# SI Workshop Problems #8: Energy

1. A 50 kg block is suspended from a 5.0 m rope. How much work is necessary to push it sideways 1.0 m from the vertical? [53.9 J] What is the energy transformation? [W→PE]

2. A 70 kg skier is carried up to the top of a 500 m mountain by a chair lift. There is a 20,000 J thermal loss due to frictional forces. She then skis down to the bottom of the mountain, arriving there with a speed of 12 m/s. How much work was done by the chair lift on the way up and how much thermal energy is dissipated by the skier on the way back down? [363,000J; 337,960 J]

3. A 1500 kg car reaches 100 km/h in 9 seconds starting from rest. What is the average power of the engine (assume negligible friction)? [P=64,310 Watts = 86.2 hp]

4. A 20 g bullet going at 500 m/s penetrates into a block of wood to a depth of 10 cm. What is the average force exerted by the block on the bullet? Assuming that force to be mainly friction, how much heat (negative work) is generated in the block? [friction force = 25,000N, Heat loss due to friction (negative work) = 2500J]

5. As shown in figure 1, the system is starting from rest. The masses of the two blocks are m_1 = 5 kg and m_2 = 10 kg.

   a. If m_2 goes down 1.4 m while m_1 goes up 1 m (measured vertically), how fast are they moving [3.43 m/s] at the end and how much energy has been transferred from m_2 to m_1? [78.4 J] Assume there's no friction.

   b. What is the energy transformation for each block?
   [m_1: PEm_2→KEm_1 + PEm_1]
   [m_2: PEm_2→KEm_2]

   c. How fast are the blocks moving if μ_k = 0.25? [3.19 m/s]

1 meter

figure 1
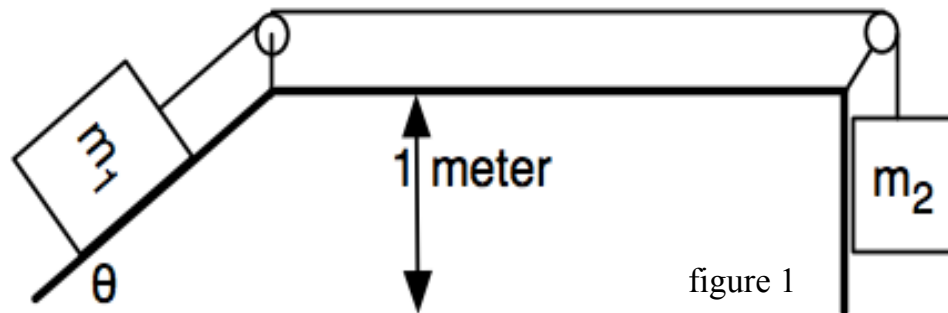
6. A 40 ton nuclear powered flying saucer acquires a speed of 3000 mph and an altitude of 120 miles launching from rest. If the average friction force experienced by the saucer is 5000 lb, what is the average horsepower developed by the saucer's motors?

   [7.8056 x 10^{10} ft•lbs; P= 2.71 x 10^8 ft•lbs/s = 4.928x10^5 hp]

7. At a ski resort a chair lift takes skiers up a 28° hillside to an elevation of 200 m. How much horsepower is required to pull 80 skiers at a time, at a speed of 1.2 m/s, if their average mass with equipment is 90 kg, and the friction force is 1,000 N? [45.75 hp]
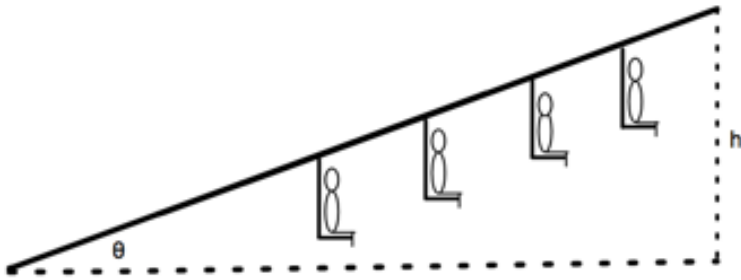
More Difficult

8. A block is rotating in a vertical circle attached to the end of a string. Show that the tension in the string is larger at the lowest point than at the highest by 6 times the weight of the block.