Mechanical Energy

Useful Info:

Kinetic Energy: $K = \frac{1}{2} m v^2$

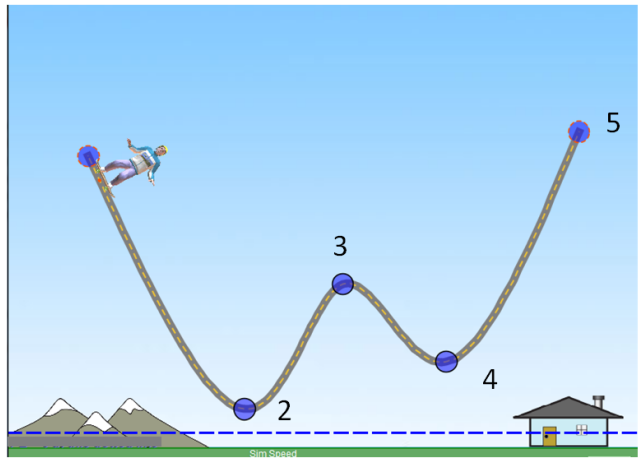
Gravitational Potential Energy: $U_g = mgh$

Conservation of Mechanical Energy:

$$K_i + U_{gi} = K_f + U_{gf}$$

$$\frac{1}{2} m v_i^2 + mgh_i = \frac{1}{2} m v_f^2 + mgh_f$$

A 70 kg skater starts from rest 15 m above the bottom of the *frictionless* track as shown. The bottom of the track is 2.0 m above the ground.



1. When he starts,
   a. how much potential energy does he have relative to the bottom of the track?

   b. how much potential energy does he have relative to the blue dashed line, which is midway between the ground and the bottom of the track?

   c. how much potential energy does he have relative to the ground?

2. The bottom of the track is labeled point 2.
   a. What is his potential energy at this point?

   b. What is his kinetic energy?

   c. What is his speed?

3. The first hill (point 3) is 6.0 m above the bottom of the track.
   a. What is his potential energy at this point?

   b. What is his kinetic energy?

   c. What is his speed?

4. The second dip (point 4) is 2.0 m above the bottom of the track.
   a. What is his potential energy at this point?

   b. What is his kinetic energy?

   c. What is his speed?

5. The last blue dot (point 5) is 16m above the bottom of the track.
   a. What is his potential energy at this point?

   b. What is his kinetic energy?

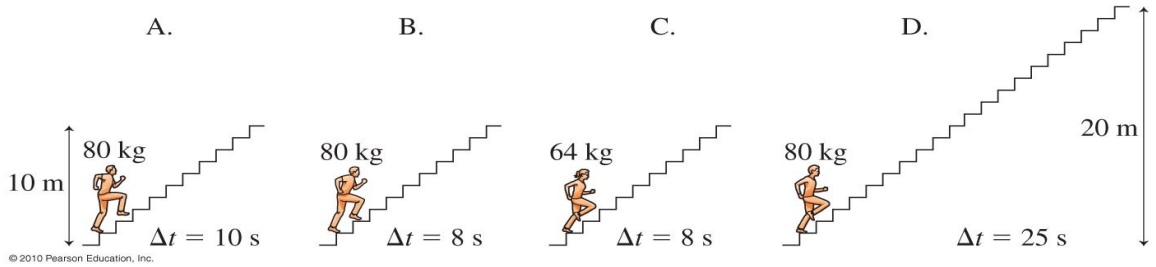
   c. What is his speed?

6. Using conservation of energy, calculate the speed of a basketball just before it hits the floor if it is dropped from a height of 2.0 m.

7. Sarah has a mass of 55 kg and is running at a steady speed of 5.0 m/s down the 1st floor hallway.
   a. What is her mechanical energy relative to the hallway floor?

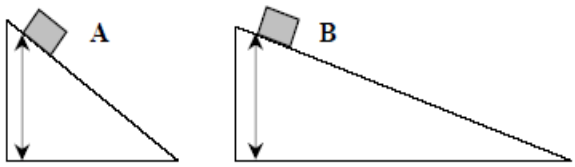
   b. If she runs up a flight of stairs with a total height gain of 3.0 m and continues to run down the 2nd floor hall at 5.0 m/s, what is her new mechanical energy relative to the 1st floor?

8. Each person in the figure below runs up their respective set of stairs at a *constant* speed.
   a. Which person has a greater *increase* in mechanical energy after reaching the top of the stairs?



   b. Which has the smallest increase in mechanical energy after reaching the top of the stairs?

9. Two identical blocks are released from rest at the top of two different *frictionless* ramps.
   a. Which block do you think will have a higher speed at the bottom of the ramp? Why?



   b. Each ramp is 3.0 m in height. Ramp A has an incline 45° above the horizontal and ramp B has an incline 30° above the horizontal. Use conservation of energy to determine the speed at the bottom of each ramp.