Energy Conservation: Roller Coaster Lab

1. At which place (or places) on the roller coaster do you think the marble moves fastest? Why?

Position (cm)	Height (cm)	Time (@A)	Distance (cm)	Speed (cm/sec)
5			1.9	
10			1.9	
15			1.9	
20			1.9	
25			1.9	
30			1.9	
35			1.9	
40			1.9	
45			1.9	
50			1.9	
55			1.9	
60			1.9	
65			1.9	
70			1.9	
75			1.9	
80			1.9	
85			1.9	
90			1.9	
95			1.9	
100			1.9	
105			1.9	
110			1.9	
115			1.9	
120			1.9	
125			1.9	

2. Did your measurements support or reject your hypothesis? If the measurements rejected your hypothesis how would you change your hypothesis for another experiment?

3. What did you notice about the motion of the marble from the measurements?

   a. Do you think that going uphill or downhill makes a difference in speed?

   b. Does the height affect speed?

   c. Which had a larger impact, height or direction (uphill/downhill)?

4. Use graph paper (backside of this page) to create a graph of Speed vs. Position AND Height vs. Position.
   a. What can you tell from your graph? Describe the relationship you see between the speed of the marble and the height.
   b. Where is the speed of the marble the greatest?

5. Does the uphill or downhill direction matter to the speed of the marble, or is height the only contributing variable?

6. Describe the flow of energy between potential and kinetic along the roller coaster. Your answer should indicate where the potential energy is greatest and smallest AND where the kinetic energy is greatest and smallest.

Potential and Kinetic Energy

Potential Energy

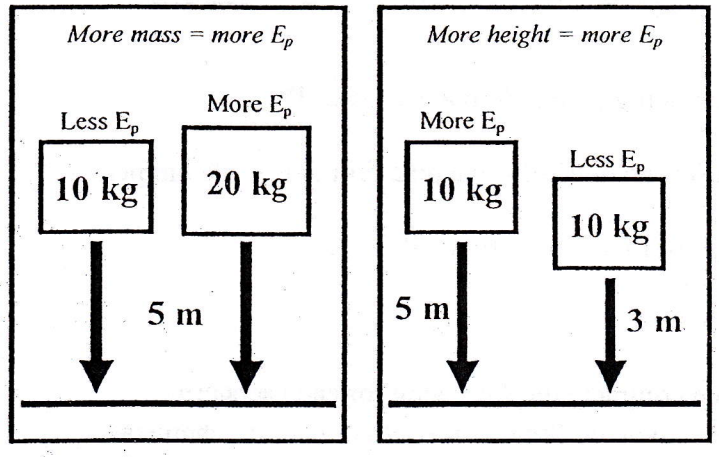
Potential Energy is energy of position.

An object gets potential energy from height, mass and gravity. An object with potential energy has the **potential to do work**. This potential is only released if the object falls. The energy is then transformed into energy of motion or transformed into work.

Potential Energy (in Joules) → $E_p = mgh$ ← mass (in kilograms), ← height (in meters), ← acceleration due to gravity (9.8 m/s^2)

Potential energy equals mass times gravity times height.

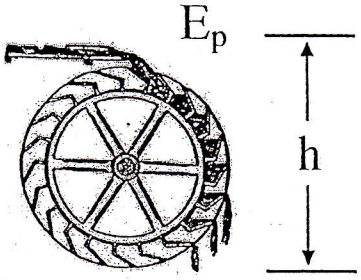
And since $F_w = mg$, then $E_p = F_w h$



Ex: How much potential energy does a 4 kg object have that is 5 meters off the ground?

m = 4 kg h = 5 m g = 10 m/s^2 E_p = ?	$E_p = mgh$ $E_p = (4\ kg)(10\ m/s^2)(5\ m)$ $= (40\ kgm/s^2)(5\ m)$ $= 200$ Joules

Potential energy helps us generate electricity in hydroelectric dams. When the water falls, gravity helps turn energy of height to electrical energy.



Kinetic Energy

Kinetic Energy is energy of motion.

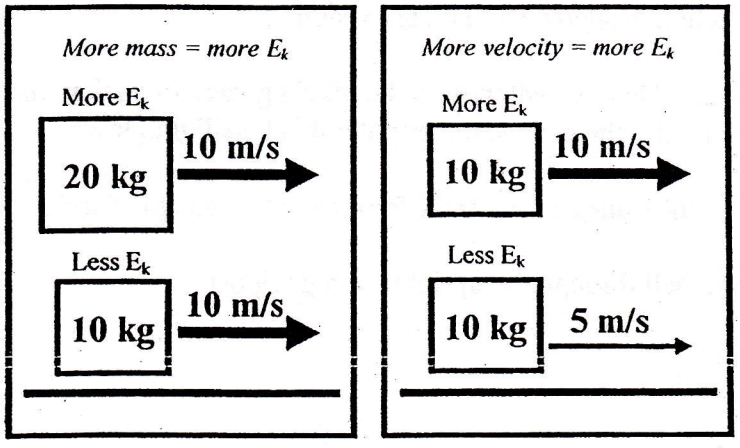
An object gets kinetic energy from its mass and velocity. An object with kinetic energy has energy stored in motion. When the object slows down the energy is released into potential energy (if going up) or some other kind of energy (like heat [thermal energy] in the brakes of car).

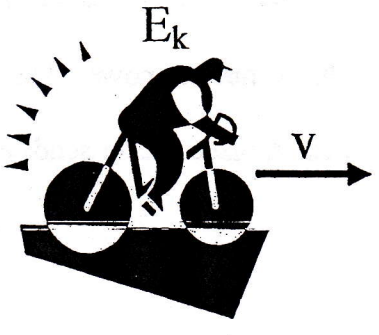
Kinetic Energy (in Joules) → $E_k = (\frac{1}{2})mv^2$ ← mass (in kilograms), ← velocity (m/s)

Kinetic energy equals one-half times mass times velocity squared.

Ex: How much kinetic energy does a 10 kg object traveling 3 m/s?

m = 10 kg v = 3 m/s E_k = ?	$E_k = \frac{1}{2}mv^2$ $E_k = \frac{1}{2}(10\ kg)(3\ m/s)^2$ $= (5\ kg)(9\ m^2/s^2)$ $= 45$ Joules





Kinetic energy helps you bike up a hill. The energy of motion helps you overcome gravity. The faster you are moving, the easier it is to get up a hill.

Potential Energy (E_p = MGH) (note this equation is for Gravitational P_E and G = 9.8 m/sec^2- potential energy is the energy of position. An object gets potential energy from height, mass, gravity, and/or position/configuration. An object with potential energy has the potential to do Work. This potential can be released/transformed into motion (kinetic energy) and/or do Work.

Kinetic Energy (E_k = ½ MV^2) - kinetic energy is the energy of motion. An object gets kinetic energy from its mass and velocity. An object with kinetic energy has energy being released as motion. When the object slows down the energy is released and stored as potential and/or transformed into another kind of energy.

1. For each of the following state whether the object has Potential or Kinetic Energy.
   a. A car traveling 45 mph _____
   b. A rock perched on a ledge 5 meters high _____
   c. A snowboarder resting at the top of a mountain _____
   d. A golf-ball driven down the fairway _____
2. For each of the following circle the object with more Gravitational Potential Energy
   a. A 25 kg mass 10 m off the ground **OR** A 30 kg mass 8 m off the ground.
   b. A 1500 kg car at the top of a hill **OR** A 1500 kg car at the bottom of the same hill.
   c. A plane on the runway **OR** A plane flying through the air.
   d. You standing on top of Bogus Basin **OR** You standing on top of Mount Everest.
3. For each of the following circle the object with more Kinetic Energy
   a. A 25 kg mass moving at 5 m/sec **OR** a 45 kg mass moving at 7 m/sec.
   b. A 10 kg mass moving at 75 m/sec **OR** A 10 kg mass moving at 45 m/sec.
   c. A car at rest **OR** a car rolling downhill.
   d. A heavy bike moving at 10 m/sec **OR** a light bike moving at 10 m/sec.

4. Calculate the Gravitational Potential Energy of a 5 kg object sitting on a 3 meter ledge.

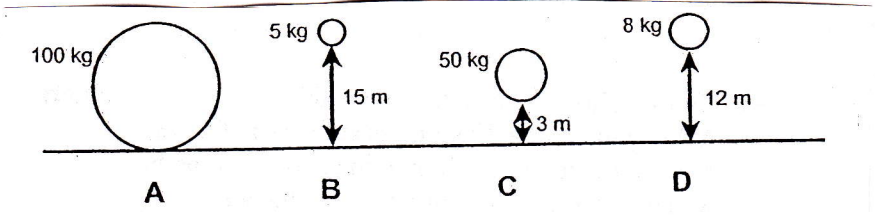
5. Calculate the Kinetic Energy of a 4 kg meteorite falling to Earth at 17,000 m/sec.

6. You serve a volley ball with a mass of 0.5 kg. The ball leaves your hand with a speed of 10 m/sec. What type of energy (Potential OR Kinetic) does this object possess? Calculate the energy.

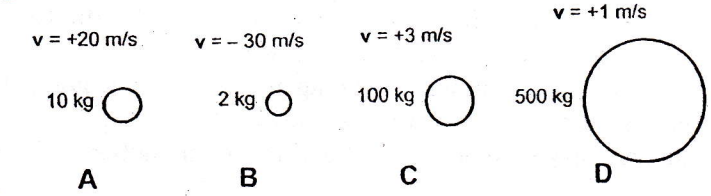
7. A skate-boarder is sitting at the top of a hill that is 200 meters tall. The skate-boarder has a mass of 75 kg. What type of energy (Potential OR Kinetic) does the skate-boarder have? Calculate the energy.

8. A car is traveling with a velocity of 40 m/sec and has a mass of 1120 kg. What type of energy (Potential OR Kinetic) does the car have? Calculate the energy.

9. Which object below has the most Gravitational Potential Energy relative to the surface? Explain your choice.



10. Which object below the most Kinetic Energy? Explain your choice.



Energy Transformation Worksheet

Identify the different types of energy transformation in each of the pictures

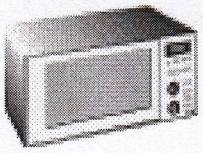
Windmill

Energy Transformation:

Flashlight

Energy Transformation:

Microwave

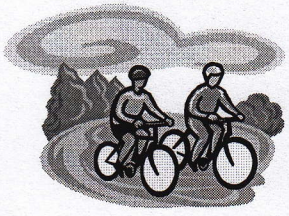


Energy Transformation:

Firecracker

Energy Transformation:

Bicycle



Energy Transformation:

Battery

Energy Transformation:

Give an example where the following energy changes would take place:

Electrical to Thermal

Chemical to Thermal

Electrical to Mechanical