Haloalkanes and Haloarenes

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The C–X bond in haloalkanes is polar because:

(a) both atoms have equal electronegativity

(b) the bond is ionic

(c) carbon is more electronegative

(d) the halogen is more electronegative than carbon

2. The IUPAC name of $(CH_3)_2CHI$ is:

(a) 2-iodopropane **(b)** 2-iodobutane

(c) 2-iodo-2-methylpropane **(d)** 1-iodobutane

3. 2-chloropropane ($(CH_3)_2CHCl$) is a:

(a) tertiary (3°) alkyl halide **(b)** primary (1°) alkyl halide

(c) vinylic halide **(d)** secondary (2°) alkyl halide

4. Of chloroethane and 2-chloropropane, which reacts faster by the SN2 mechanism?

(a) chloroethane **(b)** 2-chloropropane

(c) both react at the same rate **(d)** neither reacts

5. 2-bromopropane reacts with AgCN. The main product is:

(a) the isocyanide $(CH_3)_2CHNC$ **(b)** 2,3-dimethylbutane

(c) propan-2-ol **(d)** the nitrile $(CH_3)_2CHCN$

6. The correct order of boiling points is:

(a) 2-chlorobutane < 1-bromopropane < 1-chlorobutane

(b) 1-chlorobutane < 1-bromopropane < 2-chlorobutane

(c) 2-chlorobutane < 1-chlorobutane < 1-bromopropane

(d) 1-bromopropane < 1-chlorobutane < 2-chlorobutane

7. The percentage of iodine by mass in $CH_3CH_2CH_2I$ is: (C = 12, H = 1, Cl = 35.5, Br = 80, I = 127)

(a) 127% **(b)** 25.29% **(c)** 74.71% **(d)** 42.76%

8. Assertion (A): 1-bromopropane reacts faster than 2-bromopropane by the SN1 mechanism.
Reason (R): SN1 reactions go through a carbocation, and more substituted carbocations are more stable.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. Why are haloalkanes only slightly soluble in water, though they are polar?

10. Give the IUPAC name and the common name of CH_3CH_2Br, and classify it as primary, secondary or tertiary.

11. Name the major alkene formed when 2-chlorobutane is heated with alcoholic KOH. Which rule decides it?

12. Find the molar mass of 2-chloro-2-methylpropane ($(CH_3)_3CCl$) and the percentage of halogen in it. (C = 12, H = 1, Cl = 35.5, Br = 80, I = 127)

13. Arrange in increasing order of boiling point, and give a reason: 1-chloropropane, 1-bromopropane, 2-bromopropane.

14. What is formed when 1-bromobutane is treated with sodium in dry ether? Name the reaction.

15. What is formed when propene reacts with HBr with a peroxide? Name the reaction.

16. 165.6 g of 2-iodo-2-methylpropane is completely hydrolysed by aqueous KOH. What mass of 2-methylpropan-2-ol is formed? (C = 12, H = 1, O = 16, Cl = 35.5, Br = 80, I = 127)

Section C — Word problems — 4 × 4 = 16 marks

17. Explain the SN2 mechanism with an example, and say how the structure of the halide affects its rate.

18. Identify the compounds in: propene —HBr→ A —alc. KOH→ B —HBr, peroxide→ C.

19. Arrange 2-iodopropane, 1-iodo-2-methylpropane, iodoethane in order of decreasing reactivity by (a) SN2 and (b) SN1, and explain each order.

20. 63.9 g of iodomethane is heated with sodium in dry ether. Write the equation, name the product, and find its mass if the yield is 60%. (C = 12, H = 1, Cl = 35.5, Br = 80, I = 127)

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Answer key

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Q	Answer	Working
1	**(d) the halogen is more electronegative than carbon**	—
2	**(a) 2-iodopropane**	common name: isopropyl iodide
3	**(d) secondary (2°) alkyl halide**	count the carbons attached to the carbon bearing the halogen
4	**(a) chloroethane**	SN2 needs backside attack: less crowding is faster, 1° > 2° > 3°
5	**(a) the isocyanide $(CH_3)_2CHNC$**	—
6	**(a) 2-chlorobutane < 1-bromopropane < 1-chlorobutane**	boiling points: 2-chlorobutane 68.3 °C, 1-bromopropane 71 °C, 1-chlorobutane 78.5 °C
7	**(c) 74.71%**	M = 170; 127 ÷ 170 × 100
8	**(d) A is false, but R is true.**	A is false: 2-bromopropane gives the more substituted, more stable carbocation. R is true.
9	**To dissolve, energy is needed to break the hydrogen bonds between water molecules, and haloalkanes cannot form hydrogen bonds with water to release as much energy.**	—
10	**bromoethane; ethyl bromide; primary (1°)**	count the carbons on the C–X carbon
11	**but-2-ene; Saytzeff (Zaitsev) rule: the more substituted alkene is the major product**	dehydrohalogenation (β-elimination)
12	**92.5 g/mol; 38.38%**	C4H9Cl
13	**1-chloropropane < 2-bromopropane < 1-bromopropane**	boiling point rises with molar mass and falls with branching; data: 46.6 °C, 71 °C, 59.4 °C
14	**octane; Wurtz reaction**	2R–X + 2Na → R–R + 2NaX
15	**1-bromopropane; anti-Markovnikov (peroxide) addition**	—
16	**66.6 g**	0.9 mol of halide gives 0.9 mol of alcohol (M = 74)
17	**In SN2 the nucleophile attacks the carbon from the side opposite the leaving group in one step through a five-coordinate transition state; the configuration is inverted. E.g. $CH_3Cl + OH^- \rightarrow CH_3OH + Cl^-$, rate = k[$CH_3Cl$][$OH^-$]. Bulky groups block the backside, so the order is CH_3X > 1° > 2° > 3°.**	—

Q	Answer	Working
18	**A = 2-bromopropane, B = propene, C = 1-bromopropane**	follow each reagent in turn
19	**(a) SN2: iodoethane > 1-iodo-2-methylpropane > 2-iodopropane, since backside attack is hindered by bulky groups; (b) SN1: 2-iodopropane > 1-iodo-2-methylpropane > iodoethane, since tertiary carbocations are most stable (halides of the same class are ranked by size)**	1° > 2° > 3° for SN2; 3° > 2° > 1° for SN1
20	**$2CH_3I + 2Na \rightarrow C_2H_6 + 2NaI$; ethane; 4.05 g**	2 mol of halide give 1 mol of alkane (M = 30)