Candidate's Name ……………………………………………… CTG **2**…..............

YISHUN JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2015

PHYSICS — **8866/02**
HIGHER 1 — **20 August 2015**
Paper 2 Short Structured Question — **Thursday**
120 minutes

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name and CTG in the spaces provided above.

Write in dark blue or black pen on both sides of the paper.

Do not use paper clips, highlighters, glue or correction fluid.

The use of approved scientific calculator is expected, where appropriate.

Answer **all** questions in Section **A** and any 2 questions from Section **B**

All working must be shown clearly in the spaces provided.

Paper 2	
Section A	
Q1	/4
Q2	/4
Q3	/5
Q4	/7
Q5	/7
Q6	/7
Q7	/6
Section B	
Q8	/20
Q9	/20
Q10	/20
Paper 2	
	/80
Paper 1	
	/30
Final Total	
	%

This question paper consists of 21 printed pages, inclusive of the cover 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	=	$R_1 + R_2 + \ldots\ldots\ldots$
Resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$

Section A

Answer **all** questions. Show your workings clearly in the spaces provided.

1 A spherical ball of radius r experiences a resistive force F due to air as it moves through the air at speed v. The resistive force F is given by the expression:

$$F = c\, r\, v$$

where c is a constant.

The ball is dropped from rest through a height of 4.5 m.

(a) Assuming air resistance to be neligible, calculate the final speed of the ball just before reaching the ground.

Final speed = ………………….. m s^{-1} [1]

(b) The ball has a mass of 15 g and radius of 1.2 cm.

The numerical value of the constant c in the equation in **Q1** is equal to 3.2×10^{-4} N s m^{-2}.

Show quantitively whether the assumption made in **(a)** is justified.

[3]

2 The volume of fuel in the tank of a car is monitored using a meter as illustrated in Fig. 2.1.

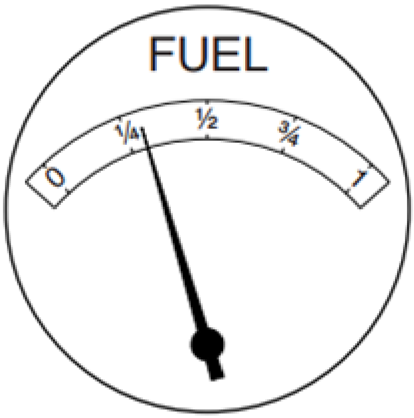

Fig. 2.1

The meter has an analogue scale. The meter reading for different volumes of fuel in the tank is shown in Fig. 2.2.

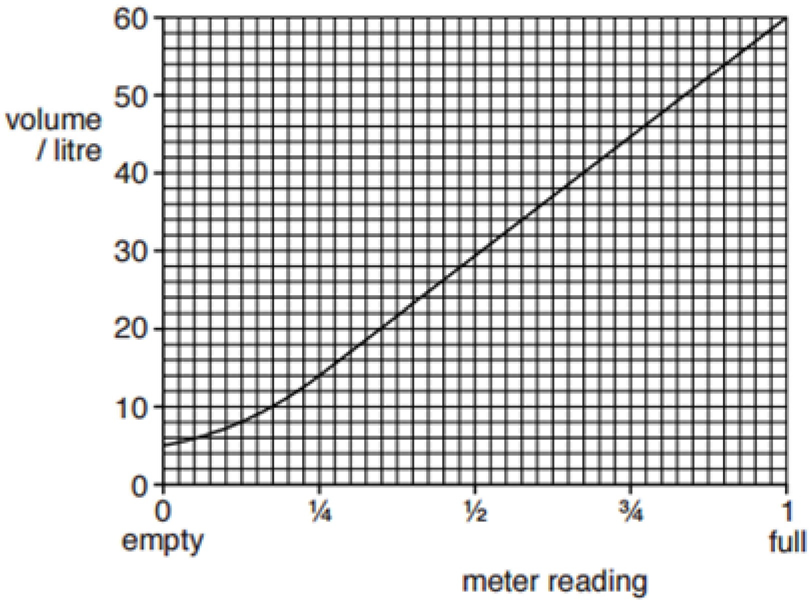

Fig. 2.2

The meter is calibrated in terms of the fraction of the tank that remains filled with fuel.

(a) The car uses 1.0 litre of fuel when travelling 14 km. The car starts a journey with a full tank of fuel.

(i) Calculate the volume of fuel remaining in the tank after a journey of 210 km.

Volume of fuel remaining =………………………………….litre [1]

(ii) Use your answer to **(i)** and Fig. 2.2 to determine the change in the meter reading during the 210 km journey.

From full to …………………………… [1]

(b) **(i)** State the feature of Fig. 2.2 that indicates that there is an error in the meter readings.

…………………………………………………………………………………………

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

(ii) Suggest why, for this meter, it is an advantage to have this error.

…………………………………………………………………………………………...

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

3 Fig.3.1 shows an apparatus used to locate the centre of gravity of a non-uniform metal rod.

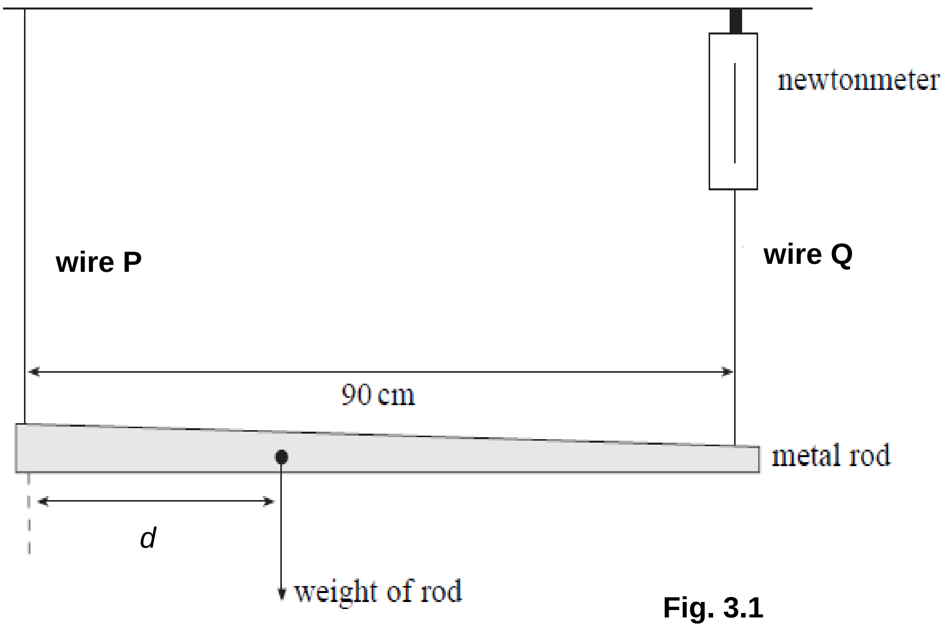

Fig. 3.1

The rod is supported horizontally by two wires, **P** and **Q** and is in equilibrium.

(a) State two conditions that must be satisfied for the rod to be in equilibrium.

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

…………………………………………………………………………………………….

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

(b) Wire **Q** is attached to a newtonmeter so that the force it exerts on the rod can be measured. The reading on the newtonmeter is 2.0 N and the weight of the rod is 5.0 N. Calculate

(i) the force that wire **P** exerts on the rod,

Force = …………………………N [1]

(ii) the distance *d*, as shown in Fig. 3.1.

d = …………………………m [2]

4 A 2.0 kg box on a frictionless incline of angle $\theta = 40^o$ is connected by a cord that runs over a massless and frictionless pulley to a light spring of spring constant $k = 120\ N\ m^{-1}$, as shown in Fig. 4.1. The box is released from rest along the inclined plane when the spring is unstretched.

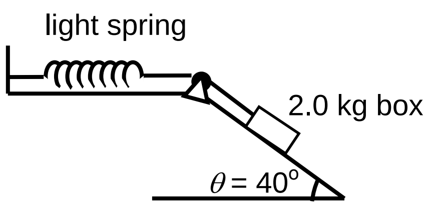

Fig. 4.1

(a) Calculate the energy stored in the spring when the box has moved 10 cm down along the incline.

Energy = …………………………J [1]

(b) Calculate the speed of the box when it moved 10 cm down the incline.

Speed = …………………………m s^{-1} [2]

(c) Calculate the distance moved by the box down along the incline, *D* from its point of release before it momentarily stops.

D = ……………………………m [2]

(d) Calculate the magnitude of acceleration of the box at the instant the box momentarily stops.

Acceleration = ……………………………. m s^{-2} [2]

5 A battery of e.m.f, E = 1.5 V and internal resistance, r = 1.2 Ω is connected to a light bulb and an ideal ammeter as shown in Fig. 5.1. A current of 220 mA flows through the circuit for 6.0 s.

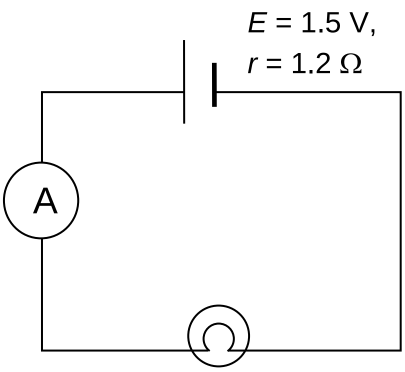

Fig. 5.1

Determine,

(a) The amount of charge that passes through the light bulb,

Amount of charge = ……………………. C [1]

(b) the number of electrons that flow through the light bulb,

Number of electrons = ……………………. [1]

(c) the resistance of the light bulb,

Resistance = ……………………… Ω [2]

(d) the power loss in the battery,

Power loss = ……………………… W [1]

(e) the power supplied to the light bulb,

Power supplied = ……………………… W [1]

(f) The fraction of the power supplied by the battery to the light bulb.

Fraction = ……………………….. [1]

6 The circuit in Fig. 6.1 shows a light dependent resistor (LDR) two resistors of resistance 30.0 Ω and 50.0 Ω connected to a battery of e.m.f 110 V of negligible internal resistance. The ideal ammeter records a reading of 2.0 A.

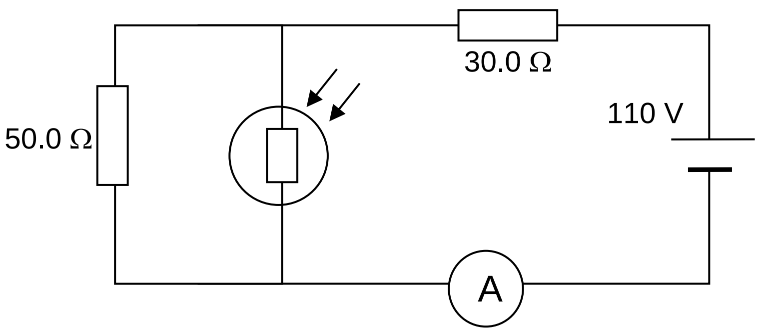

Fig. 6.1

(a) Determine the potential difference across the 30.0 Ω resistor.

Potential difference = ………………………… V [1]

(b) Determine the current flowing in the 50.0 Ω resistor.

Current = ……………………… A [2]

(c) Determine the resistance of the LDR.

Resistance = ……………………….. Ω [2]

(d) Hence or otherwise, state and explain how the current recorded by the ammeter will change when the surrounding is dimmer.

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

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

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

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

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

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

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

7 Fig. 7.1 shows a wire frame **ACDF** that is supported on a sharp edge at **B** and **E** such that section **BCDE** lies within a solenoid that provides a magnetic field of flux density, B = 5.0 mT. A current I of 2.0 A is then passed through the frame in the direction **EDCB** and the position of the non-conducting rod of mass, m = 0.10 g is adjusted so that the frame is balanced horizontally on the sharp edge.

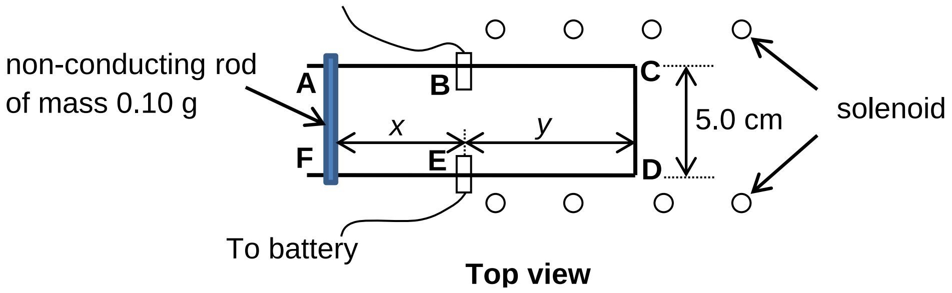

Fig. 7.1

(a) Given that **CD** = 5.0 cm, calculate the ratio of distances, x:y as shown in Fig. 7.1.

x:y = …………………………… [3]

(b) State and explain the direction of magnetic field due to the solenoid.

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

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

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

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

(c) Describe what will happen to the set-up as shown in Fig. 7.1 if the direction of flow of current in the <u>solenoid</u> is reversed.

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

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

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

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

Section B

Answer any two questions in this section. Show your workings clearly in the spaces provided.

8 A flat board is placed horizontally on a spring and different weights are placed on it, as shown in Fig. 8.1.

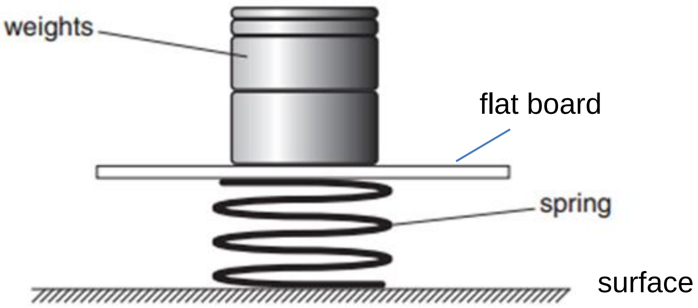

Fig. 8.1

The variation with weight of the compression of the spring is shown in Fig. 8.2.

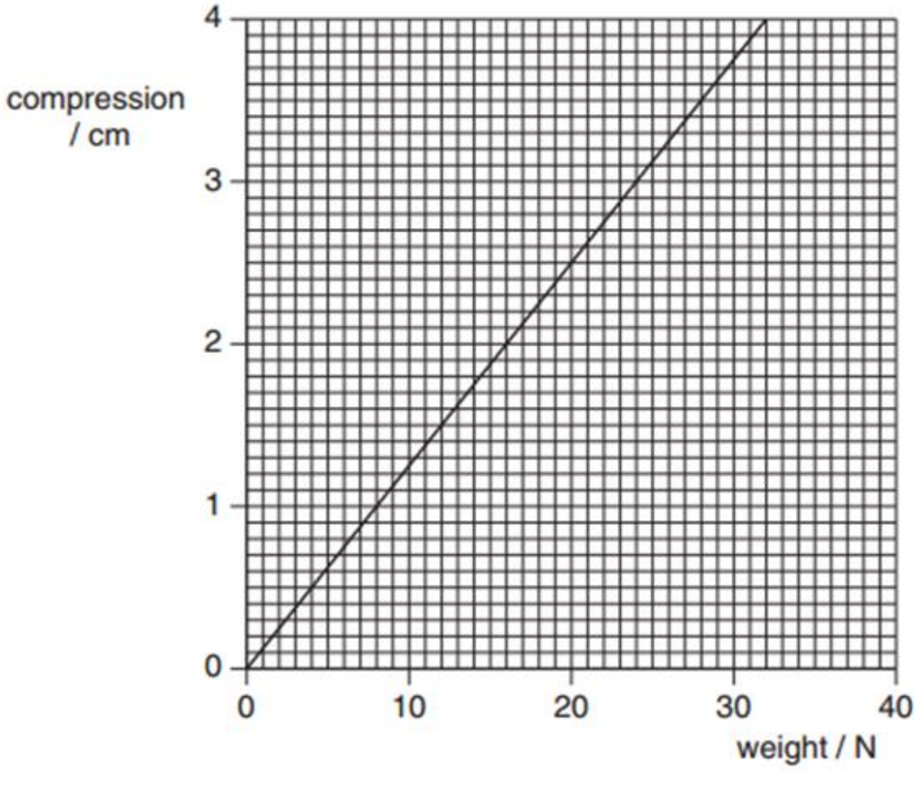

Fig. 8.2

The elastic limit of the spring has not been exceeded.

(a) **(i)** Determine the spring constant *k* of the spring.

k = ... N m^{-1} [2]

(ii) Deduce that the elastic potential energy stored in the spring is 0.49 J for a compression of 3.5 cm.

[2]

(b) Two trolleys, of masses 800 g and 2400 g, are free to move on a smooth horizontal table. The spring in **(a)** is placed between the trolleys and the trolleys are tied together using thread so that the compression of the spring is 3.5 cm, as shown in Fig. 8.3.

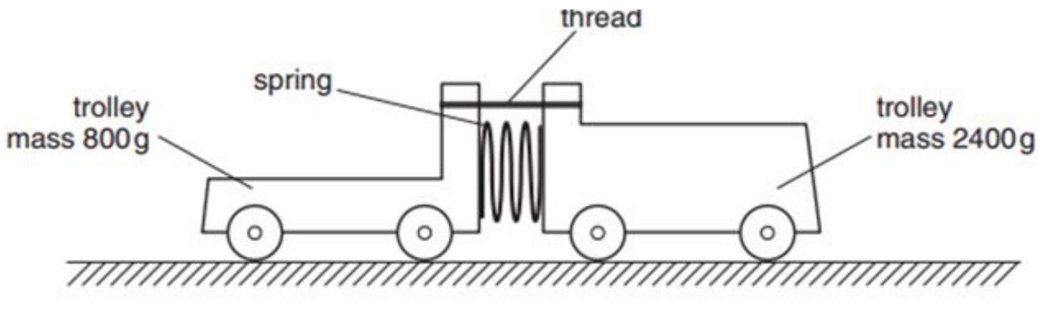

Fig. 8.3

Initially, the trolleys are not moving.

The thread is then cut and the trolleys move apart.

(i) Deduce that the ratio $\frac{speed\ of\ trolley\ of\ mass\ 800g}{speed\ of\ trolley\ of\ mass\ 2400\ g}$ is equal to 3.0.

[2]

(ii) Use the answers in **(a)(ii)** and **(b)(i)** to calculate the speed of the trolley of mass 800 g.

Speed = ………………………………….m s^{-1} [3]

(c) Another shopping trolley and its content have a total mass of 42 kg. The trolley is being pushed along a horizontal surface at a constant speed of 1.2 m s^{-1}. When the trolley is released, it travels a distance of 1.9 m before coming to rest.

(i) Assuming that the total force opposing the motion of the trolley is constant,

1. Calculate the deceleration of the trolley,

Deceleration = ……………………………… m s^{-2} [2]

2. Show that the total force opposing the motion of the trolley is 16 N.

[1]

(ii) Using the total opposing force of 16 N, calculate the power required to overcome the total force opposing motion of the trolley at the constant speed of 1.2 m s^{-1}.

Power = ………………………………….W [2]

(iii) The trolley now moves down a straight slope that is inclined at an angle of 2.8° to the horizontal, as shown in Fig. 8.4.

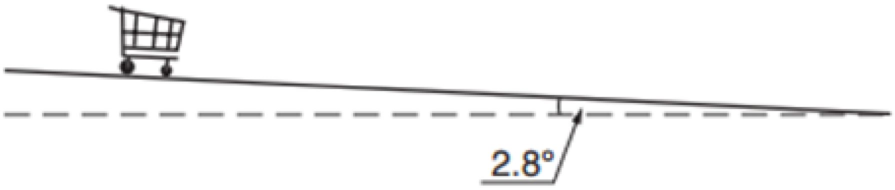

Fig. 8.4

The constant force that opposes the motion of the trolley is 16 N.

Calculate, for the trolley moving down the slope,

1. the component of the trolley's weight down the slope,

Component of weight = ……………………………… N [2]

2. the time for the trolley to travel from rest a distance of 3.5 m along the length of the slope.

Time =………………………………s [3]

(iv) Use your answer in **(c)(iii)(2)** to explain why, for safety reasons, the slope is not made any steeper.

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

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

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

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

9 **(a)** **(i)** State what is meant by the term *photoelectric effect*.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(ii) Give an expression for E, the energy of a photon, in terms of λ, its wavelength, h, the Planck's constant and c, the speed of light in free space.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(iii) The wavelength of red visible light is measured experimentally to be (700 ± 30) nm. Express the energy of a red light photon with its associated uncertainty.

Energy = …………………………….. J [4]

(b) In a photoelectric emission experiment, a metal plate is irradiated with light of wavelengths λ_1 = 388 nm and λ_2 = 283 nm. The stopping potentials recorded are V_1 and V_2 respectively. If the larger stopping potential is twice of the other, determine the work function of the metal in eV.

Work function =………………………………..eV [3]

(c) A light source of constant power 0.20 W emits light of wavelength 480 nm uniformly in all directions. A metal plate with a small surface area is placed 30 cm from this source and facing the source directly. Electrons are emitted from the metal surface. At this wavelength, only one in eight of the incident photons succeeds in ejecting a photoelectron from the metal. Assuming that all the emitted electrons are collected, the current detected is 8.5 μA.

(i) Calculate the rate of photoelectrons emitted from the metal plate.

Rate = ………………………………..s^{-1} [2]

(ii) Hence or otherwise, determine the rate of photons incident on the metal plate

Rate = ………………………………..s^{-1} [1]

(iii) Calculate the power of light incident on the metal plate.

Power = ………………………………..W [2]

(iv) State and explain how your answer calculated in **(iii)** will change if the intensity of the light describe in part **(c)** is doubled while keeping its frequency constant.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [3]

(d) Fig. 9.1 shows some of the energy levels for an atom of hydrogen.

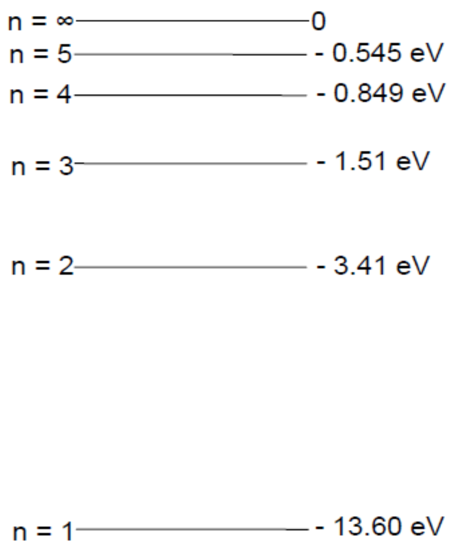

Fig. 9.1

Calculate the wavelength of the photon released when an electron transits from n = 5 to n = 3 state.

Wavelength = ………………………………..m [2]

10 (a) Sound waves are longitudinal waves. What is meant by *longitudinal wave*?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(b) Fig. 10.1 shows an arrangement which demonstrates interference of sound waves. The two loudspeakers **M** and **N** are driven by the same signal generator set to a frequency of 13600 Hz. The speakers are perfectly matched to emit the same power at this frequency. An observer identifies **A** as being the position where the loudest sound is heard.

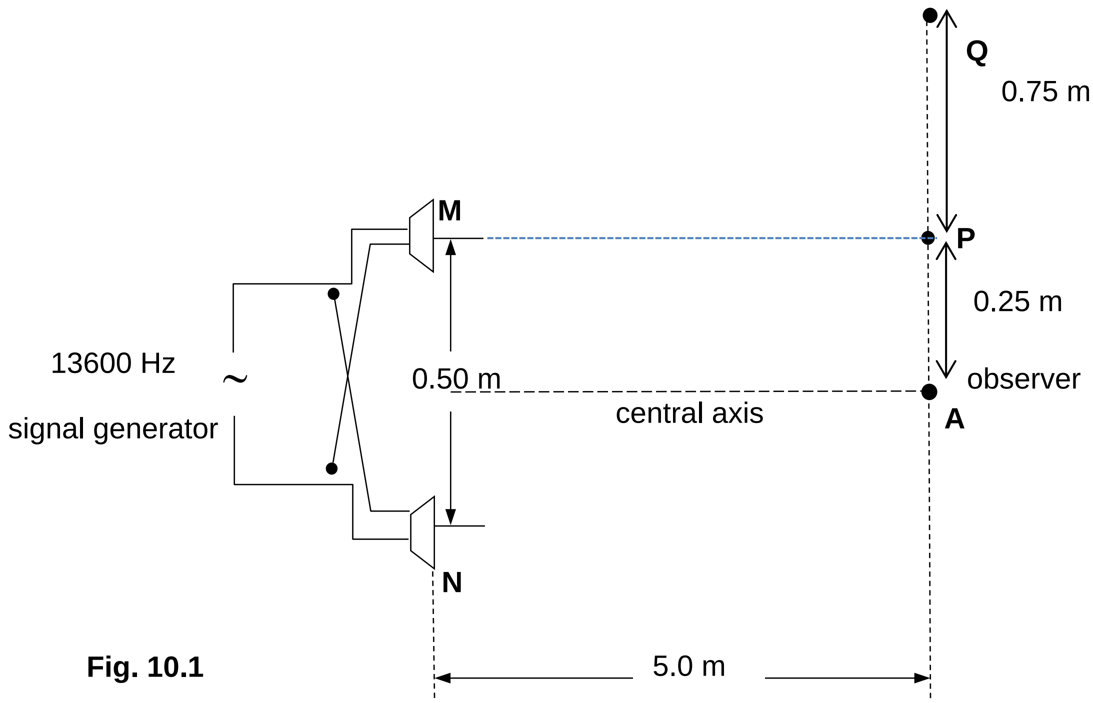

Fig. 10.1

(i) The sound from the speakers is coherent. Explain what is meant by the term 'coherent'.

....

.... [1]

(ii) **1.** The observer walks from **A** towards **P** which is at a distance 0.25 m away from **A** as shown in Fig. 10.1. Show that there are 200 wavelengths between **M** and **P**. The speed of sound waves is 340 m s^{-1}.

[2]

2. Using Pythagoras Theorem, calculate the number of wavelengths between **N** and **P**.

Number of wavelengths =............................ [2]

3. State and explain the intensity of sound (high or low) heard by the observer at **P**.

....
....
....
....
....
....
....
....
....
....
....
....
.... [3]

4. Describe how the intensity varies as the observer walks from **P** towards **Q** which is at a distance of 0.75 m away from **P** as shown in Fig. 10.1.

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

(c) (i) State the conditions required to produce stationary waves.

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

(ii) A student is provided with a signal generator and a speaker, reflecting wall and microphone connected to a cathode ray oscilloscope. Describe with the aid of a diagram, how it can be used to produce and detect stationary waves.

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

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

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

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

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

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

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

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

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

[4]

(iii) Describe how the student may determine the frequency of the sound in **(ii)**, given that the speed of sound is 340 m s^{-1}.

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

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

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

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

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

[2]

END OF PAPER