CBSE Board
Class XI Chemistry

Time: 3 Hours **Total Marks: 70**

General Instructions

1. All questions are compulsory.
2. Question nos. 1 to 8 are very short answer type questions and carry 1 mark each.
3. Question nos. 9 to 18 are short answer type questions and carry 2 marks each.
4. Question nos. 19 to 27 are also short answer type questions and carry 3 marks each.
5. Question nos. 28 to 30 are long answer type questions and carry 5 marks each.
6. Use log tables if necessary, use of calculators is not allowed.

Q1: Complete and balance the given equation:

$Na_2B_4O_7 + H_2O + HCl \rightarrow$

Q2: If value of Azimuthal quantum number l is 2 & 3 respectively, state the number of orbitals it will contain.

Q3: Write Lewis dot symbol for Br atom.

Q4: Calculate pH of solution having concentration of hydrogen ion as $10^{-3}M$

Q5: Give an example for disproportionation reaction along with appropriate oxidation state of element undergoing simultaneous oxidation and reduction.

Q6: What does the statement "10 volume of hydrogen peroxide" convey?

Q7: Why boron does not form B^{3+} ions?

Q8: Identify electrophilic centre in CH_3CN.

Q9: Calculate the number of molecules and number of atoms present in 11.2 litres of oxygen of oxygen (O_2) at N.T.P.

Q10: An element with mass number 81 contains 31.7% more neutrons as compared to protons. Assign the atomic symbol to the element.

OR

Q10: Calculate the kinetic energy of the ejected electron when ultra-violet radiation of frequency $1.6 \times 10^{15} s^{-1}$ strikes the surface of potassium metal.
Threshold frequency of potassium is $5 \times 10^{14} s^{-1}$.$(h = 6.63 \times 10^{-34}\ J\,s)$

Q11: Among the elements B, Al, C and Si:

a) Which element has the highest first ionization enthalpy? Explain briefly.
b) Which element has the largest atomic radius? Explain briefly.

Q12: Generally electron gain enthalpy becomes less negative as we move down the group. However electron gain enthalpy of O & F is less than that of succeeding elements (i.e. S and Cl) in their respective group. Explain

Q13: Draw molecular orbital energy level for O_2 molecule. Calculate its bond order.

Q14: Give reasons:

a) NH_3 shows hydrogen bonding while HCl does not, although N & Cl have same electronegativity (3.0).
b) BeH_2 molecule has zero dipole moment although the Be-H bonds are polar.

Q15: Calculate the number of moles of hydrogen (H_2) present in a 500 mL sample of hydrogen gas at a pressure of 1 bar and 27^0C. (R = 0.083 bar mol^{-1} K^{-1})

Q16: Define surface tension. Explain effect of temperature on it.

Q17: Permanganate ion (MnO_4^-) reacts with bromide ion in basic medium to give manganese dioxide (MnO_2) and bromate ion (BrO_3^-). Write the balanced ionic equation for the reaction, using oxidation number method.

Q18: Why do saline hydrides produce fire on reacting with water? Give reactions of sodium hydride and calcium hydride with water.

Q19:

a) Two particles A and B are in motion. If the wavelength associated with the particle A is 5×10^{-8} m calculate the wavelength of particle B if its momentum is half of A.
b) Symbols $^{79}_{35}$Br and ^{79}Br can be written, whereas symbols $^{35}_{79}$Br and ^{35}Br are not acceptable. Answer briefly.

Q20: A Chemist while studying the properties of gaseous $C_2Cl_2F_2$, a chlorofluorocarbon refrigerant cooled a 1.25 g sample at constant atmospheric pressure of 1.0 atm from 320 to 293 K. During cooling, the sample volume decreased from 274 to 248 mL. Calculate ΔH and ΔU for the chlorofluorocarbon for this process. For $C_2Cl_2F_2$, C_P = 80.7 J/mol K.

Q21: Shreya is feeling very hot in the house. Her sister asks her to come to the sea shore along with her. Shreya denies going at sea shore during day but her sister insists saying that she'll better there.

a) Is going to sea shore during day helpful in getting relief from heat? How?
b) What values do you get from it?

Q22: Explain:

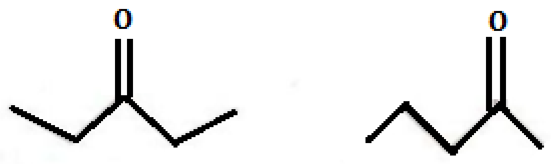
a) Ionisation enthalpy decreases sharply from B to Al and then the ionisation enthalpy of Ga is unexpectedly higher than that of Al.
b) Lead (IV) chloride is highly unstable towards heat.

Q23:

a) Define limiting reagent.
b) $3.0\,g$ of H_2 reacts with $29\,g$ of O_2 to yield H_2O .Which is the limiting reagent?

Q24: What is the relation between members of the following pairs of structures? Are they identical structures, structural isomers, geometrical isomers or resonance contributors?

a)



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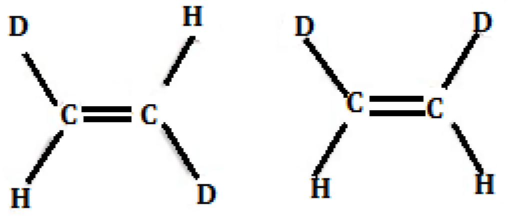

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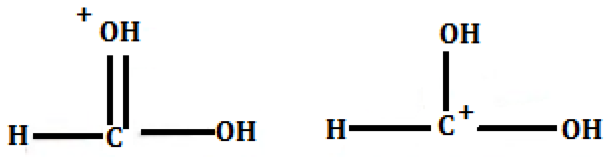


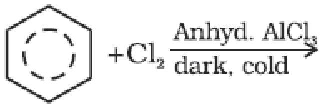
Q25:

a) Draw the resonance structures of phenol. Show the electron shift using curved arrow notation.

b) Name the method used to separate chloroform (B.P. 334 K) and aniline (B.P. 457K). Explain briefly

Q26: Complete the following reactions:

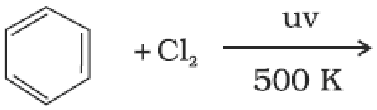
a)



b)

$$HC \equiv CH + H_2O \xrightarrow[333\,K]{Hg^{2+}/H^{+}}$$

c)



Q27: Name any three major water pollutants and their sources.

OR

Q27:

a) Give only chemical equations for formation of ozone in stratosphere.

b) Also mention only chemical equations for breakdown of ozone by chlorofluorocarbons in stratosphere.

c) Give one important use of ozone layer in stratosphere

Q28: Give reasons for the following

a) Unlike Na_2CO_3, K_2CO_3 cannot be prepared by Solvay process. Why?

b) Why are alkali metals not found in nature?

c) Sodium is less reactive than potassium why?

d) Alkali metals are good reducing agents. Why?

e) Alkali metals are paramagnetic but their salts are diamagnetic. Why?

OR

Q28:

a) Sodium fire in the laboratory should not be extinguished by pouring water. Why?
b) LiCl is soluble in organic solvents. Explain
c) Though Be & Mg are alkaline earth metals, they do not give any colour in Bunsen flame.
d) Hydroxides of alkaline earth metal are less basic than alkali metals of corresponding period.
e) Na_2SO_4 is soluble in water whereas $BaSO_4$ is insoluble in water. Explain

Q29:

a) At 700 K, the equilibrium constant K_p, for the reaction $2SO_3(g) \rightleftharpoons 2SO_2(g)+O_2(g)$ is 1.8×10^{-3} kPa. What is the numerical value in moles per dm^3 of K_c for the reaction at the same temperature
b) Calculate the solubility of A_2X_3 in pure water, assuming that neither kind of ion reacts with water. The solubility product of A_2X_3, $K_{sp} = 1.1\times10^{-23}$
c) What is the effect of temperature on ionic product of water?

OR

Q29:

a) The equilibrium constant for the reaction: $H_2(g)+Br_2(g) \rightleftharpoons 2HBr(g)$ at 1024 K is 1.6×10^{5}. Find the equilibrium pressure of all gases if 10 bar of HBr is introduced into a sealed container at 1024 K.
b) What does the equilibrium constant K less than 1 indicates?

Q 30:

a) Give two tests to distinguish 1-pentene from n-pentane.
b) How do you account for the formation of ethane during chlorination of methane?

OR

Q30: Addition of HBr to propene yields 2-bromopropane, while in the presence of benzoyl peroxide, the same reaction yields 1-bromopropane. Explain and give mechanism.

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Solution

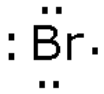
Ans1:

$Na_2B_4O_7 + 5H_2O + 2HCl \rightarrow 2NaCl + 4B(OH)_3$ (1 mark)

Ans 2:

Value of Azimuthal quantum number(l)	No. of orbitals	Marks
2	5	$\left(\frac{1}{2}\text{mark}\right)$
3	7	$\left(\frac{1}{2}\text{mark}\right)$

Ans 3:



(1mark)

Ans 4:

$pH = -\log\left[H^+\right]$ $\left(\frac{1}{2}\text{mark}\right)$

$= -\log\left[10^{-3}\right]$

$= 3$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 5:

$$\overset{+1\ -1}{H_2O_2}(aq) \rightarrow \overset{+1\ -2}{H_2O}(l) + \overset{0}{O_2}(g)$$

($\frac{1}{2}$mark for reaction + $\frac{1}{2}$mark for oxidation states)

Ans 6:10 volume of hydrogen peroxide means that 1L of this H_2O_2 will give 10L of oxygen at STP.

(1mark)

Ans 7: Boron has very small size and has very high sum of three ionization enthalpies ($IE_1 + IE_2 + IE_3$). Therefore, it cannot lose its three electrons to form B^{3+} ions. (1mark)

Ans 8: $H_3C-\overset{*}{C}\equiv N$ (1mark)

The starred carbon atom is the electrophilic centre as it will have partial positive charge due to polarity of $C\equiv N$ bond.

Ans 9: We know that one mole of O_2 at N.T.P. occupies 22.4 litres.

Therefore, 11.2 litres of O_2 at N.T.P. = $\frac{11.2}{22.4} = 0.5$ mole $\left(\frac{1}{2}\text{mark}\right)$

1 mole of O_2 contains =6.022×10^{23} molecules $\left(\frac{1}{2}\text{mark}\right)$

0.5 moles of O_2 contains = $(0.5 \times 6.022 \times 10^{23})$ molecules

=3.01×10^{23}molecules $\left(\frac{1}{2}\text{mark}\right)$

3.01×10^{23}molecules of oxygen = $2 \times 3.01 \times 10^{23}$ atoms

= 6.02×10^{23} atoms $\left(\frac{1}{2}\text{mark}\right)$

Ans 10:

Mass number = No. of protons + No. of neutrons = 81

i.e., $p + n = 81$ (Eq-1)

Let number of protons = a

Number of neutrons $= a + \frac{a \times 31.7}{100}$ $\left(\frac{1}{2}\text{mark}\right)$

$= a + 0.317a$

$= 1.317\ a$

By (Eq-1)

$a + 1.317\ a = 81$ $\left(\frac{1}{2}\text{mark}\right)$

$\therefore 2.317a = 81$

$\Rightarrow a = \frac{81}{2.317} = 34.96 \approx 35$ $\left(\frac{1}{2}\text{mark}\right)$

$\therefore$ Symbol of element $= {}^{81}_{35}\text{Br}$ $\left(\frac{1}{2}\text{mark}\right)$

OR

Ans 10: According to Einstein's equation, kinetic energy of ejected electron is given by

Kinetic energy $, \frac{1}{2}mv_e{}^2 = h\upsilon - h\upsilon_0$ $\left(\frac{1}{2}\text{mark}\right)$

$= h(\upsilon - \upsilon_0)$

$= (6.63 \times 10^{-34}\ \text{J s}) \times (1.6 \times 10^{15} - 5 \times 10^{14})\text{s}^{-1}$ $\left(\frac{1}{2}\text{mark}\right)$

$= (6.63 \times 10^{-34}\ \text{J s}) \times (11 \times 10^{14}\ \text{s}^{-1})$

$= 7.29 \times 10^{-19}\ \text{J}$ (1 mark)

Ans 11:

(a) C $\left(\frac{1}{2}\text{mark}\right)$

Ionisation enthalpy increases across a period and decreases down the group.

$\left(\frac{1}{2}\text{mark}\right)$

(b) Al $\left(\frac{1}{2}\text{mark}\right)$

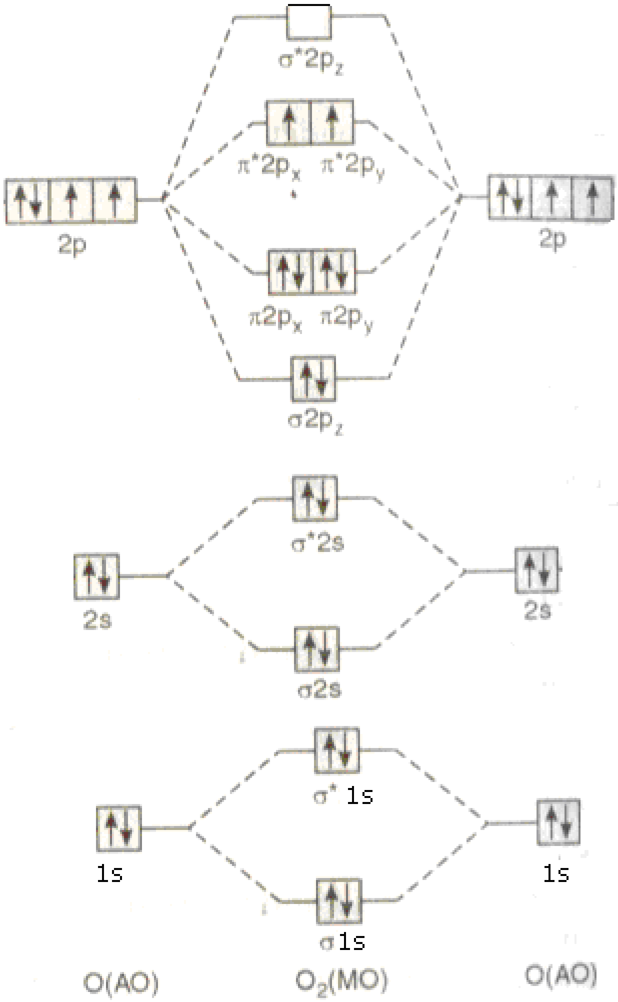
Atomic radius decreases across a period and increases down the group. $\left(\frac{1}{2}\text{mark}\right)$

Ans 12: Electron gain enthalpy becomes less negative on moving down a group because the size of the atom increases and the added electron is held farther away from the nucleus. $(1\,\text{mark})$

However, electron gain enthalpy of O or F is less than that of the succeeding element because when an electron is added to O or F, the added electron goes to the smaller n=2 shell and suffers significant repulsion from the other electrons present in this level. $\left(\frac{1}{2}\text{mark}\right)$

For the n = 3 shell (in case of S or Cl), the added electron occupies a larger region of space and the electron-electron repulsion is much less. $\left(\frac{1}{2}\text{mark}\right)$

Ans 13: For O_2 molecule total number of electrons is 8+8=16



(1 mark)

Bond order

$$=\frac{(\text{No. of electrons in bonding orbital})-(\text{No. of electrons in antibonding orbital})}{2} \quad \left(\frac{1}{2}\text{mark}\right)$$

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

$$=2 \quad \left(\frac{1}{2}\text{mark}\right)$$

Ans 14:

a. Smaller the size of electronegative atom, the greater will be its attraction for the bonded electron pair. This will cause greater polarity in the bond between H and electronegative atom which results in stronger hydrogen bond. $\left(\frac{1}{2}\text{mark}\right)$

Because of small size of N it shows hydrogen bonding. $\left(\frac{1}{2}\text{mark}\right)$

b. BeH_2 is a linear molecule and therefore, the dipole moments of two Be – H bonds cancel each other giving a zero resultant dipole moment. (1 mark)

Ans 15:

According to ideal gas equation

$pV = nRT \quad (Eq\text{-}1)$ $\left(\frac{1}{2}\text{mark}\right)$

$p = 1\,\text{bar},$
$V = 500\,\text{mL} = 0.5\,\text{L},$
$T = 27 + 273 = 300\,\text{K},$

$R = 0.083\,\text{bar}\,\text{L}\,\text{K}^{-1}\,\text{mol}^{-1}$ $\left(\frac{1}{2}\text{mark}\right)$

Using Eq-1,

$$n = \frac{pV}{RT}$$

$$n = \frac{1\,\text{bar} \times 0.5\,\text{L}}{0.083\,\text{bar}\,\text{L}\,\text{mol}^{-1}\,\text{K}^{-1} \times 300\,\text{K}}$$ $\left(\frac{1}{2}\text{mark}\right)$

$= 0.0201\,\text{mol}$

$= 2.01 \times 10^{-2}\,\text{mol}$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 16:

Surface tension is defined as force per unit length acting perpendicular to the line drawn on surface of liquid. $\left(\frac{1}{2}\text{mark}\right)$

Surface tension decreases with rise in temperature. $\left(\frac{1}{2}\text{mark}\right)$

As the temperature increases, kinetic energy of the molecules increases. As a result, the intermolecular forces decrease and therefore, surface tension also decreases. (1 mark)

Ans 17:

Step1: The skeletal ionic equation along with oxidation numbers for Mn and Br:

$$\overset{+7}{MnO_4^-}(aq) + \overset{-1}{Br^-}(aq) \rightarrow \overset{+4}{MnO_2}(s) + \overset{+5}{BrO_3^-}(aq) \qquad \left(\frac{1}{2}\text{mark}\right)$$

Step 2: Calculate the increase and decrease of oxidation number, and make the increase in oxidation number equal to the decrease in oxidation number.

$$2MnO_4^-(aq) + Br^-(aq) \rightarrow 2MnO_2(s) + BrO_3^-(aq) \qquad \left(\frac{1}{2}\text{mark}\right)$$

Step 3: As the reaction occurs in the basic medium, and the ionic charges are not equal on both sides, add 2 OH^- ions on the right to make ionic charges equal.

$$2MnO_4^-(aq)+Br^-(aq)\rightarrow 2MnO_2(s)+BrO_3^-(aq)+2OH^-(aq) \qquad \left(\frac{1}{2}\text{mark}\right)$$

Step 4: Finally, count the hydrogen atoms and add appropriate number of water molecules (i.e. one H_2O molecule) on the left side to achieve balanced redox change.

$$2MnO_4^-(aq)+Br^-(aq)+H_2O(l)\rightarrow 2MnO_2(s)+BrO_3^-(aq)+2OH^-(aq) \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans 18:

Saline hydrides react with water violently to form corresponding metal hydroxide with the evolution of dihydrogen. This reaction is highly exothermic and evolved hydrogen gas catches fire. (1 mark)

$$NaH(s)+H_2O(l)\rightarrow NaOH(aq)+H_2(g) \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$CaH_2(s)+2H_2O(l)\rightarrow Ca(OH)_2(aq)+2H_2(g) \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans 19:

(a)

According to de-Broglie equation,

$$\lambda = \frac{h}{p} \qquad \left(\frac{1}{2}\text{mark}\right)$$

For particle A, $\lambda_A = \frac{h}{p_A} \quad (\text{Eq} - 1)$

For particle B, $\lambda_B = \frac{h}{p_B} \quad (\text{Eq} - 2)$

But $\quad p_B = \frac{p_A}{2} \qquad \left(\frac{1}{2}\text{mark}\right)$

$$\therefore \quad \lambda_B = \frac{h}{p_B}$$

$$= \frac{h}{p_A / 2}$$

$$= \frac{2h}{p_A}$$

$$= \frac{2h\lambda_A}{h} \qquad (\text{From Eq} - 1)$$

or $\lambda_B = 2\lambda_A \qquad \left(\frac{1}{2}\text{mark}\right)$

Now, $\quad \lambda_A = 5 \times 10^{-8}\,\text{m}$

$$\therefore \quad \lambda_B = 2 \times 5 \times 10^{-8} = 10^{-7}\,\text{m} \qquad \left(\frac{1}{2}\text{mark}\right)$$

(b) Atomic number of an element (say Br) is fixed but its mass number is not fixed. Mass number depends on isotope selected. Hence, it is necessary to indicate mass number. (1 mark)

Ans 20:

Fall in temperature (ΔT) = 320 -293 = 27K

Molar mass of $C_2Cl_2F_2$ $= 2\times12+2\times35.5+2\times19$
$= 133\,g\,mol^{-1}$

$C_p = 80.7\,J\,mol^{-1}\,K^{-1}$

$or = \dfrac{80.7\ J\,mol^{-1}\,K^{-1}}{133\,g\,mol^{-1}}$

$= 0.6068\,J\ \ g^{-1}\,K^{-1}$ $\left(\dfrac{1}{2}\text{mark}\right)$

Heat evolved from 1.25 g of sample on being cooled

$q_p = m\times C_p\times\Delta T$ $\left(\dfrac{1}{2}\text{mark}\right)$

$= 1.25\,g\times0.6068\,J\,K^{-1}\,g^{-1}\times27\,K$
$= 20.48\ J$

Since heat is evolved, reaction is exothermic i.e. $\Delta H = -20.48\ J$ $\left(\dfrac{1}{2}\text{mark}\right)$

$$p\Delta V = \left[1\ \text{atm}\times\frac{(248-274)}{1000}L\right]$$
$$= -0.026\,x\,101.325 \quad (\because 1\,L\,atm = 101.325\,J)$$
$$= -2.63\,J$$

Now, $\Delta H = \Delta U + p\Delta V$ $\left(\dfrac{1}{2}\text{mark}\right)$

$\therefore -20.48 = \Delta U - 2.63$ $\left(\dfrac{1}{2}\text{mark}\right)$

$\therefore\ \ \Delta U = -20.48 + 2.63$

$= -17.84\ J$ $\left(\dfrac{1}{2}\text{mark}\right)$

Ans 21:

(a) Yes, going to sea shore will be helpful in getting relief from heat since cool sea breezes occur in coastal areas. (1 mark)
These are created because of the temperature difference between land and water. The specific heat of water is very high and hence the sea warms up slowly as compared to land and a low pressure region is created which results in the movement of cold air from sea towards land. (1 mark)

(b) Knowledge of chemistry put to use and care for others. (1 mark)

Ans 22:

(a)The sharp decrease in ionisation enthalpy from B to Al is due to increase in size of Al.

$\left(\frac{1}{2}\text{mark}\right)$

In case of Ga, there are ten d-electrons in its inner electronic configuration. Since the d-electrons shield the nuclear charge less effectively than the s- and p-electrons, the outer electron is held fairly strongly. As a result the ionization enthalpy increases slightly inspite of the increase in atomic size as we move from Al to Ga. (1 mark)

(b) Pb(+2) oxidation state is more stable than Pb(+4) because of inert pair effect. Therefore Pb(IV)Cl_4 is unstable towards heat and decomposes to give Pb(II)Cl_2 (1 mark)

$$PbCl_4 \xrightarrow{\text{Heat}} PbCl_2 \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans 23(a): During a chemical reaction, the reactant which gets consumed and thus limits the product formed is called limiting reagent. (1 mark)

(b)

$$\text{Moles of } H_2 = \frac{3}{2} = 1.5 \text{ mol}$$

$$\text{Moles of } O_2 = \frac{29}{32} = 0.906 \text{ mol}$$

Balanced chemical equation is:

$$\begin{array}{cccccc} 2H_2 & + & O_2 & \rightarrow & 2H_2O \\ 2\,\text{mol} & & 1\,\text{mol} & & 2\,\text{mol} \end{array}$$ (1 mark)

Calculation of limiting reagent

According to the above equation, 2 mol of H_2 require 1 mol O_2

Therefore, 1.50 mol of H_2 require $O_2 = \frac{1 \times 1.5}{2} = 0.75$ mol $\left(\frac{1}{2}\text{mark}\right)$

But number of moles of O_2 actually present = 0.906 mol

Therefore, O_2 is in excess and H_2 is the limiting reagent. $\left(\frac{1}{2}\text{mark}\right)$

Ans 24:

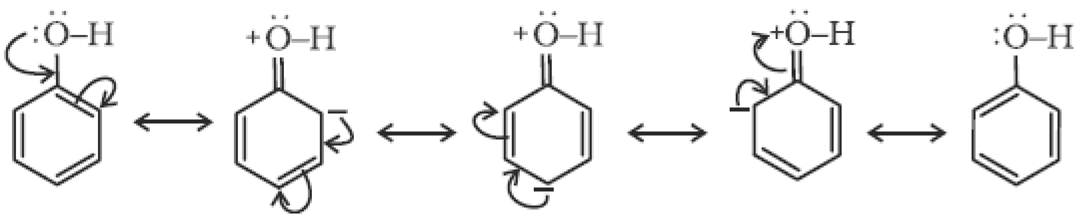
(a)Structural isomers (1 mark)

(b)Geometrical isomers (1 mark)

(c)Resonance contributors (1 mark)

Ans 25:

(a)



$\left(\frac{1}{2}\text{mark}\right)$ $\left(\frac{1}{2}\text{mark}\right)$ $\left(\frac{1}{2}\text{mark}\right)$ $\left(\frac{1}{2}\text{mark}\right)$

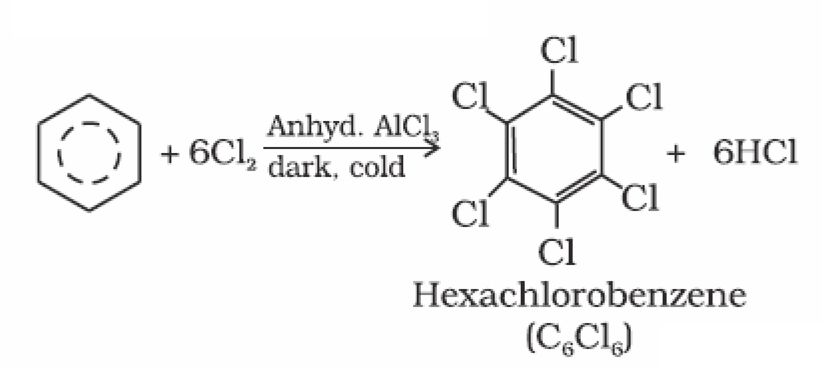
(b) Simple distillation method $\left(\frac{1}{2}\text{mark}\right)$

This method is useful for separating liquids having sufficient difference in boiling points.

$\left(\frac{1}{2}\text{mark}\right)$

Ans 26:

(a)



Hexachlorobenzene

(C_6Cl_6)

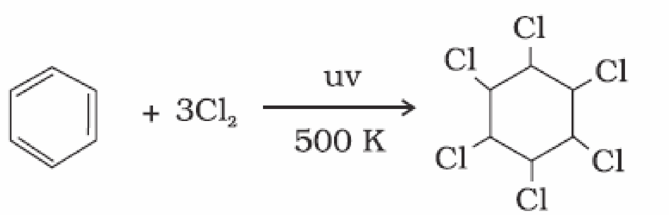
$(1\,\text{mark})$

(b)

$$HC \equiv CH + H_2O \xrightarrow[333K]{Hg^{2+}/H^{+}} H_2C = CHOH \xrightarrow{\text{Isomerisation}} CH_3CHO$$

$(1\,\text{mark})$

(c)



Benzene hexachloride,

(BHC)

$(1\,\text{mark})$

Ans 27:

Pollutant	Source
Micro organisms $\left(\frac{1}{2}\text{mark}\right)$	Domestic sewage $\left(\frac{1}{2}\text{mark}\right)$
Toxic heavy metals $\left(\frac{1}{2}\text{mark}\right)$	Industries and chemical factories $\left(\frac{1}{2}\text{mark}\right)$
Radioactive substances $\left(\frac{1}{2}\text{mark}\right)$	Mining of uranium containing materials $\left(\frac{1}{2}\text{mark}\right)$

(Any other pollutant and their sources can also be mentioned)

OR

Ans 27:

(a) Chemical equations for formation of ozone in stratosphere

$$O_2(g) \xrightarrow{UV} O(g) + O(g) \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$O(g) + O_2(g) \xrightleftharpoons{UV} O_3(g) \qquad \left(\frac{1}{2}\text{mark}\right)$$

(b) Chemical equations for breakdown of ozone in stratosphere

$$CF_2Cl_2\,(g) \xrightarrow{UV} \dot{C}l\,(g) + \dot{C}F_2Cl\,(g)$$ $\left(\frac{1}{2}\text{mark}\right)$

$$\dot{C}l\,(g) + O_3\,(g) \rightarrow Cl\dot{O}\,(g) + O_2\,(g)$$ $\left(\frac{1}{2}\text{mark}\right)$

$$Cl\dot{O}\,(g) + O\,(g) \rightarrow \dot{C}l\,(g) + O_2\,(g)$$ $\left(\frac{1}{2}\text{mark}\right)$

These chloride radicals are continuously generated and cause the breakdown of ozone.

(c) Ozone layer in upper stratosphere protects living beings from harmful ultraviolet radiations.

$\left(\frac{1}{2}\text{mark}\right)$

Ans 28:

(a) Unlike $NaHCO_3$ (formed during formation of Na_2CO_3), the intermediate $KHCO_3$ formed during reaction, is highly soluble in water and thus cannot be precipitated by the addition of ammonium hydrogen carbonate to a saturated solution of potassium chloride. Hence, K_2CO_3 cannot be prepared by Solvay process. (1 mark)

(b) Alkali metals are highly reactive because of low ionization enthalpy value and therefore are not found in nature. They are present in combined state only in form of halides, oxides etc. (1 mark)

(c) Ionization Energy of potassium is less than sodium because of large size or less effective nuclear charge of K. Thus, potassium is more reactive than sodium. (1 mark)

(d) Alkali metals are strong reducing agents due to their greater ease to lose electrons. (1 mark)

(e) Alkali metals have one unpaired electrons (ns^1) and are paramagnetic. However, during the salt formation, the unpaired electron is lost by alkali metals to other atom forming anion. Their salts have all paired electrons and show diamagnetic nature. (1 mark)

OR

Ans 28:

(a)Sodium reacts violently with water producing hydrogen which also catches fire. Therefore, the intensity of fire increases on adding water instead of getting extinguished. Hence, water should not be used for extinguishing sodium fire. (1 mark)

(b) Li^+ has very high polarizing power and, therefore, LiCl is covalent in nature. Being covalent in nature it is soluble in organic solvents. (1 mark)

(c)Beryllium and magnesium atoms are comparatively smaller and the ionization energies are very high. Hence energy of the flame is not sufficient to excite their electrons to higher energy levels. These elements, therefore, do not give any colour in Bunsen flame. (1 mark)

(d) Alkaline earth metals have high ionization enthalpies and smaller ionic size as compared to alkali metal. As a result, the metal-O bond in these hydroxides is relatively stronger than that of corresponding alkali metal and therefore, does not break. Therefore, they are less basic than corresponding alkali metals. (1 mark)

(e)If the hydration enthalpy is greater than lattice enthalpy the salt will dissolve. In case of Na_2SO_4 hydration enthalpy is greater than lattice enthalpy and hence it dissolves in water. In case of $BaSO_4$ hydration enthalpy is not sufficient enough (due to bivalent charge of Ba) to break the lattice and hence it does not dissolve in water (1 mark)

Ans 29:

(a)

K_p and K_c are related as :

$K_p = K_c (RT)^{\Delta n}$ (Eq – 1) $\left(\frac{1}{2}\text{mark}\right)$

$T = 700\,K, R = 8.314\,J\ mol^{-1}\,K^{-1}$

$\Delta n = (2+1) - 2 = 1$ $\left(\frac{1}{2}\text{mark}\right)$

$K_p = 1.8 \times 10^{-3}\,kPa = 1.8\,Pa$

From (Eq – 1)

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

$$= \frac{1.8\,Pa}{\left[(8.314 J\ mol^{-1}\,K^{-1})\ (700 K)\right]^1}$$ $\left(\frac{1}{2}\text{mark}\right)$

$$= \frac{1.8\,Nm^{-2}}{\left[(8.314\ Nm\,mol^{-1}\,K^{-1})\ (700 K)\right]}$$

$(\because Pa = Nm^{-2}, J = Nm)$

$= 3.09 \times 10^{-4}\,mol\,m^{-3}$

$= 3.09 \times 10^{-7}\,mol\,dm^{-3}$ $\left(\frac{1}{2}\text{mark}\right)$

$(\because 10\ dm = 1m)$

(b)

$A_2X_3 \rightarrow 2A^{3+} + 3X^{2-}$ $\left(\frac{1}{2}\text{ mark}\right)$

$K_{sp} = [A^{3+}]^2 [X^{2-}]^3 = 1.1 \times 10^{-23}$

If S is the solubility of A_2X_3 then

$[A^{3+}] = 2S$ & $[X^{2-}] = 3S$ $\left(\frac{1}{2}\text{ mark}\right)$

$\therefore K_{sp} = [2S]^2[3S]^3 = 1.1 \times 10^{-23}$ $\left(\frac{1}{2}\text{ mark}\right)$

$\therefore 108S^5 = 1.1 \times 10^{-23}$

$\Rightarrow S = 1 \times 10^{-5}$ mol/L $\left(\frac{1}{2}\text{ mark}\right)$

(c)For water Ionic product $K_w = [H_3O^+][OH^-]$ $\left(\frac{1}{2}\text{mark}\right)$

As the temperature increases ionic product increases because the dissociation of water increases with increase of temperature $\left(\frac{1}{2}\text{mark}\right)$

OR

Ans 29:

$H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$

Equilibrium constant K for the above reaction is 1.6×10^5

Equilibrium constant for the reverse reaction is the inverse of the equilibrium constant for the reaction in the forward direction

$\therefore$K for reaction $2HBr(g) \rightleftharpoons H_2(g) + Br_2(g)$ is $\dfrac{1}{1.6 \times 10^5}$ $\left(\frac{1}{2}\text{mark}\right)$

Let at equilibrium pressure of HBr be decreased by p bar

	$2HBr(g)$	$\rightleftharpoons$	$H_2(g)$	$+$	$Br_2(g)$	
Initial concentration	10		0		0	
Concentration at equilibrium	$10-p$		$\frac{p}{2}$		$\frac{p}{2}$	$\left(\frac{1}{2}\text{mark}\right)$

$$K_p = \frac{(pH_2)\,(pBr_2)}{(pHBr)^2} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$= \frac{\left(\frac{p}{2}\right)\times\left(\frac{p}{2}\right)}{(10-p)^2} = \frac{1}{1.6\times10^5}$$

$$\frac{p^2}{4(10-p)^2} = \frac{1}{1.6\times10^5}$$

Taking square root on both sides, we get

$$\frac{p}{2(10-p)} = \frac{1}{4\times10^2}$$

or $400p = 20 - 2p$

or $402p = 20$

or $p = \frac{20}{402}$

$= 4.98\times10^{-2}$ bar (1mark)

Hence at equilibrium,

$$pH_2 = \frac{4.98\times10^{-2}}{2} = 2.49\times10^{-2} \text{ bar} \qquad \left(\frac{1}{2}\text{mark}\right)$$

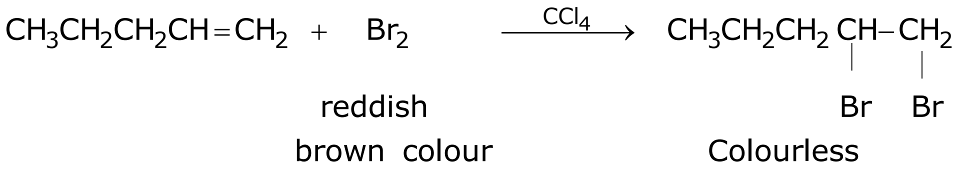
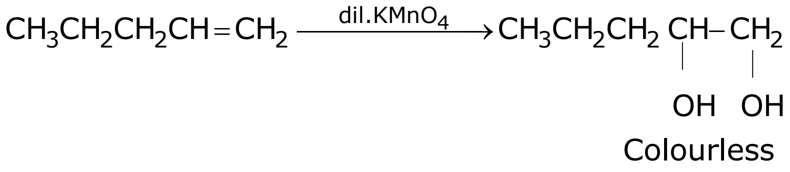
$$pBr_2 = \frac{4.98\times10^{-2}}{2} = 2.49\times10^{-2} \text{ bar} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$pHBr = 10 - 4.98\times10^{-2} \simeq 10 \text{ bar} \qquad \left(\frac{1}{2}\text{mark}\right)$$

(b)If the value of equilibrium constant K<1, it indicates that reaction does not proceed much in forward reaction. (1mark)

Ans 30:

(a)

Test	Name of compound	Observation and equation
Reaction with Br_2 in CCl_4	1-pentene	Decolorises Br_2 in CCl_4  $CH_3CH_2CH_2CH=CH_2 + Br_2 \xrightarrow{CCl_4} CH_3CH_2CH_2\underset{Br}{\underset{\vert}{CH}}-\underset{Br}{\underset{\vert}{CH_2}}$ reddish brown colour Colourless $\left(\frac{1}{2}\text{mark}\right)$
	n-pentane	Br_2 is not decolorized $\underset{n-\text{Pentane}}{CH_3CH_2CH_2CH_2CH_3} \xrightarrow{Br_2/CCl_4} \text{No reaction}$ $\left(\frac{1}{2}\text{mark}\right)$
Baeyer's Test: Reaction With dil. $KMnO_4$	1-pentene	Decolorises dil. $KMnO_4$ solution  $CH_3CH_2CH_2CH=CH_2 \xrightarrow{dil.KMnO_4} CH_3CH_2CH_2\underset{OH}{\underset{\vert}{CH}}-\underset{OH}{\underset{\vert}{CH_2}}$ Colourless $\left(\frac{1}{2}\text{mark}\right)$
	n-pentane	dil. $KMnO_4$ solution is not decolorized $\underset{n-\text{Pentane}}{CH_3CH_2CH_2CH_2CH_3} \xrightarrow{dil.KMnO_4} \text{No reaction}$ $\left(\frac{1}{2}\text{mark}\right)$

(b)Chlorination of methane is free radical reaction and occurs by the following mechanism:

(i)Chain initiation

$Cl-Cl\xrightarrow[\text{Fission}]{\text{Homolytic}}\dot{Cl}+\dot{Cl}$ $\left(\frac{1}{2}\text{mark}\right)$

(ii)Chain propagation

$CH_4+\dot{Cl}\rightarrow\dot{C}H_3+HCl$ $\left(\frac{1}{2}\text{mark}\right)$

$\dot{C}H_3+Cl-Cl\rightarrow CH_3Cl+\dot{Cl}$ $\left(\frac{1}{2}\text{mark}\right)$

(iii)Chain termination

$\left(\frac{1}{2}\text{mark}\right)$

$\dot{C}H_3 + \dot{C}H_3 \rightarrow \underset{\text{Ethane}}{CH_3-CH_3}$

$\dot{C}H_3+\dot{Cl}\rightarrow CH_3Cl$ $\left(\frac{1}{2}\text{mark}\right)$

$\dot{Cl}+\dot{Cl}\rightarrow Cl_2$ $\left(\frac{1}{2}\text{mark}\right)$

From the above mechanism it can be said that free radical $\dot{C}H_3$ may combine with itself to form ethane molecule.

OR

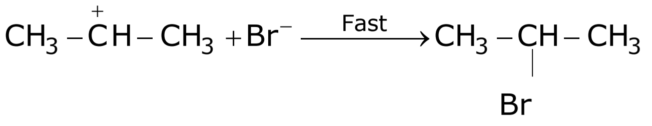
Ans 30: Addition of HBr to propene is an electrophilic addition reaction which follows Markovnikov rule. In this case H^+ adds to alkene to give a more stable 2° carbocation. This is rapidly attacked by nuleophile Br^- ion to give 2- bromo propane.

$\left(\frac{1}{2}\text{mark}\right)$

$H-Br\rightleftharpoons H^++Br^-$ $\left(\frac{1}{2}\text{mark}\right)$

$$CH_3-CH=CH_2+H^+\xrightarrow{\text{Slow}}CH_3-\overset{+}{C}H-CH_3 \qquad \left(\frac{1}{2}\text{mark}\right)$$

2° – Carbocation
(more stable)



$$CH_3-\overset{+}{C}H-CH_3+Br^-\xrightarrow{\text{Fast}}CH_3-\underset{\underset{\displaystyle Br}{|}}{C}H-CH_3 \qquad \left(\frac{1}{2}\text{mark}\right)$$

2 – Bromopropane

In the presence of benzoyl peroxide, the reaction follows free radical addition. In this case $\dot{Br}$ free radical acts as electrophile which is obtained from the action of benzoyl peroxide on HBr.

$\left(\frac{1}{2}\text{mark}\right)$

$$C_6H_5CO-O-O-COC_6H_5\xrightarrow[\text{Heat}]{\text{Homolytic fission}}2\,C_6H_5CO-\overset{\bullet}{O}\longrightarrow 2\,\overset{\bullet}{C}_6H_5+2CO_2 \qquad \left(\frac{1}{2}\text{mark}\right)$$

Phenyl free radical

$$\overset{\bullet}{C}_6H_5 \quad + \quad HBr \quad \rightarrow \quad C_6H_6 \quad + \quad \overset{\bullet}{Br} \qquad \left(\frac{1}{2}\text{mark}\right)$$

Benzene

$\overset{\bullet}{Br}$ free radical attacks propene in such a way to generate a more stable 2° free radical. This free radical obtained rapidly abstracts a hydrogen atom of HBr to give 1-Bromoporpane. $\left(\frac{1}{2}\text{mark}\right)$

$$CH_3-CH=CH_2+\overset{\bullet}{Br}\xrightarrow{\text{Slow}}CH_3-\overset{\bullet}{C}H-CH_3Br \qquad \left(\frac{1}{2}\text{mark}\right)$$

2° – Free radical
(Stable)

$$CH_3-\overset{\bullet}{C}H-CH_2\,Br+H-Br\xrightarrow{\text{Fast}}CH_3\;CH_2CH_2Br+\overset{\bullet}{Br} \qquad \left(\frac{1}{2}\text{mark}\right)$$

1 – Bromopropane