ST. XAVIER'S SENIOR SECONDARY SCHOOL, DELHI – 110 054

Class 11 Time: 3 hrs.

25-9-2023 MID TERM EXAMINATION - **CHEMISTRY** Max. Marks : 70

General Instructions:

a) There are 33 questions in this question paper with internal choices.
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 each.
f) SECTION E consists of 3 long answer questions carrying 5 marks each.
g) All questions are compulsory.
h) Use of log tables and calculators is not allowed.

SECTION – A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. Select the correct order of bond angle:
A) $PCl_3 > PBr_3 > PI_3 > PF_3$ B) $PI_3 > PF_3 > PCl_3 > PBr_3$
C) $PI_3 > PBr_3 > PCl_3 > PF_3$ D) $PF_3 > PCl_3 > PBr_3 > PI_3$ 1

2. Magnetic quantum number specifies :
A) orbital size B) orbital shape
C) orbital orientation D) nuclear stability 1

3. A subshell with n= 6, l = 2 can accommodate a maximum of:
A) 12 electrons B) 36 electrons C) 10 electrons D) 72 electrons 1

4. What is the molecular formula of a compound, which has an empirical formula of CH_2 and a relative molecular mass of 70?
A) C_5H_{10} B) C_2H_4 C) C_3H_6 D) C_4H_8 1

5. Which of the following sets of the quantum numbers is not permitted?
A) n=5, l=2, m=0, s=½ B) n=5, l=2, m=3, s=½
C) n=5, l=3, m=2, s=½ D) n=5, l=2, m=0, s=-½ 1

6. Which one of the following has maximum number of atoms?
(At Mass : Mg= 24 u , O =16 u , Li = 7 u, Ag = 108 u)
A) 1 g of Mg B) 1 g of O_2
C) 1 g of Li D) 1 g of Ag 1

7. If azimuthal quantum number, l =0, shape of orbital would be :
A) spherical B) dumb-bell
C) double dumb-bell D) oval 1

8. What is the type of interparticle force of attraction present in methane gas?
A) Hydrogen bonding B) Dipole-dipole interactions
C) Electrostatic force of attraction D) van der Waals force of attraction 1

9. The number of molecules of SO_2 present in 11.2 L, at STP :
A) 3.011×10^{23} B) 6.011×10^{23}
C) 3.011×10^{22} D) 6.011×10^{22} 1

10. Select the incorrect option from the following:
A) Resonating structures have a real existence.
B) The actual structure lies between various possible resonating structures.
C) Resonating structures are useful as they allow us to describe molecules.
D) None of the above. 1

11. Bond dissociation energies of HF, HCl, HBr follow the order:
A) HCl > HBr > HF B) HF > HBr > HCl
C) HF > HCl > HBr D) HBr > HCl > HF 1

12. What is the correct order of size of the following isoelectronic species?
Mg^{2+}, Ne, Al^{3+}, N^{3-}, O^{2-} (At. No: N = 7, O = 8, Ne = 10, Mg = 12, Al = 13)
A) $Ne < Al^{3+} < N^{3-} < O^{2-} < Mg^{2+}$ B) $Al^{3+} > Mg^{2+} > Ne > O^{2-} > N^{3-}$
C) $Al^{3+} < Mg^{2+} < Ne < O^{2-} < N^{3-}$ D) $O^{2-} < Ne < Al^{3+} < Mg^{2+} < N^{3-}$ 1

In questions 13-16 a statement of assertion (A) followed by a statement of reason(R) is given. Choose the correct answer out of the following choices.

A) Both A and R are true and R is the correct explanation of A.
B) Both A and R are true but R is not the correct explanation of A.
C) A is true but R is false.
D) A is false but R is true.

13. Assertion (A) : The atoms in a covalent molecule are said to share electrons, yet some covalent molecules are polar.
Reason (R) : In polar covalent molecule, the shared electrons, are shifted towards the atom having greater electronegativity. 1

14. Assertion (A) : The reducing character of the elements increases across the period.
Reason (R) : Atomic size decreases across the period. 1

15. Assertion (A) : First ionization energy for nitrogen is higher than that of oxygen.
Reason (R) : Across a period effective nuclear charge decreases. 1

16. Assertion (A) : Many endothermic reactions which are non-spontaneous at room temperature become spontaneous on increasing the temperature.
Reason (R) : Endothermic reactions become spontaneous at high temperature if ΔS is +ve and $T\Delta S > \Delta H$. 1

SECTION – B

This section contains 5 very short answer type questions and carry 2 marks each.

17. a) An atomic orbital has n = 3. What are the possible values of l and m?
b) Why the ball hit with a hockey by a player does not make a wave? 2

18. Define electronegativity. How does it vary along a period and along a group? 2

19. a) What mass of copper oxide will be obtained by heating 12.35 g of copper carbonate.
$CuCO_3 \rightarrow CuO + CO_2$
(At. mass : Cu =63.5 u, C = 12 u, O = 16 u)
b) Calculate the mass of 1 molecule of benzene (C_6H_6). (Molar mass = 78 g/mol) 2

20. If 4 g of NaOH dissolves in 36 g of H_2O, calculate the mole fraction of each component in the solution. (molar mass: NaOH =40g, H_2O = 18g) 2

21. Draw and explain the shape of **any one** of the following molecules on the basis of VSEPR model 2
a) $BeCl_2$ b) SF_6

SECTION – C

This section contains 7 short answer type questions with internal choice in one question and carry 3 marks each.

22. a) For the reaction, $Ag_2O(s) \rightarrow 2Ag(s) + \frac{1}{2}O_2(g)$, ΔH = 30.56 KJ/mol and ΔS=0.066 KJ/mol. Calculate the temperature at which the reaction is in equilibrium.
b) Calculate the enthalpy change accompanying the transformation of $C_{(graphite)}$ to $C_{(diamond)}$. Given that enthalpies of combustion of graphite and diamond are 393.5 and 395.4 KJ/mol respectively. 3

23. Commercially available conc. HCl contains 45 % HCl by mass. What is the molality of this solution? If the density of HCl solution is 1.19 g/ml, calculate its molarity.
(Molar mass of HCl = 36.5 g/mol) 3

24. a) How would you justify the presence of 18 elements in the 5th period of the periodic table?
b) Write any two characteristics of d-block elements.
c) On moving down in a group metallic character increases. Why?

(OR)

a) Assign the position of the element having outer electronic configuration, $(n-1)d^2ns^2$ for n = 4.
b) Why first group elements are called alkali metals? Give any two characteristics of these elements. 3

25. Give reason:
a) BeH_2 molecule has zero dipole moment although the Be –H bonds are polar.
b) Axial bonds are longer than equatorial bonds in PCl_5.
c) NH_3 is pyramidal in shape but BF_3 is triangular planar. 3

26. Define hybridization. Explain sp^3d^2 hybridization with the help of an example. 3

27. 3 g of H_2 react with 29 g of O_2 to form water. (Molar mass : H_2 = 2 g, O_2 = 32 g)
    i) Identify the limiting reagent?
    ii) Calculate the amount of water that is formed in the reaction.
    iii) Calculate the amount of the reactant, which remains unreacted. 3

28. a) What is meant by electron gain enthalpy?
    b) Account for the following:
        i) The radius of Na^+ cation is less than that of Na atom.
        ii) Halogens have high negative electron gain enthalpy. 3

SECTION – D

The following questions are case -based questions. Each question has an internal choice and carries 4 (1+1+2) marks each.

29. Read the passage given below and answer the following questions:

A system's condition at any given time is called its thermodynamic state. For a gas in a cylinder with a movable piston, the state of the system is identified by the temperature, pressure, and volume of the gas. These properties are characteristic parameters that have definite values at each state and are independent of the way in which the system arrived at that state. In other words, any change in value of a property depends only on the initial and final states of the system, not on the path followed by the system from one state to another. Such properties are called state functions. In contrast, the work done as the piston moves and the gas expands and the heat the gas absorbs from its surroundings depend on the detailed way in which the expansion occurs.

Besides enthalpy of formation and enthalpy of combustion, there are some other enthalpy changes, which we come across during the study of chemical energetics. These include enthalpy of neutralization, enthalpy of solution, enthalpy of hydration, enthalpy of phase transformation, enthalpies of allotropic transformation, lattice enthalpies etc. Some of these are obtained by applying Hess's law while some others can be obtained directly. For example, enthalpies of phase transitions can be obtained from their enthalpies of transition, lattice enthalpy can be obtained by applying Born-Haber cycle. Besides these quantities, another important quantity is the 'bond enthalpy'. Knowing the bond enthalpies of the reactants and products, enthalpy change of the reaction can be calculated either directly or by applying Hess's law. Conversely, knowing the enthalpy change of a reaction and bond enthalpies of all reactants and products except one, the unknown bond enthalpy can be calculated.

a) Neither q nor w is a state function but q + w is a state function. Why?
b) Out of mass and density, which is an intensive property and why?
c) Calculate the enthalpy change for the reaction: $H_{2\,(g)} + I_{2\,(g)} \rightarrow 2\,HI_{(g)}$. Given that the bond energies of H-H, I-I and H-I are 433,151 and 209 kJ mol^{-1} respectively.

(OR)

c) When NH_4NO_2(s) decomposes at 373 K, it forms $N_{2\,(g)}$ and H_2O (g). The ΔH for the reaction at one atmospheric pressure and 373 K is – 223.6 kJmol^{-1}. What is the value of ΔU for the reaction under the same conditions?
(R = 8.31 J K^{-1}mol^{-1}) 4

30. Read the passage given below and answer the following questions:

A period is a horizontal row in the periodic table. Although groups generally have more significant periodic trends, there are regions where horizontal trends are more significant than vertical group trends, such as the f-block, where the lanthanides and actinides form two substantial horizontal series of elements.
Elements in the same period show trends in atomic radius, ionization energy, electron affinity, and electronegativity. Moving left to right across a period, atomic radius usually decreases. This occurs because each successive element has an added proton and electron, which causes the electron to be drawn closer to the nucleus. Metals (left side of a period) generally have larger atomic radius than non-metals (right side of a period), with the exception of the noble gases.
(Reference: https://en.wikipedia.org/wiki/Periodic_table)

a) "Properties of the elements are periodic function of their atomic numbers".
Justify the given statement.

b) Why does $_4Be$ has higher ionization enthalpy than $_5B$?

c) What is screening effect? How does it affect ionization enthalpy of an atom?

(OR)

c) i) Define covalent radius.
ii) The size of the atoms of inert gases are larger than those of the preceding halogens. Explain. 4

SECTION – E

This section contains 3 questions carrying 5 marks each. All 3 questions have internal choice.

31. Attempt **any five** of the following:
a) Distinguish between sigma and pi bonds. (2 points)
b) Write the type of hybridization of each carbon in $CH_3 - CH = CH_2$
c) On the basis of molecular orbital theory, explain why Be_2 molecule does not exist?
d) Define lattice enthalpy. How is it related to the stability of ionic compounds?
e) Write the bond order and magnetic nature of the diatomic molecule O_2.
(Atomic No. of O = 8)
f) Give the potential energy diagram for the formation of H_2 molecule on the basis of valence bond theory.
g) Why NH_3 has higher boiling point than PH_3? 5

32. a) What are degenerate orbitals?
b) State Hund's rule of maximum multiplicity.
c) Draw the shape of dz^2 orbital.
d) Write the orbital electronic configuration and the number of unpaired electrons in Cr^{3+}.
(Atomic no of Cr = 24)
e) Calculate the wavelength of a tennis ball of mass 60 g moving with a velocity of 10 m/s.
$(h = 6.6 \times 10 - 34 \text{ Kg } m^2 s^{-1})$

(OR)

a) State Aufbau Principle.
b) Write the orbital electronic configuration and the number of unpaired electrons in Fe^{2+}.
(Atomic no of Fe = 26)
c) Draw the shape of $dx^2 - y^2$ orbital.
d) Calculate the uncertainty in velocity of an electron, if uncertainty in its position is 10^{-11} m.
$(h = 6.6 \times 10^{-34} \text{ Kg } m^2 s^{-1}$, mass of electron $= 9.11 \times 10^{-31}$ kg)

33. a) Define Standard enthalpy of formation.
b) In a process 701 J of heat is absorbed by a system and 394 J work is done by the system. What is the change in internal energy for the process?
c) Chloroform is prepared from methane according to the reaction:

$$CH_{4\,(g)} + 3\,Cl_{2\,(g)} \rightarrow CHCl_{3\,(l)} + 3HCl_{(g)}$$

Calculate ΔH for the reaction. Given that enthalpies of formation of $HCl_{(g)}$, $CH_{4\,(g)}$ and $CHCl_{3\,(l)}$ are -92.0, -74.9 and -134.3 kJ/mol respectively. 5

(OR)

a) Predict the sign of entropy change for the following reaction and give reason:

$$H_2 \text{ (at } 25^oC) \rightarrow 2H \text{ (at } 25^oC)$$

b) Calculate the enthalpy of formation of C_2H_6 from the following data:

i) $C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$ $\Delta H = -393.5 \text{ KJ mol}^{-1}$

ii) $H_{2\,(g)} + \frac{1}{2} O_{2\,(g)} \rightarrow H_2O_{(l)}$ $\Delta H = -285.5 \text{ KJ mol}^{-1}$

iii) $C_2H_{6\,(g)} + \frac{7}{2} O_{2\,(g)} \rightarrow 2CO_{2\,(g)} + 3\,H_2O_{(l)}$ $\Delta H = -1560 \text{ KJ mol}^{-1}$ 5

-x-x-x-x-x-x-x-x-x-