



Scheme of work – Cambridge IGCSE[®] Chemistry (US) 0439

Unit 4: Acids, bases and salts

Recommended prior knowledge

Students should be familiar with the laboratory techniques introduced in Unit 1 and they have some knowledge on particle theory, atomic structure and ionic bonding (Unit 2).

Context

This unit builds on ideas from earlier units. The concepts of this unit will be revisited in Units 6, 8 and 9.

Outline

This unit starts with introduction to writing and balancing equations (this might have been introduced in earlier units – depending on ability of the students). Equations can then be written for the reactions of acids and bases. There is a considerable range of practical work that can be carried out. Opportunity for students to research the common products used in the home that are acidic/alkaline in nature and apply this knowledge to some everyday examples of neutralisation reactions- indigestion tablets, insect bites or stings. In addition, students can make and test their predictions in respects to salt preparation. This unit is cross-referenced to assessment objectives A1–5, B1–7, C1–4 and Units 1 and 2.

(Please note: **(S)** in **bold** denotes material in the Supplement (Extended syllabus) only)

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
4	Construct word equations and simple balanced chemical equations	<p>This can be linked with law of conservation of mass. Various test tube reactions can be done- $\text{FeCl}_3 + \text{NaOH}$ & $\text{CuSO}_4 + \text{NaOH}$.</p> <p>Stress equations are balanced by inserting a number in front of particular reactants or products.</p> <p>Students can then work in groups with simple formulae cards to construct balanced equations from word equations.</p>	www.docbrown.info/page04/4_73calcs03com.htm

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
8.1	Describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only) measured using Universal Indicator paper	<p>Students can arrange solutions of varying pHs in terms of increasing acidity / basicity e.g. milk, vinegar, ammonia solution, 'bench' and 'household' chemicals.</p> <p>The pH scale runs from 0–14 and it is used to show the acidity or alkalinity of a solution.</p> <p>Universal indicator can be used to find the pH of a solution.</p>	
8.1	Describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus	<p>Opportunity for experiments to show exothermic nature of neutralisation.</p> <p>Students could prepare hydrogen and carbon dioxide gas and perform the distinctive test (see later in this Unit).</p> <p>Test tube experiments linked to Unit 6 – Metals.</p>	<i>R. Norris & R. Stanbridge. Chemistry for IGCSE, Nelson Thornes, 2009, ISBN 9781408500187, p122 Fig 10.2.1.</i>
8.1	Describe the characteristic properties of bases as reactions with acids and with ammonium salts and effect on litmus	<p>Illustrate by reference to examples of neutralisation e.g. indigestion tablets, treatment of bee and wasp stings, addition of sodium hydroxide to (acidic detergent in) shower gel/washing up liquid/bubble bath (could look at labels of ingredients).</p> <p>Test tube experiments linked to above and heating ammonium salts with hydroxides.</p> <p>Extension – students could look at safety issues associated with mixing acid cleaner to alkaline bleach.</p>	<i>R. Norris & R. Stanbridge. Chemistry for IGCSE, Nelson Thornes, 2009, ISBN 9781408500187, p125 Fig 10.3.1.</i>

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11	Describe the displacement of ammonia from its salts	<p>Experiments involving heating ammonium salts with or without added hydroxide (test for ammonia, see later in this unit).</p> <p>Illustrate by reference to how the liming of soils by farmers to neutralize acidity can lead to ammonia loss from ammonium salts added as fertilizers: $\text{Ca(OH)}_2 + 2\text{NH}_4\text{Cl} \rightarrow 2\text{NH}_3 + \text{CaCl}_2 + \text{H}_2\text{O}$</p>	
8.1(S)	Define acids and bases in terms of proton transfer, limited to aqueous solutions	<p>Can introduce the concept of pH meters (conductivity) to measure pH for advanced students.</p> <p>Extension – a low pH indicates a high <u>concentration</u> of H^+ ions and high pH a high concentration of OH^- ions.</p>	
8.1(S)	Describe the meaning of weak and strong acids and bases	<p>Emphasise acids are proton donors e.g. dilute mineral acids, ethanoic acid (vinegar), and bases are proton acceptors e.g. alkali metal hydroxides and aqueous ammonia.</p> <p>Extension- the terms concentrated and dilute solutions can be introduced and clearly distinguished from weak and strong acids.</p>	
8.2	Classify oxides as either acidic or basic, related to metallic and non-metallic character	<p>Demonstration of the reaction of the elements with oxygen.</p> <p>Linked to Unit 2 and 3, oxides of sodium, magnesium, carbon, sulfur and phosphorus are all good examples to use.</p> <p>Examples of acid oxides are P_2O_5, SO_2, SO_3 and NO_2.</p> <p>Examples of basic oxides are Na_2O, CaO and BaO.</p>	

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
8.2(S)	Further classify other oxides as neutral or amphoteric	Examples of amphoteric oxides are Al_2O_3 and ZnO . Examples of neutral oxides are nitrogen(I) oxide (N_2O), nitrogen(II) oxide [NO] and carbon monoxide (CO).	
13	Describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of thermal decomposition	Students can investigate the limestone cycle by heating a limestone chip <u>very</u> strongly for 20 minutes and cool to form calcium oxide on the surface. Observe reaction of calcium oxide when drops of water are added to make slaked lime (example of exothermic reaction – steam and solid crumbling). Then add excess water to form limewater and test the pH.	<i>R. Norris & R. Stanbridge. Chemistry for IGCSE, Nelson Thornes, 2009, ISBN 9781408500187, p204 Fig 16.5.1.</i> Notes on limestone cycle: www.docbrown.info/page01/ExIndChem/ExIndChem.htm ink doesn't work
8.1	Describe and explain the importance of controlling acidity in soil	Teach with section 13 below.	
13	Name the uses of calcium carbonate in the manufacture of iron and of cement	Discuss the importance of limestone in the extraction of iron (link to Unit 6 – Metals), the building industry and the manufacture of cement.	
13	Name some uses of lime and slaked lime as in treating acidic soil and neutralising acidic industrial waste products, e.g. flue gas desulfurisation	Possible issues to discuss include: <ul style="list-style-type: none"> the importance using lime or slaked lime for treating excess acidity in soils, thus making unfertile land fertile. Also in neutralising acidic waste products from industry; the use of calcium carbonate to remove sulfur dioxide from power station emissions by flue-gas emissions; the environmental effects of large scale limestone quarrying to meet the huge demand. 	www.allotment.org.uk/fertilizer/garden-lime.php www.en.wikipedia.org/wiki/Flue-gas_desulfurization

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8.3	Describe the preparation, separation and purification of salts as examples of some of the techniques specified in section 2.2(b) and the reactions specified in section 8.1	Experiments should include the preparation of salts such as copper(II) sulphate, magnesium sulphate (filtration method) and sodium or potassium salts (titration method) [link to Unit 1 – Experimental Techniques].	www.docbrown.info/page03/AcidsBasesSalts06.htm <i>Chemistry Experiments, J. A. Hunt, A. Geoffrey Sykes, J. P. Mason, Longman 1996, Experiments G6, G7 & G9.</i>
8.3(S)	Describe the preparation of insoluble salts by precipitation	Extend the salt preparation to include lead(II) chloride, lead(II) iodide and barium sulfate. (CARE: Pb and Ba compounds are poisonous)	www.practicalchemistry.org/experiments/preparing-an-insoluble-salt,174,EX.html
8.3(S)	Suggest a method of making a given salt from suitable starting material, given appropriate information	Introduce solubility rules and ask students to suggest a suitable method of preparing a particular salt. Students can then put their theory into practice.	

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8.4	<p>Describe the following tests to identify:</p> <p><i>aqueous cations:</i> aluminium, ammonium, calcium, copper(II), iron(II), iron(III) and zinc (using aqueous sodium hydroxide and aqueous ammonia as appropriate) (Formulae of complex ions are not required.)</p> <p><i>anions:</i> carbonate (by reaction with dilute acid and then limewater), chloride (by reaction under acidic conditions with aqueous silver nitrate), iodide (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium), sulfate (by reaction under acidic conditions with aqueous barium ions)</p> <p><i>gases:</i> ammonia (using damp red litmus paper), carbon dioxide (using limewater), chlorine (using damp litmus paper), hydrogen (using lighted splint), oxygen (using a glowing splint).</p>	<p>This allows a great range of simple test tube reactions to be conducted.</p> <p>First, known samples can be used in experiments so that the students may find out the answers for themselves.</p> <p>Then the experiments can be made more challenging by using unknown samples of an ionic compound (or even a mixture) to enable students to develop analytical skills.</p> <p>Extension – experimental work on flame tests of these ions.</p> <p>Demonstration or experimental work to prepare some of these gases.</p>	<p><i>Cambridge IGCSE Chemistry</i>, S.Goodman & C. Sunley, Collins, 2006. CD ROM video clips 12-17.</p> <p><i>Chemistry for IGCSE</i>, R. Norris & R. Stanbridge, Nelson Thornes, 2009: Testing for aqueous cations, Fig 11.5.1-11.5.2, p140-1. Testing for aqueous anions, Fig 11.6.1, p142-143. Identifying a gas, Fig 11.4.1-11.4.3, p138-139.</p> <p>Summary sheet for most of these reactions: www.creative-chemistry.org.uk/gcse/documents/Module22/N-m22-02.pdf</p> <p>www.docbrown.info/page13/ChemicalTests/ChemicalTestsc.htm#KEYWORDS</p>