CBSE Class 11 Chemistry

Sample Paper 09 (2020-21)

Maximum Marks: 70

Time Allowed: 3 hours

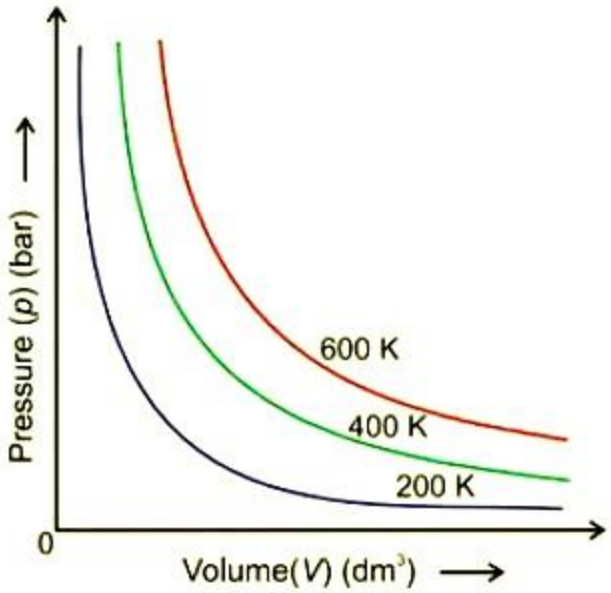
General Instructions:

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 passage given below and answer the following questions:**

   At constant temperature, the pressure of a fixed amount of gas varies inversely with its volume. This is known as Boyle's law. There are two conventional ways of graphically presenting Boyle's law. The value of k_1 for each curve is different because, for a given mass of gas, it varies only with temperature. If a fixed amount of gas at constant temperature T occupying volume V_1 at pressure p_1 undergoes expansion, so that volume becomes V_2 and pressure becomes p_2, then according to Boyle's law. At high pressures, gases deviate from Boyle's law and under such conditions, a straight line is not obtained in the graph. Experiments of Boyle, in a quantitative manner, prove that gases are highly compressible because when a given mass of a gas is compressed, the same number of molecules occupy a smaller space. This means that gases become denser at high pressure.



Graph of pressure. p vs. Volume. V of a gas at different temperatures.

i. Who concluded that at a constant temperature, the pressure of a fixed amount of gas varies inversely with its volume?
   a. Robert Boyle
   b. Charles Lussac
   c. Gay Lussac
   d. none of these

ii. A relationship can be obtained between the _____ and _____ of a gas by using Boyle's law.
   a. density, pressure
   b. pressure, temperature
   c. temperature, density
   d. none of these

OR

The temperature at which the volume of gas is theoretically zero is called
   a. transition temperature
   b. apparent temperature
   c. absolute temperature
   d. critical temperature

iii. Each curve of the graph is known as

a. isotherm
b. isobar
c. isochore
d. none of these

iv. According to Boyle's law :
a. $p_1V_1 = p_2V_2 =$ constant
b. p_1V_1 is not equal to p_2V_2
c. $p_1V_1 = p_2V_2$ but both are not equal to constant
d. none of these

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

The existing large number of organic compounds and their ever-increasing numbers has made it necessary to classify them on the basis of their structures. Organic compounds are broadly classified as open-chain compounds which are also called aliphatic compounds. Aliphatic compounds further classified as homocyclic and heterocyclic compounds. Aromatic compounds are special types of compounds. Alicyclic compounds, aromatic compounds may also have heteroatom in the ring. Such compounds are called heterocyclic aromatic compounds. Organic compounds can also be classified on the basis of functional groups, into families or homologous series. The members of a homologous series can be represented by general molecular formula and the successive members differ from each other in molecular formula by a $-CH_2$ unit.

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:** Tetrahydrofuran is aliphatic compounds
Reason: Sometimes atoms other than carbon are also present in the ring known as heterocyclic.

ii. **Assertion:** Hydroxyl group (–OH) is a functional group.

Reason: The functional group is defined as an atom or group of atoms joined in a specific manner with characteristic chemical properties of the organic compounds.

iii. **Assertion:** Non-benzenoid compound is a classification as the alicyclic compound.
Reason: Aniline is a benzenoid compound.

iv. **Assertion:** $H_2C=CH_2$ is a condensed structural formula.
Reason: Condensed structural formula is represented by omitting some or all of the dashes representing covalent bonds.

OR

Assertion: Cyclic compound is classified as a carbocyclic and heterocyclic compound.
Reason: Thiophene is a homocyclic compound.

3. Molarity is defined as:
   a. the number of moles of the solute in 1 m^3 of the solution
   b. the number of moles of the solvent in 1 litre of the solution
   c. the number of moles of the solute in 1 litre of the solution
   d. the number of grams of the solute in 1 litre of the solution
4. The energy associated with the first orbit in the hydrogen atom is -2.18×10^{-18} J/atom. What is the energy associated with the fifth orbit?
   a. -7.72×10^{-20} J/atom
   b. -5.72×10^{-20} J/atom
   c. -3.72×10^{-20} J/atom
   d. -8.68×10^{-20} J/atom

OR

The de Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 metres per second is approximately:

   a. 10^{-33}m
   b. 10^{-31}m
   c. 10^{-23}m
   d. 10^{-43}m

5. Thus ethyne molecule consists of:
   a. three C - C σ bond, two C - H σ bonds and three C - C π bonds.
   b. one C - C σ bond, two C - H σ bonds and two C - C π bonds.
   c. one C - C σ bond, three C - H σ bonds and two C - C π bonds.
   d. one C - C σ bond, two C - H σ bonds and three C - C π bonds.
6. Which of the following always has a negative value?
   a. Heat of reaction
   b. Heat of solution
   c. Heat of formation
   d. Heat of combustion

OR

To vaporize 100.0 g carbon tetrachloride at its normal boiling point, 349.9 K, and P =1 atm, 19.5 kJ of heat is required. Calculate ΔH_{vap} for CCl_4?

   a. 30.0 kJ
   b. 42.0 kJ
   c. 34.0 kJ
   d. 23.0 kJ
7. What is the correct expression for the representation of the solubility product constant of Ag_2CrO_4?
   a. $[2Ag^+]^2[CrO_4^{2-}]$
   b. $[2Ag^+][CrO_4^{2-}]$
   c. $[Ag^+]^2[CrO_4^{2-}]$
   d. $[Ag^+][CrO_4^{2-}]$

OR

On increasing the pressure, in which direction will the gas phase reaction proceed to re-establish equilibrium is predicted by applying the Le Chatelier's principle. Consider the reaction. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3$ (g) Which of the following is correct, if the total pressure at which the equilibrium is established, is increased without changing the temperature?

a. K will remain same
b. K will increase
c. K will decrease
d. K will increase initially and decrease when pressure is very high

8. Arrange the following in decreasing order of their boiling points.
   A. n-butane
   B. 2-methylbutane
   C. n-pentane
   D. 2, 2-dimethylpropane
   a. B > C > D > A
   b. C > B > D > A
   c. D > C > B > A
   d. A > B > C > D
9. The order of decreasing ionisation enthalpy in alkali metals is
   a. K < Li < Na < Rb
   b. Na > Li > K > Rb
   c. Li > Na > K > Rb
   d. Rb < Na < K < Li
10. The hydrocarbon which can react with sodium in liquid ammonia is_____.
    a. $CH_3CH{=}CHCH_3$
    b. $CH_3CH_2C \equiv CH$
    c. $CH_3CH_2CH_2C \equiv CCH_2CH_2CH_3$
    d. $CH_3CH_2C \equiv CCH_2CH_3$
11. When O_2 is converted into O_2^+
    a. paramagnetic character increases
    b. both paramagnetic character and bond order increase
    c. paramagnetic character decreases and the bond order increases
    d. bond order decreases
12. **Assertion:** The standard unit for expressing the mass of atoms is a.m.u.
    Reason: a.m.u. stands for mass of 1 atom of carbon.
    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:** Diamond is a bad conductor of electricity.

Reason: All C-C bond lengths in a diamond are of 154 pm.

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):** At constant temperature, pV vs V plot for real gases is not a straight line.

Reason (R): At high pressure all gases have $Z > 1$ but at intermediate pressure most gases have $Z < 1$.

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: The value for van der Waal's constant 'a' is higher for ammonia than for nitrogen.

Reason: Intermolecular hydrogen bonding is present in ammonia.

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:** In aqueous solution, SO_2 reacts with H_2S liberating sulphur.

Reason: SO_2 is an effective reducing agent.

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:** Nitration of nitrobenzene gives mainly m-dinitrobenzene.
Reason: -NO group is electron donation group.
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.

Section B

17. The elements Z = 117 and 120 have not yet been discovered. In which family/group would you place these elements and also give the electronic configuration in each case.

OR

How did Mendeleev arrange the elements?

18. Explain why alkyl groups act as electron donors when attached to a $\pi-$ system.
19. One millilitre solution of 0.01 M HCI is added to 1 L of sodium chloride solution. What will be the pH of the resulting solutions?

OR

The pH of a sample of vinegar is 3.76. Calculate the concentration of hydrogen ion in it.

20. Why do alkali metals give characteristic flame colouration?

OR

Why is LiF almost insoluble in water whereas LiCl soluble not only in water but also in acetone?

21. Why is water an excellent solvent for ionic or polar substances?

22. Consider the reaction of water with F_2 and suggest, in terms the oxidation and reduction. Which species are oxidized / reduced?
23. Convert:
    i. Ethene to Ethyne
    ii. Methane to ethane
24. Why is ionization enthalpy of nitrogen greater than that of oxygen?
25. Why does fluorine not show disproportionation reaction?

Section C

26. At 700 K, the equilibrium constant for the reaction:
    $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

    is 54.8. If 0.5 mol L^{-1} of HI(g) is present at equilibrium at 700 K, what are the concentration of $H_2(g)$ and $I_2(g)$ assuming that we initially started with HI(g) and allowed it to reach equilibrium at 700K?

    OR

    K_p = 0.04 atm at 898 K for the equilibrium shown below. What is the equilibrium concentration of C_2H_6 when it is placed in a flask at 4 atm pressure and allowed to come to equilibrium.
    $C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$

27. At 60° C, dinitrogen tetroxide is fifty percent dissociated. Calculate the standard free energy change at this temperature and at one atmosphere.

    OR

    A swimmer coming out from a pool is covered with a film of water weighing about 18g. How much heat must be supplied to evaporate this water at 298 K? Calculate the internal energy of vaporization at 298K.

    $\Delta_{vap}H^{\ominus}$ for water at 298K= 44.01kJ mol^{-1}

28. Write structures of different isomers corresponding to the 5^{th} member of alkyne series. Also write IUPAC names of all the isomers. What type of isomerism is exhibited by different pairs of isomers?

29. Identify the pairs of compounds which are functional group isomers.

I. $CH_3 - CH_2 - CH_2 - CH_2 - OH$

II. $CH_3 - CH_2 - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_3$

III. $CH_3 - \underset{\displaystyle OH}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{CH}}}} - CH_3$

IV. $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - OH$

V. $CH_3 - CH_2 - O - CH_2 - CH_3$

VI. $CH_3 - O - CH_2 - CH_2 - CH_3$

VII. $CH_3 - O - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$

30. The reactant which is entirely consumed in reaction is known as limiting reagent. In the reaction 2A + 4B → 3C + 4D, when 5 moles of A react with 6 moles of B, then

i. Which is the limiting reagent?

ii. Calculate the amount of C formed?

Section D

31. What is meant by the term bond order? Calculate the bond order of: N_2, O_2, O_2^+, O_2^-

OR

Discuss the orbital structures of the following molecules on the basis of hybridization.

i. BH_3

ii. C_2H_2

iii. BeF_2

32. Define atomic number, mass number and neutron. How are the three related to each other?

OR

Indicate the number of unpaired electrons in :

i. P

ii. Si

iii. Cr

iv. Fe and

v. Kr.

33. BCl_3 is trigonal planar while ACl_3 is tetrahedral in a dimeric state. Explain.

OR

Starting from $SiCl_4$ prepare the following in steps exceeding the number given in parenthness (give reactions only).

i. Silicon

ii. Linear silicon containing methyl groups only

iii. Na_2SiO_3

CBSE Class 11 Chemistry

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Solution

Section A

1. i. (a) Robert Boyle
   ii. (a) density, pressure

OR

(c) absolute temperature

   iii. (a) isotherm
   iv. (a) $p_1V_1 = p_2V_2$ = constant
2. i. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.
   ii. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.
   iii. (a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.
   iv. (d) Assertion is the wrong statement but reason is correct statement.

OR

(c) Assertion is the correct statement but reason is wrong statement.

3. (c) the number of moles of the solute in 1 litre of the solution

   Explanation: Molarity is the most widely used method of expressing the strength or concentration of a solution.

   It is denoted by ' M '.

   Molarity is defined as the number of moles of solute present per litre of solution.

   Mathematically,

   Molarity (M) = Number of moles of solute / Volume of solution in Litres
4. (d) -8.68×10^{-20} J/atom

   Explanation: The energy of first (Bohr) orbit in hydrogen atom = $-2.17 \times 10^{-18} Jatom^{-1}$

Energy of the fifth orbit will be given by $E_n = E_1 \times \frac{Z^2}{N^2}$

$E_5 = \frac{-2.17 \times 10^{-18}}{5^2} = 8.68 \times 10^{-20} Jatom^{-1}$.

OR

(a) 10^{-33}m

Explanation: The mass of the ball = 60 g = 6×10^{-2} kg

Velocity of the ball = 10m/s

let the de broglie wavelength be λ.

We know, $\lambda = \frac{h}{mv}$

$\lambda = \frac{6.626 \times 10^{-34}}{6 \times 10^{-2} \times 10} = 1.103 \times 10^{-33} \approx 10^{-33} m$

5. (b) one C - C σ bond, two C - H σ bonds and two C - C π bonds.

   Explanation: Ethyne is an unsaturated compound which belongs to the alkyne family and has the formula C_2H_2. Thus it consists of one C–C σ bond, two C–H σ bonds, and two C–C π bonds.

6. (d) Heat of combustion

   Explanation: Combustion is an exothermic process. Hence heat of combustion has a negative value.

OR

(a) 30.0 kJ

Explanation: Number of moles of CCl_4 = $\frac{100}{154}$ = 0.6493 moles.

Heat required for 0.6493 moles = 19.5kJ

$\Rightarrow$ Heat required for 1.00 moles = $\frac{19.5}{0.6493}$ = 30.032kJ

7. (c) $[Ag^+]^2[CrO_4^{2-}]$

   Explanation: $Ag_2CrO_4 \rightarrow 2\ Ag^+ + CrO_4^{2-}$

   Suppose solubility is 's' then K_{sp}= $[2s]^2[s] = 4s^3$

OR

(a) K will remain same

Explanation: In the reaction $Na(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

According to the the Le Chatelier's principle, at constant temperture, the equilibrium

constant will change but K will remain same.

8. (b) C > B > D > A

   Explanation: The boiling point depends on the molecular mass and surface area. As the number of carbon atoms increases, the boiling point increases, hence n-butane has the minimum boiling point. Among isomeric alkanes, the boiling point decreases with branching. Hence the order.

9. (c) Li > Na > K > Rb

   Explanation: As we more down the group size increases and also ionization energy decreases.

10. (b)

    $CH_3CH_2C \equiv CH$

    Explanation: Terminal alkynes react with Na in the presence of liquid NH_3 to form higher alkynes. The alkyne contains acidic H at the end (i.e. the H bonded to C_1 of the chain). Therefore, it is easily replaced with highly electropositive metals such as Na in liquid ammonia, to form sodium alkaline ion which can react further in the presence of a suitable catalyst to yield higher alkynes/hydrocarbons.

11. (c) paramagnetic character decreases and the bond order increases

    Explanation: For O_2: $\sigma 1s^2$, $\sigma^* 1s^2$, $\sigma 2s^2$, $\sigma^* 2s^2$, $\sigma 2pz^2$

    $(\pi 2py^2 = \pi 2px^2)$, $(\pi^* 2py^1 = \pi^* 2px^1)\sigma^* 2pz$

    For O_2: $\sigma 1s^2$, $\sigma^* 1s^2$, $\sigma 2s^2$, $\sigma^* 2s^2$, $\sigma 2pz^2$

    $(\pi 2py^2 = \pi 2px^2)$, $(\pi^* 2py^1 = \pi^* 2px^0)\sigma^* 2pz$

    Bond order = $\frac{N_b - N_a}{2}$

    For O_2 = $\frac{10-6}{2}$ = 2

    For O_2^+ = $\frac{10-5}{2}$ = 2.5

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. (b) Both A and R are true but R is not the correct explanation of A.
Explanation: At constant temperature pV vs V plot for real gases is not a straight line because intermolecular forces of attraction are present in real gases.

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. (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.

16. (c) Assertion is CORRECT but, reason is INCORRECT.
Explanation: Assertion is CORRECT but, reason is INCORRECT.

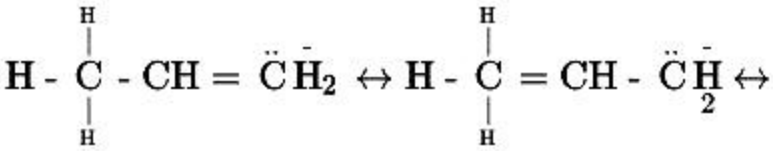
Section B

17. From the periodic table, that element with Z = 117, would belong to the halogen family (Group 17) and the electronic configuration would be [Rn] $5f^{14}6d^{10}7s^{2}7p^{5}$. The element with Z = 120, will be placed in Group 2 (alkaline earth metals), and will have the electronic configuration [Uuo]$8s^{2}$.

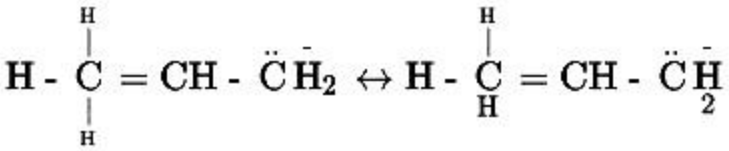
OR

According to Mendeleev the physical and chemical properties of elements are periodic function of atomic mass. He arranged elements in horizontal rows and vertical columns of a table in order of their increasing atomic weights in such a way that the elements with similar properties occupied the same vertical column or group. He treated formulae of hydrides and oxides as one of the basic criteria for categorization.

18. Due to hyperconjugation, alkyl groups act as electron donors when attached to a $\pi-$ system as shown below:



Propene



19. One millilitre solution of 0.01 M HCI is added to 1 L of sodium chloride solution.
As NaCl is neutral, it simply dilutes the HCI solution from 1 mL to 1000 mL so that
$[H^+] = \frac{0.01}{1000} = 10^{-5}$
Therefore, pH = -log(10^{-5}) = 5

OR

We know that, pH = -log[H^+] or log [H^+] = -pH = -3.76 = $\bar{4}.24$ Before taking antilog, add -1 in the characteristic (-3) and +1 in mantissa (0.76), i.e. (-3.76-1 +1 =$\bar{4}.24$)]
$\therefore [H^+] = Anti\log \bar{4}.24 = 1.738 \times 10^{-4} M = 1.74 \times 10^{-4} M$

20. The alkali metals and their salts impart characteristic colour to an oxidizing flame. This is because the heat from the flame excites the outermost orbital electron to a higher energy level. When the excited electron comes back to the ground state, there is emission of radiation in the visible region.

OR

The low solubility of LiF in water is due to its high lattice energy which couldnot be compensated by hydration energy. LiCl is soluble in water,acetone and ethanol as well , it is because of its hydration energy which compensates the low lattice energy.

21. Water is a good solvent due to its polarity and high dielectric constant. When an ionic compound or polar compound is immersed in water, it is surrounded by water molecules. Due to the high dielectric constant of water, the force of attraction between cation and anion gets weakened. Hence, water acts as a good solvent.
22. $\underset{(oxidant)}{2F_2(g)} + \underset{(\text{Re}\,duc\,\tan t)}{2H_2O(l)} \rightarrow O_2(g) + 4H^+(aq) + 4F^-(aq)$

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.

23. i. $\underset{\text{Ethene}}{H_2C = CH_2} \xrightarrow[CCl_4]{Br_2} \underset{Br}{\underset{|}{C}H_2} - \underset{Br}{\underset{|}{C}H_2} \xrightarrow{\text{2 alc. KOH}} \underset{\text{Ethyne}}{CH \equiv CH}$

ii. $\underset{\text{Ethene}}{CH_4} \xrightarrow[\text{Sunlight}]{Cl_2} CH_3Cl \xrightarrow[\text{Wurtz reaction}]{\text{Na, ether}} \underset{\text{Ethane}}{CH_3\ CH_3}$

24. The electronic configuration of Nitrogen is $1s^2\ 2s^2\ 2p^3$ and that of Oxygen is $1s^2\ 2s^2\ 2p^4$. Nitrogen has half filled p-orbitals which is a very stable configuration. Oxygen will readily loose its extra electron to attain the nitrogen-like configuration. Hence, oxygen will have a lower ionization enthalpy than nitrogen.

25. In a disproportionation reaction, the same species is simultaneously oxidised as well as reduced. Therefore, for such a redox reaction to occur, the reacting species must contain either two or more than two positive or negative oxidation state including zero.
The element, in reacting species must present in intermediate states of higher and lower oxidation state, but in case of flourine, fluorine does not show a positive oxidation state. That's why fluorine does not show a disproportionation reaction.

Section C

26. For the reaction,

H_2 (g) + I_2 (g) $\rightleftharpoons$ 2HI (g)

Equilibrium constant is given to be 54.8.

i.e. $K_c = \frac{[HI]^2}{[H_2]\times[I_2]}$

Let x be equilibrium concentration of H_2 at equilibrium. Then the equilibrium concentration of I_2 will also be x. Since initially, there was only HI present, an equal amount of H_2 and I_2 will be produced.

At equilibrium: $\underset{x}{H_2(g)} + \underset{x}{I_2(g)} \rightleftharpoons \underset{0.5}{2HI(g)}$

$K_c = \frac{[HI]^2}{[H_2]\times[I_2]}$

$= \frac{(0.5)^2}{x^2} = 54.8$

$x = \sqrt{\frac{(0.5)^2}{54.8}}$

= 0.0675

Therefore, the concentration of H_2 and I_2 is 0.0675 mol L^{-1}.

OR

The equilibrium in the reaction is:

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

Initial pressure:	**4atm**	**0**	**0**
Eqn. pressure:	**(4 – *p*) atm**	***p* atm**	***p* atm**

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

Initial pressure	4 atm	0	0
Eqn. pressure	(4 - p) atm	p atm	p atm

$K_p = \frac{pC_2H_4 \times pH_2}{pC_2H_6}$ or $0.04 = \frac{p^2}{(4-p)}$

$p^2 = 0.04(4 - p)$ or $p^2 + 0.04p - 0.16 = 0$

$p = \frac{(-0.04 \pm \sqrt{0.0016 - 4(-0.16)}}{2}$

$p = \frac{(-0.04) \pm 0.08}{2} = \frac{0.76}{2} = 0.38$ (By taking positive value)

Hence, Equilibrium pressure or concentration of C_2H_6 = (4 - 0.38) = 3.62 atm = 3.62 atm

27. According to the question, at 60° C, dinitrogen tetroxide is fifty percent dissociated.

Reaction:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

If N_2O_4 is 50 % dissociated,

$x_{N_2O_4} = \frac{1 \times 0.5}{1+0.5}$

$\Rightarrow x_{NO_2} = \frac{2 \times 0.5}{1+0.5}$

$p_{N_2O_4} = \frac{0.5}{1.5} \times 1 \text{ atm}, \; p_{NO_2} = \frac{1}{1.5} \times 1 \text{ atm}$

The equilibrium constant K_p is given by

$$K_p = \frac{\left(p_{NO_2}\right)^2}{p_{N_2O_4}} = \frac{1.5}{(1.5)^2(0.5)} = 1.33 \text{ atm}$$

We know that, $\Delta_r G^{\ominus} = -2.303RT \log K_p$

= -2.303 × 8.314 × 333 log 1.33 = - 789.7 $Jmol^{-1}$

OR

We can represent the process of evaporation as

$$\underset{1\text{ mol}}{H_2O(1)} \xrightarrow{\text{vapertation}} \underset{1\text{ mol}}{H_2O(g)}$$

No. of moles in 18 g H_2O(l) is

$= \frac{18g}{18gmol^{-1}} = 1$ mol

Heat supplied to evaporate18g water at

298 K = n $\times$ $\Delta_{vap}H^{\ominus}$

= (1 mol) $\times$ (44.01 kJ mol^{-1})

= 44.01 kJ

(assuming steam behaving as an ideal gas).

$$\Delta_{uap}U = \Delta_{uap}H^{e} - p\Delta V = \Delta_{oap}H^{\ominus} - \Delta n_g RT$$

$$\Delta_{eq}H'' - \Delta n_e RT = 44.01\text{kJ} - (1)\left(8.314\text{JK}^{-1}\text{mol}^{-1}\right)(298\text{K})\left(10^{-3}\text{kJJ}^{-1}\right)$$

$$\Delta_{exp}U^{v} = 44.01\text{kJ} - 2.48\text{kJ}$$

$$= 41.53\text{kJ}$$

28. 5^{th} member of alkyne has the molecular formula C_6H_{10}. The possible isomers are and their possible IUPAC name is as follows:

1. $HC \equiv C - CH_2 - CH_2 - CH_2 - CH_3$

   Hex-1-one

2. $CH_3 - C \equiv C - CH_2 - CH_2 - CH_3$

   Hex-2-yne

3. $CH_2 - CH_2 - C \equiv C - CH_2 - C$

   Hex-3-yne

4. $HC \equiv C - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CH_3$

   3-Methylpent-1-yne

5. $HC \equiv C - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$

   4-Methylpent-1-yne

6. $CH_3 - C \equiv C - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$

   4-Methylpent-2-yne

7. $HC \equiv C - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_3$

3,3-Dimethylbut-1-yne

Position and chain isomerism shown by different pairs.

29. All the seven compounds given have the same molecular formula, so each alcohol is a functional group isomer of each ether given and visa-versa. Functional group isomers are a type of structural isomers having the same molecular formula but different functional groups. In the given structures, I, II, III, IV represent alcohols and V, VI, VII are ethers. Hence, I and V, I and VI, I and VII, II and V, II and VI, II and VII, III and V, III and VI, etc.

30. The given equation is : 2A + 4B → 3C + 4D

    i. It is clear from the above equation that: 2 moles of 'A' requires 4 moles of 'B' for the reaction i.e. ratio of moles of A to B is 2: 4 or 1:2. Hence, for 5 moles of 'A', the moles of 'B' required

    = 5 mole of A $\times \frac{4 \text{ mol of } B}{2 \text{ mol of } A} = 10 \text{ mol of } B.$

    But we have only 6 moles of 'B', hence, 'B' is the limiting reagent.

    ii. Since 4 moles of 'B' gives 3 moles of 'C'. Hence, 6 moles of 'B' will produce $\frac{3}{4} \times 6 = 4.5$ mole of C.

Section D

31. Bond order is defined as half of the difference between the number of electrons present in bonding and antibonding molecular orbitals.

Bond order = $\frac{1}{2}(N_b - N_a)$

E.C. of $N_2 = 1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$

M.O. configuration of N_2= $[\sigma 1s]^2 [\sigma * 1s]^2 [\sigma 2s]^2 [\sigma^* 2s]^2 [\pi 2p_x]^2 [\pi 2p_y]^2 [\sigma 2p_z]^2$

Bond order (B.O) = $\frac{1}{2}(N_b - N_a)$

$= \frac{1}{2}[10 - 4] = 3$

B.O. of O_2

M.O. of configuration of O_2 =

$(\sigma 1S)^2 (\sigma^* 1S)^2 (\sigma 2S)^2 (\sigma^* 2S)^2 (\pi 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2 (\pi^* 2p_x)^2$

B.O. = $\frac{1}{2}(N_b - N_a)$

= = $\frac{1}{2}[10 - 6] = 2$

M.O. of the configuration of O_2^+ = $KK[\sigma 2s]^2 \ [\sigma^* 2s]^2 \ [\sigma 2p_z]^2 \ [\pi 2p_x]^2 \ [\pi 2p_y]^2$

$[\pi * 2p_x]^1$

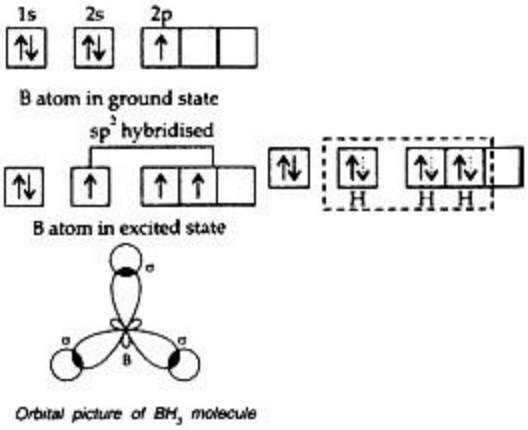
$= \frac{1}{2}$ [8-3] = 2.5

M.O. configuration of O_2^- = $KK[\sigma 2s]^2 [\sigma^* 2s]^2 [\sigma 2p_z]^2 [\pi 2p_x]^2 [\pi 2p_y]^2 [\pi^* 2p_x]^2$ $[\pi^* 2p_y]^1$

$= \frac{1}{2}$ [8-5] = 1.5

OR

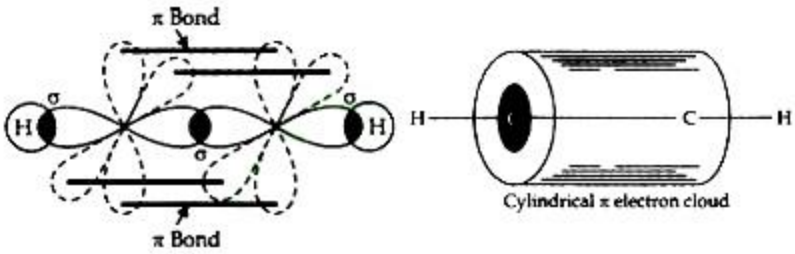
i. Formation of BH_3 (atomic no. of B is 5)



Orbital picture of BH_3 molecule

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°.

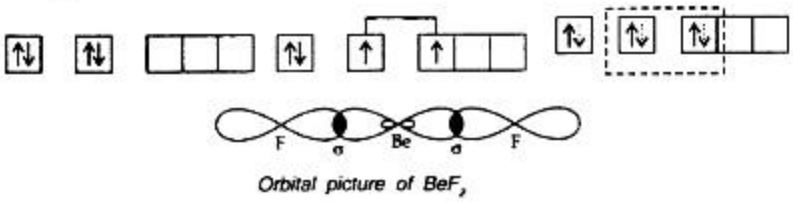
ii. C_2H_2



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.

32. **Atomic Number (Z):** The atomic number of an element is equal to the number of protons present inside the nucleus of its atoms. Since, an isolated atom has no net charge on it, in neutral atoms, the total number of electrons is equal to its atomic number.

Atomic number (Z) = Number of protons in the nucleus of an atom

= Number of electrons in the neutral atoms

Mass Number (A): The sum of the number of neutrons and protons in the nucleus of an atom is called its mass number. Mass number is denoted by A. Thus, for an atom,

Mass number (A) = Number of protons (p) + Number of neutrons (n)

A = p + n

Neutron: It is neutral particle. It is present in the nucleus of an atoms. Expect hydrogen (which contains only one electron and one proton but no neutron), the atoms of all other elements including isotopes of hydrogen contain all the three fundamental particles called neutron, proton and electron.

The relation between mass number, Atomic no. and no. of neutrons is given by the equation:

A = Z + n

Where A= Mass number

Z = Atomic number

n = Number of neutrons in the nucleus.

OR

i. P (Z = 15) : $[Ne]^{10}3s^2 3p^3$ No. of unpaired electrons = 3
ii. Si (Z = 14) : $[Ne]^{10}3s^2 3p^2$ No. of unpaired electrons = 2
iii. Cr (Z = 24) : $[Ar]^{18}4s^1 3p^5$ No. of unpaired electrons = 6
iv. Fe (Z = 26) : $[Ar]^{18}4s^2 3p^6$ No. of unpaired electrons = 4
v. Kr (Z = 36) : $[Ar]^{10}4s^2 3d^{10}4p^6$ No. of unpaired electrons = Nil.

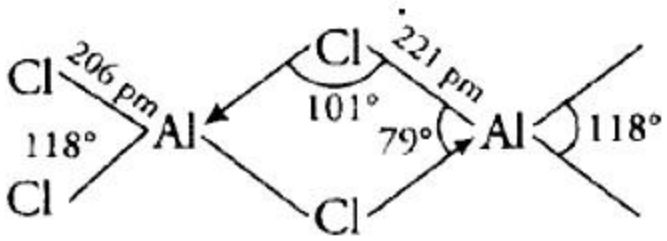
33. Both BCl_3 and $AlCl_3$ are electron deficient molecules having six electrons in the valence shell of their respective central atoms.

To complete their octets, the central atom in each case can accept a pair of electrons from the chlorine atom of another molecule forming dimeric structures.

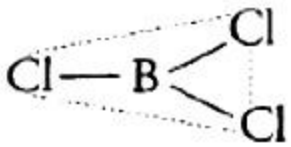
However, because of the small size of B, it cannot accommodate four big sized Cl atoms around it.

Al because of its bigger size can easily accommodate four Cl atoms around it.

As a result, $AlCl_3$ exists as a dimer. In this dimer, since the covalency of Al has increased to 4.



Therefore, BCl_3 prefers to exist as a monomeric planar molecule in which B atom is sp^2 - hybridised.



So, BCl_3 is trigonal planar while ACl_3 is tetrahedral in a dimeric state.

OR

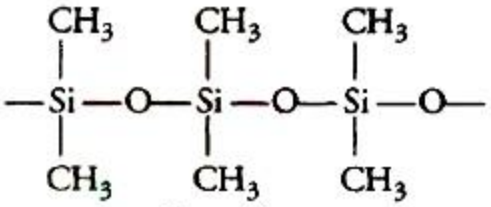
i. Preparation of Silicon from $SiCl_4$:

$$3SiCl_4 + \underset{\text{Molten}}{4Al} \rightarrow 4AlCl_3 + 3Si$$

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

$$(CH_3)_2SiCl_2 \xrightarrow{HOH} HO-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{S}}}}-OH$$

$$n(CH_3)_2Si(OH)_2 \xrightarrow{\text{Heat}}$$



Linear silicone

iii. Preparation of Na_2SiO_3 from $SiCl_4$:

$$SiCl_4 + 4H_2O \rightarrow \underset{\text{Orthosilicic acid}}{H_4SiO_4} + 4HCl$$

$$H_4SiO_4 \xrightarrow{\Delta} SiO_2 + 2H_2O$$

$$SiO_2 + Na_2CO_3 \longrightarrow Na_2SiO_3 + H_2O$$