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: How many significant figures are there in 0.0052?

Q2: Calculate the wave number of yellow radiation having wavelength 5800Å.

Q3: Why is σ bond stronger than π bond?

Q4: State the relation between K_a, K_b and K_w

Q5: Represent MnO_2 using Stock notation.

Q6: Ammonia (NH_3) is a covalent hydride. How will your further categorize it as –electron deficient, electron precise or electron rich hydride?

Q7: State "Avogadro's law"

Q8: Which of the following is an electrophile: $HS^-, C_2H_5O^-, H_2N:^-, BF_3$?

Q9: Complete the following equations:

a) $Al + NaOH + H_2O \rightarrow$

b) $CaCO_3 + HCl \rightarrow$

Q10: The work function for cesium atom is 1.9 eV. Calculate

i. Threshold frequency of radiation

ii. Threshold wavelength of radiation

$(h = 6.63 \times 10^{-34}\ Js)$

OR

Q10: Calculate de- Broglie wavelength of an electron having $\text{mass} = 9.1 \times 10^{-31}$ kg and moving at 1% speed of light. $(h = 6.63 \times 10^{-34}\ \text{kg m}^2\ \text{s}^{-1}, \text{Speed of light} = 3 \times 10^8\ \text{m s}^{-1})$

Q11: In terms of period and group where would you locate the element with Z= 114.

Q12: State the number of valence electrons & valence for elements belonging to group 14 & 17 respectively.

Q13: Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear. Explain this on the basis of dipole moment.

Q14: Explain why N_2 has greater bond dissociation enthalpy than N_2^+.

Q15: At 273 K, the density of a gaseous oxide at 2 bar is same as that of nitrogen at 5 bar. Calculate the molecular mass of oxide.

Q16: Mention differences between ideal gas and real gas in terms of

a) Temperature and pressure conditions under which gas laws are obeyed
b) Equation obeyed by ideal and real gas

Q17: Balance reaction of potassium dichromate (VI), $K_2Cr_2O_7$ with sodium sulphite, Na_2SO_3, in an acid solution to give chromium (III) ion and the sulphate ion using oxidation number method.

Q18:

a) Why is dihydrogen gas not preferred in balloons?
b) Name the radioactive isotope of hydrogen along with its notation.

Q19: What is the energy in joules, required to shift the electron of hydrogen atom from first Bohr orbit to fifth Bohr orbit and what is the wavelength of light emitted when the electron returns the ground state. The ground state electron energy is -2.18×10^{-11} ergs and $h = 6.63 \times 10^{-34}$ Js

Or

a) What do you infer about the structure of CO_2 if its dipole moment is zero?
b) Write the molecular orbital configuration of N_2^- and calculate its bond order.
c) Draw the resonating structures of NO_3^- ion.

Q20:

a) Out of the following reaction, in which case heat evolved will be more?

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$$

b) In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process?

Q21:

a) Calculate the enthalpy change for the process:
$CCl_4(g) \rightarrow C(g) + 4Cl(g)$ and calculate the bond enthalpy of C-Cl bond in CCl_4.

$$\Delta_{vap}H^o (CCl_4) = 30.5 \text{ kJ/mol}$$

$$\Delta_f H^o (CCl_4) = -135.5 \text{ kJ/mol}$$

$$\Delta_a H^o (C) = 715 \text{ kJ/mol}$$

$$\Delta_a H^o (Cl_2) = 242 \text{ kJ/mol}$$

b) When is bond dissociation energy equal to bond energy?

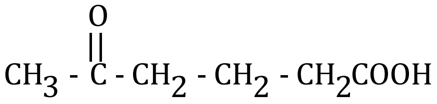
Q 22:

a) Though both B & Al are electron deficient compounds $AlCl_3$ exists as dimer Al_2Cl_6 while BCl_3 exist as monomer.
b) Suggest a reason as to why CO is poisonous.
c) What happens when borax solution is acidified?

Q23: A compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine. Its molecular mass is 98.96. What is molecular formula of compound? (Atomic mass of C=12 u, H=1 u and Cl=35.5. u)

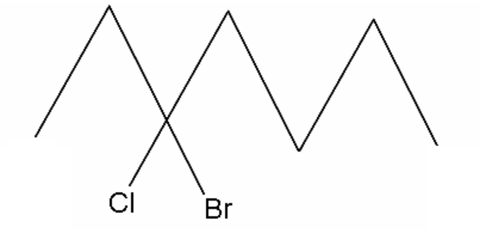
Q24: Give IUPAC name of the following

a)

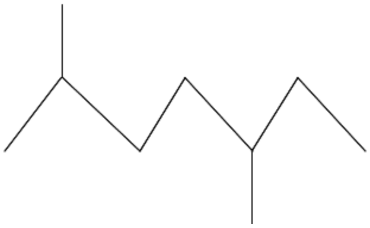


$$CH_3 - \overset{\overset{\large O}{||}}{C} - CH_2 - CH_2 - CH_2COOH$$

b)



c)



Q25: An organic compound contains 69% carbon and 4.8% hydrogen, the remainder is oxygen. Calculate the masses of carbon dioxide and water produced when 0.20 g of this substance is subjected to complete combustion.

Q26:

a) Draw cis-trans isomer of CHCl=CHCl and write their IUPAC names
   i. Draw structure of anthracene.
   ii. Mention the number of π-electrons in anthracene?

Q27: Water is a universal solvent. But alcohol also dissolves most of the substances soluble in water and also many more. Boiling point of water is 100°C and that of alcohol is 80°C. The specific heat of water is much higher than the specific heat of alcohol. List out three possible differences, if instead of water as the liquid, we had alcohol in our body.

Q28:

a) Two moles of PCl_5 were introduced in a 2L flask and heated at 600 K to attain the equilibrium. PCl_5 was found to be 40% dissociated into PCl_3 and Cl_2 Calculate the value of K_C

b) The solubility of $Sr(OH)_2$ at 298 K is 19.23 g L^{-1} of solution. Calculate the concentration of strontium and hydroxyl ions and also the pH of the solution. Molar mass of $Sr(OH)_2$=121.6 g/mol

OR

Q28:

a) An equilibrium system for the reaction between hydrogen and iodine to give hydrogen iodide at 670 K in a 5 litre flask contains 0.4 mole of hydrogen, 0.4 mole of iodine and 2.4 moles of hydrogen iodide. Calculate equilibrium constant.

b) Write expressions for K_p and K_c the decomposition reaction of calcium carbonate.

c) A system is in equilibrium as: $SO_2Cl_2 + \text{Heat} \rightleftharpoons SO_2 + Cl_2$

Why does the temperature of the system increase when Cl_2 is added to the equilibrium mixture at constant volume?

Q29: Discuss the various reactions that occur in the Solvay process

OR

Q29:

a) Alkali metals are soft and have low boiling and melting points. Explain.

b) What happens when:

   i. Quicklime is heated with silica

   ii. Calcium nitrate is heated

   iii. Chlorine reacts with slaked lime

c) When is a cation highly polarising? Which alkali metal ion has the highest polarizing power?

Q30:

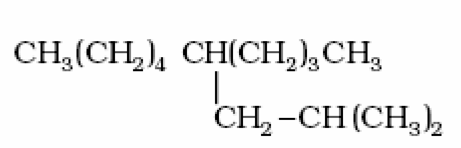
a) Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty.

b) Write IUPAC names of the following compounds:

i.

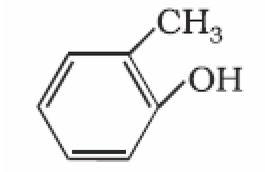
$CH_2{=}CH\text{-}C{\equiv}C\text{-}CH_3$

ii.



$CH_3(CH_2)_4\underset{\substack{|\\ CH_2-CH(CH_3)_2}}{CH}(CH_2)_3CH_3$

iii.



c) Which of the two: trans-but-2-ene or trans-pent-2-ene is non polar?

OR

Q30:

a) Why is Wurtz reaction not preferred for the preparations of alkanes containing odd number of carbon atoms. Illustrate your answer by taking one example.

b) Write IUPAC names of the products obtained by the ozonolysis of the following compounds:

i. Pent-2-ene
ii. 3,4-Dimethylhept-3-ene
iii. 2-Ethylbut-1-ene

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Solution

Ans 1:

There are two significant figures in digit 0.0052. $(1\,\text{mark})$

Ans 2:

$$\lambda = 5800\,\overset{o}{A} = 5800 \times 10^{-8}\,\text{cm}$$

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

$$= \frac{1}{5800 \times 10^{-8}}$$

$$= 1.724 \times 10^{4}\,\text{cm}^{-1} \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans 3: σ bond is stronger than a π bond because a σ-bond is formed by head on overlapping of orbitals and therefore, overlapping to a larger extent.

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

On the other hand π-bond is formed by the sidewise overlapping, which is to smaller extent. $\left(\frac{1}{2}\text{mark}\right)$

Ans 4: Relation between K_a, K_b and K_w is $K_a \times K_b = K_w$ $(1\,\text{mark})$

Ans 5: $Mn(IV)O_2$ $(1\,\text{mark})$

Ans 6: Electron rich hydride $\left(\frac{1}{2}\text{mark}\right)$

Electron rich hydrides have excess electrons which are present as lone pairs. $\left(\frac{1}{2}\text{mark}\right)$

Ans 7: Avogadro's law states that "under similar condition of temperature and pressure, equal volumes of all gases contain equal number of molecules." (1 mark)

Ans 8: BF_3 $(1\,\text{mark})$

Ans9:

(a)

$2Al + 2NaOH + 6H_2O \rightarrow 2Na\left[Al(OH)_4\right] + 3H_2$ (1 mark)

(b)

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$ (1 mark)

Ans 10:

Work function $W_0 = hv_0$

$\therefore W_0 = 1.9\,eV$

$= 1.9 \times 1.602 \times 10^{-19}\,J = 3.04 \times 10^{-19}\,J$

$\therefore$ Threshold frequency $v_0 = \frac{W_0}{h}$ $\left(\frac{1}{2}\text{ mark}\right)$

$= \frac{3.04 \times 10^{-19}\,J}{6.626 \times 10^{-34}\,Js}$

$= 4.59 \times 10^{14}\,s^{-1}$ $\left(\frac{1}{2}\text{ mark}\right)$

Threshold wavelength, $\lambda_0 = \frac{c}{v_0}$ $\left(\frac{1}{2}\text{ mark}\right)$

$= \frac{3 \times 10^{8}\,ms^{-1}}{4.59 \times 10^{14}\,s^{-1}}$

$= 6.54 \times 10^{-7}\,m$

$= 654\,nm$ $\left(\frac{1}{2}\text{ mark}\right)$

OR

Ans 10:

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

$m = 9.1 \text{ x } 10^{-31} \text{ kg}$

$h = 6.63 \text{ x } 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$

$v = 1\% \text{ of speed of light}$

$$= \frac{1 \times 3 \times 10^8}{100} \text{ m s}^{-1}$$

$$= 3 \text{ x } 10^6 \text{ m s}^{-1} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$\therefore \lambda = \frac{6.63 \times 10^{-34} \text{kg m}^2 \text{ s}^{-1}}{(9.1 \times 10^{-31} \text{kg}) \times (3 \times 10^6 \text{ ms}^{-1})} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$= 2.43 \text{ x } 10^{-10} \text{ m} \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans 11:

The electronic configuration of the element with Z=114 would be $[\text{Rn}]\ 5f^{14}\ 6d^{10}\ 7s^2\ 7p^2$

(1 mark)

Since n for the valence shell is 7, the element belongs to 7th period.

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

Since last electron enters p-orbital, the element belongs to p-block.

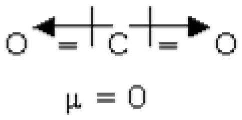
For p-block element, group number is equal to 10+ number of valence electrons (ns and np), therefore group number =10+4=14 $\left(\frac{1}{2}\text{mark}\right)$

Therefore element with atomic number 114 belongs to 7th period and 14th group.

Ans 12: Number of valence electrons & valence:

Group	14	17
No. of valence electrons	4 $\left(\frac{1}{2}\text{mark}\right)$	7 $\left(\frac{1}{2}\text{mark}\right)$
Valence	4 $\left(\frac{1}{2}\text{mark}\right)$	1 $\left(\frac{1}{2}\text{mark}\right)$

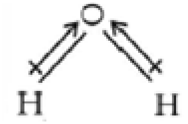
Ans 13: CO_2 has zero dipole moment. This indicates that CO_2 molecule must be linear so that the two C=O bond dipole moments cancel eachother giving zero resultant dipole moment. $\left(\frac{1}{2}\text{mark}\right)$



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

H_2O molecule has a resultant dipole moment indicating that it cannot be linear. The two O-H bonds must be arranged in such a manner so that bond moment of two O-H bonds gives resultant dipole moment. Thus H_2O adopts a bent shape.

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



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

Ans 14: Electronic configurations of N_2 and $N_2^+$are:

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

$$\text{Bond order} = \frac{10 - 4}{2} = 3$$ $\left(\frac{1}{2}\text{mark}\right)$

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

$$\text{Bond order} = \frac{9 - 4}{2} = 2.5$$ $\left(\frac{1}{2}\text{mark}\right)$

Greater is the bond order stronger is the bond and hence greater is the bond dissociation enthalpy. $\left(\frac{1}{2}\text{mark}\right)$

Since bond order of N_2 is larger than N_2^+, N_2 has greater bond dissociation enthalpy than N_2^+. $\left(\frac{1}{2}\text{mark}\right)$

Ans 15:

$$pV = nRT$$

$$= \frac{m}{M}RT$$

$(\text{m is mass and M is molar mass})$

$$\therefore \frac{m}{V} = \frac{pM}{RT}$$

$$\text{i.e. } d = \frac{pM}{RT} \qquad \left(\frac{1}{2}\text{mark}\right)$$

For nitrogen gas at 5 bar pressure and 273 K temperature

$$d_{(N_2)} = \frac{5\,\text{bar} \times 28\,\text{g mol}^{-1}}{R \times 273\ \text{K}} \qquad \left(\frac{1}{2}\text{mark}\right)$$

For gaseous oxide at 2 bar pressure and 273 K temperature

$$d_{(\text{oxide})} = \frac{2\,\text{bar} \times M\ \text{g mol}^{-1}}{R \times 273\ \text{K}} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$\text{Since } d_{(N_2)} = d_{(\text{oxide})}$$

$$\therefore \frac{5\,\text{bar} \times 28\,\text{g mol}^{-1}}{R \times 273\ \text{K}} = \frac{2\,\text{bar} \times M\ \text{g mol}^{-1}}{R \times 273\ \text{K}}$$

$$\Rightarrow M = \frac{5 \times 28}{2} = 70\,\text{g mol}^{-1} \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans 16:

Ideal gas	Real gas
Ideal gas obeys all gas laws under all conditions of temperature and pressure. $\left(\frac{1}{2}\text{mark}\right)$	Real gases obey gas laws under high temperature and low pressure. $\left(\frac{1}{2}\text{mark}\right)$
Ideal gas obeys the ideal gas equation: $pV = nRT$ $\left(\frac{1}{2}\text{mark}\right)$	Real gas obeys van der Waals equation: $\left(p + \frac{an^2}{V^2}\right)(V - nb) = nRT$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 17:

Step 1: Writing oxidation numbers for elements

$$\overset{+6}{Cr_2}\overset{-2}{O_7^{-2}}(aq) + \overset{+4}{S}\overset{-2}{O_3^{-2}}(aq) \rightarrow \overset{+3}{Cr^{3+}}(aq) + \overset{+6}{S}\overset{-2}{O_4^{2-}}(aq)$$

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

Step 2: Calculation of increase and decrease of oxidation numbers and making them equal:

$$\overset{+6}{Cr_2}\overset{-2}{O_7^{-2}}(aq) + 3\,\overset{+4}{S}\overset{-2}{O_3^{-2}}(aq) \rightarrow 2\overset{+3}{Cr^{3+}}(aq) + 3\,\overset{+6}{S}\overset{-2}{O_4^{2-}}(aq)$$

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

Step 3: As the reaction occurs in the acidic medium, and further the ionic charges are not equal on both the sides, $8H^+$ are added on the left to make ionic charges equal.

$$Cr_2O_7^{2-} + 3SO_3^{2-} + 8H^+ \rightarrow 2Cr^{3+} + 3SO_4^{2-} \qquad \left(\frac{1}{2}\text{mark}\right)$$

Step 4: For balancing of H atoms, $4H_2O$ are added on the right to achieve balanced redox reaction.

$$Cr_2O_7^{2-} + 3SO_3^{2-} + 8H^+ \rightarrow 2Cr^{3+} + 3SO_4^{2-} + 4H_2O \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans18:

(a) Dihydrogen gas is combustible in nature. Therefore, it may react with oxygen violently causing an accident. Thus, it is not used in balloons. $(1\,\text{mark})$

(b)

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

(ii)$^{3}_{1}\text{H}$ or T $\left(\frac{1}{2}\text{mark}\right)$

Ans19: Ground state energy of electron is -2.18×10^{-11} ergs

$$\therefore\ E_n = -\frac{2.18\times10^{-11}}{n^2} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$\Delta E = E_5 - E_1 \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$= -2.18\times10^{-11}\left(\frac{1}{5^2}-\frac{1}{1^2}\right)$$

$$= -2.18\times10^{-11}\left(\frac{-24}{25}\right)$$

$$= 2.093\times10^{-11}\ \text{ergs}$$

$$= 2.093\times10^{-18}\text{J}\ \ (Q\,1\,\text{erg} = 10^{-7}\ \text{J}) \qquad \left(\frac{1}{2}\text{mark}\right)$$

When an electron returns to ground state energy emitted is 2.093×10^{-18}J

$$\Delta E = h\upsilon \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$= \frac{c\,h}{\lambda}$$

$$\therefore\ \lambda = \frac{c\,h}{\Delta E}$$

$$= \frac{3\times10^{8}\ \text{m/s}\times6.626\times10^{-34}\ \text{Js}}{2.093\times10^{-18}\text{J}} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$= 9.5\times10^{-8}\ \text{m}$$

$$= 950\,\overset{0}{\text{A}} \qquad \left(\frac{1}{2}\text{mark}\right)$$

OR

Ans 19

a) CO_2 has a linear structure and does not contain any lone pair of electrons. Two dipoles are equal and opposite so they cancel each other. (1mark)

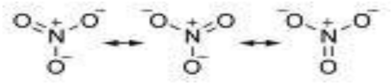
b) N_2^- (15 e^-)- $\sigma\ 1s^2\sigma^*1s^2\sigma\ 2s^2\sigma^*\ 2s^2\ \Pi 2p_x^2 = \Pi 2p_y^2\sigma 2p_z^2\ \Pi^* 2p_x^1$

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

Bond Order = ½ (No. of bonding electrons – No. of antibonding electrons)

Bond Order = ½ (10 - 5) = 2.5 $\left(\frac{1}{2}\text{mark}\right)$

(c)



(1 mark)

Ans. 20.

(a) Both the reactions are exothermic in nature but the heat evolved in the second case will be more because when H_2O (g) changes to H_2O (l), energy is released in the process of liquefaction. (1 mark)

(b) $\Delta U = q + w$ $\left(\frac{1}{2}\text{mark}\right)$

Where, ΔU is change in internal energy, q is the heat and w is work done.

Since according to question heat is absorbed by the system hence q is positive and work is done by the system hence w is negative.

$\Delta U = +701\text{ J} - 394\text{ J}$ $\left(\frac{1}{2}\text{mark}\right)$

$= +307\text{ J}$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 21:

(a) Reaction for which enthalpy change to be calculated is

$\Delta_{vap}H^{\theta}(CCl_4) = 30.5\,kJ/mol$

$\Delta_{f}H^{\theta}(CCl_4) = -135.5\,kJ/mol$

$\Delta_{a}H^{\theta}(C) = 715\,kJ/mol$

$\Delta_{a}H^{\theta}(Cl_2) = 242\,kJ/mol$

$\Delta_{a}H^{\theta}(Cl\ ) = \frac{242}{2} = 121\,kJ/mol$ $\left(\frac{1}{2}\text{mark}\right)$

$CCl_4(g) \rightarrow C(g) + 4Cl(g)$

Enthalpy of reaction, $\Delta_{r}H^{\theta}$

$= [\text{sum of bond enthalpies of products}] - [\text{sum of bond enthalpies of reactants}]$

$= \left[\Delta_{a}H^{\theta}(C) + 4\Delta_{a}H^{\theta}(Cl\ )\right] - \left[\Delta_{f}H^{\theta}(CCl_4) + \Delta_{vap}H^{\theta}(CCl_4)\right]$ $\left(\frac{1}{2}\text{mark}\right)$

$= [715\,kJ/mol\,kJ/mol + 484\,kJ/mol] - [-135.5\,kJ/mol + 30.5\,kJ/mol]$

$= 1304\,kJ/mol$

Since bond enthalpy of CCl_4 corresponds to breaking of 4C - Cl bonds

$\therefore$ Bond enthalpy of C - Cl bond $= \frac{1304\,kJ/mol}{4}$ $\left(\frac{1}{2}\text{mark}\right)$

$= 326\ kJ/mol$ $\left(\frac{1}{2}\text{mark}\right)$

(b) Bond dissociation energy is equal to bond energy for diatomic molecules such H_2, N_2 etc. because only one bond is broken. (1 mark)

Ans 22:

(a)Since aluminium in $AlCl_3$ has six electrons in its valence shell it accepts a lone pair of electrons from the chlorine atom of other neighbouring $AlCl_3$ molecule forming a dimer and becomes stable. Further Al because of its large size can easily accommodate four large sized Cl atoms around it whereas B because of its very small size cannot accommodate four large sized chlorine atoms around it to form dimer. (1 mark)

(b) CO is highly poisonous because of its ability to form a complex with haemoglobin in the red blood corpuscles (RBC) which is about 300 times stable than the oxygen – haemoglobin complex. This prevents haemoglobin in the RBC from carrying oxygen round the body. Deficiency of oxygen causes suffocation and may finally lead to death. (1 mark) (c)When borax solution is acidified it forms boric acid. $\left(\frac{1}{2}\text{mark}\right)$

$$\underset{}{Na_2B_4O_7} + 2HCl + 5H_2O \longrightarrow 2NaCl + \underset{\text{Boric acid}}{4H_3BO_3}$$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 23: Calculation of empirical formula

Element	Percentage composition	Atomic mass (u)	Moles of atoms	Mole ratio of atomic ratio	Marks
C	24.27	12	$\frac{24.27}{12}=2.02$	$\frac{2.02}{2.02}=1$	$\left(\frac{1}{2}\text{mark}\right)$
H	4.07	1	$\frac{4.07}{1}=4.07$	$\frac{4.07}{2.02}=2$	$\left(\frac{1}{2}\text{mark}\right)$
Cl	71.65	35.5	$\frac{71.65}{35.5}=2.02$	$\frac{2.02}{2.02}=1$	$\left(\frac{1}{2}\text{mark}\right)$

Empirical formula of the compound = CH_2Cl $\left(\frac{1}{2}\text{mark}\right)$

Now,

$$n = \frac{\text{Given molar mass}}{\text{Empirical formula mass}}$$ $\left(\frac{1}{2}\text{mark}\right)$

$$n = \frac{98.96}{49.5} \approx 2$$

Molecular formula of the compound = 2 x CH_2Cl = $C_2H_4Cl_2$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 24:

(a) 5-Oxohexanoic acid (1 mark)

(b) 3-Bromo-3-chloroheptane (1 mark)

(c) 2, 5-Dimethylheptane (1 mark)

Ans 25:

Percentage of carbon = 69%

Amount of carbon in 0.20 g of compound $= 0.2 \text{ x } \frac{69}{100}$ $\left(\frac{1}{2}\text{mark}\right)$

$= 0.138 \text{ g}$

Percentage of hydrogen = 4.8%

Amount of hydrogen in 0.20 g of compound $= \frac{0.2\text{x}4.8}{100}$

$= 0.0096$ $\left(\frac{1}{2}\text{mark}\right)$

$C + O_2 \rightarrow CO_2$ $\left(\frac{1}{2}\text{mark}\right)$

12 g of carbon on combustion give CO_2 = 44 g

$\therefore$ 0.138 g of carbon on combustion give $= \left(\frac{44}{12} \text{x } 0.138\right) \text{g } CO_2$

$= 0.506 \text{ g } CO_2$ $\left(\frac{1}{2}\text{mark}\right)$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\left(\frac{1}{2}\text{mark}\right)$

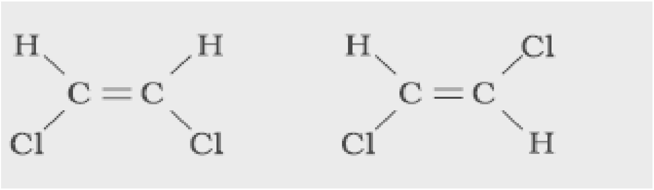
2 g of hydrogen on combustion give water = 18 g

$\therefore$ 0.0096 g of hydrogen on combustion give water = $\frac{18}{2} \text{x } 0.0096$

$= 0.0864 \text{ g}$ $\left(\frac{1}{2}\text{mark}\right)$

Ans 26:

(a)



cis isomer

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

trans isomer

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

cis-1,2-Dichloroethene

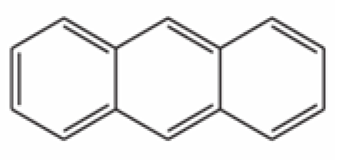
$\left(\frac{1}{2}\text{mark}\right)$

trans-1,2-Dichloroethene

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

(b)

(i)



Anthracene

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

(ii) 14 π -electrons $\left(\frac{1}{2}\text{mark}\right)$

Ans 27:

(i) Even a small raise in temperature in the surroundings will raise the temperature of the body because the specific heat of alcohol is much less than the specific heat of water. In order to cool the body more sweating will take place.

(ii) As there is less H bonding in alcohol it will get evaporated faster. The alcohol will be evaporated at such a fast rate that the liquid has to be ingested always.

(iii) Ice which floats on water helps aquatic life to exist even in winter as water insulates the heat from liquid below it to go back to the surroundings. Solid alcohol does not have such special properties.

(1 x 3 = 3 marks)

Ans 28:

(a)

PCl_5 dissociates as:

$PCl_5 \rightleftharpoons PCl_3 + Cl_2 \qquad (Eq-1)$ $\left(\frac{1}{2}\text{mark}\right)$

Initial concentration of $PCl_5 = 2\,\text{mol}$
% dissociation at equilibrium = 40%
$\therefore$ Number of moles of PCl_5 dissociated $= \frac{2\times 40}{100}$
$= 0.8\,\text{mol}$

Now, 1 mol of PCl_5 on dissociation gives 1 mole of PCl_3 and 1 mole of Cl_2
$\therefore$ concentration in terms of moles at equilibrium for

PCl_5 = 2.0 - 0.8 = 1.2 mol
PCl_3 = 0.8 mol
Cl_2 = 0.8 mol

Since volume of flask is 2L, molar concentrations are

$$[PCl_5] = \frac{1.2}{2} = 0.6\,\text{mol}L^{-1}$$ $\left(\frac{1}{2}\text{mark}\right)$

$$[PCl_3] = \frac{0.8}{2} = 0.4\,\text{mol } L^{-1}$$ $\left(\frac{1}{2}\text{mark}\right)$

$$[Cl_2] = \frac{0.8}{2} = 0.4\,\text{mol}L^{-1}$$ $\left(\frac{1}{2}\text{mark}\right)$

$$\text{From Eq}-1, K_c = \frac{[PCl_3]\,[Cl_2]}{[PCl_5]}$$ $\left(\frac{1}{2}\text{mark}\right)$

$$= \frac{(0.4)\,x\,(0.4)}{(0.6)}$$

$$= 0.267\,\text{mol } L^{-1}$$ $\left(\frac{1}{2}\text{mark}\right)$

(b)

$$\text{Molarity} = \frac{19.23}{121.6}$$
$$= 0.1581\,\text{M}$$

$Sr(OH)_2 \rightleftharpoons Sr^{2+} + 2OH^-$

$\left[Sr^{2+}\right] = 0.1581\,\text{M},$ $\left(\frac{1}{2}\text{mark}\right)$

$\left[OH^-\right] = 2 \times 0.1581 = 0.3162\,\text{M}$ $\left(\frac{1}{2}\text{mark}\right)$

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

$$\left[H_3O^+\right] = \frac{1 \times 10^{-14}}{\left[OH^-\right]}$$
$$= \frac{1\text{x}10^{-14}}{0.3162}$$
$$= 3.163\text{x}10^{-14}$$

$pH = -\log\left[H_3O^+\right]$ $\left(\frac{1}{2}\text{mark}\right)$

$$= -\log(3.163\text{x}10^{-14})$$
$$= -(0.499 - 14)$$
$$= 13.50$$

OR

Ans 28:

(a) For the reaction,

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

$K_c = \frac{HI\;^{2}}{H_2\quad I_2}$ $\left(\frac{1}{2}\text{mark}\right)$

The molar concentrations of various species at equilibrium are:

$$[H_2]=\frac{0.4}{5}=0.08\,\text{mol}L^{-1},\qquad \left(\frac{1}{2}\text{mark}\right)$$

$$[I_2]=\frac{0.4}{5}=0.08\,\text{mol}L^{-1},$$

$$[HI]=\frac{2.4}{5}=0.48\,\text{mol}L^{-1}\qquad \left(\frac{1}{2}\text{mark}\right)$$

Substituting the various values in the above expression of K_c

$$K_c=\frac{(0.48)^2}{(0.08)(0.08)}=36.0\qquad \left(\frac{1}{2}\text{mark}\right)$$

(b) Decomposition reaction for calcium carbonate is given by equation:

$$CaCO_3\,(s) \rightleftharpoons CaO\,(s)+CO_2\,(g)\qquad \left(\frac{1}{2}\text{ mark}\right)$$

$$K_c=\frac{CaO(s)\quad CO_2(g)}{CaCO_3(s)}\qquad \left(\frac{1}{2}\text{ mark}\right)$$

Since by convention concentration of all pure solids are taken as unity, therefore $[CaO(s)]$ =1 and $[CaCO_3(s)]$=1

$$\therefore K_c=[CO_2(g)]\qquad \left(\frac{1}{2}\text{ mark}\right)$$

Since the partial pressure of a gaseous component is proporitonal to its concentration

$$\therefore K_p=p_{CO_2}\qquad \left(\frac{1}{2}\text{ mark}\right)$$

(c) When Cl_2 is added to the equilibrium system, the reaction shifts to the left. This produces more heat and therefore, temperature is increased. (1 mark)

Ans 29: Various reactions that occur in the Solvay process.

In Solvay process, carbon dioxide is passed through brine solution saturated with ammonia to give ammonium carbonate.

$$\underset{}{2NH_3 + H_2O + CO_2} \rightarrow \underset{\text{Ammonium carbonate}}{(NH_4)_2CO_3} \qquad (1\,\text{mark})$$

$$(NH_4)_2CO_3 + H_2O + CO_2 \rightarrow 2NH_4HCO_3 \qquad (1\,\text{mark})$$

$$NH_4HCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl \qquad (1\,\text{mark})$$

The precipitated sodium bicarbonate is filtered and dried. It is heated to give sodium carbonate.

$$2NaHCO_3 \xrightarrow{\text{Heat}} \underset{\text{Sodium carbonate}}{Na_2CO_3} + CO_2 + H_2O \qquad (1\,\text{mark})$$

Ammonia is recovered by heating ammonium chloride obtained above with calcium hydroxide.

$$2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + 2H_2O \qquad (1\,\text{mark})$$

OR

Ans 29:

(a) All alkali metals have only one valence electron per metal atom and therefore, energy binding the atoms in crystal lattice of metal is very low. Thus the metallic bonds in these metals are not very strong. Thus less energy is required to break these metallic bonds. Thus alkali metals are soft and have low melting and boiling points. (1 mark)

(b)

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

$$\underset{\text{Calcium oxide}}{CaO} + \underset{\text{Silica}}{SiO_2} \xrightarrow[\text{Heat}]{} \underset{\text{Calcium silicate}}{CaSiO_3} \qquad (1\text{ mark})$$

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

$$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2 \qquad (1\,\text{mark})$$

(iii)Chlorine reacts with slaked lime to form calcium hypochlorite, ($Ca(OCl)_2$) which is a constituent of bleaching powder.

$$2Ca(OH)_2 + 2Cl_2 \rightarrow CaCl_2 + \underset{\{Bleaching\,powder\}}{Ca(OCl)_2} + 2H_2O \qquad (1\,mark)$$

(c) A cation is highly polarizing if its charge/radius ratio is high. $\left(\frac{1}{2}\,mark\right)$

Li^+ ion has the highest polarizing power among the alkali metal ions because it has the highest charge/radius ratio. $\left(\frac{1}{2}\,mark\right)$

Ans 30:

(a) The orbital structure of benzene show that the π-electrons cloud lying above and below the benzene ring is loosely held and is thus available to the π-electron seeking reagents i.e., electrophiles. Therefore benzene undergoes electrophilic reactions readily and nucleophilic substitution reactions with difficulty. (1 mark)

(b)

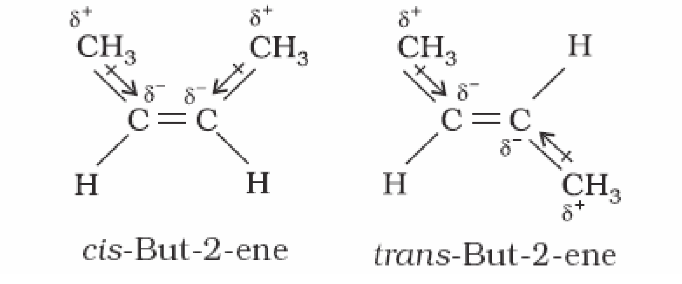
(i)Pent-1-en-3-yne (1 mark)

(ii)5-(2-Methylpropyl) decane (1 mark)

(iii)2-Methylphenol (1 mark)

(c) In trans-but-2-ene, the dipole moments of the two $C-CH_3$ bonds are equal and opposite and therefore, they cancel out each other. Hence trans-2-butene is non-polar.

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



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

OR

Ans 30:

(a)For preparing alkanes containing odd number of carbon atoms, a mixture of two alkyl halides has to be used. These two alkyl halides may react in three different ways producing a mixture of three alkanes instead of desired alkane. Thus yield of required reaction is very low. $\left(\frac{1}{2}\text{mark}\right)$

For example, Wurtz reaction between bromoethane and 1-bromopropane give the following three alkanes instead of a single alkane of odd number of C-atoms.

$$\underset{\text{Bromoethane}}{CH_3CH_2\,Br} + 2Na + Br\,CH_2CH_3 \xrightarrow{\text{Dry ether}} \underset{\text{Butane}}{CH_3CH_2CH_2CH_3} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$\underset{1-\text{Bromopropane}}{CH_3CH_2CH_2\,Br} + 2Na + Br\;CH_2CH_2CH_3 \xrightarrow{\text{Dry ether}} \underset{n-\text{Hexane}}{CH_3CH_2CH_2CH_2CH_2CH_3} \quad \left(\frac{1}{2}\text{mark}\right)$$

$$\underset{1-\text{Bromopropane}}{CH_3CH_2CH_2\;Br} + 2Na + \underset{\text{Bromoethane}}{Br-CH_2CH_3} \xrightarrow{\text{Dry ether}} \underset{n-\text{Pentane (desired)}}{CH_3CH_2CH_2CH_2CH_3}$$

$$+ \underset{\text{Butane}}{CH_3CH_2CH_2CH_3}$$

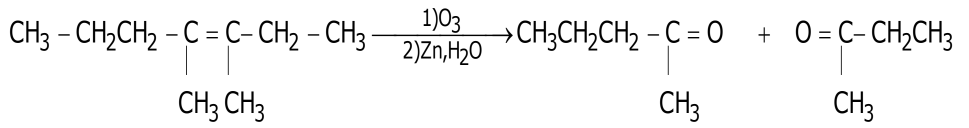
$$+ \underset{n-\text{Hexane}}{CH_3CH_2CH_2CH_2CH_2CH_3} \quad \left(\frac{1}{2}\text{mark}\right)$$

(b)

(i)

$$\underset{\text{Pent}-2-\text{ene}}{CH_3-CH_2-CH=CH-CH_3} \xrightarrow[\text{(ii)}\,Zn,\,H_2O]{\text{(i)}\,O_3} \underset{\substack{\text{Propanal}\\ \left(\frac{1}{2}\text{mark}\right)}}{CH_3-CH_2-CHO} + \underset{\substack{\text{Ethanal}\\ \left(\frac{1}{2}\text{mark}\right)}}{CH_3-CHO}$$

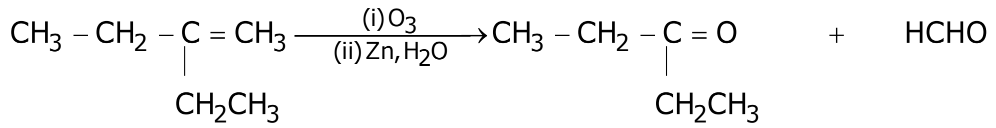
(ii)



$$CH_3-CH_2CH_2-\underset{CH_3}{\underset{|}{C}}=\underset{CH_3}{\underset{|}{C}}-CH_2-CH_3\xrightarrow[2)Zn,H_2O]{1)O_3}CH_3CH_2CH_2-\underset{CH_3}{\underset{|}{C}}=O\quad+\quad O=\underset{CH_3}{\underset{|}{C}}-CH_2CH_3$$

3, 4 – Dimethylhept – 3 – ene Pentan– 2 – one $\left(\frac{1}{2}\text{mark}\right)$ Butan– 2 – one $\left(\frac{1}{2}\text{mark}\right)$

(iii)



$$CH_3-CH_2-\underset{CH_2CH_3}{\underset{|}{C}}=CH_3\xrightarrow[(ii)\,Zn,H_2O]{(i)\,O_3}CH_3-CH_2-\underset{CH_2CH_3}{\underset{|}{C}}=O\quad+\quad HCHO$$

2 – Ethylbut – 1 – ene Pentan– 3 – one $\left(\frac{1}{2}\text{mark}\right)$ Methanal $\left(\frac{1}{2}\text{mark}\right)$