CBSE Board
Class XI Chemistry

Time: 3 Hours **Total Marks: 70**

General Instructions

1. All questions are compulsory.
2. Question nos. 1 to 8 are very short answer type questions and carry 1 mark each.
3. Question nos. 9 to 18 are short answer type questions and carry 2 marks each.
4. Question nos. 19 to 27 are also short answer type questions and carry 3 marks each.
5. Question nos. 28 to 30 are long answer type questions and carry 5 marks each.
6. Use log tables if necessary, use of calculators is not allowed.

Q1. Write the expression for K_{sp} of As_2S_3.

Q2. If we get a blood red colouration on adding $FeSO_4$ and dil.H_2SO_4 to the sodium extract, what do you infer about the elements present in the organic compound?

Q3. Would the aq.solution of NaCN be acidic, basic or neutral?

Q4. Calculate the percentage of N in NH_3. (Atomic mass N = 14, H =1 u)

Q5. Calculate the oxidation number of C in HCHO and S in $S_2O_4^{2-}$.

Q6. Name two types of smog. Which of the two is oxidizing in nature?

Q7. Predict the group and period of the element in the periodic table satisfying the electronic configuration $(n-1)d^1 ns^2$ for n = 4.

Q8. Give an equation showing the oxidizing action of H_2.

Q9. Describe the soil pollution caused by excessive use of pesticides and fertilizers.

Q10. On the basis of VSEPR theory, predict the shapes of the following species:
a) PH_3 b) SF_4

Q11. Why is LiF almost insoluble in water whereas LiCl is soluble in both water and acetone?

Q12. Account for the following:
a) Will Dalton's law hold good for a mixture of CO and O_2? Why?
b) Which out of NH_3 and N_2 will have a higher value of van der Waal's constant 'a' and why?

Q13. Balance the following equation by the half reaction method(acidic medium):
$Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$

Q14. How many grams of chlorine (atomic mass=35.5g/mole) are required to completely react with 0.40g of hydrogen (atomic mass =1g/mole) to yield hydrochloric acid? Also calculate the amount of HCl formed.

Q15. How many moles and how many grams of sodium chloride are present in 250 mL of a 0.50 M NaCl solution?

Q16.

a) Why do carbon hydrides of the type C_nH_{2n+2} not act as Lewis acids or Lewis bases?
b) Give a balanced equation showing the reaction between $KMnO_4$ and acidified hydrogen peroxide.

Q17.

a) Give conjugate acid and base of HSO_4^-.
b) Write the nature of the following solution:
(i) $[OH^-] = 10^{-6}$ (ii) $[OH^-] = 10^{-10}$

OR

Q17.

a) Give the conjugate acid and base of H_2O.
b) If $K_w = 25 X10^{-12}$, what will be the pH of neutral water?

Q18. At 273 K the density of a gaseous oxide at 2 bar is the same as that of nitrogen (atomic mass =14u) at 5 bar. Calculate the molar mass of the oxide.

Q19.

a) Calculate the wavelength of an electron moving with a velocity of 2.05×10^7m/s. (mass of electron = 9.1×10^{-31}kg , h =6.63×10^{-34}Js)

b) How many nodes are present in the 3p orbital?
c) What is the value of all the four quantum numbers of the valence electron in potassium? (Atomic number = 19)

OR

Q19.

a) Two particles A and B are in motion. If the wavelength of A is 5×10^{-8}m, calculate the wavelength of B if its momentum is half of A.
b) How many electrons are possible in all shells with n + l = 5?
c) Write the electronic configuration of Cu^+. (atomic number of Cu=29)

Q20.

a) Arrange the following elements in increasing order of metallic character: Si, Be, Mg, Na, P.
b) Out of Be and B which has higher first ionization energy and why?
c) Give two species isoelectronic with F^-.

Q21.

a) What is diagonal relationship? Give two points of similarity between Li and magnesium.
b) What happens when sodium metal reacts with liquid ammonia?

Q22. Rajat and Rajesh are conducting an experiment in laboratory. They require to make 100 cm^3 0.15 M Na_2CO_3 solution. Now, both are confused as in how many grams of Na_2CO_3 should be dissolved. Their classmate comes and says to dissolve 1.59 grams.

a) Is the classmate right or wrong? Elaborate.
b) What values do you get from this?

Q23.

a) What do you infer about the structure of CO_2 if its dipole moment is zero?
b) Write the molecular orbital configuration of N_2^- and calculate its bond order.
c) Draw the resonating structures of NO_3^- ion.

Q24.

a) What will be the pH of 0.1M ammonium acetate solution? $pK_a = 4.76$ and $pK_b = 4.75$
b) Calculate the concentration of hydroxyl ion in 0.1M solution of ammonium hydroxide having $K_b = 1.8 \times 10^{-5}$

Q25.

a) Write the designations for the orbital with the following quantum numbers:
(i) n = 3, l = 1 (ii) n = 5, l = 3
b) Why does 3d subshell have higher energy than 4s for a multielectron system?
c) How many electrons in a fully filled f- subshell have $m_l = 0$?

Q26.

a) How would you distinguish between but-1-yne and but-1-ene?
b) An alkene 'A' on ozonolysis gives a mixture of propanal and pentan-3-one. Write the structure and IUPAC name of 'A'.

Q27.

a) Write the IUPAC name of:
(i) $CH_3CH(CN)CH_2CH_2CH_2CH_2OH$ (ii) CHOCHO
b) Arrange in increasing order of stability:
CH_3^-, $(CH_3)_3C^-$, $(CH_3)_2CH^-$, $CH_3CH_2^-$

Q28.

a) For the reaction at 298K: $2A + B \rightarrow C$,
$\Delta H = 400 kJ/mol$ and $\Delta S = 200 JK^{-1}mol^{-1}$. At what temperature will the reaction become spontaneous?

b) ΔU^0 of combustion of methane is –X kJ/mol. The value of ΔH^0 is
(i) = ΔU^0 (ii) < ΔU^0 (iii) > ΔU^0 (iv) = 0.

c) Predict the sign of ΔS for the following processes:
(i) $PCl_5(s) \rightarrow PCl_5(g)$
(ii) Boiling of egg

OR

Q28.

a) For the reaction: $2A(g) + B(g) \rightarrow 2D(g)$,
$\Delta U^0 = -10.5$kJ and $\Delta S^0 = -44.1 JK^{-1}$.
Calculate ΔG^0 and predict whether the reaction may occur spontaneously.

b) For a process to occur under adiabatic conditions, the correct condition is

(i) $\Delta T = 0$ (ii) $\Delta P = 0$ (iii) $q = 0$ (iv) $w = 0$.

c) A reaction $A + B \rightarrow C + D + q$ is found to have a positive entropy change. The reaction will be
i. possible at high temperature
ii. possible only at low temperature
iii. not possible at any temperature
iv. possible at all temperatures.
Explain.

Q29.

a) Name the type of hybridization of carbon in carbon monooxide.
(i) sp (ii) sp^2 (iii) sp^3 (iv) sp^3d

b) How can you explain the higher stability of BCl_3 as compared to $TlCl_3$?

c) $[SiF_6]^{2-}$ is known but $[CF_6]^{2-}$ is not known. Why?

d) Write a short note on silicones and give two of their uses.

OR

Q29.

a) The tendency to show catenation in group 14 decreases down the group. Explain.
b) Lead (IV) chloride is highly unstable towards heat. Why?
c) Which of the following statement about boric acid is false?

(i) it exists as a polymer due to the presence of hydrogen bonds
(ii) it is formed by the hydrolysis of boron halides
(iii) it has a planar structure
(iv) it acts as a tribasic acid.

d) Anhyd. $AlCl_3$ is covalent while hydrated is ionic.Why?

Q30.

a) Convert 2-Bromopropane to 1- Bromopropane.
b) Predict the major products of the following:
   i. $C_6H_5CH = CH_2 \xrightarrow{HBr}$
   ii. $CH_3 - C \equiv CH \xrightarrow{NaNH_2} X \xrightarrow{CH_3CH_2Br} Y$
c) A hydrocarbon 'A' adds one mole of hydrogen in the presence of platinum catalyst to form n-hexane. When 'A' is oxidized vigorously with $KMnO_4$, a single carboxylic acid containing three carbon atoms is isolated. Give the structure of 'A' and explain. Also give the equations involved.

OR

Q30.

a) Convert ethane into butane.
b) Give IUPAC name of product formed when benzene is made to react with ethanoyl chloride in the presence of anhy. $AlCl_3$.
c) Draw the geometrical isomers of but-2-ene and predict which would have a higher boiling point and why?
d) Arrange the following in decreasing order of reactivity towards electrophilic substitution reaction: Benzene, nitrobenzene, phenol.

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Solution

1. $K_{sp} = [As^{3+}]^2[S^{2-}]^3$ (1 mark)

2. Blood red colouration indicates the presence of both N and S in the organic compound. (1 mark)

3. Basic. (1 mark)

4. % N = (14/17) X 100 = 82.35% (1 mark)

5. C = 0 , S = 3 (½ + ½ = 1 mark)

6. Classical and photochemical smog. $\left(\frac{1}{2}\text{mark}\right)$

Photochemical smog is oxidizing in nature. $\left(\frac{1}{2}\text{mark}\right)$

7. Period = 4, group = 3B (½ + ½ = 1 mark)

8. $CuO + H_2 \rightarrow Cu + H_2O$ (1 mark)

9. Pesticides: are used to save plants from pests, rats etc. The remains of pesticides may get absorbed by the soil particles which contaminate crops grown in the soil. By consuming these crops, the pesticides enter the human body and affect them adversely. They also decrease the fertility of the soil as some of them are not biodegradable. (1 mark)

Fertilizers: The metals present in fertilizers are non biodegradable and hence become poison for crops. Excess fertilizers in soil reduce the protein content of crops and vegetables/ fruits grown in over fertilized soil are more prone to attack by insects and diseases. (1 mark)

10.

(a) PH_3 has 3 bond pairs and one lone pair & is therefore trigonal pyramidal.

(1 mark)

(b) SF_4 has 4 bond pairs and 1 lone pairs and has a see-saw shape.

(1 mark)

11. LiF is insoluble in water due to its high lattice energy whereas LiCl is soluble in water as its lattice energy is less than corresponding hydration energy. It is also soluble in acetone as it has some covalent character due to greater polarization of the Cl^- ion. (2 mark)

12.

(a) Dalton's law does not hold good for a mixture of CO and O_2 as they react with each other.

(1 mark)

(b) NH_3 is asymmetric with a lone air of electrons. Hence it has diplole which results in higher intermolecular attractive forces. Also it involves in hydrogen bonding. Therefore NH_3 has a higher value of van der waal's constant 'a' than N_2.. (½ + ½= 1 mark)

13. Oxidation half reaction:

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ $\left(\frac{1}{2}\text{mark}\right)$

Reduction half reaction:

$Cr_2O_7^{2-} + 6\ e^- \rightarrow 2Cr^{3+}$

Balance charge using H^+, H_2O

$Cr_2O_7^{2-} + 14H^+ + 6\ e^- \rightarrow 2Cr^{3+} + 7H_2O$ $\left(\frac{1}{2}\text{mark}\right)$

Multiply oxidation half reaction by 6 and add both of them,

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$ (1 mark)

14. The equation is : $H_2 + Cl_2 \rightarrow 2HCl$

2g 71g 73g

2 g hydrogen reacts with 71 g of Chlorine.

Therefore 0.40g of H_2 will react with = (71 x 0.40)/2

= 14.2g Cl_2 (1 mark)

2 g hydrogen produces 73g HCl

Therefore 0.40g of H_2 will produce = (73 x 0.40)/2

= 14.6g Cl_2 (1 mark)

15. We know that,

$$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution (in L)}} \qquad \left(\frac{1}{2}\text{ mark}\right)$$

$$0.50 = \frac{\text{Moles of solute}}{250} \times 1000$$

$$\text{Moles of solute} = \frac{0.50 \times 250}{1000} = 0.125\,\text{mol} \qquad \left(\frac{1}{2}\text{ mark}\right)$$

Molar mass of NaCl =58.5 gm

Therefore,

Mass of NaCl solution (in gram) = Moles of NaCl x Molar mass $\left(\frac{1}{2}\text{mark}\right)$

= 0.125 x 58.5 = 7.31 gm $\left(\frac{1}{2}\text{mark}\right)$

16.

(a) Carbon hydrides of the type C_nH_{2n+2} not act as Lewis acids or Lewis bases as they are electron precise hydrides. (1 mark)

(b) $2KMnO_4 + 5\,H_2O_2 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$ (1 mark)

17.

(a) Acid: H_2SO_4, Base: SO_4^{2-} (1 mark)

(b) (i)Basic (ii) Acidic (½ x 2 = 1 mark)

OR

(a) Acid: H_3O^+, Base: OH^- (1 mark)

(b) $K_w = 25 \times 10^{-12}$

$\Rightarrow [H_3O^+]^2 = 25 \times 10^{-12}$

$\therefore [H_3O^+] = 5 \times 10^{-6}$.

$pH = -\log [H_3O^+]$

$= -\log (5 \times 10^{-6})$

$= -0.6990 + 6$

$= 5.301$ (1 mark)

18. We know $\rho = PM/RT$

Since $\rho N_2 = \rho$ Oxide

$5 \times 28/R \times 273 = 2 \times M_{oxide}/R \times 273$

or $M_{oxide} = 5 \times 28/2 = 70$g/mol (2 mark)

19.

(a) Using formula $\lambda = h/mv$

$\lambda = 6.63 \times 10^{-34} / (9.1 \times 10^{-31} \times 2.05 \times 10^{7})$

$= 3.55 \times 10^{11}$ m (1 mark)

(b) Number of nodes in an orbital = (n-l -1)

For 3p orbital nodes = 3-1-1 =1 (1 mark)

(c) Valence electron in potassium is in 3s orbital.

The quantum number are: n = 3, l = 1, m=either 1,0 or -1, s = either +1/2 or -1/2

(1 mark)

OR

(a) Using $\lambda = h/p$

$\lambda_A = h/p_A$ and $\lambda_B = h/p_B$ $P_B = 1/2\ P_A$

Therefore $\lambda_A/ \lambda_B = P_B/ P_A$

$= 1/2\ P_A/ P_A = 1/2.$

or $\lambda_B = 2 \times \lambda_A = 2 \times 5 \times 10^{-8} = 10^{-7}$m (1 mark)

(b) For n + l = 5, the orbitals associated are 5s, 4p and 3d. The total number of electrons are = 2+6+10 = 18. (1 mark)

(c) $Cu^+ = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$ (1 mark)

20. (a) P < Si < Be < Mg < Na (1 mark)

(b) Be due to penetration of s orbitals being more than the penetration of p orbitals in B. (1 mark)

(c) O^{2-}, Ne (½ + ½ = 1 mark)

21. (a) Similarity in properties of diagonally located members of second and third period of modern periodic table is called diagonal relationship. (1 mark)

Two similarities between Li and Mg:

(i) Both LiCl and $MgCl_2$ are covalent and deliquescent.

(ii) Both Li and Mg form normal oxides. (½ + ½ = 1 mark)

(b) A deep blue colour is obtained due to ammoniated e^- present in the solution.

(1 mark)

22. (a) The classmate is right; 1.59 grams of Na_2CO_3 should be dissolved to form 0.15 M solution.

1000 cm^3 of 0.15 M Na_2CO_3 contains Na_2CO_3 = 0.15 mole

So, 100 cm^3 will contain = $\frac{0.15}{1000} \times 100 = 0.015\,\text{mole}$

Mass of Na_2CO_3 = 0.015 x 106 = 1.59 g (2 marks)

(b) Values: Correct knowledge of chemistry and helpful nature. (1 mark)

23. (a) CO_2 has a linear structure and does not contain any lone pair of electrons. Two dipoles are equal and opposite so they cancel each other. (1 mark)

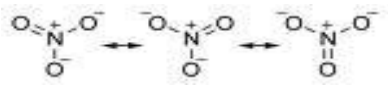
(b) N_2^- (15 e^-)- $\sigma 1s^2\sigma^*1s^2\sigma\ 2s^2\sigma^*\ 2s^2\ \Pi 2p_x^2 = \Pi 2p_y^2\sigma 2p_z^2\ \Pi^* 2p_x^1$

$\left(\frac{1}{2}\text{mark}\right)$

Bond Order = ½ (No. of bonding electrons – No. of antibonding electrons)

Bond Order = ½ (10 - 5) = 2.5 $\left(\frac{1}{2}\text{mark}\right)$

(c)



(1 mark)

24. (a) $pH = 7 + \frac{1}{2}(pK_a - pK_b)$ $\left(\frac{1}{2}\text{mark}\right)$

$\Rightarrow pH = 7 + \frac{1}{2}(4.76 - 4.75))$

or $pH = 7.005$ $\left(\frac{1}{2}\text{mark}\right)$

(b) $NH_4OH(aq) = NH_4^+(aq) + OH^-(aq)$

$K_b = [NH_4^+][OH^-] / NH_4OH$ $\left(\frac{1}{2}\text{mark}\right)$

or $K_b = [OH^-]^2 / NH_4OH$ (as $[NH_4^+] = [OH^-]$) $\left(\frac{1}{2}\text{mark}\right)$

or $1.8 \times 10^{-5} = [OH^-]^2 / 0.1$

or $[OH^-]^2 = 1.8 \times 10^{-6}$ $\left(\frac{1}{2}\text{mark}\right)$

$\Rightarrow [OH^-] = 1.34 \times 10^{-3}$ mol/l $\left(\frac{1}{2}\text{mark}\right)$

25. (a) (i) 3p (ii) 5f (½ + ½ = 1 mark)

(b) 3d subshell has higher (n+l) i.e. 3+2=5 than 4s i.e.4+0=4. Thus 3d has higher energy (1 mark)

(c) 2 (1 mark)

26. (a) But-1-yne is a terminal alkyne and therefore reacts with ammonical $AgNO_3$ to give a white precipitate of $CH_3CH_2C{\equiv}CAg$, whereas But-1- ene does not give a white precipitate on reacting with ammonical $AgNO_3$. (1 mark)

(b) Propanal is CH_3CH_2CHO and pentan-3-one is $CH_3CH_2COCH_2CH_3$. The alkene 'A' is $CH_3CH_2CH=C(CH_2CH_3)_2$. Name is 3-Ethylhex-3-ene.

(1+1 = 2 marks)

27. (a) (i) 6-Hydroxy-2-methylhexanenitrile (ii) Ethanedial (1+1 = 2 marks)

(b) $(CH_3)_3C^- < (CH_3)_2CH^- < CH_3CH_2^- < CH_3^-$ (1 mark)

28. (a) Using $\Delta G = \Delta H - T\Delta S = 0$

$\Rightarrow T = \Delta H / \Delta S = 400/0.2$ (½ + ½ = 1 mark)

$= 2000$ K

The reaction will be spontaneous at a temperature > 2000K, since above 2000K, ΔG will be –ve. (½ + ½=1mark)

(b) (ii) (1 mark)

(c) (i) positive

ii)Positive (1 mark)

OR

(a) For the reaction $\Delta n_g RT = 2-3 = -1$. $\left(\frac{1}{2}\text{mark}\right)$

$\Delta H^0 = \Delta U^0 + \Delta n_g RT$

$= -10.5 + (-1) \times (8.14 \times 10^{-3}) \times 298$

$= -10.5 - 2.43 = -12.93$kJ. $\left(\frac{1}{2}\text{mark}\right)$

$\Delta G^0 = \Delta H^0 - T\Delta S^0$

$= -12.93 - 298(-44.10 \times 10^{-3})$

$= -12.93 + 13.14 = 0.22$kJ $\left(\frac{1}{2}\text{mark}\right)$

Since ΔG^0 is positive, the reaction is non- spontaneous. $\left(\frac{1}{2}\text{mark}\right)$

(b) (iii) (1 mark)

(c) (iv) (1 mark)

ΔG= ΔH -T ΔS Since ΔH is negative as heat is evolved and ΔS is positive, ΔG will always be a negative value hence this reaction will be spontaneous at all temperatures. (1 mark)

29.

(a) sp (1 mark)

(b) Due to inert pair effect higher oxidation state of Tl is less stable. Loss of outer s electrons is difficult due to poor screening effect of d electrons in the core. BCl_3 is a covalent compound.

(1 mark)

(c) Due to absence of vacant d- orbitals in C, it is unable to extend its covalency while Si can.

(1 mark)

(d) Silicones are synthetic organosilicon polymers containing R_2SiO units. (1 mark)

They are used as electric insulators and water repellants. (1 mark)

OR

(a) The tendency to show catenation decreases down the group as size increases and the bond dissociation energy decreases. (1 mark)

(b) Pb(II) is more stable than Pb(IV) due to inert pair effect, therefore Pb(IV) is unstable to heat. (1 mark)

(c) (iv) (1 mark)

(d) Al has higher ionization enthalpy. Thus forms covalent compound as $AlCl_3$. When added to water hydration enthalpy is released which causes complete electron transfer from Al to Cl making it ionic. (2 mark)

30.

(a)

$$CH_3 - CH(Br)CH_3 \xrightarrow{\text{alc.KOH}} CH_3 - CH = CH_2 \xrightarrow{\text{HBr / Peroxide}} CH_3 - CH_2 - CH_2(Br)$$

(1 mark)

(b) (i) $C_6H_5CH(Br)CH_3$ (1 mark)

(ii) X = $CH_3C{\equiv}CNa$, Y = $CH_3C{\equiv}CCH_2CH_3$ (½ + ½ = 1 mark)

(c) A = $CH_3CH_2CH{=}CHCH_2CH_3$. (1 mark)

Hex-3-ene on oxidation gives propanoic acid and in the presence of hydrogen/platinum forms n-hexane. $CH_3 - CH_2 - CH = CH - CH_2 - CH_3 \xrightarrow{KMnO_4 / OH^-, \Delta} 2CH_3 - CH_2 - COOH$

$\left(\frac{1}{2}\text{ mark}\right)$

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

$\left(\frac{1}{2}\text{ mark}\right)$

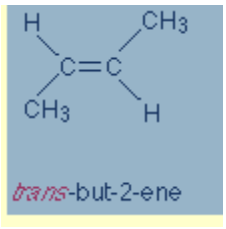
OR

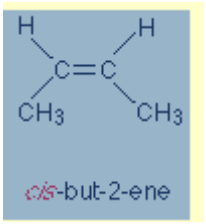
(a) $CH_3 - CH_3 \xrightarrow{Cl_2 / h\nu} CH_3 - CH_2Cl \xrightarrow{Na / \text{dryether}} CH_3 - CH_2 - CH_2 - CH_3$

(1 mark)

(b) phenyl ethanone (1 mark)

(c)





(½ + ½ = 1 mark)

Cis isomer has higher boiling point due to dipole – dipole interactions between the molecules whereas trans hex-3-ene has zero dipole moment. (1 mark)

(d) Phenol < benzene < nitrobenzene (1 mark)