

PHYSICAL PROPERTIES OF MATTER

PHYSICAL PROPERTIES

Physical properties are CHARACTERISTICS that exist in a material.

We will study the following PHYSICAL properties:

- State
- Hardness
- Malleability
- Ductility
- Melting point and Boiling point
- Viscosity
- Density
- Solubility

STATE:

- A substance can be either a SOLID, LIQUID or GAS. This is known as its STATE.
- The PERIODIC TABLE tells you the state of all elements at ROOM temperature (25°C)
- Knowing when the state of a substance CHANGES is important.
 - Ex. PROPANE changes state from liquid to gas at -42°C
 - Ex. MERCURY changes from liquid to solid at -38.9°C
 - So, Propane HEAT and Mercury THERMOMETERS are not useful at really cold TEMPERATURES

HARDNESS:

- Hardness refers to a material's ability to resist being SCRATCHED or DENTED.
- Measured on the MOHS SCALE of mineral hardness, with GRAPHITE being the SOFTTEST (1) and DIAMOND being the HARDEST (10).
- A FINGERNAIL is around 2.5, GOLD is around 3 while your TEETH are around 5

MALLEABILITY:

- Refers to how much a material can be BENT
- Malleable materials can be HAMMERED and ROLLED into sheets
 - Ex. GOLD & SILVER
- Non-malleable materials are BRITTLE and will BREAK

- Ex. GLASS

DUCTILITY:

- Ductility measures how easily a material can be drawn into a WIRE.
- Ex. SILVER AND COPPER are very ductile

MELTING POINT & BOILING POINT

- These properties are CONSTANT for the same materials. They are CHARACTERISTICS of the materials.
- Ex. WATER melts at 0°C and boils at 100°C.
- NITROGEN melts at -210°C and boils at -196°C
- TUNGSTEN melts at 3410°C and boils at 5900°C
- ANTIFREEZE melts at -37°C and boils at 109°C

VISCOSITY

- Viscosity refers to the ability of a material to FLOW. The HARDER it is for a material to flow, the MORE VISCOUS it is.
- Ex. WATER flows more easily than CHOCOLATE SYRUP, so chocolate syrup has a GREATER viscosity.

DENSITY

- Density refers to a materials MASS per unit VOLUME.
- Density is different than weight, and is a CONSTANT for all materials.
- It is measured using the following formula:

$$Density = \frac{mass}{volume} \text{ or } D = \frac{M}{V}$$

- WATER has a density of 1g/cm³ while LEAD has a density of 11.34g/cm³ and ICE has a density of 0.971g/cm³. So, lead will SINK in water but ice will FLOAT.

Ex. The volume of a sample of molten iron is 43.56cm³ and has a mass of 343g. What is the density of iron? Round your answer to 2 decimal places.

SOLUBILITY:

- Items that will **DISSOLVE** easily in water are considered soluble.
- Items that do not dissolve are considered **INSOLUBLE**.
- When something dissolves in water the water is called the **SOLVENT** and the item that dissolves is called the **SOLUTE**.
- Ex. You make **KOOL-AID** for breakfast and the **SUGAR** dissolves in water. You accidentally drop a **PENNY** in the Kool-Aid but nothing happens to it. Which item is soluble? Which item is insoluble? What is the solute? What is the solvent?

CHEMICAL PROPERTIES:

Chemical properties describe the **BEHAVIOUR** of a substance as it **REACTS** with another substance to form **NEW MATERIALS**.

Here are some **CHARACTERISTICS** of chemical changes:

- **BURNING:** Some materials are **COMBUSTIBLE**, which means they **BURN**. Ex. **HYDROGEN GAS** reacts with **OXYGEN** from a **SPARK** and explodes. The result is **WATER**.
- **COLOUR CHANGE:** Chemical changes can result in a **COLOUR** change. Ex. **SILVER** reacts with **OXYGEN** in the air and turns **BLACK**. The result is **SILVER OXIDE**.
- The release of a **GAS:** Some liquids will appear to **BUBBLE** when mixed. This is because a **GAS** is released. Ex. **LITHIUM** metal fizzes, sparks, and releases a **GAS** when dropped in **WATER**. **HYDROGEN GAS** is released.
- Materials react with **ACIDS:** A **PENNY** will disappear when dropped in **NITRIC ACID**. The result is **COPPER NITRATE** and **NITROGEN DIOXIDE**, a poisonous brown **GAS**.
- Substances can react to **HEAT:** A chemical change occurs in the morning when you **FRY AN EGG**.

It is important to know the properties of a material because they help us to:

- Determine how a substance can be **USED**.
- Determine whether a substance is **HAZARDOUS** to your **HEALTH** or the **ENVIRONMENT**.

PHYSICAL AND CHEMICAL CHANGES

In a **PHYSICAL** change, materials remain the **SAME** even though their **STATE** or **FORM** has changed.

- Ex. Ice **MELTS** to form water which **BOILS** to form water vapour. The material remains the **SAME**. This is called a **CHANGE IN STATE**.
- You can test for a change in state by trying to get the **ORIGINAL** substance back.
- However, you cannot always get the **ORIGINAL** substance back from a **PHYSICAL** change.

- Ex. A carpenter cuts a 2x4 with a **TABLE SAW**, producing a pile of **SAWDUST**. The material has not changed, so this is a physical change, but you can't change the **SAWDUST** back into a 2x4.

In a **CHEMICAL** change, the original substance is changed into a **NEW MATERIAL** that has new **PROPERTIES**.

- Examples of chemical changes include **BURNING**, **RUSTING**, and **COOKING**.
- You cannot change a **BURNT** piece of wood back into a **LOG** or a **FRIED** egg back into a **RUNNY** egg.
- A characteristic of a chemical reaction is the **INABILITY** to change back to the **ORIGINAL** material.

CHARACTERISTICS OF A CHEMICAL CHANGE

- A new **COLOUR** appears
 - When **IRON** reacts with **OXYGEN** in the air it changes from **GREY** to a dull **ORANGE** (iron oxide or rust).
- **HEAT** or **LIGHT** has been given off
 - When the **WAX** of a candle **BURNS** it is converted to **CARBON DIOXIDE** and **WATER VAPOUR** and produces **LIGHT** and **HEAT**
 - When we eat, a chemical change changes the **HYDROCARBONS** in food into **HEAT** (energy), carbon dioxide and water vapour.
- **BUBBLES** are formed
 - **GASES** are often by-products of chemical reactions.
 - When **VINEGAR** and **BAKING SODA** are mixed, **BUBBLES** of carbon dioxide forms.
- A **SOLID** appears in the liquid
 - When two liquids are mixed a solid, called a **PRECIPITATE**, can be formed. This is a sure sign of a **CHEMICAL** reaction. A **GAS** can also react with a liquid to create a **PRECIPITATE**.
- The reaction is **NOT REVERSIBLE**
 - After an **EGG** is heated it undergoes a **TRANSFORMATION**. After the heat is removed you cannot change the egg back so it's a **CHEMICAL** reaction.
 - After dissolving **SALT** in water, you can **BOIL** the water, **EVAPORATING** the water, and you have **SALT CRYSTALS** again. So dissolving salt in water is a **PHYSICAL** reaction.
 - However, if you **HEAT** copper sulphate it turns from **BLUE** to **GREY**. If you add a little **WATER** it turns back to **BLUE**. This changed back, but actually is a **CHEMICAL** reaction.

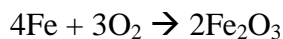
- A material with new **PROPERTIES** is formed
 - When **PAPER** is burned you have **ASH**. The **PHYSICAL** properties of **ASH** are quite different than that of the **PAPER**.

If **TWO OR MORE** of the above characteristics are observed, a **CHEMICAL** reaction has probably taken place.

CHEMICAL EQUATIONS

- Whenever a chemical **CHANGE** happens **NEW** chemicals are formed. We can write these using a **CHEMICAL EQUATION**.

Ex. When Iron **RUSTS**, the iron combines with **OXYGEN** in the air to make **IRON OXIDE**.



- In a chemical equation we have **REACTANTS** and **PRODUCTS**
- **REACTANTS** are the materials that **REACT** together.
- What are the reactants in the above equation?

- **PRODUCTS** are the materials that are **PRODUCED** after a reaction has taken place.

What are the products in the above chemical equation?

To conclude, most **PHYSICAL** changes are **REVERSIBLE** and most **CHEMICAL** changes are not.

Assignment: pg. 169 #3, 4