

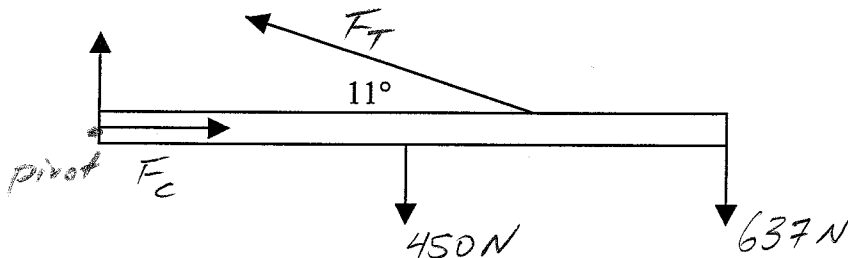
Phys 10154 - Fall 2006 - Exam #8A

Be sure to answer with the proper units and significant figures. Indicate your answers clearly with boxes. **SHOW ALL WORK.** Even if your answer is correct, I will deduct points if I can't see how you solved the problem. Both problems are worth 50 points.

#1. The spine and upper body of a man are represented by a uniform rod with a weight of 450 N. At the left end of the rod is the reaction force exerted by the hip on the base of the spine. The component of this force acting along the spine is also called the "compression force".

The man tries to pick up a 65-kg weight, which can be represented by the mass hanging from the right end of the rod. The other force on the spine is exerted by the muscles in the back, which are attached to the spine about 65% of the way up the spine from the hip, making an angle of 11 degrees.

Find the force exerted by the muscles in the back and the compression force acting on the spine.



$$\Sigma F_x = F_C - F_T \cos 11^\circ = 0$$

$$\Sigma \tau = -0.5 \ell (450) \sin 90^\circ - \ell (637) \sin 90^\circ + .65 \ell F_T \sin 169^\circ = 0$$

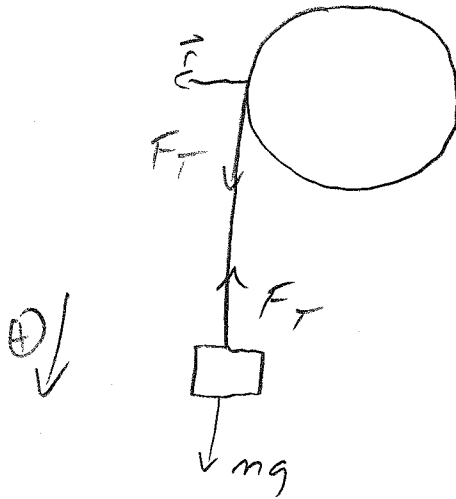
$$-225 - 637 + .65 F_T \sin 169^\circ = 0$$

$$F_T = \frac{862}{.65 \sin 169^\circ} = 6950 \text{ N} \rightarrow \boxed{7000 \text{ N}}$$

$$F_C = F_T \cos 11^\circ = \boxed{6800 \text{ N}}$$

#2. Starting from rest, a cylindrical spool with a radius of 12cm unwinds a thin string that supports a 1.2-kg mass hanging vertically. There is a frictional torque of 0.25 N-m opposing the motion of the spool.

It takes the mass 2.5 seconds to fall the 1.0 meter distance from its original location to the floor. What is the moment of inertia of the spool?



$$\Delta y = 1.0 \text{ m}$$

$$v_0 = 0$$

$$v = ?$$

$$a = ?$$

$$t = 2.5 \text{ s}$$

$$\Delta y = v_0 t + \frac{1}{2} a t^2$$

$$1.0 = 0 + \frac{1}{2} a (2.5)^2$$

$$a = 0.32 \text{ m/s}^2$$

$$\text{mass: } \Sigma F_y : mg - F_T = ma$$

$$\text{Wheel: } \Sigma \tau : (0.12) F_T \sin 90 = I \alpha$$

$$F_T = mg - ma = (1.2)(9.8 - 0.32) = 11.4 \text{ N}$$

$$(0.12)(11.4) - 0.25 = \frac{I(0.32)}{0.12}$$

$$1.12 = 2.67 I$$

$$I = 0.42 \text{ kg} \cdot \text{m}^2$$