PHYSICS 2 - SUMMER 2009

MIDTERM

1) $F = \frac{GMm}{R^2} \Rightarrow g = \frac{GM}{R^2}$ since $F = mg$

$\rho = \frac{M}{V}$ $M = \rho V \Rightarrow g = \frac{G\rho V}{R^2}$

But $V = \frac{4}{3}\pi R^3 \Rightarrow g = \frac{G\rho\frac{4}{3}\pi R^3}{R^2} = \frac{4G\rho\pi}{3} R$

$\boxed{\frac{g_1}{g_2} = \frac{R_1}{R_2}}$ $\boxed{D}$

2) $\vec{F}$ is $\perp$ to the path $\Rightarrow \vec{F}d\vec{r} = 0 \Rightarrow \boxed{W = 0}$ $\boxed{C}$

3) $\frac{1}{2}mv_{esc}^2 = \frac{GMm}{R}$ $v_{esc}^2 = 2\frac{GM}{R}$ But $g = \frac{GM}{R^2}$ from question 1

$\Rightarrow v_{Esc}^2 = 2gR \Rightarrow v_{Esc} = \sqrt{2gR}$

IF $g \to 4g$ & $R \to 4R$ $v_{Esc} \to \sqrt{2(4g)(4R)} = 4\sqrt{2gR} = \underline{\underline{4v_{Esc}}}$ $\boxed{B}$

4) steel has larger density than wood

$\Rightarrow I_1 > I_2$ $\tau_1 = \tau_2$ $\tau = I\alpha$ $\frac{I_2}{I_1} < 1$

$I_1\alpha_1 = I_2\alpha_2$ $\alpha_1 = \frac{I_2}{I_1}\alpha_1 \Rightarrow \boxed{\alpha_1 < \alpha_2}$ $\boxed{B}$

5) Conservation of angular momentum -
At A and B the velocity vector is perpendicular to the radial vector $L_A = mv_AR_A = mv_AR$

$L_B = mv_BR_B = 3mv_BR$

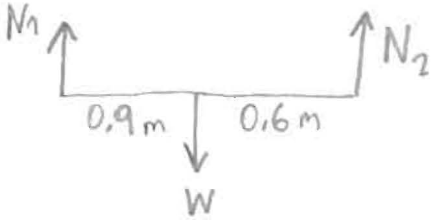
$L_A = L_B$ gives $mv_AR = 3mv_BR \Rightarrow \boxed{v_A = 3v_B}$ $\boxed{B}$

(2)

6) $\alpha = \frac{\Delta \omega}{\Delta t} = \frac{(300-100)\,rpm}{2\ min} = 100\ \frac{revolutions}{min^2}$

1 revolution = 2π rad $\boxed{\alpha = 200\pi \frac{rad}{min^2}}$ $\boxed{D}$

7) The horizontal components of T_1 and T_3 are $\boxed{T_1 \cos\alpha}$ $\boxed{A}$

8) 

$N_2 = ?$ $N_1 + N_2 = W$ $(\Sigma F = 0)$

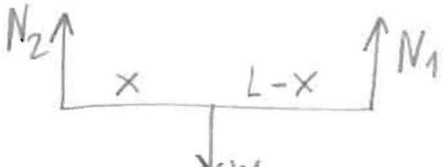
taking torques about the feet

$0.9\,m \cdot W = (0.9+0.6)\,m\, N_2$

$N_2 = \frac{0.9}{1.5} W = \frac{0.9}{1.5}\, 46\ 9.8\,N = \underline{270\,N}$ $\boxed{B}$

9) Take torques about the hinge _ d = length of strut

$100\,N \times d = T_2 \times d \times \sin 30$ $T_2 = \frac{100\,N}{\sin 30} = \underline{200\,N}$ $\boxed{B}$

10) 

$N_1 = 420\ N$ $L = 170\ cm$

$N_2 = 380\ N$

$\Sigma F = 0 \Rightarrow N_1 + N_2 = W \Rightarrow W = 800\,N$

$\Sigma \tau = 0$, take torques around feet

$W x = N_1 L$ $x = \frac{N_1 L}{W} = \frac{420}{800}\, 170\,cm$ $\boxed{x = 89.25\,cm}$ $\boxed{D}$

11) The speed is at maximum as we travel through the equilibrium position _ At equilibrium $F=0$ therefore $\boxed{a=0}$

$\boxed{D}$

12) $W = \frac{2\pi}{T} \Rightarrow \omega = \pi/\text{sec}$

$x = A\cos(\omega t + \phi)$ $\quad \begin{cases} x_0 = A\cos\phi & (1) \\ v_0 = -\pi A \sin\phi & (2) \end{cases}$ $\quad x_0 = 20\text{ cm}$

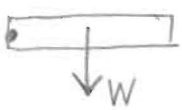
$v = -\omega A(\sin \omega t + \phi)$ $\quad v_0 = 40\text{ cm/sec}$

$\frac{(2)}{(1)}$ gives $-\pi \tan\phi = \frac{v_0}{x_0}$ $\quad \tan\phi = -\frac{1}{\pi}\frac{v_0}{x_0} = -\frac{1}{\pi}\frac{40}{20}$ $\quad \phi = -32.4°$ $\quad \boxed{\phi = -0.567}$

From equation (1): $A = \frac{x_0}{\cos\phi} = \frac{20\text{cm}}{0.84356} = \underline{\underline{23.70\text{ cm}}}$ $\quad \boxed{A}$

13) $F = -kx = ma \Rightarrow a = -\frac{k}{m}x$ $\quad \boxed{A}$

$a = -\frac{10}{0.5} 3\, 10^{-2} \text{ m/sec}^2 = \underline{0.6 \text{ m/sec}^2}$

14) 

$\tau = \frac{WL}{2} = \frac{MgL}{2}$ $\quad \tau = I\alpha = \frac{ML^2}{3}\alpha \Rightarrow \frac{MgL}{2} = \frac{ML^2}{3}\alpha$

$\alpha = \frac{3}{2}\frac{g}{L} = \frac{3}{2}\frac{9.8}{4}\frac{\text{rad}}{\text{sec}^2}$ $\quad \boxed{\alpha = 3.68 \frac{\text{rad}}{\text{sec}^2}}$ $\quad \boxed{B}$

15) $Mgh = K_{TRANSL} + K_{ROT}$ $\quad K_{ROT} = \frac{1}{2}I\omega^2 = \frac{1}{2}I\frac{v^2}{R^2} = \frac{1}{2}MR^2\frac{v^2}{R^2} = \frac{1}{2}Mv^2$

$K_{TRANS} = \frac{1}{2}Mv^2$

$\Rightarrow Mgh = Mv^2$

$v = \sqrt{gh} = \sqrt{9.8\ 3}\ \text{m/sec} = 5.4 \text{ m/sec}$ $\quad \boxed{C}$

16) $I_1 \rightarrow I_2$ $\quad$ Conservation of angular momentum $\quad I_1\omega_1 = I_2\omega_2$

$\omega_1 \rightarrow \omega_2$

$\omega_2 = \frac{I_1}{I_2}\omega_1$

$I_1 > I_2$

Initially $K_1 = \frac{1}{2}I_1\omega_1^2$

Finally $K_2 = \frac{1}{2}I_2\omega_2^2 = \frac{1}{2}I_2\frac{I_1^2}{I_2^2}\omega_1^2 = \frac{1}{2}\left(\frac{I_1}{I_2}\right)I_1\omega_1^2 = \frac{I_1}{I_2}K_1$

Since $\frac{I_1}{I_2} > 1$, $\boxed{K_2 > K_1}$

$\boxed{B}$

17) $\boxed{D}$ $\frac{F/A}{\Delta\ell/\ell} = Y$

18) $\longrightarrow F = \frac{\Delta\ell}{\ell} Y A \quad A \propto d^2 \Rightarrow F \propto d^2$ $\boxed{A}$

19) $E = U + K \quad E = U_{MAX} = \frac{1}{2} k A^2$

U and K will be the same when $K = U = \frac{1}{2} E = \frac{1}{4} k A^2$

$\hookrightarrow \frac{1}{2} k x^2 = \frac{1}{4} k A^2 \Rightarrow x^2 = \frac{A^2}{2}, \boxed{x = \frac{A}{\sqrt{2}}}$

$\boxed{A}$

20) $E = U(x=0) = 22\,J$

$E = U(x=2m) + K(x=2m)$

$22\,J = 10\,J + \frac{1}{2} m v^2 \quad 12\,J = \frac{1}{2} m v^2 \quad v^2 = \frac{24\,J}{2\,Kg} = 12 \frac{m^2}{s^2}$ $\boxed{v = 3.5\,m/sec}$

$\boxed{C}$