Northern Ireland Chemistry Curriculum Map

	Foundation phase (ages 4-6)	KS1 (age 6-8)	KS2 (age 8-11)	KS3 (Age 11-14)	KS4 (age 14-16)(higher content embolidened)	KS5	Higher Education Year 1
Atomic structure and the periodic table				Atoms and elements	Atomic structure; protons, neutrons and electrons, including relative charges and masses. Atomic numbers and mass numbers of elements, and electronic configurations of atoms	**Atomic orbitals:** define; shapes; classify the element as belonging to the s, p, d or f block from the electronic configuration; explain colour of compounds based on electron delocalisation.	**The Bohr atom;** wave-particle duality; Schrodinger wave equation; Quantum numbers, s, p, d orbitals. Rules and principles governing filling of orbitals.
					Definition of isotopes , and **use of mass numbers and relative abundances to calculate relative atomic mass of isotopes.**	Define atomic number; mass number; relative atomic; relative isotopic; relative molecular and relative formula mass; isotopes	
					The difference between mixtures, elements and compounds; classification of substances as elements, compounds or mixtures.		
					Basic structure of the periodic table, including the position of metals, non-metals, halogens, noble gases etc. Know how position in the periodic table relates to electronic structure		
					Historical development of atomic theory and the Periodic Table; contribution of Rutherford, Chadwick, Newlands and Mendeleev.		
						Electronegativity; trends across periods and down groups; how differences in electronegativity cause bond polarity	Trends in the periodic table.
						Ionisation energy; define and explain using shielding and stability; use to predict the group of an element and provide evidence for subshells	
					Know some properties of group 1 and group 7, and know trends related to reactivity **Relate reactivity to electronic configuration for Groups 1,7 and 0; write half equations for these reactions**	**Group 2;** trends within groups, reactions, thermal stability and solubility of their sulphates, hydroxides and carbonates, uses	Chemistry of the s block and p block elements, to include halides and hydrides
						Halogens; trends within group, colours, solubility, reaction with sodium hydroxide, sulphuric acid and water; trends in oxidising ability	
						Explain trend in melting point across period 3 in terms of structure and bonding.	
					Know about the specified properties, reactions, uses and societal impact of hydrogen, carbon (and carbon dioxide), nitrogen (and ammonia, particularly its use as a fertiliser), oxygen and sulfur (with reference to acid rain).		
					Recall the environmental problems of nitrogen fertilisers, including eutrophication; **Describe the contact process for manufacture of sulphuric acid, including how rates are increased; Use of ammonia solution to identify metal ions, and sulphuric acid to dehydrate sugar**		
					Reactivity series; know about displacement reaction of metals and their reactions with water, steam and oxygen; relate rate of reaction to reactivity; relate this to metal extraction		
Inorganic chemistry						**Transition metals;** characteristic behaviour, electronic configuration, oxidation numbers, changing oxidation states with particular reference to vanadium	Co-ordination chemistry of the d block elements - trends and general properties, extending to crystal field theory, d-orbital splitting and thermodynamic stability.
						Formation of complex ions; ligand type, coordination number, relative strengths of ligands	
						Ligand replacement reactions; colours, detection tests, electrochemistry, entropy	
Properties of matter			How changes in state are brought about		Practical investigation of physical properties of water and changes of state.		Ideal gases and ideal solutions
			The effect of heating and cooling				Basic principles of chemistry in the solid state.
							Changes of state, and liquid-liquid vapour equilibria.
	Investigate the way materials change through physical force	Everyday materials can be heated or cooled to change them		Properties of materials			
	Substances can be heated or cooled to change them		Changes of state in the water cycle				
Bonding				Elements, compounds	Ionic bonding; know how an ion is formed; be able to draw dot and cross diagrams of ions understand that attraction of oppositely charged ions is the basis of ionic bonding	**Bonding:** Describe metallic, ionic, coordinate and covalent bonding in terms of electrostatic interactions; construct dot and cross diagrams for simple; double, triple and coordinate bonds	Common theories of bonding, structures and representations.
					Covalent bonding; know that this is sharing of atoms; draw dot and cross diagrams for specific species, **including specified multiple bonds**		Homonuclear and Heteronuclear Diatomic molecules. Polyatomic molecules
					Metallic bonding		Bonding of p block elements emphasising multiple bonding. VSEPR theory, octet rule, hypervalency, and hydrogen bonding.
					Relate types of bonding and subsequent structures to the properties of the materials formed, **including ionic lattice, giant molecular, simple molecular and metallic.**	Relate bonding to types of structure and the physical properties of these structures	Extended solid structures - Metals, semi-metals , ionic solids and covalent solids. Structure, energy and chemical bonding of solids.
					Van der waals forces		
						Intermolecular forces; including induces dipole, dipole-dipole and hydrogen bonding, and how this affects physical properties	Intermolecular forces
						Understand difference between polar bonds and polar molecules.	
						Know the octet rule and its limitations	
						Shape of molecules; VSEPR to explain shapes of molecules and to predict angles	
Materials	Recognise the different materials used for different purposes and identify their properties	Different materials have different properties and are used for different uses	The use of materials relates to their properties; including electrical conductors and insulators	Structure, properties, uses of materials	Natural and synthetic materials, and their sources. Alloys and use of metals		Salts, metals, ceramics, semiconductors and polymers
			The origins of materials		Nano-materials; surface to volume ratio; risks and benefits		Applications in materials chemistry.
Earth science			Some materials decay and others form fossils		The earth's surface; volcanos, earthquakes and continental drift		
Chemical changes, redox and acids	Understand that some materials change if kept in different conditions		How materials are changed to make new materials	Chemical changes	Acids and bases; acids are H+ and bases are OH- different between dilute and concentrated, how pH relates to acid strength	Bronsted-Lowry acid-base theory	Conjugate acids and bases
					Use of indicators (phenolphthalein, red and blue litmus paper and universal indicator paper) and comparison of validity and reliability of these indicators compared with a pH meter.		
					Reactivity of acids; with metals, with bases, with metal carbonates, **with ammonia**	Define and calculate Kw, Ka, pH, pKw and pKa	Define and calculate Kw, pH, pKw, pKa and pKb
					Differences between strong and weak acids and bases; know the reaction for neutralisation of an acid	Weak and strong acids in terms of dissociation	Strong and weak acids and bases. Importance of acidity and basicity in organic chemistry.
					Salts; colours of copper salts and general colours of Group 1 and 2 salts, and how to prepare salts using various methods	Understand techniques and procedures in acid-base titrations, including selecting the correct types of indicator and pH curves	Poly-functional acids and their behavior in titrations.
						Buffer solutions	Buffer solutions
					Redox; as loss or gain of oxygen; relate to common reactions	Assigning oxidation states to elements in compounds.	
					Redox as loss or gain of electrons; relate to important industrial reactions (Haber, iron and aluminium production)	Redox in terms of electron transfer; understand oxidising and reducing agents; write ionic equations for redox reactions	
					Electrolysis; know about electrodes and electrolytes and movement of ions	Disproportionation, including reaction of chlorine with water	
					Predict the properties of electrolysis of molten salts	Standard electrode potential, the hydrogen electrode, electrochemical cells and fuel cells	Electrochemistry, standard hydrogen electrode, standard electrode potential, oxidation and reduction , electrochemical series and standard cell potential calculations. Nernst equation.
					Half equations for reactions occurring at electrodes		Applied electrochemistry; Galvani cells, fuel cells, electrolytic cells. Heterogeneous electron transfer kinetics, electro-catalysis, potentiometry, chronoamperometry and cyclic voltammetry
Organic					Hydrocarbons are obtained from crude oil by fractional distillation and are widely used in industry	Know and name the structural and molecular formula up to 6 atoms, including geometric, structural and stereo isomerism, for alkanes, alkenes, halogenoalkanes, alcohols, aldehydes, ketones, carboxylic acids, esters, acyl chlorides, amines and amides	Structure and functional group chemistry of alkanes, alcohols, amines, alkyl halides, cyanides, ethers, alkenes, alkynes, aldehydes, ketones, carboxylic acids, acyl halides, esters and amides. Includes structural formulae, molecular formulae, isomerism, naming.
					Understand homologous series and functional groups as applied to alkanes and alkenes; **(alcohols and carboxylic acids; recognise carboxylic acids as weak acids)**	Relate reactivity (including acidity and basicity) and physical properties of organic compounds to their structure and bonding, including reference to relative strength of sigma and pi bonds.	Reactivity and interconversion of listed functional groups to include bonding sequences, electron configuration, hybridization, geometry and electronegativity features of the functional groups, and mechanisms for reactions
					Know about combustion of hydrocarbons, including environmental impact, **including alcohols and carboxylic acids**	Recall the formation and reactions of alkanes, alkenes, halogenoalkanes, alcohols, aldehydes, ketones, carboxylic acids, esters, acyl chlorides, amines and amides, nitriles, aromatic compounds, amino acids and polymers, including oxidation, reduction, combustion, hydrolysis	Recognise nucleophiles, electrophiles, bases, substitution, elimination and addition mechanisms. Fundamental principles of representing organic reaction mechanisms. Overview of important mechanisms.
						How organic compounds affect the environment (climate change, pollutants: CFCS, biodiesel)	Modern oxidation and reduction methods; Wittig reaction, hydroboration; epoxidation; Grignard reactions; aldol reaction, cycloaddition; Diels-alder reaction.
					Describe how monomers join together to make polymers in polymerisation; know about the recycling addition polymers	Polymers; condensation reactions and how properties of polymers are related to their structure	
					Write equations for polymerisation; relate properties of polymers to their use		
					Preparation of ethanol from sugars and use in alcohol; carboxylic acid as related to vinegar	Proteins and enzymes.	Natural product chemistry - carbohydrates, amino acids
					Preparation of ethanol from ethene and steam; oxidation of ethanol to ethanoic acid in air ; and colour changes on oxidation		Stereochemistry, chirality and optical activity, including stereochemistry of chemical reactions
						Chemistry in medicine, know basic mechanisms of action of specified medicines, including calculating percentages of active ingredients	
						Mechanisms, electrophile, nucleophile, radicals; substitution and addition, fission and fusion	
						Mechanisms for electrophilic substitution of benzene	Aromatic chemistry of benzene derivatives. Heterocyclic chemistry. Electrophilic aromatic substitution reactions, preparation and reactions of aromatic amines, diazonium salts and phenols
Rates, equilibria and thermody namics			Some changes can be controlled.		**Relate rates to collision theory and activation energy**	Collision Theory, Maxwell Boltzmann distribution. Experimental methods for studying rates.	Methods for measuring reaction rates. Arrhenius equation. Collision theory. Measurement of activation energy.
					Know how to measure and calculate rate using graphs	Calculating order of reaction and rate constant from rate equations and concentration-time graphs. Understand effect of temperature and activation energy on rate constant.	Determining order; distinction between order and molecularity.
					Describe the effect of concentration, temperature, particle size and catalyst on rate of chemical reaction	Rate determining step and the relationship between rate equation and mechanism	Reaction kinetics in relation to reaction mechanism.
					Catalysts	Relate conditions in industrial processes to equilibrium vs rate compromise	Classes of reaction including gas phase, chain and branched chain, reactions of solids, in solution, with catalysts
					Relate factors that effect rate to increasing yield in the Haber process and the Contact Process	Equilibrium and factors that affect equilibrium position; calculate equilibrium constant and relate magnitude to position	Homogeneous and heterogeneous equilibria, Kc and Kp calculations. Le Chatelier's Principle. The Common ion effect.
					Reversible reactions	Calculate equilibrium constants and concentrations including appropriate units	Phase equilibria, including entropy. Raoult's Law and Henry's Law in ideal 2 component systems. Simple P-T diagrams. Separation processes, one component and two component systems.
					Exothermic and endothermic reactions	Standard enthalpy changes; of combustion, formation, neutralisation, lattice, dissolving, average bond, enthalpy level diagrams; Hess's law, Born Haber cycles, and qi=mct	Thermodynamics, Internal energy and enthalpy; standard enthalpies of formation, reaction, solution and lattice energy. Heat capacities, temp dependence of enthalpy and equilibrium constants
					Relate endothermic and exothermic reactions to bond making and breaking		Bond dissociation and bond energy terms.
						Entropy; definition and calculating standard entropy change	Entropy and Gibbs free energy.
						Calculating Gibbs free energy	
							Latent heat - Kirchoff, Calpeyron and Clausius-Clapeyron equations
Chemical calculatio ns					Symbols and names of elements, chemical formulae of compounds, recall diatomic elements.	Use Roman numerals to indicate the oxidation states.	
					Write word and balanced symbol equations **(including state symbols)**; understand conservation of mass	Write (full and ionic) balanced equations including state symbols. Write equations for first and successive ionisation energies.	
					Write ionic equations for simple reactions	Molarity and other units for concentration	
					Relative atomic mass, moles, empirical and molecular formula; percentage of an element in a compound	Define Avagadro's constant, the mole and molar mass	
						Empirical and molecular formula	
					Experimental determination and calculation of empirical formulae of simple compounds		
					Calculate the reacting masses of reactants and products using moles and ratios	Calculate reacting masses of substances; and the moles of water of crystallisation	
					Percentage of water of crystallisation		
					Theoretical yield and percentage yield	Percentage yield and atom economy	
					Volume; concentration; mole; mass calculations	Reacting gas volumes from calculations	
					Titration calculations	Titration calculations	Calculation of pH, pKa, pKb, Kw and pKw; Titration calculations, buffer calculations
Chemical analysis and preparati on			Some substances dissolve and others do not	Mixtures	Mixtures can be separated using filtration, chromatography, evaporation, distillation and fractional distillation	**Chromatography;** paper, TLC, GLC; calculate percentage composition of a mixture, Rf values	Separation processes and the phase rule
					Paper chromatography and its use to analyse composition of mixtures.		
					Carrying out solubility experiments and drawing up a solubility curve. **Calculating mass of precipitate on cooling a concentrated, hot solution.**	Understand how solubility curves are drawn from experimental data.	
					Use bromine water to identify alkanes and alkenes		
					Use of silica gel and calcium chloride as drying agents, **terms dessicant and deliquescent.**		
						Proton NMR; chemical shifts, spin-spin splitting, integration curves	Proton NMR spectroscopy
					Understand how elements and compounds may be detected and identified using modern instrumental analysis (Mass Spec., HPLC)	**Mass spec;** use mass spectra to suggest formula for fragment ions	
						IR can be used to characterise organic groups by absorption arising from molecular vibrations	Infrared, Ultraviolet and visible spectroscopy
					Tests for hydrogen gas, carbon dioxide, oxygen, ammonia	Chemical tests for gases; iodine test with starch; also for inorganic compounds.	
					Know about flame tests for cations, including colours, and solution test for anions	Cation tests, including flame tests and adding sodium hydroxide	
					Write ionic equations for the anionic tests, and understand that these are often precipitation reactions	Anion tests, including using barium chloride solution, acidified silver nitrate solution and testing for the carbonate ion with acid	
					Testing for water using cobalt chloride and copper (II)sulfate.	Titrations, inc procedures for preparing standard solutions. Volumetric analysis, including for back titrations and redox titrations.	
					Analyse data on mixtures and plan effective methods of separation.	Identify uncertainties in measurements of titrations, calculate concentrations and volumes from titrations, calculate molarity	
Chemistr y in the industry and environm ent	How we can reduce, reuse and recycle	Environmental benefits of recycling, reusing and reducing	The environment and human influences	Limestone quarrying, thermal decomposition, environmental impacts. **Factors affecting the siting of an aluminium extraction plant.**	Explain how a catalytic converter reduces the environmental impact of burning alkane fuels.		Appreciation of process economics and awareness of industrial/practical thermal efficiency, and an understanding of the complexities of scale up design.
	Human waste can negatively affect the environment	Renewable and non-renewable energy resources	Investigate the effects of pollution and specific measures to improve and protect the environment.	Understand the importance of scale in calculations for industrial processes.			Developing competency in chemical engineering through basic understanding of heat exchange systems; fluid flow, material and enthalpy balances, and thermodynamics, along with separation processes.
		Some waste materials can be recycled and this is beneficial to the environment.		Understand the terms fossil fuel, renewable resource, non-renewable resource. Evaluate energy sources in terms of environmental and other criteria	Environmental issues associated with fuel cells.		
				Composition of the earth's atmosphere and how it changed over time, climate change			
				Rusting and barrier methods			
				Know about extraction of aluminium and iron, including environmental impact of the reactions and recycling of metals; **factors to lower cost**			
				Hard and soft water; know what causes hardness and how to test for it; advantages and disadvantages of hard water			
				Fluoridation of public water supply; advantages and disadvantages			
				Ion exchange to soften water; **what a precipitation reaction is and how it relates to softening hard water**			

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