Selected Questions – Set 8

1.

(a) Fig. 4.1 shows a section of a uniform string under tension at one instant of time. A progressive wave of wavelength 80 cm is moving along the string from left to right. At the instant shown, the displacement of the string is zero at the point opposite the zero mark on the scale beneath the string.

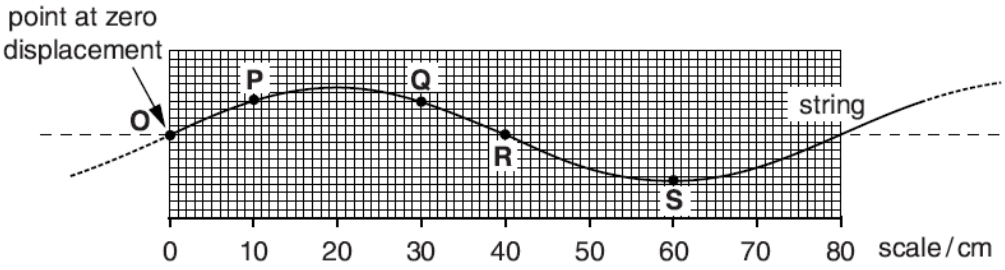

Fig. 4.1

Four points **P**, **Q**, **R** and **S** at 10, 30, 40 and 60 cm respectively, are marked on the string. The oscillatory motion of each point can be described in terms of amplitude, frequency and phase difference from **O**.

(i) State the meaning of each of the terms

1 *amplitude*

.....

.....

2 *frequency*

.....

.....

3 *phase difference*.

.....

.....

[3]

(ii) Describe using these three terms how the motion of points **P**, **Q**, **R** and **S**

1 is similar,

.....

.....

2 is different.

.....

.....

[2]

(b) Fig. 4.2 shows the same section of string now held under tension between a clamp and a pulley, 80 cm apart. A mechanical oscillator is attached to the string close to the clamped end. The frequency of the mechanical oscillator is varied until the stationary wave shown is set up between the clamp and the pulley. The same four points as in Fig. 4.1 are marked on the string.

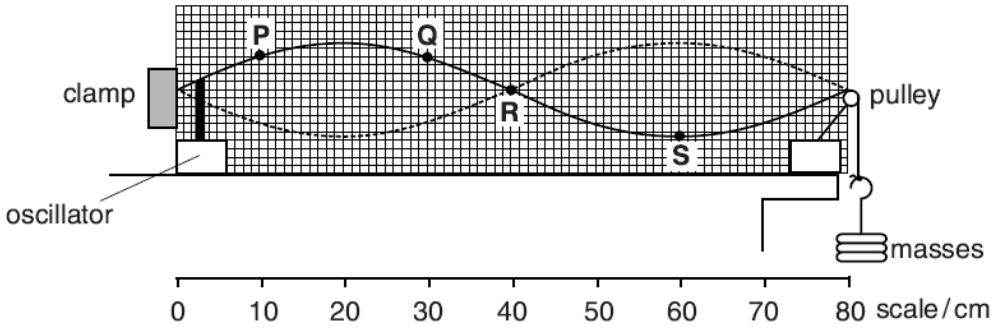

Fig. 4.2

(i) Describe how a stationary wave is different from a progressive wave.

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.....

.....

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

(ii) Explain how the stationary wave is formed on this string.

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.....

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.....

.....

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

(iii) Describe, using the terms amplitude, frequency and phase difference, how the motions of the points **P**, **Q** and **S**

1 are similar,

.....

.....

2 are different.

.....

.....

[3]

(iv) In Fig. 4.2 the frequency of oscillation is 30 Hz. State, with a reason, the lowest frequency of oscillation of the string at which the motions of all of the points **P**, **Q**, **R** and **S** are

1 in phase,

.....

.....

2 all at rest.

.....

.....

[4]

2.

Fig. 5.1 shows two microwave transmitters **A** and **B** 0.20 m apart. The transmitters emit microwaves of frequency 10 GHz, of equal amplitude and in phase. A microwave detector is placed at **O** a distance of 4.0 m from **AB**.

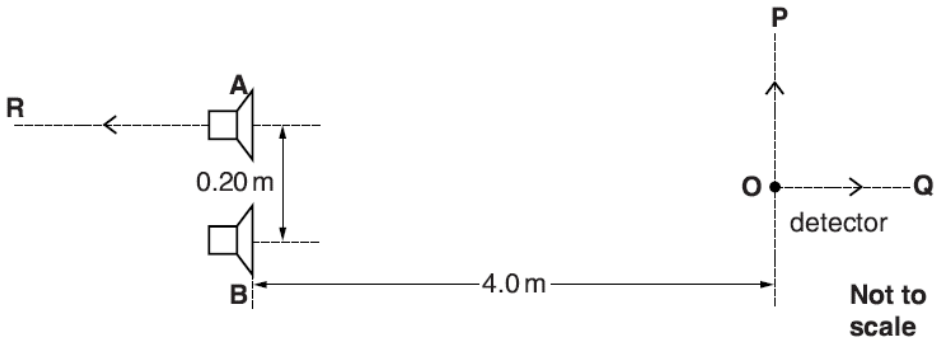

Fig. 5.1

(a) Interference of the waves from the two transmitters is detected only when the transmitters are coherent. Explain the meaning of

(i) *interference*

.....

.....

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

(ii) *coherent.*

.....

..... **[1]**

(b) The length of the detector aerial is half a wavelength. Calculate the length of the aerial.

Show your working.

aerial length = ... m **[2]**

(c) (i) 1 Explain why the amplitude of the detected signal changes when the detector is moved in the direction **OP**.

.....

.....

.....

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

2 Calculate the distance between adjacent **maximum** and **minimum** signals.

distance = ... m **[2]**

(ii) Explain why the amplitude of the detected signal changes when the detector is moved in the direction **OQ**.

.....

.....

.....

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

(iii) Explain why the amplitude of the detected signal decreases to a minimum before increasing again as transmitter **A** is moved a small distance in the direction **AR** with the detector fixed at **O**. Calculate the distance **A** is moved to cause this minimum signal at **O**.

.....

.....

.....

.....

.....

.....

distance = ... m **[2]**

(d) State, with a reason, the effect on the intensity of the signal detected at **O** when each of the following changes is made.

(i) The amplitude of the waves emitted from **A** and **B** is doubled.

.....

.....

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

(ii) The detector **O** is rotated 90° about the axis through **OQ**.

.....

.....

.....

.....

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

3.

(a) State **one** similarity and **one** difference between progressive waves and standing waves.

similarity

.....

.....

difference

.....

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

(b) A standing sound wave can be produced in an air column by blowing across the open end of a tube as shown in Fig. 5.1.

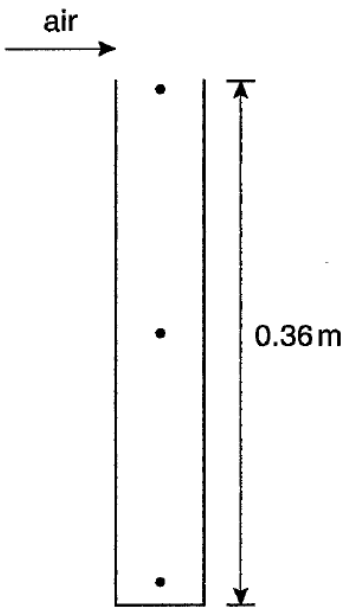

Fig. 5.1

The length of the tube is 0.36 m. The air column in the tube is sounding its lowest (fundamental) frequency note.

(i) Add **arrowed** lines to the dots in Fig. 5.1 to show the direction of movement and relative amplitudes of the air at these positions. [3]

(ii) Calculate the wavelength of the sound produced.

wavelength = ... m [1]

(iii) The speed of sound in air is $330\,m\,s^{-1}$. Determine the frequency of this standing wave.

frequency = ... Hz [2]

(iv) Determine the value of the lowest frequency of the note produced in a tube of this length but open at **both** ends. Show your reasoning.

lowest frequency = ... Hz [3]

4.

(a) The I/V characteristic of a particular component is shown in Fig. 1.1.

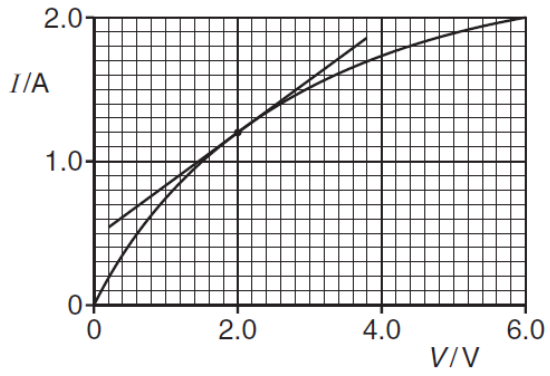

Fig. 1.1

(i) Name the component.

..... [1]

(ii) According to one student, the *'gradient of the graph at 2.0 V can be used to determine the resistance of the component at 2.0 V'*.
Explain why the student is wrong.

.....

..... [1]

(iii) Determine the resistance of the component at 2.0 V.

resistance = ... Ω **[2]**

(b) Fig. 1.2 shows a sketch graph of the variation of resistance *R* of a different component with potential difference (voltage) *V*.

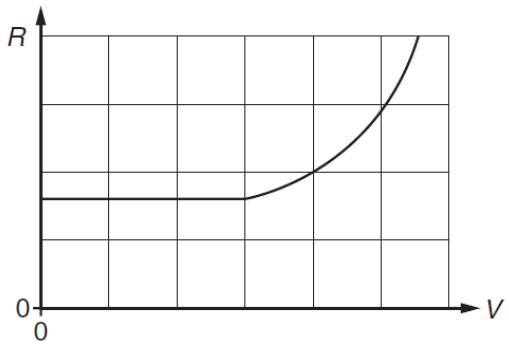

Fig. 1.2

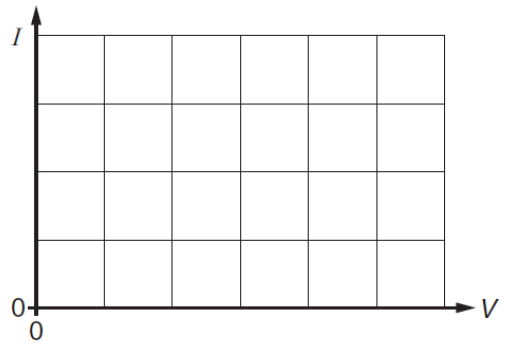

Fig. 1.3

Complete Fig. 1.3 by drawing a sketch graph to show the *I*/*V* characteristic of the component. **[2]**

(c) Fig. 1.4 shows an electrical circuit containing a semiconductor diode.

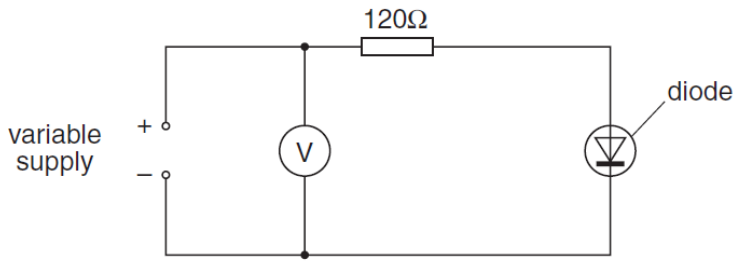

Fig. 1.4

This diode has a very low resistance when it conducts. It has an infinite resistance when the potential difference across it is less than 0.6V. The variable supply is adjusted to give a reading of 0.4V on the voltmeter.

(i) State the current in the 120Ω resistor.

current = ... A **[1]**

(ii) State the potential difference across the diode.

potential difference = ... V **[1]**

5.

(a) A battery delivers a constant current through a circuit when a switch is closed at time $t = 0$.

(i) On Fig. 5.1, sketch a graph to show how the total charge that has been supplied by the battery varies with time *t*.

[1]

Fig. 5.1

(ii) The battery delivers a constant current of 5.2A for a time of 3.5 hours. Calculate the total charge supplied by the battery after a time of 3.5 hours.

charge = ... unit ..... **[3]**

(b) Fig. 5.2 shows an electrical circuit.

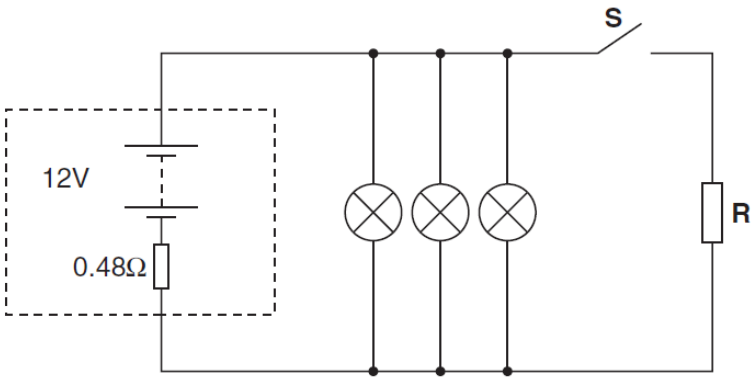

Fig. 5.2

The switch **S** is open. The battery has e.m.f. 12V and an internal resistance 0.48 Ω. The three lamps are identical, each of resistance 3.6 Ω. The filament of each lamp is a coiled wire of cross-sectional area of $2.0 \times 10^{-8}\,m^2$. The material of the filament has resistivity $7.9 \times 10^{-7}\,\Omega m$.

(i) Calculate the length of the filament wire in each lamp.

length = ... m **[3]**

(ii) With the switch **S open**, determine

1 the total resistance of the circuit

total resistance = ... Ω **[2]**

2 the current from the battery.

current = ... A **[1]**

(iii) With the switch **S closed**, the current in the resistor **R** is 20 A. Explain why the lamps dim when the switch is closed.

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.....

.....

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