

Electromagnetic waves 2 Calculations

Name & Set

Speed of light, c , = 300,000,000 m/s

- 1** The wavelength of red light is 700 nm. Calculate the frequency of red light.

(nm = nanometre, 1 nm = 0.000 000 001 m or 10^{-9} m).

The first stages of the solution are shown below. Finish off by calculating the frequency.

$$\text{wavespeed} = \text{wavelength} \times \text{frequency}$$

$$300,000,000 = (700 / 1,000,000,000) \times \text{frequency}$$

frequency = _____ [2]

- 2** Radio waves travel through air at the speed of light.

(a) What is the frequency of the following radio stations?

(i) Radio 4 (long wave), $\lambda = 1500$ m _____

_____ [2]

(ii) Virgin radio, $\lambda = 247$ m _____

_____ [2]

(b) What is the wavelength of the following radio stations?

(i) London News, $f = 97.3$ MHz _____

_____ [2]

(ii) Atlantic 252, $f = 252$ kHz _____

_____ [2]

- 3** A VHF radio station transmits on a frequency of 100 Mhz. (*1 Mhz = 1,000,000 hz.*)

(a) What is the wavelength of these waves?

_____ [2]

(b) How long does the transmission take to travel 60 km?

_____ [2]

- 4** In a microwave oven the microwaves used to cook food are produced in a device called a magnetron. These microwaves have a frequency of 2.45 Ghz. 1 Ghz is 10^9 or 1,000,000,000. Like all electromagnetic waves, microwaves travel at the speed of light through a vacuum and through air.

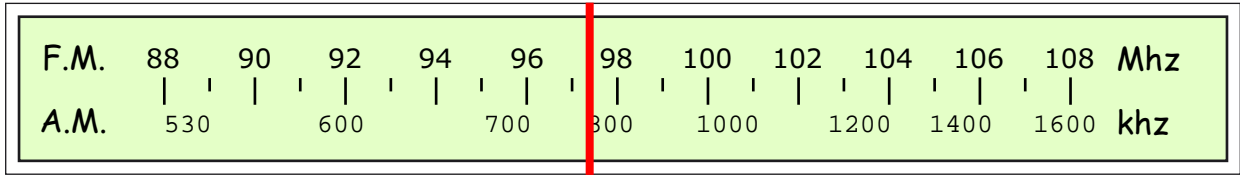
(a) Calculate the wavelength of these microwaves.

_____ [2]

(b) Why do you think microwaves are sometimes called *millimetre waves*?

_____ [2]

5 The diagram shows a radio dial on a radio receiver. It has two bands: f.m. & a.m.



(a) Is the dial calibrated in terms of frequency or wavelength? How can you tell?

_____ [2]

(b) The radio is tuned to *News Direct*, a radio station that broadcasts on F.M. Calculate the wavelength of the radio wave used by *News Direct*.

_____ [2]

(c) The *World Service* broadcasts on 648 khz. Mark with a labelled arrow on the dial where this is located & calculate the wavelength of the radio wave used by the *World Service*.

_____ [2]

(d) *Classic Radio* broadcasts on a wavelength of 3 metres. Calculate the frequency of these radio waves and mark with a labelled arrow on the dial the position to which you would have to tune this station.

_____ [2]

(e) What is the minimum wavelength that this radio receiver is capable of receiving on the F.M. band?

_____ [2]

(f) Would you be able to receive a station that broadcasts on a wavelength of 1000 metres on this radio receiver? Justify your answer.

_____ [2]

(g) Here are a few questions about your listening habits.

How often do you listen to the radio?

<i>Regularly</i>	<i>Sometimes</i>	<i>Never</i>
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Name your favourite radio station. _____ [1]

At what frequency & band does this station broadcast? _____ [1]

Why do you listen to this radio station?

_____ [1]

Could you listen to your radio station on the radio receiver in this example? _____ [1]

Do you ever listen to other radio stations? _____ [1]

6 (i) What form of e.m. radiation carries the signal from a transmitter to a T.V. set?

_____ [1]

(ii) What form of e.m. radiation transmits the picture from the screen to your eye?

_____ [1]

(iii) How long does it take the sound from your T.V. to reach you? Assume that you are sitting 3.3 m from the set. Speed of sound in air is 330 m/s.

_____ [2]

(iv) How far can the signal that carries the transmission travel in this time?

_____ [2]

7 Here in South London we receive our TV programs from a transmitter in Crystal Palace. Information about the frequencies at which each channel is broadcast is given in the table below.

Channel	BBC 1	BBC 2	ITV (Carlton)	Channel 4
Frequency/Mhz	511.25	567.25	487.25	543.25

(i) Which TV channel broadcasts at the lowest frequency?

Channel frequency [2]

(ii) What is the shortest wavelength used for T.V. transmissions by the Crystal Palace transmitter?

_____ [1]

8 (i) A radio signal takes 140 seconds to travel from Earth to a satellite orbiting Mars. How many kilometres from Earth is the satellite ?

_____ [2]

(ii) What difficulties, if any, does the finite speed of light create if one wishes to directly control a probe on the Martian surface?

_____ [2]

9 (a) A light year is defined as the distance covered by light in one year. How many kilometres are there in a light year?

_____ [2]

(b) The nearest star visible from the northern hemisphere is Sirius. It is 8 light years away. How many kilometres is this?

_____ [1]

10 Pioneer 10 was launched on March 2, 1972, from Cape Kennedy. At the time it was the fastest spacecraft ever to leave Earth. It was the first spacecraft to travel through the asteroid belt, the first to visit Jupiter, and the first to use a planet's gravity to change course and reach solar-system escape velocity. On April 28th, 2001 Pioneer was sent a radio signal from its base station here on Earth. When Pioneer received this it sent back a weak radio signal. The entire exchange, from the moment the signal was sent from Earth to the moment when the return signal from Pioneer was received back at the base took 22 hours.

(i) How far away from Earth was Pioneer at this time?

_____ [2]

(ii) Calculate the average speed at which Pioneer 10 has traveled in its journey.

_____ [2]

(iii) How would you describe where Pioneer is in relation to the Solar System given that Pluto, the outermost planet orbits at a distance of 6,000,000,000 km from the Sun.

_____ [2]

(iv) How long will it take Pioneer 10 to reach the nearest star system, the Centauri system 4.2 light years away? (Pioneer is not, in fact heading in that direction)

_____ [2]

11 In what sense do astronomers look into the past.

_____ [2]