Unit 9 · Organic Compounds

HARDER PRACTICE QUESTIONS

Full marks 45

Write your answers on separate paper. Show your working. H = 1, C = 12, O = 16, Cl = 35.5, Br = 80. Molar volume at STP = 22.4 L.

1 Spot the errors [3]

Find the two mistakes and correct them.

Reshma was asked to name all the isomers of C_6H_{14}. She wrote:
"Hexane, 1-methylpentane, 2-methylpentane, 3-methylpentane, 4-methylpentane, 2,2-dimethylbutane and 2,3-dimethylbutane. So C_6H_{14} has **7** isomers."

2 Two bottles [4]

Anil has two gases, A and B, each with a molecular mass of 42 and containing only carbon and hydrogen. Both fit the general formula C_nH_{2n}. Gas A takes the color from bromine solution at once; gas B doesn't.

i. Find the molecular formula.
ii. Name A and B.
iii. Write the equation for A with bromine, and name the product.
iv. Name the kind of isomerism they show.

3 Aromatic, antiaromatic or neither? [4]

Each ring is flat. Count the π electrons in each, and say whether it is aromatic, antiaromatic or non-aromatic.

i. The cyclopropenyl cation, $C_3H_3^+$: three carbons, one double bond, and the third carbon has an empty orbital.
ii. The cyclopentadienyl cation, $C_5H_5^+$: five carbons, two double bonds, and the fifth carbon has an empty orbital.
iii. Cyclohepta-1,3,5-triene, C_7H_8: seven carbons, three double bonds and one CH_2.
iv. Furan, C_4H_4O: two double bonds, with one lone pair of its oxygen in the ring of π electrons.

4 Read the boiling points [4]

Compound	Formula	Boils at (°C)
butane	C_4H_{10}	−0.5
2-methylpropane	C_4H_{10}	−12
pentane	C_5H_{12}	36
2-methylbutane	C_5H_{12}	28
2,2-dimethylpropane	C_5H_{12}	9.5

i. On a morning at 5 °C, which of the five are gases at normal pressure?
ii. On a night at −5 °C, which is the only one still a gas?
iii. Zeenat says, "Going by this table, the formula matters more than the branching." What in the table supports her?
iv. Why does the boiling point fall as the chain branches?

5 Which structure fits the evidence? [4]

Prashant says benzene really has three fixed double bonds and three single bonds. Shruti says its six π electrons are shared evenly round the ring. For each measurement, say what Prashant's structure would predict, and whose structure the result supports.

i. All six carbon–carbon bonds are 139 pm long.
ii. Benzene leaves bromine water orange.
iii. Adding hydrogen to one mole gives out about 208 kJ. (One double bond, in cyclohexene, gives out about 120 kJ.)
iv. In 1929, X-rays showed the ring in hexamethylbenzene to be a regular hexagon.

6 Plan a route [4]

Nima wants to make each product in two steps from the starting material. Write the two equations with conditions, and name the kind of each reaction.

i. Ethanol to ethane.
ii. Bromoethane to 1,2-dibromoethane.

7 Work backward [3]

0.7 g of an alkene, C_nH_{2n}, takes the color from exactly 1.6 g of bromine.

i. Find the alkene's molar mass.
ii. Find its molecular formula.
iii. Name two position isomers of it with an unbranched chain.

8 Alkene or alkyne? [3]

1.3 g of a hydrocarbon adds 16 g of bromine completely. Bibek says it is an alkene, which takes one Br_2 per molecule; Richa says it is an alkyne, which takes two. Show which is possible, and name the compound.

9 All the way to the end [4]

Chiring replaces every hydrogen of 8 g of methane with chlorine.

i. Write the overall equation.
ii. What mass of chlorine is needed?
iii. What masses of tetrachloromethane and hydrogen chloride form?
iv. Show that mass is conserved.

10 Count every bond [3]

Count the σ and π bonds in the whole molecule.

i. Benzene, in one Kekulé structure.
ii. Cyclohexene, C_6H_{10}.
iii. But-1-yne, $CH{\equiv}CCH_2CH_3$.

11 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Salina wrote: "Aromatic compounds are the ones with a strong smell. Butane is called a straight chain because its four carbons lie in a straight line. Aqueous KOH and alcoholic KOH do the same thing to bromoethane, since both are KOH."

12 Think [4]

How many structural isomers has C_4H_8? Remember that the formula also fits rings. Name each, and say which is related to but-1-ene by chain, position and functional isomerism.

13 Make your own [2]

Write a two-step route from one compound in this unit to another, using one elimination and one addition, and give it to a friend with the middle compound left out. Give the answer.