CBSE Class 11 Chemistry

Sample Paper 01 (2020-21)

Maximum Marks: 70

Time Allowed: 3 hours

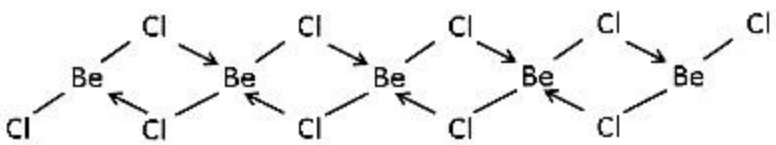
General Instructions:

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:**

   The dipositive oxidation state (M^{2+}) is the predominant valence of Group 2 elements. The alkaline earth metals form compounds that are predominantly ionic but less ionic than the corresponding compounds of alkali metals. The oxides and other compounds of beryllium and magnesium are more covalent than those formed by the heavier and large-sized members (Ca, Sr, Ba). The nitrates are made by the dissolution of the carbonates in dilute nitric acid. Carbonates of alkaline earth metals are insoluble in water and can be precipitated by addition of a sodium or ammonium carbonate solution to a solution of a soluble salt of these metals. Except for beryllium halides, all other halides of alkaline earth metals are ionic in nature. Beryllium halides are essentially covalent and soluble in organic solvents. Beryllium chloride has a chain structure.



i. Beryllium hydroxide is _____ in nature.
   a. amphoteric
   b. basic
   c. acidic
   d. can be acidic and basic both

ii. Why Beryllium does not compare well with other members of the group?
   a. small size
   b. ionic sizes
   c. both (a) and (b)
   d. none of these

OR

Which of the following crystallises as the anhydrous salt?
   a. Barium nitrate
   b. Magnisium nitrate
   c. Aluminum nitrate
   d. none of these

iii. The basic strength of which hydroxide is maximum
   a. LiOH
   b. NaOH
   c. $Ca(OH)_2$
   d. KOH

iv. Why $BeSO_4$, and $MgSO_4$ are readily soluble in water?
   a. due to greater hydration enthalpies of Be^{2+} and Mg^{2+}
   b. due to greater solvation enthalpies of Be^{2+} and Mg^{2+}
   c. due to less hydration enthalpies of Be^{2+} and Mg^{2+}
   d. none of these

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

The presence of a positive charge on the nucleus is due to the protons in the nucleus. The number of electrons in an atom is equal to the number of protons (atomic number, Z). The positive charge of the nucleus is due to protons, the mass of the nucleus, due to protons and neutrons. The composition of any atom is represented by using the normal

element symbol (X) with super-script on the left-hand side as the atomic mass number (A) and subscript (Z) on the left-hand side as the atomic number. Isotopes are the chemical properties of atoms that are controlled by the number of electrons, which are determined by the number of protons in the nucleus. Isobars are atoms with the same mass number but a different atomic number. Atoms with identical atomic number but a different atomic mass number are known as Isotopes. Number of neutrons present in the nucleus have very little effect on the chemical properties of an element.

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:** Chlorine atoms contain 17 protons and 28 neutrons.
Reason: The total number of nucleons is termed as mass number (A) of the atom.

ii. **Assertion:** ^{1}H, ^{2}H, and ^{3}H are isotopes.
Reason: Atoms with identical atomic number but different atomic mass number are known as Isotopes.

iii. **Assertion:** The charge on the proton is equal but opposite to that of the electron.
Reason: The number of protons present in the nucleus is equal to the atomic number (Z).

iv. **Assertion:** Carbon atoms generally have 6, 7 and 8 neutrons besides 6 protons.
Reason: Number of electrons in the hydrogen atom and sodium atom are 2 and 13 respectively.

OR

Assertion: All the isotopes of a given element show same chemical behaviour.
Reason: Protons and neutrons present in the nucleus are collectively known as nucleons.

3. The mass of 1 molecule of O_2 is
   a. 6.32×10^{-23}g
   b. 5.32×10^{-23}g
   c. 4.32×10^{-23}g
   d. 7.32×10^{-23}g
4. The orbital with n = 3 and l = 2 is
   a. 3p
   b. 3d
   c. 3s
   d. 3f

OR

The number of radial nodes for 3p orbital is _____.

   a. 1
   b. 2
   c. 4
   d. 3
5. Ozonolysis of an organic compound gives formaldehyde as one of the products. This confirms the presence of:
   a. a vinyl group
   b. two ethylenic double bonds
   c. an isopropyl group
   d. an acetylenic triple bond
6. For the process to occur under adiabatic conditions, the correct condition is:
   a. q = 0
   b. $\triangle$T = 0
   c. $\triangle$p = 0
   d. w = 0

OR

According to the first law of thermodynamics ΔU = q + w, here what is a sign of q and w?

a. q is negative if heat is transferred into the system and w is negative if work is done on the system.
b. q is positive if heat is transferred into the system and w is positive if work is done by the system.
c. q is negative if heat is transferred from the system and w is negative if work is done by the system.
d. q is positive if heat is transferred into the system and w is positive if work is done on the system.

7. The general electronic configuration of alkali metals is:
   a. $1s^1 2s^1$
   b. ns^2
   c. ns^1
   d. $1s^2$

OR

The general electronic configuration of ns^2 exists in:

   a. transition elements
   b. alkali metals
   c. alkaline earth metals
   d. coordination compounds

8. The increasing order of reduction of alkyl halides with zinc and dilute HCl is
   a. R–Cl < R–Br < R–I
   b. R–I < R–Br < R–Cl
   c. R–Br < R–I < R–Cl
   d. R–Cl < R–I < R–Br
9. An atom of an element contains 29 electrons and 35 neutrons. The electronic configuration of the element:
   a. $1s^2 2s^2 2p^6 3s^2 3p^5 4s^1 3d^9 4s^2$
   b. $1s^2 2s^2 2p^6 3s^2 3p 4s^2 3d^6 4s^2 4p^2$
   c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$
   d. $1s^2 2s^2 2p^6 3s^2 3p 4s^2 3d^8 4s^2$
10. Arrange the following hydrogen halides in order of their decreasing reactivity with

propene.

a. HCl > HBr > HI
b. HI > HBr > HCl
c. HCl > HI > HBr
d. HBr > HI > HCl

11. Based on VSEPR theory, the number of 90^0 F — Br — F angles in BrF_5 is:

    a. 8
    b. 2
    c. 4
    d. 0

12. **Assertion:** Vapour density of sulphur relative to oxygen is 2 because sulphur atom is twice as heavy as that of the oxygen atom.

    Reason: Vapour density depends upon the molecular state of the substance in the vapour state.

    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:** Glass is not an example of silicates.

    Reason: All silicates have tetrahedral SiO_4^{4-} unit.

    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
    d. Assertion is INCORRECT but, reason is CORRECT.

14. **Assertion (A):** At critical temperature liquid passes into gaseous state imperceptibly and continuously.

    Reason (R): The density of liquid and gaseous phase is equal to critical temperature.

    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 root mean square velocity of an ideal gas at constant pressure varies with density as $1\sqrt{d}$.
Reason: Average kinetic energy of a gas is directly proportional to the absolute temperature.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the
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:** Oxidation number of C in HCHO is zero.
Reason: Formaldehyde is a covalent compound.
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:** Terminal alkynes on oxidation with Bayer's reagent give a mixture of carboxylic acid and CO_2.
Reason: Terminal alkynes show acidic character.
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. How do alkali and alkaline earth metals react with water?

OR

On the basis of quantum numbers, justify that the sixth period of the periodic table should have 32 elements.

18. Why is sp hybrid orbital more electronegative than sp^2 or sp^3 hybridized orbitals?
19. The species H_2O, HCO_3^- , HSO_4^- and NH_3 can act both as Bronsted acid and base. For each case, give the corresponding conjugate acid and base.

OR

For the reaction, $NO(g) + O_3(g) \rightleftharpoons NO_2(g) + O_2(g)$, $K_c = 6.3 \times 10^{14}$ at 1000 K. Both the forward and reverse reactions are elementary bimolecular reactions in equilibrium. What is K_c for the reverse reaction?

20. Classify the following reactions in one of the reaction type studied in this unit.
    i. $CH_3CH_2Br + Hs^- \longrightarrow CH_3CH_2SH + Br^-$
    ii. $(CH_3)_2C = CH_2 + HCl \longrightarrow (CH_3)_2CCl - CH_3$
    iii. $CH_3CH_2Br + HO^- \longrightarrow CH_2 = CH_2 + H_2O + Br^-$
    iv. $(CH_3)_3C\text{-}CH_2OH + HBr \longrightarrow (CH_3)_2C\ Br\ CH_2CH_3 + H_2O$

OR

Why does SO_3 act as an electrophile?

21. Do you expect the carbon hydride of type (Cn H_2n + 2) to act as Lewis acid or base?
22. If same mass of liquid water and a piece of ice is taken, then why is the density of ice less than that of liquid water?
23. Complete the following reactions:
    i. Isopropyl bromide $\xrightarrow[\text{Heat}]{\text{alc. KOH}}$ A $\xrightarrow[\text{Peroxide}]{\text{HBr}}$ B
    ii. n-Propyl alcohol $\xrightarrow[443\ \text{K}]{\text{Conc. } H_2SO_4}$ A $\xrightarrow[\text{Heat}]{O_2, \text{Ag}}$ B
24. What do you understand by iso-electronic species? Name a species that will be iso-

electronic with each of the following atoms or ions.

25. What are the net charges on the left and right sides of the following equations? Add electrons as necessary to make each of them balanced half-reactions.
    i. $NO_3^- + 10H^+ \rightarrow NH_4^+ + 3H_2O$
    ii. $Cl_2 + 4H_2O \rightarrow 2ClO_2^- + 8H^+$

Section C

26. The drain cleaner, Drainex contains small bits of aluminium which react with caustic soda to produce dihydrogen. What volume of dihydrogen at 20°C and one bar will be released when 0.15 g of aluminium reacts?

OR

A flask was heated from 27°C to 227°C at constant pressure. Calculate the volume of the flask if a volume of air, measured at 227°C, was expelled from the flask.

27. A flask P contains 0.5 mole of oxygen gas. Another flask Q contains 0.4 mole of ozone gas. Which of the two flasks contains greater number of oxygen atoms?

OR

Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueous hydrochloric acid given reaction,

$4HCl(aq) + MnO_2(s) \rightarrow 2H_2O(l)$ + $MnCl_2$(aq) + Cl_2(g)

Calculate how many gram of HCl reacts with 5.0 g of manganese dioxide?

28. The dipole moment of trans 1,2-dichloroethane is less than the cis – isomer. Explain.
29. What are allotropes? Sketch the structure of two allotropes of carbon namely diamond and graphite. What is the impact of structure on physical properties of two allotropes?
30. For the reaction, 2A(g) + B (g)$\longrightarrow$ 2D(g); ΔU^o = - 10.5 kJ and ΔS^o = -44.1 JK^{-1}. Calculate ΔG° for the reaction and predict whether the reaction may occur spontaneously.
    (R = 8.314 $\times$ 10^{-3} kJ mol^{-1}, T = 298 K)

Section D

31. The energy of $\sigma 2p_z$ molecular orbital is greater than $\pi 2p_x$ and $\pi 2p_y$ molecular orbitals in nitrogen molecule. Write the complete sequence of energy levels in the increasing order of energy in the molecule. Compare the relative stability and the magnetic behaviour of

the following species: N_2, N_2^+, N_2^-, N_2^{2+}

OR

Write the Lewis structure of the nitrite ion, NO_2^-.

32. At 1127 K and 1 atmosphere pressure, a gaseous mixture of CO and CO_2 in equilibrium with solid carbon has 90.55% CO by mass.
$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$
Calculate K_c for the reaction at the above temperature.

OR

The value of K_c = 4.24 at 800K for the reaction, $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ Calculate equilibrium concentrations of CO_2, H_2, CO and H_2O at 800 K, if only CO and H_2O are present initially at concentrations of 0.10M each.

33. What are hybridisation states of each carbon atom in the following compounds?
    i. $CH_2 = C = O$
    ii. $(CH_3)_2CO$
    iii. $CH_3 = CH_2$
    iv. C_6H_6
    v. $CH_2 = CHCN$

OR

Explain the terms inductive and electromeric effects. Which electron displacement effect explain the following correct orders of acidity of the carboxylic acids?

i. Cl_3 CCOOH > Cl_2CHOOH > $ClCH_2COOH$

ii. CH_3CH_2COOH > $(CH_3)_2$ CHOOH > $(CH_3)_3$ C · COOH

CBSE Class 11 Chemistry

Sample Paper 01 (2020-21)

Solution

Section A

1. i. (a) amphoteric

   ii. (c) both (a) and (b)

OR

(a) Barium nitrite

   iii. (d) KOH

   iv. (a) due to greater hydration enthalpies of Be^{2+} and Mg^{2+}

2. i. (d) Assertion is the wrong statement but reason is correct statement.

   ii. (a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.

   iii. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.

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

OR

(b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.

3. (b) 5.32×10^{-23}g

   Explanation: Since, as per Avogadro's law,

   the mass of 6.02×10^{23} molecules of O_2 = 32 g

   $\therefore$ mass of 1 molecule of $O_2 = \frac{32}{6.022 \times 10^{23}} g = 5.32 \times 10^{-23}$ g

4. (b) 3d

   Explanation: For n = 3 the possible values of l are l = 0, the s orbital

   l = 1, the p orbital and l = 2, the d orbital

OR

(a) 1

Explanation: Explanation: For p orbital, n = 3 and l = 1

No. of radial nodes = n - l - 1

No. of radial nodes for 3p orbital = 3 - 1 - 1 = 1

5. (a) a vinyl group

   Explanation: The presence of a double bond on terminal carbon will give formaldehyde as one of the products.

6. (a) q = 0

   Explanation: Adiabatic condition would not allow exchange of heat between system and surroundings. Hence q = 0

OR

(d) q is positive if heat is transferred into the system and w is positive if work is done on the system.

Explanation: The first law is simply the conservation of energy equation. q is positive if heat is added to the system, and negative if heat is removed; w is positive if work is done on the system, and negative if work is done by the system.

7. (c) ns^1

   Explanation: The general electronic configuration of alkali metals is ns1 as their outermost electron enters the s orbital and they have only on an electron in their valence shell.

OR

(c) alkaline earth metals

Explanation: The general electronic configuration of ns^2 exists in alkaline earth metals as their outer most electron enter the S orbital and they have only two electrons in their valence shell.

8. (a) R–Cl < R–Br < R–I

   Explanation: As we move from I to Br to Cl,atomic size decreases,it becomes difficult to release the halogen as the bond length decreases.Hence I^- is the best leaving group among halogens and reacts the fastest.

9. (c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

Explanation: Exceptional electronic configuration arises because of the extra stability due to the half-filled and fully filled electronic configuration. Half filled and fully filled electronic configuration has extra stability due to two factors:

- Symmetrical arrangement.
- Stability due to the exchange energy.

10. (b) HI > HBr > HCl

    Explanation: As we move from Cl to I,the atomic size increases,bond length increases,bond strength decreases,hence it becomes easier to release halogen and hence the order.I^- is the a better leaving group.

11. (d) 0

    Explanation: The steric number of BrF_5 is 6. So the geometry is octahedral. It will have 5 bps and one lp which is present in the axial position. Because of distortion caused by lp, there is no 90^o F—Br—F bond angle in BrF_5.

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

    Explanation: Assertion is INCORRECT but, reason is CORRECT.

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

    Explanation: Assertion is INCORRECT but, reason is CORRECT.

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

    Explanation: At critical temperature density of liquid becomes equal to its vapour phase. Due to which liquid changes into a gaseous state imperceptibly and continuously.

OR

(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.

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. (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.

Section B

17. Alkali metals and alkaline earth metals react vigorously with water to form their respective hydroxide.
    The rate of reaction is slower for alkaline earth metals than the alkali metals.
    Reactions:
    $$2Na + 2H_2O \longrightarrow 2NaOH + H_2 \quad Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$$

    OR

    The sixth period corresponds to sixth shell. The orbitals present in this shell are 6s, 4f, 5p, and 6d. The maximum number of electrons which can be present in these sub-shell is 2 + 14 + 6 + 10 = 32. Since the number of elements in a period corresponds to the number of electrons in the shells, therefore, sixth period should have a maximum of 32 elements.
18. The greater the s - character of the hybrid orbital's, the greater is the electronegativity.
    A carbon atom having an sp hybrid orbital with 50% s – the character is more electronegative than that possessing sp^2 or sp^3 hybridized orbital's.
19. The conjuagte acids and conjugate bases for the given species are given below:

Species	conjugate acid	conjugate base
H_2O	H_3O^+	OH^-
HCO_3^-	H_2CO_3	CO_3^{2-}
HSO_4^-	H_2SO_4	SO_4^{2-}
NH_3	NH_4^+	NH_2^-

    OR

    For the reaction,

    $NO(g) + O_3(g) \rightleftharpoons NO_2(g) + O_2(g)$, $K_c = 6.3 \times 10^{14}$

    Therefore equilibrium constant for reverse reaction (K'_c) i.e. backward reaction is the inverse of an equilibrium constant for forward reaction (K_c). Hence

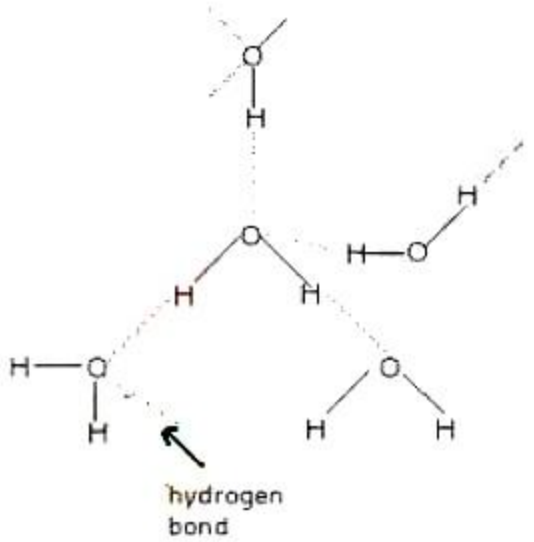
$K'_c = \frac{1}{K_c} = \frac{1}{6.3 \times 10^{14}} = 1.587 \times 10^{-15}$

20. i. Nucleophilic substitution
    ii. Electrophilic Addition
    iii. Bimolecular elimination
    iv. Nucleophilic substitution with rearrangement.

OR

SO_3 acts as an electrophile because three highly electronegative oxygen atoms are attached to Sulphur atom in SO_3 which makes sulphur atom electron deficient.

21. Carbon hydrides of the type (Cn H_2n + 2) are electron precise hydrides. Because they have an exact number of electrons in Carbon atom to form covalent bonds. Thus they do not behave as a Lewis acid or base since they have no tendency to accept or lose electrons.
22. In ice, each water molecule is surrounded by the four other water molecules with their oxygen atom occupying the corner of the tetrahedron. There are four hydrogen atoms attached to an oxygen atom; two of the hydrogen atoms are bonded by the covalent bond while another two by the hydrogen bond. This gives a huge 3D structure having large vacant spaces. Due to this, the volume of ice is more than water and thus density is less than water.



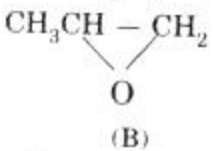
23. i. $\underset{\underset{\text{Br}}{|}}{CH_3CHCH_3} \xrightarrow[\text{Heat}]{\text{alc.KOH}} \underset{\text{(A)}}{CH_3CH = CH_2} \xrightarrow[\text{peroxide}]{\text{HBr}} \underset{\text{(B)}}{CH_3CH_2CH_2Br}$

Propene — 1−Bromopropene

ii. $CH_3CH_2CH_2OH \xrightarrow[\text{Heat}]{\text{cone } H_2SO_4} \underset{\text{(A)}}{CH_3CH = CH_2} \xrightarrow[\text{Heat}]{O_2, Ag}$

Propene

1-Bromopropane



(B)

Propylene oxide

24. Iso-electronic species are atoms or ions having same number of electrons. The iso electronic species are: O^{-2}, F^{-1} Ne. All they contains 10 electrons

25. i. + 9 charges on the left, + 1 charge on the right; add 8 electrons top the left side.

ii. 0 charge on the left, +6 charges on the right; add 6 electrons on the right side.

Section C

26. The chemical equation for the reaction is

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

According to given equation

2 x 27= 54 g of Al at N.T.P. release

H_2 gas $= 3 \times 22400$ mL

0.15 g of Al at N.T.P release

$\frac{3\times22400\times0.15}{54} = 186.7\ mL$ of H_2 gas

Assuming the inital conditions at N.T.P.

Initial volume V_1 = 186.67 mL, Final volume V_2 = ?

Initial pressure P_1 = 1.013 bar, Final pressure P_2 = 1 bar

Initial temperature T_1 = 0 + 273 = 273 K,

Final temperature T_2 = 20 + 273 = 293 K

According to gas equation

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ or $V_2 = \frac{P_1V_1T_2}{P_2T_1}$

$V_2 = \frac{1.013bar\times186.7mL\times293K}{1\ bar\times273K}$ = 203 mL

Thus 203 mL of H_2 gas is released.

OR

Let the volume of the flask = V dm^3 (after expelling the air)

V_1 = V dm^3

T_2 = 27 + 273 = 300 K

V_2 = (V + 0.1) dm^3

T_1 = 227 + 273 = 500 K

Since the pressure of the gas is constant, Charles' law is applicable.

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

or $V = \frac{(300K) \times (V + 0.1 dm^3)}{(500K)}$ or $V = \frac{3(V+0.1)}{5} dm^3$

or 5V - 3V = 0.3 dm^3 or 2V = 0.3 dm^3

$\therefore V = \frac{0.3 dm^3}{2} = 0.15 dm^3$

27. Step 1:

1 molecule of oxygen (O_2) contains 2 atoms of oxygen

1 molecule of ozone (O_3) contains 3 atoms of oxygen

In flask P:

The number of molecules in 1 mole of oxygen gas

= 69.022 × 1023 molecules

The number of molecules in 0.5 mole of oxygen gas

= $6.022 \times 10^{23} \times 0.5$ molecules

= $6.022 \times 10^{23} \times 0.5 \times 2$ atoms, (since O_2 is a diatomic gas)

= 6.022×10^{23} atoms, (i)

Step 2:

In flask Q:

The number of molecules 1 mole of ozone gas molecules

= 6.022 x 10^{23} molecules

The number of molecules in 0.4 moles of ozone gas

= $6.022 \times 10^{23} \times 0.4$ molecules

The number of oxygen atoms in 0.4 moles of ozone gas

= $6.022 \times 10^{23} \times 0.4 \times 3$ atoms, because Ozone (O_3) is a triatomic gas)

= 7.23×10^{23} atoms, (ii)

Comparing results in (i) & (ii) we infer that,

∴ Flask Q has a greater number of oxygen atoms as compared to that of in flask P.

OR

The given chemical equation is:

$$\underset{4\times36.5}{4HCl(aq)} + \underset{87g}{MnO_2} \rightarrow 2H_2O(l) + MnCl_2(aq) + Cl_2(g)$$

It is clear from balanced chemical equation,

87 g of MnO_2 reacts with 146 g HCl

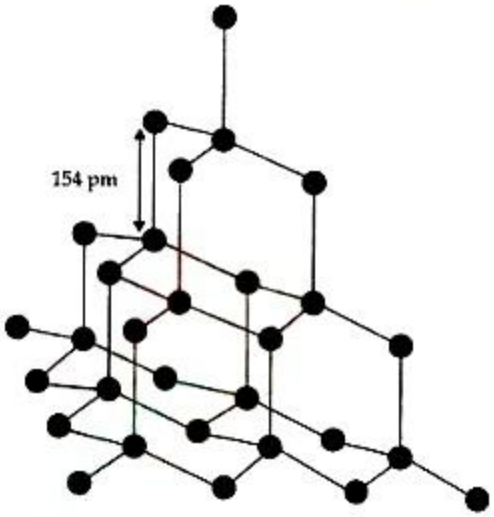
Therefore, 5 g of MnO_2 will react with = $\frac{146 \times 5}{87}$ = 8.4 g HCl.

28. The structure of trans isomer is more symmetrical as compared to the cis – isomer. Due to symmterical structure of the trans – isomer, the dipole moments of the polar C-Cl bonds are likely to cancel each other and the resultant dipole moment of the molecule is nearly zero. But in the cis – isomer, these do not cancel.

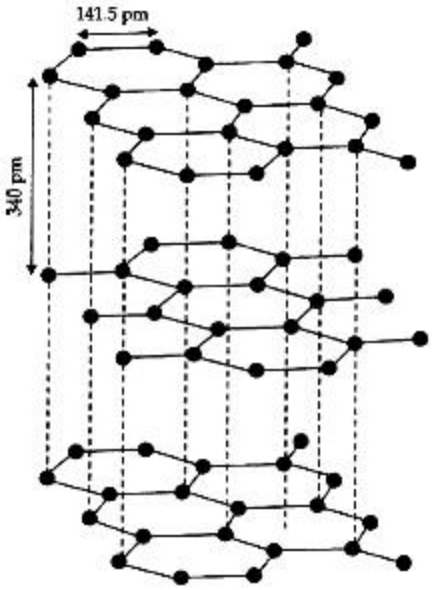
cis-1,2-dichloro ethene

trans-1,2-dichloro ethane

29. **Allotropes:** Allotropes are the different forms of an element which are having same chemical properties but different physical properties due to their structures.



Structure of diamond



Graphite

In diamond carbon is sp^3-hybridized. Since diamond has three dimensional network solid, it is hardest substance with high density whereas Graphite has a layered structure. The various layers are formed by Van der Waal forces of attraction that's why Graphite is soft and slippery.

30. According to the question, $\Delta U^\circ = -10.5$ kJ and $\Delta S^\circ = -44.1\ JK^{-1}$, R = 8.314×10^{-3} kJ mol^{-1}, T = 298 K.

Reaction:

$2A(g) + B(g) \longrightarrow 2D(g)$

$\Delta n_g = n_p - n_r = 2 - 3 = -1$

We know that, $\Delta H^\circ = \Delta U^\circ + \Delta n_g RT$

$\Delta H^\circ = -10.5$ + (- $1 \times 8.314 \times 10^{-3} \times 298$)

= - 12.977 kJ mol^{-1}

Now, $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$\Delta G^\circ = -12.977$ - ($298 \times$ - 44.1×10^{-3})

= 0.165 kJ mol^{-1}

The reaction will not occur spontaneously because ΔG° is positive.

Section D

31. Sequence o energy levels

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \pi 2p_x = \pi 2p_y < \sigma 2p_z$

For N_2 molecule the M.O. configuration is:

$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$

B.O. = $\frac{1}{2}(10-4)$ = 3, diamagnetic in nature.

$N_2^+ : 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^1$

B.O. = $\frac{1}{2}(9-4)$ = 2.5 paramagnetic in nature

$N_2^- : 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2 \pi * 2p_x^1$

B.O. = $\frac{1}{2}(10-5)$ = 2.5, paramagnetic in nature.

$N_2^{2+} : 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2$

B.O. = $\frac{1}{2}(8-4)$ = 2, diamagnetic in nature

Stability order: $N_2 > N_2^- > N_2^+ > N_2^{2+}$

(N_2^- has more bonding electrons as compared to N_2^+)

OR

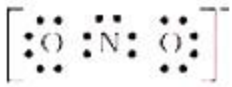
Step 1. Count the total number of valence electrons of the nitrogen atom, the oxygen atoms and the additional one negative charge (equal to one electron).

N($2s^2\ 2p^3$), O ($2s^2\ 2p^4$)

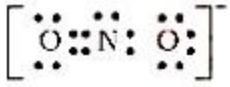
5 + (2 × 6) +1 = 18 electrons

Step 2. The skeletal structure of NO_2^- is written as: O N O

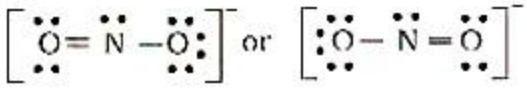
Step 3. Draw a single bond (one shared electron pair) between the nitrogen and each of the oxygen atoms completing the octets on oxygen atoms. This, however, does not complete the octet on nitrogen if the remaining two electrons constitute lone pair on it.



Hence we have to resort to multiple bonding between nitrogen and one of the oxygen atoms (in this case a double bond). This leads to the following Lewis dot structures.



or



32. **Calculation of K_p for the reaction**

Let the total mass of the gaseous mixture = (100 - 90.55) = 9.45 g

No. of moles of CO = $\frac{90.55g}{(28g mol^{-1})} = 3.24 mol$

No. of moles of $CO_2 = \frac{90.55g}{(44g\ mol^{-1})} = 0.215\ mol$

pCO in the mixture $= \frac{(3.234mol)}{(3.234+0.215)} \times 1\ atm = \frac{(3.234\ mol)}{(3.449\ mol)} \times 1\ atm = 0.938\ atm$

pCO$_2$ in the mixture $= \frac{(0.215\ mol)}{(3.449\ mol)} \times 1\ atm = 0.062\ atm$

$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$

Equi. Pressure 0.062 atm 0.938 atm

$K_p = \frac{p^2CO}{pCO_2} = \frac{(0.938\ atm)^2}{(0.062\ atm)} = 14.19\ atm$

Step II. Calculation of K_c for the reaction.

$K_c = \frac{K_p}{(RT)^{\Delta ng}}$

K_p = 1.419 atm, R = 0.0821 L atm K^{-1} mol^{-1}, T = 1127 K, $\triangle n_g$ = 2 - 1 = 1

$K_c = \frac{(14.19\ atm)}{(0.0821L\ atm\ K^{-1}mol^{-1}) \times (1127K)^1} = 0.153mol\ L^{-1}$

OR

For the reaction CO (g) + H_2O (g) $\rightleftharpoons$ CO_2(g) + H_2(g)

Initial concentration:

0.1M, 0.1M, 0, 0

Let x mole per litre of each of the product be formed.

At equilibrium:

(0.1 - x)M, (0.1-x)M, x M, x M

where x is the amount of CO_2 and H_2 at equilibrium.

Hence, equilibrium constant can be written as,

Kc = $\frac{x^2}{(0.1-x)^2}$ = 4.24

$x^2 = 4.24(0.01 + x^2 - 0.2x)$

$x^2 = 0.0424 + 4.24x^2 - 0.848x$

$3.24x^2 - 0.848x + 0.0424 = 0$

a = 3.24, b = -0.848, c = 0.0424

(for quadratic equation $ax^2 + bx + c = 0$

x = $\frac{(-b \pm \sqrt{b^2-4ac})}{2a}$

$x = \frac{-(-0.848) \pm \sqrt{(-0.848)^2 - 4(3.24)(0.0424)}}{2(3.24)}$

$x = \frac{-0.848 \pm 0.4118}{6.48}$

$x_1 = (0.848 - 0.4118)/6.48 = 0.067$

$x_2 = (0.848 + 0.4118)/6.48 = 0.194$

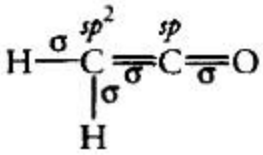
the value 0.194 should be neglected because it will give concentration of the reactant which is more than initial concentration.

Hence the equilibrium concentrations are,

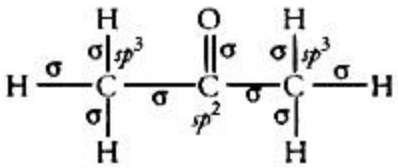
$[CO_2] = [H^{2-}] = x = 0.067$ M

$[CO] = [H_2O] = 0.1 - 0.067 = 0.033$ M

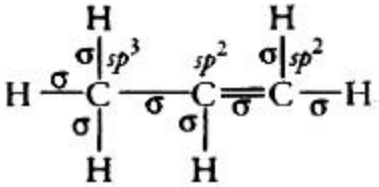
33. i. Structure and Hybridisation states of each carbon atom in $CH_2 = C = O$:



ii. Structure and Hybridisation states of each carbon atom in $(CH_3)_2CO$:



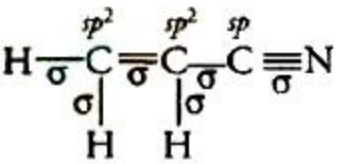
iii. Structure and Hybridisation states of each carbon atom in $CH_3 = CH_2$:



iv. Structure and Hybridisation states of each carbon atom in C_6H_6:

In benzene, each C is sp^2-hybridised.

v. Structure and Hybridisation states of each carbon atom in $CH_2 = CHCN$:



OR

Inductive Effects:

The inductive effect refers to the polarity produced in a molecule as a result of higher electronegativity of one atom compared to another.

Atoms or groups which lose electron towards a carbons atom are said to have a + I Effect.

Those atoms or groups which draw electron away from a carbon atom are said to have -I Effect.

Common examples of -I effect are:

NO_2, F, Cl, Br, I, OH etc.

Examples of

+R effect are (Electron releasing)

$(CH_3)_2C$-, $(CH_3)_2CH$-, CH_3CH_2-, CH_3- etc.

Electromeric effect:

The electromeric effect refers to the polarity produced in a multiple bonded compound as it is approached by a reagent.

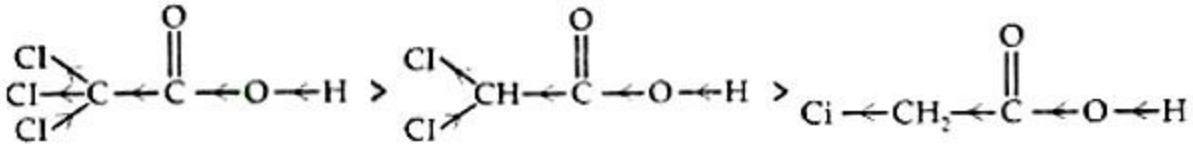
The atom A has lost its share in the electron pair and B has gained this share.

As a result A acquires a positive charge B a negative charge.

It is a temporary effect and takes place only in the presence of a regent.

i. -I-effect as shown below:

As the number of halogen atoms decreases, the overall -I- effect decreases and the acid strength decreases accordingly.



ii. +I-effect as shown below:

As the number of alkyl groups increases, the +I-effect increases and the acid strength decreases accordingly.