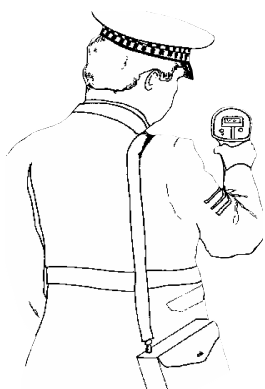


## Longer questions on Waves

**3.18** Police forces use a radar ‘gun’ which emits radio waves to measure the speed of approaching cars.



The radio waves are sent out and bounce off an approaching car. Since the car is moving forward the reflected waves are squeezed together slightly and so these have a slightly shorter wavelength than the transmitted waves.

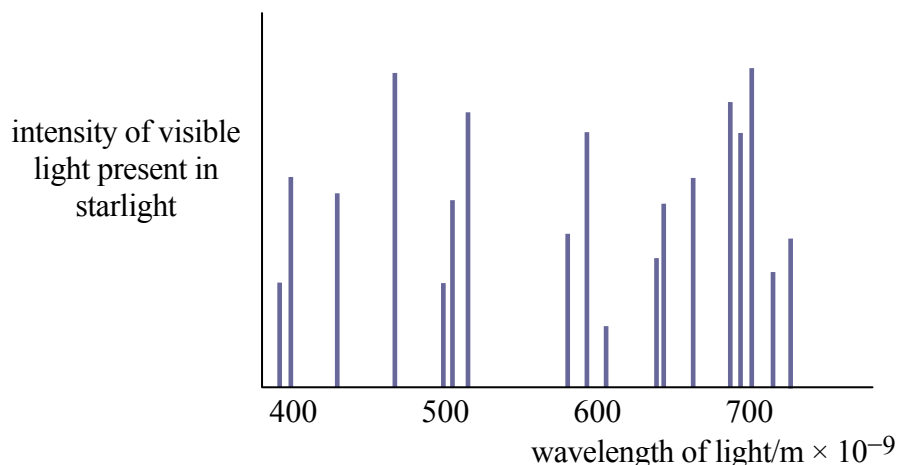
- (a) If the transmitted radio waves have a wavelength of 4 cm what will be the frequency of these waves?
- (b) The wavelength of the reflected waves is less than the wavelength of the transmitted wave. How will this change affect:
- A. the **frequency** of the reflected wave;
  - B. the **speed** of the reflected wave?

**3.19** A boat is sailing in the sea off the west coast of Scotland when it becomes stuck on a sandbank. To signal for help a flare is released which explodes with a loud bang directly above the boat.



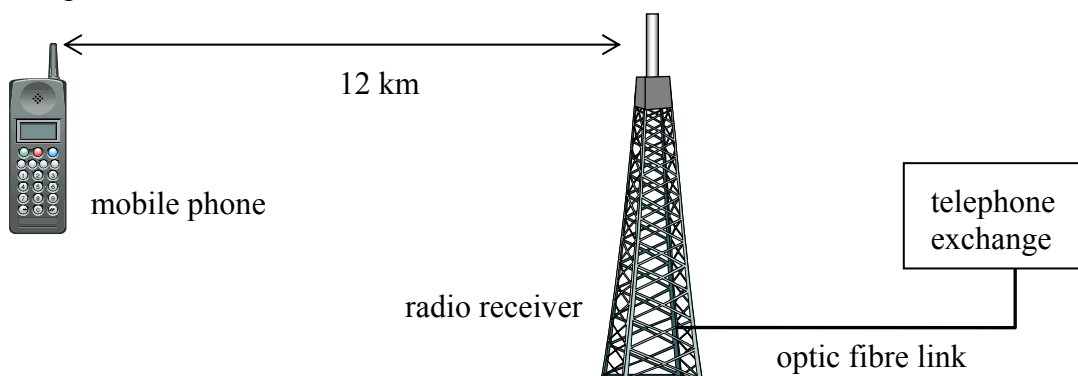
- (a) An echo from the bang is heard 7 s after the flare explodes. How far is the boat from the house?
- (b) The crew of the boat also decide to signal for help using a radio transmitter.
- (i) The transmitter uses radio waves which are part of the electromagnetic spectrum. Microwaves are also found in the electromagnetic spectrum. Compare the wavelength and the frequency of radio waves with microwaves.
  - (ii) What is the wavelength of the radio wave if it has a frequency of 160 MHz?

- 3.20 (a) Astronomers often use the term a ‘light year’. This is the distance that light can travel in 1 year. Calculate how far this distance is.
- (b) Waves from the electromagnetic spectrum travel from a star that is 24 light years away. These waves include visible light, infra red, ultra violet and microwaves.
- (i) List the four waves above in order of **decreasing wavelength** with the longest wavelength first and the shortest wavelength last.
- (ii) X rays are also part of the electromagnetic spectrum. Name a detector of X rays.
- (c) Light from a star is passed through a prism and is found to consist of a range of different wavelengths of light as shown by the graph below.



What will be the frequency of light which has a wavelength of  $600 \times 10^{-9}$  m?

- 3.21 A plumber buys a mobile phone so that he can remain in contact with his customers when working away from his house. The mobile phone he buys uses radio waves to communicate with a radio receiver which is linked to the telephone network via an optic fibre link.



- (a) The instruction manual tells the person making the call to “extend the aerial fully if reception is poor”. Why does this have to be done?
- (b) Calculate the time it takes for the radio wave to travel from the mobile phone to the radio receiver 12 km away.
- (c) The radio wave is converted into a light signal. The light is transmitted down the glass optic fibre with a frequency of  $4 \times 10^{14}$  Hz. Calculate the wavelength of the light signal in the glass if it travels with a speed of  $2 \times 10^8$  m/s.