NUMERICAL PROBLEMS

10.1 The time period of a simple pendulum is 2s. What will be its length on Earth? What will be its length on the moon if $g_m = g_e /6$? Where $g_e = 10ms^{-2}$.

Answer

$T = 2Sec$

$l_e = ?$

$l_m = ?$

$g_e = 10ms^{-2}$

$g_m = \frac{g_e}{6} = 1.6ms^{-2}$

a) For earth,

$T = 2\pi \sqrt{\frac{l_e}{g_e}}$

or $T^2 = 4\pi^2 \left(\frac{l_e}{g_e}\right)$

$l_e = \frac{T^2 \times 10}{4\pi^2}$

or $\boxed{l_e = 1.02 \text{ m}}$

a) For moon,

$T = 2\pi \sqrt{\frac{l_m}{g_m}}$

$T^2 = 4\pi^2 \left(\frac{l_m}{g_m}\right)$

$l_e = \frac{T^2 \times g_m}{4\pi^2}$

As the time period is same;

So, $I_m = \dfrac{2^2 \times 1.6}{4\pi^2}$

$\boxed{I_m = 0.17 \text{ m}}$

10.2 A pendulum of length 0.99 m is taken to the moon by an astronaut. The period of the pendulum is 4.9s. What is the value of g on the surface of the moon?

Answer

$I_m = 0.99 \text{ m}$

$T_m = 4.9 \text{ Sec}$

$g_m = \quad ?$

$\Rightarrow \quad T_m = 2\pi \sqrt{\dfrac{I_m}{g_m}}$

$\Rightarrow \quad T_m^2 = 4\pi^2 \sqrt{\dfrac{I_m}{g_m}}$

$g_m = \dfrac{4\pi^2 \times 0.99}{(4.9)^2}$

$\boxed{g_m = 1.63 \text{ ms}^{\cdot 2}}$

10.3 Find the time periods of a simple pendulum of 1-meter length, placed on Earth and on moot). The value of g on the surface of moon is 1/6th of its value on Earth. Where g$_e$ is 10ms$^{\cdot 1}$.

$T_e = Tm = ?$

$\Rightarrow \quad I = 1m$

$g_e = 10ms^{\cdot 2}$

$g_m = 1.67ms^{\cdot 2}$

$$\Rightarrow \quad T = 2\pi \sqrt{\frac{l_e}{g_e}} \quad \text{(As the length is same on earth and moon)}$$

$$T_e = 2\pi \sqrt{\frac{1}{10}}$$

$$T_e = 2 \text{sec}$$

and, $\quad T_m = 2\pi \sqrt{\frac{l_m}{g_m}}$

$$T_m = 2\pi \sqrt{\frac{1}{1.87}}$$

$$\boxed{T_m = 4.9 \text{ Sec}}$$

10.4 A simple pendulum completes one vibration in two seconds. Calculate its length when g 10.0ms⁻²

$$l = 1m$$

$$T = ?$$

$$g = 10ms^{-2}$$

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

$$T^2 = 4\pi^2 \left(\frac{l}{g}\right)$$

$$l = \frac{T^2 \times g}{4\pi^2}$$

$$l = \frac{2^2 \times 10}{4\pi^2}$$

$$\boxed{l = 1.02 \text{ m}}$$

10.5 If 100 waves pass through a point of a medium in 20 seconds, what is the frequency and the time period of the wave? If its wavelength is 6cm, calculate the wave speed.

Answer

$f = ?$ $n = 100, t = 20Sec$

$T = ?$

$\lambda = 6cm = 0.06m$

We know that. $f = \dfrac{n}{t}$

$= \dfrac{100}{20}$

$\boxed{f = 5 \text{ Hz}}$

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

$T = \dfrac{1}{5}$

$\boxed{T = 0.2 \text{ Sec}}$

$v = ?$

$\Rightarrow \qquad v = f\lambda$

$\qquad = 5 \times 0.06$

$\boxed{v = 0.3 \text{ ms}^{-1}}$

10.6 A wooden bar vibrating into the water surface in a ripple tank has a frequency of 12 Hz. The resulting wave has a wavelength of 3 cm. What is the speed of the wave?

Answer

$f = 12 \text{ Hz}$

$\lambda = 3 \text{ cm}$

$= 0.03 \text{ m}$

$v = ?$

We know that v = f λ

$$= 12 \times 0.03$$

$$\boxed{v = 0.36 \text{ ms}^{-1}}$$

10.7 A transverse wave produced on a spring has a frequency of 190 Hz and travels along the length of the spring of 90 m, in 0.5 s.

a)   **What is the period of the wave?**

b)   **What is the speed of the wave?**

c)   **What is the wavelength of the wave?**

f = 190 Hz

T =?

v =? λ =?

We know that, $T = \frac{1}{f}$

$$= \frac{1}{190}$$

T = 0.005 Sec

or $\boxed{T = 0.01 \text{ Sec}}$

$$v = \frac{d}{t} , \frac{90}{0.5}$$

$$\boxed{v = 180 \text{ ms}^{-1}}$$

⇒   v = f λ

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

$$\lambda = \frac{180}{190}$$

$$\boxed{\lambda = 0.95 \text{m}}$$

10.8 Water waves in a shallow dish are 6.0 cm long. At one point, the water moves up and down at a rate of 4.8 oscillations per second.

    a) What is the speed of the water waves?

    b) What is the period of the water waves?

Answer

$$\lambda = 6 \text{ cm}$$

$$= 0.06 \text{ m}$$

$$f = 4.8 \text{ Hz}$$

$$V = ?$$

$$T = ?$$

As we know that, $V = f\lambda$

$$v = 4.8 \times 0.06$$

$$\boxed{v = 0.29 \text{ ms}^{-1}}$$

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

$$T = \frac{1}{4.8}$$

$$\boxed{T = 0.21 \text{ Sec}}$$

10.9 At one end of a ripple tank 80 cm across, a 5 Hz vibrator produces waves whose wavelength is 40 mm. Find the time the waves need to cross the tank.

Answer

$$f = 5 \text{ Hz}$$

$$\lambda = 40 \text{ mm}$$

$$= 0.04 \text{ m}$$

$$t = ?$$

We know that $v = f \lambda$

$\qquad = 5 \times 0.04$

$\boxed{v = 0.2 \ ms^{-1}}$

$\Rightarrow \qquad v = \dfrac{d}{t}$

$\qquad = \dfrac{0.8}{0.2}$

$\boxed{v = 4 \ Sec}$

10.10 what is the wavelength of the radio waves transmitted by an FM station at 90 MH$_z$? where 1M =10^6 and speed of radio wave is 3x 10^8 ms^{-1}.

Answer

$\lambda = ?$

$f = 90 \ MHz$

$f = 90 \times 10^6 \ HZ$

$V = 3 \times 10^8 \ ms^{-1}$

$\Rightarrow \qquad v = f \lambda$

$\lambda = \dfrac{v}{f}$

$\lambda = \dfrac{3 \times 10^8}{90 \times 10^6}$

$\boxed{\lambda = 3.33m}$