# Year 13 Chemistry Learning Journey

**YEAR GROUP: 13** **SUBJECT: Chemistry**

| When? | Knowledge | Understanding | Assessment |
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| **PC8 Thermodynamics** | **PC8 Thermodynamics**<br>**Be able to:**<br>• **Construct Born-Haber cycles to calculate lattice enthalpies and other enthalpy changes, and compare lattice enthalpies from Born-Haber cycles with those from calculations based on a perfect ionic model to provide evidence for covalent character in ionic compounds.**<br>• **Use enthalpy cycles to calculate enthalpies of solution for ionic compounds from lattice enthalpies and enthalpies of hydration.**<br>• **Understand the concept of increasing disorder (entropy change $\Delta S$) plus calculate entropy changes from absolute entropy values.**<br>• **Understand and use the relationship $\Delta G = \Delta H - T\Delta S$.** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**PC8 Thermodynamics**<br><br>• Students perform calculations of an enthalpy change using Born-Haber cycles<br>• Students could be asked to find $\Delta S$ for vaporization of water using a kettle.<br>• Students rearrange the equation $\Delta G = \Delta H - T\Delta S$ to find unknown values.<br>• Students determine $\Delta S$ and $\Delta H$ from a graph of $\Delta G$ versus T. | PC8 Thermodynamics Test (40 marks) |

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| **PC9 Rate equation**<br><br>**PC10 Equilibria 2** | **<u>PC9 Rate equation</u>**<br>**Be able to:**<br>• **Measure rate of reaction experimentally using different methods.**<br>• **Determine the rate equation from given orders.**<br>• **Perform calculations using the Arrhenius equation**<br><br>**<u>PC10 Equilibria 2</u>**<br><br>**Be able to:**<br>• **construct an expression for Kc for a homogeneous system in equilibrium and perform more complex calculations involving Kc.**<br>• **construct an expression for Kp for a homogeneous system in equilibrium and perform calculations involving Kp.**<br>• **calculate an equilibrium constant experimentally**<br>• **predict the qualitative effects of changes in** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>PC9 Rate equation</u>**<br><br>• Students use given rate data and deduce a rate equation, then use some of the data to calculate the rate constant including units. Rate equations could be given and students asked to calculate rate constant or rate.<br>• Students use a graph of concentration–time and calculate the rate constant of a zero-order reaction by determination of the gradient.<br>• Students could determine the order of reaction for a reactant in the iodine clock reaction.<br>• Students could be given data to plot and interpret in terms of order with respect to a reactant. Alternatively, students could just be given appropriate graphs and asked to derive order(s).<br>• Students calculate the rate constant of a zero-order reaction by determining the gradient of a concentration–time graph.<br>• Students plot concentration–time graphs from collected or supplied data and draw an appropriate best-fit curve.<br>• Students draw tangents to such curves to deduce rates at different times.<br><br>**<u>PC10 Equilibria 2</u>**<br><br>• Students report calculations to an appropriate number of significant figures, given raw data quoted to varying numbers of significant figures.<br>• Students calculate the partial pressures of reactants and products at equilibrium. Students calculate the value of an equilibrium constant K p. | PC9 Rate equation Test (40 marks)<br><br>PC10 Equilibria 2 Test (40 marks) |

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| | **temperature and pressure on the position of equilibrium and Kp.** | | |
| **OC7 isomerism, aldehydes e.t.c**<br><br>**PC11 Electrochemistry** | **<u>OC7 isomerism, aldehydes e.t.c</u>**<br>**Be able to:**<br>• **Name and draw aldehydes and ketones.**<br>• **outline the mechanism for nucleophilic addition reaction for the reduction of carbonyls and formation of hydroxynitriles.**<br>• **Draw pairs of enantiomers and describe their effect on plane polarised light.**<br><br>**<u>PC11 Electrochemistry</u>**<br><br>**Be able to:**<br><br>• **state and use the rules to assign oxidation states of a variety of elements in a compound or ion**<br>• **write half equations identifying oxidation and reduction and give** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>OC7 isomerism, aldehydes e.t.c</u>**<br><br>• Students could be asked to recognise the presence of a chiral centre in a given structure in 2D or 3D forms. They could also be asked to draw the 3D representation of chiral centres in various species.<br>• Students understand the origin of optical isomerism.<br>• Students could carry out test-tube reactions of Tollens' reagent and Fehling's solution to distinguish aldehydes and ketones.<br><br>**<u>PC11 Electrochemistry</u>**<br><br>• Students could make simple cells and use them to measure unknown electrode potentials.<br>• Students could be asked to plan and carry out an experiment to investigate the effect of changing conditions, such as concentration or temperature, in a voltaic cell such as Zn\|Zn2+\|\|Cu2+\|Cu<br>• Students could use EΘ values to predict the direction of simple redox reactions, then test these predictions by simple test-tube reactions.<br>• Students investigate how knowledge and understanding of electrochemical cells has evolved from the first voltaic battery. | OC7 Isomerism, aldehydes e.t.c Test (40 marks)<br><br>PC11 Electrochemistry Test (40 marks) |

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| | **overall redox equations**<br>• **write and draw the conventional representation of cells and calculate the EMF of a cell also SHE.**<br>• **use the EΘ values to predict the direction of redox reactions**<br>• **Describe reactions in a lithium battery and fuel cells also use electrode data to deduce reaction in rechargeable and non-rechargeable cells.** | | |
| **OC8 Carboxylic acids e.t.c**<br><br>**PC12 Acids and Bases** | **<u>OC8 Carboxylic acids e.t.c</u>**<br>**Be able to:**<br>• **Draw and name carboxylic acids and give equations for the reactions of carboxylic acids.**<br>• **Write equations for the formation and hydrolysis of esters.**<br>• **Outline mechanisms for nucleophilic addition-elimination reactions.**<br>• **Describe different organic techniques for synthesis, separation and analysis.**<br><br>**<u>PC12 Acids and bases</u>** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>OC8 Carboxylic acids e.t.c</u>**<br>• Students make esters by reacting alcohols with carboxylic acids, purifying the product using a separating funnel and by distillation<br>• Students carry out the preparation of aspirin, purification by recrystallisation and determination of its melting point.<br>• Students carry out the purification of impure benzoic acid and determination of its melting point.<br><br>**<u>PC12 Acids and bases</u>**<br>• Students carry out pH calculations.<br>• Students could be given concentration values and asked to calculate pH or vice versa.<br>• Students use an appropriate number of decimal places in pH calculations. | OC8 Carboxylic acids e.t.c Test (40 marks)<br><br>PC12 Acids and bases Test (40 marks) |

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| | **Be able to:**<br><br>• **define an acid and a base and identify conjugate acids and bases**<br>• **explain the pH of pure water and calculate pH for strong and weak acids and strong bases.**<br>• **construct an expression for Ka for a weak acid and calculate from an experiment**<br>• **sketch and explain the shapes of typical pH curves and use to determine indicators**<br>• **explain the actions of an acidic and basic buffer and calculate the pH of acidic buffers.** | • Students understand standard form when applied to areas such as (but not limited to)<br>• Students use KW = [H+][OH– ] to find the pH of strong bases.<br>• Students carry out pKa calculations and give appropriate units.<br>• Students understand standard form when applied to areas such as (but not limited to) Ka<br>• Students could calculate Ka of a weak acid by measuring the pH at half neutralisation<br>• Students could plot pH curves to show how pH changes during reactions.<br>• Students make appropriate mathematical approximations in buffer calculations. | |
| **OC9 Aromatics** | **<u>OC9 Aromatics</u>**<br>**Be able to:**<br>• **Describe the structure and bonding in benzene, including the stability of the benzene ring.**<br>• **Explain the substitution reactions of Benzene including mechanisms** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>OC9 Aromatics</u>**<br><br>• Students use thermochemical evidence from enthalpies of hydrogenation to account for this extra stability<br>• Students explain why substitution reactions occur in preference to addition reactions.<br>• Students outline mechanisms | OC9 Aromatics Test (40 marks) |

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| **OC10 Nitrogen Chemistry**<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>**IC4 Period 3** | **<u>OC10 Nitrogen Chemistry</u>**<br>**Be able to:**<br>• **Describe and outline the mechanism of the nucleophilic-addition elimination reactions and substitution.**<br>• **Draw and name primary – quaternary salts.**<br>• **Describe the repeating units of poylesters and polyamides and the intermolecular forces between them.**<br>• **Name and draw amino acids as well as repeating units.**<br>• **Describe DNA and draw repeating units and hydrogen bonds between DNA bases.**<br><br><br><br><br>**<u>IC4 Period 3</u>**<br>**Be able to:**<br>• **describe the reactions of sodium and Magnesium with water**<br>• **describe and explain the trends in reactions of the elements of sodium, magnesium aluminium, silicon, phosphorus and** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>OC10 Nitrogen Chemistry</u>**<br><br>• Students explain the difference in base strength in terms of the availability of the lone pair of electrons on the N atom.<br>• Students describe and draw condensation polymers<br>• Students outline mechanisms.<br>• Students explain why polyesters and polyamides can be hydrolysed but polyalkenes cannot.<br>• Students draw the structures of amino acids as zwitterions and the ions formed from amino acids<br>• Students describe the different components that make up proteins<br>• Students explain why a stereospecific active site can only bond to one enantiomeric form of a substrate or drug.<br>• Students explain how hydrogen bonding between base pairs leads to the two complementary strands of DNA<br><br><br><br>**<u>IC4 Period 3</u>**<br>• Students carry out reactions of elements with oxygen and test the pH of the resulting oxides.<br>• Students explain the trend in the melting point of the oxides of the elements Na–S in terms of their structure and bonding<br>• Students explain the trends in the reactions of the oxides with water in terms of the type of bonding present in each oxide<br>• Students write equations for the reactions that occur between the oxides of the elements Na–S and given acids and bases. | OC10 Nitrogen Chemistry Test (40 marks)<br>IC4 Period 3 Test (40 marks) |

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| | sulfur with oxygen<br>• describe the trends in melting points of the oxides of the elements Na-S<br>• describe the reactions of the oxides of the elements Na-S with water and the pH of the solutions formed and write equations for the reactions between oxides of the elements Na-S and acids and bases | | |
| **OC11 Organic Synthesis**<br><br>**IC5 Transition Metals** | **<u>OC11 Organic Synthesis</u>**<br>**Be able to:**<br>• **Be able to construct summary charts of organic reactions**<br>• **Be able to determine more complex organic synthesis pathways**<br><br>**<u>IC5 Transition metals</u>**<br>**Be able to:**<br>• **write the electronic configurations of d block atoms and ions**<br>• **define complex ion and ligand plus**<br>• **determine the coordination number, types of ligands and shapes of complex ions**<br>• **identify the types of isomerism in octahedral and square complexes** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>OC11 Organic Synthesis</u>**<br>• Students explain why chemists aim to design processes that do not require a solvent and that use non-hazardous starting materials<br>• Students explain why chemists aim to design production methods with fewer steps that have a high percentage atom economy<br>• Students use reactions learnt throughout the course to devise a synthesis, with up to four steps, for an organic compound.<br><br>**<u>IC5 Transition metals</u>**<br>• Students carry out test-tube reactions of complexes with monodentate, bidentate and multidentate ligands to compare ease of substitution.<br>• Students carry out test-tube reactions of solutions of metal aqua ions with ammonia or concentrated hydrochloric acid.<br>• Students understand and draw the shape of complex ions.<br>• Students draw cis–trans and optical isomers.<br>• Students describe the types of stereoisomerism shown | OC11 Organic Synthesis Test (40 marks)<br><br>IC5 Transition Metals Test(40 marks) |

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| | • **explain colour and spectroscopy in complex ions**<br>• **explain stability of complex ions**<br>• **Investigate complexes of copper and oxidation states of vanadium.**<br>• **perform calculations for titrations of redox reactions**<br>• **explain catalysts in terms of transitions metals and compounds**<br>• **describe and explain test tube reactions on $M^{2+}$ and $M^{3+}$ ions of hydroxide ions, ammonia and carbonate ions.** | by molecules/ complexes.<br>• Students determine the concentration of a solution from a graph of absorption versus concentration.<br>• Students could carry out redox titrations.<br>• Students could identify unknown substances using reagents. | |
| **OC12 NMR and Chromatography** | **<u>OC12 NMR and Chromatography</u>**<br>**Be able to:**<br><br>• **Analyse NMR chromatograms for C NMR and H NMR using integration, chemical shift values and splitting patterns where applicable.**<br>• **Describe gas, column, and TLC chromatography.** | Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification.<br><br>**<u>OC12 NMR and Chromatography</u>**<br><br>• Students should be able to use data in the Chemistry Data Booklet to suggest possible structures for molecules.<br>• Students calculate Rf values from a chromatogram<br>• Students compare retention times and Rf values with standards to identify different substances. | OC12 NMR and Chromatography Test (40 marks) |