

Q1. (a) Dichloromethane, CH_2Cl_2 , is one of the products formed when chloromethane, CH_3Cl , reacts with chlorine.

(i) Name the type of mechanism involved in this reaction and write an equation for each of the steps named below.

Name of type of mechanism

Initiation step

.....

First propagation step

.....

Second propagation step

.....

(ii) Write an overall equation for the formation of dichloromethane from chloromethane.

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(5)

(b) A compound contains 10.1% carbon and 89.9% chlorine by mass. Calculate the molecular formula of this compound, given that its relative molecular mass (M_r) is 237.0

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(3)

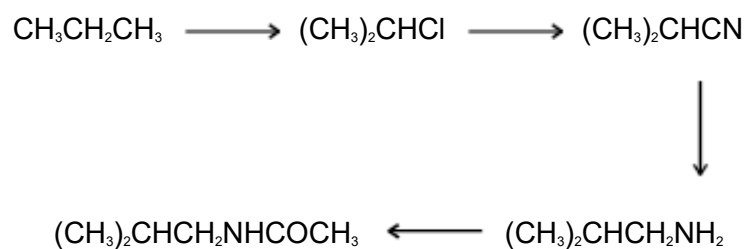
(c) Suggest the formulae of two bromine-containing organic compounds formed when dibromomethane, CH_2Br_2 , reacts with bromine.

Compound 1

Compound 2

(2)
(Total 10 marks)

Q2. Which one of the following types of reaction mechanism is **not** involved in the above sequence?



- A free-radical substitution
- B nucleophilic substitution
- C elimination
- D nucleophilic addition-elimination

(Total 1 mark)

Q3. When chlorine reacts with trichloromethane, tetrachloromethane, CCl_4 , is formed.

(a) (i) Write the overall equation for this reaction.

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(ii) State **one** essential condition for this reaction.

.....

(2)

(b) The mechanism for the chlorination of trichloromethane is free-radical substitution,

which proceeds by a series of steps. Write equations for the steps named below in this chlorination.

Initiation step

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First propagation step

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Second propagation step

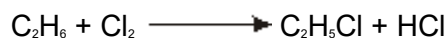
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A termination step

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(4)
(Total 6 marks)

- Q4.** Chlorination of ethane follows a free-radical substitution mechanism. This mechanism is similar to that which occurs when methane is chlorinated. The overall equation for the reaction of ethane to form chloroethane is given below.



State the conditions and outline a mechanism for this reaction. Show how butane can be formed in this reaction.

(Total 5 marks)

- Q5.** (a) Chloromethane can be made by the reaction of chlorine with methane.

(i) Give **one** essential condition for this reaction.

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(ii) Name the mechanism for this reaction.

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- (iii) Further substitution can occur during this reaction. Identify the main organic product when a large excess of chlorine is used in this reaction.

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(3)

- (b) Ethanenitrile can be made by reacting chloromethane with potassium cyanide.

- (i) Write an equation for this reaction.

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- (ii) Name the mechanism for this reaction.

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- (iii) Explain, in terms of bond enthalpies, why bromomethane reacts faster than chloromethane with potassium cyanide.

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(3)

- (c) Ethanenitrile can be hydrolysed to a carboxylic acid by heating it under reflux with a dilute acid. Identify the carboxylic acid formed in this reaction.

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(1)

- (d) Chloromethane can react with ammonia to produce a primary amine.

- (i) What feature of the chloromethane molecule makes it susceptible to attack by

an ammonia molecule?

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(ii) Name the amine produced in this reaction.

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(iii) Outline a mechanism for this reaction.

(6)
(Total 13 marks)

Q6. (a) Bromomethane, CH_3Br , can be formed by a reaction between bromine and methane.

The mechanism for this reaction is similar to the mechanism for the chlorination of methane.

(i) Name the mechanism for this reaction.

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- (ii) Give the name of, and state an essential condition for, the first step in the mechanism for this reaction.

Name

Essential condition

- (iii) Write an equation for a termination step in the mechanism for this reaction which gives ethane as a product.

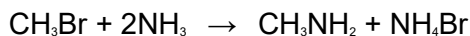
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- (iv) Bromomethane can undergo further substitution. Write an overall equation for the reaction between bromomethane and bromine in which dibromomethane is formed.

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(5)

- (b) Bromomethane reacts with the nucleophile ammonia according to the following equation.



- (i) Explain what is meant by the term *nucleophile*.

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.....

(ii) Name the organic product of this reaction.

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(iii) Outline a mechanism for this reaction.

(6)
(Total 11 marks)

Q7. The mechanism for the reaction of methane with fluorine is a free-radical substitution similar to the chlorination of methane.

(a) Outline the following steps in the mechanism for the reaction of methane with fluorine to form fluoromethane, CH_3F

Initiation step

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First propagation step

.....

Second propagation step

.....

A termination step

.....

(4)

- (b) Write an overall equation for the reaction of fluorine with fluoromethane to form tetrafluoromethane.

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(1)

(Total 5 marks)