CBSE Board
Class XI Chemistry

Time: 3 Hours **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.

Q. 1 Explain why o- nitrophenol has a lower boiling point than p – nitrophenol? [1]

Q. 2 Out of CO_2 and BF_3, which one of them will have a larger bond angle and why? [1]

Q. 3 Which of the following will be a state function? [1]

(i) Distance travelled in climbing the hill

(ii) Energy change in climbing the hill

Q. 4 When sodium hydride is electrolyzed; hydrogen gas is liberated at which electrode? [1]

Q. 5 Why are alkali metals used in photoelectric cells?

Q. 6 Is the eclipsed conformation of propane has the same or different energy as the eclipsed conformation of ethane? [1]

Q. 7 Which of the two - $O_2NCH_2CH_2O^-$ or $CH_3CH_2O^-$ is expected to be more stable and why? [1]

Q. 8 Due to which compound, ozone depletion is caused in Antarctica? [1]

Q. 9 Among the elements B, Al, C and Si: [2]

(a) Which has the highest first ionization enthalpy?

(b) Which has the most negative electron gain enthalpy? Give reason.

Q. 10 Which of the following statements related to the modern periodic table is incorrect and why? [2]

(a) Each block contains a number of columns equal to the number of electrons that can occupy that sub shell.

(b) The d - block has 8 columns, because a maximum 8 electrons can occupy all the orbitals in d - sub shell.

OR

(a) Write the atomic number of the element present in the third period and seventeenth group of the periodic table.

(b) Out of the elements Cr (Z = 24), Mg (Z=12) and Fe (Z =26), identify the element with five electrons in 3d sub shell.

Q. 11 The drain cleaner contains small bits of aluminium which react with caustic soda to produce dihydrogen gas. What volume of dihydrogen at 20°C and one

bar pressure will be released when 0.15 g of aluminium reacts. [2]

Q. 12 Critical temperature of ammonia and carbon dioxide are 405.5 K and 304.10 K respectively. Which these gases will liquefy first when you start cooling from 500K to their critical temperature [2]

Q. 13 Consider the reaction of water with F_2 and suggest, in terms of oxidation and reduction, which species are oxidized/ reduced. [2]

Q. 14 An element 'A' belongs to group 2 of the periodic table. It shows anomalous behaviour from the rest of the elements of its group. It shows a diagonal relationship with another element 'B'. Chlorides of both 'A' and 'B' have bridged structure in vapour phase. Identify A and B and draw the structures of their respective chlorides. [2]

Q. 15 A metal 'X' is present in chlorophyll. Identify the metal 'X'. How does this metal react with N_2? [2]

Q. 16 Calculate the mass percent of different elements in sodium sulphate,(Na_2SO_4 [2]

Q. 17 A compound (C_7H_{14}) on ozonolysis gives ethanal and pentan–3- one. What is the structure of alkene? [2]

Q. 18 Why does the rain water normally have a pH of about 5.6? When does it become acid rain? [2]

Q. 19 Calculate the molarity of a solution of ethanol in water in which the mole fraction of ethanol is 0.40. [3]

Q. 20 Kavita was playing a game with her friends. As a part of the game they asked her to express a wish. She said that she wanted to be able to see the atom. Atomic dimensions are from 10^{-12} m and nucleus is 10^{-15} m; visible range in the electromagnetic spectrum is for wavelengths in the range of 10^{-7}m. As a student of chemistry [3]

a. Describe how the world would look for kavita if she is granted her wish.
b. What value can you draw from this?

Q. 21 (a) The 4f sub shell of an atom contains 12 electrons. What is the maximum number of electrons having the same spin in it? [3]

(b) Explain the meaning of $4p^6$.

(c) Write the electronic configuration of the atom with atomic number

OR

(a) Calculate the total number of electrons present in one mole of methane.

(b) An atomic orbital has n = 3. What are the possible values of l and m_l ?

Q. 22 Explain the hybridisation of SF_4 ? [3]

Q. 23 (a) Write the expression for equilibrium constant for the reaction: [3]

$$H_2\ g + I_2\ s \rightleftharpoons 2HI\ g$$

(b) Calculate the pH of a buffer solution containing 0.2 mole of NH_4Cl and 0.1 mole of NH_4OH per litre. Given K_b for $NH_4OH = 1.85 \times 10^{-5}$

Q. 24 Consider the reaction: [3]

$2SO_2\ g + O_2\ g \rightleftharpoons 2SO_3\ g + 189.4\,kJ$. Indicate the direction in which the equilibrium with shift when:

(a) Temperature is increased

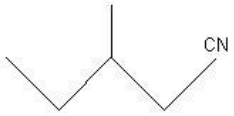
(b) Pressure is increased

(c) Concentration of SO_2 is increase

Q. 25 Balance $P + HNO_3 \longrightarrow H_3PO_4 + NO_2 + H_2O$ by oxidation number method. [3]

Q. 26 Write the IUPAC names of: [3]

(a)



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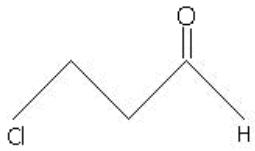

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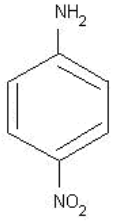


Q. 27 (a) Arrange the following carbanions in the increasing order of their stability:-

$CH_3\ _3\bar{C}, CH_3\bar{C}H_2, \bar{C}H_3, CH_3\ _2\bar{C}H$ [3]

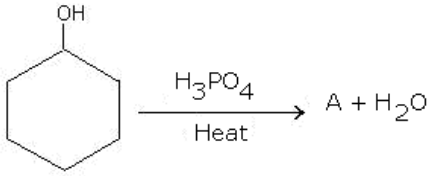
(b)What is the hybridisation of the negatively charged carbon atom in a carbanion?

Q. 28 (a) Compound 'A' with the molecular formula C_5H_8 reacts with hydrogen in the presence of Lindlar's catalyst to form a compound B with the molecular formula C_5H_{10}. A on reacting with sodium in liquid ammonia forms a compound 'C' with the same molecular formula as that of B. Identify 'A', 'B' and 'C'. Give the chemical reactions involved. [5]

(b) Write the chemical reaction involved in Kolbe's electrolytic process.
What are the products formed at cathode and anode?

OR

(a) Complete the reactions and identify A, B and C.



$CH_3CH = CH_2 + HBr \longrightarrow B$

$\downarrow$ (i) O_3 (ii) Zn/H_2O

C + HCHO

$CaC_2 + H_2O \rightarrow Ca(OH)_2 + E$

Q. 29 For the reaction $NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g)$ at 25°C, enthalpy change $\Delta H = +177\ kJ\,mol^{-1}$ and entropy change $\Delta S = +285\,JK^{-1}\,mol^{-1}$. Calculate free energy change ΔG at 25°C and predict whether the reaction is spontaneous or not. [5]

OR

Calculate the enthalpy of formation of benzene, using the following data-

$C_6H_6(l) + \frac{15}{2}O_2(g) \longrightarrow 6\,CO_2(g) + 3H_2O(l) \quad \Delta_C H^\theta = -3266.0\,kJ$

$C(s) + O_2(g) \longrightarrow CO_2(g) \quad \Delta_f H^\theta = -393.1\ kJ$

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l) \quad \Delta_f H^\theta = -286.0\ kJ$

Q. 30 Explain giving reasons for the following: [5]

a. Boron does not form B^{3+} ions.
b. Molten aluminium bromide is a poor conductor of electricity.
c. BCl_3 is more stable than $TlCl_3$.
d. B-Cl bond has a dipole moment but BCl_3 has zero dipole moment.
e. Al is used to make transmission cables.

OR

Explain the following reactions:

a. Silicon is heated with methyl chloride at high temperature in the presence of copper powder
b. CO is heated with ZnO
c. Reaction of boron trifluoride with $LiAlH_4$ in diethyl ether
d. Reaction of boron trifluoride with sodium hydride at 450 K
e. Reaction of diborane and water

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Solution

Ans1. This is because o – nitro phenol has intramolecular hydrogen bonding where as p-nitro phenol has intermolecular hydrogen bonding. [1]

Ans2. CO_2 has a larger bond angle than BF_3. This is because CO_2 has a linear shape and the bond angle is 180^o, BF_3 on the other hand has a trigonal planar geometry and hence the bond angle is 120^o. [1]

Ans3. Energy change in climbing the hill is a state function. This is because it is independent of the path followed to reach the state. [1]

Ans4. $NaH \xrightarrow{\text{electrolysis}} Na^+ + H^-$ [1]

At anode: $2H^- - 2e^- \longrightarrow H_2(g)$

Ans5. Alkali metals have low ionization energies. They can lose electrons when light falls on them, and hence are used in photo electric cells. [1]

Ans6. The eclipsed conformation of propane is less stable and has more energy than the eclipsed conformation of ethane. This is because in propane there are additional interactions between C-H and C-C bond of methyl group. [1]

Ans7. $O_2NCH_2CH_2O^-$ will be more stable because $-NO_2$ group has electron withdrawing inductive effect or – I effect. [1]

Ans8. In Antarctica, ozone depletion is due to the formation of chlorine nitrate. [1]

Ans9. (a) C will have the highest first ionization enthalpy since it has the smallest size and highest effective nuclear charge. [1]

(b) C will have the most negative electron gain enthalpy because of its small size. [1]

Ans10. Statement a is correct and b is incorrect.
Statement b is incorrect because d sub shell can have a maximum of 10 electrons. Therefore it has 10 columns and not 8. [2]

OR

(a) Since the element is in the third period $\therefore n = 3$

The element is in the seventeenth group

$\therefore$ The outermost configuration is: $3s^2 3p^5$

Therefore, the atomic number of the atom is 17.

(b) Cr (Z=24) has 5 electrons in the d sub shell. Its electronic configuration is:
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Ans11. [2]

$$2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$$

2×27 $3 \times 22.4\ L$

$= 54\ g$

$54\ g$ of Al give H_2 $= 3 \times 22.4\ L$

$$0.15\ g \text{ of Al gives } H_2 = \frac{3 \times 22.4}{54} \times 0.15$$

$$= 0.186\ L$$

So, 0.186 L will be released at 1 bar pressure and 273 K. To calculate volume of H_2 at 20°C and 1 bar pressure,

$V_1 = 0.186\ L$ $V_2 = ?$

$T_1 = 273\ K$ $T_2 = (20°C + 273)\ K = 293\ K$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_2 = \frac{0.186 \times 293}{273} = 0.1996\ L = 199.6\ mL$$

Ans12. Ammonia will liquefy first because its critical temperature will be reached first. Liquefaction of CO_2 will require more cooling. [2]

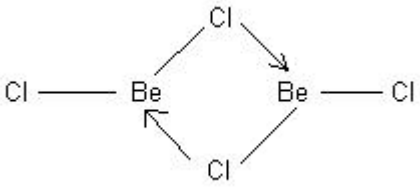
Ans13. $2H_2O + 2F_2 \longrightarrow 4HF + O_2$ [2]

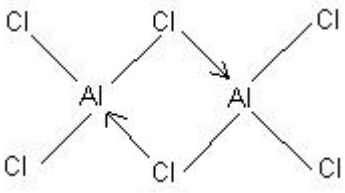
F_2 is the oxidizing agent and H_2O is reducing agent.

H_2O is getting oxidized to O_2 whereas F_2 is getting reduced to F^- ion.

Ans14. A is Beryllium (Be)

B is Aluminum (Al) [2]





Ans15. Mg is present in chlorophyll. [2]

N_2 reacts with Mg to form magnesium nitride.

$$3Mg + N_2 \longrightarrow Mg_3N_2$$

Magnesium nitride

Ans16. Molar mass of Na_2SO_4= (2 x 23)+32+(4 x 16)=142 g mol^{-1} [2]

$$\text{Mass \% of sodium} = \frac{2 \times 23}{142} \times 100 = 32.39\%$$

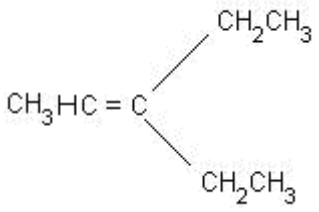
$$\text{Mass \% of sulphur} = \frac{32}{142} \times 100 = 22.53\%$$

Mass % of oxygen = $\frac{4 \times 16}{142} \times 100 = 45.07\%$

Ans17. [2]

$$C_7H_{14} \xrightarrow{\text{Ozonolysis}} \underset{\text{Ethanal}}{CH_3CHO} + \underset{\text{Pentan - 3 - one}}{CH_3CH_2\overset{\overset{O}{\|}}{C}CH_2CH_3}$$

Therefore the structure of the compound will be –



(1)

Ans18. Normally, rain water has a pH of about 5.6 due to the dissolution of CO_2 of the atmosphere into it. [2]

$H_2O(l) + CO_2 \longrightarrow H_2CO_3$

$H_2CO_3 \longrightarrow 2H^+ + CO_3^{2-}$

When the pH of rain water falls below 5.6, it becomes acid rain.

Ans19. $x_{C_2H_5OH} = \frac{n_{C_2H_5OH}}{n_{C_2H_5OH} + n_{H_2O}}$ [3]

For dilute solution, 1 L of solution can be nearly equal to 1 L of water.

$n_{H_2O} = \frac{1000}{18} = 55.55$ moles

$\frac{n_{C_2H_5OH}}{n_{C_2H_5OH} + 55.55} = 0.040$

$n_{C_2H_5OH} = 2.31$ moles

Ans20. (a) Atom is empty space. Being able to see the atom and structure of the atom itself means looking at empty space. Hence all of us will be seen as empty space. The wall will be seen as empty space. You and I will be seen as empty space. Hence, kavita will not be able to see anything. In any other words she will be blind.

(b) Praise to the almighty who has limited our abilities such that we are able to enjoy this colourful world. [3]

Ans21. (a) 7 [3]

(b)This means that 6 electrons are present in p sub shell of the 4^{th} shell

(c) Z =29

Electronic configuration $1s^2\ 2s^2 2p^6 3s^2 3p^6\ 3d^{10}\ 4s^1$

OR

(a) Number of electrons in 1 molecule of methane = 6 + 4 =10 electrons

Number of molecules in 1 mole of methane = 6.022×10^{23} molecules of methane

Number of electrons in 1 mole of methane $= 6.022 \times 10^{24}$ electrons

(b) n = 3

$l = 0\ to (n-1)$

= 0, 1, 2

For $l = 0$,

$m_l = 0$

For $l = 1$

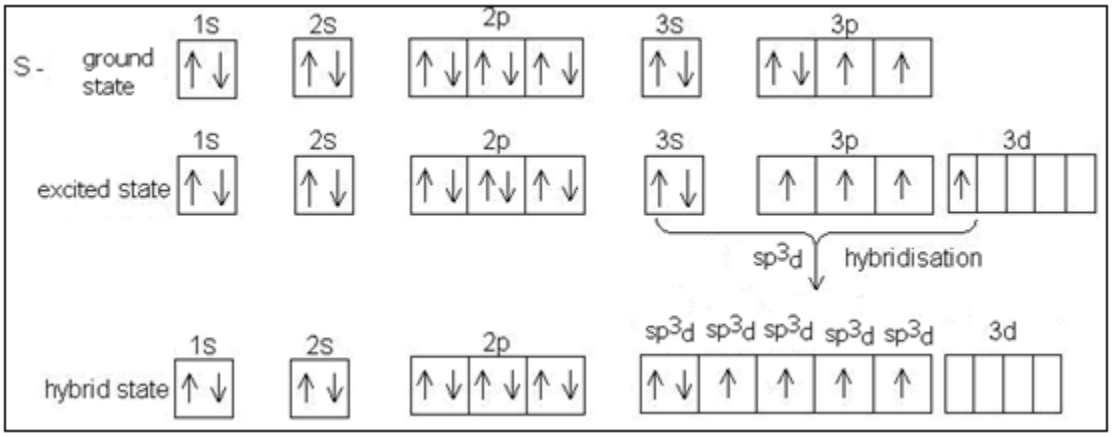
$m_l = -1, 0, +1$

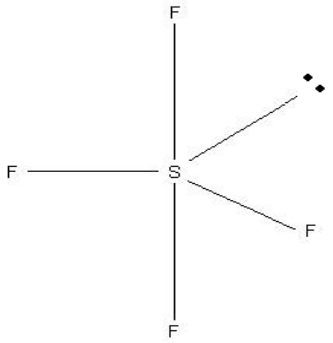
For $l = 2$

$m_l = -2, -1, 0, +1, +2$

Ans22. The electronic configuration of $S = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

Sulphur undergoes sp^3d hybridisation. [3]





Ans23. (a) $K = \frac{[HI]^2}{[H_2]}$ [3]

(b) According to Henderson's equation,

$$pOH = pK_b + \log\frac{[salt]}{[base]}$$

Also, $pK_b = -\log K_b$

$$= -\log 1.85 \times 10^{-5} = 4.733$$

$$pOH = 4.733 + \log\frac{0.2}{0.1}$$

$$= 4.733 + 0.3010 = 5.034$$

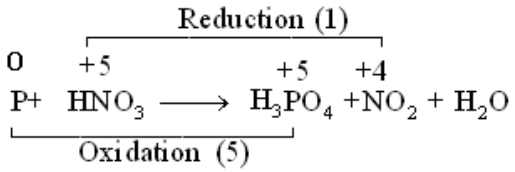
$$pH = 14 - pOH = 14 - 5.034 = 8.966$$

Ans24. (a) The equilibrium will shift the backward direction as the increase in temperature will be compensated by absorbing heat. It is an exothermic reaction. [3]

(b) The equilibrium will shift in the forward direction since the reaction will shift to the direction of lesser number of moles.

(c) The equilibrium will shift in the forward direction so that additional SO_2 is used up.

Ans25.



$$P + 5\,HNO_3 \longrightarrow H_3PO_4 + 5\,NO_2 + H_2O$$

O = 15 O =15

H = 5 H = 5

Oxygen and Hydrogen atoms are balanced.

Ans26. (a) 3 – Methylpentanenitrile [3]

(b) 3-Chloropropanal

(c) 4- Nitroaniline

Ans27. (a) Order of stability [3]

$$CH_3\overset{-}{C}, \; CH_3CH_2\overset{-}{C}H, \; CH_3\overset{-}{C}H_2, \; \overset{-}{C}H_3$$

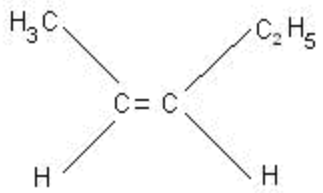
This is because $-CH_3$ group has electron releasing inductive effect or +I effect. Due to this, electron density increases on the negatively charged carbon and hence makes it more unstable. As the number of methyl groups increases the instability increases.

(b) The negatively charged carbon atom in a carbanion is sp^3 hybridised

Ans28. Compound A is $H_3C-C\equiv C-C_2H_5$ [5]

$$H_3C - C \equiv C - C_2H_5 + H_2 \xrightarrow{Pd\,/\,C}$$

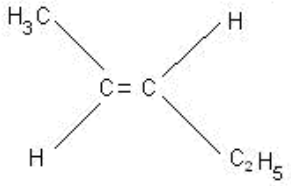
A



cis – isomer

(B)

$$H_3C - C \equiv C - C_2H_5 + H_2 \xrightarrow{Na \text{ in liq. } NH_3}$$



trans - isomer

(C) (1)

(b) <u>Kolbe's electrolytic method</u> –

$$2CH_3COO^- Na^+ + 2H_2O \xrightarrow{\text{electrolysis}} CH_3CH_3 + 2CO_2 + H_2 + 2NaOH$$

Mechanism:

$$2CH_3 - \overset{O}{\overset{\|}{C}} - O^-Na^+ \rightleftharpoons 2CH_3 - \overset{O}{\overset{\|}{C}} - O^- + 2Na^+$$

At anode:

$$2CH_3 - \overset{O}{\overset{\|}{C}} - O^- \xrightarrow{-2e^-} 2CH_3 - \overset{O}{\overset{\|}{C}} - O \text{ ®} \quad 2\dot{C}H_3 + 2CO_2$$

$$H_3\dot{C} + \dot{C}H_3 \rightarrow H_3C - CH_3$$

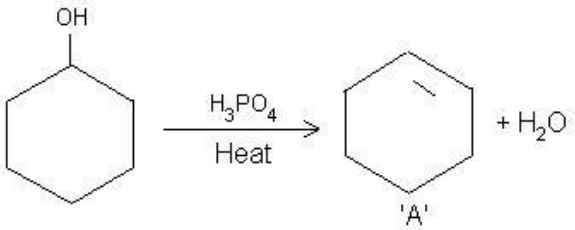
At cathode:

$$H_2O + e^- \rightarrow {}^-OH + \dot{H}$$

$$2\dot{H} \rightarrow H_2 \uparrow$$

At cathode hydrogen is liberated. At anode ethane is formed.

OR



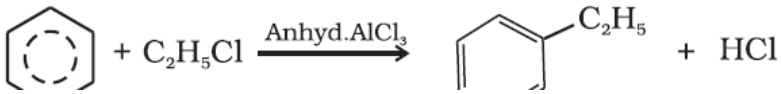
$CH_3CH = CH_2 + HBr \longrightarrow CH_3\underset{\underset{Br}{|}}{C}HCH_3$

'B'

$\downarrow$ (i) O_3 (ii) Zn/H_2O

$CH_3CHO + HCHO$

'C'



c. B exhibits +3 oxidation state and can form stable BCl_3. Thallium shows +3 oxidation state as well as +1 oxidation state but +1 oxidation state is more predominant than +3 oxidation state because of inert pair effect. Therefore, $TiCl_3$ is not stable. It can form stable TiCl.

d. BCl_3 molecule has a symmetrical trigonal planar structure in which three B-Cl bonds are oriented at an angle of 120° to one another. The three bonds lie in one plane and the dipole moments of these bonds cancel one another giving net dipole moment zero.

e. Electrical conductivity of Aluminium is twice as that of copper. On mass to mass basis, Al conducts electricity twice as Cu. Therefore, it is used in transmission cables.

OR

a.

$$2\,CH_3Cl + Si \xrightarrow[570K]{\text{Cu powder}} (CH_3)_2SiCl_2$$

Dichlorodimethyl silicon

b. $ZnO + CO \xrightarrow{\Delta} Zn + CO_2$

c. $4BF_3 + LiAlH_4 \xrightarrow{\text{diethyl ether}} 2B_2H_6 + 3LiF + 3\,AlF_3$

d. $2\ BF_3 + 6\ NaH \xrightarrow{450\,K} B_2H_6 + 6\ NaF$

e. $B_2H_6 + 6\,H_2O \longrightarrow 2\,H_3BO_3 + 6\,H_2$

Boric acid