

Lecture 7 - CONSERVATION PRINCIPLES – 24 Jan 2001

- A. **What does it mean to say a quantity is conserved?** We observe events in nature where obvious changes take place. Some things we can measure (quantities) **do** change. However, these quantities change in ways predicted by principles that do not change. Other quantities are conserved. That is, they do not change even in the midst of violent change.
- B. **Is it possible to either create or destroy mass?** No. The total amount of mass does not change. Events occur where there is significant change in the material afterward. However, the total mass after the event is the same as the total mass before. (This principle will be refined later.)
- C. **Is it possible to either create or destroy electric charge?** No. The total amount of positive charge minus the total amount of negative charge does not change.
- D. **Is it possible to either create or destroy energy?** Energy is a rather abstract quantity associated with a situation or condition. The total energy is always conserved. An amount of energy can be calculated for each of the following conditions:
1. **Kinetic Energy (K.E.)** - The energy of motion. The amount of K.E. equals one half the mass times the speed squared.
  2. **Gravitational Potential Energy (G.P.E.)** - The energy of position relative to the earth or another mass. G.P.E. equals the weight times the height above some reference level.
  3. **Electrical Potential Energy (E.P.E.)** - The energy of position of a charged object relative to another charged object. When the two charged objects have charges of the same sign, the E.P.E. increases as the two objects are brought closer together. When the two charged objects have opposite kinds of charge, the E.P.E. increases as the two objects are moved apart.
  4. **Internal Energy (I.E.)** - The energy inside an object. I.E. is associated with either thermal energy (molecular kinetic energy) or chemical potential energy (electrical potential energy due to physical state, shape, or chemical state).
  5. **Radiant Energy (R.E.)** - The energy of sunlight, etc.
- Energy can neither be created nor destroyed. The total energy is always constant. In more recent times, it has been learned that changes in internal energy equal the mass times the square of the speed of light. This means that there is an energy associated with mass. Therefore, the modern conservation principle is called the **principle of conservation of mass-energy**.
- E. **Energy transfer processes** include:
1. **Work** - Transfer of energy by forces exerted against moving objects. Work equals force times distance.
  2. **Heat flow or conduction** - Transfer of energy between materials that are touching through molecular collisions.
  3. **Radiation** - Energy transfer through a vacuum or a material by electromagnetic waves (light).
  4. **Convection** - Transfer of energy by moving the material to another place taking the internal energy with it.
  5. **Chemical reactions** - Transfer of chemical potential energy to another form. For example in combustion, chemical potential energy becomes thermal energy and radiant energy.