QUIZ 9, PHY 191 B, Blue, Monday, Nov 14, 2016 (20 pts)

[see both sides of sheet!]

SHOW WORK CLEARLY OTHERWISE ZERO CREDIT!!

Question 1: Your physics professor stands on a turntable and instantly transforms himself into an orangutan (monkey with lo-o-ong arms), holding 2kg dumb-bells in each outstretched hand (model each dumb-bell as a particle). The axis of rotation is vertical and passes through the center of his body. When his arms are extended horizontally, each dumb-bell is 2m from the axis of rotation. The moment of inertia of the orangutan-plus-stool is 2kgm^2. Initially the orangutan, with his arms fully extended, is rotating with an angular speed of ω_i = 6rad/s. He now pulls each brick in to a distance of 1m from the rotation axis. His new angular speed ω_f after he pulls the bricks in is: (7 pts)

a) 6 rad/s b) 12 rad/s c) 15 rad/s d) 18 rad/s e) 24 rad/s

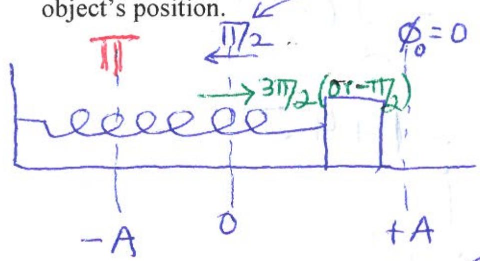
C.O.A.M.: $L_i = L_f$

$$\left[2 + 2(2)2^2\right]6 = \left[2 + 2(2)1^2\right]\omega_f$$

'I' for orangutan + stool (1); 2 dumb bells, mass of dumbbell, radius (2); ω_i (1); 'I' for orangutan + stool, unchanged; 2 dumb-bells, mass of dumbbell, new radius (2)

$$\Rightarrow 18(6) = 6\,\omega_f \Rightarrow \omega_f = 18 \text{ rad/s}$$ (1)

Question 2: An object in simple harmonic motion has frequency 3.0 Hz and amplitude 4.0 cm. At $t = 0$ s it passes through the equilibrium position moving to the left. Write the function $x(t)$ that describes the object's position. (5 pts)



$x(t) = A\cos(\omega t + \phi_0)$

(1) A = 4cm. $\omega = 2\pi f = 2\pi(3) = 6\pi$ (1) $\phi_0 = \pi/2$ (1)

So $x(t) = 4\cos(6\pi t + \pi/2)$ cm (1) (1)!

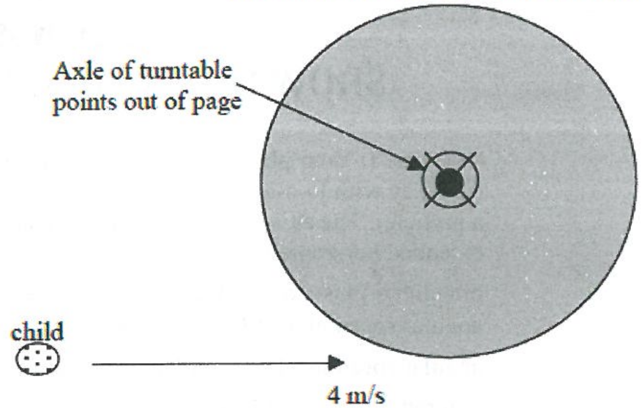
GREEN: $x(t) = 4\cos(6\pi t + 3\pi/2)$ cm or $4\cos(6\pi t - \pi/2)$ cm

RED: $x(t) = 4\cos(6\pi t + \pi)$ cm

Question 3: A 360 kg disk-shaped playground turntable has radius $R = 2$m. It is initially at rest. A child of mass 20 kg runs tangent to the outer rim, jumps on and holds on to a support so that he stays at the outer rim. His speed *just before* landing on the turntable was 4 m/s.

i) Find the angular speed in rad/s of the "child and turntable" system immediately after the child hops on. (4 pts)

View from above of Turntable & Child



C.O.A.M.: $L_i = L_f$

$L_f = \left(\frac{m_{disk}R^2}{2} + m_{boy}R^2\right)\omega$ ← find this!

$rp\sin\theta$ (1, b/c $\theta = 90°$) $= 2(20 \times 4) = 160$ (2)

$= \frac{1}{2}(360)2^2 + 20(2^2) = 720 + 80 = 800$ (1) (1)

$\therefore 160 = 800\,\omega \Rightarrow \omega = 0.2\ \text{rad s}^{-1}$

ii) The energy lost in the "collision" between the child and the turntable is (4 pts)

a) 12J b) 16J c) 80J d) 144J

Change in energy $= KE_{rot\,final} - KE_{initial}$ (1)

$= \frac{1}{2}\left[\frac{m_{disk}}{2}R^2 + m_{boy}R^2\right]\omega^2 - \frac{1}{2}m_{boy}v^2$ (1) + (1) (1)

$= \frac{1}{2}(800)(0.2^2) - \frac{1}{2}(20)4^2$

$= 16 - 160 = -144\text{J}$

↑ Loss!