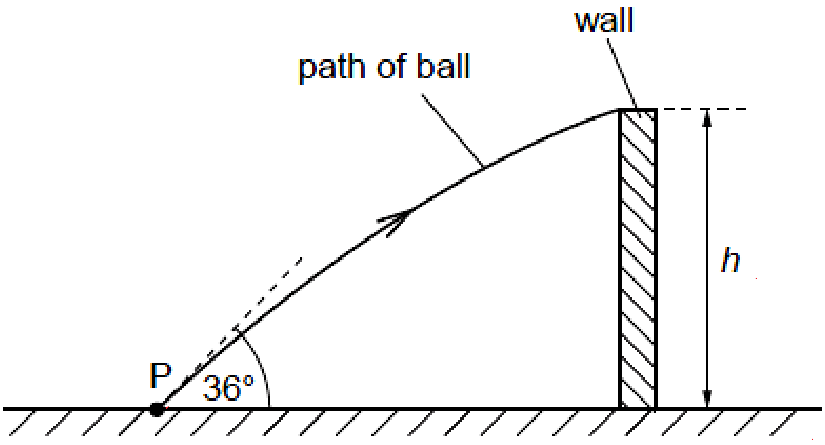

Fig. 2.1

The initial velocity of the ball is 12.4 m s^{-1} at an angle of 36° to the horizontal.

The ball just passes over a wall of height *h*. The ball reaches the wall 0.17 s after it has been thrown.

(a) Assuming air resistance to be negligible, calculate the height *h* of the wall.

h = ……………………. m [2]

(b) A second ball is thrown from point P with the same velocity as the ball in **(a)**. For this ball, air resistance is not negligible. This ball hits the wall and rebounds.

On Fig. 2.1, sketch the path of this ball between point P and the point where it first hits the ground.

[2]

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

....

.... [1]

(b) An object A of mass 4.2 kg and horizontal velocity 3.6 m s^{-1} moves towards object B as shown in Fig. 3.1. Object B of mass 1.5 kg is moving with a horizontal velocity of 1.2 m s^{-1} towards object A.

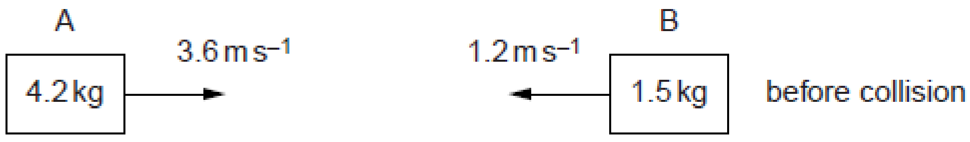

Fig. 3.1

The objects collide and then both move to the right as shown in Fig. 3.2.

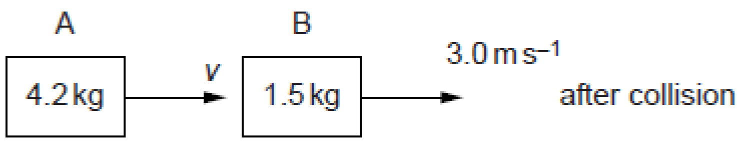

Fig. 3.2

Object A has velocity v and object B has velocity 3.0 m s^{-1}.

(i) Calculate the velocity v of object A after collision.

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

(ii) Determine whether the collision is elastic or inelastic.

[2]

#

4 Two blocks, P and Q, of masses 0.30 kg and 1.50 kg respectively, are connected by a string that passes over a pulley as shown in Fig. 4.1. The pulley is frictionless and the string is inelastic. The system is released from rest. Block Q falls vertically before it strikes a spring that is firmly attached to the floor. The spring constant is 500 N m^{-1}.

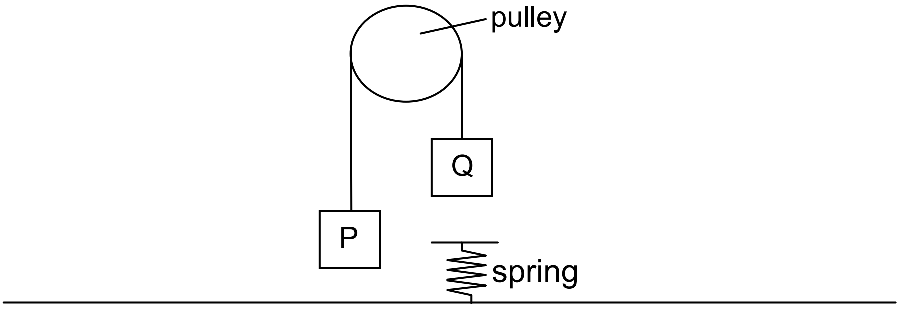

Fig. 4.1

(a) **(i)** Show that the magnitude of the acceleration of block Q is 6.54 m s^{-2} before striking the spring.

[2]

(ii) Hence, determine the tension in the string before block Q strikes the spring.

tension = ……………………. N [1]

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(b) Block Q slows down after it touches the spring and the system eventually comes to a stop after some time. The spring is observed to be compressed. Calculate the compression of the spring.

compression = ……………………. m [2]

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5 The graph in Fig. 5.1 shows how the acceleration of freefall *g* changes with distance from the centre of the Earth.

The distance from the centre of the Earth, *x* is given in terms of the radius *r* of the Earth. At the centre of the Earth the value of the acceleration is zero and the value increases to the value of 9.8 m s^{-2} at the Earth's surface. From the surface of the Earth the value decreases as shown.

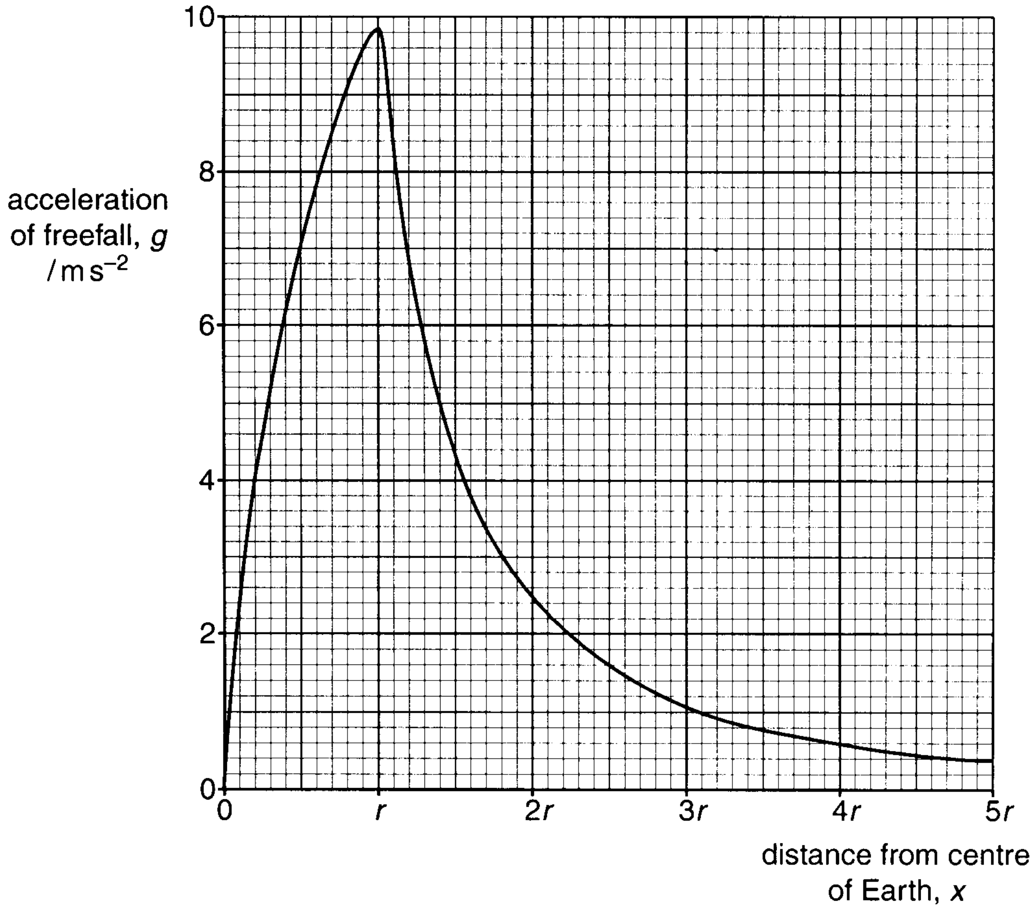

Fig. 5.1

(a) Show, by taking readings from the graph, that *g* is inversely proportional to x^2, for distances beyond the Earth's surface.

[3]

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(b) The centre of the Moon is at a distance of 60*r* from the centre of the Earth. Deduce the value of *g* at this distance.

g at the Moon's distance = …………………… m s^{-2} [2]

(c) The International Space Station is at a height *h* above the Earth's surface. The value of *g* at this height is 8.81 m s^{-2}. Calculate *h*.

The radius of the Earth is 6370 km.

height of station = …………………… km [2]

(d) The graph in Fig. 5.2 shows how the force *F* acting on a mass of 1.0 kg changes with distance from the centre of the Earth.

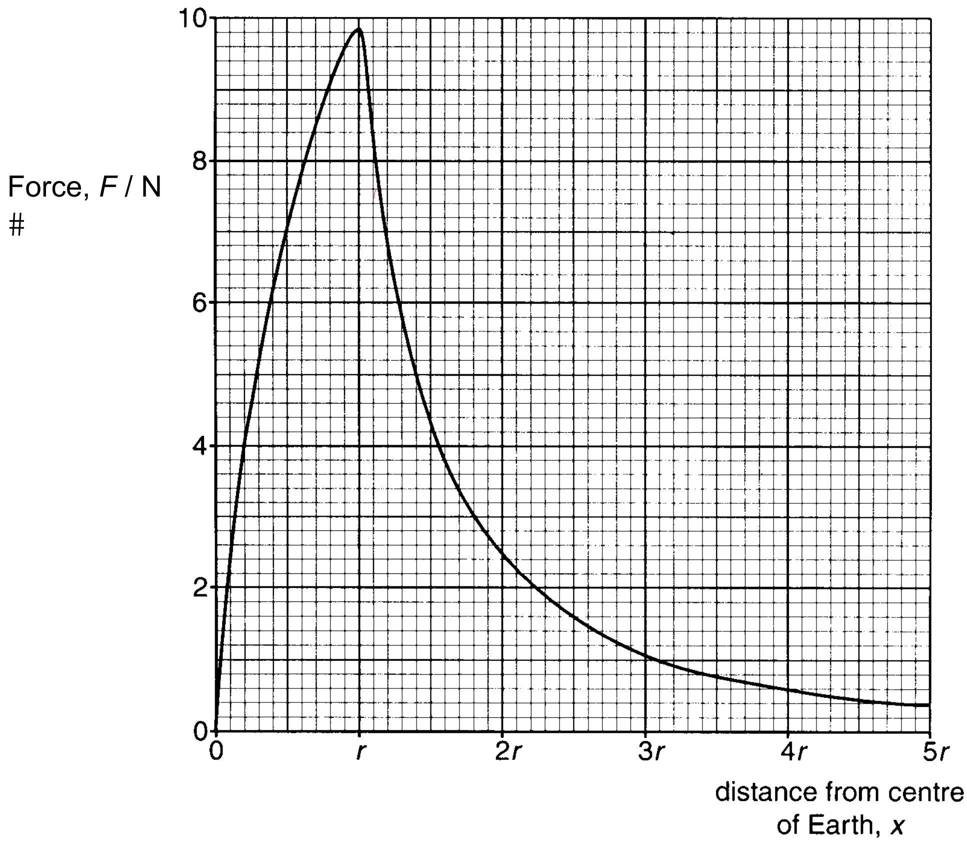

Fig. 5.2

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(i) Use the graph in Fig. 5.2 to estimate the increase in gravitational potential energy of the mass when the mass moves from the Earth's surface and reaches a height of 2*r*.

The radius of the Earth is 6370 km.

increase in gravitational potential energy = ……………………. J [2]

(ii) Hence, or otherwise, determine the minimum speed that the mass needs to have to move from the Earth's surface to reach the height of 2*r*.

speed = ……………………. m s^{-1} [1]

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6 **(a)** State what is meant by a photon.

....

....

.... [2]

(b) It has been observed that, where photoelectric emission of electrons takes place, there is negligible time delay between illumination of the surface and emission of an electron. State two other pieces of evidence provided by the photoelectric effect for the particulate nature of electromagnetic radiation.

1. ……………………………………………………………………………………..

....

2. ……………………………………………………………………………………..

....

[2]

(c) The work function of a metal surface is 3.5 eV. Light of wavelength 450 nm is incident on the surface. Determine whether electrons will be emitted, by the photoelectric effect, from the surface.

[2]

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7 Fig 7.1 shows a diagram of the electron energy levels in the hydrogen atom.

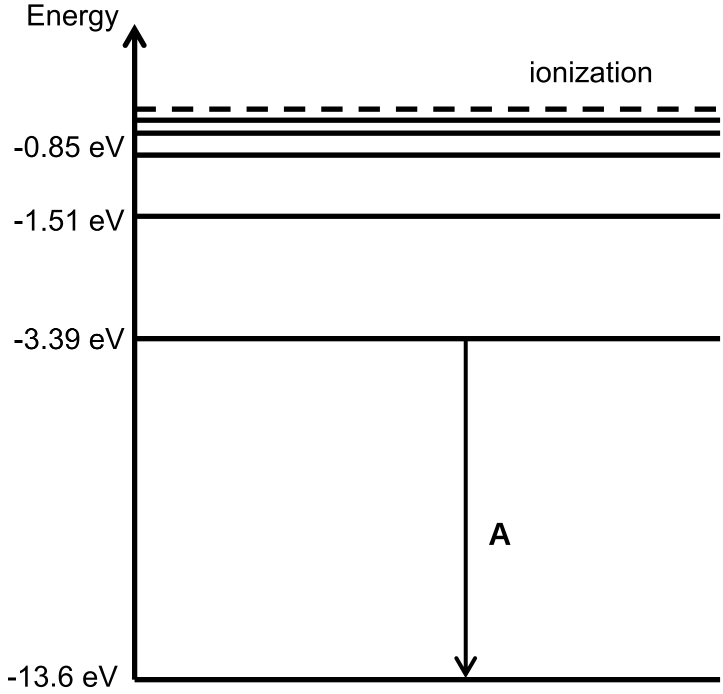

Fig. 7.1

(a) Explain why all the energy states shown in Fig. 7.1 have negative values.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(b) A possible transition **A** is shown on Fig.7.1. Calculate the momentum of the radiation emitted by the atom.

momentum = ……………………. N s [3]

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Section B

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

8 **(a)** With reference to a battery connected to a resistor, distinguish between the definitions of *electromotive force* and *potential difference*.

....

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....

.... [3]

(b) A battery of electromotive force (e.m.f.) 12 V and internal resistance *r* is connected in series to two resistors, each of constant resistance *X*, as shown in Fig. 8.1.

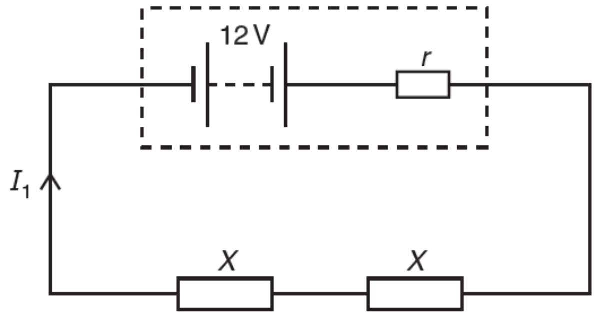

Fig. 8.1

The current I_1 supplied by the battery is 1.2 A. The same battery is now connected to the same two resistors in parallel, as shown in Fig. 8.2.

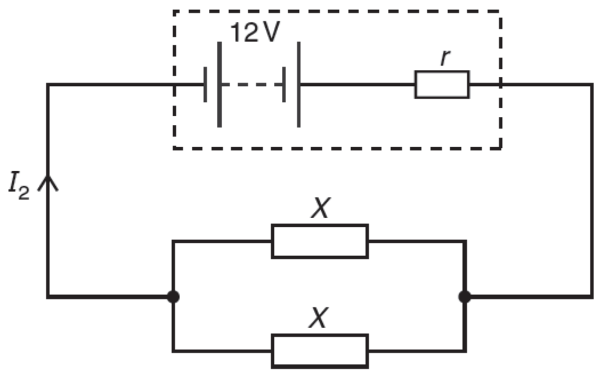

Fig. 8.2

The current I_2 supplied by the battery is 3.0 A.

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(i) Show that the combined resistance of the two resistors, each of resistance *X*, is four times greater in Fig. 8.1 than in Fig. 8.2.

[2]

(ii) Explain why I_2 is not four times greater than I_1.

....

....

....

.... [3]

(iii) State equations, in terms of e.m.f., current, *X* and *r*, for

1. the circuit of Fig. 8.1,

   ……………………………………………………………………………………

2. the circuit of Fig. 8.2

   ……………………………………………………………………………………

[2]

(iv) Use the equations in **(iii)** to calculate the resistances *X* and *r*.

X = …………………… Ω

r = …………………… Ω [3]

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(v) Suggest two factors which could affect the internal resistance of the battery.

....

.... [2]

(c) Calculate the ratio

$$\frac{\text{power transformed in one resistor of resistance } X \text{ in Fig. 8.1}}{\text{power transformed in one resistor of resistance } X \text{ in Fig. 8.2}}.$$

ratio = …………………… [2]

(d) The resistors in Fig. 8.1 and Fig. 8.2 are replaced by identical 12 V filament lamps. Explain how the resistance of each lamp, when connected in series, is different from the resistance of each lamp when connected in parallel.

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.... [3]

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9 **(a)** State the conditions necessary for an object to be in static equilibrium.

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.... [2]

(b) A block of mass 3.50 kg is placed on a rough slope, which is inclined at 30° to the horizontal, as shown in Fig. 9.1 below. The block is in equilibrium.

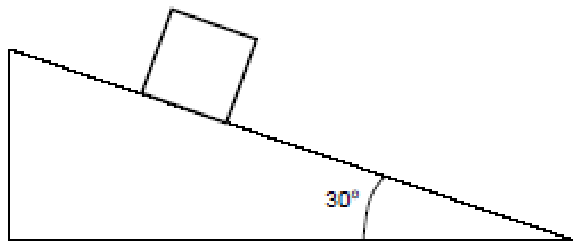

Fig. 9.1

(i) On Fig. 9.1, draw and label the forces experienced by the block. [3]

(ii) Calculate the magnitude of the frictional force experienced by the block.

frictional force = ……………………. N [2]

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(c) The slope is now lubricated such that the frictional force experienced by the block is halved. As a result, the block accelerates down the slope from rest. During this motion, the block slides down a distance of 0.800 m before reaching the bottom of the slope.

(i) Calculate the acceleration of the block down the slope.

acceleration = …………………… m s^{-2} [2]

(ii) Hence, or otherwise, determine the kinetic energy of the block when it reaches the bottom of the slope.

kinetic energy = …………………… J [3]

(iii) Calculate the loss in gravitational potential energy of the block as a result of this motion.

loss in gravitational potential energy = …………………… J [2]

#

(iv) Compare and comment on your answers to parts **(ii)** and **(iii)**.

....

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.... [2]

(v) Determine the average rate of heat dissipated during this motion.

average rate of heat dissipated = ……………………. W [4]

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10 **(a)** Fig. 10.1 shows the variation with time t of the displacements x_A and x_B at a point P of two sound waves A and B.

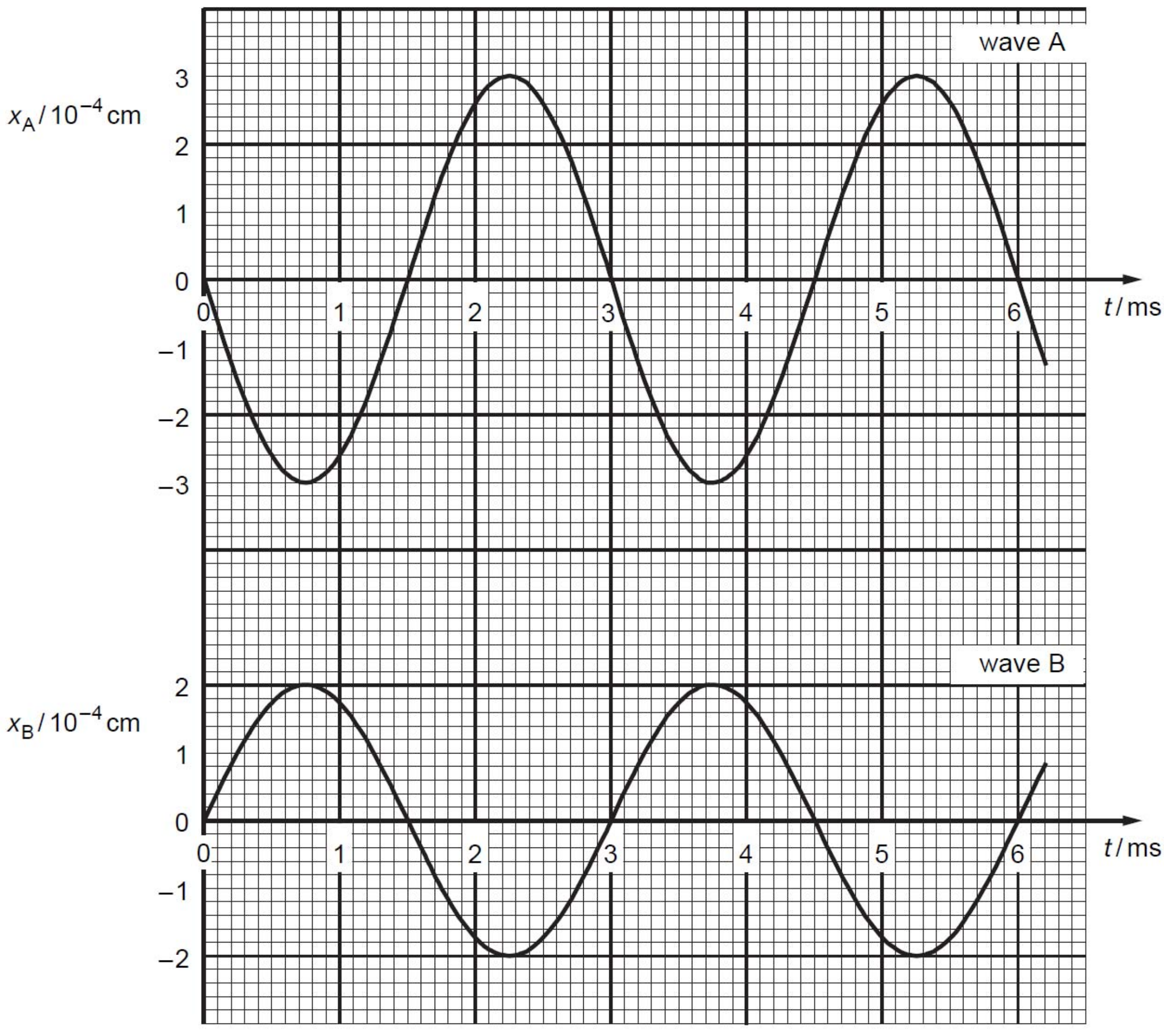

Fig. 10.1

(i) By reference to Fig. 10.1, state one similarity and one difference between these two waves.

Similarity:

....

Difference:

....
[2]

(ii) State, with a reason, whether the two waves are coherent.

....

.... [1]

#

(iii) The intensity of wave A alone at point P is I.

1. Show that the intensity of wave B alone at point P is $\frac{4}{9}I$. [2]

2. Calculate the resultant intensity, in terms of I, of the two waves at point P.

resultant intensity = ……………………. I [2]

(iv) Determine the resultant displacement for the two waves at point P

1. at time t = 3.0 ms.

resultant displacement = ……………………. cm [1]

2. at time t = 4.0 ms.

resultant displacement = ……………………. cm [2]

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(b) Light of frequency 4.8×10^{14} Hz incidents normally on a double slit, as illustrated in Fig. 10.2.

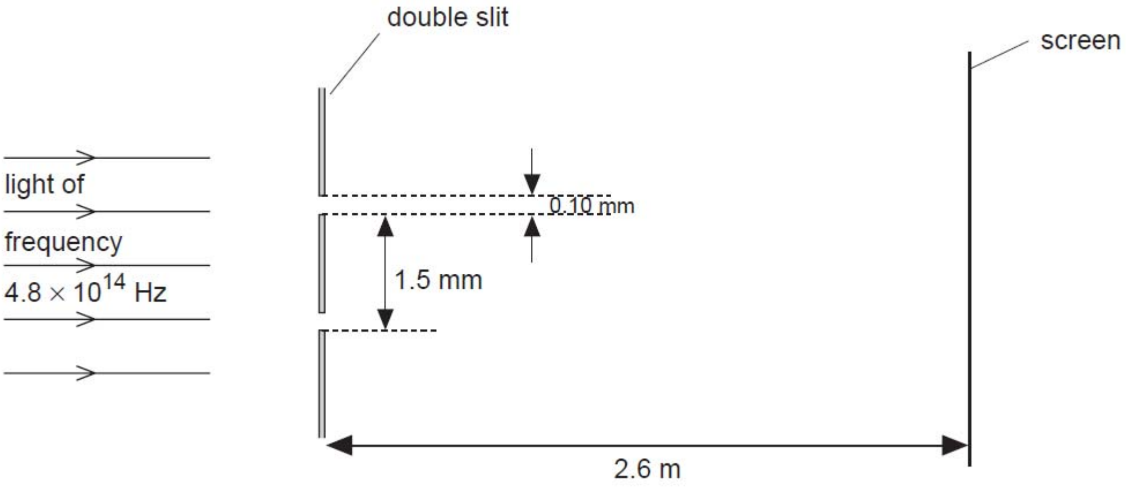

Fig. 10.2
(not to scale)

Each slit of the double slit arrangement is 0.10 mm wide and the slits are separated by 1.5 mm. The pattern of fringes produced is observed on a screen at a distance of 2.6 m from the double slit.

(i) **1.** Show that the width of each slit is approximately 160 times the wavelength of the incident light.

[2]

2. Hence, explain why the pattern of fringes is seen over a limited area of the screen.

....

....

....

....

.... [2]

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

separation = ……………………. mm [2]

(iii) The intensity of the light incident on the double slit is increased. State and explain the effect, if any, on the separation and on the appearance of the fringes.

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…………………………………………………………………………………... [4]

#