Sample Paper-02
Chemistry (Theory)
Class – XI

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

1. 1L of nitrogen will react with 3L of hydrogen,
2L of nitrogen will react with 6L of hydrogen, but we have 2L of hydrogen, therefore hydrogen is limiting reactant.
So, 3L of hydrogen gives 2L of ammonia,
2L of hydrogen gives $\frac{2}{3} \text{ x } 2 = \frac{4}{3} = 1.33\text{L}$ of ammonia.

2. ΔH, the enthalpy change and ΔU, the internal energy change are state functions as they depend on initial and final state and note on the path.

3. It is because acetone has weak van der Waals' forces of attraction whereas water molecules have strong hydrogen bonding, therefore, $\Delta_{vap}H^0$ of water is more.

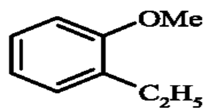
4. 1 molecule of methane = 6 + 4 = 10 electrons
16 of methane contains 10 x 6.022 x 10^{23} electrons = 6.022 x 10^{24} electrons.

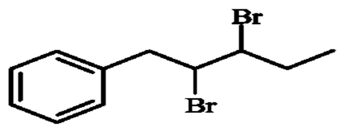
5. 1000 cm^3 of 0.15 M Na_2CO_3 contains 0.15 moles of Na_2CO_3
So, 100 cm^3 of 0.15 M Na_2CO_3 will contain = $\frac{0.15 \text{ x } 100}{1000}$
= 0.015 moles of Na_2CO_3
$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molar mass}}$$
$$\therefore 0.015 = \frac{\text{Mass}}{106\text{g}}$$
Molar mass of Na_2CO_3 = 106 g
= 0.015 x 106 = 1.59 g

6. As we go away from the nucleus, the effective nuclear charge pull goes on increasing. Hence electrons present in 4p orbital experience the lowest effective nuclear charge.

7. (a) $CH_3-CH_2-CH(CH_3)-C(CH_3)_2-CH(CH_3)-CH-CH_3$
(b) $CH_3-CH(CH_3)-CH_2-CH_2-CH(CH_3)-CH_3$

Or





8. (a) Wavelength decreases with increase in velocity of moving particle.

(b) Angular momentum of 3p and 4p orbitals will be same because l = 1 for p-orbital.

9. The metals of groups 7, 8 and 9 do not form hydrides. This region of periodic table from group 7 to 9 is referred to as hydride gap. Heavy water is used in the nuclear reactors to slow down the speed of neutrons (as moderator).

10. Carbon dioxide absorbs IR radiations from atmosphere which lead to global warming. So, if carbon dioxide level increases beyond 0.03%, the natural greenhouse balance may get disturbed. So it is considered as serious pollutant.

11. (a) BOD is a measure of level of pollution caused by organic biodegradable material. Low value of BOD means water is less polluted.

(b) 1 ppm is desirable concentration of fluoride ions in drinking water. The pH of drinking water should be between 5.5 – 9.5.

(c) Nitrogen dioxide is extremely toxic to living tissues and harmful to plants, paints, textiles and metals. It causes acid rain. It produces photochemical smog.

12. (a) (i) The properties which depend only on the nature of the substance and not on the amount of the substance are called intensive properties. Example: Density.

(ii) A process in which no heat flows between the system and the surroundings is called an adiabatic process i.e. q= 0.

(b) Change in Gibbs energy, $\Delta G = G_2 - G_1$,

Enthalpy change, $\Delta H = H_2 - H_1$,

Entropy change, $\Delta S = S_2 - S_1$,

$\Delta G = \Delta H - T\Delta S$

$\Delta S_{total} = \Delta S_{system} + \Delta S_{surrounding}$

$$\Delta S_{total} = \Delta S_{system} - \frac{\Delta H_{sys}}{T}$$

$$\Delta S_{total} = \Delta S - \frac{\Delta H}{T}$$

Multiply by T,

$T\Delta S_{total} = T\Delta S - \Delta H$

$T\Delta S_{total} = \Delta H - T\Delta S = \Delta G$

Therefore, $\Delta G = - T\Delta S_{total}$

13. (a) Using CNG as a fuel, using public transports, electric cars and bicycles and avoiding burning of dry leaves, plastic bags etc.

(b) Banning CFCs used in refrigerators, AC etc., and using less amount of diesel and petrol.

(c) Yes. Solar energy reduces pollution. By making green building, a lot of natural light and natural cooling and heating takes place which save lot of energy and environment.

14. It represents the graph between p and 1/V. It is a straight line passing through origin. However at high pressures, gases deviate from Boyle's law and under such conditions a straight line is not obtained in the graph.

15. Molarity = 3M

Density = 1.25g/mL

Mass of NaCl in 1L solution

= Molarity x molar mass = 3 x 58.5 = 175.5g

Density = Mass/Volume

Mass of 1LNaCl solution = 1.25 x 1000 = 1250g

Mass of water in solution = 1250-175.5 = 1074.5g = 1.0745 kg

Molality = No. of moles of solute/ Mass of water

$= \frac{3}{1.0745} = 2.79 \text{ m}$

16. (a) Combustion of methanol:

$CH_3OH\ (l) + 3/2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (l); \Delta H = -726$ kJ/mol ----- (1)

(b) Enthalpy of formation of carbon dioxide:

$C_{(graphite)} + O_2\ (g) \rightarrow CO_2\ (g)\ ; \Delta H = - 393$ kJ/mol ----------- (2)

(c) Enthalpy of formation of water:

$H_2\ (g) + ½\ O_2\ (g) \rightarrow H_2O\ (l); \Delta H = - 286$ kJ/mol ------------ (3)

(d) Required reaction:

$C_{(graphite)} + 2H_2\ (g) + 1/2\ O_2 \rightarrow CH_3OH\ (l)\ ; \Delta H = ?$ --------------- (4)

$\Delta H = (- 572 - 393) - 726 = - 239$ kJ/mol

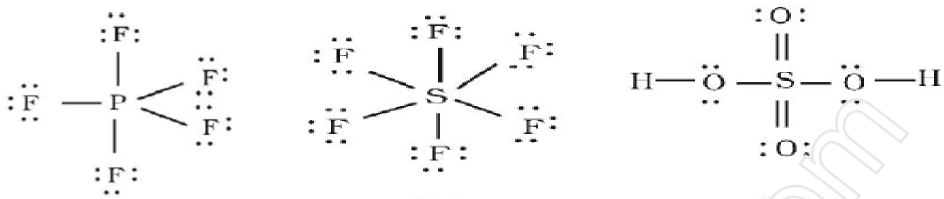
17. (a) It is used in water softening, laundering and cleaning.

(b) It is used in the manufacture of glass, soap, borax and caustic soda.

(c) It is used in paper, paints and textile industries.

(d) It is an important laboratory reagent both in qualitative and quantitative analysis.

18. Elements in and beyond the third period of the periodic table have, apart from 3*s* and 3*p* orbitals, 3*d* orbitals also available for bonding. In a number of compounds of these elements there are more than eight valence electrons around the central atom. This is termed as the expanded octet. Obviously the octet rule does not apply in such cases. Some of the examples of such compounds are: PF_5, SF_6, H_2SO_4 and a number of coordination compounds.



PF_5 10 electrons around the P atom

SF_6 12 electrons around the S atom

H_2SO_4 12 electrons around the S atom

19. Dihydrogen gas adds to alkenes and alkynes in the presence of finely divided catalysts like platinum, palladium or nickel to form alkanes. This process is called hydrogenation. These metals adsorb dihydrogen gas on their surfaces and activate the hydrogen – hydrogen bond. Platinum and palladium catalyses the reaction at room temperature but relatively higher temperature and pressure are required with nickel catalysts.

$$CH_2 = CH_2 + H_2 \xrightarrow{Pt/Pd/Ni} CH_3 - CH_3$$

$$CH_3 - CH = CH_2 + H_2 \xrightarrow{Pt/Pd/Ni} CH_3 - CH_2 - CH_3$$

20. (a) $NH_4OH(aq) \Leftrightarrow NH_4^+(aq) + OH^-(aq)$

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_4OH]}$$

$$[NH_4^+] = [OH^-]$$

$$[NH_4OH] = 0.1M$$

$$K_b = \frac{[OH^-]^2}{[NH_4OH]}$$

$$[OH^-]^2 = 1.8 \text{ x } 10^{-5} \text{ x } 0.1$$

$$= 0.18 \text{ x } 10^{-5}$$

$$\therefore [OH^-] = 1.34 \text{ x } 10^{-3} \text{ mol/L}$$

(b) $AgCN \Leftrightarrow Ag^{+} + CN^{-}$

Let x mol/L be the solubility of AgCN

Thus $[Ag^{+}] = x$

$[CN^{-}] = x$

$K_{SP} = [Ag^{+}][CN^{-}]$ = X^2

$x = \sqrt{K_{SP}}$

$= \sqrt{6.0 \text{ x } 10^{-17}}$

= 7.75 x 10^{-9}

$Ni(OH)_2 \Leftrightarrow Ni^{2+} + 2OH^{-}$

Let y mol/L be the solubility of $Ni(OH)_2$

Thus $[Ni^{2+}] = y \,\&\, [OH^{-}] = 2y$

$K_{SP} = [Ni^{2+}][OH^{-}]^2$

= y x $(2y)^2$ = 4 y^3

$$y = \left(\frac{K_{SP}}{4}\right)^{1/3}$$

$$y = \left(\frac{2x10^{-1}}{4}\right)^{1/3}$$

$$y = \sqrt[3]{0.5x10^{5}}$$

Since solubility of $Ni(OH)_2$ is more than AgCN, $Ni(OH)_2$ is more soluble than AgCN.

Or

(a) Here, $HCOO^-$ is common ion. So when small amount of hydrogen ions are added, it combines with $HCOO^-$ which are in excess to form HCOOH and H^+ remains the same. So pH remains constant. When a small amount of hydroxide ions are added, hydroxide ions take up hydrogen ions and so dissociation of HCOOH will increase so as to maintain concentration of hydroxide ions. So pH is not affected.

(b) Here, ammonium ions are common ions. So when a small amount of hydrogen ions are added, hydrogen ion will take up hydroxide ion and dissociation of ammonium hydroxide will increase so as to maintain hydroxide constant. So, pH remains constant. When a small amount of hydroxide ions are added, ammonium ions which are in excess will combine with hydroxide ions to form ammonium hydroxide back so as to maintain hydroxide constant. So, pH remains constant.

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. $\% \ C = \frac{12}{44} x \frac{0.792}{0.43} x100 = 48\%$

$\%H = \frac{2}{18} x \frac{0.324}{0.45} x100 = 8\%$

$\underset{(NaOH)}{M_1V_1} = \underset{(H_2SO_4)}{2M_2V_2}$

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

$V_2 = 30.8cm^3$

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. (a)

Species	Conjugate Acid	Conjugate Base
H_2O	H_3O^+	OH^-
HCO_3^-	H_2CO_3	CO_3^-
HSO_4^-	H_2SO_4	SO_4^{2-}
NH_3	NH_4^+	NH_2^-

(b) For the reaction: $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

(i) $K_p = \frac{(p_{CO})(p_{H_2})^3}{(p_{CH_4})(p_{H_2O})}$

(ii) (a) On increasing pressure, the reaction equilibrium will shift in the backward direction.

(b) There is no effect of catalyst in equilibrium composition; however the equilibrium will be attained faster.

Or

(a) NaCN, $NaNO_2$– Solution are basic as they are salts of strong base and weak acid. (HCN and HNO_2 are weak acids and NaOH is strong base). NH_4NO_3- Its solution is acidic as it is salt of strong acid (HNO_3) and weak base (NH_4OH).

(b) KBr - This solution is neutral as it salt of strong acid HBr and strong base KOH.

25. $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ - n-hexane

$CH_3 - CH\ (CH_3) - CH_2 - CH_2 - CH_3$ - 2-Methylpentane

$CH_3 - CH_2 - CH\ (CH_3) - CH_2 - CH_3$ - 3-Methylpentane

$CH_3 - C\ (CH_3)_2 - CH_2 - CH_3$ - 2,2-Dimethylpentane

$CH_3 - CH(CH_3) - CH(CH_3) - CH_3$ - 2,3-Dimethylbutane

Or

(a) Wacker's method.

(i) Eco-friendly and safest method.

(ii) It gives 90% yield.

(b) In Wacker's method,

$$R - CH = CH_2 \xrightarrow{PdCl_2\ /\ air\ /\ Cu_2Cl_2} R - CO - CH_3$$

$$CH_2 = CH_2 \xrightarrow{PdCl_2\ /\ air\ /\ Cu_2Cl_2} CH_3 - CHO$$

(c) $HgSO_4$ is unsafe for the environment.

26. Step 1: The skeletal ionic equation is:

$$Cr_2O_7^{2-}(aq) + SO_3^{2-}(aq) \rightarrow Cr^{3+}(aq) + SO_4^{2-}(aq)$$

Step 2: Assign oxidation numbers for Cr and S $\overset{+6}{Cr_2}\overset{-2}{O_7}(aq) + \overset{+4}{S}\overset{-2}{O_3}(aq) \rightarrow \overset{+3}{Cr}(aq) + \overset{+6}{S}\overset{-2}{O_4}(aq)$

Step 3: Calculate the increase and decrease of oxidation number, and make them equal: $\overset{+6}{Cr_2}\overset{-2}{O_7}(aq) + 3\overset{+4}{S}\overset{-2}{O_3}(aq) \rightarrow 2\overset{+3}{Cr}(aq) + 3\overset{+6}{S}\overset{-2}{O_4}(aq)$

Step 4: As the reaction occurs in the acidic medium, and further the ionic charges are not equal on both the sides, add 8H+ on the left to make ionic charges equal

$$Cr_2O_7^{2-}(aq) + 3SO_3^{2-}(aq) + 8H^+ \rightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq)$$

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

$Cr_2O_7^{2-}(aq)+3SO_3^{2-}(aq)+8H^+(aq) \rightarrow 2Cr^{3+}(aq)+3SO_4^{2-}(aq)+4H_2O$

Or

Pb_3O_4 is actually a stoichiometric mixture of 2 mol of PbO and 1 mol of PbO_2. In PbO_2, lead is present in +4 oxidation state, whereas the stable oxidation state of lead in PbO is +2. PbO_2 thus can act as an oxidant (oxidising agent) and, therefore, can oxidiseCl^- ion of HCl into chlorine. Since PbO is a basic oxide, the reaction

$Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + Cl_2 + 4H_2O$ can be splitted into two reactions namely:

$2PbO + 4HCl \rightarrow 2PbCl_2 + 2H_2O$ (acid-base reaction)

+4 −1 +2 0

$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$ (redox reaction)

Since HNO_3 itself is an oxidising agent therefore, it is unlikely that the reaction may occur between $PbO_2$and HNO_3. However, the acid-base reaction occurs between PbO and HNO_3 as:

$2PbO + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + 2H_2O$

It is the passive nature of PbO_2 against HNO_3 that makes the reaction different from the one that follows with HCl.