OSDAV Public School, Kaithal

Half yearly Exams (2024-25)

Class : XI **SET- A**

Subject : CHEMISTRY

Time: 3 Hrs . **M.M. : 70**

General Instructions:-

All questions are compulsory.

(a) There are 33 questions in this question paper.

(b) SECTION A consists of 16 multiple -choice questions carrying 1 mark each.

(c) SECTION B consists of 5 short answer questions carrying 2 marks each.

(d) SECTION C consists of 7 short answer questions carrying 3 marks each.

(e) SECTION D consists of 2 case - based questions carrying 4 marks.

(f) SECTION E consists of 3 long answer questions carrying 5 marks.

(g) Use of log tables and calculators is not allowed

Q.N.	Questions	Marks
	SECTION-A **The following questions are multiple -choice questions with one correct answer. Each question carries 1 mark.**	
1	5.0L of 0.4M H_2SO_4 contains: a. 2.0 mol of H_2SO_4 b. 0.4 mol of H_2SO_4 c. 5.0 mol of H_2SO_4 d. 2.0 mol of H_2O	**1**
2	No. of radial nodes for 5d orbital is: a. 1 b. 3 c. 4 d. 2	**1**
3	The first ionisation energies of Na, Mg ,Al and Si are in the order: a. Na < Mg > Al < Si b. Na > Mg > Al >Si c. Na < Mg < Al > Si **d.** Na > Mg > Al < Si	**1**
4	Which of the following is a non polar molecule: a. NF_3 b. BF_3 c. SF_4 d. PCl_3	**1**
5	The shape of PCl_5 molecule is: a. Trigonal bipyramidal b. square planer c. tetrahedral d. Octahedral	**1**
6	The oxidation no. of Mn is maximum in : **a.** MnO_2 b. K_2MnO_4 c. Mn_3O_4 d. $KMnO_4$	**1**
7	Which among the following is most electronegative element: a. N b. Cl c. O d. F	**1**
8	What is the maximum no. of orbitals that can be identified with the following quantum numbers n=3 , l=1 $m_l = 0$ a. 1 b. 2 c. 3 d. 6	**1**
9	The value of Azimuthal quantum no. for all electrons in 5p orbitals is: a. 4 b. 5 c. 2 d. 1	**1**
10	Which of the following molecule has maximum dipole moment a. CO_2 b. CH_4 c. NH_3 d. NF_3	**1**
11	Number of atoms of oxygen present in 10.6g Na_2CO_3 will be: a. 6.02×10^{23} b. 12.04×10^{23} c. 1.806×10^{23} d. 31.80×10^{23}	**1**
12	What does the reducing agent do in an oxidation-reduction reaction? a. Gains electrons from the oxidising agent b. Loses electron to the oxidising agent c. Is always reduced	**1**

	d. Is reduced by oxidising agent	
13	***Given below are two statements labelled as Assertion (A) and Reason (R)*** ***Select the most appropriate answer from the options given below:*** ***a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion*** ***b. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion*** ***c. Assertion is true but Reason is false.*** ***d. Assertion is false, but reason is correct*** Assertion: The decomposition of hydrogen peroxide to form water and oxygen is an example of disproportional reaction. Reaction: The oxidation state of oxygen changes from -1 to -2 and zero in the products.	**1**
14	Assertion: Noble gases have highest first ionisation energy in their respective periods Reason: Noble gases have stable electronic configuration	**1**
15	Assertion: BF_3 molecule is planar but NF_3 is pyramidal Reason: N atom is smaller than B.	**1**
16	Assertion: In multielectron atoms, such as sodium , all the subshells of a particular energy level have different energies. Reason: Electrons in different subshells feel different screening effect.	**1**
	SECTION-B **This section contains 5 questions .The following questions are very short answer type and carry 2 marks each.**	
17	a. What is the change in the hybridisation of Al atom in the reaction. $AlCl_3 + Cl^- \longrightarrow AlCl_4^{--}$ **b.** Why axial bonds are longer as compared to equatorial bonds in PCl_5	**1** **1**
18	What would be the ratio of velocities of CH_4 and O_2 molecules so that they are associated with de Broglie waves of equal wavelength?	**2**
19	a. Although geometries of NH_3 and H_2O molecules are distorted tetrahedral, bond angle in water is less than that of ammonia , Explain? b. What are the necessary conditions for the combination of atomic orbitals to form molecular orbitals.	**1** **1**
20	Balance the redox reaction by ion electron method: MnO_4^- (aq)+ I^-(aq) $\longrightarrow$ $MnO_2 + I_2$ (Basic medium)	**2**
21	Give reasons why First ionisation energy of Mg is more than that of Na while its second ionisation energy is less.	**2**
	SECTION-C **This section contains 7 questions. The following questions are short answer type and carry 3 marks each.**	
22	Using VSEPR theory predict the shapes of following molecules: a. $BeCl_2$ b. PH_3 c. H_3O^+	**3**
23	a. Would you expect the second electron gain enthalpy of O as positive, more negative or less negative than the first ? Justify your answer. b. Out of F and Cl which element has more negative electron gain enthalpy and why? c. Predict the group and period of element having configuration $1s^2\ 2s^2\ 2p^6 3s^2\ 3p^3$	**1** **1** **1**
24	a. When electromagnetic radiation of wavelength 300nm falls on the surface of sodium, electrons are emitted with a kinetic energy of 1.68×10^5 J/mol. What is	**2**

	the minimum energy needed to remove an electron from sodium? What is the maximum wavelength that will cause a photoelectron to be emitted? b. Define Pauli's exclusion principle.	1
25	a. An aqueous solution of sodium chloride is marked 10% (w/w) on the bottle. The density of the solution is 1.071 g/ml. What is the molality and molarity? b. State Gay Lusac law of combining volumes.	**2** **1**
26	a. Why H_2O is a liquid while H_2S is a gas? b. Explain why BeH_2 molecule has zero dipole moment although Be-H bonds are polar. **c.** Why NaCl does not conduct electricity in solid state?	**1** **1** **1**
27	a. Chlorine is prepared in lab by treatment manganese dioxide with aqueous hydrochloric acid according to the reaction: $4\,HCl\,(aq) + MnO_2\,(s) \longrightarrow 2H_2O + MnCl_2 + Cl_2$ How many grams of HCl react with 5 g of manganese dioxide (Atomic mass Mn = 55) b. What is limiting reactant in a reaction?	**2** **1**
28	**a.** What is the difference between notations l and L **b.** State de Broglie principle. **c.** What are degenerate orbitals?	**1** **1** **1**

SECTION -D

The following questions are case -based questions. Each question carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

29 Modern periodic table is based on increasing order of atomic no. It has 18 groups and 7 periods. It has four blocks s block, p block , d block and f block elements. It relates electronic configuration with position in periodic table. Elements present in group resemble in chemical properties whereas elements in a period show gradation in properties. Lanthanoids and Actinoids belong to f block because last electron enters f orbital. They are all metals. They mostly form coloured ions, complexes show variable oxidation states, paramagnetism and used as a catalyst. Elements in periodic table show different periodic properties.

Periodic properties are the properties of elements which are directly or indirectly related to electronic configuration which show gradation when we move along a period or move down the group. The different periodic prop are atomic radii, ionisation energy , electron gain enthalpy and electronegativity.

Answer the following questions:

a. Write the general outer electronic configuration of d block elements **1**

b. Define the term ionisation energy. **1**

c. The first and second ionisation energy of few elements are given

Element	IE 1	IE 2
I	**2372**	**5251**
II	**520**	**7300**
III	**900**	**1760**
IV	**1680**	**3380**

1) Which of the above element is likely to be a reactive metal **2**

2) Which of the above element is a noble gas.

30 Spectrum is a combination of radiations of different wavelengths. Visible spectrum is continuous spectrum. Atomic spectrum is discontinuous spectrum. It can be absorption or emission spectrum when energy is supplied to electrons, these get excited to higher energy levels. When they come back , they radiate energy in the form of bright spectral

	lines separated by dark bands. Each element has its unique spectrum by which it can be identified. ***Answer the following questions:*** a. What is the maximum no. of emission lines obtained when the excited electron of a H atom in n=6 drops to ground state? b. What do you mean by emission spectrum? **c.** What is the wavelength of a photon emitted during a transition from n=5 to n=2 state in hydrogen spectrum.	 **1** **1** **2**
31	**SECTION-E** **The following questions are long answer type and carry 5 marks each.** a. A Welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 mL (measured at STP) of this welding gas is found to weigh 11.6g. Calculate the 1) empirical formula 2) molar mass of gas 3) molecular formula. Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% oxygen by mass (At.mass Fe= 55.85 , O = 16 amu)	 **3** **2**
32	a. Draw the MOT diagram of N_2, write its magnetic nature and also find the bond order b. Write difference between sigma and Pi bond.	**3** **2**
33	a. An electron has a speed of 500 m/s with an accuracy of 0.02% . What is the uncertainty in locating its position. (mass of electron = 9.1×10^{-31}kg) b. An atomic orbital has n = 3 . What are the possible values of l and m_l ? c. Write the electronic configuration of F^- ion d. State Hunds rule of maximum multiplicity.	**2** **1** **1** **1**

OSDAV PUBLIC SCHOOL. KAITHAL

Answer Key for Mid Term Chemistry

Class-XI (2024-25)

SET-A

SECTION A

1. a. 2.0 mol of H_2SO_4

2. d. 2

3. a. Na>Mg<Al<Si

4. b. BF_3

5. a. Trigonal bipyramidal

6. d. $KMnO_4$

7. d. F

8. a. 1

9. d. 1

10. c. NH_3

11. c. 1.806×10^{23}

12. b. loses electron to the oxidising agent

13. a. Both A and R are true and R is the correct explanation of A.

14. a. Both A and R are true and R is the correct explanation of A.

15. b. Both A and R are true but R is not the correct explanation of A.

16. a. Both A and R are true and R is the correct explanation of A.

SECTION B

17. a. Before the reaction, the metal centre could be described as sp^2 hybridized, and trigonal planar in structure. Much of the chemistry of aluminium can be described in terms of the metal filling its vacant p orbital to give a sp^3 description.

b. Axial bonds are not stronger than equatorial bonds. In fact, axial bonds are generally weaker because they experience more repulsion from nearby atoms, making them longer and less stable compared to equatorial bonds.

18. he ratio of their velocities is:

$V_{CH4}/V_{O2} = m_{CH4}/m_{O2}$

Now, using the molar masses:

- Molar mass of CH_4= 16 g/mol,
- Molar mass of O2= 32 g/mol.

Taking the ratio of their velocities:

32/16= 2

Therefore, the velocity of methane molecule is **twice** the velocity of oxygen molecules for them to have the same de Broglie wavelength.

19. a. The bond angle in H_2O is smaller than in NH_3 because H_2O has two lone pairs on oxygen, while NH_3 has only one lone pair on nitrogen. Lone pairs repel more strongly than bonding pairs, and the additional lone pair in H_2O causes greater repulsion, pushing the hydrogen atoms closer together and reducing the bond angle to 104.5°. In contrast, NH_3 experiences less repulsion with only one lone pair, resulting in a slightly larger bond angle of 107°.

b. Atomic orbitals must have similar energy, proper symmetry, and significant overlap for effective combination into molecular orbitals.

20.

Step 1. First Write the Given Redox Reaction.

$MnO_4^- + I^- \text{ -------- } MnO_2 + I_2$

Step2. Identify Oxidation and Reduction half Reaction.

$MnO_4 \text{ ------ } MnO_2$ *[Reduction]*

$I^- \text{ --------} I_2$ *[Oxidation]*

Step3. Balance the atoms undergoing change in the Oxidation number.

$\therefore MnO_4 \text{ -------- } MnO_2$ *[Change of 4 units].*

$2I^- \text{ ---------- } I_2$ *[Change of 2 units]*

Step 4 . Multiply 1st equation by 1 and second equation by 2.

$\therefore MnO_4 \text{ -------- } MnO_2$ *and* $4I^- \text{ ---------- } 2I_2$

Step 5. Now, Add both the equations,

$\therefore 4I^- + MnO_4 \text{ ---------- } I_2 + MnO_2$

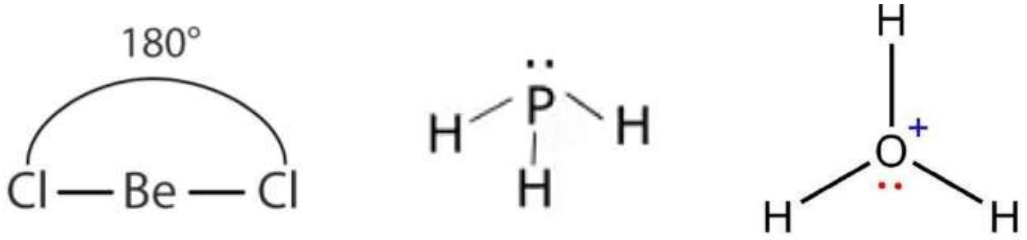
Step 6. Now, Balance the charges by adding water and Hydrogen ions.

$\therefore 4I^- + MnO_4 + 2H_2O \text{ ---------- } I_2 + MnO_2 + 4OH^-$

21. Magnesium's first ionization energy is higher than sodium's because its outer electron is more tightly bound due to a greater nuclear charge. However, sodium's second ionization energy is much higher than magnesium's because, after losing one electron, sodium attains a stable noble gas configuration. Removing an electron from this stable core requires significantly more energy than removing magnesium's second outer electron.

SECTION- C

22.



23.a. The second electron affinity of oxygen is expected to be positive (or less negative) compared to the first. The first electron affinity is negative because energy is released when an electron is added to a neutral oxygen atom, forming O^-. In contrast, the second electron affinity involves adding another electron to the negatively charged O^- ion, which requires energy to overcome the repulsion between the two negatively charged species, making the process endothermic.

b. Fluorine (F) has a less negative electron gain enthalpy than chlorine (Cl), even though fluorine is more electronegative. This is because fluorine's small atomic size results in significant electron-electron repulsion in its compact 2p orbital. When an electron is added to fluorine, the high electron density causes more repulsion, making the process less energetically favourable. On the other hand, chlorine has a larger atomic size and a 3p orbital, where the added electron experiences less repulsion.

c. Period- 3, Group- 15

24.a.

The energy (E) associated with 300 nanometre photon is given by:

$$E = \frac{hc}{\lambda}$$
$$= \frac{(6.626 \times 10^{-34})(3.0 \times 10^{8} ms^{-1})}{300 \times 10^{-9}}$$
$$= 6.62 \times 10^{-9} J$$

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$$= \frac{(6.626 \times 10^{-34})(3.0 \times 10^{8} ms^{-1})}{300 \times 10^{-9}}$$
$$= 6.62 \times 10^{-9} J$$

Now, we will find energy of one mole of photons.

$$= (6.626 \times 10^{-19} J) \times (6.022 \times 10^{23} mol^{-1})$$
$$= 3.9 \times 10^{5} Jmol^{-1}$$

Now, we will find minimum energy needed to remove a mole of electrons from sodium

$$= 3.9 \times 10^{5} Jmol^{-1} - 1.68 \times 10^{5} Jmol^{-1}$$
$$= (3.99 - 1.68) \times 10^{5} Jmol^{-1}$$
$$= 2.31 \times 10^{5} Jmol^{-1}$$

We will find the minimum energy for one mole of electron

$$= \frac{2.31 \times 10^{5} Jmol^{-1}}{6.022 \times 10^{23} mol^{-1}}$$
$$= 3.84 \times 10^{-19} J$$

Now, by using this we will find the wavelength.

$$\lambda = \frac{hc}{E}$$
$$= \frac{(6.626 \times 10^{-34})(3.0 \times 10^{8} ms^{-1})}{3.84 \times 10^{-19} J}$$
$$= 517nm$$

b. Pauli's Exclusion Principle states that no two electrons in an atom can have identical sets of four quantum numbers, meaning each electron must occupy a unique state, allowing a maximum of two electrons per orbital with opposite spins.

25. a.

$100g$ solution contains $10gNaCl$

$w = 10g, m_{NaCl} = 58.5,$

$$\text{Volume of solution } = \frac{100}{1.071 \times 1000}\text{litre}$$

$w_{H_2}o = 100 - 10 = 90g$

$$\text{Molarity} = \frac{\text{Wt.of soulute}}{\text{mol.wt.of solute} \times V_{\text{in}L}}$$

$$= \frac{10 \times 1.071 \times 1000}{58.5 \times 100} = 1.83M$$

$$\text{Molality} = \frac{\text{Wt.of solute}}{\text{mol.wt.of solute} \times \text{weight of solvent in kg}}$$

$$= \frac{10 \times 1000}{58.5 \times 90} = 1.90m$$

b. Gay-Lussac's Law of Combining Volumes states that when gases react together at constant temperature and pressure, the volumes of the gaseous reactants and products can be expressed in simple whole number ratios. For example, if two gases react to form a gas, the volume of the product gas relative to the volumes of the reactants will be in a simple ratio, such as 1:1, 2:1, or 3:2, depending on the specific reaction.

26. a. Water (H_2O) is a liquid at room temperature due to strong hydrogen bonding between its molecules, which results from its bent shape and high polarity. In contrast, hydrogen sulfide (H_2S) has weaker dipole-dipole interactions and London dispersion forces, leading to lower boiling and melting points, causing it to exist as a gas at room temperature.

b. BeH_2 has a zero dipole moment because its linear molecular geometry allows the polar Be-H bonds to cancel each other out. Although each Be-H bond is polar due to the difference in electronegativity between beryllium and hydrogen, the symmetry of the linear structure means the dipoles are equal in magnitude and opposite in direction, resulting in no overall dipole moment for the molecule.

c. NaCl does not conduct electricity in the solid state because its ions are held tightly in a rigid crystal lattice, preventing them from moving freely. Electrical conductivity requires the movement of charged particles, which only occurs when NaCl is dissolved in water or melted. In these states, the ions are free to move, allowing the substance to conduct electricity.

27. a.

1 mol (55 + 2 × 16 = 87 g) of MnO_2 reacts completely with 4 mol (4 × 36.5 = 146 g) of HCl.

Now, 87 g of MnO_2 will react with 146 g of HCl.

So, 5.0 g of MnO_2 will react with (5 X 146)/87 g of HCl.

5.0 g of MnO_2 will react with 8.3 g of HCl.

Therefore, 8.4 g of HCl will react entirely with 5 g of manganese dioxide.

b. The limiting reagent in a chemical reaction is the reactant that is consumed first, thus determining the maximum amount of product that can be formed. Once the limiting reagent is used up, the reaction cannot proceed any further, even if other reactants are still available.

28. a. In quantum mechanics, L represents the principal quantum number, indicating the main energy level of an electron, while l denotes the azimuthal quantum number, which defines the shape of the atomic orbital. L indicates energy levels, and l specifies orbital shapes.

b. De Broglie's principle states that every moving particle or object has an associated wave-like nature. This means that particles such as electrons exhibit both particle and wave characteristics, leading to the concept of wave-particle duality in quantum mechanics.

c. Degenerate orbitals are orbitals that have the same energy level. In an atom, multiple orbitals within a given subshell are degenerate, meaning they are equal in energy. Degeneracy occurs in systems where the electrons experience the same potential energy, allowing them to occupy any of these orbitals without preference.

SECTION-D

29. a. $(n-1)d^{1\text{-}10}\ ns^{0\text{-}2}$

b. Ionization energy is the energy required to remove an electron from an atom or ion in its gaseous state, forming a positively charged ion. It reflects the atom's tendency to lose an electron and varies across the periodic table.

c. 1) II

2) I

30. a.

$$\text{Number of spectral lines} = \frac{n(n-1)}{2}$$
$$= \frac{6(6-1)}{2}$$
$$= 15$$

b. Emission spectra are the wavelengths of light emitted by atoms or molecules when electrons transition from higher to lower energy states. These spectra can be continuous or consist of distinct lines, allowing for the identification of elements based on their unique spectral signatures.

c.

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

λ is the wavelength

R is the Rydberg Constant which is $1.097 \times 10^{-7}\ m^{-1}$

n_1 is the lower energy level

n_2 is the higher energy level

Putting in the numbers:

$$\frac{1}{\lambda} = 1.097 \times 10^7\left[\frac{1}{2^2} - \frac{1}{5^2}\right]$$

$$\frac{1}{\lambda} = 1.097 \times 10^7[0.25 - 0.04] = 0.2304 \times 10^7\ m^{-1}$$

$$\therefore \lambda = 4.34 \times 10^{-7}\ m$$

$$\lambda = 434\ nm$$

SECTION- E

31. a.

Assuming 1 gm. Of gas is burnt

The weight % of $C = \frac{3.38 \times 12}{44} \times 100 = 92.18\ \%$

The weight % of .H. $= \frac{0.69 \times 2}{18} = 7.67\ \%$

S.No.	Element	%	% / Atomic wt.	Divide with least value
1.	C	92.18	$\frac{92.18}{12} = 7.68$	$\frac{7.68}{7.67} = 1.001$
2.	H	7.67	$\frac{7.67}{1} = 7.67$	$\frac{7.67}{7.67} = 1$

Experical formula of compound = C_1H_1

(ii) Given 10 lit of gas at STP weighs - 11.6 gas

22.44 lit of gas at STP weights $= \frac{22.4 \times 11.6}{10} = 25.984$

$\therefore$ Molecular weight of given gas = 25.984

(iii) Molecular formula = n (emperical formula)

$n = \frac{\text{Mol wt}}{\text{Emp.wt}} = \frac{25.984}{13} = 2$ $\therefore$ Molecular formula $= 2(CH) = C_2H_2$.

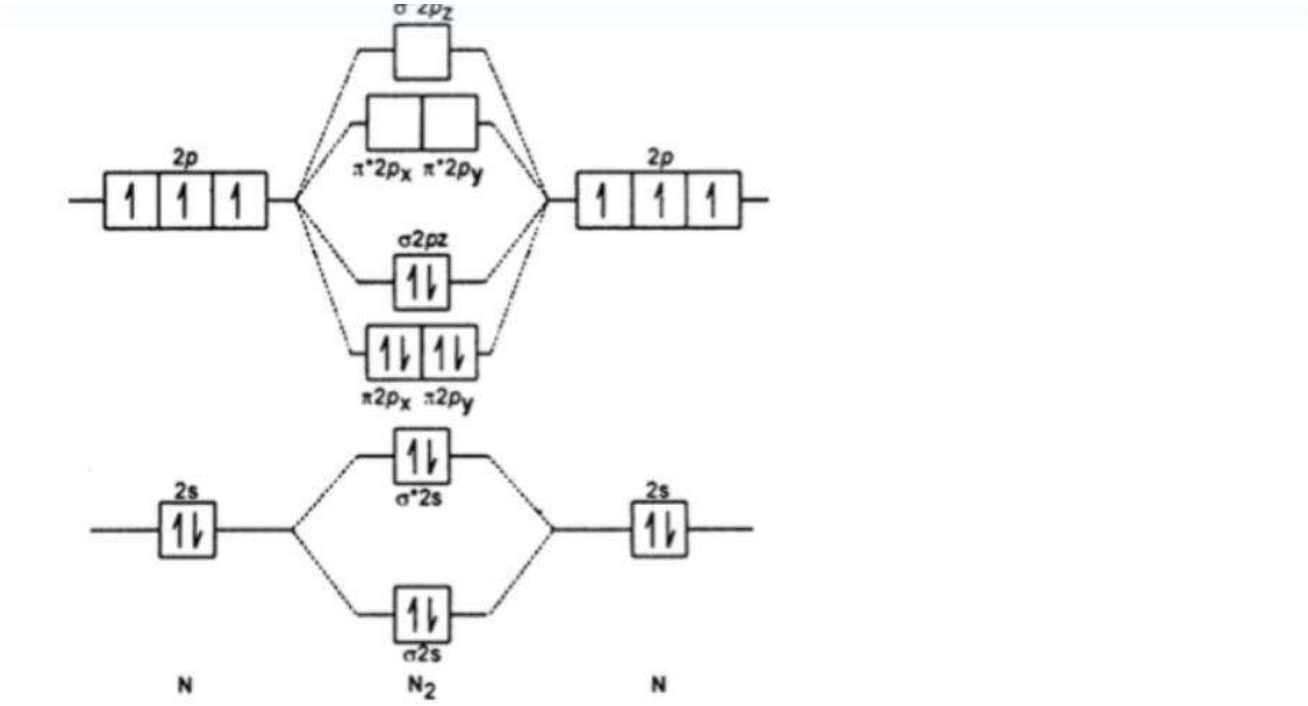
b.

Element	Symbol	Percentage of elements	At. mass of element	moles of the element	Conversion	simplest molar ratio	simplest whole number
Iron	Fe	69.9	55.8	69.9/55.8 = 1.25	1.25/1.25 =1	1	2
Oxygen	O_2	30.1	32	30.1/32 = 0.94	2* 0.94 = 1.88. 1.88/1.25 =1.5	1.5	3

In the conversion, the 0.94 is multiplied with 2 because the oxygen is diatomic.

Hence, the formula is Fe_2O_3 .

32. a.



Electronic configuration:

$$\sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 , [\pi 2p_x^2 = \pi 2p_y^2] < \sigma 2p_z^2 < [\pi^* 2p_x = \pi^* 2p_y] < \sigma^* 2p_z$$

Let's calculate the bond order of N_2;

$$Bond\ order = \frac{Bonding\ electrons - Anti\ bonding\ electrons}{2}$$

$$= \frac{10-4}{2} = 3$$

N_2 does not have unpaired electrons, hence it is diamagnetic.

b.

S. No	Sigma Bond	Pi Bond
1	Covalent bond which is formed by the head on overlapping atomic orbitals is called sigma bond.	Covalent bond which is formed by lateral overlapping of the half-filled atomic orbitals of atoms is called pi bond.
2	It is the strongest covalent bond.	It is weaker than a sigma bond.
3	It is denoted by σ .	It is denoted by π .
4	In sigma bonds, overlapping orbitals can be pure orbitals, hybrid orbitals and one hybrid and one pure orbital.	In pi bond, overlapping orbitals are always pure orbitals only. Pure orbitals are unhybridized orbitals.
5	It can exist independently. Example -alkane.	It can exist with a sigma bond only. Example- alkene and alkyne.
6	It allows free rotation of orbitals.	It restricts free rotation of orbitals.

33.a.

Speed = v = 500 m/s.
Uncertainty in speed is 0.02 %
Δv = 0.02 % of 500 m/s
= 0.02100 × 500 = 0.1 m/s
According to Heisenberg uncertainty principle,
$\Delta x * \Delta p \geq h / 4\pi$
Here Δx = uncertainty in position
Δp = uncertainty in momentum
h = Planck's constant = 6.63×10^{-34} kg m^2/s
$\Delta p = m*\Delta v$
m = mass of electron = 9.1×10^{-31} kg
Δv = uncertainty in speed = 0.1 m/s
$\Delta p = m\Delta v = 9.1\times10^{-31}$ kg × 0.1 m/s = 9.1×10^{-32} kg m/s
$\Delta x * \Delta p \geq h / 4\pi$
Plug all the values;

$\Delta x \geq h / 4\pi * \Delta p$
$\Delta x = 5.8\times10^{-4}$ m

b.

If $l = 0$ $m = 0$. This is an s orbital
If $l = 1$, m = -1, 0, +1. This gives the three p orbitals. So $m = 0$ is ok.
If $l = 2$ m = -2, -1, 0, 1, 2. This gives the five d orbitals.

c.

$F^-: 1s^2 2s^2 2p^6$

d. Hund's Rule of Maximum Multiplicity states that for degenerate orbitals (orbitals of the same energy), electrons will occupy these orbitals singly before pairing up. This means that each orbital within a given subshell receives one electron with the same spin direction before any orbital gets a second electron. This arrangement minimizes electron-electron repulsion and maximizes the total spin, resulting in a more stable electron configuration.

OSDAV Public School, Kaithal

Half yearly Exams (2024-25)

Class : XI **SET-B**

Subject : CHEMISTRY

Time: 3 Hrs . **M.M. : 70**

General Instructions:-

All questions are compulsory.

(a) There are 33 questions in this question paper.

(b) SECTION A consists of 16 multiple -choice questions carrying 1 mark each.

(c) SECTION B consists of 5 short answer questions carrying 2 marks each.

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(e) SECTION D consists of 2 case - based questions carrying 4 marks.

(f) SECTION E consists of 3 long answer questions carrying 5 marks.

(g) Use of log tables and calculators is not allowed

Q.N.	Questions	Marks
	SECTION-A **The following questions are multiple -choice questions with one correct answer. Each question carries 1 mark.**	
1	What is the mole fraction of solute in a 1.00 m aqueous solution? a. 0.177 b. 1.770 c. 0.0177 d. 0.0354	**1**
2	No. of Angular nodes for 3d orbital is: a. 1 b. 3 c. 4 d. 2	**1**
3	The electronegativities of the following elements increases in the order: a. C,N,Si,P b. N,Si,C,P c. Si,P,C,N d. P,Si,N,C	**1**
4	Which of the following is a non polar molecule: a. NF_3 b. BF_3 c. SF_4 d. PCl_3	**1**
5	The shape of SF_6 molecule is: a. Trigonal bipyramidal b. square planer c. tetrahedral d. Octahedral	**1**
6	The oxidation no. of Mn is maximum in : a. MnO_2 b. K_2MnO_4 c. Mn_3O_4 d. $KMnO_4$	**1**
7	Which among the following has highest first ionisation energy? a. Na b. K c. Sc d. Rb	**1**
8	According to Aufbau rule, the 19^{th} electron in an atom goes into the: a. 4s orbital b.3d orbital c. 4p orbital d. 3p orbital	**1**
9	Orbital angular momentum depends on: a. n and l b. l c. m d. n and m	**1**
10	What does the reducing agent do in an oxidation-reduction reaction? a. Gains electrons from the oxidising agent b. Loses electron to the oxidising agent c. Is always reduced d. Is reduced by oxidising agent	**1**
11	Number of atoms of oxygen present in 10.6g Na_2CO_3 will be: a. 6.02×10^{23} b. 12.04×10^{23} c. 1.806×10^{23} d. 31.80×10^{23}	**1**
12	Which of the following molecule has maximum dipole moment a. CO_2 b. CH_4 c. NH_3 d. NF_3	**1**

13	***Given below are two statements labelled as Assertion (A) and Reason (R)*** ***Select the most appropriate answer from the options given below:*** ***a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion*** ***b. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion*** ***c. Assertion is true but Reason is false.*** ***d. Assertion is false, but reason is correct*** Assertion: BF_3 molecule is planar but NF_3 is pyramidal Reason: N atom is smaller than B.	**1**
14	Assertion: In multielectron atoms, such as sodium , all the subshells of a particular energy level have different energies. Reason: Electrons in different subshells feel different screening effect	**1**
15	Assertion: The decomposition of hydrogen peroxide to form water and oxygen is an example of disproportional reaction. Reaction: The oxidation state of oxygen changes from -1 to -2 and zero in the products.	**1**
16	. Assertion: Noble gases have highest first ionisation energy in their respective periods Reason: Noble gases have stable electronic configuration	**1**
17	**SECTION-B** **This section contains 5 questions .The following questions are very short answer type and carry 2 marks each.** a. Is there any change in the hybridisation of B and N atoms as a result of the reaction: $BF_3 + NH_3 \longrightarrow F_3B.NH_3$ b. Presence of lone pairs distorts the geometry of a molecule. Explain with example.	**1** **1**
18	When would the de Broglie wavelength of a moving electron becomes equal to that of a moving proton. (Mass of electron = 9.1×10^{-31} kg and mass of proton = 1.675×10^{-27} kg)	**2**
19	a. Although geometries of NH_3 and H_2O molecules are distorted tetrahedral, bond angle in water is less than that of ammonia , Explain? b. What are the necessary conditions for the combination of atomic orbitals to form molecular orbitals.	**1** **1**
20	Balance the redox reaction by ion electron method MnO_4^- (aq) + $SO_2 \longrightarrow Mn^{+2} + HSO_4^-$ (Acidic medium)	**2**
21	**a.** Would you expect the first ionisation energy of two isotopes of the same element to be same or different? Justify **b.** State modern periodic law.	**1** **1**
22	**SECTION-C** **This section contains 7 questions. The following questions are short answer type and carry 3 marks each.** a. Chlorine is prepared in lab by treatment manganese dioxide with aqueous hydrochloric acid according to the reaction: $4\ HCl\ (aq) + MnO_2\ (s) \longrightarrow 2H_2O + MnCl_2 + Cl_2$ How many grams of HCl react with 5 g of manganese dioxide (Atomic mass Mn = 55) **b.** What is limiting reactant in a reaction?	**2** **1**

23	a. Would you expect the second electron gain enthalpy of O as positive, more negative or less negative than the first ? Justify your answer. b. Out of O and S which element has more negative electron gain enthalpy and why? c. Predict the group and period of element having configuration $1s^2\ 2s^2\ 2p^6 3s^2$	1 1 1
24	a. When electromagnetic radiation of wavelength 300nm falls on the surface of sodium, electrons are emitted with a kinetic energy of 1.68 x 10^5 J/mol. What is the minimum energy needed to remove an electron from sodium? What is the maximum wavelength that will cause a photoelectron to be emitted? **b.** Define Pauli's exclusion principle.	2 1
25	**a.** What is the difference between notations l and L **b.** State Heisenberg's uncertainty principle **a.** What are degenerate orbitals?	1 1 1
26	Give reasons: a. Covalent bonds are directional while ionic bonds are non directional. b. Why KHF_2 exists but $KHCl_2$ does not? c. AlF_3 is high melting solid while SiF_4 is a gas?	1 1 1
27	Using VSEPR theory predict the shapes of following molecules: a. CS_2 b. ClF_3 c. NH_4^+	3
28	a. Find molarity and molality of 15% solution of H_2SO_4 (Density of H_2SO_4= 1.020 g/ml) **b.** State Avogadro's law.	2 1

SECTION -D

The following questions are case -based questions. Each question carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

29

Modern periodic table is based on increasing order of atomic no. It has 18 groups and 7 periods. It has four blocks s block, p block , d block and f block elements. It relates electronic configuration with position in periodic table. Elements present in group resemble in chemical properties whereas elements in a period show gradation in properties. Lanthanoids and Actinoids belong to f block because last electron enters f orbital. They are all metals. They mostly form coloured ions, complexes show variable oxidation states, paramagnetism and used as a catalyst. Elements in periodic table show different periodic properties.
Periodic properties are the properties of elements which are directly or indirectly related to electronic configuration which show gradation when we move along a period or move down the group. The different periodic prop are atomic radii, ionisation energy , electron gain enthalpy and electronegativity.

Answer the following questions:

a. Write the general outer electronic configuration of p block elements 1
b. Define the term electronegativity. 1
c. The first and second ionisation energy of few elements are given 2

Element	IE 1	IE 2
I	2372	5251
II	520	7300
III	900	1760
IV	1680	3380

1) Which of the above element is likely to be a reactive non metal
2) Which of the above element is a noble gas.

30	Spectrum is a combination of radiations of different wavelengths. Visible spectrum is continuous spectrum. Atomic spectrum is discontinuous spectrum. It can be absorption or emission spectrum when energy is supplied to electrons, these get excited to higher energy levels. When they come back , they radiate energy in the form of bright spectral lines separated by dark bands. Each element has its unique spectrum by which it can be identified. ***Answer the following questions:*** a. What is the maximum no. of emission lines obtained when the excited electron of a H atom in n=6 drops to ground state? b. What do you mean by Absorption spectrum? **c.** What is the wavelength of a photon emitted during a transition from n=5 to n=2 state in hydrogen spectrum.	**1** **1** **2**
	SECTION-E **The following questions are long answer type and carry 5 marks each.**	
31	a. A golf ball has mass of 40g and speed of 45m/s .If the speed can be measured within accuracy of 2% . Calculate the uncertainty in position. b. An atomic orbital has n = 4 . What are the possible values of l and m_l ? c. Write the electronic configuration of Al^{+3} ion d. State Hunds rule of maximum multiplicity.	**2** **1** **1** **1**
32	a. A Welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 mL (measured at STP) of this welding gas is found to weigh 11.6g. Calculate the 1) empirical formula 2) molar mass of gas 3) molecular formula. **b.** Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% oxygen by mass (At.mass Fe= 55.85 , O = 16 amu)	**3** **2**
33	a. Draw the MOT diagram of O_2, write its magnetic nature and also find the bond order b. Write difference between ionic compounds and Covalent compounds	**3** **2**

OSDAV PUBLIC SCHOOL. KAITHAL

Answer Key for Mid Term Chemistry

Class-XI (2024-25)

SET-B

(only different questions)

SECTION-A

1. c. 0.0177

2. d. 2

3. c. Si,P,C,N

4. b. BF_3

5. c. Octahedral

6.d. $KMnO_4$

7. a. Na

8. a. 4s orbital

9. b. 1

10. b. Loses electron to the oxidising agent

11. c. 1.806×10^{23}

12. c. NH_3

13. b.

14. a.

15.a.

16.a.

SECTION- B

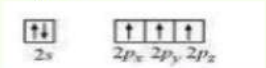
17.b. Lone pairs of electrons distort the geometry of molecules because they exert greater repulsive forces on bonded electron pairs. Unlike bonding pairs, lone pairs are located closer to the nucleus, leading to stronger repulsion. For example, in water (H_2O), the oxygen atom has two lone pairs and two bonding pairs of electrons. According to the ideal tetrahedral arrangement, the bond angle should be 109.5°, but the lone pairs push the hydrogen atoms

closer together, reducing the bond angle to about 104.5°. This distortion results in a bent molecular shape rather than a perfect tetrahedral.

a.

Boron atom in BF_3 is sp^2 hybridized. The orbital picture of boron in the excited state can
be shown as:

Nitrogen atom in NH_3 is sp^3 hybridized. The orbital picture of nitrogen can be represented as:



After the reaction has occurred, an adduct $F_3B.NH_3$ is formed as hybridization of 'B' changes to sp^3 . However, the hybridization of 'N' remains intact.

18.

For the electron, the de Broglie wavelength is:

$$\lambda_E = \frac{h}{m_e v_e}$$

For the proton, the de Broglie wavelength is:

$$\lambda_P = \frac{h}{m_p v_p}$$

Step 3: Set the wavelengths equal to each other

To find when the de Broglie wavelengths are equal, we set them equal:

$$\lambda_E = \lambda_P$$

This gives us:

$$\frac{h}{m_e v_e} = \frac{h}{m_p v_p}$$

Step 4: Cancel Planck's constant

Since h is common on both sides, we can cancel it out:

$$\frac{1}{m_e v_e} = \frac{1}{m_p v_p}$$

Step 5: Rearrange the equation

Rearranging gives us:

$$m_p v_p = m_e v_e$$

Step 6: Substitute the known masses

Substituting the known values of the masses:

- Mass of electron $m_e = 9.1095 \times 10^{-31}\,\text{kg}$
- Mass of proton $m_p = 1.6725 \times 10^{-27}\,\text{kg}$

This gives us:

$$1.6725 \times 10^{-27}\, v_p = 9.1095 \times 10^{-31}\, v_e$$

Step 7: Express v_e in terms of v_p

Rearranging this equation to express v_e in terms of v_p:

$$v_e = \frac{1.6725 \times 10^{-27}}{9.1095 \times 10^{-31}} v_p$$

Step 8: Calculate the ratio of the masses

Calculating the ratio:

$$\frac{1.6725 \times 10^{-27}}{9.1095 \times 10^{-31}} \approx 1836$$

Thus, we have:

$$v_e = 1836\, v_p$$

19. a. Both NH_3 (ammonia) and H_2O (water) have distorted tetrahedral geometries due to lone pairs of electrons, but the bond angle of water is smaller than that of ammonia. In NH_3, nitrogen has one lone pair and three bonding pairs, creating a bond angle of around 107°. In H_2O, oxygen has two lone pairs and two bonding pairs, resulting in a bond angle of about 104.5°. The reason for the smaller angle in water is that lone pairs repel more strongly than bonding pairs, and in water, the two lone pairs exert even greater repulsion, compressing the bond angle more than in ammonia, which has only one lone pair.

20.

$SO_{2(g)} + 2H_2O_{(l)} \rightarrow HSO^-_{4(aq)} + 3H^+_{(aq)} + 2e^-_{(aq)}$

And the reduction half reaction as:

$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

Multiplying the oxidation half reaction by 5 and the reduction half reaction by 2, and then by adding them, we have the net balanced redox reaction as:

$2MnO^-_{4(aq)} + 5SO_{s(g)} + 2H_2O_{(l)} + H^+_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 5HSO^-_{4(aq)}$

21. The first ionization energy of isotopes is generally the same. This is because ionization energy primarily depends on the number of protons and the arrangement of electrons in an atom, which remain the same for isotopes of an element. Isotopes differ only in the number of neutrons, and since neutrons are neutral particles, they do not significantly affect the attraction between the nucleus and the electrons. Consequently, isotopes of the same element have nearly identical ionization energies.

b. Modern periodic law states that the physical and chemical properties of elements are periodic functions of their atomic numbers. This means that when elements are arranged in order of increasing atomic number (the number of protons in an atom's nucleus), elements with similar properties recur at regular intervals or periods. The atomic number, rather than atomic mass as in Mendeleev's periodic law, is the key determinant in organizing the periodic table, providing a more accurate reflection of element properties.

SECTION- C

23. c. Period- 3

Group- 2

26. a. Ionic bonds form due to the electrostatic attraction between positively and negatively charged ions. This attraction occurs equally in all directions around the ions, meaning the strength of the bond is the same in every direction, making ionic bonds non-directional.

In contrast, covalent bonds involve the sharing of electrons between atoms, and this sharing happens along specific axes between the bonded atoms. The electron density is concentrated between the atoms, resulting in a specific spatial orientation, making covalent bonds directional in nature.

b. KHF_2 exists, but $KHCl_2$ does not, due to the unique ability of fluoride ions (F^-) to form stable hydrogen bonds, which chloride ions (Cl^-) cannot. In potassium bifluoride (KHF_2), the fluoride ion forms a strong hydrogen bond with the hydrogen atom, creating a $[HF_2]^-$ ion.

This structure is stabilized because fluoride is small, highly electronegative, and can easily form these strong hydrogen bonds.

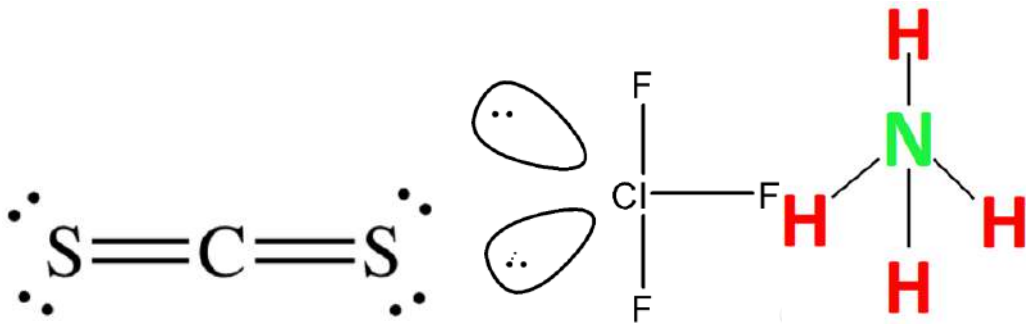
Chloride ions, being larger and less electronegative than fluoride, cannot form similarly strong hydrogen bonds. As a result, a compound like $KHCl_2$, where $[HCl_2]^-$ would need to form, is not stable and does not exist.

c. AlF_3 (aluminum fluoride) is a high-melting solid, while SiF_4 (silicon tetrafluoride) is a gas due to the nature of bonding in these compounds.

In AlF_3, the bond between aluminum and fluorine is highly ionic, meaning the attraction between the oppositely charged ions forms a strong lattice structure. This ionic lattice requires a significant amount of energy to break, resulting in a high melting point and solid state at room temperature.

On the other hand, SiF_4 has covalent bonds between silicon and fluorine, forming discrete molecular units. The intermolecular forces (van der Waals forces) between these SiF_4 molecules are weak, leading to a much lower boiling point, and making SiF_4 a gas at room temperature. Thus, the difference in bonding (ionic in AlF_3 and covalent in SiF_4) explains their different physical states.

27.



28.

15% (w/w) $H_2SO_4 \Rightarrow$ 15 g H_2SO_4 in 100 g of solution

$\Rightarrow$ 150 g H_2SO_4 in 1000 g solution

$$\text{Volume of the solution} = \frac{\text{Mass}}{\text{density}} = \frac{1000}{1.10} = 909 \text{ mL}$$

$$\text{Molarity} = \frac{\text{Number of moles of Solute}}{\text{volume of solution in L}}$$

$$\Rightarrow \frac{150 \times 1000}{98 \times 909} = 1.68 \text{ M}$$

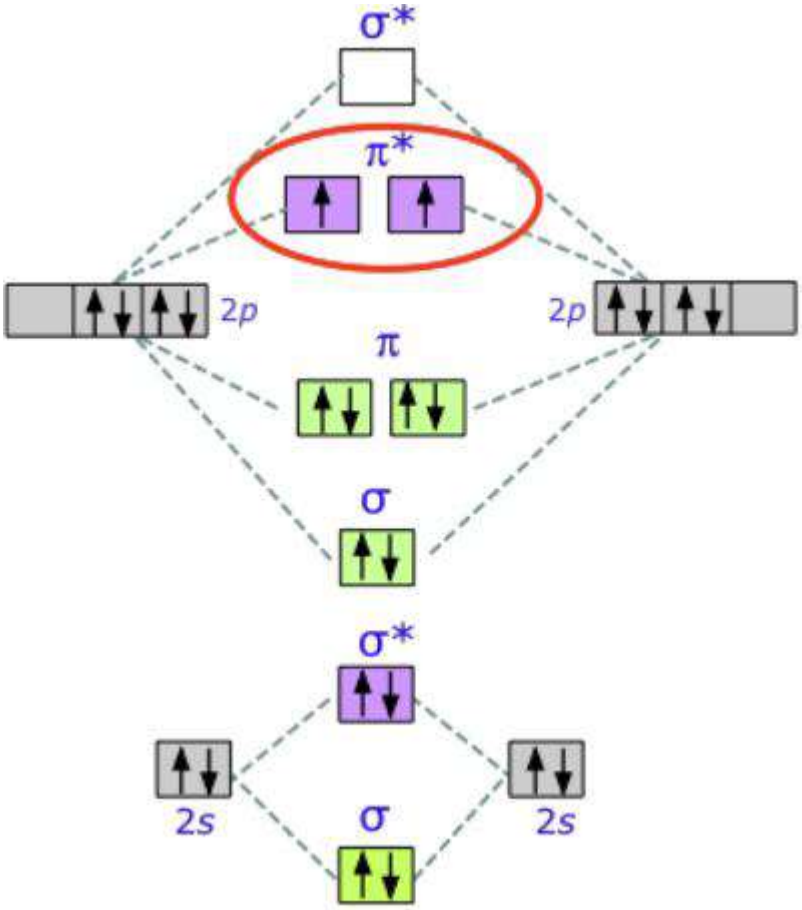
Mass of solvent = 1000 − 150 = 850 g

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

$$\Rightarrow \frac{150 \times 1000}{98 \times 850} = 1.80 \text{ m}$$

SECTION-E

33. a.



Bond Order- 2, magnetic nature- Paramagnetic

b.

Covalent Bonds	Ionic Bonds
Covalent bonding is a form of chemical bonding between two non metallic atoms which is characterized by the sharing of pairs of electrons between atoms and other covalent bonds.	Ionic bond, also known as electrovalent bond is a type of bond formed from the electrostatic attraction between oppositely charged ions in a chemical compound. These kinds of bonds occur mainly between a metallic and a non metallic atom.
A covalent bond is formed between two non-metals that have similar electronegativities. Neither atom is "strong" enough to attract electrons from the other. For stabilization, they share their electrons from outer molecular orbit with others.	An ionic bond is formed between a metal and a non-metal. Non-metals(-ve ion) are "stronger" than the metal(+ve ion) and can get electrons very easily from the metal. These two opposite ions attract each other and form the ionic bond.
Two non-metals	One metal and one non-metal
Electrons are shared in covalent bonds.	In ionic bonds, electrons are transferred from one atom to another, resulting in two charged ions - one positively charged, and one negatively charged. The two ions are attracted to each other and form an ionic bond.
Methane (CH_4), Hydro Chloric acid (HCl)	Sodium chloride (NaCl), Sulphuric Acid (H_2SO_4)