PHET Energy Assignment

What is energy? That is a difficult question – no one really knows. The formal definition is "the ability to do work". What does that really mean? One way that I like to think about energy is to compare it with currency (money). What do you do with money? You either save it or spend/earn it. When you spend it, you are transferring money from yourself to someone else. When you earn it, money transfers from another person to yourself. And if you aren't transferring money, you are saving it.

Energy is like money. When we talk about energy, we always refer to it in only one of two contexts – as a *transfer* of energy from one object to another, or as a *storage* of energy. Whenever we discuss energy, try to get in the habit of immediately identifying whether we are talking about a transfer of energy, or a storage of energy.

ENERGY TRANSFER:	**work** (force x distance)
ENERGY STORAGE:	**Kinetic Energy** (energy in the form of motion of an object)
	Gravitational Potential Energy (energy we consider to be present because an object is elevated and we know that when the object is let go that gravity (a force) will do work on it as the object drops.
	Thermal Energy (energy associated with the motion of an object's molecules and atoms)

Go to the following website: http://phet.colorado.edu/web-pages/simulations-base.html . Select the "Physics" category on the left side of the page. Then select the "Work, Energy & Power" category on the left. This will narrow down the applets that show up on the right side of the screen. For each section of this assignment, start the applet indicated in the section title, and then answer the questions that follow.

THE RAMP

Click on the applet entitled "The Ramp". Do not select "The Ramp: Forces & Motion". Explore how the applet works for a couple of minutes. Attempt to change the object, the applied force, the ramp angle, and the starting position and watch the resulting motion by pressing "Go". Variables can be changed as the applet proceeds. Also explore the various graphs that can be displayed.

Now that you are familiar with the applet, do the following.

1. Reset the applet by clicking on the reset button. Select the piano as the object on the ramp. Click the go button.
   a. Use the force graph to determine the force of gravity.
   b. Use the force graph to determine the force of friction.
   c. Why doesn't the piano move? Explain.
   d. If the piano moved the 10 meters down the ramp, what work would gravity do on the piano? Use the five steps. (Hint: W=Fxd)
   e. What energy does the piano have as it sits on the ramp? (Hint: use the energy graph to report both the type of energy as well as how much)
   f. How do your answers to "d" and "e" compare?

2. Reset the applet again. Set the ramp angle to 25^o, and choose the file cabinet as the object but don't click go yet.
   a. What is the force of gravity before you click go? (use the force graph)
   b. What is the force of friction before you click go? (use the force graph)
   c. Will the file cabinet travel down the ramp this time? How do you know? Explain how you know.
   d. Use the five steps to predict the work that gravity will do on the file cabinet as it slides down the entire ramp. (Hint: look at the position on the ramp to get the distance).
   e. Use the five steps to predict the work that friction will do on the file cabinet as it slides down the entire ramp.
   f. Run the applet and check your answers using the work graph. Were you right?

3. There is a principle that says energy cannot be created nor destroyed. This is known as the **Conservation of Energy**. Look at the energy graph produced from your last run (re-run it if you need to).
   a. What type(s) of energy is stored in the file cabinet initially before it starts moving?
   b. What type(s) of energy are present *while* the file cabinet slides down the ramp?
   c. What type(s) of energy is stored in the system after the file cabinet comes to a stop?
   d. What is the shape of the Total Energy line on the energy graph (the yellow one)? Why does this shape make sense given the Law of the Conservation of Energy?

4. Reset the applet. Adjust the ramp angle to 25^o again. Also, this time, add an applied force of -50 N (entered in the little box on the left of the screen). The negative sign will make the applied force directed down the ramp.
   a. Before running the applet, predict what work the person does on the file cabinet. (Use the five steps).
   b. Given your answer to “a”, predict whether the total energy of the system will be larger, smaller, or remain the same as the last trial. Explain your answer.
   c. Run the applet with these settings. Was your prediction for “b” correct? If not, explain how your answer and the simulation are different.

The Energy Skate Park

Click on the applet entitled “The Energy Skate Park”. In this applet, you have the ability to design and modify the track that the skater uses. In addition, you have the ability to modify friction, the force of gravity, the skater’s mass, and the skater’s “bounciness”. There are a number of graphs that allow you to monitor the various types of energy associated with the skater as he moves along your track. As before, explore how the applet works for a couple of minutes. Attempt to change the track, friction, and the force of gravity. Variables can be changed as the applet proceeds. Also explore the various displays of energy that are a part of the applet.

Now that you are familiar with the applet, do the following:

1. Reset the applet to the original screen.
   a. Describe what happens to the skater.
   b. Click on the “show pie chart” and “bar graph” options. What kinds of energy does the skater have at the top of the track?
   c. What kind of energy does the skater have when at the bottom of the curve?
   d. What can you say about the total energy as the skater moves back and forth on the track?
   e. Does the track have any friction at this point? Explain how the MOTION OF THE SKATER tells you the answer you give.

2. Without resetting the applet, now add friction to your simulation by clicking on the “track friction” button and dragging the slider that modifies the coefficient of friction.
   a. What happens to the skater?
   b. What new form of energy is present now with friction that wasn’t present before?
   c. How does this new form of energy change as the simulation continues?
   d. The initial energy eventually becomes what kind of energy?

3. Make the following predictions (answer these BEFORE checking your answers):
   a. How would the motion of the skater change if the skater starts at the top of a track on the Moon (where the force of gravity on the surface is smaller)?
   b. How will the energies for the skater be different on the Moon as compared to when on Earth?
   c. How would the motion of the skater change if the skater starts at the top of a track on Jupiter (where the force of gravity on the surface is stronger)?
   d. How will the energies for the skater be different on Jupiter as compared to when on Earth?
   e. How would the motion of the skater change if the skater starts at the top of a track in deep space (where there is no force of gravity)?
   f. How will the energies for the skater be different in deep space as compared to when on Earth?

4. Reset the applet. Click on the “show pie chart” and “bar graph” options. When you reset the applet, the skater returns to earth and begins going back and forth on the simple parabolic track.
   a. When the skater is near the top of the track and starting back down, click on the “Moon” option. Were your predictions for the skater’s motion and the differences in energy correct? Explain.
   b. When the skater is near the top of the track, click on the “Jupiter” option. Explain what happens to the skater.
   c. How is the potential energy of the skater on both the Moon and Jupiter different from the potential energy of the skater on Earth?

5. Reset the applet. Click on the “show pie chart” and “bar graph” options.
   a. When the skater is near the top of the track BUT STARTING TO HEAD BACK DOWN, click on the “Space” option. What happens to the skater?
   b. How do the various kinds of energies change as the skater moves?

6. Design your own track that has both a loop-d-loop and a jump (therefore you will need two separate pieces of track). Do not include any friction initially.
    a. Sketch your track design. Include the dimensions of your track using the measuring tape tool.
    b. Indicate which planet you are on (do not use the space option).
    c. On your sketch, label where on your track your potential energy is the highest.
    d. On your sketch, label where on your track your kinetic energy is the highest.
    e. On your sketch, label where your total energy is highest (think about this one carefully!).
    f. Add some friction. On your sketch, label where your thermal energy is highest (you will need to add some friction).

7. For the track you designed, using complete paragraphs and sentences, describe the potential, kinetic, thermal and total energies of your skater and how they change as the skater travels from the beginning to the end of your track.