The **key areas** are from the Added Value Unit Specification. **Suggested learning activities** are not mandatory. This offers examples of suggested activities, from which you could select a range. It is not expected that all will be covered. The contexts for key areas are open to personalisation and choice, so centres are likely to devise their own learning activities. **Exemplification of key areas** provides an outline of the level of demand and detail of the key areas.

Risk assessment should always be carried out by teachers/lecturers prior to doing any of the experiments and demonstrations listed in the table.

Chemical Changes and Structure		
Key areas	**Suggested learning activities**	**Exemplification of key areas**
Rates of reaction		
Factors affecting rate of reaction	Learners will carry out a series of experiments that involve production of a gas, for example acid with metal carbonate or metal. Alternatively, an effervescent tablet can be added to water.	A working knowledge of the factors affecting rates of reaction including temperature, concentration, surface area/particle size and the presence of a catalyst
Monitoring reactions in terms of rate of reaction	Learners can collect data manually or by using data-logging technology.	To compare rates of chemical reactions, changes in mass, volume and other quantities can be measured. Graphs can then be drawn to help this comparison.
Interpreting rate of reaction graphs	Learners can be given a pre-drawn graph and asked to add lines to it to show differences in the rate and the end-point of a reaction when conditions have been changed.	Change in mass, volume etc vs time graphs can be interpreted in terms of: ♦ rate (qualitative only) ♦ end-point of a reaction ♦ quantity of product ♦ quantity of reactant used ♦ effect of changing conditions (qualitative only)

Atomic structure and bonding related to properties of materials Learners should be familiar with the structure of the periodic table.		Learners should have a working knowledge of the structure of the periodic table in terms of groups and periods.
Elements		All matter is made of atoms. When a substance contains only one kind of atom it is known as an element.
Structure of the atom Atomic number Mass Number Why atoms are neutral	Learners can be introduced to the three subatomic particles in a variety of ways. Learners can take part in an activity to 'build an atom'. Using small beads/sweets or even their classmates, they can build a model of the positions of the particles in an atom. It may be useful to show the electrons in shells as a simple target diagram. Simple card sorts can be used for the sub-atomic particles and the elements, allowing the learners to generate their own general rules from the patterns that they observe. The learners can produce lists of similarities and differences in the cards. Interactive alternatives are available online from the University of Colorado, Education — the build-an-atom simulation and K Science — atom animation. The idea of mass and charge can be discussed allowing learners to link the properties of the three particles to the mass number and charge.	Atoms contain protons, neutrons and electrons each with a specific charge, mass and position within the atom. The mass of an electron is negligible. The number of protons defines an element and is known as the atomic number. The mass number of an atom is the number of protons plus neutrons. Atoms do not have an electric charge and are said to be neutral.

Structure of the periodic table		Elements are arranged in the periodic table in order of increasing atomic number. Elements in the group have similar chemical properties.
Classifying elements as metals and non-metals		The position of metals and non-metals in the periodic table.
Compounds and how they are named	Learners can carry out simple chemical reactions that form two-element compounds (eg magnesium + oxygen, hydrogen and oxygen, and burning iron filings). They could be shown some reactions more suited to teacher demonstration (aluminium + iodine and the combustion of iron wool — details available at the Royal Society of Chemistry's Practical Chemistry website).	Compounds are substances formed when atoms of two or more elements join together. The name of a compound is derived from the names of the elements from which it is formed with a suffix of -ide, -ite, or -ate.
Chemical formulae	Learners learn to write formulae from named compounds and chemical equations from word equations. Learners can then practise this through card sorts and games.	The ratio in which elements combine to form two element compounds can be determined using valency rules and hence a formula can be written. The chemical formula can also be determined from names with prefixes, models or structures.
Calculation of formula mass	Learners will explore the link between the formula mass and the mass of the individual atoms within it. Small beads, sweets or learners themselves can be used to demonstrate this principle as can the animation available from Sunflower Learning.	From the formula of a substance, its formula mass can be calculated using the Relative Formula Mass of the elements.

Word equations and chemical equations including state symbols		A chemical reaction which can be described using word equations can also be described using chemical symbol equations. Use of state symbols in equations.
The two types of compound, covalent and ionic, in terms of their elements, sharing/transfer of electrons and their structure		There are two types of compound. Covalent compounds form when non-metal atoms form covalent bonds by sharing their outer electrons. Covalent compounds exist as molecules. Ionic compounds form when metal atoms join to non-metal atoms by transferring electron(s) from the metal to the non-metal. The resulting charged particles are called ions and an ionic bond is the attraction of the oppositely charged ions.
Properties of covalent and ionic compounds including, melting point, boiling point, state at room temperature and conductivity.	Learners will test the electrical conductivity of various compounds as solids, liquids, gases and solutions. Teachers can demonstrate the electrical conductivity of molten and solid wax and lead bromide.	Covalent compounds, made of molecules, have low melting and boiling points. As a result, they can be found in any state at room temperature. Ionic compounds have high melting and boiling points. As a result, they are found in the solid state at room temperature. Only ionic compounds can conduct electricity, they can only do this when molten or in solution.
Determining the type of bonding present in a compound.		To be sure of the bonding present in a substance the conductivity must be tested.

Energy changes of chemical reactions Exothermic and endothermic reactions	Explore examples of exothermic reaction which could include combustion and neutralisation. Reactions of metals in water or acid. Adding water to anhydrous copper sulphate. Explore examples of endothermic reactions which could include solubility of ammonium nitrate and reaction of barium hydroxide with ammonium nitrate. RSC has resources available to investigate handwarmers and the exothermic/endothermic changes involved.	Reactions can be defined as exothermic or endothermic depending on the overall energy change that takes place. Reactions that give out heat/energy are exothermic and those that take in heat/energy are endothermic

Acids and bases		Learners should be familiar with: ♦ pH ♦ acids and bases in ♦ neutralisation reactions ♦ salt formation
pH of oxides	Learners could investigate the effect on pH of various oxides to establish a pattern. A description of one such investigation is given at the Royal Society of Chemistry's Practical Chemistry website.	The pH of water can only be affected by the addition of soluble substances: ♦ Soluble metal oxides produce alkaline solutions ♦ Soluble non-metal oxides produce acidic solutions ♦ Insoluble oxides will not affect the pH of water
Sources of carbon dioxide in the atmosphere	Learners will investigate sources of CO_2 in the atmosphere including the burning of fossil fuels and cement manufacture. Carbon/global footprints may be discussed at this point. A good resource for this is Education Scotland's 'Schools Global Footprint'. Online resources are available on LTS schools global footprint index.	Candidates may have an appreciation that CO_2 is a by-product of burning fossil fuels but another large contribution is made by cement manufacturing for use in new buildings.
Sources of non-metal oxides, particularly carbon dioxide, sulfur dioxide and	Learners can study the effect of CO_2 on global warming by charting the temperature of plastic bottles filled with air, water vapour, CO_2 (and possibly methane)	Non-metal oxides play a large role in the environment.

oxides of nitrogen, and their effects on the environment.	exposed to a heat source over time. The effect of increased temperature on the ability of the oceans to absorb extra CO_2 as well as the effect of reduced pH on shells could also be investigated. A suitable resource can be found at the Royal Society of Chemistry website called 'Sea Change'. Learners can be introduced to other non-metal oxide pollutants and can investigate the effects of lower pH on cress seed growth, limestone or marble. These investigations can be accessed on the Education Scotland website.	Carbon dioxide, sulfur dioxide and oxides of nitrogen are produced as a result of our continued use of fossil fuels. Although these oxides are produced in nature the increased production of these oxides is linked to environmental problems including acid rain, global warming and ocean acidification.
Acids in food and drink and the effect these have on human health.	Learners could investigate the effect of low pH drinks on teeth (using pieces of bone) as described in the Sip Smart BC Tooth Experiment website. Learners should also investigate the positive uses of acids, eg acidity regulators in foodstuffs such as ethanoic acid (E260) and citric acid (E330). Benzoic acid (E210) is a preservative. HCl is used by the body for digestion. Lightning storms supply much needed nitrates to the soil of rain forests. Another positive use can be found at the apple-browning demonstrations, experiments at 'about.com'.	Acids play an important role in the food and drink industry eg as preservatives. These acids have an impact on human health eg tooth erosion, indigestion, etc.
Neutralisation reactions and salt formation.	The role of neutralisation can be investigated in the prevention of acid damage. Various practical	

Bases Following the course of a neutralisation reaction Word equations for neutralisation reactions and naming the salt produced.	experiments could be carried out here such as the investigation into changing the pH of soil in agriculture. A suitable resource can be found at the Royal Society of Chemistry's Practical Chemistry website: 'Curing Acidity'. Copper carbonate and sulfuric acid could be used to investigate a neutralisation reaction that does not need an indicator. Learners could also make indicators from natural resources to follow the course of a neutralisation reaction. Suitable resources can be found out at the Planet Science: Cabbage-chemistry website or the Woodrow Wilson Foundation's website: Say pH with Flowers. Website available at woodrow.org/teachers/1986/exp23	A neutralisation reaction is one in which an acid reacts with a base to form water. A salt is also formed in this reaction. Bases are metal oxides, metal carbonates and metal hydroxides. The course of a neutralisation reaction can be followed using a pH indicator; if the base is insoluble an indicator is not required. Neutralisation reactions can be described through the use of word equations and should include the correct name for the salt.

Nature's Chemistry		
Key areas	**Suggested learning activities**	**Exemplification of key areas**
Fuels Fuels store energy in chemical bonds.	More information on which wood burns best and which wood contains the most energy can be found at the website juliantrubin.com. Information on how charcoal can be made can be found on the MIT Open Courseware site: http://ocw.mit.edu. Information on how to make charcoal in the classroom can be found on http://chemistry.about.com/ under 'blacksnakes'. Further information and activities on fuels can be found through the Royal Society of Chemistry website and on the European Union's Popularity and Relevance of Science Education for Scientific Literacy (Parsel) site.	A fuel is any compound that has stored energy. Energy is captured in chemical bonds through processes such as photosynthesis. Wood, petrol, coal, peat and a number of other fuels have energy-rich chemical bonds created using the energy from the Sun
Fossil fuels	Video clips on the formation of fossil fuels and fractional distillation can be found on the website. A methane explosion can be demonstrated using the ratio of 1 part methane to 2 parts oxygen. This can also be shown by an 'exploding can' demonstration as detailed in the book *101 Classic Chemistry Demonstrations* published by the RSC.	Fossil fuels are a useful reserve of fuels and are therefore used extensively to satisfy the demands of an energy-dependent world. Fossil fuels are principally hydrocarbons with minor impurities. They are so named because they originate from the decayed and fossilised remains of plants and animals that lived millions of years ago. They are a finite resource.

Some reactions release energy from fuels	Demonstration of fractional distillation using synthetic crude oil. Further details on this can be found through the SSERC website.	Crude oil is a mixture of hydrocarbons. Energy is released during burning/oxidation and respiration. The most common form of oxidation is the direct reaction of a fuel with oxygen through combustion. Combustion is the reaction of burning a fuel in oxygen.
Fire triangle		Controlling fires can be explained through the fire triangle.
Complete and incomplete combustion	The products of combustion can be shown through a demonstration of burning a hydrocarbon and drawing the products of combustion through a test tube with cobalt chloride paper surrounded by an ice bath and through another test tube with lime water. The products of incomplete combustion can be shown by heating a beaker of water using the safety flame of a Bunsen burner.	Hydrocarbons burn in a plentiful supply of oxygen to produce carbon dioxide and water. Carbon monoxide, a poisonous gas, and carbon are produced when hydrocarbons burn in a limited supply of oxygen.
Use of catalytic converters to reduce carbon monoxide emissions		In engines, catalytic converters can be used to minimise the output of carbon monoxide
Reducing carbon emissions		Ways to reduce carbon dioxide emissions are explored (including methods of carbon capture).

Conservation of mass during chemical reactions Impact on the environment of burning fossil fuels including the effect on the carbon cycle		The concept of conservation of mass will be introduced through equations relating to combustion of hydrocarbons. Combustion of fossil fuels impacts on the environment and contributes to the carbon cycle.
Exothermic and endothermic reactions	Reacting solid potassium permanganate and adding a few drops of glycerol can show an exothermic chemical reaction. A demonstration of the flammability of alcohols is provided by the 'whoosh bottle' demonstration. A mixture of alcohol and air in a large polycarbonate bottle is ignited. The resulting rapid combustion reaction, often accompanied by a dramatic 'whoosh' sound and flames, demonstrates the large amount of chemical energy released in the combustion of alcohols. Equally dramatic are the 'alcohol gun' experiment, or the 'flaming pumpkin'. Centres should carry out risk assessments before carrying out these experiments. A more mysterious element can be introduced with the 'non-burning £5 note' experiment.	Exothermic chemical reactions give out energy and endothermic chemical reactions take in energy. Combustion is an example of an exothermic reaction.

Finite energy sources and biofuels. Benefit and risks of different energy sources Biomass	 Practical experiments on making biofuels can be found on the parsel and science buddies' websites. Learners can also take part in a debate about the pros and cons of using biofuels and whether or not they should be used to replace fossil fuels. Further examples on topical science debates can be obtained from Dundee Science Centre. Education Scotland has a website called STEM central through which additional information can be accessed.	Finite energy sources will be investigated in conjunction with the development of biofuels as alternative sources of energy to support society's energy needs. The benefits and risks of different energy sources and their impact on the carbon cycle can be researched. Energy sources could include: ♦ wind power ♦ wave and tidal power ♦ geothermal ♦ biomass and biofuels ♦ solar power ♦ nuclear Biomass, a source of biofuels, is plant-based material which can be burned to release energy. Biomass can also be converted to other usable forms of fuel. These include methane gas or fuels used for transportation such as ethanol and biodiesel.
Hydrocarbons Fractional distillation		Hydrocarbon molecules contain carbon and hydrogen only. Fractional distillation is the process used for separating crude oil into fractions. The properties, including melting point, boiling point, flammability and viscosity, and the use of the fractions

		can be compared. A fraction is a group of hydrocarbons with boiling points within a given range.
Hydrocarbon chains		There are many different hydrocarbon molecules as carbon and hydrogen can form chain molecules of different lengths.
Alkanes	Animations on the naming of alkanes, alkenes and fractional distillation can be found through the Scholar website (in the higher world of carbon unit) and the e-chalk website. Chemsketch can be used to draw and show the geometry of alkanes and alkenes. Chemsketch is available free of charge for schools.	The alkanes are a subset of hydrocarbons and are identified from the '-ane' ending. Straight-chain alkanes can be named and identified from full structural formulae and molecular formulae up to C_8.
Alkenes	A demonstration can be used to show learners how to distinguish between an alkane and an alkene. During the demonstration bromine water is added to an alkene and an alkane. The bromine water will decolourise immediately in the alkene and stay yellow in the alkane.	The alkenes are also a subset of hydrocarbons. An alkene can be identified from the carbon-to-carbon double bond and '-ene' ending. Straight-chain alkenes can be named and identified from full structural formulae and molecular formulae up to C_8.

Cracking	Cracking can be carried out in the classroom using an aluminium oxide catalyst. To do this, soak some ceramic wool in paraffin and place in a boiling tube. Place some aluminium oxide powder in a beaker and add some ceramic wool and cover it in aluminium oxide. Place the ceramic wool containing aluminium oxide in the boiling tube about 3 cm away from the paraffin ceramic wool. Attach a delivery tube to the boiling tube and place into a tub of water. Heat the boiling tube at the ceramic wool covered in aluminium oxide. Collect the gas given off over water. Remove the delivery tube from the water before stopping heating to prevent 'suck back'. To prove the gas is an alkene, bromine water can be added and will decolourise in the test tube with the gas.	Cracking is a process used to meet the demand for shorter chain alkanes and alkenes.
Everyday consumer products Use of carbohydrates and oils from plants Carbohydrates including glucose and starch	The 'Screaming Jelly babies' demonstration can be used to show the energy content of carbohydrates. This involves warming potassium chlorate until it melts and adding the jelly baby. This will combust and release the stored energy. Centres should carry out their own risk assessment before undertaking this experiment. To show the elements present in a carbohydrate, learners can watch a demonstration of a few drops of concentrated sulfuric acid being added to a few grams of solid sucrose. This will remove the hydrogen and oxygen from the carbohydrate through steam. Solid carbon is left behind.	Plants are a source of carbohydrates and oils which can be used for food or fuel. Carbohydrates are compounds which contain carbon, hydrogen and oxygen with the hydrogen and oxygen in the ratio of two to one.

		Glucose is a simple carbohydrate with the formula $C_6H_{12}O_6$. Starch is a complex carbohydrate formed by joining many glucose molecules. Plants store energy by converting glucose into starch..
Testing for starch and glucose	Practical tasks should be carried out to demonstrate the differences between glucose and starch and how starch can be hydrolysed into glucose. This can be confirmed through chemical tests.	Chemical tests can carried out to distinguish between glucose and starch using Benedict's solution and iodine respectively.
Digestion of starch and respiration		Starch is broken down into glucose in the body, during digestion. Glucose, due to its small molecular size, can pass through the gut wall into the bloodstream to be used in cells, throughout the body, during respiration.
Fermentation	To form ethanol, learners can add yeast to fruit juice in a conical flask. A balloon can be placed over the neck of the conical flask to collect the gas given off. The resulting ethanol/fruit juice mixture can then be distilled to produce a higher concentration of ethanol.	Enzymes present in yeast can convert glucose into ethanol. This process is called fermentation. Different plants are used to produce different alcoholic beverages. As the fermentation process continues the concentration of ethanol causes the enzyme to stop working. This limits the ethanol concentration achievable by fermentation. Enzymes operate under optimal conditions of temperature and pH.
Distillation		To achieve higher concentrations of ethanol for production of spirits, distillation must be carried out.
Units of alcohol	To achieve an understanding of units of alcohol, learners can look at different alcoholic beverage labels that show the number of units in the drink.	The alcohol content of drinks is measured in units.

Plants to products Plants are used to make a wide variety of products. How products are made from plants.	Approximately 30% of medicines used today are derived from plants. The label on a medicine or pharmaceutical product describes the contents of the product and what is can be used for. There are a variety of medicines which are legal. While alcohol is also a legal drug there are other drugs which are illegal and may be harmful. Plants such as foxglove, willow, meadowsweet, poppies and chinchona were commonly used in earlier times for the treatment of diseases such as heart disease, inflammatory diseases and malaria. Scottish scientists were instrumental in the development of willow, poppies and chinchona in the treatment of disease. Aspirin is a medicine that is derived from meadowsweet and willow. Morphine, used to treat pain, is derived from poppies.	Many plants are used by chemists in the design and manufacture of many everyday products such as pharmaceuticals soaps, cosmetics, dyes, medicines, foods or food colourings. Learners will research and investigate how plants are used to make products. For each plant they should cover: ♦ where they are found and grown ♦ the identification of the active ingredient ♦ the role of the chemists in extracting the useful chemicals ♦ the variety of uses and applications of plant-based products ♦ how the plant-based products have enhanced everyday life

Chemistry in Society		
Key areas	**Suggested learning activities**	**Exemplification of key areas**
Metals and alloys The chemical and physical properties of materials are linked to their use.	The practical chemistry branch of the RSC website has examples of practical activities related to metals, polymers, and analysis.	Materials are all substances and include metals, ceramics and plastics as well as natural and novel substances. Chemical and physical properties of materials are linked to their uses.
Reactions of metals with oxygen, water and dilute acid.	Reactions of metals (Cu, Zn, Mg) with air, water and dilute acid. Testing hydrogen. Suggested demo using Arculus method.	Observation of the reaction of metals with: oxygen, water and dilute acid.
Reactivity series	TES website now contains the Teachers' TV videos. *The Periodic Table — Ferocious Elements* could be used. BBC Learning Zone has a video clip on alkali metals. The Open University has a clip on the reaction of rubidium and caesium with water.	Learners should be able to use the reactions of metals with oxygen, water and dilute acid to deduce a reactivity series.
The method of extracting a metal is related to the reactivity series	Extraction of metals: ♦ heat alone — silver oxide ♦ copper from copper oxide using carbon ♦ electrolysis	Methods used to extract metals from their ores are dependent on the position of the metal in the reactivity series. Methods include: ♦ heating alone ♦ heating with carbon ♦ electrolysis
Corrosion of metals		Metals corrode by their reaction with oxygen and water. Different metals corrode at different rates.

Rusting and methods of preventing iron from rusting Sacrificial protection of iron to prevent rusting Chemical cells and the electrochemical series	 Pairs of metals to determine electrochemical series. 'Fruity' batteries using different metal pairs. Simple cells.	Rusting is the corrosion of iron. It occurs when iron is exposed to oxygen and water. Various methods can be used to prevent iron form rusting including: ♦ painting ♦ coating with oil or grease ♦ electroplating ♦ chrome plating ♦ plastic coating ♦ sacrificial protection ♦ attaching to the negative terminal of a power source Ferroxyl indicator can be used to show rusting occurring. The use of certain metals to protect iron from rusting is related to their relative position to iron in the electrochemical series. When different metals are connected by an electrolyte, an electric current flows from one metal to the other through connecting wires. By comparing pairs of metals the electrochemical series can be constructed. The electrochemical series is used to predict the size of voltage and direction of current in chemical cells. This forms the basis for batteries.

Alloys	'Turning copper coins gold'. The RSC website has guidance and risk assessments for this experiment. Possible scope to investigate carbon in steel.	An alloy is a mixture of two or more elements, at least one of which is a metal. Alloys have different physical properties in comparison to the pure elements.
Materials Polymers and polymerisation Thermosoftening and thermosetting plastics Burning plastics Biodegradable plastics	The National STEM centre E-Library contains all the resources produced by the Gatsby Science Enhancement Programme. These include resource booklets and suggested experiments on: Fantastic Plastic, fibres and fabrics, 'bouncy fluids', novel materials and SMART applications. Mindsets is an organisation sponsored by Middlesex University. Resources and chemicals can be purchased from its website. Fantastic Plastic is a website sponsored by the University of Reading. It has a variety of resources available. Investigate polymers and their properties. Types of plastic — thermosoftening and thermosetting. Burning of plastics related to poisonous gases released and consequences on the environment.	Plastics are a group of important materials. They are long-chain molecules called polymers and can be made by a process called polymerisation. Plastics are made from small units called monomers. The name of the polymer can be deduced from the name of the monomer. Polymers can be engineered to be used in a variety of environments. Plastics can be grouped in different ways: thermosoftening and thermosetting plastics. Thermosoftening plastics or thermoplastics can be reshaped once heated whereas thermosetting polymers cannot. Plastics burn to release harmful gases. Plastics have been developed which can biodegrade.

Novel materials Ceramics	 Investigate types of ceramics and properties of ceramics including strength and heat resistance. Activities might include making glass, investigating clay vs. fired clay and porosity. Other suggested activities are available from Education Scotland.	Properties of materials are constantly updated and adapted and new materials developed to meet the demands of society. These tend to have special and unique properties. The properties of ceramic materials have made them vital components for many modern applications.
Fertilisers Importance of fertilisers Three essential elements and percentage composition Natural and manmade fertilisers Environmental impact of fertilisers	 Percentage composition calculations can be related to the packaging of fertilisers. Design and prepare fertilisers using neutralisation reactions. Possible investigation into effectiveness of fertilisers: Different school-made fertilisers could be compared by growing suitable plants. Investigate the solubility of fertilisers and the potential environmental consequences associated with fertiliser use.	 The chemist has an important role in helping to make sure plants have the correct nutrients to ensure sufficient food production. There are three key elements which provide the nutrients required for plant growth: nitrogen, phosphorus and potassium. The % composition of an element in the fertiliser can be calculated. They are usually shown as percentage amounts on the side of fertiliser packaging. Fertilisers can be produced naturally or in laboratories by chemists using neutralisation reactions. The use of fertilisers may have an environmental impact. This should include the effect of fertilisers leeching into water courses.

Nuclear chemistry Formation of elements in stars	Internet search: ‘teachers domain nova science formation of elements’. Carry out research into formation of elements.	Heavier elements are formed from lighter elements in stars.
Background radiation	Use a gieger-muller tube to measure background radiation and that of various everyday objects such as bananas.	Background radiation is a natural phenomenon and is caused by various factors including: ♦ rocks ♦ cosmic rays ♦ medical uses
Chemical analysis Importance of chemical analysis to our everyday life.		Chemical analysis permeates all aspects of chemistry. It is important that learners understand the significance of analysis in terms of: ♦ testing purity of eg water ♦ identifying pollutants
Simple analytical techniques	Learners carry out simple chemical analysis which can build on knowledge and skills from across any of the National 4 Chemistry Units. Possible activities could include: ♦ analysis of rock salt to determine % of sodium chloride ♦ crime scene scenario — poison-pen letter — using paper chromatography to separate and identify ink samples ♦ soil or water analysis using pH testing	Learners should carry out simple analytical techniques. These could include: ♦ chromatography ♦ flame tests ♦ pH measurement using indicators / pH meters ♦ separation techniques including filtration, evaporation and distillation