Physics 10154 - Exam #3D

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) Block A slides across a frictionless, horizontal table and has an elastic collision with block B, which is initially at rest and twice as massive. After the collision, block B slides horizontally off the edge of the 1.4-meter high table and lands 2.2-meters horizontally away from the base of the table. What was the initial speed of block A?

Collision: $V_{Bf} = \frac{2m_A}{m_A+m_B} V_{Ai} + (\ )(0)$

$= \frac{2m}{m+2m} V_{Ai} = 0.667 V_{Ai}$

Free-fall

$\Delta x = 2.2m$	$\Delta y = 1.4m$
$V_{ox} = ?$	$V_{oy} = 0$
$V_x = ?$	$V_y = ?$
$a_x = 0$	$a_y = 9.8\ m/s^2$
$t = ?$	$t = ?$

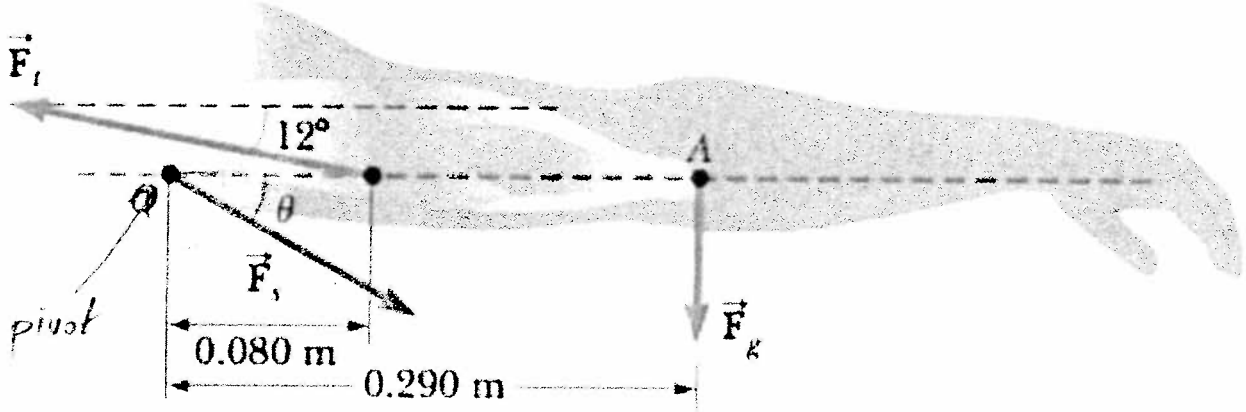
$1.4 = 0 + \frac{1}{2}(9.8)t^2$

$t = 0.535s$

$V_{ox} = \frac{\Delta x}{t} = \frac{2.2}{.535} = 4.12\ m/s$ ← use as V_{Bf} from collision

$V_{Ai} = 1.5 V_{Bf} = \boxed{6.2\ m/s}$

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.



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

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

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

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

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

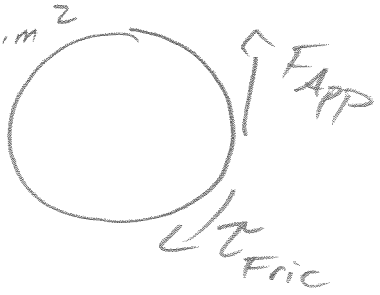
$$\Sigma F_y = -F_{s,y} + F_T \sin 12 - F_{grav} = 0$$

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

3. (30 pts) A 450-kg turntable with a radius of 1.70 meters can be treated as a solid cylinder. An applied force tangent to the rim of the turntable makes the wheel rotate 25.0 revolutions in 14.2 seconds after starting from rest. There is a also a frictional torque of magnitude 227 N-m opposing the motion. What is the magnitude of the applied force?

$\Sigma \tau = I\alpha$ $\quad I = \frac{1}{2}MR^2$

$= 650.25\ kg \cdot m^2$



$+RF_{App}\sin 90 - \tau_{Fric} = I\alpha$

$\Delta\theta = 25.0\ rev = 157\ rad$

$\omega_0 = 0$

$\omega = ?$

$\alpha = ?$

$t = 14.2\ s$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$157 = 0 + \frac{1}{2}\alpha (14.2)^2$

$\alpha = 1.558\ rad/s^2$

$(1.70)F_{App}(1) - 227 = (650.25)(1.558)$

$F_{App} = \frac{1013 + 227}{1.70} = 729\ N$