Oscillations and Waves

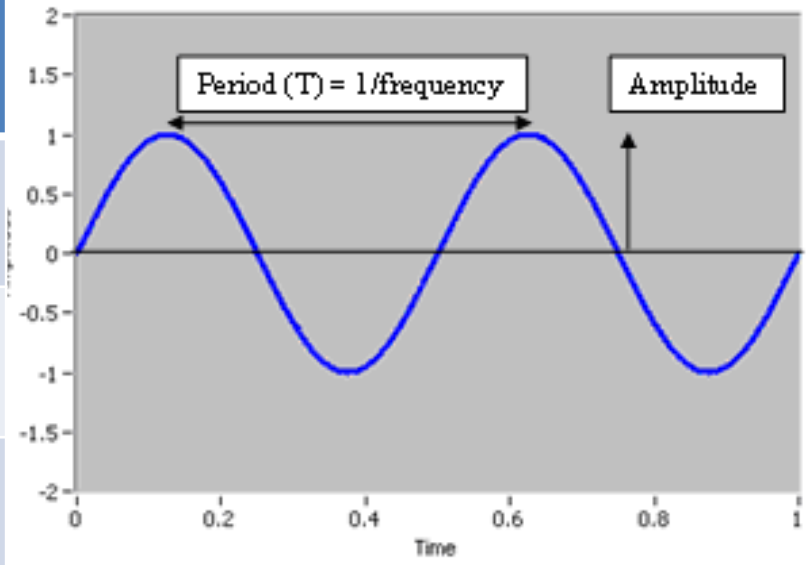
Frequency, f =1/T

$$u(t) = A\sin\left(2\pi ft + \phi_0\right)$$

Amplitude

Phase Shift

Parameter	Formula	Units
Period	T	s
Frequency	f=1/T	1/s=Hz (Hertz)
Amplitude	A	varies

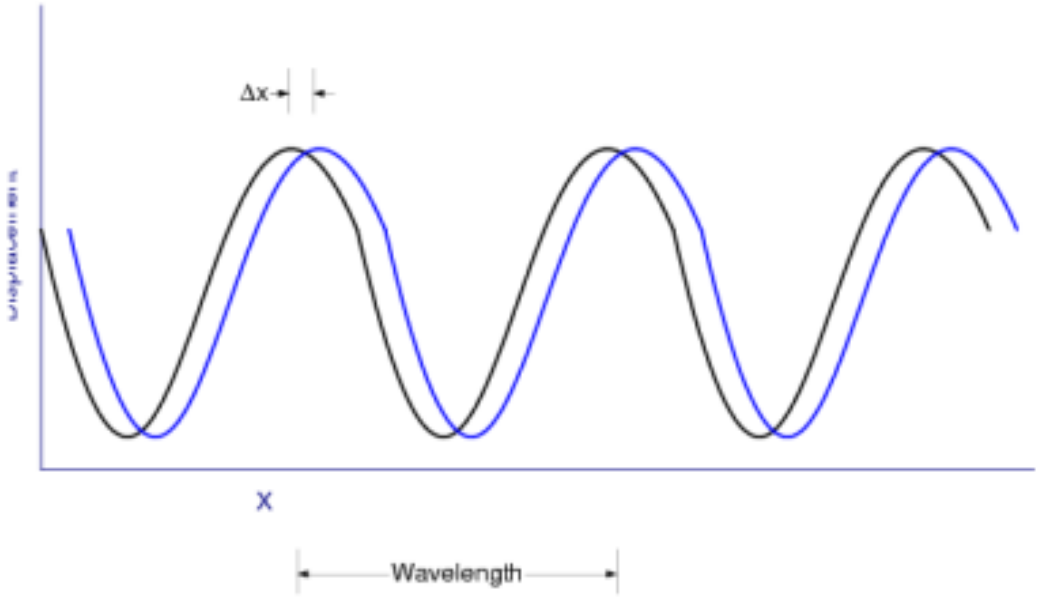


Travelling wave

$$x(t) = A\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right)$$

λ is wavelength. The wave moves to the positive direction of ***x*** with speed ***s***:

$$s = \frac{\lambda}{T} = \lambda f$$



Electromagnetic waves (radio, infrared, light, ultraviolet, X-ray); gravitational waves all travel at speed of light, c=300,000 km/s

Homework

Cosmic microwave background radiation (CMBR) has survived from the early Universe to our days. After nuclei and electrons recombined to create neutral atoms, the Universe became transparent for light. At that time, temperature of the Universe was about 4000K, which corresponds to the wavelength of that ancient light to be about λ=750 nm (red).

Since then, Universe had expanded, and the wavelength of that radiation have increased as well (this phenomenon is called red shift).

Find factor z of that expansion, if frequency of CMBR is now about f=160 GHz.

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