CHE-2C11: ORGANIC CHEMISTRY

REVISION CHECKLIST

Section	Topic	Complete?
1	**Aromatic Compounds and Aromaticity** Professor Cammidge	
2	**Carbonyl Group Chemistry** Professor Cammidge	
3	**Stereochemistry & Mechanism** Doctor Bew	
4	**Pericyclic Reactions** Doctor Richards	

Aromatic Compounds and Aromaticity – Professor Cammidge

Topic	Subtopic	Before Revision	After Revision
Aromaticity	The structure of benzene using Valence Bond Approach		
	Molecular Orbital representation of Benzene		
	Frost-Musulin diagrams (polygon in a circle)		
	Huckel's Rule (4n + 2) Electron Rule		
	Criteria for a compound to be aromatic		
	Determining whether a molecule is aromatic, anti-aromatic or non-aromatic		
	The exceptions of [10]-annulene due to central protons		
	Using NMR as a test for aromaticity		
Aromatic Ions	Acidity of cyclopentadiene		
	Acidity of cycloheptatriene and loss of hydride to form the tropyllium ion		
Benzenoid / Heterocyclic Aromatic Compounds	Benzenoid Aromatic Compounds		
	Heterocyclic Aromatic Compounds (Pyridine, Pyyrole, Furan, Thiophene)		
	Molecular Orbital representation of pyridine		
	Molecular Orbital representation of pyrrole, furan and thiophene		
Electrophillic aromatic substitution	Halogenation (Bromination of Benzene)		
	Nitration		
	Sulfonation		
	Friedel-Crafts Acylation using an acyl (acid) chloride		
	Friedel-Crafts Acylation using an acid anhydride		
	The acylium ion		
	Friedel-Crafts Alkylation		
	Problems with Fridel-Crafts Alkylation (prevention of double substitutions & rearrangement of intermediate carbocation)		
	Other sources of carbocations (ie alkene or alcohol in acid)		

Multiply Substituted Aromatics	Ortho, meta and para prefixes		
	Activating substituents (Electron Donating)		
	Deactivating substituents (Electron Withdrawing)		
	The relative (de)activation of single substituents through explanation of resonance and inductive effects		
	Effect of Substituent on Orientation for activating and deactivating groups		
Electophillic aromatic substitution and multiple substitution reactions for heterocyclic aromatic compounds	Heterocyclic aromatic compounds that are π-excessive		
	Electrophillic aromatic substitution at a heterocyclic aromatic compound		
	Effect of Substituent on Orientation for activating and deactivating groups on heterocyclic aromatic compounds		
	Reaction of 5-membered heteroaromatics with electrophiles (pyrrole and acid, furan and acid)		
	Vilsmeier-Haack Acylation (used to introduce formyl group)		
	Mannich Reaction (used for substituent CH_2Nu)		
Arene diazonium salts	Synthesis of arene diazonium salts		
	Sandmeyer reactions of Cu(I) salts -CN -Cl -Br -I		
	Scheimann reaction : HBF_4 gives - F		
	Phenol formation: - OH		
	Hydride formation: - H – reduction of the NH_2 group (or its removal)		
Pyridine lone pair reactivity	Pyridine – lone pair on nitrogen reactivity – (with H^+, MeI, HOOH)		

Aromatic Compounds and Aromaticity – Professor Cammidge

Final Sign Off

Topic	**Fully Revised and Understood?**
Aromaticity	
Aromatic Ions	
Benzenoid / Heterocyclic Aromatic Compounds	
Electrophillic aromatic substitution	
Multiply Substituted Aromatics	
Electophillic aromatic substitution and multiple substitution reactions for heterocyclic aromatic compounds	
Arene diazonium salts	
Pyridine lone pair reactivity	
Aromatic Compounds and Aromaticity – Entire Topic	

Carbonyl Group Chemistry – Professor Cammidge

Topic	Subtopic	Before Revision	After Revision
Basic Carbonyl Chemistry	Reaction mechanism of a carbonyl as an electrophile (ie with Nu^-)		
	Reaction mechanism of a carbonyl as a nucelophile		
	Formation of enolates		
	Enolate alkylation with an alkyl halide		
	Acidity of the α – hydrogen atoms of carbonyl compounds		
	Formation of enols : Keto-enol tautomerism		
	1,3-Dicarbonyl species		
	Carbonyl α – substitution reactions		
	Bases used for enolate formation		
	Chemical and Sterochemical Consequences of Enolization		
Advanced Carbonyl Chemistry	Racemization		
	Epimerization		
	Reactions with Electrophiles: Halogenation		
	Use of Lewis acid as a catalyst		
	Unsymmetrical Ketones		
	Alkylation of Enolate Ions		
	Enolates of Unsymmetrical Ketones - Kinetic Enolate - Thermodynamic Enolate		
	Kinetic Enolates		
	Thermodynamic Enolates		
	Alkylation of Esters and Nitriles		

Reaction Mechanisms	1,3 – Dicarbonyl compounds - Alkylation		
	1,3 – Dicarbonyl compounds - Dianions		
	β – Ketoesters - Decarboxylation		
	The 'Malonate and Acetoacetate Syntheses'		
	Malonate Synthesis		
	The Aldol Reaction		
	Dehydration of Aldol Products: Synthesis of Enones		
	Mechanism of Aldol Dehydration		
	Intramolecular Aldol Reactions		
	The Claisen Condensation		
	Intramolecular Claisen Condensation – The Dieckmann Cyclization		
	Knoevenagel Condensation		
	The Michael Reaction		
	Examples of typical Michael donors and acceptors		
	The Robinson Annelation		
	Condensation with Amine Derivatives (Imine formation)		
	Enamine Reactivity		
	The Wittig Reaction		
Planning a Synthesis of a Target Molecule	Understanding of Functional Group Interconversions		
	Understanding of Carbon – Carbon bond forming reactions		
	Recognise functional groups in the target molecule		
	Be aware of how you could make these functional groups and how they react		
	Recognise potential carbon – carbon bond forming steps		
	Idea of Synthons and Reagents		
	Synthetic Equivalents to Common Synthons		

Carbonyl Group Chemistry – Professor Cammidge

Final Sign Off

Topic	**Fully Revised and Understood?**
Basic Carbonyl Chemistry	
Advanced Carbonyl Chemistry	
Reaction Mechanisms	
Planning a Synthesis of a Target Molecule	
Carbonyl Group Chemistry – Entire Topic	

Stereochemistry & Mechanism – Doctor Bew

Topic	Subtopic	Before Revision	After Revision
Beginning Concepts	Conformations and Configurations		
	Sawhorse and Newman Projections of ethane		
	Staggered Conformations of n-Butane (eclipsed, staggered, synperiplanar, synclinal or gauche, anticlinal, antiperiplanar) and relative energy level diagram for central bond rotation		
	Explanation for why energy barriers occur – torsional/Pitzer strain		
Cyclohexane	Structure of cyclohexane – chair and boat		
	Can you draw a cyclohexane ring properly?		
	Side on view of cyclohexane and a newman projection		
	Why is boat conformation of higher energy? Flagstaff C-H bonds etc		
	Equatorial and Axial interactions, they have different environments.		
Ring Inversion	Process of the ring flip (chair – half chair – twist boat – half chair – chair)		
	Relative energies with the chair, half chair and twist boat and their structures		
Smaller cycloalkyl rings	Cyclopropane		
	Cyclobutane - puckered		
	Cyclopentante – open envolope		
	Determination of ring strain from heat of combustion relative to straight chain alkanes		
	Stablility of Ring Systems – 5 membered has minimum ring strain		
	Consideration of (1) Torsion (2) Sterics (3) Angles		
Cycloalkenes	Cyclopropene		
	Cyclobutene		
	Cyclopentene strain is the same as Cyclopentane		
	Cyclohexene – adopts two structures (cis/trans) and exists as half chair form		
	Cyclohexadienes (1,4 cyclohexadiene and 1,3 cyclohexadiene)		

Monosubstituted cyclohexane	Methylcyclohexane and 1,3-diaxial interactions and due to anti-periplanar carbon structure (prefers equatorial position)		
	Conformational Free Energy of common substituents		
	Tert-butyl lock		
	Cis 1,4 di(t-butyl)cyclohexane forms pseudoequatorial		
Disubstituted Cyclohexanes	Prediction of steroisomerism, configuration and conformation of disubstituted cyclohexanes		
Heteroatoms in or on rings	Atomic radii changes ring geometry		
	Geometric effects on substituent preferences		
	Syn-axial interactions with lone pairs (1,3 diaxial interactions)		
Anomeric Effect	Preferation of glucose and sugars		
	Electronegative substituent at an anomeric centre prefers axial due to overlap of orbtials – lone pair must be anti-periplanar to C-X bond		
Fundamentals of Carbonyl Chemistry	Curly arrows are very important		
	If R groups not same (unsymmetrical ketone) then enantiomers formed		
	Steric Effects – Increase size of C=O substituents slows the addition. Bond angles change from 120 to 109’.		
	Simple Addition Reactions to Carbonyl Groups		
	Attack at the Carbonyl Group of Cyclohexane – nucleophile can attack from two faces		
	Crams Rule!		
Neighbouring Group Participation	Examples of anchimeric assistance (NGP)		
	Results in a rate acceleration		
	Payne rearrangement		
	Wagner-Meerwein Rearrangements		
	Pinacol Rearrangements		
	E2 elimination reactions on cyclohexane ring systems		
	Sterochemistry of E2 reactions on cyclohexane rings		

Stereochemistry & Mechanism – Doctor Bew

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Beginning Concepts	
Cyclohexane	
Ring Inversion	
Smaller cycloalkyl rings	
Cycloalkenes	
Monosubstituted cyclohexane	
Disubstituted Cyclohexanes	
Heteroatoms in or on rings	
Fundamentals of Carbonyl Chemistry	
Neighbouring Group Participation	
Stereochemistry & Mechanism – Entire Topic	

Pericyclic Reactions – Doctor Richards

Topic	Subtopic	Before Revision	After Revision
Interpretation of Spectra	The basics of ^{1}H NMR Spectroscopy		
	Chemical Shift and ppm		
	Integration		
	Magnetic Equivalence		
	Coupling		
	Magnitude of three-bond coupling constants (J)		
	Reporting ^{1}H NMR date		
	^{13}C NMR Spectroscopy		
	IR Spectroscopy		
	Microanalysis (combustion analysis)		
	Mass Spectrometry		
	High Resolution Mass Spectrometry		
	Specific Rotation		
Pericyclic Reactions	Definition of pericyclic reactions in terms of concerted and rearrangement		
	Types of pericyclic reactions - Cycloaddition - Electrocyclic reactions - Sigmatropic rearrangement		
Cycloadditions	Diels-Alder reaction		
	Examples of Diels-Alder reactions		
	Orientation of reactants (diene and dienophile)		
	Diene conformation		
	Sterochemistry		
	Hetero-Diels-Alder Reactions		
	Other cycloadditions ([6+4],[8+2])		
	Thermal cycloadditions in terms of aromaticity		
	Photochemical [2 + 2] Cycloaddition		
	Thermal [2 + 2] Cycloaddition		
Sigmatropic Rearrangements	Claisen Rearrangement		
	Nomenclature for sigmatropic rearrangements		
	Aliphatic Claisen rearrangement		
	Cope rearrangement		
	[2,3]-sigmatropic rearrangements		
	[1,5]-signmatropic Hydrogen Shifts		
Electrocyclic Reactions	Nazarov Cyclisation		

Ionic (Cation) Rearrangements	Carbocation Rearrangements		
	Wagner-Meerwein Rearrangements		
	The Pinacol Rearrangement		
	Choice of Migrating Group		
	The Dienone-Phenol Rearragement		
	The Beckmann Rearrangement		
Ionic (Anion) Rearrangements	Benzillic Acid Rearrangement		
	Favorskii Rearrangement		
	Baeyer – Villiger Reaction		

Pericyclic Reactions – Doctor Richards

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Interpretation of Spectra	
Pericyclic Reactions	
Cycloadditions	
Sigmatropic Rearrangements	
Electrocyclic Reactions	
Ionic (Cation) Rearrangements	
Ionic (Anion) Rearrangements	
Pericyclic Reactions – Entire Topic	