

THERMODYNAMICS

Three laws sometimes stated

1. You can't win
2. You must lose
3. You can't get out of the game

1. CONSERVATION OF ENERGY (1840's: Mayer 1842, Helmholtz 1847, Joule)

ENERGY CAN NEITHER BE CREATED NOR DESTROYED, ONLY TRANSFERRED

- FROM ONE SYSTEM TO ANOTHER
- FROM ONE FORM TO ANOTHER

WORK, KE, GRAV. P.E., ELECTRICAL P.E.
AND HEAT

How do we change the energy of a SYSTEM

If we consider the workings of the system itself the energy contained within it is its INTERNAL ENERGY

$$E_{\text{internal}} \equiv U$$

including all of its various forms. Consider the earth as a system. Internal energy includes

$U =$ microscopic energies of all components
(e.g. thermal energy of animals, plants, humans, inanimate objects...)

- + macroscopic KE of all components
(KE due to motions of automobiles, humans, rivers ..., earth rotation)
- internal PE of objects in system
(grav PE of airplanes
chemical energy of petroleum deposit
food (chemical) energy of crops)

So how do we alter this energy - we can do work on the earth or have the earth do work on something else. We can transfer thermal energy in or out - heat transfer

We can write the first law for a system

1st Law

$$\Delta U = Q - W \quad \text{or} \quad Q = W + \Delta U$$

where Q is heat transfer

Q is positive = HEAT IN

Q is negative = HEAT OUT

W is work done by the system

W = positive, system does work on its environment

W = negative environment does work on system