

Structured Questions

Electron Pair Sharing Reactions

Nucleophilic Substitution / Heterolytic Fission / Electrophilic Addition Reactions

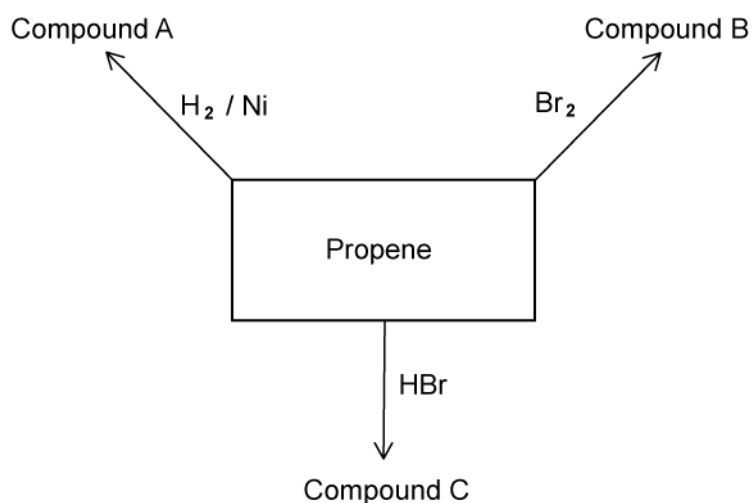
Easy (4 questions)	/34
Medium (6 questions)	/15
Hard (2 questions)	/14
Total Marks	/63

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Easy Questions

1 (a) A reaction scheme for propene is shown below.



State the condensed structural formula of propene.

.....
(1 mark)

(b) State the IUPAC names for compounds A, B and C shown in the reaction scheme in part (a)

.....
.....
.....
(3 marks)

(c) Propene will also react to form an alcohol. State the reagents and conditions required for the formation of an alcohol from propene.

.....
.....
(3 marks)

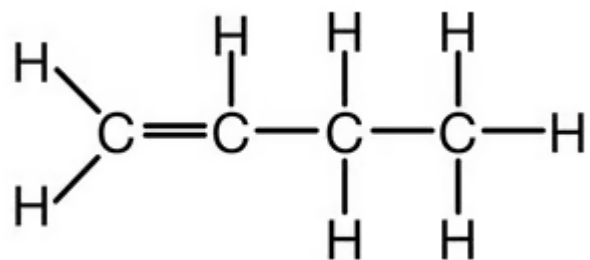
(d) State the colour change when compound B is formed from propene.

.....
(1 mark)

(e) Propene can form polypropene. Draw the repeating unit that will be formed via the addition polymerisation of propene.

.....
.....
(2 marks)

2 (a) The structure of but-1-ene is shown below.



Draw and state the name of the secondary halogenoalkane formed when but-1-ene reacts with HCl.

.....
.....
(2 marks)

(b) Explain why halogenoalkanes are more reactive than alkanes.

.....
.....
(2 marks)

(c) State the reagents and conditions required for the formation of propan-1-ol from 1-bromopropane.

.....
.....
.....
(3 marks)

(d) The type of reaction outlined in part (c) is *nucleophilic substitution*. State the meaning of the term *nucleophile*.

(1 mark)

3 (a) Define the term *nucleophile*.

.....

.....

(2 marks)

(b) Explain why the hydroxide ion, OH^- , is a stronger nucleophile than water.

.....

.....

(2 marks)

4 (a) Propan-1-ol can be synthesised from alkene P in the following synthetic route:



i) State the identity of halogenoalkane Q. [1]

ii) Give the reagents and conditions needed for Step 2. [2]

.....
.....
.....

(3 marks)

(b) Give the name and structure of alkene P.

.....
.....

(2 marks)

(c) Give a reagent that could be used to convert P to Q and outline why this synthesis of propan-1-ol might not be very efficient.

.....
.....
.....

(3 marks)

(d) This question is about alkene P and Step 1.

i) Give the empirical formula of P.

[1]

ii) Give the reagents and conditions needed for Step 1.

[2]

iii) State the type of reaction mechanism.

[1]

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.....

(4 marks)

Medium Questions

1 An aromatic organic compound with molecular formula C_7H_8 reacts with bromine in the presence of UV light to produce a compound with molecular formula C_7H_7

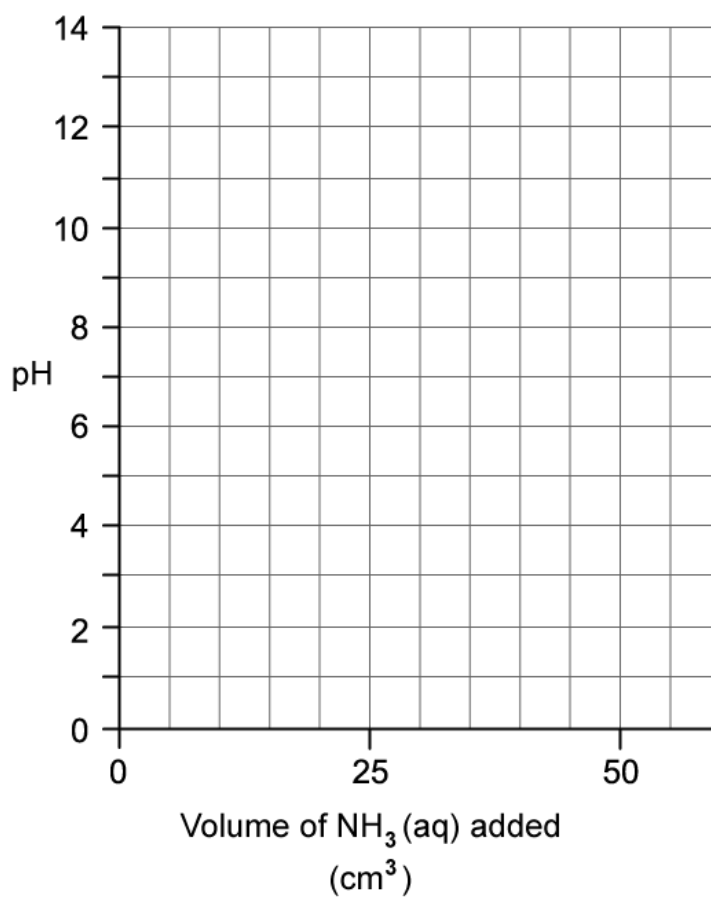
i) Name the type of reaction taking place. [1]

ii) Deduce the structures of the reactant and product. [1]

iii) Give the formula of an additional organic product that could be obtained in the reaction. [1]

(3 marks)

2 Sketch a graph to indicate the change in pH during a titration of 25.0 cm^3 of 0.100 mol dm^{-3} hydrochloric acid, $HCl(aq)$, with 0.100 mol of ammonia, $NH_3(aq)$.



(2 marks)

3 (a) The starting materials for many products are alkenes such as propene.

State the type of reaction that occurs when propene is converted into chloropropane.

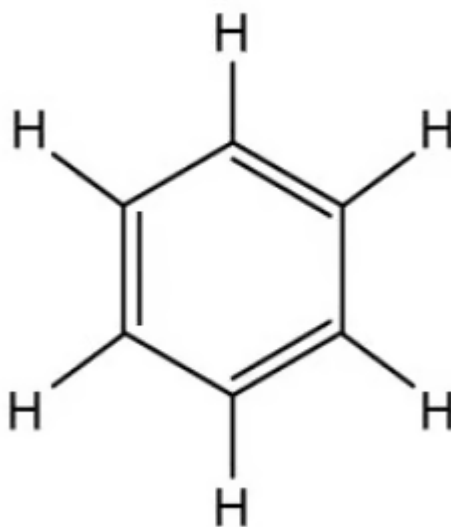
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(1 mark)

(b) Two possible isomeric products can be formed in the conversion of propene to chloropropane.

State the type of isomerism that is exhibited by these chloropropane products.

.....
(1 mark)

4 Kekulé proposed the following structure of benzene.



Discuss the physical and chemical evidence to suggest that the Kekulé structure of benzene is incorrect.

.....
.....
.....
(3 marks)

5 (a) Butan-1-ol can also be formed by the catalytic reduction of butanal. State the reagents for this reduction to occur

.....
(1 mark)

(b) State the reagent required to reduce butanoic acid to butan-1-ol.

.....
(1 mark)

(c) Using your answer to (b), write the equation for the reduction reaction of butanoic acid.

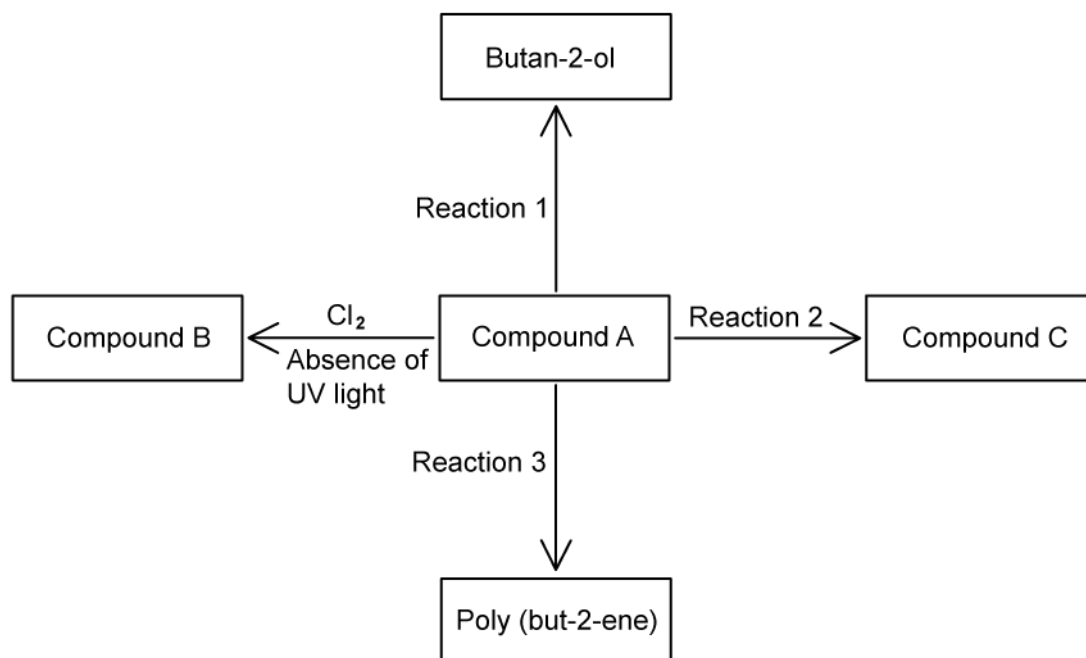
.....
(1 mark)

6 1-bromobutane and 2-bromo-2-methylpropane are isomers. State the type of structural isomerism that they exhibit, explaining your reasoning.

.....
.....
(2 marks)

Hard Questions

1 (a) The following scheme shows reactions of Compound **A**.



i) Deduce the structural formula of compound **A**.

[1]

ii) Apply IUPAC rules to name compound **B**.

[1]

(2 marks)

(b) Reaction 1 forms an alcohol when reacted with concentrated sulfuric acid, H_2SO_4 and steam.

i) State the conditions required for this reaction. [1]

ii) Deduce the structure of the intermediate in this reaction. [1]

.....
.....

(2 marks)

(c) Butan-2-ol can also be directly formed from a halogenoalkane.

i) State the name of the type of reaction occurring in this conversation. [2]

ii) State the conditions for this reaction. [1]

.....
.....

.....
(3 marks)

(d) Identify the structure of the repeating unit of poly(but-2-ene).

.....
(1 mark)

(e) Compound A reacts with hydrogen bromide to form compound C. A student suggested a possible formula of compound C is $\text{CH}_2(\text{Br})\text{CH}_2\text{CH}_2\text{CH}_3$.

State whether the student is correct and justify your answer.

(1 mark)

2 (a) A complex of cobalt has the following composition by mass:

Co, 21.98%; N, 31.35%; H, 6.81%; Cl, 39.86%

i) Calculate the empirical formula of this complex. [2]

ii) The formula of this cobalt complex can be expressed in the form $[\text{Co}(\text{L})_m]^{x+}(\text{Cl}^-)_n$. Suggest the chemical formula of $[\text{Co}(\text{L})_m]^{x+}$. [1]

(3 marks)

(b) Nickel(II) forms a complex ion with water, $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$

i) Outline how the bond is formed between Ni^{2+} and H_2O during the formation of the complex. [1]

ii) State the geometry of the complex formed. [1]

(2 marks)