SACRED HEART MATRICULATION HIGHER SECONDARY SCHOOL

UNIT TEST – 01, JULY - 2024

STD: **11** **CHEMISTRY ANSWERKEY**

TIME: **90 MINUTES** MAXIMUM MARKS: **35**

I. ***Answer all the questions. Choose the correct answer from the given four alternatives and write the option code and the corresponding answer.*** **(5x1=5)**

1. a) $_{6}C^{12}$
2. a) 9
3. b) $NH_{3(g)}$
4. c) C_nH_{2n-2}
5. a) 102g

II. ***Answer any three questions. Question No.8 is compulsory.*** **(3x2=6)**

6. Define Relative Atomic Mass?

The relative atomic mass of element is defined as the ratio of mass of one atom of the element to the mass of 1/12th mass of one atom of carbon-12

Relative atomic mass (Ar) $= \frac{Mass\ of\ one\ atom\ of\ the\ element}{Mass\ of \frac{1}{12th} mass\ of\ one\ atom\ of\ Carbon-12}$

$= \frac{Mass\ of\ one\ atom\ of\ an\ element}{1.6605\ X\ 10^{-27}\ Kg}$

7. State Boyle's Law?

At a given temperature the volume occupied by a fixed mass of a gas is inversely proportional to its pressure. Mathematically, Boyle's law can be written as $V \propto \frac{1}{P}$ ……..(1)

(T and n are fixed, T-temperature, n-number of moles) $V = k \times \frac{1}{P}$ ……..…(2)

k – proportionality constant PV = k (at constant temperature and mass)

8. How many Orbitals are possible for n = 4?

If n = 4, the possible number of orbitals are calculated as follows.

n	***l***	***m***
If n = 4	0	4s orbital = 1 orbital
	1	-1, 0, 1 = 3 orbitals
	2	-2, -1, 0, 1, 2 = 5 orbitals
	3	-3, -2, -1, 0, 1, 2, 3 = 7 orbitals

∴ Total number of orbitals = 16 orbitals.

9. Calculate the equivalent mass of Sulphuric acid?

H_2SO_4 basicity = 2eq mol^{-1}

Molar mass of H_2SO_4 = (2 x 1) + (1 x 32) + (4 x 16) = 98 g mol-1

Gram equivalent of H_2SO_4 $= \frac{98}{2} = 49$ g eq^{-1}

10. Write a note on Homologous Series?

- **Homologous series:** A series of organic compounds each containing a characteric functional group and the successive members differ from each other in molecular formula by a CH_2 group is called homologous series.

- Eg.
  - **Alkanes:** Methane (CH_4), Ethane (C_2H_6), Propane (C_3H_8) etc.
  - **Alcohols:** Methanol (CH_3OH), Ethanol (C_2H_5OH) Propanol (C_3H_7OH) etc.)

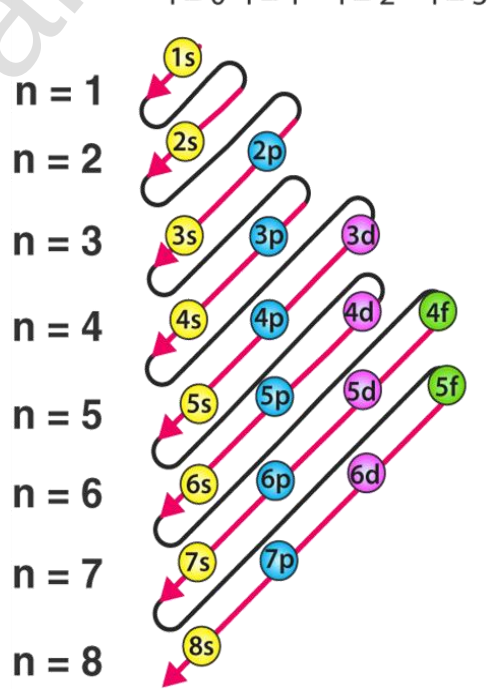
Compounds of the homologous series are represented by a general formula Alkanes C_nH_{2n+2}, Alkenes C_nH_{2n}, Alkynes C_nH_{2n-2} and can be prepared by general methods. They show regular gradation in physical properties but have almost similar chemical property

III. ***Answer any three questions. Question No.15 is compulsory.*** **(3x3=9)**

11. **Distinguish between Oxidation and Reduction.**

	Oxidation	Reduction
(i)	Addition of oxygen and removal of hydrogen	Additional of hydrogen and removal of oxygen
(ii)	This process involves loss of electrons $Fe^{2+} \rightarrow Fe^{3+} + e^-$	This process involves gain electrons. $Cu^{2+} + 2e^- \rightarrow Cu$
(iii)	Oxidation number increases	Oxidation number decreases
(iv)	$Ca + S \rightarrow Ca^{2+} + 2e^-$	$Zn^{2+} + 2e^- \rightarrow Zn$
(v)	Removal of Metal $2KI + H_2O_2 \rightarrow 2KOH + I_2$	Addition of metal $HgCl_2 + Hg \rightarrow Hg_2Cl_2$

12. **Describe the Aufbau Principle?**



The word Aufbau in German means 'building up'. In the ground state of the atoms, the orbitals are filled in the order of their increasing energies. That is the electrons first occupy the lowest energy orbital available to them.
Once the lower energy orbitals are completely filled, then the electrons enter the next higher energy orbitals. The order of filling of various orbitals as per the Aufbau principle which is in accordance with $(n+l)$ rule.
The lower the value of $(n+l)$ for an orbital, the lower is its energy. If two orbitals have the same value of $(n+l)$, the orbital with lower value of n will have the lower energy.

13. **Derive Ideal gas Equation.**

Boyle's law $V \alpha \frac{1}{P}$

Charles law $V \alpha T$

Avogadro's law $V \alpha n$

We can combine these equations into the following general equation that describes the physical behaviour of all gases.

$V \alpha \frac{nT}{P}$ $\qquad$ $V = \frac{nRT}{P}$

where, R is the proportionality constant called universal gas constant.

14. **Give the Electronic Configuration of Mn^{2+} and Cr^{3+}?**

Mn (Z=25-2 = **23**) $\qquad$ $Mn \rightarrow Mn^{2+} + 2e^-$

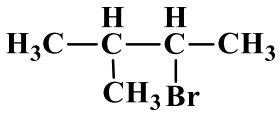
Mn^{2+} Electronic configuration is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^5$

Cr (Z=24-3 = **21**) $\qquad$ $Cr \rightarrow Cr^{3+} + 3e^-$

So, Cr^{3+} Electronic configuration is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^3$

15. **Give the IUPAC names of the following Compounds.**

(i) $CH_2=CH-CH=CH_2$ **Buta-1,3-diene**

(ii)  **2-bromo-3-methylbutane**

IV. ***Answer all the questions.*** **(3x5=15)**

16.(a) **Calculate the Empirical and molecular formula of the compound containing 76.6% Carbon, 6.38% Hydrogen and rest Oxygen. Its Vapour density is 47.**

Element	Percentage	Atomic mass	Relative number of atoms	Simple ratio	Whole no
C	76.6	12	$\frac{76.6}{12} = 6.38$	$\frac{6.38}{1.06} = 6$	6
H	6.38	1	$\frac{6.38}{1} = 6.38$	$\frac{6.38}{1.06} = 6$	6
O	17.02	16	$\frac{17.02}{16} = 1.06$	$\frac{1.06}{1.06} = 1$	1

Empirical formula = C_6H_6O

$$n = \frac{Molar\ mass}{Calculated\ empirical\ formula\ mass}$$

$$= \frac{2 \times vapour\ density}{94} = \frac{2 \times 47}{94} = 1,$$

since Molar mass = 2 x Vapour density

molecular formula = n × empirical formula

∴ molecular formula $(C_6H_6O) \times 1 = C_6H_6O$

(OR)

(b) **Write a short note on (i) Principle Quantum number (ii) Azimuthal Quantum number.**

Principle Quantum number:

This quantum number represents the energy level in which electron revolves around the nucleus and is denoted by the symbol '*n*'.

- The '*n*' can have the values 1, 2, 3,… *n*=1 represents K shell; *n*=2 represents L shell and *n* = 3, 4, 5 represent the M, N, O shells, respectively.
- The maximum number of electrons that can be accommodated in a given shell is $2n^2$.

'*n*' gives the energy of the electron, $E_n = \frac{-1312.8(Z^2)}{n^2}$ kJ mol^{-1} and the distance of the electron from the nucleus is given by $r_n = \frac{(0.529)n^2}{Z}$ Å

Azimuthal Quantum number:

- It is denoted by the letter 'm_l'. It takes integral values ranging from -*l* to +*l* through 0. i.e. if *l*=1; *m* = -1, 0 and +1
- Different values of *m* for a given *l* value, represent different orientation of orbitals in space.
- The Zeeman Effect (the splitting of spectral lines in a magnetic field) provides the experimental justification for this quantum number.
- The magnitude of the angular momentum is determined by the quantum number *l* while its direction is given by magnetic quantum number.

17.(a) Derive the values of Critical constants in terms of Vander Waals Constants.

The van der Waals equation for n moles is

$$\left(P+\frac{a\,n^2}{V^2}\right)(V-nb)=nRT \quad \text{---------- (6.22)}$$

For 1 mole

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT \quad \text{---------- (6.23)}$$

From the equation we can derive the values of critical constants P_c, V_c and T_c in terms of a and b, the van der Waals constants, On expanding the above equation

$$PV+\frac{a}{V}-Pb-\frac{ab}{V^2}-RT=0 \quad \text{------- (6.24)}$$

Multiply equation (6.24) by V^2 / P

$$\frac{V^2}{P}\left(PV+\frac{a}{V}-Pb-\frac{ab}{V^2}-RT\right)=0$$

$$V^3+\frac{aV}{P}+-bV^2-\frac{ab}{P}-\frac{RTV^2}{P}=0 \text{--- (6.25)}$$

When the above equation is rearranged in powers of V

$$V^3-\left[\frac{RT}{P}+b\right]V^2+\left[\frac{a}{P}\right]V-\left[\frac{ab}{P}\right]=0 \text{--- (6.26)}$$

The equation (6.26) is a cubic equation in V. On solving this equation, we will get three solutions. At the critical point all these three solutions of V are equal to the critical volume VC. The pressure and temperature becomes Pc and Tc respectively

i.e., $V = V_C$ $\qquad (V - V_C)^3 = 0$

$V - V_C = 0$ $\qquad V^3 - 3V_CV^2 + 3V_C^2V - V_C^3 = 0$ ---- (6.27)

As equation (6.26) is identical with equation (6.27), we can equate the coefficients of V2, V and constant terms in (6.26) and (6.27).

$$-3V_CV^2=-\left[\frac{RT_C}{P_C}+b\right]V^2 \qquad 3V_C=\frac{RT_C}{P_C}+b \quad \text{---- (6.28)} \qquad 3V_C^2=\frac{a}{P_C} \quad \text{---- (6.29)}$$

$$V_C^3=\frac{ab}{P_C} \quad \text{---- (6.30)}$$

Divide equation (6.30) by equation (6.29)

$$\frac{V_C^3}{3V_C^2}=\frac{ab/P_C}{a/P_C}$$

$$\frac{V_C}{3}=b \qquad \text{i.e. } V_C=3b \quad \text{-------} \quad (6.31)$$

when equation (6.31) is substituted in (6.29)

$$3V_C^2=\frac{a}{P_C}$$

$$P_C=\frac{a}{3V_C^2}=\frac{a}{3(3b^2)}=\frac{a}{3\times 9b^2}=\frac{a}{27\,b^2} \qquad P_C=\frac{a}{27b^2} \quad \text{------ (6.32)}$$

substituting the values of Vc and Pc in equation (6.28),

$$3V_C=b+\frac{R\,T_C}{P}$$

$$3(3\,b)=b+\frac{R\,T_C}{\left(a/27\,b^2\right)} \qquad 9\,b-b=\left(\frac{R\,T_C}{a}\right)27\,b^2$$

$$8\,b = \frac{T_C\,R\,27b^2}{a}$$

$$\therefore\ T_C = \frac{8\,a\,b}{27\,R\,b^2} = \frac{8\,a}{27\,R\,b} \qquad T_C = \frac{8\,a}{27\,R\,b} \qquad \text{------ (6.33)}$$

The critical constants can be calculated using the values of van der waals constant of a gas and vice versa.

$$a = 3\,V_C^2\,P_C \ \text{ and } \ b = \frac{V_C}{3}$$

(OR)

(b) (i) **Derive De-Broglie Equation?**

- de-Broglie combined the following two equations of energy of which one represents wave character (hυ) and the other represents the particle nature (mc^2).

(i) Planck's quantum hypothesis: $E = h\nu$

(ii) Einstein's mass-energy relationship: $E = mc^2$

From eq. (i) and (ii) $h\nu = mc^2$

$hc/\lambda = mc^2$ $\therefore$ **$\lambda = h / mc$**

- The equation represents the wavelength of photons whose momentum is given by mc (Photons have zero rest mass)
- For a particle of matter with mass m and moving with a velocity v, the equation can be written as $\therefore$ **$\lambda = h / mv$**

This is valid only when the particle travels at speeds much less than the speed of Light.

(ii) **Calculate the Oxidation number of underlined elements** (a) $\underline{S}O_2$ (b) $\underline{C}H_2F_2$

(a) $\underline{S}O_2 = x + 2(-2) \Longrightarrow x = +4 \Longrightarrow$ **S = +2**

(b) $\underline{C}H_2F_2 = x + 2(+1) + 2(-1) \Longrightarrow x = 0 \Longrightarrow$ **C = 0**

18.(a) (i) **Give the General Characteristics of Organic Compound.**

- They are covalent compounds of carbon and generally insoluble in water and readily soluble in organic solvent such as benzene, toluene, ether, chloroform etc...
- Many of the organic compounds are inflammable (except CCl_4). They possess low boiling and melting points due to their covalent nature
- Organic compounds are characterized by functional groups. A functional group is an atom or a specific combination of bonded atoms that react in a characteristic way, irrespective of the organic molecule in which it is present. In almost all the cases, the reaction of an organic compound takes place at the functional group. They exhibit isomerism which is a unique phenomenon.
- **Homologous series:** A series of organic compounds each containing a characteric functional group and the successive members differ from each other in molecular formula by a CH_2 group is called homologous series. Eg.
  - **Alkanes:** Methane (CH_4), Ethane (C_2H_6), Propane (C_3H_8) etc.
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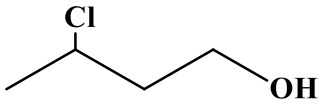
(ii) **What is meant by a Functional Group?**

A functional group is an atom or a specific combination of bonded atoms that react in a characteristic way, irrespective of the organic molecules in which it is present.

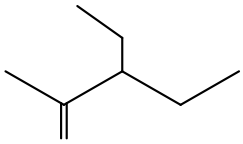
(OR)

(b) **Give the Structure of the following Compound.**

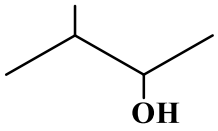
(i) **3-Chlorobutanol**



(ii) **3-ethyl-2-methyl-1-pentene**



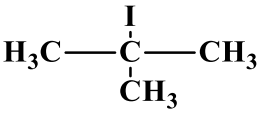
(iii) **3-methylbutan-2-ol**



(iv) **Acetaldehyde**

CH_3-CHO

(v) **Tertiary butyl iodide**



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