Announcements

1. **Exam 2 starts Friday!**
   a. Available in Testing Center from Friday, Oct 19 (opening time), up to Monday, Oct. 22 at 4:00 pm.
      i. Late fee if you start your exam after 4 pm
   b. Covers Ch. 4,5 (homeworks 6-10)
   c. Sample Exam 2 is posted on the web site and Sample Exam 2 Solutions also.
      i. As before, don't look at the solutions until you've *worked* the sample exam
      → It's easy to fool yourself!
   d. There's a **3 hour time limit**
      i. Might be a bit harder than the last exam
      → plan for a little more time than the last one
   e. Remember to write out solutions on your exam, even though it's graded via bubble sheet
   f. We'll have same answering system
      i. [1?] = pick a multiple choice answer
      ii. [1S] = get a numerical answer; bubble in the **S**econd digit.

Exam Formulas (also on website)

<u>To be given on exam</u>

Continued from exam 1

g=9.80 m/s^2

If $ax^2 + bx + c = 0, \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

For constant *a*:

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

New for exam 2

gravity: $w = mg$, $PE_g = mgy$

friction: $f = \mu N$ (or $f \le \mu N$, for static friction)

springs: $F = -kx$, $PE_s = ½ kx^2$

$P = F \cdot v$

<u>To be memorized</u>

Continued from exam 1

Definition: $v_{ave} = \langle v \rangle = \frac{\Delta x}{\Delta t}$

Definition: $a_{ave} = \langle a \rangle = \frac{\Delta v}{\Delta t}$

For constant *a*:

$$v = v_o + at$$

$$v_{ave} = \langle v \rangle = \frac{v_i + v_f}{2}$$

New for exam 2

Newton's 2nd Law: $\sum \vec{F} = m\vec{a}$

Newton's 3rd Law: $\vec{F}_{12} = -\vec{F}_{21}$

Definition: $W = F_{//}\,\Delta x = F\cos\theta\,\Delta x$

Definition: $KE = ½\, m v^2$

<u>Colton conservation of energy</u>: $E_{before} + W_{net} = E_{after}$

<u>Hess conservation of energy</u>:

$$KE_i + PE_i + W_{in} = KE_f + PE_f + W_{out}$$

Definition: $P = \Delta E/\Delta t$

Exam 2 - Review of important concepts

1. Newton's Laws
   a. 1st Law: inertia
   b. 2nd Law: $\sum \vec{F} = m\vec{a}$
      i. True for each object, as well as for groups
      ii. True for both x- and y-components
   c. 3rd Law: force pairs, equal & opposite

2. Forces
   a. unit: Newtons
   b. free-body diagrams
   c. weight = *mg*
      i. don't need to know "Universal Gravitation" yet
   d. Normal force
   e. friction: $f = \mu N$ (or $f \le \mu N$, for static friction)
   f. tension
   g. pulleys
   h. spring: $F = -kx$

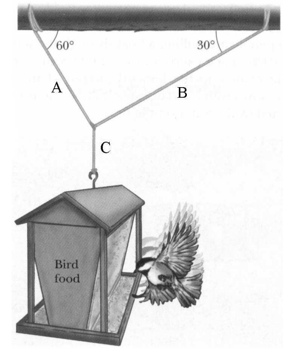
3. Work
   a. $W = F_{//}\,\Delta x = F\cos\theta\,\Delta x$
      i. unit: Joules

4. Energy
   a. unit: Joules
   b. Kinetic: $KE = ½\, m\, v^2$
   c. Gravity: $PE_g = mgy$
      i. don't need to know "Universal Gravitation" yet
   d. Springs: $PE_s = ½\, kx^2$
   e. **Conserved!!** $E_{before} + W_{net} = E_{after}$
      i. "before" and "after" pictures
      ii. include both PE and KE in "E" terms
      iii. include all nonconservative forces in W
         1. work occurs "during" the change
         2. positive and negative work

5. Power
   a. Definition: $P = \Delta E/\Delta t$
      i. unit: Watts
   b. Power from velocity: $P = F \cdot v$

HW 6, Problem 4

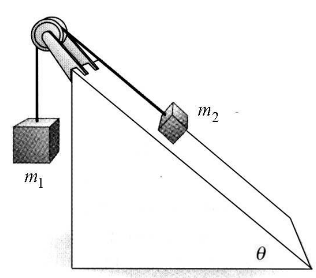
A 166 N bird feeder is supported by three cables as shown in the figure. Find the tension in (a) cable A, (b) cable B, and (c) cable C.



Answers 143.76 N, 83.00 N, 166 N

HW 7, Problem 4

Two objects are connected by a light string that passes over a frictionless pulley as in the figure. One object lies on a smooth incline. In the figure, m1 = 9.39 kg, m2 = 4.56 kg, and θ = 44.6° Find (a) the magnitude of the acceleration of the objects and (b) the tension in the string.



Answers: 4.347 m/s^2, 51.204 N

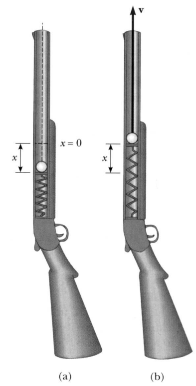
HW 8, Problem 4

A box of books weighing 287 N is shoved across the floor of an apartment by a force of 424 N exerted downward at an angle of 34.7° below the horizontal. If the coefficient of kinetic friction between the box and floor is 0.571, how long does it take to move the box 4.00 m, starting from rest?

Answer: 2.235 s

HW 9, Problem 3

The launching mechanism of a toy gun consists of a spring of unknown spring constant, as shown in Figure (a). If the spring is compressed a distance of 0.127 m and the gun fired vertically as shown, the gun can launch a 20.3-g projectile from rest to a maximum height of 17.7 m above the starting point of the projectile shown in Fig. (a). Neglecting all resistive forces, determine (a) the spring constant and (b) the speed of the projectile as it moves through the equilibrium position of the spring (where x = 0), as shown in Figure (b).



Answers: 436.634 N/m, 18.626 m/s

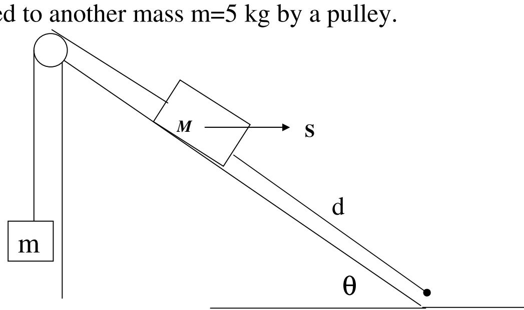
HW 10, Problem 1

A 20.3-kg child on a 2.26-m-long swing is released from rest when the swing supports make an angle of 33.1° with the vertical. (a) Neglecting friction, find the child's speed at the lowest position. (b) If the speed of the child at the lowest position is 1.51 m/s, what is the mechanical energy lost due to friction?

Answers: 2.681 m/s, 49.828 J

Detailed Sample Exam Problem

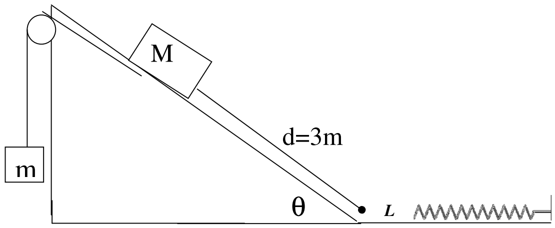
A block of mass M=25 kg slides a distance d=3 m down a ramp (θ=30^o) while being pulled with a force S=75 N horizontally, and the kinetic coefficient of friction is μ=0.2. It is also attached to another mass m=5 kg by a pulley.



1. Draw all the forces on *m* and *M.*
2. Write down Newton 2 for each object (both x- and y-coordinates where appropriate), and for the system.

3. Find the normal force of the incline on M. (answer: 174.676 N)
4. Find the frictional force on M. (answer: 34.935 N)
5. Find the acceleration of the system. (answer: 3.451 m/s^2)
6. Find how long it takes for the block to slide a distance d=3 m down the slope. (answer: 1.319 s)
7. Find the tension in the rope. (answer: 31.75 N)

A block of mass M=25 kg slides a distance d=3 m down a ramp. It is also attached to another mass m=5 kg by a pulley. At the bottom, the string is cut. The block travels a distance L=1 m to a stiff spring of constant k=40000 N/m and then compresses it, coming to a stop. The kinetic coefficient of friction is everywhere μ=0.2.



1. Find the work done by friction while sliding down the ramp. (answer: 127.31 J)

2. Write a conservation of energy equation to find the speed v_f of the block at the bottom of the ramp. (answer: 2.493 m/s)

3. Write a conservation of energy equation you could use to find how far the spring compresses (Δx). (answer: 3.7 cm, *I think*)