CBSE
Class XI Chemistry
Sample Paper – 3 Solution

Section A

1. HI>HBr>HCl>HF

2. $BeCl_2$: Linear
$SiCl_4$: Tetrahedral

OR

The electron pairs involved in the bond formation are known as bond pairs or shared pairs.

3. IUPAC name of allyl alcohol: Prop-2-en-1-ol

4. The amount of oxygen required by bacteria to breakdown the organic matter present in a certain volume of a sample of water is called biochemical oxygen demand.

OR

Carboxyhaemolobin is the compound formed when CO combines with blood.

5. Sodium (Na) – Yellow
Poassium (K) - Violet

Section B

6. Metallic character decreases and non metallic character increases in moving from left to right in a period. This is due to increase in ionization enthalpy and electron gain enthalpy.

7. Increasing order of size: $Al^{3+} < Mg^{2+} < Na^{+} < F^{-} < O^{2-}$
This is an isoelectronic series i.e. the number electrons are the same in all the elements. Thus, as the effective nuclear charge decreases, electrons are held away from the nucleus and thus size increases.

8. Given:

Velocity of electron = 2.07×10^{7} m/s

Mass of electron = 9.1×10^{-31} kg

We know,

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times2.05\times0.5\times10^{7}}$$

$$= 3.55\times10^{-11}\ \text{m}$$

9. Given:

Pressure P = 5 bar

Molar mass of nitrogen M = 28 g/mol

Density of nitrogen,

$$\rho = \frac{PM}{RT}$$

Density of gaseous oxide is,

$$\frac{0.987\times5\times28}{273\times0.0821} = \frac{0.987\times5\times(x)}{273\times0.0821}$$

$$X = \frac{0.987\times5\times28\times273\times0.0821}{273\times0.0821\times0..987\times5}$$

$$= 70$$

The molar mass of the oxide is 70 g/mol

10. $2H_2O + 2F_2 \rightarrow 4HF + O_2$

In this reaction H_2O is getting oxidized to O_2 and F_2 is getting reduced to F^- ion. Therefore, F_2 is the oxidizing agent and H_2O is reducing agent.

OR

(a) $PbS_{(g)} + H_2O_{2(aq)} \rightarrow PbSO_{4(s)} + 4H_2O_{(l)}$

(b) $CO_{(g)} + 2\,H_{2(g)} \xrightarrow[\text{catalyst}]{\text{Cobalt}} CH_3OH$

11. Given:

No.	Nuclei	No. of protons	No. of neutrons
1	$^{56}_{26}Fe$	26	30
2	$^{88}_{38}Sr$	38	50

12. Molar mass of methanol (CH_3OH) = 32 g/mol

= 0.032 kg/mol

Molarity of solution =

$$= \frac{0.793}{0.032}$$

$$= 24.78 \text{mol} / \text{l}$$

We have,

$M_1V_1 = M_2V_2$

$24.78 \times V_1 = 0.25 \times 2.5$

$V_1 = 25.22$ ml

The required volume is 25.22 ml

OR

Given:

M= 3 mol/lit

Mass of NaCl in 1 litre solution = 3×58.5

= 175.5 g

Mass of water in solution = 1000×1.25

= 1250 g

Mass of water in solution = 1250- 175.5

= 1074.5 g

Molarity

$$= \frac{\text{Number of moles of solute}}{\text{Mass of solvent in kg}}$$

$$= \frac{3}{1.074}$$

$$= 2.79 \text{m}$$

Section C

13.

We know,

$$E_n = \frac{-\left(2.18\times10^{-18}\right)Z^2}{n^2}$$

For He^+,

$n = 1,\ n = 2$

$$E_1 = \frac{-\left(2.18\times10^{-18}\right)2^2}{1^2}$$

$$= -8.72\times10^{-18}\ J$$

$$r_n = \frac{\left(0.0529\right)n^2}{Z}$$

Here, $n = 1,\ Z = 2$

$$r_n = \frac{\left(0.0529\right)1^2}{2}$$

$$= 0.02645\ nm$$

Energy is 8.72×10^{-18} J

Radius of the orbit is 0.02645 nm

OR

Let us find out the atomic number of element.

Let the number of protons = x

$$\text{Number of neutrons} = x + \frac{x \times 31.7}{100}$$

$$= \left(x + 0.317x\right)$$

$$\text{Mass no. of element} = \text{No. of protons} + \text{No. of neutrons}$$

$$81 = x + x + 0.317x$$

$$81 = 2.317x$$

$$x = 35$$

$$\therefore \text{No. of protons} = 35$$

$$\text{No. of neutrons} = 81 - 35$$

$$= 46$$

Atomic numer of element is 35

The element with atomic number 35 is bromine (Br).

14. The balanced chemical equation is

$$2CO + O_2 \longrightarrow 2CO_2$$

$$2\,mol \quad 1\,mol$$

$$2 \times 22.4\,L \quad 22.4\,L$$

Volume of oxygen required to convert 2 x 22.4 L of CO at N.T.P. = 22.4 L

Volume of oxygen required to convert 5.2 L of CO at N.T.P. = $\frac{22.4}{2 \times 22.4} \times 5.2 = 2.6$ L

OR

(i) H_2^+ is more stable than H_2^- as it contains no electron in antibonding MO while latter contains an electron in antibonding MO making it less st

(ii) PCl_5 contains axial and equatorial bonds. Axial bonds are longer than equatorial bonds as they face more repulsion from equatorial bonds. Hence axial bonds are weaker than equatorial bonds.

(iii) NaI is more covalent due to high polarizability of iodide ion due to its bigger size than chloride ion.

15.

(i) This is due to the reason that the molecules which undergo evaporation are high energy molecules and therefore, the kinetic energy of the remaining molecules becomes less. Since the remaining molecules have lower average kinetic energy, their temperature becomes low.

(ii) This is due to surface tension of liquids. Due to surface tension, the molecules of a liquid, try to make surface area to be minimum and for a given volume, sphere has the minimum surface area. Therefore the falling liquid drops are spherical.

(iii) Intermolecular forces are stronger in acetone than in ether. Thus the vapour pressure of acetone is less than ether.

16.

(i) Combustion of methanol

$CH_3OH\ (l) + \frac{3}{2}\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O(l)$;ΔH= -726 kJ/mol (Eq-1)

(ii) Enthalpy of formation of CO_2

$C\ (graphite) + O_2\ (g) \rightarrow CO_2\ (g)$;ΔH= -393 kJ/mol (Eq-2)

(iii) Enthalpy of formation of H_2O

$H_2\ (g) + \frac{1}{2}\ O_2\ (g) \rightarrow H_2O\ (l)$;ΔH= -286 kJ/mol (Eq-3)

Required reaction :

$C(graphite) + 2H_2\ (g) + \frac{1}{2}\ O_2 \rightarrow CH_3OH(l)$;ΔH= ? (Eq-4)

(Eq-2) + (2 x Eq-3) - (Eq-1) gives the required enthalpy

for formation of methanol

ΔH = (-572-393)+726

= -239 kJ mol^{-1}

17. For AgBr, $K_{sp} = 5.0 \times 10^{-13}$

Precipitation of AgBr will occur when ionic product $[Ag^+]\ [Br^-]$ becomes larger than K_{sp}.

$AgNO_3 \rightleftharpoons Ag^+ + NO_3^-$

$[Ag^+] = 0.05\,M$

The concentration of Br^- required to start precipitation.

$$[Br^-] = \frac{K_{sp}}{[Ag^+]} = \frac{5.0 \times 10^{-13}}{0.05} = 1.0 \times 10^{-11}$$

Now, $[Br^-] = [KBr] = 1.0 \times 10^{-11}$

Molar mass of KBr = 120

Therefore, the amount of KBr required $= 1.0 \times 10^{-11} \times 120$

$= 1.20 \times 10^{-9}$ g

OR

For the reaction CH4(g) +H2O(g) CO(g) + 3H2 (g)

(i) $K_p = \frac{(p_{CO})(p_{H_2})^3}{(p_{CH_4})(p_{H_2O})}$

(ii) On increasing pressure, the reaction equilibrium will shift in the backward direction.

There is no effect of catalyst in equilibrium composition; however the equilibrium will be attained faster.

18. Reduction half reaction:

Step 1:

$MnO_4^- + 5e^- \rightarrow Mn^{2+}$

Step 2: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

Oxidation half reaction:

Step 1:

$SO_2 \rightarrow HSO_4^- + 2e^-$

Step 2: $SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-$

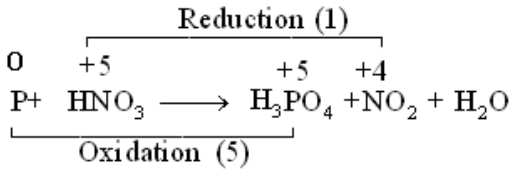
Multiply by required coefficient and add the two equations

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4\ H_2O)$ x2

$(SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-)$ x5

Final reaction: $2MnO_4^- + 5SO_2 + 2H_2O + H^+ \rightarrow 2Mn^{2+} + 5\ HSO_4^-$

OR



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

O = 15 O =15

H = 5 H = 5

Oxygen and Hydrogen atoms are balanced.

19.

(a) H_2O is covalent hydride whereas NaH is ionic or saline hydride.

(b) Group 7 to group 9 elements do not form hydrides. This region of periodic table from group 7 to 9 is called as hydride gap.

(c) 1 L of H_2O_2 gives 15 L of O_2 at NTP.

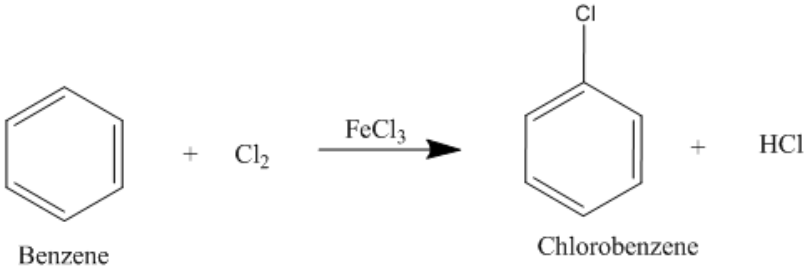
20.

(a) 2-Ethyl-3methylpentan-1-ol

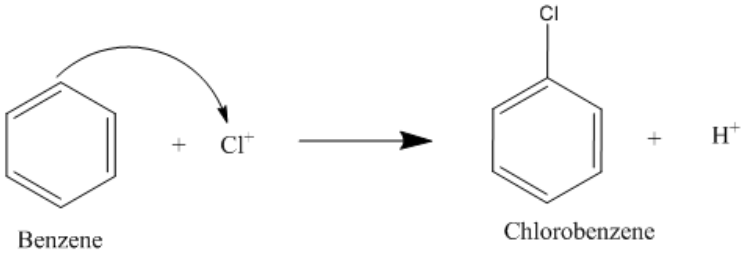
(b) 1-Chloropropan-2-one

(c) 2,4,6-Tribromophenol

21. A reagent which can accept an electron pair in a reaction is called an electrophile.
Examples: H^+, Cl^+,NO_2^+, R_3C^+.



Mechanism:



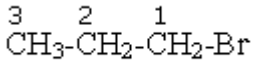
22.

(a) Lithium and magnesium follow diagonal relationship and so lithium like magnesium forms nitride while other alkali metals do not.

(b) Size of O 2- ion is smaller than SO42-. Since a bigger anions stabilizes bigger cation more than a smaller cation stabilizes a bigger anion, lattice enthalpy of BaO is smaller than BaSO4. BaO is soluble as hydration energy is more than lattice energy but BaSO4 (as hydration energy is less than lattice energy) is insoluble in water.

23.

(a) The inductive effect is least in C2-C3 bond because the magnitude of inductive effect decreases as the number of intervening bonds increases.



(b)

(i) Metamerism

(ii)Functional group isomerism

24.

(a)

(i) When quicklime is heated with silica it gives calcium silicate.

$$\underset{\text{Calcium oxide}}{CaO} + \underset{\text{Silica}}{SiO_2} \xrightarrow{\text{Heat}} \underset{\text{Calcium silicate}}{CaSiO_3}$$

(ii)When calcium nitrate is heated it forms CaO, NO_2 and O_2

$$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$$

(b) A cation is highly polarizing if its charge/radius ratio is high.
Li^+ ion has the highest polarizing power among the alkali metal ions because it has the highest charge/radius ratio.

Section D

25.

Given:

$CCl_{4(l)} \rightarrow CCl_{4(l\,(g)}$	ΔH= 30.5 kJ/mol ……(1)
$C_{(s)} + Cl_{2(g)} \rightarrow CCl_{4(g)}$	ΔH= -135.5 kJ/mol……(2)
$C_{(s)} \rightarrow C_{(g)}$	ΔH= 715.0 kJ/mol……(3)
$Cl_{2(g)} \rightarrow 2Cl_{(g)}$	ΔH= 242 kJ/mol……(4)
$CCl_{4(g)} \rightarrow C_{(g)} + 4Cl_{(g)}$	ΔH=?

By solving,

Equation(3) +2(equation4) – equation (1) –equation(2)

Substituting the values,

ΔH= [715.0 + 2(242) -30.5-(-135.5)] kJ/mol

= 1304 kJ/mol

Bond enthalpy of C-C in CCl_4 (average value)

$$= \frac{1304}{4}$$

$$= 326 \text{ kJmol}^{-1}$$

Enthalpy of change for the process is 1304 kJ/mol

Bond enthalpy is 326 kJ/mol

OR

(a) Bond energy is the amount of energy required to dissociate one mole of bonds present between the atoms in the gaseous phase. As molecules dissociate completely into atoms in the gaseous phase therefore bond energy of a diatomic molecule is called enthalpy of atomization.

(b) $C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)}$ $\Delta_r H$ = -74.8 kJ

$C_{(s)} \rightarrow C_{(g)}$ $\Delta_r H^0 = +719.6kJ$

$H_{2(g)} \rightarrow 2H_{(g)}$ $\Delta_r H^0 = +435kJ$

$C_{(s)} + 2H_{2(g)} \rightarrow C_{(g)} + 4\ H_{(g)}$

$C_{(s)} - 2H_{2(g)} - CH_{4(g)}$

$0 = C_{(g)} + 4\ H_{(g)} - CH_{4(g)}$

$\Delta_r H = 719.6 + 2(435.4) + 74.8$

$\Delta_r H = +1665.2\ kJ$

This gives the enthalpy of dissociation of four moles C-H bons.

Hence bond energy for C-H bond

$$= \frac{1665.2}{4}$$

$$= 416.3 kJ / mol$$

26.

(a) This is because boric acid does not act as proton donor rather it accepts a lone pair of electrons from OH- ions. There by acting as monobasic lewis acid.

(b) PbO_2 and SnO_2 both are in +4 oxidation state. But due to sronger ionetr par effect Pb^{2+} ion is more stable than Sn^{2+} ion.

(c) In other way Pb^{2+} ions is more easily reduced to Pb^{2+} ions. Thus PbO_2 acts as a stronger oxidizing agent than SnO_2.

(d) The molecules of CO_2 are held together by weak Van der Waals forces of attraction which can be easily overcome by collisions of the molecules at room temperature. Onsequently CO_2 is a gas.
While silicon atoms forms four single covalent bonds with 0-atm which are tetrahedrally arranged and form a three- dimensional structure. Thus SiO_2 is a high melting solid.

(e) SiF_6^{2-} is known but $SiCl_6^{2-}$ is not known, because interaction between lone pair of chloride ion and Si^{4+} ion is not strong. Also six large chloride ions cannot be accommodated around Si^{4+} due to limitation of its size.

(f) Borazine is called inorganic benzene, as its structure is similar to that of benzene. Its formula is $B_3N_3H_6$. The compound is isoelectric and isostructural with benzene.

OR

Metal X on treatment with sodium hydroxide gives white precipitate which dissolves in excess of NaOH to give soluble complex (B), therefore, the metal X is Al.

$$Al + 3NaOH \rightarrow \underset{(X)}{Al(OH)_3}\downarrow + 3Na^+$$

$$\underset{}{Al(OH)_3} + \underset{(Excess)}{NaOH} \rightarrow \underset{Sodium\ tetrahydroaluminate}{2Na^+\left[Al(OH)_4\right]^-}$$

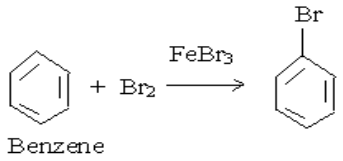
$$\underset{(A)}{Al(OH)_3} + 3HCl_{(aq)} \rightarrow \underset{(C)}{AlCl_3} + 3H_2O$$

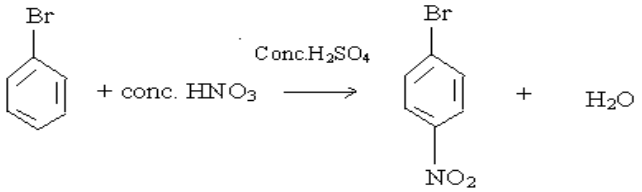
$$\underset{(A)}{Al(OH)_3} \xrightarrow{\Delta} \underset{(D)}{Al_2O_3} + 3H_2O$$

27.

(a)

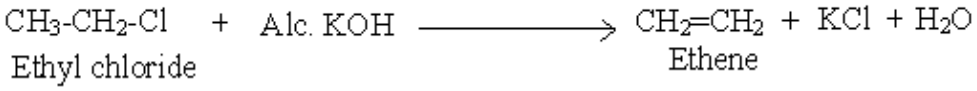
(i) Benzene to p-Nitrobromobenzene



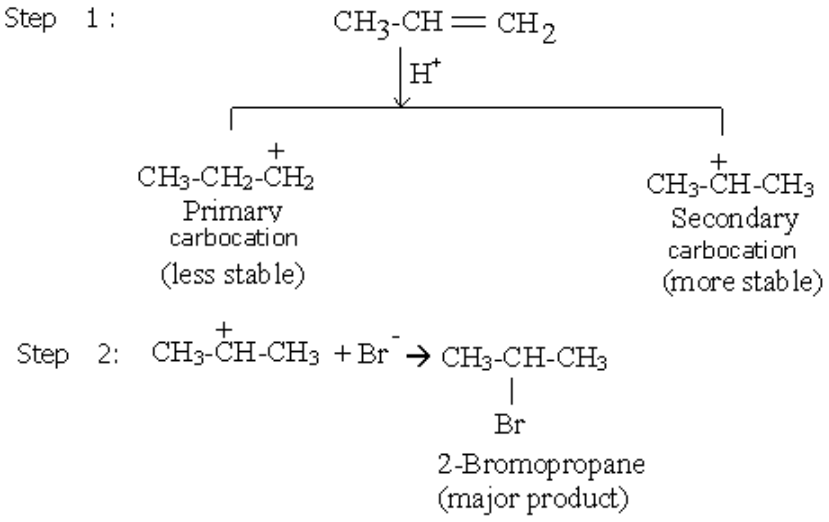


p-Nitrobromobenzene

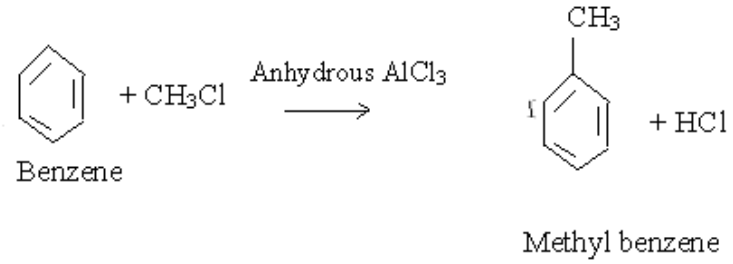
(ii) Ethyl chloride to ethene



(b) Mechanism of addition of HBr to propene



(c) Friedel- Crafts alkylation- It is the reaction of benzene with alkyl halide in presence of anhydrous aluminium chloride. The reaction results in the formation of alkyl benzene.



OR

(a)

$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$	$CH \equiv CH$
n-hexane	Ethyne
sp^3 hybridised carbon	sp hybridized carbon
s-character 25%	s-character 50%

Since s-orbital are closer to the nucleus, hence due to more s character in ethyne (sp hybridized) the hybridized orbital is nearest to this carbon atom in comparison to sp^2 hybridised carbon. This leads to the movement of C-H bond pair more towards sp hybridized carbon, leading to the development of partial positive charge on the hydrogen attached to sp hydridised carbon and eventually helps in release of proton (H^+). Thus, ethyne is more acidic than n-hexane.

(b)

(i) Wurtz reaction: Alkyl halides on treatment with sodium metal in dry ether medium give higher alkanes. This is called Wurtz reaction and is used for the preparation of alkanes with even number of carbon atoms.

$$\underset{\text{Bromomethane}}{CH_3Br} + 2Na + BrCH_3 \xrightarrow{\text{Ether}} \underset{\text{Ethane}}{CH_3\text{-}CH_3} + 2NaBr$$

(ii) Acidic dehydration: Alcohols on heating with conc. H_2SO_4 at 443 K form alkenes with elimination of one water molecule. Since a water molecule is lost in the presence of acid, the reaction is called acidic dehydration of alcohols.

$$CH_3\text{-}CH_2OH \xrightarrow{\text{conc. } H_2SO_4} CH_2=CH_2 + H_2O$$

(c)