20.1 Types of Organic Reactions

Question Paper

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

Time allowed: 60

Score: /45

Percentage: /100

Question 1a

a)
Halogen molecules can react with alkenes to produce halogenoalkanes which contain two halogen atoms. Explain why halogen molecules can react with alkenes.

[2]

[2 marks]

Question 1b

b)
Outline the mechanism for the reaction between 1–methylcyclohex-1–ene and hydrogen bromide, HBr, to form the major product.

[3]

[3 marks]

Question 1c

c)
Explain why a major product and minor product are produced in the reaction outlined in part b).

[3]

[3 marks]

Question 1d

d)
The major product from the reaction of part b) forms an alcohol when reacted with water. Predict the type of mechanism for this reaction and the structure of the alcohol.

i)
State the type of mechanism that will occur.

[1]

ii)
Give the structure of the alcohol formed.

[1]

iii)
Explain why ethanol would be a suitable solvent for this reaction

[2]

[5 marks]

Question 2a

a)
$C_5H_{11}Cl$ is a chiral molecule.

Draw the three-dimensional shape of each enantiomer of this isomer showing their spatial relationship to each other.

[2]

[2 marks]

Question 2b

b)
One of these enantiomers undergoes alkaline hydrolysis and approximately 75 % of the product formed shows an inversion of configuration.

Outline the mechanism that causes approximately 100% of the inversion of configuration.

[3]

[3 marks]

Question 2c

c)
Explain why the inversion of configuration is 75%.

[2]

[2 marks]

Question 2d

d)
Explain what would happen to the rate of the mechanism in part b) if the concentration of alkali is doubled.

[1]

[1 mark]

Question 2e

e)
Comment on the rate if ammonia was reacted with $C_5H_{11}Cl$ compared to alkaline hydrolysis.

[2]

[2 marks]

Question 3a

a)
The theoretical molecule cyclohexa-1,3,5–triene reacts differently with bromine than benzene.

Benzene will react with bromine in the presence of aluminium bromide. Outline the mechanism for this reaction.

[3]

[3 marks]

Question 3b

b)
State the name of the mechanism that occurs during the reaction between cyclohexa-1,3,5–triene and bromine.

[1]

[1 mark]

Question 3c

c)
The nitration of benzene is the first important step in the manufacture of dyes and explosives.

i)
Outline the generation of the electrophile for the nitration of benzene by writing an equation.

[1]

ii)
Indicate in your equation which reactant is acting as a Brønsted Lowry base.

[1]

iii)
Explain your answer and identify the conjugate acid and base pairs in the reaction.

[1]

[3 marks]

Question 3d

d)
Phenylamine can be formed from nitrobenzene in two steps. The first step involves heating nitrobenzene in a water bath under reflux with a mixture of zinc and hydrochloric acid.

i)
Write a full redox equation for this first step.

[1]

ii)
Explain how phenylamine is formed in the second step of this reaction.

[2]

[3 marks]

Question 3e

e)
Explain why benzene can only undergo substitution reactions.

[3]

[3 marks]

Question 4a

a)
Aqueous sodium tetrahydridoborate, $NaBH_4$, is a common reducing agent.

State the IUPAC name of the two isomers with the formula C_3H_6O that can be reduced by aqueous $NaBH_4$.

[2]

[2 marks]

Question 4b

b)
State the IUPAC name of **two** non-cyclic isomers with the formula C_3H_6O that cannot be reduced by aqueous $NaBH_4$.

[2]

[2 marks]

Question 4c

c)
When $NaBH_4$ is used as a reducing agent followed by the addition of acid, the reduction products of ketones can exhibit optical isomerism, while the reduction products of aldehydes cannot.

i)
Classify the reduction products of aldehydes and ketones.

[2]

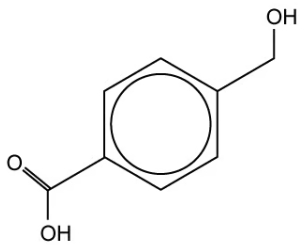
ii)
Explain why the reduction products of ketones can exhibit optical isomerism, while the reduction products of aldehydes cannot.

[2]

[4 marks]

Question 4d

d)
Deduce the structure when the following compound is reduced using $NaBH_4$.



[1 mark]