X3.5a **1130**

PHYS-1130(5) (Kaldon-40443) **Name** S O L U T I O N
WMU - Fall 2007
Exam 3A - 100,000 points

Rev. 11/18/07 Su.3

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Short Answers Should Be Short! – Feel Free to Ask Any Questions

EXAM 3 [FORM - A]

PHYS-1130 (KALDON-5)

FALL 2007

WMU

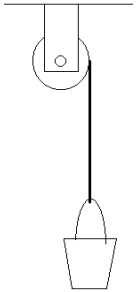
Economics, Finance, and Retailing, 1924
The first Macy's Thanksgiving Day parade moves 2 miles from Central Park West down Broadway to Herald Square, beginning an annual promotion event designed to boost Christmas sales.

Microsoft Bookshelf 95
The People's Chronology is licensed from Henry Holt and Company, Inc.

Giant helium-filled balloons of cartoon characters held down by ropes in the hands of Macy's employees came later.

Happy Thanksgiving...

The Tension Builds (50,000 points)



1.) A loaded bucket (m = 40.0 kg) is attached to a cable wrapped around a solid cylinder (m = 10.0 kg , R = 0.200 m). A motor driving the cylinder is pulling up the bucket at a constant speed, *v = 1.00 m/s*. Find (a) the θ which the cylinder has to rotate to pull up the bucket a distance of 2.00 meters.

$$s = r\theta\ ;\ \theta = \frac{s}{r} = \frac{2.00m}{0.200m} = 10.00\,rad$$

(b) Find the angular velocity ω of the cylinder.

$$\omega = \frac{v}{r} = \frac{1.00m/s}{0.200m} = 5.000\,rad/\sec$$

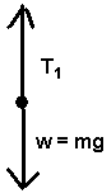
(c) Find the total Kinetic Energy of the system as the bucket is being pulled up.

$$I_{solid\ cylinder} = \tfrac{1}{2}MR^2 = \tfrac{1}{2}(10.0kg)(0.200m)^2 = 0.2000kg\cdot m^2$$
$$KE_{total} = KE + KE_{rot} = \tfrac{1}{2}mv^2 + \tfrac{1}{2}I\omega^2$$
$$= \tfrac{1}{2}(40.0kg)(1.00m/s)^2 + \tfrac{1}{2}(0.2000kg\cdot m^2)(5.000rad/\sec)^2$$
$$= 20.0J + 2.500J = 22.500J$$

Draw the Free Body Diagram for the bucket and the Free Rotation Diagram for the cylinder, while you (d) find the tension *T* of the cable and (e) the torque τ provided by the motor.

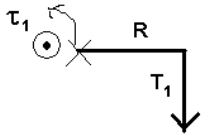
v = constant, so a = α = 0

(d)



$$\sum F_y = T_1 - mg = 0$$
$$T_1 = mg = (40.0kg)(9.81m/s^2)$$
$$= 392.4N$$

(e)



$$\sum \tau = \tau_1 - T_1R = 0$$
$$\tau_1 = T_1R = (392.4N)(0.200m)$$
$$= 78.48N\cdot m$$

"I Feel Like I'm Floating, Man." (50,000 points)

2.) (a) A rectangular barge measures 40.0 m × 10.0 m × 10.0 m high and by itself has a mass of 250,000 kg. The shipper wants to put 2,000,000 kg of grain into the barge. Will the loaded barge float in water?

$\rho_{water} = 1000\ kg/m^3$

$$\rho_{loaded\ boat} = \frac{m_{total}}{V_{boat}} = \frac{250{,}000kg + 2{,}000{,}000kg}{(40.0m)(10.0m)(10.0m)} = 562.5kg/m^3 < 1000.kg/m^3$$

(b) The barge is leaking water. Workers use a pump and a hose to lift the water in the bottom of the barge 10.0 meters to dump it over the side. Find the pressure P due to a column of liquid 10.0 meters high.

$$P = \rho gh = (1000.kg/m^3)(9.81m/s^2)(10.0m) = 98{,}100Pa$$

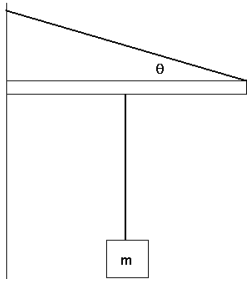
(c) The outside air is at $P_2 = 1.00\ atm = 101{,}300\ Pa$. The water inside the pump is moving at $v_1 = 2.00\ m/s$ and the water coming out of the hose 10.0 meters above is moving at $v_2 = 2.00\ m/s$. Find the pressure P_1 inside the pump.

$$v_1 = v_2$$
$$P_1 + \rho gh_1 + \tfrac{1}{2}\rho v_1^2 = P_2 + \rho gh_2 + \tfrac{1}{2}\rho v_2^2$$
$$P_1 = P_2 + \rho gh_2$$
$$= P_2 + (1000.kg/m^3)(9.81m/s^2)(10.0m)$$
$$= 101{,}300Pa + 98{,}100Pa$$
$$= 199{,}400Pa$$

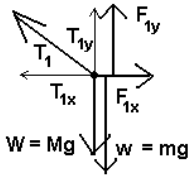
(d) When the water is pumped out, a crane is used to lift the pump, $m = 125\ kg$. At one point, the cable is stopped and the pump is left hanging there. If the current cable ($Y = 13.5 \times 10^{10}\ N/m^2$) length is 5.00 meters and the cable has a square cross-section of 4.00 mm × 4.00 mm (in order to make it easier to calculate), then how far, ΔL, is the cable stretched?

$$F = T = mg$$
$$Y = \frac{F/A}{\Delta L/L_0} = \frac{FL_0}{A\Delta L}$$
$$\Delta L = \frac{FL_0}{YA}$$
$$= \frac{(125kg)(9.81m/s^2)(5.00m)}{(13.5\times10^{10}N/m^2)(0.00400m)^2}$$
$$= 0.002839m\ \ (= 2.839mm)$$

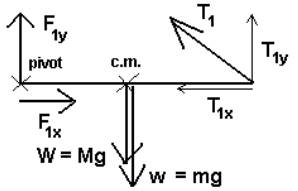
(e) The cable holding the pump is attached exactly halfway along the beam of the crane with length L and mass M. A second cable holds the end of the beam at an angle θ as shown. Draw the F.B.D. and F.R.D. for this problem and write down the Sum of Forces and Sum of Torques equations – *But DO NOT solve them!*



F.B.D.



F.R.D.



$$\sum F_y = T_{1y} + F_{1y} - Mg - mg = 0$$
$$= T_1\sin\theta + F_{1y} - Mg - mg = 0$$
$$\sum F_x = F_{1x} - T_{1x} = 0$$
$$= F_{1x} - T_1\cos\theta = 0$$
$$\sum \tau = T_{1y}L - Mg\frac{L}{2} - mg\frac{L}{2} = 0$$
$$= (T_1\sin\theta)L - Mg\frac{L}{2} - mg\frac{L}{2} = 0$$