Short Notes on Chemical Reactions and Equations

1. Chemical Reactions and Identification

A chemical reaction is said to have taken place whenever a chemical change occurs.
Observations that indicate a chemical reaction:

- **Change in state**
- **Change in colour**
- **Evolution of a gas**
- **Change in temperature**

Examples:
Milk turning sour, rusting of iron, fermentation of grapes, and respiration.

1.1 Chemical Equations

1. **Representation:**
   A chemical reaction can be written in a shorter form using a word equation:
   Reactants → Products
   Reactants are written on the Left-Hand Side (LHS) and products on the Right-Hand Side (RHS). Using chemical formulae instead of words makes the equation concise and useful.
2. **Skeletal vs. Balanced Equations:**
   - **A *skeletal* chemical equation is unbalanced (mass not same on both sides).**
   - **A *balanced* chemical equation obeys the Law of Conservation of Mass (total mass and number of atoms remain the same before and after the reaction).**
3. **Balancing Method:**
   Balancing is done by the hit-and-trial method.
4. **Informativeness (Physical States):**
   Physical states are mentioned to make equations more informative:
   (g) – gas, (l) – liquid, (aq) – aqueous solution, (s) – solid.
   Reaction conditions (like temperature, pressure, catalyst) are written above or below the arrow.

1.2 Types of Chemical Reactions

1. Combination Reactions

A single product is formed from two or more reactants (elements or compounds).

- **Exothermic Reactions: Heat is released during the reaction.**
  Example: Calcium oxide reacts with water to form calcium hydroxide (slaked lime).
  Respiration is also an exothermic process.

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2. Decomposition Reactions

A single substance breaks down into two or more simpler substances. These are generally endothermic.

- **Thermal Decomposition: Decomposition by heating (e.g., limestone, ferrous sulphate).**
- **Electrolytic Decomposition: Decomposition by electricity (e.g., electrolysis of water).**
- **Photolytic Decomposition: Decomposition by light (e.g., silver chloride turning grey in sunlight).**

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3. Displacement and Double Displacement Reactions

- **Displacement Reaction:**
  A more reactive element displaces a less reactive element from its compound.
  (e.g., Zinc displaces copper from copper sulphate.)
- **Double Displacement Reaction:**
  Exchange of ions between two compounds.
- **Precipitation Reaction:**
  Formation of an insoluble solid (precipitate). Example: Reaction between sodium sulphate and barium chloride.

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4. Oxidation and Reduction (Redox Reactions)

- **Oxidation: Gain of oxygen or loss of hydrogen.**
- **Reduction: Loss of oxygen or gain of hydrogen.**
- **Redox Reaction: Both oxidation and reduction occur simultaneously.**

1.3 Effects of Oxidation in Everyday Life

1. **Corrosion:**
   Metals are attacked by substances like moisture or acids.
   - **Iron → rust (reddish-brown)**
   - **Silver → black coating**
   - **Copper → green coating**
2. **Rancidity:**
   Fats and oils get oxidised, changing their smell and taste.
   - **Prevented by using antioxidants or flushing with nitrogen gas (as in chip packets).**

Important Reactions

Combination Reactions

1. **Formation of Slaked Lime (Exothermic):**
   $CaO\ (s) + H_2O\ (l) \rightarrow Ca(OH)_2\ (aq) + Heat$
2. **Reaction of Slaked Lime with Air (CO_2):**
   $Ca(OH)_2\ (aq) + CO_2\ (g) \rightarrow CaCO_3\ (s) + H_2O\ (l)$
3. **Burning of Coal:**
   $C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$
4. **Formation of Water:**
   $2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l)$

Exothermic Reactions

1. **Burning of Natural Gas:**
   $CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (g)$
2. **Respiration:**
   $C_6H_{12}O_6\ (aq) + 6O_2\ (aq) \rightarrow 6CO_2\ (aq) + 6H_2O\ (l) + Energy$

Decomposition Reactions

1. **Thermal Decomposition of Ferrous Sulphate:**
   $2FeSO_4\ (s) \rightarrow Fe_2O_3\ (s) + SO_2\ (g) + SO_3\ (g)$
2. **Thermal Decomposition of Limestone:**
   $CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$
3. **Thermal Decomposition of Lead Nitrate:**
   $2Pb(NO_3)_2\ (s) \rightarrow 2PbO\ (s) + 4NO_2\ (g) + O_2\ (g)$
4. **Photolytic Decomposition of Silver Chloride:**
   $2AgCl\ (s) \rightarrow 2Ag\ (s) + Cl_2\ (g)$
5. **Photolytic Decomposition of Silver Bromide:**
   $2AgBr\ (s) \rightarrow 2Ag\ (s) + Br_2\ (g)$

Displacement Reactions

1. **Iron displacing Copper:**
   $Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$
2. **Zinc displacing Copper:**
   $Zn\ (s) + CuSO_4\ (aq) \rightarrow ZnSO_4\ (aq) + Cu\ (s)$
3. **Lead displacing Copper:**
   $Pb\ (s) + CuCl_2\ (aq) \rightarrow PbCl_2\ (aq) + Cu\ (s)$

Double Displacement and Precipitation Reaction

1. **Sodium Sulphate and Barium Chloride:**
   Na_2SO_4 (aq) + $BaCl_2$ (aq) → $BaSO_4$ (s) + 2NaCl (aq)

Oxidation and Reduction (Redox) Examples

1. **Oxidation of Copper:**
   $2Cu + O_2 \rightarrow 2CuO$
2. **Reduction of Copper Oxide:**
   $CuO + H_2 \rightarrow Cu + H_2O$
3. **Zinc Oxide and Carbon:**
   $ZnO + C \rightarrow Zn + CO$
4. **Manganese Dioxide and Hydrochloric Acid:**
   $MnO_2 + 4HCl \rightarrow MnCl_2 + H_2O + Cl_2$
