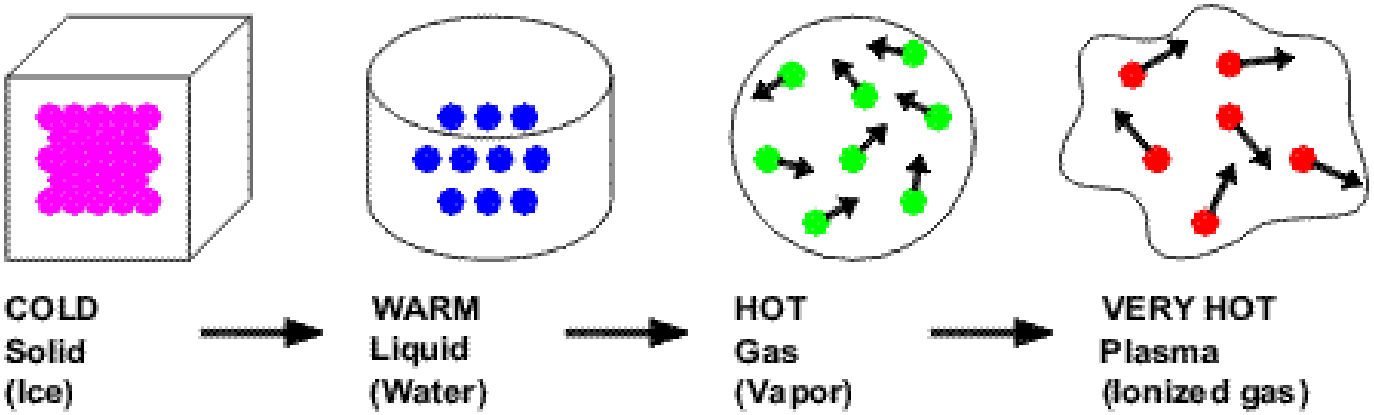
# What is matter?

- Matter is anything that has mass and takes up space.



# • ***<u>The Four States of Matter</u>***

- Solid
- Liquid
- Gas
- Plasma

# KINETIC THEORY

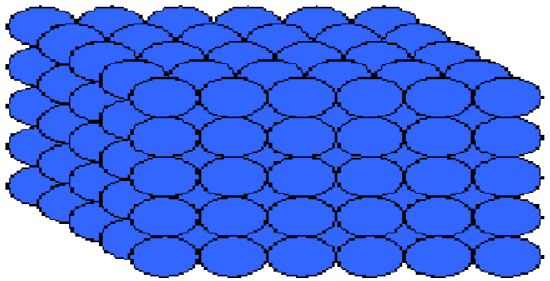
- Kinetic Theory states that the tiny particles in all forms of matter are in constant motion.
  - Kinetic refers to motion
  - Helps you understand the behavior of solid, liquid, and gas atoms/molecules as well as the physical properties

# KINETIC THEORY

- 3 Principles of Kinetic Theory
  - All matter is made of tiny particles (atoms)
  - These particles are in constant motion
  - When particles collide with each other or the container, the collisions are perfectly elastic (no energy is lost)

# SOLIDS

- Particles are tightly packed and close together
- Particles do move but not very much
- Definite shape and definite volume (because particles are packed closely and do not move)
- Have very little energy.

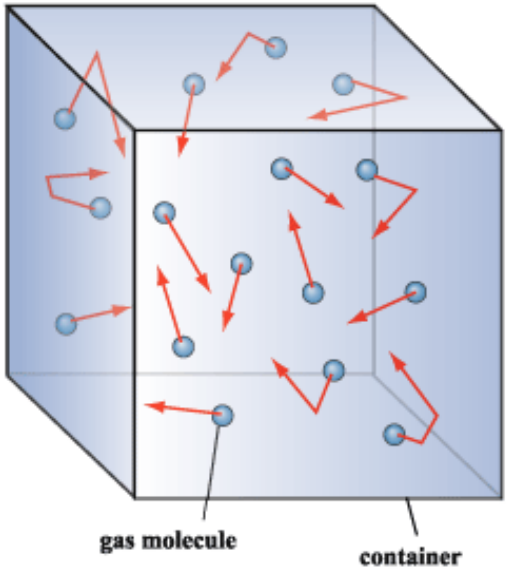


# LIQUIDS

- Particles are spread apart
- Particles move slowly through a container
- No definite shape but do have a definite volume
- Flow from one container to another
- Viscosity – resistance of a liquid to flowing
  - Honey – high viscosity
  - Water – low viscosity

# GASES

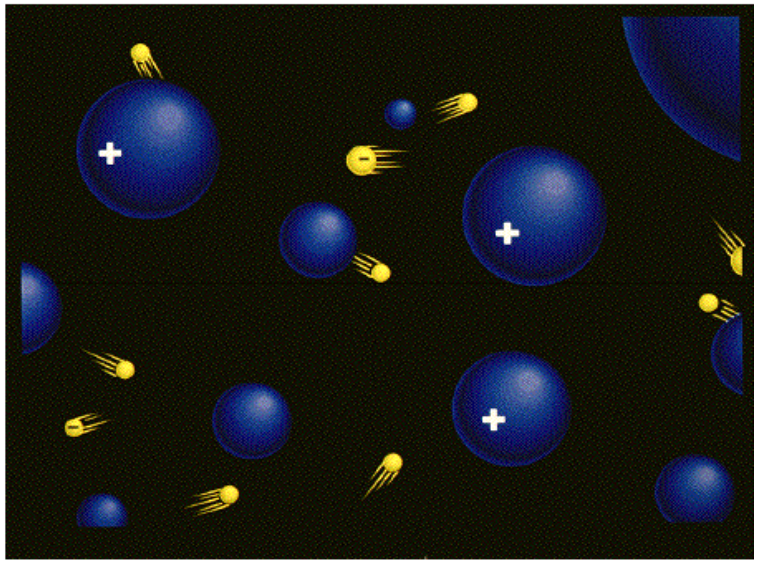
- Particles are very far apart
- Particles move very fast
- No definite shape and No definite volume



# STATES OF MATTER

## PLASMA

- **A plasma is an ionized gas.**
- **A plasma is a very good conductor of electricity and is affected by magnetic fields.**
- **Plasmas, like gases have an indefinite shape and an indefinite volume.**



- **Plasma is the common state of matter**

A plasma is an **ionized gas**, a **gas** into which sufficient energy is provided to free electrons from atoms or molecules and to allow both species, ions and electrons, to coexist.

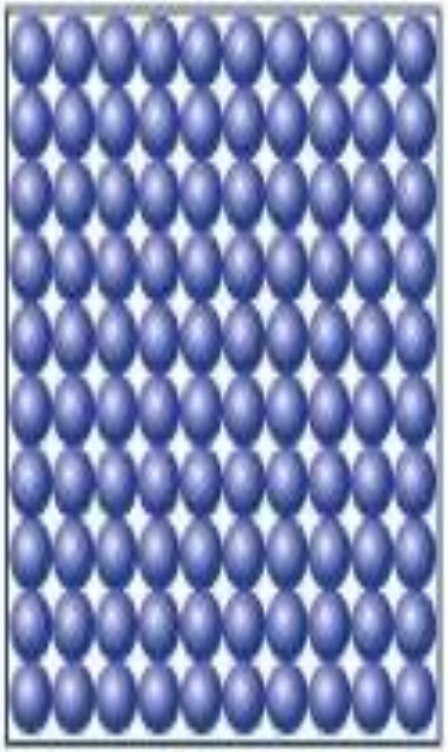
# Some places where plasmas are found...

1. Flames

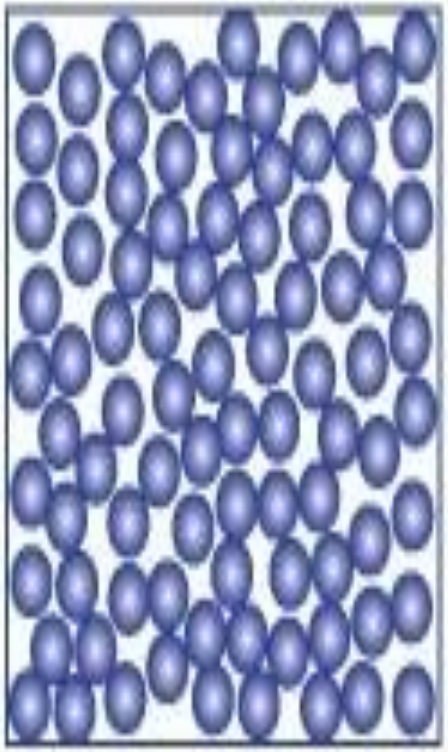

2. Lightning

# 3. Aurora (Northern Lights)

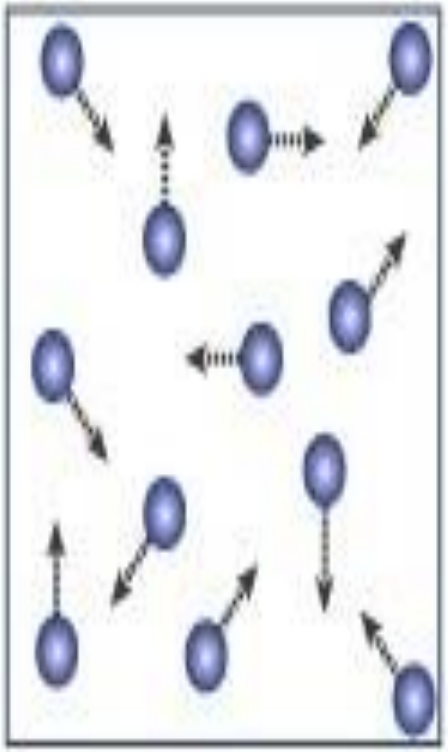
# The Sun is an example of a star in its plasma state



Solid

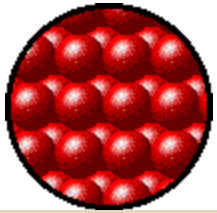


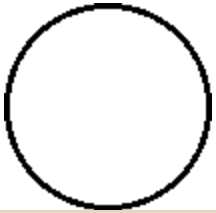
Liquid

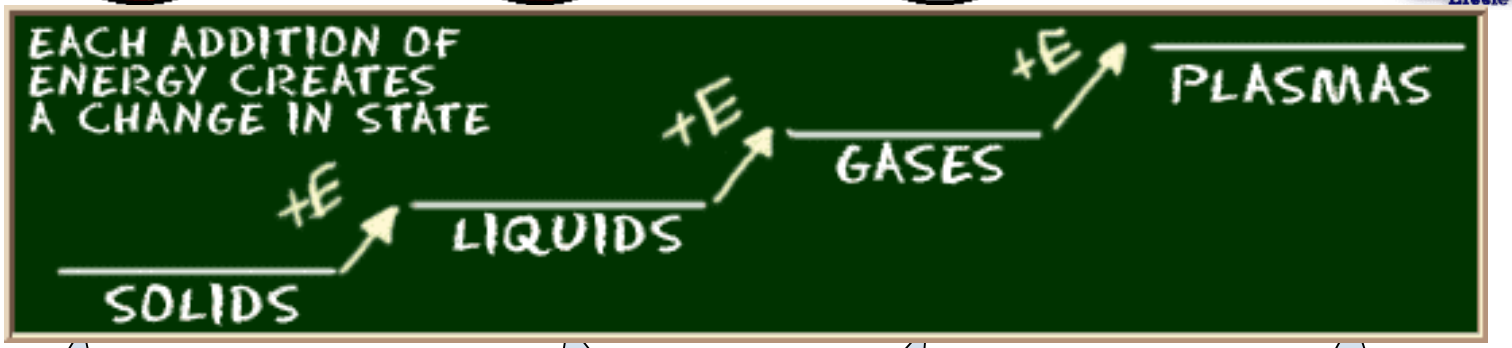


Gas

# STATES OF MATTER






**SOLID**

Tightly packed, in a regular pattern Vibrate, but do not move from place to place

**LIQUID**

Close together with no regular arrangement. Vibrate, move about, and slide past each other

**GAS**

Well separated with no regular arrangement. Vibrate and move freely at high speeds

**PLASMA**

Has no definite volume or shape and is composed of electrical charged particles

# Enthalpy

1. Definition Heat flow in a system

Symbol H

*Like internal energy, the change in enthalpy is important*

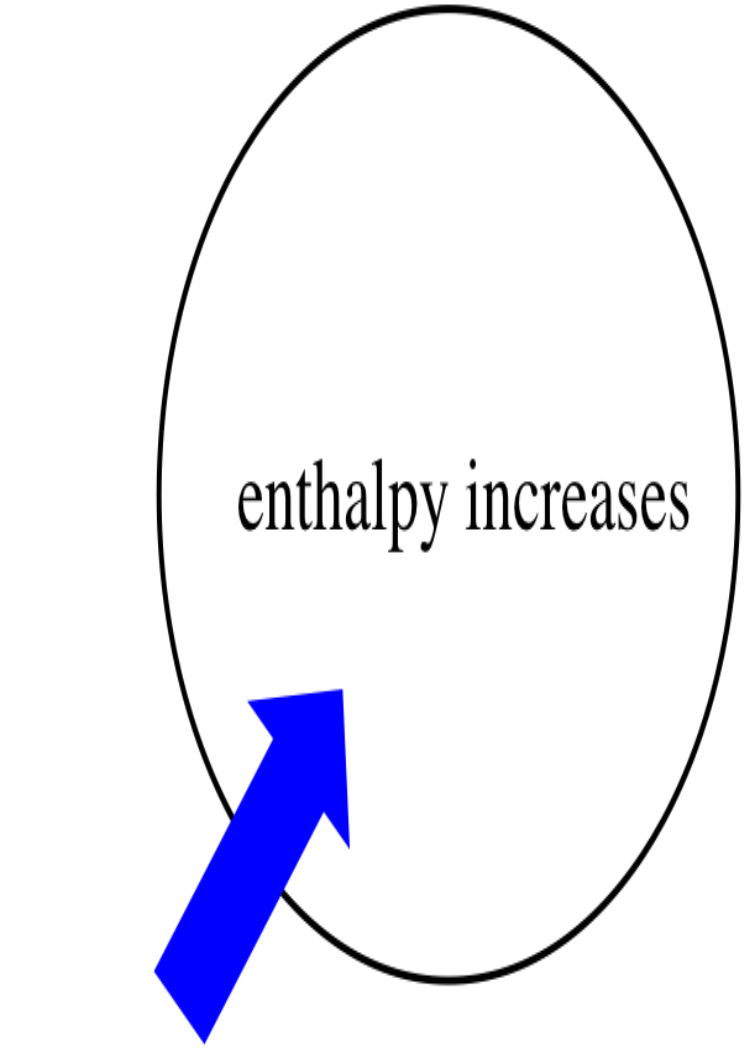
*State function – measure of its current conditions*

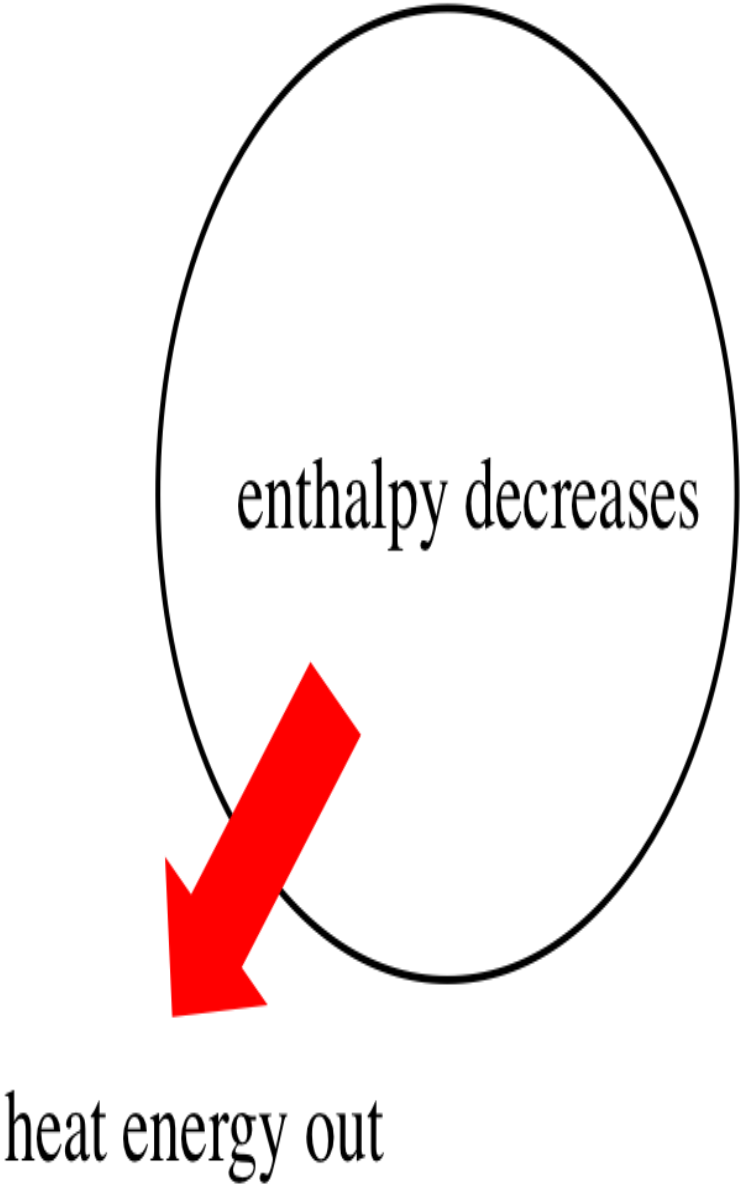
$$\Delta H = H_{products} - H_{reactants}$$

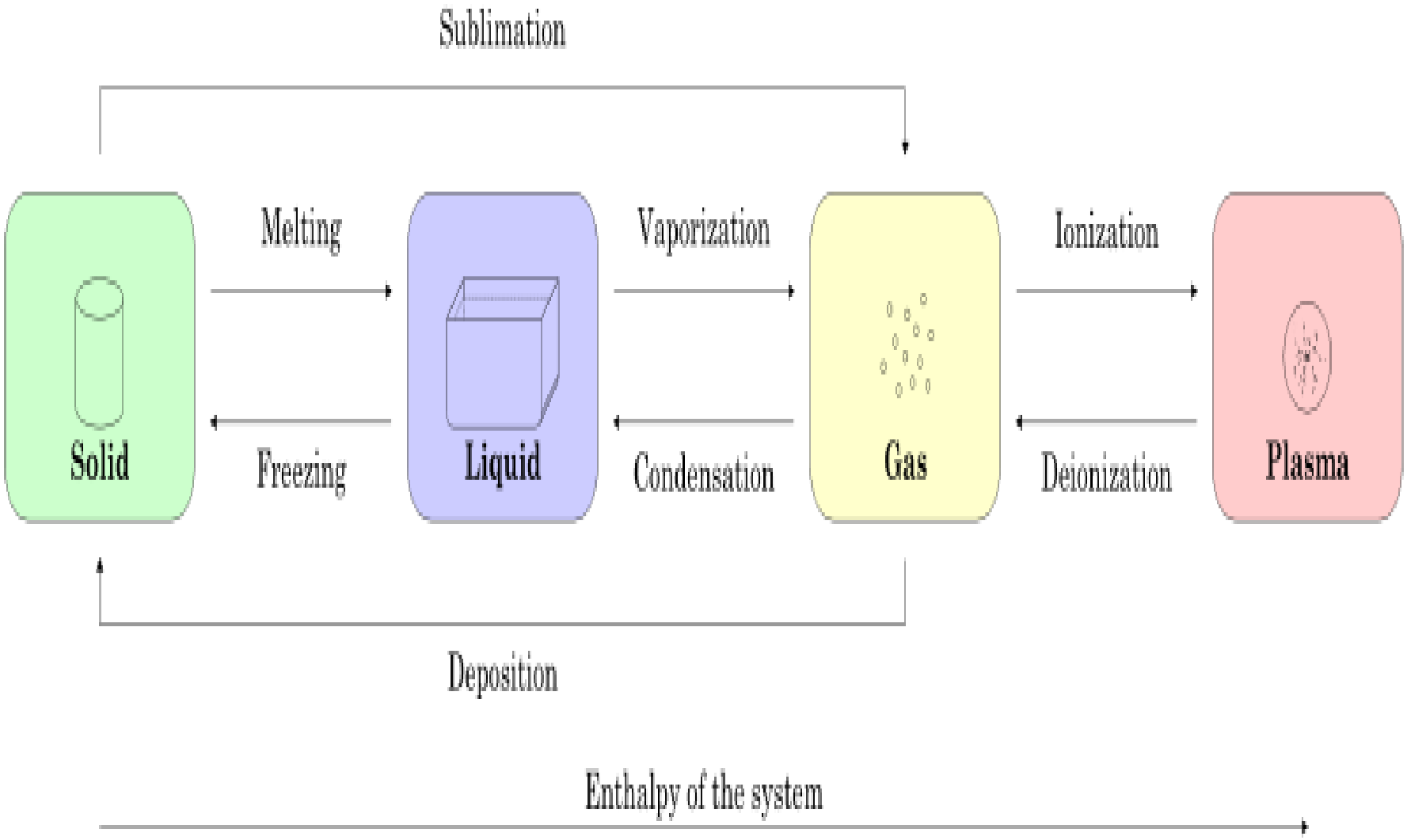
$\Delta H = +$ System is gaining heat Endothermic

$\Delta H = -$ System is losing heat Exothermic

Enthalpy of a chemical reaction = Heat of Reaction


enthalpy increases
heat energy in


enthalpy decreases
heat energy out


Sublimation
Melting
Vaporization
Ionization
Solid
Liquid
Gas
Plasma
Freezing
Condensation
Deionization
Deposition
Enthalpy of the system

# TERMINOLOGY for PHASE CHANGES

- Points to Know:
  - Melting Point-Temperature when solid turns to a liquid
  - Freezing Point-Temperature when liquid turns to a solid
  - Boling Point-Temperature when a liquid turns to a vapor
    - Doesn’t boil unitl vapor pressure coming off liquid is equal to the air pressure around it
    - Since air pressure changes with height, water does not always boil at 100°C
  - Condensing Point-Tempeature when vapor turns to liquid
  - **Sublimation** is a specialized change of state when a solid substance skips the liquid phase and moves directly into the gas phase. ... "Dry ice" or solid carbon dioxide sublimes. 2. **Snow** and ice can sublime in the winter months without melting

# PHASE CHANGES

| Description of Phase Change | Term for Phase Change | Heat Movement During Phase Change |
| --- | --- | --- |
| Solid to liquid | Melting | Heat goes into the solid as it melts. |
| Liquid to solid | Freezing | Heat leaves the liquid as it freezes. |

# PHASE CHANGES

| Description of Phase Change | Term for Phase Change | Heat Movement During Phase Change |
| --- | --- | --- |
| Liquid to gas | Vaporization, which includes boiling and evaporation | Heat goes into the liquid as it vaporizes. |
| Gas to liquid | Condensation | Heat leaves the gas as it condenses. |
| Solid to gas | Sublimation | Heat goes into the solid as it sublimates. |

# Boiling point is the temperature at which something becomes a gas.

Water has a boiling point of 100° C.

This means that at 100° C, water changes from a liquid to a gas.

# Melting point is the temperature at which something becomes a liquid.

Water has a melting point of 0° C.
This means that at 0° C, water changes from a solid to a liquid.

| Substance | Melting Point $^0C$ | Boiling Point $^0C$ |
|---|---|---|
| Aluminium | 661 | 2467 |
| Ethanol | -117 | 79 |
| Magnesium | 827 | 3627 |
| Mercury | -30 | 357 |
| Methane | -182 | -164 |
| Oxygen | -218 | -183 |
| Sodium chloride | 801 | 1413 |
| Sulfur | 113 | 445 |
| Water | 0 | 100 |

# Heating and cooling curve

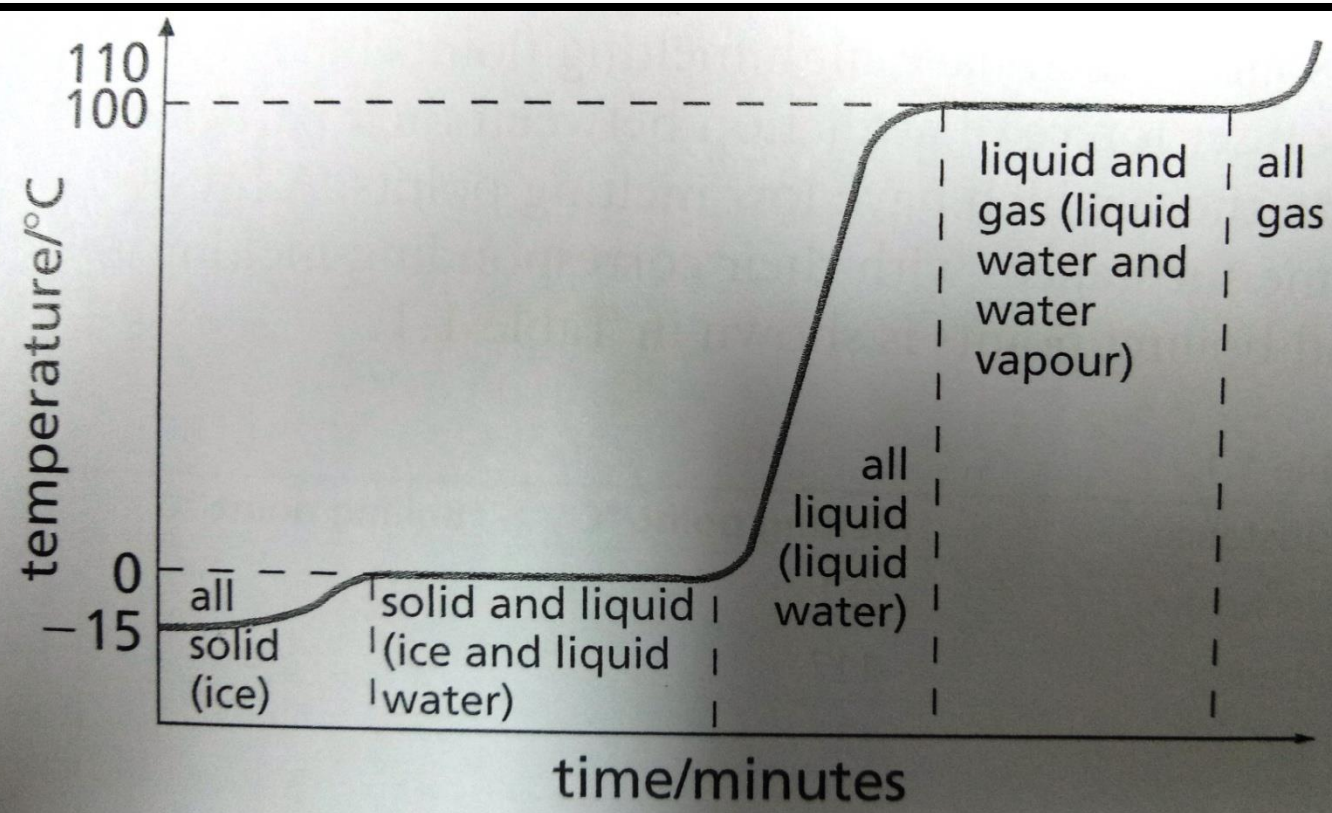


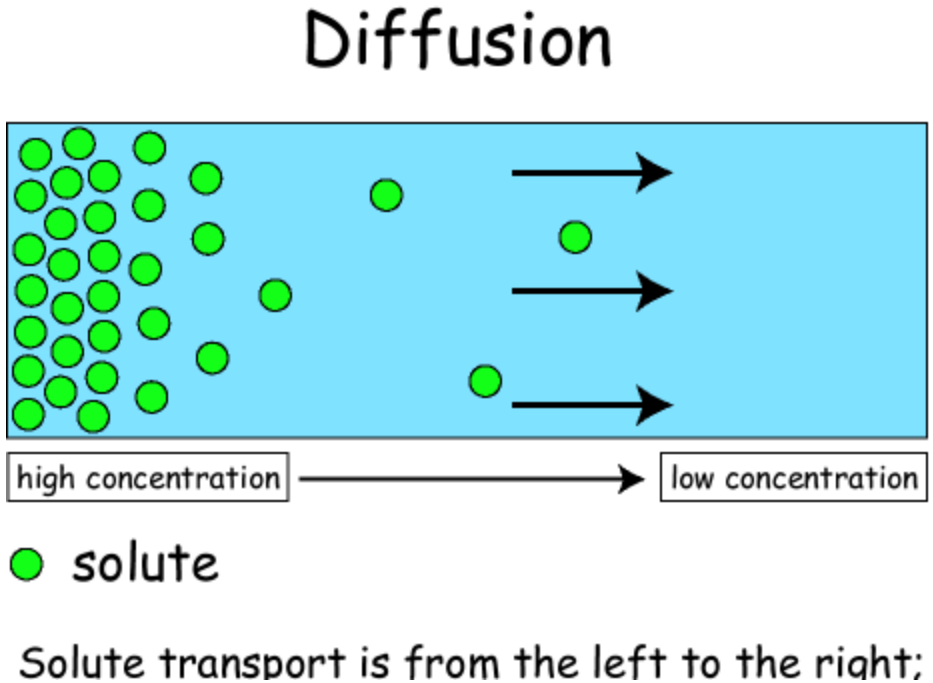

**Figure 1.11** Graph of temperature against time for the change from ice at −15 °C to water to steam.

# Liquid crystal

- Liquid crystals are an unusual state of matter.
- Uses : digital watches, calculators, laptop computers and televisions.
- They are also useful in thermometers because liquid crystals change colour as the temperature rises and fall.

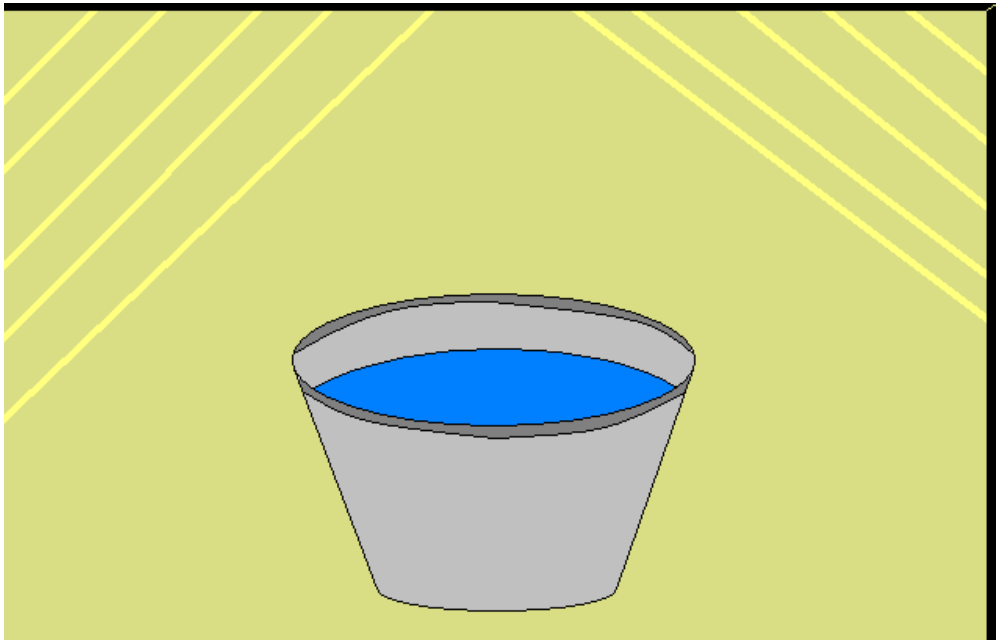
# What is Diffusion?

- Diffusion is the movement of molecules from high concentration to low concentration, until equilibrium is reached.

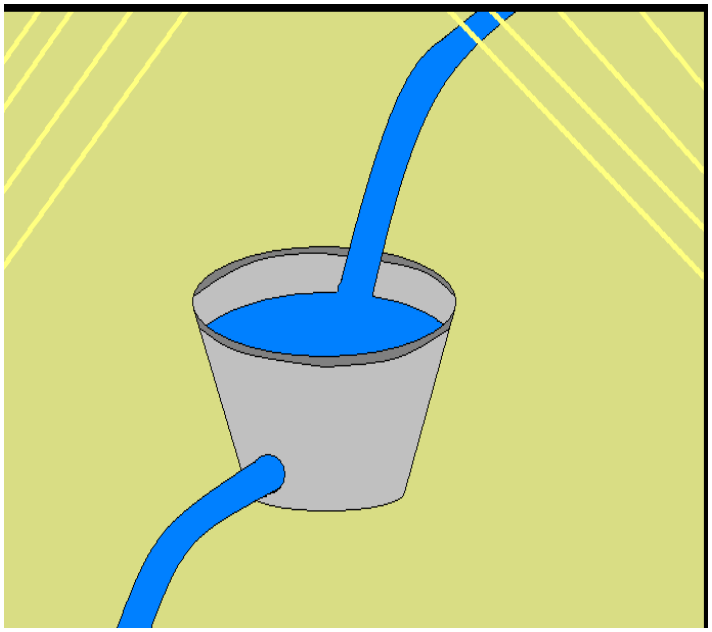


# Equilibrium

- Static equilibrium: no change in the system is occurring.
- For example, a bucket of water is in equilibrium because there is no change occurring to it.



- Dynamic equilibrium: changes in the system are occurring, but at the same rate as one another.
- For example, a bucket of water with a hole.



# Intimate Mixing

- Diffusion takes place between a liquid and a gas.
- Collision taking place between liquid and gas particles.
- Gas particles diffuse faster than liquid particles.
- Example: Conc. Ammonia solution and Conc. Hydrochloric acid.

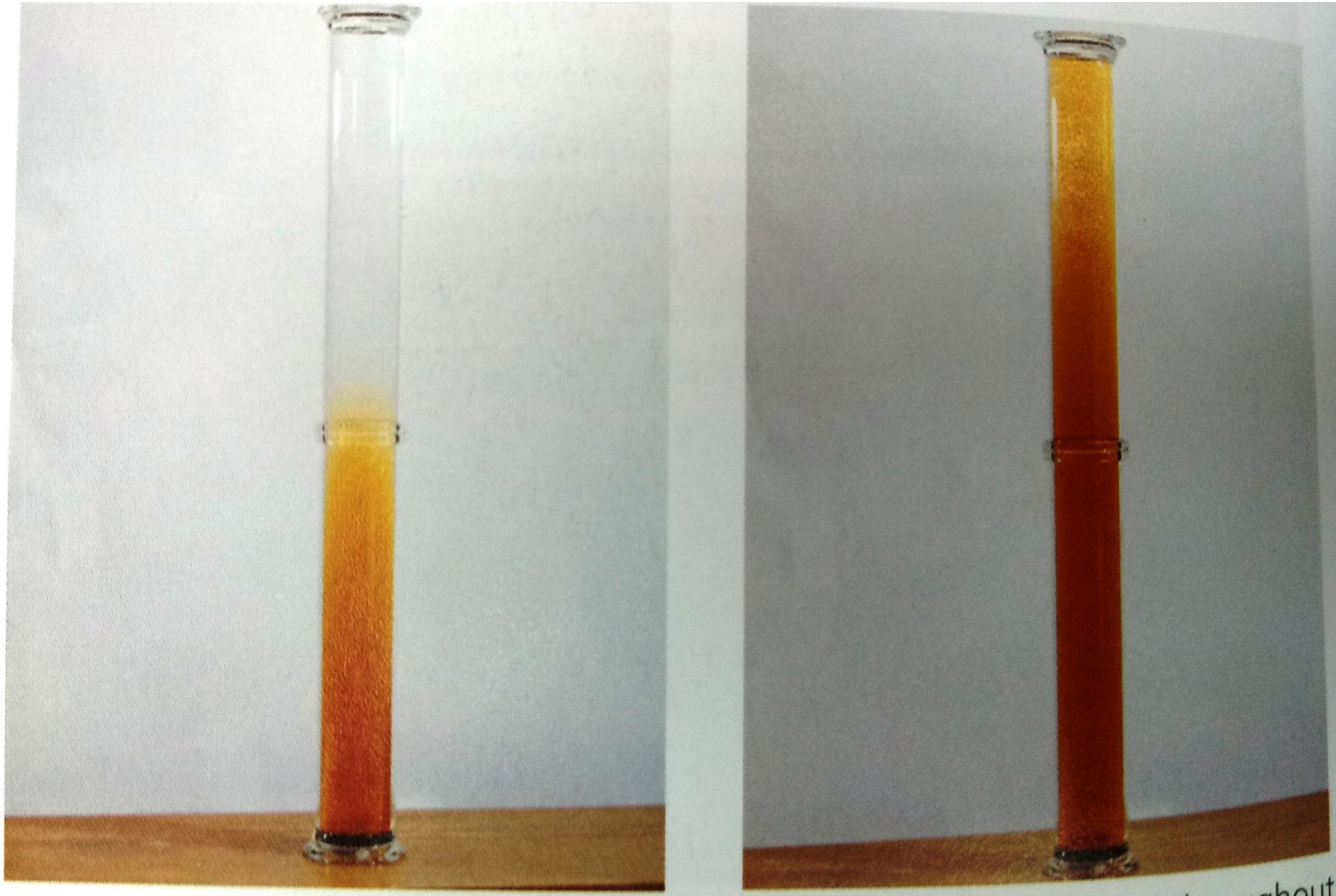
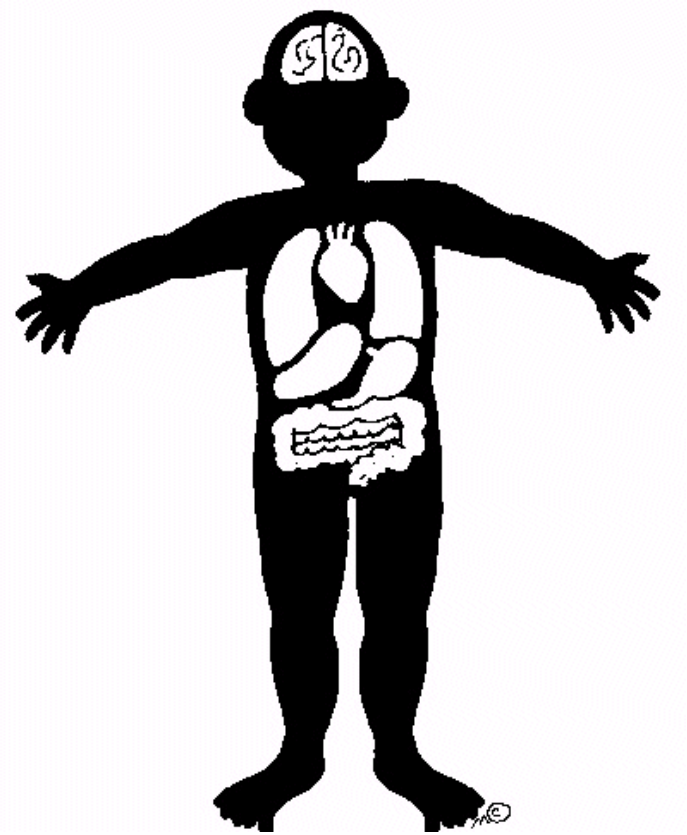


**Figure 1.13** After 24 hours the bromine fumes have diffused throughout both gas jars.

# How is this Important?

- Diffusion is an important concept for humans because our existence depends on it.

- The cells of the human body utilize diffusion every day!

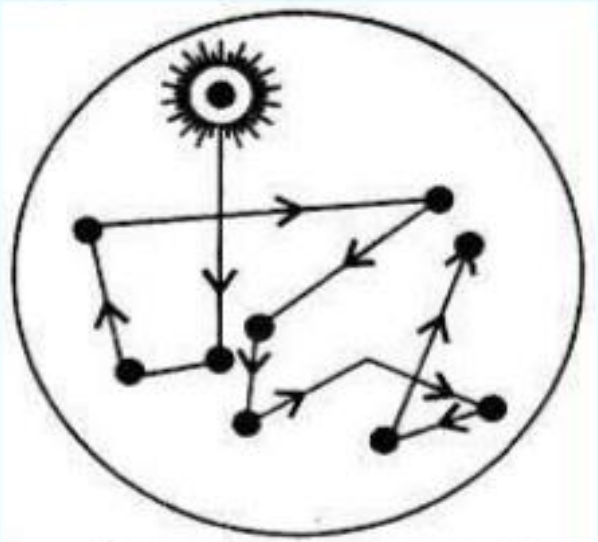


# Brownian Motion: Discovery

- Discovered by Scottish botanist Robert Brown in 1827 while studying pollens of *Clarkia* (primrose family) under his microscope

# What is Brownian movement ?

**Brownian movement:** the random motion of small colloidal particles suspended in a liquid or gas medium, caused by the collision of the medium's molecules with the particles. Also called **Brown'ian movement.**



Brownian movement

# How are the brownian motion different from diffusion?

Brownian motion differs from diffusion most significantly in that diffusion results in a net transfer of material from one location to another on a macro scale, while Brownian motion is randomly directed motion of molecules and similarly sized particles and does not result in net mass transfer from one place to another.

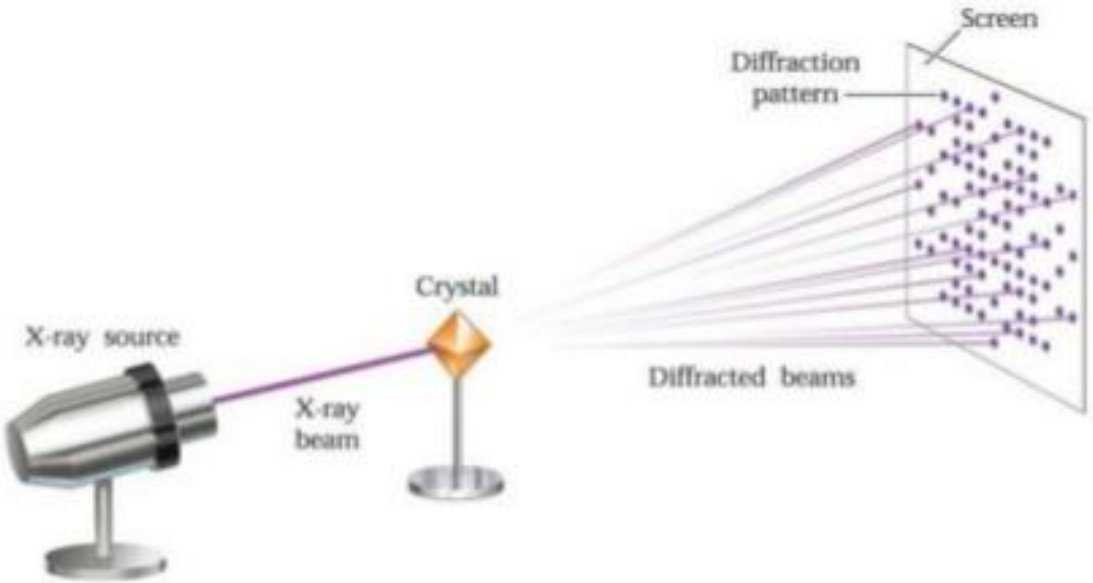
# X-Ray Crystallography

- It is method of determining the arrangement of atoms within a crystal, in which a beam of x-ray strikes a crystal and causes the beam of light to spread into different directions

# X RAY DIFFRACTION

- X-Ray Crystallography uses the uniformity of light diffraction of crystals to determine the structure of a molecule or atom.

- Then they use an X-ray beam to “hit” the crystallized molecule. The electrons surrounding the molecule diffract as the X-rays hit them. This forms a pattern, this type of pattern is called the X-ray diffraction pattern.


Screen
Diffraction pattern
Crystal
X-ray source
X-ray beam
Diffracted beams

W. W. Norton

# Uses of X-Ray Crystallography

- Used to study many materials which form crystals like salts, metals, minerals as well as various inorganic, organic and biological molecules.
- Position of the atoms in the crystal  and their chemical bonds.
- Size of atom