# Work & Energy Problems

1. Betty is pulling Irene with a constant force and velocity on a flat level surface. Betty is pulling horizontally with a force of 40 N. She pulls for 30 seconds, and does a total of 240 Nm of work.
   a. How far did Betty pull Irene?

   b. How much power did Betty produce?

   c. How much work did friction do?

   d. How much total work was done on Irene?

2. Sam is pulling his wagon with a force of 50 N at an angle of 40° above the horizontal. He pulls the wagon for a distance of 200 meters over a flat level ground. How much work did Sam do? *(Hint: what is the horizontal component of Sam's pulling force?)*

3. Sam is now pulling his wagon up a hill. The base angle of the hill is 30°. Sam is pulling the wagon with a force of 40 N, and is pulling parallel to the hill. The hill is 5 meters long.
   a. How much work does Sam do?

   b. If Sam's power was 25 W, how long did it take to pull the wagon up the hill?

   c. If the wagon does not speed up or slow down, what would happen to the work that Sam did?

4. Alfred and Beth are doing a physics lab with skateboards. Al pulls Beth, who is on the skateboard, with a constant force of 20 N. Starting from rest, he pulls her for a distance of 15 meters. They calculate that Beth was traveling with a speed of 2.7 m/s at the end of the 15 meters. Beth and the skateboard have a combined mass of 50 kg.
   a. How much work did Alfred do?

   b. How much kinetic energy did Beth have at the end?

   c. How much work did friction do?

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d. What was the average force of friction acting on Beth?

5. A skier of mass 75 kg is at the top of a ski run. The ski run is 2500 meters long, and has a vertical drop of 500 meters. The skier has an initial velocity of zero at the top of the hill, and a velocity of 15 m/s at the bottom of the hill.
   a. What was the potential energy of the skier at the top of the hill?

   b. What was the kinetic energy of the skier at the bottom of the hill?

   c. Why are your answers to a and b different?

   d. Calculate the average force of friction acting on the skier.

   e. If the hill were somehow frictionless, how fast would the skier have been going at the bottom of the hill? (Aren't you glad there is friction?)

6. Jason, Gilbert and Maria are sad that school was canceled because of three feet of snow, and decide to cheer themselves up by sledding down the big hill (height = 7 meters.) The three of them get on their sled (total mass = 215 kg) and give themselves a small push (1 m/s) at the top of the hill. They sled all the way to the bottom of the hill, a total distance of 23 meters, and get to the bottom of the hill with a speed of 6.8 m/s.
   a. What was their kinetic energy at the bottom of the hill?

   b. How was their total energy at the top of the hill? (Include the small push)

   c. What was the force of friction acting on them on the hill?

*Answers:*

1. *a) 6 m  b) 8 W  c) -240 J  d) 0 J*
2. *7660 J*
3. *a) 200 J  b) 8 s  c) some stored as potential energy, some "wasted" in overcoming friction.*
4. *a) 300 J  b) 182 J  c) -118 J  d) -7.9 N*
5. *a) 375,000 J  b) 8440 J  c) because it took energy to overcome friction*
   *d) -116 N  e) 100 m/s (that's about 223 mph!)*
6. *a) 4971 J  b) 15,160 J  c) -443 N*