

QER Examples

7. Halogenoalkanes are compounds in which one or more hydrogen atoms in an alkane have been replaced by halogen atoms. Halogenoalkanes have been known for centuries e.g. chloroethane was produced synthetically in the 15th century. Today they are widely used commercially; however many have also been shown to be serious pollutants.

- (a) Halogenoalkanes can be formed directly from alkanes and alkenes but the ease of formation differs greatly. Briefly outline and explain this difference by considering the types of reactions involved and the bonding in the hydrocarbons. [6 QER]

(No reaction mechanisms are required)

The halogenation of an alkene is an electrophilic addition as the halogen molecule is polarised and attacks the $C=C$ double bond as this is an area of high electron density.

The halogenation of an alkane is by free radical substitution in the presence of UV light. As the hydrogen-carbon bond is broken in this reaction and the $Cl-Cl$ bond it requires energy as there are strong covalent bonds that require energy from UV light to break although the $C=C$ in an alkene is bonded by strong sigma and pi bonds which require more energy to break, therefore halogenation of an alkene is more slow.

- (b) A compound is known to be either 1-chlorobutane or 1-iodobutane. Describe a test to show that the compound is 1-chlorobutane. Give any reagent(s) used and expected observation(s). [3]

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Halogenation of alkanes is free radical substitution but halogenation of alkenes is electrophilic addition. It needs ultraviolet for alkanes, but alkenes do not need. A mixed product will form from alkanes as the radicals can form together, then the reaction will stop. For alkenes, halogenoalkanes can be formed by reacting with halogen and hydrogen halide, the double bond is resulted in the electrophile, when using hydrogen halide, a mixed product can also form, primary/secondary halogenoalkane, but as the secondary carbocation is more stable, secondary halogenoalkane is more likely to form.

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Alkanes are very unreactive, as it is completely non-polar as it has no $C=C$ double bonds, while alkenes do. The $C=C$ double bond causes alkenes to be susceptible to attacks from electrophiles, as the dense cloud of electrons in the double bond repels electrons. The only way to form halogenoalkanes from alkanes is to use free radical substitution by a photochemical chain reaction. This process requires halogen free radicals to be formed from exposure to UV light. This rarely occurs naturally. However, halogenoalkanes can be formed by alkenes easily, as they can be attacked by halogens and hydrogen halides directly. Because these processes do not require UV light, they are more likely to occur naturally. As a result it is easier to form halogenoalkanes from alkenes compared with alkanes.

- (b) A compound is known to be either 1-chlorobutane or 1-iodobutane. Describe a test to show that the compound is 1-chlorobutane. Give any reagent(s) used and expected observation(s). [3]

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7.	(a)			Indicative content <ul style="list-style-type: none"> Alkenes react more readily than alkanes Alkanes react by radical substitution / photohalogenation Alkanes are unreactive since they contain strong σ-bonds only Alkenes react by electrophilic addition Alkenes contain σ-bonds and π-bonds π-bond is weaker than σ-bond so is easily broken π-bond gives region of high electron density 						
				5-6 marks Names both types of reaction and fully explains difference in reactivity <i>The candidate constructs a relevant, coherent and logically structured account including key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.</i> 3-4 marks Names at least one type of reaction and partially explains difference in reactivity <i>The candidate constructs a coherent account including many of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.</i> 1-2 marks Names type of reactions but gives no explanation or simply explains why alkenes are more reactive but does not name reaction types <i>The candidate attempts to link at least two relevant points from the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material. There is some evidence of appropriate use of scientific conventions and vocabulary.</i> 0 marks <i>The candidate does not make any attempt or give an answer worthy of credit.</i>	5	1		6		