X2.4a **1130**

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

WMU - Fall 2006

Exam 2A - 100,000 points **Book Title** ____________

Rev. 10/24/06 Tu.5

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 2 [FORM - A]

PHYS-1130 (KALDON-4)

FALL 2006

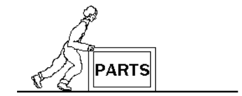
WMU

What's round and
got a flaky crust, brown spicy custard center
and represents the circumference
divided by the diameter?

It's Pumpkin π !

Happy Halloween A Week Early…

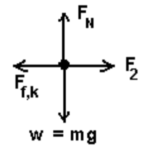
Taking A Physics Test By Force (50,000 points)



1.) Bert is pushing a 185 kg crate of parts horizontally across a floor. (a) If the crate is accelerating at $a_x = 0.300\ m/s^2$ and there is no friction, find the force F_1 Bert is applying to the crate.

$$F = ma = (185kg)(0.300m/s^2) = 55.50N$$

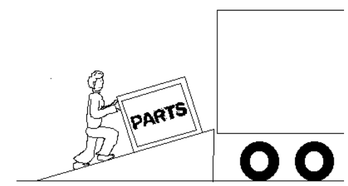
(b) Suppose there *is* friction and Bert is pushing the crate with a force $F_2 = 535\ N$ at a constant speed of $v = 0.300\ m/s$. Identify the relevant coefficient of friction and find its value.



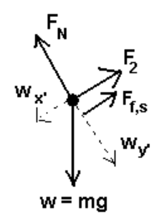
Need KINETIC friction.

$$\sum F_y = F_N - mg = 0$$
$$\sum F_x = F_2 - F_{f,k} = 0$$
$$F_2 = F_{f,k} = \mu_k F_N = \mu_k mg$$
$$F_2 = \mu_k mg$$
$$\mu_k = \frac{F_2}{mg} = \frac{535N}{(185kg)(9.81m/s^2)} = 0.2948$$

(c) Bert goes to push the crate up a 26° ramp with a force $F_2 = 535\ N$ and finds that it won't move (but if he pushed just a little harder, it would). Identify the type and find the magnitude of the friction force. Does it point UP or DOWN the ramp?

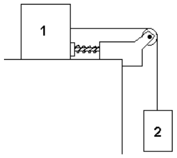


NOTE: $w_{x'} > F_2$, so the <u>STATIC friction</u> will have to <u>point UP</u> the incline to hold the crate. (However, once you break the static friction barrier, the crate will slide down the ramp – Oops!)

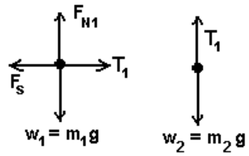


$$w_{x'} = mg\sin\theta = (185kg)(9.81m/s^2)\sin 26° = 795.6N$$
$$\sum F_{x'} = F_2 + F_{f,s} - w_{x'} = 0$$
$$F_{f,s} = w_{x'} - F_2 = 795.6N - 535N = 260.6N$$

Block 1 (20.0 kg) and Block 2 (8.00 kg) are connected by a single cable and a pulley as shown. Block 1 is also being pushed by a spring compressed 10.0 cm. There is no friction. (d) Draw the Free Body Diagrams for both blocks. (e) If the blocks stay at rest, find the spring constant k.



(d)



(e)

$$\sum F_{2y} = T_1 - m_2 g = 0$$
$$\sum F_{1y} = F_N - m_1 g = 0$$
$$\sum F_{1x} = T_1 - F_s = 0$$
$$T_1 = m_2 g$$
$$F_s = T_1$$
$$kx = m_2 g$$
$$k = \frac{m_2 g}{x} = \frac{(8.00kg)(9.81m/s^2)}{0.100m}$$
$$= 784.8N/m$$

F_s = -kx, but we can ignore the minus sign here.

The New Hit Music Group – The Exploding Pumpkins! (50,000 points)

2.) Billy and Katie carve a lovely pumpkin for Halloween next week. Unfortunately, Johnny puts a big firecracker inside and explodes the pumpkin, breaking it into two pieces. (a) If the left half has a mass of 3.00 kg and travels to the left at $v_1 = 12.0\ m/s$, and the right half has a mass of 2.00 kg, what is the speed v_2 and direction of the right half?

$$p_{before} = p_{after}$$
$$0 = -m_1 v_1 + m_2 v_2$$
$$m_2 v_2 = m_1 v_1$$
$$v_2 = \frac{m_1 v_1}{m_2} = \frac{(3.00kg)(12.0m/s)}{(2.00kg)}$$
$$= 18.00m/s$$

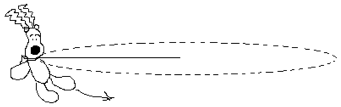
Since the left half is going to the left, the right half must be going TO THE RIGHT.

(b) Excluding the noise, flash and splatter – what was the energy of the firecracker? *If you didn't get an answer to (a), use $v_2 = 12.0\ m/s$.*

$$W = \Delta KE = KE_f - KE_i = KE_f$$
$$= \tfrac{1}{2} m_1 v_1^2 + \tfrac{1}{2} m_2 v_2^2$$
$$= \tfrac{1}{2}(3.00kg)(12.0m/s)^2 + \tfrac{1}{2}(2.00kg)(18.0m/s)^2$$
$$= 216.0J + 324.0J$$
$$= 540.0J$$

The energy of the firecracker must supply the work which becomes the Kinetic Energy of the two halves.

(c) Rodney is undergoing U.C.M. and is traveling at a speed v on an 95.0 cm string. The string is 5.00 pound test – that means a tension equal to an five pound weight (22.3 N) will cause the string to fail. If Rodney has a mass $m = 1.00\ kg$, how fast of a v can Rodney safely go? *Ignore gravity in this problem.*



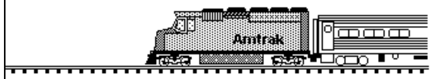
$$F_{c,\max} = \frac{mv^2}{r} = 22.3N$$
$$v^2 = \frac{r\,F_{c,\max}}{m}$$
$$v = \sqrt{\frac{r\,F_{c,\max}}{m}} = \sqrt{\frac{(0.950m)(22.3N)}{(1.00kg)}} = 4.603m/s$$

An Amtrak train of weight 2,250,000 N is heading to Chicago traveling at 100 mph (45.0 m/s). The coefficients of friction for steel wheels on steel rail: $\mu_S = 0.740,\ \mu_k = 0.570$. (d) Use Newton's Laws and the kinematic equations to find the minimum distance it will take to stop this train if it is under control.

$$F_{f,s,\max} = \mu_s F_N = \mu_s mg = ma$$
$$a_x = -\mu_s g = -(0.740)(9.81m/s^2) = -7.259m/s^2$$
$$v^2 = v_0^2 + 2a_x(x - x_0)$$
$$0 = v_0^2 + 2a_x x$$
$$2a_x x = -v_0^2$$
$$x = \frac{-v_0^2}{2a_x} = \frac{-(45.0m/s)^2}{2(-7.259m/s^2)} = 139.5m$$

(e) Use Work and Energy to find the distance it will take to stop this train if it is sliding.

$$W = Fd = -F_{f,k}d = -\mu_k F_N d = -\mu_k mgd$$
$$W = \Delta KE = KE_f - KE_i = -KE_i$$
$$-\mu_k mgd = -\tfrac{1}{2}mv^2$$
$$\mu_k gd = \tfrac{1}{2}v^2$$
$$d = \frac{v^2}{2\mu_k g} = \frac{(45.0m/s)^2}{2(0.570)(9.81m/s^2)} = 181.1m$$



Note that the sliding distance > controlled stop.