Transformations of Matter

Change

- Matter around us goes through many changes.
  - E.g. Water evapourates, bread is toasted for your breakfast
- Changes are divided into two categories:
  - Physical changes
  - Chemical changes

Physical Changes

- **<u>Physical change</u>** is when the appearance of a substance is changed but not the nature of the substance.
- Does not alter the composition
  - E.g. Ice, water, steam all are water in a different state

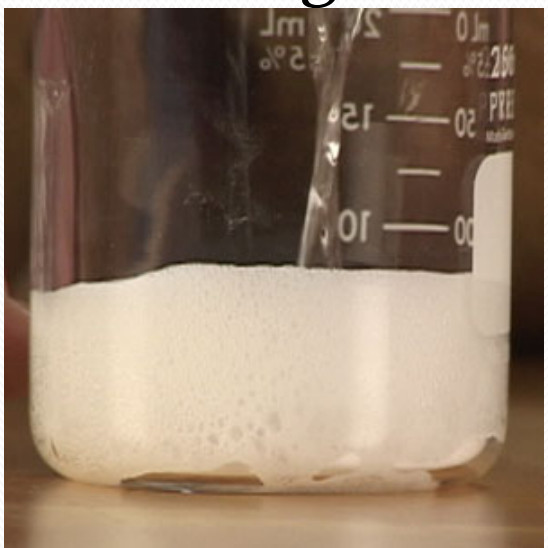
Chemical Changes

- **Chemical change** happens when two or more substances (reactants) react with each other to produce a new product
- The nature of the substance is modified as are the properties
  - E.g. Iron + Oxygen = Iron oxide (rust)

Indicators of a chemical change

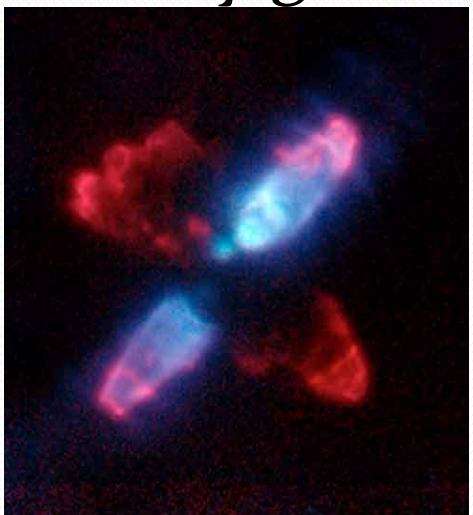
1. A change in colour- indicates presence of a new substance

2. Formation of a gas- easily seen with bubbles in a liquid, or the presence of smoke e.g. Baking soda and vinegar



3. Formation of a precipitate- when some solutions are mixed, a solid will form and settle to the bottom

4. Variation in heat- a chemical reaction will require or give off heat, some may give off light too



Identify each of the following as either a chemical or a physical change. Why?

a. Melting candle wax. -
b. Burning a candle. -
c. Tearing paper. -
d. Burning paper. -
e. Dissolving table salt. -
f. Cutting pieces of cucumber. -
g. Food rotting. -

Physical Changes

- Matter can undergo many physical changes that change its appearance, but not its composition
  - E.g. Cut bread, spread butter on the bread, chew the bread (yum)
- We will focus on:

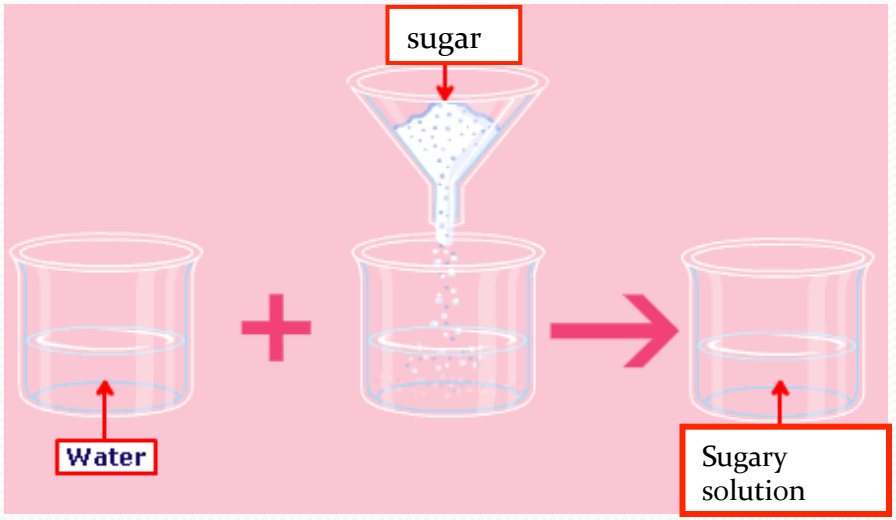
1. Dissolution
2. Dilution
3. Phase changes

Dissolution

- **Dissolution** or dissolving is the action of completely mixing one or more solutes with a solvent to form a solution.

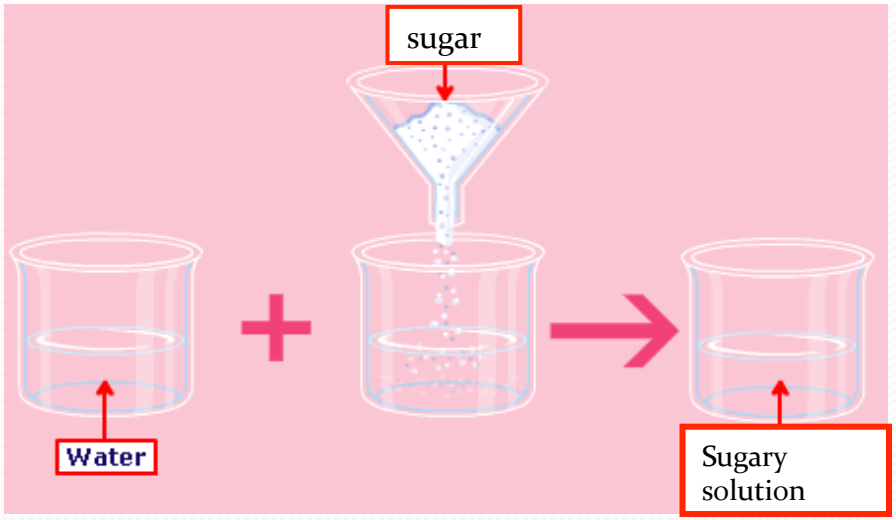
Phenomena explained by the mechanism of dissolution (particle theory)

1. **The behaviour of mass and volume before and after dissolution:**
   - E.g. 25 g sugar has a volume of 30ml and 100 g of water a volume of 100ml
   - When mixed together, what will their mass be?



125g

- What will the final volume be of the 30ml of sugar and the 100ml of water?
- 113ml
- Why is this?



2. **Insolubility** of certain substances

- E.g. Water and oil or oil base paints

- The oil molecules are more strongly attracted to themselves than to the solute (water)

3. **Saturated solutions.**

- Particle theory also explains why there is a limit to how much solute will dissolve. It is limited by the number of molecules of solvent.

What are some Factors that effect the Rate of Dissolving?

- Surface area of the solute
- Agitation (stirring)
- Temperature of the solvent

1. **Surface area.**

- The smaller the particles of the solute, the more surface area is open to attack from the solvent.
- A higher S.A. will speed up the rate of dissolving.

2. Agitation of solution

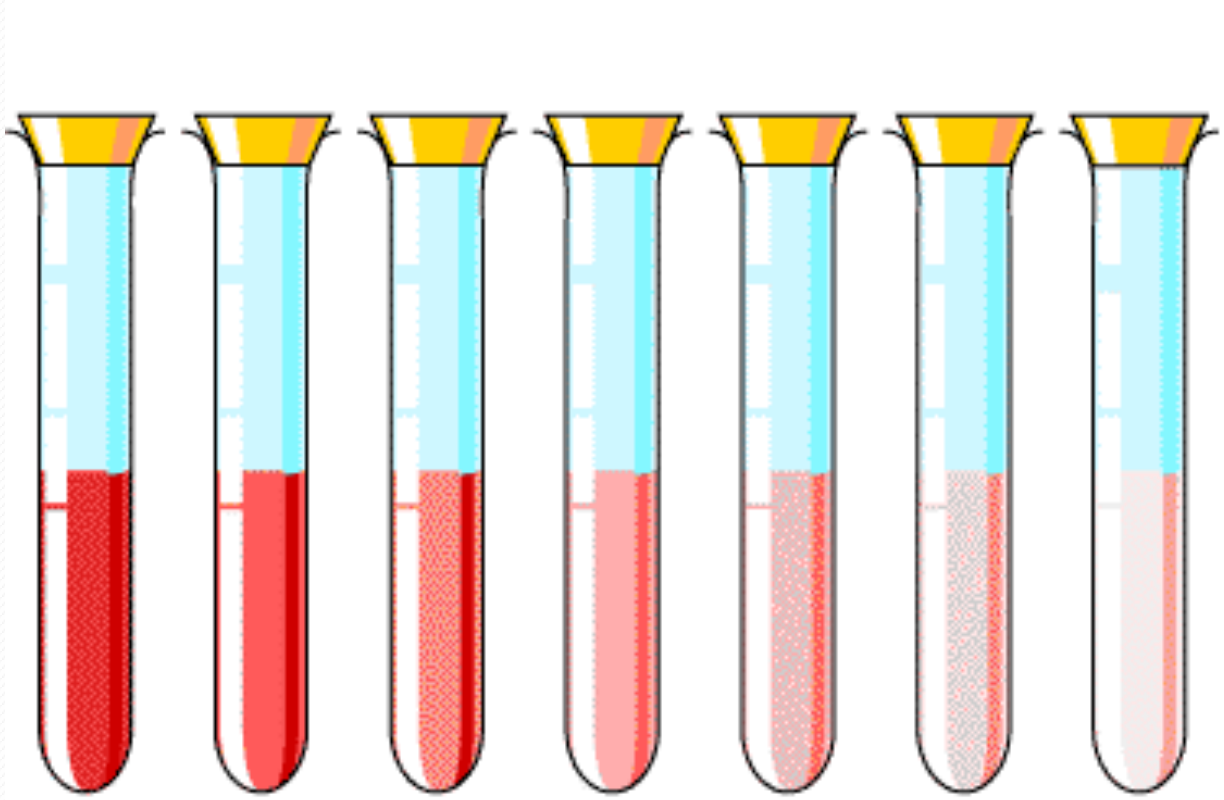
- By moving/stirring the solvent, you speed up the movement of the solvent molecules and increase the contact with the solute

3. Temperature of the solvent

- By heating up the solvent, the particles have more energy and collide more with the solute.

Dilution

- **Dilution** is the procedure making a final solution that is weaker than the initial solution
  - E.g. Concentrated soups need to be mixed with one can of water.

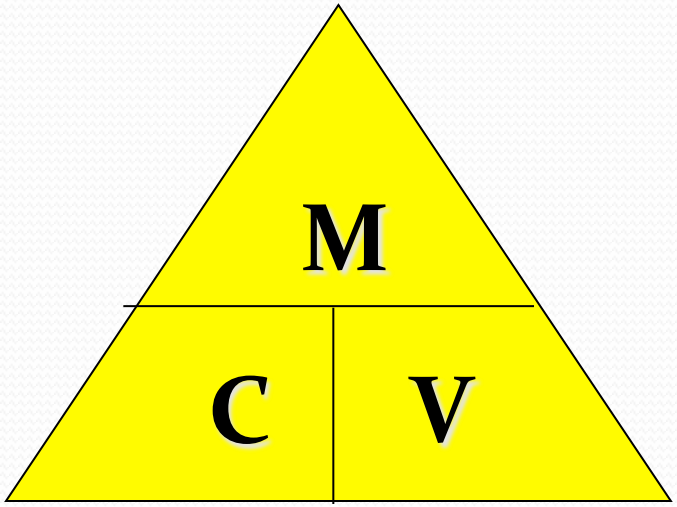


- One way to do this is to add additional solvent to the solution e.g. Add more water to frozen juice

Or

- take part of the original solution and add more solvent to get the desired volume. E.g. Add a small amount of chocolate syrup to a glass of milk.

The "CONCENTRATION TRIANGLE" (of science)



$$C = \frac{m}{v}$$

Is used to make the initial solution

Now to dilute it….

- The initial solution will have a given number of particles.
- For example, if you double the volume of this solution by adding more solvent, the total volume will double but the number of solute particles will remain the same.

Calculating dilutions

- Formula:
- **$C_1V_1=C_2V_2$**
  - C_1 is the initial concentration (g/100 mL or g/L)
  - V_1 is the initial volume (ml or L)
  - C_2 is the final concentration (g/100 mL or g/L)
  - V_2 is the final volume (ml or L)

$C_1V_1=C_2V_2$

- Calculate the volume in litres, to which 500 ml of 0.02 g/ml copper sulfate solution must be diluted to make a new concentration of 0.001 g/ml
- C_1= 0.02 g/ml
- V_1= 500 ml
- C_2= 0.001 g/ml
- V_2= ?

- $C_1V_1=C_2V_2$
- $V_2 = \frac{C_1V_1}{C_2}$

$= \frac{(0.02\ \cancel{g/ml})(500\ ml)}{0.001\ \cancel{g/ml}}$ units cancel each other out

$= 10\ 000\ ml$

$= 10\ L$

Concentration

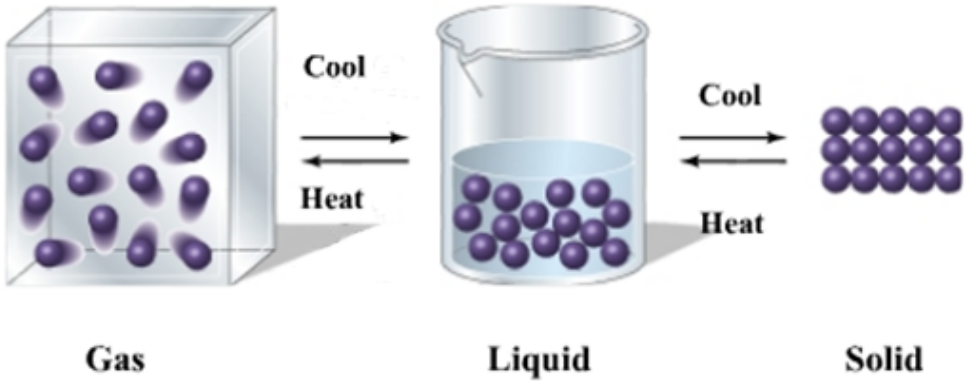
- A measure of how much of a given substance there is mixed with another substance- most often with solutions referring to the amount of solute compared to the solvent in the solution

Phase Change

- A **phase change** is when a substance passes from one state into another.
- May happen naturally (water in a puddle evaporates)
- Happens when a substance is heated or cooled

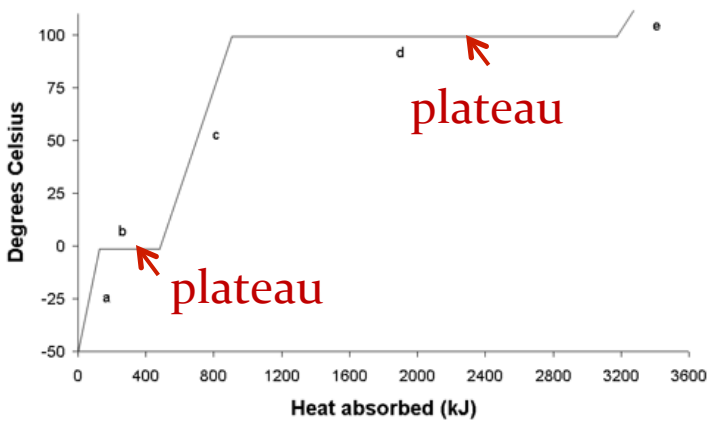
Phase Change

- Are physical changes as the composition of the substance doesn't change
  - E.g. Ice, water, and steam are still H_2O molecules



Particle Theory and phase changes

- To change from a solid to a liquid a lot of energy is needed to break the bonds that hold the molecules in the solid form.
- Similarly to go from liquid to gas, the molecules need more energy to break free of the surface of the liquid.
- This change [illegible] "plateau" in a heat curve



- Each pure substance passes from

  Solid→ liquid→ gas

  at precise temperatures (characteristic physical property)

Particle Model

- Allows us to understand abstract ideas like matter not being continuous
- 4 Statements make up the particle model
  - 1) Particles of matter are extremely small
  - 2) They are in constant movement (vibration)
  - 3) An increase in temp. causes more movement in particles
  - 4) Particles may be held by forces of attraction

Properties of Solids:

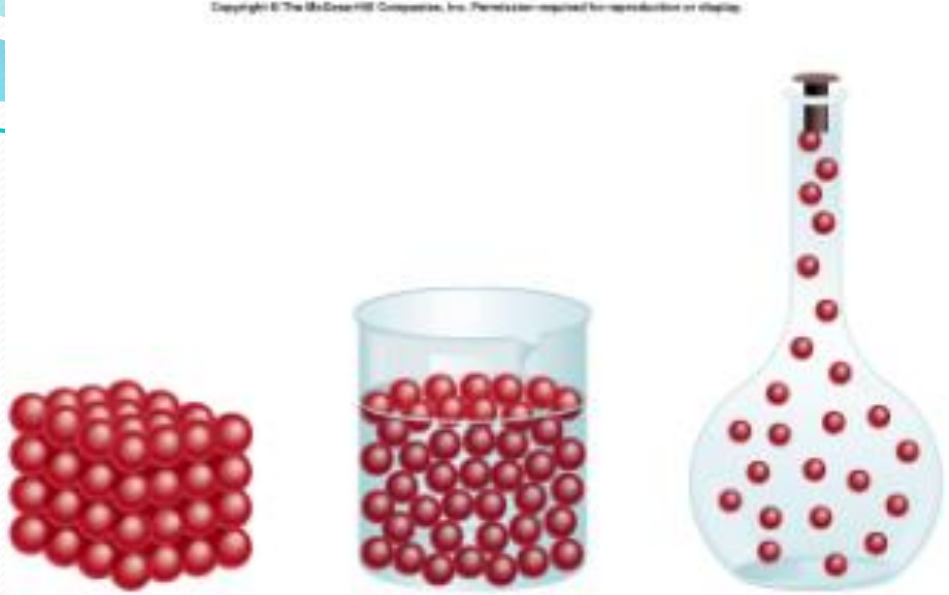
1) Definite volume
2) Definite shape

Particle Arrangement

1) Particles close together and little movement
2) Vibrate in 1 spot
3) Strong forces of attraction between particles
4) Non-Compresible

Solids

Properties of Liquids:



1) a definite volume
2) No definite shape – they take the shape of whatever they are in

Particle Model:

1. Particles close but weak forces keep them together
2. Non-compresible

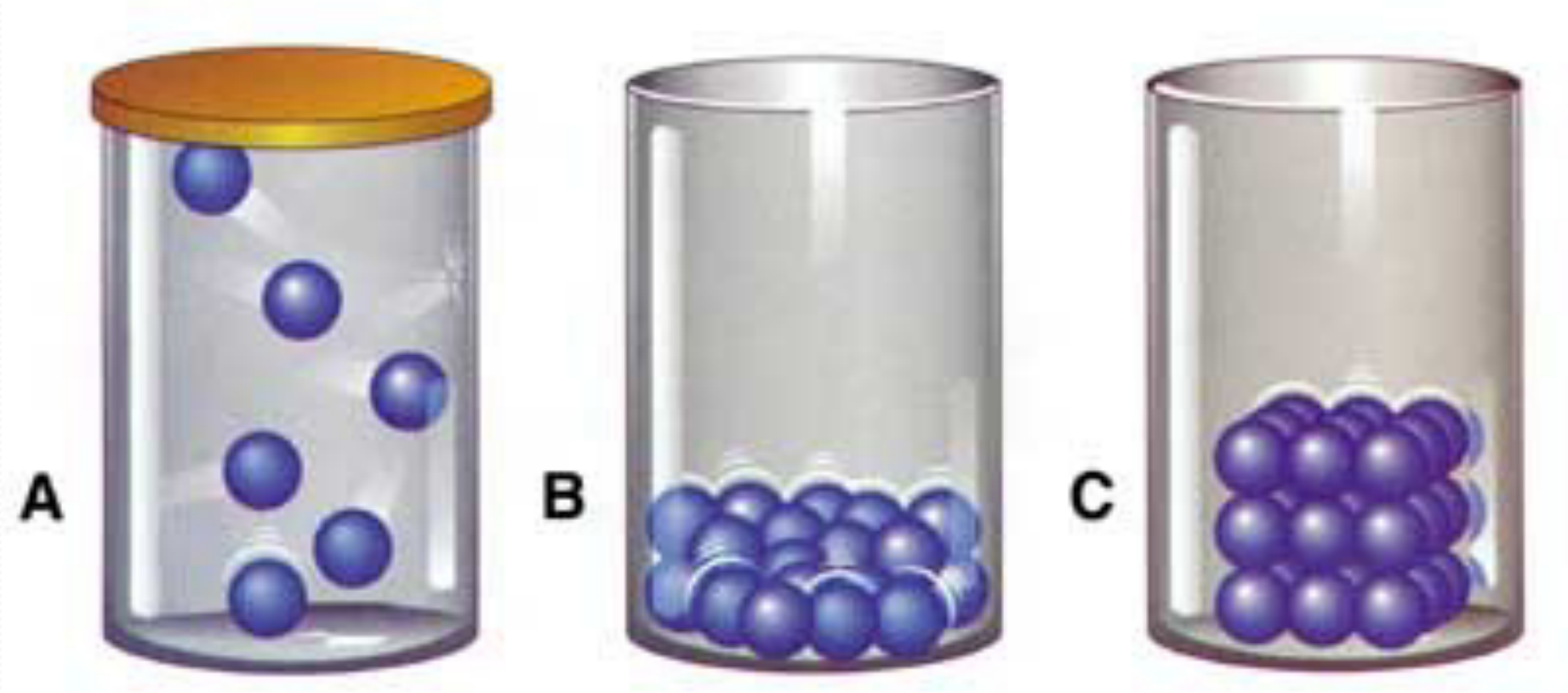
Properties of Gases:

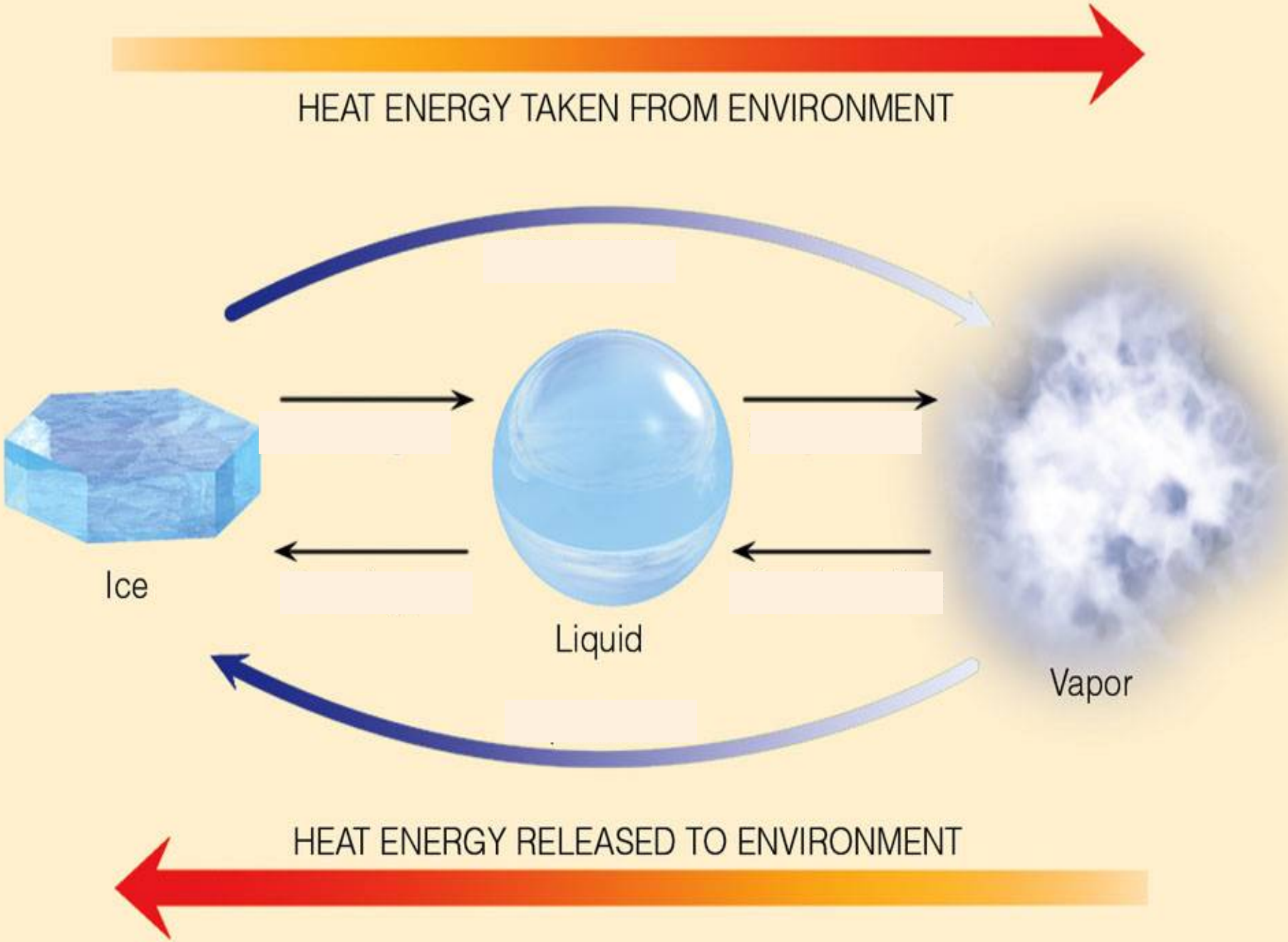
1) No definite volume
2) No definite shape.
3) Gases take the shape of their container.
4) Low density because the atoms are well spaced

Particle Model:

1) Extremely weak (no) forces of attraction between particles
2) Lots of space between particles and freedom of movement

Which is which?





- Bill Nye- phase changes

Chemical Changes

Chemical transformations

- A chemical transformation occurs when 2 or more substances called “reactants” interact to produce new substances called “products” having totally different characteristic properties.
- To represent a chemical transformation we use “equations”

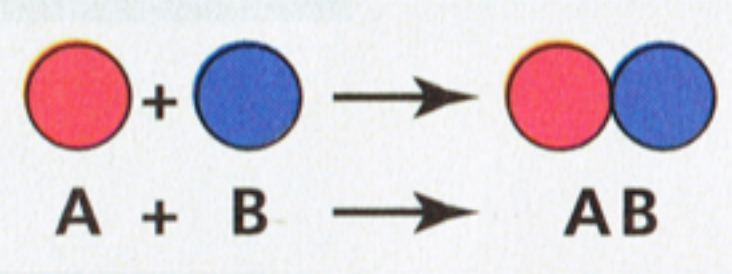
A+B  AB

(Reactants) (Product(s))

- $2H_2 + O_2$ $2H_2O$

Synthesis reaction

- A **synthesis reaction** occurs when 2 or more reactants combine together to produce a new product.

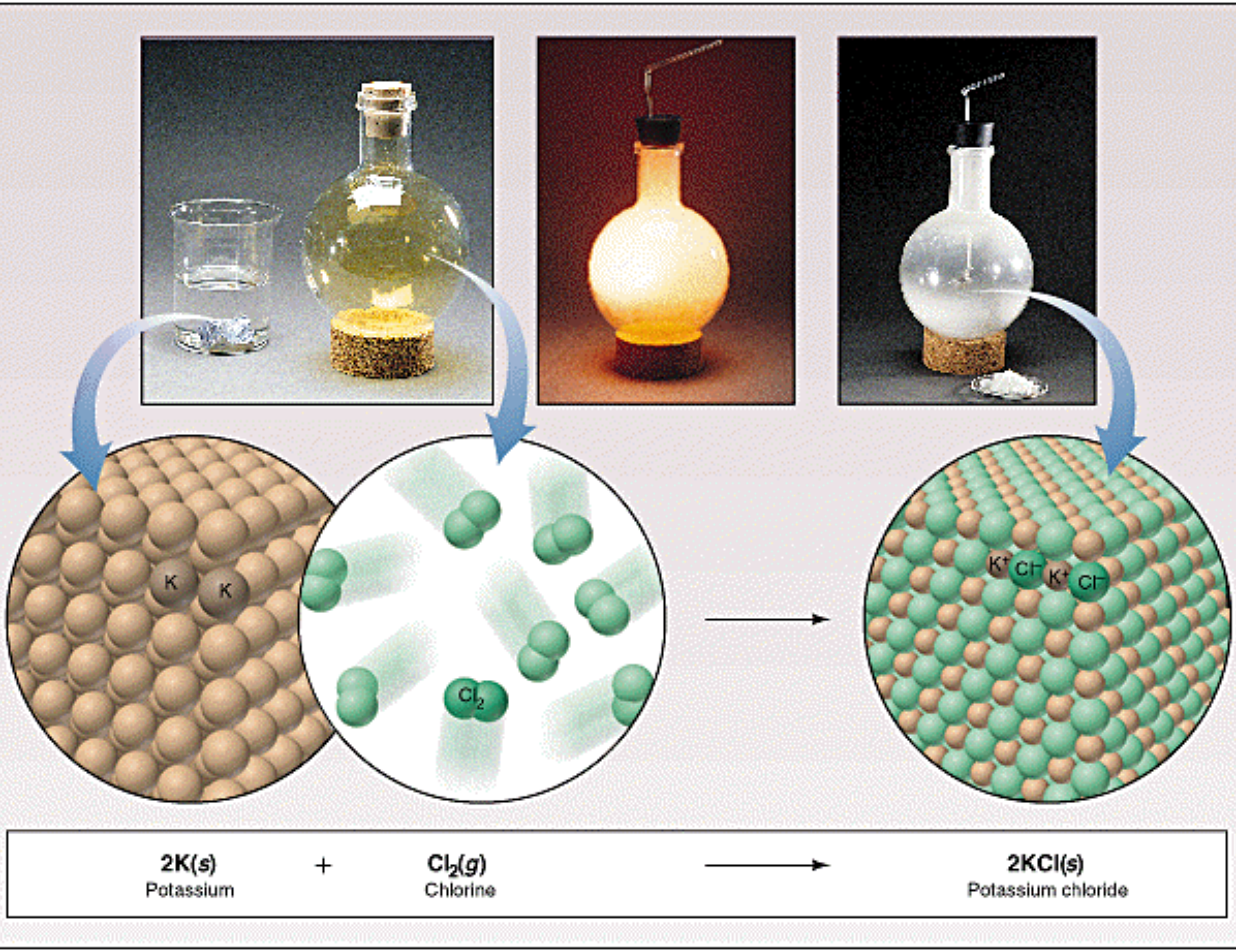


E.g. $2H_2 + O_2 \longrightarrow 2H_2O$

Hydrogen + Oxygen — Water

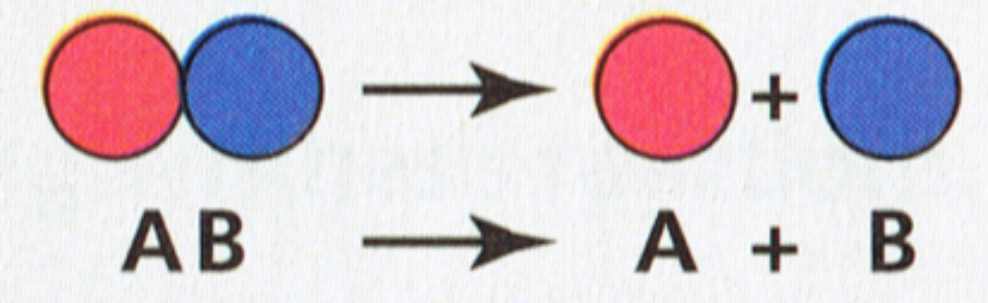
$Cl_2 + 2Na \longrightarrow 2NaCl$

Chlorine + Sodium — Sodium chloride


K
K
Cl2
K+
Cl−
K+
Cl−
2K(s)
Potassium
+
Cl2(g)
Chlorine
2KCl(s)
Potassium chloride

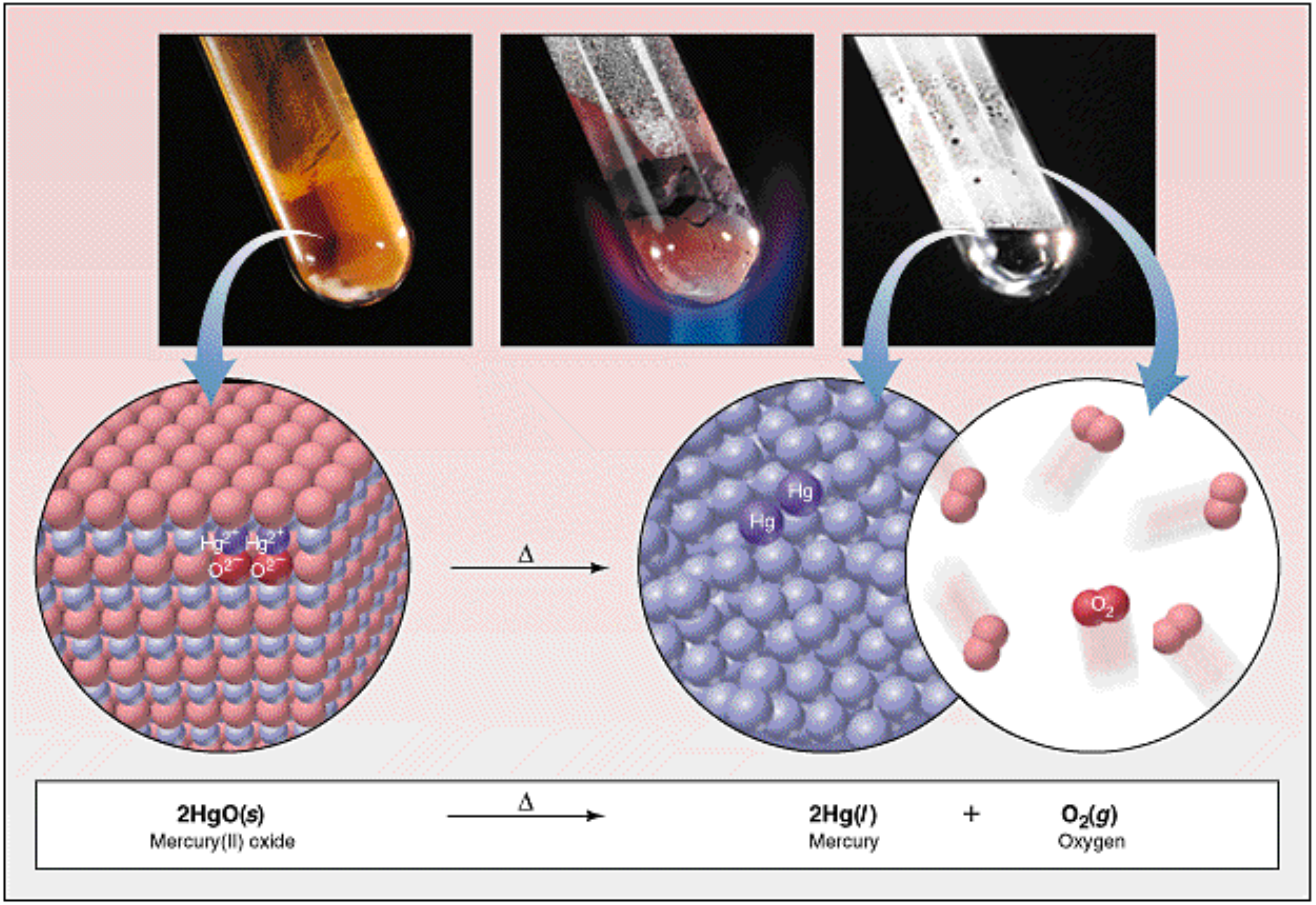
Decomposition reaction

- A **decomposition reaction** occurs when a compound is broken down into 2 or more substances



- Eg $2H_2O \rightarrow 2H_2 + O_2$
  Water — Hydrogen, Oxygen

$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$
Sodium Bicarbonate — sodium carbonate, carbon dioxide, water


Hg2+ Hg2+
O2− O2−
Δ
Hg
Hg
O2
2HgO(s)
Mercury(II) oxide
Δ
2Hg(l)
Mercury
+
O2(g)
Oxygen

Oxidation reactions

- An **oxidation reaction** occurs when a substance combines with one or more oxygen atoms
- The resulting substance is an OXIDE.
- Some common oxidation reactions are:
  - Copper turns black
  - Aluminum turns grey(dull)
  - Iron rusts $4Fe + 3O_2 \rightarrow Fe_2O_3$
  - Magnesium gives of a bright white light $2Mg + O_2 \rightarrow 2MgO$
  - Glucose oxidises into CO2 and water

Precipitation reaction

- A **precipitation reaction** occurs when 2 substances in solution combine to form a new substance that is insoluble in the solution
- This insoluble substance is called the precipitate.

- $Pb(NO_3)2 + 2KI \rightarrow PbI_2 + 2KNO_3$

- Bill Nye – chemical reactions