6.1 Is Energy Conserved in Energy Conversions?

a) Energy conservation with gravitational potential energy.

1) Drop a ball and watch how high it bounces. Does it reach the same height with each successive bounce? What eventually happens to the ball’s gravitational potential energy?

2) The click-clack machine is the pendulum with 5 balls. Watch what happens when you swing 1, 2, 3, or 4 balls. What happens to the balls’ gravitational potential energy? List the series of energy conversions that occur when one ball is raised and released.

b) Energy conservation with an applied force.

1) Watch as two rolling carts collide with a wall. Both carts have approximately the same mass and the same frictional force with the floor. Describe what happened to the carts after they collided with the wall.

2) Now watch the carts, without their outer covers, collide with the wall. How can you explain the difference in the behavior of the carts after they hit the wall?

3) Explain how energy was conserved in their collisions.

6.2 How Do We Measure Work and Energy?

a) Work and energy are measured in units of joules.

1 joule = 1 kg m²/s²

1 newton = 1 kg m/s²

Explain why a joule can also be called a newton meter.
b) This activity illustrates the amount of energy in one joule.

1) Lift the 1 newton plastic apple up a distance of 1 meter. How much work did you do? How much energy did you exert? (Assume no energy was wasted.)

________________

Based on your answer to question 1, predict whether it would take more or less than one joule of energy to climb to the top of the classroom stairs. Prediction: _________

2) Use the classroom scale to measure the weight of one of your group members in pounds. Convert this weight into mass in kilograms. (Hint: 1 lb = 4.45 N)

________

3) Measure the height of the classroom stairs in meters. _________

4) Calculate how much work this student must do against the force of gravity to climb to the top of the stairs.

________

5) Considering only the energy required to overcome the force of gravity, how many joules of energy are required to climb the stairs? _________

Was your prediction correct?

c) In this activity, we measure the work done against the force of friction by a toy truck pulling a block connected to a spring scale.

1) Once the truck and block are moving at a constant speed, how much force does the truck exert on the block? __________

2) How far did the truck pull the block? ___________________

3) Calculate how much work the truck did to pull the block that far.

__________

4) Would the amount of work done by the truck change if we added a 1 kilogram mass on top of the block? Watch the demonstration and note how much force the truck exerts on the moving block and 1 kg mass. ______________

5) How much work must the truck do to move the block and 1 kg mass the same distance as in question 2?

___________
6) Add more mass to the block just until the truck can no longer move the block. How does the amount of the force of friction between the block and the floor compare to the amount of force exerted by the truck on the block? What is the net force acting on the block and mass?

d) Group Discussion Question: Once the toy truck and block were moving at a constant speed, the truck did no work on the box to accelerate it. However, the spring scale continued to measure a force. What happened to this energy?

6.3 How Do We Store and Use Potential Energy?

a) Examine the spring wound toys on your table. Explain how they store energy. What form of energy do they store?

Squeeze a small spring with your fingers. Describe the energy transformations that take place.

b) Your instructor will demonstrate the pile driver.

1) Explain how the pile driver stores energy. What form of energy does it store?

2) How much potential energy does the pile driver mass store?
   a) To what height was the pile driver mass raised? __________
   b) Calculate how much work must be done to raise the mass to this height. (Ignore any frictional forces).

   __________
   c) How much potential energy does the mass store? __________

3) What happens to this stored energy when the pile driver’s mass is released? List the series of energy conversions that occur when the mass falls and hits an object beneath it.
4) If this pile driver’s mass requires a force of 50 N to drive a nail into a board a distance of 3 cm, how much work does has the pile driver done on the nail?

6.4 Kinetic Energy $\leftrightarrow$ Potential Energy

a) Draw a sketch of the bowling ball pendulum. Use letters to label the positions where the bowling ball has (A) the most potential energy, (B) the least potential energy, (C) the most kinetic energy, (D) the least kinetic energy, (E) the greatest velocity, and (F) the least velocity.

b) Your instructor will demonstrate a water wheel. List the energy conversions that take place when the water flows.

c) Roll or slide the toy car, marble, ping pong ball, and a wooden block with smooth and rough sides in the curved plastic track. Make predictions first.

1) Which object will waste the most energy overcoming the force of friction? Experiment to test your prediction.
   
   Prediction: ___________________  Answer: ___________________

2) Which object will waste the least energy overcoming the force of friction?
   
   Prediction: ___________________  Answer: ___________________

d) Group Discussion Question: Would it ever be possible for an object to roll higher than its original starting position? Explain why or why not.