C8: Acids and alkalis Knowledge Organiser

Lesson sequence

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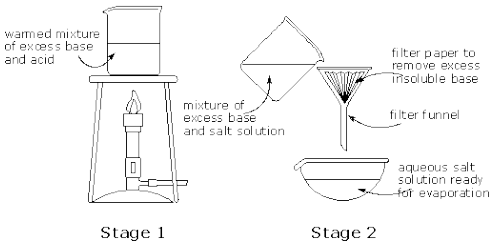
1. Acids, alkalis and indicators	
***pH scale**	A scale running from 0 to 14 that measures how acid or alkaline a solution is.
***Acid**	A solution with a pH less than 7.
Alkali	A substance with a pH greater than 7.
***Neutral**	A substance with a pH equal to 7.
***Indicator**	A substance that changes colour depending on the pH.
****Common indicators**	**Litmus:** red in acid, blue in alkali **Methyl orange:** red in acid, orange in alkali **Phenolphthalein:** colourless in acid, pink in alkali
***Universal indicator**	A mixture of several indicators that is red in strong acid, green when neutral and purple in strong alkali.
****Acids and ions**	Acids dissolve in water to produce an excess of hydrogen ions (H^+).
****Alkalis and ions**	Alkalis dissolve in water to produce an excess of hydroxide ions (OH-).
***Hydrochloric acid**	**Formula:** HCl **Hydrogen ions formed:** 1 **Anion formed:** Chloride, Cl^-
***Nitric acid**	**Formula:** HNO_3 **Hydrogen ions formed:** 1 **Anion formed:** Nitrate, NO_3^-
***Sulfuric acid**	**Formula:** H_2SO_4 **Hydrogen ions formed:** 2 **Anion formed:** Sulfate, SO_4^{2-}
****Ions and pH**	The higher the hydrogen ion concentration the lower the pH, the higher the hydroxide ion concentration, the higher the pH.

2. Acids in detail (HT)	
****Concentrated solution**	A solution with a large amount of solute dissolved in a given volume.
****Dilute solution**	A solution with a small amount of solute dissolved in a given volume.
****pH and hydrogen ion concentration**	Every step down the pH scale is a ten-fold increase in hydrogen ion concentration and vice versa. - pH 3 to 1 = 100 times increase - pH 4 to 7 = 1000 times decrease
****Dissociation**	When an acid dissolves in water, it splits up into positive hydrogen ions and negative anions.
****Strong acids**	Acids that dissociate fully when dissolved in water – every single molecule splits up.
****Weak acids**	Acids that do not fully dissociate when dissolved in water – only some molecules split up.
****Acid examples**	**Strong:** hydrochloric, sulfuric **Weak:** ethanoic
****Properties of strong acids**	Strong acids react more quickly than weak acids because there are more hydrogen ions available for reactions.

3. Bases and salts	
***Base**	A substance that neutralises an acid to form a salt and water.
***Salt**	A compound formed from the metal cation of a base and the non-metal anion of an alkali.
***Naming salts**	Two-part names. First part = the metal from the base, second part = the anion from the acid.
***Acids and their anions**	Sulfuric acid → sulfate Nitric acid → nitrate Hydrochloric acid → chloride
****Reaction of metal oxides with acid**	Metal oxide + acid → salt + water E.g. Magnesium oxide + hydrochloric acid → magnesium chloride + water $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$
***Preparing soluble salts**	- Gently warm a beaker of acid - Add a spatula of metal oxide and stir until dissolved - Repeat until it no longer dissolves - Filter to remove excess oxide - Allow water to evaporate to produce pure crystals



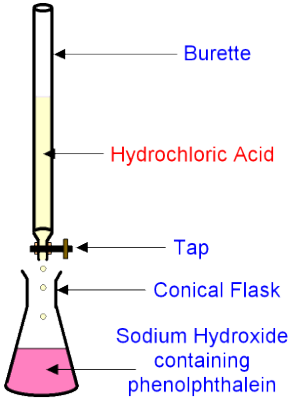
4. Core practical – preparing copper sulfate (CP8)	
***CP8 - Aim**	To produce crystals of copper sulfate by reacting copper oxide with sulfuric acid.
***CP8 - Setup**	Place 20 cm^3 of dilute sulfuric acid in a beaker and warm to 50 ^oC.
***CP8 – Adding excess copper oxide**	Add a spatula of black copper oxide and stir until dissolved. Repeat this process until a spatula does not fully dissolve.
***CP8 - Filtration**	Filter the solution and collect the filtrate.
***CP8 - Crystallisation**	- Place the filtrate in an evaporating basin - Heat the evaporating basin by placing above a beaker of boiling water. - Remove from heat when crystals start to form. - Leave somewhere warm to dry.
***CP8 - Results**	As the copper oxide dissolves the sulfuric acid turns blue. When there is copper oxide remaining, the solution looks black from the copper oxide floating in it. Blue diamond-shaped crystals should form.

5. Alkalis and balancing equations	
****Bases and alkalis**	A base is a substance that neutralises an acid to form a salt and water. An alkali is a base that is soluble in water.
***Common alkalis**	Sodium hydroxide, NaOH Potassium hydroxide, KOH Calcium hydroxide, $Ca(OH)_2$
***Reaction of alkalis with acids**	Acid + alkali → salt + water Eg: Sodium hydroxide nitric acid → sodium nitrate + water $NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$
****Balancing equations**	- Use a tally chart to keep track of the number of atoms on each side. - Change the coefficients (the big numbers) to add more of things that are missing. - DO NOT TOUCH the little numbers

6. Core practical – investigating neutralisation (CP9)	
**pH meter	An instrument that can measure pH more accurately than universal indicator.
*CP9 - Aim	To see how the pH of an acid changes as you gradually add a base.
*CP9 - Setup	Place 50 cm^3 of hydrochloric acid in a beaker and estimate its pH using a pH meter or universal indicator paper.
*CP9 – Run the experiment	Add 0.3 g of calcium hydroxide powder, stir to dissolve and re-measure the pH. Repeat 7 more times.
*CP9 – Graph your results	Plot a graph with mass of calcium on the x-axis and pH on the y-axis.
*CP9 - Results	The pH will increase slowly at first, then very rapidly, then more slowly again.

7. Alkalis and neutralisation	
**Acid and alkali ions	Acids produce hydrogen ions, H^+, alkalis produce hydroxide ions, OH^-.
**Ions and neutralisation	The H^+ ion and OH^- ion react together to form H_2O (water).
**Producing a salt by neutralisation	The salt is produced from the ions left over once the H^+ and OH^- ions have reacted together.
**Burette	A tall glass tube with 0.1 cm^3 markings on it and a tap at the bottom used for accurately adding variable amounts of liquid.
**Pipette	A piece of glassware used to very accurately measure a fixed amount of liquid.
**Titration	A method used to find out exactly how much acid is needed to neutralise an alkali

**Titration method	- Add alkali to beaker with a pipette - Add an alkali to the beaker - Gradually add acid from a burette - Note how much has been added at the point of neutralisation.
**Titration indicators	Use indicators with a sharp colour change – such as phenolphthalein – rather than a gradual one such as universal.



8. Reactions of acids with metals and metal carbonates	
**Reaction of acid with metal	Metal + acid → salt + hydrogen E.g. magnesium + hydrochloric acid → magnesium chloride + hydrogen $Mg(s) + 2HCl)aq) \rightarrow MgCl_2(aq) + H_2(_g)$
**Metal and acid observations	- Bubbles of hydrogen gas - Metal dissolves - Warms up
***Ionic equation	A chemical equation that shows changes to the ions in a reaction.
***Ionic equation for magnesium and acid	$Mg + 2H^+ \rightarrow Mg^{2+} + H_2$
***Spectator ion	An ion that does not change during a chemical reaction.

***Half-equations	An equation that shows what happens to just one of the ions during chemical reaction. Two half-equations combine to give the overall ionic equation
***Half-equation examples	- $Mg \rightarrow Mg\ 2^+ + 2e^-$ - $2H^+ + 2e^- \rightarrow H_2$ Combine to give: $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$
**Reaction of metal carbonates with acid	Carbonate + acid → salt + water + carbon dioxide E.g: Calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$
**Carbonate and acid observations	- Bubbles of CO_2 gas - Solid carbonate dissolves
***Carbonate and acid ionic equation	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

9. Solubility	
*Soluble	When a substance can be dissolved by a liquid.
*Insoluble	When a substance cannot be dissolved by a liquid.
**Soluble in water	-All common sodium, potassium and ammonium salts - All nitrates - Most chlorides - Mot sulfates
**Insoluble in water	- Silver and lead chlorides - Lead, barium and calcium sulfates - Most carbonates - Most hydroxides
*Precipitate	A solid (insoluble) product formed by mixing two solutions. Turns the solution cloudy.

*Precipitation reaction	A reaction that produces a solid precipitate by mixing two solutions.
**Predicting precipitation	When mixing two solutions, swap the names of the salts around to find the possible products. If one is insoluble a precipitate forms.
**Precipitation equations	AB + YX → AX + YB E.g: Sodium chloride + silver nitrate → silver chloride + sodium nitrate $NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$
***Precipitation ionic equations	Only include the ions that make the solid precipitate E.g: $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
*To prepare insoluble salts	- Mix your two solutions - Filter the mixture - Wash the residue by pouring distilled water through the filter - Leave somewhere warm to dry