CHURCH STRETTON SCHOOL

Triple Science - Chemistry

SC8 Knowledge organiser

SC8: Acids and alkalis

Lesson sequence

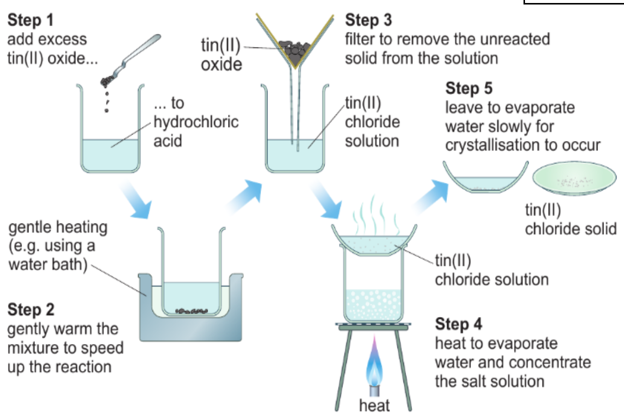
1. Acids, alkalis and indicators
2. Acids in detail (HT)
3. Bases and salts
4. Core practical – preparing copper sulfate (CP8)
5. Alkalis and balancing equations
6. Core practical – investigating neutralisation
7. Alkalis and neutralisation
8. Reactions of acids with metals and carbonates
9. Solubility

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.

indicator	litmus	methyl orange	phenolphthalein
colour in alkaline solutions	blue	yellow	pink
colour in acidic solutions	red	red	colourless

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



$SnO(s) + 2HCl(aq) \rightarrow SnCl_2(aq) + H_2O(l)$

tin(II) oxide + hydrochloric acid → tin(II) chloride + water

D the preparation of tin(II) chloride (eye protection must be worn)

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.

Common acids	Formula
hydrochloric acid	HCl
sulfuric acid	H_2SO_4
nitric acid	HNO_3
Common alkalis	**Formula**
sodium hydroxide	NaOH
potassium hydroxide	KOH
calcium hydroxide	$Ca(OH)_2$

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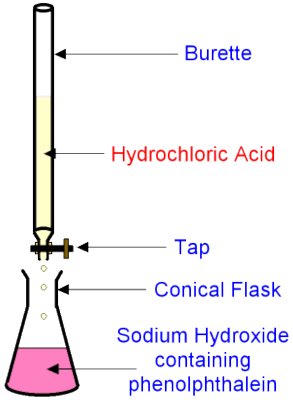
5. Alkalis and balancing equations	
Bases and alkalis	A base is a substance that neutralises an acid to form a salt and water. An alkali is a base that is soluble in water.
Common alkalis	Sodium hydroxide, NaOH Potassium hydroxide, KOH Calcium hydroxide, $Ca(OH)_2$
Reaction of alkalis with acids	Acid + 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

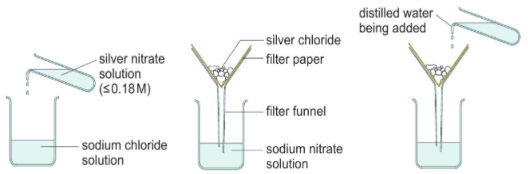
6. Core practical – investigating neutralisation (CP9)	
pH meter	An instrument that can measure pH more accurately than universal indicator.
CP9 - Aim	To see how the pH of an acid changes as you gradually add a base.
CP9 - Setup	Place 50 cm^3 of hydrochloric acid in a beaker and estimate its pH using 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



C preparing an insoluble salt