Sample Paper-01
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.

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1. "BeH_2 molecule has zero dipole moment although the Be-H bonds are polar" Explain.
2. Give water gas shift reaction.
3. Arrange the following metals in the order in which they displace each other from the solution of their salts. Al, Cu, Fe, Mg and Zn.
4. What is the maximum number of electrons in f subshell with same spin?
5. Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion?
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. Give reasons: "The reaction $2Na(s)+H_2(g)\rightarrow 2NaH(s)$ is a redox change".
12. Give reason:
   (i) Graphite is used as lubricant.
   (ii) Diamond is used as an abrasive.
   (iii) Aluminium alloys are used to make aircraft body.

Or

Explain isomerization in alkanes with examples.

13. An alkyl halide compound 'A' $\left(C_5H_{11}Br\right)$ reacts with ethanolic KOH to give compound 'B', an alkene. 'B' on reaction with bromine gives compound 'C'. 'C' on further dehydrobromination gives compound 'D'. When one mole of 'D' is treated with sodium metal in liquid ammonia, it gives one mole of sodium salt of 'D' and half a mole of hydrogen gas. On complete hydrogenation, 'D' gives a straight reactions involved.
14. Calculate the amount of ammonia formed when 50 kg of N_2 (g) and 10.0 kg H_2 (g) of are mixed to produce NH_3 (g). Identify the limiting reagent.
15. Give reasons:
    (i) Evaporation causes cooling.
    (ii) Falling liquids drops are spherical.
    (iii) Vapour pressure of acetone is less than that of ether at same temperature.
16. What happens when alkali metals reacts in air?
17. Give the Lewis representation of:
    (i) Nitric acid
    (ii) Ammonia
    (iii) Ozone molecule
18. In the reaction: $2SO_2(g) + O_2 \rightleftharpoons 2SO_3(g) + 189.4\text{ kJ}$
    (i) Indicate the direction in which the equilibrium will shift when:
    (ii) Concentration of SO_2 is increased.
    (iii) Concentration of SO_3 is increased.
    (iv) Temperature is increased.
19. Calculate the wavelength in nm, of visible light having a frequency of 4.37×10^{-14}/s.
20. Comment on each of the following observations:
    (i) Lithium forms a nitride directly like magnesium. Give equation involved.
    (ii) BaO is soluble but $BaSO_4$ is insoluble in water.
21. Give a note on:
    (i) Mist
    (ii) Smoke
    (iii) Fumes
    (iv) Dust
22. Calculate the enthalpy change when 2.38g of CO vaporizes at its normal boiling point, if the enthalpy of vaporization of CO is 6.04 kJ/mol.
23. John takes snacks every day to school, but Mala takes vegetables, chapattis and curd. Chips and snacks packet are filled with nitrogen gas. If they are filled with oxygen, they will get rancid.
    (a) What is meant by rancidity?
    (b) How do you preserve butter?
    (c) Why chips are packed with nitrogen gas?
24. Differentiate valency and oxidation number. [Any five points]

Or

Calculate equilibrium concentrations of CO_2, H_2, CO and H_2O in $CO(g) + H_2O\ (g) \rightleftharpoons CO_2(g) + H_2(g)$ at 800 K, if only CO and H_2O are present initially at concentrations of 0.1 M each. [Kc = 4.24] for the reaction:

25. Explain the rules for calculating oxidation number.

Or

(i) Write 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.

26. (a) In which C-C bond of $CH_3CH_2CH_2Br$, the inductive effect is expected to be least?

(b) Which of the following compound shows geometrical isomerism?

(i) Pent-1-ene

(ii) Pent-2-ene

(iii) 2-Methylbut-2-ene

(c) What type of isomerism is present in the following pairs?

(i) $CH_3 - CH_2 - CH_2 - OH$ and $CH_3 - CH\ (OH) - CH_3$

(ii) $CH_3 - CH_2 - CO - CH_2 - CH_3$ and $CH_3 - CO - CH_2 - CH_2 - CH_3$

(iii) $CH_3 - CH_2 - OH$ and $CH_3 - O - CH_3$

Or

(a) How will you convert ethanoic acid into benzene?

(b) "Branched chain hydrocarbons have lower boiling point than straight chain hydrocarbon". Why?

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

1. 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.
2. (i) $C + H_2O \text{ (steam)} \rightarrow CO + H_2$
   (ii) $CO + H_2O \text{ (steam)} + H_2 \rightarrow CO_2 + 2H_2$
3. Mg, Al, Zn, Fe, Cu.
4. Total number of electrons in f subshell is 14 but half of them will have the same spin i.e. 7 electrons will have same spin.
5. We have $q = -w = p_{ex}(10 - 2) = 0(8) = 0$
   No work is done; no heat is absorbed.
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 are themselves 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. Since in the above reaction the compound formed is an ionic compound, which may also be represented as Na^+H^- (s), this suggests that one half reaction in this process is:

$2 Na (s) \rightarrow 2 Na^+(g) + 2e^-$ and the other half reaction is: $H_2 (g) + 2e^- \rightarrow 2 H^-(g)$. This splitting of the reaction under examination into two half reactions automatically reveals that here sodium is oxidised and hydrogen is reduced, therefore, the complete reaction is a redox change.

12. (i) Graphite has layered structure in which the different layers are held together by weak Vander Waals forces and hence can be made to slip over one another. So, graphite acts as a lubricant.
(ii) Since diamond is very hard, it can be used as an abrasive.
(iii) Aluminium alloys are light, tough and resistant to corrosion and so are used to make aircraft body.

Or

The n-Alkanes on heating in the presence of anhydrous aluminium chloride and hydrogen chloride gas isomerize to branched chain alkanes. Major products are given below. Some minor products are also possible but are not reported in organic reactions.

$$CH_3(CH_2)_4CH_3 \xrightarrow{\text{Anhy.}AlCl_3/HCl} CH_3-CH(CH_3)-(CH_2)_2-CH_3$$
$$+ CH_3-CH_2-CH(CH_3)-CH_2-CH_3$$

13. (a) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - Br + \text{alc. } KOH \rightarrow CH_3 - CH_2 - CH_2 - CH = CH_2$
(b) $CH_3 - CH_2 - CH_2 - CH = CH_2 + Br_2 (aq) \rightarrow CH_3 - CH_2 - CH_2 - CH (Br) - CH_2 - Br$
(c) $CH_3-CH_2-CH_2-CH(Br)-CH_3 + 2 \text{ alc. } KOH \rightarrow \frac{1}{2} H_2(g) + CH_3-CH_2-CH_2-C\equiv CNa$
(d) $\frac{1}{2} H_2(g) + CH_3-CH_2-CH_2-C^oCNa \xrightarrow{Na/NH_3} CH_3-CH_2-CH_2-C^oCH$
(e) $CH_3-CH_2-CH_2-C\equiv CH \xrightarrow{Ni/2H_2} CH_3-CH_2-CH_2-CH_2-CH_3$

14. Moles of nitrogen = $\frac{\text{Mass}}{\text{Molar mass}}$ = 1.786×10^3mol

Moles of hydrogen = $\frac{\text{Mass}}{\text{Molar mass}}$ = 5.0×10^3mol

Then, to identify the limiting reagent

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

1 mole of nitrogen gas reacts with 3 moles of hydrogen gas

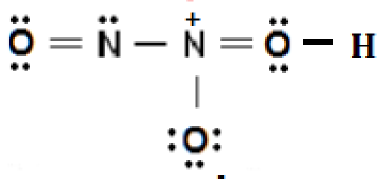
Therefore 1.786×10^3mol of nitrogen will react with $\frac{3 \times 1.786 \times 10^3}{1}$ moles of hydrogen = 5.36×10^3mol

Since, there is 5.0×10^3mol of hydrogen only, it is the limiting reagent.
To calculate the amount of ammonia formed,
3 moles of hydrogen gives 2 moles of ammonia,
Therefore 5.0×10^3 moles of hydrogen gives $\frac{2}{3} \times 5 \times 10^3$ of ammonia = 3.3×10^3 moles of ammonia.
Mass of NH_3 produced = $3.3 \times 10^3 \times 17$ g of NH_3 = 56.1 kg

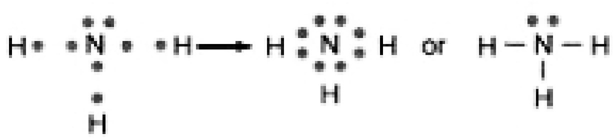
15. (i) This is due to the reason that the molecules which undergo evaporation are high energy molecules and therefore, the kinetic energy of the remaining molecules becomes less. Since the remaining molecules have lower average kinetic energy, their temperature becomes low.
    (ii) This is due to surface tension of liquids. Due to surface tension, the molecules of a liquid, try to make surface area to be minimum and for a given volume, sphere has the minimum surface area. Therefore the falling liquid drops are spherical.
    (iii) Intermolecular forces are stronger in acetone than in ether. Thus the vapour pressure of acetone is less than ether.
16. The alkali metals tarnish in dry air due to the formation of their oxides which in turn react with moisture to form hydroxides. They burn vigorously in oxygen forming oxides. Lithium forms monoxide, sodium forms peroxide, the other metals form super oxides. The superoxide O^{2-} ion is stable only in the presence of large cations such as K, Rb, Cs.

    $4\ Li + O_2 \rightarrow 2LiO_2$ (oxide)

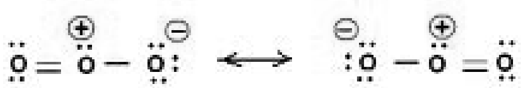
    $2\ Na + O_2 \rightarrow Na_2O_2$ (superoxide)
17. (i) Nitric acid



    (ii) Ammonia



    (iii) Ozone



18. (i) If the concentration of SO_2 is increased the equilibrium will shift in the forward direction to consume the reactant SO_2.
    (ii) If the concentration of SO_3 is increased the equilibrium will shift in the backward direction to consume the product SO_3.
    (iii) If the temperature is increased, the equilibrium will shift in the backward direction as the increase in temperature will be compensated by absorbing heat
19. Since, $\nu = \frac{c}{\lambda}$

    Substituting the values,

    $\Lambda = 686$ nm

    Here, $n_1 = 6$ and $n_2 = 1$,

    The energy gap between two orbits for a hydrogen atom is given as,

$$\Delta E = 2.18 \times 10^{-18}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$= - 2.11 \times 10^{-18}$ J

Since ΔE is negative energy, the frequency of photon is given by $\nu = \frac{\Delta E}{h}$

Substituting, we get

$\nu = 3.18 \times 10^{15}$ Hz

20. (a) Lithium and magnesium follow diagonal relationship and so lithium like magnesium forms nitride while other alkali metals do not.

(b) Size of O^{2-} ion is smaller than SO_4^{2-}. Since a bigger anions stabilizes bigger cation more than a smaller cation stabilizes a bigger anion, lattice enthalpy of BaO is smaller than $BaSO_4$. BaO is soluble as hydration energy is more than lattice energy but $BaSO_4$ (as hydration energy is less than lattice energy) is insoluble in water.

21. (i) Mists are formed when certain herbicides and insecticides are sprayed in the liquid form over the plants.

(ii) Smokes are small particles of soot which are released in atmosphere in the form of oil, smoke etc by incomplete combustion of organic matter.

(iii) Fumes are released to atmosphere in metallurgical operations due to result of reactions in factories.

(iv) Dusts are released by grinding limestone, cement as fly ash etc.

22. Enthalpy of vaporization of CO = 6.04 kJ/mol

Molar mass of CO = 28 g/mol

Enthalpy change for vaporization of 28 g of CO at boiling point = 6.04 kJ

Therefore, the enthalpy change for vapourization of 2.38 g of CO at boiling point will be,

$\frac{6.04 \times 2.38}{28} = 0.5134 \text{kJ} = 513.4$ J

23. (a) The spoilage of food due to oxidation is called rancidity.

(b) We preserve butter at low temperature. Adding common salt and antioxidants to prevent it from getting spoiled.

(c) It is done to prevent it from oxidation.

24.

No	Valency	Oxidation Number
1.	It is always a whole number.	It can be even fractional.
2.	It defined as the number of hydrogen atoms which combine with one atom of the element.	It is defined as the charge assigned to an atom of a molecule or ion.
3.	Usually an element has fixed valency in all its compounds.	An element has different valency in different compounds.
4.	It does not have any sign.	It has either positive or negative sign.
5.	Valency of no other element is zero except noble gases.	It can be zero.

Or

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

Initialconcentration

0.1 M 0.1 M 0 0

Let x mole of each of the product be formed.

At equilibrium:

(0.1 – x) M (0.1 – x) M x M x M

Where x is the amount of carbon dioxide and hydrogen at equilibrium.

Hence equlibrium constant can be,

$$K_c = K_c = \frac{x^2}{(0.1-x)^2} = 4.24$$

$x^2 = 4.24\ (0.01 + x^2 - 0.2x)$

$= 0.0424 + 4.24x^2 - 0.848x$

$3.24x^2 - 0.848x + 0.0424 = 0$

a = 3.24, b = - 0.848, c = 0.0424

for quadratic equation $ax^2 + bx + c = 0$,

$$x = \frac{(-b \pm \sqrt{b^2 - 4ac})}{2a}$$

Substituting the values, we get

$$x = \frac{(0.848 \pm 0.4118)}{6.48}$$

$$x_1 = \frac{(0.848 - 0.4118)}{6.48} = 0.067$$

$$x_2 = \frac{(0.848 + 0.4118)}{6.48} = 0.194$$

The value 0.194 should be neglected because it will give concentration of the reactant which is more than initial concentration.

Hence the equilibrium concentrations are,

$[CO_2] = [H_2] = x = 0.067$ M

$[CO] = [H_2O] = 0.1 - 0.067 = 0.033$ M

25. (a) 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.

(b) 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.

(c) 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 dioxygen difluoride (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.

(d) 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,and CaH_2, its oxidation number is –1.

(e) 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.

(f) 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.

Or

(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. Thus, 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_3 dimerises 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 solidity.

26. (a) The inductive effect is least in C2-C3 bond because the magnitude of inductive effect decreases as the number of intervening bonds increases.

(b) Pent-2- ene will show geometrical isomerism.

(c) Position isomerism, Metamerism, Functional isomerism.

Or

(a) $CH_3COOH \xrightarrow{\text{Aq.NaOH}} CH_3COONa \xrightarrow{\text{soda lime}} CH_4$

$\xrightarrow{Cl_2/h\nu} CH_3Cl \xrightarrow{\text{Na/dry ether}} C_2H_6 \xrightarrow{Cl_2} C_2H_5Cl$

$\xrightarrow{\text{alc. KOH}} CH_2 = CH_2 \xrightarrow{Br_2} 2(C_2H_4Br) \xrightarrow{\text{alc.KOH}} CH_2 = CHBr$

$CH_2 = CHBr \xrightarrow{NaNH_2} CH \equiv CH \xrightarrow{\text{Red hot iron tube/873K}} C_6H_6$

(b) Branched chain hydrocarbons try to acquire spherical shape which has minimum surface area, therefore minimum van der Waals' forces of attraction and hence they have lower boiling point.