Bangladesh University of Engineering and Technology

Department of Chemistry

CHEM113: Chemistry

For Students of CSE

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CHEM113 : Chemistry

Total Credit Hours: 3 ; L1/T2

Course Content

Quantum concept in atomic structure, VSEPRT; molecular geometry, Quantum concept in bonding; VBT and MOT, Frontier MOT and electronic transition, Silicon chemistry, Properties of solutions, Colloid and Nano-chemsitry, **Phase rule and phase diagram; Energy and chemistry, Electrochemistry; electrolytic conduction, corrosion, devices for energy storage, Chemistry of biodegradable and conductive polymer; LED, LCD/touch screen,** Chemistry of proteins, nucleic acids (DNA, RNA), carbohydrates and lipids; Introduction to computational chemistry; Design of new molecules, materials and drug.

Content

Everything is energy

Forms of energy

Chemical energy

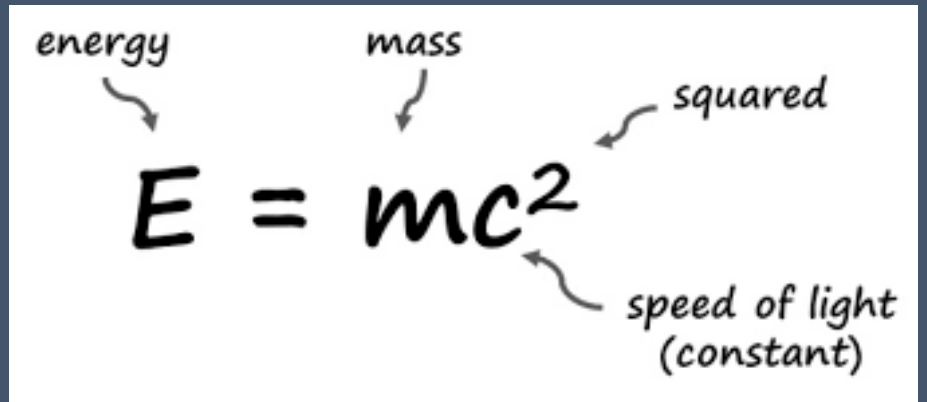
Low of thermodynamics

System and surroundings

Energy transfer

Heat and work

The Universe



Energy forms and conversion

Electrical energy >>> light energy ; Chemical energy >>> Kinetic energy; Light energy >>> chemical energy ; Electrical energy >>> heat energy; Kinetic energy >>> thermal energy ; Wind energy >>> mechanical energy; Electrical energy >>> sound energy ; Chemical energy >>> heat energy; Sound energy >>> electrical energy ; Heat energy >>> electrical energy; Kinetic energy >>> electrical energy

FORMS OF ENERGY

All forms of energy fall under two categories

Kinetic energy (K.E.)
Potential energy (P.E.)
Internal energy = K.E. + P. E.

POTENTIAL

Potential energy is stored energy
and
the energy of position (gravitational)

KINETIC

Kinetic energy is energy in motion.
It is the motion of waves, electrons,
atoms, molecules and substances

CHEMICAL ENERGY

Chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are examples of stored chemical energy.

RADIANT ENERGY

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

Sources of energy

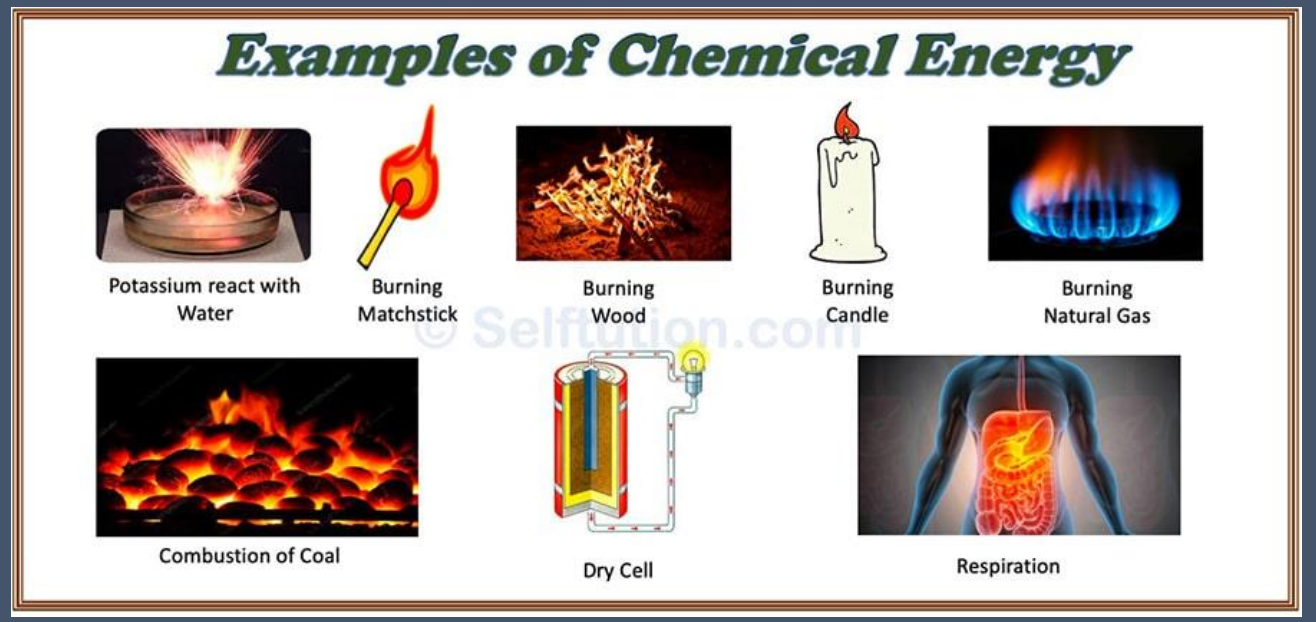
Fig. 3.1.2. Main natural sources of energy.

MAIN SOURCES OF ENERGY

- **Non-renewable**
  - Radioactive metals (uranium, plutonium, etc.)
  - Hydrocarbons / Fossil fuels
    - Crude oil
    - Natural gas
    - Stone coal and brown coal
    - Peat
- **Renewable**
  - Hydroelectricity
  - Tidal energy
  - Geothermal energy
  - Wind energy
  - Solar energy
  - Biomass

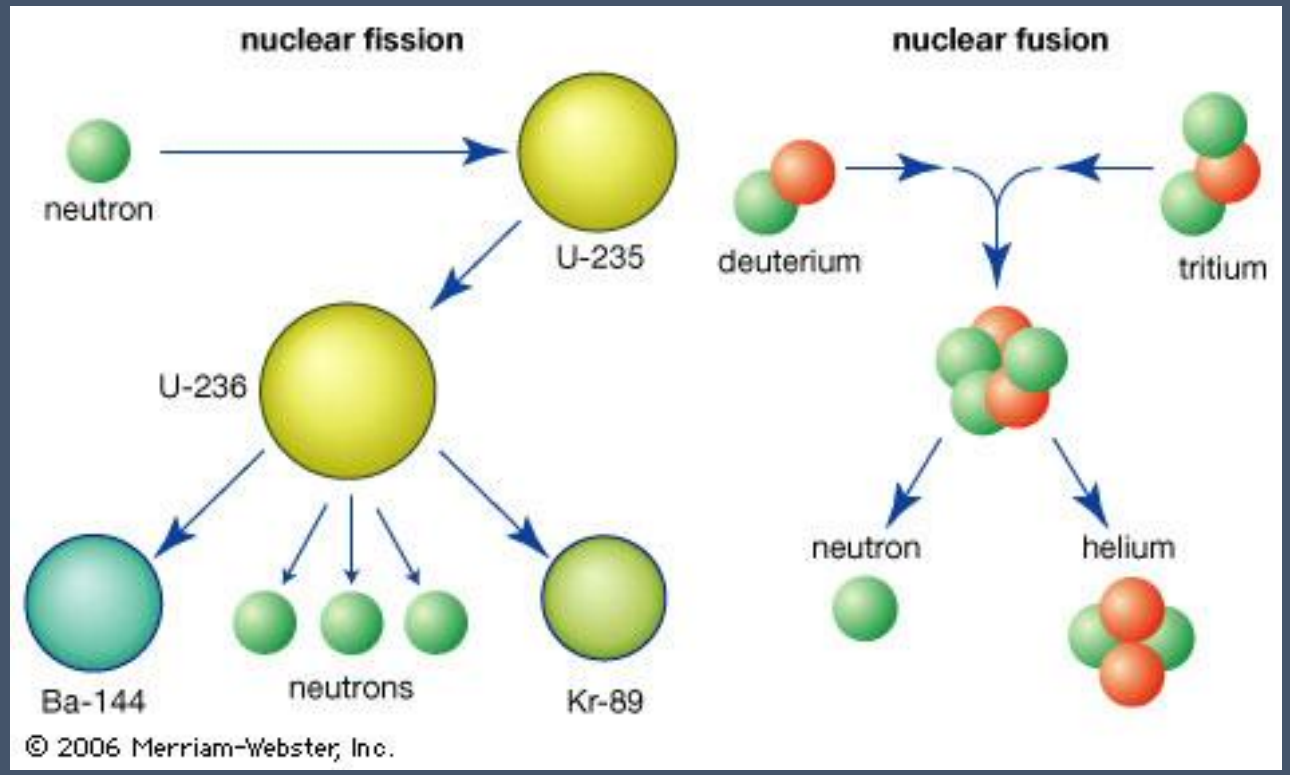
Chemical energy

Chemical (Internal) Energy: The molecules and atoms in a matter possess K.E. due to continuous motion or vibration, along with the P.E. that is originated from the attraction and repulsions between them. This P.E. and K.E. constitute the chemical energy. When fuel is burned (a chemical reaction), a rearrangement of the electrons and atoms in the fuel occurs, and the chemical energy is released.



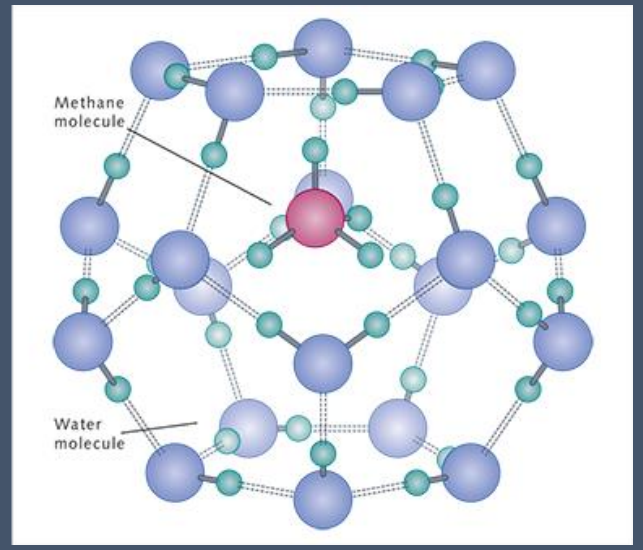
Nuclear energy

Nuclear Energy: A more recent entry into the energy sweepstakes is nuclear energy. Nuclear energy is the source of the Sun's energy. Fundamental nuclear forces are involved, and the rearrangement of nuclear particles to form different nuclei results in the release of energy as some of the mass of the nuclei is converted into energy.



Chemical reactions	Nuclear reactions
- Takes place on the outer energy level containing valence electrons	- Takes place within the nucleus and involves neutrons and protons
- Heat energy released in much less	- Releases large amount of heat energy
- Are affected by environmental factors such as temperature and pressure	- Not affected by environmental factors

Chemical energy: Special chemical energy_Ice that burns



Natural gas; 95% CH_4

Methane, a 'greenhouse' gas, is 10 times more effective than carbon dioxide in causing global warming.

Ice that Burns : Characteristics and reserves

- A frozen substance, methane hydrate, is described as "***ice that burns***".

- Found under the ocean floors and below polar regions, methane hydrate is a crystalline form of natural gas and water (CH_4 is the major constituent of natural gas.) Methane hydrate resembles ice, but it burns if ignited.

- Until recently, it was looked upon as a nuisance because it sometimes plugged natural gas lines in polar regions. Methane hydrate occupies as much as 50% of the space between sediment particles in samples obtained by exploratory drilling. But now it has been estimated that the **energy locked in methane hydrate amounts to twice the global reserves of conventional sources** (coal, oil, and natural gas).

Conservation of Energy

"Energy can be neither created nor destroyed."

"In changing from one form to another, energy is always conserved."

"The total energy of an isolated system remains constant."

Although energy may be changed from one form to another, energy is not lost from the system, and so it is conserved. A system is something enclosed within boundaries, which may be real or imaginary, and *isolated* means that nothing from the outside affects the system.

$$\text{initial energy} = \text{final energy}$$

$$(E_k + E_p)_1 = (E_k + E_p)_2$$

$$\left(\tfrac{1}{2}mv^2 + mgh\right)_1 = \left(\tfrac{1}{2}mv^2 + mgh\right)_2$$

First law of thermodynamics

Energy can neither be created nor destroyed; it can only be converted from one form into another.

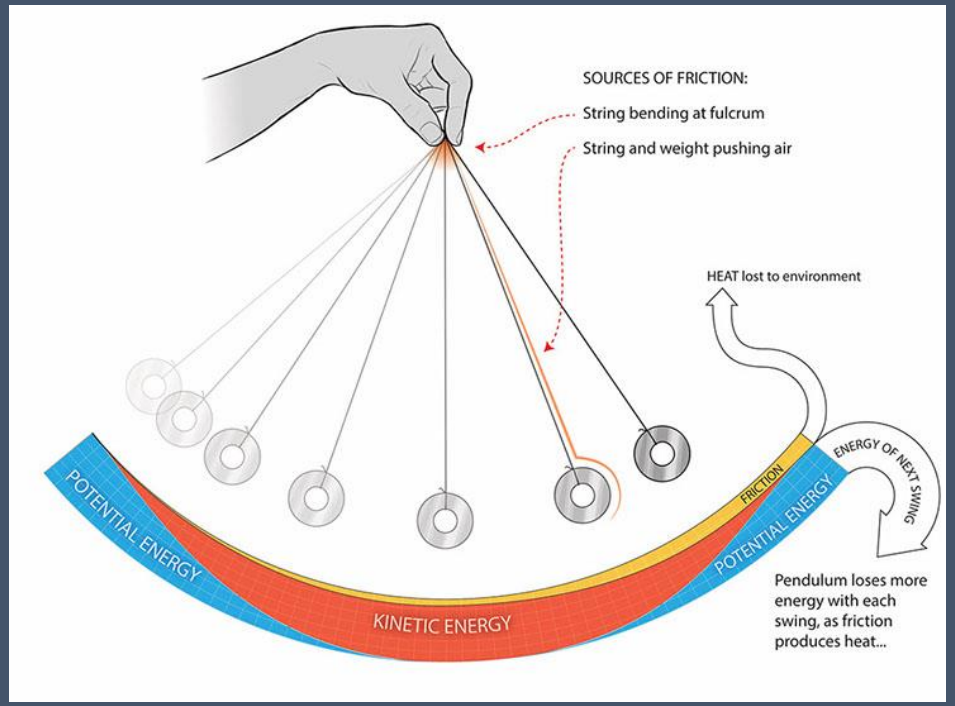
The total energy (internal energy) of an isolated system is constant.

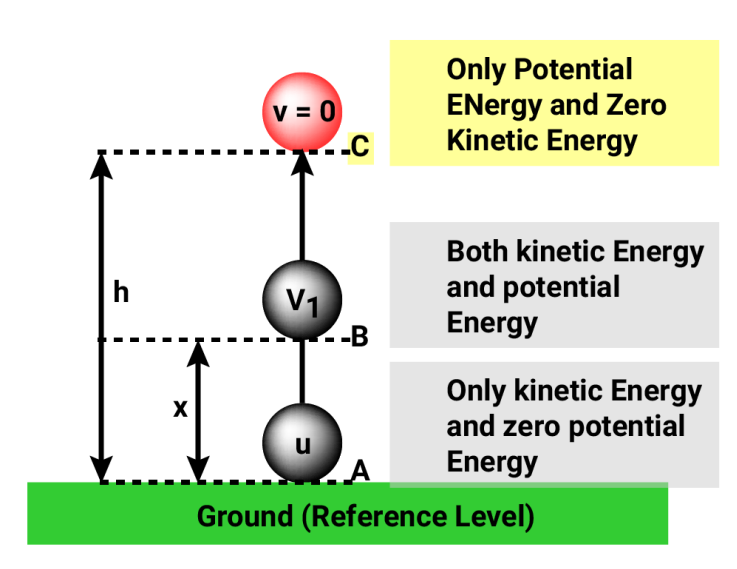
Evidence: Attempts for creation of 'perpetual motion machine' have failed.

Exception/Failure: Mass–energy equivalence; $E = mc^2$

Interchange between P.E. and K. E.

A swinging pendulum bob is an example of a body whose energy can be either potential or kinetic, or a mixture of both. At the extreme ends of the swing, the energy is all potential. The energy is all kinetic when passing through the rest position. At intermediate points, the energy is partly kinetic and partly potential.





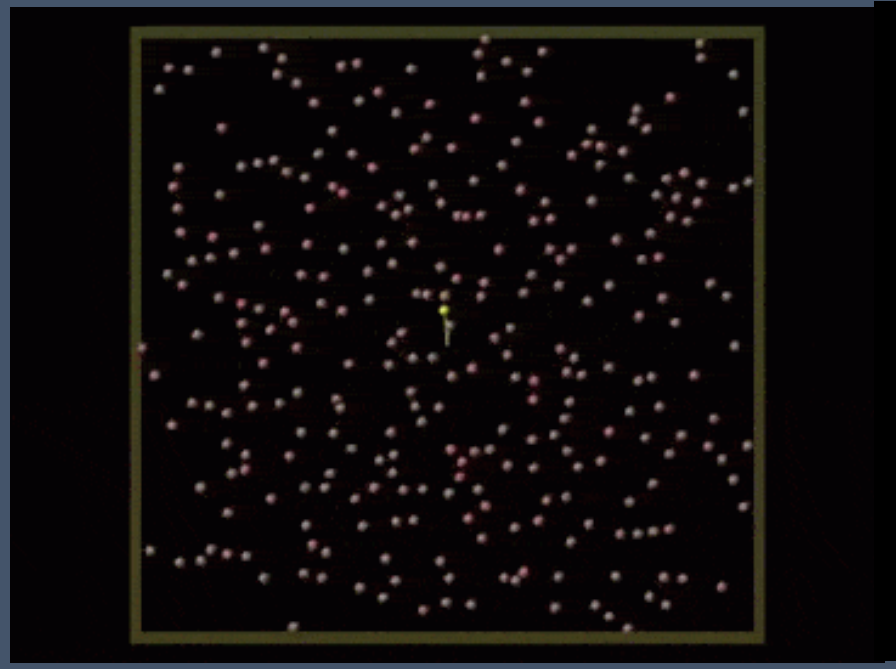
A falling stone, at any moment possesses both K.E. and P.E. As it falls, its speed increases so that it gains more K.E. at the expense of its P.E. If we ignore the energy the stone gives to the air molecules as it pushes them out of its way, then the loss in P.E. of the stone is exactly equal to it gain in K.E.

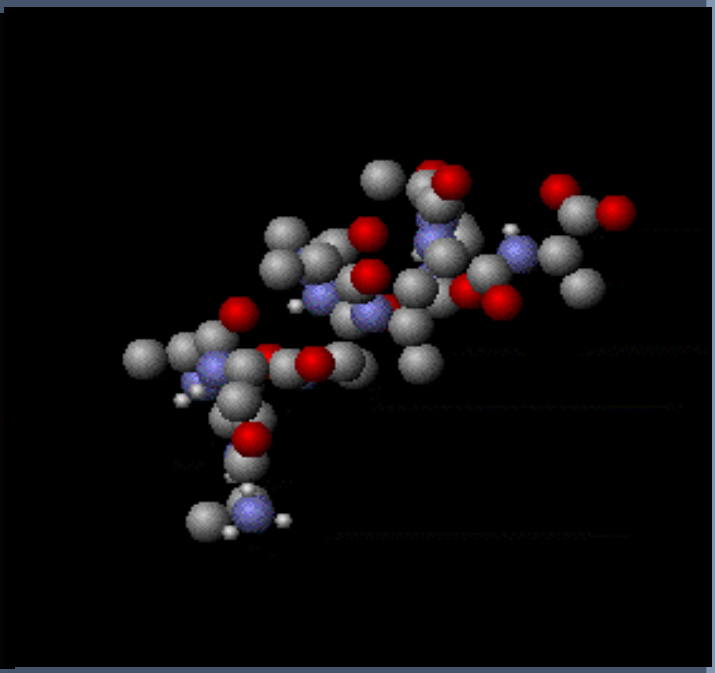
Chemical Energy

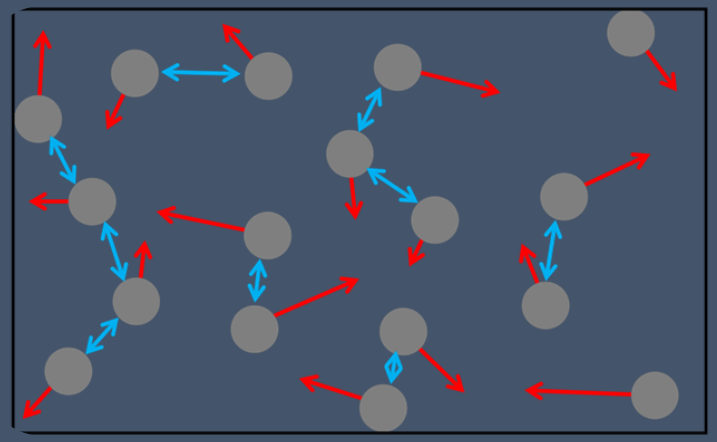
Potential energy

Kinetic energy

Internal energy

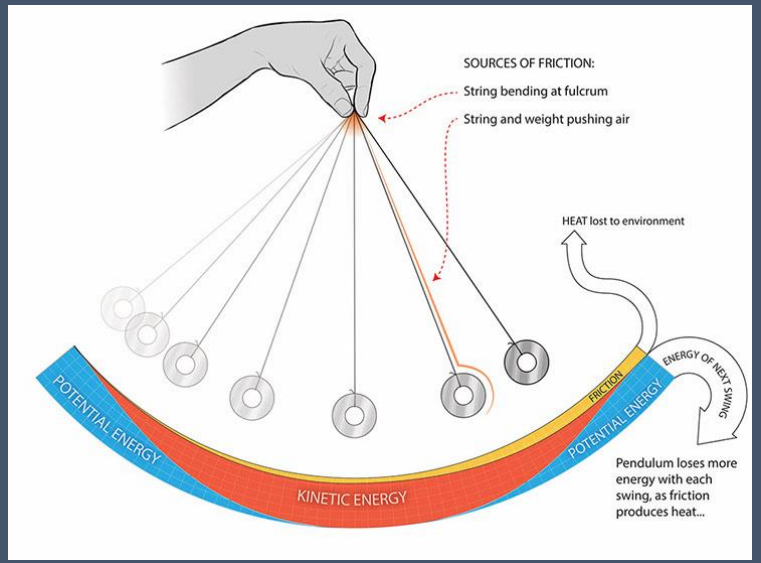






Kinetic Energy

Potential Energy



Review of 1st Law

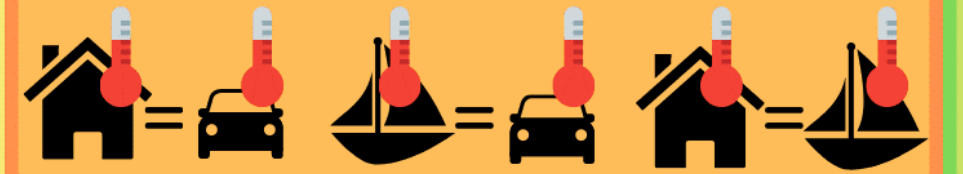
Thermodynamic Laws

Laws of Thermodynamics

Zeroeth law

Temperature

Two systems in equilibrium with a third system are in thermal equilibrium with each other.



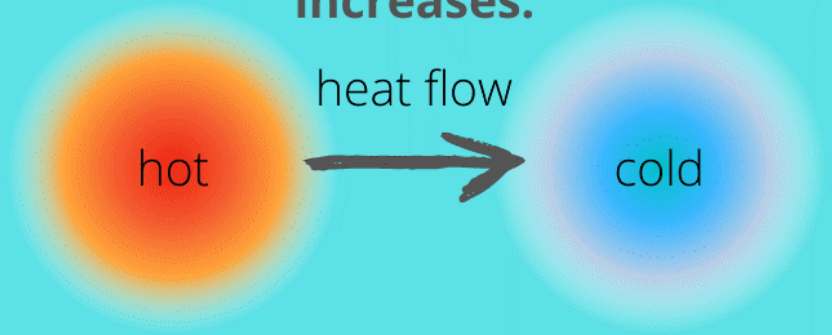
First law

Conservation of Energy

Energy can change forms, but is neither created nor destroyed.

Second law

Entropy of an isolated system always increases.



Third law

Entropy of a system approaches a constant as temperature approaches absolute zero.

[.. zero (0)]

Enthalpy, *H*

$$\Delta G = \Delta H - T\Delta S$$

$$H = U + PV$$

H = Enthalpy
P = Pressure
V = Volume
U = Internal Energy

DEFINITION

$$\Delta H = \Delta U + P\Delta V$$

$$\Delta H = (\Delta Q - P\Delta V) + P\Delta V$$

$$\Delta H = \Delta Q$$

Helps to understand heat content under different situations

- Under Constant Volume (**U**)
- Under Constant Pressure (**H**)

$\Delta H = \Delta U + P\Delta V$
State Function

$\Delta U = \Delta Q - P\Delta V$
$\Delta Q = \Delta U + P\Delta V$
Path Function

$\Delta U = \Delta Q - P\Delta V$

$\Delta H = \Delta U + P\Delta V$