O- In the oceans, whales communicate by sound transmission through the water. A whale emits a sound of 60 Hz to tell a wayward calf to catch up to the pod. The speed of sound in water is about 1500 m/s.

(a) How long does it take the sound to reach the calf if he is 1.46 km away?

The time taken is given by distance/velocity and hence

t = 1460 m/(1500 m/s) = 0.973 s

(b) What is the wavelength of this sound in the water?

The wavelength λ is given by

$$\lambda = \frac{c}{n} = \frac{1500}{60} = 25m$$

(c) If the whales are close to the surface, some of the sound energy might refract out into the air. What would be the frequency and wavelength of the sound in the air?

When a wave is refracted from one medium to the other its frequency 'n' remains constant but the wavelength will change according to the relation

$$c = n^* \lambda$$

Hence we have

$$\frac{c_1}{\lambda_1} = \frac{c_2}{\lambda_2}$$

Or

 $\lambda_2 = \frac{c_2 \lambda_1}{c_1} = \frac{343 \cdot 25}{1500} = 5.72m$ Thus the frequency of the wave in air will be 60 Hz and the wavelength will be 5.72 m.