Physics 10154 - Exam #3B

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (35 pts) A small rock is thrown straight up from ground level with an initial speed of 27.2 m/s. At a height 16.0 meters above the ground on its way up, it strikes a blob of putty (initially at rest) that has half the mass of the rock. After the collision, the two objects stick together and rise to what maximum height above ground level?

$\Delta y = 16.0\ m$

$v_0 = 27.2\ m/s$

$v = ?$

$a = -9.8\ m/s^2$

$t = ?$

$v^2 = v_0^2 + 2a\Delta y$

$v^2 = (27.2)^2 + 2(-9.8)(16)$

$= 426.24$

$v = 20.65\ m/s \Rightarrow v_i$ for collision

Collision:

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$

$m(20.65) + \frac{1}{2}m(0) = (m + \frac{1}{2}m) v_f$

$20.65 m = 1.5 m v_f$

$v_f = \frac{20.65}{1.5}$

$= 13.76\ m/s$

$= v_0$ for pt 3

Pt 3: $\Delta y = ?$

$v_0 = 13.76\ m/s$

$v = 0$

$a = -9.8\ m/s^2$

$t = ?$

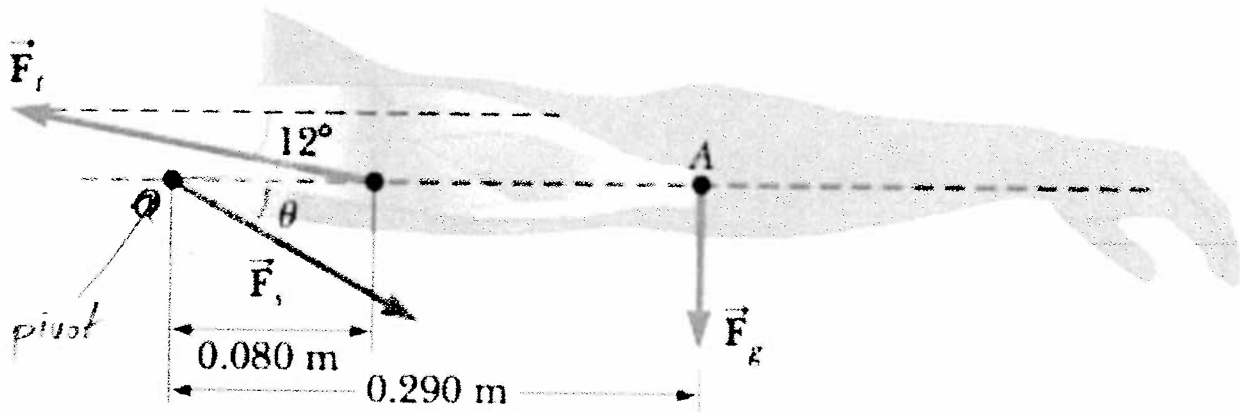
$v^2 = v_0^2 + 2a\Delta y$

$\Delta y = \frac{-v_0^2}{2(-9.8)} = 9.665\ m$

$\Delta y_{tot} = 16 + 9.665$

$= 25.7\ m$

2. (35 pts) The arm shown below weighs 45.6 N, and the force of gravity on the arm acts through point A. Determine the magnitude of the tension force (F_t) in the deltoid muscle and also the horizontal and vertical components of the reaction force (F_s) exerted by the shoulder socket on the arm in order to hold the arm in the equilibrium position shown below. You do not need to find θ although it is shown in the diagram.



$$\Sigma \tau = \tau_t + \tau_{grav} = 0$$

$$+(.080) F_T \sin 168^\circ - (.290)(45.6) \sin 90^\circ = 0$$

$$.0166 F_T - 13.22 = 0 \Rightarrow F_T = 797\ N$$

$$\Sigma F_x = + F_{s,x} - F_T \cos 12^\circ = 0$$

$$F_{s,x} = (797) \cos 12^\circ = 779\ N \text{ (right)}$$

$$\Sigma F_y = - F_{s,y} + F_T \sin 12 - F_{grav} = 0$$

$$F_{s,y} = (797) \sin 12 - 45.6 = 120\ N \text{ (down)}$$

3. (30 pts) A 45.0-kg child is standing at the center (rotation axis) of a rotating turntable. The turntable has a radius of 1.20 meters and a moment of inertia of 362 kg-m². Both turntable and child are initially rotating at a rate of 122 rev/min. The child moves from the center of the turntable out to the edge, still moving at the same angular speed as the turntable.

a) What is the new angular speed of the child/turntable system (in rad/sec)?

b) How much does kinetic energy change during this motion? Is KE gained or lost?

a) $I_{1i} = 0$ (child at center) $I_{1f} = MR^2 = 64.8\ kg\cdot m^2$

$I_{2i} = 362$ (turntable) $I_{2f} = 362\ kg\cdot m^2$

$\omega_{1i} = \omega_{2i} = 122 \frac{rev}{min} \cdot \frac{2\pi\ rad}{rev} \cdot \frac{1\ min}{60\ s} = 12.78\ rad/s$

$\omega_f = ?$

$(I_{1i} + I_{2i})\omega_i = (I_{1f} + I_{2f})\omega_f$

$(362)(12.78) = (426.8)\,\omega_f$

$\boxed{\omega_f = 10.8\ rad/s}$

b) $K_i = \frac{1}{2}(0)\,\omega_i^2 + \frac{1}{2}(362)(12.78)^2 = 29560\ J$

$K_f = \frac{1}{2}(64.8)(10.8)^2 + \frac{1}{2}(362)(10.8)^2 = 24890\ J$

$\Delta K = K_f - K_i = -4670\ J$

$\boxed{4670\ J\ \text{lost}}$