****

**AS – Chemistry –Year 12**

**Autumn Term: 2024**

**Autumn Term: 2024**

**Winter Term: 2025**

**Spring Term: 2025**

**Spring term -2025**

3.3 Organic chemistry

3.3.1 Introduction to organic chemistry

3.3.2 Alkanes

3.3.3 Halogenoalkanes

3.3.4 Alkenes

3.3.5 Alcohols

3.3.6 Organic analysis

**Winter term -2025**

3.1.7 Oxidation, reduction and redox equations

**3.2 Inorganic chemistry**

3.2.1 Periodicity

3.2.2 Group 2, the alkaline earth metals

3.2.3 Group 7(17), the halogens

**Autumn term - 2024**

**3.1 Physical Chemistry**

3.1.1 Atomic structure

3.1.2 Amounts of substance

**Half term**

3.2.3 Bonding

3.1.4 Energetics

3.1.5 Kinetics

3.1.6 Chemical equilibria, Le Chatelier’s principle and Kc

**Christmas break**

**Curriculum Intent and Implementation**

**Vision:**

Our vision here in the Chemistry department is to inspire and equip students with the knowledge, skills, and enthusiasm necessary to understand and apply chemical principles through hands-on experiments, fostering a deeper appreciation of the scientific method and its impact on the world around us.

**Mission:**

Our mission is to provide a stimulating and supportive learning environment where students can develop their practical chemistry skills, critical thinking, and scientific literacy. We aim to cultivate curiosity, innovation, and a lifelong passion for science through engaging and meaningful laboratory experiences. Through our practical chemistry curriculum, we aim to nurture inquisitive minds, develop competent and confident individuals, and inspire the next generation of scientists.

**Goals:**

Develop Scientific skills:

We work hard to ensure that all students are helped to develop the following scientific Skills:

* Acquire essential laboratory techniques and safety practices.
* Promote precision, accuracy, and attention to detail in experimental work.
* Develop independent and collaborative problem-solving abilities.

Enhance Scientific Understanding

* All students are helped to reinforce their theoretical knowledge through practical application.
* Teachers must foster an understanding of the scientific method, including hypothesis formulation, experimental design, data collection, and analysis.
* Students are helped to see the relevance of chemistry in everyday life and its applications in various fields such as medicine, industry, and environmental science.

**Promote Inquiry and Critical Thinking:**

Teachers at Brook sixth form stimulate curiosity and questioning, encourage students to analyse and interpret data, draw conclusions, and communicate findings effectively. Through class discussions, students are helped to develop the ability to critically evaluate scientific information and experimental outcomes.

**Cultivate a Safe and Supportive Learning Environment:**

Here in the chemistry department, we understand the importance of safety and we take on the challenge to ensure all students understand and adhere to safety protocols. The science team provides equal opportunities for all students to participate and succeed in laboratory activities. We celebrate and welcome the diversity of our students, hence foster a collaborative and respectful atmosphere that supports diverse learning needs and styles.

**Prepare our students for Future Endeavours:**

Here in the Chemistry department, we know that transferable skills are critical for science students as they equip them with versatile abilities that are valuable across various professional and academic fields. Whatever, endeavours our students may pursue in their future careers, we equip them with the skills and confidence needed for higher education and careers in science and related fields.

As a team, we aim at developing them into lifelong learners with the ability to adapt in an ever-changing scientific landscape. In addition, we encourage ethical and responsible conduct in scientific practice.

**Implementation:**

**Constructive learning:**

We understand the need to place the learner in the centre of their learning journey. Therefore, the department adopt and implement the constructive learning approach in our lessons, enabling learners actively construct their own understanding and knowledge through experiences and reflecting on those experiences. We therefore emphasise of hands-on activities, critical thinking, and collaboration, allowing students to connect new information to prior knowledge and apply it in meaningful ways and ultimately take responsibility for their learning.

**Structured Curriculum:**

 A well-organized sequence of practical activities aligned with theoretical lessons, progressing from fundamental techniques to more complex experiments. We work collaboratively at helping our learner link ideas across different areas of the curriculum.

**Resources and Support:**

We adapt learning to the very needs of individual students in order to help them reach their potential. In addition, we provide appropriate materials, equipment, and guidance to facilitate effective learning experiences.

**Assessment and Feedback:**

We aim at developing our students into reflective learners, through regular formative and summative assessments to monitor progress, identify areas for improvement, and provide constructive feedback.

### 3.1.1 Atomic structure

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| **Prior learning**  | **Retrieval :**  | **Inclusivity and Differentiations:** |
| **Prior Knowledge]****GCSE Chemistry**- The structure of atoms (although this is revisited here). **GCSE Physics** - The structure of atoms (although this is revisited here). - The effect of a force on mving objects. - The effect of a magnetic field on a moving, electrically charged particle (Separate Science)  | **Retrieval:**Starter- Retrieval at the start of each lesson/ Quizzes to retrieve previous knowledge/ opportunities in the lesson to link new knowledge to previous knowledge.**Strategies:*** Spaced retrieval (to combats the forgetting curve)
* Retrieval mats/grids
* Draw it !..label it!
* Free recall Concept mapping
* Peer teaching
 | **Inclusivity and Differentiations:**To ensure we provide a supportive environment and meet the individual learning needs of our SEND students we adopt the following strategies in our science lessons:* Chunk information into manageable bite sized tasks
* Provide Visual /multisensory aids to help students develop understanding
* Provide tiered activities/HW that allows all learners to make progress at their own pace
* Flexible groupings to provide effective collaboration
* Provide text that caters to the reading ages of individual learners

*SEND support (K) and EHCP (E= statemented) – for pupils with IEPs targets in their pupil past-ports are used to inform planning*  |
| **Afl strategies:** Low/high stake Quizzes, Targeted Questioning, Peer Talk and responses Peer Assessment & Self-Assessment, Thumb signs pose-pause –pounce, exit and self-peer assessment etc. |
| **Literacy in Chemistry:** | **Reflection:** | **Numeracy Skills:** |
| 1. **Response to six markers (two-week cycle)**
* Teacher provide detailed feedback to a six marker response with focus on; **content**, use of **key terms,** SPAG, **presentation**, **command words** and **coherence**, **logical reasoning**
* Student respond and improve their work
1. **Frayers model**
2. Writing descriptions/observation during experiments
3. Lesson **key terms** provided during lessons
4. Claim –Evidence –Reasoning
5. **Read** and **translate** information into other formats
 | Students are encouraging to reflect and to evaluate their own and others' which work fosters reflective learning and helps them understand how to improve. The following strategies are employed:* Peer on peer/self-assessment during lesson
* Teacher feedback and student respond to improve
* End of unit/end of topic assessments are used to help student reflect and improve
 | **Experimental skills:**Practical sessions are used to develop the following skills:* Choosing appropropriate graph, identifying variables and controls
* Collecting and Recording data, interpreting and describing trends and drawing conclusions
* Observing safety protocols and setting up apparatus safely
* Carrying out repeats, testing reliability of test data and identifying anomalous data
* Drawing conclusions
* Calculating averages/mean
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**3.1.2.1 Relative atomic mass and relative molecular mass**

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| **Week 1:** **3.1.1.1 Fundamental particles**  |  |
| Learning Outcome | Activities |  | Skills | Resources |
| **Week 2:** **09/09/24 to 13/09/24****Students should be able to:*** describe the structure of atoms in terms of protons, neutrons and electrons
* recall the relative mass and relative charge of protons, neutrons and electrons.
 | •Students research how the model of the atom changed over time (examples of key contributions could include the Ancient Greeks, Dalton, Thompson, Rutherford, Bohr, Chadwick- understanding of atomic structure- Evaluate how and why atomic structure model developed over time).•Rich question – How can we tell what is inside an atom if we can’t see it |  |  | RSC timeline:<http://www.rsc.org/chemsoc/timeline>RSC: Chemists in a social & historical context: <http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives?cmpid=CMP00002843> RI Christmas Lecture – section on atomic structure <http://www.rsc.org/learn-chemistry/resource/res00001119/ri-christmas-lectures-2012-atomic-structure> |
| **Week 2:** **3.1.1.2 Mass number and isotopes**  |
| Students should be able to: define atoms and ions in terms of numbers of protons, neutrons and electrons, as well as atomic number and mass number (including isotopes)• describe how a time of flight mass spectrometer works• identify elements and calculate relative atomic mass from mass spectroscopy data• find the relative formula mass of compounds from mass spectroscopy data. | * Students identify atoms and ions from numbers of protons, neutrons and electrons, and vice versa
* Students determine the relative atomic mass of elements using isotope abundance data (this could include data for elements found in meteorites to show some difference) quoting answers to a suitable number of significant figures for data provided
* - Use an appropriate number of significant figures to find relative masses
* Find arithmetic means to find relative masses.
* Students look at the mass spectra of compounds to determine the relative formula mass
 |  |  | RSC: Build an atom simulation:<http://www.rsc.org/learn-chemistry/resource/res00001433/build-an-atom-simulation-rsc-funded>RSC Spectral School: <http://www.rsc.org/learn-chemistry/collections/spectroscopy>Isotope data:<http://www.chem.ualberta.ca/~massspec/atomic_mass_abund.pdf> Data on isotopes in meteorites: ‘The Elements: Their Origin, Abundance, and Distribution' by P. A. CoxAQA Time of flight mass spectrometry Teachers’ Notes and Student guide: |
| **Week 3:** **3.1.1.3 Electron configuration** |
| **16/09/24 to 20/09/24****Students should be able to:*** give the electron structure of atoms and ions up to *Z*=36 in terms of s, p and d sub-shells
* explain how data from ionisation energies provides evidence for electron structure.
 | Students write the electron structure of atoms and ions with Z=1-36 Demonstrate knowledge and understanding of scientific ideas).Students research values of first ionisation energies for elements Z=1–36 and plot them on a graph and then explain trends  Plot two variables from experimental or other dataStudents write explanations for trends in ionisation energies down a group and across a period  Demonstrate knowledge and understanding of scientific ideas).Students determine which Group an element is in using successive ionisation energy data. |  |  |  |
| **Week 3: Revision – End of unit assessments – Reflections – Targets – GAP analysis**  |
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| **Prior learning**  | **Retrieval :**  | **Inclusivity and Differentiations:** |
| **Prior Knowledge]****GCSE Chemistry**- Relative atomic mass, relative molecular mass, relative formula mass (although this is revisited here).- Writing formulae (elements, common compounds and ionic compounds).- Balancing equations (although this is revisited here).- Moles (although this is revisited here).- Calculations involving Masses (although this is revisited here).- Concentration of solutions (Separate Science - although this is revisited here).- Empirical and molecular formulae (although this is revisited here). | **Retrieval:**Starter- Retrieval at the start of each lesson/ Quizzes to retrieve previous knowledge/ opportunities in the lesson to link new knowledge to previous knowledge.**Strategies:*** Spaced retrieval (to combats the forgetting curve)
* Retrieval mats/grids
* Draw it !..label it!
* Free recall Concept mapping
* Peer teaching
 | **Inclusivity and Differentiations:**To ensure we provide a supportive environment and meet the individual learning needs of our SEND students we adopt the following strategies in our science lessons:* Chunk information into manageable bite sized tasks
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* Provide tiered activities/HW that allows all learners to make progress at their own pace
* Flexible groupings to provide effective collaboration
* Provide text that caters to the reading ages of individual learners

*SEND support (K) and EHCP (E= statemented) – for pupils with IEPs targets in their pupil past-ports are used to inform planning*  |
| **Afl strategies:** Low/high stake Quizzes, Targeted Questioning, Peer Talk and responses Peer Assessment & Self-Assessment, Thumb signs pose-pause –pounce, exit and self-peer assessment etc. |
| **Literacy in Chemistry:** | **Reflection:** | **Numeracy Skills:** |
| 1. **Response to six markers (two-week cycle)**
* Teacher provide detailed feedback to a six marker response with focus on; **content**, use of **key terms,** SPAG, **presentation**, **command words** and **coherence**, **logical reasoning**
* Student respond and improve their work
1. **Frayers model**
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4. Claim –Evidence –Reasoning
5. **Read** and **translate** information into other formats
 | Students are encouraging to reflect and to evaluate their own and others' which work fosters reflective learning and helps them understand how to improve. The following strategies are employed:* Peer on peer/self-assessment during lesson
* Teacher feedback and student respond to improve
* End of unit/end of topic assessments are used to help student reflect and improve
 | **Experimental skills:**Practical sessions are used to develop the following skills:* Choosing appropropriate graph, identifying variables and controls
* Collecting and Recording data, interpreting and describing trends and drawing conclusions
* Observing safety protocols and setting up apparatus safely
* Carrying out repeats, testing reliability of test data and identifying anomalous data
* Drawing conclusions
* Calculating averages/mean
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### 3.1.2 Amount of substance

**3.1.2.1 Relative atomic mass and relative molecular mass**

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| **Week 4: Relative atomic mass and relative molecular mass** and Avogadro’s constant  |
| Learning Outcome | Activities | Required practical  | Skills |
| **23/09/24 to 27/09/24****3.1.2.1 Relative atomic mass and relative molecular mass****Students should be able to:*** define relative atomic mass (*A*r)
* define relative molecular mass (*M*r)

determine relative molecular mass (*M*r) of a substance using relative atomic mass (*A*r) values. | * The relative mass of different substances is calculated from the formula
* The mass of everyday objects could be measured relative to a specific object of known
* Determine the relative formula mass (*Mr*) of substances using relative atomic mass values

**Extension task:**Students could research why 12C was chosen as the standard  |  |  |
| **3.1.2.2 The mole and Avogadro constant****Students should be able to****carry out calculations:****•using the Avogadro constant****•using mass of substance, Mr, and amount in moles****•using concentration, volume and amount of substance in a solution.** | •Students calculate the mass (in g) of atoms/ions using the masses sub atomic particles, quoting answers to a suitable number of significant figures for data provided •Students practice doing calculations involving Avogadro constant, involving mass, Mr and moles, and involving concentration, volume and amount of substance and quoting the final results to the appropriate number of significant figures for data provided Use an appropriate number of significant figures to find relative masses).Students find the concentration of NaCl in intravenous saline (9 g per dm3), glucose in**Extension**:Students research how Avogadro determined the value of his constant | **Practical opportunity:** Students measure out 1 mole (and other mole quantities) of different substances (e.g. sucrose, salt, water) | Student weigh and calculate the number of mole in an **iron nail** |
|  **Week 5:****30/09/24 to 04/10/24****2: 3.1.2.3: The ideal gas equation**Students should be able tocarry out calculations:• Using the ideal gas equation.  | Students will need to rearrange the ideal gas equation, work in appropriate units and quote answers to an appropriate number of significant figures Recognise and make use of appropriate units in ideal gas calculations Change the subject of the ideal gas equation; Substitute numerical values into the ideal gas equation using appropriate units for physical quantities).Recognise and make use of appropriate units in ideal gas calculations Change the subject of the ideal gas equation;  Substitute numerical values into the ideal gas equation using appropriate units for physical quantities Recognise and make use of appropriate units in ideal gas calculations Change the subject of the ideal gas equation; Substitute numerical values into the ideal gas equation using appropriate units for physical quantities). | Students find the mass of argon inside a gas cylinder (23 MPa pressure, 146 ×23 cm dimensions | Data processing:Process and analyse data . |
| **Week 5: Empirical and molecular formula – Ionic equation - Balancing equation**  |
| **3.1.2.4 Empirical and molecular formula****Students should be able to:*** explain the difference between empirical and molecular formulae
* carry out calculations:
* to find empirical formula from data giving composition by mass or percentage by mass
* to find molecular formula from the empirical formula and relative molecular mass.
* process & analyse data using appropriate mathematical skills).
* Students find empirical formulae (and molecular formulae where relevant) from data
* Use ratios, fractions and percentages).
 |  | **Practical opportunity:** * Students find the empirical formula of a metal oxide (eg magnesium oxide or copper oxide)
 | * process & analyse data using appropriate mathematical skills).

Students find empirical formulae (and molecular formulae whereUse ratios, fractions and percentages). |
| Week 6**07/09/24 to 13/10/24****3.1.2.5 Balanced equations and associated calculations****Students should be able to:*** write balanced equations
* write ionic equations
* carry out calculations for reactions involving:

• masses, • percentage yields, • atom economies, • volumes of gases, • concentrations & volumes of solutions, * give economic, ethical and environmental advantages for society and industry of processes with a high atom economy.

**Week 6** **3.1.2.5 Balanced equations and associated calculations****students should be able to:**• atom economies, • volumes of gases, • concentrations & volumes of solutions, •give economic, ethical and environmental advantages for society and industry of processes with a high atom economy.**Week 7 Student should be able to:**Use laboratory apparatus for a variety of experimental techniques including titration, using burette and pipette; **21/10/24 to 24/10/24****Week 8**  | Students balance equations, including ones where formulae are given and some where they are not.Students write ionic equations from given equations Students practise calculations to find masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions  Use an appropriate number of significant figures;  Substitute numerical values into algebraic equations using appropriate units for physical quantities).:Students use equation to calculate masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions.To understand the importance of processes having a high atom economy for society and industry. Students balance equations, including ones where formulae are given and some where they are not Students write ionic equations from given equationsStudents practise calculations to find masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions Substitute numerical values into algebraic equations using appropriate units for physical quantities). | **Practical opportunity:** the yield for the conversion of magnesium to magnesium oxide Process and analyse data using appropriate mathematical skills).**Practical opportunity:** Students find the Mr of a hydrated salt (eg copper sulphate or magnesium sulphate) by heating to constant mass Practical opportunity: Students find the percentage conversion of a Group 2 carbonate to its oxide by heatPractical opportunity: the yield for the conversion of magnesium to magnesium oxide **Required practical** 1 - Make up a volumetric solution and carry out a simple acid–base titration the concentration of ethanoic acid in vinegar  | Apply knowledge and understandingProcess and analyse data using appropriate mathematical skills).Process and analyse data using appropriate mathematical skills).Process and analyse data using appropriate mathematical skills); Consider margins of error, accuracy and precision of data; Process and analyse data using appropriate mathematical skills).• Process and analyse data using appropriate mathematical skills |

### 3.1.3 Bonding

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| **Prior Knowledge]****GCSE Chemistry**- Structure and bonding - properties of ionic and covalent compounds- ions and metallic bonding  | **Retrieval:**Starter- Retrieval at the start of each lesson/ Quizzes to retrieve previous knowledge/ opportunities in the lesson to link new knowledge to previous knowledge.**Strategies:*** Spaced retrieval (to combats the forgetting curve)
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**3.1.3.1 Ionic bonding**

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| **Week 9:** **3.1.1.1 Understanding ionic bonding**  |  |
| Learning Outcome | Activities | Practical  | Skills | Date |
| **11/11/24 – 17/11/24**Students should be able to:* describe the structure of ionic compounds
* explain the properties of ionic compounds using an understanding of ionic bonding
* predict the formula of simple ions based on the position of the element in the Periodic Table and knowledge of common compound ions
* write the formula of ionic compounds.
 | •Students explain the properties of ionic compounds •Students write the formula of ionic compounds, including those with common compound ions **Rich question:** Which of the following ionic compounds have the highest and lowest melting points: sodium chloride, potassium chloride; magnesium chloride – explain your reasoning? |  |  |  |
| **Week 9****3.1.3.2 Nature of covalent and dative covalent bonds** |
| **Students should be able to:**•describe the nature of covalent bonds, including co-ordinate and multiple bonds•represent molecules by diagrams where lines represent each covalent bond, with an arrow to represent a co-ordinate bond•describe the structure of molecular substances•explain the properties of molecular substances. | * Students describe differences between ionic and covalent bonding
* Students describe similarities and differences between covalent and co-ordinate bonds
* Students draw diagrams of molecules showing covalent and co-ordinate bonds as lines/arrows respectively (“stick” diagrams
* Students explain the properties of molecular substances

**Rich question:** The ammonium ion has three covalent N–H bonds and one co-ordinate N–H bond – how does the strength of the covalent bonds compare to the co-ordinate bond – explain your reasoning? |  |  |  |
| **Week 9:****3.1.3.3 Metallic bonding** |
| Students should be able to:•describe the nature of metallic bonding•describe the structure of metals•explain the properties of metals. | •Students describe differences between metallic, ionic and covalent bonding •Students explain the properties of metals **Rich question:** Which metals have the highest and lowest melting points – sodium, potassium, magnesium – explain your reasoning? |  |  |  |
| **Week 10** **3.1.3.4 - Bonding and physical properties** |
| **18/11/24 – 24/11/24****Students should be able to:**• describe and explain the properties of ionic, molecular, giant covalent and metallic substances, in terms of melting/boiling points and conductivity•describe in detail and draw the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride**.** | * Students create a summary table to describe and explain the structure and properties of ionic, molecular, giant covalent and metallic substances
* Students sketch the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride as solids and label the diagrams to explain their melting/boiling points and conductivity

Students determine which type of structure a substance has from its properties using data and/or experimentally (eg to test solubility, conductivity and ease of melting  | **Practical opportunity:** Investigate the melting point, solubility and conductivity of substances with different structure types  |  |  |
| **Week 10****3.1.3.5 Shapes of simple molecules and ions** |  |  |
| Students should be able to:Work out, name and sketch the shape of molecules and ions with up to six electron pairs surrounding the central atom, including bond anglesexplain using VSEPR theory why molecules and ions have the shapes that they do, including the effect on the bond angles of the great repulsion by lone (non-bonding) pairs. | * Make models of molecular shapes
* Use balloons to represent electron pairs to demonstrate shapes

Deduce, sketch and name the shapes of given molecules and ions, including bond angles Use angles and shapes in regular 2D and 3D structures;  Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects; Understand the symmetry of 2D and 3D shapes). |  | Predicting Molecular Shapes: Using VSEPR theory, students predict the geometry of molecules based on bonding.Interpreting Data: Students analyse diagrams, graphs, and experimental data to make conclusions about bonding and structures. |  |
| **Week 10:****3.1.3.6 Bond polarity** |
| **Students should be able to:*** define and understand the concept of electronegativity
* understand why some covalent bonds are polar and deduce whether a bond is polar

understand why some molecules are polar and deduce whether a molecule has a permanent dipole. | * Predict and explain the trend in electronegativity down a group and across a period
* Predict whether covalent bonds are polar or not
* Predict whether molecules have permanent dipoles or not
* Understand the symmetry of 2D and 3D shapes
 |  | **Making prediction** **Identifying** Patterns: analyse e data to make predictions.**Data Interpretation:** This involves looking at qualitative and quantitative data and making sense of it in order to forecast possible outcomes. |  |
| **Week 10:****3.1.3.7 Forces between molecules** |
| **Students should be able to:**•understand that there are three types of intermolecular force•explain how each of the intermolecular forces arise•explain how the melting points are influenced by these intermolecular forces•explain the anomalous nature of ice and how its low density can be explained through a knowledge of hydrogen bonding. | Students produce a summary to compare the three types of intermolecular force Students explain trends in Group 4, 5, 6 and 7 hydrides (to show relative strength of the three types of force and the effect of Mr on van der Waals’ forces)  Students explain why ice floats on water by reference to hydrogen bonding **Rich question** – Why is there no hydrogen bonding between molecules of HCl gas even though Cl is more electronegative than N yet NH3 has hydrogen bonding? | **Practical opportunity:** Students could try to deflect jets of various liquids from burettes to investigate the presence of different types and relative size of intermolecular forces | Student develop **written research** and **communication skills** Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; |  |
| **Week 10: Revision – End of unit assessments – Reflections – Targets –GAP analysis** |
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### 3.1.4 Energetics

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Required practical**  |
| **Week 11****25/11/24 – 30/11/24**Know that reactions can be exothermic or endothermic.Know what an enthalpy change and is and about standard conditions.Define standard enthalpies of formation and combustion. | **Students should be able to:*** define enthalpy change and standard conditions
* define standard enthalpy changes of combustion and formation.
 | * Students list examples of endothermic and exothermic reactions
* Students draw enthalpy profiles for exothermic and endothermic reactions
* Write balanced chemical equations, to include state symbols, to represent the changes shown by standard enthalpy changes of formation and combustion
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**3.1.4.1 Enthalpy change**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Required Practical** |
| Know that reactions can be exothermic or endothermic.Know what an enthalpy change and is and about standard conditions.Define standard enthalpies of formation and combustion. | **Students should be able to:*** define enthalpy change and standard conditions
* define standard enthalpy changes of combustion and formation.
 | * Students list examples of endothermic and exothermic reactions
* Students draw enthalpy profiles for exothermic and endothermic reactions
* Write balanced chemical equations, to include state symbols, to represent the changes shown by standard enthalpy changes of formation and combustion
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**3.1.4.2 Calorimetry**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Required practical**  |
| Understand and be able to use the equation *q = mc∆T* to calculate molar enthalpy changes. | **Students should be able to:*** recall the equation

*q = mc∆T* * Calculate *∆H* for reactions using calorimetry experiment data.
 | * Students calculate molar enthalpy changes using provided data from calorimetry experiments
* Use an appropriate number of significant figures;
* Substitute numerical values into algebraic equations using appropriate units for physical quantities).
 | **Required practical 2****Measurement of an enthalpy change.*** Practical opportunity: Students find *∆H* for a reaction by calorimetry eg

• dissolution of potassium chloride• dissolution of sodium carbonate• neutralising NaOH with HCl• displacement reaction between CuSO4 + Zn* Combustion of alcohols
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**3.1.4.3 Applications of Hess’s law**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Assessment opportunities** |
| **Week 12****2/12/24 – 6/12/24**Understand Hess’s law.Use Hess’s law to calculate enthalpy changes using enthalpies of formation and combustion. | **Students should be able to:*** Recall the equation

*q = mc∆T* * Calculate *∆H* for reactions using calorimetry experiment data
 | * Students calculate Hess’s law plus enthalpies of formation and enthalpies of combustion

 - Use appropriate apparatus to record a range of measurements (to include mass, time, volume of solutions, temperatureIdentify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined;  Plot two variables from experimental data; Plot and interpret graphs;  - Process and analyse data using appropriate mathematical skills; - Consider margins of error, accuracy and precision of data). | * Practical opportunity: Students could be asked to find *ΔH* for a reaction using Hess’s law and calorimetry, then present data in appropriate ways. Examples of reactions could include:

• thermal decomposition of NaHCO3• hydration of MgSO4• Enthalpy of formation of CaCO3 |

**3.1.4.4 Bond enthalpies**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Required Practical** |
| Understand the term mean bond enthalpy.Use mean bond enthalpies to calculate approximate values for *∆H* for reactionsUnderstand why most bond enthalpies are mean values. | **Students should be able to:*** calculate enthalpy changes using mean bond enthalpies
* understand why most bond enthalpies are mean values.
 | * Students calculate *∆H* for reactions using mean bond enthalpies
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| End of unit assessments -  |

### 3.1.5 Kinetics

**3.1.5.1 Collision theory**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| Week 139/12/24 – 13/12/24Collision theory. | **Students should be able to:*** explain that reactions can only take place when particles collide with energy greater than or equal to the activation energy.
 | * Students should be able to explain why reacts do or do not take place using collision theory
 |  |

## **3.1.5.2 Maxwell–Boltzmann distribution**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| Drawing Maxwell–Boltzmann distribution curves. | **Students should be able to:*** draw and interpret Maxwell–Boltzmann distribution curves.
 | * Students draw and Maxwell–Boltzmann curves at different temperatures, pressures and number of particles, identifying the most probable energy and particles with *E* ≥ *E*a on between graphical, numerical and algebraic forms).
 |  |

**3.1.5.3 Effect of temperature on reaction rate**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| Understand how and why temperature affects the rate of chemical reactions. | **Students should be able to:*** define the term rate of reaction
* explain how and why temperature affects the rate of reactions using Maxwell–Boltzmann distributions.
 | * Use Maxwell–Boltzmann curves to explain why a small increase in temperature leads to a large increase in reaction rate
* Students could investigate how knowledge and understanding of the factors that affect the rate of chemical reaction have changed methods of storage and cooking of food
* Practical opportunity: Students could investigate the effect of temperature on the rate of reaction of sodium thiosulfate and hydrochloric acid by an initial rate method.
 | **Required practical 3****Investigation of how the rate of a reaction changes with temperature.** |

**3.1.5.4 Effect of concentration and pressure**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| Understand how and why concentration and pressure affect the rate of chemical reactions. | **Students should be able to:*** explain how and why concentration of solutions affects the rate of reactions.
* explain how and why pressure of gases affects the rate of reactions.
 | * Use collision theory, including diagrams, to explain why an increase in solution concentration leads to an increase in reaction rate
* Use collision theory, including diagrams, to explain why an increase in gas pressure leads to an increase in reaction rate
* Students could investigate the effect of changing the concentration of acid on the rate of a reaction of calcium carbonate and hydrochloric acid by a continuous monitoring method
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**3.1.5.5 Effect of catalysts**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| Understand how and why a catalyst affects the rate of chemical reactions. | **Students should be able to:*** state what a catalyst is
* explain how and why a catalyst affects the rate of reactions.
 | * Use a Maxwell–Boltzmann curve to explain how a catalyst increases the rate of a reaction.
* Students could research the use of catalysts in catalytic converters in cars.
 | Practical opportunity: Students could use Co2+ as a catalyst in the oxidation of potassium sodium tartrate by hydrogen peroxides, including corrosive, irritant, flammable and toxic substances). |
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**3.1.6.1 Chemical equilibria and Le Chatelier’s principle**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| **Week 14**16/12/24 – 20/12/24Understand how reversible reactions can reach a state of dynamic equilibrium.Understand Le Chatelier’s principle.Understand why a compromise temperature and pressure may be used for a reversible reaction in an industrial process.Understand the effect of a catalyst on an equilibrium. | **Students should be able to:*** describe what is meant the term dynamic equilibrium
* explain how changes in temperature, pressure and concentration affect the position of a system at equilibrium
* explain why compromise conditions of temperature and pressure may be used for a reversible reaction in an industrial process.
 | * Predict and explain the effect of changes in temperature, pressure and concentration on the position of an equilibrium
* Students explain how conditions in temperature and pressure are a compromise in examples of industrial processes
 |  * Practical opportunity: Students carry out test-tube equilibrium shifts to show the effect of concentration and temperature (eg Cu(H2O)62+ with concentrated HCl).
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**3.1.6.2 Equilibrium constant *K*c for homogeneous systems**

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| **Learning objective** | **Learning outcome** | **Learning activity with opportunity to develop skills** | **Practical**  |
| Write an expression for and calculate *K*c including units.Predict the effect, if any, of changes in conditions on the value of *K*c. | **Students should be able to:*** write an expression for *K*c for a homogeneous equilibrium, including its units
* calculate the moles and concentration of reagents at equilibrium
* calculate the value of *K*c
* predict qualitatively how the value of *K*c will change, if at all, as the position of an equilibrium moves as conditions are changed.
 | * Write expressions for *K*c and derive units for a variety of equilibria.
* Calculate the moles and concentration of reagents at equilibrium given initial quantities and the quantity of one reagent at equilibrium
* Calculate *K*c from data.
* Students predict qualitatively how the value of *K*c will change, if at all, as the position of an equilibrium moves as conditions are changed.
 | Practical opportunity: Students set up a reaction between ethanol and ethanoic acid with acid catalyst and leave to reach equilibrium before titrating and using the results to determine *K*c |
| Assessments – Practical – Buffer – feedback – Reflections**Christmas break**  |