#

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 **18 September 2014**

2 hours

Candidates are to 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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

The use of an appropriate 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.

Marks will be deducted for using inappropriate number of significant figures or wrong value of *g*.

For Examiner's Use	
Section A	
1	**14**
2	**7**
3	**9**
4	**10**
Section B	
5	**20**
6	**20**
7	**20**
Penalty	
Total	**80**
Percentage	

This document consists of **25** 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	=	$\rho g h$
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** the questions in this section.

1 Fig. 1.1 shows a section of a roller coaster track, not drawn to scale.

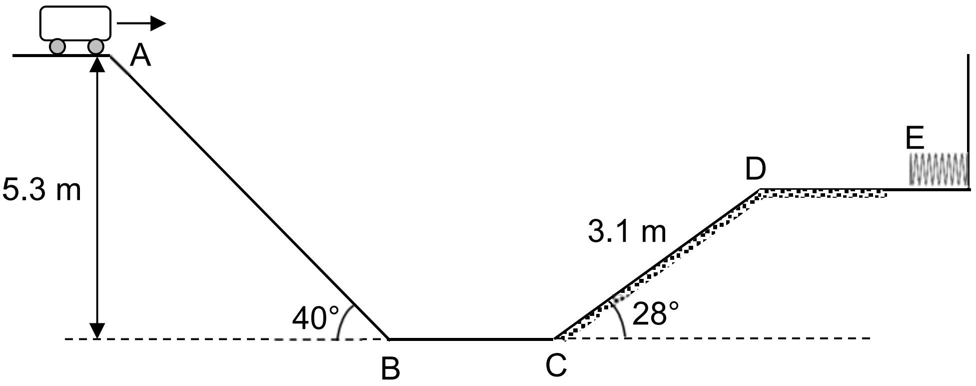

Fig. 1.1

The roller coaster enters the section of track at A, slides down a frictionless slope that makes an angle of 40° with the horizontal. It then travels along a straight, frictionless track BC before travelling along a rough incline CD. The incline CD has a length of 3.1 m and it makes an angle of 28° with the horizontal. It finally enters a rough braking zone DE where it is slowed down by the rough track. If the roller coaster still has some speed upon reaching E, a spring will eventually bring it to a complete stop.

At t = 0 s, a roller coaster of total mass 250 kg approaches A with a speed of 2.5 m s^{-1}.

(a) Determine the acceleration of the roller coaster along the slope AB.

acceleration = ... m s^{-2} [2]

(b) Show that the speed of the roller coaster when it reaches B is 10.5 m s^{-1}.

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#
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#
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#
#

[2]

#

#

(c) Given that the roller coaster reaches C at t = 2.5 s, determine the length of the track between B and C.

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length = ... m [3]

(d) Given that a constant frictional force of 290 N acts on the roller coaster along CD, determine the speed of the roller coaster when it reaches D.

speed = ... m s^{-1} [4]

#

(e) After further slowing down along the rough braking zone DE, the speed of the roller coaster was reduced from the speed in **(d)** to 3.0 m s^{-1}. It is then brought to rest by a spring whose force-compression (*F*-*x*) graph is shown in Fig. 1.2.

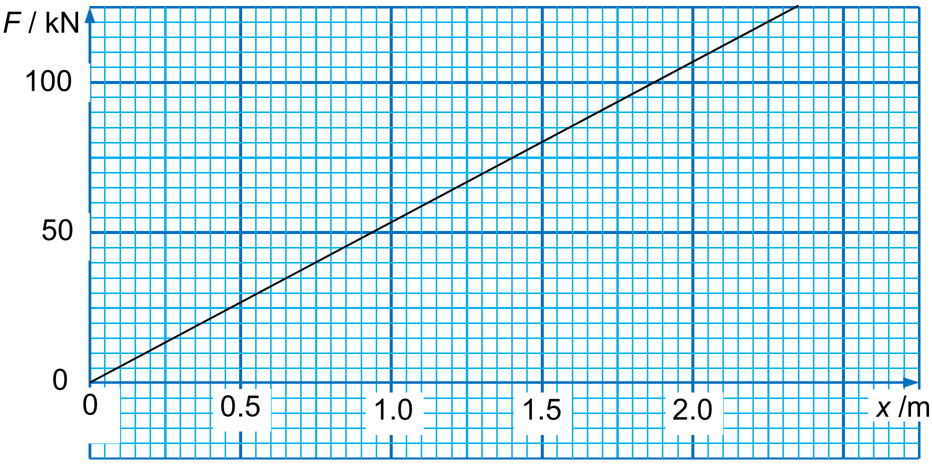

Fig. 1.2

Determine the maximum compression of the spring as it brings the roller coaster to a complete stop.

compression = ...m [3]

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2 The variation with potential difference V of the current I in a component Y and in a resistor R is shown in Fig. 2.1.

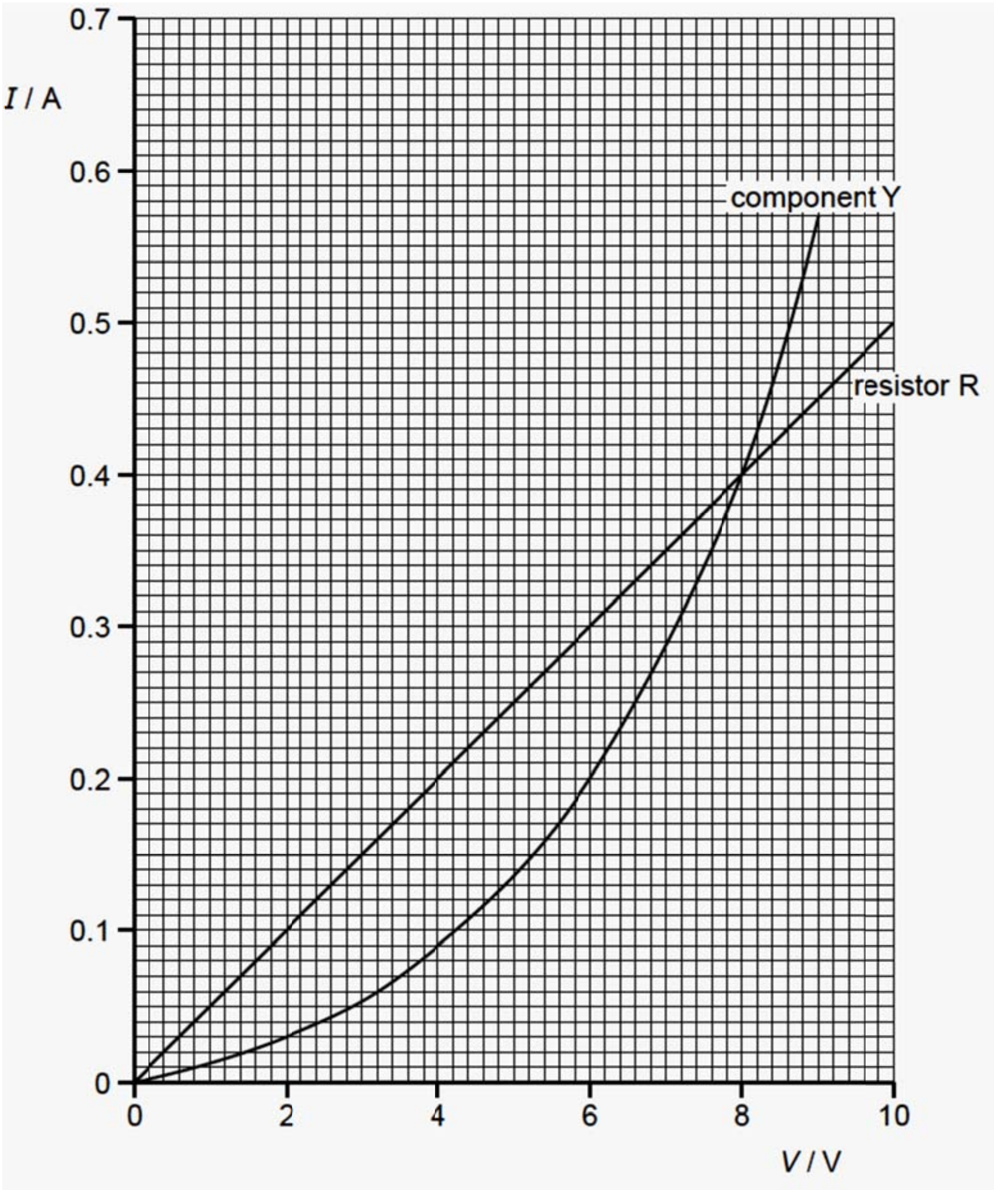

Fig. 2.1

(a) Use Fig. 2.1 to explain how it can be deduced that resistor R has a constant resistance of 20 Ω.

....

....[1]

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(b) The component Y and the resistor R are connected in parallel as shown in Fig. 2.2.

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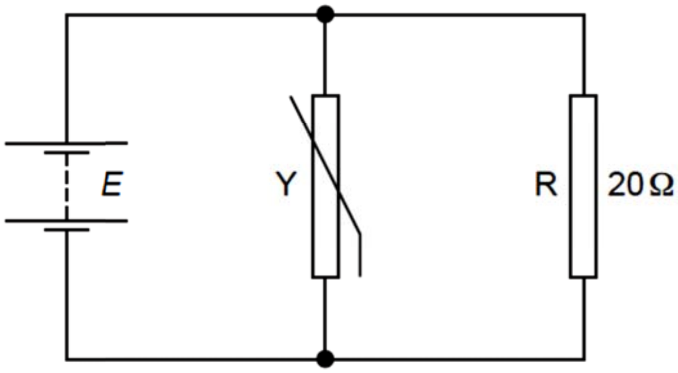

Fig. 2.2

A battery of e.m.f. *E* and negligible internal resistance is connected across the parallel combination.

Use data from Fig. 2.1 to determine

(i) the current in the battery for an e.m.f. *E* of 4.0 V,

current = ... A [1]

(ii) the total resistance of the circuit for an e.m.f. *E* of 8.0 V.

resistance = ... Ω [2]

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(c) The circuit of Fig. 2.2 is now re-arranged as shown in Fig. 2.3.

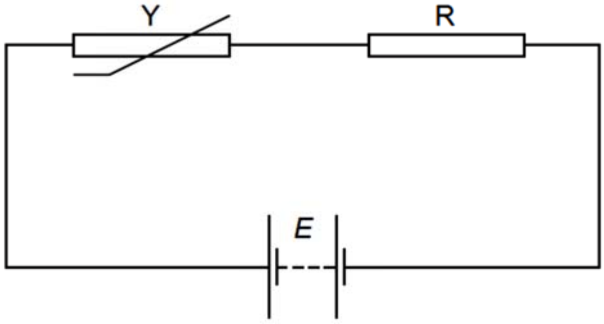

Fig. 2.3

The current in the circuit is 0.20 A.

(i) Use Fig. 2.1 to determine the e.m.f. *E* of the battery.

E = ...V [1]

(ii) Calculate the ratio of the power dissipated in component Y to the power delivered by the battery.

ratio = ………………………….. [2]

#

3 Electromagnetic radiation of frequency *f* is incident on a metal surface. The variation with frequency *f* of the maximum kinetic energy E_{MAX} of electrons emitted from the surface is shown in Fig. 3.1.

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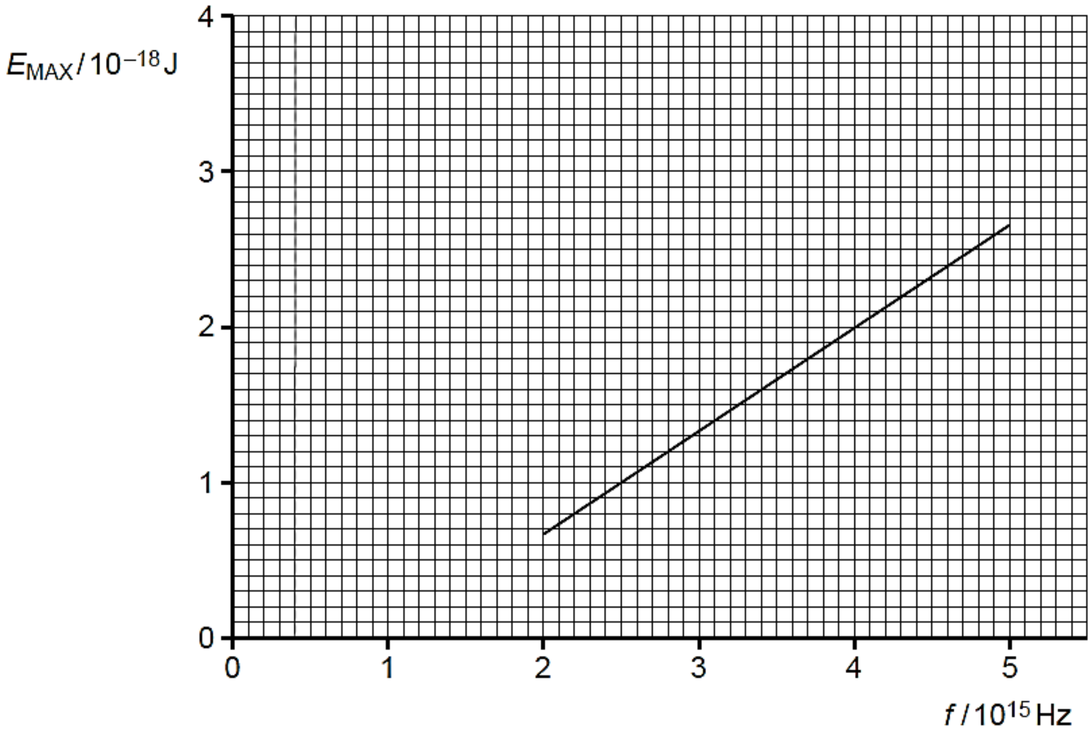

Fig. 3.1

(a) By reference to the photoelectric effect, explain what is meant by *work function energy*.

....

....[1]

(b) **(i)** Use Fig. 3.1 to determine the work function energy of the metal surface.

work function energy = ... J [2]

#

(ii) Explain why, even when the incident light is monochromatic, the emitted electrons have a range of kinetic energy up to a maximum value.

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....

....

....[2]

(iii) A second metal has a smaller work function energy than that in **(i)**.

On Fig. 3.1, draw a line to show the variation with f of E_{MAX} for this metal. [2]

(c) Explain why the graphs in Fig 3.1 and **(b)(iii)** do not depend on the intensity of the incident radiation.

....

....

....[2]

#

4 The graph in Fig. 4.1 shows how the acceleration of freefall *g* changes with distance from the centre of the Earth.

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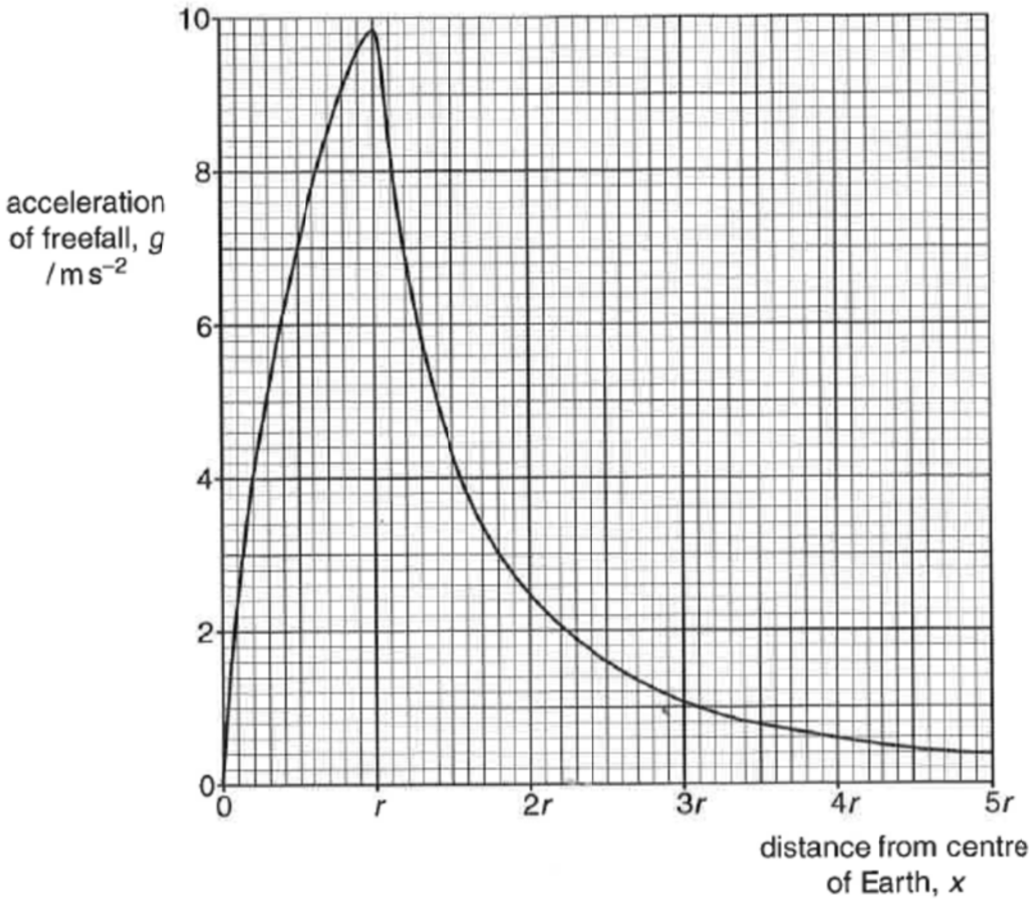
The distance from the centre of the Earth *x* is given in terms of the radius of the Earth *r*. At the centre of the Earth, the value of the acceleration is zero and the value increases to the value of 9.81 m s^{-2} at the Earth's surface. From the surface of the Earth the value decreases as shown.



#

Fig. 4.1

(a) Suggest why the value of the acceleration *g* increases with distance from the centre of the Earth until the surface.

....

....[1]

#

#

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

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[3]

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

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

(d) The International Space Station (ISS) is at a height h above the Earth's surface. The value of g at this height is 8.81 m s^{-2}. The radius of the Earth is 6370 km.

(i) Calculate h.

height of Station = ... km [2]

#

(ii) In finding the work done W to moving the ISS of mass m from the distance $x = r$ to $x = 3r$, suggest why it is wrong to use *the equation*

$$W = mg\Delta h$$

where g is the acceleration of free fall 9.81 m s^{-2} *and* $\Delta h = 2r$.

....

....

....[2]

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Section B

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

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5 **(a)** A straight conductor carrying a current I is placed in a uniform magnetic field of flux density B, as shown in Fig. 5.1.

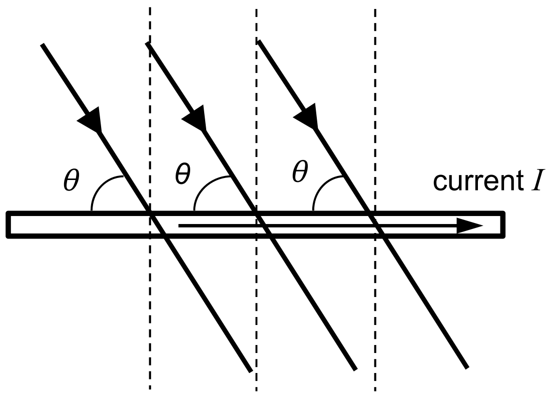

Fig. 5.1

The conductor and the magnetic field are both in the plane of the paper.

(i) Write an expression for the force per unit length acting on the conductor due to the magnetic field.

force per unit length = ...[1]

(ii) State the direction of the magnetic force acting on the conductor.

direction of magnetic force = ... [1]

(iii) The current in the conductor is a movement of free electrons along the conductor.

The number of electrons flowing through the conductor in 1 minute is 5.6×10^{21}.

If θ = 30° and the magnetic flux density is 2.6×10^{-2} T, determine the force per unit length acting on the conductor.

force per unit length = ... $N\ m^{-1}$ [4]

#

(b) Two long vertical conductors X and Y pass through a horizontal board, as shown in Fig. 5.2.

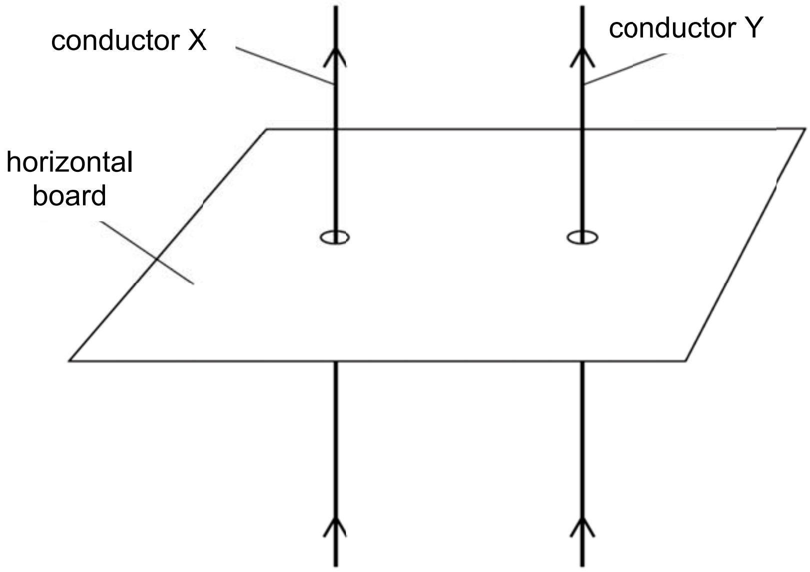

Fig. 5.2

The current in each conductor is in the upward direction.

(i) In Fig. 5.3, draw four field lines to represent the pattern of the magnetic field **due solely** to the current in conductor X. [2]

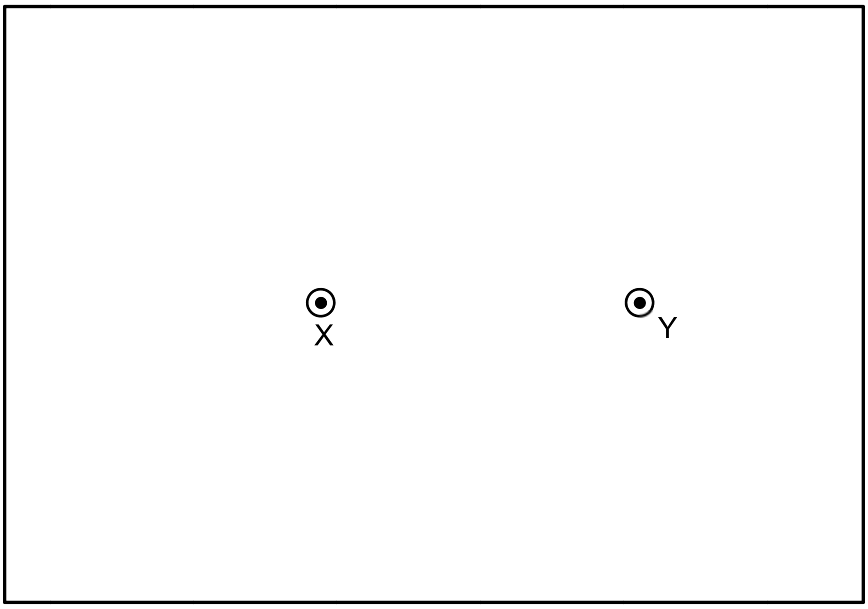

Fig. 5.3

(ii) In Fig. 5.3, draw an arrow to show the direction of the force on conductor Y due to the magnetic field of conductor X. [1]

#

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

$$B = 2.0 \times 10^{-7}\left(\frac{I}{x}\right)$$

The currents in conductor X and Y are 4.0 A and 6.0 A respectively. The separation of the conductors is 3.0 cm.

(i) Calculate the force per unit length on conductor Y due to the current in conductor X.

force per unit length = ... N m^{-1} [3]

(ii) The currents in the conductors are not equal.

State and explain whether the forces on both the conductors are equal in magnitude.

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....[2]

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(d) Two loops of a coil are suspended from a fixed point as shown in Fig. 5.4.

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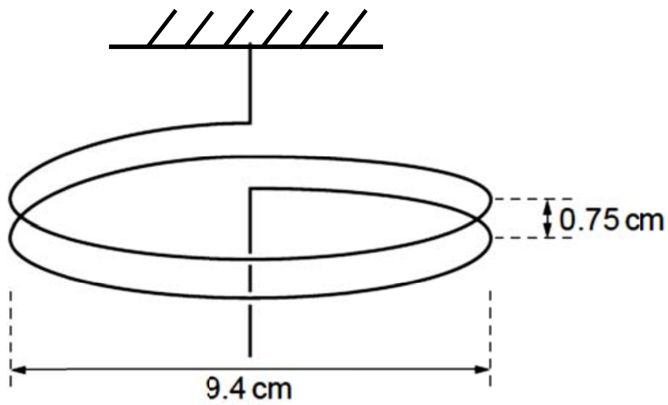

Fig. 5.4

Each loop of the wire has a diameter of 9.4 cm and is separated by 0.75 cm. The coil is connected to a circuit such that the lower end of the coil is free to move.

(i) State and explain the change in the separation distance of the two loops of wire when a current is made to flow in the coil.

....

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....[3]

(ii) A mass of 0.30 g is hung at the free end of the coil when a current is flowing in the coil. If the separation distance between the loops remains unchanged as shown in Fig. 5.4, calculate the magnitude of the current.

[You may use the expression for magnetic flux density *B* given in part **(c)**].

current = ... A [3]

#

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6 **(a)** **(i)** Define *work done by a force*.

....

....[1]

(ii) The S.I. unit of work is the joule (J) which is also equivalent to newton metre (N m).

A student states that "the moment of a force is equivalent to work since the unit of moment can also be expressed as newton metre (N m)".

Comment on the validity of his statement.

....

....

....[1]

(b) Energy is defined as the ability to do work.
In each of the scenarios below, discuss **quantitatively**, with relevant calculations, how energy is transformed for the body in motion, including how work is done by the body if any.

(i) A 70 kg swimmer makes an upward leap at an angle from the starting platform with a speed of 3.7 m s^{-1}. The starting platform is 0.60 m above the water surface. The swimmer rises by 0.45 m before plunging downwards.

Discuss **quantitatively** how energy is transformed from the point right after making the leap to the highest point of his leap.

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....

....[3]

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(ii) A 3.0 kg box is released down a rough, steep slope from rest until it reaches a constant speed of 5.8 m s^{-1} after falling through a vertical height of 8.2 m.

Discuss **quantitatively** how energy is transformed from the point of release to the point of just reaching constant speed

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....

....

....[4]

(iii) A 50 g metal sphere is released from just below the surface of a long, vertical tube of viscous fluid.

Discuss **quantitatively** how energy is transformed from the point the sphere just reaches its terminal speed of 3.5 cm s^{-1} to the point just before hitting the base of the tube after falling a further 45 cm.

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....[2]

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(c) A light helical spring is suspended vertically from a fixed point, as shown in Fig. 6.1.

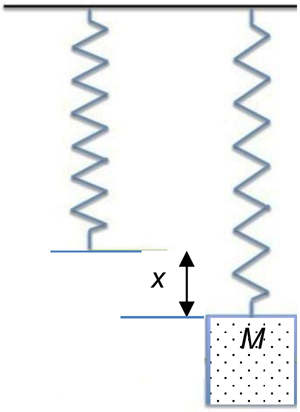

Fig. 6.1

Different masses M are suspended from the spring. The variation with extension x of the spring with mass M is shown in Fig. 6.2.

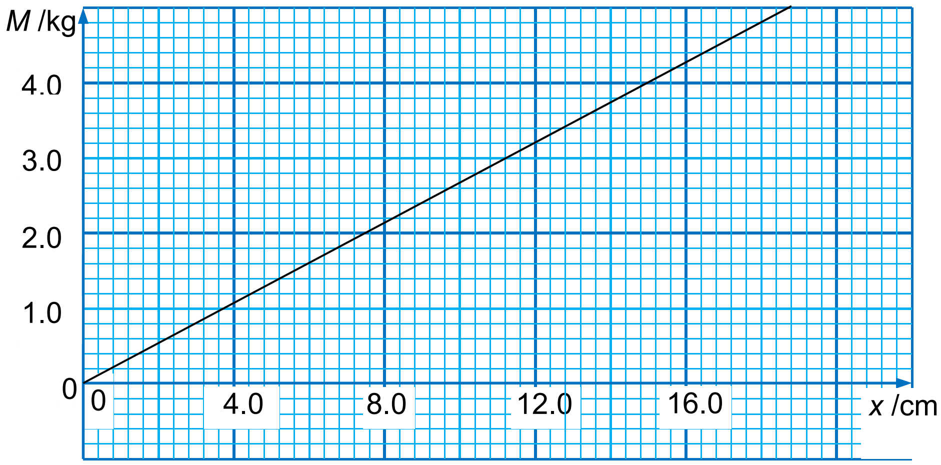

Fig. 6.2

(i) Using Fig. 6.2, determine the elastic potential energy stored in the spring when the mass M is 3.2 kg.

elastic potential energy .... J [2]

(ii) By considering the spring when the mass M is 3.2 kg or otherwise, show that the spring constant k of the spring is 260 N m^{-1}.

[2]

#

(iii) The mass is raised by hand a distance of 3.6 cm vertically upwards and held stationary there. For this raising of the mass by the hand,

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1. determine the increase in gravitational potential energy of the mass,

increase in gravitational potential energy = ... J [1]

2. determine the decrease in elastic potential energy of the spring,

decrease in elastic potential energy = ... J [2]

3. and explain why the answers in **1.** and **2.** are not the same.

....

....[2]

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7 **(a)** Explain the term *interference*.

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....[1]

(b) Fig. 7.1 shows a string stretched between two fixed points P and Q.

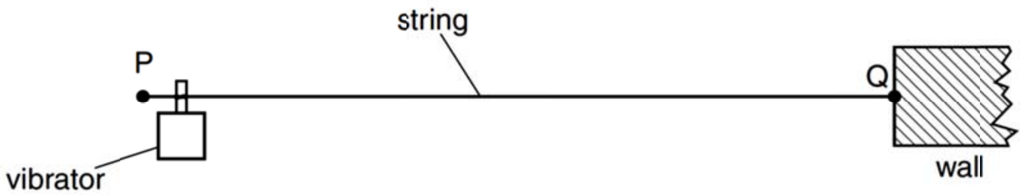

Fig. 7.1

A vibrator is attached near end P of the string. End Q is fixed to a wall. The vibrator has a frequency of 50 Hz and causes a transverse wave to travel along the string at a speed of 40 m s^{-1}.

(i) Calculate the wavelength of the transverse wave on the string.

wavelength = ... m [2]

(ii) Explain how this arrangement may produce a stationary wave on the string.

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....

....[2]

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(iii) The stationary wave produced on PQ at one instant of time t is shown on Fig. 7.2. Each point on the string is at its maximum displacement.

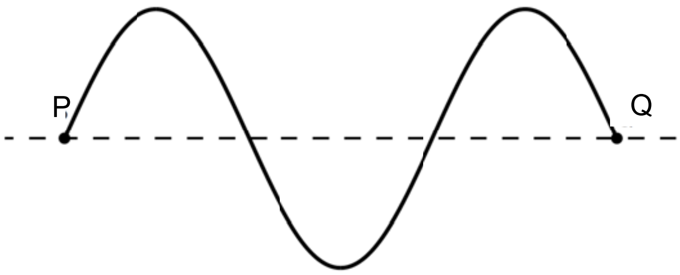

Fig. 7.2

1. On Fig. 7.2, label all the nodes with the letter N and all the antinodes with the letter A. [2]

2. Calculate the length of the string PQ.

length = ... m [1]

3. On Fig. 7.2, draw the stationary wave at time (t + 5.0 ms). Explain your answer.

....

....

....

....[3]

(c) A ripple tank is used to demonstrate interference between water waves.

(i) Describe the apparatus used to produce two sources of coherent waves that have circular wavefronts and how the pattern of interfering waves may be observed.

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....

....[3]

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(ii) A wave pattern produced in **c(i)** is shown in Fig 7.3.

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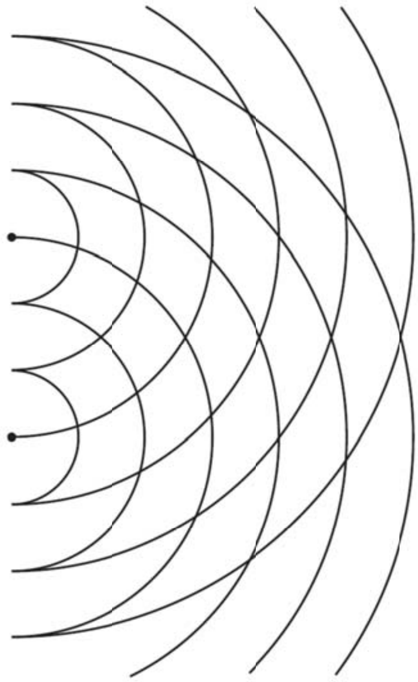

Fig. 7.3

Solid lines on Fig. 7.3 represent crests.

On Fig. 7.3.,

1. draw two lines to show where maxima would be seen (label each of these lines with the letter A), [1]

2. draw one line to show where minima would be seen (label this line with the letter N), [1]

#

(d) Sound waves travel from a source S to a point X along two paths SX and SPX, as shown in Fig. 7.4. The waves undergo a phase change of π radians as it reflects off the surface at **P**.

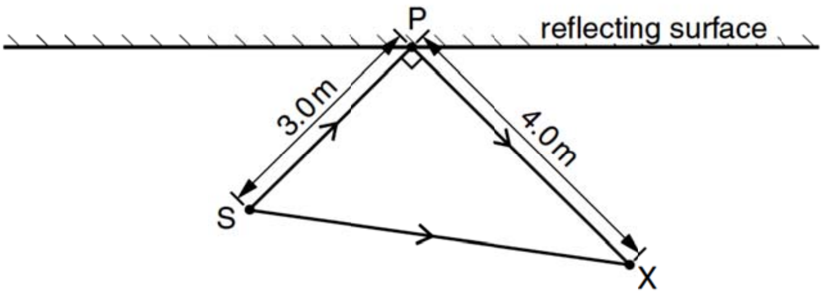

Fig. 7.4

(i) The frequency of the sound from S is 400 Hz and the speed of sound is 320 m s^{-1}. Calculate the wavelength of the sound waves.

wavelength = ... m [2]

(ii) The distance SP is 3.0 m and the distance PX is 4.0 m. The angle SPX is 90°. Suggest whether a maximum or a minimum is detected at point X. Explain your answer.

....

....

....[2]

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