

## Biddulph High School Curriculum Intent

To deliver a broad and enriching curriculum through engaging and challenging lessons that provide a wide range of opportunities for all students to achieve their potential.

Students will all be prepared to take their next steps in a diverse and ever changing future ready to make a positive contribution to society.

Through a broad programme of extracurricular activities students will have the opportunities to showcase their talents and experience new challenges.

We value individuals and all that they can offer as well as supporting each other with kindness and empathy.

### Curriculum Intent for Chemistry: Year 12

*. Our overarching aim is to develop well rounded chemists who can not only explain complex theoretical concepts, but can investigate them practically for themselves. Investigative skills and techniques are at the heart of chemistry at BHS and we have embedded frequent opportunities for our learners to develop these at all stages of the curriculum. Our curriculum reflects the vast number of our students for whom chemistry will form part or all of their further studies and to this end, from year 9 to year 13, we deliver our lessons with the expectation that our students will take the skills and knowledge they have gained here on into their future careers*

All teachers will follow the schemes of work provided by the department. This will ensure that all students receive the same high-quality provision. All units of work will provide a clear outline of the knowledge and skills required and assessments will ensure that this knowledge has been retained and that skills can be evidenced.

Teachers will ensure that gaps are closed through regular monitoring within the classroom. DINT activities will allow for interleaving and recap of previous learning. Misconceptions will be identified through effective questioning and the regular inspection of student work.

Chemistry Long Term Overview						
Year Group	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
9	Particle theory, equations and the periodic table	Methods of separation	Maths skills and calculating relative formula mass	pH, acids and indicators	Green Chemistry	Energetics and atomic theory
10	Atoms, isotopes and periodicity	Bonding and molar calculations	Acid, base reactions and electrolysis	Energetics and electrochemical cells. Rates of reaction.	Mock examinations and intervention	Equilibrium
11	Equilibria and extracting metals	Corrosion, Alloys and Mock examinations	Organic Chemistry	Interpreting and interacting with Earth systems.	Examinations	Examinations
12	Foundations in Chemistry. Nomenclature and alkanes	Acids and base chemistry. Periodicity. Alkene reactions and mechanisms.	Energetics. Alcohols and Haloalkanes	Hess's Law and Rates. Synthetic pathways.	Equilibria and revision. Analysis – Mass spec and IR.	Examinations. Intervention. begin Module 5 – Rates and Module 6 – Benzene.
13	Equilibria – Kc and Kp. Acids and bases. Arenes and carbonyls.	Buffers. Energetics. Carboxylic acids and derivatives. Amines and amides. C-C bond formation.	Revision Mock examinations.	Redox titration. Electrochemistry. Transition metals. Synthesis. NMR and gas chromatography.	Examinations	Examinations

<b>Chemistry: Medium Term Overview</b>			
<b>Year 12</b>	<b>Autumn Term 1</b>	<b>Unit Title: Core Organic Chemistry</b>	<b>No of Lessons: 20</b>
<b>Overview/Intent</b>	<p>The content within this module assumes knowledge and understanding of the chemical concepts developed in Module 2: Foundations in chemistry and Module 4: Core organic chemistry. This module introduces several new functional groups and emphasises the importance of organic synthesis. This module also adds NMR spectroscopy to the instrumentation techniques used in organic and forensic analysis. The main areas of organic chemistry studied include: • aromatic compounds • carboxylic acids and esters • organic nitrogen compounds: amines and amino acids • polymerisation: addition polymers and condensation polymers • synthetic organic chemistry and further development of practical skills • the importance of modern analytical techniques in organic analysis.</p> <p>Aromatic compounds are first introduced, including the central role of delocalisation within the chemistry of arenes and phenols. Directing groups are also introduced, including their importance to organic synthesis. The important carbonyl compounds, aldehydes and ketones, are then studied. Finally, carboxylic acids and their related functional groups, acyl chlorides and esters, are studied. The importance of acyl chlorides in organic synthesis is emphasised.</p> <p>This section also focuses on organic nitrogen compounds, including amines, amides and amino acids. Chirality and optical isomerism is also introduced. Condensation polymerisation is also introduced and compared with addition polymerisation. The importance of carbon-carbon bond formation in organic synthesis is stressed. Learners are also able to consider multi-stage synthetic routes towards an organic product. This module allows learners many opportunities to further develop their organic practical skills, especially in preparing and purifying organic solids, including recrystallisation and determination of melting points.</p>		
<b>Assessment</b>	Homework tasks.		

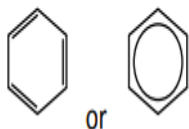
End of topic tests and formative assessments.

**Essential Knowledge (what must students know):****Benzene and aromatic compounds**

- the comparison of the Kekulé model of benzene with the subsequent delocalised models for benzene in terms of p-orbital overlap forming a delocalised  $\pi$ -system
- Development of the model for benzene over time. (b) the experimental evidence for a delocalised, rather than Kekulé, model for benzene in terms of bond lengths, enthalpy change of hydrogenation and resistance to reaction
- Acceptance of the delocalised benzene model by the scientific community in light of supporting experimental evidence. (c) use of IUPAC rules of nomenclature for systematically naming substituted aromatic compounds
- the electrophilic substitution of aromatic compounds with: (i) concentrated nitric acid in the presence of concentrated sulfuric acid (ii) a halogen in the presence of a halogen carrier (iii) a haloalkane or acyl chloride in the presence of a halogen carrier (Friedel–Crafts reaction) and its importance to synthesis by formation of a C–C bond to an aromatic ring (see also 6.2.4 d) Halogen carriers include iron, iron halides and aluminium halides. (e) the mechanism of electrophilic

**Essential Skills (what must students be able to demonstrate):****Students will be able to:**

Learners may represent the structure of benzene in equations and mechanisms as:



For nitration mechanism, learners should include equations for formation of  $\text{NO}_2^+$ . Halogen carriers include iron, iron halides and aluminium halides. For the halogenation mechanism, the electrophile can be assumed to be  $\text{X}^+$ .

- Be able to show mechanisms for Friedel–Crafts reaction to include the formation of the nucleophile.
- Compare the reactivity of phenol to benzene.
- Know the reactions of phenol.
- Predict products of reactions with arenes dependant on the directing groups in terms of position around the benzene ring.
- Recognise carbonyls.
- Predict the products of the reactions with carbonyls.

**Lessons:**

- Benzene
- Benzene and reactivity
- Nitration
- Halogenation
- Acylation and alkylation
- Phenol
- Directing groups
- TEST
- Carbonyl compounds
- Reactions of carbonyls
- Identifying carbonyls
- Carboxylic acids
- Carboxylic acid derivatives
- PAG 7.1
- PAG 7.1
- Amines
- Amino acids
- Condensation Polymers
- Hydrolysis
- TEST
- Intervention
- C–C bond formation
- C–C bond formation
- Practical Techniques.

<p>substitution in arenes for nitration and halogenation</p> <ul style="list-style-type: none"> <li>the explanation of the relative resistance to bromination of benzene, compared with alkenes, in terms of the delocalised electron density of the <math>\pi</math>-system in benzene compared with the localised electron density of the <math>\pi</math>-bond in alkenes</li> <li>the interpretation of unfamiliar electrophilic substitution reactions of aromatic compounds, including prediction of mechanisms</li> </ul> <p><b>Phenols</b></p> <ul style="list-style-type: none"> <li>the weak acidity of phenols shown by the neutralisation reaction with NaOH but absence of reaction with carbonates</li> <li>the electrophilic substitution reactions of phenol: (i) with bromine to form 2,4,6-tribromophenol (ii) with dilute nitric acid to form a mixture of 2-nitrophenol and 4-nitrophenol (j) the relative ease of electrophilic substitution of phenol compared with benzene, in terms of electron pair donation to the <math>\pi</math>-system from an oxygen p-orbital in phenol</li> <li>the 2- and 4-directing effect of electron donating groups (OH, NH<sub>2</sub>) and the 3-directing effect of electron-withdrawing groups (NO<sub>2</sub>) in electrophilic substitution of aromatic compounds</li> </ul>	<ul style="list-style-type: none"> <li>State the tests used to identify carbonyls and know the observations expected.</li> <li>Predict the products of reactions with carboxylic acids.</li> <li>Identify the carboxylic acid derivatives and how they react.</li> <li>Identify the classification of an amine</li> <li>Know the basic properties of amines and why they act as a base.</li> <li>Be able to draw amino acids and how they react dependant on their R group.</li> <li>Draw out full diagrams to show the products on polymerisation to form esters and amides.</li> <li>Recognise chiral carbons in a range of large molecules.</li> <li>Draw enantiomers</li> <li>Identify monomers that form condensation polymers.</li> <li>Draw the products of both acid and base hydrolysis.</li> <li>Give examples including mechanisms of how to extend the carbon chain of a chemical.</li> </ul>	
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<ul style="list-style-type: none"><li>• Correlation between substituted group and position of reaction. (l) the prediction of substitution products of aromatic compounds by directing effects and the importance to organic synthesis</li></ul> <p><b>Reactions of carbonyl compounds</b></p> <ul style="list-style-type: none"><li>• oxidation of aldehydes using <math>\text{Cr}_2\text{O}_7^{2-}/\text{H}^+</math> (i.e. <math>\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4</math>) to form carboxylic acids</li><li>• nucleophilic addition reactions of carbonyl compounds with: (i) <math>\text{NaBH}_4</math> to form alcohols (ii) <math>\text{HCN}</math> [i.e. <math>\text{NaCN}(\text{aq})/\text{H}^+(\text{aq})</math>], to form hydroxynitriles . the mechanism for nucleophilic addition reactions of aldehydes and ketones with <math>\text{NaBH}_4</math> and <math>\text{HCN}</math></li><li>• use of 2,4-dinitrophenylhydrazine to: (i) detect the presence of a carbonyl group in an organic compound (ii) identify a carbonyl compound from the melting point of the</li><li>• use of Tollens' reagent (ammoniacal silver nitrate) to: (i) detect the presence of an aldehyde group (ii) distinguish between aldehydes and ketones, explained in terms of the oxidation of aldehydes to carboxylic acids with reduction of silver ions to silver.</li><li>• explanation of the water solubility of carboxylic acids in terms of hydrogen bonding (b) reactions in aqueous conditions of carboxylic acids with</li></ul>		
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<p>metals and bases (including carbonates, metal oxides and alkalis)</p> <ul style="list-style-type: none"><li>esterification of: (i) carboxylic acids with alcohols in the presence of an acid catalyst (e.g. concentrated H<sub>2</sub>SO<sub>4</sub>) (ii) acid anhydrides with alcohols (d) hydrolysis of esters: (i) in hot aqueous acid to form carboxylic acids and alcohols (ii) in hot aqueous alkali to form carboxylate salts and alcohols Acyl chlorides (e) the formation of acyl chlorides from carboxylic acids using SOCl<sub>2</sub> (f) use of acyl chlorides in synthesis in formation of esters, carboxylic acids and primary and secondary amides.</li></ul> <p><b>Nitrogen compounds, polymers and synthesis</b></p> <ul style="list-style-type: none"><li>the basicity of amines in terms of proton acceptance by the nitrogen lone pair and the reactions of amines with dilute acids, e.g. HCl(aq), to form salts</li><li>the preparation of: (i) aliphatic amines by substitution of haloalkanes with excess ethanolic ammonia and amines (ii) aromatic amines by reduction of nitroarenes using tin and concentrated hydrochloric acid.</li></ul> <p><b>Reactions of amino acids</b></p> <ul style="list-style-type: none"><li>the general formula for an <math>\alpha</math>-amino acid as RCH(NH<sub>2</sub>)COOH and the following reactions of amino acids: (i) reaction of the carboxylic acid group with alkalis and in the formation of esters (ii) reaction of</li></ul>		
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<p>the amine group with acids Amides (b) structures of primary and secondary amides)</p> <p><b>Chirality</b></p> <ul style="list-style-type: none"><li>optical isomerism (an example of stereoisomerism, in terms of nonsuperimposable mirror images about a chiral centre) Learners should be able to draw 3-D diagrams to illustrate stereoisomerism. identification of chiral centres in a molecule of any organic compound.</li></ul> <p><b>Condensation polymers</b></p> <ul style="list-style-type: none"><li>condensation polymerisation to form: (i) polyesters (ii) polyamides Formation from carboxylic acids/dicarboxylic acids (or respective acyl chlorides) and from alcohols/diols or amines/diamines. (b) the acid and base hydrolysis of: (i) the ester groups in polyesters (ii) the amide groups in polyamides (c) prediction from addition and condensation polymerisation of: (i) the repeat unit from a given monomer(s) (ii) the monomer(s) required for a given section of a polymer molecule (iii) the type of polymerisation.</li></ul> <p><b>Extending carbon chain length</b></p> <ul style="list-style-type: none"><li>the use of C–C bond formation in synthesis to increase the length of a carbon chain</li><li>formation of C–C–N by reaction of: (i) haloalkanes with CN<sup>–</sup> and ethanol,</li></ul>		
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<p>including nucleophilic substitution mechanism</p> <ul style="list-style-type: none"><li>• ii) carbonyl compounds with HCN, including nucleophilic addition mechanism</li><li>• reaction of nitriles from (b): (i) by reduction (e.g. with H<sub>2</sub>/Ni) to form amines (ii) by acid hydrolysis to form carboxylic acids</li><li>•</li></ul> <p><b>Practical Skills:</b></p> <p>Module 1 of the specification content relates to the practical skills learners are expected to gain throughout the course, which are assessed throughout the written examinations and also through the Practical Endorsement (see Section 5). Practical activities are embedded within the learning outcomes of the course to encourage practical activities in the classroom which contribute to the achievement of the Practical Endorsement (Section 5) as well as enhancing learners' understanding of chemical theory and practical skills..</p> <ul style="list-style-type: none"><li>• the techniques and procedures used for the preparation and purification of organic solids involving use of a range of techniques (see also 4.2.3 a) including: (i) organic preparation • use of Quickfit apparatus • distillation and heating under reflux (ii) purification of an organic solid • filtration under reduced pressure • recrystallisation • measurement of melting points</li></ul>		
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<p><b>Careers Links:</b> Nuclear physics with particle models. Laboratory work. Analytical chemist. Medicinal chemist. Forensic Scientist.</p> <p><b>Homework</b> SENECA learning and examination style questions to support learning and improve skill. Work booklet for homework tasks. Completion of additional reading and research.</p>	<p><b>Enrichment:</b> Students will have the opportunity to attend the trip to Geneva.</p>	<p><b>MY PB</b> <b>Social Me- active listening, speaking effectively, working with others</b> Practical work will require aspects of the social me strand <b>Thinking Me – evaluating &amp; creativity</b> Evaluation will be utilised when assessing data from investigations <b>This is Me – Resilience, responsibility, self-motivation, integrity, self-management</b> Students will need to demonstrate resilience and self-management when looking at the assessed points across the lessons</p>

Chemistry <b>Medium Term Overview</b>			
Year 12	<i>Spring Term 2</i>	Unit Title: <b>Analysis and Synthesis</b>	No of Lessons: <b>35</b>
<b>Overview</b>	This section develops and complements the spectroscopic areas of organic chemistry previously encountered (see Module 4: Core organic chemistry; 4.2.4 Analytical techniques). This section demonstrates how analytical techniques introduced in Module 4 (infrared spectroscopy, mass spectrometry and elemental analysis) may be used in combination with NMR spectroscopy to provide evidence of structural features in molecules. The instrumentation methods of analysis studied during the A level course provide learners with an important base of knowledge, understanding and awareness for further study in Higher Education and in many		
<b>Assessment</b>			

	<p>areas of employment in the broad scientific field. This section also looks at how unknown organic functional groups can be analysed and identified using simple test-tube tests.</p> <p>Mock examinations</p>	
<p><b>Essential Knowledge (what must students know):</b></p> <p><b>Synthetic routes</b></p> <ul style="list-style-type: none"> <li>for an organic molecule containing several functional groups: (i) identification of individual functional groups (ii) prediction of properties and reactions Development of synthetic routes. (c) multi-stage synthetic routes for preparing organic compounds.</li> </ul> <p><b>Types of chromatography</b></p> <ul style="list-style-type: none"> <li>interpretation of one-way TLC chromatograms in terms of R<sub>f</sub> values</li> <li>Interpretation of TLC to analyse organic compounds. (b) interpretation of gas chromatograms in terms of: (i) retention times (ii) the amounts and proportions of the components in a mixture To include creation and use of external calibration curves to confirm concentrations of components. Peak integration values will be supplied. HSW3 Interpretation of GC to analyse organic compounds. Tests for organic functional groups (c) qualitative analysis of organic functional groups on a test-tube scale; processes and techniques needed to identify the following functional groups in an unknown compound: (i) alkenes by reaction with bromine (see also 4.1.3 f) (ii) haloalkanes by reaction with</li> </ul>	<p><b>Essential Skills (what must students be able to demonstrate):</b></p> <p><b>Students will be able to:</b></p> <ul style="list-style-type: none"> <li>After the mock examinations, students will use their QLAs to identify gaps in their subject knowledge and close them gaps through a range of activities</li> <li>learners will be expected to be able to devise multistage synthetic routes by applying transformations between all functional groups studied throughout the specification. Extra information may be provided on exam papers to extend the learner's toolkit of organic reactions.</li> <li>Learners will be expected to identify functional groups encountered in Module</li> <li>All carbon-13 NMR spectra that are assessed will be proton decoupled. In examinations, NMR chemical shift values will be provided on the Data Sheet. Restricted to functional groups studied in the A level specification.</li> <li>Learners will be expected to identify aromatic protons from chemical shift values but will not be expected to analyse their splitting patterns.</li> </ul>	<p><b>Lessons:</b></p> <p>1 – 4 Revision for mock examinations</p> <p>5 – 9 Mock examinations</p> <p>1 – 14 Intervention and QLAs</p> <p>15 – Synthesis</p> <p>16 – Synthesis</p> <p>17 – Gas chromatography</p> <p>18 NMR</p> <p>19 – NMR</p> <p>20 – NMR</p> <p>21 – NMR</p> <p>22 – NMR</p> <p>23 – Combined techniques</p> <p>24 – Combined techniques</p> <p>25 – 35 Past papers</p>

<p>aqueous silver nitrate in ethanol (iii) phenols by weak acidity but no reaction with <math>\text{CO}_3^{2-}</math> (iv) carbonyl compounds by reaction with 2,4- DNP (v) aldehydes by reaction with Tollens' reagent</p> <ul style="list-style-type: none"><li>• primary and secondary alcohols and aldehydes by reaction with acidified dichromate (vii) carboxylic acids by reaction with <math>\text{CO}_3^{2-}</math></li></ul> <p><b>NMR Spectroscopy</b></p> <ul style="list-style-type: none"><li>• analysis of a carbon-13 NMR spectrum of an organic molecule to make predictions about: (i) the number of carbon environments in the molecule (ii) the different types of carbon environment present, from chemical shift values (iii) possible structures for the molecule</li><li>• (b) analysis of a high resolution proton NMR spectrum of an organic molecule to make predictions about: (i) the number of proton environments in the molecule (ii) the different types of proton environment present, from chemical shift values (iii) the relative numbers of each type of proton present from relative peak areas, using integration traces or ratio numbers, when required</li><li>• the number of non-equivalent protons adjacent to a given proton from the spin-spin splitting pattern, using the <math>n + 1</math> rule (v) possible structures for the molecule</li><li>• (c) prediction of a carbon-13 or proton NMR spectrum for a given molecule</li></ul>	<ul style="list-style-type: none"><li>• Use their knowledge of synthetic pathways, identify a products using a range of methods and data provided such as mass spec, IR spec, NMR graphs and data that will enable to calculate the empirical formula of a molecule.</li></ul>	
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<ul style="list-style-type: none"> <li>(i) the use of tetramethylsilane, TMS, as the standard for chemical shift measurements</li> <li>(ii) the need for deuterated solvents, e.g. CDCl<sub>3</sub>, when running an NMR spectrum</li> <li>(iii) the identification of O–H and N–H protons by proton exchange using D<sub>2</sub>O</li> </ul> <p><b>Combined techniques</b></p> <ul style="list-style-type: none"> <li>deduction of the structures of organic compounds from different analytical data including: (i) elemental analysis (ii) mass spectra (iii) IR spectra (iv) NMR spectra.</li> </ul>		
<p><b>Careers Link:</b> Forensics and police work. Environmental scientists. Medicinal chemistry</p> <p><b>Homework</b> SENECA learning and examination style questions to support learning and improve skill. Homework booklets. Research and further reading.</p>	<p><b>Enrichment</b> Students will be taught about the role of analysis in drug production and detection.</p>	<p><b>MY PB</b> <b>Social Me- active listening, speaking effectively, working with others</b> Practical work will require aspects of the social me strand <b>Thinking Me – evaluating &amp; creativity</b> Evaluation will be utilised when assessing data from investigations <b>This is Me – Resilience, responsibility, self-motivation, integrity, self-management</b> Students will need to demonstrate resilience and self-management when looking at the assessed points across the lessons</p>

Chemistry <b>Medium Term Overview</b>			
<b>Year 9</b>	<b>Summer Term 3</b>	<b>Unit Title: End of Year examinations</b>	<b>No of Lessons: NA</b>
<b>Overview</b>	<p><b>Periodic table, elements and physical chemistry (Component 01)</b> This component is worth 100 marks and is split into two sections and assesses content from teaching modules 1, 2, 3 and 5. Learners answer all questions. Section A contains multiple choice questions. This section of the paper is worth 15 marks. Section B includes</p>		

<p><b>Assessment</b></p>	<p>short answer question styles (structured questions, problem solving, calculations, practical) and extended response questions. This section of the paper is worth 85 marks.</p> <p><b>Synthesis and analytical techniques (Component 02)</b> This component is worth 100 marks and is split into two sections and assesses content from teaching modules 1, 2, 3 and 5. Learners answer all questions. Section A contains multiple choice questions. This section of the paper is worth 15 marks. Section B includes short answer question styles (structured questions, problem solving, calculations, practical) and extended response questions. This section of the paper is worth 85 marks.</p> <p><b>Unified chemistry (Component 03)</b> This component assesses content from across all teaching modules 1 to 6. Learners answer all questions. This component is worth 70 marks. Question styles include short answer (structured questions, problem solving, calculations, practical) and extended response questions.</p> <p><b>Practical Endorsement in chemistry (Component 04)</b> Performance in this component is reported separately to the performance in the A level as measured through externally assessed components 01 to 03. This non-exam assessment component rewards the development of practical competency in chemistry and is teacher assessed. Learners demonstrate competence in the range of skills and techniques specified in Section 1.2 of the specification by carrying out a minimum of 12 assessed practical activities. The Practical Endorsement is teacher assessed against the Common Practical Assessment Criteria as specified in Section 5g. Learners may work in groups but must demonstrate and record independent evidence of their competency. Teachers who award a pass to their learners must be confident that each learner consistently and routinely exhibits the competencies listed in Section 5g and has demonstrated competence in all the skills detailed in section 1.2.1 and in all the apparatus and techniques detailed in Section 1.2.2 before completion of the A level course. The practical activities provided by OCR are all mapped against the specification and assessment criteria.</p>	
