Unit Test: Halogenoalkanes, Halogenoarenes and Isomerism

SCHOAE 2002-2003

Name: _____

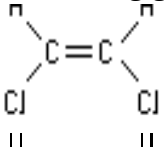
(Total Score: /50)

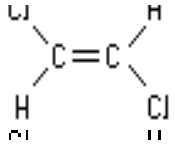
Multiple Choice (6)

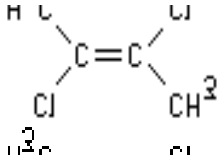
1. Which of the following is an isomer of 2-butene (C_4H_8)?

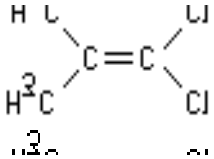
   a) 2-methylpropane b) cyclobutene c) 2-methylbutene
   d) methylcyclopropane e) 1,3-dimethylpropane

2. The cis-isomer in the following group of molecules is:

i) 

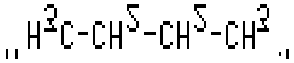
ii) 

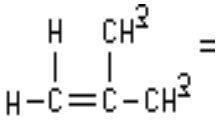
iii) 

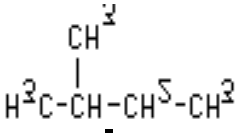
iv) 

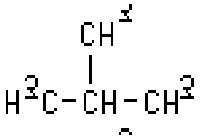
   a) i b) ii c) ii and iii d) iv e) i and iv

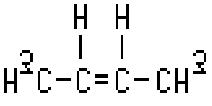
3. Which of the following has the possibility of existing in both <u>cis and trans</u> forms?

a) 

b) 

c) 

d) 

e) 

4. The total number of isomers with the formula $C_2H_2Cl_2$ is:
   a. 1 b. 2 c. 3 d. 4

5. Which of the following compounds is optically active?
   a. Tetrachloromethane b. Dichloromethane
   c. But-2-ene d. 2-bromo-butane

6. The reaction between 2-chloro-2-methyl propane, $(CH_3)_3$ CCl, and aqueous sodium hydroxide is an example of:
   a. Electrophilic substitution b. Electrophilic elimination
   c. Nucleophilic substitution d. Nucleophilic addition.

Problems (44)

1. This part of the question is about the hydrolysis of halogenoalkanes:

   2 cm^3 of ethanol is added to each of three test-tubes.

   Three drops of 1-chlorobutane are added to the first, three drops of 1-bromobutane to the second, and three drops of 1-iodobutane to the third test-tube.

   2 cm^3 portions of hot aqueous silver nitrate solution are added to each test-tube. A precipitate forms immediately in the third test-tube, slowly in the second test-tube and extremely slowly in the first test-tube. In each reaction the precipitate is formed by silver ions, $Ag^{+1}_{(aq)}$, reacting with the halide ions formed by the hydrolysis of the halogenoalkane.

i. Why was ethanol added to each test-tube? 1

ii. The same organic product forms in each reaction. Name this organic product. 1

iii. Write a balanced structural equation for the hydrolysis of 1-bromobutane. 2

iv. What is the colour of the precipitate in the third test tube? 1

v. Name the precipitate which forms extremely slowly in the first test-tube and write the ionic equation, including state symbols, for its formation. 2

vi. Which halogenoalkane has the most polar carbon-halogen bond? 1

vii. Is differing polarity the reason for the different rates of hydrolysis? 1

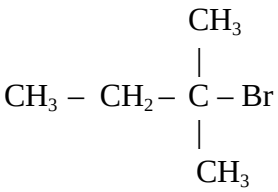
viii. Explain why the rates of hydrolysis of the three halogenoalkanes are different. 2

ix. If the above reaction was carried out using bromobenzene, explain what would be observed, and briefly account for your observations. 2

x. Compare the rates of hydrolysis of 1-bromobutane, 2-bromobutane with 2-bromo-2-methylpropane, explain which bromoalkane is hydrolysed fastest? Which is hydrolysed the slowest. 2

xi. Draw two possible isomers of 2-bromobutane. Hydrolysis of this produces a product that is optically inactive. Explain what mechanism accounts for this product, illustrate the mechanism. 4

2. This question concerns 2-bromo-2-methylbutane:



which reacts with aqueous potassium hydroxide solution via an S_N1 mechanism.

a. (i) Explain what is meant by S_N1. 1

(ii) Show this mechanism and identify the rate determining step. 3

(ii) State the rate equation, (the rate law) for this substitution reaction involved. 1

(iii) State the order of this reaction. 1

(iv) If the concentration of the potassium hydroxide were doubled, state and explain what effect, if any would have on the rate of this equation. 2

(v) If the concentration of the haloalkane were doubled, state and explain what would be the effect, if any, on the kinetics of this reaction. 2

b. If the conditions were changed, potassium hydroxide will react to give an elimination reaction with the same haloalkane.

(i) Give the conditions required for this elimination reaction. 1

(ii) Predict the structure and name of the organic product of this elimination reaction showing all the covalent bonds. 2

(iii) Give the name of the mechanism involved. 1

(iv) Show the mechanism for this elimination reaction, and explain the type of isomerism, if any, displayed by the product. 4

(v) Suggest a chemical test for the product of the elimination reaction, state the colour change you would observe. 2

(vi) If the same haloalkane is reacted with cyanide ions instead of hydroxide ions, and all other conditions remain the same, state with reasons whether the rate of the reaction would alter. Give the name and the structural formula for the product of this reaction.

2

(vii) Explain what is meant by optical activity, and the criteria required for a species to be optically active. Explain if the product obtained from b.(vi), above would be optically active? 3