UNIT 8 Acids, Bases and Salts (including Qualitative Analysis)

Recommended Prior Knowledge It is suggested that this unit is taught later in the course. The unit assumes that students can confidently handle complex practical procedures, write full and ionic equations and carry out calculations using ideas about amount of substance. It is essential that Units 1, 2 and 5 are studied prior to Unit 8. It is recommended that Unit 6 is taught before Unit 8 to give the students practice with practical techniques.

Context This unit contains a substantial quantity of learning objectives that are regularly assessed as part of both theory and practical components. The unit contains the more complex inorganic chemistry in the course. The reaction of acids and carbonates is commonly used to teach Speed of Reaction (Unit 7). There are strong links between the two units.
Outline Students study the reactions of acids and the preparation and analysis of metal salts. This unit has an extensive practical component. Student should carry out as many of the reactions as possible in the laboratory. More able pupils should use this unit to consolidate their learning about equations, calculations, volumetric analysis and ionic bonding. Reactions of acids are accessible to all pupils. Less able pupils should use this unit in preparation for the practical component of the examination by focusing on techniques for salt preparation and analysis.
Two industrial processes are studied. These can be taught anywhere in the unit.

	Summary of learning Outcomes (see syllabus for full detail)	**Suggested Teaching Activities**	**Further teacher guidance**	**Online resources**
7.1 a b d	**Characteristic Properties of Acids and Bases** describe acids and alkalis in terms of the ions they contain and how they affect Universal Indicator paper describe how to test hydrogen ion concentration using Universal Indicator paper and the pH scale describe the difference between strong and weak acids (extent of ionisation)	Students can test a range of laboratory acids and alkalis, including weak acids (e.g. ethanoic acid) and weak alkalis (e.g. aqueous sodium carbonate) using Universal Indicator paper and/or solution. An interesting extension is to test 'everyday' substances e.g. fruits, milk, toothpaste, skin etc. and find their pH. Students should be able to discriminate between a strong and weak acid by using Universal Indicator or by considering the different rates of reaction with the substances named below.	If available, students can be shown other methods of measuring pH e.g. using pH meters, pH probes or a pH probe attached to a data logger. Issues to discuss include the increased accuracy and convenience of using electronic methods of measuring pH in the workplace and industry. This links to work in Unit 10 relating to the properties of ethanoic acid.	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiments 10, 38. www.wpbschoolhouse.btinternet.co.uk/page10/page10.htm Click on 'Types of chemical reactions' 'Acids, Bases…' http://antoine.frostburg.edu/chem/senese/101/acidbase/indicators.shtml www.lhs.berkeley.edu/ChemMystery/#indicator
c	describe the characteristic properties of acids (reactions with metals, bases and	These reactions can be carried our as student experiments. Main ideas that	Students have already met the reactions of dilute acids	

g	carbonates) describe the properties of bases (reactions with acids and ammonium salts) – note that an alkali is a soluble base	should be emphasised include: • equations for the reactions (include state symbols) • trends in reactivity of the metals • gas tests for hydrogen and carbon dioxide • change in pH during the reactions • temperature changes in the reactions (an opportunity to revise exothermic reactions) • practise choosing reagents to make a named salt. • practising techniques named in sections 1.1, 1.2 and 7.2 (see below)	with metals in Unit 6. Students should carry out at least one of each type of reaction. This links directly with '7.2 Preparation of Salts', '1.1 Experimental Design' and '1.2 Methods of Purification' below. It is very important that these techniques are practised alongside the teaching of these reactions.	www.wpbschoolhouse.btinternet.co.uk/page10/page10.htm Click on 'Reactivity of Metals'
e	describe neutralisation as the reaction between hydrogen and hydroxide ions to produce water	Students may have carried out a titration during Unit 5. The emphasis this time should be on titration followed by partial evaporation and crystallisation as a method of preparing a soluble salt. Students could make an ammonium salt such as ammonium nitrate or ammonium sulphate to show how artificial fertilisers are made. This links to 7.3 below.	This provides an opportunity to teach volumetric analysis using an acid-base titration (Syllabus learning outcome 3(j), Unit 5) Students may note the exothermic nature of neutralisation by using a thermometer to monitor temperature changes during the reaction (Syllabus learning objective 5(a))	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiments 45, 48, 60.
f	know how acid soils are treated with calcium hydroxide	Students can discuss reasons why calcium hydroxide is chosen to use on soil. Issues to discuss include the treatment of soil or lakes in areas where rain water is polluted and acidic.	This can be taught in the context of the effect of calcium hydroxide on ammonium salts (7.3 below)	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiment 91. http://ltpwww.gsfc.nasa.gov/globe/soil_pH/plant_pH.htm
h	classify oxides as acidic, basic or amphoteric, based on metallic/non-metallic character	This should be linked to the Periodic Table. Students can test the pH of some soluble oxides (e.g. calcium oxide, and bubbling carbon dioxide through Universal Indicator	This is an opportunity to revise metallic and non-metallic elements related to their positions on the	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiment 21.

		solution) and should practise predicting the character of an oxide from the position of an element in the Periodic Table.	Periodic Table (Syllabus learning outcome 8.1 (e), Unit 2). Acidic oxides were met in Atmosphere and Environment, Unit 4	
7.2 a B c	**Preparation of Salts** describe techniques used to prepare, separate and purify salts including… titration precipitation reactions of acids with metals, insoluble bases and carbonates describe the rules of solubility for common salts (see syllabus for full list) suggest a method for preparing a given salt	This section is commonly assessed via the Practical/Alternative to Practical paper (Paper 4). Students should refer to past papers to practise the range of common tasks. One approach is to ask students to research and devise their own method for making a named salt. Section 7.1 above can be used to teach the techniques needed in preparation for the investigation. Students will need to choose a method based on the solubility of the salt and sequence the techniques involved.	This should be taught parallel to 1.2 below. More able students should calculate a theoretical yield and an experimental percentage yield (Syllabus learning objective 3 (k), Unit 5). Each working group can enter their yield on the board for a discussion relating to how to increase yields. This can be linked to the economic importance of high yields in industry.	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiments 47, 48.
1.1 a	**Experimental Design** name appropriate apparatus for the measurement of mass and volume including burettes, pipettes and measuring cylinders	This should be taught alongside 7.1 and 7.2 above. See past papers of Paper 4 for practise.		http://www.btinternet.com/~chemistry.diagrams/miscellaneous.htm
1.2 a	**Methods of purification** describe methods of purification by the use of a solvent, filtration and crystallisation revise the fact that the measurement of purity in everyday substances (e.g. drugs, foodstuffs) is important	This should be taught alongside 7.1 and 7.2 above. See past examples of Paper 4 for practise.	This can be used to revise ideas about tests for purity, Syllabus learning outcome 1.2 (e) from Unit 1	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiments 1, 99.
1.3 a	**Identification of ions and gases** describe the use of aqueous sodium hydroxide to identify the cations named in syllabus section 1.3(a) .	Students need to be familiar with the methods of carrying out these tests. Students should carry out the experiments and focus on learning to… • recall how to carry out each test.	See Practical/ Alternative to Practical past papers for guidance on how to set out the recording and processing of results.	http://www.crocodile-clips.com/absorb/AC4/m3.htm go to 'water' and click on

b	describe tests to identify the anions as described in syllabus section 1.3(b).	• write an equation for each reaction • knowing how to test for any gas evolved (Syllabus learning outcome 1.3(c)) • recall the outcomes of the cation tests. • being able to record their observations and conclusions systematically • being able to identify a salt by combining the results of the cation and anion tests.		'view unit' for 'qualitative analysis' www.wpbschoolhouse.btinternet.co.uk/page10/page10.htm Click on ''Chemical tests' www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiment 80.
7.3 a,c	**Properties and uses of ammonia** describe the manufacture of ammonia by the Haber process – NB. The sources of nitrogen and hydrogen for the process.	This should be taught alongside 6.3 below. Students should be familiar with the yield against temperature/pressure graph and be able to discuss optimum conditions in terms of yield and rate. There is an opportunity to discuss the issue of the economic and environmental need for fuel and energy conservation in industry.	Stress the importance of iron as a transition metal catalyst to reinforce syllabus learning objectives 8.3(b) (properties of transition metals) and 6.1 (b) (catalysts and speed of reaction) An interesting extension is for students to research the life of Fritz Haber.	www.chemsoc.org/networks/learnnet/classic_exp.htm Look at experiment 49.
6.3 a,b	**Reversible reactions** describe the idea that some reactions are reversible and reach dynamic equilibrium predict the effect of changing conditions on reversible reactions	This should be taught in the context of the manufacture of ammonia, 7.3 above. Students should be familiar with the symbol for reversible reactions. These ideas can be revisited in the study of sulphuric acid manufacture (below)	It is also important that students practise predicting the effect on yield of changing conditions of temperature and pressure by looking at equations for unfamiliar reactions and considering the molar volumes of gases involved and the value of ΔH	www.wpbschoolhouse.btinternet.co.uk/page10/page10.htm Click on 'Reversible Reactions and Ammonia Synthesis'
7.3 d e	describe the use of nitrogenous fertilisers in promoting plant yield and growth compare nitrogen content of salts in fertilisers by calculation of percentage masses	Students are not expected to know details of the role of nitrogen in the growth of plants. One approach is to look at labels of fertiliser bags. Students can identify the compounds used and calculate the percentage nitrogen in each compound.	This links to calculations based on relative molecular masses first met in Unit 5.	http://www.ukagriculture.com/uk_farming/crops/fertilising_crops.html

f g	describe eutrophication and water pollution problems caused by nitrates leaching and explain how high solubility increases these problems describe the displacement of ammonia from its salts and explain why adding calcium hydroxide to soil causes loss of nitrogen from added fertiliser.	One approach is to summarise eutrophication using a flow chart. It is important to focus on the chemical process of solubility causing leaching and give only a brief outline of the subsequent biological processes that occur in the river. Students can heat ammonium salts with solid calcium hydroxide in test tubes. Use damp Universal Indicator paper to test for ammonia evolved. This also works with proteins e.g. hair, nail clippings.	Water pollution was introduced in Unit 4.	www.wpbschoolhouse.btinternet.co.uk/page10/page10.htm Click on 'Reversible Reactions' for information on eutrophication.
7.4 a b c	**Sulphuric acid** describe the manufacture of sulphuric acid state the use of sulphur dioxide as a bleach and food preservative state the uses of sulphuric acid (manufacture of fertilisers, detergents, battery acid)	Use fertilisers – ammonium sulphate - as the link to this section Students should study the manufacture of sulphuric acid with emphasis on… • a summary of the main reactions (e.g. using a flow chart) • equations, including state symbols for each reaction • considering the reversible nature of the reaction to form sulphur trioxide (see 6.3 above) • the large scale importance of sulphuric acid with reference to its uses.	Stress the importance of vanadium(V) oxide as a transition metal compound catalyst to reinforce syllabus learning objectives 8.3(b) (properties of transition metals) and 6.1 (b) (catalysts and speed of reaction) This is an opportunity to teach the gas test for sulphur dioxide (Syllabus learning outcome 1.3(c))	www.wpbschoolhouse.btinternet.co.uk/page10/page10.htm Click on 'Extra Industrial Chemisty'