Heat and Transfer of Heat

Fundamentals of Physics

Chapters 9 and 10

Heat and Temperature

Heat is a form of energy

- Heat is the energy of random motion of molecules constituting the body. It flows from a hot body to a cold body.
- Unit of heat is 'joule' (J) and calorie (cal). 1 cal = 4.186 J rounded to 4.2 J.

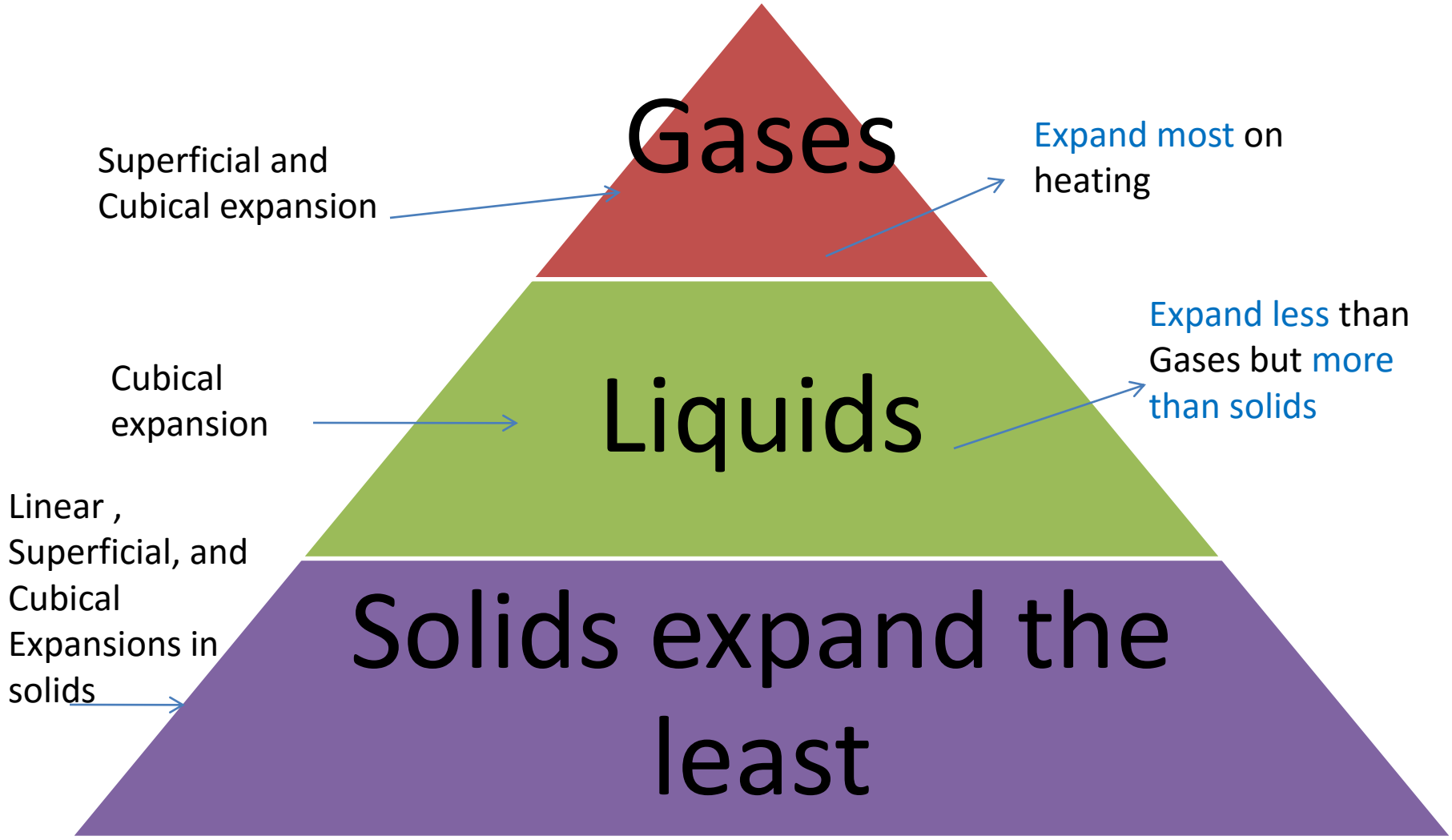
Temperature is the degree of hotness or coldness of a body

- Temperature is the parameter which tells the thermal state of a body . It determines the direction of flow of heat when two bodies at different temperatures, are placed in contact.
- Unit of temperature is kelvin (K) and degree celsius (^{0}C). By adding 273 to the temperature in degree celsius unit, temperature is converted into kelvin unit.

Thermal Expansion

- The expansion of a substance on heating is called the thermal expansion of that substance.
- Linear expansion,(length wise) superficial expansion (area wise) and cubical expansion (Volume wise)

Comparative expansions of three states of matter



Thermal expansion of solids liquids/gases

1. The amount of heat contained in the body depends on mass, temperature and material of the body

2. The coefficient of linear expansion of a substance is numerically equal to the increase in length of the rod of that substance of unit length when its temperature is increased by 1 degree C.

3. In linear expansion, increase in length depends on the material and is directly proportional to its original length, and to increase in its temperature.

It is not affected by whether the rod is solid or hollow.

Real expansion of liquid = Apparent expansion of liquid + volume expansion of container.

The expansion of water when it is cooled from 4 degree C to 0 degree C, is known as the anomalous expansion of water.

Anomalous expansion of water helps in preservation of aquatic life during freezing and sub freezing temperatures in Tundra Regions. It is also responsible for bursting of water pipes and destruction of crops during winter months.

Three Scales of Temperature

Celsius and Kelvin:

K= 273 + C or C = K -273

All three scales:

C/5 = F-32/9 = K-273 / 5

Celsius scale has 0 as freezing point of water to 100 degrees as boiling point of water. It has 1/100th part of interval between the two points

Fahrenheit scale has 32 degree as freezing point, and 212 degree as boiling point. It has 1/180th part of interval between the two points.

Kelvin is called the absolute scale of temperature. Zero is the point at which molecular motion ceases and average kinetic energy flow is zero. This is also called the absolute zero.

The size is the same 0 to 100 of the Celsius scale. Gas laws are made simpler due to Kelvin scale

For conversion

C/5 = F-32 /9

One centigrade degree = 9/5 fahrenheit degree and

One fahrenheit degree = 5/9 centigrade degree

Ch. 10 Transfer of Heat

1. Heat can be transferred by

(a) Conduction (in solids, without movement of atoms)

(b) Convection (In liquids and gases, with movement in one direction, upwards only)

(c) Radiation

(a) Conduction is the process of transfer of heat from hot to cold end from particle to particle of the medium, without leaving their position. In conduction, heat is transferred only through vibration of atoms, and no change in their position is involved.

Conductors of Heat are substances that allow heat to pass through them. Silver is the best conductor, followed in decreasing sequence by copper, aluminium, zinc, brass, iron, steel, lead, constantan, water, ice, rubber, wood, asbestos, ebonite and air. All liquids , except mercury, are very poor conductors.

(b) In Convection, heat is transferred through the actual movement of particles in the medium, vertically, upwards in one direction only. Convection method does not function in a vacuum.

(c) In Radiation, heat passes directly from one body to another without involving the medium. In vacuum, heat is transferred only through Radiation method. Heat from the Sun is the best example of radiation method.