Exam Papers Practice

20.1 Types of Organic Reactions

Mark Schemes

Course	DP IB Chemistry
Section	20. Organic Chemistry (HL only)
Topic	20.1 Types of Organic Reactions
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful

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The correct answer is **C** because:

- Tertiary halogenoalkanes favour nucleophilic substitution via the S_N1 mechanism
- Primary halogenoalkanes favour nucleophilic substitution via the S_N2 mechanism
- The C-Br bond is weaker than the C-C/bond
  - This is due to C/being smaller than Br, so there will be more attraction to the nucleus and less electron shielding
  - So the bond length will be shorter and thus be a stronger bond
  - Therefore, 1-bromobutane would react quicker than 1-chlorobutane

A & **D** are incorrect as	these are tertiary halogenoalkanes which react most readily via an S_N1 mechanism
B is incorrect as	the C-C/bond is stronger than the C-Br bond

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The correct answer is **B** because:

- The minor product of the reaction between but-1-ene and hydrogen bromide is 1-bromobutane
  $CH_3CH_2CH{=}CH_2 + HBr \rightarrow CH_3CH_2CH_2CH_2Br$
- 1-bromobutane will undergo nucleophilic substitution with the hydroxide ion to form butan-1-ol
  $CH_3CH_2CH_2CH_2Br + :OH^- \rightarrow CH_3CH_2CH_2CH_2OH + :Br^-$

A is incorrect as	the longest carbon chain (prop-) cannot react according to the reactions described to produce an organic compound with 4 carbons
C is incorrect as	the reaction of but-2-ene with hydrogen bromide produces only one product -, there is no minor product
D is incorrect as	the minor product of pent-1-ene with hydrogen bromide is 1-bromopentane

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The correct answer is **D** because:

- Aluminium chloride, $AlCl_3$, is not required in nitration of the benzene ring
- The $AlCl_3$ reacts with an acyl chloride or chloroalkane to produce the electrophile and the $AlCl_4^-$ ion
- The overall reaction is:

$$C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O$$

- The sulfuric acid acts as a catalyst in this reaction and is regenerated
- The substituted proton from the benzene ring combines with HSO_4^- to form H_2SO_4
    - $HSO_4^- + H^+ \rightarrow H_2SO_4$

A is incorrect as	the formation of the electrophile, NO_2^+, occurs by the reaction of concentrated nitric acid and concentrated sulfuric acid $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ In this reaction the HNO_3 acts as a proton acceptor / Brønsted-Lowry base
B is incorrect as	the nitronium ion, NO_2^+, acts as the electrophile in this reaction. The mechanism is electrophilic substitution.
C is incorrect as	the reaction to form the nitronium ion, NO_2^+, produces HSO_4^- The sulfuric acid acts as a proton donor / Brønsted-Lowry acid $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$

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The correct answer is **C** because:

- Butanone is a ketone and undergoes reduction when heated under reflux with a reducing agent such as $NaBH_4$ or $LiAlH_4$ to form a secondary alcohol
  - In this case, the product will be butan-2-ol, $CH_3CHOHCH_2CH_3$
- The equation for this reaction is:
  - $CH_3CH_2COCH_3 + 2[H] \rightarrow CH_3CH_2CH(OH)CH_3$

A is incorrect as	$CH_3CH_2CHCH_2$ is an alkene which is not a reduction product
B is incorrect as	$CH_3CH_2CH_2CH_2OH$ is a primary alcohol and would have been formed from the reduction of an aldehyde (butanal) with $NaBH_4$
D is incorrect as	$CH_3CH_2CH_2CHO$ is an aldehyde.

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The correct answer is **B** because:

- $C_6H_5CH_3$ contains hydrogen atoms which are not bonded to electronegative atoms so they cannot participate in hydrogen bonding
- A protic, polar solvent contains a hydrogen atom bonded to a very electronegative atom, oxygen, nitrogen or fluorine
- This allows them to participate in hydrogen bonding
- An aprotic, polar solvent does contain hydrogen atoms, but these are not bonded to the electronegative atoms oxygen, nitrogen or fluorine
- This means they can not participate in hydrogen bonding

A, C & **D** are incorrect as	these molecules are all protic solvents.