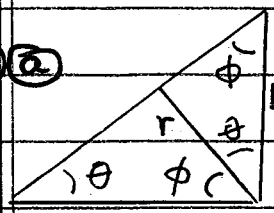
PHY 2048 — Solutions

Test III — 24 April 2017 — V.I

(1) (a) 

$\theta = 36.9^\circ$ and $\phi = 90^\circ - 36.9^\circ = 53.1^\circ$

$L = 3.00\ m \rightarrow \boxed{r = L\cos\theta = L\sin\phi = 2.40\ m}$

(b) Torques about pt P $\rightarrow F_T r = F_{app} y \Rightarrow F_T = F_{app}(y/r)$

$F_{app} = 75.0\ N,\ y = 2.00\ m \Rightarrow \boxed{F_T = 62.5\ N}$

(c) $\boxed{F_V = F_T \sin\theta + Mg = 185\ N}$ for $M = 15.0\ kg$

(d) $F_H + F_T\cos\theta = F_{app} \Rightarrow \boxed{F_H = F_{app} - F_T\cos\theta = 25.0\ N}$

$\rightarrow$ acts to the left

(2) (a) $a = 0.150\ m \Rightarrow V = a^3 = 3.375\times10^{-3}\ m^3$

$\rho = 680\ kg/m^3 \Rightarrow m = \rho V = 2.295\ kg \Rightarrow \boxed{F_g = mg = 22.5\ N}$

(b) $\rho_{fl} = 1000\ kg/m^3$ and $V_{disp} = V \Rightarrow \boxed{F_B = \rho_{fl} V_{disp} g = 33.1\ N}$

(c) $F_T + F_g = F_B \Rightarrow \boxed{F_T = F_B - F_g = 10.6\ N}$

(d) Now $F_B = F_g$ and $V_{disp} = V_{imm}$

$\Rightarrow \rho_{fl} V_{imm} g = \rho V g \Rightarrow V_{imm} = (\rho/\rho_{fl})V = 0.680\,V$

$\rightarrow \boxed{V_{imm} = 2.30\times10^{-3}\ m^3}$

(3) (a) $M = 7.36\times10^{22}\ kg$ and $R = 1.74\times10^{6}\ m$

$\boxed{g_{surf} = GM/R^2 = 1.61\ m/s^2} \rightarrow \boxed{v_{esc} = \sqrt{2 g_s R} = 2.37\ km/s}$

(b) $\frac{1}{2}mv_0^2 - \frac{GMm}{R} = -\frac{GMm}{r} \Rightarrow v_0 = \sqrt{2\left(\frac{GM}{R} - \frac{GM}{r}\right)}$

$r = R + h = R + \frac{2}{3}R = \frac{5}{3}R \Rightarrow \frac{1}{R} - \frac{1}{r} = \frac{1}{R}\left(1 - \frac{3}{5}\right) = \frac{2}{5}\frac{1}{R}$

$\Rightarrow \boxed{v_0 = \sqrt{\frac{2}{5}}\, v_{esc} = 0.6325\, v_{esc} = 1.50\ km/s}$

(c) $v_{orb} = \sqrt{GM/r}$, $r = 2R \rightarrow v_{orb} = 1.185\times10^{3}\ m/s$

$\Rightarrow \boxed{\Delta t = 4T = 8\pi r/v = 7.38\times10^{4}\ s = 20.5\ hrs}$

(d) $m = 500\ kg \rightarrow \boxed{U = -GMm/r = -7.06\times10^{8}\ J}$

$\rightarrow \boxed{E = \frac{1}{2}U = -3.53\times10^{8}\ J}$

(4) (a) $m = 2.40$ kg, $k = 300$ N/m $\Rightarrow \omega = \sqrt{k/m} = 11.18$ rad/sec

5/ $\rightarrow$ **$T = 2\pi/\omega = 0.562$ s** $\rightarrow$ **$n = \Delta t / T = 40$ osc in $\Delta t = 22.5$ s**

4/ (b) **$v_{max} = \omega x_0 = 0.839$ m/s** for $x_0 = 7.50$ cm $= 0.0750$ m

6/ (c) $K = U_{elastic} \Rightarrow \frac{1}{2} m v^2 = \frac{1}{2} k x^2 \Rightarrow v^2 = \omega^2 x^2$

Now $v^2 = \omega^2 (x_0^2 - x^2) \Rightarrow x_0^2 - x^2 = x^2 \Rightarrow$ **$x = x_0/\sqrt{2} = 5.30$ cm**

5/ (d) $x = x_0 \cos(\omega t) \Rightarrow \omega t = \cos^{-1}(x/x_0) = \pi/4$

$\Rightarrow$ **$t = \pi/4\omega = 0.0702$ sec** $\rightarrow$ **$v = \omega x = 0.593$ m/s**