Chemistry PT2 Answers

Aditya V. Nebhrajani

September 17, 2020

Contents

1 Why does a solution of ethanol & cyclohexane show positive deviation from Raoult's Law? 2

2 Why is sulphuric acid not used during the reaction of alcohols with KI? 2

3 Define chirality? Give one example? 2

4 Why do phenols not give protonation reactions readily? 2

5 What is the arrangement of atoms in the lattice structure of diamond and give a contribution of each Carbon atom? 2

6 State Henry's law? Explain the significance of Henry's Constant (k_H). At the same temperature, Hydrogen is more soluble than Helium. Which of them will have a higher value of k_H and why? 3

7 Arrange each set of compounds in order of increasing boiling points? With reasons. 3

8 Arrange the following in increasing order of acidic strength? 4

1 Why does a solution of ethanol & cyclohexane show positive deviation from Raoult's Law?

A mixture of cyclohexane and ethanol shows positive deviation from Raoult's law. In ethanol there is hydrogen bonding while in cyclohexane there is weak Van der Waal 's forces of attraction. When they are mixed the hydrogen bonding of ethanol is disturbed as cyclohexane molecules are placed in between ethanol molecules. There is no possible bonding between ethanol and cyclohexane molecules but only weak Van der Waals' forces exist so the molecules in the mixture have higher tendency to escape. This reduces the boiling point of solution. On adding cyclohexane, its molecules get in between the molecules of ethanol thus breaking the hydrogen bonds and reducing ethanol - ethanol interactions. This will increase the vapour pressure of the solution and result in positive deviation from Raoult's law.

2 Why is sulphuric acid not used during the reaction of alcohols with KI?

In the presence of sulphuric acid (H_2SO_4), KI produces HI.

$2\,KI + H_2SO_4 \longrightarrow 2\,KHSO_4 + 2\,HI$

Since H_2SO_4 is an oxidizing agent, it oxidizes HI (produced in the reaction to I_2).

$2\,HI + H_2SO_4 \longrightarrow I_2 + SO_2 + H_2O$

As a result, the reaction between alcohol and HI to produce alkyl iodide cannot occur. Therefore, sulphuric acid is not used during the reaction of alcohols with KI. Instead, a non-oxidizing acid such as H_3PO_4 is used.

3 Define chirality? Give one example?

A compound is said to be chiral if it exists in two stereoisomeric forms which are non-superimposable mirror images of each other. For example, butan-2-ol is a chiral compound because it exists in two stereoisomers which are non-superimposable mirror images of each other.

4 Why do phenols not give protonation reactions readily?

The lone pair on oxygen of O-H in phenol is being shared with benzene ring through resonance. Thus, lone pair is not fully present on oxygen and hence phenols do not undergo protonation reactions. Resonance will stabilise it. So the lone pair is not fully present on oxygen. Hence phenols do not undergo protonation reactions.

5 What is the arrangement of atoms in the lattice structure of diamond and give a contribution of each Carbon atom?

Diamond is a covalent crystal in which each C-atom is sp3sp3 hybridized. Thus, each C-atom is covalently bonded to four other C-atoms tetrahedrally. These tetrahedra are linked together into a three-dimensional giant molecule. Thus, diamond has face-centred cubic structure in which C-atoms are present at the corners as well as face-centres and alternate

tetrahedral voids. Every carbon atom is surrounded by four other carbon atoms situated at the corners of regular tetrahedral by the covalent linkages.

The diamond cubic structure is a combination of two interpenetrating FCC sub lattices displaced along the body diagonal of the cubic cell by 1/4th length of that diagonal.

The points at 0 and 1/2 are on the FCC lattice, those at 1/4 and 3/4 are on a similar FCC lattice displaced along the body diagonal by one-fourth of its length.

Thus the origins of two FCC sub lattices lie at (0, 0, 0) and (1/4, 1/4,1/4).

In the diamond cubic unit cell, there are eight corner atoms, six face centred atoms and four more atoms.

Each carbon atom is surrounded by four more carbon atoms,the co-ordination number is 4.

No. of atoms contributed by the face centred atoms to the unit cell is $1/2 \times 6 = 3$

No. of atoms contributed by the corner atoms to a unit cell is $1/8 \times 8 = 1$.

Total no. of atoms present in a diamond cubic unit cell is $1 + 3 + 4 = 8$.

6 State Henry's law? Explain the significance of Henry's Constant (k_H). At the same temperature, Hydrogen is more soluble than Helium. Which of them will have a higher value of k_H and why?

Henry was the first to give a quantitative relation between pressure and solubility of a gas in a solvent which is known as Henry's law.

The law states that at a constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas.

Therefore,

$$p = k_H \times C$$

Where p = partial pressure of solute in the gas. C = concentration of solute k_H is Henry's constant.

Different gases have different k_H values at the same temperature. This suggests that k_H is a function of the nature of the gas. Thus, Henry's constant helps us to determine the solubility of gases.

At a same temperature, hydrogen is more soluble in water than helium. The value of k_H of helium is more than the value of k_H of hydrogen. The value of k_H depends on the nature of gas. Greater the value of k_H, lesser is the solubility. k_H is Henry's Law constant. Different gases have different k_H at same temperature. Since hydrogen is more soluble than helium, and Henry's constant is inversely proportional to solubility, k_H of hydrogen is smaller than k_H of helium.

7 Arrange each set of compounds in order of increasing boiling points? With reasons.

(i) Chloromethane (CH_3Cl) < Bromomethane (CH_3Br) < Dibromomethane (CH_2Br_2) < Bromoform ($CHBr_2$).

For alkyl halides containing the same alkyl group, the boiling point increases with an increase in the atomic mass of the halogen atom. Since the atomic mass of Br is greater

than that of Cl, the boiling point of bromomethane is higher than that of chloromethane. the boiling point increases with an increase in the number of halides. Therefore, the boiling point of Dibromomethane is higher than that of chloromethane and bromomethane, but lower than that of bromoform.
(ii) Isopropyl chloride < 1-Chloropropane < 1-Chlorobutane

For alkyl halides containing the same halide, the boiling point increases with an increase in the size of the alkyl group. Thus, the boiling point of 1-chlorobutane is higher than that of isopropyl chloride and 1-chloropropane. Further, the boiling point decreases with an increase in branching in the chain. Thus, the boiling point of isopropyl alcohol is lower than that of 1-chloropropane.

8 Arrange the following in increasing order of acidic strength?

We know that +I groups ($-CH_3$) in Phenols decrease its acidity while -I groups ($-NO_2$) increase it. Therefore, the correct order of increasing acidity is:

Propan-1-ol < 4-methylphenol < 4-MethoxyPhenol < Phenol < 3-nitrophenol < 4-nitrophenol < 3,5-dinitrophenol < 2,4,6-trinitrophenol