विद्या सर्वार्थ साधिका

ANANDALAYA
ANNUAL EXAMINATION
Class: XI

Subject: Chemistry (043) MM: 70
Date : 18-02-2025 Time: 3 hours

General Instructions:
Read the following instructions carefully.
1. There are 33 questions in this question paper with internal choice.
2. Section A consists of 16 multiple -choice questions carrying 1 mark each.
3. Section B consists of 5 short answer questions carrying 2 marks each.
4. Section C consists of 7 short answer questions carrying 3 marks each.
5. Section D consists of 2 case - based questions carrying 4 marks each.
6. Section E consists of 3 long answer questions carrying 5 marks each.
7. All questions are compulsory.
8. Use of log tables and calculators is not allowed.

SECTION A

1. For the electrons of oxygen atom, which of the following statements is correct? (1)
   (A) Z_{eff} for an electron in a 2s orbital is the same as Z_{eff} for an electron in a 2p orbital.
   (B) An electron in the 2s orbital has the same energy as an electron in the 2p orbital.
   (C) Z_{eff} electron in 1s orbital is the same as Z_{eff} for an electron in a 2s orbital.
   (D) The two electrons present in the 2s orbital have spin quantum numbers m, but of opposite sign.

2. Number of angular nodes for 4d orbital is _____ . (1)
   (A) 4 (B) 3 (C) 2 (D)1

3. Which element is isoelectronic with Na^+? (1)
   (A) Ne (B) He (C) K^+ (D) C

4. Hydrogen bonds are formed in many compounds, e.g., H_2O, HF, NH_3. The boiling point of such compounds depends to a large extent on the strength of hydrogen bond and the number of hydrogen bonds. The correct decreasing order of the boiling points of above 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

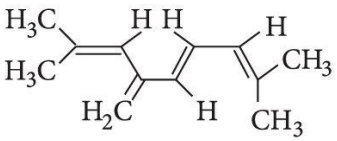
5. In which of following, the heat of neutralisation is least? (1)
   (A) NaOH is neutralised by CH_3COOH (B) NaOH is neutralised by HCl
   (C) NH_4OH is neutralised by HC1 (D) NH_4OH is neutralised by CH_3COOH

6. What will be the relation between ΔH and ΔU for the following reaction? (1)

$$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$$

   (A) $\Delta H < \Delta U$ (B) $\Delta H = \Delta U$ (C) $\Delta H > \Delta U$ (D) $\Delta H \neq \Delta U$

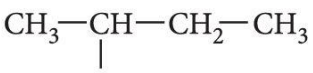
7. The total number of π – bond electrons in the following structure is _____. (1)

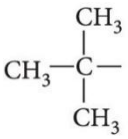


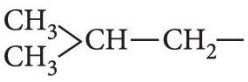
   (A) 12 (B) 16 (C) 4 (D) 8

8. The structure of iso-butyl group in an organic compound is _____. (1)

(A) $CH_3—CH_2—CH_2—CH_2—$

(B) 

(C) 

(D) 

9. The conjugate base of HSO_4^- is _____. (1)

(A) H_2O (B) SO_4^{2-} (C) OH^- (D) H_3O^+

10. If the value of Ka increases, then the acidic character of any weak acid _____. (1)

(A) increases (B) decreases

(C) remains constant (D) first increases and then decreases

11. Bond length of (I) ethane, (II) ethene, (III) Acetylene, (IV) Benzene follows the order: (1)

(A) I > II > III > IV (B) I > II > IV > III (C) I > IV > II > III (D) III > IV > II > I

12. Reaction of hydrogen bromide with propene in the absence of a peroxide is a/an _____. (1)

(a) free radical reaction (b) nucleophilic substitution

(c) electrophilic addition (d) nucleophilic substitution

Select the most appropriate answer from the options given below for questions 13-16.

(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. A: Significant figures for 0.200 is 3 whereas for 200 it is 1. (1)

R: Counting numbers has infinite significant figures.

14. A: The total number of electrons present in an orbital with quantum numbers n=3 and l = 1 are 6. (1)

R: The total number of electrons in any orbital can be given as n × 2.

15. A: $CaCl_2$ is less ionic than NaCl. (1)

R: Ca^{+2} in $CaCl_2$ is more polarising than Na^+ and hence exhibits the covalent character.

16. A: Propanal and Propanone cannot be considered as isomers of each other. (1)

R: Propanal contains aldehyde functional group whereas Propane contains ketone functional group.

SECTION B

17. The electronic configuration for some neutral atoms is given below; (2)

(i) $1s^2\ 2s^2$ (ii) $1s^2\ 2s^2\ 2p^6\ 3s^1$ (iii) $1s^2\ 2s^2\ 2p^4$ (iv) $1s^2\ 2s^2\ 2p^3$

Identify the element with highest I.E. (1) and the one with highest I.E. (2).

18. Write the expression for the equilibrium constant for each of the following reactions. (2)

$(i)\ Fe^{3+}(aq) + 3OH^-(aq) \longrightarrow Fe(OH)_3(s)$

$(ii)\ 2NOCl(g) \longrightarrow 2NO(g) + Cl_2(g)$

OR

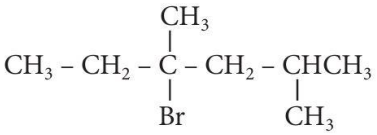
Consider the following reaction and predict in which direction the equilibrium would shift on (i) addition of CH_3OH and (ii) removal of CH_3OH.

$$2H_2(g) + CO(g) \leftrightharpoons CH_3OH(g)$$

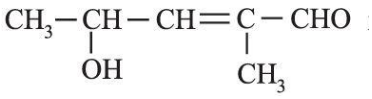
19. Draw the resonance structures of aniline correctly with the help of curved arrow in each step. (2)

20. Write down the correct IUPAC name for the following compound. (2)

(i)



(ii)



21. The enthalpy of combustion of methane, graphite and dihydrogen at 298 K are, –890.3 kJ mol^{-1} –393.5 kJ mol^{-1}, and –285.8 kJ mol^{-1} respectively. What will be the Enthalpy of formation of methane gas? (2)

SECTION C

22. Calculate the wave number for the longest wavelength transition in the Balmer series of atomic hydrogen. (3)

23. (a) Out of Oxygen and fluorine, which one would have more negative electron gain enthalpy? Why? (3)
(b) Assign the position of the clement having outer electronic configuration (n - 1) d^2 ns^2 for n = 4.

24. A photon of wavelength 4×10^{-7} m strikes on metal surface; the work function of metal being 2.13 eV. Calculate (i) the energy of the photon (ii) the kinetic energy of emission (iii) the velocity of the photoelectron. (Given 1 eV = 1.6020×10^{-19} J). (3)

25. Find the value of K_c the following equilibria from the value of K_p. (3)

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$; K_p = 167 atm at 1073 K.

26. Convert: Ethanoic acid to ethane. (3)
(Show step by step conversion in the form of chemical reactions. Mention the name of each reaction on the arrow, also write the names of product at each step.)

OR

(a) How will you convert Phenol to Benzene sulphonic acid?
(b) Write one reaction that proves the acidic nature of alkynes.

27. (a) Round off 0.04597 up to three significant figures. (3)
(b) How many atoms are present in 1 ml of NH_3 at STP? (Molecular mass of NH_3 = 17 u)

28. Conc. HCl is 38 % HCl by mass. What is the molarity of this solution if d = 1.19 g cm^{-3}? What volume of this conc. HCl is required to make 1.00 L of 0.10 M HCl? (Molecular mass of HCl = 36.5 u) (3)

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.

29. Stability in organic molecules is a key concept in organic chemistry that determines how likely a molecule is to maintain its structure under various conditions. Several factors influence the stability of organic molecules:

Resonance Stabilization

Resonance structures delocalize electron density across atoms, making the molecule more stable.
Example: Benzene is highly stable due to delocalized π-electrons.

Inductive Effect

Electron-withdrawing or electron-donating groups affect the distribution of electron density.
Electron-withdrawing groups (like halogens) stabilize negative charges, while electron-donating groups stabilize positive charges.

Hyperconjugation

Interaction between σ-bonds (usually C-H) and adjacent π-or empty orbitals leads to stabilization.
Example: More is the probability of hyperconjugation, more is the stability of carbocation as exhibited by carbocations.

Aromaticity

Molecules that follow Huckel's rule (4n+2 π-electrons) exhibit extra stability due to aromaticity.
Example: Benzene is more stable than other conjugated compounds.

Conjugation

Extended π-conjugation systems stabilize molecules by delocalizing electrons.
Example: Polyenes (like β-carotene) have enhanced stability.

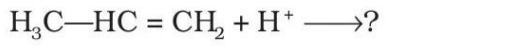
Bond Strength and Bond Order

Higher bond order (double or triple bonds) often corresponds to greater bond stability.
Example: C≡C bonds are stronger and more stable than C=C bonds.

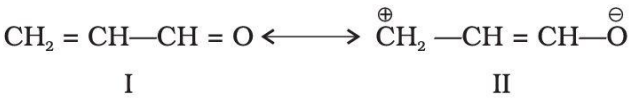
Answer the following questions:

(a) Show the orbital diagram of hyperconjugation in ethyl cation. (1)

(b) Electrophilic addition reactions proceed in two steps. The first step involves the addition of an electrophile. Name the type of intermediate formed in the first step of the following addition reaction. (1)



(c) Resonance structures of propenal are given below. Which of these resonating structures is more stable? Give reason for your answer. (2)



I II

OR

(c) Identify the most stable species in the following set of ions giving reasons.

30. Redox reactions, or oxidation-reduction reactions, are chemical processes involving the transfer of electrons between two substances. These reactions are crucial in various natural and industrial processes, including metabolism, corrosion, energy production, and synthesis of materials.

Oxidation:

- Loss of electrons
- Increase in oxidation state
- Example: $Fe^{2+} \rightarrow Fe^{3+} + e^{-} Fe^{2+}$

Reduction:

- Gain of electrons
- Decrease in oxidation state
- Example: $Cu^{2+} + 2e^{-} \rightarrow Cu$

Oxidizing Agent (Oxidant):

- The substance that accepts electrons (gets reduced)

Reducing Agent (Reductant):

- The substance that donates electrons (gets oxidized)

Example of Redox Reactions in a Galvanic Cell (Zn-Cu Cell)

Overall Reaction: $Zn\ (s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu$

Anode (Oxidation): $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ (Zinc is oxidized, losing electrons)
Cathode (Reduction): $Cu^{2+}(aq) + 2e^- \rightarrow Cu$ (Copper ions are reduced, gaining electrons)

Galvanic Cells are used in batteries (e.g., alkaline and lithium-ion batteries).

(a) What will be the oxidation state of phosphorous in PO_4^{3-}? (1)

(b) A hypothetical electrochemical cell is: $A|A^+(xM)||B^+(yM)|B$. The emf measured is +0.20 V. (1)
Write down the overall cell reaction taking place in this cell.

(c) Balance the following reaction by any of the appropriate method. (2)

$$MnO_4^- + Fe^{2+} + H^+ \rightarrow Mn^{2+} + Fe^{3+}$$

OR

(c) The compound AgF_2 is unstable compound. However, if formed, the compound acts as a very strong oxidising agent. Why?

SECTION E

31. (a) Name the hybridisation of sulphur involved in SF_6. (5)
(b) Why dipole moment of CO_2 is zero while H_2O is not, though both have polar covalent bonds? Explain.
(c) Calculate the bond order for N^{2+} molecule on the basis of Molecular orbital theory.

32. (a) Calculate the enthalpy change on freezing of 1.0 mol of water at 10.0°C to ice at –10.0°C. (5)
$\Delta_{fus}H = 6.03$ kJ mol^{-1} at 0°C. $Cp[H_2O(l)] = 75.3$ J mol^{-1} K^{-1} $Cp[H_2O(s)] = 36.8$ J mol^{-1} K^{-1}.
(b) Define: Lattice enthalpy
(c) Can enthalpy of combustion be positive?

OR

(a) If ΔH_{vap} of water is 186.5 J mol^{-1}, what is value of ΔS_{vap} for water in J K^{-1} mol^{-1} ?
(b) HCl is added to $AgNO_3$ and a precipitate of AgCl is obtained. Mention the change in entropy for this.
(c) Calculate ΔG and ΔG^o for the reaction A + B → C + D at 27°C. Equilibrium constant (K) for this reaction = 10^2.

33. (a) Draw the Newman's projection formula of the staggered form of ethane. (5)
(b) Write a short note on Friedel-Draft acylation of benzene. Describe the following steps with the help of chemical reaction.
(i) Generation of the electrophile
(ii) Formation of carbocation intermediate
(iii) Removal of proton from the carbocation intermediate
(c) Write the structural formula of the products obtained by the ozonolysis of Pent-2-ene.

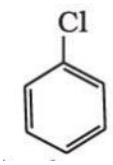
OR

(a) Which of the following compounds will show cis-trans isomerism? Also draw the geometrical isomers of the selected option.
(i) $(CH_3)_2C=CH-C_2H_5$ (ii) CHCl=CHCl (iii) $(CH_3)_2CH=CClCH_3$

(b) Write the structure of substrate A in the reaction given below.

$$(A) \xrightarrow{NaOH,\ CaO,\ \Delta} CH_3\ CH_3$$

(c) Considering the concept of directive influence during the reactions of benzene, give one point of similarity as well as one point of difference between the following compound.



and