SAMPLE PAPER-04
CHEMISTRY (Theory)
Class – XI

Time allowed: 3 hours Maximum Marks: 70

General Instructions:

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6** to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Questions **23**is value based question carrying **four** marks.
g) Questions **24**to **26** carry **five** marks each.
h) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
i) Use of calculators is **not** permitted. However, you may use log tables if necessary.

1. What does the property of molecules of real gases is indicated by van der Waals constant 'a'?
2. Using periodic table, identify
   a) An element that would tend to gain two electrons.
   b) An element that would tend to lose two electrons.
3. Give IUPAC name of allyl alcohol.
4. Explain why BeH_2 molecule has zero dipole moment although the Be - H bonds are polar?
5. In the given equation, determine ΔH^{θ} for the reaction.

$$2Al\,(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s),\ \Delta_f H^{\theta} = -1{,}670 kJ/mol \text{ for } Al_2O_3(s)$$

6. Why the symbols of $^{79}_{35}Br$ and $_{35}Ba$ are not acceptable?
7. Why alkali and alkaline earth metals cannot be obtained by chemical reduction methods?
8. Give reason:
   a) F has lower electron gain enthalpy than Cl.
   b) Ionization enthalpy of N is higher than O.
9. Arrange benzene, hexane and ethyne in decreasing order of acidic behaviour by giving reasons.
10. How domestic waste can be used as manure?

Or

a) Give reasons: "Extra-ordinary stability of benzene though it contains three double bonds".

b) Give the balanced ionic reaction of Mn^{3+} on disproportionation.

11.

a) Which undergo nitration easily m-dinitrobenzene or toluene? Give reason.

b) What is the number of σ and π bonds in $N \equiv C - CH = CH - C \equiv N$?

c) Indicate the number of σ and π bonds in $HCONHCH_3$.

12. If successive ionization energies of a certain element are I_1 = 589.5 kJ/mol, I_2 = 1145 kJ/mol, I_3 = 4900 kJ/mol, I_4 = 6500 kJ/mol, I_5 = 8100 kJ/mol, then identify the unknown element as K, Si, Ca or As from the pattern of ionization energies

13. Professor of Delhi University found that some scraps emit high energy radiations which harmed large number of people. There are certain elements like Co-60 which emit radiations at their own and this phenomenon is called radioactivity. There are three kinds of rays.

a) Name the ray which is used to treat cancer.

b) Give the source of γ-rays used for treating cancer.

c) Discuss the values not possessed by people disposing off radioactive waste materials.

14. These people are not concerned with the health of other people.The first element in every group of representative elements shows properties different from the characteristic properties of the group.

a) Name three such elements.

b) Give two abnormal properties of each one of them.

15.

a) Lifetimes of the molecules in the excited states are often measured by using pulsed radiation source of duration nearly in the nano second range. If the radiation source has the duration of 2 ns and the number of photons emitted during the pulse source is 2.5 x 10^{15}, then calculate the energy of the source.

b) Calculate the wave number for the longest wavelength transition in the Balmer series of atomic hydrogen.

16. Give reasons:

a) LiCl is more covalent than KCl.

b) In aqueous solution Li+ has lowest mobility.

17. BARC at Trombay in Mumbai has five nuclear reactors which produce electricity. Boron rods are used as control rods to absorb neutrons in nuclear reactors, used for the production of electricity. Boron steel containers are used to dispose nuclear waste materials safely. Metal borides are used as protective shield.
    a) Give reason for the absorption of neutrons by boron.
    b) Give methods to dispose-off nuclear wastes safely.
    c) Give harmful effects of nuclear radiations.

18. Give reasons:
    a) Ethyne molecule is linear.
    b) Covalent bonds are directional while ionic bonds are non-directional.
    c) Water molecule has bent structure.

19. When we eat sweets, they form acid in our mouth which reacts with calcium phosphate of the enamel and tooth starts to decay. In order to avoid tooth decay, we should brush our teeth after every meal.
    a) Comment: "Calcium phosphate is a basic salt".
    b) Give reason: "Toothpaste is basic in nature".
    c) Give the expression for K_{sp} of calcium phosphate.

Or

How would you classify the state of chemical equilibrium in a chemical reaction based on the extent to which the reactions proceed?

20. Explain the physical significance of van der Waals parameters.

21. Give the names and formulae of the compounds in the statements given below:
    i. A compound of Ca used in setting fractured bones.
    ii. A compound of Mg, S, O and H used as purgative in medicines.
    iii. A compound of Ca and C used for the production of acetylene.
    iv. A compound of Ca, C and N used as fertilizer.

22. 0.45 g of an organic compound gave 0.792 g of CO_2 and 0.324 g of water on combustion. 0.24 g of same substance was Kjeldahlised and the NH_3 formed was absorbed in 50.0 $cm^3$of $\frac{M}{8} H_2SO_4$. The excess acid required 77.0 cm^3 of $\frac{M}{8} NaOH$ for complete neutralization. Calculate the empirical formula of the compound.

23. Prasad did not paint his iron gate and so it got corroded. Iron gets rusted in presence of oxygen and moisture and large amount of iron gets wasted due to corrosion. Corrosion is a process in which metals react with compounds present in atmosphere to form surface compounds.

a) Justify: "Corrosion is an electrochemical phenomenon".
b) How rusting of iron be prevented?
c) What happens to the metal which undergoes corrosion?

24.

i) Give the chemical reactions when borax solution is acidified.

ii) Explain why BF_3 exists whereas BH_3 does not?

iii) SiO_2 is solid but CO_2 is a gas at room temperature.

Or

a) Explain the rule for the formation of 1-bromopropane by adding HBr to propene in presence of benzoyl peroxide.
b) What is the cause of extra ordinary stability of benzene inspite of presence of three double bonds in it?
c) Alkenes prefer to undergo electrophilic addition reaction while arenes prefer electrophilic substitution reactions. Why?
d) Why moist ethene be dried by passing it through concentrated sulphuric acid?

25. Write the balanced ionic equation for the reaction of permanganate ion with bromide ion in basic medium to give manganese dioxide and bromate ion.

Or

Explain the rules for calculating oxidation number.

26. What are the uses of dihydrogen?

Or

a) Out of n-hexane and ethyne which will be more acidic. Also give reason for this behaviour.
b) Explain with an example: i) Wurtz reaction ii) Acidic Dehydration
c) Convert propyne to propanone.

SAMPLE PAPER-04
CHEMISTRY (Theory)
Class – XI

Time allowed: 3 hours **Answer** Maximum Marks: 70

1. Prop-2-en-1-ol.
2. BeH_2 is a linear molecule with H-Be-H bond angle as 180°. Although the Be-H bonds are polar, the bond polarities cancel each other and the net dipole moment is zero.
3. $\Delta H^{\ominus}$ = 2 x (+ (1,670)) kJ/mol = + 3,340 kJ/ mol.
4. Here, 'a' indicates the intermolecular forces of attraction.
5.
   a) O = $1s^2\ 2s^2\ 2p^4$
   b) Ca = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
6. For a given element the number of protons is the same for its isotopes whereas the mass number can be different for the given atomic number.
7. Alkali and alkaline earth metals arethemselves act as strong reducing agents. So these metals cannot be obtained by reduction of their oxides or chlorides.
8.
   a) Less negative electron gain enthalpy value of F is due to very small size of F atom. As a consequence of small size there are strong inter-electronic repulsions in relatively compact 2p-subshell of fluorine and thus electron does not feel much attraction. Cl is comparatively bigger in size than F and can accommodate electron easily.
   b) Due to exactly half filled configuration of N [$1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$] it is more stable than O [$1s^2\ 2s^2\ 2p_x^2\ 2p_y^1\ 2p_z^1$]. So, ionization enthalpy of N is higher than O.
9. The decreasing order of acidic behaviour is: Ethyne > benzene > n-pentane. The C-H bond in ethyne, benzene and n-pentane are formed overlap. Now, greater the percentage s character, greater is the electronegativity. The C- H bond in ethyne, benzene and n – pentane is formed by sp – s, sp^2 – s, sp^3 – s overlap. Now, greater the percentage s character, greater is the electronegativity. Therefore, sp-hybridised carbon in ethyne is more electronegative than sp^2hybridised carbon of benzene which in turn is more electronegative than sp^3hybridised carbon of n – pentane. Thus the polarity of C – H bond is in the order: Ethyne > Benzene > Pentane.

10. Domestic waste consists of both biodegradable and non-biodegradable components. The latter consisting of plastic, glass, metal scrap etc., that is separated from it. The biodegradable portion which consists of organic matter can be converted into manures by suitable methods.

Or

a) The extra-ordinary stability of benzene is due to resonance. Due to this, the π electron cloud gets delocalized resulting in the stability of the molecule.

b) $2Mn^{3+} + 2H_2O \rightarrow Mn^{2+} + MnO^2 + 4H^+$

11.

a) Toluene – Nitration is an electrophilic substitution reaction. Since – CH_3 group is electron donating group, it increases the electron density on the benzene ring, thereby improves electrophilic substitution reaction. The nitro group is electron withdrawing group, therefore it is deactivating.

b) Number of sigma bonds – 7, number of pi bonds – 5.

c) Number of sigma bonds – 8, number of pi bonds – 1.

12. The unknown element is Ca. Here the third ionization energy is very high which suggest that the removal of the third electron is difficult. The electronic configuration of calcium is [Ar] $4s^2$ first two electrons can be removed without much difficulty. But the removal of third electron from the stable electronic configuration of argon is difficult. Hence, the third ionization energy is high.

13.

a) The γ-ray is used for treating cancer.

b) Co-60.

14.

a) B, C and N

b) Boron

i. It forms acidic oxide whereas other elements form amphoteric oxide and basic oxides.

ii. It cannot form $[BF_6]^{3-}$ whereas others can form such complexes.

Carbon

i. It shows the property of catenation to maximum extent.

ii. It cannot form $[CCl_6]^{2-}$ due to non-availability of d-orbitals.

Nitrogen

i. It is a gas others are solid.

ii. Ammonia is a liquid whereas others are gases.

15.

a) Frequency $\upsilon = \frac{1}{2 \times 10^{-9}} = 0.5 \times 10^{9}/s$

Energy = $Nh\upsilon$

Substituting the values, we get 8.275×10^{-10} J

b) $\bar{\nu} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For Balmer series $n_1 = 2$, for longest wavelength, $\bar{\nu}$ should be minimum so that $n_2 = 3$

Substituting the values, we get $\bar{\nu} = 1.097 \times 10^{7}\left(\frac{5}{36}\right) = 1.523 \times 10^{6}\ m^{-1}$

16.

a) According to Fajan's rule smaller the size of cation and larger the size of anion greater is the covalent character of ionic bond. Li is small in size than K, thus Li^+ has a high charge density. Thus polarizing power of Li^+ is higher than K^+, hence LiCl is more covalent than KCl.

b) Smaller the size of ion greater is the degree of hydration. In aqueous medium Li^+ gets heavily hydrated. Thus mobility of hydrated Li^+ is low.

17.

a) Since it is unstable and becomes stable on absorbing neutron.

b) Nuclear wastes should be filled in boron steel containers and buried deep into the earth.

c) It results in genetic disorders.

18.

a) Due to sp-hybridization with bond angle 180^0.

b) Covalent bond is formed by overlapping of atomic orbitals, therefore they are directional whereas the ionic bonds are formed by the transfer of electrons and so are non-directional.

c) It is due to sp^3 hybridization and two lone pairs of electrons.

19.

a) It is because it is a salt of strong base and weak acid i.e., calcium hydroxide and phosphoric acid.

b) It is because it neutralizes the acid released in the mouth.

c) $K_{sp} = \left[Ca^{2+}\right]^3 \left[PO_4^{3-}\right]^2$

Or

Based on the extent to which the reactions proceed, the state of chemicalequilibriumin a chemical reaction may be classified into three groups as follows:

(i) The reactions that proceed nearly to completion and only negligible concentrations of the reactants are left. In some cases, it may not be even possible to detect these experimentally.

(ii) The reactions in which only small amounts of products are formed and most of the reactants remain unchanged at equilibrium stage.

(iii) The reactions in which the concentrations of the reactants and products are comparable, when the system is in equilibrium.

20. Significance of constant 'b' - The constant 'b' is called co-volume or excluded volume per mol of a gas. Its units are L/mol. The volume of 'b' is four times the actual volume of the molecules.

Significance of constant 'a' – The value of constant 'a' gives the idea of the magnitude of attractive forces between the molecules of the gas. Its units are $atm/L^2/mol^2$. Larger the value of 'a' larger will be the intermolecular attraction among the gas molecules.

21.

a) Plaster of Paris: $CaSO_4.1/2H_2O$

b) Epsom salt: $MgSO_7.H_2O$

c) Calcium carbide: CaC_2

d) Calcium cyanamide: $CaCN_2$

22.

$$\% \ C = \frac{12}{44} \text{x} \frac{0.792}{0.43} \text{x} 100 = 48\%$$

$$\%H = \frac{2}{18} \text{x} \frac{0.324}{0.45} \text{x} 100 = 8\%$$

$M_1V_1 \quad = \quad 2M_2V_2$

$(NaOH) \qquad (H_2SO_4)$

$\frac{1}{10}$x77 = 2x$\frac{1}{8}$xV_2

$V_2 = 30.8cm^3$

Volume of $\frac{M}{8}H_2SO_4$ consumed by NH_3 = 2(50 – 30.8) = 2 x 19.2 cm^3

19.2 cm^3 of $\frac{M}{8}H_2SO_4$ = 2 x 19.2 cm^3 of $\frac{M}{8}NH_3$

$\%N = \frac{1.4x2xV_1xM_1}{W} = \frac{1.4x2x19.2x1}{0.24x8} = 28\%$

23.

a) electrons in presence of oxygen to form water.

b) It can be prevented by painting, oiling, greasing and galvanization.

c) The metal gets oxidised.

24.

i) Borax solution on acidification forms boric acid.

$Na_2B_4O_7 + 2HCl + 5H_2O \rightarrow 2NaCl + 4H_3BO_3$

ii) BF_3 is trigonal planar molecule. Due to pπ - pπ back bonding lone pair of electrons of F is back donated to B atom. This delocalization reduces the deficiency of electrons of boron thereby increasing the stability of BF_3 molecule. Due to absence of lone pair of electrons on H atom this compensation does not occur in BH_3. In other words electron deficiency of B stays & hence it reduces its electron deficiency as BH_3dimerises to form B_2H_6.

iii) Carbon is able to form pπ – pπ bond with O atom and constitute a stable non - polar molecule O = C = O. Due to weak inter particle force its boiling point is low and it is gas at room temperature. Si on the other hand is not able to from pπ – pπ bond with O atoms because of its relatively large size. In order to complete its octet Si is linked to four O atoms around it by sigma bond & these constitutes network structure, which is responsible for its solid.

Or

a) Anti-Markovnikov rule or peroxide effect or Kharash effect. According to this, when HBr is added to unsymmetrical alkene or alkyne in presence of peroxide, the negative part goes to that carbon atom which possesses more number of hydrogen atoms and

positive part goes to that carbon atom which possesses lesser number of hydrogen atoms.

b) It is due to resonance. Six π-electrons are delocalized.

c) Alkenes undergo addition reactions because addition of electrophile gives more stable product as sp^2hybridised 'C' changes to sp^3. Addition to double bond of an arene would give a product with less or no resonance stability. Hence addition is difficult but in substitution reactions, resonance stability is retained. Therefore, arenes undergo electrophilic substitution reactions more readily.

d) No, because it reacts with water in presence of sulphuric acid to form ethanol.

25. Step 1: The skeletal ionic equation is

$$MnO_4^-(aq) + Br^-(aq) \rightarrow MnO_2(s) + BrO_3^-(aq)$$

Step 2: Assign oxidation numbers for Mn and Br.

$$\overset{+7}{Mn}O_4^-(aq) + \overset{-1}{Br}^-(aq) \rightarrow \overset{+4}{Mn}O_2(s) + \overset{+5}{Br}O_3^-(aq)$$

Step 3: Calculate the increase and decrease of oxidation number, and make them equal.

$$2\overset{+7}{Mn}O_4^-(aq) + \overset{-1}{Br}^-(aq) \rightarrow 2\overset{+4}{Mn}O_2(s) + \overset{+5}{Br}O_3^-(aq)$$

Step 4: As the reaction occurs in the basic medium, and the ionic charges are not equal on both the sides, add 2 OH^- ions on the right to make ionic charges equal.

$$2MnO_4^-(aq) + Br^-(aq) \rightarrow 2MnO_2(s) + BrO_3^-(aq) + 2OH^-(aq)$$

Step 5: Finally, count the hydrogen atoms, and add appropriate number of water molecules on the right to achieve balanced redox change.

$$2MnO_4^-(aq) + Br^-(aq) + H_2O(l) \rightarrow 2MnO_2(s) + BrO_3^-(aq) + 2OH^-(aq)$$

Or

1. In elements, in the free or the uncombined state, each atom bears an oxidation number of zero. Evidently each atom in H_2, O_2, Cl_2, O_3, P_4, S_8, Na, Mg, Al has the oxidation number zero.

2. For ions composed of only one atom, the oxidation number is equal to the charge on the ion. Thus Na^+ ion has an oxidation number of +1, Mg^{2+} ion, +2, Fe^{3+} ion, +3, Cl^- ion, –1, O^{2-} ion, –2; and so on. In their compounds all alkali metals have oxidation number of +1, and all alkaline earth metals have an oxidation number of +2. Aluminium is regarded to have an oxidation number of +3 in all its compounds.
3. The oxidation number of oxygen in most compounds is –2. However, we come across two kinds of exceptions here. One arises in the case of peroxides and superoxides, the compounds of oxygen in which oxygen atoms are directly linked to each other. While in peroxides (e.g., H_2O_2, Na_2O_2), each oxygen atom is assigned an oxidation number of –1, in superoxides (e.g., KO_2,RbO_2) each oxygen atom is assigned an oxidation number of –(½). The second exception appears rarely, i.e. when oxygen is bonded to fluorine. In such compounds e.g., oxygen difluoride (OF_2) and dioxygendifluoride (O_2F_2), the oxygen is assigned an oxidation number of +2 and +1, respectively. The number assigned to oxygen will depend upon the bonding state of oxygen but this number would now be a positive figure only.
4. The oxidation number of hydrogen is +1, except when it is bonded to metals in binary compounds (that is compounds containing two elements). For example, in LiH, NaH,andCaH_2, its oxidation number is –1.
5. In all its compounds, fluorine has an oxidation number of –1. Other halogens (Cl,Br, and I) also have an oxidation number of –1, when they occur as halide ions in their compounds. Chlorine, bromine and iodine when combined with oxygen, for example in oxoacids and oxoanions, have positive oxidation numbers.
6. The algebraic sum of the oxidation number of all the atoms in a compound must be zero. In polyatomic ion, the algebraic sum of all the oxidation numbers of atoms of the ion must equal the charge on the ion. Thus, the sum of oxidation number of three oxygen atoms and one carbon atom in the carbonate ion, $(CO_3)^{2-}$ must equal –2.

26.

a) The largest single use of dihydrogen is in the synthesis of ammonia which is used in the manufacture of nitric acid and nitrogenous fertilizers.
b) Dihydrogen is used in the manufacture of vanaspati fat by the hydrogenation of polyunsaturated vegetable oils like soyabean, cotton seeds etc.

c) It is used in the manufacture of bulk organic chemicals, particularly methanol.

d) It is widely used for the manufacture of metal hydrides.

e) It is used for the preparation of hydrogen chloride, a highly useful chemical.

f) In metallurgical processes, it is used to reduce heavy metal oxides to metals.

g) Atomic hydrogen and oxy-hydrogen torches find use for cutting and welding purposes. Atomic hydrogen atoms (produced by dissociation of dihydrogen with the help of an electric arc) are allowed to recombine on the surface to be welded to generate the temperature of 4000K.

h) It is used as a rocket fuel in space research.

Dihydrogen is used in fuel cells for generating electrical energy. It has many advantages over the conventional fossil fuels and electric power. It does not produce any pollution and releases greater energy per unit mass of fuel in comparison to gasoline and other fuels.

Or

a)

$CH_3\text{-}\,CH_2\text{-}\,CH_2\text{-}\,CH_2\text{-}\,CH_2\text{-}\,CH_3 - sp^3$ hybridized with s-character 25%

$CH \equiv CH -$ sp hybridized with s-character 50%

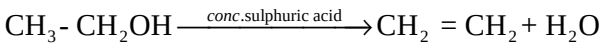
Since s-orbital are closer to the nucleus, hence due to more s character in ethyne (sp hybridized) the hybridized orbital is nearest to this carbon atom in compared to sp^2hybridised carbon. This leads to the movement of C-H bond pair more towards sp hybridized carbon, leading to the development of partial positive charge on the hydrogen attached to sphydridised carbon and eventually helps in release of proton (H^+). Thus ethyne is more acidic than n-hexane.

b)

(i)Wurtz reaction: Alkyl halides on treatment with sodium metal in dry ether medium give higher alkanes. This is called Wurtz reaction and is used for the preparation of alkanes with even number of carbon atoms.

$$CH_3Br + 2Na + CH_3Br \xrightarrow{ether} CH_3\text{-}\,CH_3 + 2NaBr$$

(ii)Acidic dehydration: Alcohols on heating with conc. H2SO4 at 443 K form alkenes with elimination of one water molecule. Since a water molecule is lost in the presence of acid, the reaction is called acidic dehydration of alcohols.



c)