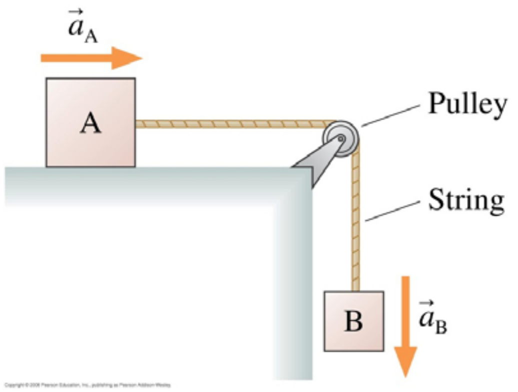
Physics 2211K
Practice for Test 3

1. In the system sketched below, block A slides on a ***frictionless surface*** and the string connecting the two blocks is ***massless***.

   a. If M_B = ***2 kg*** and M_A = ***6 kg***, use work and energy methods to calculate how fast M_B and M_A are traveling after starting from rest and M_B has fallen ***2 m***. $\boxed{v_f = 3.16\ m/s}$



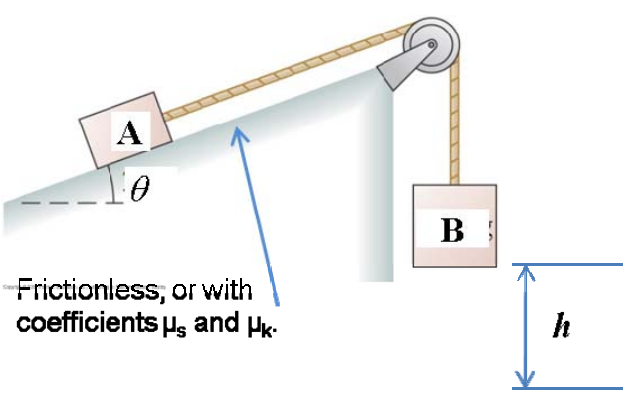
   b. Repeat ***part a.*** for the case where $\mu_k = 0.2$ for M_A sliding on the horizontal surface. $\boxed{v_f = 2.0\ m/s}$

   c. Repeat ***part a.*** for the case where the ***pulley is a solid cylinder of mass 2kg, radius 6 cm***, and the string ***does not slip*** as it passes over the pulley. $\boxed{v_f = 2.98\ m/s}$

   d. Repeat ***part b.*** for the case where the ***pulley is a solid cylinder of mass 2kg, radius 6 cm***, and the string ***does not slip*** as it passes over the pulley. $\boxed{v_f = 2.49\ m/s}$

   e. Repeat ***parts c. and d.*** using force and torque methods. (Remember that the tension in the string connected to ***B*** is not the same as that in the string connected to ***A***. This is necessary because a net torque is needed to accelerate the pulley.)

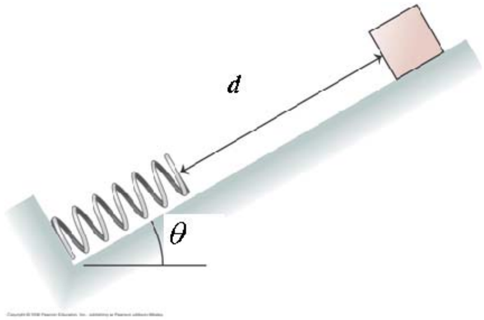
2. In the system below, the string is massless, ***A = 4.0 kg, B = 10.0 kg, θ = 30°, and h = 2.5m***.



   a. Use work and energy to find the ***speed of B*** when it has fallen the ***distance h*** if it ***begins from rest*** and the ***coefficient of kinetic friction for A is*** μ_k ***= 0.2. (Ignore static friction.)*** $\boxed{v_f = 3.61\ m/s}$

   b. ***Repeat part c.*** for the case where the ***pulley has mass 4kg***, ***radius 6 cm***, and can be approximates as a solid disk (***I = ½MR²***). (Assume that the string does not slip as it passes over the pulley.) $\boxed{v_f = 3.37\ m/s}$

3. On the sketch below, the sloping surface is frictionless, $\theta = 30°$, the block has mass $M = 4\ kg$, and the spring constant $k = 500\ N/m$.

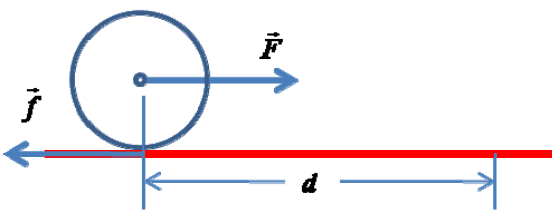


a. If the block just rests against the end of the spring how far is it compressed? $\boxed{\Delta s = 0.04\ m = 4\ cm}$

b. If the spring is compressed by ***20 cm*** and then released, how far does the block travel up the incline beyond the end of the uncompressed spring (i.e., ***what is d***)? (Assume the block is released so that it begins from rest.) $\boxed{d = 0.3\ m = 30\ cm}$

c. If the block is allowed to slide back down the incline, how far does it compress the spring when it has (momentarily) come to rest again? $\boxed{\Delta s = 20\ cm}$

4. As sketched below, the force $F = 200\ N$ acts (through the center of mass) for the distance $d = 8\ m$ on the solid circular cylinder of ***mass*** $M = 12\ kg$ and radius $R = 30\ cm$. ***The cylinder rolls without slipping on the horizontal surface.***



a. Calculate how much work $\vec{F}$ does on the object over the distance; $\boxed{W = 1600\ J}$

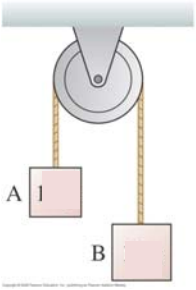
b. Use work and energy considerations to calculate the ***angular speed*** of the object, and ***the linear speed of its center of mass***, at the ***end of the 8 m*** if it began from rest; $\boxed{v_f = 13.3\ m/s}$

c. The object will accelerate uniformly over the distance as its speed increases. Use that fact and our previous kinematic procedures to calculate the object's acceleration. $\boxed{a = 11.1\ m/s^2}$

d. ***How much time*** does it take for the object to travel the ***8 m***? $\boxed{t = 1.2\ s}$

e. Use force considerations and the ***result from part c*** to calculate the ***necessary (static) frictional force*** $\vec{f}$ at the point of contact between the object and the surface for it to roll without slipping. (If it is necessary that $\mu_s > 1$, then it is unlikely that the object actually can roll without slipping under these conditions.) $\boxed{f_s = 66.8\ N}$

5. In the system sketched below, the string is massless, $M_A = 4$ ***kg***, and $M_B = 10$***kg***:



a. Use energy methods to calculate ***B's*** speed after falling $h = 1.2$ ***m*** if it began from rest; (What is the speed of *A*?) $\boxed{v_f = 2.27\ m/s}$

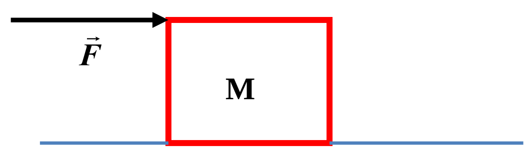
b. As it falls, ***B will accelerate uniformly***. Use that fact and kinematic procedures to calculate its acceleration. (What is the acceleration of *A*?) $\boxed{a = 2.14\ m/s^2}$

c. Repeat ***parts a. and b.*** for the case where the pulley is best described as a hoop of radius $R_{pulley} = 8$ ***cm*** and mass $M_{pulley} = 4$ ***kg***, and ***the string does not slip*** as it passes over the pulley. $\boxed{v_f = 2\ m/s;\ a = 1.67\ m/s^2}$

d. Repeat ***part c.*** using force and torque methods. (Remember that the tension in the string connected to ***B*** is not the same as that in the string connected to ***A***. This is necessary because a net torque is needed to accelerate the pulley.) $\boxed{T_A = 48\ N;\ T_B = 80\ N}$

6. Re. the object sketched below:

a. Calculate the work $\vec{F} = 50\ N$ does on the object over the distance $d = 2.5\ m$. $\boxed{W_F = 125\ J}$

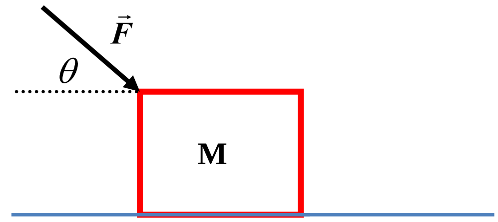


b. Use work and energy methods to calculate the object's final speed if its mass is $M = 12$ ***kg*** and it began from rest; $\boxed{v_f = 4.56\ m/s}$

c. Given that the object accelerates uniformly, use the result from ***part b*** and kinematic relations to calculate its acceleration. $\boxed{a = 4.17\ m/s^2}$

d. Repeat ***parts b & c*** for the case $\mu_k = 0.2$. $\boxed{v_f = 3.16\ m/s;\ a = 2.0\ m/s^2}$

7. Re. the object sketched below:



   a. Calculate the work that the force $\vec{F} = 50\ N$ does on the object over the horizontal distance $d = 2.5\ m$ when $\theta = 30°$. $\boxed{W_F = 108.3\ J}$

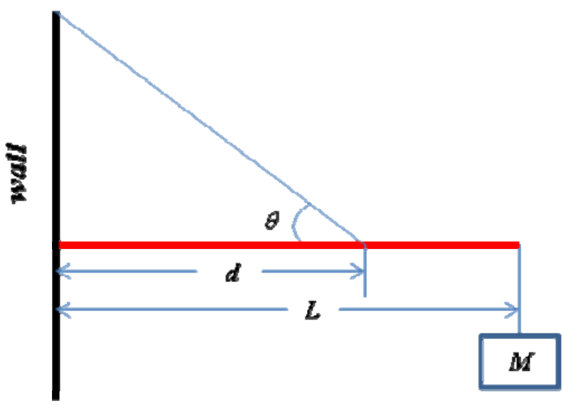
   b. Use work and energy methods to calculate the object's final speed if its mass is $M = 4\ kg$ and it began from rest; $\boxed{v_f = 7.36\ m/s}$

   c. Given that the object accelerates uniformly, use the result from ***part b*** and kinematic relations to calculate its acceleration. $\boxed{a = 10.8\ m/s^2}$

   d. Repeat ***parts b & c*** for the case $\mu_k = 0.2$. $\boxed{v_f = 6.15\ m/s;\ a = 7.58\ m/s^2}$

8. For the object in # 7, the force can be written as $\vec{F} = 50\left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right) N$ and the displacement as $\vec{d} = \left(2.5\ \hat{i}\right) m$. Use ***vector dot product*** methods to calculate the work done by the force in moving the object. $\boxed{W_F = 108.3\ J}$

9. In the situation below, the (uniform) beam has mass $M_{beam} = 750\ kg$, length $L = 6\ m$, the load has mass $M = 500\ kg$, and the cable is attached at $\theta = 30°$ and $d = 4m$ from the wall. The system is in equilibrium.



   a. Calculate the horizontal and vertical components of the force on the beam from the connection to the wall. $\boxed{F_x = 22733\ N;\ \ F_y = -625\ N}$

   b. Calculate the tension in the cable. $\boxed{T = 26250\ N}$