CBSE Class 11 Chemistry

Sample Paper 04 (2020-21)

Maximum Marks: 70

Time Allowed: 3 hours

General Instructions:

i. There are 33 questions in this question paper. All questions are compulsory.
ii. Section A: Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
iii. Section B: Q. No. 17 to 25 are short answer questions and carry 2 marks each.
iv. Section C: Q. No. 26 to 30 are short answer questions and carry 3 marks each.
v. Section D: Q. No. 31 to 33 are long answer questions carrying 5 marks each.
vi. There is no overall choice. However, internal choices have been provided.
vii. Use of calculators and log tables is not permitted.

Section A

1. **Read the following passage and answer the following questions:**

Lithium shows anomalous behaviour, there is increased covalent character of lithium compounds which is responsible for their solubility in organic solvents. Further, lithium shows a diagonal relationship with magnesium. Lithium nitrate when heated gives lithium oxide, Li_2O, whereas other alkali metal nitrates decompose to give the corresponding nitrite

$$4LiNO_3 \xrightarrow{heat} \underset{Lithium\ oxide}{2Li_2O} + 4NO_2 + O_2$$

$$2NaNO_3 \xrightarrow{heat} 2NaNO_2 + O_2$$

Lithium is the least reactive but the strongest reducing agent among all the alkali metals. On combustion in excess of air, lithium forms mainly the oxide, Li_2O (plus some peroxide Li_2O_2), sodium forms the peroxide, Na_2O_2 (and some superoxide NaO_2) whilst potassium, rubidium and caesium from the superoxides, MO_2. The alkali metal halides, MX, (X=F, Cl, Br, I) are all high melting, colourless crystalline solids. They can be prepared by the reaction of the appropriate oxide, hydroxide or carbonate with aqueous hydrohalic acid (HX).

i. Why lithium shows anomalous behaviour?
   a. the small size of its atom and ion
   b. high polarising power
   c. both (a) and (b)
   d. none of these
ii. The melting and boiling point always follow
   a. F > C > B > I
   b. F > I > B > C
   c. B > C > I > F
   d. B > C > I > F

OR

Why LiF has low solubility?
   a. due to high lattice enthalpy
   b. due to low lattice enthalpy
   c. due to high hydration enthalpy
   d. due to low hydration enthalpy
iii. Halides of lithium are soluble in
   a. ethanol
   b. acetone
   c. ethylacetate
   d. all of these
iv. Why is KO_2 paramagnetic?
   a. due to one unpaired electron in π^*2p molecular orbital
   b. due to two unpaired electron in π^*2p molecular orbital
   c. due to four unpaired electron in π^*2p molecular orbital
   d. none of these

2. **Read the passage and answer the following questions:**

A large number of orbitals are possible in an atom. Qualitatively these orbitals can be distinguished by their size, shape and orientation. An orbital of smaller size means there is more chance of finding the electron near the nucleus. Similarly, shape and orientation mean that there is more probability of finding the electron along with certain directions than along others. The principal quantum number determines the size and to large extent the energy of the orbital. Azimuthal quantum number, 'l' is also known as orbital angular momentum or subsidiary quantum number. It defines the three-dimensional shape of the orbital. Each shell consists of one or more subshells or sub-levels. The number of sub-shells in a principal shell is equal to the value of n. Magnetic orbital quantum number. 'ml ' gives information about the spatial orientation of the orbital with respect to a standard set of co-ordinate axis. The fourth quantum number is known as the electron spin quantum number (m_s). An electron spins around its own axis, much in a similar way as the earth spins around its own axis while revolving around the sun.

In these questions, a statement of assertion followed by the statement of reason is given. Choose the correct answer out of the following choices:

a. Assertion and reason both are correct statements and reason is the correct explanation for assertion.
b. Assertion and reason both are correct statements and reason is not the correct explanation for assertion.
c. Assertion is the correct statement but reason is wrong statement.
d. Assertion is the wrong statement but reason is correct statement.

i. **Assertion:** Each orbital is designated by three quantum numbers labelled as n, l and m_l.

   Reason: 'n' is a positive integer with value of n = 1,2,3.

ii. **Assertion:** The principal quantum number identifies the shell.

   Reason: Size of an orbital decrease with the increase of principal quantum number 'n'.

iii. **Assertion:** For n = 2, the possible value of l can be 0 and 1.

   Reason: For a given value of n, l can have n values ranging from 0 to n – 1.

iv. **Assertion:** Each orbital in an atom, is defined by a set of values for n, l and m_l.

   Reason: m_l designates the orientation of the orbital.

OR

   Assertion: Spin quantum numbers m_s can take the values of +½ or –½.

   Reason: Two spin states of the electron and are normally represented by two arrows,

↑ (spin down) and ↓ (spin up).

3. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.

Student	Readings	
A	3.01	2.99
B	3.05	2.95

   a. Results of student B are neither precise nor accurate.
   b. Results of student B are both precise and accurate.
   c. Results of student A are both precise and accurate.
   d. Results of both the students are neither accurate nor precise.

4. According to the quantum-theoretical model of an atom, each orbital is designated by three quantum numbers labelled as n, l, and ml. These are referred to respectively as:
   a. Azimuthal quantum number or orbital angular momentum, Principal quantum number, and Magnetic orbital quantum number.
   b. Principal quantum number, Azimuthal quantum number or orbital angular momentum and Magnetic orbital quantum number.
   c. Principal quantum number, Azimuthal quantum number or orbital angular momentum and spin quantum number
   d. Azimuthal quantum number or orbital angular momentum, Principal quantum number, and spin quantum number.

OR

The formula $E = h\nu$ is used to calculate

   a. wave number
   b. energy of the ejected electrons
   c. radiation emitted by a black body
   d. energy of quantum

5. Majority of the reactions of alkynes are examples of:
   a. Electrophilic addition
   b. Nucleophilic addition

c. Electrophilic substitution

d. Nucleophilic substitution

6. The pressure-volume work for an ideal gas can be calculated by using the expression w = $-\int_{V_i}^{V_f} p_{ex}\, dV$. The work can also be calculated from the pV–plot by using the area under the curve within the specified limits. When an ideal gas is compressed (a) reversibly or (b) irreversibly from volume Vi to Vf. choose the correct option.

a. w (reversible) < w (irreversible)

b. w (reversible) > w (irreversible)

c. w (reversible) = w (irreversible)

d. w (reversible) = w (irreversible) + $p_{ex} \cdot \Delta V$

OR

Given $N_2(g) + 3H_2(g) \rightarrow NH_3(g)$; $\Delta_r H° = -92.4$ kJ mol^{-1}. What is the standard enthalpy of formation of NH_3 gas?

a. -41.3 kJ mol^{-1}

b. -46.2 kJ mol^{-1}

c. -56.5 kJ mol^{-1}

d. -36.9 kJ mol^{-1}

7. Lithium has the most negative E^0 value, its reaction with water is less vigorous than that of sodium which has the least negative E^0 value among the alkali metals. The reason is:

a. low hydration energy of Li

b. it is a strong reducing agent

c. small size of Li

d. it is a proton donor

OR

Choose the correct statements from the following.

A. Beryllium is not readily attacked by acids because of the presence of an oxide film on the surface of the metal.

B. Beryllium sulphate is insoluble in water as the greater lattice enthalpy factor of Be^{2+} overcomes the hydration enthalpy.

C. Beryllium exhibits a coordination number of more than four.

D. Beryllium oxide is purely acidic in nature.

a. (B)
b. (D)
c. (A)
d. (C)

8. The boiling point of isomeric branched chain alkene is:
   a. lower than the boiling point of straight chain alkene.
   b. higher boiling point than straight chain alkenes.
   c. same boiling point as straight chain alkenes except for optical isomers.
   d. same boiling point as straight chain alkenes.
9. The electrons present in the outermost shell are called
   a. Valency electrons
   b. Valence electrons
   c. Octate electrons
   d. Duplet electrons
10. In the alkene having IUPAC name 3-Methyl-1-butene the double bond lies on carbon atom numbered ______.
    a. 1
    b. 2
    c. 4
    d. 3
11. In case of a heteronuclear molecule like HF, the shared electron pair between the two atoms gets displaced more towards fluorine since the electronegativity of fluorine is far greater than that of hydrogen. This results in the molecule a
    a. dipole moment
    b. resonance hybrid
    c. Lewis structure
    d. resonance
12. **Assertion:** Empirical formula of glucose is HCHO.

    Reason: Molecular formula of glucose will also be equal to HCHO.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

13. **Assertion:** Carbon dioxide has linear geometry involving sp hybridisation of C.
Reason: Dry ice is solid CO_2.
a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

14. **Assertion (A):** Gases do not liquefy above their critical temperature, even on applying high pressure.
Reason (R): Above the critical temperature, the molecular speed is high and intermolecular attractions cannot hold the molecules together because they escape because of high speed.
a. Both A and R are true and R is the correct explanation of A.
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

OR

Assertion: A lighter gas diffuses more rapidly than a heavier gas.
Reason: At a given temperature, the rate of diffusion of a gas is inversely proportional to the square root of its density.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

c. Assertion is CORRECT but, reason is INCORRECT.

d. Assertion is INCORRECT but, reason is CORRECT.

15. **Assertion:** Redox reactions are also called neutralisation reactions.

    Reason: The number of electrons gained or lost in the reaction are balanced.

    a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

    b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

    c. Assertion is CORRECT but, reason is INCORRECT.

    d. Assertion is INCORRECT but, reason is CORRECT.

16. **Assertion (A):** Among isomeric pentanes, 2, 2-dimethylpentane has the highest boiling point.

    Reason (R): Branching does not affect the boiling point.

    a. Both A and R are correct and R is the correct explanation of A.

    b. Both A and R are correct but R is not the correct explanation of A.

    c. Both A and R are not correct.

    d. A is not correct but R is correct.

Section B

17. Define ionization enthalpy and electron gain enthalpy.

OR

How does the reactivity of non–metals changes in a period and group?

18. How does

    i. an electron donating group (EDG) and

    ii. an electron withdrawing group (EWG) influence the acid strength of carboxylic end?

19. A reaction between ammonia and boron trifluoride is given below:

    $: NH_3 + BF_3 \rightarrow H_3N : BF_3$

    Identify the acid and base in this reaction. Which theory explains it? What is the hybridization of B and N in the reactants?

OR

A certain buffer is made by mixing sodium formate and formic acid in water. With the help of equations explain how this buffer neutralises addition of a small amount of an acid or a base?

20. Which of the following represents the correct IUPAC name for the compounds concerned?
(a) 2, 2-Dimethylpentane or 2-Dimethylpentane (b) 2, 4, 7-Trimethyloctane or 2, 5, 7-Trimethyloctane (c) 2-Chloro-4-methylpentane or 4-Chloro-2-methylpentane (d) But-3-yn-1-ol or But -4-ol-yne.

OR

Arraang the following:

i. $C_6H_5\overset{+}{C}HCH_3, C_6H_5\overset{+}{C}HCH = CH_2, C_6H_5CH_2\overset{+}{C}H_2, C_6H_5\overset{+}{C}(CH_3)_2$ in order of increasing stability.
ii. $CH_3CH_2^+, C_6H_5CH_2^+, (CH_3)_3C^+, CH_2 = CHCH_2^+$ in order of decreasing stability.
iii. $HC \equiv C^-$, $CH_2 = CH^-$, $CH_3CH_2^-$, CH_3^-, $(CH_3)_2CH^-$, $C_6H_5CH_2^-$ in order of increasing stability.

21. Consider the reaction of water with F_2 and suggest, in terms the oxidation and reduction. Which species are oxidized / reduced?
22. Give the main characteristics of isotopes.
23. How is benzene converted to benzene hexachloride?
24. Why does lithium form covalent bond unlike other alkali which forms ionic bond?
25. Why ClO_4^- does not show disproportionation reaction whereas ClO^-, ClO_2^-, ClO_3^- shows?

Section C

26. One mole of CO_2 occupies 1.5 L at 25°C. Calculate the pressure exerted by the gas using
i. Ideal gas equation
ii. van der Waals' gas equation with a = 3.6 L^2 bar mol^{-2} and b = 0.04 L mol^{-1}

OR

Pressure of 1 g of an ideal gas A at 27°C is found to be 2 bar. When 2 g of another ideal gas B is introduced in the same flask at same temperature, the pressure becomes 3 bar. Find the relationship between their molecular masses.

27. Calculate the number of atoms in each of the following.
    i. 52 mole of Ar
    ii. 52 u of He
    iii. 52 g of He

OR

The density of water at room temperature is 1.0g / mL.
How many molecules are there in a drop of water if its volume is 0.05 mL?

28. Write down the products of ozonolysis of 1, 2-dimethylbenzene (o-xylene). How does the result support Kekule structure of benzene?

29. Draw the structural formulae of the following:
    1. BF_3
    2. Peroxodisulphate ion ($S_2O_9^-$)
    3. XeF_4

30. 10 g of argon is compressed isothermally and reversibly at a temperature of 27°C form 10 L to 5 L. Calculate q, W, ΔU and ΔH for this process
$R = 2.0 \text{ cal K}^{-1}\text{mol}^{-1}, \log 2 = 0.30$. Atomic weight of Ar = 40.

Section D

31. Discuss the orbital structures of the following molecules on the basis of hybridization.
    i. BH_3
    ii. C_2H_2
    iii. BeF_2

OR

Discuss the shape of the following molecules using the VSEPR model:
$BeCl_2$, BCl_3, $SiCl_4$, AsF_5, H_2S, PH_3

32. The first ionization constant of H_2S is 9.1×10^{-8}. Calculate the concentration of HS^- ions in its 0.1 M solution and how will this concentration be affected if the solution is 0.1 M in HCl also? If the second dissociation constant of H_2S is 1.2×10^{-13}, calculate the

concentration of S^{2-} under both conditions.

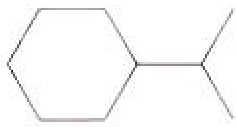
OR

At certain temperature and under a pressure of 4 atm, PCl_5 is 10% dissociated. Calculate the pressure at which PCl_5 will be 20% dissociated temperature remaining constant.

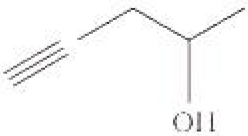
33. What is meant by hybridization? Compound $CH_2 = C = CH_2$ contains sp or sp^2 hybridized carbon atoms. Will it be a planar molecule?

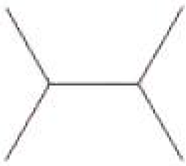
OR

Expand each of the following bond-line formulas to show all the atoms including carbon and hydrogen.

a. 

b. 

c. 

d. 

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Solution

Section A

1. i. (c) both (a) and (b)
   ii. (a) F > C > B > I

OR

(a) due to high lattice enthalpy
   iii. (d) all of these
   iv. (a) due to one unpaired electron in π^*2p molecular orbital
2. i. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.
   ii. (c) Assertion is the correct statement but reason is wrong statement.
   iii. (a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.
   iv. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.

OR

(c) Assertion is the correct statement but reason is wrong statement.
3. (c) Results of student A are both precise and accurate.
   Explanation: The average of readings of student A and B is 3.00. But the readings of student A are close to each other as well as close to average value as compare to values of student B. Hence, Results of student A are both precise and accurate.
4. (b) Principal quantum number, Azimuthal quantum number or orbital angular momentum and Magnetic orbital quantum number.
   Explanation: Quantum numbers designate specific shells, subshells, orbitals, and spins of electrons. This means that they describe completely the characteristics of an electron in an atom, i.e., they describe each unique solution to the Schrödinger equation, or the wave function, of electrons in an atom.

There are a total of four quantum numbers: the principal quantum number (n), the orbital angular momentum quantum number (l), the magnetic quantum number (m_l), and the electron spin quantum number (m_s). The principal quantum number, n, describes the energy of an electron and the most probable distance of the electron from the nucleus. In other words, it refers to the size of the orbital and the energy level an electron is placed in. The number of subshells, or ll, describes the shape of the orbital. It can also be used to determine the number of angular nodes.

The magnetic quantum number, m_l , describes the energy levels in a subshell, and m_s refers to the spin on the electron, which can either be up or down.

OR

(d) energy of quantum

Explanation: Max Planck theorized that energy was transferred in chunks known as quanta, equal to hv. The variable h is a constant equal to 6.63×10^{-34} J·s and the variable v represents the frequency in 1/s.

This equation allows us to calculate the energy of photons, given their frequency.

If the wavelength is given, the energy can be determined by first using the wave equation ($c = \lambda \times v$) to find the frequency, then using Planck's equation to calculate energy.

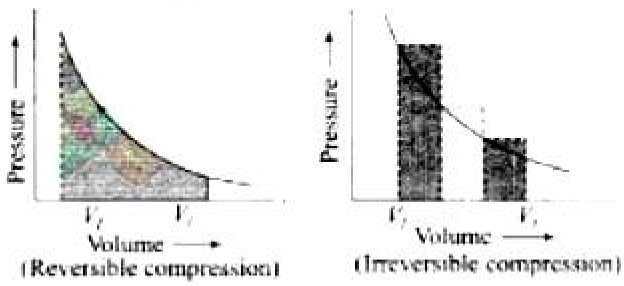
5. (a) Electrophilic addition

   Explanation: Alkynes have two pi bonds, hence they are electron rich species. They attract electrophiles thereby undergoing electrophilic addition reactions.

6. (a) w (reversible) < w (irreversible)

   Explanation: w (reversible) < w (irreversible) (for compression process)

   Justification: Area under the curve is always more in irreversible compression as can be seen from Fig (a) and (b).



OR

(b) -46.2 kJ mol^{-1}

Explanation: Given, N_2 (g) + $3H_2$ (g) $\rightarrow$ 2 NH_3 (g) ; $\Delta_r H^\circ = -92.4$ kJ mol^{-1} .

Chemical reaction for the enthalpy of formation of NH_3 (g) is as follows:

$\frac{1}{2}N_2\ (g)\ +\frac{3}{2}H_2(g)\ \rightarrow NH_3(g)$

Therefore, $\Delta_f H^\circ\ =\frac{-92.4}{2}=$ - 46.2 kJ/mol

7. (c) small size of Li

   Explanation: This behaviour of lithium is attributed to its small size and very high hydration energy. Li^+ has a maximum degree of hydration.

OR

(c) (A)

Explanation: The surface of the Beryllium metal is covered with a thin layer of oxides that helps protect the metal from attack by acid, but powdered beryllium metal dissolves readily in dilute acids.

8. (a) lower than the boiling point of straight chain alkene.

   Explanation: As the surface area decreases with branching, the boiling point also decreases.

9. (b) Valence electrons

   Explanation: Valence electrons

10. (a) 1

    Explanation: '1' is written before butene which indicates that the position of the double bond is on carbon 1. The structure of the compound is CH_2 =CHCH(CH_3)CH_3 .

11. (a) dipole moment

    Explanation: because of slight shifting of electron towards more electronegative element like F in HF brings a small amount of negative charge on F and positive charge on H which results in dipole moment.

12. (c) Assertion is CORRECT but, reason is INCORRECT.

    Explanation: Assertion is CORRECT but, reason is INCORRECT.

13. (b) Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

    Explanation: Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

14. (a) Both A and R are true and R is the correct explanation of A.

Explanation: Both A and R are correct. The reason for the assertion is also correct. Gases do not liquefy above their critical temperature even on applying high pressure because the molecular speed is high and intermolecular forces of attraction cannot hold the molecules together.

OR

(a) Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

Explanation: Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

15. (d) Assertion is INCORRECT but, reason is CORRECT.

Explanation: Assertion is INCORRECT but, reason is CORRECT.

16. (c) Both A and R are not correct.

Explanation: Both A and R are not correct.

Among isomeric pentanes 2, 2-dimethylpentane has the lowest boiling point and on branching, the boiling point decreases.

Section B

17. **Ionization enthalpy** – The minimum amount of energy required to remove an electron from an isolated gaseous atom (X) in ground state resulting in the formation of a positive ion.

$X(g) + \text{Energy} \rightarrow X^+ (g) + e^-$.

The ionization enthalpy is expressed in kJ/mol.

Electron gain enthalpy – When an electron is added to a neutral gaseous atom (X) to convert it into a negative ion, the enthalpy change accompanying the process is defined as the electron gain enthalpy.

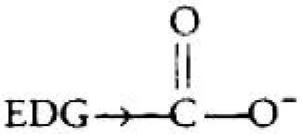
$X(g) + e^- \rightarrow X^- (g)$.

It is expressed in kJ/mol. Depending upon an element, the process of adding the electron can either be endothermic or exothermic.

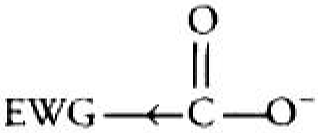
OR

The reactivity of non – metals is measured in terms of its tendency to gain electrons to form an ion. The reactivity of non – metals increases from left to right in a period because of increase in nuclear charge due to succesive addition of electron in same shell whereas reactivity decreases in a group as we go down the group because of increase in atomic size and decrease in nuclear charge. Therefore, the tendency to accept electrons decreases down the group.

18. The influence of the inductive effect on acidity is best understood in terms of the conjugate base, $RCOO^-$ and can be summarised as follows

1. 

Electron withdrawing group destabilises $RCOO^-$ because there exists a repulsion between electrons from EDG and negative charge of O. Hence, EDG weakens the acid.

2. 

Electron withdrawing group stabilities $RCOO^-$ by taking negative charge from O. Hence, EWG strengthens the acid.

19. The acid is BF_3 and the base is NH_3. The Lewis theory of acids and bases explains it. The hybridization of B in BF_3 is sp^2 and the hybridization of N in NH_3 is sp^3.

OR

According to the question, buffer is made by mixing sodium formate and formic acid in water.

Reactions:

$$\mathbf{HCOOH \rightleftharpoons HCOO^- + H^+}$$

$$\mathbf{HCOONa \longrightarrow HCOO^- + Na^+}$$

$HCOO^-$ is a common ion in the above acidic buffer.

When a small amount of OH ions are added, OH ions will combine with H^+. Also, association of HCOOH will increase to maintain the concentration of H^+ ions.

So, pH remains constant.

When a small amount of H^+ ions is added, these H^+ ions combine with $HCOO^-$ which are in excess to form HCOOH back and $[H^+]$ remains practically the same.

So, pH remains constant.

20. (a) 2, 2-Demethylpentane (b) 2, 4,7-Trimethyloctane. For two alkyl groups on the same carbon its locant is repeated twice, 2, 4, 7-locant set is lower than 2, 5, 7 . (c) 2-Chloro-4-methylpentane. Alphabetical order of substituents. (d) But-3-yn-1-ol. Lower locant for the principal functional group, i.e., alcohol.

OR

i. Increasing order of stability:

$$C_6H_5CH_2\overset{+}{C}H_2 < C_6H_5\overset{+}{C}HCH_3 < C_6H_5\overset{+}{C}(CH_3)_2 < C_6H_5\overset{+}{C}HCH = CH_2$$

ii. Decreasing order of stability:

$$(CH_3)_3C^+ > C_6H_5CH_2^+ > CH_2{=}\ CHCH_2^+ > CH_3CH_2^+$$

iii. Increasing order of stability:

$$(CH_3)_2CH^- < CH_3CH_2^- < CH_3^- < CH_2{=}CH^- < C_6H_5CH_2^- < HC \equiv C^-$$

21. $$\underset{(oxidant)}{2F_2(g)} + \underset{(Reductant)}{2H_2O(l)} \rightarrow O_2(g) + 4H^+(aq) + 4F^-(aq)$$

In the above reaction, water acts as a reducing agent and itself gets oxidized to O_2 while F_2 acts as an oxidizing agent and hence itself reduced to F^- ions.

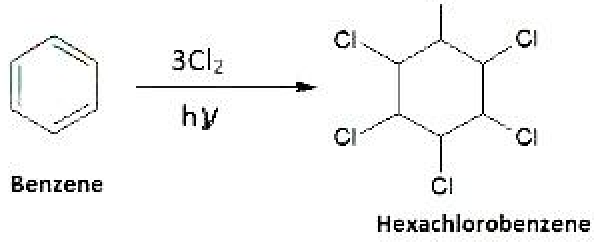
22. Isotopes shows the following characteristics:

1) Since, the isotopes have the same electronic configuration, they have almost the same chemical properties.

2) As, they have different mass numbers so they different physical properties such as boiling point, melting point etc.

3) Their rates of reactions are different mainly due to their different enthalpy of bond dissociation.

23. Under ultra-violet light, three chlorine molecules add to benzene to produce Benzene hexachloride, $C_6H_6Cl_6$ which is also called gammaxane can be produced by light-induced addition of chlorine to benzene.



24. Lithium forms covalent bond which is different from its group members because of its

anomalous behaviour Li is small in size, large charge / radius ratio and has high electro negativity value. Also, it has only $1s^2\ 2s^1$ orbital for bonding.

25. To show disproportionation reaction, an element must be present in its intermediate oxidation state, so that it can oxidised and reduced simultaneously during the reaction. In ClO_4^- ion, Chlorine atom exhibits +7 oxidation state which is its maximum oxidation state therefore it will not get further oxidised, it will get reduced only to form either its minimum oxidation state(-1) or any other state.

    In other ions, Chlorine are in its intermediate state therefore they get oxidised and reduced simultaneously during the reaction to form maximum(+7) or minimim(-1) oxidation state

Section C

26. i. According to ideal gas equation,

    pV = nRT or p = $\frac{nRT}{V}$

    n = 1 mol, T = 273 + 25 = 298 K, V = 1.5 L, R = 0.083 atm L bar K^{-1} mol^{-1}

    $\therefore p = \frac{1\text{mol}\times 0.083\text{L bar mol}^{-1}\text{K}^{-1}\times 298\text{K}}{1.5\text{L}}$

    = 16.49 bar

    ii. According to van der Waals' gas equation,

    $\left(p + \frac{an^2}{V^2}\right)(V - nb) = nRT$

    or $p = \frac{nRT}{(V-nb)} - \left(\frac{an^2}{V^2}\right)$

    $p = \frac{1\text{mol}\times 0.083\text{L bar mol}^{-1}\text{K}^{-1}\times 298\text{K}}{(1.5-1\times 0.04)\text{L}} - \frac{3.6\text{L}^2\text{ bar mol}^{-2}\times(1\text{mol}^2)}{(1.5\text{L})^2}$

    = 16.94 - 1.60 = 15.34 bar

OR

Suppose molecular masses of A and B are M_A and M_B respectively. Then their number of moles will be

$n_A = \frac{1}{M_A}, n_B = \frac{2}{M_B}\ \left(as\ number\ of\ moles = \frac{given\ mass}{molar\ mass}\right)$

Pressure of A= P_A = 2 bar, Pressure of both A and B = $P_A + P_B$ = 3 bar, i.e. Pressure of B = P_B = 1bar

Applying the relation PV = nRT where P=Pressure, V=Volume, n=number of moles, R=Gas constant, T=Temperature

$P_AV = n_ART$, $P_BV = n_BRT$

$\therefore \frac{P_A}{P_B} = \frac{n_A}{n_B} = \frac{1/M_A}{2/M_B} = \frac{M_B}{2M_A}$

or $\frac{M_B}{M_A} = 2 \times \frac{P_A}{P_B} = 2 \times \frac{2}{1} = 4$ or $M_B = 4M_A$

27. i. 1 mole of Ar contains 6.022×10^{23} atoms

$\therefore$ 52 mole of Ar will contain $6.022 \times 10^{23} \times 52 = 3.13 \times 10^{25}$ atoms

ii. 4 u of He = 1 He atom

$\therefore$ 52 u of He = $\frac{1}{4} \times 52$ He atoms = 13 He atoms.

iii. 1 mol atom of He = 4g = 6.023×10^{23} atoms

4 g of He contains 6.022×10^{23} atoms

52 g of He will contain = $\frac{6.022 \times 10^{23} \times 52}{4} = 7.83 \times 10^{24}$ atoms.

OR

Number of moles in a drop of water:-

Volume of a drop of water = 0.05 mL

Mass of a drop of water

= (Volume $\times$ density)

= (0.05 mL) $\times$ (1.0 g/mL)

= 0.05 g

Gram molecular mass of water

(H_2O) = $2 \times 1 + 16$

= 18 g

$\therefore$ 18g of water = 1 mol & 0.05 g of water

= $\frac{1\ mol}{(18\ g)} \times (0.05)$ g

= 0.0028 mol

No. of molecules present:-

1 mole of water contains number of molecules

= 6.022×10^{23}

0.0028 mole of water contain molecules

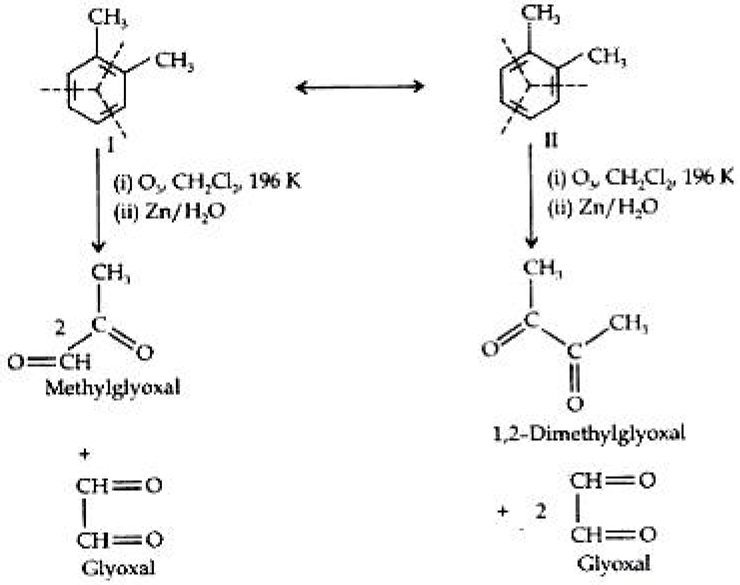
= $6.022 \times 10^{23} \times 0.0028 = 1.68 \times 10^{21}$ molecules.

= 1.68×10^{21} molecules

Thus, a drop of water with its volume equal to 0.05 mL would contain 1.68×10^{21}

molecules

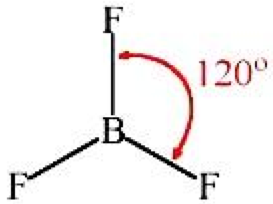
28. o-Xylene may be regarded as a resonance hybrid of the following two Kekule structures. Ozonolysis of each one of these gives two products as shown below:



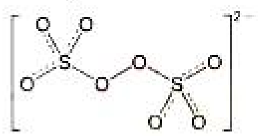
Thus, in all, three products are formed. Since all the three products cannot be obtained from any one of the two Kekule structures, this shows that O-xylene is a resonance hybrid of the two Kekule structures (I and II).

29. Structures of compounds are given below:

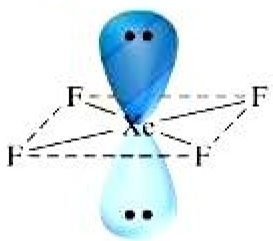
i. BF_3



ii. $S_2O_9^-$



iii. XeF_4



30. According to the question, T = 27°C, V_2 = 10 L, V_1 = 5 L, $R = 2.0 \text{ cal K}^{-1}\text{mol}^{-1}$.

Atomic weight of Ar = 40

Given weight of Ar = 10

Now, $q = 2.303nRT\log\frac{V_2}{V_1}$

$= 2.303 \times \frac{10}{40} \times 2 \times 300 \times \log\frac{5}{10}$

$= -103.635\text{cal}$

For isothermal expansion, $\Delta U = 0$

W = $\Delta U - q$

$= 0 - (-103.635)$

$= +103.635\text{cal}$

Also, when a temperature is constant,

$pV = \text{constant}$

$\Delta pV = 0$

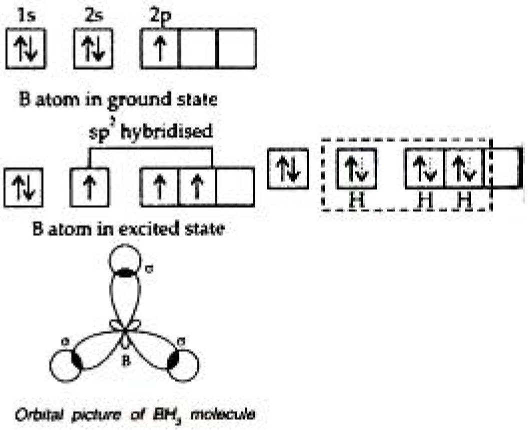
So, $\Delta H = \Delta U + \Delta(pV)$

= 0 + 0

= 0.

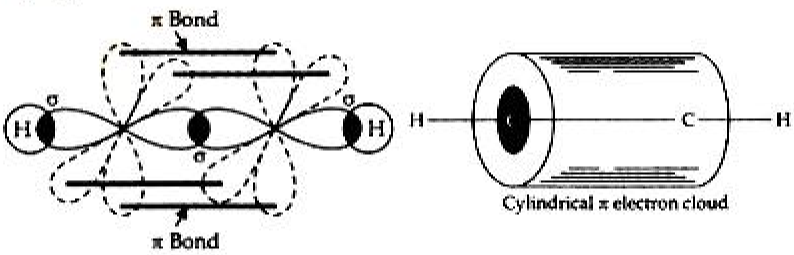
Section D

31. i. Formation of BH_3 (atomic no. of B is 5)



B atom gets hybridized to form three equivalent hybrid orbitals directed towards three corners of an equivalent triangle with B atoms in the center. Bond angle = 120°.

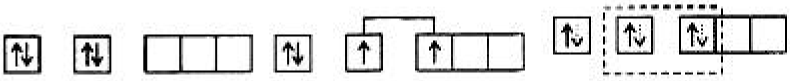
ii. C_2H_2



Orbitals picture of ethyne

Both the carbon atoms are sp hybridized. Both the carbon atoms have also two unhybridized orbitals which overlap sidewise with the similar orbitals of the other carbon atom to form two π bonds.

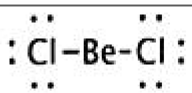
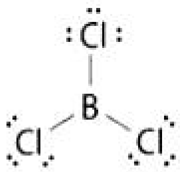
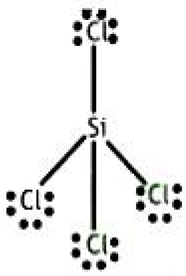
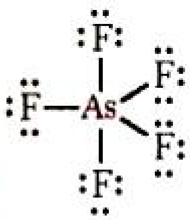
iii. BeF_2

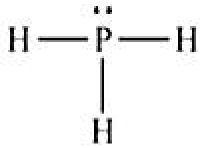


Orbital picture of BeF_2

The orbital picture of BeF_2 molecule is Linear.

OR

Molecules	**Lewis symbol**	**No. of bond pairs**	**No. of lone pairs**	**Type**	**Shape**
$BeCl_2$		2	0	AB_2	Linear
BCl_3		3	0	AB_3	Triangular planar
$SiCl_4$		4	0	AB_4	Tetrahedral
ASF_5		5	0	AB_5	Trigonal Bipyramidal
H_2S		2	2	AB_2L_2	Bent/V-shaped
					Trigonal

PH_3		3	1	AB_2L	pyramidal

32. To calculate $[HS^-]$

$$H_2S \rightleftharpoons H^+ + HS^-$$

	H_2S	H^+	HS^-
Initial	0.1 M		
After disso.	$0.1 - x$ $\simeq 0.1$	x	x

$k_A = \frac{x/x}{0.1} = 9.1 \times 10^{-8}$ or $x^2 = 9.1 \times 10^{-9}$ or $x = 9.54 \times 10^{-5}$

In presence of 0.1 M HCl, suppose H_2S dissociated is y. Then at equilibrium,

$[H_2S] = 0.1 - y \simeq 0.1,\ [H^+] = 0.1 + y \simeq 0.1, [HS^-] = yM$

$K_a = \frac{0.1 \times y}{0.1} = 9.1 \times 10^{-8}$ (given) or $y = 9.1 \times 10^{-8} M$

To calculate $[S^{2-}]$

$$H_2S \xrightleftharpoons{K_{a_1}} H^+ + HS^- \ ; \ HS^- \xrightleftharpoons{K_{a_2}} H^+ + S^{2-}$$

For the overall reaction,

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

$K_a = K_{a_1} \times K_{a_2} = 9.1 \times 10^{-8} \times 1.2 \times 10^{-13} = 1.092 \times 10^{-20}$

$K_a = \frac{[H^+]^2 [S^{2-}]}{[H_2S]}$

In the absence of 0.1 MHCl, $[H^+] = 2[S^{2-}]$

Hence, if $[S^{2-}] = x, [H^+] = 2x$

$\therefore \frac{(2x)^2 x}{0.1} = 1.092 \times 10^{-20}$ or $4x^3 = 1.092 \times 10^{-21} = 273 \times 10^{-24}$

3 log x = log 273 - 24 = 2.4362 - 24

log x = 0.8127 - 8 = 8.8127

or x = Antilog $\bar{8}.8127 = 273 \times 10^{-24} = 6.497 \times 10 = 6.5 \times 10^{-8} M$

In presence of 0.1 M HCl, suppose $[S^{2-}]$ = y, then

$[H_2S] = 0.1 - y \simeq 0.1M, [H^+] = 0.1 + y \simeq 0.1M$

$K_a = \frac{(0.1)^2 \times y}{0.1} = 1.09 \times 10^{-20}$ or $y = 1.09 \times 10^{-19} M$

OR

Calculation of K_p

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

$$\begin{array}{ccc} 1 & 0 & 0 \\ (1-\alpha) & \alpha & \alpha \end{array}$$

Total no. of moles in the equilibrium mixture = $1-\alpha+\alpha+\alpha$

$= (1+\alpha)$ mol.

Let the total pressure of equilibrium mixture = p atm

Partial pressure of PCl_5

$_{P}PCl_5 = \frac{1-\alpha}{1+\alpha} \times p\, atm$

Partial pressure of $PCl_3 = \frac{\alpha}{1+\alpha} \times \ atm$

Partial pressure of Cl_2

$_{p}Cl_2 = \frac{\alpha}{(1+\alpha)} \times p\, atm$

$K_p = \frac{_{p}PCl_3 \times PCl_2}{_{p}PCl_5}$

$= \frac{\left(\frac{\alpha}{1+\alpha}p\ atm\right) \times \left(\frac{\alpha}{1+\alpha}p\ atm\right)}{\frac{1-\alpha}{1+\alpha}p\ atm}$

$= \frac{\alpha^2 p}{1-\alpha^2} atm$

P = 4 atm

and $\alpha = 10\% = \frac{10}{100} = 0.1$

$K_p = \frac{(0.1)\times(0.1)\times(4\ atm)}{(1-(0.1)^2}$

$= \frac{0.04}{0.99} = 0.04\ atm$

Calculation of P under new condition

$\alpha = 0.2$

K_p = 0.04 atm

$K_p = \frac{\alpha^2 p}{1-\alpha^2}$ or $P = \frac{K_p(1-\alpha^2)}{\alpha^2}$

$= \frac{(0.04\ atm)(1-(0.2)^2)}{(0.2)^2}$

$= \frac{0.04\ atm \times 0.96}{0.04} = 0.96\ atm$

33. **Hybridisation:** The process of intermixing of the orbitals of slightly different energies so as to redistribute their energies, resulting in the formation of new set of orbitals of equivalent energies and shape. For example, when one 2s and three 2p-orbitals of carbon hybridise, there is the formation of four new sp^3 hybrid orbitals.

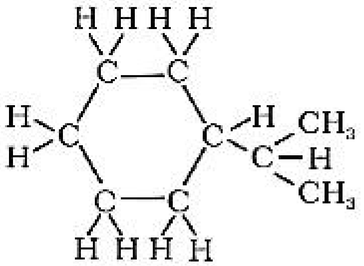
In CH_2=C=CH_2(allene), 1 and 3 carbon atoms are sp^2 hybridized because it has 3σ bonds.

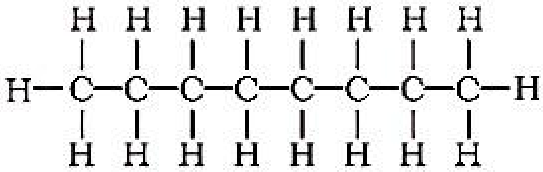
While carbon atom 2 has 2σ bonds, so it is sp hybridized.

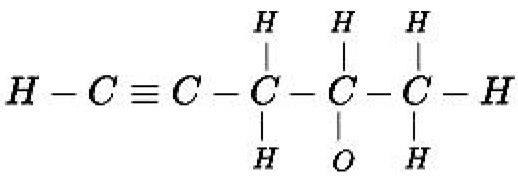
So, Allene molecule is non-planar because hybridisation of carbons are different.

OR

Expended formula is as follows:

a. 

b. 

c. 

d.