Curriculum overview: Chemistry

Key Stage 2

Properties and changes of materials:

- Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity and response to magnets.
- Know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution
- Use knowledge of solids, liquids and gases to decide how mixtures might be separated
- Explain and demonstrate reversible and irreversible changes

Key skills/content requirements at GCSE

Chemistry content and understanding

Topics students need to have a good understand of

1. States of matter and the structure of the atom
2. Organisation of the periodic table
3. Chemical changes
4. Calculations in chemistry
5. Energy changes in chemical reactions
6. Rates of chemical reactions
7. Chemical tests to identify different chemicals
8. Chemistry of resources
9. Chemistry of the atmosphere
10. Organic chemistry

Students will need to know appropriate key terminology in order to describe and explain the chemical concepts within each topic and how they interrelate with appropriate academic depth.

Students will need to know a range of required practical's. These require a high level of applied practical knowledge.

Chemistry is split into two broad aspects, the fundamentals of chemistry in the 21st century – which includes our current understanding of the structure of the atom and periodic table, complex ideas of chemical reactions including thermodynamics and the reactivity series. Students will also need to know the calculations required to complete chemistry to a high degree. The second aspect of chemistry at King Charles is the application of chemistry in society, including the chemistry of the atmosphere and how humans can have an impact on the environment. Also how the rate of chemical reactions can be used in different applications and the production of chemicals fundamental to modern society, including the agrochemical and petrochemical industries.

Scientific skills

Development of scientific thinking

- Understand how scientific methods and theories develop over time.
- Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.
- Appreciate the power and limitations of science and consider any ethical issues which may arise.
- Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.
- Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.
- Recognise the importance of peer review of results and of communicating results to a range of audiences.

Experimental skills and strategies

- Use scientific theories and explanations to develop hypotheses.
- Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.
- Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment.
- Carry out experiments appropriately having due regard for the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.
- Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative
- Make and record observations and measurements using a range of apparatus and methods.
- Evaluate methods and suggest possible improvements and further investigations.

Analysis and Evaluation

- Presenting observations and other data using appropriate methods.
- Translating data from one form to another.
- Carrying out and represent mathematical and statistical analysis.
- Representing distributions of results and make estimations of uncertainty.
- Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.
- Presenting reasoned explanations including relating data to hypotheses.
- Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.
- Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.

	Term 1	**Term 2**	**Term 3**	**Portable knowledge**	**Key terms**
Year 7	**Introduction to Working Scientifically** ▪ Lab safety ▪ Risks and hazards ▪ Making observations ▪ Using a Bunsen ▪ Recording data ▪ Interpreting & evaluating data ▪ Command Words **Particle model & separating mixtures** ▪ Particles ▪ Change of state ▪ Change of state graphs ▪ Factors affecting diffusion ▪ Gas pressure ▪ Pure and impure substances ▪ Solutions and solubility ▪ Mass & volume in solutions ▪ Filtration and evaporation ▪ Distillation ▪ Chromatography	**Metals and non metals and acids and alkalis** ▪ Metals and non metals ▪ Reactions of metals and non-metals ▪ Displacement reactions ▪ Oxidation reactions ▪ Acids and alkalis ▪ Indicators ▪ Neutralisation ▪ Investigating neutralisation	**Earth Structure.** ▪ Structure of the Earth ▪ Igneous rocks ▪ Sedimentary rocks ▪ Metamorphic rocks ▪ The Rock Cycle	Structure of matter – how physical changes can impact the organisation of matter. Separation – How different materials can be categorised and isolated using chemical properties Patterns in the periodic table Reactions of acids and alkalis	Element Compound Mixture Atom Particle Pure Solid Liquid Gas Vacuum Melting Condensing Freezing Boiling Evaporating Sublimation Deposition Melting point Boiling point Diffusion Solvent Solute Solution

					Chromatography Distillation Separation Decomposition Acid Alkali Base Concentrated Corrosive Dilute Indicator Litmus Neutral Neutralisation pH scale Salt Universal indicator
Year 8	**Periodic table, elements & compounds** ▪ Elements, compounds, mixtures ▪ Periodic table structure & history ▪ Atomic structure ▪ Group 1 elements - reactivity & properties ▪ Group 7 elements - reactivity & properties ▪ Group 0/8 - reactivity & properties ▪ Compounds & naming of compounds ▪ Polymers ▪ Ceramics	**Chemical Energy & Types of Reaction** ▪ Chemical and physical reactions ▪ Exothermic and endothermic reactions ▪ Exo and endo PRAC ▪ Reaction profiles and catalysts ▪ Fuels and combustion ▪ Combustion PRAC ▪ Thermal decomposition ▪ Conservation of mass	**Climate & Earths Resources** ▪ Natural resources ▪ Ores and mining ▪ Extraction of metals by reduction/electrolysis ▪ Recycling and consolidation ▪ Atmosphere ▪ Carbon cycle ▪ Global warming, acid rain and global dimming	As Yr 7 plus: The fundermental particles of matter and the arrangement of the periodic table. How chemical reactions rearrange chemicals but do not create or destroy any other matter The effects of global warming and climate change The cycle of carbon around Earth How to extract metals from ores The process of recycling materials for new uses	Atom Proton Neutron Electron Electronic structure Atomic nucleus Atomic number Mass number Isotope Group 0 Group 1 Group 7 Periodic table Carbon cycle Atmosphere Photosynthesis Respiration Emissions Carbon footprint Greenhouse effect Carbon monoxide Acid rain Climate change Combustion Complete combustion Deforestation Activation energy Chemical reaction Combustion Complete combustion Conservation of mass Decomposition Endothermic change Exothermic change Fuel

					Incomplete combustion Oxidation Physical change Product Reactant. Thermal decomposition Catalyst Displacement reaction Metal Ore Reactivity series Thermite reaction

Year 9	**Atomic Structure** ▪ Formula and equations ▪ Filtration and evaporation ▪ Distillation ▪ Chromatography ▪ Structure of the atom ▪ History of the atom ▪ Mass and isotopes ▪ Electronic structure **Periodic Table** ▪ Origins of the periodic table ▪ Organisation of the periodic table ▪ Group 1 ▪ Group 7 ▪ Group trends ▪ *The transition elements*	**Earth's atmopshere** ▪ History of the atmosphere ▪ Our evolving atmosphere ▪ Greenhouse gases ▪ Global climate change ▪ Atmospheric pollutants **Using resources** ▪ Drinking water ▪ Waste water ▪ Phytomining and bioleaching (HT only)	**Using resources** ▪ LCAs ▪ Glass, ceramics, alloys etc. (TRIPLE) **Chemical analysis** ▪ Pure substances and formulations ▪ Chromatography (RP) ▪ Testing for gases ▪ TRIPLE testing for ions	How the periodic table was devised and it can be interpreted to explain the behaviour of atoms. Pure substances in chemistry are a substance made of only one type of element or compound. Chemical reactions can be used to identify the presence of specific chemicals. Humans are having an impact on the environment. Chemistry can be used to solve many issues relating to climate change. How to test for gases. How to determine a pure substance or a mixture?	Alkali metals Atomic number Chromatography Crystallisation Distillation Element Group Halogen Mass number Noble gases Periodic table Isotope Group 0 Group 1 Group 7 Renewable Non-renewable Potable Bioleaching Phytomining Waste product Pure Rf value Halide Sulfate Hydroxide Spectroscopy Litmus Climate change Greenhouse effect Global dimming Acid rain Chromatogram Mobile phase Stationary phase

Year 10	**Structure and bonding** ▪ States of matter ▪ Forming ions ▪ Ionic bonding ▪ Giant ionic lattices - structure & properties. ▪ Covalent bonding ▪ Properties of simple covalent molecules ▪ Giant covalent structures: diamond & silicon dioxide ▪ Giant covalent molecules - graphite, graphine & buck... ▪ Metallic bonding & properties of metals ▪ Nanoparticles ▪ Uses of nanoparticles	**Energy changes** ▪ Endothermic & exothermic reactions (& using them) ▪ Reaction profiles ▪ Bond energy calculations (HT only) ▪ Temperature changes. Required practical ▪ Chemical cells, batteries & fuel cells **Rates** ▪ Calculating rate of reaction ▪ Measuring reaction rates: RPRAC ▪ Factors affecting rate of reaction ▪ Collison theory ▪ Effect of temperature/surface area on rate of reaction: PRAC ▪ Catalysts ▪ Reversible reactions ▪ Factors affecting equilibrium (HT only) ▪ Habor process (HT only)	**Chemical changes** ▪ Acids, bases and pH ▪ Strong and weak acids (HT only) ▪ Neutralisation ▪ Reactions of metals & acids ▪ Making salts - RPRAC ▪ Titration - RPRAC ▪ Reactivity of metals - ion formation & reativity series ▪ Displacement reactions ▪ Redox reactions (HT only) ▪ Electrolysis ▪ Extraction of metals ▪ Electrolysis - RPRAC ▪ Electrolysis half equations (HT only)	How the structure of the atom will affect the bonding of the atom and the properties of any material. All chemical reactions result in a change of energy, often a measurable temperature change. All chemical reactions result in a change of energy, often a measurable temperature change. Extraction of metals Redox reactions Solubility and production of soluble salts and from insoluble bases General reactions of metal compounds and acids. Process of electrolysis and how reactive metals can be extracted using the process. Factors that affect rates of reaction. What is a reversible reaction?	Molecule Boiling point Melting point Conductivity Malleable Ductile Nano Endothermic Exothermic Activation energy Reduction Oxidation Extraction Ore Redox Concentration Surface area Reversible Equilibrium Catalyst Rate of reaction Potable Sedimentation Screening Sterilisation Polymer Composite Corrosion Haber process Ammonia Compromise conditions Yield

Year 11	**Quantitative chemistry** ▪ Balancing equations (all tiers) ▪ Conservation of mass (all tiers) ▪ Formulae (all tiers) ▪ Relative formula mass (all tiers) ▪ Moles (HT & triple) ▪ Reacting masses (HT & triple) ▪ Limiting reactants (HT & triple) ▪ Concentration, g/dm3 (all tiers) AND mol/dm3 ▪ % yield & atom economy ▪ Titration calculations ▪ Titration REQ PRAC ▪ Gas volumes **Organic chemistry** ▪ Crude oil, hydrocarbons and alkanes ▪ Fractional distillation ▪ Cracking ▪ Combustion (homework) ▪ Alcohols and carboxylic acids ▪ Esters & polymers ▪ Biomolecules	**Chemical analysis** Testing for anions Testing for cations and spectroscopy **Paper 1 Revision** ▪ Atomic structure & the periodic table ▪ Bonding, structure & the properties of matter ▪ Quantitative chemistry ▪ Chemical changes ▪ Energy changes **Paper 2 Revision** ▪ Rate & extent of chemical change ▪ Organic chemistry ▪ Chemical analysis ▪ Chemistry of the atmosphere ▪ Using resources	**Paper 2 Revision** ▪ Chemical analysis ▪ Chemistry of the atmosphere ▪ Using resources	How chemical reactions show change of arrangement of atoms, but no overall change in the number of atoms. Chemical reactions can be used to identify the presence of specific chemicals.	Hydrocarbon Fractional distillation Combustion Cracking Alkane Alkene Pure Impure Mixture Alcohol Carboxylic acid Addition Combustion Polymerisation Addition polymer Condensation polymer

GCSE External assessment:

Combined science is assessed by six written examinations, each exam lasting 1 hour and 15 minutes. All examinations are taken at the end of Year 11. Two grades are awarded as described in the table.

	Weighting	
Biology paper 1	16.7%	The qualification will be graded on a 17-point scale: 1 – 1 to 9 – 9, where 9 – 9 is the best grade. This counts as two GCSE grades.
Biology paper 2	16.7%	
Chemistry paper 1	16.7%	
Chemistry paper 2	16.7%	
Physics paper 1	16.7%	
Physics paper 2	16.7%	

Students studying the separate sciences will achieve three science GCSEs at the end of Year 11. These will be in the following subjects

- GCSE biology
- GCSE chemistry
- GCSE physics

All content is examined at the end of Year 11. All of the GCSE science courses are split into two units:

	Weighting	
Biology Paper 1	50%	A GCSE grade in Biology from grade 9 to grade 1
Biology Paper 2	50%	
Chemistry Paper 1	50%	A GCSE grade in Chemistry from grade 9 to grade 1
Chemistry Paper 2	50%	
Physics Paper 1	50%	A GCSE grade in Physics from grade 9 to grade 1
Physics Paper 2	50%	

Each examination is available at two tiers. Teachers will use internal class assessments to decide which tier is most appropriate for you.

Tier	**Available Grades**
Higher	4-9 if studying the separate sciences 4-4 to 9-9 if studying combined science
Foundation	4- 5 if studying the separate sciences 1-1 to 5-5 if studying combined science

In addition to acquiring knowledge and understanding, students learn a range of practical and investigative skills that are assessed in each of the 6 examinations.

SMSC in science:

Spiritual development in science

In the science department we look to maintain a neutral approach as we study issues and ideas which are sometimes a source of tension in our society today. The modern world is full of potential areas for conflict, when scientific and spiritual ideas come together. Students will study topics such as evolution and the universe's origins using an evidence-based approach. This

means scientific theories can be introduced then evaluated from an unbiased perspective. From this students often see how it is possible for spiritual and scientific theories to exist alongside each other, and how this may lead to more tolerance of different viewpoints.

Moral development in science

Rapid advances in science have given us the opportunity to influence and change the world in which we live, often with positive outcomes. However, the new powers given to society by science have also led to moral issues arising, and in lots of cases vigorous debate surrounds these ideas, for example with genetically modified organisms. We give students the opportunity to engage with some of the most significant scientific developments and to weigh up the evidence to form their own conclusions on some moral issues facing society today. This is not only a key exam skill, but a vital skill for all students as they develop as young adults.

Social development in science

The impact of science on society is extremely significant. Medical advances in particular are changing the way we live, with a continued increase in global population and longer life expectancy. Students will study the scientific advances that have led to this, the problems caused and possible solutions to them, whilst being encouraged to deepen their own understanding and form and support views using scientific fact. Through this approach students will gain a wider perspective on the changing society that surrounds them.

Cultural development in science

Achievement in the field of science is truly global, and promoting cultural awareness is an intrinsic part of the science curriculum. From the Russian origins of the periodic table to the discovery of radioactivity by the French physicist Henri Becquerel, progress in all areas of scientific study is a consequence of a worldwide commitment to continuing discovery.

Key Stage 5 Curriculum Overview

Subject: Chemistry

Year 12

Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2	Assessment
Atomic structure; ▪ Fundamental particles ▪ Mass number, atomic number and isotopes ▪ Electron arrangement ▪ Ionisation energy Amount of substance; ▪ Relative atomic mass ▪ Moles ▪ Ideal gas equation ▪ Empirical and molecular formulae ▪ Balanced equations ▪ Atom economy Introduction to organic chemistry; ▪ Carbon compounds ▪ Nomenclature ▪ Isomerism Alkanes ▪ Fractional distillation of crude oil ▪ Industrial cracking ▪ Combustion	Bonding; ▪ Ionic bonding ▪ Covalent bonding ▪ Metallic bonding ▪ Electronegativity ▪ Forces acting between molecules ▪ Shapes and bond angles ▪ Bonding and physical properties Energetics; ▪ Exothermic and endothermic reactions ▪ Enthalpy ▪ Measuring enthalpy change ▪ Hess's law ▪ Thermochemical cycles ▪ Bond enthalpies Periodicity; ▪ The periodic table ▪ Trends in period 3 ▪ Trends in ionisation energy Halogenoalkanes; ▪ Nucleophilic substitution in halogenoalkan ▪ Elimination reactions	Kinetics ▪ Collision theory ▪ Maxwell-Boltzmann distribution ▪ Catalysts Equilibrium; ▪ Changing conditions ▪ Equilibrium in industry ▪ Equilibrium constant ▪ Kc calculations ▪ Dynamic equilibrium Group 2 ▪ The physical and chemical properties of group 2 elements Alkenes ▪ Reactions of alkenes ▪ Addition polymers Alcohols ▪ Ethanol production ▪ Reactions of alcohols Organic analysis ▪ Test tube reactions ▪ Mass spec ▪ Infrared spec	Oxidation and reduction; ▪ Oxidation states ▪ Redox equations Halogens ▪ Chemical reactions of halogens ▪ Reactions of halide ions ▪ Uses of chlorine	Revision; Atomic structure Amount of substance Bonding Kinetics Energetics	Revision; Equilibrium Organic intro Alkanes Redox Halogenoalkanes Periodicity G2 and 7 Alcohols Organic analysis Kinetics; • Rate expression • Determining rate equation • Rate determining step Optical isomerism Aldehydes and ketones	CPAC End of unit assessment PPQs homework

Key Stage 5 Curriculum Overview

Subject: Chemistry

Year 13

Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2	Assessment
Period 3 ▪ Reactions of P3 ▪ Oxides of P3 ▪ Acidic/basic nature of P3 oxides Transition metals ▪ Properties of transition metals ▪ Complex ions ▪ Coloured ions ▪ Variable oxidation states ▪ Catalysts Ions in solution ▪ Acid-base chemistry of aqueous transition ions ▪ Ligand substitution reactions Carboxylic acids; ▪ Carboxylic acids and esters ▪ Reactions of carboxylic acids and esters ▪ Acylation Aromatic chemistry; ▪ Arenes ▪ Naming and properties ▪ Reactions of arenes	Acids, bases and buffers; ▪ pH scale ▪ Weak acids and bases ▪ Titration ▪ Indicators ▪ Buffers Electrode potentials; ▪ Electrochemical series ▪ Predicting direction of redox Electrochemical cells Thermodynamics; ▪ Enthalpy change ▪ Born-Haber cycles ▪ Why do reactions take place? Equilibrium constant; ▪ Kp for homogenous systems	Organic synthesis; ▪ Synthetic routes ▪ Organic analysis Amines ▪ Properties of amines as bases ▪ Amines as nucleophiles Polymers ▪ Condensation polymers Biological molecules ▪ Amino acids ▪ Peptides, polypeptides and proteins ▪ Enzymes ▪ DNA ▪ Action of anticancer drugs Structure determination; ▪ H nmr ▪ Interpreting nmr Chromatography;	Revision of A Level topics	Revision Deliberate practice A Level examinations		CPAC End of unit assessment PPQs homework