

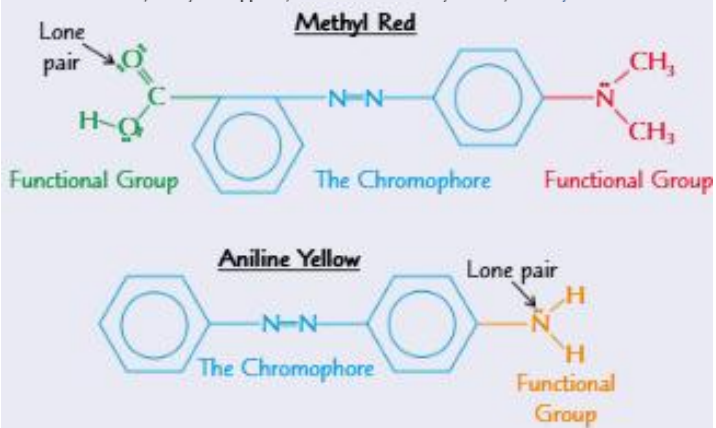
CD.a-n - Colour by design | CD1-11 |

CD.Q Exam questions from past papers

<p>(c) A synthesis of benzocaine occurs in several stages.</p> <p>A first step involves the conversion of benzene into methylbenzene as shown in the equation below:</p> $\text{C}_6\text{H}_6 + \text{CH}_3\text{Cl} \rightarrow \text{C}_6\text{H}_5\text{CH}_3 + \text{HCl}$ <p>The benzene is heated with chloromethane and aluminium(III) chloride as a catalyst in anhydrous conditions.</p> <p>(i) Explain why this reaction must be carried out in anhydrous conditions.</p> <p>..... [1]</p> <p>Explain why this reaction must be carried out in anhydrous conditions?</p>	<p>The aluminium(III) chloride reacts (vigorously) with water ✓</p> <p>The aluminium (III) chloride reacts vigorously with water</p>
<p>24 A pure sample of fat was known to be a triester of propane-1,2,3-triol with a fatty acid.</p> <p>0.15 mol of the fat required 10.8 dm³ of hydrogen at room temperature and pressure for complete hydrogenation.</p> <p>Identify which fatty acid formed the triester.</p> <p>A Palmitic acid, C₁₅H₃₁COOH</p> <p>B Linoleic acid, C₁₇H₃₃COOH</p> <p>C Oleic acid, C₁₇H₃₃COOH</p> <p>D Stearic acid, C₁₇H₃₅COOH</p> <p>Your answer <input type="checkbox"/></p> <p>0.15 mol of fat required 10.8dm³ of hydrogen at room temperature and pressure for complete hydrogenation</p> <p>Identify which fatty acid formed the triester</p>	<p>3. A pure sample of fat was known to be a triester of propane-1, 2, 3-triol with a fatty acid.</p> <p>0.15 mol of the fat required 10.8 dm³ of hydrogen at room temperature and pressure for complete hydrogenation.</p> <p>Identify which fatty acid formed the triester.</p> <p>A. Palmitic acid, C₁₅H₃₁COOH B. Linoleic acid, C₁₇H₃₃COOH C. Oleic acid, C₁₇H₃₃COOH D. Stearic acid, C₁₇H₃₅COOH</p> <p>Handwritten notes: C₁₅H₃₁ ← alkane, C₁₇H₃₃ ← alkene, C₁₇H₃₅ ← alkane, C₁₇H₃₃ ← alkene. Also: 19/100 COOH + 3H</p> <p>Your answer <input checked="" type="checkbox"/> A <input checked="" type="checkbox"/> C</p> <p>10.8 ÷ 24 = 0.45 mol</p> <p>C_nH_{2n} C_nH_{2n+2}</p> <ul style="list-style-type: none"> C as when the COOH group is replaced with H it would be an alkene
<p>Explain why compounds with an aromatic ring usually form substituted derivatives, rather than addition compounds? (1)</p> <p>(b) Explain why compounds with an aromatic ring usually form substituted derivatives, rather than addition compounds.</p> <p>..... [2]</p>	<p>(aromatic compounds have) delocalised electrons that are lost on addition AND retained on substitution ✓ (loss of delocalisation causes) less stability AW ✓</p> <ul style="list-style-type: none"> Aromatic compounds have delocalised electrons that are lost on addition AND retained on substitution (1) Less delocalisation causes less stability (1)

CD.a-b - Bonding & Structure | CD5 | CD6 |

Define Colorfast dye?	A dye that doesn't wash out easily
What are the 4 different ways dyes attach	<ul style="list-style-type: none"> Ionic bonds (between dyes and nylon, wool or

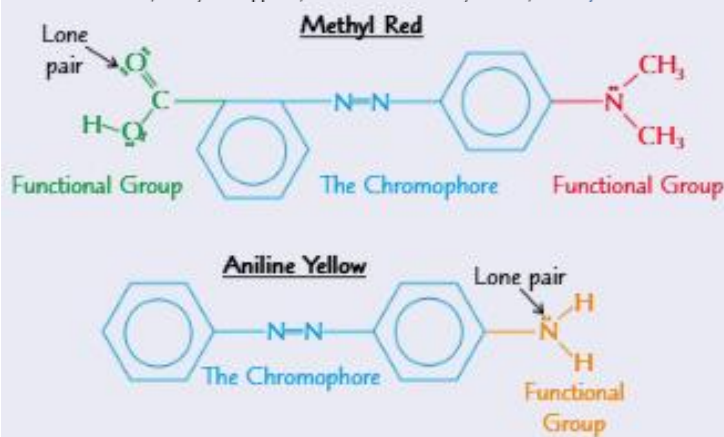
<p>themselves to fibres?</p>	<p>silk)</p> <ul style="list-style-type: none"> • Covalent bonds (between dyes and cotton, cellulose) • Hydrogen bonds (between dyes and cotton) • Id-id bonds (dyes and polyesters) <p><i>Mordanting as well in the textbook never seen it in past paper though</i></p>
<p>What are the ways in which dyes bond to fibres and the functional groups to which this occurs?</p>	<ul style="list-style-type: none"> • Ionic bonds via -COOH or -SO₃H group on a dye and a -NH₂ group in fibres (fibres such as wool, silk or nylon) • Strong covalent bonds forming via fibre-reactive dyes bonding with -OH or -NH group in the fibre (cotton, cellulose) • Hydrogen bonds via -NH₂ groups on a dye and a -OH group on a fibre (cellulose fibres such as cotton, rayon or linen) • Dissociation of ionic groups then forming ionic bonds via dyes having -SO₃⁻Na⁺ and dissociating in water to produce -SO₃⁻ group and then -NH₂ group on the fibre (nylon, wool silk) which in the presence of an acid produces -NH₃⁺ which then -SO₃⁻ binds with -NH₃⁺ • Acidic conditions (i.e in a weak acid) could also mean -NH₂ groups become protonated and turn into -NH₃⁺ on either dye or fibres <p><i>All of these are types of examples for which a dye could bond to a fibre it does not represent all the ways so make sure to interpret a question carefully bestie</i></p>
<p>Define Chromophore?</p>	<p>A part of a molecule that is responsible for the colour of a substance</p> <p><i>It does this by changing the wavelength the electrons absorb and they usually contain: double or triple bonds like C=C or N=N, lone pair of electrons or benzene rings</i></p> <p>The structures of the azo dyes methyl red (in acidic conditions) and aniline yellow are shown below. In the forms shown, methyl red appears, err... red and aniline yellow is, well... yellow.</p> 
<p>Which atoms as part of the functional group</p>	<ul style="list-style-type: none"> • Oxygen and Nitrogen atoms lone pair of

on the chromophore/azo dye changes the colour of the azo dye and why?

electrons (mostly likely from an -OH or NH₂ group)

- As these groups have lone pair of electrons that become part of the extended system of delocalised electrons that spans between the two benzene rings and the -N=N- group
- They change the frequency of light they absorb and so the colour of the molecule

The structures of the azo dyes **methyl red** (in acidic conditions) and **aniline yellow** are shown below. In the forms shown, methyl red appears, err... **red** and aniline yellow is, well... **yellow**.



Which functional groups on the chromophore affect the solubility of the dye AND what is the name of that functional group (1)

- Usually ionic groups such as SO₃⁻ (usually in the form of its sodium salt e.g. -SO₃⁻Na⁺)
- As the SO₃⁻ group can form ion-dipoles with water molecules which is stronger than hydrogen bonds from an -OH or -NH₂ group
- SO₃⁻ is a **sulfonate group (1)**

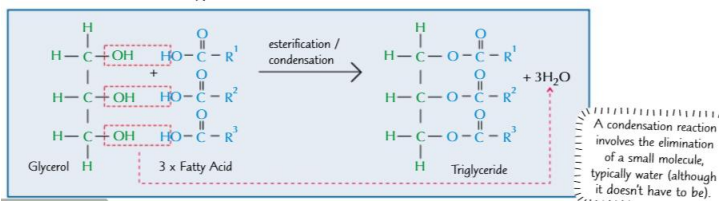
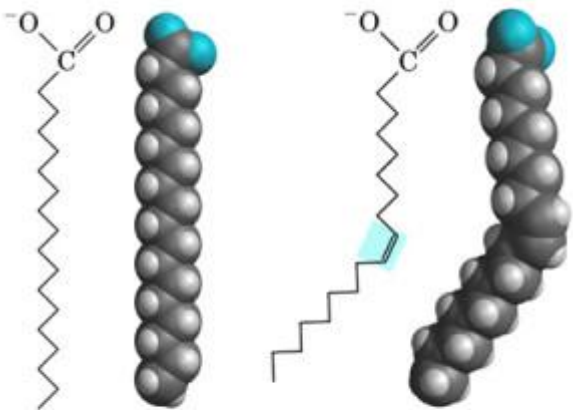
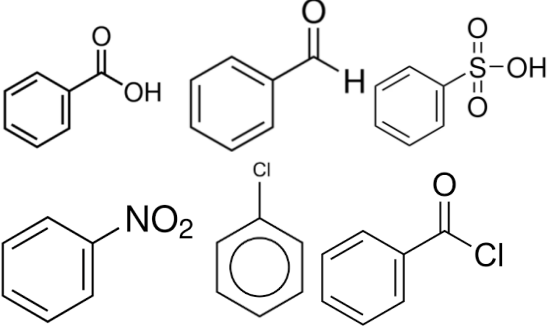


CD.c-f - Organic functional groups | CD2 | CD3 | CD4 | CD7 | CD10 |

What are triglycerides?

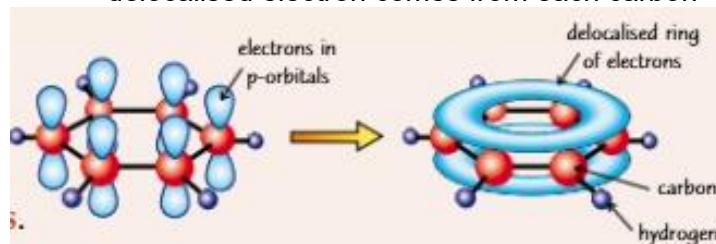
They are **triesters** of glycerol (propane-1,2,3-triol) and (unsaturated or saturated) fatty **acids**

They usually ask about condensation or hydrolysis reactions to do with these, make sure to balance the equations correctly and a long chain group might be

	<p>represented using <i>R</i> e.g RCOOH or K^+ e.g KOH</p> 
<p>How does a fatty acid/ triglyceride(triester) being unsaturated affect its melting point</p>	<p>The melting point would be lower as the fatty acid would do E/Z isomerism and so would have a 'kink' in the chain which pushes the chains apart allowing for less id-id bonds to form</p>  <p style="text-align: center;">Saturated Unsaturated</p>
<p>What are the names for these 6 arenes?</p> 	<ul style="list-style-type: none"> • Benzoic acid • Benzaldehyde • Benzene sulfonic acid • Nitrobenzene • Chlorobenzene • Benzoyl chloride

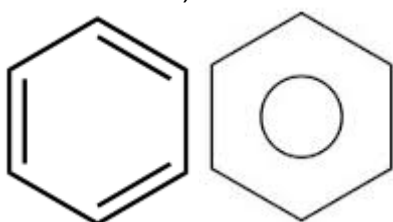
What does the actual structure for benzene look like? (2)

- 2 rings of 6 delocalised electrons (1) above and below the ring of carbon atoms (1) where 1 delocalised electron comes from each carbon



The pi ring or the sideways overlapping of the 6 p orbitals means low electron density therefore benzene is unable to polarise many molecules requiring catalysts

What was wrong with Kekule's benzene structure and why is the current/actual benzene structure correct? (4 reasons for each structure)



Kekule's Structure

- Not hexagonal
- Should undergo electrophilic addition as it has C=C bonds
- It would decolourise bromine water
- Enthalpy change of hydration should be -360 kJ/mol as its -120 per double bond $\times 3$
- Bond lengths would not be the same (*as C=C is shorter than C-C therefore 3 short bonds 3 longer ones*)
- *There would have been 2 isomers if Kekulé's*

Benzene structure

- Hexagonal
- All bonds same length
- Actually undergoes electrophilic substitution reactions (as it keeps more stable delocalised structure)
- 2 rings of delocalised electrons above and below the carbon atoms
- Each atom in the ring contains 1 lone electron (delocalised electron)
- Enthalpy change of hydration is actually -208 kJ mol^{-1}
- Actual benzene has 1 isomer
- Energetics suggest actual benzene would be more stable than Kekulé's
- *Its electron density maps*
- *Actual benzene needs 'forcing' conditions to undergo addition*


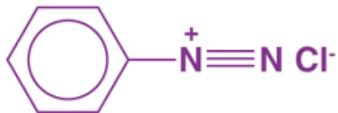
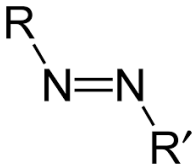

Don't talk about bond angles as they are the same 120° for both structures

Italics are fine details

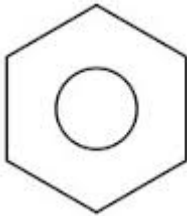
Based of H433 Paper 3 June 2023 6 marker

Functional group of diazonium salt and draw benzenediazonium chloride?

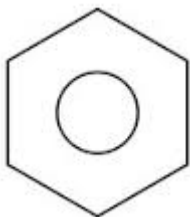
- Functional group

	 <ul style="list-style-type: none"> Benzenediazonium chloride 
Functional group of azo dye?	<ul style="list-style-type: none"> Functional group  <p><i>Usually two or more benzene rings on either R group as dyes are coloured and more than 1 benzene ring is needed for an extended system of delocalised electrons to be coloured</i></p>
Functional group of Nitrile and why is forming them via nucleophilic substitution often useful	<ul style="list-style-type: none"> Functional group  <p>It's useful as it creates an extra carbon along the organic chain</p> <p><i>Usually related to nucleophilic addition or substitution</i></p>

CD.g-j - Organic Reactions | CD4 | CD5 | CD9 | CD10 | CD11 |

<p>What are the conditions, reagents, products and the equation for the formation of electrophile for the chlorination of benzene?</p> 	<ul style="list-style-type: none"> Conditions: Anhydrous, Heating under reflux Reagents: Cl_2 and AlCl_3 as a catalyst 1. The halogen carrier (AlCl_3) polarises the chlorine allowing it to react with the halogen carrier to form a positive electrophile $\text{AlCl}_3 + \text{Cl}_2 \rightarrow \text{AlCl}_4^- + \text{Cl}^+$ 2. React the electrophile with the benzene Products: Chlorobenzene, HCl <p><i>A positive electrophile has to be formed because benzene isn't very polarising</i></p> <p><i>Mechanism: Electrophilic Substitution</i></p>
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What are the conditions, reagents, products and the equation for the formation of electrophile for the bromination of benzene?

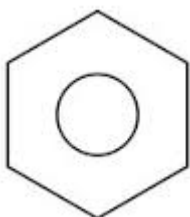


- Conditions: Anhydrous, Heating under reflux
- Reagents: Br_2 and FeBr_3 as a catalyst
- 1. The halogen carrier (FeBr_3) polarises the bromine allowing it to react with the halogen carrier to form a positive electrophile
- $\text{FeBr}_3 + \text{Br}_2 \rightarrow \text{FeBr}_4^- + \text{Br}^+$
- 2. React the electrophile with the benzene
- Products: Bromobenzene, HBr

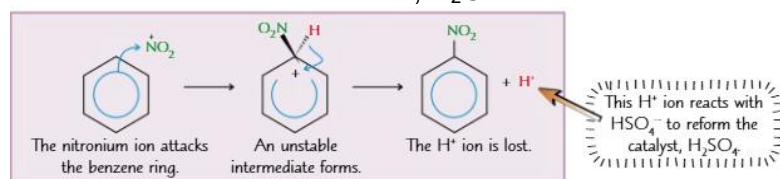
A positive electrophile has to be formed because benzene isn't very polarising

Mechanism: Electrophilic Substitution

What are the conditions, reagents, products and the equation for the formation of electrophile for the nitration of benzene?



- Conditions: below 55°C
- Reagents: Conc HNO_3 , conc H_2SO_4
- 1. Formation of the electrophile nitronium ion
- Overall: $\text{H}_2\text{SO}_4 + \text{HNO}_3 \rightarrow \text{HSO}_4^- + \text{NO}_2^+ + \text{H}_2\text{O}$
- 2. React nitronium ion with benzene...
- Products: Nitrobenzene, H_2O

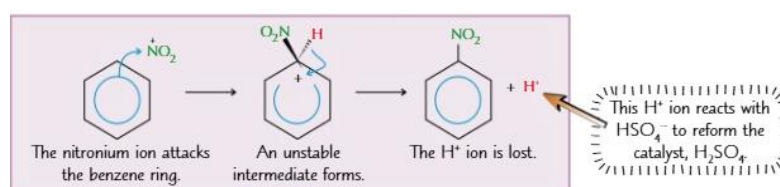
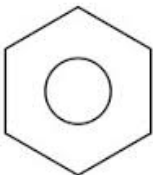


The catalyst H_2SO_4 has reformed. You need concentrated conditions

Perform within a water bath as reaction is exothermic. Any temperature too high will lead to polynitration rather than mononitration

Mechanism: Electrophilic Substitution

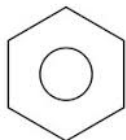
Draw the mechanism for the nitration of benzene



Reagents: Conc HNO_3 , conc H_2SO_4

Overall: $\text{H}_2\text{SO}_4 + \text{HNO}_3 \rightarrow \text{HSO}_4^- + \text{NO}_2^+ + \text{H}_2\text{O}$

What are the conditions, reagents, products and the equation for the formation of electrophile for the sulfonation of benzene?

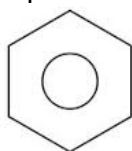


- Conditions: Heating under reflux
- Reagents: Concentrated H_2SO_4
- 1. Formation of the electrophile sulfonate (sulfur trioxide)
- $\text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{O} + \text{SO}_3$
- Products: Benzenesulfonic acid, H_2O

Reagents and conditions could also be fuming sulfuric acid and 40°C instead

Mechanism: Electrophilic Substitution

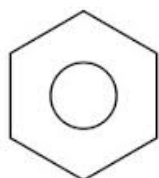
What are the conditions, reagents and products for Friedel-Crafts alkylation of benzene as well as the equation for the formation of the electrophile?



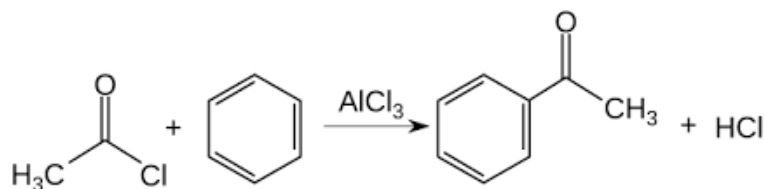
- Conditions: Anhydrous, heating under reflux
- Reagents: AlCl_3 (halogen carrier), CH_3Cl
- Formation of Electrophile: $\text{CH}_3\text{Cl} + \text{AlCl}_3 \rightarrow \text{CH}_3^+ + \text{AlCl}_4^-$
- Products: Methylbenzene, HCl

Mechanism: Electrophilic substitution

What are the conditions and reagents for Friedel-Crafts acylation of benzene as well as the equation for the formation of the electrophile?



- Conditions: Anhydrous
- Reagents: CH_3COCl and AlCl_3
- Formation of Electrophile: $\text{CH}_3\text{COCl} + \text{AlCl}_3 \rightarrow [\text{CH}_3\text{CO}]^+ + [\text{AlCl}_4]^-$



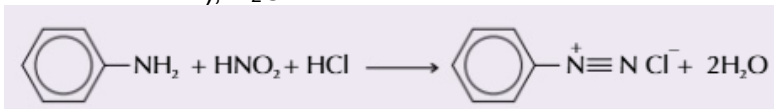
Names of products for acylation is not required for our spec

Mechanism: Electrophilic substitution

What are the conditions, reagents, products for diazotisation of aminobenzene?



- Conditions: below 5°C (ice cold)
- Reagents: Aminobenzene, HNO_2 (or NaNO_2), HCl
- Products: diazonium salt (Benzenediazonium chloride), H_2O

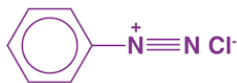


If NaNO_2 is used instead of HNO_2 products would be diazonium salt, NaCl and H_2O just check that the equation is balanced and if the reagents are in excess

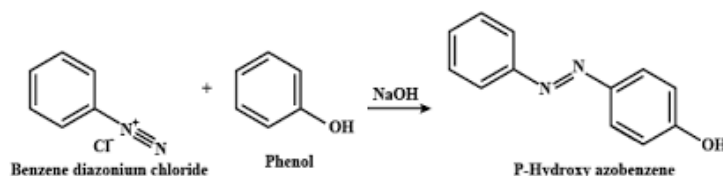
Diazotisation needs to be kept separate from a coupling reaction as diazotisation requires acidic conditions and coupling requires alkaline conditions.

Mechanism: Electrophilic substitution

What are the conditions, reagents, products and coupling agent for the coupling reaction for making an azo dye?



- Conditions: below 5°C (ice cold)
- Reagents: NaOH, diazonium salt (Benzenediazonium chloride)
- Coupling agent: E.g phenol (could also be considered to be another reagent)
- Products: azo dye, HCl



Don't ever forget that it needs to be in alkaline conditions

*An Asterisk * is OFTEN used to show where a coupling agent would most likely bond to reagent; don't assume it could bond on any part of the benzene ring. Sometimes but not always if the coupling agent is e.g. phenol then it would bond on the opposite side of 1 benzene ring to the -OH bond as shown above*

Diazotisation needs to be kept separate from a coupling reaction as diazotisation requires acidic conditions and coupling requires alkaline conditions.

You don't need to know how to name azo dyes so relax

Mechanism: Electrophilic substitution

What are the reagents, and conditions for forming carboxylic acids from aldehydes?

- Acidified potassium dichromate (VI) (ADP)
- Heating under reflux

What are the 3 laboratory tests that could be done to distinguish between an aldehyde and a ketone and what is observed for each? (2)

- Warm with acidified potassium dichromate (1) turns from orange to green (1)
- Warm with Tollen's reagent (1) turns from colourless to a silver mirror (1)
- Warm with Fehling's solution (1) solution turns from blue to a red/orange ppt (1)

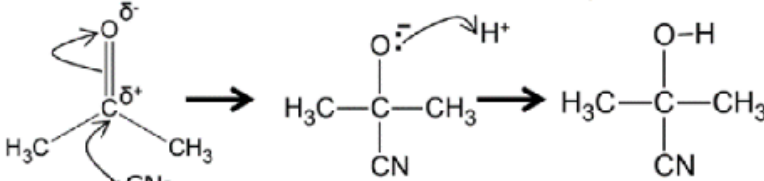
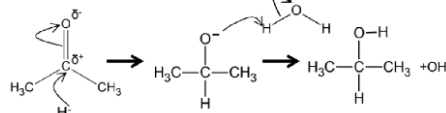
In all 3 cases the aldehyde is being oxidised to make a carboxylic acid ketone would never be oxidised

The word 'Warm' is a necessity

*Tollen's reagent is also known as ammoniacal silver nitrate
Benedict's reagent can be said/used instead of Fehling's solution*

How can carbonyls (ketones/aldehydes) become hydroxynitriles with reagents and conditions and what is the name of the functional group formed in the product (1) ?

- Reagents: HCN
- Conditions: RTP
- Cyanohydrin (1)

	 <p>H⁺ ion from HCN</p> <p><i>Cyanohydrin and hydroxynitrile are both names for the functional group</i></p> <p><i>HCN is highly toxic</i></p> <p><i>Mechanism Nucleophilic Addition</i></p>
<p>What are the reagents, conditions, products and type of reaction for forming nitriles from haloalkanes? E.g. HBr</p> <p><i>[Its on the data sheet]</i></p>	<ul style="list-style-type: none"> • Conditions: Heating under reflux • Reagents: NaCN, ethanol • Products: nitrile, NaBr • Type of reaction: Nucleophilic substitution <p>1 $\text{R-Br} + \text{CN}^- \longrightarrow \text{R-CN} + \text{Br}^-$</p> <p><i>IT'S ON THE DATA SHEET</i></p>
<p>How are carboxylic acids formed from nitriles (Conditions, reagents, type of reaction)</p> <p><i>[Its on the data sheet]</i></p>	<ul style="list-style-type: none"> • Conditions: Heating under reflux • Reagents: HCl • Type of reaction: Hydrolysis <p>2 $\text{R-CN} \xrightarrow[\text{reflux}]{\text{H}^+ (\text{aq})} \text{R-COOH}$</p> <div style="background-color: #e6f2ff; padding: 10px; margin-top: 10px;"> <p> $\text{R-CH}_2\text{-C}\equiv\text{N} + 2\text{H}_2\text{O} + \text{HCl} \longrightarrow \text{R-CH}_2\text{-C}\begin{matrix} \text{O} \\ \parallel \\ \text{OH} \end{matrix} + \text{NH}_4\text{Cl}$ </p> <p style="text-align: center;"> nitrile carboxylic acid </p> <hr/> <p> $\text{R}\begin{matrix} \text{O-H} \\ \\ \text{C} \\ \\ \text{C}\equiv\text{N} \end{matrix} + 2\text{H}_2\text{O} + \text{HCl} \longrightarrow \text{R}\begin{matrix} \text{O-H} \\ \\ \text{C} \\ \\ \text{C=O} \\ \\ \text{OH} \end{matrix} + \text{NH}_4\text{Cl}$ </p> <p style="text-align: center;"> hydroxynitrile 2-hydroxycarboxylic acid </p> </div> <p><i>IT'S ON THE DATA SHEET</i></p>
<p>How are carbonyls reduced to alcohols? (reagents and type of reaction)</p> <p><i>[Its on the data sheet]</i></p>	<ul style="list-style-type: none"> • NaBH₄ • Reduction  <p><i>IT'S ON THE DATA SHEET</i></p> <p>3 $\text{R}\begin{matrix} \text{R} \\ \\ \text{C=O} \\ \\ \text{R}' \end{matrix} \xrightarrow{\text{NaBH}_4} \text{R}\begin{matrix} \text{R} \\ \\ \text{CH-OH} \\ \\ \text{R}' \end{matrix}$</p>
<p>How are acyl chlorides formed from carboxylic acids (catalyst, conditions, type of reaction)</p>	<ul style="list-style-type: none"> • By reacting Carboxylic acid with SOCl₂ • RTP

[Its on the data sheet]

- Type of reaction: substitution
- $\text{CH}_3\text{COOH} + \text{SOCl}_2 \rightarrow \text{CH}_3\text{COCl} + \text{SO}_2 + \text{HCl}$

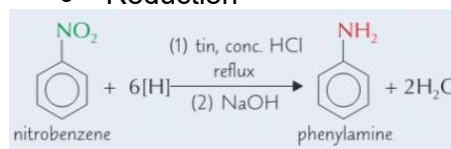


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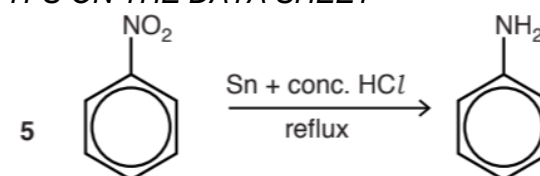
How is aminobenzene formed from nitrobenzene?
(reagents, conditions and type of reaction)

[Its on the data sheet]

- Sn and conc H_2SO_4
- Heat under reflux
- Reduction



IT'S ON THE DATA SHEET



What are the reagents, conditions and products for forming haloalkanes from alcohols (e.g ethanol and HBr)?

- NaBr, conc H_2SO_4
- Heating under reflux
- Haloalkane + H_2O

Occurs via:

- $\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$
- E.g $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

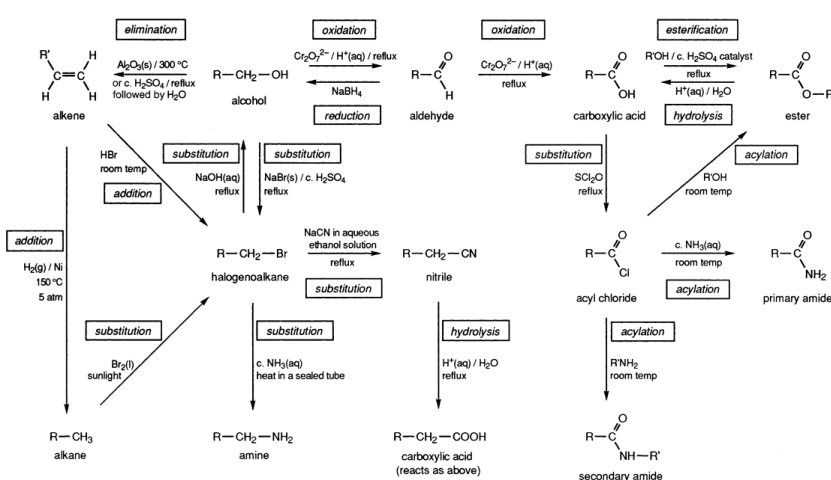
Mechanism: Nucleophilic substitution

What are the reagents, conditions, products and type of reaction for forming amines from haloalkanes? E.g R-Br

- Conditions: Heat in a sealed tube
- Reagents: NH_3 , ethanol
- Products: R-amine, HBr
- Type of reaction: Nucleophilic substitution

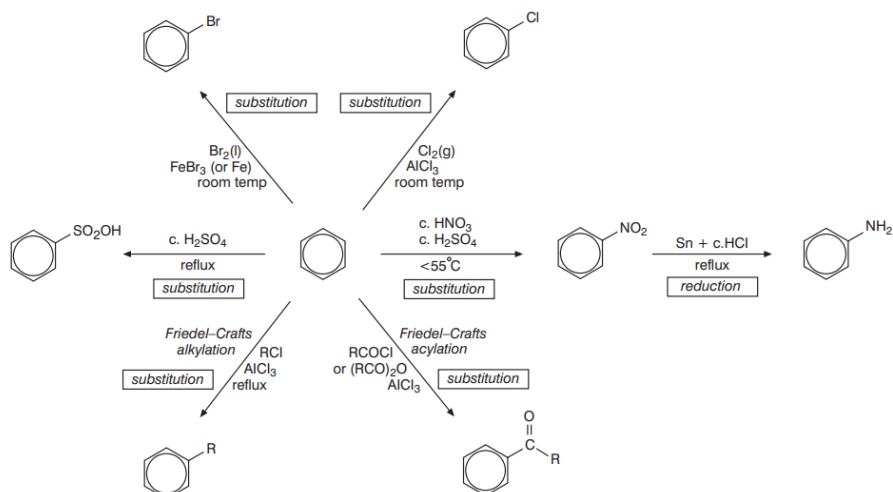
The toolkit: Chart A

A2 LEVEL



- Notes
1. The formation of a nitrile from a halogenoalkane is a carbon-carbon bond forming reaction. The carboxylic acid formed from the nitrile has an extra carbon atom in the side-chain. All the other reactions are simple functional group interconversions.
 2. The halogenoalkane shown will only be a minor product of the reaction from the alkene. The main product will be the isomer with the Br atom attached to the second carbon atom.
 3. Students may wish to add other reactions to this toolkit, for example the formation of a secondary alcohol from an alkene RCH=CHR' and thence oxidation to a ketone.

The toolkit: Chart B



- Notes
1. The Friedel-Crafts reactions are carbon-carbon bond forming reactions.
 2. All the substitution reactions of arenes are *electrophilic*.

Functional group	Test	Observation	Notes
alkene	Shake with bromine water or bromine water.	Red-brown colour of bromine decolourises.	
haloalkane	Warm with $\text{NaOH}(\text{aq})$, then acidify and add $\text{AgNO}_3(\text{aq})$.	Precipitate forms.	A white precipitate indicates chlorine. A cream precipitate indicates bromine. A yellow precipitate indicates iodine.
alcohol	Warm with acidified potassium dichromate(VI).	Colour change from orange to green.	Not for tertiary alcohols. Aldehydes also give this reaction.
aldehydes	Add Fehling's solution and warm. or Add Tollens' reagent and warm.	Change from blue solution to red precipitate. Silver mirror forms.	
phenol	Add iron(III) chloride.	Purple colour forms.	
carboxylic acid	Add sodium carbonate solution.	Bubbles of gas formed.	Also for any phenolic OH.

▼ Table 1 (continued)

Functional group	Structure	Typical properties of the functional group	Topic reference
esters	$R-COOR$	Hydrolysed to carboxylic acids and alcohols.	PL 3
amides	$R-CONH_2$, $R-CONHR$, etc.	Hydrolysed to carboxylic acid and ammonia.	PL 3
acyl chlorides and acid anhydrides	$R-COCl$ $(RCO)_2O$	Esterification with alcohols and phenols. Amide formation with amines.	WM 2, PL 1 PL 2
amines	$R-NH_2$, $R-NH-R$, etc.	Act as nucleophiles in reactions with acyl chlorides. Act as bases.	PL 2
aldehydes and ketones	$R-CHO$ $R-CO-R$	Oxidised to carboxylic acids (aldehydes only). Addition reactions with HCN. Reduced to alcohols by $NaBH_4$.	CD 9 Data sheet
nitro groups	$R-NO_2$	Reduced to amines by Sn and conc HCl.	Data sheet
nitriles	$R-C\equiv N$	Hydrolysed to carboxylic acids by reflux with acids.	Data sheet

Type of reaction	Definition of reaction	Examples of functional groups that take part in this type of reaction	Topic reference
addition	Two molecules react together to form a single product.	alkenes	DF 6
elimination	A small molecule (such as water or HCl) is removed from a larger one, leaving an unsaturated molecule.	aldehydes and ketones	CD 9
		alcohols	WM 1
condensation	Two molecules react together to form a larger molecule, and a small molecule (such as water or HCl) is removed.	haloalkanes	WM, PL 1
		carboxylic acids and alcohols	PL 1, PL 2
substitution	One group of atoms takes the place of another.	acyl chlorides, alcohols and amines	OZ 8
		haloalkanes	OZ 8, WM 1
		alcohols (reacting with hydrogen halides)	OZ 3
oxidation	Oxygen atoms are gained and/or hydrogen atoms are lost.	alkanes and alkyl groups	WM 1
		alcohols	WM 1, CD 9
reduction	Oxygen atoms are lost and/or hydrogen atoms are gained.	aldehydes	CD 9
		aldehydes and ketones	CD 11
hydrolysis	Bonds are broken by the action of water (although OH^- may appear in the equation in base-catalysed reactions).	nitro groups	PL 1
		esters	PL 2
		amides/peptides	CD 9
		nitriles	OZ 8
		haloalkanes	

▼ **Table 1** A summary of the chemical behaviour of various functional groups and topic references to find out more

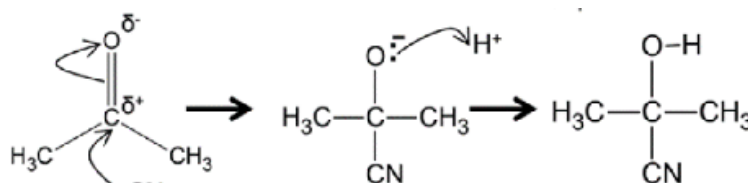
Functional group	Structure	Typical properties of the functional group	Topic reference
alkene	—C=C—	Addition reactions with electrophiles, including halogens, hydrogen halides, hydrogen, and water.	DF 6
haloalkanes	R—X (X = Cl, Br, etc.)	Substitution reactions with nucleophiles, including CN^- .	OZ 8 Data sheet
alcohols	R—OH	Oxidised to carbonyl compounds and/or carboxylic acids. Esterification reactions with carboxylic acids and acyl chlorides. Substitution reactions with nucleophiles (halides). Dehydrated to alkenes.	WM 1 WM 1 WM 1 WM 1
carboxylic acids	R—COOH	Weak acids. Esterification reactions with alcohols. Converted into acyl chlorides by SOCl_2 .	WM 2 WM 1 Data sheet
phenols	$\text{C}_6\text{H}_5\text{—OH}$	Weak acids. Esterification reaction with acyl chlorides and acid anhydrides.	WM 1 WM 2

Reactant	Product	Reagents	Reaction
Benzene	Methylbenzene / toluene	$\text{CH}_3\text{Cl} / \text{AlCl}_3$	Alkylation / Electrophilic substitution
Benzene	Bromobenzene	$\text{Br}_2 / \text{FeBr}_3$	Bromination / Electrophilic substitution
Benzene	Chlorobenzene	$\text{Cl}_2 / \text{AlCl}_3$	Chlorination / Electrophilic substitution
Benzene	Nitrobenzene	$\text{HNO}_3 / \text{H}_2\text{SO}_4$	Nitration / Electrophilic substitution
Nitrobenzene	Aminobenzene / phenylamine / aniline	Sn / HCl	Reduction
Aminobenzene	2,4,6-tribromoaminobenzene / 2,4,6-tribromoaniline	Bromine	Electrophilic substitution
Benzene	Phenylethanone	$\text{CH}_3\text{COCl} / \text{AlCl}_3$	Acylation / Electrophilic substitution
Phenylethanone	1-phenylethanol	NaBH_4	Reduction

Reactant	Product	Reagents	Reaction
Alkene	Haloalkane	Hydrogen halide	Electrophilic addition
Alkene	Alcohol	Steam + H_2SO_4 / heat	Hydration
Alkene	Alkane	Hydrogen + Ni catalyst / 150°C	Electrophilic addition / hydrogenation
Alcohol	Alkene	Al_2O_3 or conc. acid / heat	Elimination / dehydration
Alcohol	Haloalkane	$\text{NaX} + \text{H}_2\text{SO}_4$ / heat under reflux	Nucleophilic substitution
Haloalkane	Alcohol	NaOH (aq) / heat under reflux	Nucleophilic substitution
Alkane	Haloalkane	Halogen / UV light	Free radical substitution
Primary alcohol	Aldehyde	$\text{K}_2\text{Cr}_2\text{O}_7$ / H_2SO_4 / Distillation	Oxidation
Secondary alcohol	Ketone	$\text{K}_2\text{Cr}_2\text{O}_7$ / H_2SO_4 / Heat	Oxidation
Primary alcohol	Carboxylic acid	$\text{K}_2\text{Cr}_2\text{O}_7$ / H_2SO_4 / Heat under reflux	Oxidation
Aldehyde	Primary alcohol	NaBH_4 / H_2O	Reduction
Ketone	Secondary alcohol	NaBH_4 / H_2O	Reduction
Haloalkane	Nitrile	NaCN	Nucleophilic substitution
Haloalkane	Amine	NH_3 / ethanol	Nucleophilic substitution
Nitrile	Carboxylic acid	H_2O / HCl	Hydrolysis
Aldehyde	Hydroxynitrile	NaCN / H^+	Nucleophilic addition
Alcohol	Ester	Carboxylic acid / H_2SO_4	Esterification
Carboxylic acid	Ester	Alcohol / H_2SO_4	Esterification

CD.k-I - Reaction mechanisms | CD9 | CD11 |

What is the nucleophilic addition mechanism for the formation of a hydroxynitrile from propanone and HCN?



H⁺ ion from HCN

The negative charge is on the nitrogen

CD.m - Energy & Matter | CD1 |

What are the 3 pairs of complementary colours?

- Red and green
- Blue and orange
- Violet and yellow



So when a compound absorbs red wavelengths, it transmits (or reflects) the complementary colour green, and so green is what seen

Do not allow 'emit' light

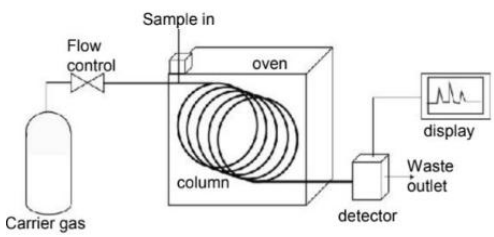
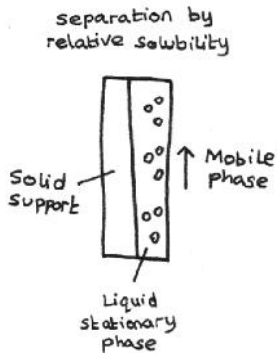
Explain why coloured compounds such as dyes are coloured and benzene is colourless (6) [Mr Harbage script]

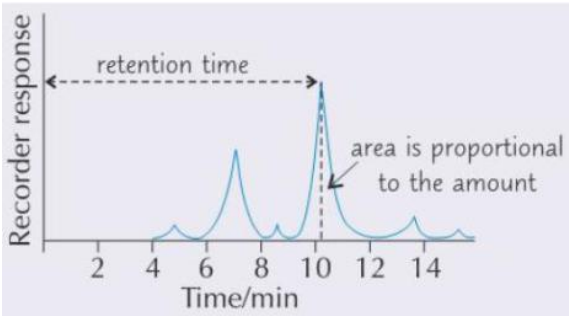
1. Electrons move to a higher energy level by absorbing EM radiation via $\Delta E = h\nu$ (2)
2. A dye would have a greater extended system of delocalised electrons (larger chromophore) and so energy levels are closer (as E is smaller) (2)
3. Energy absorbed is a lower frequency for dyes (in the VL region), and a complementary colour is transmitted (or reflected) (2)

1. Whilst benzene has less delocalisation (smaller chromophore), and energy levels are further apart (2)
2. Energy absorbed is high frequency (in the UV) (1)
3. Therefore, all visible light is transmitted (or reflected) (1)

	<ul style="list-style-type: none"> Remember frequency of UV radiation is higher than Visible light radiation [Please say this when comparing colourless and coloured compounds from F335 June 2015] <p><i>Do not allow 'emit' light AND do not allow $E=h\nu$</i></p>
What are the properties that dyes (coloured compounds) have compared to benzene (colourless)	<ul style="list-style-type: none"> Energy levels are closer as they absorb lower freq VL compared to UV More Conjugation A greater extended system of delocalised electrons Larger chromophore More than one benzene ring <p><i>More than one benzene ring - some Mark Schemes have it, some don't, your choice whether to say it</i></p>

CD.n - Modern analytical techniques | CD8 |

Describe the setup of gas-liquid chromatography (GLC)?	 <ul style="list-style-type: none"> Mobile phase is a mixture of gas Stationary phase is high b.p liquid coating the column
What does the column in GLC consist of? (2)	<ul style="list-style-type: none"> High boiling point liquid (1) on a porous support (1)
What are the 2 phases in GL chromatography?	<ul style="list-style-type: none"> Stationary phase - liquid on solid support (as in GLC) Mobile phase - gas (as in GLC) <p>separation by relative solubility</p> 
What is the nature of the stationary phase	<ul style="list-style-type: none"> High boiling point (1)

for GLC? (1)	<ul style="list-style-type: none">• Involatile (1)• Non-volatile liquid (1) <p><i>The stationary phase can also potentially contain solids</i></p>			
Name a suitable substance for the mobile phase for GLC (1) and the property it has (1)?	<ul style="list-style-type: none">• Nitrogen (as well as argon but any other named noble gas is NOT ALLOWED) (1)• Inert (I.e unreactive) (1) <table><tr><td>Nitrogen/N₂ ✓</td><td>1</td><td>ALLOW argon/Ar IGNORE other noble gases</td></tr></table> <p><i>It is also referred to as the carrier gas so look out for this name</i></p>	Nitrogen/N ₂ ✓	1	ALLOW argon/Ar IGNORE other noble gases
Nitrogen/N ₂ ✓	1	ALLOW argon/Ar IGNORE other noble gases		
How do you interpret a gas chromatogram?	 <ul style="list-style-type: none">• Time taken to pass via column / retention time is used to identify substance• Area under each peak is proportional to amount of substance (called peak integration value)• You would use a ruler to measure the amount of substance			
What 5 factors affect retention time? And why?	<ol style="list-style-type: none">1. Solubility - more soluble compounds will take longer to move via the tube as they would prefer the stationary phase -> higher RT2. Boiling point - a substance with a high boiling point will spend more time turning from a liquid to a gas -> higher RT3. Temperature - high temperature means more evaporated liquid as gas so moves quickly spending more time in the mobile phase -> shorter RT4. Volatility - a more volatile liquid would spend more time in the mobile phase than the stationary -> shorter RT5. Length of column - a longer column would mean longer retention time <p><i>When referring to temperature its the temperature of the column not of the substance</i></p> <p><i>These are some examples and so would not represent all the factors</i></p>			

What problems are there with GLC? Why?

Some substances won't separate since they have similar retention factors/retention times because they are structurally similar

It is often used alongside mass spectroscopy