Conservation of Energy

COE

LAW OF CONSERVATION OF ENERGY—**COE**

- Energy can't be created or destroyed.
- It can be **changed** from one form to another.
- **W = E**
- Work = Energy
- Work and energy are two sides of the same coin.
- **One can be changed into the other.**
- The unit for both is Joules, symbol is "J"

COE

- Example:
  - I do some number of Joules of work lifting my book into the air.
  - Now, in its position up in the air, the book has that same number of Joules of gravitational potential energy.
  - If I drop the book, it is capable of doing the same number of Joules of work on an egg which is sitting on the floor.
  - Work = energy = work

COE

- In terms of energy, the book has gravitational potential energy in its lifted position.
- Halfway down it has half as much gravitational potential energy, but it also has some kinetic energy because it is moving.
- When it reaches the ground it has all kinetic and no gravitational potential because height is zero.
- The amount of kinetic at the bottom is equal to the amount of gravitational potential that it had at the top.
- PE_G = KE

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- W = Fd = mad = E = PE_G = mgh = ΔKE = ($1/2mv_f^2 - 1/2mv_i^2$)
  - W = work
  - E = Energy
  - PE_G = gravitational potential energy
  - KE = kinetic energy
  - Q = heat

Example

- What is the final velocity of 1500 kg car if 450,000J of net work is applied to accelerate that car from rest?

$$\Sigma W = \Delta KE$$ **Work-Energy Theorem**

$$450{,}000J = \frac{1}{2}(1500kg)v_f^2 - \frac{1}{2}(1500kg)v_i^2$$

$$450{,}000J = \frac{1}{2}(1500kg)v_f^2$$

$$v_f = 24.49m/s$$

Practice

- I apply 10 N of force to a 10 kg chair and move it 50 meters. How fast is it moving?
- Solution:

$\Sigma W = \Delta KE$ (The work I did became the kinetic energy of the chair)

$Fd = 1/2mv_f^2 - 1/2mv_i^2$

$10N\ (50\ m) = ½(10\ kg)\ v_f^2 - ½(10\ kg)(0\ m/s)^2$

$v = 10\ m/s$

Practice

- I do 600 Joules of work to lift a 10 kg bucket. How much gravitational potential energy does it have?

  Answer: 600 J because **W = E**

- How high does it go?

  $W = E = PE_G = mgh$

  So, $W = mgh$

  $600\ J = 10\ kg\ (9.8\ m/s^2)h$

  $h = 6.12\ m$

COE

- Energy can be neither created nor destroyed . . .it may be converted from one form to another.

$$\bullet\ E_{\text{"start"}} = E_{\text{"end"}}$$

- The energy at the "**start**" must be equal to the energy at the "**end**"
- The "**start**" and "**end**" of a problem are arbitrary points.

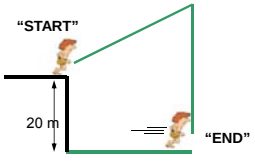
Solving COE Problems

- At the "start"
- Can it ***Fall***
  - Yes add **PE_G**
- Is it Moving
  - Yes add **KE**
- Is work being done
  - Yes add **W**
- Is there a spring
  - Yes add **PE_s**

- At the "end"
- Can it ***Fall***
  - Yes add **PE_G**
- Is it Moving
  - Yes add **KE**
- Is there ***Friction***
  - Yes add ***Q***
- Is there a spring
  - Yes add **PE_s**

Practice

Tarzan standing on a 20 meter high cliff swings on a vine to the jungle floor below. How fast is Tarzan traveling when he reaches the jungle floor? Tarzan Yell



COE:

$PE_G = KE$

1st substitution:

$\cancel{m}\ g\ h = 1/2\ \cancel{m}\ v^2$

Number substitution:

$(9.8\ m/s/s * 20\ m) = (1/2\ v^2)$

$v = 19.8\ m/s$