1 **(a)** When used to describe stationary (standing) waves explain the terms

(i) node ....

.... **[1]**

(ii) antinode. ....

.... **[1]**

(b) Fig. 5.1 shows a string fixed at one end under tension. The frequency of the mechanical oscillator close to the fixed end is varied until a stationary wave is formed on the string.

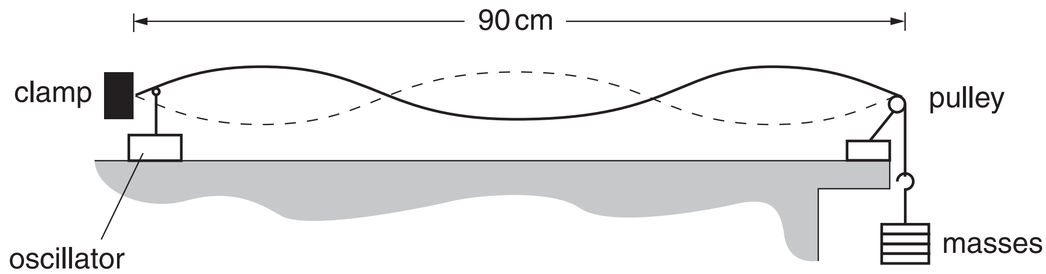

Fig. 5.1

(i) Explain with reference to a progressive wave on the string how the stationary wave is formed.

....

....

....

....

....

....

.... **[3]**

(ii) On Fig. 5.1 label one node with the letter **N** and one antinode with the letter **A**. **[1]**

(iii) State the number of antinodes on the string in Fig. 5.1.

number of antinodes = ... **[1]**

(iv) The frequency of the oscillator causing the stationary wave shown in Fig. 5.1 is 120 Hz.

The length of the string between the fixed end and the pulley is 90 cm.

Calculate the speed of the progressive wave on the string.

speed = ... $m s^{-1}$ **[3]**

(c) The speed v of a progressive wave on a stretched string is given by the formula

$$v = k\sqrt{W}$$

where k is a constant for that string. W is the tension in the string which is equal to the weight of the mass hanging from the end of the string.

In **(b)** the weight of the mass on the end of the string is 4.0 N. The oscillator continues to vibrate the string at 120 Hz. Explain whether or not you would expect to observe a stationary wave on the string when the weight of the suspended mass is changed to 9.0 N.

....

....

....

....

....

.... **[3]**

[Total: 13]

2 Fig. 4.1 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.

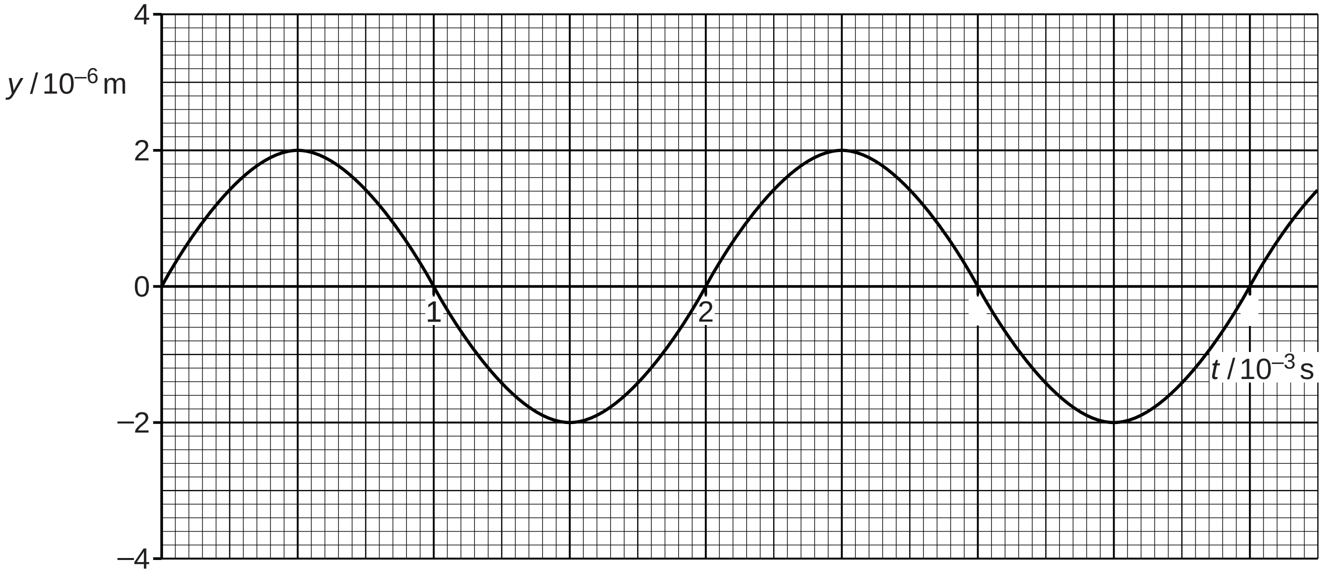

Fig. 4.1

(a) Calculate

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

f = ... Hz **[2]**

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

λ = ... m **[2]**

(b) Draw on Fig. 4.1 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]**

(c) 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**.

....

....

....

....

....

....

.... **[3]**

(d) The amplitude of vibration of the loudspeaker is increased to produce a wave at the original frequency, but of twice the **intensity**. Sketch on Fig. 4.1 the new displacement against time graph, for $t = 0$ to $t = 2 \times 10^{-3}$ s, at point **P**. Label this curve **P**. Explain your reasoning.

....

....

....

....

.... **[3]**

(e) An open tube is placed in front of the loudspeaker such that its far end is at point **Q**. See Fig. 4.2.

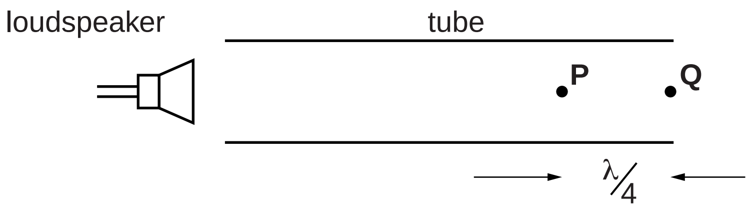

Fig. 4.2

(i) Explain how and under what conditions a stationary sound wave is formed in the tube.

....

....

....

....

....

....

....

.... **[3]**

(ii) Assume that the conditions are met for a stationary wave to be set up in the tube. The distance between the points **P** and **Q** is $\lambda/4$.

Describe the motion of the air molecules

1 at point **Q**

....

....

....

2 at point **P**.

....

....

.... **[3]**

[Total: 18]

3 **(a)** State the principle of superposition of waves.

....

....

.... **[2]**

(b) Coherent red light of wavelength 6.00×10^{-7} m is incident normally on a pair of narrow slits $\mathbf{S_1}$ and $\mathbf{S_2}$. A pattern of bright and dark lines, called fringes, appears close to point **P** on a distant viewing screen.

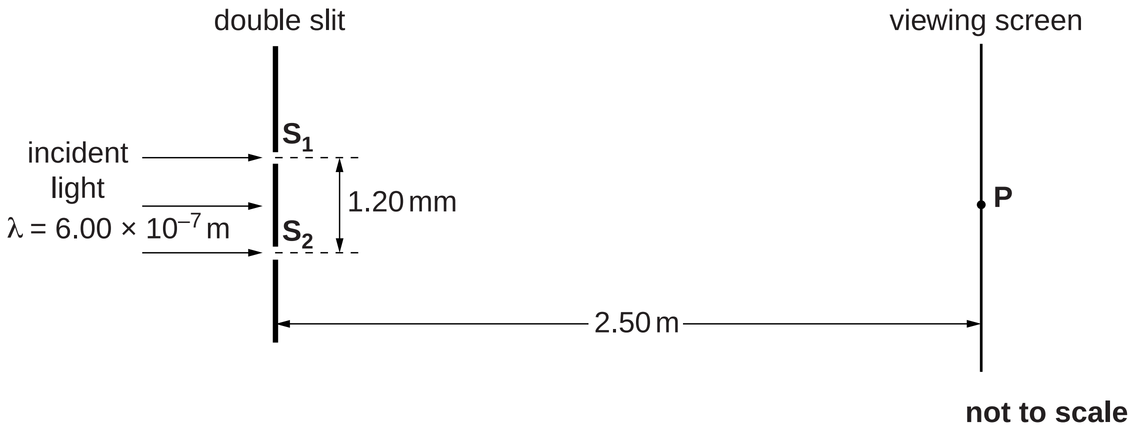

Fig. 5.1

(i) Explain the term *coherent*.

....

....

.... **[1]**

(ii) State a value of the path difference between the light waves from slits $\mathbf{S_1}$ and $\mathbf{S_2}$ to the screen to produce a **dark** fringe on the screen.

path difference = ... m **[1]**

(iii) Calculate the separation of adjacent dark fringes on the screen near to point **P**.

Use the following data: slit separation $\mathbf{S_1S_2}$ = 1.20 mm
distance between slits and screen = 2.50 m

separation = ... m **[3]**

(iv) State and explain the effect, if any, on the **position** of the bright fringes on the screen when each of the following changes is made, separately, to the apparatus.

1 The light source is changed from a red to a yellow light source.

....

....

....

.... **[2]**

2 Slit $\mathbf{S_1}$ is made wider than slit $\mathbf{S_2}$ but their centres remain the same distance apart.

....

....

....

.... **[2]**

3 The viewing screen is moved closer to the slits.

....

....

....

.... **[2]**

[Total: 13]