Edexcel Chemistry C3

Topic 3 — Chemical Detection

In this topic analytical chemistry is used to enable students to widen and deepen their experience of reaction chemistry and related calculations. Students should come to understand that the first step, when an unidentified substance is found, is to discover what the substance contains. The reactions of ions in solution provide extensive opportunity for practical work and consolidation of the idea that given ions have characteristic reactions and that these reactions can be used to identify them. The final challenge in this area, to identify an unknown ionic compound, can give students satisfaction and proof of their new-found abilities!
Students can be introduced to ionic equations as an extension of their practical work and should come to appreciate that these equations show only the ions which react to give, or are produced from, non-ionic products and precipitates.
Calculations will help students to understand that amounts of substances can be measured in moles of particles as well as in grams or as a number of particles. The idea that one mole of molecules of any gas occupies the same volume under the same conditions of temperature and pressure enables students to do calculations involving the production of gases from solid and liquid reactants. An understanding of Avogadro's law enables them to do calculations for reactions involving solely gaseous reactants and products.
Students can investigate applications of qualitative and quantitative analysis in fields such as forensic science, quality control and research. The topic will also help students to appreciate the need for accuracy and reliability of data.

Questions

- How does a forensic scientist works?
- Why do we need to analyse substances?
- Why is it important to know that the label of contents on the packet is correct?
- How do we find out how much of a substance is present in a given sample?
- How pure is our water and how pure does it need to be?

Know

- Cations and anions are present in many samples and can be identified.
- Amounts of substances present can be calculated in moles.
- How to calculate the amount of raw materials to use in a chemical reaction inorder to produce the mass of product required
- The importance of knowing the purity of substances and that different users require different levels of purity.

Glossary

You will be expected to be able to recall, explain, describe and use appropriately the following words and phrases:
Acid, flame test, mole, reactant, Anion, indicator, precipitation, titration, Avogadro's law, ion, purity,
Base, ionic substance, qualitative, Cation, molar, volume, quantitative,

Know how to:
- distinguish between and use primary and/or secondary data
- discuss and evaluate evidence and data

- consider the ethical, contemporary and social issues.
- recall the formulae of elements and simple compounds in the topic
- represent chemical reactions by word equations and simple balanced equations and use state symbols (s), (l), (g) and (aq)
- write balanced equations to describe and explain a wide range of reactions in this topic
- write balanced ionic equations to describe and explain a wide range of reactions in this topic.

What is present?

- why substances need to be identified and their purity determined
- analysis may be qualitative or quantitative
- ionic substances are identified by identifying each type of ion they contain
- why the test for each ion must be unique
- precipitation reactions form the basis of some tests for ions
- the tests for the following ions in solids or solutions as appropriate:
    - H^+ using acid/base indicators and typical acid reactions
    - Na^+, K^+, Ca^{2+}, Cu^{2+} using flame tests
    - Al^{3+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, NH_4^+ using sodium hydroxide solution
    - CO_3^- using dilute acid and identifying the carbon dioxide evolved
    - SO_3^- using dilute hydrochloric acid and identifying the sulphur dioxide evolved
    - SO_4^- using dilute hydrochloric acid and barium chloride solution
    - Cl^-, Br^-, I^- using dilute nitric acid and silver nitrate solution
    - OH^- using acid/base indicators and reaction when heated with an ammonium salt

How much is present?

- the amount of a substance can be measured in grams, numbers of particles or number of moles of particles
- how to convert masses of substances into moles of particles of the substance and vice versa
- to produce required amounts of product chemists must be able to calculate how much reactant to use
- calculate the mass of substances involved in reactions, given the relevant equation
- the use of Avogadro's law to calculate the volumes of gases involved in reactions, given the relevant equation
- the amount of a substance present in a solution can be determined by experiments involving mass or concentration determination
- how to determine the mass of substance dissolved in water by evaporating the water from a known mass of solution
- calculate the volume of a given mass of gas (given the molar volume at the appropriate temperature and pressure) and vice versa
- calculate and interrelate masses or volumes of substances involved in a reaction, given the relevant equation
- convert mass-concentration into mol dm^{-3} and vice versa
- titration can be used to determine the exact amount of a soluble substance dissolved in a solution
- the procedure for carrying out simple acid-base titrations using burette, pipette and suitable indicators
- perform simple calculations from the results of titration.

Water: how water is used in everyday life and why it is important not to waste it.

Topic 4 — Chemistry Working for Us

This topic is intended to enable students to widen and deepen their knowledge of previous topics. Thus the properties of transition metals can be contrasted with the properties of metals already encountered and this should lead to the idea that these are the metals which have the properties of typical metals: examination of the periodic table shows why! The existence of ions is extended to an understanding of redox in terms of electron transfer and of reactions caused by the action of direct electric current on ionic substances in electrolysis.
Students should come to appreciate the importance of alkali metal compounds, sulphuric acid, and how chemical substances play a part in our everyday lives enhancing our standard of living and quality of life.

Questions

What solvents are used in cosmetics?
How is glass made and coloured?
How do paints get their colours?
What is an electrolyte?
Which chemical substance smells like pear drops?
What is in toothpaste?
How do detergents remove fats or dirt from clothes?
Which dye is used in denim?
What is meant by ‘hydrophilic’ and ‘hydrophobic’?

Know

- Chemistry is used in our everyday lives, for example in washing powders, sweets, cosmetics, paints, dyes and plastics.
- The chemical and physical properties of elements and compounds are exploited to make useful and/or aesthetic products.
- Chemists are given a product specification and investigate which chemicals will be able to meet the requirements.
- Chemical substances need to be managed safely and considerately to ensure that they do not impact negatively on the environment.

Glossary

You will be expected to be able to recall, explain, describe and use appropriately the following words and phrases:
Alcohol, detergent, immiscible, solvent, Alkali, electrode, ion, surfactant, alkali metal, electrolysis, miscible, transition metal, carboxylic acid, electrolyte, oxidation, catalyst, ester, pigment, Contact process, flavouring, reduction, Cosmetic, hard water, soap

Know how to:

- distinguish between and use primary and/or secondary data
- discuss and evaluate evidence and data
- consider the ethical, contemporary and social issues.
- recall the formulae of elements and simple compounds in the topic
- represent chemical reactions by word equations and simple balanced equations and use state symbols (s), (l), (g) and (aq)
- write balanced equations to describe and explain a wide range of reactions in this topic
- write balanced ionic equations to describe and explain a wide range of reactions in this topic.

Aspects of safety, sustainability and effects on the environment of the following chemical substances and processes:

Transition metals, their compounds and uses

- the characteristic physical properties of the common transition metals — high melting points, good conductors of heat and electricity and high density as exemplified by iron and copper
- uses of transition metals and their compounds as catalysts and pigments.

Organic acids, alcohols and esters

- the useful chemical and physical properties of alcohols, carboxylic acids and esters
- uses of alcohols in cosmetics and preparation of esters, of salts of acids in soaps and detergents and of esters in cosmetics and fruit flavourings.

Electrolysis

- that oxidation may involve the loss of electrons and reduction may involve the gain of electrons
- the process of electrolysis to include the types of electrolytes, electrodes, half equations, movement of ions and electrical circuits
- the purification of copper by electrolysis, including a simple diagram of the cell.

Alkali metals and their compounds

- that alkali metals are soft and have comparatively low melting and boiling points
- the reactions of lithium, sodium and potassium with water to form hydroxides and hydrogen gas
- the use of sodium carbonate in producing glass and washing soda crystals
- the uses of sodium hydroxide to illustrate its economic importance in producing detergents, soaps, fibres, etc.

Sulphuric acid

- the manufacture of sulphuric acid from sulphur and sulphide ores
- the operating conditions used in the 'Contact process'
- the uses of sulphuric acid to illustrate its economic importance in producing fertilisers, detergents, soaps, dyes, fibres, plastics, paints, etc.

Soap and detergents

- the preparation of soap from carboxylic acids and alkalis
- the detergent action of surfactants in lowering surface tension to remove dirt and or oil/grease
- the practical differences between 'biological' and 'non-biological' detergents
- the practical advantages of using detergents instead of soaps in hard water areas.