# Physics 10154 - Exam #4c

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. (30 pts) A 95-kg person stands on a 750-kg cylindrical turntable with a radius of 3.0 meters. Initially, the person is standing at the edge of the turntable, and both person and turntable move together at a rate of 12 rev/min.

a) If the person walks inward to a radius of 1.5 meters, what is the new angular speed (rad/sec) of the person and turntable?

b) How much work does the person do while moving from a radius of 3.0 meters to 1.5 meters?

a) $I_{P,i} = MR^2 = (95)(3.0)^2 = 855\ kg\,m^2$

$I_{P,f} = (95)(1.5)^2 = 214\ kg\,m^2$

$I_{t,i} = I_{t,f} = \frac{1}{2}(750)(3)^2 = 3375\ kg\,m^2$

$\omega_i = 12\ \frac{rev}{min} \cdot \frac{2\pi\ rad}{rev} \cdot \frac{1\ min}{60\ s} = 1.26\ rad/s$

$(I_{P,i} + I_{t,i})\omega_i = (I_{P,f} + I_{t,f})\omega_f$

$(4230)(1.26) = (3589)\omega_f$

$\boxed{\omega_f = 1.5\ rad/s}$

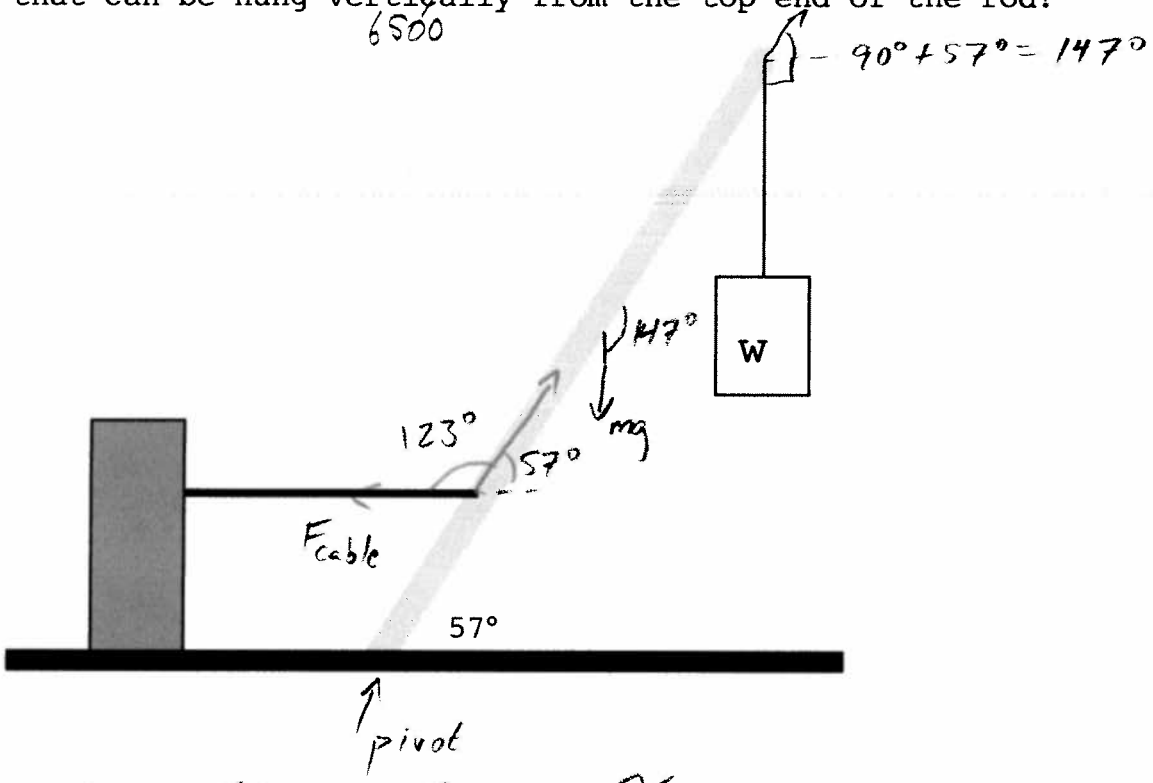
---

b) $K_i = \frac{1}{2} I_{TOT}\omega_i^2 = \frac{1}{2}(4230)(1.26)^2 = 3340\ J$

$K_f = \frac{1}{2} I_{TOT,f}\omega_f^2 = \frac{1}{2}(3589)(1.485)^2 = 3940\ J$

$W_{TOT} = \Delta K = \boxed{600\ J}$

2. (30 pts) (30 pts) A 9.0 meter uniform 35-kg rod makes an angle of 57° with the horizontal. The rod rests on the ground, and there is a horizontal support cable attached 2.2 meters from the lower end of the rod as shown below. This cable can withstand a maximum tension of [redacted] Newtons. What is the maximum weight, w, that can be hung vertically from the top end of the rod?




$$\Sigma\tau = \tau_{cable} + \tau_{rod} + \tau_w$$

$$\tau_{cable} = +(2.2)(6500)\sin 123° = 11990\ N\cdot m$$

$$\tau_{rod} = -(4.5)(35)(9.8)\sin 147° = -841\ N\cdot m$$

$$\tau_w = -(9.0)w \sin 147° = -4.90w$$

$$11990 - 841 - 4.90w = 0$$

$$4.90w = 11100$$

$$\boxed{w = 2300\ N}$$

3. (40 pts) A water tank has a cross-sectional area of 25 square meters and is open to the air. 12 meters below the surface of the water, a small hole in the tank has a diameter of 4.0 mm, through which water leaks out. How long (in seconds) does it take for the water from this leak to fill a 5.0 gallon container?

$$P_{TOP} + \rho g h_{TOP} + \frac{1}{2}\rho V_{TOP}^2 = P_{BOT} + \rho g h_{BOT} + \frac{1}{2}\rho V_{BOT}^2$$

$P_{TOP} = P_{BOT} = 101300\ Pa$

Also, assume $h_{BOT} = 0$, $h_{TOP} = 12\ m$

Also, assume $V_{TOP} \approx 0$ since $V_{TOP} << V_{BOT}$ due to continuity equation

$$\rho g h_{TOP} = \frac{1}{2}\rho V_{BOT}^2 \qquad V_{BOT} = \sqrt{2 g h_{TOP}}$$

$$= 15.34\ m/s$$

$$A_{BOT} = \pi (2.0 \times 10^{-3})^2 = 1.26 \times 10^{-5}\ m^2$$

$$A_V = 1.93 \times 10^{-4}\ \frac{m^3}{sec} \cdot \frac{1\ gal}{.003786\ m^3}$$

$$= .509\ \frac{gal}{sec}$$

or $\frac{19.6\ sec}{gal} \times 5\ gal = \boxed{98\ sec}$