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. Which quantum number/s define energy of an electron in a multielectron atom?

Q2. Which phenomenon explains the spherical shape of falling liquid drops?

Q3. What is the name of element with atomic number 115?

Q4. What is the IUPAC name of allyl alcohol?

Q5. What is the value of ionisation constant of water at 298K?

Q6. Write the conditions in terms of ΔH and ΔS when a reaction would be always spontaneous?

Q7. Which of the two is more stable- Secondary carbocation or tertiary carbocation? Why?

Q8. Calculate the oxidation number of B in $NaBH_4$.

Q9.

a) Why does F have lower electron gain enthalpy than Cl?
b) Why is Ga smaller in size than Al?

Q10. Alkali metals impart colour to the flame.Why?

Q11. Define the terms -:

a) Gibbs free energy change
b) Enthalpy of formation

OR

Q11. Explain Hess's law of constant heat summation with the help of an example.

Q12.

a) Li is the best reducing agent inspite of having high ionisation enthalpy.Why?
b) Cs is used in photoelectric cells.

Q13. Give IUPAC name and structure of major product formed when:

a) 1,1,2,2-Tetrabromoethane is treated with Zn
b) Cold dilute potassium permanganate is added to but-2-ene

Q14. Give reason:

a) Tl (III) is less stable than Tl (I).
b) BCl_3 molecule has zero dipole moment.

Q15. Balance the given redox reaction in acidic medium.

$MnO_4^- + SO_2 \rightarrow Mn^{2+} + HSO_4^-$

Q16. What is the maximum number of emission lines obtained when the excited electron of a H atom in n=5 drops to the ground state?

Q17. Calculate the bond order of O_2 and O_2^{2-}. Predict their magnetic behaviour.

Q18. Blue coloured solution of alkali metals in liquid ammonia is a good conductor of electricity.Why?

Q19.

a) Calculate the molarity of oxalic acid in the solution prepared by dissolving its 2.52 g in enough water to form 250 mL of the solution.
b) Round off the following in three significant figures
(i) 3289 (ii) 0.03265

Q20.

a) Configuration of N is given as $1s^2\ 2s^2\ 2p_x^2\ 2p_y^1$. Which rule of electronic configuration is violated?
b) Write the electronic configuration of Co^{3+}. Count the number of unpaired electrons present in it. (Given: Atomic number of Co = 27)

Q21. Calculate the enthalpy of combustion of ethylene gas to form carbon dioxide and water at 298 K and 1 atm pressure. The enthalpies of formation of CO_2, H_2O & C_2H_4 are -393.5, -241.8 & +52.3 $kJmol^{-1}$ respectively.

Q22. Explain the following.

a) Which of the two is expected to have higher value of BOD - drinking water or sewage water?
b) Name two greenhouse gases.
c) What are secondary pollutants?

Q23.

a) What are electrophiles? Write with an example.
b) Define position isomerism with an example.

Q24. Vanita is doing an experiment in laboratory. According to the observations, 0.50 g of an organic compound was Kjeldahlised and the ammonia obtained was passed into 100 mL of M/10 H_2SO_4. The excess acid required 160 mL of M/10 NaOH for neutralization. The volume of acid used by ammonia is 2 mL. She was asked to calculate the percentage of nitrogen in the compound. According to vanita, the percentage required is 13% but her friend sunita says it is 11.2%.

a) Which one is the correct answer?
b) What values do you get from this?

Q25.

a) Predict the shapes of following molecules on the basis of VSEPR theory.
PCl_5, XeO_3
b) All bond C-C lengths in benzene are equal inspite of presence of single and double bonds. Why?

OR

a) What is the hybridization of S atom in SF_4 and SO_4^{2-}?
b) Water has a high boiling point of 373K.Why?

Q26.

a) Explain the physical significance of van der Waals parameter. Also give their units.
b) In terms of Charles' law explain why -273^oC is the lowest possible temperature?

Q27. In three moles of ethane (C_2H_6), calculate the following:-

i. Number of moles of carbon atoms.
ii. Number of moles of hydrogen atoms.
iii. Number of molecules of ethane.

Q28.

a) Give reason
i. H_2S should be passed in the presence of HCl for Group II analysis
ii. HF is a stronger acid than water
b) K_p = 0.04 atm at 899K for the equilibrium shown below. What is the equlibrium concentration of C_2H_6 when it is placed in a flask at 4.0 atm pressure and allowed to come to equilibrium?
$C_2H_6\ (g) \rightleftharpoons C_2H_4\ (g) + H_2\ (g)$

OR

Q28.

a) What will happen to the pH of a solution of weak acid when small amount of its salt with a strong base is added? Give reason.
b) Write expression for K_c for the reaction
$CaCO_3\ (s) \rightleftharpoons CaO(s) + CO_2\ (g)$
c) Discuss the effect of catalyst & addition of SO_3 gas for the reaction
$2SO_2\ (g) + O_2\ (g) \rightleftharpoons 2SO_3\ (g)$

Q29.

a) Write the IUPAC names of the product obtained by the ozonolysis of following compound 2-ethyl but-1-ene.
b) Why is Wurtz reaction not preferred for alkanes containing odd number of carbon atoms? Illustrate your answer by taking one example.
c) Which electrophile is generated to attack the benzene ring during Friedal Craft's acylation?
d) Name the product obtained when ethyne is reacted with hydrogen in the presence of Na in liq. ammonia.

OR

Q29.

a) Complete the following equations

i. $CH_3\text{-}CH{=}C\text{-}(CH_3)_2 + H_2O \xrightarrow{H^+/Hg^{2+}}$

ii. $CH_3\text{-}CH_2\text{-}CH{=}CH_2 + HBr \xrightarrow{\text{Peroxide}}$

iii. $C_6H_6 + Cl_2 \xrightarrow{\text{Anhy. } AlCl_3}$

b) What are the necessary conditions for any system to be aromatic?

Q30.

a) Assign reason for each of the following
   i. Ga(I) undergoes disproportionation reaction.
   ii. Anhy. $AlCl_3$ used as catalyst
   iii. Boron is unable to form $[BF_6]^-$ ion. Explain.
b) Complete the following equation.
   i. $Sn + H_2O \xrightarrow{\Delta} ?$
   ii. $BF_3 + NaH \rightarrow ?$

OR

Q30.

a) Write equation to justify amphoteric nature of aluminium.
b) Give reasons:
   i. Conc HNO_3 can be stored in aluminium container
   ii. Ionization enthalpy decreases from carbon to silicon.
   iii. Boric acid is a weak acid

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Solution

Ans1 n and l (1)

Ans2

Because of surface tension falling liquid drops are spherical in shape. (1)

Ans3 Ununpentium (1)

Ans 4

Prop-2-en-1-ol (1)

Ans 5

1.008×10^{-14} (1)

Ans 6 For a reaction to be always spontaneous, ΔH should be negative and ΔS should be positive. (1)

Ans 7

Tertiary carbocation is more stable because of higher electron releasing inductive effect of more number of R groups and more hyperconjugating structures. (1)

Ans 8

$+1+(X) - 4=0$

$X= +3$ (1)

Ans9

(a) Due to small size of fluorine, new electron faces inter electronic repulsions which decrease the value of electron gain enthalpy. (1)

(b) Due to poor screening effect provided by d electrons in Ga, effective nuclear charge increases leading to decrease in size. (1)

Ans 10

Alkali metals have low ionisation enthalpies. (1)

Valence electrons in alkali metal atoms are loosely held. They get excited by energy of the flame.When they fall back, energy released fall in the visible region of spectrum giving colour to the flame. (1)

Ans 11

(a) Amount of useful work obtainable from a system is Gibbs free energy change (1)

(b) Enthalpy change accompanying formation of 1mole of a compound from its pure elements is called enthalpy of formation. (1)

OR

Enthalpy change in a reaction remains the same whether the reaction takes place in one step or in number of steps. (1)

Eg. When carbon burns to form carbon dioxide directly in one step, 393.5

kJ mol^{-1} of heat produced.

$C + O_2 \rightarrow CO_2$ $\Delta H = -393.5$ kJ mol^{-1} (1)

While

(i) $C + ½\ O_2 \rightarrow CO$; $\Delta H = -110.5$ kJ mol^{-1}

(ii) $CO + ½\ O_2 \rightarrow CO_2$; $\Delta H = -283.0$ kJ mol^{-1} (1)

Sum of (i) & (ii) is same (-393.5 kJ mol^{-1}) when the reaction takes place directly in one step.

Ans 12

(a) Li has a small size due to which Li^+ has high charge density. Hence it is heavily hydrated in solution. Thus, lithium is the best reducing agent. (1)

(b) Cs has a big size and low ionization enthalpy. Hence electron is easily ejected using light energy. Therefore it is used in photoelectric cells. (1)

Ans 13

(a) Ethyne, HC≡CH (1)

(b) Butane-2,3-diol , $CH_3CH(OH)CH(OH)CH_3$ is formed (1)

Ans 14

(a) Due to inert pair effect outer's' electron are reluctant to participate in reactions. Thus lower oxidation state is more stable. (1)

(b) BCl_3 is a symmetrical molecule. This molecule is trigonal planar without any free electron pair. Resultant dipole moment of two B-Cl bonds is cancelled by the third one. It can also be explained as due to the planar symmetrical structure, the dipole moments of three B-Cl bonds compensate eachother, thus giving zero dipole moment. (1)

Ans 15

Reduction half reaction:

Step 1:

$MnO_4^- + 5e^- \rightarrow Mn^{2+}$

Step 2: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ (1/2)

Oxidation half reaction:

Step 1:

$SO_2 \rightarrow HSO_4^- + 2e^-$

Step 2: $SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-$ (1/2)

Multiply by required coefficient and add the two equations

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4\ H_2O)$ x2

$(SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-)$ x5

Final reaction: $2MnO_4^- + 5SO_2 + 2H_2O + H^+ \rightarrow 2Mn^{2+} + 5\ HSO_4^-$ (1)

Ans 16

Number of emission lines= n(n-1)/2 (1)

= 5 x (4)/2 = 10 (1)

Ans 17

O_2 = KK $\{\sigma(2s)^2\ \sigma^*(2s)^2\ \sigma\ (2pz)^2\ \pi(2px)^2\ \pi\ (2py)^2\ \pi^*(2px)^1\ \pi^*(2py)^1\}$

Bond order= (number of bonding electrons-no. of antibonding electrons)/2

Bond order = 2

Paramagnetic (1)

O_2^{2-} = KK $\{\sigma(2s)^2\ \sigma^*(2s)^2\ \sigma\ (2pz)^2\ \pi(2px)^2\ \pi\ (2py)^2\ \pi^*(2px)^2\ \pi^*(2py)^2\}$

Bond order = 1

Diamagnetic (1)

Ans 18

Solution of alkali metals in liquid ammonia contains ammoniated electron and ammoniated ions which make the solution conducting in nature. (2)

Ans 19

(a)M = (W_B x 1000)/ (M_B x vol. of solution in mL)

= (2.52 x 1000) / (126 x 250) (1)

= 0.08 M (1)

(b) (i) 3.29×10^3

(ii) 0.0326 (1)

Ans 20

(a) Hund's rule of maximum multiplicity (1)

(b) Electronic configuration = $1s^2\ 2s^2\ 2p^6\ 3s^2 3p^6\ 3d^6$ (1)

No. of unpaired electrons = 4 (1)

Ans 21

(i) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ mol^{-1}

(ii) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g)$ $\Delta H = -241.8$ kJ mol^{-1}

(iii) $2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$ $\Delta H = +52.3$ kJ mol^{-1} (1)

Required equation is

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$ $\Delta H = ?$ (1)

2 x eq (i) +2 x eq (ii) - eq (iii) gives

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$

$\Delta H = 2(-393.5) + 2(-241.8) - 52.3$

= - 1322.9 kJ mol^{-1} (1)

Ans 22

(a) Sewage water (1)

(b) Carbon dioxide and methane (1)

(c) Primary pollutants get converted into various other pollutants by various chemical changes. The new products formed are called secondary pollutants. (1)

Ans 23

(i) Electrophiles are the positively charged or electron deficient species.

Example - BF_3, CH_3^+ (1½)

(ii) Compounds having same molecular formula but differ in the position of substituent or functional group on the carbon skeleton.

CH_3-CH(OH)-CH_3 & CH_3-CH_2-CH_2-OH (1½)

Ans 24

To determine the volume of H_2SO_4 used

Volume of acid taken = 100 mL of M/10 H_2SO_4 = 10 mL of 1M H_2SO_4

Volume of alkali used for neutralization of excess acid ≡ 160 mL of

M/10 NaOH = 16 mL of 1M NaOH

Now 1 mole of acid neutralises 2 mole of NaOH

So 16 ml of NaOH ≡ 8 mL of H_2SO_4

Volume of acid used by ammonia = 10 - 8 = 2 mL

To determine the percentage of nitrogen

1 mole of H_2SO_4 neutralizes 2 mole of NH_3

2 mL of 1M of H_2SO_4 ≡ 4 mL of 1M NH_3

but 1000 mL of 1M NH_3 contain Nitrogen = 14 g

Then 4 mL of 1M NH_3 will contain Nitrogen = 14 x 4 /1000 = 0.056g (1/2)

But this much of amount of nitrogen is present in 0.50 g of the organic compound

Then % of N_2 = (0.056 / 0.5) x100 = 11.2 % (1)

So, sunita is right since percentage of N = 11.2% (1/2)

Values associated: Good knowledge of chemistry and helping and caring nature for friends. (1)

Ans 25

(a) PCl_5: 5 bond pairs trigonal bipyramidal (1)

XeO_3: 3 bond pairs and 1 lone pair, trigonal pyramidal (1)

(b) Because of resonance all bonds possess partial double bond character hence bond lengths are equal. (1)

OR

(a)Hybridization of S atom in SF_4 is sp^3d (1)

Hybridization of S atom in SO_4^{2-} is sp^3 (1)

(b) Due to intermolecular H-bonding, water has a high boiling point. (1)

Ans 26

Van der Waals parameter 'a' is the measure of intermolecular forces while 'b' is the measure of effective size of gas particles. (1)

Unit of a = bar L^2 mol^{-2}

Unit of b = L mol^{-1} (1)

(b) At OK or -273^oC, volume of the gas will be zero which is not possible. (1)

Ans. 27

(i) 1 mole of C_2H_6 contains 2 moles of carbon.

Therefore, number of moles of carbon in 3 moles of C_2H_6 =6 (1)

(ii) 1 mole of C_2H_6 contains 6 moles of atoms of hydrogen.

Therefore, number of moles of hydrogen atoms in 3 moles of C_2H_6 = 3 x 6 =18 (1)

(iii) 1 mole of C_2H_6 = 6.022 x10^{23} molecules

Therefore, number of molecules in 3 mole of C_2H_6 = 3 x 6.022 x 10^{23}

= 1.807 x 10^{23} molecule (1)

Ans.28

(a) (i) Group II cations have low K_{sp}. In the presence of HCl, degree of dissociation of H_2S is suppressed so only Group II is precipitated.

$HCl \rightarrow H^+ + Cl^-$

$H_2S \rightleftharpoons 2H^+ + S^{2-}$ (1)

F is more electronegative than O. Hence H-F bond is more polar thereby HF is more acidic. (1)

(b) $C_2H_6\,(g) \rightleftharpoons C_2H_4\,(g) + H_2\,(g)$

Initial preassure	4.0 atm	0 atm	0 atm
At Equilibrium	4 - p	p	p

(1)

$K_p = (p \times p) / (4-p)$ (1)

$= 0.04$ (1)

OR

(a)pH would increase. Due to common ion effect degree of dissociation of weak acid is suppressed causing pH to increase. (2)

(b) $K_c = [CO_2(g)]$ (1)

(c) No effect of catalyst (1)

Equilibrium will shift towards backward direction. (1)

Ans 29

(a) Pentan-3-one & methanal (1)

(b) For alkanes containing odd number of carbon atoms a mixture of two alkyl halides has to be used since two alkyl halides can react in three different ways therefore gives mixture of three different alkanes. (1)

$CH_3\text{-}Br + Br\text{-}CH_2\text{-}CH_3 \rightarrow CH_3\text{--}CH_2\text{-}CH_3$

$CH_3\text{-}Br + Br\text{-}CH_3 \rightarrow CH_3\text{-}CH_3$

$CH_3\text{-}CH_2\text{-}Br + Br\text{-}CH_2\text{-}CH_3 \rightarrow CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3$ (1)

(c) CH_3CO^+ (1)

(d) ethene (1)

OR

(a) (i) $CH_3\text{-}CH_2C(OH)\text{-}(CH_3)_2$ (1)

(ii) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2Br$ (1)

(iii) C_6H_5Cl (1)

(b) (i) Planarity

(ii) Complete delocalization of the π electrons in the ring

(ii) Presence of $(4n+2)$ π electrons in the ring where n is an integer (n = 0,1,2,…)

(1)

Ans 30

(a)

(i) Because it has +3 and 0 oxidation states also which are more stable (1)

$Ga^{+} \rightarrow Ga + Ga^{+3}$

(ii) It is a lewis acid (1)

(iii) Due to absence of d orbital (1)

(b)

(i) $Sn + 2\ H_2O \xrightarrow{\Delta} SnO_2 + 2H_2$ (1)

(ii) $2BF_3 + 6NaH \rightarrow B_2H_6 + 6NaF$ (1)

OR

(a) $2Al + 6HCl \rightarrow 2Al^{3+} + 6Cl^{-} + 3\ H_2$ (Basic nature of Aluminium) (1)

$Al + 2NaOH \rightarrow Na_2AlO_2 + H_2$ (Acidic nature of aluminium) (1)

(b) (i) It forms aluminium oxide on the surface so Al becomes passive. (1)

(ii) Due to increase in size which is due to screening effect provided by core electrons.

(1)

(iii) It does not behave as a protonic acid rather as Lewis acid and accepts hydroxyl ion from water.

(1)