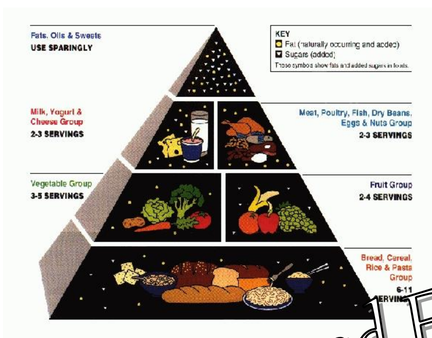
Physical Science
Unit 10: Energy

Potential Energy



Stored Energy

Kinetic Energy

Energy of Motion

ENERGY Reading Guide

Directions: Read pages 443-448 in your textbook to complete the following questions:

1. What is energy?

2. What are the two main types of energy?

3. What is kinetic energy? What are the 2 factors that affect kinetic energy?

4. What is the equation for finding kinetic energy?

5. What is potential energy? What is potential energy related to?

6. What is the equation for potential energy?

7. What is mechanical energy?

8. How do we find the mechanical energy of an object?

ENERGY Reading Guide (Part 2)

Directions: Read pages 458-459 in your textbook to complete the following questions:

1. What does the Law of Conservation of Energy tell us?

2. If energy cannot be created or destroyed, where does it go?

3. Give one example of an energy transformation that is described in your textbook.

4. What other scientific concept that we have discussed in class can be conserved?

5. How are energy and your answer to #4 related?

Information: What is Energy?

Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work. People have learned how to change energy from one form to another so that we can do work more easily and live more comfortably.

In general, energy is defined as the ability to do work. Anything that has energy can apply a force on an object. If that object moves, then work was done. The more energy an object has, the more work it can do. Like work, energy is also measured in Joules (J).

Energy is found in different forms, such as light, heat, sound and motion. There are many forms of energy, but they can all be put into two categories: kinetic and potential.

Critical Thinking Questions:

1. Define energy.

   ____

2. How are energy and work related?

   ____

   ____

3. What units is energy measured in?

   ____

4. What are the two categories or forms of energy?

   ____

   ____

Teacher's Initials

Information: Conservation of Energy

Many of us have heard the word conservation, and usually we hear it in relation to saving or protecting something on Earth – "Water Conservation" or "Wildlife Conservation". But, to scientists, conservation of energy is not saving energy. The law of **conservation of energy** says that energy is neither created nor destroyed. When we use energy, it doesn't disappear. We change it from one form of energy into another. Energy changes form so that no energy is made or lost. Below, are some examples of how energy changes form.

<u>Energy is conserved.</u> When you drop a ball, the potential energy is changed into kinetic energy. When the ball bounces to a lower and lower height, it is not losing energy. As the falling balls rubs against the air, some of the kinetic energy is changed into heat. Some energy changes into sound when the ball hits the floor. Because some energy becomes unusable when it changes from one form to another, the ball will never have enough energy to bounce back to its starting height. In any conversion of energy, some of the energy becomes unavailable for future use. <u>Energy can be neither created nor destroyed, but it can be converted from one form to another and it can be transferred from one object to another. You can't ever get as much energy out of transformation as you out into it.</u>

Example #1: A car engine burns gasoline, converting the chemical energy in gasoline into mechanical energy that powers your car to move.

Example #2: Solar cells change radiant energy into electrical energy.

Energy changes form, but the total amount of energy in the universe stays the same.

Critical Thinking Questions:

1. What is the Law of Conservation of Energy? ____

   ____

2. Energy is always __________________________. It is never ________________________ or __________________________.

3. Just before you drop a ball from the ceiling, what form of energy does it have?

   ____

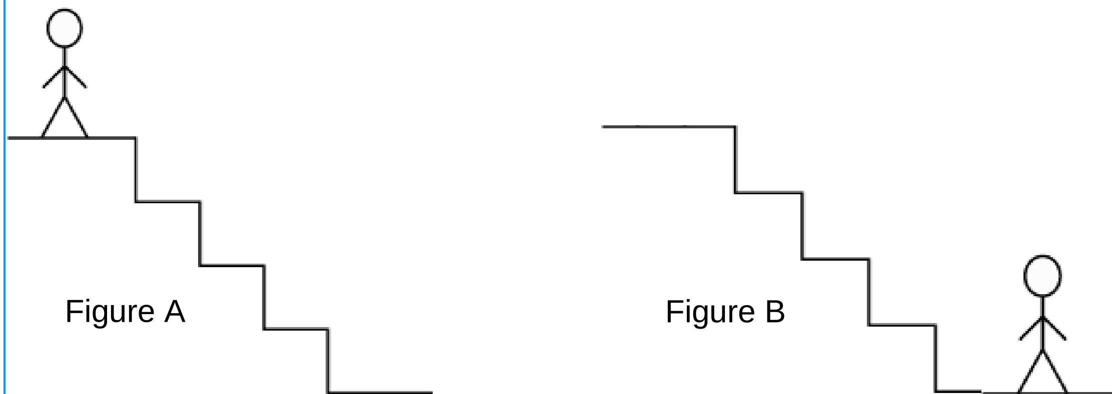
4. As it falls it is losing PE. According to the Law of Conservation of Energy, what happens to that "lost" PE? ____

   ____

Teacher's Initials

Information: What is Potential Energy?

Potential energy is stored energy and the energy of **position**. Potential energy exists whenever an object (which has mass) has a position that is different from the resting position. One example of this is the position of objects above the earth's surface. The **resting position** of any object is its natural state or position. For any object on Earth, the resting position is on the surface of Earth or on the ground. Look at the diagram below:



In Figure A, the person is at the top of the stairs, and is above the normal resting position for Earth's surface. In figure B, the person is standing on the ground, and is in the normal resting position for Earth's surface. The higher an object is above the ground, the more potential energy that object has. This is because the height above the ground is proportional to the amount of work gravity can do on an object. The more work done, the more energy used.

Potential energy can also be stored in objects moved out of their resting positions like a rubber band or a spring.

The potential energy of an object can be calculated by the relation:

$$PE = mgh$$

- PE = Potential (stored) Energy (in Joules)
- m = mass (in kilograms)
- g = gravitational acceleration of the earth (9.8 m/sec^2)
- h = height above earth's surface (in meters)

Critical Thinking Questions:

1. Define Potential Energy.

---

2. What is resting position?

---

3. Which Figure above shows a person with a greater amount of potential energy?

4. The __________________ an object is above the ground, the ______________ potential energy that object has.
5. What kind of relationship do height and Potential Energy have?

6. Give two examples of potential energy.

7. What 3 things does potential energy depend on?

8. Write the equation for PE (potential energy).

Teacher's Initials

Potential Energy Problems

Directions: Use your knowledge of potential energy to answer the following problems. Make sure to show all work and include all units.

1) What is the potential energy of a 15 kg Road Runner standing on the edge of a cliff that is 56 m high?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

2) What is the potential energy of a 40 kg coyote suspended in the air near the edge of a cliff 56 m high?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

3) What is the mass of a pic-a-nic basket if a smarter than average bear "lifts" it 2 m and gives the basket 46 J of potential energy?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

4) A very strong mouse is flying 6 meters in the air saying, "Here I come to save the day!" He has a potential energy of 12 J. What is his mass?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

5. How high in the air is a dog with a mass of 2.5 kg if he has 350 J of potential energy while saving little Timmy?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

6. What is the potential energy of a hippo and a monkey if they are ballooning 64 m off the ground and they have a combined mass of 204 kg?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

7. A piece of clay is pushed out of a window 12 m high. If the clay has a mass of 0.2 kg, what is its potential energy before it falls out of the window?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

8. George is hiding in the jungle from his friend. If he is 6 m up in a tree and has a potential energy of 4800 J, what is his mass?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

9. Mr. Youngbauer's turtle, Belle, finds herself on the ledge outside the window of a building. How high in the air is she if she has a mass 20 kg and a potential energy of 35,000 J?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

10. Oscar leaps 3 meters in the air to catch a frisbee. If he weighs 150 N, how much potential energy does he have at the top of his jump?

Givens		Solving For
Equation	Substitution	Answer with Units

Givens		Solving For
Equation	Substitution	Answer with Units

11. Bobby has a mass of 5kg and climbs to the top of a jungle gym with the help of Mr. Litchfield. How much potential energy does Trenton have if the jungle gym is 1.75 meters high?

Givens		Solving For
Equation	Substitution	Answer with Units

12. If Bobby, Mr. Litchfield, and the jungle gym are transported to the moon, how much potential energy does Trenton have on top of the jungle gym? Gravity on the moon is 1.63 m/s^2.

Givens		Solving For
Equation	Substitution	Answer with Units

13. Mr. Youngbauer's turtle, Belle, finds herself on the ledge outside the window of a building. How high in the air is she if she has a mass 20 kg and a potential energy of 35,000 J?

Givens		Solving For
Equation	Substitution	Answer with Units

Bounce! Lab

Be very careful with the balls. Do not throw them DROP the balls as instructed in the procedure.

Background Information: Energy causes things to happen. Energy is defined as the ability to do work or cause change in the speed, direction, shape, or temperature of an object. Work is done when a force causes an object to move. There is a very close relationship between work and energy. Both work and energy are measured in Joules.

Energy can be divided into two main types:

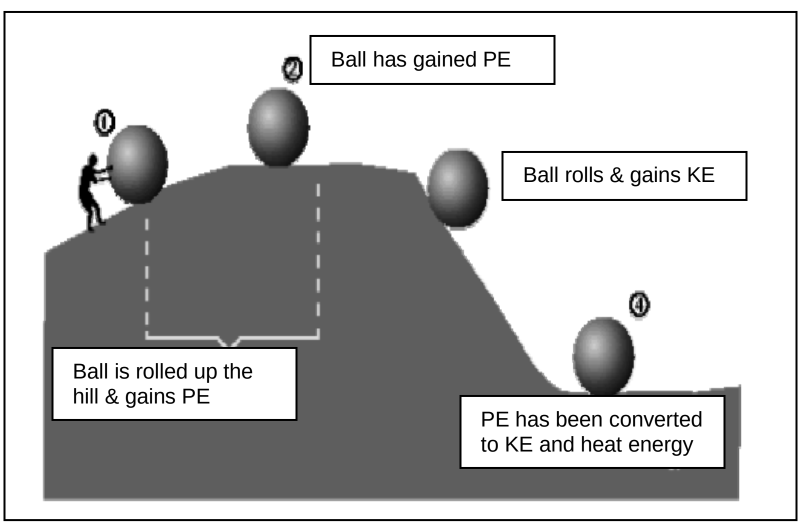
<u>Potential Energy</u> – energy that is stored (energy of position or height).

- Gravitational potential energy is the energy stored in an object as the result of its height. The higher the object is, the greater its potential energy.
- There is a relationship between the mass of an object and its gravitational potential energy. The more massive an object, the greater it potential energy.

<u>Kinetic Energy</u> – energy that is moving (energy of motion).

- A rubber band flying through the air has kinetic energy, a falling ball has kinetic energy, and you have kinetic energy as you are walking to class.
- Kinetic energy is related to both mass and speed. The greater the mass or speed of an object, the greater the kinetic energy.

Potential energy is converted into Kinetic energy.



For example – A waterfall has both potential and kinetic energy. The water at the top of the waterfall has potential energy. When the water begins to fall, its potential energy is changed into kinetic energy. This change in energy happens at Niagara Falls where it is used to provide electricity. The energy from the moving water is transformed into mechanical and electromagnetic energy and used to power parts of the northeastern United States.

Pre-lab Questions:

1. What is energy?

___

2. What is potential energy?

___

3. According to the background information, what is kinetic energy?

___

4. Give an example of potential energy in nature.

___

5. Give an example of kinetic energy in nature.

___

6. Explain how the water at Niagara Falls provides energy to people.

___

___

7. Energy cannot be ____________________ or ______________________, but it can be _______________________ from one form to another and it can be transferred from one object to another.

Teacher's Initials

Problem: What factors affect the energy of an object?

Hypothesis: As you increase the drop height of the ball, what will happen to the rebound height? ____

Materials:

- Small rubber ball
- Tennis ball
- Meter Stick

Procedure: *Check off the procedure steps as you complete them.*

1. _____Hold the meter stick straight up, into the air, on top of the lab bench. Make sure the "zero" end is on the table.
2. _____Partner A holds the tennis ball at the 33 cm mark, so that the bottom of the ball is lined up with 33 cm.
3. _____ Drop the tennis ball **WHILE (at the same time)** Partner B crouches down to observe the height of the first bounce.
4. _____Record the height of the first bounce in data table 1.
5. _____Repeat steps 1-4 for a total of 5 trials.
6. _____Hold the tennis ball at the 66 cm mark and repeat steps 1-5.
7. _____Hold the tennis ball at the 100cm (1 meter) mark and repeat steps 1-5.

Table 1: Rebound/Bounce Height vs. Drop Height for a Tennis Ball

	Rebound/Bounce Height (m)					
Drop Height	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Rebound Height
0.33 m						
0.66 m						
1 m						

8. _____ Repeat steps 1-7 for a ping pong ball and record this data in data table 2.

Table 2: Rebound/Bounce Height vs. Drop Height for a Ping Pong Ball

Drop Height	***Rebound/Bounce Height (m)***					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Rebound Height
0.33 m						
0.66 m						
1 m						

9. ______ Find the mass of the tennis ball and the ping pong ball using a balance. Convert the mass into kilograms and then find the force weight of the ball.

Tennis Ball _____________ grams _____________ kg _____________ N

Ping Pong Ball _____________ grams _____________ kg _____________ N

---

10. _____ Trade your tennis ball and ping pong ball for a cold tennis ball.
11. _____ Repeat steps 1-7 for a cold tennis ball and record this data in data table 3.

Table 3: Rebound/Bounce Height vs. Drop Height for a Cold Tennis Ball

Drop Height	***Rebound/Bounce Height (m)***					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Rebound Height
0.33 m						
0.66 m						
1 m						

12. _____ Find the mass of the tennis ball and the ping pong ball using a balance. Convert the mass into kilograms and then find the force weight of the ball.

Cold Tennis Ball _____________ grams _____________ kg _____________ N

Analysis:

1. Make one line graph of the average rebound/bounce height vs. the drop height for the tennis ball, ping pong ball, and cold tennis ball. You will have one graph with three different lines.

   Title: ____

1. What pattern or relationships do you see in the data? (ex: As the drop height increased…)

___

___

2. When is work being done in this lab?

___

3. When did each ball have the most potential energy in this lab? Explain.

___

4. How were you able to increase the amount of potential energy each ball had?

___

5. Explain another way to increase the amount of potential energy in an object.

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6. How was potential energy of the ball changed to kinetic energy in this lab?

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7. How was kinetic energy of the ball changed back into potential energy in this lab?

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8. Not all of the potential energy was converted into kinetic energy. Where did this energy go?

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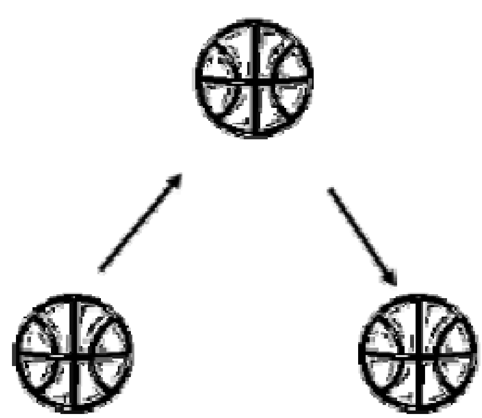
9. Complete the following chart for each ball.

	Tennis Ball	Ping Pong Ball	Cold Tennis Ball
PE at h = 0.33 m			
PE at h = 0.66 m			
PE at h = 1.0 m			

10. A basketball player bounces a ball into the air.
    Label where the ball has
    a. greatest potential energy
    b. greatest kinetic energy
    c. the two areas of energy conversion
        i. kinetic energy → potential energy
        ii. potential energy → kinetic energy).



More PE Problems

Directions: Use your knowledge of potential energy to answer the following problems. Make sure to show all work and include all units.

1) What is the potential energy of a 20 kg Wylie Coyote standing on the edge of a cliff that is 56 m high?

Givens		Solving For
Equation	Substitution	Answer with Units

2) What is the potential energy of a 20 N coyote suspended in the air near the edge of a cliff 56 m high?

Givens		Solving For
Equation	Substitution	Answer with Units

3) Rambo jumps straight up in the air at a speed of 6m/s. It takes him 2 seconds to reach the top of his jump. At the top of his jump he yells, "Come and get me!" and has a potential energy of 367 J. What is his mass?

Givens		Solving For
Equation	Substitution	Answer with Units

Givens		Solving For
Equation	Substitution	Answer with Units

Information: What is Kinetic Energy?

Kinetic energy is motion—of waves, electrons, atoms, molecules, substances, and objects.

Kinetic Energy exists whenever an object (which has mass) is in motion with some measurable speed. The faster the speed of an object, the more kinetic energy the object has. Everything you see moving about has kinetic energy.

The kinetic energy of an object can be calculated by the relation:

$KE = (1/2)mv^2$

- KE = Kinetic Energy (in Joules)
- m = mass (in kilograms)
- v = velocity or speed (in meters/sec)

Critical Thinking Questions:

1. Define Kinetic Energy.

____

____

2. The ____________________ speed an object has, the ________________ kinetic energy that object has.
3. What kind of relationship do speed and Kinetic Energy have?

____

4. Give two examples of kinetic energy.

____

____

5. What two things does kinetic energy depend on?

____

____

6. Write the equation for KE (kinetic energy).

Teacher's Initials

Kinetic Energy Problems

Directions: Use your knowledge of kinetic energy to answer the following problems. Make sure to show all work and include all units.

1. Rambo zips by the bad guys in his car the "Thunderbolt" at 40 m/s. He says the car has a mass of 2000 kg. What is the kinetic energy?

Givens		Solving For
Equation	Substitution	Answer with Units

2. George drops into Mr. Spacely's office at 6 m/s. If he has a mass of 50 kg, what is his kinetic energy?

Givens		Solving For
Equation	Substitution	Answer with Units

3. El Kabong swings down a rope to save his side-kick Baba Looey. If he has a kinetic energy of 4000 J and a mass of 20 kg then what is his velocity (speed)?

Givens		Solving For
Equation	Substitution	Answer with Units

4. If Bugs Bunny has a kinetic energy of 1000 J and is moving at a speed 12 m/s then what is the mass of Bugs Bunny?

Givens		Solving For
Equation	Substitution	Answer with Units

5. If Marty the Martian was flying in his spacecraft around Earth at 25 m/s and the total weight of the spacecraft is 300 N, then what is the kinetic energy? (HINT: WATCH YOUR UNITS!!!)

Givens		Solving For
Equation	Substitution	Answer with Units

Givens		Solving For
Equation	Substitution	Answer with Units

6. What is the velocity of Mr. Z if he has 1128J of KE while running from Rambo, if his mass is 65kg?

Givens		Solving For
Equation	Substitution	Answer with Units

7. Trenton crawls a distance of 3 m in 2 seconds. What is his kinetic energy if he *weighs* 150N?

Givens		Solving For
Equation	Substitution	Answer with Units

Givens		Solving For
Equation	Substitution	Answer with Units

8. A bird is flying at a speed of 10 m/s and is 20 m up in the air. If the bird has a mass of 8 kg.
    a. What is its potential energy?

Givens		Solving For
Equation	Substitution	Answer with Units

    b. What is its kinetic energy?

Givens		Solving For
Equation	Substitution	Answer with Units

9. A 2000 kg car is cruising along the road with a velocity of 30 m/s.
    c. What is the kinetic energy of the car?

Givens		Solving For
Equation	Substitution	Answer with Units

    d. What is the potential energy of the car?

Givens		Solving For
Equation	Substitution	Answer with Units

Energy Internet Exploration

Objectives:

- Explain the Conservation of Mechanical Energy concept using kinetic and gravitational potential energy.
- Design a skate park using the concept of Mechanical energy

Part A Directions: check off each step as you complete them.

1. _____Type in the following web page:

   https://phet.colorado.edu/en/simulation/legacy/energy-skate-park-basics
2. _____On the left side of the page, click on "Work, Energy & Power".
3. _____Find the "Energy Skate Park" simulation and click on it.
4. _____Click the "Play" button. (you will need to ensure it that it is ok to open it)
5. _____Resize the windows by dragging the edges.
6. _____Click on the "Track Playground" tab at the top of the screen.
7. _____Play with the simulation for a few minutes:
   a. _____adding track
   b. _____moving track
   c. _____resetting the skater when he falls off the track
   d. _____resetting the track

Questions:

1. _____Click on the "Friction" tab at the top of the screen.
2. _____Turn on "Track Friction". Move the arrow over towards "None".
3. _____Turn on the Grid. Notice that the grid measures in meters.
4. _____Place the skater at the top of the right side of the track.
5. _____ Use the "pause" button and the grid to help with the next few questions.
   a) Does the skater hit the same height on the opposite sides of the track? ______
   b) At the top of the track, what is the skater's potential energy if his mass is 70 kg? __________________
   c) At the bottom of the track, what is the skater's potential energy if his mass is 70 kg? __________________
   d) What is the skater's kinetic energy at the bottom of the track? _______________
   e) Can you figure out where the simulation has set the skater's potential energy as zero?

6. _____Go to the "Track Playground" tab. Build a good track (one where the skater doesn't biff) and sketch it on your paper. Have your teacher check your track and settings.

Teacher's Initials

7. _____Turn on the energy Pie Chart and Bar Graph. (You may need to move things around a little to see everything.)
   a) On both graphs, what color represents…
      i. potential energy?________________________________
      ii. kinetic energy? ________________________________
      iii. total energy? ________________________________
   b) Describe how the bar graph changes as the skater moves along the track (i.e. what happens when the skater is high on the track? Low on the track?).

   ____

   ____

   c) Explain which visual aid (the pie graph or bar graph) helps ***you*** understand conservation of energy better, and why.

   ____

   ____

   ____

   ____

Part B:

1. _____Open the following website: https://phet.colorado.edu/en/simulation/legacy/energy-skate-park
2. _____Build a track that looks very similar to what you sketched for question #6 above
3. _____Turn on the grid, click on "track friction>>" and move the arrow over one bar
4. _____Open the type graph that you decided was most helpful
5. _____Place the skater on your track, and make sure he is on "Location" **Earth**.

6. _____As the skater rides the track, record your observations:
   a) gravity = ________________
   b) describe the motion of the skater

7. _____ Keeping the same track, take the skater to the moon, by clicking the "Location" **moon**.
8. _____As the skater rides the track, record your observations:
   a) gravity = ________________
   b) describe the motion of the skater

9. _____ Keeping the same track, take the skater into space, by clicking the "Location" **space**.
10. _____As the skater rides the track, record your observations:
    a) gravity = ________________
    b) describe the motion of the skater

11. _____ Keeping the same track, take the skater to Jupiter, by clicking the "Location" **Jupiter**.
12. _____As the skater rides the track, record your observations:
    a) gravity = ________________
    b) describe the motion of the skater

13. Analysis Questions:

1. How is potential energy affected by changing gravities?

2. How is kinetic energy affected by changing gravities?

3. Did the total energy of the skater ever change when in the same "Location"?

Just for fun (IF YOU FINISH EARLY!!)

1. See if you can have the skater do two loops. Draw your track.

2. See if you can have the skater go airborne, but land on another track. Draw your track.

3. See if you can have the skater say cow-a-bunga. Draw your track.

Information: Converting Forms of Energy

There are several forms of potential energy. There are also several forms of kinetic energy. Because energy cannot be created or destroyed, energy changes form.

One simple example is a rock at the top of a hill.

1. The rock starts will 100% potential energy.
2. As the rock starts to roll downhill the potential energy decreases as it is **converted** into kinetic energy.
3. As the rock rolls downhill the friction between the rock and the ground **converts** some of the potential & kinetic energy into heat (thermal) energy.
4. When the rock reaches the bottom of the hill, all of the potential energy has been **converted** into kinetic energy.
5. The rock rolls along the ground until friction between the rock and the ground **converts** all of the kinetic energy into heat (thermal) energy.

Forms of Potential Energy

Gravitational Energy is the energy of position or place. A rock resting at the top of a hill contains gravitational potential energy. Hydropower, such as water in a reservoir behind a dam, is an example of gravitational potential energy.

Chemical Energy is energy stored in the bonds of atoms and molecules. It is the energy that holds these particles together. Biomass (anything alive that has mass), petroleum, natural gas, and propane are examples of stored chemical energy.

Stored Mechanical Energy is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of stored mechanical energy.

Nuclear Energy is energy stored in the nucleus of an atom—the energy that holds the nucleus together. The energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called fission. The sun combines the nuclei of hydrogen atoms in a process called fusion.

Forms of Kinetic Energy

Electrical Energy is the movement of electrical charges. Everything is made of tiny particles called atoms. Atoms are made of even smaller particles called electrons, protons, and neutrons. Electrical charges moving through a wire is called electricity. Lightning is another example of electrical energy.

Radiant Energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Light is one type of radiant energy. Solar energy is an example of radiant energy.

Thermal Energy, or heat, is the internal energy in substances—Geothermal energy is an example of thermal energy.

Motion Energy is the movement of objects and substances from one place to another. Objects and substances move when a force is applied according to Newton's Laws of Motion. Wind is an example of motion energy.

Sound is the movement of energy through substances in longitudinal (compression/rarefaction) waves.

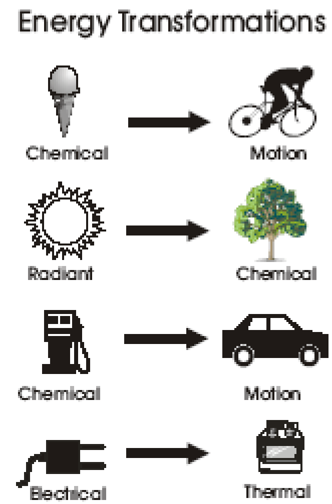
Critical Thinking Questions:

1. In simple terms, what does the Law of Conservation of Energy say about energy?

____

____

2. Look at the "Energy Transformations" graphic on the right. For each of the four examples write the starting form of energy (potential or kinetic) and the ending form of energy (potential or kinetic) based upon the information in the reading on the previous page. Ex: potential → potential



____

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____

____

3. Is energy ever created or lost? ________________

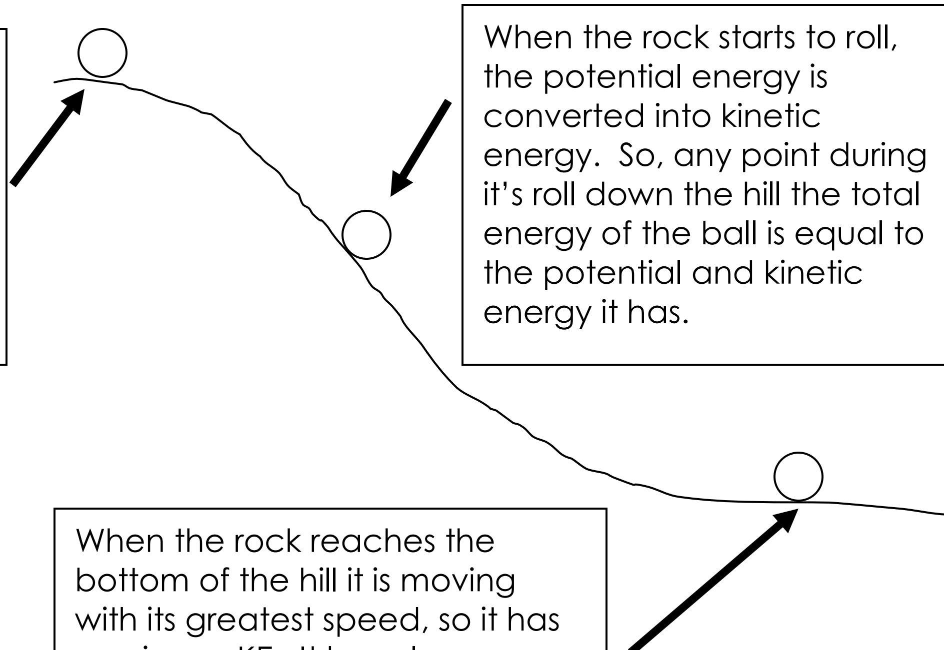
Teacher's Initials

Information: Total Energy

You just learned about the Law of Conservation of Energy: energy is not created or destroyed. Because of this law of nature we can describe the total energy an object has as a combination of the object's potential energy and the object's kinetic energy. Since all forms of energy fall under one of these two categories, we can make it that simple. The total energy of an object can be calculated by adding the object's PE and KE.

Let's take a look at the example of a rock rolling down a hill again.

When the rock is at the top of the hill it is not moving so it has 0% KE. Therefore, all the energy it has is in the form of potential energy. So, the total energy of the rock is equal to the potential energy it has.



When the rock starts to roll, the potential energy is converted into kinetic energy. So, any point during it's roll down the hill the total energy of the ball is equal to the potential and kinetic energy it has.

When the rock reaches the bottom of the hill it is moving with its greatest speed, so it has maximum KE. It has also reached the resting position of all objects on Earth so it has no more PE. Therefore, the total energy of the rock is the kinetic energy it has.

Critical Thinking Questions:

1. At the top of the hill, what is the total energy of the rock equal to?

____

2. During it's roll downhill, what is the total energy of the rock equal to?

____

3. At the bottom of the hill, what is the total energy of the rock equal to?

____

4. What is the equation for total energy?

____

5. When does the rock have the greatest PE? ____________________________

6. When does the rock have the least KE? ____

7. When does the rock have the least PE? ____

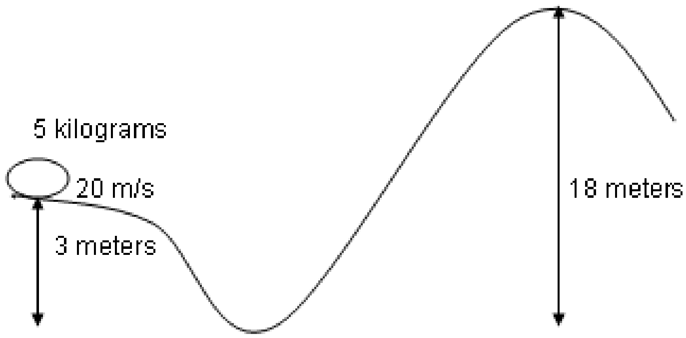
8. When does the rock have the greatest KE? ____

9. When does the rock have equal amounts of KE and PE? ___________________________

Teacher's Initials

Total Energy Problems

Directions: Use your knowledge of kinetic and potential energy to answer the following problems. Make sure to show all work and include all units.



1. Calculate the potential energy at the start of this rollercoaster.

Givens		Solving For
Equation	Substitution	Answer with Units

2. Calculate the kinetic energy at the start of this problem.

Givens		Solving For
Equation	Substitution	Answer with Units

3. What is the total energy?

4. What is the potential energy at the top of the second hill (18 m)?

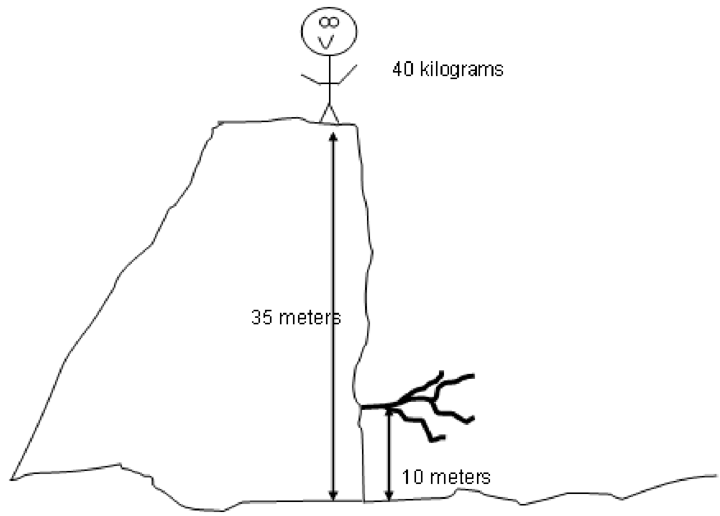
Givens		Solving For
Equation	Substitution	Answer with Units

5. What is the kinetic energy at the top of the second hill? (KE = Total – PE)

6. What is the speed at the top of the second hill?

Givens		Solving For
Equation	Substitution	Answer with Units

Total Energy Continued



If this person that has no starting speed at the top of this cliff falls off but catches himself on a branch that is 10 m off the ground, what speed would this person be going when they catch the branch?

1. Calculate the potential energy at the start of the problem.

Givens		Solving For
Equation	Substitution	Answer with Units

2. Calculate the kinetic energy at the start of the problem.

Givens		Solving For
Equation	Substitution	Answer with Units

3. Calculate the total energy.

4. How much potential energy does the person have when they are on the branch?

Givens		Solving For
Equation	Substitution	Answer with Units

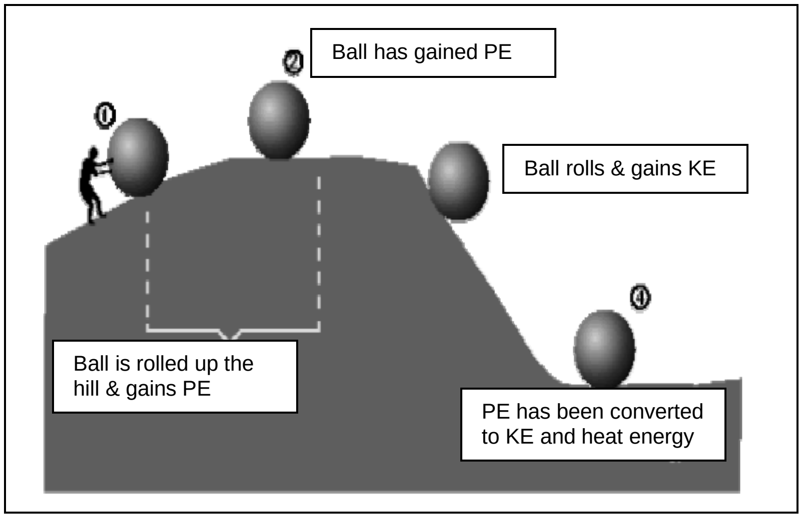
5. How much kinetic energy does this person have when they get to the branch? (Hint: Think about what you already know…you do not need to use the KE equation)

6. Finally, what speed is this person going?

<table>
<tr><td colspan="2">Givens</td><td colspan="2">Solving For</td></tr>
<tr><td>Equation</td><td colspan="2">Substitution</td><td>Answer with Units</td></tr>
</table>

Total Energy Continued

A ball is rolled to the top of a hill that is 20 meters high. The ball has a mass of 50 kg.



1. Calculate the potential energy at the start of the problem.

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

2. Calculate the kinetic energy at the start of the problem.

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

3. Calculate the total energy.

4. How much potential energy does the ball have when it is halfway down the hill?

Givens		Solving For
Equation	**Substitution**	**Answer with Units**

5. How much kinetic energy does the ball have when it gets halfway down the hill?

Givens		Solving For
Equation	Substitution	Answer with Units

6. Finally, what speed is this ball going?

Givens		Solving For
Equation	Substitution	Answer with Units

Energy Give One/Get One

Directions: Using your classroom as an example, list as many kinds of kinetic and potential energy as you can in column 1. Put a PE for potential or a KE for kinetic in column 2 to describe that example.

GIVE ONE		GET ONE	
Example	*PE or KE*	*Example*	*PE or KE*

Challenge Activities:

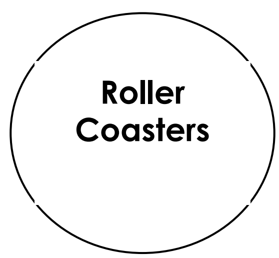
Word Mapping – How Roller Coasters Work

Directions: Write down 10 words that come to mind when you think about a roller coaster. Don't forget words you've learned in this class that apply as well!

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Directions:

1. *Working as a team, group the words into 2-3 categories that pertain to roller coasters to create a word map.*
2. *Bring up this page, show the teacher and receive the article to read on roller coasters.*



Energy Conversions

Directions: Use what you have learned about energy and energy conversions to answer the questions or situations below.

1. The controller of a remote control car contains a 9 volt battery and the car contains 2 D batteries. The controller and the car both have an on/off switchs and both have antennas on them. The controller has a joy stick which can make the car move. Explain how this car works and indicate the types of energy used or converted.

2. I'm hungry for a steak after a long day at school. I have a gas BBQ grill. Explain how energy is used and/or converted when I cook my steak.

3. I just bought a new car. It has On Star in it, which can alert someone in an emergency. It has satellite radio in it. It even has a button on my keys to start the car from a distance. It also has the usual like heat, air conditioning, and power windows. List the types of energy this car uses with examples of the parts the car using that energy.

4. State the law of conservation of energy.

5. Use the following choices to match the type of energy each example provides:

C=chemical *N=nuclear* *E=electrical* *T=thermal*

M=mechanical *EM = electromagnetic*

____ two cheeseburgers, fries, and a milkshake

____ a turbine spinning wind or water

____ an electrical wall socket

____ your remote control changing your TV channel

____ pedaling your bike

____ steam from a hot spring

____ an atomic reaction

____ a TV station emitting a signal

____ mixing vinegar and baking soda

____ pulling a string looped around a pulley to raise a mass

Use the following data to make a graph for battery charge time and time light bulb lit.

Charging Time (sec)	Light Bulb Lit (sec)
30	15
60	30
90	45
150	75
210	105

1. What is the independent variable? ____
2. What is the dependent variable? ____
3. Based on your graph, what pattern do you see about charging time and how long the bulb stays lit?

Title: ____

Student Generated Heat (Energy)

Objectives:

- Measure the energy a student can put into a small volume of water.
- Explore ways heat can be added to water.
- Explain how energy, work, and power are related to each other.

Materials:

- 1 - Test tube
- 1 – Test tube stopper
- 1 – Thermometer
- 1 – 50 mL graduated cylinder

Procedure: Check off the steps of the procedure as you complete them.

1. _____Measure 20 mL of water and pour the water into the test tube. Record the volume of water you used in Data Table 1.

2. _____Measure the initial temperature of the water: Let the thermometer rest in the test tube for three minutes.

3. _____Measure the mass of the water (1mL of water= 1g). Record the temperature in Data Table 1.

4. _____Design a procedure to heat the water in the test tube using ONLY your body heat.

____

____

____

____

5. _____Follow the procedure above for FIVE minutes, to heat the water as much as possible.

6. _____After five minutes, measure the final temperature of the water, and record this value in Data Table 1.

7. _____Repeat your procedure two more times and calculate the average values.

Date Table 1: Student Generated Heat (Energy)

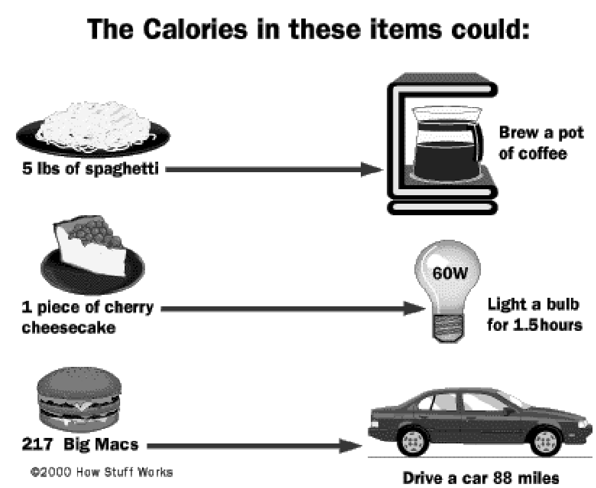
	Volume of Water (mL)	Mass of Water (g)	Initial Temperature (°C)	Final Temperature (°C)	Heat Gained (°C)
Trial 1					XXXXXXX
Trial 2					XXXXXXX
Trial 3					XXXXXXX
Average Values					

Calculations and Application:

1. _____ Calculate the **average** heat gained. (Note: Use the average values) Record the average heat gained in Data Table 1 and Data Table 2.

Heat gained (ΔH) = Final Temperature (T_f) – Initial Temperature (T_i)

Information Application #1: We have all heard of calories. Most often we hear about them while talking about food. A calorie is actually a unit for measuring energy. People count calories and try to cut calories from their diet. But what is a calorie?



"A calorie is a unit of energy. We tend to associate calories with food, but they apply to *anything* containing energy. For example, a gallon of gasoline contains about 31,000,000 calories.

One calorie is equal to 4.184 joules, a common unit of energy used in the physical sciences." © 1998-2007 HowStuffWorks, Inc.

You can calculate how much energy (calories) you put into the test tube using the following equation:

Energy (calories) = (change in °C)(grams of water in test tube)

OR

E = (Δ°C)(grams water)

2. _____Calculate the average amount of calories you used to heat the water. Record this value in Data Table 2.

Information Application #2: As stated above, a more common unit for measuring energy is joules (J). A joule is equal to force (Newtons) multiplied by distance (meters). 1 J = 1N*m. This is also the measurement for work, which makes sense because energy is defined as the ability to do work.

Power companies also use joules (J) when determining how much to charge you for the energy you use.

3. _____Convert the calories you used into joules (J). (Hint: **One calorie is equal to 4.184 joules**) Record the average number of joules (J) in Data Table 2.

Information Application #3: The power companies determine what to charge you based on how much POWER you use. Power is measured in watts (W). You may have heard this word in association with light bulbs. For example, Mrs. Young has numerous light bulbs in her house, such as 60 watt, 75 watt and 100 watt. The number of watts indicates how bright a light bulb will be. The more watts the light bulb uses (100 watts), the brighter it will be.

Power is a measure of how much energy you use (or work you do) and how much time you use the energy. One watt of power is equal to 1 joule of energy per one second of time (1 W = 1 J/s).

With the information above, you can determine the amount of *power* you used to heat the water in the test tube.

4. _____Calculate the average amount of watts you used and record in Data Table 2.

Data Table 2: Calculations of Student Energy

	Heat Gained (°C)**	Energy Used (cal)	Energy Used (J)	Power Used (W)
Average Values				

**Copy Heat Gained values from Data Table 1.

Questions:

1. Name two units for measuring *energy*.

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2. ____________ is the most common unit for measuring energy.

3. What does the wattage of a light bulb tell you about the bulb?

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4. How many Watts of power did you use to heat the water in your test tube? ________
5. Power is a measurement of ____________________ per ____________________.
6. How are energy and work related?

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7. How are energy and power related?

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8. How does your calculated power rating compare to a light bulb? Would you be brighter or dimmer than a 40W bulb?
