มหาวิทยาลัยราชภัฏนครปฐม

Nakhon Pathom Rajabhat University

Chapter 9
HEAT AND KINETIC THEORY OF GAS

Kittipong Siengsanoh, Ph.D.(Physics)

Physics, Science and Technology Department

Nakhon Pathom Rajabhat University

Curriculum

Standard Sc 5.1

Understand the relationship between energy and life. energy conversion interaction between energy and substances the effects of energy on life and the environment. The process of inquiry and communicate what you learn and use.

Heat And Kinetic theory of gases

Heat	Ideal gas	Kinetic theory of gases	Internal energy of system	Apply
Temperature	Boyle's Law	Pressure and the average molecular weight of gas		Engine
Heat capacity	Charles's Law	Speed of gas molecules		
Expansion of the object due to heat	Ideal gas Law			
Status and change status				
Heat transfer				

Ideal gas

Substances in the gas state molecular molecules move freely and disperse fully filled containers. the volume of gas depends on the pressure, temperature and mass. the equation that expresses the relationship between quantities is called the gas law, which evolves from the rules of Boyle and Charles. gas can be divided into three types.

1.Monatomic gas (He,Ne,Ar)
2.Diatomic gas (H_2,N_2, O_2)
3.Polyatomic gas (O_3,CH_4,NH_3)

Ideal gas

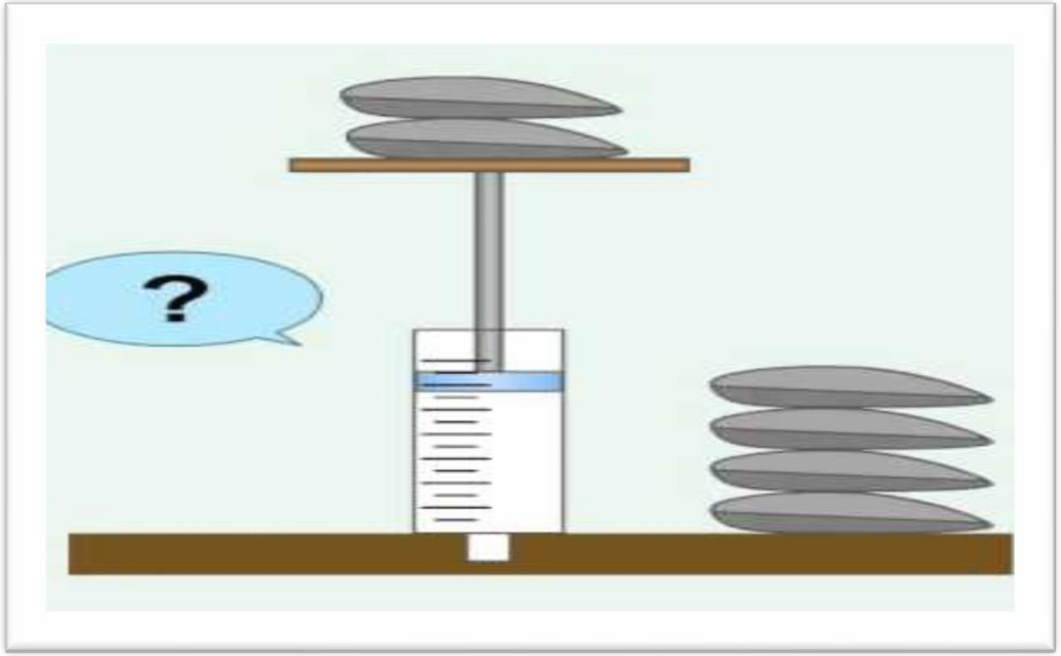
Boyle’s Law

For gas in closed containers, if the temperature (T) of the gas is constant, the volume (V) of the gas is inversely proportional to the pressure (P) write a relationship.

$V \propto 1/P$ (m^3) or PV = steady(Pascal/m^3)

Ideal gas

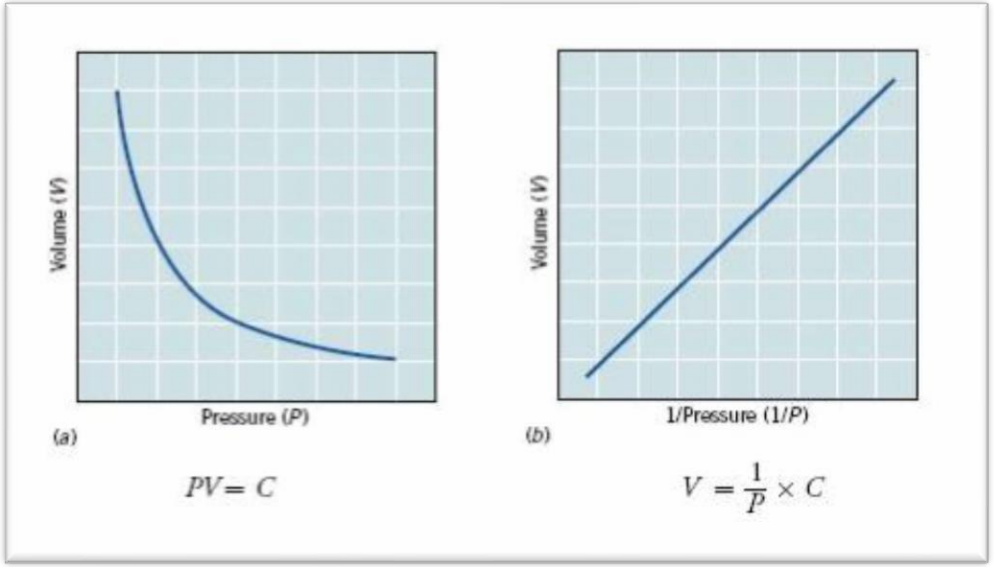
Boyle's Law



To study the relationship between pressure and volume of gas. When the temperature stabilizes.

Ideal gas

Boyle’s Law



Boy's Law Experiment Chart.

Ideal gas

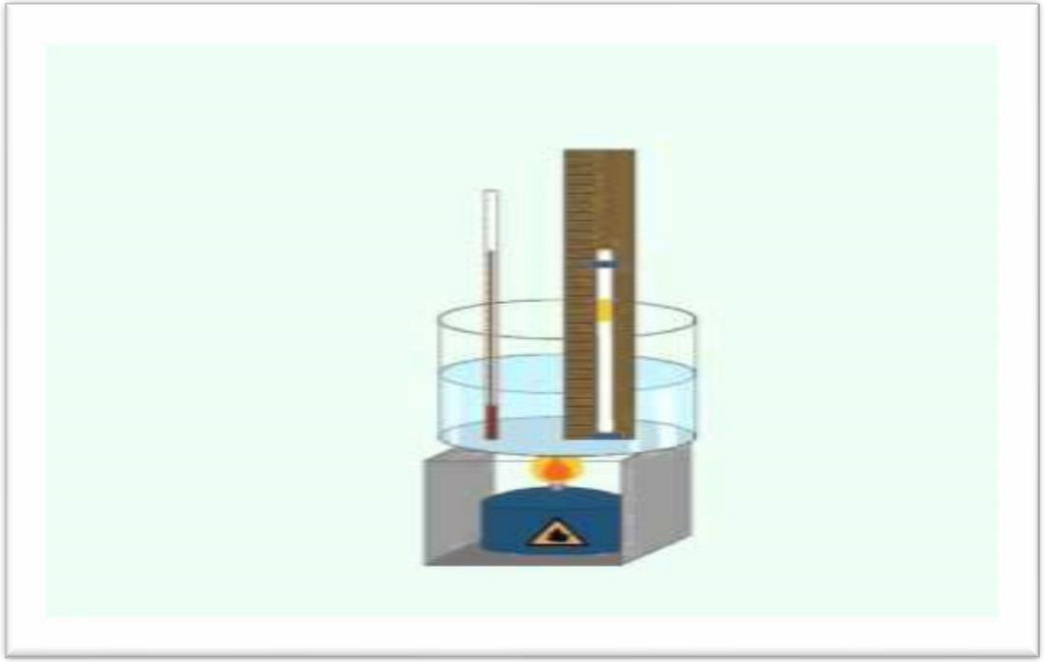
Charles's Law

For gas in closed containers. If the pressure (P) is constant, the volume (V) of the gas will vary with the absolute temperature (T) of the gas.

V $\propto T\ m^3$ (When P persists) **or V/T = steady** (m^3/K)

Ideal

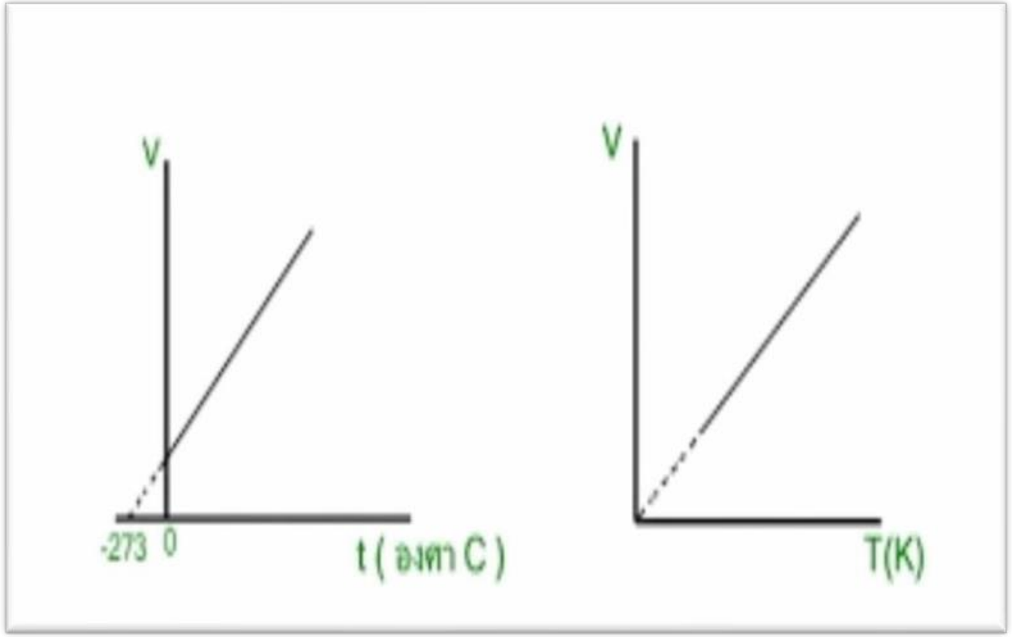
Charles's Law



To study the relationship between gas volume and temperature. When the pressure is constant.

Ideal gas

Charles's Law



Graphs between volume and temperature When the pressure is constant.

Ideal

Ideal gas Law

PV = nRT

P = pressure (Pascal)
V = volume ($m3$)
N = Moles of gases (mol)
R = gas constant (J/mol K)
T = temperature (Kelvin)

Kinetic theory of gases

The pressure and the average kinetic energy of the gas molecules.

$$E_k = \frac{2}{3} K_B T$$

E_k = kinetic energy (J.)

K_B = Boltzmann constant (J/K)

T = temperature (K.)

Kinetic theory of gases

The pressure and the average kinetic energy of the gas molecules.

Gas consists of small molecules. A lot of that at the time. The average kinetic energy of the molecules varies with the absolute temperature of the gas.

Kinetic theory of gases

Speed of gas molecules.

$$V_{rms} = \sqrt{\frac{RT}{M}}$$

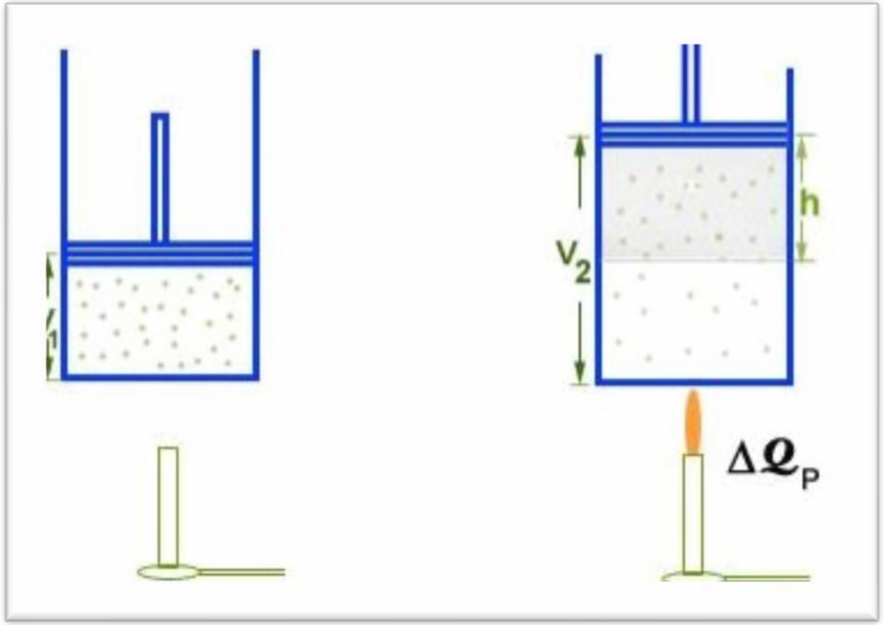
V_{rms} = RMS speed (m/s)
M = Mole (Kg/mol)
R = gas constant (J/mol K)
T = temperature (K.)

Internal energy of system

The total energy of the gas molecules in that system.

Within the system, there are thousands of molecular ligands and the average kinetic energy of each molecule is E_k Internal energy is U = NE_k unit is J.

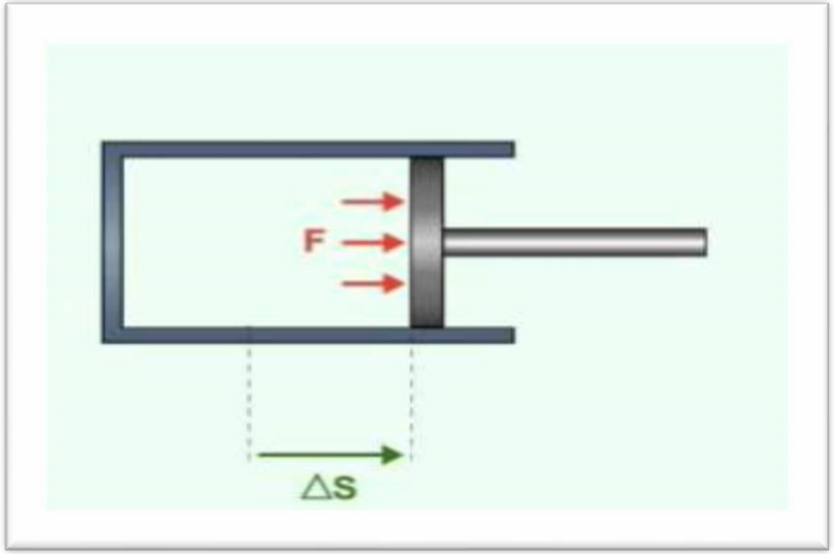
Internal energy of system



Heat energy to the system to work.

Internal energy of system

Work done by gas.



$$W = F\Delta S$$
$$= PA\Delta S$$
$$W = P\Delta V \text{ J.}$$

W = work(J)
P = pressure(Pascal)
ΔV = Volume sum (m^3)

Internal energy of system

Thermal balance

$$Q = \Delta U + W \quad (J.)$$

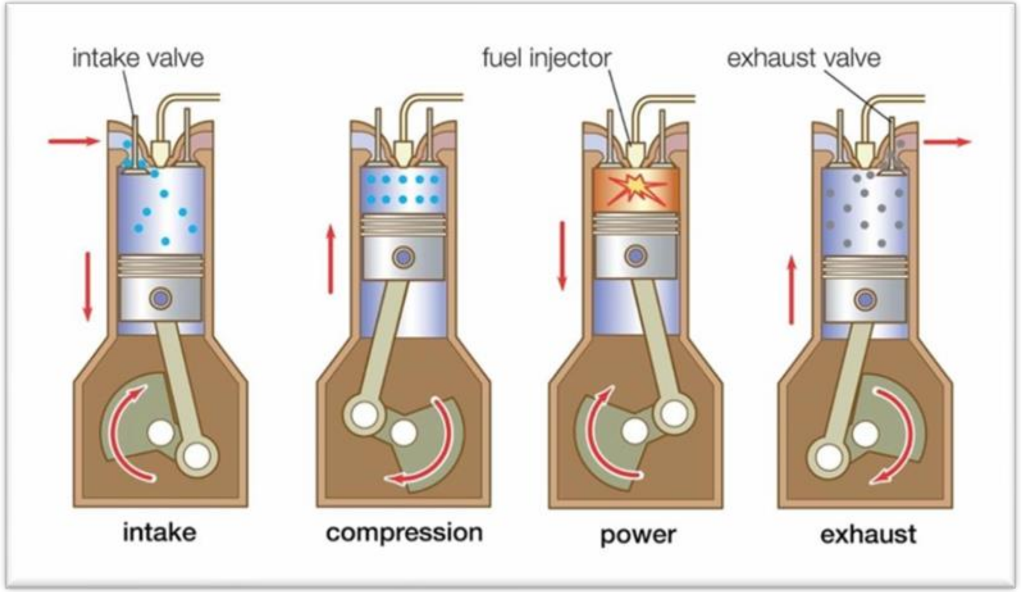
Q = heat (J)

ΔU = Internal energy (J)

W = work (J)

Apply

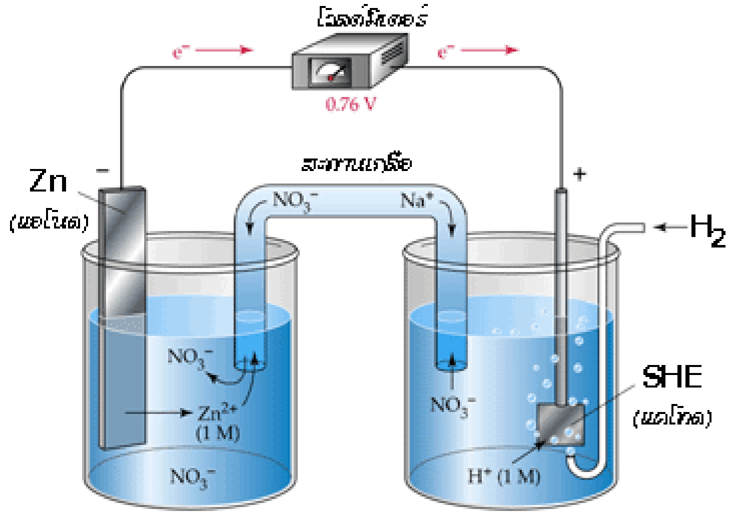
Engine



The operation of the gasoline engine with internal combustion 4-stroke.

Heat

electrical energy

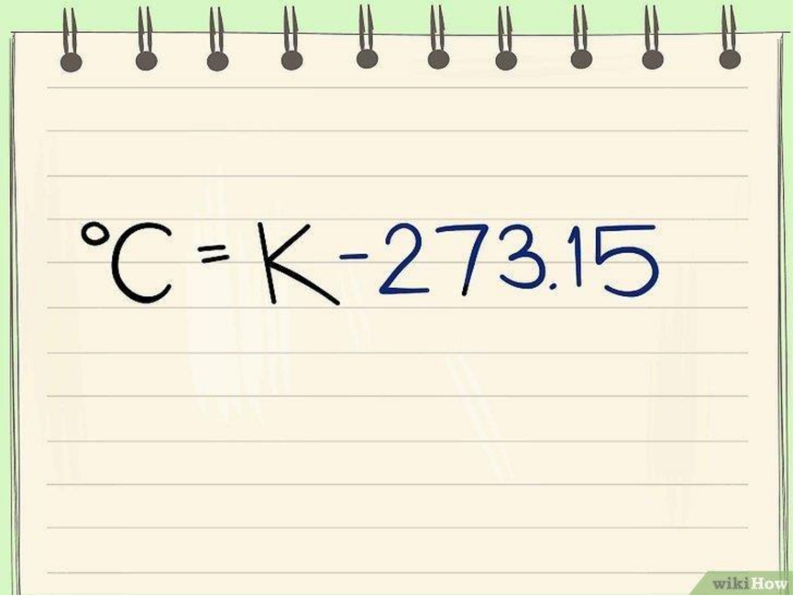


Chemical energy

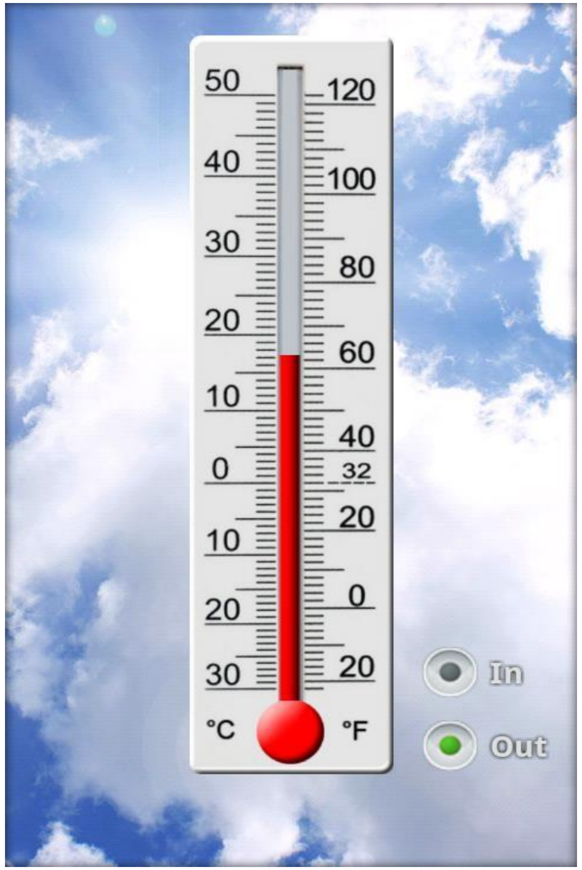
Nuclear energy

Temperature

Temperature using heat



Temperature change formula



Thermometer

Heat capacity

1. Heat capacity is the amount of heat causes all substances to change temperature One unit.

$$\Delta Q = C\Delta T$$

Q is heat unit is joule
C is heat capacity (J/K)
T is temperature (K)

Heat capacity

2. Specific heat is the amount of heat that causes a mass of one mass to change.

$$Q = mc\Delta T$$

Q = heat (J)
m = weight (Kg)
c = specific heat (J/kg*K)
ΔT = temperature (K)

Heat capacity

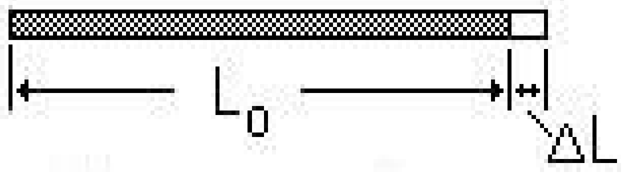
Ex The specific heat capacity of copper is 400 J / kg.K. How much heat does it take to make 0.1 kg of copper change from 3 K to 8 K?

$$Q = mc\Delta T$$

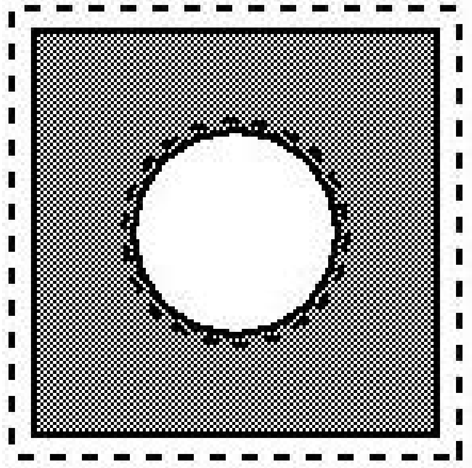
$$Q = (0.1)*400*(8-3)$$

$$= 200\ J$$

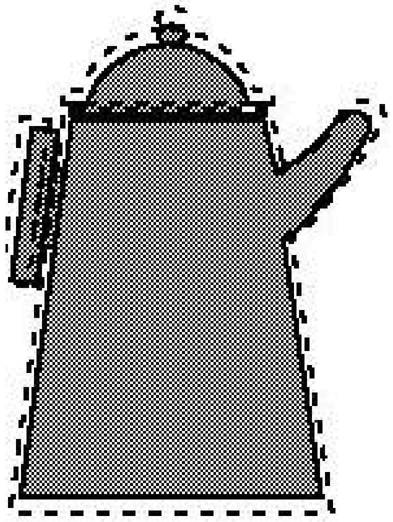
Expansion of the object due to heat



Expanded by line



Expanded by area



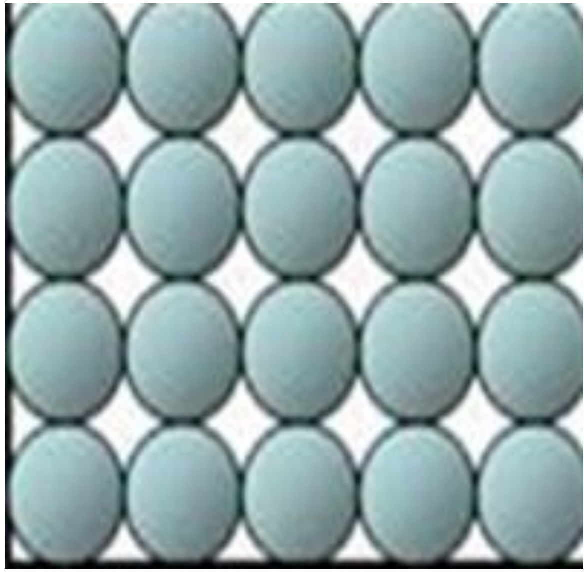
Expand by volume

Expansion of the object due to heat

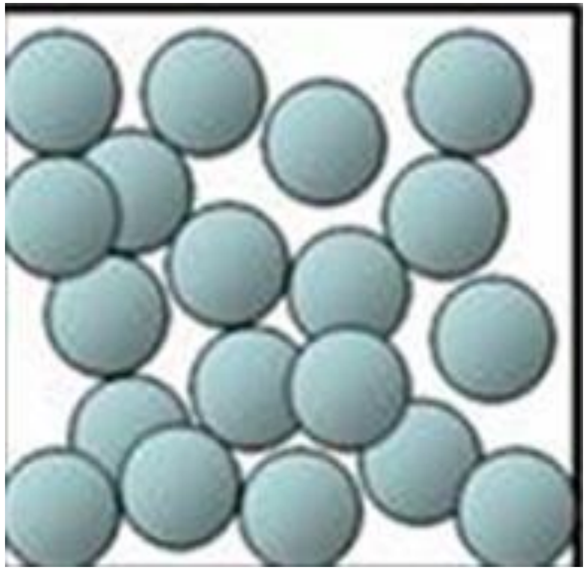
The key features of the expansion of solid.

1. Solid is same type length when the same temperature rise, the same.
2. Different solid have the same length as the temperature rises expand Is not equal.

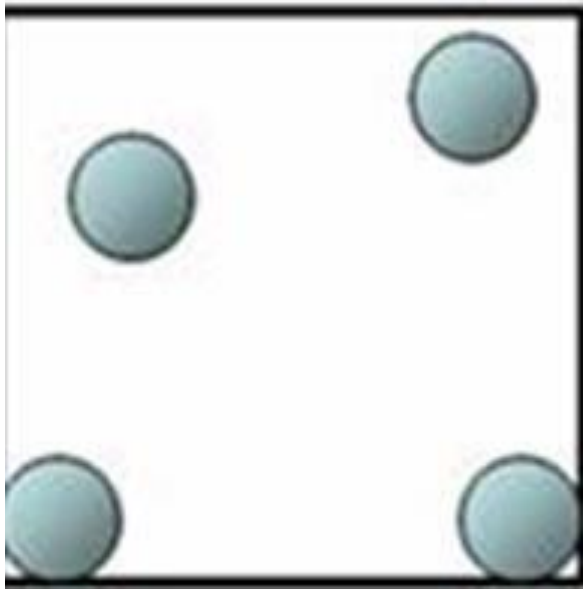
Status and change of status



Solid



Liquid



Gas

Status and change of status

Finding the thermal energy used to change the state of a substance some quantities are involved.

1. Latent heat is the amount of heat that causes the object to change state.temperature does not change.

2. Specific latent heat the amount of heat that makes a mass object 1 unit change status the temperature does not change.

Status and change of status

$$\Delta Q = mL$$

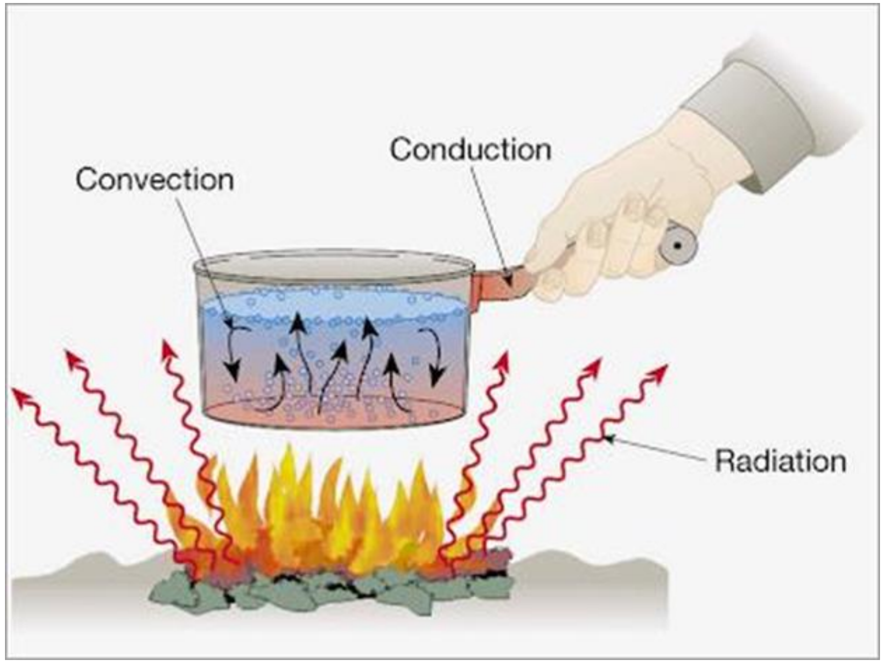
ΔQ = heat unit is J

m = weight unit is kg

L= Specific latent heat unit is J/Kg

Find the heat energy at 2 kilograms of ice. Smelt water is 0 degrees Celsius. (L = 333J / Kg)

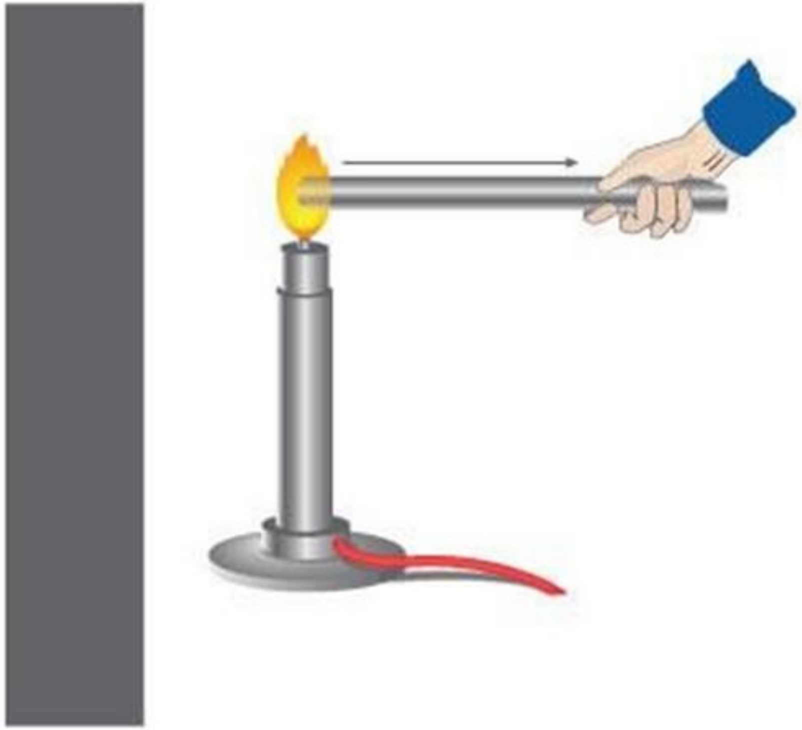
Heat transfer



The transfer of heat is normally from a high temperature object to a lower temperature object.

Heat transfer

5.1 Heat conduction



Heat transfer

5.2 Convection

Heat transfer

5.3 Radiation