1. (i) Define the terms *wavelength, frequency* and *speed* used to describe a progressive wave.

wavelength, λ ....

....

frequency, f ....

....

speed, v ....

....

[3]

(ii) Hence derive the wave equation $v = f\lambda$ which relates these terms together.

[2]

[Total 5 marks]

2. The figure below shows an arrangement that can be used to determine the wavelength of microwaves.

Microwaves leave the transmitter and move in a direction **TP** which is at right angles to the metal plate. A standing (stationary) wave is formed between **T** and **P**.

(i) State what is meant by a *standing wave* and explain how it is formed in this case.

....

....

....

....

....

....

....

[3]

(ii) When a small microwave detector **D** is moved slowly from **T** towards **P** the signal received changes from strong to weak to strong to weak etc. The distance between the positions of neighbouring weak signals is 1.4 cm.

Calculate for these microwaves

1 the wavelength

wavelength = ... cm

[1]

2 the frequency.

frequency = ... Hz

[2]

(iii) Describe how you could test whether the microwaves leaving the transmitter were plane polarised.

....

....

....

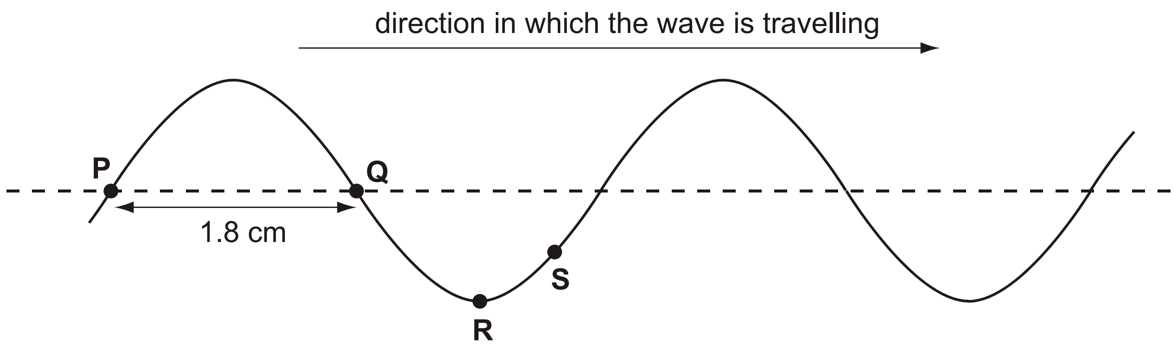
....

....

[2]

[Total 8 marks]

3. The figure below shows, at a given instant, the surface of the water in a ripple tank when plane water waves are travelling from left to right.



(a) Show on the figure

(i) the amplitude of the wave – label this **A**

[1]

(ii) the wavelength – label this λ.

[1]

(b) On the figure above

(i) draw the position of the wave a short time, about one-tenth of a period, later

[2]

(ii) draw arrows to show the directions in which the particles at **Q** and **S** are moving during this short time.

[2]

(c) State the phase difference between the movement of particles at **P** and **Q**.

phase difference = ... °

[1]

(d) The frequency of the wave is 25 Hz and the distance between **P** and **Q** is 1.8 cm. Calculate

(i) the period of the wave

period = ...s

[2]

(ii) the speed of the wave.

speed = ...m s^{-1}

[3]

(e) (i) Suggest how the speed of the waves in the ripple tank could be changed.

....

....

[1]

(ii) The frequency of the wave source is kept constant and the wave speed is halved. State what change occurs to the wavelength.

....

....

....

[2]

[Total 15 marks]

4. State **two** properties of electromagnetic waves which **do not** change across the whole of the spectrum.

Discuss **two** features of electromagnetic waves, other than just wavelength and frequency, which **do** change across the spectrum.

(Allow one lined page).

[Total 6 marks]

5. (i) Explain what is meant by *infra-red radiation*.

....

....

....

[2]

(ii) For infra-red radiation emitted at a frequency of 6.7×10^{13} Hz, calculate

1 its wavelength

wavelength = ... m

[2]

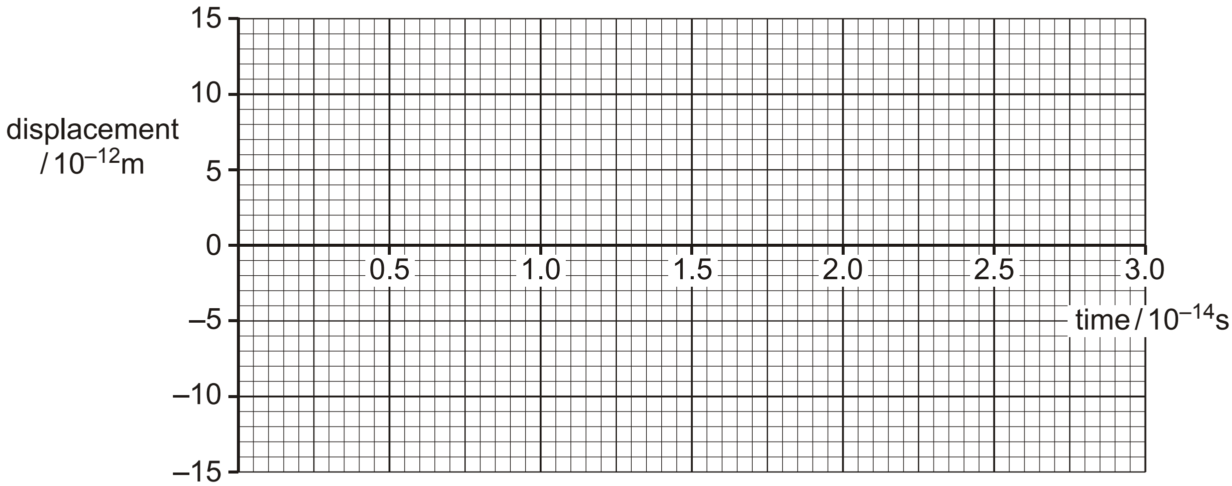
2 its period of oscillation.

period = ... s

[2]

(iii) Infra-red radiation is absorbed by molecular ions in a crystal causing them to vibrate at a frequency of 6.7×10^{13} Hz. The amplitude of oscillation of the ions is 8.0×10^{-12} m.

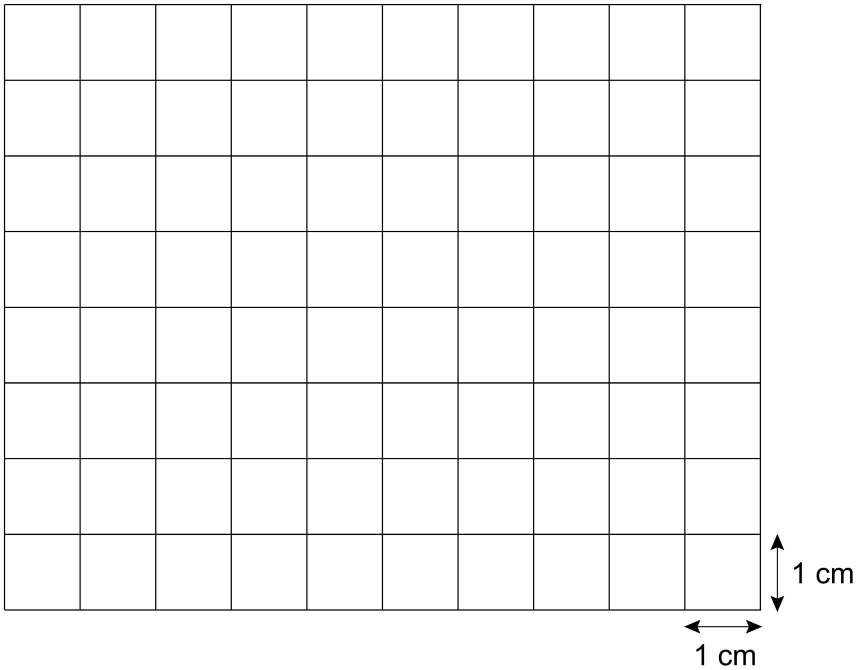
On the grid below sketch a graph showing the variation with time of the displacement of an ion.



[3]

[Total 9 marks]

6. The diagram below represents the screen of a cathode ray oscilloscope (c.r.o.).



The time-base setting is 0.50 ms cm^{-1} and the voltage (y-gain) setting is 2.0 mV cm^{-1}. A microphone connected to the c.r.o. detects a pure (sinusoidal) sound wave note of frequency 500 Hz.

(i) Calculate the period of the note.

period = ... s

[1]

(ii) The amplitude of the signal from the microphone produced by the note is 6.0 mV.

Draw on the diagram above the trace produced on the c.r.o. screen when the microphone detects the sound wave. Draw at least two full cycles of the wave on the diagram.

[3]

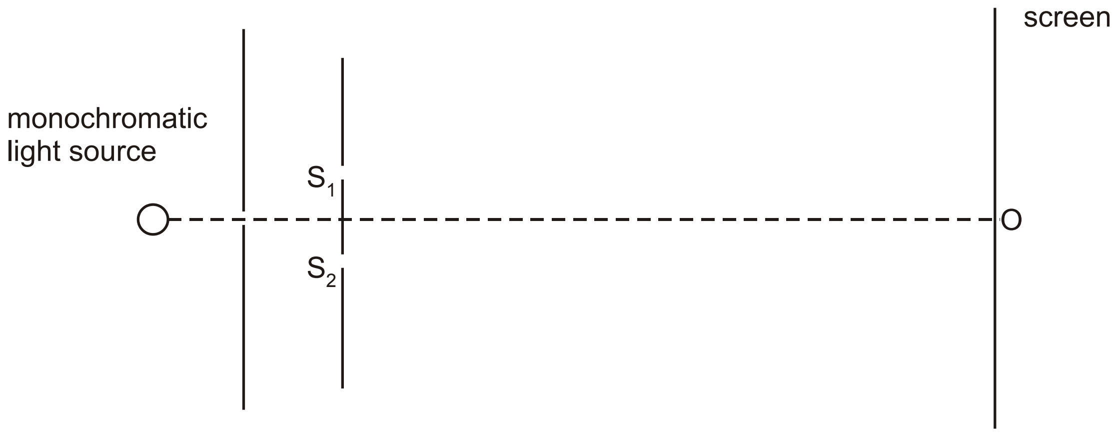
(iii) The speed of sound in air is 330 m s^{-1}. Calculate the wavelength of the sound received by the microphone.

wavelength = ... m

[2]

[Total 6 marks]

7. The diagram below shows the arrangement for viewing a visible interference pattern on a screen.



In a darkened room, a double slit (**S_1S_2**) is placed in front of a narrow single slit situated in front of a monochromatic (one frequency only) light source.

(i) In order to produce a clear interference pattern on the screen, the wave sources must be *coherent*. State what is meant by *coherent*.

....

....

[1]

(ii) Explain how the arrangement shown ensures that the slits **S_1** and **S_2** act as coherent light sources.

....

....

....

[2]

(iii) The point **O** on the screen is directly opposite the centre of the double slit. State and explain the nature of the interference that occurs at **O**.

....

....

....

[2]

(iv) The distance between slits **S_1** and **S_2** is 0.6 mm. When the screen is placed 1.8 m from the slits, the distance between neighbouring minima in the interference pattern formed on the screen is 2.0 mm. Calculate the wavelength of the light.

wavelength = ... m

[3]

(v) State and explain how the interference pattern changes when light of a shorter wavelength is used in the experiment.

....

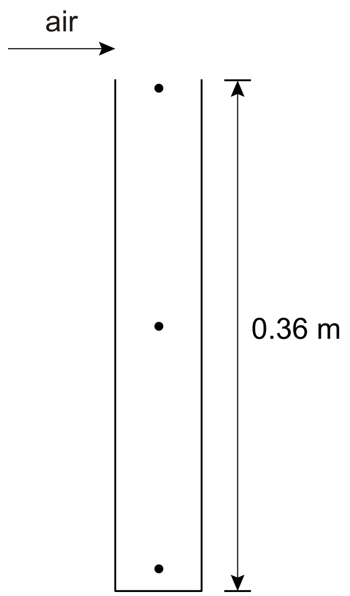
....

....

[2]

[Total 10 marks]

8. A standing sound wave can be produced in an air column by blowing across the open end of a tube as shown in the diagram below.



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 the diagram above 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]

[Total 9 marks]

9. Explain what is meant by the *principle of superposition* of two waves.

....

....

....

[Total 2 marks]