X3.4a **1130**

PHYS-1130(4) (Kaldon-40519) Name S O L U T I O N

WMU - Fall 2006

Exam 3A - 100,000 points

Rev. 11/19/06 Su.4

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-4)

FALL 2006

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.

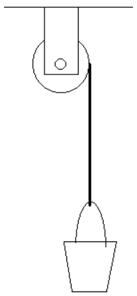
Microsoft Bookshelf 95

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

Happy Thanksgiving...

Construction Site Physics (50,000 points)

1.) A bucket of dirt (m = 23.0 kg) has to be lifted 15.0 m by a cable wrapped around a solid cylinder (m = 12.5 kg , R = 0.200 m). (a) Find the θ which the cylinder has to rotate to pull up the bucket.



$$s = r\theta$$
$$\theta = \frac{s}{r} = \frac{15.0m}{0.200m} = 75.00rad$$

(b) The cylinder rotates once every 1.25 seconds. Find the angular velocity ω of the cylinder.

$$\omega = \omega_0 = \frac{1rev}{1.25\sec} = \frac{2\pi rad}{1.25\sec} = 5.027rad/\sec$$

NOTE: ω = constant in this problem.

(c) How long (time) does it take to lift the bucket?

$$\theta = \omega_0 t$$
$$t = \frac{\theta}{\omega_0} = \frac{75.00rad}{5.027rad/\sec} = 14.92\sec$$

OR

$$v = r\omega = (0.200m)(5.027rad/\sec)$$
$$= 1.005m/s$$
$$d = vt$$
$$t = \frac{d}{v} = \frac{15.0m}{1.005m/s} = 14.93\sec$$

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

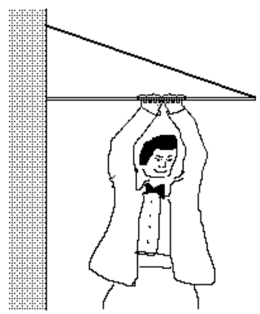
$$v = r\omega = (0.200m)(5.027rad/\sec)$$
$$= 1.005m/s$$
$$I_{solid\ cylinder} = \tfrac{1}{2}MR^2 = \tfrac{1}{2}(12.5kg)(0.200m)^2 = 0.2500kg\cdot m^2$$
$$KE_{total} = KE + KE_{rot} = \tfrac{1}{2}mv^2 + \tfrac{1}{2}I\omega^2$$
$$= \tfrac{1}{2}(12.5kg)(1.005m/s)^2 + \tfrac{1}{2}(0.2500kg\cdot m^2)(5.027rad/\sec)^2$$
$$= 6.313J + 3.159J = 9.471J$$

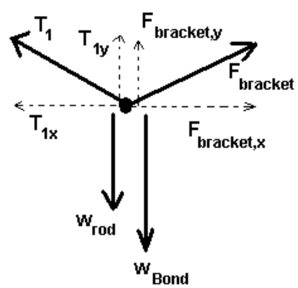
(e) Before the bucket was lifted, 15.0 meters of cable ($Y = 13.5 \times 10^{10}\ N/m^2$) was stretched by 4.00×10^{-3} m by the weight of the bucket of dirt. What is the diameter of the cable?

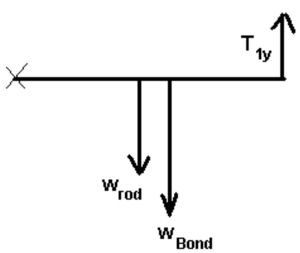
$$Y = \frac{F/A}{\Delta L / L_0} = \frac{FL_0}{A\Delta L}$$
$$A = \frac{FL_0}{Y\Delta L}$$
$$= \frac{(23.0kg)(9.81m/s^2)(15.0m)}{(13.5\times10^{10}N/m^2)(0.00400m)}$$
$$= 0.000006268m^2$$
$$A = \frac{\pi D^2}{4}$$
$$D = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{4(0.000006268m^2)}{\pi}}$$
$$= 0.002825m = 2.825\times10^{-3}m$$

"The Name's Bond, James Bond." (50,000 points)

2.) British super-secret agent James Bond (m = 75.0 kg) finds himself hanging 0.700 m from a wall by a 1.20 m steel rod (m = 5.00 kg). The rod is attached to the wall by a bracket on the left and is held up by a cable on the right.
(a) Draw the Free Body Diagram and the Free Rotation Diagram for the rod.







(b) Using the wall bracket as a pivot point, find the y-component of the tension in the cable.

$$\sum \tau = +T_{1y}L - w_{rod}\tfrac{L}{2} - w_{Bond}(0.700m) = 0$$
$$T_{1y}L = m_{rod}g\tfrac{L}{2} + m_{Bond}g(0.700m)$$
$$T_{1y} = \tfrac{1}{2}m_{rod}g + m_{Bond}g\left(\frac{0.700m}{L}\right)$$
$$= \tfrac{1}{2}(5.00kg)(9.81m/s^2) + (75.0kg)(9.81m/s^2)\left(\frac{0.700m}{1.20m}\right)$$

CORRECTION --> $= 429.2N$ + 24.5N = 453.7 N

(c) Find the y-component of the wall bracket attachment force. *If you didn't get an answer to (b), set T_y = 555N.*

$$\sum F_y = F_{1y} + T_{1y} - m_{rod}g - m_{Bond}g = 0$$
$$F_{1y} = m_{rod}g + m_{Bond}g - T_{1y} = (m_{rod} + m_{Bond})g - T_{1y}$$
$$= (5.00kg + 75.0kg)(9.81m/s^2) - 429.2N$$

CORRECTION --> - 453.7 N = 331.1 N

$$= 784.8N - 429.2N = 355.6N$$

(d) James drops from the metal rod onto a wooden box in the water below. The box measures 0.400 m × 1.00 m × 0.200 m high and by itself weighs 245 N. Does James in the box float in water? $\rho_{water} = 1000\ kg/m^3$

$$w_{boat} = m_{boat}g$$
$$m_{boat} = \frac{w_{boat}}{g} = \frac{245N}{9.81m/s^2} = 24.97kg$$
$$\rho_{loaded\ boat} = \frac{m_{total}}{V_{boat}} = \frac{24.97kg + 75.0kg}{(0.400m)(1.00m)(0.200m)}$$
$$= 1250.kg/m^3 > 1000.kg/m^3$$

(e) To surprise bad guys, James Bond has a "pen" made by Q-Branch which can shoot a stream of water at a speed of 166 m/s. What gauge pressure must the tank of water in the pen be pressurized to?

$$P_1 + \rho g h_1 + \tfrac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \tfrac{1}{2}\rho v_2^2$$
$$P_1 = P_2 + \tfrac{1}{2}\rho v_2^2$$
$$P_1 - P_2 = \tfrac{1}{2}\rho v_2^2 = \tfrac{1}{2}(1000kg/m^3)(166m/s)^2$$
$$= 13{,}780{,}000Pa = 136.0atm$$