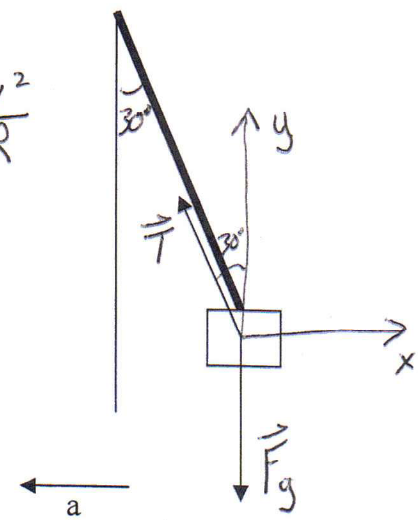
Physics 160-01 Exam #2

Name:________________________ **Box#:**____________

1) You are riding in a school bus. As the bus rounds a flat curve at constant speed, a lunch box with mass 0.500 kg, suspended from the ceiling of the bus by a string 1.8m long, is found to make an angle 30.0° with the vertical. In this position, the lunch box is 50.0 m from the center of curvature of the curve. What is the speed of the bus?



$$\Sigma F_x = -T\sin 30^\circ = -ma_x = -m\frac{v^2}{R}$$

$$\Sigma F_y = T\cos 30^\circ - F_g = \emptyset$$

$$T = \frac{mg}{\cos 30^\circ}$$

substitute into first equation

$$\frac{\cancel{m}g}{\cos 30^\circ}\sin 30^\circ = \cancel{m}\frac{v^2}{R} \Rightarrow$$

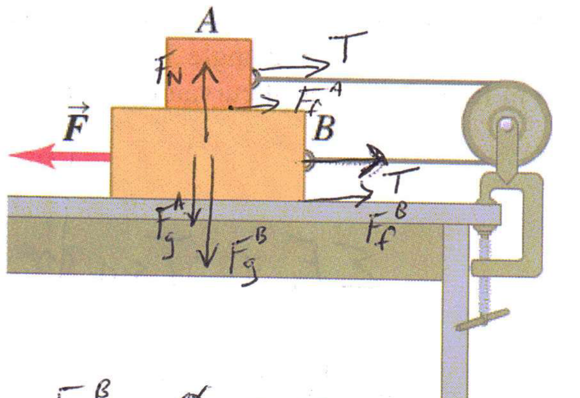
$$v^2 = gR\tan 30^\circ \Rightarrow$$

$$v = \sqrt{gR\tan 30^\circ}$$

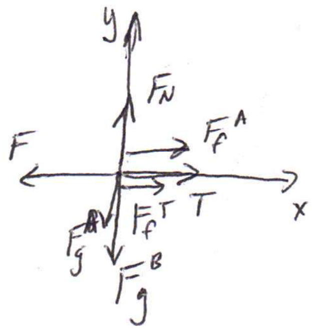
$$= \sqrt{\left(9.8\tfrac{m}{s^2}\right)(50\,m)\tan 30^\circ}$$

$$= 16.8\,\tfrac{m}{s}$$

2) Block A in the figure weighs 2.9N and block B weighs 5.2N. The coefficient of kinetic friction between all surfaces is 0.35. Find the magnitude of the horizontal force F necessary to drag block B to the left at a constant speed if A and B are connected by a light, flexible cord passing around a light, fixed, frictionless pulley.



For block B:



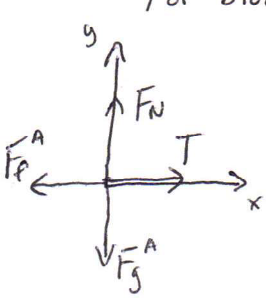
$$\Sigma F_y = F_N - F_g^A - F_g^B = \emptyset \Rightarrow F_N = m_A g + m_B g$$

$$\Sigma F_x = T + F_f^A + F_f^B - F = \emptyset$$

Now $F_f^A = \mu_k m_A g$

$F_f^B = \mu_k (m_A g + m_B g)$

For block A:



$$\Sigma F_x = T - F_f^A = 0 \Rightarrow T = F_f^A = \mu_k F_N^A = \mu_k m_A g \Rightarrow$$

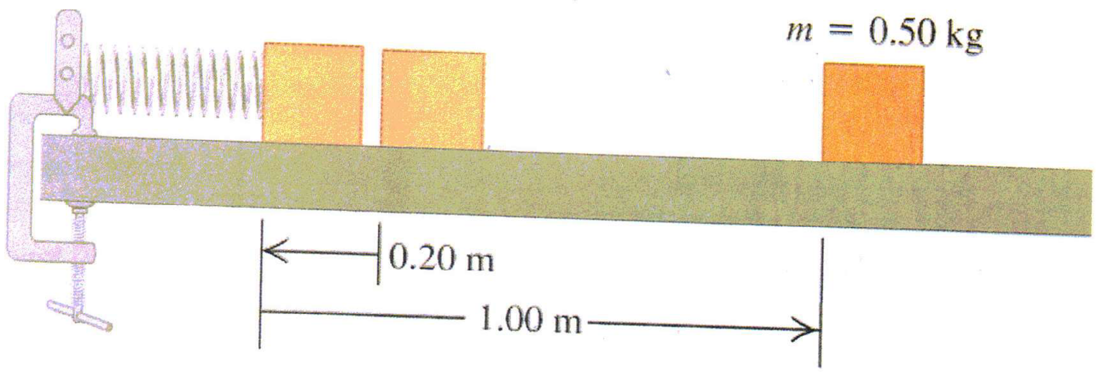
$$\mu_k m_A g + \mu_k m_A g + \mu_k (m_A g + m_B g) - F = \emptyset$$

$$\therefore F = \mu_k g (3m_A + m_B)$$

$$= 0.35(3 \cdot 2.9N + 5.2N)$$

$$= 4.86N$$

3) A block of mass 0.50 kg is forced against a horizontal spring of negligible mass, with a force of 20 N, compressing the spring a distance of 0.20 m. When released, the block moves on a horizontal tabletop for 1.00 m before coming to rest. What is the coefficient of kinetic friction between the block and the tabletop?



Since $F = kx \Rightarrow$

$$20N = k \cdot 0.2m \Rightarrow$$

$$k = 100 \frac{N}{m}$$

Then,

$$W_{oth} = \Delta KE + \Delta U_g + \Delta U_{el}$$

$$-\mu_k \cdot F_N \cdot 1m = \cancel{KE_f}^{\to 0} - \cancel{KE_i}^{\to 0} + \cancel{U_{gf} - U_{gi}}^{\to 0} + \cancel{U_{el_f}}^{\to 0} - U_{el_i}$$

$$-\mu_k \cdot mg \cdot 1m = -\frac{1}{2} k x^2$$

$$\mu_k = \frac{\frac{1}{2} k x^2}{m g (1.m)} = \frac{\frac{1}{2}(100 \frac{N}{m})(0.2\,m)^2}{(0.5\,kg)(9.8 \frac{m}{s^2})(1.0\,m)}$$

$$= 0.41$$

4) A system of two paint buckets connected by a lightweight rope is released from rest with the 12.0 kg bucket 2.00 m above the floor. During the time that the 12.0 kg bucket drops to the floor, friction in the pulley removes 10.0 J of energy from the system. What is the speed of the bucket when it hits the floor?

$$W_{oth} = \Delta KE + \Delta U_g + \cancel{\Delta U_{el}} \rightarrow \emptyset$$

$$-10\,J = KE_f - \cancel{KE_i}^{\rightarrow \emptyset} + U_{g_f} - U_{g_i}$$

$$-10\,J = \tfrac{1}{2}(12.0\,kg + 4.0\,kg)v^2 + (4.0\,kg)g(2.00\,m) - (12.0\,kg)g(2.00\,m)$$

$$\Rightarrow v = 4.28\,m/s$$