CBSE Class 11 Chemistry
Sample Paper 09 (2019-20)

Maximum Marks: 70

Time Allowed: 3 hours

General Instructions:

a. All questions are compulsory.

b. Section A: Q.no. 1 to 16 are very short answer questions (objective type) and carry 1 mark each.

c. Section B: Q.no. 17 to 23 are short answer questions and carry 2 marks each.

d. Section C: Q.no. 24 to 30 are long answer questions and carry 3 marks each.

e. Section D: Q.no. 31 to 33 are also long answer questions and carry 5 marks each.

f. There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.

g. Use log tables if necessary, use of calculators is not allowed.

Section A

1. Covalent molecules formed by heteroatoms bound to have some ionic character. The ionic character is due to shifting of the electron pair towards A or B in the molecule AB. Hence, atoms acquire small and equal charge but opposite in sign. Such a bond which has some ionic character is described as a polar covalent bond. Polar covalent molecules can exhibit a dipole moment. The dipole moment is equal to the product of charge separation, q and the bond length, d for the bond. The unit of dipole moment is Debye. One Debye is equal to 10^{-18} esu cm.

   The dipole moment is a vector quantity. It has both magnitude and direction. Hence, the dipole moment of molecules depends upon the relative orientation of the bond dipole, but not the polarity of bonds alone. The symmetrical structure shows a zero dipole moment. Thus, a dipole moment help to predict the geometry of the molecules. Dipole moment values can be used to distinguish between cis- and trans-isomers;

ortho-, meta- and para-forms of a substance, etc. The percentage of ionic character of a bond can be calculated by the application of the following formula:

% ionic character $\dfrac{\text{Experimental value dipole moment}}{\text{Theoretical value of dipole moment}} \times 100$

Answer the following questions:

i. Out of and which compounds have zero dipole moments?
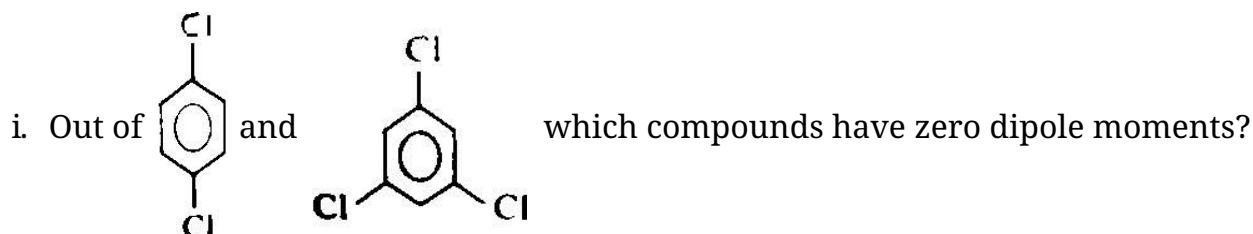
ii. _____ and _____ are non-polar molecules? (xeF_4, BF_3, NH_3, H_2O)

iii. A diatomic molecule has a dipole moment of 1.2D. If the bond length is 1.0×10^{-8}cm, what fraction of charge does exist on each atom?

[Hind: Charge = $\dfrac{\text{Dipole moment}}{\text{Bond length}} = \dfrac{1.2 \times 10^{-18}}{1.0 \times 10^{-8}} = 1.2 \times 10^{-10}$ esu]

iv. The dipole moment of NF_3 is very much less that of NH_3. Why?

v. A covalent molecule, x-y, is found to have a dipole moment of 1.5×10^{-29}cm and a bond length 150 pm. What will be the percentage of ionic character of the bond?

[Hint: $\mu_{ca} = 1.602 \times 10^{-19}C \times 150 \times 10^{-12}m = 2.4 \times 10^{-29}$cm]

2. What is the difference between a quantum and a photon?

3. Name the two elements whose existence and properties were predicted by Mendeleev though they did not exist then.

4. Which quantity out of $\Delta_r G$ and $\Delta_r G^\circ$ will be zero at equilibrium?

5. The melting and boiling points of alkaline metals are higher than alkali metals. Give reason.

6. What primary pollutants are responsible for photochemical smog?

7. The reaction,

$(CH_3)_3 C - Br \xrightarrow{H_2O} (CH_3)_3 C - OH$ is
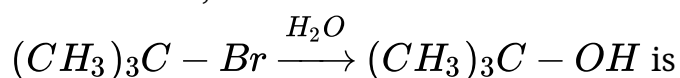
a. Displacement reaction

b. Elimination reaction

c. Substitution reaction

d. Free radical reaction

8. Oxidation number denotes the oxidation state of an element in a compound ascertained on the basis that electron in a covalent bond belongs

    a. entirely to transition elements if present

    b. entirely to halogens in a compound

    c. entirely to more electronegative element

    d. entirely to more electronegative element

9. A plot of volume (V) versus temperature (T) for a gas at constant pressure is a straight line passing through the origin. The plots at different values of pressure are shown in Figure. Which of the following order of pressure is correct for this gas?

Temperature (K) ──→
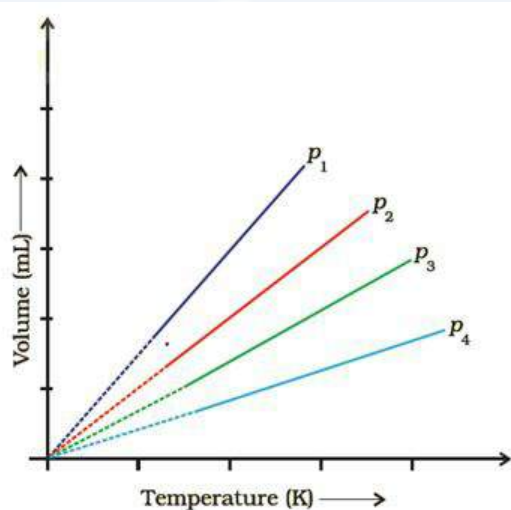
    a. $P_1 < P_2 < P_3 < P_4$

    b. $p_1 < p_2 = p_3 < p_4$

    c. $p_1 > p_2 > p_3 > p_4$

    d. $p_1 = p_2 = p_3 = p_4$

10. Oxidation and reduction always occur simultaneously, hence, the word "redox" was coined for this class of chemical reactions. In the following redox reaction, identify the species undergoing oxidation and reduction:

$$3Fe_3O_4 \, (s) \; + \; 8 \, Al \, (s) \; \rightarrow \; 9 \, Fe \, (s) \; + \; 4Al_2O_3 \, (s)$$
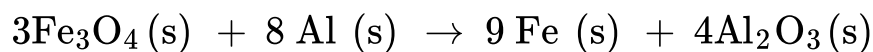
   a. Aluminium (Al) is oxidised, (Fe_3O_4) is reduced

   b. Al_2O_3 is reduced, Fe_3O_4 is oxidised

   c. Fe_3O_4 is oxidised, Aluminium is reduced

   d. Fe_3O_4 is oxidised, Fe is reduced

11. Select the nucleophile(s) among the following molecules/ions

    HS^-, BF_3, $C_2H_5O^-$, $(CH_3)_3N:$, Cl^+, $CH_3C^+ =O$, $H_2N:^-$, NO_2^+

    a. Cl^+, $CH_3C^+ =O$

    b. $CH_3C^+ =O$, NO_2^+

    c. HS^-, $H_2N:^-$ $(CH_3)_3N:$, $C_2H_5O^-$

    d. BF_3, Cl^+

12. **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.

13. **Assertion:** 1 mol of O and 1 mol of O_2 contain equal number of particles.

Reason: 1 mol of molecules is always double than 1 mol of atoms in all diatomic molecules.

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:** Oxygen has an oxidation state of -2 in both O_2 and O_3.

Reason: Oxygen is assigned an oxidation state of -2 in almost all its compounds.

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:** The compound cyclooctane has the following structural formula :

It is cyclic and has conjugated 8π-electron system but it is not an aromatic compound.
Reason: $(4n + 2) \pi$ electrons rule does not hold true for cyclooctane and the ring is not planar.

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:** 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.

Section B

17. What do you understand by bond pairs and lone pairs of electrons? Illustrate by giving one example of each type.

18. Why does fluorine not show disproportionation reaction?

19. Compare the alkali metals and alkaline earth metals with respect to (i) ionization enthalpy, (ii) basicity of oxides, (iii) solubility of hydroxides.

20. What happens when

   i. bromoethane is treated with zinc and hydrochloric acid?
   ii. hydrogen is passed into 2-bromopropane in the presence of palladium?

21. The molar solubility of lead iodate, $Pb(IO_3)_2$ is 4.0×10^{-5} mol/L at 25°C. Calculate its K_{sp}.

OR

Write the Lewis dot symbols of the following elements and predict their valencies.

  i. Cl

  ii. P

22. How will you detect the presence of nitrogen and sulphur in Lassaigne's extract?

OR

Why is the difference between ΔH and ΔU not significant for solids or liquids?

23. The boiling point of alkanes shows a steady increase with an increase in molecular mass. Why?

Section C

24. 1 mole of an ideal gas undergoes reversible isothermal expansion from an initial volume of V_1 to a final volume of 10 V_1 and does 10 kJ of work. The initial pressure was 1×10^7 Pa.

  i. Calculate V_1.

  ii. If there were 2 moles of gas what must its temperature have been?

25. Write the electron configurations and calculate the bond order of H_2^+, H_2 and He_2. Explain why bond length in H_2^+ is longer than in H_2?

OR

The concentration of sulphide ion in 0.1 M HCl solution saturated with hydrogen sulphide is $1.0 \times 10^{-19} M$. If 10 mL of this solution is added to 5 mL of 0.04 M solution of $FeSO_4$, $MnCl_2$, $ZnCl_2$ and $CaCl_2$ in which solutions precipitation will take place? Given K_{sp} for $FeS = 6.3 \times 10^{-18}$, $MnS = 2.5 \times 10^{-13}$, $ZnS = 1.6 \times 10^{-24}$ and $CdS = 8.0 \times 10^{-27}$.

26. Write formulas for the following compounds:

  i. Mercury (II) chloride

ii. Nickel (II) sulphate

iii. Tin (iv) oxide

iv. Thallium (I) sulphate

v. Iron (III) sulphate

vi. Chromium (III) oxide

27. Non-stoichiometric cuprous oxide, Cu_2O can be prepared in laboratory. In this oxide, copper to oxygen ratio is slightly less than 2 : 1. Can you account for the fact that this substance is a p-type semiconductor?

28. The density of 3 M solution of NaCl is 1.25 g mL^{-1}. Calculate the molality of the solution.

29. Energy of an electron in the ground state of the hydrogen atom is $-2.18 \times 10^{-18} J$. Calculate the ionization enthalpy of atomic hydrogen in terms of J mol^{-1}?
[Hint : Apply the idea of mole concept to derive the answer].

OR

Write the name and deduce the atomic numbers of the following atoms:

i. The third alkali metal

ii. Second transition element

iii. The fourth noble gas

iv. Fourth element in the second period

30. A farmer was using pesticides on his farm. He used the produce of his farm as food for rearing fishes. He was told that fishes were not fit for human consumption because large amount of pesticides had accumulated in the tissues of fishes. Explain how did this happen?

Section D

31. Using the standard electrode potentials given below, predict if the reaction between the following is feasible or not.

i. Fe^{3+} (aq) and I^- (aq)

ii. Ag^+ (aq) and Cu(s)

iii. Fe^{3+} (aq) and Cu(s)

iv. Ag(aq) and Fe^{3+} (aq)

v. Br_2(aq) and Fe^{2+} (aq)

Given $E^0_{I_2/I^-}$ = 0.54 V, $E^0_{Br_2/Br^-}$ = 1.09 V, $E^o_{Fe^{3+}/Fe^{2+}}$ = 0.77 V, $E^0_{Cu^{2+}/Cu}$ = 0.34 V, $E^\circ_{Ag^+/Ag}$ = 0.80 V,

OR

i. Comment upon the reactions of dihydrogen with

  a. Chlorium

  b. Sodium and

  c. Copper (II) oxide

ii. Can phosphorus with outer electric configuration $3s^2 3p^3$ form PH_5?

32. A hydrocarbon containing two double bonds gave on reductive ozonolysis ethanal, glyoxal and propanone. Predict the structure of the hydrocarbon and give its IUPAC name.

OR

For the following compounds, write structural formulae and IUPAC names for all possible isomers having the number of double or triple bond as indicated

i. C_4H_8 (one double bond)

ii. C_5H_8 (one triple bond)

33. i. Calculate the uncertainty in the position of an electron if the uncertainty in its velocity is 5.7×10^5 m s^{-1}. (h = 6.6×10^{-34} J s and mass of electron = 9.1×10^{-31} kg)

ii. Calculate the uncertainty in the velocity in a waggon of mass 2000 kg whose position is known to an accuracy of $\pm$ 10 m.

OR

Calculate the number of atoms in each of the following. Which one of the following

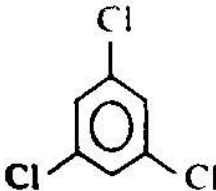will have the largest number of atoms?

  i.   1 g Au(s)
 ii.   1g Na(s)
iii.   1g Li(s)
 iv.   1g of CI_2(g)

Solution

Section A

1. i. Both the molecules have zero dipole moments since both and

    shows symmetrical structure.

    ii. XeF_4 and BF_3

    iii. Fraction of electronic charge = $\frac{1.2 \times 10^{-10}}{4.8 \times 10^{-10}} = 0.25$

    iv. Because of different direction of moment of N-H and N-F bonds.

    v. % ionic character = $\frac{1.5 \times 10^{-29}}{2.4 \times 10^{-29}} \times 100 = 62.5$

2. The smallest packet of energy of any radiation is called a quantum whereas that of light is called photon. A photon is an elementary particle but quantum can be described as a measure of quantity. It is not considered as an elementary particle.

3. Mendeleev predicted the existence of gallium and germanium. He named them as Eka-Aluminium and Eka-Silicon.

    He described some of their general physical properties. These elements were discovered later.

4. We know that, $\Delta_r G = \Delta_r G^\circ + RT \ln K$

    At equilibrium, $\Delta_r G = 0$

    So, $0 = \Delta_r G^\circ + RT \ln K$

    $\therefore \Delta_r G^\circ$ = - RT ln K

    $\Delta_r G^\circ = 0$ when K = 1

    For all other values of K, $\Delta_r G^\circ$ will be non-zero.

    Therefore, $\Delta_r G$ will be zero at equilibrium.

5. Due to smaller size, the melting and boiling points of alkaline metals are higher than

alkali metals.

6. Nitric oxide, carbon monoxide, and various unburned hydrocarbons are the primary pollutants that are responsible for the formation of photochemical smog in the presence of sunlight.

7. (c) Substitution reaction

   Explanation: Substitution reaction

8. (d) entirely to more electronegative element

   Explanation: Oxidation number is a number assigned to an element in a compound according to some rules. This number enable us to describe oxidation-reduction reactions, and balancing redox chemical reactions. When a covalent bond forms between two atoms with different electronegativities the shared electrons in the bond lie closer to the more electronegative atom eg. HCl

   The oxidation number of an atom is the charge that results when the electrons in a covalent bond are assigned to the more electronegative atom. It is the charge on an atom would possess if the bonding were ionic. In HCl (above) the oxidation number for the hydrogen would be +1 and that of the Cl would be -1

9. (a) $P_1 < P_2 < P_3 < P_4$

   Explanation: Keeping Temperature constant we know $V \propto 1/P$. So as P increases V decreases.

10. (a) Aluminium (Al) is oxidised, (Fe_3O_4) is reduced

    Explanation: In the above reaction oxygen is transferred from Fe_3O_4 to Al, so Fe_3O_4 is reduced while Al is oxidised.

    As per definition of oxidation and reduction , loss of oxygen i.e reduction occurs in Fe_3O_4 and gain of oxygen i.e Oxidation occurs in Al.

11. (c) HS^- , H_2N^-: $(CH_3)_3N$:, $C_2H_5O^-$

    Explanation: Nucleophiles are nucleus loving species. These can be negatively charged or netural having lone pair of electrons. So among the given options nucleophiles are HS^- , H_2N^-:, $(CH_3)_3N$:, $C_2H_5O^-$

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

Explanation: Assertion is INCORRECT but, reason is CORRECT.

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

    Explanation: Assertion is CORRECT but, reason is INCORRECT.

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

    Explanation: Assertion is INCORRECT but, reason is CORRECT.

15. (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.

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

   **Explanation:** Assertion is INCORRECT but, reason is CORRECT.

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.
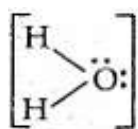
Section B

17. The electron pair involved in sharing between two atoms during covalent bonding is called shared pair or bond pair. At the same time, the electron pair which is not involved in sharing is called a lone pair of electrons.

    For Example. In a case of CH_4 molecule.There are only 4 bond pairs.
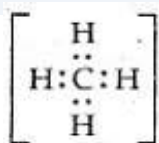
    but in a case of H_2O molecule.There are two bond pairs and two lone pairs.


18. 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.
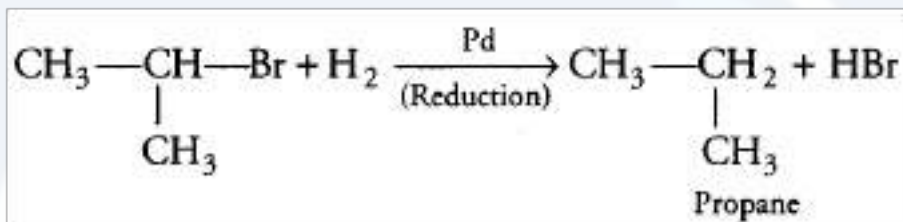
    The element, in reacting species must present in intermediate states of higher and lower oxidation state, but in case of flourine, fluorine does not show a positive

oxidation state. That's why fluorine does not show a disproportionation reaction.

19. (i) **Ionization enthalpy.** Because of high nuclear charge the ionization of alkaline earth metals are higher than those of the corresponding alkali metals.

(ii) **Basicity of oxides.** Basicity of oxides of alkali metals are higher than that of alkaline earth metals.

(iii) **Solubility of hydroxides**. Alkali metals hydroxides are more soluble than that of alkaline earth metals.

20. i. Bromoethane when treated with zinc and hydrochloric acid, it is reduced to the Ethane.

$$CH_3CH_2\text{—}Br + 2[H] \xrightarrow[\text{(Reduction)}]{Zn/HCl} CH_3CH_3 + HBr$$
Bromoethane
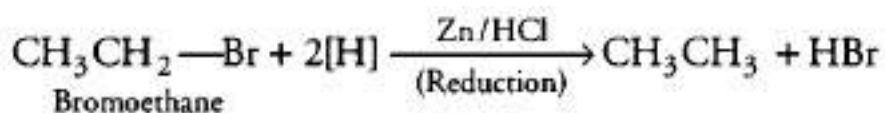
ii. 2-Bromopropane is treated with hydrogen in the presence of palladium, Pd, propane is obtained as a major product.

$$CH_3\text{—}\underset{\underset{CH_3}{|}}{CH}\text{—}Br + H_2 \xrightarrow[\text{(Reduction)}]{Pd} CH_3\text{—}\underset{\underset{CH_3}{|}}{CH_2} + HBr$$
Propane

21. According to the question, molar solubility of lead iodate at 25°C is 4.0×10^{-5} mol/L.

Reaction:

$Pb(IO_3)_2 \rightleftharpoons Pb^{2+} + 2IO_3^-$
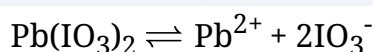
$\therefore K_{sp} = \left[Pb^{2+}\right]\left[IO_3^-\right]^2$

Given, $[Pb^{2+}] = 4.0 \times 10^{-5}$ mol L^{-1}

$\left[IO_3^-\right] = 2 \times 4.0 \times 10^{-5}$ mol L^{-1}

$\therefore K_{sp} = (4.0 \times 10^{-5})(8.0 \times 10^{-5})^2$

$= 2.56 \times 10^{-13}$

OR

i. $: \ddot{\underset{..}{C}}l \cdot$

(valency = 8 - 7 = 1)

ii. $\cdot \ddot{\underset{..}{P}} \cdot$

(valency = (8 - 5) = 3

22. If freshly prepared $FeSO_4$ and then dil. H_2SO_4 is added to Lassaigne's extract A blue green colouration confirms the nitrogen.

OR

Solids or liquids do not suffer any significant volume changes upon heating. So, the difference between ΔH and ΔU is not usually significant for systems consisting of only solids or liquids.

23. With the increase in molecular weight or the molecular size of the molecule, the surface area of the molecule increases. Due to which the extent of the intermolecular Vanderwall forces increases which causes the increase in the boiling point of alkanes.

Section C

24. According to the question, n = 1, Initial volume = V_1, final volume = 10 V_1, W = 10 kJ, p = 1×10^7 Pa.

  i. $W = -2.303nRT \log \frac{V_2}{V_1}$

    $10 \times 10^3 J = -2.303 \times 1 \times 8.314 \times T \times \log \frac{10V_1}{V_1}$

    $\Rightarrow$ T = 522.3 K

    For initial conditions, $p_1 V_1 = n_1 RT$

    $\Rightarrow \left(10^7\right) V_1 = 1 \times 8.314 \times 522.3$

    $\Rightarrow V_1 = 4.342 \times 10^{-4} m^3$

    $= 4.342 \times 10^2 cm^3$

    = 434.2 cm^3

  ii. If there were 2 moles of the gas, applying $p_1V_1 = n_1RT$, we get

    $\left(10^7\right) \left(4.342 \times 10^{-4}\right) = 2 \times 8.314 \times T$

    $\Rightarrow T = 261.1$ K

25. The number of electrons, their configurations, etc., for the species, are:

Species	No. of electrons	Configurations	N_b	N_a	Bond order = $\frac{1}{2}$ [N_b - N_a]
H_2^+	1	$(\sigma ls)^1$	1	0	$\frac{1}{2}$
H_2	2	$(\sigma ls)^2$	2	0	1
He_2	4	$(\sigma ls)^2 (\sigma ls)^2$	2	2	0

The bond length in H_2^+ is longer than in H_2 because in H_2^+ only one electron is present to shield the two nuclei from mutual repulsion. In H_2 there are two electrons to hold the two nuclei thus nuclear repulsion is less than that in H_2^+. hence, nuclear separation in H_2^+ is more than in H_2.

OR

Precipitation will take place in the solution for which ionic product is greater than solubility product.

As 10 mL of solution containing S^{2-} ion is mixed with 5 mL of metal salt solution, after mixing
$$[S^{2-}] = 1.0 \times 10^{-19} \times \frac{10}{15} = 6.67 \times 10^{-20}$$
$$[Fe^{2+}] = [Mn^{2+}] = [Zn^{2+}] = [Cd^{2+}] = \frac{5}{15} \times 0.04 = 1.33 \times 10^{-2} M$$

As ionic product is greater than solubility product of ZnS and CdS.

So, these ($CdCl_2$ and $ZnCl_2$) are precipitated as CdS and ZnS.

26. i. $HgCI_2$

   ii. $NiSO_4$

  iii. SnO_2

  iv. TI_2SO_4

   v. $Fe_2(SO_4)_3$

  vi. Cr_2O_3

27. The ratio is less than 2 : 1 in Cu_2O shows that some cuprous (Cu^+) ions have been

replaced by (Cu^{2+}) ions. In order to maintain electrical neutrality, every two Cu^+ ions will be replaced by one Cu^{2+} ion which results in creating cation vacancies lading to positive holes. As conduction will be due to these positive holes, hence it is a p-type semiconductor.

28. Given, Molarity of solution, M = 3 mol L^{-1}

Mass of NaCl in 1 L solution = 3 × 58.5 = 175.5 g

Mass of 1 L solution = Volume × density of solution = 1000 mL × 1.25 g/mL = 1250 g

(since density = 1.25 g mL^{-1})

Mass of water solution = 1250 -175.5 = 1074.5 g = 1.0745 kg.

Now, Molality of solution = $\dfrac{\text{number of moles of solute}}{\text{mass of solvent in kg}}$ = $\dfrac{3mol}{1.0745kg}$ = 2.79m.

29. The ionisation enthalpy is for 1 mole atoms. Therefore, ground state energy of the atoms may be expressed as

E (ground state) = $(-2.18 \times 10^{-18}\,J) \times (6.022 \times 10^{23}\,mol^{-1})$

$= -1.312 \times 10^6\,J\,mol^{-1}$

Ionisation enthalpy $= E\infty - E$ ground state

$= 0 - (-1.312 \times 10^6\,J\,mol^{-1})$

$= 1.312 \times 10^6\,J\,mol^{-1}$

OR

i. K, 19
ii. Ti, 22
iii. Kr, 36
iv. C, 6

30. Farmers use fertilisers, pesticides and biological control to increase crop yields. These pesticides are one group of toxic compounds that have a profound effect on aquatic life and water quality. Most of the organic toxins are water-insoluble and non-biodegradable. These high persistent toxins are, therefore, transferred from lower tropic level to higher tropic level through food chain. Over the time, the concentration of toxins in higher animals reach a level which causes serious metabolic and physiological disorders.

31. For spontaneity of the reaction, E_{cell} value must be positive because the relation between standard Gibbs free energy and E_{cell} value is given as $\Delta G = -n\, F\, E_{cell}$

From the formula it is clear that higher the positive value of E_{cell}, more negative will be the value of ΔG and higher will be the spontaneity.

To calculate E_{cell}, the following formula is used:

$E_{cell} = E^0_{cathode} - E^0_{anode}$

Here both E^0 values are of standard reduction potential.

It may be noted that whenever any half-reaction equation is multiplied by an integer, its $E°$ is not multiplied by that integer.

   i. Fe^{3+}(aq) and I^-(aq)

     The possible reaction between Fe^{3+}(aq) and I^-(aq) is as follows:

     $2Fe^{3+}$ (aq) + $2I^-$ (aq) $\longrightarrow$ $2Fe^{2+}$ (aq) + I_2 (s)

     Oxidation half-reaction:
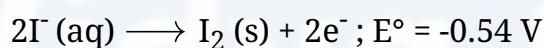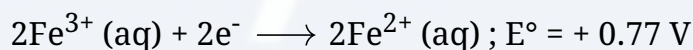
     $2I^-$ (aq) $\longrightarrow$ I_2 (s) + $2e^-$; $E° = -0.54$ V

     Reduction half-reaction:

     $2Fe^{3+}$ (aq) + $2e^-$ $\longrightarrow$ $2Fe^{2+}$ (aq) ; $E° = + 0.77$ V

     Overall reaction

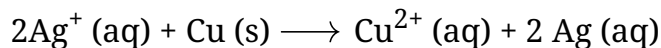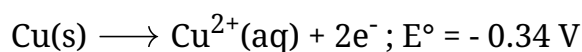 $2Fe^{3+}$ (aq) +$2I^-$ (aq) $\longrightarrow$ $2Fe^{2+}$ (aq) + I_2 (s); $E° = + 0.23$ V
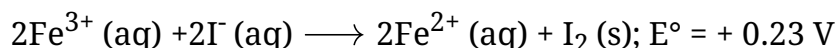
     Positive emf indicates that the reaction is feasible because ΔG will be negative.

   ii. The possible reaction between Ag^+ (aq) and Cu(s) is as follows:

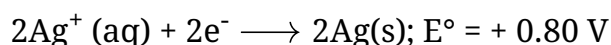 $2Ag^+$ (aq) + Cu (s) $\longrightarrow$ Cu^{2+} (aq) + 2 Ag (aq)

     Separate the equation into two half reactions and write electrode potential for each half-reaction.

     Oxidation half-reaction:
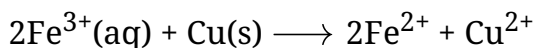
     Cu(s) $\longrightarrow$ Cu^{2+}(aq) + $2e^-$; $E° = - 0.34$ V

     Reduction half reaction:

     $2Ag^+$ (aq) + $2e^-$ $\longrightarrow$ 2Ag(s); $E° = + 0.80$ V

Overall reaction:

Cu(s) + 2Ag⁺(aq) $\longrightarrow$ Cu²⁺(aq) + 2Ag; E° = + 0.46 V
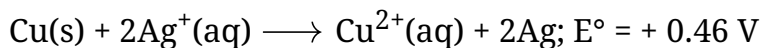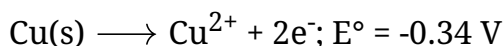
Positive emf indicates that the reaction is feasible because ΔG will be negative.

iii. The possible reaction between Fe^{3+}(aq) and Cu(s) occurs according to the following equation,

$2Fe^{3+}$(aq) + Cu(s) $\longrightarrow$ $2Fe^{2+}$ + Cu^{2+}

Oxidation half-reaction:

Cu(s) $\longrightarrow$ Cu^{2+} + 2e⁻; E° = -0.34 V

Reduction half-reaction:

$2Fe^{3+}$(aq) + 2e⁻ $\longrightarrow$ $2Fe^{2+}$(aq) ; E° = + 0.77 V

Overall reaction:

Cu(s) + $2Fe^{3+}$(aq) $\longrightarrow$ Cu^{2+}(aq) + $2Fe^{2+}$ (aq); E° = + 0.43 V
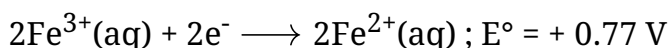
Positive emf indicates that the reaction is feasible because ΔG will be negative.

iv. The possible reaction between Fe^{3+}(aq) and Ag(s) occurs according to the following equation

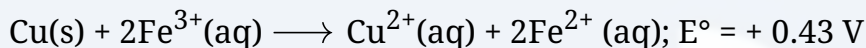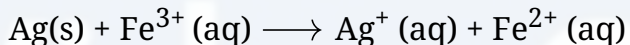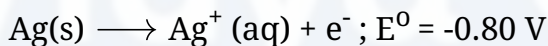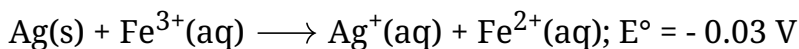Ag(s) + Fe^{3+} (aq) $\longrightarrow$ Ag^+ (aq) + Fe^{2+} (aq)

oxidation half-reaction

Ag(s) $\longrightarrow$ Ag^+ (aq) + e⁻ ; E^0 = -0.80 V

Reduction half-reaction

Fe^{3+}(aq) + e⁻ $\longrightarrow$ Fe^{2+}(aq) ; E° = + 0.77 V

Overall reaction

Ag(s) + Fe^{3+}(aq) $\longrightarrow$ Ag^+(aq) + Fe^{2+}(aq); E° = - 0.03 V
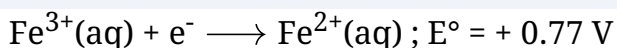
Negative emf indicates that the reaction is not feasible because ΔG will be positive.

v. The possible reaction between Br_2(aq) and Fe^{2+} (aq) occurs according to the following equation.
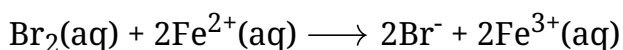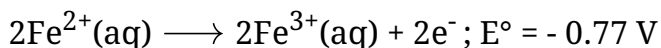
Br_2(aq) + $2Fe^{2+}$(aq) $\longrightarrow$ 2Br⁻ + $2Fe^{3+}$(aq)

Oxidation half reaction

$2Fe^{2+}$(aq) $\longrightarrow$ $2Fe^{3+}$(aq) + 2e⁻ ; E° = - 0.77 V

Reduction half reaction

Br_2(aq) + 2e⁻ $\longrightarrow$ 2Br⁻(aq); E° = + 1.09 V

Overall reaction
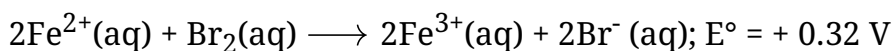
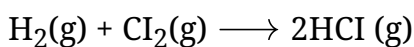$2Fe^{2+}(aq) + Br_2(aq) \longrightarrow 2Fe^{3+}(aq) + 2Br^{-}(aq); E° = + 0.32 V$

Positive emf indicates that the reaction is feasible because ΔG will be negative.

OR

i.

   a. Dihydrogen reduces chlorine to chloride (CI^{-}) ion and itself gets oxidised to H+ ion in HCI. An electron pair is shared between H and Cl to form a covalent molecule of hydrogen chloride.

      $H_2(g) + CI_2(g) \longrightarrow 2HCI (g)$

   b. Sodium reduces dihydrogen to form hydride (H^{-}) ion and itself gets oxidised to sodium (Na^{+}) ion. During this reaction, an electron is transferred from Na to H leading to the formation of an ionic compound sodium hydride, $Na^{+}H^{-}$.

      $2Na(s) + H_2(g) \xrightarrow{\text{Heat}} 2Na + H^{-}(s)$
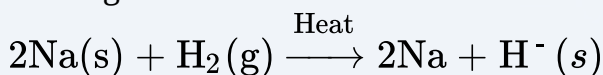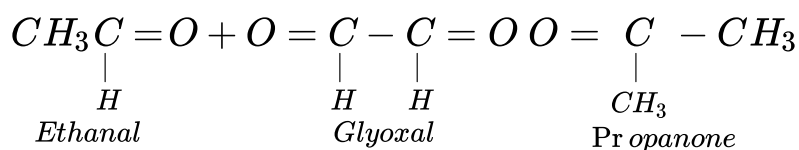
   c. Hydrogen reduces copper (II) oxide to copper metal (in zero oxidation state) and itself gets oxidised to H_2O, which is a covalent molecule.

      $\overset{+1}{C}u\overset{-2}{O} + \overset{0}{H_2}(g) \rightarrow \overset{0}{Cu}(s) + \overset{+1}{H_2}\overset{-2}{O}(l)$
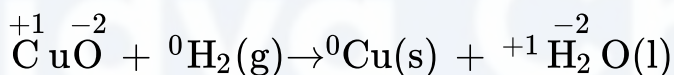
ii. Though phosphorus exhibits +3 and +5 oxidation states, it cannot form PH_5. This is because high enthalpy of atomisation ($\Delta_a H$) values of dihydrogen (435.89 kJ mol^{-1}) and slightly negative electron gain enthalpy, $\Delta_{eg}H$(-73 kJ mol^{-1}) value do not favour to exhibit the highest oxidation state of P. Thus, it can oxidise P to +3 oxidation state but not to its highest oxidation state of +5 . Thus, P forms PH_3 but not PH_5.

32. The products of reductive ozonolysis are (write the structures with their carbonyl groups facing one another).

$$CH_3 \underset{\underset{H}{|}}{C} = O + O = \underset{\underset{H}{|}}{C} - \underset{\underset{H}{|}}{C} = O \quad O = \underset{\underset{CH_3}{|}}{C} - CH_3$$

Ethanal   *Glyoxal*   *Propanone*

The hydrocarbon can be written by removing oxygen atoms and writing double

bonds between the carbonyl carbon atoms:

$$\overset{6}{C}H_3 - \overset{5}{C} = \overset{4}{C} - \overset{3}{C} = \overset{2}{C} - \overset{1}{C}H_3$$

with substituents:
- position 5: H
- position 4: H
- position 3: H
- position 2: CH₃
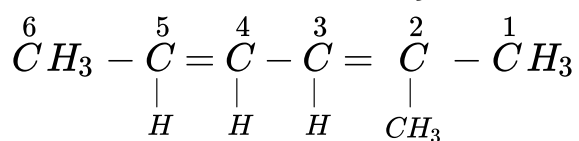
IUPAC name: 2-Methylhexa-2,4-diene

OR

i. Isomers of C_4H_8 having one double bond are

  a.

$$\overset{4}{C}H_3\overset{3}{C}H_2 - \overset{2}{C}H = \overset{1}{C}H_2$$
   But-1-ene

  b.

   Cis-but-2-ene

  c.

   Trans-but-2-ene
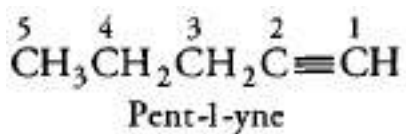
  d.

$$CH_3 - \underset{\overset{|}{CH_3}}{C} = CH_2$$
   2-methylprop-1-ene
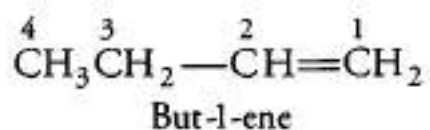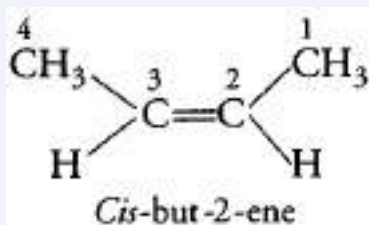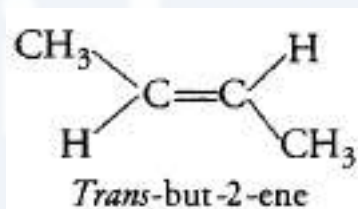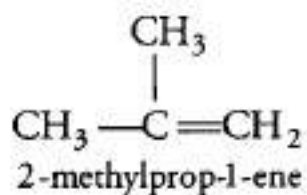
ii. Isomers of C_5H_8 having one triple bond are

  a.

$$\overset{5}{C}H_3\overset{4}{C}H_2\overset{3}{C}H_2\overset{2}{C} \equiv \overset{1}{C}H$$
   Pent-1-yne

  b.

Pent-2-yne

c.

3-methylbut-1-yne

33. i. According to Heisenberg's uncertainty principle,

$\Delta x \times \Delta p \geq \frac{h}{4\pi}$ or $\Delta x \times m\Delta v \geq \frac{h}{4\pi}$

$\therefore \Delta x \geq \frac{h}{4\pi m \Delta v}$

$\Delta v = 5.7 \times 10^5$ m s^{-1}, m = 9.1×10^{-31} kg,

h = 6.6×10^{-34} J s

$\therefore \Delta x = \frac{6.6 \times 10^{-34} \text{kgm}^2\text{s}^{-1}}{4 \times 3.142 \times (9.1 \times 10^{-31} \text{kg}) \times (5.7 \times 10^5 \text{ms}^{-1})}$

= 1.012×10^{-10} m

ii. mass of wagon = 2000 kg

Uncertainty in position, $\Delta x = \pm 10$ m

According to Heisenberg uncertainty principle

$\Delta x \times \Delta p = \frac{h}{4\pi}$ or $\Delta x \times \Delta v = \frac{h}{4\pi m}$

or $\Delta v = \frac{h}{4\pi m \Delta x}$

= $\frac{6.626 \times 10^{-34} \text{kgm}^2\text{s}^{-1}}{4 \times 3.1416 \times (2000\text{kg}) \times (10\text{m})}$

= 2.636×10^{-39} m s^{-1}

OR

No. of atoms can be calculated as:

i. 1g Au = $\frac{1}{197} \times 6.022 \times 10^{23} = \frac{6.022}{197} \times 10^{23}$

ii. 1g na = $\frac{6.022}{23} \times 10^{23}$

iii. 1g Li = $\frac{6.022 \times 10^{23}}{7}$

iv. 1g CI$_2$ = $\frac{2 \times 6.022 \times 10^{23}}{71} = \frac{6.022 \times 10^{23}}{35.5}$

It is clear that 1 g Li contains the largest number of atoms.