Virtual Laboratory

Topic 06 – Energy

			06
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Energy Skate Park: Basics

Introduction:

When Tony Hawk wants to launch himself as high as possible off the half-pipe, how does he achieve this? The skate park is an excellent example of the law of **conservation of energy**. The law of conservation of energy tells us that we can never create or destroy energy, but we can change its form, In this virtual lab. we will look at the conversion of energy between *gravitational-**potential*** energy, work, and ***kinetic*** (or moving) energy.

Use the internet, your textbook, or notes to define the following key terms:

1. Kinetic Energy ____

2. Potential Energy ____

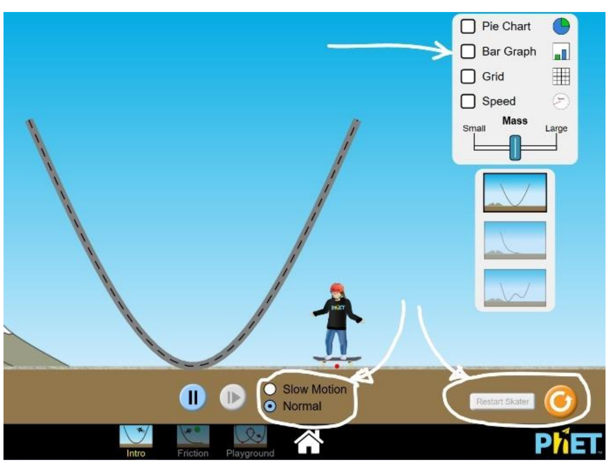
3. Mechanical Energy____

4. Joule ____

5. State, in **your own words**, the **Law of the Conversation of Energy**.

Procedure: *Google PHET Energy Skate Park: **Basics*** Run Now!

Click on INTRO. Take some time and play with the skater. Turn on the Bar Graph, Pie Chart, and Speed options. Become familiar with the orange '***Reset***' button on the right and how to change the speed of the simulation with the buttons on the bottom.



How does increasing skater's **mass** change the skater's….

6. Kinetic Energy? __________ 7. Potential Energy? __________ 8. Total Energy? ____________

The following words are used to answer the following questions: Increase, decrease, stays the same, maximum value, minimum value, or zero.

9. How does the skater's **kinetic energy** change as he moves **down** the ramp? ________________________________

10. How does the skater's **kinetic energy** change as he moves **up** the ramp? __________________________________

11. How does the skater's **potential energy** change as he moves **down** the ramp? ______________________________

12. How does the skater's **potential energy** change as he moves **up** the ramp? ________________________________

13. How does the skater's **total energy** change as he moves **down** the ramp? _________________________________

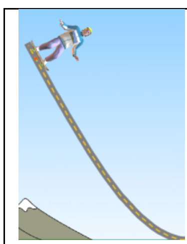
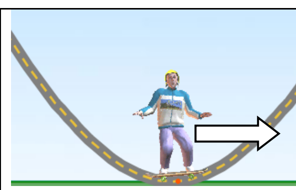
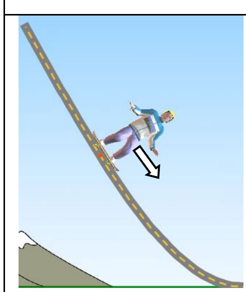
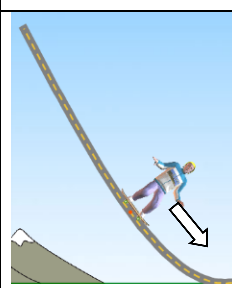
14. How does the skater's **total energy** change as he moves **up** the ramp? ____________________________________

15. Describe the skater's **kinetic** energy at the bottom of the ramp.
____

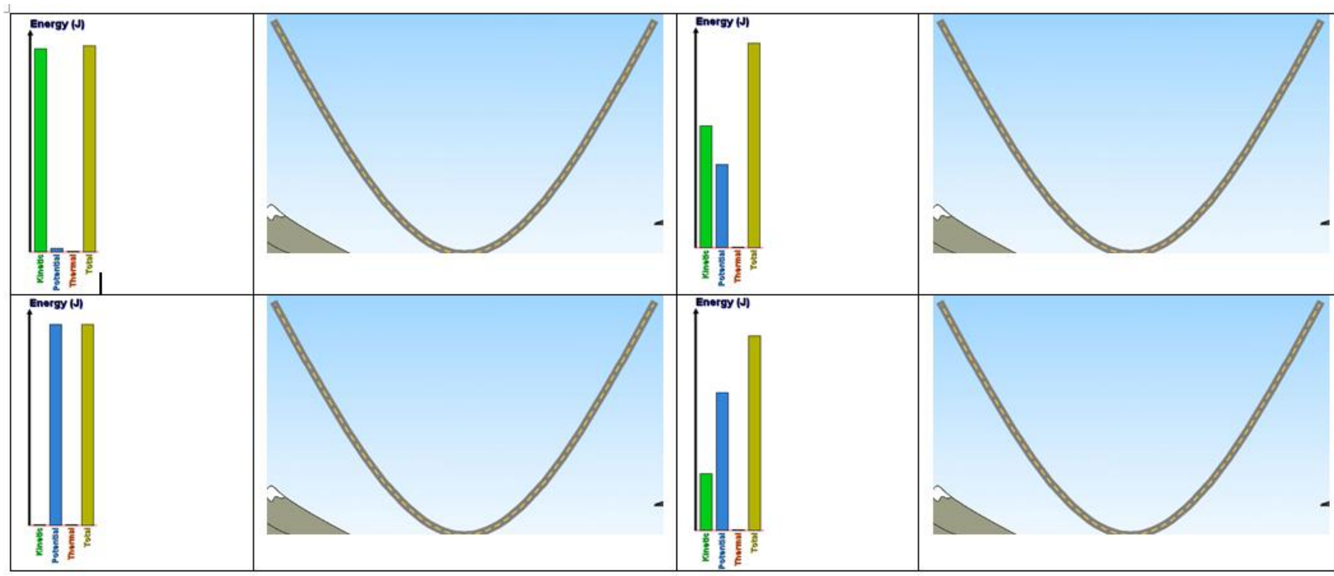
16. Describe the skater's **potential** energy at the bottom of the ramp.
____

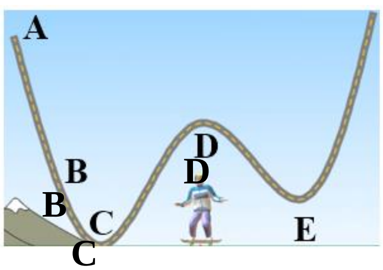
17. What happens when the skater is dropped onto the ramp from above the ramp? (Look at the bar graph.)
____

18. - 25. Observe the following situations. Draw the possible bar graphs for the situation shown. (**The following instruction is for hybrid section students only**: In Microsoft word click on INSERT at the top of your screen. Then click on SHAPES. Select the rectangle. Click the location on the page where you want it, and drag to the desired shape and location. If you have difficulty with this, just print this document, hand draw your answers on it, and bring your assignment to class.)

 Top of the ramp. stopped for just an instance.		 Bottom of the ramp. zooming past the middle.	
 Mid-way down the ramp. picking up speed.		 3/4 of the way down the ramp. moving pretty fast.	

Draw where the skater might be based on the bar graphs shown. Just copy, paste, and drag the red dot into position. Or you can make your own mark. **3 of the pictures below will have 2 red dots**. 





← Consider this zany track. What point or points on this track would the skater have

Note: Points B and E are located at the same height above the ground.

19. The most kinetic energy? _________________

20. The most potential energy? _________________

21. The same kinetic energy (two points) __________ and __________

<u>Questions:</u> (highlight ***the correct answers***)

22. At the highest point kinetic energy is *zero / maximum* while the potential energy is *zero / maximum*.

23. At the lowest point kinetic energy is *zero / maximum* while potential energy is *zero / maximum*.

24. Mass *affects / does not affect* the amount of energy.

25. As an object falls in gravity, kinetic energy *increases / decreases / remains the same*.

26. As an object falls in gravity, potential energy *increases / decreases / remains the same*.

27. As an object falls in gravity, total energy *increases / decreases / remains the same*.

28. A freely falling object travelling faster and faster has a kinetic energy that *increases / decreases / remains the same*.

29. A freely falling object travelling faster and faster has a potential energy that *increases / decreases / remains the same*.

30. As a freely falling object speeds up, the total energy *increases / decreases / remains the same.*

31. As a freely falling object slows down, the total energy *increases / decreases / remains the same.*

32. How ***useful for your learning*** was this activity, compared to other science class activities? (highlight your answer)

More useful   About the same   Less useful

How ***enjoyable*** was this science class activity. compared to other science class activities? (circle)

More enjoyable   About the same   Less enjoyable

Why did you or did you not find it useful or enjoyable?

• 06 •
E N E R G Y

Report Name (ie. 019912)

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Part A - Energy Conversions

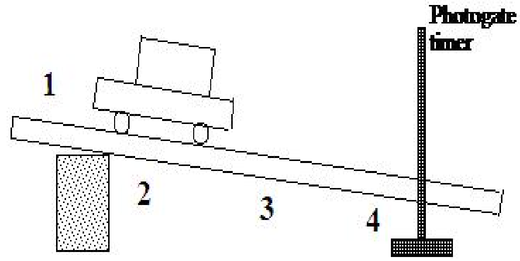
How can one form of energy be converted to another form of energy?

In the chart write the name of a device that converts the form of energy listed along the left of the chart to the form of energy listed along the top of the chart. For example: the conversion of light energy to mechanical occurs using a device called the Radiometer.

	Light	Mechanical	Heat	Sound	Electrical	Chemical
Light		Radiometer				
Mechanical						
Heat						
Sound			HIFU High Intensity Focused Ultrasound			
Electrical						
Chemical						

1. Describe all steps in an energy chain beginning with the sun and ending with a light bulb. ______

Part B - Energy Conversions Quantitatively



In this experiment you will compare the gravitational potential energy stored in the truck to the kinetic energy that the truck has at various heights.

Set up the inclined track as indicated. Measure the height of the truck above the table at positions 1, 2, 3, and 4. Be consistent by always measuring the vertical distance from the table to the same point on the truck for each position. Use a piece of tape to keep track of each position. (Do not place position 1 at very top of ramp!)

Truck Mass _________(kg) **PE = mass x 9.8 x height**

	Position 1	Position 2	Position 3	Position 4
Height (m)				
Potential Energy (J)				

Place the truck at the top of the ramp and release it from rest. The truck is released from this position for all 4 trials. Use the photogate timer (Gate Mode) to time the truck as it passes through the photogate at each position. Make sure it reads zero before each measurement. Repeat the time measurement 3 times for each position and then average these times to calculate the speed, v, of the truck at positions 2, 3, and 4. Calculate the kinetic energy for each position, and the total energy using the Potential energy from the table above and add it to the kinetic energy from the table below.

Remember: v = d / t, where **d = width of the flag** and t = avg. time. Total E = PE + KE d= _____________m
KE = ½ x mass x v^2 NOTE: Look for pattern in the times. If broken retake measurement.)

	Position 1	Position 2	Position 3	Position 4
Time 1 (seconds)				
Time 2 (seconds)				
Time 3 (seconds)				
Average time (s)				
Speed (m/s)				
Kinetic Energy (J)				
Total Energy (J)				

1. Make 3 separate graphs. (Note: the following are all Y vs X.)
   a. Graph Kinetic Energy vs. Potential Energy.
   b. Graph speed vs. Potential Energy.
   c. Graph Total Energy vs. Potential Energy.

Your answers to the following questions are based on your graphs.

2. When the potential energy is large, the kinetic energy is
   a. also large
   b. small
   c. about the same

3. The relationship between kinetic and potential energy is
   a. a straight line sloping down
   b. a curve that is concave up
   c. a curve that is concave down.
   d. a horizontal straight line
   e. a straight line sloping up

   What does this mean? ____

4. When the potential energy is large. the speed is
   a. also large
   b. small
   c. about the same

5.The relationship between potential energy and speed is
   a. a straight line sloping down
   b. a curve that is concave up
   c. a curve that is concave down.
   d. a horizontal straight line
   e. a straight line sloping up

   What does this mean? ____

6. When the potential energy is large the total energy
   a.is also large   b.is small   c. stays about the same

7. The relationship between potential and total energy is
   a. a straight line sloping down
   b. a curve that is concave up
   c. a curve that is concave.
   d. a horizontal straight line
   e. a straight line sloping up

   What does this mean? ____

8. Is total mechanical energy conserved? (Does the total energy stay about the same for all 4 positions)? Explain your answer.

9. How much work was done between positions 1 and 4? (W = F x d) Hook the force meter onto the truck and hold it parallel to the inclined plane. Measure the distance, along the inclined plane between positions 1 and 4.

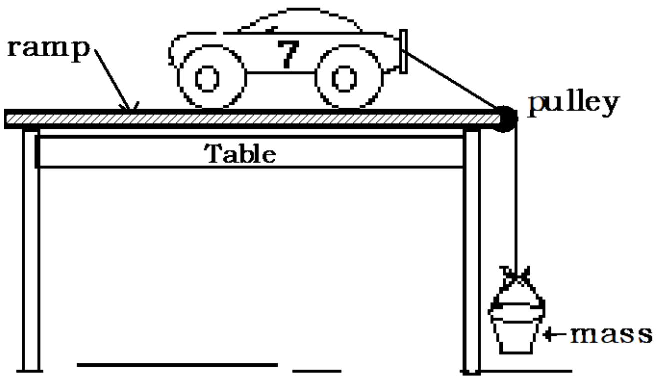
   W = __________N x __________m = _________ Joules

10. Calculate the Percent Error between the Work and ΔKE Energy. ____________

$$\%Error = \frac{|\Delta KE - W|}{AverageTotalEnergy} x100\%$$ where $\Delta KE = KE_4 - KE_1$.

Determine the horsepower of a small battery powered car

Determine the horsepower of a small battery powered car as it lifts a load (force = weight) through a timed distance. Use photogates in **Pulse Mode**. Set-up the equipment on the table top as indicated in the above figure. If the wheels spin you will need to wash them with soapy water and possibly even the tabletop to get the best traction.



To determine *work* done by the car measure the distance, in meters, that your car pulls the load and multiply it by the force of the load being lifted. W = F x d. Convert the Power in Watts to Horsepower.

Force (weight of load) F = m x g			Work W = F x d		Power Power = Work / time		Horsepower 1 Hp = 746 Watts
m. (kg)	g (m/s^2)	F (Newton)	d (meters)	W (Joules)	t (seconds)	P (watts)	Hp
	9.8						

Part C – Simple Machines revisited

Pre-lab Preparation: Copy your data from Forces & Simple Machines Lab into the tables below. Then complete the calculations for W_I, W_O, and % E. Answer all questions that follow the tables. This section should be completed at home prior to attending the Energy Lab.

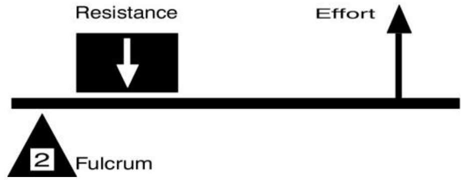
Lever

Section 1: 1st Class Levers

	Trial 1	Trial 2	Trial 3
1. Distance (meters) a. Resistance Placement	0.100	0.100	0.100
b. Resistance Distance D_R			
c. Effort Placement	0.050	0.100	0.050
d. Effort Distance D_E	0.010	0.020	0.020
2. Force (Newton's) a. Resistance R			
b. Effort E			
3. Work Input (Joules) $W_I = E \times D_E$			
4. Work Output (Joules) $W_o = R \times D_R$			
5. % EFFICIENCY $\%E = (W_O / W_I) \times 100$			

Average % Efficiency of First Class Levers = _____

Is this answer realistic? Explain.

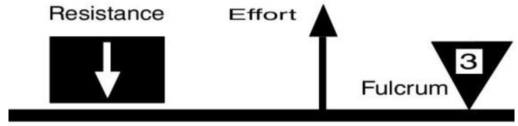


2^{nd} Class Levers

	Trial 1	Trial 2	Trial 3
1. Distance (meters) a. Resistance Placement	0.050	0.050	0.050
b. Resistance Distance D_R			
c. Effort Placement	0.100	0.150	0.150
d. Effort Distance D_E	0.020	0.030	0.030
2. Force (Newton's) a. Resistance R			
b. Effort E			
3. Work Input (Joules) $W_I = E \times D_E$			
4. Work Output (Joules) $W_O = R \times D_R$			
5. % EFFICIENCY $\%E = (W_O / W_I) \times 100$			

Average % Efficiency of Second Class Levers = _____

Is this answer realistic? Explain.



3rd Class Levers

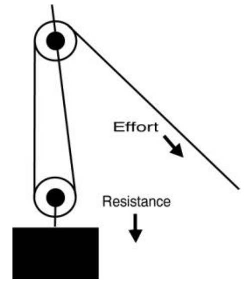
	Trial 1	Trial 2	Trial 3
1. Distance (meters) a. Resistance Placement	0.200	0.200	0.200
b. Resistance Distance D_R			
c. Effort Placement	0.050	0.100	0.100
d. Effort Distance D_E	0.010	0.020	0.020
2. Force (Newton's) a. Resistance R			
b. Effort E			
3. Work Input (Joules) $W_I = E \times D_E$			
4. Work Output (Joules) $W_O = R \times D_R$			
5. % EFFICIENCY $\%E = (W_O / W_I) \times 100$			

Average % Efficiency of Third Class Levers = _____

Average % Efficiency for All Levers = _____

Are these answers realistic? Explain.

1. Describe the relationship of force and distance for work input and work output. $E \times D_E = R \times D_R$ _____
2. Why are W_O and W_I are not the same for levers. _____
3. How could an efficiency of greater than 100% be obtained? In reality is it possible? _____
4. How does the mechanical advantage compare to the change in effort? _____
5. Could the placement distances of the effort and the resistance be used to estimate the work input and work output? _____



Pulley

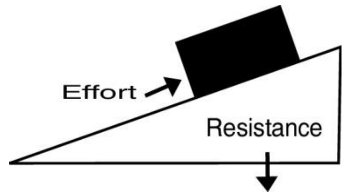
	Section 1 One Pulley	Section 2 Two Pulleys	Section 3 Three Pulleys	Section 4 Four Pulleys
1. Distance (meters) a. Resistance Distance D_R	0.100	0.100	0.100	0.100
b. Effort Distance D_E	0.1012	0.1991	0.3102	0.3893
2. Force (Newton's) a. Resistance R				
b. Effort E				
3. Work Input (Joules) $W_I = E \times D_E$				
4. Work Output (Joules) $W_O = R \times D_R$				
5. % EFFICIENCY $\%E = (W_O / W_I) \times 100$				

Average % Efficiency for All Pulleys = _____

Is this answer realistic? Explain.

1. Describe the relationship of force and distance for work input and work output. $E \times D_E = R \times D_R$ _____
2. Explain why W_O and W_I not the same for pulleys. _____
3. How could one obtain an efficiency of greater than 100%. _____
4. How does the mechanical advantage compare to the change in effort? _____

Inclined Plane



	Trial 1	Trial 2	Trial 3
Support Rod Placement	1	3	5
1. Distance (meters) a. Resistance Distance D_R			
b. Effort Placement (notch on inclined plane)	2	2	2
b. Effort Distance D_E			
2. Force (Newton's) a. Resistance R			
b. Effort E			
3. Work Input (Joules) $W_I = E \times D_E$			
4. Work Output (Joules) $W_O = R \times D_R$			
5. % EFFICIENCY $\%E = (W_O / W_I) \times 100$			

Average % Efficiency for Inclined Planes = _____

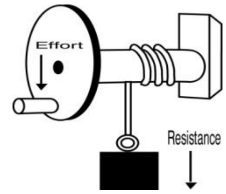
1. Describe the relationship of force and distance for work input and work output. $E \times D_E = R \times D_R$ _____

2. Explain why W_O and W_I are not the same for inclined planes. _____

3. How could one obtain an efficiency of greater than 100%? Is it possible? _____

4. How does the mechanical advantage compare to the change in effort? _____

Wheel and Axle



	Trial 1	Trial 2	Trial 3
1. Distance (meters) a. Resistance Placement (Axle)	0.045	0.045	0.045
b. Resistance Distance D_R			
c. Effort Placement (Wheel)	0.045	0.090	0.135
d. Effort Distance(1 rotation $2\pi r$) D_E	0.283	0.565	0.848
2. Force (Newton's) a. Resistance R			
b. Effort E			
3. Work Input (Joules) $W_I = E \times D_E$			
4. Work Output (Joules) $W_O = R \times D_R$			
5. % EFFICIENCY $\%E = (W_O / W_I) \times 100$			

Average % Efficiency for Wheel and Axle = _____

1. Describe the relationship of force and distance for work input and work output. $E \times D_E = R \times D_R$ _____

2. Explain why W_O and W_I are not the same for wheel and axles. _____

3. How could one obtain an efficiency greater than 100%? Is it possible? _____

4. How does the mechanical advantage compare to the change in effort? _____

5. Compare the efficiencies of all the machines studied. _____

6. Which simple machine would you use to move your refrigerator? . _____
   Describe how you would move your refrigerator onto your truck. _____