2S.4 Acids and Bases

1) An acid is a substance that produces hydrogen ions (H^+) when dissolved in water
2) **An acid only shows its properties when dissolved in water** because they dissociate in water for form hydrogen ions which are responsible for its acidic properties. They do not dissociate to form hydrogen ions when dissolved in organic solvents (alcohol, oil, etc.)
3) Strong acids:
    - Ethanioc acid (vinegar)
    - Citric acid (oranges, lemons, all citrus fruits)
    - Lactic acids (yoghurt)
    - Tartaric acid (grapes)
    - Tannic acids (tea)
4) Weak acids;
    - Hydrochloric acid - HCl
    - Sulfuric acid - H_2SO_4
    - Nitric acid - HNO_3
5) Properties of acids:
    - Taste sour
    - Hazardous – cause skin problems
    - Change blue litmus paper red (Remember – Acids are red on the Universal Indictor)
    - Reacts with metals – produces a salt and hydrogen
    - Reacts with carbonates or hydrogen carbonates – produces a salt, carbon dioxide, and water
    - Reacts with metals oxides and hydroxides (bases) – produces a salt and water
    - Do not react with plastic, glass or brick (Labs store them in plastic)
6) A base is a **substance that reacts with an acid to form salt and water only** (definition)/**An alkali is a substance that produces hydroxide ions (OH^-) in water**. It is any metal oxide or hydroxide
7) Alkalis dissociate to produce hydroxide ions (OH^-) when dissolved in water
8) **Difference between alkalis and bases: All alkalis are bases, but not all bases are alkalis**
9) Strong alkalis:
    - Sodium hydroxide – NaOH
    - Potassium hydroxide – KOH
10) Weak alkalis:
    - Aqueous ammonia - NH_3
11) Properties of alkalis:
    - Alkalis feel slippery and soapy

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- Alkalis are hazardous – Burn skin when concentrated, irritate skins when dilute
- Alkalis change red litmus paper blue (Remember alkalis are blue on the Universal Indicators)
- Alkalis react with acids to form a salt and water
- Alkalis react with ammonium compounds to form a salt, ammonia gas and water

12) Strong alkalis or acids vs Weak alkalis or acids
- A strong acid is one that completely ionizes in water
- For example, all the molecules in hydrogen chloride (HCl) dissociates in water to form H^+ and Cl^-. There are no HCl molecules left
- A weak acid is one that partially ionizes in water
- For example, only 4 out of 1000 of the molecules in ethanioc acid (CH_3COOH) dissociates in water to form H^+ and CH_3COO^-. The rest remain as CH_3COOH.
- Therefore, in ammonia solution, there is a pungent smell as most of the ammonia molecules do not dissociate

13) Concentrated and dilute NOT the same as strong and weak
- Concentrated refers to having more molecules in the same solution → Unit used to measure concentration is known as molarity/ mol/dm^3

14) pH scale:
- pH stands for **"power of hydrogen"**
- >7 is alkaline
- 7 is neutral (pure water)
- <7 is acidic

15) Indicators:
- Chemical substances that change colour in solutions of different pH values but over a definite pH range
- Table of Indicators:

Indicator solution	Colour in acidic solution	pH level when it changes colour	Colour in alkaline solution
Methyl orange	Red	4	Yellow (from pH 5 onwards)
Bromothymol blue	Yellow	7	Blue (from pH 7 onwards
Phenolphthalein	Colourless	9	Pink (from pH 9 onwards)

- Good indicators are:
  - Observable and distinct colour change
  - Required only in small amounts
  - Does not affect pH level

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- Universal indicator is a mixture of indicators which change colour at every pH value
    - Liquid and paper
- Advantages of Universal Indicator paper:
    - pH paper is disposable, so it reduces the risk of contamination
    - pH paper can be used on small sample size (1 drop is enough) while the sample solution has to cover the whole bulb of the pH meter
    - pH paper measures the pH faster than the pH meter, as it has to adjust for a while
- pH meter measures accurate pH values (1 or more d.p.)
- A probe is dipped into a solution until the whole bulb is covered to show the pH digitally
- pH probe can be connected to a compute or data logger to collect pH readings.

16) When cleaning up acid spills, calcium oxide (or any other solid base) is used because it can be cleaned up easily. Using an alkali may cause the spill to turn alkaline when used in excess. This is used in factories around the world.
17) Tests for gases:
    - Hydrogen **– Gas extinguishes a lighted splint with a "pop" sound**
    - Carbon Dioxide **– White precipitate forms in the solution when bubbled through limewater (calcium hydroxide)**
    - Ammonia gas: **Turns red litmus paper blue and has a pungent smell**
18) Oxides:
    - Acidic oxides:
        - Oxides of non-metals
        - React with water to produce acids
        - Have acidic properties
        - Examples are: Sulfur trioxide, Carbon dioxide and Phosphorus(V) oxide, Sulfur dioxide
    - Basic oxides:
        - Oxides of metals
        - Are bases
        - Examples are Copper(II) oxide, Magnesium oxide, Calcium oxide
    - Amphoteric oxides
        - Behave as an acidic oxide or basic oxide
        - For example:
            - ❖ Aluminum oxide + Hydrochloric acid $\longrightarrow$ Aluminum chloride + water
            - ❖ Aluminum oxide + Sodium hydroxide $\longrightarrow$ Sodium aluminate + water
        - Examples are: Zinc oxide, Lead(II) oxide, Aluminum oxide

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- Neutral oxides
  - Do not react with either acids or bases
  - Examples are: Water, Carbon monoxide, Nitrogen monoxide

19) Salts

- The hydrogen ion in acids is replaced by a metal
- When naming salts, the name of the metal is placed in front, followed by the other part of the acid
- Hydrochloric Acid - _____ Chloride
- Sulfuric Acid - _____ Sulfate
- Nitric Acid - _____ Nitrate
- Sulfurous Acid - _____ Sulfite
- Salts are usually in aqueous state

20) Reactions:

- Acid + Metal $\longrightarrow$ Salt + Hydrogen
- Acid + Base $\longrightarrow$ Salt + Water
- Acid + Carbonate $\longrightarrow$ Salt + Carbon dioxide + Water
- Alkali + Ammonium compounds $\longrightarrow$ Salt + Ammonia gas + Water

21) Neutralization

- Acid + Alkali
- Produces salt + water
- The hydroxide ions combine with the hydrogen ions to form water
- $H^+ + OH^- \longrightarrow H_2O$
- Uses
  - Controls pH of soil – Calcium oxide/hydroxide if too acidic, Compost if too alkaline (Compost is made of rotting plat material which gives off carbon dioxide which is acidic when dissolved in water)
  - Treats indigestion due to the excess of hydrochloric acid in stomach due to too much consumption – Magnesium oxide is used
  - Treats insect stings – Add a base as it is acidic
  - Toothpaste to neutralize the acids produced by bacteria which may corrode the teeth – Magnesium hydroxide is used
  - Treatment of wastewater

22) Table of positive ions – MUST REMEMBER

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Charge	Name	Chemical Formula
+1	Hydrogen	H^+
	Lithium	Li^+
	Sodium	Na^+
	Potassium	K^+
	Silver	Ag^+
	Ammonium (Not Ammonia)	NH_4^+
+2	**Magnesium**	Mg^{2+}
	Calcium	Ca^{2+}
	Barium	Ba^{2+}
	Zinc	Zn^{2+}
	Lead (ll)	Pb^{2+}
	Copper (ll)	Cu^{2+}
	Iron (ll)	Fe^{2+}
+3	Aluminum	Al^{3+}
	Iron (lll)	Fe^{3+}

- In cases such as Lead (II) or Copper (II), the charge of the ion can be inferred from the number of "I".

23) Table of negative ions - Important

Charge	Name	Chemical Formula
-1	Fluoride	Fl^-
	Chloride	Cl^-
	Bromide	Br^-
	Iodide	I^-
	Hydroxide	OH^-
	Nitrate	NO_3^-
-2	**Oxide**	O^{2-}
	Sulfide	S^{2-}
	Sulfate	So_4^{2-}
	Carbonate	CO_3^{2-}
-3	**Phosphate**	PO_4^{3-}

24) Total charge of compound must ALWAYS be equal
25) When there is more than 1 of the same polyatomic ion in a compound, it must be bracketed (E.g. $Mg(NO_3)_2$ or $(NH_4)_2\,So_4$)
26) The positive ion must be put in front of the negative ion when naming
27) State symbols
    - Solid – s (For all metal or metalloid ions, oxides, hydroxides and carbonates)
    - Liquid – l (For water)

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- Aqueous – aq (For all acids, alkalis, and salts), aq is used when a substance is dissolved in water
- Gas – g (For hydrogen and carbon dioxide)

28) When writing chemical equations
    - Write down the unbalanced equation with state symbols
    - Leave spacing between the compounds to accommodate the coefficients
    - Balance it by adding suitable coefficients
    - Try to find the LCM (Least Common Multiple)
    - For example:
    - $CaO\ (s) + HCl\ (aq) \longrightarrow CaCl_2\ (aq) + H_2O\ (l)$
    - $CaO\ (s) + HCl\ (aq) \longrightarrow CaCl_2\ (aq) + H_2O\ (l)$
    - $CaO\ (s) + 2HCl\ (aq) \longrightarrow CaCl_2\ (aq) + H_2O\ (l)$
29) Note: Atoms cannot be created or destroyed, so the number of each atom on the left must be equal to the number of the same atom on the right.
30) Note: If on the right of the equation you have 3 "H" and on the left you have H_2, you cannot simply change H_2 to H_3. Instead you must make it as 6 "H" on the right of the equation and $3H_2$ on the left so as to balance the reaction accurately.

Note for All Chemistry Topics

1) Not all ionic solids dissolve readily in water, only some
2) All gas molecules are bonded by covalent bonds (unless ionic compounds are superheated)
3) Carbon conducts electricity sometimes, like graphite. However, diamond does not
4) Noble gases are called inert gases
5) Take note of these equations
    - $Na + H_2O \longrightarrow H_2 + NaOH$
    - Balanced Equation: $2Na + 2H_2O \longrightarrow H_2 + 2NaOH$
    - $H_2O + K \longrightarrow H_2 + KOH$
    - Balanced Equation: $2H_2O + 2K \longrightarrow H_2 + 2KOH$

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