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HALF YEARLY EXAMINATION 2024-25
CHEMISTRY

Time : 3 hrs.]   Class XI   [M.M. : 70

General Instructions—·

(i)   There are 33 questions in this question paper with internal choice.

(ii) Section A consists of 16 multiple-choice questions carrying 1 mark each.

(iii) Section B consists of 5 very short answer questions carrying 2 marks each.

(iv) Section C consists of 7 short answer questions carrying 3 marks each.

(v)   Section D consists of 2 case-based questions carrying 4 marks each.

(vi) Section E consists of 3 long answer questions carrying 5 marks each.

(vii) All questions are compulsory.

(viii)There is no overall choice. However, internal choices have been provided in questions.

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. What will be the molarity of pure water?   1

    (a) 18 M   (b) 50.0 M

    (c) 55.6 M   (d) 100 M

2. Major development(s) which are responsible for the formulation of Bohr's model of atom were :   1

    (a) dual character of the electromagnetic radiation.

    (b) experimental result regarding atomic spectra which can be explained by assuming quantised electronic energy level in atoms.

    (c) Both (a) and (b)   (d) None of the above

P. T. O.

3. Which of the following is not an example of redox reaction? 1

   (a) $CuO + H_2 \rightarrow Cu + H_2O$

   (b) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

   (c) $2K + F_2 \rightarrow 2KF$

   (d) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

4. The correct decreasing order of the boiling points of given compounds is : 1

   (a) $HF > H_2O > NH_3$ (b) $H_2O > HF > NH_3$

   (c) $NH_3 > HF > H_2O$ (d) $NH_3 > H_2O > HF$

5. If 500 mL of a 5M solution is diluted to 1500 mL, what will be the molarity of the solution obtained ? 1

   (a) 1.5 M   (b) 1.66 M

   (c) 0.017 M   (d) 1.59 M

6. Which of the following arrangements represent increasing oxidation number of the central atom? 1

   (a) $\overset{+3}{CrO_2^-}, \overset{+5}{ClO_3^-}, \overset{+6}{CrO_4^{2-}}, \overset{+7}{MnO_4^-}$ (b) $ClO_3^-, CrO_4^{2-}, MnO_4^-, CrO_2^-$

   (c) $CrO_2^-, ClO_3^-, MnO_4^-, CrO_4^{2-}$ (d) $CrO_4^{2-}, MnO_4^-, CrO_2^-, ClO_3^-$

7. In which of the following molecule/ion all the bonds are not equal ? 1

   (a) XeF_4 (b) BF_4^-

   (c) C_2H_4 (d) SiF_4

8. If travelling at same speeds, which of the following matter waves have the shortest wavelength? 1

   (a) Electron   (b) Alpha particle (He^{2+})

   (c) Neutron   (d) Proton

9. Electronic configurations of four elements A, B, C and D are given below : 1

   (A) $1s^2 2s^2 2p^6$ (B) $1s^2 2s^2 2p^4$

   (C) $1s^2 2s^2 2p^6 3s^1$ (D) $1s^2 2s^2 2p^5$

   Which of the following is the correct order of increasing tendency to gain electron?

(a) $A \leq C < B < D$ (b) $A < B < C < D$

(c) $D < B < C < A$ (d) $D < A < B < C$

10. In NO_3^- ion, the number of bond pairs and lone pairs of electrons on nitrogen atom are—

(a) 2, 2   (b) 3, 1

(c) 1, 3   (d) 4, 0

11. Which of the following statements concerning the quantum numbers are correct?

(a) The angular momentum quantum number determines the energy of the shell b.

(b) The principal quantum number determines the orientation and energy of the orbital.

(c) Magnetic quantum number determines the size of the orbital.

(d) Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

12. Which of the following electrodes will act as anodes, when connected to Standard Hydrogen Electrode?   1

(a) Al/Al^{3+} $E° = -1.66$ V

(b) Fe/Fe^{2+} $E° = -0.44$ V

(c) Cu/Cu^{2+} $E° = +0.34$ V

(d) $F_2(g)/2F^-$ $E° = +2.87$ V

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below.

(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 false but R is true.

(d) Both A and R are false.

(e) A is true but R is false

13. **Assertion (A) :** Among halogens, fluorine is the best oxidant. 1

    Reason (R) : Fluorine is the least electronegative element.

14. **Assertion (A) :** It is impossible to determine the exact position and exact momentum of an electron simultaneously. 1

    Reason (R) : The path of an electron in an atom is clearly defined.

15. **Assertion (A) :** Redox couple is the combination of oxidised and reduced form of a substance involved in an oxidation or reduction half cell. 1

    Reason (R) : In the representation $E^\circ_{Fe^{3+}/Fe^{2+}}$ and $E^\circ_{Cu^{2+}/Cu}$ Fe^{3+}/Fe^{2+} and Cu^{2+}/Cu are redox couples.

16. **Assertion (A) :** Black body is an ideal body that emits and absorbs radiations of all frequencies. 1

    Reason (R) : The frequency of the radiation emitted by the body goes from lower frequency to higher frequency with an increase in temperature.

SECTION-B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueous hydrochloric acid according to the reaction

    $$4HCl\,(aq) + MnO_2(s) \rightarrow 2H_2O\,(l) + MnCl_2(aq) + Cl_2\,(g)$$

    How many grams of HCl react with 5.0 g of manganese dioxide? (Atomic mass of Mn = 55u, Cl = 35.5u)

18. How much energy is required to ionise a H atom if the electron occupies n = 5 orbit? Compare your answer with the ionization enthalpy of H atom (energy required to remove the electron from n =1 orbit). 2

OR

If the position of the electron is measured within an accuracy of $\pm$ 0.002 nm, calculate the uncertainty in the momentum of the electron. Suppose the momentum

of the electron is $\dfrac{h}{(4\pi \times 0.05)\,nm}$ nm. Is there any problem in defining this value?

(Mass of electron $= 9.1 \times 10^{-31}$ Kg, $h = 6.626 \times 10^{-34}$ Js)

19. (i) Explain why the electron gain enthalpy of fluorine is less negative than that of chlorine.   1+1

(ii) The radius of Na^+ cation is less than that of Na atom. Give reason.

20. (i) Explain the formation of H_2 molecule on the basis of valence bond theory.

(ii) Write the significance of a plus and a minus sign shown in representing the orbitals.   1+1

21. Assign oxidation number to the underlined elements in each of the following species :   1+1

(i) $H_4\underline{P}_2O_7$ (ii) $K_2\underline{Mn}O_4$

SECTION-C

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

22. A compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine. Its molecular mass is 98.96 u. What are its empirical and molecular formulas? (Molar mass of C=12 g/mol, H=1 g/mol and Cl = 35.5 g/mol)   3

23. When electromagnetic radiation of wavelength 300 nm falls on the surface of sodium, electrons are emitted with a kinetic energy of 1.68×10^5 J mol^{-1}. 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? (h= 6.626×10^{-34} Js)   3

24. (i) Explain why N has higher $\Delta_i H$ than O.   1+1+1

(ii) Consider the following species : $N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+}$ and Al^{3+}
Arrange them in the order of increasing ionic radii. Also give reason to support your answer.

$(n-2)f^{1-14}\ (n-1)d^{a-1}\ ns^{1-2}$
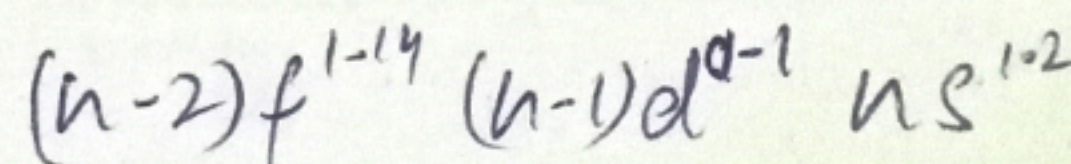
(iii) What is the significance of the terms - isolated gaseous atom and ground state while defining the ionization enthalpy and electron gain enthalpy?

OR

The first $(\Delta_i H_1)$ and the second $(\Delta_i H_2)$ ionization enthalpies (in kJ mol^{-1}) and the $(\Delta_{eg} H)$ electron gain enthalpy (in kJ mol^{-1}) of a few elements are given below :

Elements	ΔH_1	ΔH_2	$\Delta_{eg} H$
I	520	7300	−60
II	419	3051	−48
III	1681	3374	−328
IV	1008	1846	−295
V	2372	5251	+48
VI	738	1451	−40

Which of the above elements is likely to be :

(i) the least reactive element.

(ii) the most reactive metal.

(iii) the most reactive non-metal.

(iv) the least reactive non-metal.

(v) the metal which can form a stable binary halide of the formula MX$_2$ (X=halogen).

(vi) the metal which can form a predominantly stable covalent halide of the formula MX (X=halogen)

25 50.0 kg of N$_2$ (g) and 10.0 kg of H$_2$ (g) are mixed to produce NH$_3$ (g). Calculate the amount of NH$_3$ (g) formed. Identify the limiting reagent in the production of NH$_3$ in this situation. Also calculate the amount of excess reagent left after the reaction.

26. (i) Although both CO$_2$ and H$_2$O are triatomic molecules, the shape of H$_2$O molecule is bent while that of CO$_2$ is linear. Explain this on the basis of dipole moment.

2+1

(ii) Apart from tetrahedral geometry, another possible geometry for CH_4 is square planar with the four H atoms at the corners of the square and the C atom at its centre. Explain why CH_4 is not square planar ?

27. (a) Arrange the bonds in order of increasing ionic character in the molecules :

LiF, K_2O, N_2, SO_2 and ClF_3.   1+2

(b) Describe the hybridisation in case of PCl_5. Why are the axial bonds longer as compared to equatorial bonds?

28. (i) Balance the following equation in basic medium by ion-electron method or oxidation number method.   2+1

$$P_4(s) + OH^-(aq) \rightarrow PH_3(g) + HPO_2^-(aq)$$

(ii) How can $CuSO_4$ solution not be stored in an iron vessel ?

$$E^\circ_{Cu^{2+}/Cu} = 0.34 \, V \text{ and } E^\circ_{Fe^{2+}/Fe} = -0.44 \, V$$

SECTION-D

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

9. In modern periodic table, elements are arranged in increasing atomic numbers which is related to the electronic configuration. Depending upon the type of orbital receiving the last electron, the elements in the periodic table have been divided into four blocks (s, p, d and f).   (1+1+2)

The modern periodic table consist of 7 periods and 18 groups. Each period begins with the filling of new energy shell. In accordance with the Aufbau principle, the seven periods have 2,8,8, 18, 18,32 and 32 elements. According to their position in periodic table their properties (atomic radii, ionisation enthalpy, electron gain enthalpy) are studied.

Answer the following questions:

(a) The element with atomic number 57 belongs to which group. Explain.

(b) Why do elements of same group have similar physical and chemical properties.

(c) Give 2 differences between electron gain enthalpy and electron affinity.

OR

. Explain two factors that affect ionisation enthalpy.

30. Chemical bonding. involves interactions that account for the association of atoms into molecules, ions, crystals, and other stable species that make up the familiar substances of the everyday world. When atoms approach one another, their nuclei and electrons interact and tend to distribute themselves in space in such a way that the total energy is lower than it would be in any alternative arrangement. If the total energy of a group of atoms is lower than the sum of the energies of the component atoms, then bond together and the energy lowering is the bonding energy. The ideas that helped to establish the nature of chemical bonding came during early 20th century, after the electron had been discovered and quantum mechanics had provided a language for the description of the behaviour of electrons in atoms. However, even though chemists need quantum mechanics to attain a detailed quantitative understanding of bond formation, much of their pragmatic understanding of bonds 1s expressed in simple intuitive models. These models treat bonds as primarily of two kinds-namely, ionic and covalent. The type of bond that is most likely to occur between two atoms can be predicted on the basis of the location of the elements in the periodic table, and to some extent the properties of the substances so formed can be related to the type of bonding.   (1+1+2)

Answer the following questions :

(a) Is there any change in the hybridisation of B and N atoms as a result of the following reaction? If yes, specify the change.
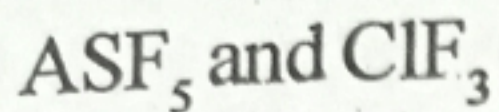
$$BF_3 + NH_3 \rightarrow F_3B.NH_3$$
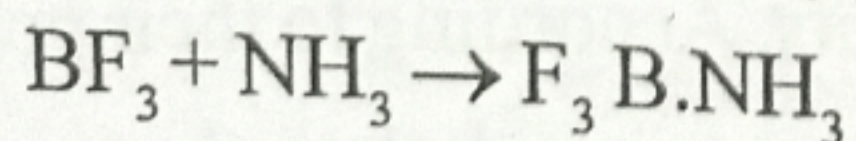
(b) Show hybridisation of C_2H_4.

(c) Compare the relative stability of the following species :

O_2 and O_2^+. Also write their configuration.

OR

Discuss the shape of the following molecules using the VSEPR model :

ASF_5 and ClF_3

As

SECTION-E

The following questions are long answer type and carry 5 marks each. All questions have an internal choice—

31. (a) Why is molality preferred over molarity to determine concentration?

(b) How are 0.50 mol Na_2CO_3 and 0.50 M Na_2CO_3 different?

(c) The density of 3M solution of NaCl is 1.25g/mL. Calculate the molality of the solution. 2·4 [1+1+3]

32. (a) Give the values of all four quantum numbers for 3d electrons in Mn atom. (Atomic no. of Mn = 25) [1+1+3]

(b) How many electrons in an atom may have the following quantum numbers?

$n = 4$; $m_s = -½$

(c) The mass of an electron is 9.1×10^{-31} kg. If its kinetic energy is 3.0×10^{-25} J, calculate its wavelength.

OR

(a) The ion of an element [M^{3+}] has configuration [Ar] $3d^4$. Write the configuration of its atom.

(b) Why do we fill electrons in 4s before 3d?

(c) State Pauli's exclusion principle.

(d) Calculate the energy of each of the photons which (1+1+1+2)

(i) correspond to light of frequency 3×10^{15} Hz

(ii) have wavelength of 0.50 Å.

33. (a) Calculate the formal charge on each atom of O_3. (1+1+3)

(b) H_2O is in liquid state whereas H_2S in gas state. Explain.

(c) Write Lewis structure of the following compounds.

HNO_3, NO_2, H_2SO_4

OR

(a) Draw the resonating structures for CO_2 and CO_3^{2-}.

(b) Give reasons for the following :

Covalent bonds are directional bonds while ionic bonds are non-directional.

(c) How do you express the bond strength in terms of bond order?

(d) Although geometries of NH_3 and H_2O molecules are distorted tetrahedral, bond angle in water is less than that of ammonia. Discuss.   [2+1+1+1]