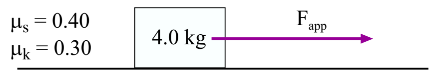
Name______________________________

Oct. 22, 2007

Quiz #2 — Fall 2007

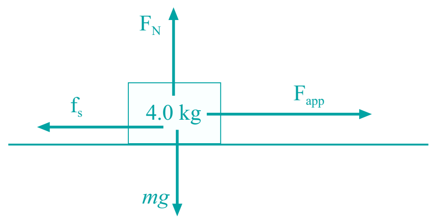
Phys 2010 – NSCC

1. A 4.0 kg mass is pulled horizontally across a rough horizontal surface by an applied force. For the mass and surface, the coefficients of static and kinetic friction are $\mu_s = 0.40$ and $\mu_k = 0.30$.



a) What applied force is required to start the block moving?

Force diagram for the mass is given here.



The normal force is $F_N = mg$, so the maximum value of the static friction force is

$$f_s^{\mathrm{Max}} = \mu_s F_N = \mu_s mg = (0.40)(4.0\ \mathrm{kg})(9.8\tfrac{\mathrm{m}}{\mathrm{s}^2}) = 15.7\ \mathrm{N}$$

so an applied force of $\boxed{15.7\ \mathrm{N}}$ is needed.

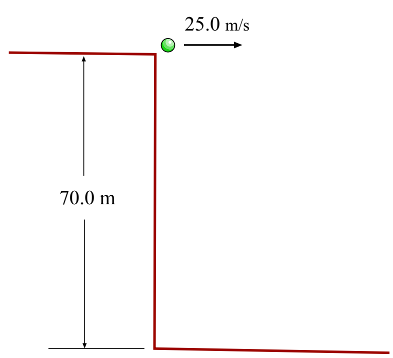
b) Suppose that once the block is moving you *keep* pulling with the same force you found in part (a). What is the acceleration of the mass?

When the mass is moving, the opposing force is that of *kinetic* friction which has magnitude

$$f_k = \mu_k F_N = \mu_k mg = (0.30)(4.0\ \mathrm{kg})(9.8\tfrac{\mathrm{m}}{\mathrm{s}^2}) = 11.8\ \mathrm{N}$$

2. A 2.0 kg mass at the top of a building of height 70 m is shot horizontally with a speed of $25.0\frac{\mathrm{m}}{\mathrm{s}}$.

Find the kinetic energy of the mass and its potential energy with respect to the ground.

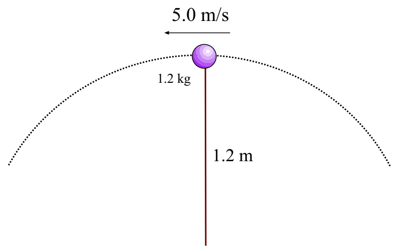


$$\mathrm{KE} = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(2.0\ \mathrm{kg})(25.0\tfrac{\mathrm{m}}{\mathrm{s}})^2 = 625\ \mathrm{J}$$

Measure height from the ground level, then $y = 70\ \mathrm{m}$ and

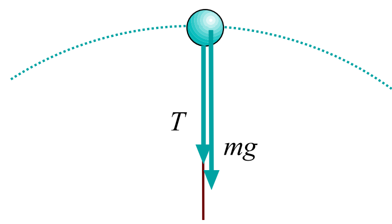
$$\mathrm{PE} = mgy = (2.0\ \mathrm{kg})(9.8\tfrac{\mathrm{m}}{\mathrm{s}^2})(70.0\ \mathrm{m}) = 1370\ \mathrm{J}$$

3. A 1.20 kg mass on the end of a string of length 1.20 m is swung in a vertical circle. We will consider the mass when it is at the *top* of the swing. At this point the mass has a speed of $5.00\frac{\text{m}}{\text{s}}$.



a) Draw a force diagram showing the forces acting on the mass at this point. (Hint: Strings pull, they don't push.)

Forces on the mass are shown here:



They are from gravity and the string tension, both of which pull downward (strings pull). There is no upward force on the mass.

b) What is the magnitude and direction of the net force on the mass at this point?

The net force must point toward the center of the circle, i.e. $\boxed{\text{downward}}$, and it has magnitude

$$F_{\text{net}} = F_c = \frac{mv^2}{r} = \frac{(1.20\ \text{kg})(5.0\frac{\text{m}}{\text{s}})^2}{(1.20\ \text{m})} = 25\ \text{N}$$

c) Find the tension in the string when the mass is at the top of its swing.

Using our force diagram and the answer to part (b) we have

$$T + mg = 25\ \text{N} \qquad \Longrightarrow \qquad T = 25\ \text{N} - mg = 25\ \text{N} - (1.2\ \text{kg})(9.8\tfrac{\text{m}}{\text{s}^2}) = 13.2\ \text{N}$$

The tension in the string here is $\boxed{13.2\ \text{N}}$.

You must show all your work and include the right units with your answers!

$$A_x = A\cos\theta \qquad A_y = A\sin\theta \qquad A = \sqrt{A_x^2 + A_y^2} \qquad \tan\theta = A_y/A_x$$

$$v_x = v_{0x} + a_x t \qquad x = v_{0x}\Delta t + \tfrac{1}{2}a_x t^2 \qquad v_x^2 = v_{0x}^2 + 2a_x x \qquad x = \tfrac{1}{2}(v_{0x} + v_x)t$$

$$g = 9.80\tfrac{\text{m}}{\text{s}^2} \qquad \mathbf{F}_{\text{net}} = m\mathbf{a} \qquad f_s^{\text{Max}} = \mu_s F_N \qquad f_k = \mu_k F_N \qquad a_c = \frac{v^2}{r} \qquad F_c = \frac{mv^2}{r}$$

$$W = Fs\cos\theta \qquad \text{KE} = \tfrac{1}{2}mv^2 \qquad \text{PE}_{\text{grav}} = mgy \qquad \Delta E = \Delta\text{KE} + \Delta\text{PE} = W_{\text{nc}}$$

$$\mathbf{p} = m\mathbf{v} \qquad \mathbf{J} = \Delta\mathbf{p} \qquad \mathbf{F}_{\text{av}} = \frac{\Delta\mathbf{p}}{\Delta t} \qquad \text{For isolated system, } \mathbf{P} \text{ is conserved}$$