CH # 16

Q.1 $T = 2\pi\sqrt{\frac{L}{g}}$

on Earth: $3 = 2\pi\sqrt{\frac{L}{9.8}}$ — ①

on moon $T = 2\pi\sqrt{\frac{L}{1.67}}$ — ②

} divide ② ÷ ①

$$\frac{T}{3} = \sqrt{\frac{9.8}{1.67}}$$

$$\Rightarrow T = 7.26\ s$$

Q.2 $E = 1\ J = K_{max} = \frac{1}{2} m v_{max}^2$

$$1 = \frac{1}{2} m (1)^2 \Rightarrow (m = 2\ kg)$$

Q.3 $T = 2\ s$, $E = 10\ J$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{2} = \pi\ rad/s$$

$$\Rightarrow \omega = \sqrt{\frac{k}{m}} \Rightarrow k = m\omega^2 = 5(3.14)^2$$

$$k = 49.3\ N/m$$

$$\Rightarrow E = \frac{1}{2} k x_m^2 \Rightarrow x_m = \sqrt{\frac{2E}{k}}$$

$$x_m = \sqrt{\frac{2 \times 10}{49.3}} = 0.637\ m$$

Q.4 $k = 40\ N/m$, $m = 0.4\ kg$, $x_m = 0.1$

This time represents $\frac{T}{4}$, $\omega = \sqrt{\frac{k}{m}}$

$$\Rightarrow \omega = \sqrt{k/m} = \sqrt{\frac{40}{0.4}} = 10\ rad/s$$

$$\omega = 10\ rad/s = \frac{2\pi}{T} \Rightarrow T = \frac{2\pi}{\omega} = \frac{2 \times 3.14}{10} = 0.628\ s$$

$$\therefore t = \frac{T}{4} = \frac{0.628}{4} = 0.157\ s$$

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Q. 5 $k = 30\ N/m$, $m = 1\ kg$, $x_m = 0.03\ m$

$K = ?$, $x = 2\ cm$

$$E = U + K \Rightarrow E = \frac{1}{2} k x_m^2 \quad , U = \frac{1}{2} k x^2$$

$$\Rightarrow \frac{1}{2} k x_m^2 = \frac{1}{2} k x^2 + K$$

$$\frac{1}{2}(30)(0.03)^2 = \frac{1}{2}(30)(0.02)^2 + K$$

$$K = 7.5 \times 10^{-3}\ J$$

Q. 6 $$T_1 = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{(3)}{9.8}} = 3.47\ s$$

$$T_2 = 2\pi\sqrt{\frac{L}{g}} \quad 2\times 3.14\sqrt{\frac{3}{9.75}} = 3.48\ s$$

$\Delta T = 8.9\ ms$

Q. 7 $$E = \frac{1}{2} k X_m^2 \quad , \omega = \sqrt{\frac{k}{m}}$$

$$\Rightarrow k = \omega^2 m = \left(\frac{2\pi}{T}\right)^2 m = \left(\frac{2\times 3.14}{0.75}\right)^2 0.2$$

$k = 126.2\ N/m$

$$\therefore 2 = \frac{1}{2} \times 126.2 (X_m^2) \Rightarrow X_m = 0.178\ m$$

Q. 8 $X_m' = 2 X_m$

$$\Rightarrow E' = 4E$$

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Q.9 $x_m = 0.04\,m$,

$v = \frac{1}{2} v_{max}$

$E = U + K = K_{max}$

$\frac{1}{2} k x_m^2 = \frac{1}{2} k x^2 + \frac{1}{2} m \left(\frac{v_{max}}{2}\right)^2$ — ①

also $\left[E = \frac{1}{2} m v_{max}^2 \right]$

$\therefore \frac{1}{2} k x_m^2 = \frac{1}{2} m v_m^2$

$k = \frac{m v_m^2}{x_m^2} = \frac{m v_{max}^2}{(0.04)^2}$, goto ①

$\frac{1}{2} \left(\frac{m v_m^2}{(0.04)^2}\right) x_m^2 = \frac{1}{2} \left(\frac{m v_m^2}{(0.04)^2}\right) x^2 + \frac{1}{2} m \frac{v_m^2}{4}$

$\frac{1}{2} = 312.5 (x)^2 + 0.25$

$x = 3.46\,cm$

Q.10 $U_{max} = \frac{1}{2} k x_m^2$, $k = m\omega^2$

$\therefore k = 0.14 (10^2) = 14\,N/m$ (from give eqn.)

$\therefore U_{max} = \frac{1}{2} (14)(0.2)^2 = 0.28\,J$

Q.11 $a(t) = -\omega^2 x(t)$

$-6 = -\omega^2 (2) \Rightarrow \omega^2 = 3$

$\therefore \omega = 1.73$

$f = \frac{\omega}{2\pi} = 0.28\,Hz$

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Q.12 $L = 1.3\ m$

$$T = \frac{\text{total time}}{\#\text{ of oscillations}} = \frac{100\ sec}{50} = 2\ sec$$

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

$$T^2 = 4\pi^2 \frac{L}{g} \Rightarrow g = \frac{4\pi^2 L}{T^2}$$

$$a_g = \frac{4 \times (3.14)^2 (1.3)}{(2)^2}$$

$$a_g = 12.817\ m/s^2$$

Q.13 $E = U + K \Rightarrow \frac{1}{2} k x_m^2 = \frac{1}{2} k x^2 + \frac{1}{2} m v^2$

$$\therefore \frac{1}{2}(20)(0.03)^2 = \frac{1}{2}(20)(0.026)^2 + \frac{1}{2} \times 0.5\, v^2$$

$$\Rightarrow v = 0.095\ m/s$$

Q.14 $k = m\omega^2$, from the eqn: $\omega = 50\ rad/s$

$$\Rightarrow k = 3 \times (50)^2 = 7500\ N/m$$

End.