# CH # 12 WAVES AND SOUND

**Some important formulae:**

$i)\ T = \frac{1}{f}$ $\quad ii)\ f = \frac{1}{T}$ $\quad iii)\ V = f\lambda$

$iv)\ T = 2\pi\sqrt{\frac{l}{g}}$ $\quad v)\ T = 2\pi\sqrt{\frac{m}{K}}$

**12.1: The wave length of a wave is 0.1nm its speed is 3 x $10^8$m/s. What is the frequency of the wave.**

*GIVEN:*

Wave length = λ = 0.1nm = 0.1 x $10^{-9}$m

Speed of waves = V = 3 x $10^8$ m/s

*REQUIRED:*

Frequency = f = ?

*SOLUTION:*

V = fλ

$$f = \frac{V}{\lambda}$$

$$f = \frac{3 \times 10^8}{0.1 \times 10^{-9}}$$

f = 30 x $10^{17}$Hz

f = 3 x $10^{18}$Hz

**12.2: A tuning fork vibrates 256times each second and produces a wave 1.3m long. Calculate (a) Period (b) The velocity of the wave.**

*GIVEN:*

Frequency = f = 256Vib/sec

Wave length = λ = 1.3m

*REQUIRED:*

a) Time period = T = ?

b) Wave velocity = V = ?

*SOLUTION:*

a) $T = \frac{1}{f}$

$$T = \frac{1}{256}$$

T = 3.9 x $10^{-3}$sec

b) V = fλ

V = (256)(1.3)

V = 332.8m/s

**12.3: A radio station broadcasts an AM radio waves whose frequency is 1230 x $10^3$Hz and an FM radio waves whose frequency is 91.9 x $10^6$Hz. Find the distance between the adjacent crests in each wave.( Speed of both waves is 3 x $10^{10}$Cm/s)**

*GIVEN:*

Frequency of AM wave = $f_{AM}$ = 1230 x $10^3$Hz

Frequency of FM wave = $f_{FM}$ = 91.9 x $10^6$Hz

Speed of both waves = V = 3 x $10^{10}$Cm/s

*REQUIRED:*

Distance between adjacent crest and trough for both waves = λ= ?

*SOLUTION:*

<u>For FM waves:</u>

$V = f_{FM}\lambda_{FM}$

$$\lambda_{FM} = \frac{V}{f_{FM}}$$

$$\lambda_{FM} = \frac{3 \times 10^{10}}{1230 \times 10^3}$$

$\lambda_{FM}$ = 24390 cm

<u>For AM waves:</u>

$V = f_{AM}\lambda_{AM}$

$$\lambda_{AM} = \frac{V}{f_{AM}}$$

$$\lambda_{AM} = \frac{3 \times 10^{10}}{91.9 \times 10^6}$$

$\lambda_{AM}$ = 326.44 cm

**12.4: Find the time period of simple pendulum whose length is 144cm.**

*GIVEN:*

Length of pendulum = l = 144cm = 144/100 = 1.44m

*REQUIRED:*

Time period = T = ?

*SOLUTION:*

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T = 2(3.14)\sqrt{\frac{1.44}{9.8}}$$

$$T = 6.28\sqrt{0.1469}$$

$$T = 6.28 \times 0.3833$$

T = 2.41 Sec

**12.5: A body of mass 0.3Kg is attached to a horizontal spring. If the value of the spring constant is 5N/m. Find the time period of the body if is given a small displacement.**

*GIVEN:*

Mass of body = m = 0.3Kg

Spring constant = K = 5N/m

*REQUIRED:*

Time period = T = ?

*SOLUTION:*

$$T = 2\pi\sqrt{\frac{m}{K}}$$

$$T = 2(3.14)\sqrt{\frac{0.3}{5}}$$

$$T = 6.28\sqrt{0.06}$$

$$T = 6.28 \times 0.2449$$

T = 1.54 Sec

**12.6: A piece of paper completes 50 vibrations in 5sec when some waves pass through the surface of the water. Find the time period and frequency of the piece of paper. If the wave length of the wave is 10cm. Find the velocity of the wave.**

*GIVEN:*

No. of vibration = 50

Time = t = 5 Sec

Wave length = λ = 10cm

*REQUIRED:*

Time period = T = ?

Frequency = f = ?

*SOLUTION:*

$$\text{Frequency} = \frac{No.\,of\ vibration}{Time}$$

$$\text{Frequency} = \frac{50}{5}$$

$$\text{Frequency} = 10\ \text{Hz}$$

$$T = \frac{1}{f}$$

$$T = \frac{1}{10}$$

T = 0.1 sec

V = fλ

V = 10 x 10

V = 100 cm/s

**12.7: 40 Waves pass through a point on the surface of a pond in 2sec. Calculate the wave length if wave velocity is 3.5m/s.**

*GIVEN:*

Number of waves = 40

Time = t = 2sec

Velocity = V = 3.5m/s

*REQUIRED:*

Wave length = λ = ?

*SOLUTION:*

$$\text{Frequency} = \frac{No.\,of\ vibration}{Time}$$

$$\text{Frequency} = \frac{40}{2}$$

$$\text{Frequency} = 20\ \text{Hz}$$

V = fλ

$$\lambda = \frac{V}{f}$$

$$\lambda = \frac{3.5}{20}$$

λ = 0.175m

**12.8: Calculate the length of second pendulum taking g is equal to 9.8m/s$^2$(Second pendulum is a simple pendulum whose time period is 2sec).**

*GIVEN:*

Time period = T = 2sec

*REQUIRED:*

Length = L = ?

*SOLUTION:*

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$2 = 2(3.14)\sqrt{\frac{l}{9.8}}$$

$$\frac{2}{2(3.14)} = \sqrt{\frac{l}{9.8}}$$

$$\frac{1}{(3.14)} = \sqrt{\frac{l}{9.8}}$$

Taking square on both sides,

$$\left[\frac{1}{(3.14)}\right]^2 = \left[\sqrt{\frac{l}{9.8}}\right]^2$$

$$\frac{1}{9.85} = \frac{l}{9.8}$$

$$l = \frac{9.8}{9.85}$$

L = 0.994m