CBSE Board
Class XI Chemistry

Time: 3 Hours **Marks: 70**

General Instructions

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

Q. 1 Calculate the number of atoms in 4g of He. [1]

Q. 2 Which quantum numbers originate from Schrodinger wave equation? [1]

Q. 3 Which of the two is bigger in size and why? Cl or Cl^- [1]

Q. 4 Predict the shape of ClF_3 and BF_3 on the basis of VSEPR theory [1]

Q. 5 What is the conjugate base of HCO_3^- and H_2O? [1]

Q.6 Define displacement reactions. Give one example for it. [1]

Q.7 Why are metallic hydrides used for storing hydrogen? [1]

Q. 8 Name the two methods for estimation of nitrogen. [1]

Q. 9 How many grams of Na_2CO_3 should be dissolved to make 100 cc of 0.15M Na_2CO_3? [2]

Q. 10 Yellow light emitted from a sodium lamp has a wavelength (λ) of 580 nm. Calculate frequency (ν) and wave number of the yellow light? [2]

Q. 11(a) What is the hybridization of central atom in following? NH_3 , C_2H_2 [2]

(b) What is the dipole moment of CCl_4 molecule? Account for your answer.

Q. 12 Describe the hybridization in case of PCl_5. Why are axial bonds longer as compared to the equatorial bonds? [2]

Q. 13 Calculate the root mean square speed of methane molecules at 27^{0}C. [2]

Q. 14 Name the intermolecular forces between (a) He atoms in liquid He

(b) Two HF molecules [2]

Q. 15 Calculate the oxidation number of Mn in K_2MnO_4 and N in HNO_3 [2]

Q. 16 Complete the given equations [2]

(i) $H_2 + CO + CH_3CH{=}CH_2 \rightarrow$

(ii) $LiH + Al_2Cl_6 \rightarrow$

Q. 17 Give reasons for the following [2]

(a) Alkali metals impart colour to the flame.
(b) Explain why alkali and alkaline earth metals cannot be obtained by chemical reduction methods?

OR

Account for the following

(a) Second ionization enthalpy of Na is higher than Mg.
(b) Cs is used extensively in photoelectric cells.

Q. 18 Calculate the volume of oxygen at N.T.P that would be required to convert 5.2 L of carbon monoxide to carbon dioxide. [2]

Q. 19 An element with atomic number 7 has following given configurations

(a) $1s^2\ 2s^2 2p_x^2 2p_y^1\ 2p_z^0$ OR (b) $1s^2\ 2s^2 2p_x^1 2p_y^1\ 2p_z^1$

Which of the two is correct and why? [3]

Q. 20 Write balanced equations or reactions between: [3]

(i) Na_2O_2 and water
(ii) KO_2 and water
(iii) Na_2O and CO_2

Q. 21

(a) Define: [3]
(i) Intensive properties
(ii) Adiabatic process
(b) Starting with thermodynamic relationship G = H- TS derive the following relationship $\Delta G = -T\Delta S_{total}$

Q. 22 Ruchi's father is suffering from high blood pressure. Ruchi's mother cooks food with very little salt in it. [3]

a. Why?
b. Doctor did not advise him not to consume salt at all. Why?
c. What value do you get from this?

Q. 23 (i) How would you justify the presence of 18 elements in the 5th period of the Periodic Table? [3]

(ii) Write the general electronic configuration of p-block and f-block elements

OR

(i) Which of the following will have the most negative electron gain enthalpy and which will have the least negative electron gain enthalpy? P, S, Cl, F. Explain your answer.

(ii)Predict the formula of binary compound of

(a) Aluminium and iodine
(b) Lithium and oxygen

Q. 24 Give IUPAC names of following: [3]

(i) $C_6H_5CH_2COOH$

(ii)
$$\begin{array}{l} CH_2-OH \\ | \\ CH-OH \\ | \\ CH_2-OH \end{array}$$

(iii) $CH_3-\overset{\overset{Br}{|}}{C}H-CH_2-\overset{\overset{O}{||}}{C}-Cl$

Q. 25 (a)What conclusion would you draw if the Lassaigne's extract gives a blood red colouration with $FeCl_3$? [3]

(b)

$$\dot{C}H_2CH_3 < \dot{C}H(CH_3)_2 < \dot{C}(CH_3)_3$$

Which of the given free radicals is most stable and why?

(c) Why is an organic compound fused with metallic sodium for testing for N, S and halogens?

Q. 26 Write a short note on the following: [3]

(i) Wurtz Reaction
(ii) Friedel-crafts alkylation

Q. 27 Define: [3]

(i) Biochemical Oxygen Demand (BOD)
(ii) Ozone Hole

(iii) Green Chemistry

Q. 28 Calculate the molar solubility of Ni $(OH)_2$ in 0.10 M NaOH. The solubility product of Ni $(OH)_2$ is 2.0×10^{-15}. [5]

OR

Equal volumes of 25.0 cm^3 of 5.0×10^{-2} M $Ba(NO_3)_2$ and 2×10^{-2} M NaF solution are mixed. Predict whether BaF_2 will be precipitated or not

(K_{sp} of $BaF_2 = 1.7 \times 10^{-6}$ at 298 K)

Q. 29 Give reasons for the following: [5]

(a) $[SiF_6]^{2-}$ is known whereas $[SiCl_6]^{2-}$ is not known.
(b) Diamond is covalent, yet has high melting point.
(c) PbX_2 is more stable than PbX_4 (X= Cl, Br)
(d) Boron is unable to form BF_6^{3-} ion.
(e) BF_3 behaves as Lewis acid.

OR

(a) Give one method for industrial preparation and one for laboratory preparation of CO and CO_2 each.
(b) Select the member(s) of group 14 that (i) forms the most acidic dioxide (ii) used as semiconductors.
(c) Explain structure of Diborane.

Q. 30 Assign structures for the following: [5]

(a) An alkyne (X) has molecular formula C_5H_8. It reacts neither with sodamide nor with ammoniacal cuprous chloride.
(b) A hydrocarbon 'Y' decolourises bromine water. On ozonolysis it gives 3-Methylbutanal and formaldehyde. Give the name of the compound.
(c) A hydrocarbon (Z) has molecular formula C_8H_{10}. It does not decolourise bromine water and is oxidized to benzoic acid on heating with $K_2Cr_2O_7$. It can also have three other isomers A, B and C. Write the structure of Z, A, B and C.

OR

(a) One mole of a hydrocarbon (A) reacts with one mole of bromine giving a dibromo compound, $C_5H_{10}Br_2$. Substance (A) on treatment with cold dilute alkaline $KMnO_4$ solution forms a compound $C_5H_{12}O_2$. On ozonolysis (A) gives equimolar quantities of propanone and ethanal. Deduce the structural formula of (A).
(b) How will you convert?
   (i) Ethyne to Methane
   (ii) Ethene to Ethyne
   (iii) Methane to Ethane

CLASS – XI
CHEMISTRY

SOLUTIONS

Time: -3 hrs **Marks: - 70**

Ans. 1 One mole of atoms = 6.022×10^{23} atoms=Gram atomic mass of elemen Gram atomic mass of helium= 4g Therefore number of atoms in 4 g helium = 6.022×10^{23} atoms (1 Mark)

Ans. 2 Principal quantum number (n), Azimuthal quantum number (l) and magnetic quantum number (m_l) (1 mark)

Ans. 3 Cl^- is bigger in size. This is because addition of an electron causes a decrease in effective nuclear charge thus causing increase in size. (1 mark)

Ans. 4

(a) ClF_3: T- shape $\left(\frac{1}{2}\text{mark}\right)$

(b) BF_3: Trigonal planar $\left(\frac{1}{2}\text{mark}\right)$

Ans. 5

(a) Conjugate base of HCO_3^- : CO_3^{2-} $\left(\frac{1}{2}\text{mark}\right)$

(b) Conjugate base of H_2O: OH^- $\left(\frac{1}{2}\text{mark}\right)$

Ans. 6 Reaction in which one ion(or atom)in a compound is replaced by an ion(or atom) of other element is called displacement reaction. $\left(\frac{1}{2}\text{mark}\right)$

$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$ $\left(\frac{1}{2}\text{mark}\right)$

Ans. 7 Metallic hydrides trap hydrogen in their voids forming interstitial hydrides, thus they can be used for storing hydrogen. (1 mark)

Ans. 8 Dumas method, $\left(\frac{1}{2}\text{mark}\right)$

Kjeldahl's method $\left(\frac{1}{2}\text{mark}\right)$

Ans. 9

$1000\ cm^3$ of $0.15\ M\ Na_2CO_3$ contains 0.15 moles of Na_2CO_3

$\therefore\ 100\ cm^3$ of $0.15\ M\ Na_2CO_3$ will contain $= \dfrac{0.15 \times 100}{1000}$

$= 0.015$ moles of Na_2CO_3 $\left(\frac{1}{2}\text{ mark}\right)$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molar mass}}$$

$\therefore\quad 0.015 = \dfrac{\text{Mass}}{106\ g}$ $\left(\frac{1}{2}\text{ mark}\right)$

(Molar mass of $Na_2CO_3 = 106\ g$) $\left(\frac{1}{2}\text{ mark}\right)$

$\therefore$ Mass of $Na_2CO_3 = 0.015 \times 106$

$= 1.59\ g$ $\left(\frac{1}{2}\text{ mark}\right)$

Ans. 10

Wavelength of the radiation $= 580\ nm = 580 \times 10^{-9}\ m$

$= 5.8 \times 10^{-7}\ m$

Velocity of radiation, $c = 3 \times 10^{8}\ m / s$

$c = \nu\lambda$

Frequency $\nu = \dfrac{c}{\lambda}$ $\left(\frac{1}{2}\text{ mark}\right)$

$$= \frac{3 \times 10^{8}\ m / s}{5.8 \times 10^{-7}\ m}$$

$= 5.17 \times 10^{14}\ s^{-1}$ $\left(\frac{1}{2}\text{ mark}\right)$

Wave number $\bar{\nu} = \dfrac{1}{\lambda}$ $\left(\frac{1}{2}\text{ mark}\right)$

$$= \frac{1}{5.8 \times 10^{-7}\ m}$$

$= 1.72 \times 10^{6}\ m^{-1}$ $\left(\frac{1}{2}\text{ mark}\right)$

Ans. 11

(a) NH_3: *sp^3* $\left(\frac{1}{2}\text{mark}\right)$

C_2H_2 : *sp* $\left(\frac{1}{2}\text{mark}\right)$

(b) Dipole moment of CCl_4 molecule is zero. Dipole moment is a vector quantity. In symmetrical molecule dipoles of individual bonds cancel each other giving resultant dipole moment as zero. (1 mark)

Ans. 12 In the formation of PCl_5, Phosphorus atom assumes a sp^3d hybrid state. (1 mark)
The longer nature of axial bonds is due to stronger repulsive interactions experienced by the axial bond pairs from equatorial bond pairs. (1 mark)

Ans. 13 Root mean square speed is given as:

$$u_{r.m.s} = \sqrt{\frac{3RT}{M}} \qquad \left(\frac{1}{2}\text{mark}\right)$$

Here, T =273 + 27 =300 K   M = 16 g mol-1   R= 8.314 x 10^7 $\left(\frac{1}{2}\text{mark}\right)$

$$u_{r.m.s} = \sqrt{\frac{3 \text{x} 8.314 \text{x} 10^7 \text{x} 300}{16}}$$

$$= 683.9 \text{ x} 10^2 \text{ cm sec}^{-1}$$

$$= 683.9 \text{ m sec}^{-1} \qquad (1 \text{mark})$$

Ans. 14

(a) Dispersion forces (1 mark)

(b) Hydrogen Bond (1 mark)

Ans. 15 For K_2MnO_4, let the oxidation number of Mn be y

Oxidation Number of each Oxygen atom = -2

Oxidation Number of each K atom = +1

In a molecule, sum oxidation number of various atoms must be equal to zero

$\therefore$ 0= 2+ y + 4(-2) = y-6

$\therefore$ y-6 = 0

$\Rightarrow$ y = 6 (1 mark)

For HNO_3, let the oxidation number of N be y

Oxidation Number of each O atom = -2

Oxidation Number of each H atom = +1

In a molecule, sum oxidation number of various atoms must be equal to zero

$\therefore$ 0= 1+y + 3(-2) = y-5

$\therefore$ y-5=0

$\Rightarrow$ y = 5 (1mark)

Ans. 16

(i) $H_2 + CO + CH_3CH = CH_2 \rightarrow CH_3CH_2CH_2CHO$ (1 mark)

(ii) $8LiH + Al_2Cl_6 \rightarrow 2LiAlH_4 + 6LiCl$ (1 mark)

Ans. 17

(a) Alkali metals have loosely held electron. Energy from the flame is sufficient to excite the electron to a high energy level. When electron falls to lower level the energy released falls in the visible region of spectrum thus imparting colour to the flame. (1 mark)

(b) Alkali and alkaline earth metals are themselves very strong reducing agents and therefore cannot be reduced by chemical reduction methods. (1 mark)

OR

(a) After losing an electron, Na attains a noble gas configuration thus it has a very high second ionization enthalpy. On the other hand magnesium after losing an electron still has one electron in the valence shell. Thus the second ionization enthalpy of Na is higher than Mg. (1 mark)

(b) Cs has a bigger size and low ionization enthalpy. So it loses electron easily and thus it is preferred in photoelectric cells. (1 mark)

Ans. 18 The balanced chemical equation is

$$2CO \ + \ O_2 \longrightarrow 2CO_2 \qquad (1/2\,mark)$$
$$2\,mol \qquad 1\,mol$$
$$2\,x\,22.4\,L \quad 22.4\,L \qquad (1/2\,mark)$$

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. =

$$\frac{22.4}{2\,x\,22.4}\,x\,5.2 = 2.6\ L$$

(1 mark)

Ans. 19 Configuration (b) is correct. (1 mark)

According to Hund's rule of maximum multiplicity, pairing of electrons in the orbitals of a particular subshell does not take place until all the orbitals of the subshell are singly occupied. (1 mark)

Since in the configuration (a) two electrons are present in $2p_x$ and no electron is present in $2p_z$, it is incorrect as per Hund's Rule. (1 mark)

Ans. 20

(a) $Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$ (1 mark)

(b) $2KO_2 + 2H_2O \rightarrow 2KOH + H_2O_2 + O_2$ (1 mark)

(c) $Na_2O + CO_2 \rightarrow Na_2CO_3$ (1 mark)

Ans. 21

(a)

(i) Intensive properties: The properties which depend only on the nature of the substance and not on the amount of the substance are called intensive properties.

Example: Density. $\left(\frac{1}{2}\text{mark}\right)$

(ii) Adiabatic process: A process in which no heat flows between the system and the surroundings is called an adiabatic process i.e. q= 0. $\left(\frac{1}{2}\text{mark}\right)$

(b)

$G = H - TS$

Change in Gibbs energy, $\Delta G = G_2 - G_1$,

Enthalpy change, $\Delta H = H_2 - H_1$,

Entropy change, $\Delta S = S_2 - S_1$

$\Delta G = \Delta H - T\Delta S$

$\Delta S_{total} = \Delta S_{system} + \Delta S_{surrounding}$ $\left(\frac{1}{2}\text{ mark}\right)$

$\Delta S_{total} = \Delta S_{system} - \frac{\Delta H_{sys}}{T}$

[Since $\Delta S_{surr} = \frac{\Delta H_{surr}}{T}$, $\Delta H_{surr} = -\Delta H_{sys}$] $\left(\frac{1}{2}\text{ mark}\right)$

Dropping subscript system:

$\Delta S_{total} = \Delta S - \frac{\Delta H}{T}$

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

$T\Delta S_{total} = T\Delta S - \Delta H$

$-T\Delta S_{total} = \Delta H - T\Delta S = \Delta G$

$\Delta G = -T\Delta S_{total}$ $\left(\frac{1}{2}\text{ mark}\right)$

Ans. 22

(a) As salt ionizes the ionic balance is disturbed and the blood pressure rises. (1 mark)

(b) Salt acts as a cofactor in enzyme action. Hence some amount of salt is required in our diet. (1 mark)

(c) Knowledge of chemistry and care for others. (1 mark)

Ans. 23

(i) When $n = 5$, $l = 0, 1, 2, 3, 4$. The order in which the energy of the available orbital's $4d$, $5s$ and $5p$ increases is $5s < 4d < 5p$. The total number of orbital's available is 9. The maximum number of electrons that can be accommodated is 18; and therefore18 elements are there in the 5th period. (2 marks)

(ii)

(a) p-block: $ns^2np^{1\text{-}6}$ $\left(\frac{1}{2}\text{ mark}\right)$

(b) d-block: $(n-1)d^{1\text{-}10}ns^{0\text{-}2}$ $\left(\frac{1}{2}\text{ mark}\right)$

OR

Ans. 23

(i) Electron gain enthalpy becomes more negative across a period as we move from left to right. And within a group, it becomes less negative down a group. Addition of an electron to the 2*p*-orbital leads to greater repulsion than addition of an electron to the larger 3*p*-orbital. Therefore, the element with most negative electron gain enthalpy is chlorine; the one with the least negative electron gain enthalpy is phosphorus. (2 marks)

(ii)

(a) AlI_3 $\left(\frac{1}{2}\text{mark}\right)$

(b) Li_2O $\left(\frac{1}{2}\text{mark}\right)$

Ans. 24

(i) 2-Phenylethanoic acid (1 mark)

(ii) Propane-1, 2, 3-triol (1 mark)

(iii) 3-Bromobutanoyl chloride (1 mark)

Ans. 25

(a) If the Lassaigne's extract gives a blood red colouration with $FeCl_3$, it indicates that the compound contains both N and S. During fusion, sodium thiocyanate is formed which gives blood red colouration.

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

$$3NaSCN + FeCl_3 \rightarrow \underset{\text{Blood red}}{Fe(SCN)_3} + 3NaCl$$ $\left(\frac{1}{2}\text{mark}\right)$

(b) $\dot{C}(CH_3)_3$ is most stable since it is a tertiary free radical and therefore has the maximum hyperconjugation .Larger the number of alkyl groups attached to the carbon atom carrying the odd electron, greater is the delocalisation of the odd electron and hence more stable is the free radical. (1 mark)

(c) The organic compound is fused with sodium because it reacts with some of the elements present in the organic compound and form corresponding sodium salts. (1 mark)

Ans. 26

(i) Wurtz reaction: Alkyl halides on treatment with sodium in dry ether give higher alkanes. This is called Wurtz reaction and is used to prepare higher alkanes with even number of carbon atoms. (1 mark)

Example:

$$\underset{\text{Bromomethane}}{CH_3Br} + 2Na + BrCH_3 \xrightarrow{\text{Ether}} \underset{\text{Ethane}}{CH_3\text{-}CH_3} + 2NaBr \qquad \left(\frac{1}{2}\text{mark}\right)$$

(ii) Friedel –Crafts alkylation reaction: It is the reaction of benzene with alkyl halide in presence of anhydrous aluminium chloride. The reaction results in the formation of alkyl benzene (1 mark)

Example:

$$\underset{\text{Benzene}}{C_6H_6} + CH_3Cl \xrightarrow[AlCl_3]{\text{Anhydrous}} \underset{\text{Toluene}}{C_6H_5CH_3} + HCl \qquad \left(\frac{1}{2}\text{mark}\right)$$

Ans. 27

(i) Biochemical Oxygen Demand (BOD): It is a measure of dissolved oxygen that would be needed by the micro-organisms to oxidize organic and inorganic compounds present in polluted water. (1 mark)

(ii) Ozone Hole: Depletion of ozone layer over Antarctica leading to the formation of a hole in the stratosphere over Antarctica is called ozone hole. (1 mark)

(iii) Green Chemistry: Chemistry and chemical processes involving the minimum use and generation of harmful substances is called green chemistry (1 mark)

Ans. 28

For $Ni(OH)_2$ $K_{sp} = 2.0 \times 10^{-15}$

As K_{sp} is small, 2s<< 0.10 so that 2s + 0.10 = 0.10 $\left(\frac{1}{2}\text{mark}\right)$

$\therefore K_{sp} = s \times (0.10)^2$ $\left(\frac{1}{2}\text{mark}\right)$

$$\text{Or } s = \frac{K_{sp}}{(0.10)^2}$$

$$= \frac{2.0 \times 10^{-15}}{(0.10)^2} \qquad \left(\frac{1}{2}\text{mark}\right)$$

$$= 2.0 \times 10^{-13}$$

Molar solubility of $Ni(OH)_2$ in 0.1 M NaOH = 2.0×10^{-13} M (1 mark)

OR

The solubility equilibrium BaF_2 is:

$BaF_2 \rightarrow Ba^{2+} + 2F^-$

On mixing 25.0 cm^3 of $Ba(NO_3)_2$ and 25.0 cm^3 of NaF,

the volume of the solution becomes 25.0 + 25.0 = 50.0 cm^3 $\left(\frac{1}{2}\text{mark}\right)$

The new concentrations of $Ba(NO_3)_2$ and NaF are:

Conc. of $Ba(NO_3)_2$ = $\frac{5\times10^{-2}}{50}\times25$ = 0.025 M $\left(\frac{1}{2}\text{mark}\right)$

Conc. of NaF = $\frac{2\times10^{-2}}{50}\times25$ = 0.010 M $\left(\frac{1}{2}\text{mark}\right)$

Since $Ba(NO_3)_2$ ionizes as :

$Ba(NO_3)_2 \rightarrow Ba^{2+} + 2NO_3^-$

Therefore, $[Ba^{2+}] = [Ba(NO_3)_2] = 0.025$ M $\left(\frac{1}{2}\text{mark}\right)$

Since NaF ionizes as :

$NaF \rightleftharpoons Na^+ + F^-$

Therefore, $[F^-] = [NaF] = 0.010$ M $\left(\frac{1}{2}\text{mark}\right)$

Now ionic product of BaF_2

$= [Ba^{2+}]\,[F^-]^2$ $\left(\frac{1}{2}\text{mark}\right)$

$= (0.025)\,(0.010)^2$ $\left(\frac{1}{2}\text{mark}\right)$

$= 2.5 \times 10^{-6}$ $\left(\frac{1}{2}\text{mark}\right)$

K_{sp} of $BaF_2 = 1.7 \times 10^{-6}$

As the ionic product of BaF_2 is greater than K_{sp},

hence BaF_2 will be precipitated. (1 mark)

Ans. 29

(a) $[SiF_6]^{2-}$ is known whereas $[SiCl_6]^{2-}$ is not known since six large size atoms i.e. six chlorine atoms cannot be accommodated around Si but six small size atoms (F atoms) can be comfortably accommodated. (1 mark)

(b) Diamond is a covalent solid but has a high melting point due to its three dimensional network structure involving strong C-C bonds. These bonds are difficult to break and therefore diamond has high melting point. (1 mark)

(c) Due to inert pair effect, lead shows an oxidation state of +2. Hence PbX_2 is more stable than PbX_4. (1 mark)

(d) Boron is unstable to form BF_6^{3-} ion due to non- availability of d-orbitals in the valence shell. Therefore the maximum covalency of boron cannot exceed 4 and thus does not form BF_6^{3-} ion. (1 mark)

(e) The Boron atom in BF_3 has only six electrons in the valence shell and thus needs 2 more electrons to complete its octet. Therefore, it easily accepts a pair of electrons from nucleophiles. Thus BF_3 can act as a Lewis acid. (1 mark)

OR

(a)

(i) Carbon monoxide :

Industrial Preparation:

$$2C(s) + O_2(g) \xrightarrow[\text{Air}]{\text{Limited}} 2CO(g)$$ $\left(\frac{1}{2}\text{mark}\right)$

Lab preparation:

$$HCOOH \xrightarrow{\text{Conc. } H_2SO_4} CO + H_2O$$ $\left(\frac{1}{2}\text{mark}\right)$

(ii) Carbon dioxide

Industrial preparation:

$$C(s) + O_2(g) \xrightarrow[\text{Air}]{\text{Excess}} CO_2(g)$$ $\left(\frac{1}{2}\text{mark}\right)$

Lab Preparation:

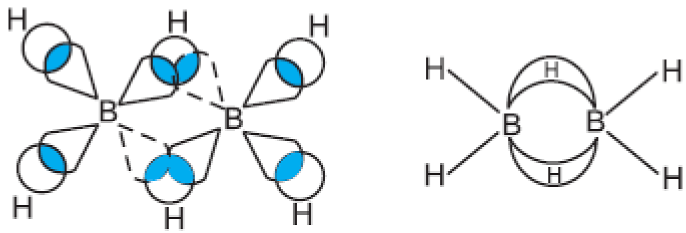
(b) Member of group 14 that

(i) forms the most acidic oxide = Carbon (i.e. CO_2) $\left(\frac{1}{2}\text{mark}\right)$

(ii) is used as semiconductor = Silicon and Germanium $\left(\frac{1}{2}\text{mark}\right)$

(c) Structure of Diborane:

Each boron atom in diborane is sp^3 hybridised. Four sp^3 hybrid orbitals adopt tetrahedral arrangement. Two hybrid orbitals of each B atom overlaps with 1s orbital of two H atoms. Of the two hybrid orbitals left on each B atom one contains an unpaired electron while other is vacant. Hybrid orbital containing unpaired electron of one boron atom and vacant hybrid orbital of second boron atom overlaps simultaneously with 1s orbital of H atom to form B-H-B bond, a three centre electron pair bond. The four terminal B-H bonds are regular two centre-two electron bonds while the two bridge (B-H-B) bonds can be described in terms of three centre–two electron bonds. $\left(1\frac{1}{2}\text{mark}\right)$



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

Ans. 30

(a) Alkyne X is C_5H_8. Since it does not react with sodamide or ammoniacal cuprous chloride, the triple bond must not be terminal.

Therefore, X = $CH_3\text{-}CH_2\text{-}C\equiv C\text{-}CH_3$ (Pent-2-yne) (1 mark)

(b) Hydrocarbon ‘Y’ is an alkene because it decolourises bromine water.

From the product of ozonolysis, the structure of alkene can be predicted.

$$\underset{\text{3-Methylbutanal}}{CH_3\text{-}\underset{\substack{|\\CH_3}}{CH}\text{-}CH_2\text{-}\overset{\substack{H\\|}}{C}{=}O} + \underset{\text{Formaldehyde}}{O{=}\overset{\substack{H\\|}}{C}\text{-}H} \rightarrow \underset{\substack{\text{4-Methylpent-1-ene}\\(Y)}}{CH_3\text{-}\underset{\substack{|\\CH_3}}{CH}\text{-}CH_2CH{=}CH_2}$$

(1 mark)

(c) Since it does not decolourise bromine water, it is an arene. $\left(\frac{1}{2}\text{mark}\right)$

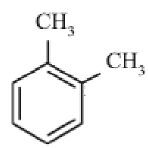
Its formula is $C_6H_5CH_2CH_3$ $\left(\frac{1}{2}\text{mark}\right)$

$$C_6H_5CH_2CH_3 \xrightarrow[K_2Cr_2O_7]{[O]} C_6H_5COOH \qquad \left(\frac{1}{2}\text{mark}\right)$$

(Z) Benzoic acid

The other three isomers are:

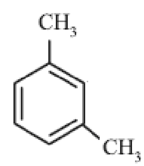
o-Xylene , m- Xylene and p-Xylene



o-Xylene

A

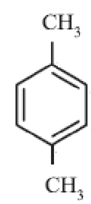
$\left(\frac{1}{2}\text{mark}\right)$



m-Xylene

B

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



p-Xylene

C

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

OR

(a) One mole of the hydrocarbon (A) adds on one mole of bromine to form $C_5H_{10}Br_2$ therefore, (A) must be an alkene having molecular formula C_5H_{10}. The position of double bond is indicated by ozonolysis as:

$$\underset{\text{Propanone}}{CH_3\text{-}\overset{\overset{CH_3}{|}}{C}\text{=}O} + \underset{\text{Ethanal}}{\overset{\overset{H}{|}}{O}\text{=}C\text{-}CH_3} \rightarrow \underset{\text{2-Methylbut-2-ene (A)}}{CH_3\text{-}\overset{\overset{CH_3}{|}}{C}\text{=}CH\text{-}CH_3}$$

(1 mark)

Therefore, compound (A) is 2-Methylbut-2-ene. With alkaline $KMnO_4$, it forms a compound $C_5H_{12}O_2$.

$$CH_3\text{-}\overset{\overset{CH_3}{|}}{C}\text{=}CH\text{-}CH_3 \xrightarrow{\text{alk } KMnO_4} \underset{(C_5H_{12}O_2)}{CH_3\text{-}\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}\text{-}CHOH\text{-}CH_3}$$

(1 mark)

(b)

(i) Ethyne to methane

$$\underset{\text{Ethyne}}{HC\equiv CH} \xrightarrow[HgSO_4]{H^+, H_2O} \underset{\text{Ethanal}}{CH_3CHO} \xrightarrow[K_2Cr_2O_7, H^+]{[O]} CH_3COOH \xrightarrow{NaOH} CH_3COONa \xrightarrow{NaOH, CaO} \underset{\text{Methane}}{CH_4}$$

(1 mark)

(ii) Ethene to Ethyne

$$\underset{\text{Ethene}}{H_2C\text{=}CH_2} \xrightarrow[CCl_4]{Br_2} \underset{\,Br\quad Br}{\overset{}{CH_2\text{-}CH_2}} \xrightarrow[\text{alc.KOH}]{\text{2 moles of}} \underset{\text{Ethyne}}{HC\equiv CH}$$

(1 mark)

(iii) Methane to Ethane

$$\underset{\text{Methane}}{CH_4} \xrightarrow[\text{Sunlight}]{Cl_2} CH_3Cl \xrightarrow[\text{Wurtz reaction}]{\text{Na,ether}} \underset{\text{Ethane}}{CH_3CH_3}$$

(1 mark)