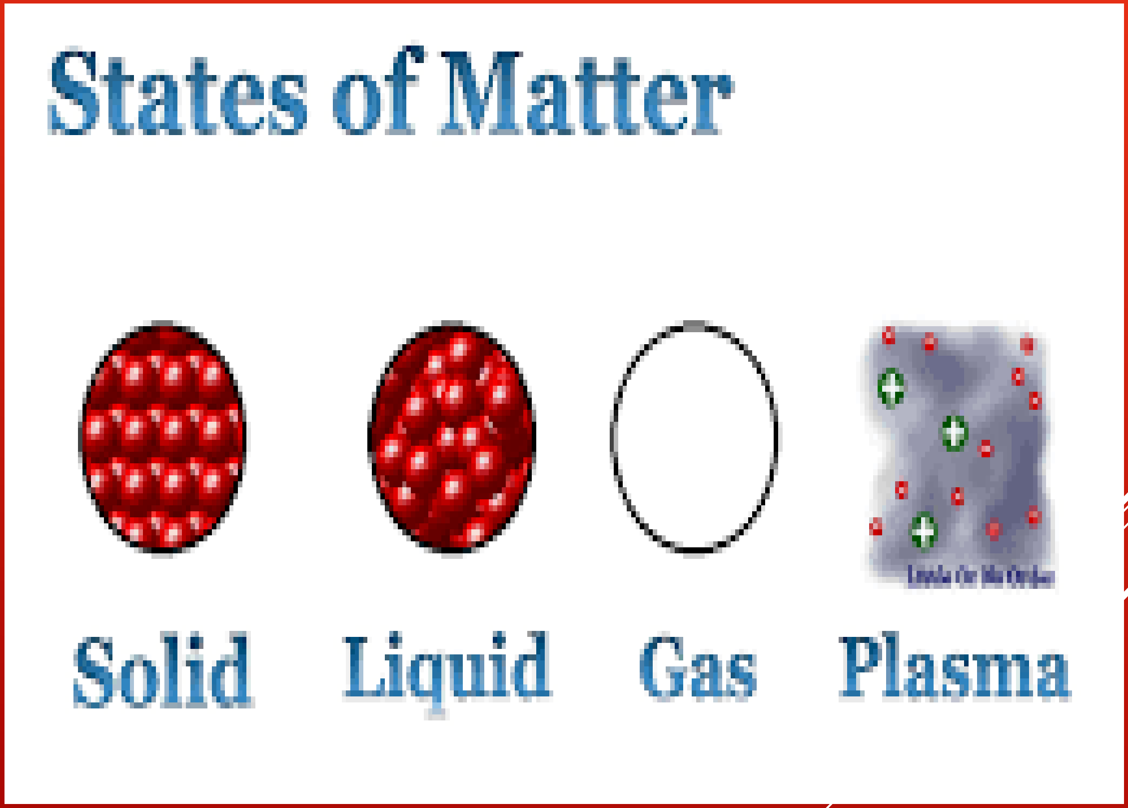
HEAT

WHAT IS MATTER?

We know that matter is defined as anything which has a mass and occupies some space. Matter exists in 4 forms which are:

- Solid
- liquid
- gas and
- plasma.



ENERGY

- Define "**Energy**":

  <u>The ability to do work or cause change.</u>

- What is the basic unit of measure for energy?

  <u>Joules</u>.

HEAT

- Define “**Heat**”:

  Heat *is the movement of thermal energy from a substance at a higher temperature to another substance at a lower temperature.*

- Heat energy of a body can also be defined as a form of energy that can be transferred from one body to the other or within the body itself with a temperature difference and can be generated by a body at the expense of other forms of energy.

- The SI unit of heat energy is Joule abbreviated as 'J'.

- In CGS system, however, heat is measured in 'Calorie' (Cal.) where 1 Calorie = **4.186 J**

WHAT IS TEMPERATURE?

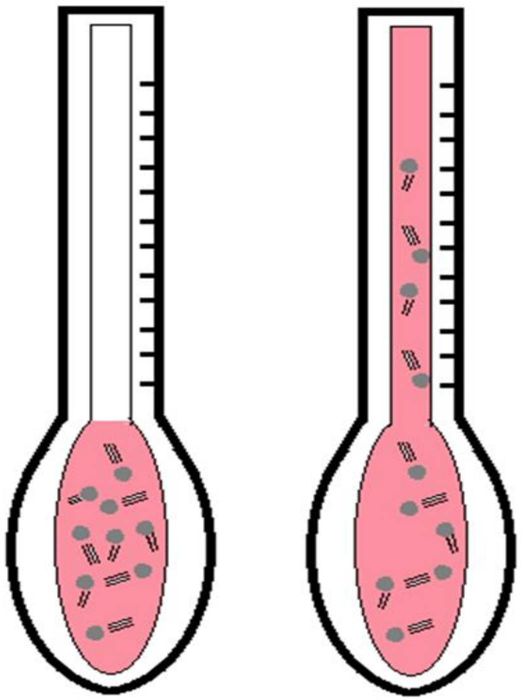
- Heat is the form of energy that leads to an increase or decrease in the internal energy of the body. This internal energy is also known as temperature. In other words, the temperature is a measurement by which we may measure the degree of hotness or coolness present in a body.

- Temperature is measured in degrees. The measuring unit for temperature in Celsius and Fahrenheit. However, these measures are used in your daily life. For scientific measurement, we use the Kelvin scale.

TEMPERATURE

A thermometer is used to measure temperature.

When the thermometer is placed in a substance, the heat from that substance may be transferred to the mercury (or alcohol) in the thermometer.

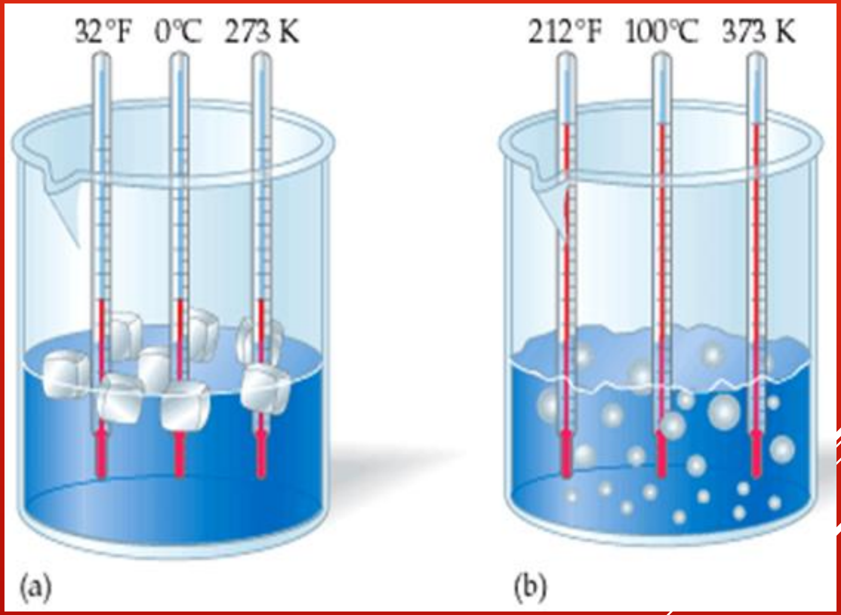


It causes the motion, or kinetic energy of the particles to increase. This rise in temperature is shown by the rising column of mercury or alcohol in the thermometer.

TEMPERATURE UNITS DEPEND OF SCALES

The temperature scales most widely used today are the

- Fahrenheit
- Celsius
- Kelvin Scales.

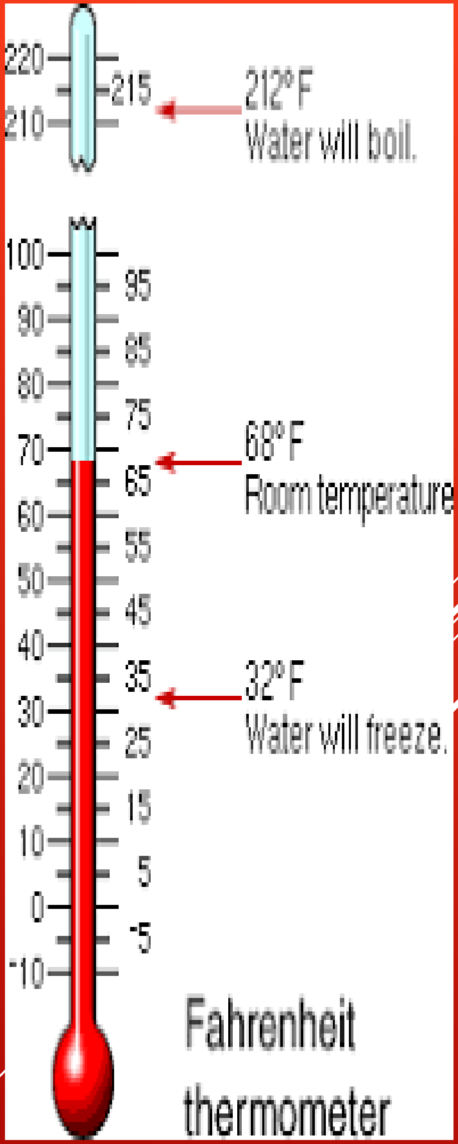


DANIEL GABRIEL FAHRENHEIT

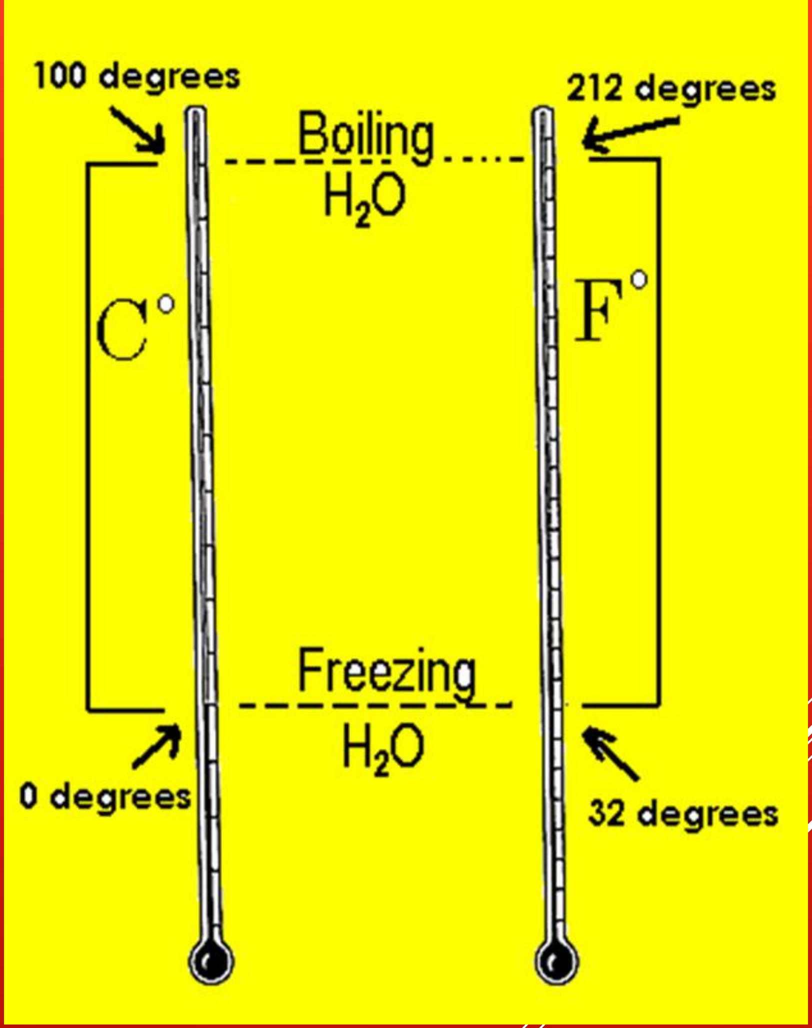
He discovered, among other things, that water can remain liquid below its freezing point and that the boiling point of liquids varies with atmospheric pressure

Fahrenheit temperature scale, scale based on 32 degree for the freezing point of water and 212 degree for the boiling point of water, the interval between the two being divided into 180 parts.

Fahrenheit originally took as the zero of his scale the temperature of an equal ice-salt mixture and selected the values of 30 degree for the freezing point of water and 90 degree for normal body temperature.



After Fahrenheit died in 1736, scientists calibrated his model of thermometer using 212 degrees, the temperature at which water boils, as the upper fixed point, and 32 degree for water freezing.
When the Fahrenheit thermometer was recalibrated, normal human body temperature registered 98.6 rather than 96.

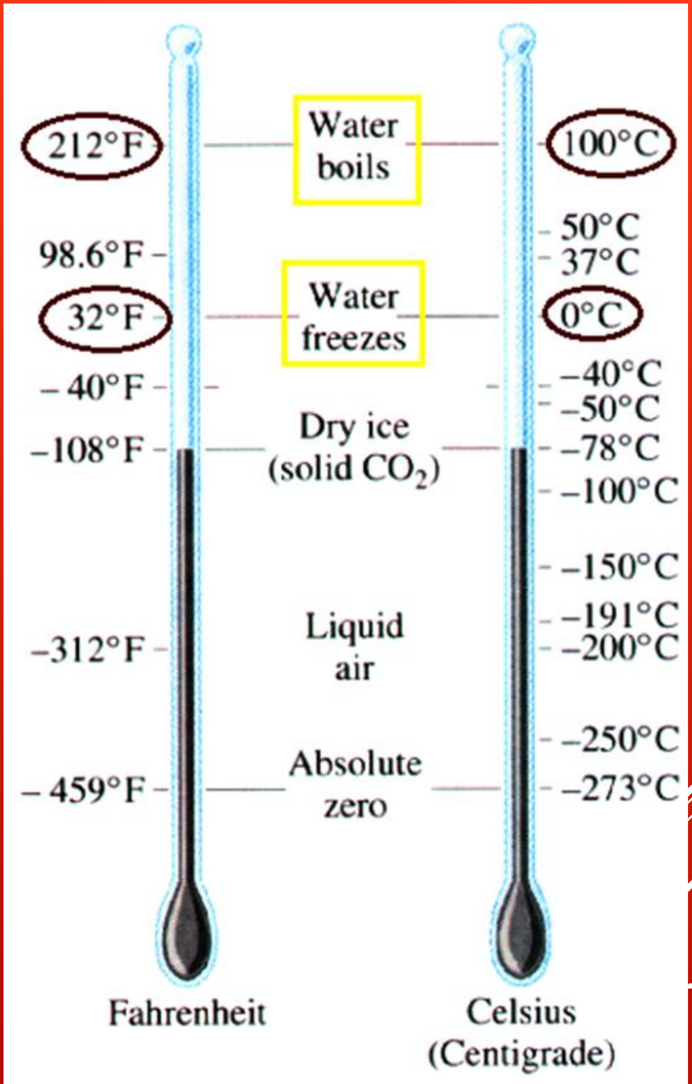


The Celsius temperature scale was invented by Anders Celsius (1701-1744) a Swedish Astronomer

- For his meteorological observations he constructed his world famous Celsius thermometer, with 0 for the boiling point of water and 100 for the freezing point.
- After his death in 1744 the scale was reversed to its present form with zero as water's freezing point.

CELSIUS TEMPERATURE SCALE

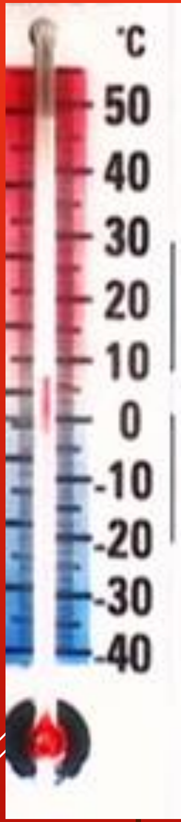
- The Celsius scale often used by countries using the metric system. It is based on water's freezing point – set at 0°C and its boiling point – set at 100°C.



Celsius

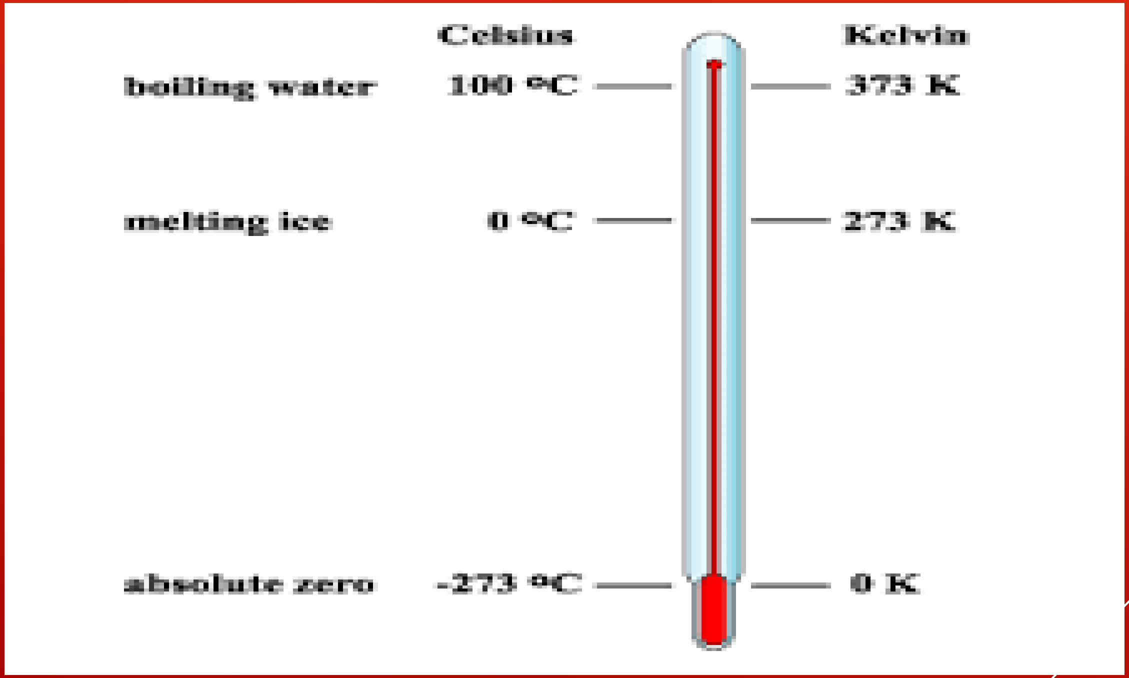
a unit of temperature in the metric system

- Water freezes at 0° C.
- Water boils at 100° C.
- Normal body temperature is 37° C
- Room temperature is 21° C.



KELVIN TEMPERATURE SCALE

The temperature scale is named after the British mathematician and physicist William Thomson Kelvin (1824 – 1907) who proposed it in 1848.



- Kelvin temperature scale, has an absolute zero below which temperatures do not exist.

- Absolute zero or 0 K, is the temperature at which molecular energy is a minimum, and it is equal to a temperature of -273.15° on the Celsius scale.
- The Kelvin degree is the same size as the Celsius degree.

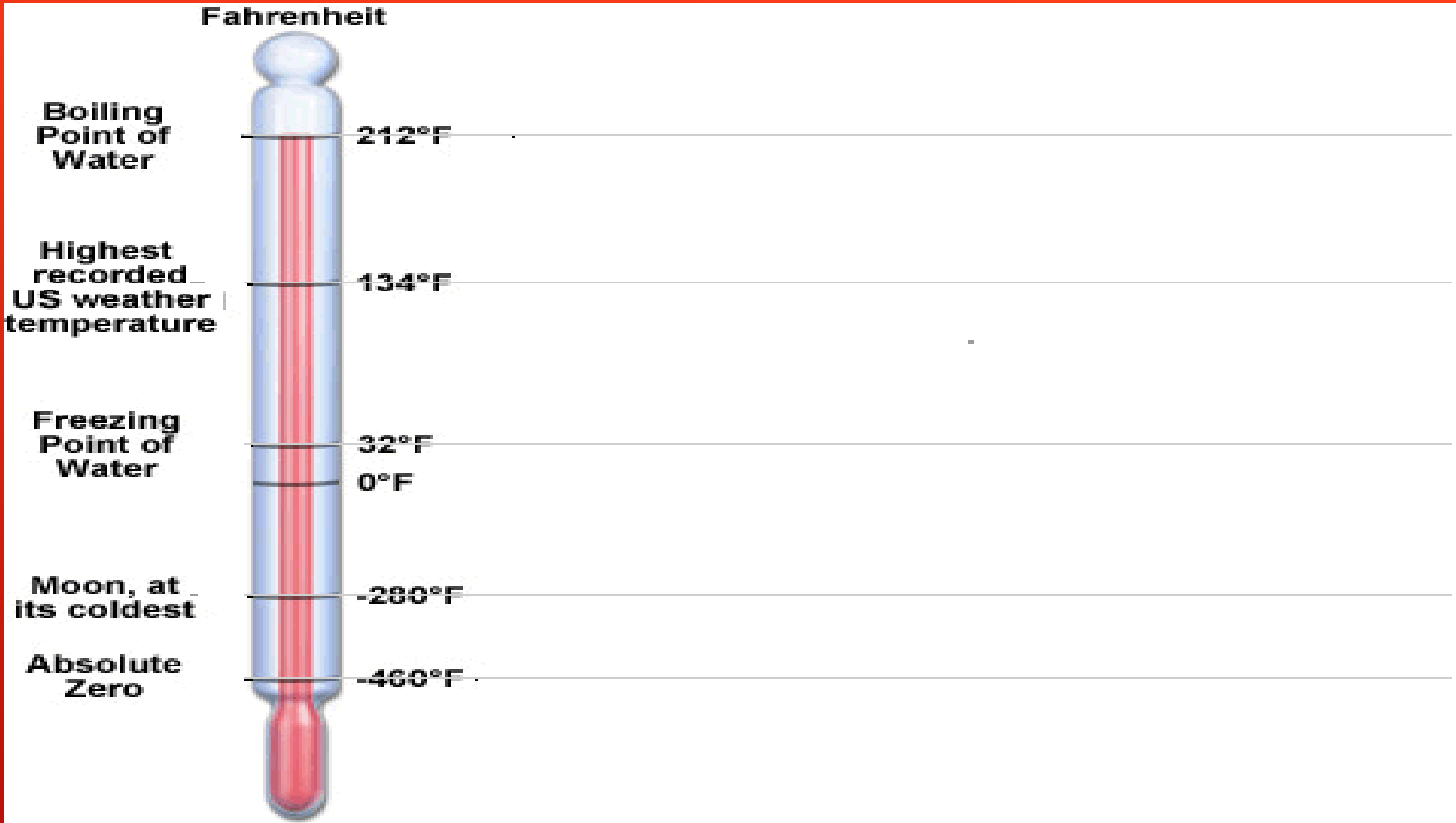
- (When writing temperatures in the Kelvin scale, convention the degree symbol is left out and we merely use the letter K.)

KELVIN

another unit of temperature in the metric system.

- The lowest possible temperature is 0 Kelvin (-273 ° C). This is Absolute Zero.
- To convert from Celsius to Kelvin:

K = C + 273°


Fahrenheit
Boiling Point of Water
212°F
Highest recorded US weather temperature
134°F
Freezing Point of Water
32°F
0°F
Moon, at its coldest
-280°F
Absolute Zero
-460°F

TEMPERATURE CONVERSION FORMULAS

- Fahrenheit to Celsius
- Celsius to Fahrenheit
- Kelvin to Celsius

$$F = C\,(1.8) + 32$$

$$C = (F - 32)/1.8$$

$$K = C + 273.15$$

TEMPERATURE CONVERSION EQUATIONS

4 equations to use:

1. oF = 9/5oC + 32

2. oC = 5/9 (oF-32)

3. K = oC + 273

4. oC = K – 273

Practice Problem #1

- $240^{o}C$ = _____K

- $K = {}^{o}C + 273$
- $K = 240 + 273$
- $K = 513$

Practice Problem #2

- 50^oF = _____ ^oC

- $^oC = 5/9\ (^oF-32)$
- $^oC = 5/9\ (50-32)$
- $^oC = 0.55\ (18)$
- $^oC = 10$

Practice Problem #3

- 510K = _____ °C

- °C = K – 273
- °C = 510 – 273
- °C = 237

Practice Problem #4

- 20 ^{o}C = _____ ^{o}F

- $^{o}F = 9/5^{o}C + 32$
- $^{o}F = 9/5(20) + 32$
- $^{o}F = 1.8(20) + 32$
- $^{o}F = 36 + 32$
- $^{o}F = 68$

THE NATURE OF HEAT

- Under normal conditions and in nature, heat energy will ALWAYS flow the warmer object to the cooler object.
- Heat energy will flow from one substance to another until the two substances have the same temperature.

SPECIFIC HEAT

- **specific heat** of a solid or liquid is the amount of heat that raises the temperature of a unit mass of the solid through 1° C.
- We symbolise it as C. In S.I unit, it is the amount of heat that raises the temperature of 1 kg of solid or liquid through 1K.
- Its unit in S.I system is always given as J kg-1 K-1 and CGS as cal g-1 C-1. If the amount of heat, ΔQ, required to raise the temperature of mass M through ΔT, then the formula for specific heat is given by:

CALCULATION OF SPECIFIC HEAT

- C = specific heat capacity
  Units [J/(kg.K)]
- m = mass
- T = change in temperature
  Tfinal – Tinitial
- Q = heat energy transferred

$$C = \frac{Q}{(m)(\Delta T)}$$

$$Q = (m)(\Delta T)(C)$$

HEAT TRANSFER

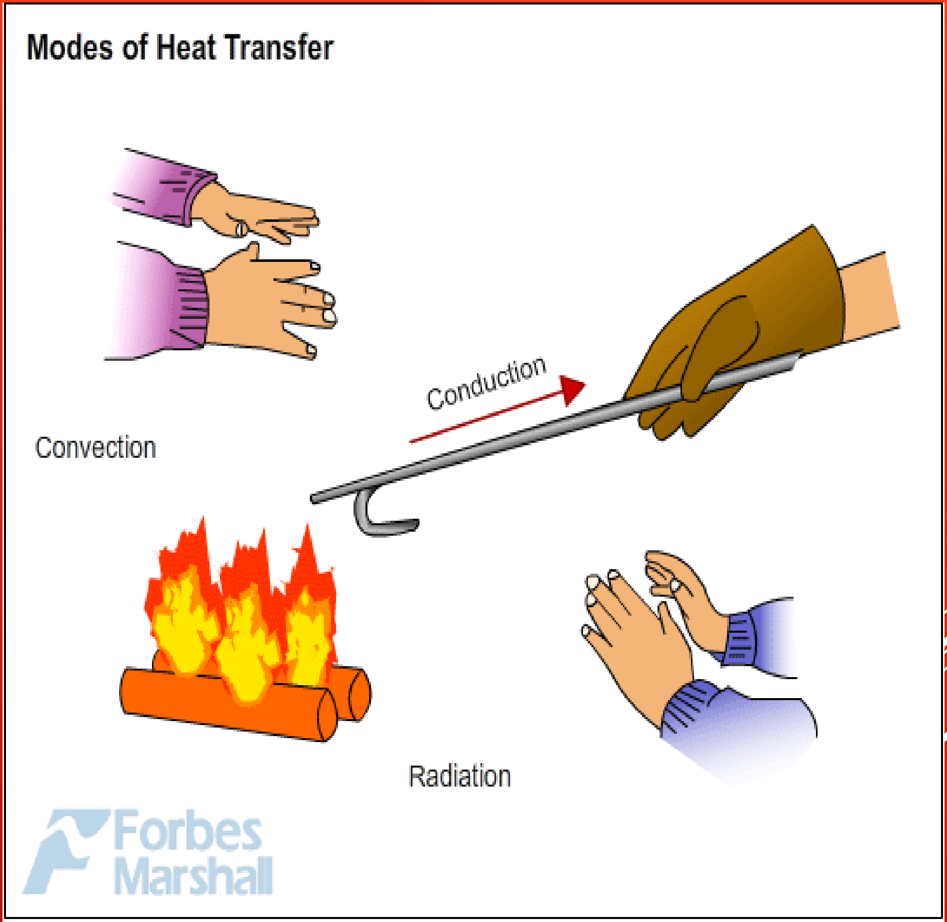
- Heat energy can be transferred from one body to the other or from one location in a body to the other. Study of the techniques and methods adopted to transfer heat energy is known as ‘Heat Transfer’. To facilitate heat transfer between 2 bodies there needs to be a temperature difference between them.This means that these bodies must be a 2 different temperatures one higher than the other to allow heat to flow from one body to the other.

- This means that no heat transfer occurs between 2 bodies which are at the same temperature. At the same time, it is very important to note that heat only flows from a body at higher temperature to a body at a lower temperature. Although this may look obvious, this law is very important from the point of view of thermodynamics.

THREE MODES OF ENERGY

Thermal energy in the form of heat can move in three ways.

1) Conduction
2) Convection
3) Radiation



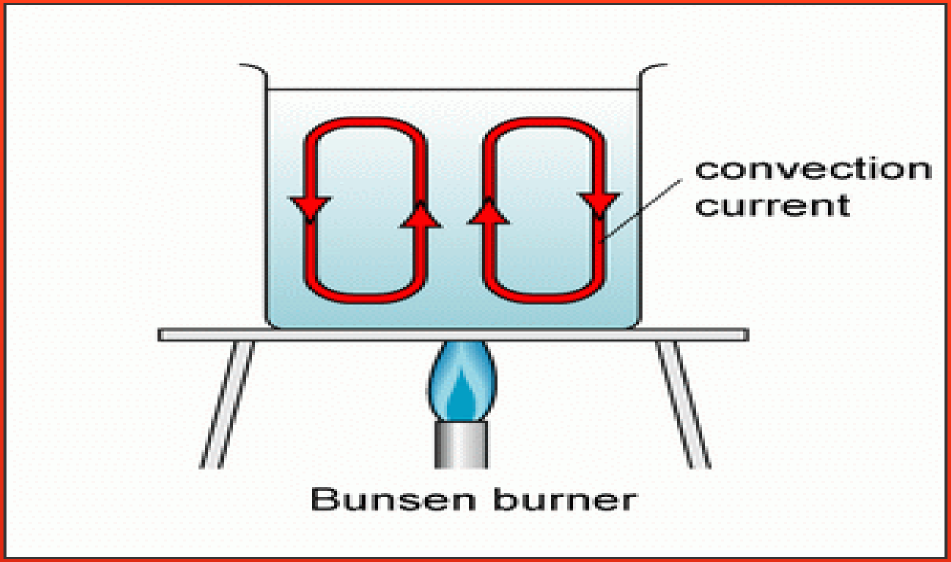
CONDUCTION

- Conduction is the method of transfer of heat within a body or from one body to the other due to the transfer of heat by molecules vibrating at their mean positions.

- The bodies through which the heat transfer must be in contact with each other. There is no actual movement of matter while transferring heat from one location to the other.

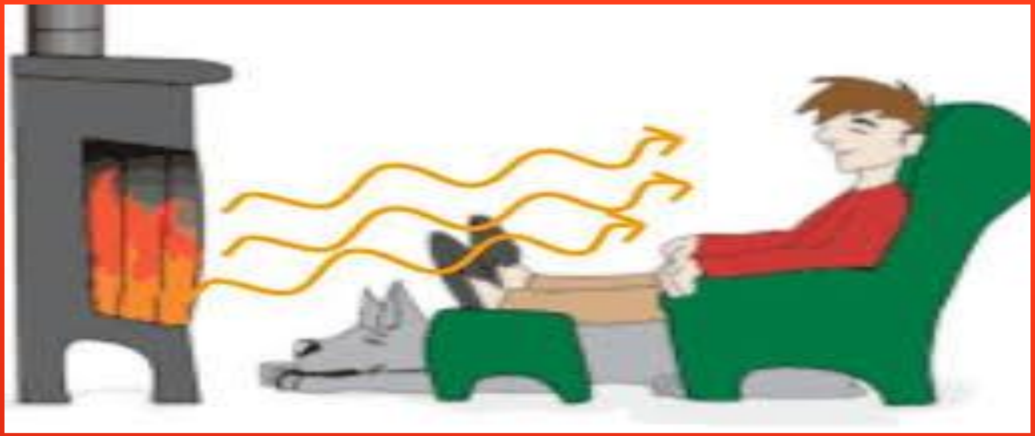
- Conduction occurs usually in solids where molecules in the structure are held together strongly by intermolecular forces of attraction amongst them and so they only vibrate about their mean positions as they receive heat energy and thus pass it to the surrounding molecules by vibrations.

CONVECTION



- Convection is the mode of heat transfer which occurs mostly in liquids and gases. In this method, heat transfer takes place with the actual motion of matter from one place within the body to the other.
- Often when we boil water we have seen bubbles and currents develop in the water on careful observation.

RADIATION



- Radiation is another form of heat transfer. It does not require any medium and can be used for transfer of heat in a vacuum as well. This method uses electromagnetic waves which transfer heat from one place to the other. The heat and light from the sun in our solar system reach our planet using radiation only.

- In fact, radiation is the most potent method of heat transfer. In winters when we sit near a fire we feel warm without actually touching the burning wood. This is possible by radiation only.

CONDUCTION, CONVECTION & RADIATION

THE NATURE OF HEAT

What happens when you put ice in a warm soft drink?

- The heat energy moves from the soft drink into the ice by conduction (particle to particle contact) causing the ice to melt.

REVIEW

Describe the three kinds of heat transfer.

a. **Conduction** – transfer of heat energy from one particle to another by direct contact. (Primarily in solids)

b. **Convection** – transfer of heat energy in fluids- gases and liquids) through the bulk movement of matter from one place to another. (Produces currents)

c. **Radiation –** transfer of energy through electromagnetic waves. (Matter is not required!) (Radiant & infrared radiation from the sun)

CONDUCTION	Radiation	Convection
▸ Direct contact of particles ▸ Solids/liquids/ gases ▸ The handle of a cooking utensil	• Transfer of energy by waves • Only radiant energy that is absorbed becomes thermal energy • Lightbulb • Fireplace	• Transfer of energy by bulk movement of matter (fluids) • Currents (wind, water) • Hot air balloon

Contrast:
Conduction
Convection
Radiation

- Direct contact of particles
- Solids/liquids/gases
- Solids -good conductors
- Gases -poor conductors

Conduction

- Transfer of energy by waves
- Only radiant energy that is absorbed becomes thermal energy
- Shiny/light colors- reflect
- Dull/dark colors- absorb

Radiation

- Transfer of energy by bulk movement of matter (fluids)
- Currents (wind,water)
- Hot air balloon

Convection

EFFECT OF IMPURITIES ON MELTING AND BOILING POINTS

FACTORS AFFECTING MELTING AND BOILING POINTS BOILING POINT

There are two factors affecting the boiling point of a liquid.

a) Pressure
b) Impurities

EFFECTS OF INCREASED PRESSURE ON BOILING POINTS.

- Increase in pressure increases the boiling point of a liquid.
- Application of this concept is the pressure cooker. It has tight fitting lid which prevents free escape of steam thus making the pressure inside to build up. Increase in the boiling point to high temperatures enables food to cook faster.
- Decrease in pressure lowers the boiling point of a liquid .

EFFECTS OF IMPURITIES ON BOILING POINT

- The boiling point for of the salt solution is higher than that of the distilled water.

- The presence of impurities in liquid raises its boiling points.

The presence of impurities in a pure substance can

a) increase its boiling point
b) b) decrease its freezing point

For example, - when a salt is added to pure water, water will be boil at a temperature higher than 100°C

MELTING POINT

There are two factors that affect the melting point of a substance.

a) Pressure

b) Impurities

EFFECT OF PRESSURE ON MELTING POINT

Melting point of ice is lowered by an increase in pressure

At higher pressure, an ice cube would melt at temperatures lower than 0 o C.

At lower pressure (on the mountain), ice would only melt at temperatures higher than 0 o C.

Which is why there can be snow on the mountain top even when surrounding temperatures are above 0 o C.

Example of pressing two ice cubes together.
When pressed together, the pressure they experience is higher, so the melting point is lowered causing the ice to melt.
When hand releases, the pressure they experience is lowered, so the water will now freeze at higher temperature.
Another example is walking on ice
And ice skating

APPLICATION OF THE EFFECTS OF PRESSURE ON MELTING POINT OF ICE.

ICE SKATING

- Weight of the skater exerts pressure on the ice below causing melting at a lower temperatures.
- The high pressure reduces melting hence melting them forming a thin film of water over which skater slides.

EFFECTS OF IMPURITIES

- Application of impurities lowers the melting point the melting point of a substance.

- Salt is spread on roads during winter to prevent freezing of roads.