Name: ____________________

Period: ____________________

The Law of Conservation of Energy

4.2

The Law of Conservation of Energy states:

"***Energy is never created nor destroyed just transformed into other forms of energy***." OR $\Sigma E_{before} = \Sigma E_{after}$

Yet if energy is added to or removed from the system the total amount of energy has changed. This can only be accomplished by external forces, which is work. If energy is added: positive work was done on the object. If energy is removed: negative work was done on the object. Therefore, work must be accounted for in our equation.

Law of Conservation of Energy

$$\Sigma E_{before} \pm W = \Sigma E_{after}$$

Solving Conservation of Energy Problems

Using Conservation of Energy, many complicated problems can be solved simply.

Example 1: A 2 kg object compresses a spring 0.5 m. If k = 72 N/m, how fast is the object going after the spring is released?

Step 1: *Identify the energies before and after.*

Step 1: $E_{before} = PE_{el}$ (*a compressed spring*)
$E_{after} = KE$ (*it is moving*)

Step 2: *Decide if energy was added (+W), removed (–W), or just transformed (W = 0).*

Step 2: No forces—energy is just transformed.
W = 0 (*no work added or removed*)

Step 3: *Put the information from steps 1 and 2 into the Conservation of Energy formula.*

Step 3: $\Sigma E_{before} \pm W = \Sigma E_{after}$
$PE_{el} + 0 = KE$

Step 4: *Put in the formulas for the different kinds of energy or for work.*

Step 4: $(\frac{1}{2})kx^2 = (\frac{1}{2})mv^2$

Step 5: *Put in all of the given information and solve.*

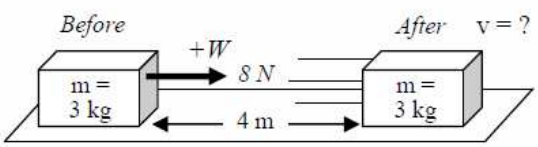
Step 5: $\frac{1}{2}72(0.5)^2 = \frac{1}{2}2(v)^2$

$36(.25) = v^2$

$9 = v^2$

$v = 3\text{m/s}$

Example 2 : A 3 kg mass at rest on the ground is pushed by an 8 N force for 4 m. How fast is the mass going afterwards?



Step 1: $E_{before} = 0$ (*at rest on the ground*)
$E_{after} = KE$ (*it is moving*)

Step 2: Energy is added: +W

Step 3: $\Sigma E_{before} \pm W = \Sigma E_{after}$
$0 + W = KE$

Step 4: $0 + Fd = (\frac{1}{2})mv^2$

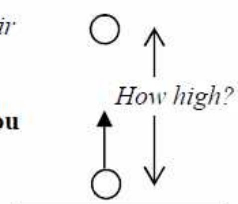
Step 5: $0 + 8(4) = \frac{1}{2}3(v)^2$

$32 = 1.5v^2$

$21.3 = v^2$

$v = 4.6\text{m/s}$

Example 3 : An object is thrown into the air going 60 m/s. How high up does it go?



NOTE: Follow the steps even though you are not given the mass of the object.

Step 1: $E_{before} = KE$ (*above the ground*)
$E_{after} = PE$ (*it is falling*)

Step 2: No work, energy is transferred, so, W = 0

Step 3: $\Sigma E_{before} \pm W = \Sigma E_{after}$
$KE + 0 = PE$

Step 4: $(\frac{1}{2})mv^2 = mgh$

Step 5: $\frac{1}{2}\cancel{m}(60)^2 = \cancel{m}(10)h$

m's cancel

$\frac{1}{2}(3600) = (10)h$

$1800 = 10h$

$h = 180\text{ m}$

NOTE: Often you don't need the mass. It may cancel.

1. PE, KE, PEel, W, or No Energy?

_____Compressing a spring

_____Friction acting on an object.

_____An object at rest on the ground.

_____Pushing an object.

_____An object above the ground.

_____An object moving.

_____A compressed spring.

_____An object as it is falling.

2. Is Energy Added (+W), Removed (-W), or Transferred (T)

_____ Slowing down an object.

_____ Lifting an object into the air.

_____ Lowering an object to the ground slowly.

_____ An object falling.

_____Speeding up an object.

_____A moving object compressing a spring.

_____A force compressing a spring.

_____An object slides up a frictionless ramp.

3. For each of the following, develop the Conservation of Energy Equation

A. A moving object speeds up.

E_{before} = *KE* Work? = *+W* E_{after} = *KE*

Conservation of Energy Equation: *KE + W = KE*

B. An object is dropped. There is air friction.

E_{before} = _____ Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

C. A moving object compresses a spring.

E_{before} = _____Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

D. An object is thrown up, going 2 m/s. How high does it go?

E_{before} = _____Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

E. A relaxed spring is compressed.

E_{before} = _____Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

F. A spring causes an object to move.

E_{before} = _____Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

G. An object slides down a frictionless ramp.

E_{before} = _____Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

H. An object is dropped. How fast is it going part way down?

E_{before} = _____Work? = _____ E_{after} = _____

Conservation of Energy Equation: ________________

4. A 5 kg mass at rest on the ground is raised up to 15 m. Find the work that was done on the object.

A. E_{before} = _____ Work? = _____ E_{after} = _____

B. Conservation of Energy equation:

C. Solve.

5. A 8 kg mass going 2 m/s compresses a spring 0.5 meters. Find the spring constant of the spring.

A. E_{before} = _____ Work? = _____ E_{after} = _____

B. Conservation of Energy equation:

C. Solve.

6. A 6 kg mass going 4 m/s is slowed to 3 m/s by a 2 N force. For how much distance did the force act?

A. E_{before} = _____ Work? = _____ E_{after} = _____

B. Conservation of Energy equation:

C. Solve.

7. A mass at rest is dropped from 12 m in the air. How fast is it going 2 m above the ground?

A. E_{before} = _____ Work? = _____ E_{after} = _____

B. Conservation of Energy equation:

C. Solve.

8. Use the law of conservation of energy (assume no friction nor air resistance) to determine the kinetic and potential energy at the various marked positions along the roller coaster track below. Finally, fill in the bars of the bar charts for positions A, B, C, D, and E.