केन्द्रीय विद्यालय संगठन

KENDRIYA VIDYALAYA SANGATHAN

आंचलिक शिक्षा एवं प्रशिक्षण संस्थान , मैसूर

ZONAL INSTITUTE OF EDUCATION AND TRAINING, MYSORE

CLASS XI
CHEMISTRY
QUESTION BANK

तत् त्वं पूषन् अपावृणु
केन्द्रीय विद्यालय संगठन

KENDRIYA VIDYALAYA SANGATHAN
ZONAL INSTITUTE OF EDUCATION AND TRAINING
MYSURU

SUPPORT MATERIAL
CLASS -XI

SUBJECT- CHEMISTRY (043)
SESSION- 2024-25

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COURSE STRUCTURE
CLASS-XI (THEORY) (2024-25)

Time: 3 Hours **Total Marks70**

S.No	**UNIT**	**No. of Periods**	**Marks**
1	Some Basic Concepts of Chemistry	12	7
2	Structure of Atom	14	9
3	Classification of Elements and Periodicity in Properties	8	6
4	Chemical Bonding and Molecular Structure	14	7
5	Chemical Thermodynamics	16	9
6	Equilibrium	14	7
7	Redox Reactions	6	4
8	Organic Chemistry: Some basic Principles and Techniques	14	11
9	Hydrocarbons	12	10
	TOTAL		**70**

SOME BASIC CONCEPTS OF CHEMISTRY

Multiple Choice Questions carrying 1 mark each

1. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.

   Student A

Student	Reading 1	Reading 2
A	3.01	2.99
B	3.05	2.95

   (a) Results of both the students are neither accurate nor precise.
   (b) Results of student A are both precise and accurate.
   (c) Results of student B are precise but not accurate.
   (d) Results of student B are both precise and accurate.

2. A measured temperature on Fahrenheit scale is 200°F. What will this reading be on Celsius scale?
   (a) 40°C
   (b) 94°C
   (c) 93.3°C
   (d) 30°C

3. If 500 mL of a 5 M solution is diluted to 1500 mL, what will be the molarity of the solution obtained?
   (a) 1.5 M
   (b) 1.6 M
   (c) 0.017 M
   (d) 1.59 M

4. The number of atoms present in one mole of an element is equal to Avogadro number. Which of the following elements contains the greatest number of atoms?
   (a) 4g He (b) 46g Na (c) 0.40 g Ca (d) 12 g He

5. If the concentration of glucose ($C_6H_{12}0_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood?
   (a) 5 M
   (b) 50 M
   (c) 0.005 M
   (d) 0.5 M

6. What will be the molality of the solution containing 18.25 g of HCl gas in 500 g of water?
   (a) 0.1 m (b) 1 M (c) 0.5 m (d) 1 m

7. One mole of any substance contains 6.022 x 10^{23} atoms/molecules. Number of molecules of H_2S0_4 present in 100 mL of 0.02 M H_2S0_4 solution is __________
(a)12.044 x 10^{20} molecules
(b) 6.022 x 10^{23} molecules
(c) 1 x 10^{23} molecules
(d) 12.044 x 10^{23} molecules

8. What is the mass per cent of carbon in carbon dioxide?
(a) 0.034%
(b) 27.27%
(c) 3.4%
(d) 28.7%

9. The empirical formula and molecular mass of a compound are CH_20 and 180g respectively. What will be the molecular formula of the compound?
(a) $C_9H_{18}0_9$,
(b) CH_20
(c) $C_6H_{i2}0_6$
(d) $C_2H_40_2$

10. If the density of a solution is 3.12 g mL^1, the mass of 1.5 mL solution in significant figures is________
(a) 4.7 g
(b) 4680 x 10^{-3} g
(c) 4.680 g
(d) 46.80 g

11. Which of the following reactions is not correct according to the law of conservation of mass?
(a) $2Mg(s) + 0_2(g) \rightarrow 2MgO(s)$
(b) $C_3H_8(g) + 0_2(g) \rightarrow C0_2(g) + H_2O(g)$
(c) $P_4(s) + 50_2(g) \rightarrow P_4O_{10}(s)$
(d) $CH_4(g) + 20_2(g) \rightarrow C0_2(g) + 2H_20(g)$

12. Which of the following statements indicates that law of multiple proportions is being followed?
(a) Sample of carbon dioxide taken from any source will always have carbon and oxygen in the ratio 1:2.
(b) Carbon forms two oxides namely $C0_2$ and CO, where masses of oxygen which combine with fixed mass of carbon are in the simple ratio 2:1.
(c) When magnesium bums in oxygen, the amount of magnesium taken for the reaction is equal to the amount of magnesium in magnesium oxide formed.
(d) At constant temperature and pressure 200 mL of hydrogen will combine with 100 mL oxygen to produce 200 mL of water vapour.

13. One mole of oxygen gas at STP is equal to____ .
    (a) 6. 022 x 10^{22} molecules of oxygen
    (b) 6.022 x 10^{23} atoms of oxygen
    (c) 16 g of oxygen .
    (d) 32 g of oxygen

14. Sulphuric acid reacts with sodium hydroxide as follows:

    $H_2S0_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_20$
    When 1 L of 0.1 M sulphuric acid solution is allowed to react with 1 L of 0.1 M sodium hydroxide solution, the amount of sodium sulphate formed and its molarity in the solution obtained is
    (a) 0.1 mol L^{-1}
    (b) 7.10 g
    (c) 0.025 mol L^{-1}
    (d) 3.55 g

15. Which of the following solutions have the same concentration?
    (a) 20 g of NaOH in 200 mL of solution
    (b) 0.5 mol of KCl in 200 mL of solution
    (c) 40 g of NaOH in 100 mL of solution
    (d) 20 g of KOH in 200 mL of solution

16. Which of the following terms are unit less?
    (a) Molality
    (b) Molarity
    (c) Mole fraction
    (d) Normality

Short Answer Type Questions carrying 2 marks

17. What will be the mass of one atom of C-12 in grams?
18. How many significant figures should be present in the answer of the following calculations?
    2.5×1.25×3.5/ 2.01
19. What is the symbol for SI unit of mole? How is the mole defined?
20. What is the difference between molality and molarity?
21. Calculate the mass per cent of calcium, phosphorus and oxygen in calcium phosphate $Ca_3(PO_{4)2}$.
22. **4 L** of dinitrogen reacted with **22.7 L** of dioxygen and **45.4 L** of nitrous oxide was formed. The reaction is given below:
    $2N_2(g) + 0_2(g) \longrightarrow 2N_20(g)$
    Which law is being obeyed in this experiment? Write the statement of the law.
23. If two elements can combine to form more than one compound, the masses of one element that combine with a fixed mass of the other element, are in whole number ratio.
    (a) Is this statement true?
    (b) If yes, according to which law?
    (c) Give one example related to this law

24. Hydrogen gas is prepared in the laboratory by reacting dilute HC1 with granulated zinc. Following reaction takes place:

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Calculate the volume of hydrogen gas liberated at STP when 32.65 g of zinc reacts with HCl.

1 mol of a gas occupies 22.7 L volume of STP; atomic mass of Zn = 65.3 u.

25. The density of 3 molal solution of NaOH is 1.110 g mL^{-1}. Calculate the molarity of the solution.

26. Volume of a solution changes with change in temperature, then, will the molality of the solution be affected by temperature? Give reason for your answer.

27. The reactant which is entirely consumed in reaction is known as limiting reagent. In the reaction $2A + 4B \longrightarrow 3C + 4D$, when 5 moles of A react with 6 moles of B, then

(i) which is the limiting reagent?

(ii) calculate the amount of C formed.

28. If 4 litres of water are added to 2 litres of 6M hydrochloric acid solution. What will be the change in the molarity of the solution?

29. How much lime would be obtained by heating 200 kg of 95% limestone?

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

31. The molar mass and empirical formula of a compound are CH_2O and 180g. What will be its molecular formula?

Assertion and Reason Type Questions

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 each question.

32. **Assertion (A):** The empirical mass of ethene is half of its molecular mass.

Reason (R): The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

(a) Both A and R are true and R is the correct explanation of A.
(b) A is true but R is false
(c) A is false but R is true
(d) Both A and R are false.

33. **Assertion (A)**: One atomic mass unit is defined as one-twelfth of the mass of one carbon-12 atom.

Reason (R): Carbon-12 isotope is the most abundant isotope of carbon and has been chosen as standard.

(a) Both A and R are the 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) Both A and R are false.

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

Reason (R): Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.

(a) Both A and R are true and R is 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) Both A and R are false.

35. **Assertion (A):** Combustion of 16 g of methane gives 18 g of water.
Reason (R): In the combustion of methane, water is one of the products.
(a) Both A and R are true but R is not the correct explanation of A.
(b) A is true but R is false
(c) A is false but R is true.
(d) Both A and R are false.

Short Answer Type Questions carrying 3 marks

36. A vessel contains 1.6 g of dioxygen at STP (273.15 K, 1 atm pressure). The gas is now transferred to another vessel at constant temperature, where pressure becomes half of the original pressure.
Calculate (i) volume of the new vessel.
(ii) number of molecules of dioxygen.

37. Calcium carbonate reacts with aqueous HC1 to give $CaCl_2$ and $C0_2$ according to the reaction given below:
$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$
What mass of $CaCl_2$ will be formed when 250 mL of 0.76 M HC1 reacts with 1000 g of $CaC0_3$? Name the limiting reagent.
Calculate the number of moles of $CaCl_2$ formed in the reaction.

38. Define the law of multiple proportions. Explain it with two examples. How does this law point to the existence of atoms?

39. A box contains some identical red coloured balls, labelled as A, each weighing 2 grams. Another box contains identical blue coloured balls, labelled as B, each weighing 5 grams. Consider the combinations AB, AB_2, A_2B and A_2B_3 and show that law of multiple proportions is applicable.

40. If 4 litres of water are added to 2 litres of 6M hydrochloric acid solution. What will be the change in the molarity of the solution?

41. How much carbon dioxide would be obtained by heating 10 kg of 90% limestone?

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

43. The molar mass and empirical formula of a compound are CH_2O and 180g. What will be its molecular formula?

44. If 4 g of NaOH dissolves in 36 g of H_2O, calculate the mole fraction of each component in the solution. Also, determine the molarity of solution (specific gravity of solution is 1g ml^{-1})

45. What volume of 10M HCl and 3M HCl should be mixed to obtain 1L of 6M HCl solution?

Case-Based Questions carrying 4 Marks

46. The mass of one mole of a substance in grams is called its molar mass. the molar mass in grams is numerically equal to atomic molecular/formula mass in u. An empirical formula represents the simplest whole number ratio of various atoms present in a compound, whereas, the molecular formula shows the exact number of different types of atoms present in a molecule of a compound. If the mass per cent of various elements present in a compound is known, its empirical formula can be determined. Molecular formula can further be obtained if the molar mass is known. Many a time, reactions are carried out with the Amounts of reactants that are different than The amounts as

required by a balanced chemical reaction. In such situations, one Reactant is in more amount than the amount required by balanced chemical reaction. The reactant which is present in the least amount Many a time, reactions are carried out with the amounts of reactants that are different than the amounts as required by a balanced chemical reaction. In such situations, one reactant is in more amount than the amount required by balanced chemical reaction. The reactant which is present in the least amount gets consumed after sometime and after that further reaction 12 does not take place whatever be the amount of the other reactant. Hence, the reactant, which gets consumed first, limits the amount of product formed and is, therefore, called the limiting reagent.

I) One atomic mass unit (amu) is defined as a mass exactly equal to one-twelfth of the mass of one ……atom.
(a) Hydrogen – 1 (b) carbon – 12 (c) Oxygen -12 (d) Chlorine – 35

II) The mass of one mole of a substance in grams is called its……………..
(a) Atomic mass (b) Molecular Weight (c) Molecular mass (d) molar mass.

III) ………………is the sum of atomic masses of the elements present in a molecule.
(a) Atomic mass (b) Molecular Weight (c) Molecular mass (d) molar mass

IV) One mole contains exactly ………………..elementary entities.
(a) 6.022×10^{21} (b) 6.022×10^{22} (c) 6.022×10^{23} (d) 6.022×10^{24}

47. Quantitative measurement of properties is required for scientific investigation. Earlier, two different systems of measurement, i.e., the English System and the Metric System were being used indifferent parts of the world. The metric system, which originated in France in late eighteenth century. The SI system has seven base units. These are listed as follows .

Base Physical Quantities	**Unit**
1. Length	Metre – m
2. Mass	Kilogram – kg
3. Time	Second – s
4. Electric current	Ampere- A
5. Thermodynamic Temperature	Kelvin – K
6. Amount of substance	Mole – mol
7. Luminous intensity	Candela- cd

Here , Mass of a substance is the amount of matter present in it, while weight is the force exerted by gravity on an object. Density of a substance is its amount of mass per unit volume. The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, N_A, when expressed in the unit per mol and is called the Avogadro number. The amount of substance, symbol n, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles. There are three common scales to measure temperature — °C (degree celsius), °F (degree fahrenheit) and K (kelvin). Here, K is the SI unit. Generally, the thermometer with celsius scale are calibrated from 0° to 100°, where these two temperatures are the freezing point and the boiling point of water, respectively. The fahrenheit scale is represented between 32°to 212°.
The temperatures on two scales are related to each other by the following relationship:

$$^{\circ}F = \underline{\;9\;}(^{\circ}C) + 32$$

The kelvin scale is related to celsius scale as follows:

$$K = {^{\circ}C} + 273.15$$

I. **The metric system ,which originated in ………… in late eighteenth century .**
(a) Ukraine (b) German (c) Russia (d) France

II. **The SI system has …. base units.**
(a) 7 (b) 3 (c) 9 (d) 1

III. **The symbol for SI unit of thermodynamic temperature is …**
(a) Kelvin (b) K (c) Degree Celsius (d) °C

IV. **A prefix giga equivalents to**
(a) 10^9 (b) 10^{10} (c) 10^{11} (d) 10^{12}

48. The uncertainty in the experimental or the calculated values is indicated by mentioning the number of significant figures. Significant figures are meaningful digits which are known with certainty plus one which is estimated or uncertain. The uncertainty is indicated by writing the certain digits and the last uncertain digit. Thus, if we write a result as 11.2 mL, we say the 11 is certain and 2 is uncertain and the uncertainty would be +1 in the last digit. Unless otherwise stated, an uncertainty of +1 in the last digit is always understood.

There are certain rules for determining the number of significant figures.
(1) All non-zero digits are significant.
2) Zeros preceding to first non-zero digit are not significant.
(3) Zeros between two non-zero digits are significant.
(4) Zeros at the end or right of a number are significant, provided they are on the right side of the decimal point.
(5) Counting the numbers of object have infinite significant figures.

Answer the following:
I) How many significant figures are there in 50.0 mL?
II) Specify the uncertainty in the above given value.
III) Write the result in significant numbers.
  a) 12.11 + 18.0 + 1.012
  b) 2.5×1.25

49. Precision refers to the closeness of various measurements for the same quantity. However, accuracy is the agreement of a particular value to the true value of the result. For example, if the true value for a result is 2.00 g and student 'A' takes two measurements and reports the results as 1.95 g and 1.93 g. Another student 'B' repeats the experiment and obtains 1.94 g and 2.05 g as the results for two measurements. When the third student 'C' repeats these measurements and reports 2.01 g and 1.99 g as the result.

I) **Answer as per data given in paragraph.**
Result that is precise as well as accurate____________
Result that is precise but not accurate___________
Result that is neither precise nor accurate_________

II) The result of a titration is 11.4, 11.5, and 11.7mL.
Write the values which are precise but not accurate if true value is 11.9 mL.

Long Answer type Questions carrying 5 Marks

50. What is the difference between empirical and molecular formula? A compound contains 4.07 % hydrogen, 24.27 % carbon and 71.65 % chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formulas?

51. Dinitrogen (2kg) and dihydrogen (1kg) react with each other to produce ammonia according to the following chemical equation:
$N2 (g) + 3H_2(g) \longrightarrow 2NH_3 (g)$
(i) Will any of the two reactants remain unreacted?
(ii) If yes, which one and what would be its mass?

52. 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 L (measured at STP) of this welding gas is found to weigh 11.6 g.
Calculate (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula.

53. A compound made up of two elements A and B has A= 70 %, B = 30 %. Their relative number of moles in the compound are 1.25 and 1.88.
Calculate a) Atomic masses of the elements A and B 14
b). Molecular formula of the compound , if its molecular mass is found to be 160

54. In a reaction $A + B_2 \rightarrow AB_2$
Identify the limiting reagent, if any, in the following reaction mixtures.
i. 300 atoms of A + 200 molecules of B
ii. 2 mol of A + 3 mol of B
iii. 100 atoms of A + 100 molecules of B
iv. 5 mol of A + 2.5 mol of B
v. 2.5 mol of A + 5 mol of B

STRUCTURE OF ATOM

SECTION- A (MCQ- 1 Marks)

1. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?
(a) Pauli's exclusion principle. (b) Heisenberg's uncertainty principle.
(c) Hund's rule of maximum multiplicity. (d) Aufbau principal

2. Number of angular nodes for 4d orbital is __________.
(a) 4 (b) 3 c) 2 (d) 1

3. For which of the following sets of quantum numbers, an electron will have the highest energy?
(a) 3, 2, +1, +1/2 (b) 4, 2, -1, +1/2
(c) 4,1,0, -1/2 (d) 5,0,0, +1/2

4. Which of the following atoms or atom/ion have identical ground state configuration?
(a) Li+ and He+ (b) Cl and Ar (c)Na and K d) F+ and Ne

5. Which of the following orbitals has dumb-bell shape?
(a)s (b)p (c)d (d) f

6. The total number of orbitals in a shell having principal quantum number n is
(a) 2n (b)n^2 (c)$2n^2$ (d)n+1

7. Azimuthal quantum number defines:
(a) e/m ratio of electron (b)spin of electron
(c) angular momentum of electron (d)magnetic momentum of electron

8. Quantum numbers n=2, l=1 represent:
(a)1s orbital (b)2s orbital (c) 2p orbital (d)3d orbital

9. The quantum number m of a free gaseous atom is associated with:
(a)The effective volume of the orbital
(b) The shape of the orbital
(c)The spatial orientation of the orbital
(d)The energy of the orbital in the absence of the magnetic field.

10.Iso-electronic species are:
(a)F-, O^{-2} (b)F-, O (c)F-, O+ (d)F-, O^{+2}

In the following questions, a statement of assertion is followed by a corresponding statement of reason. Of the following statements, choose the correct one:

A. Both assertion and reason are correct statements and reason is the correct explanation of the assertion.

B. Both assertion and reason are correct statements and reason is not the correct explanation of the assertion.

C. Assertion is correct, but reason is incorrect statement.

D. Assertion is incorrect, but reason is correct statement.

11. Assertion: Both position and momentum of an electron cannot be determined simultaneously with maximum accuracy.
Reason: The path of an electron in an atom is clearly defined.

12. Assertion: Electronic configuration of helium is $1S^2$.
Reason: Hund's rule demands that the configuration should display maximum stability.

13. A: An orbital cannot have more than 2 electrons and their spin must be opposite.
R: No two electrons in an atom can have same set of all four quantum numbers.

14. A: The energy of an electron is mainly determined by principal quantum number.
R: The principal quantum number is the measure of the most probable distance of finding the electron around the nucleus.

15. The correct order of increasing energy of atomic orbital is:
(a)5p<4f<6s<5d (b)5p<6s<4f<5d (c)4f<5p<5d<6s (d)5p<5d<4f<6s

ANSWERS - Section - A

1. B
2. C
3. B
4. B
5. B
6. B
7. c
8. C
9. C
10. a
11. c
12. b
13. a
14. a
15. b

SECTION-B Short answer questions - (2 marks)

1. What is the physical significance of Ψ^2?
2. Which orbital is non directional?
3. Heisenberg's uncertainty principle has no significance in our everyday life. Explain.
4. Out of 3d and 4s orbitals which is filled first?
5. How many electrons can be filled in all the orbitals with n+l=5?
6. Which one of the following electronic configurations is correct for chromium?
   a) $[Ar]\ 4s^2 3d^4$ or b) $[Ar] 4s^1 3d^5$? Justify your answer.
7. Explain Pauli's exclusion principle with an example.
8. Designate the orbitals using s, p, d and f notations which are applicable: a) n=4, l=2 b) n=5, l=1.
9. Calculate the total number of angular nodes and radial nodes present in 3p orbitals.
10. (a)What is the lowest value of n that allows g orbitals to exist?
    (b)An electron is in one of the 3d orbitals, Give the possible values of n, l and m_l for this electron.

ANSWERS

1. Ψ2 represents the probability of finding an electron. It is the probability of finding a particle specified by a particular wave function.
2. S- orbital is spherically symmetrical i.e. it is non-directional. It has a spherical shape, like a hollow ball.
3. In our daily life we can see only the moving macro and semi-micro-object's. The mass of the striking photons of light are too small to cause any shift in their position by the time the reflected photons form the image of the object. For such particles, there is no problem in measuring the exact momentum simultaneously. Thus, the principle has no relevance for such objects.
4. 4s orbital is filled first because it has lower energy. The energies of the orbitals can be compared by their n+l values. For 4s orbital n+l (4+0) value is 4 while for 3d orbital, n+l (3+2) value is 5, Therefore 4s orbital is filled before3d orbital.
5. (n+l) =5 has 5s,4p and 3d orbitals with two, six and ten electrons respectively. Therefore, the total number of electrons=18.
6. b) Ar]$4s^1 3d^5$is correct as half-filled orbitals are more stable than nearly half-filled orbitals due to exchange energy and more symmetry.
7. Pauli's exclusion principle: No two electrons can have all the four quantum numbers same.

Example: For Helium the three quantum numbers are same but fourth quantum number (spin quantum number) is different. E.C. of He: 1s2

For 1st electron, n=1, l=0, m=0 and s=+1/2.

For 2nd electron n=1, l=0, m=0 and s= -1/2.

8. a) 4d b) 5p.
9. For 3p orbitals, n=3, l= 1

Number of angular nodes = l= 1

Number of radial nodes = n-l-1 = 3-1-1= 1.

10. (a) minimum value of n= 5

b) n=3, l=2, ml = -2, -1, 0, +1, +2.

SECTION-C, Short answer questions - (3 marks)

1. Which of the followings are iso-electronic species, i.e. those having the same number of electrons? Na+, K+, Mg^{2+}, Ca^{2+}, S^{2-}, Ar.

2. What is the uncertainty in locating its position? [Given, me = 9.11 × 10^{-31} kg] An electron speed of 40 ms^{-1} accurate up to 99.9 percent.
3. Write the significance (one point) of each of the following:

a) Principal quantum number b) Azimuthal quantum number c) Magnetic quantum number.

4. State the following:

a) Aufbau principle, b) Hund's rule of maximum multiplicity c) Heisenberg Uncertainty principle.

5. Write the 3 points of difference between orbit and orbital.
6. An atom of an element contains 29 electrons and 35 neutrons.

Deduce (i)the number of protons and (ii) the electronic configuration of the element (iii) Identify the element.

7. Table-tennis ball has a mass 10 g and a speed of 90 m/s. If speed can be measured within an accuracy of 4%, what will be the uncertainty in speed and position?
8. (i) An atomic orbital has n = 3. What are the possible values of l and m_l?

   (ii) List the quantum numbers m_l and l of electron in 3rd orbital.

   (iii) Which of the following orbitals are possible?

   1p, 2s, 2p and 3f.

9. The quantum numbers of six electrons are given below. Arrange them in order of increasing energies. List if any of these combination(s) has/have the same energy

(i) $n = 4, l = 2, m_l = -2, m_s = -1/2$ (ii) $n = 3, l = 2, m_l = 1, m_s = +1/2$

(iii) $n = 4, l = 1, m_l = 0, m_s = +1/2$ (iv) $n = 3, l = 2, m_l = -2, m_s = -111$

(v) $n = 3, l = l, m_l = -1, m_s = +1/2$ (vi) $n = 4, l = 1, m_l = 0, m_s = +1/2$

10. Among the following pairs of orbitals, which orbital will experience more effective nuclear charge (i) 2s and 3s (ii) 4d and 4f (iii) 3d and 3p?

ANSWERS

1. Na+(11 – 1 = 10), Mg^{2+} (12 – 2 = 10) have same number of electrons.
   K+(19 – 1 = 18), Ca2+ (20 – 2 = 18), S^{2-} (16 + 2 = 18), Ar (18) are iso-electronic, i.e. they have same number of electrons.
2. $\Delta x = 0.0144$ m.
3. Significance of principal Quantum number(n): The principal quantum number determines the size and to large extent the energy of the orbital. It also identifies the shell.

Significance of azimuthal Quantum number(l): It defines the 3-dimensional shape of the orbital.

Significance of magnetic Quantum number(m): It gives information about the spatial orientation of the orbital with respect to standard set of co-ordinate axis.

4. a) Aufbau principle: In the ground state of the atoms, the orbitals are filled with electrons in order of their increasing energies. It means the lower energy orbitals are filled first followed by higher energy orbitals.

b) Hund's rule of maximum multiplicity: In the orbitals like p, d, f etc which have degenerate states, the pairing of electrons takes place after all the orbitals getting singly filled.

c) Heisenberg Uncertainty principle: It is impossible to determine simultaneously the exact position and exact momentum or velocity of subatomic particles like electrons.

Orbit	orbital
1. An orbit is a well defined circular path around the nucleus in which the electrons revolve	1. An orbital is the three dimensional space around the nucleus within which the probability of finding an electron is maximum(upto 90 %)
2. It represents the planar motion of an electron around the nucleus	2. It represents the three dimensional motion of an electron around the nucleus
3. All orbits are circular and disc like	3. Different orbitals have different shapes, i.e., s-orbitals are spherically symmetrical, p-orbitals are dumb-bell shaped and so on.

5.

6. (i)For an atom to be neutral, the number of protons is equal to the number of electrons.

∴ Number of protons in the atom of the given element = 29

(ii) The electronic configuration of the atom is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$

(iii) Copper.

$$m = 10\ \text{g} = \frac{10}{1000} = 0.01\,\text{kg}\ , c = 90\ \text{m s}^{-1}$$

$$\text{Uncertainty in speed of ball} = \frac{90 \times 4}{100} = 3.6\,\text{m s}^{-1}$$

$$\Delta x = \frac{h}{4\pi m \Delta V} = \frac{6.626 \times 10^{-34}\ \text{J s}}{4 \times 3.14 \times 0.01\ \text{kg} \times 3.6\,\text{m s}^{-1}}$$

$$= 1.46 \times 10^{-33}\ \text{m}$$

7. **(i)** For n = 3; l = 0, 1 and 2.
For l = 0 ; m_l = 0
For l = 1; m_l = +1, 0, -1
For l = 2 ; m_l = +2, +1,0, +1, + 2
(ii) For an electron in 3rd orbital ; n = 3; l = 2 ; m_l can have any of the values -2, -1, 0, + 1, +2.
(iii) 1p and 3f orbitals are not possible

8. The electrons may be assigned to the following orbitals:
(i) 4d **(ii)** 3d **(iii)** 4p **(iv)** 3d **(v)** 3p **(vi)** 4p.
The increasing order of energy is:
(v) < (ii) = (iv) < (vi), = (iii) < (i)

9. Greater the penetration of the electron presents in a particular orbital towards the nucleus, more will be the magnitude of the effective nuclear charge. Based upon this,
(i) 2s electron will experience more effective nuclear charge.
(ii) 4d electron will experience more effective nuclear charge.
(iii) 3p electron will experience more effective nuclear charge.

SECTION-D - (4 marks)

1. Read the following passage and answer the questions that follow:

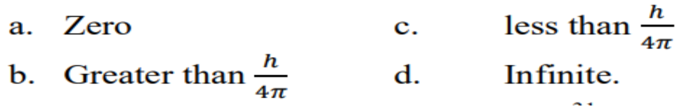
We can pin point an Aeroplan moving in the sky. Whatever may be its speed i.e. we can locate both its exact position as well as direction. However, it is not possible to do so in case of a moving microscopic particle such as electron. In fact, we cannot see any such particles without disturbing it. This has been stated by Heisenberg in the form of uncertainty principle. The mathematical form of the principle is; $\Delta x. \Delta p \geq h/4\pi$ (constant). Since the product of Δx and $\Delta p(m\Delta v)$ is constant, if one is very small, other is bound to be large. The principle as such has no significance in daily life since it applies to those particles which we cannot see.

A) Heisenberg's Uncertainty principle rules out the exact simultaneous measurement of
a. Probability and intensity. b. charge density and radius.
c. Energy and velocity d. position and momentum.

B) If the uncertainty in the position of electron is zero, the uncertainty in its momentum would be;
a. Zero b. less than h/4pi b. Greater than h/4pi d. Infinite.

C) Given the mass of electron is 9.1 x 10-31 kg and velocity of electron is 2.2 x 10^6 m/s, if the uncertainty in its velocity is 0.1%, the uncertainty in position would be;
a. 26 nm b. 32 nm c. 48 nm d. 50 nm

D) If uncertainty in position and momentum are equal, then the uncertainty in velocity is



a. Zero c. less than $\frac{h}{4\pi}$
b. Greater than $\frac{h}{4\pi}$ d. Infinite.

2. Read the following passage and answer the questions that follow:

Orbitals are region or space where there is maximum probability of finding electrons.
Qualitatively, these orbitals can be distinguished by their size, shape and orientation. An orbital of small size means there is more chance of finding the electron near the nucleus. Shape and orientation mean the direction in which probability of finding electron is maximum. Atomic orbitals can be distinguished by quantum numbers. Each orbital is designated by three quantum numbers n, l and ml (magnetic quantum number) which define energy, shape and orientation but these are not sufficient to explain spectra of multi-electrons atoms. Spin quantum number (ms) determines the spin of electron. Spin angular momentum of electron has two orientations relative to chosen axis which are distinguished by spin quantum numbers m_s which can take values +1/2 and –1/2.

a) How many orbitals are associated with n = 3?
b) Describe the orbitals represented by (i) n = 2, l = 1 (ii) n = 4, l = 0.
c) How many electrons are possible in an orbital? Why?
d) What is shape of ’s’ and 'p' orbitals?

3. Read the following passage and answer the questions that follow:
The presence of positive charge on the nucleus is due to the protons in the nucleus. As established earlier, the charge on the proton is equal but opposite to that of electron. Atomic number (Z) = number of protons in the nucleus of an atom = number of electrons in a neutral atom. protons and neutrons present in the nucleus are collectively known as nucleons. The total number of nucleons is termed as mass number (A) of the atom. mass number (A) = number of protons (Z) + number of neutrons (n). Isobars are the atoms with same mass number but different atomic number for example, 6 ^{14}C and 7 ^{14}N. On the other hand, atoms with identical atomic number but different atomic mass number are known as Isotopes. For example, considering of hydrogen atom again, 99.985%of hydrogen atoms contain only one proton. This isotope is called protium (1 ^{1}H). Rest of the percentage of hydrogen atom contains two other isotopes, the one containing 1 proton and 1neutron is called deuterium (2 1D, 0.015%) and the other one possessing 1 proton and 2neutrons is called tritium (1 ^{3} T). The studies of interactions of radiations with matter have provided immense information regarding the structure of atoms and molecules. Neils Bohr utilized these results to improve upon the model proposed by Rutherford. Two developments played a major role in the formulation of Bohr’s model of atom.

1. The pair of ions having same electronic configuration is __________.
(a) Cr3+, Fe3+ (b) Fe3+, Mn2+ (c) Fe3+, Co3+ (d) Sc3+, Cr3+

2.They have same mass number, different atomic number. These are isobars. In which of the following pairs, the ions are isoelectronic?
(a) Na+, Mg2+ (b) Al3+, O– (c) Na+, O2– (d) N3–, Cl–

3.Two atoms are said to be isobars if.
(a) they have same atomic number but different mass number.
(b) they have same number of electrons but different number of neutrons.
(c)they have same number of neutrons but different number of electrons.
(d)sum of the number of protons and neutrons is same but the number of protons is different.

4. Read the following passage and answer the questions that follow:
Bohr's model explained electrons can revolve only in certain permitted orbits who’s angular could successfully explain stability of atoms and spectrum of unielectron species. Hydrogen spectrum consists of Lyman, Balmer, Paschen, Brackett and Pfund series. Bohr's theory could not explain spectrum of multi-electron species, Stark effect, Zeeman effect, dual nature of matter, de Broglie equation and Heisenberg uncertainty principle which lead to orbital concept. Electrons were filled in orbitals according to Aufbau’s principle, Hund’s Rule and Pauli's exclusion principle. Each electron is identified by four quantum numbers n, l, ml and ms out which n, l, ml was derived from Schrodinger’s wave equation. Half-filled and completely filled orbitals are more stable due to exchange energy and symmetrical distribution of electrons.
a) Arrange 4d, 3d, 4p and 3p in increasing order of energy.
b) What is name of spectrum of radiation emitted by substance that has absorbed radiation?
c) What rules out the probability of existence of definite path of electrons?
d) Why are Half filled and completely filled orbitals are more stable?

ANSWERS

1. a) d b) d c) a d) a

2. a) Number of orbitals = $n^2 = 3^2 = 9$ orbitals, 3s, 3px, 3py, 3pz, $3dx^2-y^2$, $3dz^2$, 3dxy, 3dyz and 3dzx.
   b) (i) 2p (ii) 4s
   c) Orbital can have maximum two electrons which must be of opposite spin.
   d) 's' orbitals are spherical and 'p' orbitals have dumb-bell shaped.
3. 1. (b) Fe^{3+}, Mn^{2+}
   2. (a) and (c).
   3. (d) sum of number of protons and neutrons is same but the number of protons is different.
4. a) Ans. 3p < 3d < 4p < 4d
   b) Ans. Emission spectrum.
   c) Ans. Heisenberg's uncertainty principle
   d) Half-filled and completely filled orbitals are more stable due to exchange energy and symmetrical distribution of electrons.

SECTION-E - (5 marks)

1. Using Aufbau principle, write the ground state electronic configuration of following atoms.
   (i)Boron (Z = 5) (ii) Neon (Z = 10), (iii) Aluminium (Z = 13)
   (iv) Chlorine (Z = 17), (v) Calcium (Z = 20)
2. State and explain the following:

(i) Aufbau principle

(ii) Pauli exclusion principle.

(iii) Hund’s rule of maximum multiplicity.

3. What are quantum numbers? What permitted values can these have? Explain their significance.
4. (i) Write the electronic configuration of the following ions: (a) H (b) Na+ (c) 0^{2-} (d) F^-.

(ii) What are the atomic numbers of the elements whose outermost electronic configurations are represented by: (a) $3s^1$ (b) Ip^3 and (c) $3d^6$?

(iii) Which atoms are indicated by the following configurations?

(a) $[He]2s^1$ (b) $[Ne]\ 3s^2\ 3p^3$ (c) $[Ar]\ 4s^2\ 3d^1$.

ANSWERS

1. (i)Boron (Z = 5); $1s^2\ 2s^2\ 1p^1$
(ii)Neon (Z = 10); $1s^2\ 2s^2\ 2p^6$
(iii)Aluminium (Z = 13); $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
(iv)Chlorine (Z = 17); $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
(v)Calcium (Z = 20); $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

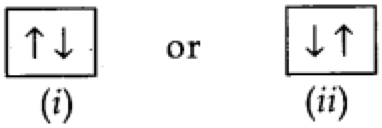
2. (i) Aufbau Principle: In the ground state of the atoms, the orbitals are filled in the order of their increasing energies. In other words, electrons first occupy the lowest-energy orbital available to them and enter into higher energy orbitals only after the lower energy orbitals are filled.

The order in which the energies of the orbitals increase and hence the order in which the orbitals are filled is as follows:

Is, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d,7p………………..

(ii) Pauli Exclusion Principle: An orbital can have maximum of two electrons and these must have opposite signs.

For example: Two electrons in an orbital can be represented by



The two electrons have opposite spin, if one is revolving clockwise, the other is revolving anticlockwise or vice versa.
(iii) Hund's Rule of Maximum Multiplicity: Electron pairing in p, d and/orbitals cannot occur until each orbital of a given subshell contains one electron each or is single occupied.

3. Quantum numbers are a set of numbers that represent the position and energy of an electron in an atom. The state of an electron in an atom or ion is defined by four quantum numbers, which yield solutions to the Schrödinger wave equation for the hydrogen atom. There are four quantum numbers:

   (i) 'n' is the principal quantum number. The quantity of the electron's shell is the principal quantum number, which is an integer. The quantity is one or more (never 0 or negative).

   (ii) 'l is orbital angular momentum quantum number (or azimuthal quantum number. The orbital's form is defined by the angular quantum number (l). Spherical ($l = 0$), polar ($l = 1$), or cloverleaf ($l = 2$) are the best descriptions for orbitals. As the angular quantum number grows greater, they can take on increasingly complicated shapes.

   (iii) Magnetic quantum number (m_l or m): characterises the subshell orbital. Having integer values range from -l to l, the magnetic quantum number is the orbital's orientation. As an outcome, for the p orbital, where $l=1$, m might be -1, 0, or 1.

   (iv) 'm_s' stands for the electron spin quantum number. The spin quantum number is a half-integer quantity that is either -1/2 (referred to as "spin down") or 1/2 (referred to as "spin-up") (called "spin up").

4. **(i)** **(a)** $1s^2$ **(b)** $1s^2\ 2s^2\ 2p^6$ **(c)** $1s^22s^22p^6$ **(d)** $1s^22s^22p^6$.
   (ii) (a) Na (Z = 11) has outermost electronic configuration = $3s^1$
   (b) N (Z = 7) has outermost electronic configuration = $2p^3$
   (c) Fe (Z = 26) has outermost electronic configuration = $3d^6$
   (iii) (a) Li **(b)** P **(c)** Sc

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

SECTION A (MCQ- 1 MARKS)

Multiple -choice questions carrying 1 mark each.

1.The symbol of an element with atomic number 120 as per IUPAC will be
(A) unb (B) unt (C) ubn (D) uun

2. The increasing order of effective nuclear charge in Na, Al, Mg and Si atoms
(a) Na < Mg < Si <Al (b) Na < Mg <Al < Si
(c) Mg < Na <Al< Si (d) Na = Mg =Al = Si

3. Whenever a list of radii is given, we find that the size of the noble gases is larger than thesize of their adjacent halogens. The reason is
(a) Noble gases have a complete octet
(b) They have a higher inter electronic repulsion
(c) In halogens it is covalent radii and in noble gases it is Vander walls radii
(d)Noble gases cannot be liquefied

4. The order of screening effect of electrons of s, p, d and f orbitals of a given shell of anatom on its outer shell electrons is
(a) s>p>d>f (b) f > d > p > s
(c) p < d < s > f (d) f > p > s >

5.The correct order of radii is
(a) N< Be< B (b) $F^{-}<O^{2-}<N^{3-}$
(c) N< Li<K (d) $Fe^{3+} < Fe < Fe^{2+}$

6. The correct order of first ionization potential among following elements, Be, B, C, N and Ois
(a) B < Be < C < O < N (b) B < Be < C < N < O
(c) Be < B < C < N < O (d) Be < B < C < O < N

7. The group number, number of valence electrons, and valency of an element with theatomic number 15, respectively, are:
(a) 16, 5 and 2 (b) 15, 5 and 3 (c) 16, 6 and 3 (d) 15, 6 and 2

8. Consider the isoelectronic series: K+ , S2- , Cl and Ca2+, radii of the ions decrease as
(a) Ca2+ < K+ > Cl– S2- (b) Cl– > S2- > K+ > Ca2+
(c) S2- > Cl– > K+ > Ca2+ (d) K+ > Ca2+ > S2- > Cl.

9. Which of the following has the smallest radius?
a. Sn+4 b. Li+ c. Ca+2 d. Al+3

10. Z = 114 has been discovered recently. It will belong to which of the following familygroup and electronic configuration?
(a) Carbon family [Rn] 5f 14 6d10 7s27p2
(b) Oxygen family [Rn] 5f 4 6d10 7s27p4
(c) Nitrogen family [Rn] 5f 14 6d10 7s2 7p5
(d) Halogen family [Rn] 5f 14 6d10 7s27p5

ASSERTION AND REASON TYPE QUESTIONS (1 MARK)

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 are 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 true but R is false.
(D) Both A and R are false.

11.Assertion (A) : Generally, ionization enthalpy increases from left to right in a period. Reason (R) : When successive electrons are added to the orbitals in the same principal quantum level, the shielding effect of inner core of electrons does not increase very much tocompensate for the increased attraction of the electron to the nucleus.

12. Assertion (A) : The value of electron gain enthalpy decrease while moving left to right ina period.
Reason (R) : The electron gain enthalpy is the energy which released hence it representedwith negative sign.

13. Assertion: The first ionization enthalpy of aluminium is lower than that of magnesium.
Reason: Ionic radius of aluminium is smaller than that of magnesium.

14. Assertion : Smaller the size of an atom greater is the electronegativity.
Reason : Electronegativity refers to the tendency of atom so share electrons with otherAtom

15. Assertion : Boron has a smaller first ionization enthalpy than beryllium.
Reason : The penetration of a 2s electron to the nucleus is more than the 2p electron hence 2p electron is more shielded by the inner core of electrons than the 2s electrons.

Answers:

1. Ans-C)ubn
2. Ans- b
3. Ans-c
4. Ans-a
5. Ans-b
6. Ans-b
7. Ans-b
8. Ans-c
9. Ans-a
10. Ans-a
11. Ans-A
12. Ans-B
13. Ans-B
14. Ans-B
15. Ans- C

SECTION B(2 Marks)

Short answer questions carrying 2 marks each.

Q1. Which of the following have largest and the shortest ionic radii? - O 2–, F–, Na+ andMg2+

Q2. What is the basic difference between the tern electron gain enthalpy andelectronegativity?

Q3. A) Arrange the following elements on the basis of first ionization enthalpy.Li, Be, B,
C, N, O, F, Ne

B) Arrange the following on the basis of their electron affinity.N, P, O,
S, F, Cl

Q4 Describe the two merits of long form periodic table over the Mendeleev's periodictable?

Q5 What is meant by periodicity in properties of elements? What is the reason behind this?

Q6 How do atomic radii vary in a group and a period?

Q7 Name the factors which affect the ionisation enthalpy of an element.

Q8 Noble gases have zero electron gain enthalpy values. Explain.

Q9 In periodic table for trangition elements there is continuous decrease in atomic size fromSc to Mn. Why?

Q10 In periodic table, the transition elements as Mn, Fe, Co and Ni have almost sameatomic size. Why?

Answers:

1. Ans. $O2^{-}$and Mg^{2+}
2. Ans- The electron gain enthalpy is the energy released when an electron is added to thevalance shell of an isolated gaseous atom where the electronegativity is is the tendency ofan atom to attract the bond pair electrons towards itself.

3.A) Ans. Ne > F > N > O > C > Be > B > Li

B) Ans. Cl > F > S > O > P > N

4. Ans- 1. It removed the anomalies about the position of isotopes which existed in theMendeleev's table.

2.It relates the position of an element in the periodic table with its electronic configuration.

5. Ans- The repetition of similar properties after regular intervals is called as periodicity. It isdue to the similarity in the outer electronic configurations which gives rise to the periodic properties of the elements.
6. Ans- In group- Atomic size increases on moving from top to bottom. In period- Atomic size decreases on moving left to right in a period.
7. Ans- (i) Size of atom or ion (ii) Nuclear charge (iii) Electronic configuration (iv) Screeningeffect (v) Penetration effect of the electrons
8. Ans- Because the outer most shell of noble gases is completely filled and no moreelectrons can be added.
9. Answer: Because from Sc to Mn, the nuclear attraction force increases which is more thanshielding effect. So due to this there is decrease in size.
10. Answer: Because in these elements the attractive nuclear force and shielding effect is equivalent that is why Mn, Fe, Co and Ni have same size.

SECTION C (3 Marks)

Short answer questions carrying 3 marks each.

Q.1. The first ionisation enthalpy of magnesium is higher than that of sodium. On the otherhand, the second ionisation enthalpy of sodium is very much higher than that of magnesium. Explain.

Q.2. Among the elements of the second period Li to Ne pick out the element:
(i) with the highest first ionisation energy
(ii) with the highest electronegativity
(iii) with the largest atomic radius Give the reason for your choice.

Q.3. Arrange the following as stated:
(i) N2, O2, F2, Cl2 (Increasing order of bond dissociation energy)
(ii) F, Cl, Br, I (Increasing order of electron gain enthalpy)
(iii) F2, N2, Cl2, O2 (Increasing order of bond length)

Q.4. Explain why are cations smaller and anions larger in size than their parent atoms?

Q.5. Consider the following species:
N3– , O2– , F – , Na+ , Mg2+ and Al3+

(a) What is common in them?
(b) Arrange them in the order of increasing ionic radii.

Q6. Elements A, B, C and D have atomic numbers 12,19, 29, and 36 respectively. On the basis of electronic configuration, write to which group of the periodic table each element belongs.

Q7. a) Arrange the following elements on the basis of first ionization enthalpy.

Li, Be, B, C, N, O, F, Ne

b) Write the IUPAC name of the elements with atomic number 112 and 123
c) Why the successive ionization enthalpies always increase?

Q8. Among the second period elements, the actual ionization enthalpies are in the order: Li <B< Be <C<O<KI<F< Ne

Explain why?

(i) Be has higher ΔiH1than B?
(ii) O has lower ΔiH1 than N and F?

Q9. a) How would you explain the fact that first ionization enthalpy of sodium is lower than Mg but its second ionization enthalpy is higher than that of Mg?

b) Oxygen has lesser first ionization enthalpy than nitrogen.

Q10. (a) What do you mean by periodicity of properties of elements?

(b) Arrange the following elements In their reasing metallic character.
Br. Al, Mg, K

(c) Determine the position of an element in periodic table whose atomic number is 32?

Answers:

1. Ans- The 1st ionisation enthalpy of magnesium is higher than that of Na due to higher nuclear charge and slightly smaller atomic radius of Mg than Na. After the loss of first electron, Na+ formed has the electronic configuration of neon (2,8). The higher stabilityof the completely filled noble gas configuration leads to very high second ionisation enthalpy for sodium. On the other hand, Mg+ formed after losing first electron still hasone more electron in its outermost (3s) orbital. As a result, the second ionisation enthalpy of magnesium is much smaller than that of

sodium.

2. Ans- (i) Ne. due to higher nuclear charge.
(ii) F. due to small size
(iii) Li .due to less nuclear charge.

3. Ans- (i) F2 < Cl2 < O2 < N2 (ii) I < Br < F < Cl (iii) N2 < O2 < F2 < Cl2

4. Ans- (a) The cations are smaller than their parent atoms due to the following reasons:
(i) Disappearance of the valence shell. (ii) Increase of effective nuclear charge
(b) The anions are larger than their parent atoms due to the following reason:

An increase in the number of electrons in the valence shell reduces the effective nuclearcharge due to greater mutual shielding by the electrons. As a result, electron cloud expands, i.e., the ionic radius increases.

5. Ans- (a) the same number of electrons (10 electrons). Hence, the given species are isoelectronic.
(b) Al3+ < Mg2+ < Na+ < F– < O2– < N3–

6. Ans- 12-s block,19-s block, 29- d block,36 pblock.

7. Ans-a. Ne > F > N > O > C > Be > B > Li
b. 112- ununnbium (uub), 123- unnbitrium (ubt)\

c. Because it requires more energy to remove an electron from the cation than the neutral atom.

8. Ans-. (i) In case of Be (1s2 2s2) the outermost electron is present in 2s-orbital while in B (1s2 2s22p1) it is present in 2p-orbital. Since 2s – electrons are more strongly attracted by the nucleus than2pelectrons, therefore, lesser amount of energy is required to knock out a 2p-electron than a 2s – electron. Consequently, ΔiH1 of Be is higher than that ΔiH1 of B.
(ii) The electronic configuration of N7 = 1s2 2s2 2px 1 2py 1 2pz
1O8 =1s2 2s2 2px 1 2py 1 2pz 1
We can see that in case of nitrogen 2p-orbitals are exactly half filled. Therefore, it is difficult to remove an electron from N than from O. As a result ΔiH1 of N is higher than that of O

9. Ans-. a)By losing one valence electron , sodium attains stable configuration. Therefore, 1st I.E. of Na is less than Mg. To remove an electron from noble gas configuration, high energy is required. Therefore 2nd ionization enthalpy is higher than Mg.
b) Nitrogen has half-filled electronic configuration and hence its ionization energy is greater than oxygen. In oxygen after it loses its electron, it goes to half-filled electronic configuration and hence, it has less ionization energy than nitrogen.

10. Ans-(a) It is tendency to reoccur the properties of elements at regular interval.
(b) Br < Al < Mg < K.
(c) Block = pPeriod
= IV
Group = 10 + 2 + 2 = 14

SECTION D (4 Marks)

Case - based questions carrying 4 marks each.

CASE STYDY BASED QUESTION –

1 The periodic table of the elements The periodic table, also known as the periodic table of the elements, arranges the chemical elements into rows ("periods") and columns ("groups"). It is an organizing icon of chemistry and is widely used in physics and other sciences. It is a depiction of the periodic law, which says that when the elements are arranged inorder of their atomic numbers an approximate recurrence of their properties is evident. The table is divided into four roughly rectangular areas called blocks. Elements in the same group tend to show similar chemical characteristics. Vertical, horizontal and diagonal trends characterize the periodic table. Metallic character increases going down a group and decreases from left to right across a period. Nonmetallic character increases going from the bottom left of the periodic table to the top right. Elements with similar chemical properties generally fall into the same group in the periodic table, although in the f-block, and to some respect in the d-block,the elements in the same period tend to have similar properties, as well. Thus, it is relatively easy to predict the chemical properties of an element if one knows the properties of the elements around it. Answer the following questions:

(a) Why do Li and Mg show similarity in their properties?
Ans: Due to similar polarizing power

(b) In terms of the period and group, where would you locate the element with Z =114?
Ans: Period = 7th, Group = 14

(c) First member of every group shows anomalous behaviour. Why?
Ans: Small atomic size, high electronegativity large charge / size ration and absence of vacant d orbital

CASE STYDY BASED QUESTION –

2 Electronegativity:

Electronegativity, described by Linus Pauling described as “The power of an atom in a molecule to attract electrons to itself” (Pauling in The nature of the chemical, is used to predict bond polarity. There are dozens of methods for empirically quantifying electronegativity including: theoriginal thermochemical technique , numerical averaging of the ionisation potential and electronaffinity, effective nuclear charge and covalent radius analysis and the averaged successive

ionization energies of an element’s valence electron etc. Indeed, there are such strong correlations between numerous atomic parameters—physical and chemical—that the term

“electro negativity” integrates them into a single dimensionless number between 0.78 and 4.00 that can be used to predict/describe/model much of an element’s physical character and chemical behaviour. The design of the common and popular medium form of the periodic table is in large part determined by four quantum numbers and four associated rules. However, adding electronegativity completes the construction so that it displays the multi-parameter periodic law operating in two dimensions, down the groups and across the periods, with minimalambiguity.

1) The electronegativity values of two atoms X and Y are 0.9 and 3.7 , predict the nature of bond formed between them.
Ans- ionic

2) Among the following elements , identify the one which will attract the shared pair of electrons most strongly . A: 0.95 B: 2.5 C: 3.9
Ans -C

Out of Fluorine and Chlorine, which will have the maximum electronegativity and which will have maximum negative value of electron affinity?

Ans – Most electronegative – Fluorine, maximum negative value of electron affinity –Chlorine

CASE STYDY BASED QUESTION – 3

PASSAGE II Read the passage given below and answer the following questions: In the periodic table electronegativity increases from left to right in a period and decreases from top to bottom in a group. The non-metallic character of an element is directly related to the electronegativity while the metallic character is inversely related to it.

1. The element with maximum electronegativity belongs to

(a) Period-1, Group-18 (b) Period-2, Group-17 (c) Period-3, Group-17 (d) Period-2, Group-1.

ANSWER: (b)

2. Which of the following groups contains metals, non-metals as well as metalloids?

(a) Group-1 (b) Group-17 (c) Group-14 (d) Group-2.

ANSWER: (c)

3. The least, metallic element of group-13 is

(a) Aluminium(b) Boron (c) Gallium (d) Indium.

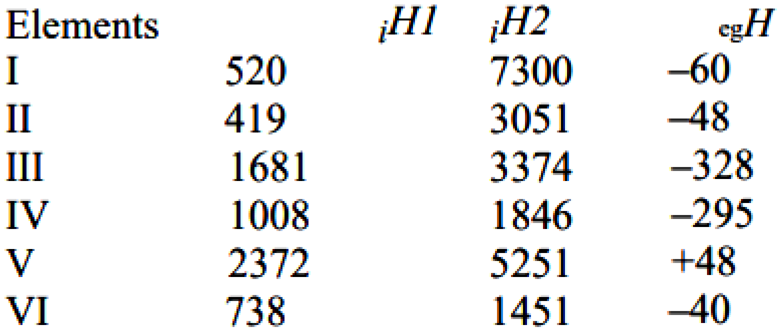
ANSWER: (b)

4. The electronegativity increases with

(a) decrease in nuclear charge (b) increase in atomic mass (c) decrease in atomic size (d) increase in atomic number.

ANSWER: (c)

CASE STYDY BASED QUESTION -4



Elements	$_iH1$	$_iH2$	$_{eg}H$
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:

(a) the least reactive element (b) the most reactive metal

(c) the most reactive non-metal (d) the least reactive non-metal

(e) the metal which can form a stable binary halide of the formula MX_2(X = halogen)

(f) the metal which can form a predominantly stable covalent halide of the formulaMX (X = halogen)?

Answer: (a) The element V has highest first ionization enthalpy (Δ_iH_1) and positive electron gain enthalpy ($\Delta_{eg}H$) and hence it is the least reactive element. Since inert gases have positive $\Delta_{eg}H$, therefore, the element-V must be an inert gas. The valuesof Δ_iH_1, Δ_iH_2 and $\Delta_{eg}H$ match that of He.

(b) The element II which has the least first ionization enthalpy (Δ_iH_1) and a lownegative electron gain enthalpy ($\Delta_{eg}H$) is the most reactive metal. The values of Δ_iH_1, Δ_iH_2 and

ΔegH match that of K (potassium).

(c) The element III which has high first ionization enthalpy (Δ iH1) and a very high negative electron gain enthalpy (ΔegH) is the most reactive non-metal. The valuesof Δ iH1, Δ iH2 and ΔegH match that of F (fluorine).

(d) The element IV has a high negative electron gain enthalpy (ΔegH) but not so highfirst ionization enthalpy (ΔegH). Therefore, it is the least reactive non-metal. The values of Δ iH1, Δ iH2 and ΔegH match that of I (Iodine).

(e) The element VI has low first ionization enthalpy (Δ iH1) but higher than that of alkali metals. Therefore, it appears that the element is an alkaline earth metal and hence will form binary halide of the formula MX2(where X = halogen). The values of Δ iH1, Δ iH2 and ΔegH match that of Mg (magnesium).

(f) The element I has low first ionization (Δ iH1) but a very high second ionization enthalpy (Δ iH2), therefore, it must be an alkali metal. Since the metal forms a pronominally stable covalent halide of the formula MX (X = halogen), therefore, the alkali metal must be least reactive. The values of Δ iH1, Δ iH2 and ΔegH match that of Li (lithium).

SECTION E (5 Marks)

long answer questions carrying 5 marks each.

Q.1. What is the cause of the periodicity in the properties of the elements? How do thefollowing properties vary in (a) a group and (b)in a period:

(i) electronegativity
(ii) ionisation enthalpy
(iii) Atomic size

Ans- It is due to the similarity in the outer electronic configurations which gives rise to theperiodic properties of the elements.

(a) In a group:
(i) Electronegativity- It decreases down the group.
(ii) Ionisation enthalpy- It decreases down the group.
(iii) Atomic size- It increases down the group.
(b) In a period:
(i) Electronegativity- Increases
(ii) Ionisation enthalpy- Increases
(iii) Atomic size- Decreases.

Q.2 Arrange the elements N, P, O and S in the order of

(i) increasing first ionisation enthalpy. (ii) increasing non-metallic character. Give reason for the arrangement assigned.

Ans : (i) S < P < O < N Ionisation enthalpy increases from left to right in a period and decreases downthe group. N has higher ionisation enthalpy than O due to extra stability of half-filled orbitals.

Similarly, P has higher ionisation enthalpy than S due to half-filled orbitals. (ii) P < S < N < O Non-metallic character decreases down the group and increases from left to right in a period.

Q3. Explain the following: (a) Electronegativity of elements increases on moving from left to right inthe periodic table. (b) Ionisation enthalpy decreases in a group from top to bottom.

Ans-: (a) The electronegativity generally increases on moving across a period from left to right (e.g., from Li to F in the second period). This is due to decrease in atomic size and increase in effective nuclear charge. As a result of increase in effective nuclear charge, the attraction for the outer electron and the nucleus increases in a period and therefore, electronegativity also increases.

(b) On moving down a group there is a gradual decrease in ionisation enthalpy. The decrease in ionisation enthalpy down a group can be explained in terms of net effect of the following factors: (i) In going from top to bottom in a group, the nuclear charge increases.

(ii) There is a gradual increase in atomic size due to an additional main energy shell (n).
(iii) There is increase in shielding effect on the outermost electron due to increase in the number of inner electrons.
The effect of increase in atomic size and the shielding effect is much more than the effect of increasein nuclear charge. As a result, the electron becomes less and less firmly held to the nucleus as wemove down the group. Hence, there is a gradual decrease in the ionization enthalpies in a group.

Q.4Write down the outermost electronic configuration of alkali metals. How will youjustify their placement in group 1 of the periodic table?

Answer.

Alkali metals' outermost electronic configuration is ns^1.

All elements of group IA (or I), i.e., alkali metals, have the same outer electronic configuration, ns^1, where n denotes the number of principal shells. These electronicconfigurations are shown in the table below.

Symbol	Atomic Number	Electronic Configuration
Li	3	1s2 2s1
Na	11	1s2 2s2 2p6 3s1
K	19	1s2 2s2 2p6 3s2 3p6 4s1
Rb	37	1s2 2s2 2p6 3s2 3p6 3d10 4s2 4p6 5s1
Cs	55	1s2 2s2 2p6 3s2 3p6 3d10 4s2 4p6 4d10 5s2 5p6 6s1
Fr	87	1s2 2s2 2p6 3s2 3p6 3d10 4s2 4p6 4d10 4f14 5s2 5p6
		5d10 6s2 6p6 7s1

As a result of their similarity in electronic configuration and properties, all of these elementsare placed in group 1 of the periodic table.

CHEMICAL BONDING AND MOLECULAR STRUCTURE

SECTION A (1 Marks)

1. Which of the following species has 120° bond angles?

   (a) NCl_3 (b) PH_3 (c) ClF_3 (d) BCl_3

2. Find the molecule in which the central atom is having one lone pair of electrons

   (a) NH_3 (b) PCl_5 (c) H_2O (d) CH_4

3. Find the molecule with the least bond angle

   (a) BeF_2 (b) CH_4 (c) NH_3 (d) H_2O

4. In BrF_3, lone pairs are present at the equatorial positions. This is to minimise

   (a) bp-bp repulsion only (b) lp-lp repulsion only

   (c) lp-bp repulsion only (d) both (b) and (c)

5. Which of the following statements is true regarding the molecular orbital theory for homonuclear diatomic molecules?

   (a) The number of molecular orbitals formed is less than the number of atomic orbitals combined.

   (b) Bonding molecular orbitals have higher energy than their corresponding antibonding molecular orbitals.

   (c) In a homonuclear diatomic molecule, the bonding molecular orbital is formed by the constructive interference of atomic orbitals.

   (d) Antibonding molecular orbitals are lower in energy than bonding molecular orbitals.

6. In molecular orbital theory, the bond order of a diatomic molecule is calculated as:

   (a) (Number of electrons in bonding orbitals + Number of electrons in antibonding orbitals) / 2
   (b) (Number of electrons in bonding orbitals - Number of electrons in antibonding orbitals) / 2
   (c) (Number of electrons in bonding orbitals - Number of electrons in antibonding orbitals)
   (d) (Number of electrons in bonding orbitals + Number of electrons in antibonding orbitals)

7. Which molecular orbital is formed from the linear combination of two 1s atomic orbitals in a homonuclear diatomic molecule like H_2?

   (a) σ^*2s (b) $\pi 2p$ (c) $\sigma 1s$ (d) σ^*1s

8. Which of the following diatomic molecules is paramagnetic according to molecular orbital theory?

   (a) N (b) O_2 (c) F_2 (d) H_2

9. Which of the following molecules can form hydrogen bonds?

   (a) CH_4 (b) HCl (c) NH_3 (d) C_2H

10. Which of the following statements about hydrogen bonding is incorrect?

    (a) Hydrogen bonding is a type of covalent bond.
    (b) Hydrogen bonds are generally weaker than ionic and covalent bonds.
    (c) Hydrogen bonding plays a significant role in determining the properties of water.
    (d) Hydrogen bonds can occur between different molecules or within different parts of a single molecule.

11. Which of the following is a necessary condition for hydrogen bonding?
    (a) Presence of hydrogen atoms only
    (b) Hydrogen atom bonded to a highly electronegative atom
    (c) Hydrogen atom bonded to a metallic atom
    (d) Hydrogen atom in a non-polar molecule

12. Which of the following molecules has a bent shape according to VSEPR theory?
    (a) CO_2 (b) H_2O (c) BF_3 (d) $BeCl_2$

13. According to VSEPR theory, the shape of a molecule with the formula AB_3E (where E represents a lone pair of electrons) is:
    (a) Trigonal planar (b) Tetrahedral
    (c) Trigonal pyramidal (d) Bent

14. What is the molecular geometry of SF_6 as predicted by VSEPR theory?
    (a) Square planar (b) Octahedral (c) Trigonal bipyramidal (d) Tetrahedral

15. According to VSEPR theory, which of the following molecules has a seesaw shape?
    (a) CH_4 (b) SF_4 (c) XeF_4 (d) PCl_5

SECTION-B (2 Marks)

16. The molecule of CO2 is linear whereas that of SnCl2 is angular why?
17. Draw molecular orbital diagram for N_2^+ molecule.
18. $N(SiH_3)_3$ and $N(CH_3)_3$ are not isostructural. Give reason.
19. N2 is diamagnetic while O2 is paramagnetic. Explain on the basis of Molecular orbital theory.
20. Arrange the following in the order of property indicated for each set:
    (i) O_2, O_2^+, O_2^-, O_2^{2-} (increasing stability)
    (ii) LiCl, NaCl, KCl, RbCl (decreasing covalent character)
    (iii) NO_2, NO_2^+, NO_2^- (decreasing bond angle)
    (iv) H–F, H–Cl, H–Br, H–I (decreasing bond dissociation enthalpy)

21. Using the molecular orbital theory, compare the bond energy and magnetic character of O^{2+} and O^{2-} species.

22. Discuss the shape of the following molecules using the VSEPR model:
    (a) $SiCl_4$ (b) AsF_5

23. Why dipole moment of BF3 is zero but for PCl3 it is non zero?

24. Arrange the bonds in order of increasing ionic character in the molecules: LiF, K_2O, N_2, SO_2, and ClF_3.

25. In both water and dimethyl ether (CH3–O–CH3), the oxygen atom is the central atom and has the same hybridisation, yet they have different bond angles. Which one has a greater bond angle? Specify with a reason.

SECTION-C (3 Marks)

26. Write the important conditions that are required for the linear combination of the atomic orbitals to form the molecular orbitals.

27. Discuss the shape of the following molecule using the VSEPR model:

$BeCl_2$, BCl_3, $SiCl_4$, AsF_5, H_2S, PH_3

28. Structures of molecules of the two compounds have given below:
    (a) Which of the following two compounds will have intermolecular hydrogen bonding, and which compound is expected to show the intramolecular hydrogen bonding?
    (b) The compound's melting point depends on, among other things, the extent of the hydrogen bonding. On the basis, explain which of the above two compounds would show the higher melting point.
    (c) Solubility of the compounds in water depends on the power to form hydrogen bonds with water, which of the above compounds will easily form a hydrogen bond with water and be more soluble in it.

29. Is there any change in the B and N atoms hybridisation due to the following reaction?

$$BF_3 + NH_3 \longrightarrow F_3B.NH_3$$

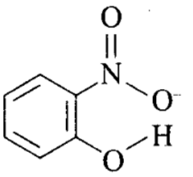
30. Use molecular orbital theory to explain why the Be_2 molecule does not exist.

31. 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?

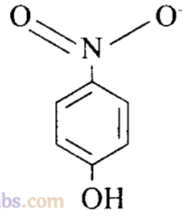
32. What do you understand by bond pairs and lone pairs of electrons? Illustrate by giving one example of each type.

33. Using the VSEPR theory identifies the type of hybridisation and draw the structure of OF_2.

34. Structures of molecules of two compounds are given below:



(i)



(ii)

    (a) Which of the two compounds will have intermolecular hydrogen bonding and which compound is expected to show intramolecular hydrogen bonding?
    (b) The melting point of a compound depends on. among other things, the extent of hydrogen bonding. On this basis explain which of the above two compounds will show higher melting point.
    (c) Solubility of compounds in water depends on power to form hydrogen bonds with water. Which of the above compounds will form hydrogen bond with water easily and be more soluble in it?

35. Match the species in Column I with the bond order in Column II.

Column I	**Column II.**
(i) NO	(a) 1.5

(ii) CO	(b) 2.0
(iii) O_2^-	(c) 2.5
(iv) O_2	(d) 3.0

SECTION D (4 Marks)

36. Hydrogen Bond It is defined as the force of attraction existing between hydrogen atom covalently bonded to highly electronegative atom (N, O or F) and the electronegative atom belonging to another molecule of the same or different substance. It is represented by dotted lines. The chains possess a zig-zag structure.

1. What is the reason for the high boiling point of HF compared to other halides?
   A) Ionic bonding
   B) Covalent bonding
   C) Hydrogen bonding
   D) Van der Waals forces

2. Which of the following is a consequence of hydrogen bonding in HF?
   A) Higher viscosity than water
   B) Lower melting point than water
   C) Higher density than water
   D) Association of molecules

3. What is the number of hydrogen bonds formed by a single HF molecule?
   A) 1
   B) 2
   C) 3
   D) 4

4. What is the effect of hydrogen bonding on the acidity of HF?
   A) Increases acidity
   B) Decreases acidity
   C) No effect on acidity
   D) Neutralizes acidity

37. This theory provides a simple procedure to predict the shapes of covalent molecules. Based on the repulsive interactions of the electron pairs in the valence shell of the atoms. The shape of a molecule depends upon the number of valence shell electron pairs (bonded or non–bonded) around the central atom. Pairs of electrons in the valence shell repel one another since their electron clouds are negatively charged. These pairs of electrons tend to occupy such positions in space that minimize repulsion and thus maximize distance between them. The valence shell is taken as a sphere with the electron pairs localising on the spherical surface at maximum distance from one another. A multiple bond is treated as if it is a single electron pair and the two or three electron pairs of a multiple bond are treated as a single super pair. Where two or more resonance structures can represent a molecule, the VSEPR model is applicable to any such structure. The repulsive interaction of electron pairs decreases in the order:

lp – lp > lp –bp > bp – bp

lone pairs are localised on the central atom and each bonded pair is shared between two atoms. As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons. These results in greater repulsion between lone pairs of electrons as compared to the lone pair – bond pair and bond pair – bond pair repulsions.

1. Percentage of s–character in sp2 hybrid orbital is
   (a) 25 (b) 50 (c) 33 (d) 75

2. Shape of XeF4 molecule is
   (a) Linear (b) Pyramidal (c) Tetrahedral (d) Square planar

3. Hybridisation involves a) Mixing up of atomic orbitals b) Addition of an electron pair c) Removal of an electron pair d) Separation of orbitals

4. Number of lone pair (s) in XeOF4 is/are:
   (a) 0 (b) 1 (c) 2 (d) 3

SECTION E (5 Marks)

38. Read the passage and answer the questions that follow:

The attractive force which holds the two atoms together is called a chemical bond. A covalent bond is formed by an equal sharing of electrons. A coordinate bond is formed by unequal sharing of electrons. An ionic bond is formed by the transfer of electrons from one atom to another. Octet rule, although very useful but is not universally applicable. According to valence bond theory, a covalent bond is formed by overlapping of half-filled atomic orbitals resulting in a lowering of energy and more stability. Bond order is the number of bonds between atoms in a molecule. The higher the bond order more will be stability and bond dissociation enthalpy but the smaller the bond length. The polarity of a covalent bond depends upon the difference in electronegativity. The covalent character of a bond depends upon polarising power, smaller cation and bigger anions have higher polarising power. VSEPR theory helps to predict the shapes of molecules.

a. Write the electron dot structure of N_2O.
b. What are the ions present in CsI_3?
c. Out of CN^+, CN^-, NO, which has the highest bond order?
d. What is the correct order of repulsion bp – bp, lp – lp, and lp – bp?
e. Draw the structure of $XeOF_4$ on the basis of VSEPR theory.

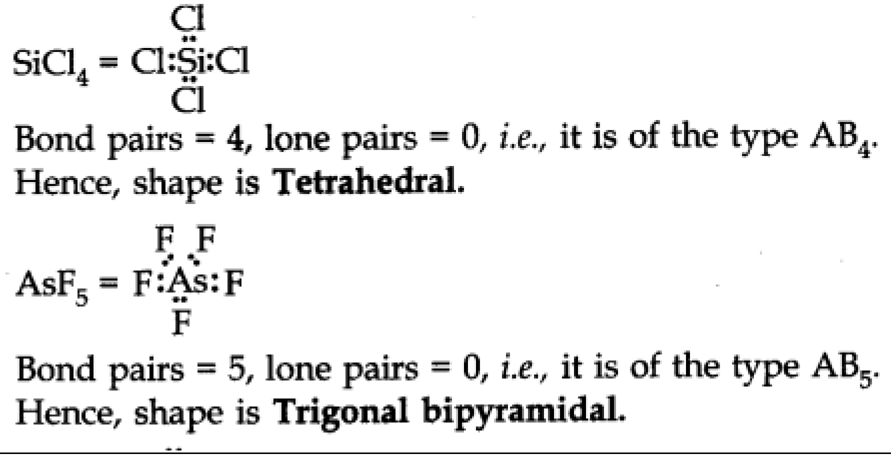
39. Draw the shape of following molecules according to VSEPR theory; XeO_3, XeF_2, $XeOF_4$, SF_4, XeF_4

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

41. What is meant by the term bond order? Calculate the bond order of N_2, O_2, O_2^+, O_2^-

ANSWERS

Section A	
1	D
2	A
3	D
4	B
5	C
6	B
7	C
8	B
9	C
10	A
11	B
12	B
13	C

14	B
15	B
Section B	
16	**CO_2** is O=C=O so there are no lone pairs around the central atom. The C is sp hybridized and the molecule is linear. Also note that atoms cannot rotate around double bonds. $SnCl_2$ is Cl--Sn--Cl with ONE LONE PAIR on the Sn. The Sn is sp^2 hybridized and the molecular geometry would be bent with bond angles of approx. 118º
17	Correct answer
18	N (SiH3)3 and N(CH3)3 are not isostructural because they have different structures. N (SiH3)3 has a planar structure due to the transfer of the lone pair on the N-atom to the empty d-orbitals of silicon, which is not possible in N(CH3)3 due to the absence of empty d-orbitals on C-atom.
19	According to the Molecular Orbital Theory, the presence of two unpaired electrons in the π π π * (2 p x) and π π π * (2 p y) molecular orbitals results in the paramagnetic nature of the Oxygen molecule. Therefore, O 2 is paramagnetic and N 2 is diamagnetic in nature. In N2, all electrons are paired, while O2 has two unpaired electrons, which are responsible for its magnetic nature3. The unpaired electrons of O2 move around in their orbits, generating a loop of current that produces a magnetic field.
20	(i) $O_2^{-2}<O_2^{-}< O_2< O_2^{+}<O_2^{+2}$ (ii) LiCl>NaCl>KCl>RbCl (iii) $NO_2^{+}>NO_2>NO_2^{-}$ (iv) H−F>H−Cl>H−Br> H–I
21	The Molecular Orbital configuration of **O_2^+** as well as **O_2^-** has given below: **O_2^+** (15): σ1**s2** σ *1**s2** σ 2**s2** σ *2**s2** σ 2pz2 π2px2 = π 2py2π *2px1 **O_2^-** (17): σ1**s2** σ *1**s2** σ 2**s2** σ *2**s2** σ 2pz2 π2px2 = π 2py2π *2px2= π*2py1 Bond order for the **O_2^+** = 10-5/2 = 2.5 Bond order for the **O_2^-** = 10-7/2 = 1.5 According to the Molecular Orbital Theory, the greater the bond order greater the bond energy. Thus, **O_2^+** is more stable than **O_2^-**
22	 Bond pairs = 4, lone pairs = 0, *i.e.,* it is of the type AB_4. Hence, shape is **Tetrahedral.** Bond pairs = 5, lone pairs = 0, *i.e.,* it is of the type AB_5. Hence, shape is **Trigonal bipyramidal.**
23	The dipole moment of BF3 is zero because it has **sp2 hybridisation and regular trigonal planal geometry.** On the other hand, PCl3 has a non-zero dipole moment because it has a **bent structure** due to the existence of a lone pair of electrons at the top of the molecule, which causes electron-electron repulsion.
24	The ionic character of a molecule depends on the difference in electronegativity between constituents atoms. So, the higher the difference, the higher the ionic character of a molecule.

	So, the required sequence of ionic character of the above-given molecules is $N_2 < SO_2 < ClF_3 < K_2O < LiF$
25	The bond angle of dimethyl ether would be greater. More repulsion will exist in between bond pairs of the C**H3** groups attached in ether than in between bond pairs of hydrogen atoms attached to the oxygen in the water. The carbon of the CH_3 in ether is attached to three hydrogen atoms via bonds, and these bonds' electron pairs contribute to the carbon atom's electronic charge density. As a result, the repulsion in between two CH_3 groups will be greater than between two hydrogen atoms
Section C	
26.	The condition that is required for the linear combination of atomic orbitals to form the molecular orbitals are as follows: (i) The joining of atomic orbitals might have approximately the same energy. This implies in the homo-nuclear molecule, the 1s-orbital of one atom can join with the 1s- orbital of another atom but can't join with the 2s-orbital. (ii) The joining atomic orbitals might have legitimate orientations to ensure the maximum overlap. (iii) The overlapping might be to a large extent.
27.	$BeCl_2$ The central atom has no lone pair but two bond pairs. Thus, its shape is AB_2. i.e. Linear shape. **BCl_3** The central atom has no lone pair but three bond pairs. Thus, its shape is AB_3. i.e. Trigonal planar. $SiCl_4$ The central atom has no lone pair but 4 bond pairs. Thus, its shape is AB_4. i.e. Tetrahedral. AsF_5 The central atom has no lone pair but 5 bond pairs. Thus, its shape is AB_5. i.e. Trigonal bipyramidal. H_2S The central atom has one lone pair and two bond pairs. Thus, its shape is AB_2E. i.e. Bent shape. PH_3 The central atom has one lone pair and three bond pairs. Thus, its shape is AB_3E. i.e. Trigonal bipyramidal.
28.	(a) Hence the N**O2** and OH groups in compound (I) are close together, and the intramolecular hydrogen bonding will form (II). Compound (II) will show the intermolecular hydrogen bonding.

(b) Hence it forms intramolecular hydrogen bonds, and compound (II) has a higher melting point. As a result, more and more molecules have linked together via hydrogen bond formation.

(c) Due to the intramolecular hydrogen bonding, compound (I) can’t form hydrogen bonds with the water and is less soluble in it, whereas compound (II) can form hydrogen bonds with the water more easily and is thus more soluble in water.

29. N- atom in **NH3** has **sp3** hybridisation. The orbital picture of N- the atom shows below:

B- atom in **NF3** has **sp2** hybridisation. The orbital picture of B- the atom shows below:

On the reaction between NH3 and BF3, F3B.NH3 is obtained as a product, as hybridisation of B- atom changed to sp3. Although, the hybridisation of N- atoms remains unchanged.

30

$$\text{E.C. of Be} = 1s^2\,2s^2$$

$$\text{M.O.E.C. of Be}_2 = \sigma^2 1s\ \sigma^{*2} 1s\ \sigma^2 2s\ \sigma^{*2} 2s$$

$$\text{Bond order} = \frac{1}{2}(4-4)$$

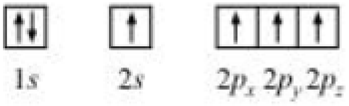
$$= 0$$

Hence, Be_2 does not exist.

31 Electronic configuration of carbon atom:

6C: $1s^2\ 2s^2\ 2p^2$

In the excited state, the orbital picture of carbon can be represented as:



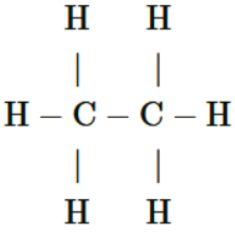
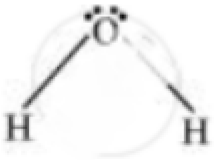
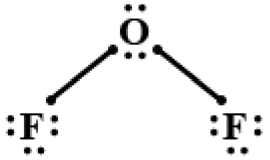
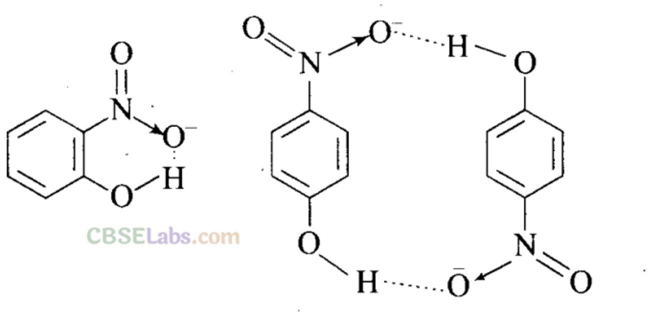
Hence, carbon atom undergoes sp^3 hybridization in CH_4 molecule and takes a tetrahedral shape. For a square planar shape, the hybridization of the central atom has to be dsp^2. However, an atom of carbon does not have d-orbitals to undergo dsp^2 hybridization. Hence, the structure of CH_4 cannot be square planar.

Moreover, with a bond angle of 90° in square planar, the stability of CH_4 will be very less because of the repulsion existing between the bond pairs. Hence, VSEPR theory also supports a tetrahedral structure for CH_4.

32 When two atoms combine by sharing their one or more valence electrons, a covalent bond is formed between them.

The shared pairs of electrons present between the bonded atoms are called bond pairs. All valence electrons may not participate in bonding. The electron pairs that do not participate in bonding are called lone pairs of electrons.

For example, in C_2H_6 (ethane), there are seven bond pairs but no lone pair present.

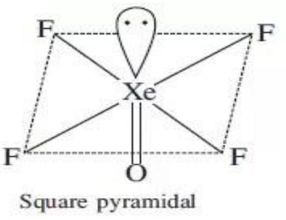
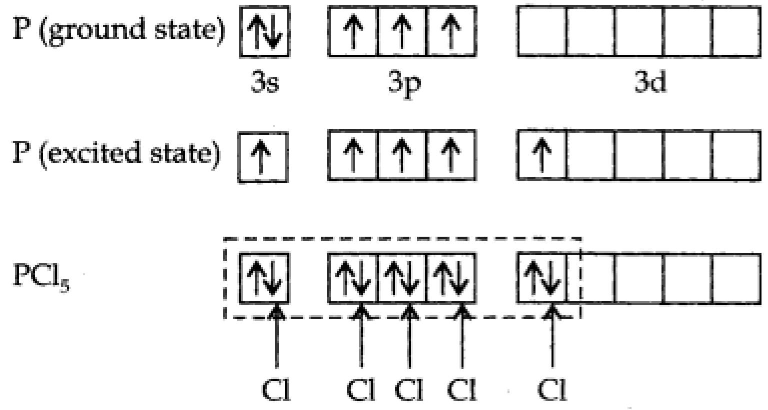
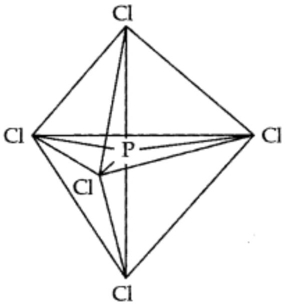
	 $\begin{array}{ccccccc} & & H & & H & & \\ & & \vert & & \vert & & \\ H & - & C & - & C & - & H \\ & & \vert & & \vert & & \\ & & H & & H & & \end{array}$ In H_2O, there are two bond pairs and two lone pairs on the central atom (oxygen). 
33	Structure of OF_2 according to VSEPR theory is is shown in the figure.The central atom O has 4 electron pairs (2 bond pairs and 2 lone pairs).Hence, its hybridisation is sp^3 and shape is bent shape i.e. V− shape. Oxidation state of O is +2 as each F has its oxidation state as −1. 
34	(a) Compound I will form intramolecular hydrogen bond because N02 and OH groups are close together whereas it is not so in compound II. Compound II will have intermolecular hydrogen bonding. Bonding in both the cases is shown below:  (i) (ii) (b) As a large number of molecules can be linked together through intermolecular hydrogen bonding, compound II will show higher melting point. (c) Due to intramolecular hydrogen bonding, compound I will not be able to form hydrogen bonds with H_20 molecules. Hence, it will be less soluble in water. However, compound II can form hydrogen bonds with H_20 molecules easily and hence it will be more soluble in water.
35	(i) c (ii) d (iii) a

	(iv) b

SECTION D

36	1. (C) Hydrogen bonding 2. (A) 3. (B) 4. (B)
37	1. (c) 33 2. (d) Square planer 3. (a)Mixing up of atomic orbitals 4. (b)1

SECTION E

38	(a). N≡N$^+$ — O$^-$ (b). Cs$^+$ and I_3^-. (c). CN$^-$ (14): $\sigma(1s)^2$, $\sigma^*(1s)^2$, $\sigma(2s)^2$, $\sigma^*(2s)^2$, $\pi(2p_x)^2 = \pi(2p_y)^2$, $\sigma\,(2pz)^2$. (d). lp – lp > lp – bp > bp – bp (bp is bond pair, lp is lone pair).  Square pyramidal (e)
39	Correct structure
40	The ground state E.C. and the excited state E.C. of phosphorus are represented as:  *sp³ hybrid orbitals filled by electron pairs donated by five Cl atoms* The one s, three-p and one d-orbitals hybridise to yield five sets of SP^{3}d hybrid orbitals which are directed towards the five corners of a trigonal bipyramidal as in Fig.  *Trigonal bipyramidal geometry of PCl$_5$ molecule*

	Because axial bond pairs suffer more repulsive interaction from the equatorial bond pairs, therefore axial bonds have been found to be slightly longer and hence slightly weaker than equatorial bonds.
41	Bond order is defined as the half of the difference between the number of electrons present in bonding and antibonding molecular orbitals. $\text{Bond order} = \frac{1}{2}(N_b - N_a)$ $\text{E.C of } N_2 = 1s^2\, 2s^2\, 2p_x{}^1 2p_y{}^1 2p_z{}^1$ (*i*) $\text{M.O. configuration of } N_2 = [\sigma 1s]^2[\sigma * 1s]^2[\sigma 2s]^2[\sigma * 2s]^2[\pi 2p_x]^2[\pi 2p_y]^2[\sigma 2p_z]^2$ $\text{Bond order (B.O.)} = \frac{1}{2}(N_b - N_a)$ $= \frac{1}{2}[8-2] = 3$ (*ii*) $\text{M.O. configuration of } O_2 = [\sigma 1s]^2[\sigma * 1s]^2[\sigma 2s]^2[\sigma * 2s]^2[\sigma 2p_z]^2$ $\text{B.O} = \frac{1}{2}[N_b - N_a]$ $= \frac{1}{2}[8-4] = 2$ (*iii*) $\text{M.O. configuration of } O_2{}^+ = \text{KK}[\sigma 2s]^2\,[\sigma * 2s]^2\,[\sigma 2p_z]^2\,[\pi 2p_x]^2\,[\pi 2p_y]^2\,[\pi * 2p_x]^1$ $\text{B.O.} = \frac{1}{2}[8-3] = 2.5$ (*iv*) $\text{M.O. configuration of } O_2{}^-$ $= \text{KK}[\sigma 2s]^2\,[\sigma * 2s]^2\,[\sigma 2p_z]^2\,[\pi 2p_x]^2\,[\pi 2p_y]^2\,[\pi * 2p_x]^2\,[\pi * 2p_y]^1$ $\text{B.O.} = \frac{1}{2}[8-5] = 1.5$

CHEMICAL THERMODYNAMICS

MCQS (1 MARKS)

Q1 Which of the following property cannot be used to describe the state of a system?

(a)pressure (b) volume (c) temperature (d) universal gas constant

Q2 The open system allows the transfer of________

(a) Only mass (b) only energy

(c) both mass and energy (d) neither mass and energy

Q 3 During the process of conversion of ice into the water the specific heat capacity is given by_______

Zero (b) positive .(c) infinity (d) negative

Q 4. Which of the following is not a spontaneous process?

(a) Sugar dissolves in water (b) melting of iron

(c)rusting of iron (d) evaporation of water

Q 5. Spontaneous reactions that occur are mostly

(a) Endothermic (b) exothermic

c) both endothermic and exothermic

(d) neither endothermic nor exothermic

Q 6. Which of the following relation is true between Gibbs energy, enthalpy, temperature and entropy?

G=H-TS (b) G=H-T (c) G=H-S (d) G=-TS

Q 7 A thermodynamic state function is a quantity

(a) Used to determine heat changes

(b) Whose value is independent of path

(c) used to determine pressure volume work

whose value depends on temperature only

Q 8 Which of the following is not correct?

(a) ΔG is zero for a reversible reaction

(b) .ΔG is positive for a spontaneous reaction

(c) ΔG is negative for a spontaneous reaction

(d) ΔG is positive for a non-spontaneous reaction

Q 9. Which of the following is an extensive property?

(a)Molar heat capacity (b) temperature

(c) enthalpy (d)all of these

Q 10. 1. Find out whether the following reaction is spontaneous or not at 127 degrees centigrade? $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$; $\Delta H = 92.22$ kJ/mol and $\Delta S = -198.75$ J/K-mol.

(a) it is spontaneous (b) it is not spontaneous

(c) it may be spontaneous (d) cannot predict

Q 11. Which of the following is an intensive property?

(a) Volume (b) Colour

(c) Enthalpy (d) Internal energy

Q 12 The first law of thermodynamics states that the energy of an isolated system is constant.

(a) True (b)false

Q 13. Enthalpy of solution can either be positive or ________

(a) negative (b) does not exist

(c) 0 (d) infinity

Q 14. When work is done on system or by a system there is a change in _________

a) external energy

b) internal energy

c) adiabatic energy
d) isothermal energy

Q 15 The enthalpies of all elements in their standard states are:

(a) Unity (b) zero (c) < 0 (d) different for each element

(2X10=20)

SECTION B (short answer questions- 2 Marks)

Q 16. Explain which of the following are extensive properties:
Temperature, internal energy, mass, pressure, volume and heat capacity

Q 17. Heat capacity (Cp) is the extensive property; however, the specific heat (c) is the intensive property. What will be the relation between the Cp and c for 1 mol of the water?

Q 18. Is a closed system the same as an isolated system?

Q 19. In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in the internal energy for the process?

Q 20. Predict the change in the internal energy for the isolated system at the constant volume.

Q 21. Given the condition, $\Delta H = 0$ for the mixing of the two gases. Explain if the diffusion of these gases into each other in the closed container is a spontaneous process or not.

Q 22. Why is the difference between ΔH and ΔU not significant for solids or liquids?

Q 23. What kind of system is the coffee held in a cup?

Q 24. How can we change the above system mentioned in q 23 into an isolated system?

Q 25. Change in internal energy is a state function while work is not, why?

SECTION C (3 Marks) **(3X10=30)**

Q 26. If water vapour is assured to be perfect gas, molar enthalpy change for vaporisation of 1 mol of water at 1 bar and 100°C is 41kJ/mol. Calculate the internal energy change when 1 mol of water is vaporised at 1 bar pressure and

Q 27. Prove that Cp-Cv=R

Q 28. How is the internal energy of a system affected when

(a) Heat passes into or out of a system?
(b) Work is done by or on the system

Q 29. ΔG is net energy available to do useful work and is thus a measure of "free energy". Show mathematically that ΔG is a measure of free energy. Find the unit of ΔG. If a reaction has positive enthalpy change and positive entropy change, under what condition will the reaction be spontaneous?

Q30. The ΔH and ΔS for $2Ag2O(s) \rightarrow 4Ag(s)+O2(g)$ are given +61.17kJmol - 1and +132Jk - 1mol - 1 respectively. Above what temperature will the reaction be spontaneous?

Q31. At the temperature 298 K, the Kp of the reaction is given as
N_2O_4 (g) ⇄ $2NO_2$ (g) is 0.98. Predict when the reaction is spontaneous or not.

Q32. Calculate the number of kj of heat necessary to raise the temperature of 60 g of aluminium from 35°C to 55°C. Molar heat capacity of Al is 24 J mol^{-1} K^{-1}.

Q33. (a)For an isolated system $\Delta U = 0$; what will be ΔS?
(b)For a reaction at 298 K
$2A + B \longrightarrow C$
ΔH = 40Q kj mot1 and AS = 0.2 kj Kr^{-1} mol^{-1}.
At what temperature will the reaction become spontaneous considering ΔH and ΔS to be constant over the temperature range?

Q34. An increase In the enthalpy of the surroundings is the same as the decrease In the enthalpy of the system. Will the temperature of the system and its surroundings be equal if they are in thermal equilibrium?

Q35. The difference between the Cp and Cv can be derived as the empirical relation H = U + PV. Calculate the difference between the Cp and Cv for the ten moles of the ideal gas.

SECTION D (4 Marks) **(4X4=16)**

Q 36 Derive the relationship between ΔH and ΔU for an ideal gas. Explain each term Involved in the equation.

Q 37. Predict in which of the following the entropy increases or decreases:

(a) A liquid crystallizes into a solid
(b) Temperature of a crystalline solid is raised from 0K to 115K
(c) $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2)(g)$
(d) $H2(g) \rightarrow 2H(g)$

Q 38. What do you understand by isothermal and free expansion of a gas?

Q 39. (a)Define entropy.
(b)Why is entropy a state function?

SECTION E (5 Marks) (5X4=20)

Q 40. Give reason for the following:
(a)Neither q nor w is a state function but q + w is a state function.
(b)A real crystal has more entropy than an ideal crystal.

Q41 (a)Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion ?
(b) Consider the same expansion, but this time against a constant external pressure of 1 atm.
(c) Consider the same expansion, to a final volume of 10 litres conducted reversibly.

Q42 (a) Give the correct relation between equilibrium constant (K), standard free energy (ΔG°) and temperature (T).
(b)Calculate the Standard Free Energy Change at 25°C given the Equilibrium constant of 1.3×10^4.

Q43 Derive the work done in
(a) an isothermally reversible process
(b) free expansion

Concepts of System and types of systems, surroundings, work, heat, energy, extensive and intensive properties, state functions. First law of thermodynamics -internal energy and enthalpy, heat capacity and Introduction of entropy as a state function, Gibb's energy change for spontaneous and non-spontaneous processes,

Answers:

Ans 15

SECTION A MCQS (1X15=15)

1. (d)	2. (c)	3. (c)	4. (b)	5. (b)
6. (a)	7. (b)	8. (b)	9. (c)	10. (b)
11. (b)	12. (a)	13. (a)	14. (b)	15.

SECTION B (2X10=20)

Ans 16 Mass, volume, heat capacity and internal energy are extensive properties as the above mentioned values depends on quantity or size of matter present in the system.

Ans 17 For the water, the heat capacity is = 18 × specific heat and Cp = 18 × c .Specific heat is c = 4.18 Jg-1 K-1

Heat capacity is Cp = 18 × 4.18 JK-1 = 75.3 J K-1.

Ans 18. No. Systems can be classified as open, closed, or isolated. Open systems allow energy and mass to pass across the system boundary. A closed system allows energy but not mass across its system boundary. An isolated system allows neither mass or energy to pass across the system boundary

Ans 19. In the given case, q =+***701 J***, w = ***-394 J***. According to the first law of thermodynamics, DeltaU = q + w = + ***701*** + (-394) = + 307 ***J*** Thus, ***internal energy= 307J***

Ans 20 There is no energy transfer as the heat or the work in the isolated system,Thus, w=0 and q=0. According to the first law of thermodynamics-$\Delta U = q + w = 0 + 0 = 0$ $\Delta U = 0$

Ans 21. The diffusion will be a spontaneous process. As the change in the enthalpy is zero, the change in the randomness or disorder that is ΔS increases. As a result, for the equation $\Delta G = \Delta H - T\Delta S$, the term TΔS will be given as negative. Thus, ΔG will be negative. Hence the process will be spontaneous.

Ans 22. The difference between ΔH and ΔU is not significant for solids or liquids because systems made up entirely of solids and/or liquids do not experience significant volume changes when heated, the difference between and is usually insignificant.

Ans 23 Coffee held in a cup is an open system because it can exchange matter (water vapour and energy (heat) with the surroundings.

Ans 24. Coffee held in a thermos flask is an example of an isolated system because it can neither exchange energy nor matter with the surroundings.

Ans 25. In a process, the change in internal energy depends upon the initial and final state of the system. Therefore, it is a state function. But work is dependent on the path followed. Therefore, it is not a state function.

SECTION C (3X10=30)

Ans 26. The change $H_2O(l) \rightarrow H_2O(g)$

$\Delta H = \Delta U + \Delta n_gRT$ or

$\Delta U = \Delta H - \Delta n_gRT$, substituting the values, we get

$\Delta U = 41.00 \text{kJmol}^{-1} - 1 \times 8.3 \text{J mol}^{-1} \text{K}^{-1} \times 373\text{K}$

$= 41.00 \text{kJ mol}^{-1} - 3.096 \text{ kJ mol}^{-1}$

$= 37.904 \text{kJ mol}^{-1}$

Ans 27. From the equation $\mathbf{q = n\ C\ \Delta T}$, we can say:

At constant pressure P, we have

$\mathbf{q_P = n\ C_P \Delta T}$

This value is equal to the change in enthalpy, that is,

$\mathbf{q_P = n\ C_P \Delta T = \Delta H}$

Similarly, at constant volume V, we have

$\mathbf{q_V = n\ C_V \Delta T}$

This value is equal to the change in internal energy, that is,

$\mathbf{q_V = n\ C_V \Delta T = \Delta U}$

We know that for one mole (n=1) of an ideal gas,

$\mathbf{\Delta H = \Delta U + \Delta(pV)} = \Delta U + \Delta(RT) = \Delta U + R\ \Delta T$

Therefore, $\mathbf{\Delta H = \Delta U + R\ \Delta T}$

Substituting the values of ΔH and ΔU from above in the former equation,

$\mathbf{C_P \Delta T = C_V \Delta T + R\ \Delta T}$

$\mathbf{C_P = C_V + R}$

$\mathbf{C_P - C_V = R}$

Ans 28. (a)When heat is transferred from the surroundings into the system there is a rise in the temperature and the internal energy and when the heat is passed out of the system into the surroundings the internal energy is decreased.

(b) If work is done by the system then Internal Energy decreases . As U (Internal energy) =Q(Heat) +W(Work done) . If work is done by the system so work is negative and hence Internal energy decreases. On the other hand, when the work is done on the system(e.g. compressing a gas), the internal energy increases

Ans 29. $\Delta S_{Total} = \Delta S_{sys} + \Delta S_{surr}$

$\Delta S_{Total} = \Delta S_{sys} + (- \Delta H_{sys}/T)$

$T\Delta S_{Total} = T\Delta S_{sys} - \Delta H_{sys}$

For spontaneous change, $\Delta S_{Total} > 0$

$\therefore T\Delta S_{sys} - \Delta H_{sys} > 0$

$-(\Delta H_{sys} - T\Delta S_{sys}) > 0$

But, $\Delta H_{sys} - T\Delta S_{sys} = \Delta G_{sys}$

$\therefore -\Delta G_{sys} > 0$

$\Delta G_{sys} = \Delta H_{sys} - T\Delta S_{sys} < 0$

ΔH_{sys} = Enthalpy change of a reaction

$T\Delta S_{sys}$ = Energy which is not available to do useful work

ΔG_{sys} = Energy available for doing useful work

- If ΔG is negative (< 0), the process is spontaneous.
- If ΔG is positive (> 0), the process is non spontaneous.

Unit of ΔG is Joule.

The reaction will be spontaneous at high temperature.

Ans 30. From the above question we have $\Delta H$and ΔS for $2Ag2O(s) \rightarrow 4Ag(s)+O2(g)$ are given as +61.17kJmol - 1 and +132Jk - 1mol - 1 respectively.

As per the Gibbs Helmholtz equation, $\Delta G=\Delta H-T\Delta S$

Here, ΔG is the change in Gibbs free energy, $\Delta H$is the change in the enthalpy, T is the absolute temperature.

For the reaction $2Ag2O(s) \rightarrow 4Ag(s)+O2(g)$

It is spontaneous when $\Delta G$is negative.

Here ΔH,$\Delta S$is positive. So $\Delta G$is negative when $\Delta H<T\Delta S$

$T>\Delta H\Delta S$

T=61170mol - 1132Jk - 1mol - 1

$T=463.4K$

Therefore, the process is spontaneous above a temperature of T=463.4K.

Ans 31. For the spontaneous reaction,

ΔrG° is given as -ve.

ΔrG° = – RT ln Kp = – RT ln (0.98)

In (0.98) is – 0.02

ΔrG° = – RT × –0.02

Δ will be positive.

Thus, the reaction will be considered as non-spontaneous.

Ans 32. No. of moles of Al (m) = (60g)/(27 g mol$^{-1)}$ = 2.22 mol
Molar heat capacity (C) = 24 J mol^{-1} K^{-1}.
Rise in temperature (ΔT) = 55 – 35 = 20°C = 20 K
Heat evolved (q) = C x m x T = (24 J mol^{-1} K^{-1}) x (2.22 mol) x (20)
= 1065.6 J = 1.067 kj

Ans 33. (a)Change in internal energy (ΔU) for an isolated system is zero for it does not exchange any energy with the surroundings. But entropy tends to increase in case of spontaneous reaction. Therefore, ΔS > 0 or positive.

(b) As per the Gibbs Helmholtz equation:
ΔG = Δ H- TΔ S For ΔG=0 ; ΔH=TΔS or T=ΔH/ΔS
T = (400 KJ mol^{-1})/(0.2 KJ K^{-1} mol^{-1}) = 2000 k
Thus, reaction will be in a state of equilibrium at 2000 K and will be spontaneous above this temperature.

Ans 34. Yes, if the system, as well as the surroundings, are in thermal equilibrium, their temperatures are equal. Also, an increase in the enthalpy of the surroundings is equal to a decrease in the enthalpy of the system.

Ans 35. For the 1 mole of the gas,

Cp – Cv = R

For n moles of the gas, the relation is given as

Cp – Cv = nR = 10 × 4.184 J

Cp – Cv = 41.84 J.

Section D **(4X4=16)**

Ans 36. (i) At constant volume-

By first law of thermodynamics: q = ΔU + (–w)

(–w) = pΔV

$\therefore q = \Delta U + p\Delta V$

$\Delta V = 0$, since volume is constant.

$\therefore q_V = \Delta U + 0 \Rightarrow qV = \Delta U$ = change in internal energy

(ii) At constant pressure $q_p = \Delta U + p\Delta V$
But, $\Delta U + p\Delta V = \Delta H$
$\therefore qp = \Delta H$ = change in enthalpy.
So, at a constant volume and at constant pressure heat change is a state function because it is equal to change in internal energy and change in enthalpy respectively which are state functions.

Ans 37 Definition: Entropy is defined as a measure of randomness or disorder of a system.
(a)A liquid crystallizing into a solid is a freezing process and after freezing, the molecules attain an ordered state and therefore, entropy decreases.

(b) Temperature of a crystalline solid is raised from 0 K to 115 K. At 0 K, the constituent particles are static, and entropy is minimum. If temperature is raised to 115 K, these begin to move and oscillate about their equilibrium positions in the lattice and system becomes more disordered, therefore entropy increases.

(c) In the given reaction, reactant (NaHCO3) is a solid and it has low entropy. Among products there are one solid and two gases. Therefore, the products represent a condition of higher entropy.

(d) In the given reaction, here one molecule gives two atoms i.e., number of particles increases leading to more disordered state. Two moles of H atoms have higher entropy than one mole of dihydrogen molecule.

Ans 38. (a) An isothermal process is a change in the system such that the temperature remains constant. In other words, in isothermal process $\Delta T = 0$. (b)Free expansion of a gas occurs when it is subjected to expansion in a vacuum (p_{ex}=0).

Ans 39. (a)entropy: the degree of disorder or uncertainty in a system. 2. a. : the degradation of the matter and energy in the universe to an ultimate state of inert uniformity. Entropy is the general trend of the universe toward death and disorder.

1. (b) The entropy is a state function because it depends on the final and initial state of the process.
2. It does not depend on the path by which the process is completed.
3. For example, entropy change for a reversible process is the same when the same process undergoes an irreversible manner but for work and heat, it is not the same because entropy is a state function and work and heat are path functions.

SECTION E

(5X4=20)

Ans 40. (a) $q + w = \Delta u$

As Δu is a state function hence, $q + w$ is a state function.

(b) A real crystal has some disorder due to the presence of defects in its structural arrangement whereas ideal crystal does not have any disorder. Hence, a real crystal has more entropy than an ideal crystal.

Ans 41.

(a) We have $q = - w = p_{ex} (10 - 2) = 0(8) = 0$ No work is done; no heat is absorbed.

(b) We have $q = - w = p_{ex} (8) = 8$ litre-atm

(c) We have $q = - w = 2.303 \times 10\ 10 \log 2 = 16.1$ litre-atm

Ans 42. (a) The correct relation between equilibrium constant (K), standard free energy ($\Delta G°$) and temperature (T) can be given as-

Consider a reaction, $A + B \rightleftarrows C + D$

$\Delta G = \Delta G^{\Theta} + RT \ln K$

For equilibrium, $\Delta G = 0$

$0 = \Delta G^{\Theta} + RT \ln K$

$\Delta G^{\Theta} = -RT \ln K$

$\Delta G^{\Theta} = -2.303RT \log K$

(b) $\Delta G^{\Theta} = -2.303\ RT\log K$

$\Delta G^{\Theta} = -2.303\ RT\log K = -8.314 \times 298 \times \log 1.3 \times 10^{4} = -23469\ J = -23.4\ KJ$

Ans 43. (a) Derivation of work done in isothermal reversible expansion

$dW=P\times A\times dl=P\times dV$

The amount of work done by isothermal reversible expansion of an ideal gas from V1 to V2 is

$W=\int V2V1PdV$

From ideal gas equation, $P=nRTV$

Hence $W=\int V2V1nRTVdV=nRT\int V2V1dVV$

On integration we get

W=nRTlnV2V1

Since

P1V1=P2V2P1P2=V2V1W=nRTlnP1P2

(b) Expansion of a gas in vacuum (pex = 0) is called free expansion. No work is done during free expansion of an ideal gas whether the process is reversible or irreversible (equation 6.2 and 6.3). Now, we can write equation 6.1 in number of ways depending on the type of processes. Let us substitute w = – pexΔV (eq. 6.2) in equation 6.1, and we get Δ = − Δ U q p V ex If a process is carried out at constant volume (ΔV = 0), then ΔU = qV the subscript V in q V denotes that heat is supplied at constant volume.

EQUILIBRIUM

MULTIPLE CHOICE QUESTIONS (1MARKS)

1. A weak electrolyte is characterized by:
   a) Complete ionization in solution
   b) Partial ionization in solution
   c) No ionization in solution
   d) High electrical conductivity
2. If the degree of ionization of an acid is 0.5, what percentage of the acid is ionized?
   a) 0.5%
   b) 5%
   c) 50%
   d) 100%
3. For a dibasic acid like H_2SO_4, the ionization can be represented as:
   a) $H_2SO_4 \rightarrow H^+ + HSO^{4-}$
   b) $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$
   c) $H_2SO_4 \rightarrow HSO_4^- + H_2O$
   d) $H_2SO_4 \rightarrow SO_4^{2-} + 2H_2O$
4. The strength of an acid is determined by its:
   a) Molecular weight
   b) Ability to donate protons
   c) Solubility in water
   d) Color change in indicators

5. The pH of a solution is a measure of its:
   a) Solubility
   b) Ionization energy
   c) Hydrogen ion concentration
   d) Density
6. Which salt, when dissolved in water, will produce a basic solution?
   a) NaCl
   b) KNO_3
   c) Na_2CO_3
   d) NH_4Cl
7. Which of the following pairs can form a buffer solution?
   a) HCl and NaCl
   b) NH_3 and NH_4Cl
   c) NaOH and NaCl
   d) H_2SO_4 and $KHSO_4$
8. For the buffer system of acetic acid (CH_3COOH) and sodium acetate (CH_3COONa), the Henderson-Hasselbalch equation is:
   a) $pH = pK_a + \log([CH_3COOH]/[CH_3COONa])$
   b) $pH = pK_a + \log([CH_3COONa]/[CH_3COOH])$
   c) $pH = 14 - pK_a$
   d) $pH = 7 + \log([CH_3COONa]/[CH_3COOH])$
9. The concentration of hydrogen ion in a sample of soft drink is 3.8×10^{-3} M. what is its pH?
   a) 1.37
   b) 2.42
   c) 3.34

d) 4.56

10. The solubility product expression for $BaSO_4$ is:
  a) Ksp = $[BaSO_4]$
  b) Ksp = $[Ba^{2+}][SO_4^{2-}]$
  c) Ksp = $[Ba^{2+}][SO_4^{2-}]/[BaSO_4]$
  d) Ksp = $[Ba^{2+}]^2[SO_4^{2-}]^2$
11. The addition of NaCl to a saturated solution of AgCl will:
  a) Increase the solubility of AgCl
  b) Decrease the solubility of AgCl
  c) Have no effect on the solubility of AgCl
  d) Increase the ionization of AgCl
12. What is the pH of a buffer solution prepared from 0.1 M acetic acid and 0.1 M sodium acetate? (Given pKa of acetic acid = 4.76)
  a) 4.76
  b) 7.00
  c) 3.76
  d) 5.76
13. Calculate the degree of hydrolysis of a mixture of containing 0.1N NH_4OH and 0.1N HCN. If $K_a=10^{-5}$ and $K_b=10^{-5}$.
  a) 10^5
  b) 10^2
  c) 10^{-5}
  d) 10^{-2}
14. The solubility product of a sparingly soluble salt AX_2 is 3.2×10^{-11}. Its solubility (in mol L^{-1}) is:
  a) 3.1×10^{-4}
  b) 2×10^{-4}
  c) 4×10^{-4}
  d) 5.6×10^{-6}
15. In which of the following acid-base titration, pH is greater than 8 at equivalence point:
  a) Acetic acid versus ammonia
  b) Acetic acid versus sodium hydroxide
  c) Hydrochloric acid versus ammonia
  d) Hydrochloric acid versus sodium hydroxide

SECTION-B [SHORT ANSWER TYPE – 2 marks]

1. Explain why the second ionization constant of a polybasic acid is typically smaller than the first.
2. Calculate the pH of a buffer solution containing 0.1 M CH3COOH and 0.1 M CH3COONa. (pKa of CH3COOH = 4.76)
3. For a buffer solution, if the ratio of [A-]/[HA] is 10 and pKa = 4, calculate the pH.
4. Calculate the degree of hydrolysis, hydrolysis constant and pH of 0.10M NH_4Cl solution. Given that: $K_b=1.8 \times 10^{-5}$.
5. Solubility of $PbSO_4$ in water at 296K is 0.038 g/lit. Calculate its solubility product constant, ($PbSO_4$ = 303)
6. 0.2 mole of CH_3COOH are half neutralised by adding NaOH solution. If K_a for CH_3COOH is 1.3×10^{-8}, calculate the pH of the solution.
7. Equal volumes of 0.002M solutions of sodium iodate and cupric chlorate are mixed together. Will it lead to precipitation of copper iodate? (For cupric iodate $K_{sp} = 7.4 \times 10^{-8}$)
8. Calculate the degree of hydrolysis and pH 0.025M ammonium acetate solution, $K_a = K_b = 1.8 \times 10^{-5}$.

9. pH of urine is 6.0. How many gram equivalents of the acid are eliminated by a patient who eliminates 1300 ml of urine per day.
10. In the qualitative analysis of group III cations, NH_4Cl is added before NH_4OH. Why?

SECTION-C [SHORT ANSWER TYPE- 3 MARKS]

1. Predict the pH of a solution resulting from the hydrolysis of ammonium chloride (NH4Cl) and explain your reasoning.
2. Discuss the significance of different ionization constants (Ka1, Ka2, Ka3) for polybasic acids.
3. Calculate the pH of a buffer solution made from 0.2 M acetic acid and 0.2 M sodium acetate, given that the pK_a of acetic acid is 4.76.
4. Use the Henderson-Hasselbalch equation to determine the pH of a buffer solution containing 0.05 M NH_4OH and 0.1 M NH_4Cl. (pK_b of NH_4OH = 4.75)
5. Calculate the solubility of calcium fluoride (CaF_2) in a solution that already contains 0.1 M NaF. (K_{sp} of $CaF_2 = 3.9 \times 10^{-11}$)
6. Explain the mechanism by which a buffer solution resists changes in pH upon the addition of a small amount of acid or base.
7. Explain the relationship between degree of ionization and the strength of an acid.
8. Calculate the degree of ionization for an acetic acid solution where the concentration of acetic acid is 0.1 M and the concentration of H+ ions is 0.001 M.
9. Calculate the percent hydrolysis of 0.15M solution of ammonium acetate. K_a for $CH_3COOH = 1.8 \times 10^{-5}$ and K_b for NH_3 is 1.8×10^{-5}.
10. The ionization constant of phenol is 1.0×10^{-10}. What is the concentration of phenolate ion in 0.05M solution of phenol? What will be its degree of ionization if the solution is also 0.01M in sodium phenolate?

SECTION-D [CASE STUDY BASED QUESTIONS- 4 MARKS]

I. The degree of ionization of a weak acid decreases as the concentration of the acid increases. For example, at 0.01 M concentration, acetic acid (CH_3COOH) has a higher degree of ionization compared to when it is at 0.1 M concentration.
A. What happens to the degree of ionization as the concentration of acetic acid increases?
B. Is acetic acid a strong or weak acid?
C. What is the general trend of degree of ionization with respect to concentration?
D. How is the degree of ionization of acetic acid measured?
II. Phosphoric acid (H_3PO_4) is a triprotic acid, meaning it can donate three protons (H^+). It has three ionization constants: $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, and $K_{a3} = 4.8 \times 10^{-13}$, each corresponding to a stepwise loss of a proton.
A. How many protons can H_3PO_4 donate?
B. What does K_{a1} represent in the ionization of H_3PO_4?
C. Which ionization constant indicates the weakest ionization step?
D. Why does K_{a3} have a much smaller value than K_{a1}?
III. Reactants and products coexist at equilibrium, so that the conversion of reactant to products is always less than 100%. Equilibrium reaction may involve the decomposition of a covalent (nonpolar) reactant or ionization of ionic compound into their ions in polar solvents. Ostwald dilution law is the application of the law of mass action to the weak electrolytes in solution. A binary electrolyte AB which dissociates into A^+ and B^- ions i.e. for every weak electrolyte, Since $\alpha << 1$ $(1 - \alpha) = 1$
(i) A monobasic weak acid solution has a molarity of 0.005 M and pH of 5. What is its percentage ionization in this solution?
(a) 2.0
(b) 0.2

(c) 0.5
(d) 0.25

(ii) Calculate ionisation constant for pyridinium hydrogen chloride. (Given that H^+ ion concentration is 3.6×10^{-4} M and its concentration is 0.02 M.)
(a) 6.48×10^{-2}
(b) 6×10^{-6}
(c) 1.5×10^{-9}
(d) 12×10^{-8}

(iii) The hydrogen ion concentration of a 10^{-8} M HCl aqueous solution at 298 K ($K_w = 10^{-14}$) is
(a) 9.525×10^{-8} M
(b) 1.0×10^{-8} M
(c) 1.0×10^{-6} M
(d) 1.0525×10^{-7} M

(iv) If a is the fraction of HI dissociated at equilibrium in the reaction: $2HI \Leftrightarrow H_2 + I_2$
then starting with 2 mol of HI, the total number of moles of reactants and products at equilibrium are
(a) 1
(b) 2
(c) $1 + \alpha$
(d) $2 + 2\alpha$

IV. Arrhenius acids give H^+ ion in aqueous solution whereas bases give OH^- in aqueous solution. Bronsted acids are proton donor whereas Bronsted bases are proton acceptors. Acids, on donating proton form conjugate base where as bases form conjugate acid after accepting proton. Buffer solution is a solution whose pH does not change by adding small amount of H^+ or OH^-. The decrease in concentration of one of the ion by adding other ions as common ion is called common ion effect. Lewis acids are electron deficient or positively charged. Lewis bases are electron rich or negatively charged, K_{sp} (solubility product) is the product of molar concentration of ions raised to power number of ions per formula of the compound in sparingly soluble salt. Precipitation occurs only if ionic product exceeds solubility product. Solubility of salt decreases in presence of common ion. K_W, is ionic product of water, 1×10^{-14} at 298 K. K_W, increases with increase in temperature. pH is -log $[H_3O^+]$ where $[H_3O^+] = C\alpha$ in monoprotic acid 'C' is molar concentration,'α' is degree of ionisation. A salt is said to be hydrolysed if pH of solution changes. K_H is hydrolytic constant. pH of salts of strong acid and strong base is equal to 7. pH of other salts can be 7. pH of buffer solution can be calculated with the help of Henderson equation: pH = pKa + log [Salt][Acid].
A. K_b for NH_3 is 1.80×10^{-5}. What will be K_a? [$K_W = 1 \times 10^{-14}$]
B. K_{sp} of $BaSO_4$ is 1.0×10^{-10}. What is its solubility?
C. Calculate pH of buffer solution containing 0.01 M CH_3COOH and 0.1 M CH_3COONa, $pK_a = 4.75$.
D. pK_a of CH_3COOH and pK_b of NH_4OH are 4.76 & 4.75 respectively. Calculate pH of CH_3COONH_4 solution. ($pK_w = 14$)

SECTION-E [LONG ANSWER TYPE- 5 MARKS]

1. A buffer solution is made by adding 0.1 mole of ammonium chloride (NH_4Cl) to 1 L of 0.1 M ammonia (NH_3). Using the Henderson-Hasselbalch equation, calculate the pH of this buffer solution. (pK_a of $NH_4^+ = 9.25$).
2. A solution is saturated with calcium fluoride (CaF_2). Calculate the molar solubility of CaF_2 in water given that the solubility product constant (K_{sp}) is 3.9×10^{-11}.

3. A buffer solution containing acetic acid and sodium acetate is prepared. If the solution is also saturated with calcium acetate ($Ca(C_2H_3O_2)_2$), explain how the solubility product of calcium acetate (K_{sp}) and the common ion effect influence the pH of the buffer. Calculate the changes in pH if the initial concentration of acetic acid is 0.1 M and sodium acetate is 0.1 M. (pK_a of acetic acid = 4.76, K_{sp} of calcium acetate = 4.0×10^{-3}).

4. The first ionization constant of H_2S is 9.1×10^{-8}. Calculate the concentration of HS^- ion in its 0.1 M solution. How will this concentration be affected if the solution is 0.1 M in HCl also? If the second dissociation constant of H_2S is 1.2×10^{-13}, calculate the concentration of S^{2-} under both conditions.

5. The ionization constant of benzoic acid is 6.46×10^{-5} and K_{sp} for silver benzoate is 2.5×10^{-13}. How many times is silver benzoate more soluble in a buffer of pH 3.19 compared to its solubility in pure water?

REDOX REACTIONS

SECTION -A (MCQ QUESTIONS) (1MARK)

1- Identify disproportionation reaction
(a) $CH4 + 2O_2 \rightarrow CO_2 + 2H_2O$
(b) $CH4 + 4Cl_2 \rightarrow CCl4 + 4HCl$
(c) $2F_2 + 2OH– \rightarrow 2F– + OF_2 + H_2O$
(d) $2NO_2 + 2OH– \rightarrow NO_2– + NO_3– + H_2O$

2- The more positive the value of E, the greater the tendency of the species to get reduced. Using the standard electrode potential of redox couples given below find out which of the following is the strongest oxidising agent.
E values: Fe3+ / Fe2+ = + 0.77; I2(s)/ I– = +0.54;
Cu2+ /Cu = + 0.34; Ag+ /Ag = + 0.80 V
(a) Fe3+
(b) I2(s)
(c) Cu2+
(d) Ag+

3- We know that metals generally react with dilute acids to produce hydrogen gas. Which one of the following metals does not react with dilute hydrochloric acid?

a. Copper
b. Magnesium
c. Iron
d. Silver

4-Why does the colourless solution of silver nitrate slowly turn blue on adding copper chips to it?

a. Dissolution of Copper
b. Oxidation of $Ag^+ \rightarrow Ag$
c. Reduction of Cu^{2+} ions
d. Oxidation of Cu atoms.

5- Which of the following is not a redox reaction?

(a) Burning of candle

(b) Rusting of iron

(c) Dissolving salt in water

(d) Dissolving Zinc in dil. H_2SO_4

6-The most powerful oxidising agent among the following is:

(a) H_2SO_4

(b) H_3BO_3

(c) HPO_3

(d) H_3PO_4

7-Consider the following reaction:

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

With reference to the above, which one of the following is the correct statement?

(a) Zn is reduced to Zn^{2+} ions.

(b) Zn is oxidised to Zn^{2+} ions.

(c) Zn^{2+} ions are oxidised to Zn.

(d) Cu^{2+} ions are oxidized to Cu.

8-Oxidation number of P in PO_4^{3-}, of S in SO_4^{2-} and that of Cr in $Cr_2O_7^{2-}$ are respectively:

(a) +3, +6 and +5

(b) +5, +3 and +6

(c) +3, +6 and +6

(d) +5, +6 and +6

9-The oxidation number of an atom in the elemental state is:
(a) –1
(b) 0
(c) 1
(d) 2

10-Values of standard electrode potential of three metals X, Y and Z are -1.2V, +0.5V and -3.0V respectively. The reducing power of these metals will be in order
(a) X>Y>Z
(b) Y>Z>X
(c) Y>X>Z
(d) Z>X>Y

11-The oxidation number of an element in a compound is evaluated on the basis of certain rules. Which of the following rules is not correct in this respect?
(a) The oxidation number of hydrogen is always +1.
(b) The algebraic sum of all the oxidation numbers in a compound is zero.
(c) An element in the free or the uncombined state bears oxidation number zero.
(d) In all its compounds, the oxidation number of fluorine is –1.

12-In which of the following compounds, 'Mn' exhibits highest oxidation state?
(a) $KMnO_4$
(b) K_2MnO_4
(c) MnO_2
(d) MnO

13-H_2SO_4 acts as a strong oxidising agent. In which of the reaction, is it not acting as an oxidising agent?
(a) $C + 2H_2SO_4 \rightarrow CO_2 + 2SO_2 + 2H_2O$
(b) $CaF_2 + 2H_2SO_4 \rightarrow CaSO_4 + 2HF$
(c) $S + 2H_2SO_4 \rightarrow 3SO_2 + H_2O$
(d) $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$

14-The values of x and y in the following reaction,
$xCl_2 + 6OH^-$ (hot & conc.) $\rightarrow ClO_3^- + yCl^- + 3H_2O$ are
(a) x = 2, y = 4
(b) x = 5, y = 3
(c) x = 3, y = 5
(d) x = 4, y = 2

15-When a zinc rod is kept in a copper nitrate solution what happens?
a) zinc is deposited on copper
b) copper is deposited on zinc
c) zinc is deposited in the beaker
d) copper is deposited in the beaker

16-Intensity of blue colour increases gradually when __________________
a) copper rod is dipped in silver nitrate solution
b) silver rod is dipped in copper nitrate solution
c) zinc rod is dipped in silver solution
d) copper rod is dipped in zinc rod solution

17-In this reaction $Cu^{+2} + Zn \rightarrow Cu + Zn^{+2}$, what is an oxidising agent?
a) copper
b) zinc
c) hydrogen
d) oxygen

18-What is the oxidation state of chlorine in $NaClO_3$?
A) -1
B) +1
C) +5
D) +7

19-Which element is reduced in the following equation: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$?
A) Fe
B) O
C) C
D) CO

20-Which of the following is a typical characteristic of redox reactions?
A) Only one reactant undergoes a change in oxidation state
B) They involve transfer of neutrons
C) They do not involve electron transfer
D) They involve changes in oxidation states of reactants

ANSWERS

1- d	6- a	11- a	16- a
2- d	7- b	12- a	17- a
3- a	8- d	13- b	18- c
4- d	9- b	14- c	19- a
5- c	10- d	15- b	20- d

SECTION -B (SA TYPE-I QUESTIONS)(2MARKS)

1- Calculate the oxidation number of each sulphur atom in the following compounds:

(a) Na_2SO_3

(b) Na_2SO_4

2-Balance the following equations by the oxidation number method.
$Fe^{2+} + Cr_2O_7^{2-} + H^+ \rightarrow Fe^{3+} + Cr^{3+} + H_2O$

3-Justify that the following reactions are redox reactions:
(a)$CuO(s)+H_2(g) \longrightarrow Cu(s)+H_20(g)$
(b) $Fe_2O_3(s) +3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$

4-Fluorine reacts with ice and results in the change:
$H_20(S)+F_2(g) \longrightarrow HF(g)+HOF(g)$
Justify that this reaction is a redox reaction.

5-.Write formulas for the following compounds:
(a) Mercury (II) chloride, (b) Nickel (II) sulphate, (c) Tin (IV) oxide, (d) Thallium (I) sulphate, (e) Iron (III) sulphate, (f) Chromium (III) oxide.

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

7-MnO_4^{2-} undergoes a disproportionation reaction in an acidic medium but $MnO4^-$ does not. Give a reason.

8-Why does ClO4- not show a disproportionation reaction whereas ClO^-, ClO_2^- and ClO_3^- show?

9- Justify that the reaction: $2Na(s) +H_2(g) \dashrightarrow 2 NaH(S)$ is redox reaction.

10-Write a balanced chemical reaction for the following:

Permanganate ion reacts with sulphur dioxide gas in acidic medium to produce Mn^{+2} and hydrogen sulphate ion. (Balance by ion electron method).

ANSWERS

SECTION-B

1-(a) Let the oxidation number in Na_2SO_3 be x.

Na_2SO_3
$\Rightarrow 2\times(+1)+x+(-2)\times3 = 0$
$\Rightarrow 2+x-6 = 0$
$\Rightarrow x = +4$
Thus, the oxidation number of sulphur in Na_2SO_3 is +4.

(b) Let the oxidation number of sulphur in Na_2SO_4 be x.
$\Rightarrow 2\times(+1)+x+(-2)\times4 = 0$
$\Rightarrow 2+x-8 = 0$
$\Rightarrow x = +6$
Thus, the oxidation number of sulphur in Na_2SO_4 is +6.

2-The chromium oxidation number drops from +6 in $Cr_2O_7^2$ to +3 in Cr^{3+}. In $Cr_2O_7^{2-}$ to Cr^{3+}, the total drop for two chromium atoms is 6. Iron's oxidation number, on the other hand, rises from +2 (in Fe^{2+}) to +3 (in Fe^{3+}).

Multiply Fe2+ by 6 and $Cr_2O_7^{2-}$ by 1 to balance the increase and reduction in oxidation numbers. Then there's,

$6Fe^{2+} + Cr_2O_7^{2-} + H^+ \rightarrow Fe^{3+} + Cr^{3+} + H_2O$

On both sides of the reaction, Fe and Cr atoms must be balanced.

$6Fe^{2+} + Cr_2O_7^{2-} + H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + H_2O$

Multiply H_2O by 7 to balance O atoms.

$6Fe^{2+} + Cr_2O_7^{2-} + H^+ \rightarrow 6Fe^3+ + 2Cr^{3+} + 7H_2O$

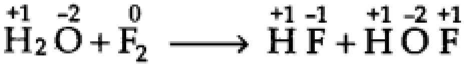
Multiply H+ by 14 to balance H-atoms.

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

3-a)Here, O is removed from CuO, therefore, it is reduced to Cu while O is added to H_2 to form H_20, therefore, it is oxidised. Further, O.N. of Cu decreases from + 2 in CuO to 0 in Cu but that of H increases from 0 in H_2 to +1 in H_20. Therefore, CuO is reduced to Cu but H_2 is oxidised to H_20. Thus, this is a redox reaction.

b) Here O.N. of Fe decreases from +3 if Fe_2O_3 to 0 in Fe while that of C increases from +2 in CO to +4 in CO_2. Further, oxygen is removed from Fe_2O_3 and added to CO, therefore, Fe_2O_3 is reduced while CO is oxidised. Thus, this is a redox reaction.

4- Writing the O.N. of each atom above its symbol, we have,



$$\overset{+1}{H_2}\overset{-2}{O} + \overset{0}{F_2} \longrightarrow \overset{+1}{H}\overset{-1}{F} + \overset{+1}{H}\overset{-2}{O}\overset{+1}{F}$$

Here, the O.N. of F decreases from 0 in F_2 to -1 in HF and increases from 0 in F_2 to +1 in HOF. Therefore, F_2 is both reduced as well as oxidised. Thus, it is a redox reaction and more specifically, it is a disproportionation reaction.

5-a) $Hg(II)Cl_2$, (b) $Ni(II)SO_4$, (c)$S_n(IV)O_2$ (d) $T_{12}(I)SO_4$, (e) $Fe_2(III)(S0_4)_3$, (f) $Cr_2(III)O_3$.

6-In AgF_2 oxidation state of Ag is +2 which is very very unstable. Therefore, it quickly accepts an electron to form the more stable +1 oxidation state.
$Ag^{2+} + e^-$ —————> Ag^+
Therefore, AgF_2, if formed, will act as a strong oxidising agent.

7-A disproportionation reaction is a redox reaction in which one component with an intermediate oxidation state results in the formation of two molecules with greater and lower oxidation states.

The oxidation states of manganese in their different compounds range from +2 to +7. Disproportionation is not possible with MnO4– because of its maximum oxidation state of +7; however, MnO42- has a +6 oxidation state and can be both oxidised and reduced.

8-ClO4- does not show a disproportionation reaction because, in this compound, chlorine is present in its highest oxidation state which is +7. However, in the case of ClO^-, ClO_2^- and ClO_3^-, chlorine exists in + 1, +3 and +5 oxidation states respectively.

9-In this reaction sodium is oxidised and hydrogen is reduced. Hence it is a redox reaction.

10-Balance by ion electron method.

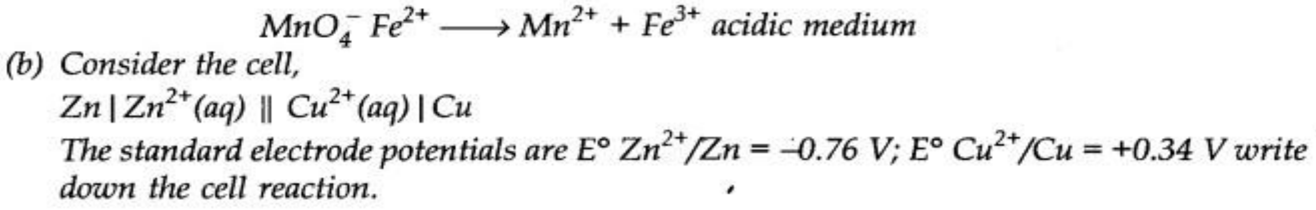
SECTION -C (SA TYPE -II QUESTIONS)(3 MARKS)

1-Balance the following equation in basic medium by ion electron method and oxidation number method and identify the oxidising agent and the reducing agent.
(a) $P_4(s) + OH^-(aq) \longrightarrow PH_3(g) + H_2PO_2^-(aq)$

2- The Mn^{3+} ion is unstable in solution and undergoes disproportionation to give Mn^{2+}, MnO_2 and H^+ ion. Write a balanced ionic equation for the reaction.

3-(a)Give two important functions of salt bridge.
(b)Balance the following equation by oxidation number method:
$Fe^{2+} + Cr_2O_7^{2-} + H+ \longrightarrow Fe^{3+} + Cr^{3+} + H_2O$

4- (a) Balance the following equation by oxidation number method or by ion electron (half reaction) method.



$MnO_4^- \; Fe^{2+} \longrightarrow Mn^{2+} + Fe^{3+}$ *acidic medium*

(b) Consider the cell,

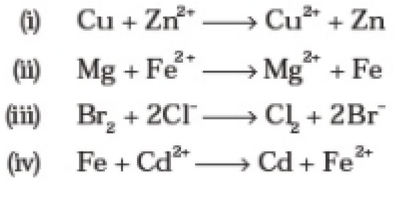
$Zn \,|\, Zn^{2+}(aq) \,||\, Cu^{2+}(aq) \,|\, Cu$

The standard electrode potentials are $E° \; Zn^{2+}/Zn = -0.76$ V; $E° \; Cu^{2+}/Cu = +0.34$ V *write down the cell reaction.*

5- Predict the products of electrolysis in each of the following:
(i) An aqueous solution of $AgNO_3$ with silver electrodes.
(ii) An aqueous solution of silver nitrate with platinum electrodes.
(iii) A dilute solution of $H_2S0_4$with platinum electrodes.

6- Depict the galvanic cell in which the reaction, $Zn(s) + 2Ag^+(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$ takes place show:
(i) which of the electrode is negatively charged.
(ii) the carriers of current in the cell and
(iii) individual reaction at each electrode.

7-On the basis of standard electrode potential values, suggest which of the following reactions would take place? (Consult the book for E^o value).

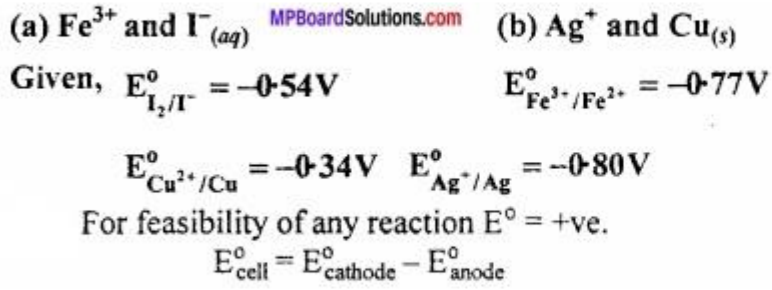


(i) $Cu + Zn^{2+} \longrightarrow Cu^{2+} + Zn$
(ii) $Mg + Fe^{2+} \longrightarrow Mg^{2+} + Fe$
(iii) $Br_2 + 2Cl^- \longrightarrow Cl_2 + 2Br^-$
(iv) $Fe + Cd^{2+} \longrightarrow Cd + Fe^{2+}$

8-What happens when Zn is kept in $CuS0_4$ solution? Explain with equation?

9-Chlorine is used to purify drinking water. Excess of chlorine is harmful. The excess chlorine is removed by treating with sulphur dioxide. Present a balanced equation for this redox change taking place in water?

10-On the basis of electrode potential values given below? Determine reaction between reactants will occur or not?



(a) Fe^{3+} and $I^-_{(aq)}$ (b) Ag^+ and $Cu_{(s)}$

Given, $E^o_{I_2/I^-} = -0{\cdot}54V$ $E^o_{Fe^{3+}/Fe^{2+}} = -0{\cdot}77V$

$E^o_{Cu^{2+}/Cu} = -0{\cdot}34V$ $E^o_{Ag^+/Ag} = -0{\cdot}80V$

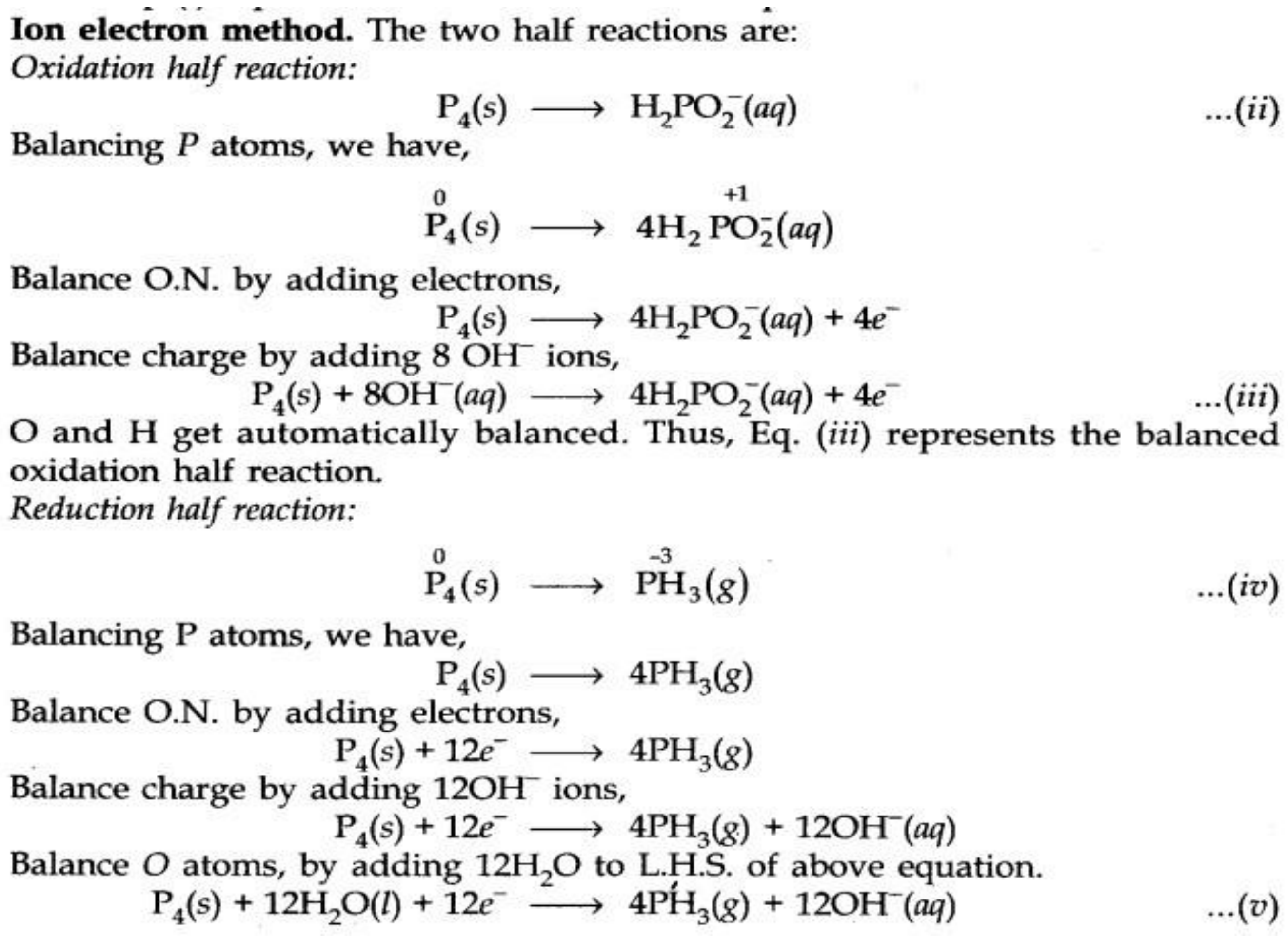
For feasibility of any reaction E^o = +ve.

$$E^o_{cell} = E^o_{cathode} - E^o_{anode}$$

ANSWERS

SECTION-C

1-



Ion electron method. The two half reactions are:

Oxidation half reaction:

$$P_4(s) \longrightarrow H_2PO_2^-(aq) \qquad ...(ii)$$

Balancing *P* atoms, we have,

$$\overset{0}{P_4}(s) \longrightarrow 4H_2\overset{+1}{P}O_2^-(aq)$$

Balance O.N. by adding electrons,

$$P_4(s) \longrightarrow 4H_2PO_2^-(aq) + 4e^-$$

Balance charge by adding 8 OH^- ions,

$$P_4(s) + 8OH^-(aq) \longrightarrow 4H_2PO_2^-(aq) + 4e^- \qquad ...(iii)$$

O and H get automatically balanced. Thus, Eq. (*iii*) represents the balanced oxidation half reaction.

Reduction half reaction:

$$\overset{0}{P_4}(s) \longrightarrow \overset{-3}{P}H_3(g) \qquad ...(iv)$$

Balancing P atoms, we have,

$$P_4(s) \longrightarrow 4PH_3(g)$$

Balance O.N. by adding electrons,

$$P_4(s) + 12e^- \longrightarrow 4PH_3(g)$$

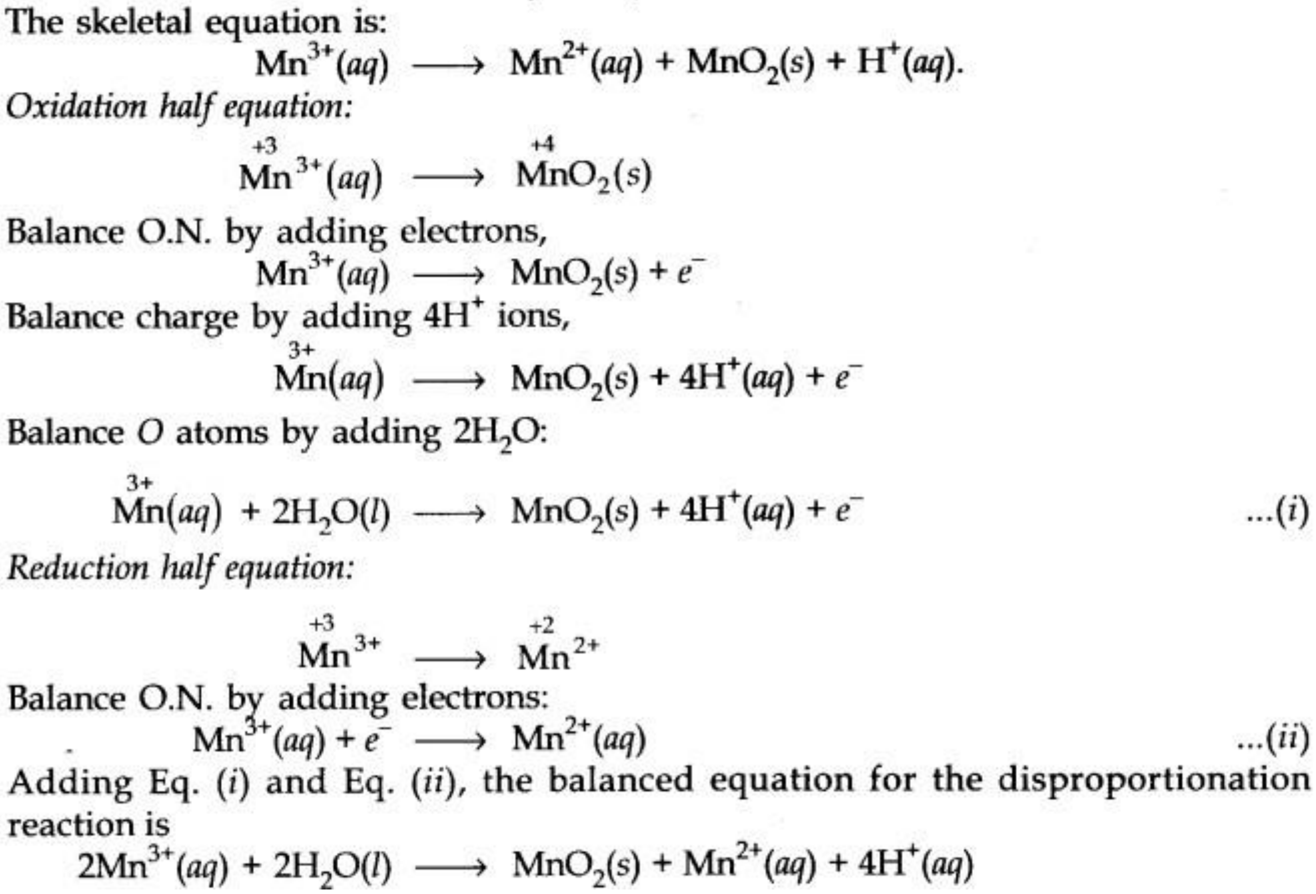
Balance charge by adding $12OH^-$ ions,

$$P_4(s) + 12e^- \longrightarrow 4PH_3(g) + 12OH^-(aq)$$

Balance *O* atoms, by adding $12H_2O$ to L.H.S. of above equation.

$$P_4(s) + 12H_2O(l) + 12e^- \longrightarrow 4PH_3(g) + 12OH^-(aq) \qquad ...(v)$$

2-



The skeletal equation is:

$$Mn^{3+}(aq) \longrightarrow Mn^{2+}(aq) + MnO_2(s) + H^+(aq).$$

Oxidation half equation:

$$\overset{+3}{Mn}{}^{3+}(aq) \longrightarrow \overset{+4}{Mn}O_2(s)$$

Balance O.N. by adding electrons,

$$Mn^{3+}(aq) \longrightarrow MnO_2(s) + e^-$$

Balance charge by adding $4H^+$ ions,

$$\overset{3+}{Mn}(aq) \longrightarrow MnO_2(s) + 4H^+(aq) + e^-$$

Balance *O* atoms by adding $2H_2O$:

$$\overset{3+}{Mn}(aq) + 2H_2O(l) \longrightarrow MnO_2(s) + 4H^+(aq) + e^- \qquad ...(i)$$

Reduction half equation:

$$\overset{+3}{Mn}{}^{3+} \longrightarrow \overset{+2}{Mn}{}^{2+}$$

Balance O.N. by adding electrons:

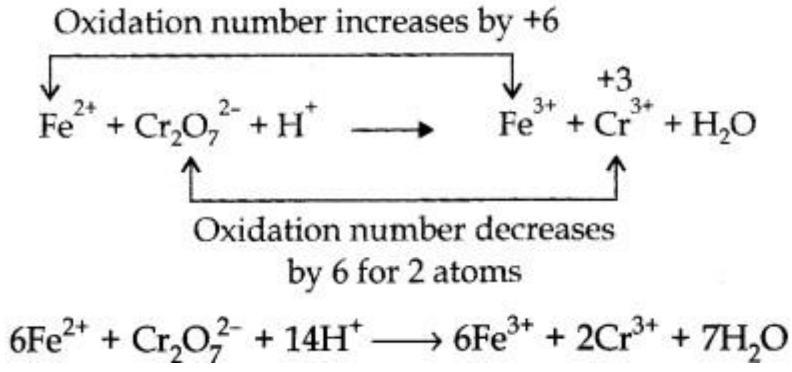
$$Mn^{3+}(aq) + e^- \longrightarrow Mn^{2+}(aq) \qquad ...(ii)$$

Adding Eq. (*i*) and Eq. (*ii*), the balanced equation for the disproportionation reaction is

$$2Mn^{3+}(aq) + 2H_2O(l) \longrightarrow MnO_2(s) + Mn^{2+}(aq) + 4H^+(aq)$$

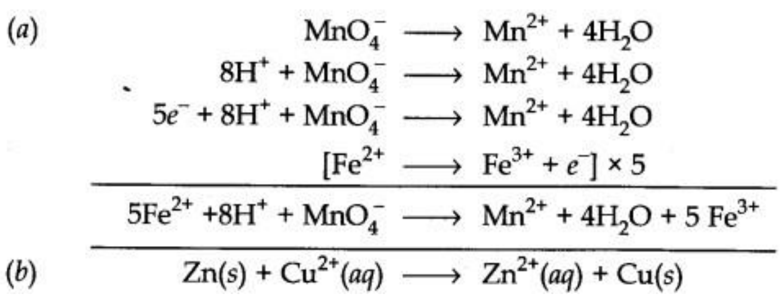
3- (a) (i) It completes the internal circuit.
(ii) It maintains the electrical neutrality.

b-



$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

4-



(*a*)

$$MnO_4^- \longrightarrow Mn^{2+} + 4H_2O$$

$$8H^+ + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O$$

$$5e^- + 8H^+ + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O$$

$$[Fe^{2+} \longrightarrow Fe^{3+} + e^-] \times 5$$

$$5Fe^{2+} + 8H^+ + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O + 5\,Fe^{3+}$$

(*b*)

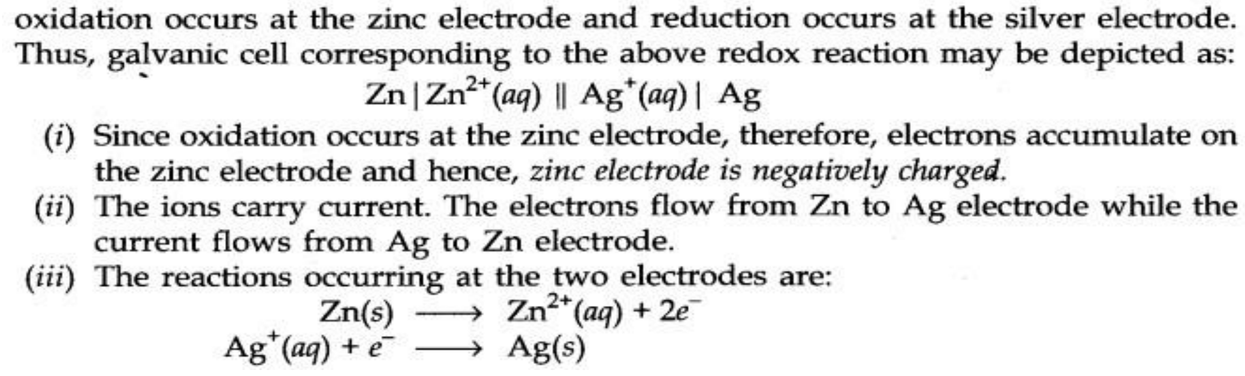
$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

5- (i) In aqueous solution, $AgNO_3$ ionises to give $Ag^+(aq)$ and NO_3^- (aq) ions.
$AgN0_3(aq)$ ———> $Ag^+(aq) + NO_3^-$ (aq)
Thus, when electricity is passed, $Ag^+(aq)$ ions move towards the cathode while NO_3^- ions move towards the anode. In other words, at the cathode, either $Ag^+(aq)$ ions or H_2O molecules may be reduced. Which of these will actually get discharged would depend upon their electrode potentials which are given below:
$Ag^+(aq) + e^-$———-> Ag(s); E° = +0.80 V …(i)
$2H_2O(Z) + 2e^-$ ————> $H_2(g) + 2OH^-(aq)$; E° = -0.83 V …(ii)
Since the electrode potential (i.e., reduction potential of $Ag^+(aq)$ ions is higher than that of H_2O molecules, therefore, at the cathode, it is the $Ag^+(aq)$ ions (rather than H_2O molecules) which are reduced.
Similarly, at the anode, either Ag metal of the anode or H_2O molecules may be oxidised. Their electrode potentials are:
Ag(s) ————> $Ag^+(aq) + e^-$; E° = -0.80 V …(iii)
$2H_2O(l)$ —————> $02(g) + 4H+(aq) + 4e^-$; E° = -1.23 V …(iv)
Since the oxidation potential of Ag is much higher than that of H_2O, therefore,
at the anode, it is the Ag of the silver anode which gets oxidised and not the H_2O molecules. It may, however, be mentioned here that the oxidation potential of $N0_3^-$ions is even lower than that of H_2O since more bonds are to broken during reduction of $N0_3$ ions than those in H_2O.
Thus, when an aqueous solution 0f $AgN0_3$ is electrolysed, Ag from Ag anode dissolves while $Ag^+(aq)$ ions present in the solution get reduced and get deposited on the cathode.

(ii) If, however, electrolysis of $AgN0_3$ solution is carried out using platinum electrodes, instead of silver electrodes, oxidation of water occurs at the anode since Pt being a noble metal does not undergo oxidation easily. As a result, O_2 is liberated at the anode according to equation (iv).
Thus, when an aqueous solution of $AgNO_3$ is electrolysed using platinum electrodes, Ag^+ ions from the solution get deposited on the cathode while 02 is liberated at the anode.

(iii) In aqueous solution, H_2S0_4ionises to give $H^+(aq)$ and $SO_4^{2-}(aq)$ ions.
$H_2S0_4(aq)$ ——> $2H^+(aq) + S0_4^-(aq)$
Thus, when electricity is passed, H^+ (aq) ions move towards cathode while $SO_4^{2-}(aq)$ ions move towards anode. In other wode either $H^+(aq)$ ions or H_2O molecules are reduced. Their electrode potentials are:$2H^+(aq)2e^-$ ——-> $H_2(g)$; E° = 0.0 V
$H_2O(aq) + 2e^-$ ——-> $H_2(g) + 2OH^-((aq)$; E° = -0.83 V
Since the electron potential (i.e., reduction potential) of $H^+(aq)$ ions is higher than that of H_2O, therefore, at the cathode, it is $H^+(aq)$ ions (rather than H_2O molecules) which are reduced to evolve H_2 gas.
Similarly at the anode, either $SO_4^{2-}(aq)$ ions or H_2O molecules are oxidised. Since the oxidation potential of SO_4^{2-} is expected to be much lower (since it involved cleavage of many bonds as compared to those in H2) than that of H_2O molecules, therefore, at the anode, it is H_2O molecules (rather than SO_4^{2-} ions) which are oxidised to evolve O_2 gas.
From the above discussion, it follows that during electrolysis of an aqueous solution of H_2S0_4 only the electrolysis of H_2O occurs liberating H_2 at the cathode and O_2 at the anode.

6- The given redox reaction is $Zn(s) + 2Ag^+(aq)$ ——————-> $Zn^{2+}(aq) + 2Ag(s)$
Since Zn gets oxidised to Zn^{2+} ions, and Ag^+ gets reduced to Ag metal, therefore,



oxidation occurs at the zinc electrode and reduction occurs at the silver electrode. Thus, galvanic cell corresponding to the above redox reaction may be depicted as:

$$Zn\,|\,Zn^{2+}(aq)\parallel Ag^{+}(aq)\,|\,Ag$$

(*i*) Since oxidation occurs at the zinc electrode, therefore, electrons accumulate on the zinc electrode and hence, *zinc electrode is negatively charged.*

(*ii*) The ions carry current. The electrons flow from Zn to Ag electrode while the current flows from Ag to Zn electrode.

(*iii*) The reactions occurring at the two electrodes are:

$$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^{-}$$

$$Ag^{+}(aq) + e^{-} \longrightarrow Ag(s)$$

7-The cell's net cell EMF determines whether or not a reaction will occur. The formula is as follows:

$Ecello = Ecathode – Eanode$

Option (ii) clearly shows that the reaction can occur because Mg has a lower Ecirc cell value. As a result, Mg is oxidised by losing an electron, whereas iron is reduced by gaining one.

$Mg+Fe2+ \rightarrow Mg2++Fe$

We can state that Fe goes through reduction and Mg goes through oxidation.

Taking the E^o values,

$E^o_{cathode}$ = -0.44V

E^o_{anode} = -2.36V

E^o_{cell} = -0.44 – (-2.36)V

8-The reaction occurring in the beaker may be written as

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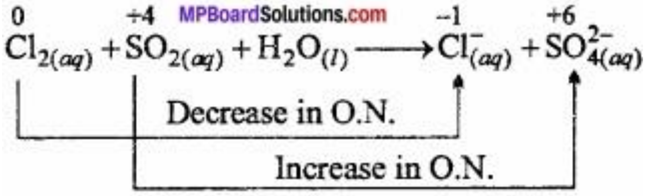
$$Zn_{(s)} + \underbrace{Cu^{2+}_{(aq)} + SO^{2-}_{4(aq)}}_{\text{From } CuSO_4 \text{ solution}} \longrightarrow Zn^{2+}_{(aq)} + SO^{2-}_{4(aq)} + Cu_{(s)}$$

Cancelling the common $S0_4^{2+}$ ions

$Zn_{(s)} + Cu^{2+}_{(eq)} \rightarrow Zn^{2+}_{(eq)} + Cu_{(s)}$

In this case Zinc metal loses electron and gets oxidised to Zn^{++} ions which goes into the solution. Due to this, weight of zinc plate gradually decreases. On the other hand, electrons lost by Zinc atom are taken up by Cu^{2+} ions of $CuS0_4$ solution.

9-Answer:



$$Cl_{2(aq)} + SO_{2(aq)} + H_2O_{(l)} \longrightarrow Cl^{-}_{(aq)} + SO^{2-}_{4(aq)}$$

Multiplying Cl^- by 2 (As 2 atoms are in Cl_2)

$Cl_{2(aq)} + SO_{2(aq)} + H_2O_{(l)} \rightarrow 2Cl^{-}_{(aq)} + SO_4^{2-}{}_{(aq)}$

On adding $4H^+$ in left side and multiplying in H_2O by 2,

$Cl_{2(aq)} + SO_{2(aq)} + 2H_2O_{(l)} \rightarrow 2Cl^{-}_{(aq)} + SO_4^{2-} + 4H^+$

It is a balanced disproportionation reaction.

10-For feasibility of any reaction E° = +ve.

$E°_{cell} = E°_{cathode} – E°_{anode}$

(a) $Fe^{3+}_{(aq)}$ and $I^{–}_{(aq)}$:

$2Fe^{3+} + 2I^{–}_{(aq)} \rightarrow 2Fe^{2+}_{(aq)} + 2I_{2g}$

Half cell reaction (oxidation)

$2I^{–}_{(aq)} \rightarrow I_{2(g)} + 2e^{–}$ E° = – 0.54 V

Reducion half cell,

$2Fe^{3+}_{(aq)} + 2e^{–} \rightarrow 2Fe^{2+}_{(aq)}$ E° = +0.77 V

Complete reaction,

$2Fe^{3+}_{(aq)} + 2I^{–}_{(aq)} \rightarrow 2Fe^{2+}_{(aq)} + I_{2(g)}$ $E°_{cell}$ = +0.23 V

E° = +ve, reaction is feasible.

(b) $Ag^{+}_{(aq)}$ and $Cu_{(s)}^{2+}$:

$2Ag_{(aq)} + Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(aq)}$

Oxidation half reaction,

$Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e^{–}$ E° = – 0.34 V

Reduction half reaction,

$2Ag^{+}_{(aq)} + 2e^{–} \rightarrow 2Ag_{(s)}$ E° = – 0.80 V

Complete reaction,

$Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$ $E°_{cell}$ = +0.46 V

SECTION -D (CASE BASED QUESTIONS)

1-Although the term valency and oxidation state or number have different meanings yet these terms are quite useful in understanding the formation of compounds. Further, compounds of metals which show more than one oxidation states are distinguished from one another by placing Roman numeral such as I,II,III,IV V, VI, VII etc. indicating the oxidation state of the metals within parenthesis after the symbol or name of the metal. This system is called Stock notation.

Based on the passage answer the following questions.

i)Define the terms valency and oxidation number.(1)

ii)Write the formula of the following compounds with Stock notation.(1)

Cuprous chloride , Potassium permanganate

iii)The formula of sodium thiosulphate is $Na_2S_2O_3$ (2)

Do the two sulphur atoms have the same or different oxidation state/s. Explain

2-Oxidation -reduction reactions are complementary. These redox reactions are classified into four types. These are : combination reaction, decomposition reaction, metal displacement /non-metal displacement reaction and displacement reaction.

Based on the passage answer the following questions.

i)Give an example of a combination redox reaction .(1)

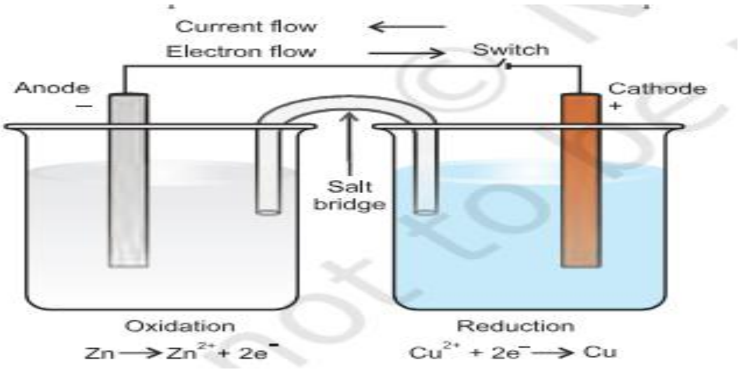
ii)Give an example of a decomposition redox reaction. (1)

iii) Are all decomposition reactions redox reaction? Justify.(2)

3- Redox reactions are important class of reactions which are taking place in our daily life. Metals are good reducing agents because they can lose electrons easily whereas non-metals are good oxidising agents which can gain electrons easily. In electrolytic cells, electricity is passed to bring about redox reaction. All rechargeable batteries are electrolytic cell while charging. Electrochemical cells produce electricity as a result of redox reactions. Salt bridge is used in electrochemical cell to complete the internal circuits and prevents accumulation of charges.

Based on the passage answer the following questions.
i)What is electrochemical cell? (1)
ii)Give one example of rechargeable cell widely used in vehicles.(1)
iii)Highly reactive metals are obtained by electrolysis of their molten ores. Why? (2)

4-Observe the following diagram and answer the questions that follows.



i)What is the direction of flow of current?
ii)What is the direction of flow of electrons?
iii)What will happen if the salt bridge is removed and why?

ANSWERS

SECTION -D (CASE BASED QUESTIONS)

1-a) Valency is the combining capacity of the element on the other hand oxidation number is the charge which an atom has or appear to have when present in the combined state.
b) $Cu_2(I)Cl_2$ and $K_2Mn(VI)O_4$
c) No, One sulphur atom has -2 and the other has +6 oxidation state.

2- a) $Mg + N_2$ --→ Mg_3N_2
b) $2H_2O$ -→ $2H_2 + O_2$
c)No ,all decomposition reactions are not redox reaction. For decomposition reaction to be redox reaction it is essential that one of the products of decomposition must be in the elemental state.

3- a)The cell in which chemical energy of redox reaction is converted into electrical energy is called electrochemical cell.
b)Lead storage battery.
c)It is because these metals are good reducing agents, cannot be obtained by chemical reduction.

4- a)current flows from cathode to anode.
b) Electrons flows from anode to cathode.
c) Voltmeter reading will drop to zero and current will stop flowing.

SECTION -E(LA TYPE QUESTIONS)(5 MARKS)

1-a)How do you count for the following observation though alkaline potassium permanganate and acidic potassium permanganate both are used as oxidants, yet in manufacture of benzoic acid from toluene we use alcoholic potassium permanganate as an oxidant, why? Write a balanced redox equation for the reaction? (3)

b) Why $\mathrm{ClO4-}ClO4-$does not show disproportionation reaction whereas $\mathrm{ClO-,ClO2-,ClO3-}ClO-,ClO2-,ClO3-$ shows? (2)

2-a) All decomposition reactions are not redox reactions. Give a reason.
b) Which gas is produced when less reactive metals like Mg and Fe react with steam?
C) Define disproportionation reaction.
d) Identify the reaction $\mathrm{2H2O2(aq)\rightarrow 2H2O(g)+O2(g)}$
e) Write the following redox reactions in the oxidation and reduction half-reaction reactions in the oxidation and reduction half-reactions.

(i) $\mathrm{2K(s)+Cl2(g)\rightarrow 2KCl(s)}$
3-a) Indicate the oxidizing and reducing agents in the following reaction : $\mathrm{2Cu2++4I-\rightarrow 2CuI+I2}2Cu2++4I-\rightarrow 2CuI+I2$. (1)

b) A metal ion $M3+$ loses 3 electrons. What will be its oxidation number? (1)

c) The displacement reactions of Cl, Br, I using fluorine are not generally carried out in an aqueous solution. Give a reason.(1)

d)Why is potassium highly reactive metal whereas gold is a noble metal? (2)

4- Consider the elements : Cs, Ne, I , F, and Fe

(a) Identify the element that exhibits only negative oxidation state.

(b) Identify the element that exhibits only positive oxidation state.

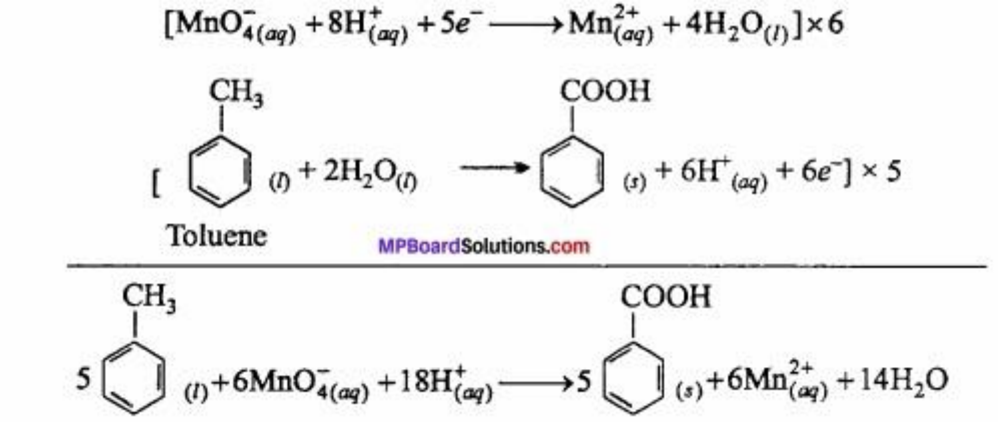
(c) Identify the element that exhibits both positive and negative oxidation states.

(d) Identify the element which exhibits neither the negative nor does the positive oxidation state.

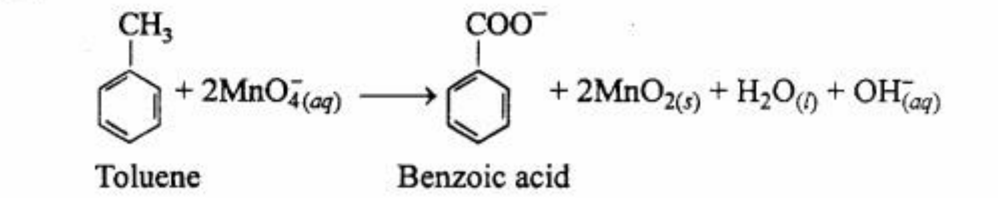
e) Identify the element that exhibits which shows +2 and +3 oxidation state.

ANSWERS SECTION-E LONG TYPE QUESTIONS

1.a) In acidic medium:
$[MnO^{-}_{4(aq)} + 8H^{+}_{(aq)} + 5e^{-} \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}] \times 6$



(ii) In alkaline and neutral medium oxidation of toluene into benzoic acid :



In the manufacture of benzoic acid alcoholic $KMnO_4$ is more useful.
Alcohol if used as solvent will help in the formation of a homogeneous mixture between toluene (non – polar) and $KMnO_4$ (ionic). Actually alcohol has non – polar alkyl group as well as polar OH^- group.

b) The chlorine atoms in ClO−,ClO2−,ClO3−$ClO-,ClO2-,ClO3-$ have an oxidation state of +1,+3+5 respectively. However, in ClO4−$ClO4-$, the oxidation state of chlorine is +7, which is maximum. That is why it doesn't show a disproportionate reaction.

2-a) It is because in a decomposition reaction both the products or one of the two products should be in elemental form, so all decomposition reactions are not redox reactions. Example- Decomposition of calcium carbonate.

b) H_2

c) In a disproportionation reaction an element in one oxidation state is oxidized and reduced simultaneously.

ORGANIC CHEMISTRY – SOME BASIC PRINCIPLES AND TECHNIQUES

MULTIPLE CHOICE QUESTIONS (1 MARKS)

SECTION-A

1. The IUPAC name of CH_3CHO is:

(a) Acetaldehyde

(b) Methylaldehyde

(c) Formyl chloride

(d) Ethanal

2. The structure of 4-Methylpent-2-en-1-ol is:

(a) $CH_3CH_2CH=CHCH_2OH$

(b) $(CH_3)_2C=CHCH_2CH_2OH$

(c) $(CH_3)_2CHCH=CHCH_2OH$

(d) $CH_3CH(OH)CH\text{-}CH=C(CH_3)_2$

3. Hyperconjugation is most useful for stabilizing which of the following carbocation?

(a) Neopentyl

(b) Tert-butyl

(c) Iso-propyl

(d) Ethyl

4. A miscible mixture of benzene and chloroform can be separated by:

(a) Sublimation

(b) distillation

(c) filtration

(d) crystallisation

5.The most satisfactory method to separate mixture of sugar is:

(a) Fractional crystallization

(b) Sublimation

(c) Chromatography

(d) None of these

6.Molecular mass of volatile substance is determined by

(a) Kjeldahl’s method

(b) Duma’s method

(c) Victor Mayer’s method

(d) Liebig’s method

7.During Lassaigne’s test set of Sulphur and nitrogen present in an organic compound change into:

(a) Na_2S and NaCN

(b) Na_2SO_4 and NaCN

(c) Na_2S and NaCNO

(d) NaCN and NaCNO

8.Which of the following molecular formulae belongs to the alkyne series?

(a) C_7H_{14}

(b) $C_{10}H_{22}$

(c) C_9H_{16}

(d) $C_{16}H_{32}$

9. Which of the following cannot be represented by resonance structures?

(a) Dimethyl ether

(b) Nitrate anion

(c) Carboxylate anion

(d) Toluene

10.The displacement of electrons in a multiple bond in the presence of attacking reagent is called

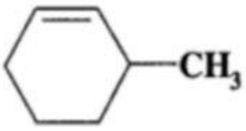
(a) Inductive effect

(b) Electromeric effect

(c) Resonance

(d) Hyperconjugation

11. .The I.U.P.A.C. name of



(a) 3–Methyl cyclohexene

(b) 1–methyl cylohex–2–ene.

(c) 6–methyl cyclohexene

(d) 1–methyl cyclohex5–ene

12. Which of the ion is the most resonance stabilized?

(a) C_2H_5O-

(b) C_6H_5O-

(c) $(CH_3)3CO$-

(d) (CH3)2CHO-

13.The increasing order of electron donating inductive effect of alkyl group is:

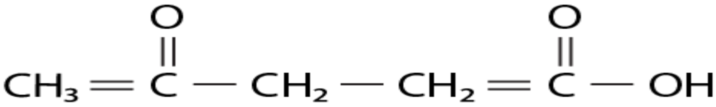
(a) $-H < -CH_3 < -C_2H_5 < -C_3H7$

(b) $-H > -CH_3 > -C_2H_5 > -C_3H7$

(c) $-H < -C_2H_5 < -CH_3 < -C_3H7$

(d) $-H > -C_2H_5 > -CH_3 > -C_3H_7$

14. The IUPAC name is ________ for



$$CH_3 = \overset{\overset{\displaystyle O}{\|}}{C} - CH_2 - CH_2 = \overset{\overset{\displaystyle O}{\|}}{C} - OH$$

(i) 1-hydroxypentane-1,4-dione

(ii) 1,4-dioxopentanol

(iii) 1-carboxybutan-3-one

(iv) 4-oxopentanoic acid

15.The principle involved in paper chromatography is

(i) Adsorption

(ii) Partition

(iii) Solubility

(iv) Volatility

SECTION-B (2MARKS)

Short answer questions carrying 2 mark each.

1. Which of the two: $O_2NCH_2CH_2O^-$ or $CH_3CH_2O^-$ is expected to be more stable and why?

2. Explain why alkyl groups act as electron donors when attached to a π-system.

3.Draw the resonance structures for the following compounds. Show the electron shift using curved-arrow notation. (a) C_6H_5OH (b) CH_3NO_2

4. Give condensed and bond line structural formulas and identify the functional group(s) present, if any, for: (a) 2, 2, 4-Trimethylpentane (b) Hexanedial

5. Draw the structure of the following compounds

1) Hex-3enoic acid

2) 2-chloro-2-methyl butan-1-ol

6) Explain, why $(CH_3)_3-C^+$ is more stable than $CH_3\text{-}CH_2^+$ and CH_3^+ is the least stable cations.

7) Give the number of sigma and pi bond in the following molecules

a) $CH_3\text{-}NO_2$ b) $HCONHCH_3$

8) It is not advisable to use sulphuric acid in place of acetic acid for acidification while testing sulphur by lead acetate test. Give reason.

9) Under what condition can the process of steam distillation is used.

10) Suggest a method to purify

i) Kerosene containing water

ii) A liquid that decomposes at its boiling point.

SECTION-C (3 MARKS)

Short answer questions carrying 3 mark each.

1) a. Which distillation method is used to separate a mixture of o-nitro phenol and p-nitro phenol?

b. Distinguish between Steam distillation and distillation under reduced pressure.

2) What are the bond line formulas for the following compounds?
(a)2, 3–dimethyl butanal
(b) Heptan–4–one
(c) Isopropyl alcohol

3) Distinguish between inductive effect and resonance effect.

4) Differentiate between the principle of estimation of nitrogen in an organic compound by (i) Dumas method (ii) Kjeldahl’s method.

5) Explain why alkyl groups act as electron donors when attached to a π-system.

6) Suggest a method to purify:

i) Camphor containing traces of common salt.

ii) Kerosene oil containing water.

iii) A liquid which decomposes at its boiling point.

7.) Describe in detail the Dumas method for the estimation of nitrogen in an organic compound?

8) a) Which test is used for detection of nitrogen, sulphur, halogens and phosphorus present in compound?

b) Explain the reason for the fusion of an organic compound with metallic sodium for testing nitrogen, sulphur and halogens.

9) Explain the terms inductive and electromeric effects. Which electron displacement effect explain the following correct orders of acidity of the carboxylic acids?

(a) Cl3CCOOH > Cl2CHCOOH > ClCH2 COOH

(b) CH3CH2COOH > (CH3)2 CHCOOH > (CH3)3CCOOH

10) Ammonia produced when 0.75g of a substance was kjeldahlized, neutralized 30cm330$cm3$ of 0.25N H2SO4$H2SO4$. Calculate the percentage of nitrogen in the compound.

SECTION-D

Case based questions carrying 4 marks each:

1) Once an organic compound is extracted from a natural resource or synthesized in the laboratory, it is essential to purify it. Various methods used for the purification of organic compounds are based on the nature of the compound and the nature of the impurity present in it. Finally, the purity of a compound is ascertained by determining its boiling point and melting point. Most of the pure compounds have sharp melting and boiling points. New methods of checking the purity of an organic compound are based on different types of chromatographic and spectroscopic methods.

a) How will you separate mixture of camphor and benzoic acid?

b) Boiling point of Chloroform is 334K and that of aniline is 457K. Which method willbe suitable to separate mixture of aniline and chloroform?

c) Which method is used to separate mixture of glycerol and spent-lye in soap industry is separated?

d) Name the method used to purify aniline

2) Chromatography is an analytical technique used for separating the mixture based on the proximate amounts of each solute distributed between a mobile phase and a stationary phase. There are many types of chromatography: Paper chromatography, Thin-layer chromatography, Paper chromatography, Gas chromatography, Column chromatography, Ion- exchange chromatography etc.

a) What are the moving and stationary phases in paper chromatography?

b) What is the size of the spot in paper chromatography?

c) What is paper chromatography?

d) What are the applications of chromatography?

3) Organic compounds are formed by covalent bonding. The nature of covalent bonding can described with the help of hybridisation, sp, Sp^2 and sp^3. The structure and reactivity depends upon type of bonds present in organic compounds. Organic compound can be represented by various structural formulae, Wedge and Dash formula is 3-D representation. Organic compounds can be classified on the basis of functional groups. Organic reactions mechanism are based on structure of substrate and the attacking reagent.

The intermediate formed can be free radical, carbocation, carbanion or carbene. The attacking reagent can be electrophile or nucleophile. The inductive, electromeric, resonance and hyper conjugative effect may help in polarisation of covalent bond. Organic reactions may be regarded as substitution, addition, elimination and rearrangement, oxidation and reduction reaction.

After the compound is obtained in pure state, qualitative analysis helps to detect elements present in organic compounds whereas quantitative analysis helps to find percentage of various elements. Dumas and Kjeldahl method help to determine percentage of nitrogen, Carius method for halogens and sulphur. Carbon and hydrogen are estimated by the amount of CO_2 and H_2O formed. Phosphorus estimation is done by oxidising it to H_3PO_4, sulphur to H_2SO_4,The percentage of oxygen is determined by taking the difference of 100 and percentage of all elements. Empirical formula gives simple ratios of elements whereas molecular formula gives exact number of atoms of each element present in a compound.

(a) An organic compound has 8% sulphur. What is minimum molar mass of compound?

(b) If C is 75%, H = 25%, what is molecular formula of compound?

(c) In estimation of sulphur, which compound of sulphur is formed?

(d) Why should we add HNO_3 to Lassaigne extract before testing for halogens.

4) It is essential to purify an organic compound. The method used for purification depends upon nature of compound and impurity present in it. The common methods to purify a solid is sublimation and crystallisation. Crystallisation is most common method applicable to most of solid organic compounds. Liquids are purified by simple distillation, fractional distillation, distillation under reduced pressure, steam distillation. Differential extraction is used to extract organic compound from aqueous solution. Chromatography is used to separate coloured substances from plants. Column chromatography, thin layer chromatography and partition chromatography are types of chromatography used for isolation and purification of organic compounds.

(a) Which method is used to purify camphor?

(b) How is unwanted colour from organic compounds removed?

(c) How is chloroform (Boiling point 334 K) and aniline (b.pt. 457 K) are separated? Why?

(d) Which is condensed first in fractionating column, vapours of higher boiling point liquid or lower boiling point liquid?

SECTION-E

Long answer questions carrying 5 marks each:

Q.1) a) Define homologous series?

b) Explain the principle of paper chromatography.

c) Write the chemistry of lassaigne's test for qualitative analysis of nitrogen.

Q.2) i) What is a functional group?

ii) Will CCl_4 give white ppt of AgCl on heating with silver Nitrate. Give reason for your answer.

iii) Define hyper conjugation.

iv) Draw the condensed formula and bond-line structural formula for

a) 2,2,4-trimethylpentane (c) Hexanedial.

b) 2-hydroxy-1,2,3-propanetricarboxylic acid.

Q.3) 1) What is hybridization?

2) What is the hybridisation of each carbon in $H_2C = C = CH_2$?

3) Explain, how is the electronegativity of carbon atoms related to their state of hybridisation in an organic compound?

Q.4) a) Which of the following compounds will not exist as a resonance hybrid. Give reason for your answer

(i) CH_3OH

(iii) $CH_3CH=CHCH_2NH_2$

b) Benzoic acid is an organic compound. Its crude sample can be purified by crystallisation from hot water. What characteristic differences in the properties of benzoic acid and the impurity make this process of purification suitable?

Answer Key

SECTION-A

1) - (a)

2) - (c)

3) - (b)

4) - (b)

5) - (c

6) - (c)

7) - (a)

8) - (c

9) - (a) Dimethyl ether

10) - (b) Electromeric effect

11) - (a) 3–Methyl cyclohexene

12) - (b) C6H5O-

13) - (a) $-H < -CH_3 < -C_2H_5 < -C_3H7$

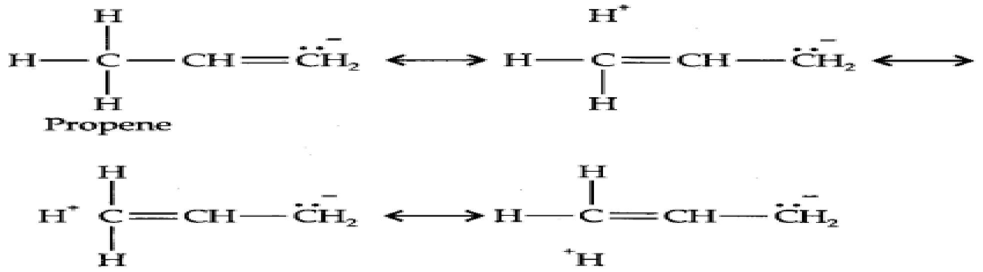
14) - (iv) is the answer.

15) - (ii) is the answer.

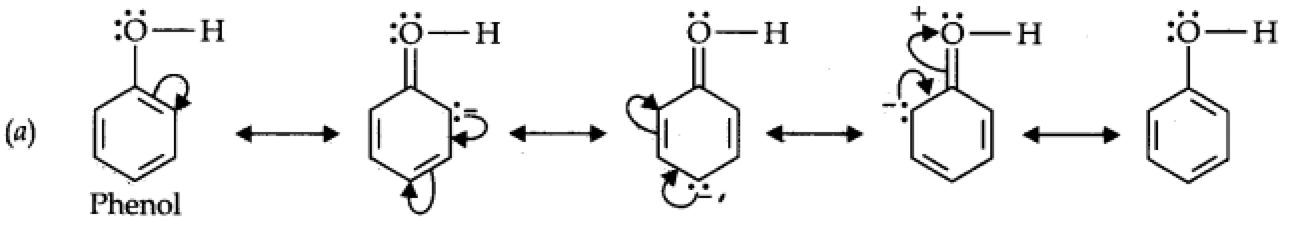
SECTION-B

Ans 1) **Answer:** O_2N——<——- CH_2——<——- CH_2 —<——- O^- is more stable than CH_3——<——-CH_2——<——-O- because NO_2 group has -I-effect and hence it tends to disperse the -ve charge on the O-atom. In contrast, CH_3CH_2 has +I-effect. It, therefore, tends to intensify the -ve charge and hence destabilizes it.

Ans-2) **Answer:** Due to hyperconjugation, alkyl groups act as electron donors when attached to a π-system as shown below:



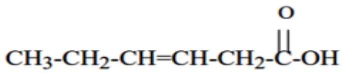
Ans -3



b)

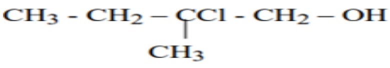
Ans -4 a) CH_3-CH_2-CH=CH-CH_2-COOH b) CH_3-CH_2-CCl (CH_3)-CH_2-OH

Ans-5) a)



$CH_3\text{-}CH_2\text{-}CH\text{=}CH\text{-}CH_2\text{-}\overset{O}{\overset{\|}{C}}\text{-}OH$

b)



$CH_3 - CH_2 - \underset{CH_3}{\underset{|}{C}}Cl - CH_2 - OH$

Ans -6) It is true that $(CH_3)_3C^+$ is highly stable when compared to $CH_3CH_2^+$ and CH_3^+. This is due to the Hyperconjugation effect. This effect is the opposite of the inductive effect. Isopropyl carbocation ($(CH_3)_3C^+$) has 6 hyper conjugating structures with 6 α-Hydrogen atoms.

Ans-7) 6 sigma and 1πbond

8 sigma and 1πbond

Ans-8) Lead acetate on reacting with sulphuric acid will give a white precipitate of lead sulphate which interfere in the detection of sulphur.

Ans -9) Steam distillation is used to purify the liquids which has steam volatile and immiscible in water.

Ans -10)

i) By solvent extraction using a separating funnel.

ii) ii) Distillation under reduced pressure.

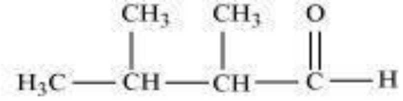
SECTION-C

Ans-1) a) Steam Distillation

Steam distillation is used to separate substances which are steam volatile and are immiscible with water.

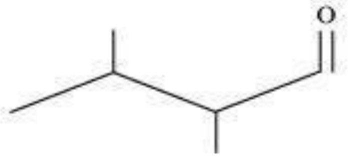
b) Distillation under reduced pressure is used to purify those liquids which decompose at or below their normal boiling points.

2) (a)2, 3–dimethyl butanal

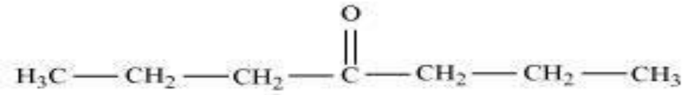


$$\begin{array}{ccccccccc} & & CH_3 & & CH_3 & & O & & \\ & & | & & | & & \| & & \\ H_3C & — & CH & — & CH & — & C & — & H \end{array}$$

⇒

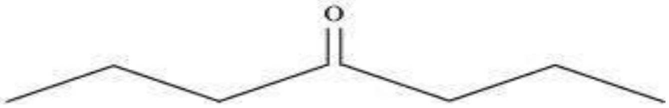


(b) Heptan–4–one

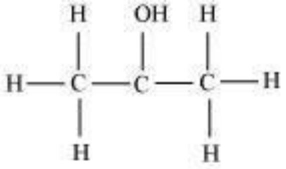


$$\begin{array}{ccccccccccccc} & & & & & & O & & & & & & \\ & & & & & & \| & & & & & & \\ H_3C & — & CH_2 & — & CH_2 & — & C & — & CH_2 & — & CH_2 & — & CH_3 \end{array}$$

⇒

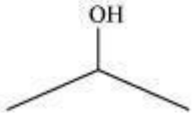


(c) Isopropyl alcohol



$$\begin{array}{ccccccccc} & & H & & OH & & H & & \\ & & | & & | & & | & & \\ H & — & C & — & C & — & C & — & H \\ & & | & & & & | & & \\ & & H & & & & H & & \end{array}$$

⇒



Ans-3

S.No	Inductive effect	Resonance effect
1.	Inductive Effect involves the displacement of electrons in saturated compounds.	Resonance Effect involves displacing % electrons or lone pairs of electrons in unsaturated and conjugated compounds.
2.	In the inductive Effect, a slight displacement of σ electrons and partial +ve or-ve charge develops.	In the resonance effect, there is a complete transfer of π electrons, and as a result, a complete +ve or -ve charge develops.
3.	The Inductive Effect can move only up to 3 to 4 carbons.	In the resonance effect, the movement of electrons all along the length of the conjugated system takes place.

Ans 4 (i) Dumas method: The organic compound is heated strongly with excess of CuO ‘ (Cupric Oxide) in an atmosphere of CO_2 when free nitrogen, CO_2 and H_2O are obtained.
(ii)Kjeldahl’s method: A known mass of the organic compound is heated strongly with cone. H_2SO_4, a little potassium sulphate and a little mercury (a catalyst). As a result of reaction the nitrogen present in the organic compound is converted to ammonium sulphate.

5) When an alkyl group is attached to a π system it acts as an electron-donor group by the process of hyperconjugation. To understand this concept better let us take the example of propene. This type of overlap leads to a delocalisation also known as no-bond resonance of the π electrons making the molecule more stable.

Ans- 6) i) Sublimation

ii) Separating funnel

(iii) Distillation under reduced pressure.

7) Dumas' method involves the determination of nitrogen content in the organic compound in the form of nitrogen (N2). Organic compound is oxidized with cupric oxide in an atmosphere of carbon dioxide which gives free nitrogen along-with carbon dioxide and water.

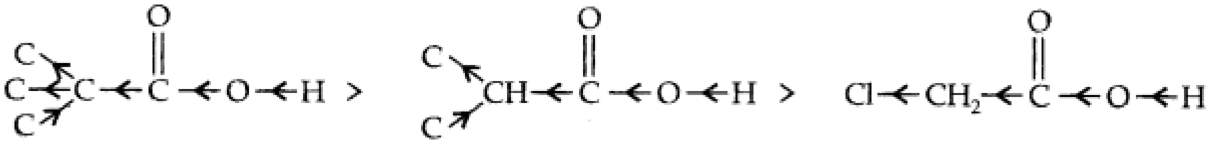
8) a) The Lassaigne's Test is a general method for detecting halogens, nitrogen, and sulphur in organic compounds.

b) The elements such as halogens, nitrogen and sulphur are covalently bonded to the organic compounds. For their detection, we need to convert them to their ionic form for performing respective tests for their detection. As per principle, on fusion Na converts all elements present in an organic compound in ionic form.

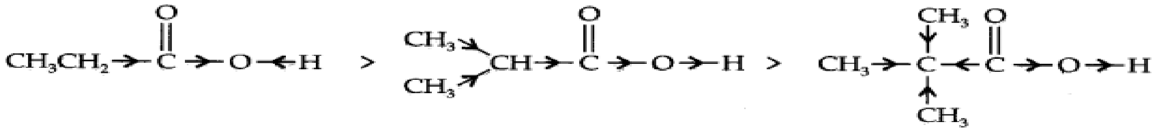
Ans-9) Inductive Effect: The inductive effect refers to the polarity produced in a molecule as a result of higher electronegativity of one atom compared to another.Atoms or groups which lose electron towards a carbon atom are said to have +1 Effect.
Those atoms or groups which draw electron away from a carbon atom are said to have -I Effect.
Commom examples of -I effect are:
NO_2, F, Cl, Br, I, OH etc.
Examples of +1 effect are (Electron releasing)
$(CH_3)_2C—$, $(CH_3)_2CH—$, $CH_3CH_2—$ $CH_3—$ etc.
Electromeric effect: The electromeric effect refers to the polarity produced in a multiple bonded compound as it is approached by a reagent.

The atom A has lost its share in the electron pair and B has gained this share.
As a result A acquires a positive charge and B a negative charge. It is a temporary effect and takes place only in the presence of a reagent.

(a) -I-effect as shown below:
As the number of halogen atoms decreases, the overall -I- effect decreases and the acid strength decreases accordingly.



(b) +I-effect as shown below:
As the number of alkyl groups increases, the +I-effect increases and the acid strength decreases accordingly.



10) Mass of the organic compound= 0.75g
Volume of H_2SO_4 used = $30cm^3$
Normality of H_2SO_4 = 0.25N
$30cm^3$ of $H_2SO_4$of normality 0.25N = 30ml of NH3 solution of normality 0.25N
But 1000cm31000cm3 of $NH_3$of normality 1 contains 14g of nitrogen.
∴30cm of 0.25N NH_3contains nitrogen= 141000 ×3 0× 0.25141000 ×30×0.25
Percentage of nitrogen = mass of nitrogenmass of substance×1000=141000×30×0.250.75×100=14.00

SECTION-D

1) a) As by the process of sublimation, both will get sublime. We can separate them by mixing them in hot water and then filtering the solution. Residue will be camphor andfiltrate will be mixture of water & benzoic acid and we can get benzoic acid by crystallization method.

b) As the difference in their boiling point is sufficiently large, simple distillationmethod is used.

c) By distillation under reduced pressure.

d) Steam distillation method because it is steam volatile and immiscible with water.

2 a) In Paper Chromatography: The paper strip acts as "stationary phase" while the solvent act as "mobile phase" in paper chromatography.

b) The spots should be between 5–8 mm in diameter. Spots larger than this will excessively spread out during the experiment and make analysis difficult.

c) Paper chromatography is an analytical method used to separate coloured chemicals or substances.

d) Chromatography is a method that is used in laboratories for the separation of a mixture. It is used to test drug levels and water purity. It is also used to determine the nutritional value of the food sample. It is used to determine the type of chlorophyll in various photosynthetic organisms.

3 a)) The least molecular mass of the compound is 400 g.
b) C H mass per 100g 75 25 no of moles 7512 =6.25 251 =25 Divide by 6.25 1 4 MF is CH_4.
c) In this test, a known mass of sulphur present in an organic compound with Silver Nitrate is heated into a sealed tube known as carius tube with silver. The organic compound is then converted to Sulphuric

acid which then reacts with excess Barium Chloride solution and produces a precipitate of Barium Sulphate.

d) Sodium extract (Lassaigne's extract) is boiled with dilute HNO_3 before testing for halogens to decompose NaCN or Na_2S present in the Lassaigne's extract otherwise these will produce white ppt. with A g N O 3 and would thus interfere with the test of halogens.

4) a) Camphor can easily be purified by the process of sublimation.

b) Activated carbon is commonly used on the laboratory scale to purify solutions of organic molecules containing unwanted coloured organic impurities.

c) When two liquids have different boiling points, they vapourise at different temperatures. The vapors condense and the two liquids are collected separately. For example, chloroform and aniline having boiling points 334 K and 457 K can be separated by distillation.

d) Here, components with the highest boiling point will condense in the lower part of the column while substances with a low boiling point will condense at the top. The condensed vapours or liquid fractions are then removed from the sides of the column.

SECTION-E

Ans-1) a) A homologous series is a collection of compounds with the same general formula that differ only in the carbon chain length. Compounds in a homologous series often have a fixed set of functional groups, resulting in chemical and physical properties that are comparable.

b) It is defined as the process of separation of the individual components of a mixture based on their relative affinities towards stationary and mobile phases. Principle: The samples are subjected to flow by mobile liquid onto or through the stable stationary phase.

c) **Lassaigne's test:** Nitrogen, sulphur, halogens and phosphorous present in an organic compound are detected by Lassaigne's test.
First of all compounds are converted to ionic form by fusing the compound with sodium metal.

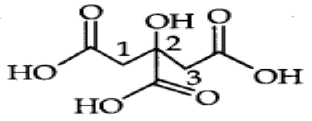
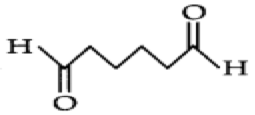
$$Na + C + N \xrightarrow{\Delta} NaCN$$
$$2Na + S \xrightarrow{\Delta} Na_2S$$
$$Na + X \xrightarrow{\Delta} NaX$$
$$[X = Cl, Br, I]$$

Cyanide, sulphide or halide of sodium are extracted from the fused mass by boiling it with distilled water. This extract is known as sodium fusion extract.

Ans-2) It may be defined as an atom or group joined in a specific manner that is responsible for the characteristic chemical properties of the organic compounds.

b) CCl_4 will not give the white precipitate of AgCl on heating it with silver nitrate. This is because the chlorine atoms are covalently bonded to carbon in CCl4. To obtain the precipitate it should be present in ionic form and for this it is necessary to prepare the Lassaigne's extract of CCl_4.

c) Hyperconjugation effect is a permanent effect in which localization of σ electrons of C-H bond of an alkyl group directly attached to an atom of the unsaturated system or to an atom with an unshared p orbital takes place.

Condensed formula	**Bond line formula**	**Functional group/s**
(*a*) $(CH_3)_3CCH_2CH(CH_3)_2$		—
(*b*) $HOOCCH_2C(OH)(COOH)CH_2COOH$		$-\overset{O}{\overset{\|}{C}}-OH$ (carboxyl) and $-OH$ (hydroxyl)
(*c*) $OHC(CH_2)_4CHO$		$-\overset{O}{\overset{\|}{C}}-H$ (aldehyde)

d) Ans-3

a) Hybridization is defined as the intermixing of atomic orbitals with the same energy levels to give the same number of a new type of hybrid orbitals. This intermixing usually results in the formation of hybrid orbitals having entirely different energies, shapes, etc.

b) In $H_2C = C = CH_2$, the terminal carbons are sp^2 hybridised as they form three (two with H and one with C) sigma bonds and one pi bond(between carbons), while the centre carbon is sp hybridised (as it forms two sigma bonds, one with each carbon and two pi bonds, one with each carbon).

c) Since s-electrons are more firmly attached by the nucleus than p-electrons, therefore, electronegativity increases as the s-character of the hybridised orbital increases, i.e., in the order

$sp^3 < sp^2 < sp$.

Ans-4

a) (i) CH_3OH does not contain pi-electrons; hence, it cannot exist as a resonance hybrid.

(ii) In $CH_3CH=CHCH_2NH_2$, the lone pair of electrons on the nitrogen atom is not conjugated with the pi -electrons. Therefore, resonance is not possible.

b) Benzoic acid can be purified by hot water because of the following characteristics.

(i) Benzoic acid is more soluble in hot water and less soluble in cold water.

(ii) Impurities in benzoic acid are either insoluble in water or more soluble in water to such an extent that they remain in solution as the mother liquor upon crystallisation

HYDROCARBONS

Topic: Alkanes

SECTION A

(Multiple -choice questions carrying 1 mark each)

Q1. Which of the following conformation of n-butane is the most stable?

(a) eclipsed

(b) gauche

(c) staggered

(d) skew boat

Q2. Find the correct order for relative energies of the ethane conformations.

(a) staggered < skewed < eclipsed

(b) skewed < staggered < eclipsed

(c) skewed < eclipsed < staggered

(d) staggered < eclipsed < skewed

Q3. Find the alkane (C_5H_{12}), which will give only one type of monohalogenated compound

(a) 2,2-dimethylpropane

(b) 2-methylbutane

(c) cyclopentane

(d) n-pentane

Q4. The bond angle between H-C-C bonds in ethane is

(a) 120°

(b) 180°

(c) 109°

(d) 109.5°

Q5. Alkanes undergo halogenation. It is an example of

(a) nucleophilic substitution

(b) elimination

(c) free-radical substitution

(d) electrophilic substitution

Q6. Which of the following is the most volatile compound?

(a) n-pentane

(b) Iso-butene

(c) 2-methyl butane

(d) 2, 2-dimethyl propane

Q7. Paraffin wax is

(a) Saturated hydrocarbons

(b) Unsaturated hydrocarbons

(c) Alcohol

(d) Ester

Q8. Find the correct order for the ease of formation of free radicals

(a) 1° > 2° > 3°

(b) 3° > 2° > 1°

(c) 2° > 1° > 3°

(d) 2° > 3° > 1°

Q9. Formation of an alkane from the reduction of an alkyl halide with Zn is known as

(a) Cannizzaro reaction

(b) Frankland reaction

(c) Kolbe's reaction

(d) Wurtz reaction

Q10. Find the compound with the highest boiling point among the following

(a) n-Butane

(b) n-Octane

(c) Iso-octane

(d) 2,2,3,3-Tetramethylbutane

Q11.Which among the following has the highest boiling point?

(a) Pentane

(b) Hexane

(c) Heptane

(d) Octane

Q12. **What is paraffin wax?**

(a) Saturated hydrocarbon

(b) Unsaturated hydrocarbon

(c) Alcohol

(d) Carboxylic acid

Q13.What does petroleum mainly consist of?

(a) Aromatic hydrocarbons

(b) Aliphatic hydrocarbons

(c) Aliphatic alcohols

(d) Aliphatic acids

Q14. Which compound is most volatile among the following?

(a) Iso-butane

(b) n-pentane

(c) 2,2 dimethylpropane

(d) Propane

Q15. Choose the alkane from the following

(a) Hexane

(b) Hexene

(c) Hexyne

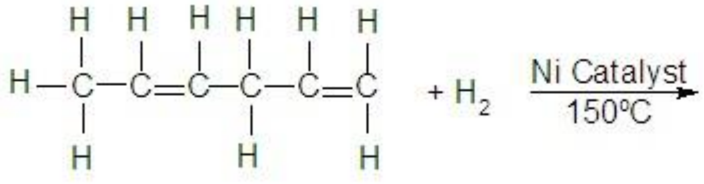
(d) Hexanol

SECTION B

(Short answer questions carrying 2 marks each.)

Q1. What is the product formed from the following reaction?

Q2. Give an example of halogenation reaction of alkanes. Methane does not react with chlorine in the dark. Why?



Q3. Why are alkanes called saturated hydrocarbons?

Q4. What is meant by incomplete combustion? During incomplete combustion of

alkanes with insufficient amount of air or dioxygen, a black colour product is obtained. Name the product and its usages.

Q5. Sodium salt of which acid will be needed for the preparation of propane ? Write chemical equation for the reaction ?

Q6. What do you mean by isomerisation of alkanes? Explain with an example.

Q7. Rotation around the carbon-carbon single bond of ethane is not completely free. Justify the statement.

Q8. Why is Wurtz reaction not preferred for the preparation of alkanes containing odd number of carbon atoms? Illustrate your answer by taking one example.

Q9. Write the product of the reaction:

$$CH_3Br + CH_3CH_2Br + 2Na \xrightarrow[Ether]{Dry}$$

Q10. Write hydrocarbon radicals that can be formed as intermediates during monochlorination of 2-methylpropane? Which of them is more stable? Give reasons.

SECTION C

(Short answer questions carrying 3 marks each.)

Q1. Match the following items of column 1 with column 2 and choose the correct answer:

Column 1	**Column 2**
1) C_5H_{12}	**a) Cyclic alkane**
2) C_3H_6	**b) Branched alkane**
3)C_8H_{18}	**c) Linear alkane**

Q2. Arrange n-pentane, iso-pentane and neo-pentane in decreasing order of their boiling points.
Q3. Explain with example the method of preparation of alkanes by the following methods.
(a) **Wurtz Reaction** **(b) Kolbe's electrolytic method**

Q4. Decane has the molecular formula $C_{10}H_{22}$

(i) **State what is meant by the term molecular formula.**

(ii) **Give the molecular formula of the alkane which contains 14 carbon atoms.**

(iii) **Write an equation for the incomplete combustion of decane, $C_{10}H_{22}$, to produce carbon and water only.**

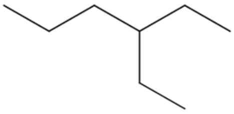
Q5. Draw Newman and Sawhorse projections for the eclipsed and staggered conformations of ethane. Which of these conformations is more stable and why?

Q6. The fractions from petroleum contain alkane hydrocarbons.

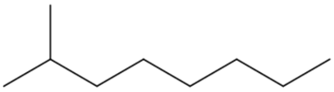
(i) **Write an equation for the incomplete combustion of the alkane C_8H_{18} to produce carbon monoxide and water only.**

(ii) **One isomer of C_8H_{18} is 2,2,3-trimethylpentane. Draw the structure of this isomer.**

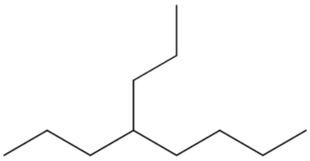
Q7. Give the name of the hydrocarbon below:



(a)



(b)



(c)

Q8. An alkane C_8H_{18} is obtained as the only product subjecting a primary alkyl halide to the Wurtz reaction. On monobromination, this alkane yields a single isomer of a tertiary bromide. Write the structure of alkane and the tertiary bromide.

Q9. The relative reactivity of 1°, 2°, 3° hydrogen’s towards chlorination is 1: 3.8: 5. Calculate the percentages of all monochlorinated products obtained from 2-methylbutane.

Q10. What effect does branching of an alkane chain have on its boiling point? Arrange the following in decreasing order of their boiling points.

(A) n-butane

(B) 2–methylbutane

(C) n-pentane

(D) 2,2–dimethylpropane

SECTION D

(Case based questions carrying 4 marks each.)

Q1. The rotation of carbon-carbon single bond (s-bond), due to cylindrical symmetry of s-MOs (molecular orbitals) long internuclear axis, in alkanes results into different spatial arrangements of atoms in space, that are interconvertible. These arrangements are called conformations.However, weak repulsive interaction are present between the adjacent bonds in alkanes so the rotation of C—C single bond is not completely free and is hindered by a small energy barriers of 1-20 kJ mol-1. The repulsive interaction between the adjacent bond is due to electron cloud. The two types of conformations are very common, i.e., staggered and eclipsed.

The conformation in which the hydrogen atoms attached to the two carbon atoms are as far apart as possible is called the staggered conformation. The conformations in which the hydrogen atoms attached to the two carbon atoms are as closed as possible is called eclipsed conformation. Any intermediate conformation between the above two is called skew or gauche conformation

(i) The electronic distribution of the sigma molecular orbital is symmetrical around the internuclear axis of C-C bond which permits free rotation around C-C bond. Such spatial arrangements of atoms in which conversion of one another takes place by rotation around C-C bond is known as
(a)rotamers
(b)conformers
(c)conformations
(d) All of these

(ii) The possible rotamers of ethane is/are
(a) 2
(b) 3
(c) 4
(d) ∞

(iii) The different conformations of ethane cannot be separated and isolated because
(a) small energy barrier
(b) large energy barrier
(c) Both (a) and (b)
(d) Neither (a) nor (b)

(iv) Which form of ethane has the least torsional strain?
(a) Staggered
(b) Skew boat
(c) Eclipsed
(d) Boat

Q2. Many hydrocarbon compounds burn readily in air. Alkanes on heating in the presence of air or dioxygen are completely oxidized to carbon dioxide and water with the evolution of large amount of heat. The incomplete combustion of methane can result in a slew of partially oxidized products, including CO, but also methanol, formic acid, formaldehyde, and higher hydrocarbons also.

(a) Which of the following reactions of methane is incomplete combustion:
(i) CH4 + O2 → C(s) + 2H2O(l)
(ii) CH4 + 2O2 → CO2(g) + 2H2O(l)

(b) Write an equation to show the complete combustion of $C_{15}H_{32}$

(c) One of the gaseous products of the incomplete combustion of methane in gas fires is known to be poisonous. Identify this product and write an equation for the reaction in which it is formed from methane.

(i) Identity of product :

(ii) Equation :

Q3. Chloromethanes, such as dichloromethane and trichloromethane, are produced in industry as they have many uses. Trichloromethane has been used in the manufacture of the refrigerant chlorodifluoromethane.

(a) Chlorine can react with dichloromethane (CH_2Cl_2) to form trichloromethane ($CHCl_3$).

(i) Write an equation for each of the following steps in the mechanism for this reaction.

Initiation step :

First propagation step :

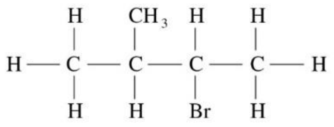
Second propagation step :

(ii) Give one essential condition for this reaction and name the type of mechanism.

Essential condition :

Type of mechanism :

Q4. There are eight structural isomers with the molecular formula C5H11Br. Four of these are classed as primary, three as secondary and one as tertiary. The graphical formula of one of the secondary compounds, isomer A, is shown below.



isomer **A**

(a) Give the name of isomer A. (2)

(b) Explain what is meant by the term structural isomers. (2)

SECTION E

(Long Answer questions carrying 5 marks each.)

Q1. Consider the following alkane and answer the following questions.
$(CH_3)_2CHCH_2CH(C_2H_5)CH(CH_3)CH_3$
(a) Write the complete structural formula of the alkane.
(b) What is its molecular formula?
(c) Write its bond line formula and give IUPAC name.
(d) How many methyl, ethyl, methylene and isopropyl groups are present in this alkane?
(e) How many carbon atoms are 1°,2°,3°,4°?

Q2. The reaction of bromine with propane is similar to that of chlorine with methane.

Three steps in the mechanism for the bromination of propane to form 1-bromopropane are shown below.

Step **1** $Br_2 \longrightarrow 2Br\bullet$

Step **2** $Br\bullet + CH_3CH_2CH_3 \longrightarrow CH_3CH_2CH_2\bullet + HBr$

Step **3** $CH_3CH_2CH_2\bullet + Br_2 \longrightarrow CH_3CH_2CH_2Br + Br\bullet$

(a) Name the type of mechanism in this reaction:

(b) Give an essential condition for Step 1 to occur.

(c) Name the type of step illustrated by Steps 2 and 3.

(d) In this mechanism, a different type of step occurs in which free radicals combine. Name this type of step.

(e)Write an equation to show how hexane could be formed from two free radicals in the mechanism of this reaction.

Type of step :

Equation :

Q3. (a) Write structural formulas of the following compounds :

(i) 3, 4, 4, 5–Tetramethylheptane

(ii) 2,5-Dimethyhexane

(b) Write structures for each of the following compounds. Why are the given names incorrect? Write correct IUPAC names.
(i) 2-Ethylpentane
(ii) 5-Ethyl – 3-methylheptane

© Write IUPAC names of the following compound:

(i) tetra – tert-butylmethane

TOPIC -ALKENES

SECTION-A

1. Which of the following compounds react most readily with Br(g)?
(a) C_2H_2 (b) C_3H_6 (c) C_2H_4 (d) C_4H_{10}

2. When propene reacts with HBr in the presence of peroxide, it gives rise to
(a) allyl bromide (b) isopropyl bromide (c) n-propyl bromide (d) 3-bromopropane

3. Find the alkene with maximum stability
(a) cis-2-Butene (b) trans-2-Butene (c) 1-Butene (d) All have the same stability

4. Ethylene bromide on treatment with Zn gives
(a) Alkyne (b) Alkene (c) Alkane (d) All of the above

5. Which of the following reactions is common in alkenes?
(a) Addition (b) Elimination (c) Substitution (d) Superposition

6. Cis-trans isomerism in alkenes is due to
(a) chiral carbon (b) free rotation about single bond
(c) free rotation about the double bond (d) restricted rotation about the double bond

7. Baeyer's reagent is used to detect
(a) glucose (b) double bonds (c) oxidation (d) reduction

8. Which of the following will form 2 acetaldehyde molecules on ozonolysis?
(a) 1-pentene (b) 2-pentene (c) 1-butene (d) 2-butene

9. Which of the following reagents will form 1-propanol from propene?
(a) B_2H_6, H_2O_2, OH^- (b) Aq. KOH (c) H_2O, H_2SO_4 (d) $Hg(OAc)_2$, $NaBH_4/H_2O$

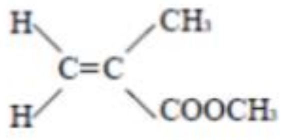
10. Geometrical isomerism is exhibited by
(a) 2-Butene (b) 2-Butyne (c) 2-Butenol (d) Butanol

11. Identify the incorrect statement regarding the synthesis of alkenes.
a.) Cracking of a hydrocarbon yields alkenes
b.) The reactions are exothermic
c.) Zeolite catalyst helps in the synthesis of alkenes
d.) The synthesis of alkenes is otherwise known as reforming

12. Which of the following alkenes are used in the production of plastics?
a.) 1, 2 – butadiene b.) 1, 3 – butadiene c.) 2 – butadiene d.) Butadiene

13. How do you test for an alkene?
a.) They turn universal indicator purple b.) They turn bromine water colourless
c.) They turn limewater cloudy d.) All of the above

14. The structure of the molecule of methyl 2-methylpropenoate is shown below.



Which one of the following statements concerning this compound is **not** true

a) It displays geometrical isomerism b) It forms an addition polymer
c) It undergoes reduction d) It decolourises Bromine

15. The lowest alkene, that is capable of exhibiting geometrical isomerism is
(a) Ethene
(b) But – 1- ene
(c) But – 2 – ene
(d) Propene.

SECTION-B

16. Which test is used to distinguish between alkane and alkenes?

17. Give the alkene structure (C_4H_8), which adds on HBr in the presence and the absence of peroxide, to give the same product, C_4H_9Br.

18. What is the decreasing order of reactivity of $H_2C = CH_2$, $(CH_3)_2$, $H_2C = CH_2$, $CH_3 – CH = CH_2$, $CH_3 – CH = CH – CH_3$, $(CH_3)_2 C = C (CH_3)_2$, $(CH_3)_2 C = CH CH_3$ towards electrophilic addition reactions?

19. How vicinal dihalide can be used in the preparation of alkene?

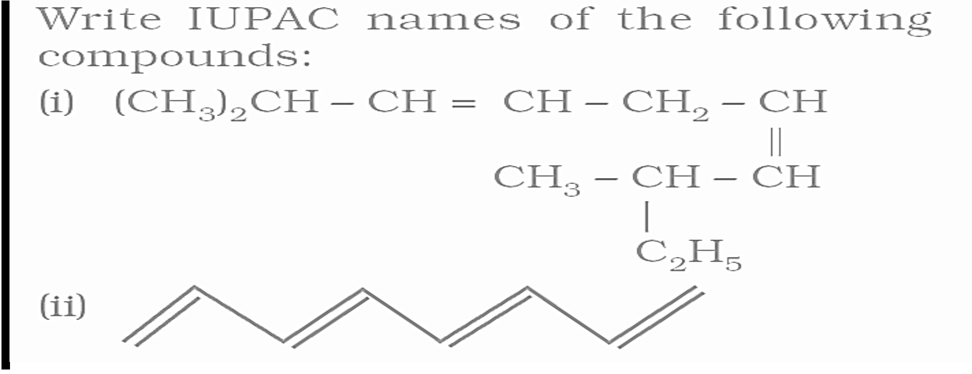
20. Alkynes on reduction with sodium in liquid ammonia form trans alkenes. Will the butene thus formed on reduction of 2-butyne show the geometrical isomerism?

21. Calculate number of sigma (σ) and pi (π) bonds in the given structures
(i) 2,8-Dimethyl-3, 6-decadiene;
(ii) 1,3,5,7 Octatetraene;
(iii) 2-*n*-Propylpent-1-ene;
(v) 4-Ethyl-2,6-dimethyl-dec-4-ene;

22. Which of the following compounds will show *cis-trans* isomerism?
(i) $(CH_3)_2C = CH – C_2H_5$
(ii) $CH_2 = CBr_2$
(iii) $C_6H_5CH = CH – CH_3$
(iv) $CH_3CH = CCl CH_3$

23. An alkene 'A' contains three C – C, eight C – H σ bonds and one C – C π bond. 'A' on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Write IUPAC name of 'A'.

24.



Write IUPAC names of the following compounds:

(i) $(CH_3)_2CH – CH = CH – CH_2 – CH$
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \|$
$\quad\quad\quad\quad\quad\quad\quad CH_3 – CH – CH$
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad |$
$\quad\quad\quad\quad\quad\quad\quad\quad\quad C_2H_5$

(ii)

25. Write IUPAC names of the products obtained by the ozonolysis of

3,4-Dimethylhept-3-ene

SECTION-C

26. Write the structure and IUPAC names of different structural isomers of alkenes corresponding to C_5H_{10}.

27. Why are addition reactions more common in alkenes and alkynes than in aromatic hydrocarbons?

28. Draw *cis* and *trans* isomers of the following compounds. Also write their IUPAC names :
(i) $CHCl = CHCl$
(ii) $C_2H_5CCH_3 = CCH_3C_2H_5$

29. Write IUPAC names of the products obtained by addition reactions of HBr to hex-1-ene
(i) in the absence of peroxide and
(ii) in the presence of peroxide.

30.Write structures of all the alkenes which on hydrogenation give 2-methylbutane

31. Propanal and pentan-3-one are the ozonolysis products of an alkene? What is the structural formula of the alkene?

32. An alkene ‘A’ on ozonolysis gives a mixture of ethanal and pentan-3-one. Write structure and IUPAC name
of ‘A’.

33. Draw the *cis* and *trans* structures of hex-2-ene. Which isomer will have higher b.p. and why?

34. In the presence of peroxide, addition of HBr to propene takes place according to Anti-Markovnikov's rule butperoxide effect is not seen in the case of HCl and HI. Explain.

35. Why do alkenes prefer to undergo electrophilic addition reaction while arenes prefer electrophilic substitution reactions? Explain.

SECTION-D

36. State Markownikov’s rule. Using this rule, write the reaction of propene with

(i) HCl & (ii) H2O

37. How can ethene be prepared from (i) Ethanol (ii) Ethyl bromide?

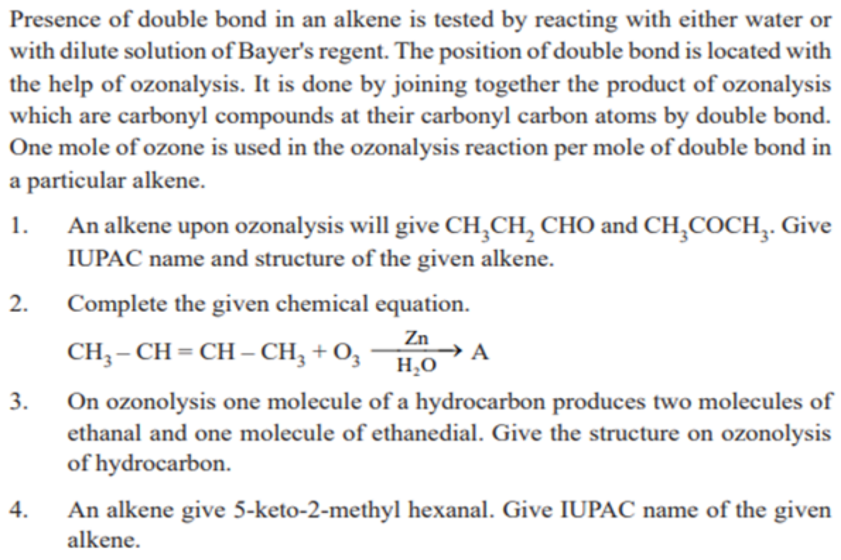
38. An alkene ‘A’ of molecular mass ‘28u’ on treatment with bromine gives a product ‘B’. The Compound ‘B’ on further dehalogenation with zinc gives back ‘A’. Give the structures of ‘A’ and ‘B’ and also the sequence of reactions.

39. An organic compound ‘A’ with formula C_4H_9Br on treatment with KOH(alc.) gave two isomeric compounds ‘B’ and ‘C’ with formula C_4H_8. Ozonolysis of ‘B’ gave only one product CH_3CHO while ’C’ gave two different products. Find the sum of carbon atoms in compound A,B and C

SECTION-E

40. Write IUPAC names of the products obtained by the ozonolysis of the following compounds :
(i) Pent-2-ene (ii) 3,4-Dimethyl-hept-3-ene (iii) 2-Ethylbut-1-ene (iv) 1-Phenylbut-1-ene

41.



Presence of double bond in an alkene is tested by reacting with either water or with dilute solution of Bayer's regent. The position of double bond is located with the help of ozonalysis. It is done by joining together the product of ozonalysis which are carbonyl compounds at their carbonyl carbon atoms by double bond. One mole of ozone is used in the ozonalysis reaction per mole of double bond in a particular alkene.

1. An alkene upon ozonalysis will give CH_3CH_2 CHO and CH_3COCH_3. Give IUPAC name and structure of the given alkene.
2. Complete the given chemical equation.

   $CH_3-CH=CH-CH_3+O_3 \xrightarrow[H_2O]{Zn} A$
3. On ozonolysis one molecule of a hydrocarbon produces two molecules of ethanal and one molecule of ethanedial. Give the structure on ozonolysis of hydrocarbon.
4. An alkene give 5-keto-2-methyl hexanal. Give IUPAC name of the given alkene.

42.(i) What factor determines the stability of alkene?

(ii) Melting point of cis-But-2-ene is lower than that of trans-But-2-ene. Give reason

(iii) Explain with the help of equation : Ozonolysis of propene.

43.(i) What happens when But-2-ene reacts with acidified potassium permanganate solution?

(ii) You are provided with But-2-yne, how will you convert it into:

(a) cis-But-2-ene (b) trans- But-2-ene

ALKENES

SECTION-A

1.b

2.c

3.b

4.b

5a

6.d

7.b

8.d

9.a

10.a

11.b

12.b

13.b

14.a

15.c

SECTION-B

16. Bromine reaction test can be used to distinguish an alkene from an alkane. Bromine water is commonly used to detect the presence of alkenes. When an alkene is added to a sample of bromine water and shaken, the solution changes from light orange to colourless.
Alkanes, on the other hand, cannot decolourize bromine water.

17. 2-Butene with structure $CH_3 – CH = CH — CH_3$ being symmetrical gives the same product, i.e., 2-bromobutane $CH_3 – CH(Br) – CH_2CH_3$.

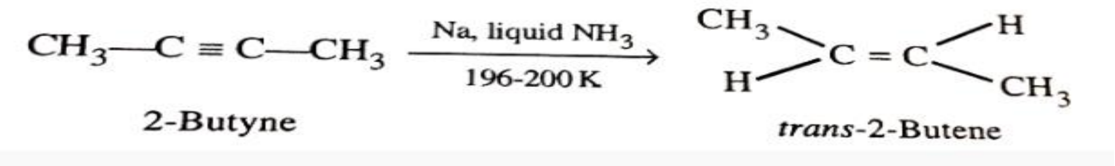
18. The order of reactivity of the given alkenes towards electrophilic addition reactions decreases in the following order–

$(CH_3)_2 C = C (CH_3)_2 > (CH_3)_2 C = CH\ CH_3 > (CH_3)_2 C = CH_2 > CH_3\ CH – CH – CH_3 > CH_3 – CH = CH, > CH_2 = CH_2$.

19. On treatment with Zn metal, Vicinal dihalide loses a molecule of ZnX_2 from an alkene. This reaction is known as dehalogenation.

$CH_2Br\text{-}CH_2Br + Zn \rightarrow CH_2 = CH_2 + ZnBr_2$.

20. since 2-butene is capable of showing geometrical isomerism, therefore, reduction of 2-butyne with sodium in liquid ammonia will give trans-2-butene.



21.(i) σ bonds : 33, π bonds : 2

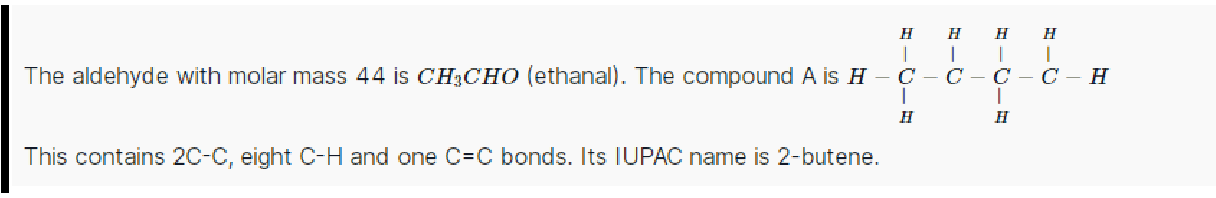
(ii) σ bonds : 7, π bonds : 4

(iii) σ bonds : 23, π bond : 1

(iv) σ bonds : 41, π bond : 1

22. (iii) and (iv). In structures (i) and (ii), two identical groups are attached to one of the doubly bonded carbon atom.

23.



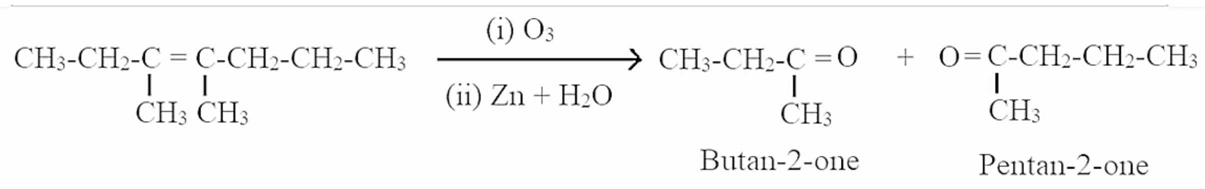
The aldehyde with molar mass 44 is CH_3CHO (ethanal). The compound A is $H - \overset{H}{C} - \overset{H}{\underset{H}{C}} - \overset{H}{C} - \overset{H}{\underset{H}{C}} - H$

This contains 2C-C, eight C-H and one C=C bonds. Its IUPAC name is 2-butene.

24. (i) 2,8-Dimethyl-3, 6-decadiene;

(ii) 1,3,5,7 Octatetraene

25.



$$CH_3\text{-}CH_2\text{-}\underset{CH_3}{C} = \underset{CH_3}{C}\text{-}CH_2\text{-}CH_2\text{-}CH_3 \xrightarrow[\text{(ii) } Zn + H_2O]{\text{(i) } O_3} CH_3\text{-}CH_2\text{-}\underset{CH_3}{C} = O + O = \underset{CH_3}{C}\text{-}CH_2\text{-}CH_2\text{-}CH_3$$

SECTION-C

26. The structure and IUPAC names of different structural isomers of Pentene are as follows-

Pent-1-ene

Pent-2-ene

2-Methylbut-2-ene

3-Methylbut-1-ene

2-Methylbut-1-ene

27. Unsaturated alkenes and alkynes have -bonds and thus do not have the full amount of hydrogen that they could have.

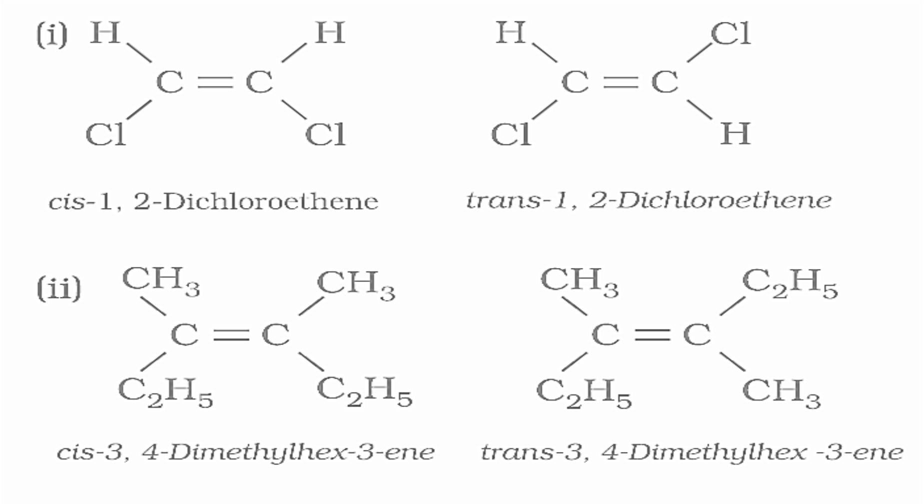
Since π-bonds are not as strong as σ-bonds, they are more unstable than alkanes. Even though alkenes and alkynes want to form more σ-bonds and have a more alkane-like structure, they undergo addition reactions.

Addition reactions occur when more atoms are added to the molecule rather than being removed. This means that the π—bonds must be removed and replaced with new atoms, rather than the existing σ-bonds being reattached – it is easier to break π- bond than to reattach σ – bond.

Alkanes do not undergo this reaction because they already have single σ-bonds and thus cannot become more structurally stable or stronger – they are already at the peak and can only swap things around in substitution reactions.

Alkanes do not undergo this reaction because they already have single σ-bonds and thus cannot become more structurally stable or stronger – they are already at the peak. They can only replace things around in substitution reactions.

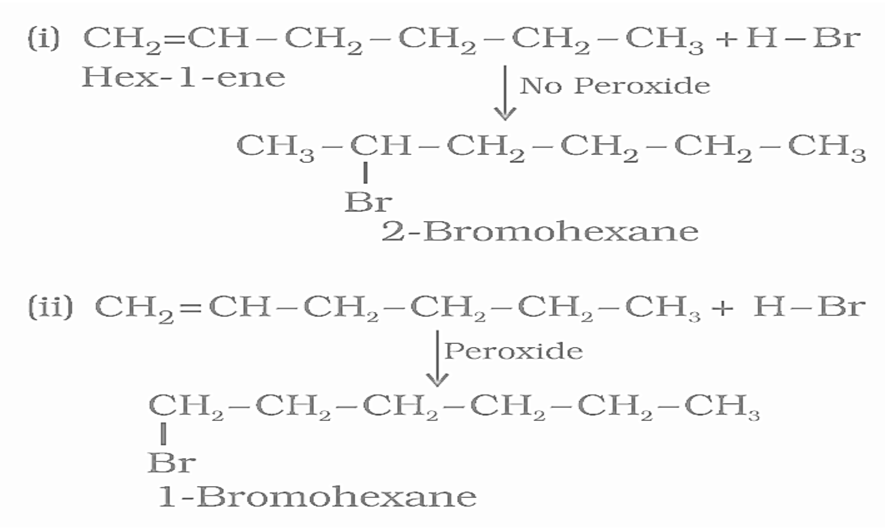
28.



cis-1, 2-Dichloroethene *trans*-1, 2-Dichloroethene

cis-3, 4-Dimethylhex-3-ene *trans*-3, 4-Dimethylhex -3-ene

29.



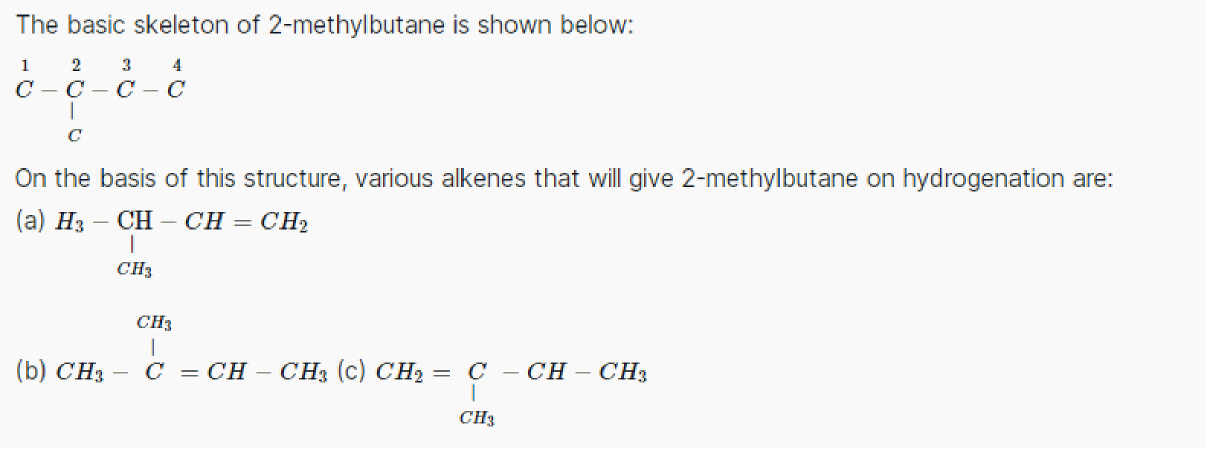
(i) $CH_2=CH-CH_2-CH_2-CH_2-CH_3 + H-Br \xrightarrow{\text{No Peroxide}} CH_3-\underset{\underset{Br}{|}}{CH}-CH_2-CH_2-CH_2-CH_3$

Hex-1-ene 2-Bromohexane

(ii) $CH_2=CH-CH_2-CH_2-CH_2-CH_3 + H-Br \xrightarrow{\text{Peroxide}} \underset{\underset{Br}{|}}{CH_2}-CH_2-CH_2-CH_2-CH_2-CH_3$

1-Bromohexane

30.



The basic skeleton of 2-methylbutane is shown below:

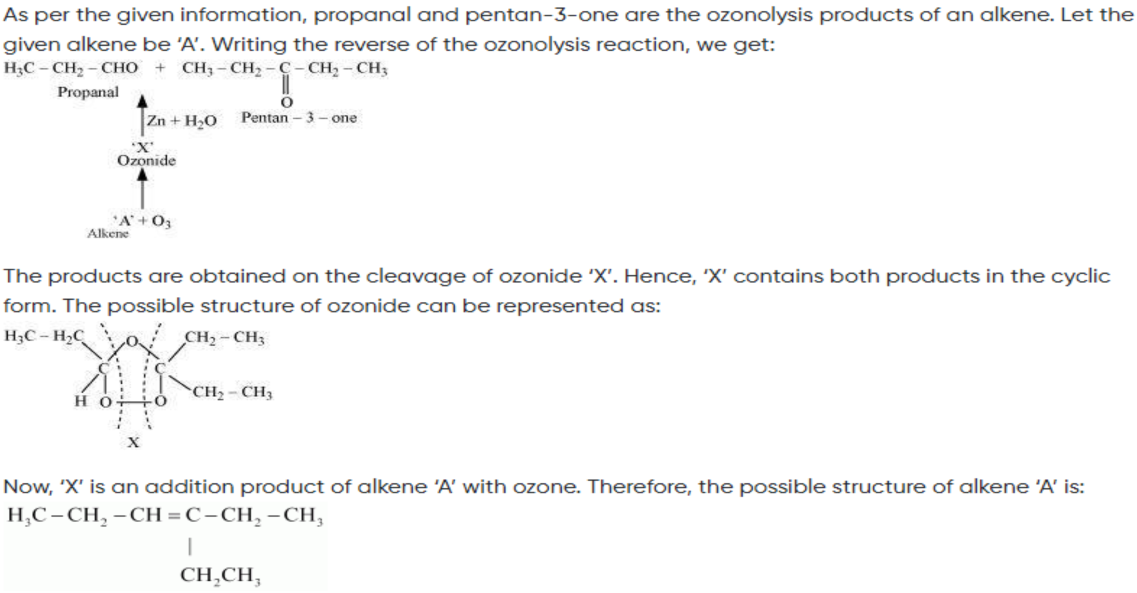
$$\overset{1}{C}-\underset{\substack{|\\ C}}{\overset{2}{C}}-\overset{3}{C}-\overset{4}{C}$$

On the basis of this structure, various alkenes that will give 2-methylbutane on hydrogenation are:

(a) $H_3-\underset{\substack{|\\ CH_3}}{CH}-CH=CH_2$

(b) $CH_3-\overset{\substack{CH_3\\ |}}{C}=CH-CH_3$ (c) $CH_2=\underset{\substack{|\\ CH_3}}{C}-CH-CH_3$

31.



As per the given information, propanal and pentan-3-one are the ozonolysis products of an alkene. Let the given alkene be ‘A’. Writing the reverse of the ozonolysis reaction, we get:

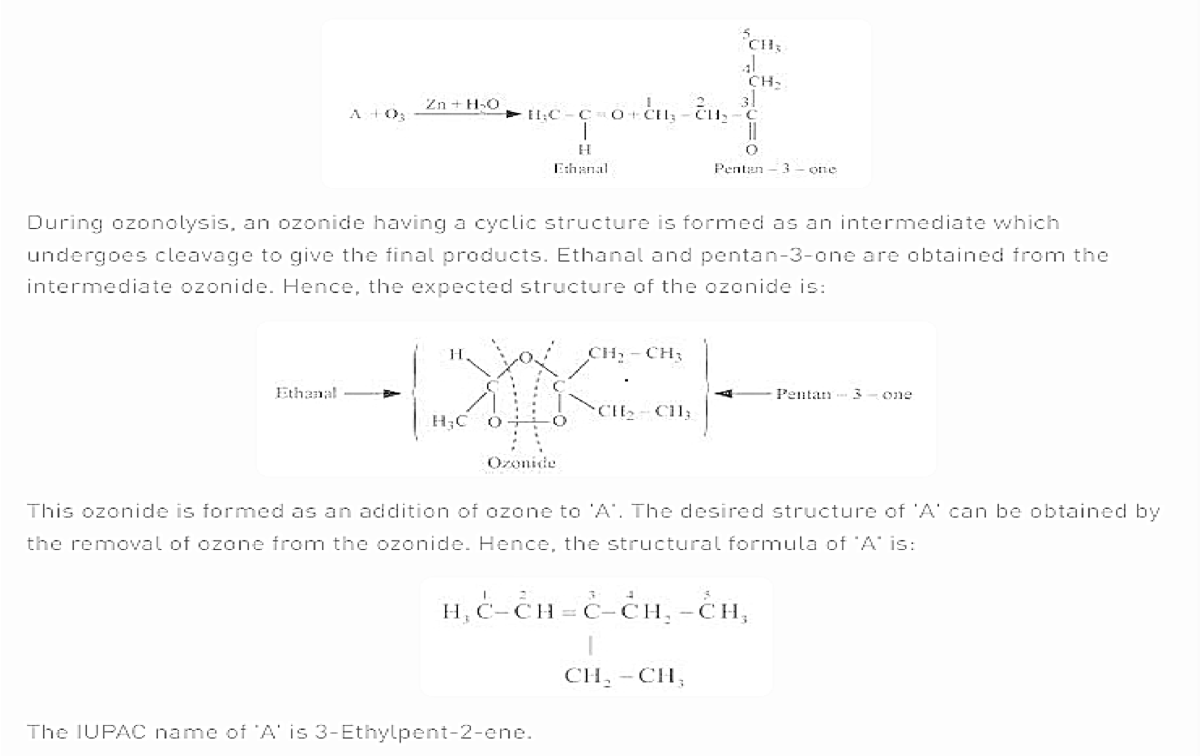
$$\begin{tikzcd} \underset{\text{Propanal}}{H_3C-CH_2-CHO} + \underset{\text{Pentan}-3-\text{one}}{CH_3-CH_2-\underset{\substack{\|\\ O}}{C}-CH_2-CH_3} \\ \underset{\text{Ozonide}}{\text{‘X’}} \arrow[u, "Zn + H_2O"] \\ \underset{\text{Alkene}}{\text{‘A’}} + O_3 \arrow[u] \end{tikzcd}$$

The products are obtained on the cleavage of ozonide ‘X’. Hence, ‘X’ contains both products in the cyclic form. The possible structure of ozonide can be represented as:

Now, ‘X’ is an addition product of alkene ‘A’ with ozone. Therefore, the possible structure of alkene ‘A’ is:

$$H_3C-CH_2-CH=\underset{\substack{|\\ CH_2CH_3}}{C}-CH_2-CH_3$$

32.



$$A + O_3 \xrightarrow{Zn + H_2O} \underset{\text{Ethanal}}{H_3C-\underset{\substack{|\\ H}}{C}=O} + \underset{\text{Pentan}-3-\text{one}}{\overset{1}{C}H_3-\overset{2}{C}H_2-\underset{\substack{\|\\ O}}{\overset{\substack{\overset{5}{C}H_3\\ |\\ \overset{4}{C}H_2\\ |}}{\overset{3}{C}}}}$$

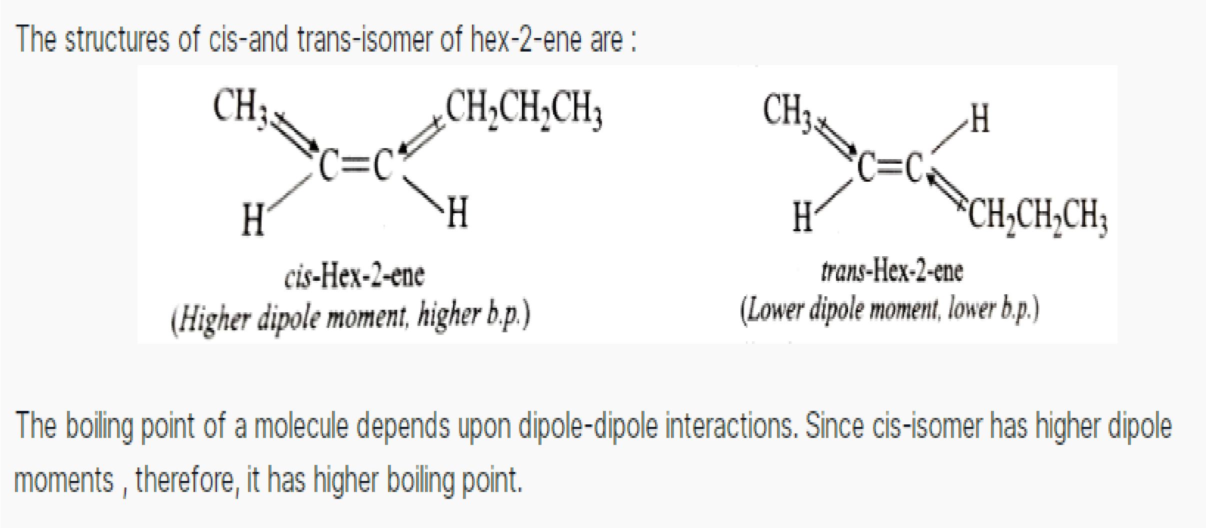
During ozonolysis, an ozonide having a cyclic structure is formed as an intermediate which undergoes cleavage to give the final products. Ethanal and pentan-3-one are obtained from the intermediate ozonide. Hence, the expected structure of the ozonide is:

This ozonide is formed as an addition of ozone to ‘A’. The desired structure of ‘A’ can be obtained by the removal of ozone from the ozonide. Hence, the structural formula of ‘A’ is:

$$H_3\overset{1}{C}-\overset{2}{C}H=\underset{\substack{|\\ CH_2-CH_3}}{\overset{3}{C}}-\overset{4}{C}H_2-\overset{5}{C}H_3$$

The IUPAC name of ‘A’ is 3-Ethylpent-2-ene.

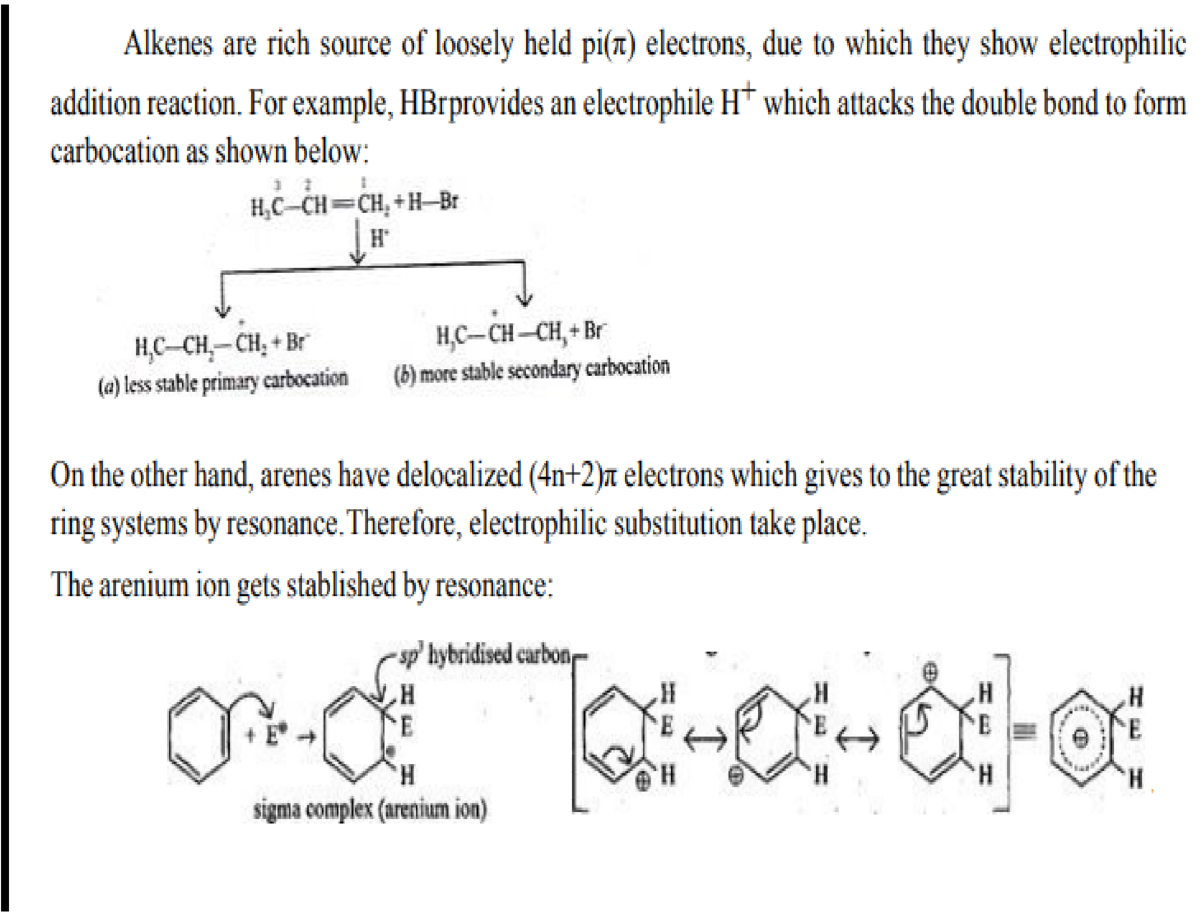
33.



The structures of cis-and trans-isomer of hex-2-ene are :

The boiling point of a molecule depends upon dipole-dipole interactions. Since cis-isomer has higher dipole moments , therefore, it has higher boiling point.

34. The mechanism of addition of HX in the presence of Peroxide is not observed in addition of HCl and HI. This is due to the fact that the H—Cl bond being stronger (430.5 kJ mol-1) than H—Br bond (363.7 kJ mol-1) is not cleaved symmetrically by the free radical and in case of H—I bond is weaker (296.8 kJ mol-1) and iodine free radicals have greater tendency to combine to form iodine molecules instead of adding to the double bond.



Alkenes are rich source of loosely held pi(π) electrons, due to which they show electrophilic addition reaction. For example, HBrprovides an electrophile H^+ which attacks the double bond to form carbocation as shown below:

On the other hand, arenes have delocalized (4n+2)π electrons which gives to the great stability of the ring systems by resonance.Therefore, electrophilic substitution take place.

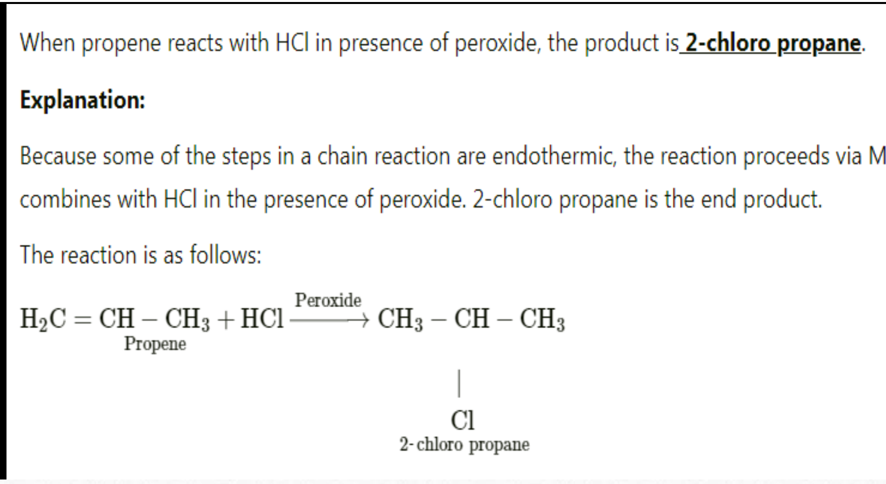
The arenium ion gets stablished by resonance:

35.

SECTION-D

36.<u>Markovnikov Rule</u>:- Negative part of the adding molecule gets attached to that double bonded carbon atom which possesses lesser number of hydrogen atoms

(i)



When propene reacts with HCl in presence of peroxide, the product is **2-chloro propane**.

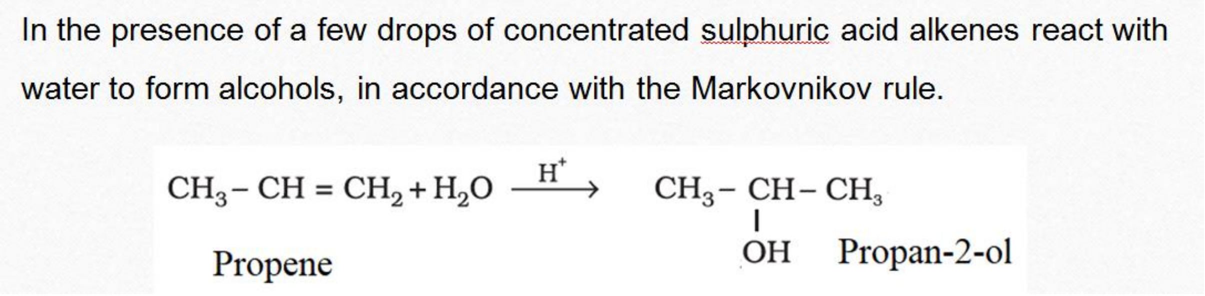
Explanation:

Because some of the steps in a chain reaction are endothermic, the reaction proceeds via Markovnikov's rule when propene combines with HCl in the presence of peroxide. 2-chloro propane is the end product.

The reaction is as follows:

$$\underset{\text{Propene}}{H_2C = CH - CH_3} + HCl \xrightarrow{\text{Peroxide}} \underset{\text{2-chloro propane}}{CH_3 - \underset{\substack{|\\ Cl}}{CH} - CH_3}$$

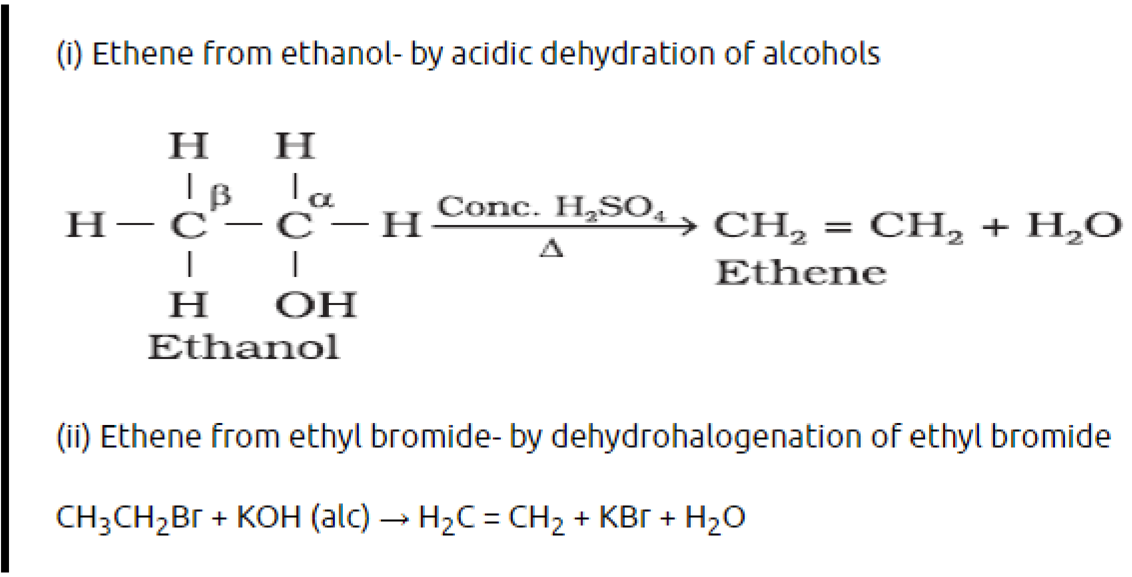
(ii)



In the presence of a few drops of concentrated sulphuric acid alkenes react with water to form alcohols, in accordance with the Markovnikov rule.

$$\underset{\text{Propene}}{CH_3 - CH = CH_2} + H_2O \xrightarrow{H^+} \underset{\text{Propan-2-ol}}{CH_3 - \underset{\substack{|\\ OH}}{CH} - CH_3}$$

37.



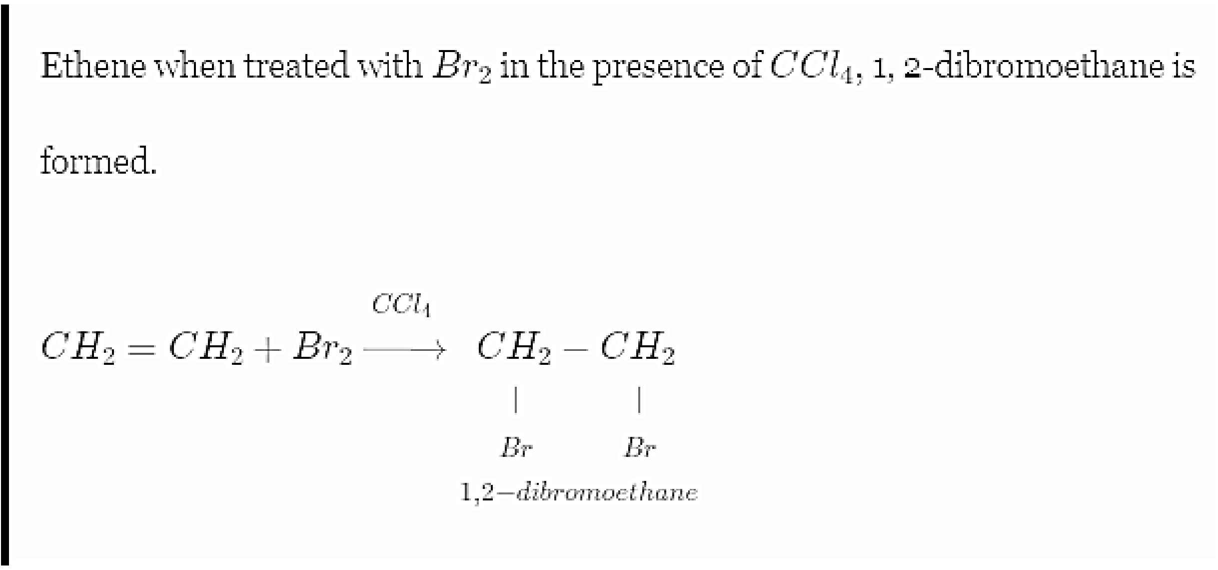
(i) Ethene from ethanol- by acidic dehydration of alcohols

$$\underset{\text{Ethanol}}{H - \overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}{}^{\beta} - \overset{\overset{H}{|}}{\underset{\underset{OH}{|}}{C}}{}^{\alpha} - H} \xrightarrow[\Delta]{\text{Conc. } H_2SO_4} \underset{\text{Ethene}}{CH_2 = CH_2} + H_2O$$

(ii) Ethene from ethyl bromide- by dehydrohalogenation of ethyl bromide

$CH_3CH_2Br + KOH\ (alc) \rightarrow H_2C = CH_2 + KBr + H_2O$

38.



Ethene when treated with Br_2 in the presence of CCl_4, 1, 2-dibromoethane is formed.

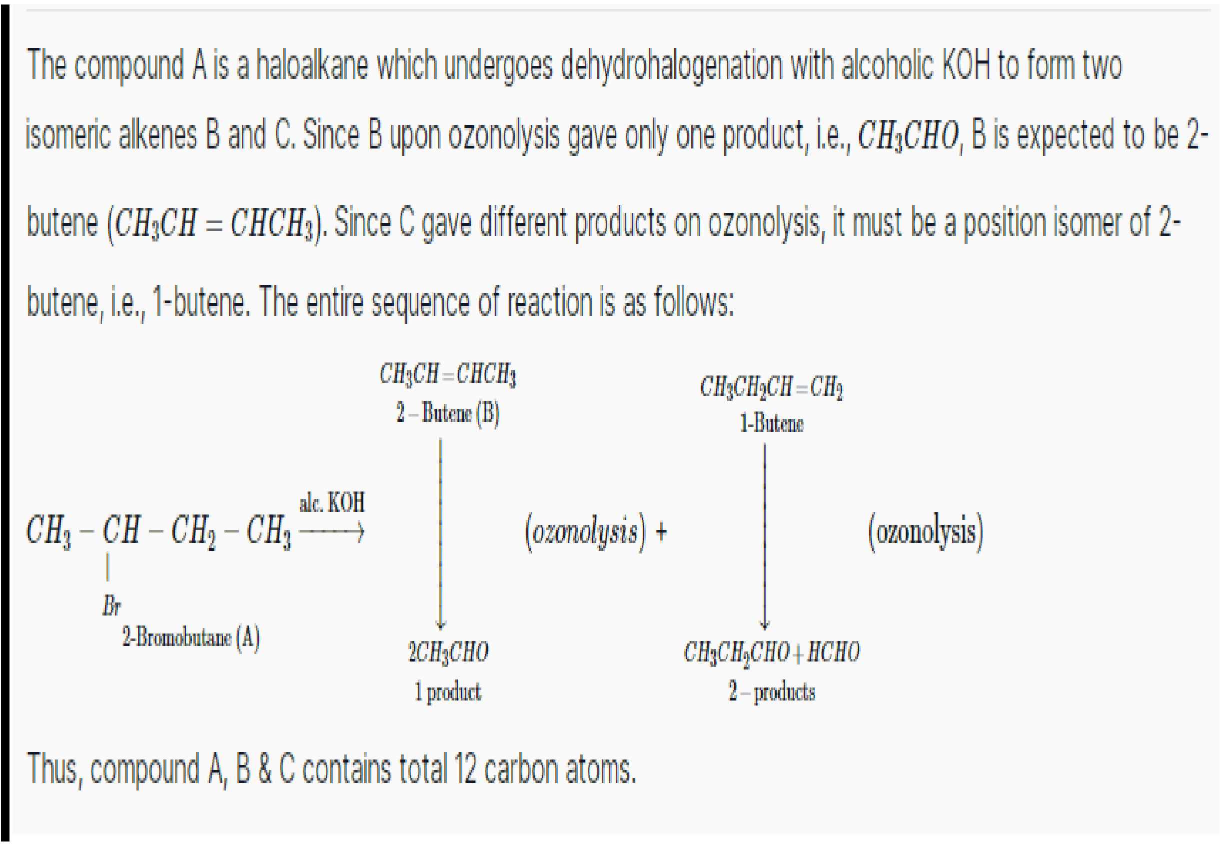
$$CH_2 = CH_2 + Br_2 \xrightarrow{CCl_4} \underset{1,2-dibromoethane}{\underset{\substack{|\\ Br}}{CH_2} - \underset{\substack{|\\ Br}}{CH_2}}$$

During the reaction of 1, 2-dibromoethane with Zn dust, dehalogenation of the alkane takes place to form ethene

$$(Br)CH_2-CH_2(Br)+Zn \rightarrow CH_2=CH_2+ZnBr_2$$

Here,Alkene A , $CH_2=CH_2$ (28u) , Product B , $(Br)CH_2-CH_2(Br)$

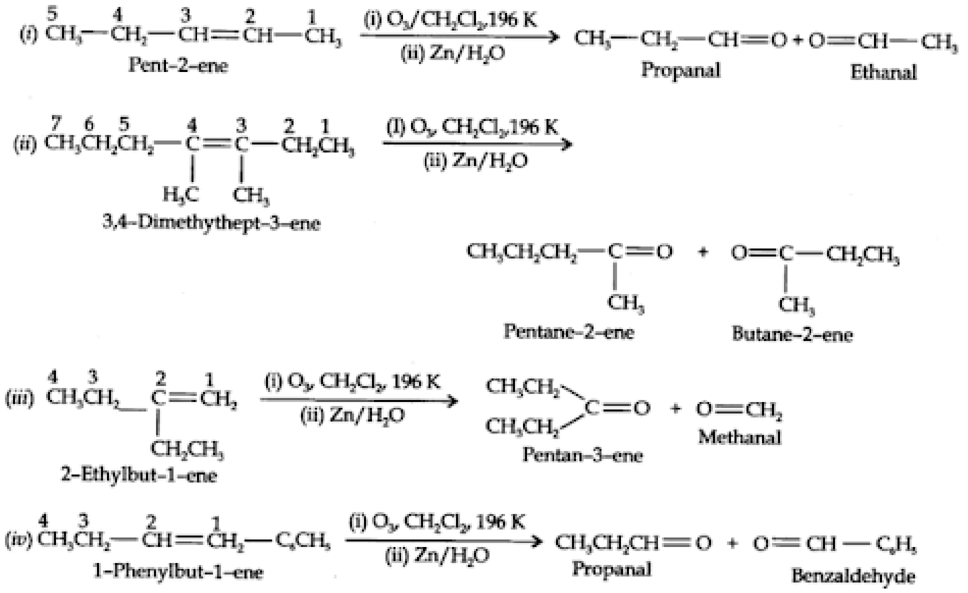
39.



The compound A is a haloalkane which undergoes dehydrohalogenation with alcoholic KOH to form two isomeric alkenes B and C. Since B upon ozonolysis gave only one product, i.e., CH_3CHO, B is expected to be 2-butene ($CH_3CH=CHCH_3$). Since C gave different products on ozonolysis, it must be a position isomer of 2-butene, i.e., 1-butene. The entire sequence of reaction is as follows:

Thus, compound A, B & C contains total 12 carbon atoms.

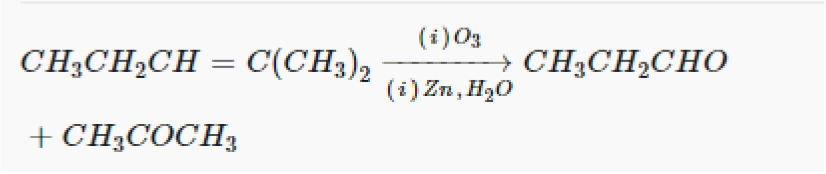
SECTION-E



40.

41.

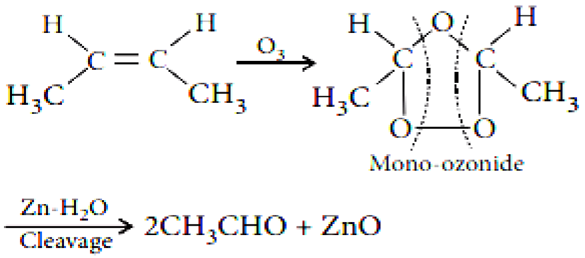
(1).



$$CH_3CH_2CH=C(CH_3)_2 \xrightarrow[(i)\,Zn,H_2O]{(i)\,O_3} CH_3CH_2CHO + CH_3COCH_3$$

2-methylpent-2-ene

(2)



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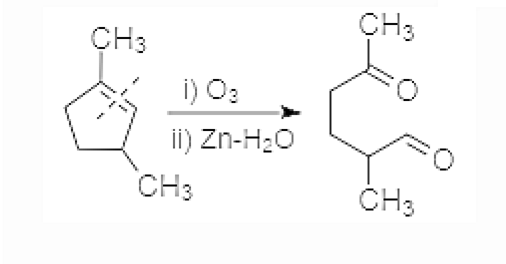
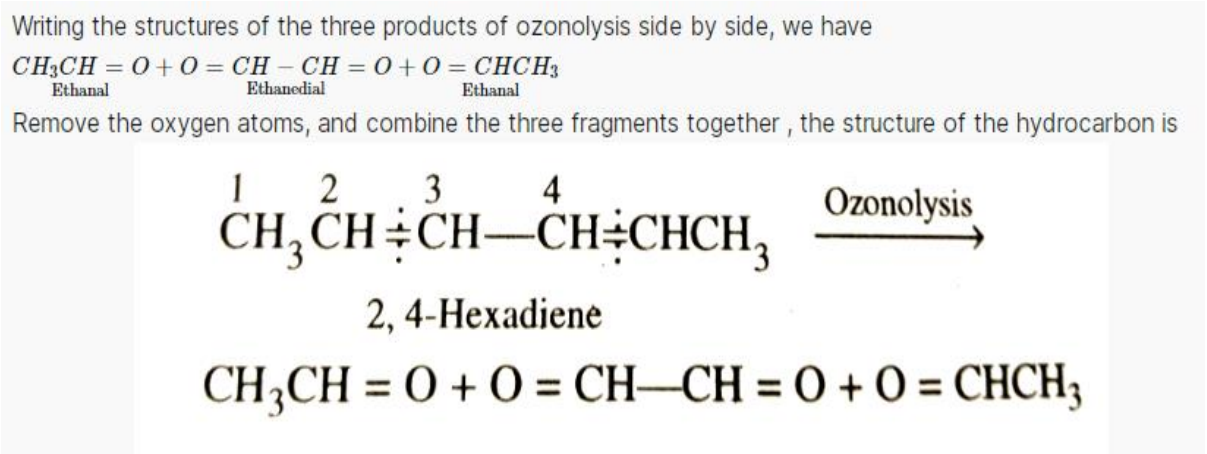




Writing the structures of the three products of ozonolysis side by side, we have

$\underset{\text{Ethanal}}{CH_3CH = O} + \underset{\text{Ethanedial}}{O = CH - CH = O} + \underset{\text{Ethanal}}{O = CHCH_3}$

Remove the oxygen atoms, and combine the three fragments together , the structure of the hydrocarbon is

$$\overset{1}{C}H_3\overset{2}{C}H \vdots \overset{3}{C}H—\overset{4}{C}H \vdots CHCH_3 \xrightarrow{\text{Ozonolysis}}$$

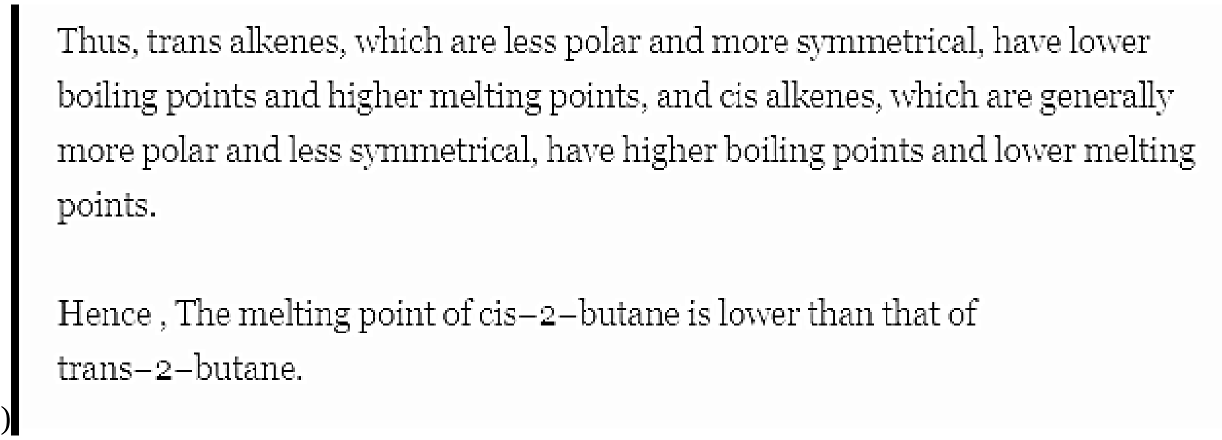
2, 4-Hexadiene

$$CH_3CH = O + O = CH—CH = O + O = CHCH_3$$

(4). ***1***,***3***-dimethylcyclopent-***1-ene***

42. (i) There are three main things that determine stability of an alkene product:

the number of substituents, their orientation, and hyperconjugation.

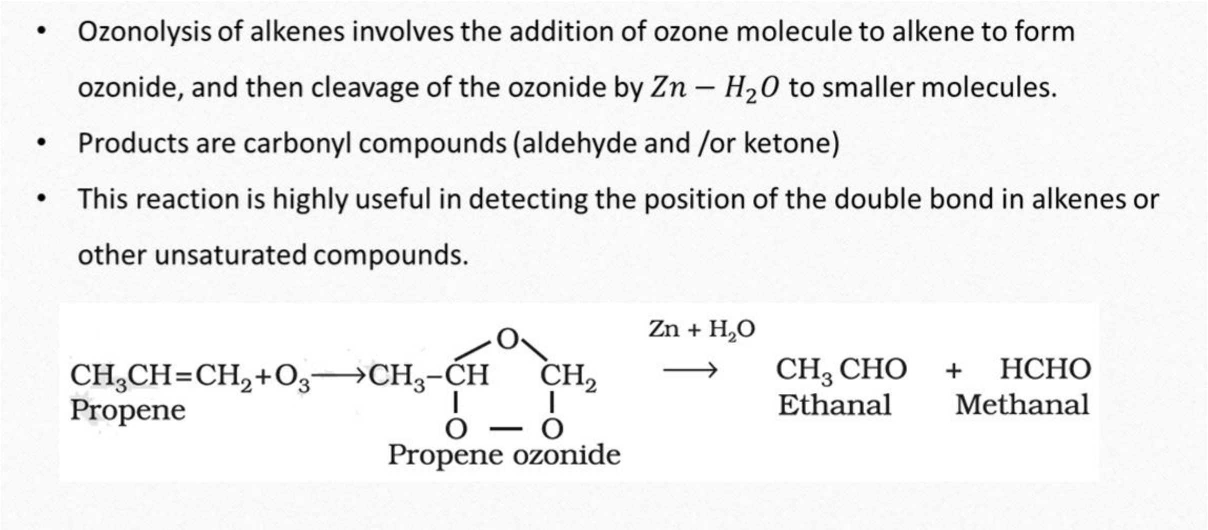


Thus, trans alkenes, which are less polar and more symmetrical, have lower boiling points and higher melting points, and cis alkenes, which are generally more polar and less symmetrical, have higher boiling points and lower melting points.

Hence , The melting point of cis−2−butane is lower than that of trans−2−butane.

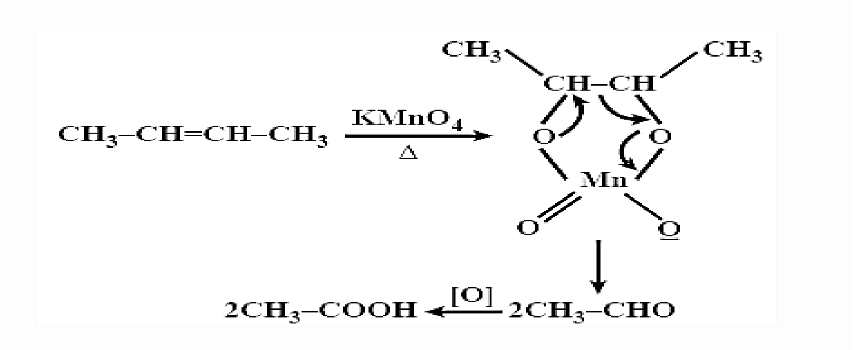
(ii)

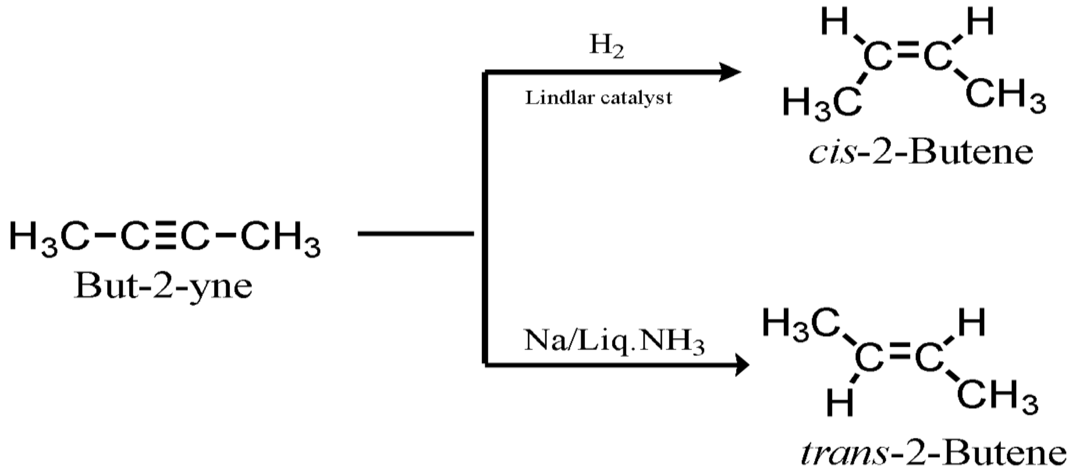
(iii)



- Ozonolysis of alkenes involves the addition of ozone molecule to alkene to form ozonide, and then cleavage of the ozonide by $Zn - H_2O$ to smaller molecules.
- Products are carbonyl compounds (aldehyde and /or ketone)
- This reaction is highly useful in detecting the position of the double bond in alkenes or other unsaturated compounds.

43(i)





(ii)

TOPIC - ALKYNES

MCQ -1 MARKS QUESTIONS – (15)

1. Ozonolysis of acetylene or ethyne gives-
a) None of these b) CH3CHO c) CHO-CHO d) HCHO

2. When acetylene is treated with HBr, the product is ———-
a) Methyl bromide b) Ethylene bromide c) Ethyl bromide d) Ethylidene bromide

3. Which one of the following is not an isomer of 3-Methylbut-1-yne?
a) Pent-1-yne b) Buta-1,3-diene c) Pent-2-yne d) Penta-1,3-diene

4. The reaction, $CH\equiv C - CH3 + HBr \rightarrow CH2=CBr - CH3$ is-
a) electrophilic substitution b) free radical addition c) nucleophilic addition d) electrophilic addition.

5. Acidic hydrogen is present in
a) Ethyne b) Ethene c) Benzene d) Ethane

6. When propyne is treated with aqueous sulphuric acid in presence of mercuric sulphate, the major product is
a) Propanal b) Propyl hydrogen sulphate c) Acetone or propanone d) Propanol

7. A gas on passing through ammoniacal solution of silver nitrate gives a precipitate. The gas may be
a) C_2H_2 B) C_2H_4 C) C_3H_4 D) C_4H_6

8. The number of sigma and pie bonds in 1-butene-3-yne are
a) 5 sigma and 5pi b)7 sigma and 3 pi c)8 sigma and 2 pi d)6 sigma and 4 pi

9. Molecule in which distance between two adjacent carbon atom is the shortest is
a) ethene b) ethyne c) ethane d) benzene

10. What is the hybridisation state of carbon atom in ethyne
a) s p b) sp_2 c) sp_3 d) sp_3d

11. The percentage of s character of the hybrid orbital of carbon in ethyne is
a) 44 b)50 c)25 d)33

12. Which of the following will have most hindered rotation about C-C bond
a) ethane b) ethyne c) ethene d) hexachloroethane

13. 2- Hexyne gives trans-2-hexene on treatment with
a) Li/NH_3 b) $Pd/BaSO_4$ c) $LiAlH_4$ d) Pt/H 2

14. Number of possible alkynes with the formula C_5H_8 is
a) 3 b) 5 c)2 d)4

15. Which of these will not react with ethyne?
a) NaOH b) ammoniacal $AgNO_3$ C) Na d) HCl

ANSWERS TO MCQ

1 c 2b 3b 4a 5a 6c 7a 8b 9b 10a 11b 12b 13a 14a 15a

Short answer questions -2 marks (10)

1. How will you distinguish between acetylene and ethylene?

Ans. Acetylene forms precipitate with ammoniacal silver nitrate solution, ethylene does not react with these reagents.

2. Arrange the following: HCl, HBr, Hl, HF in order of decreasing reactivity towards alkynes.
Ans. HI > HBr > HCl > HF

3. Which type of isomerism is exhibited by but-1-yne and but-2-yne? Show. Ans. Position isomerism. Which is more acidic: ethene or ethyne and why?

Ans. Ethyne is more acidic than ethene because it has 'sp' hybridised 'C' which is more electronegative.

4. Unsaturated compounds undergo addition reactions. Why?

Ans. Unsaturated hydrocarbon compounds undergo addition reactions because they contain carbon-carbon double or triple bonds. By addition reactions, these unstable π-bonds get broken and makes stable saturated hydrocarbons.

5. What happens when Ethyne (acetylene) on passing through red hot iron tube at 873K.

Ans It trimerises to give benzene.

6. What is the property and use of polyacetylene.

Ans Thin film of polyacetylene can be used as electrodes in batteries. These films are good conductors, lighter and cheaper than the metal conductors.

7. Name two reagents which can distinguish between alkene and alkyne. Ans Tollen's

reagent and ammoniacal Cu Cl solution.

8. Out of ethene and ethyne, which is more reactive towards nucleophilic addition reaction and why?

Ans: Ethyne as it has greater electronegative s p- hybridised carbon 10.How will you distinguish

between but-1-yne and but-2-yne?

Ans: But-1-yne will give white ppt of silver but-1-ynide with Tollens reagent but but-2-yne won't give such reaction.

Short answer question of 3 marks---(10)

1. Write the Conversion ethyne to ethane.

Ans Addition of dihydrogen to ethyne gives ethane under Pt catalyst.

2. Assign structures for the following: i) An alkyne (X) has a molecular formula C5H8. It reacts neither with sodamide nor with ammoniacal cuprous chloride.

Ans: Since the given alkyne (X) does not react with sodamide or ammoniacal cuprous chloride, thus, in Alkyne C5H8, the triple bond cannot be terminal. Pent-2-yne

Discuss briefly structure of triple bond.

Ans: Carbon atom of ethyne has two sp hybridised orbitals. Carbon-carbon sigma (σ) bond is obtained by the head-on overlapping of the two sp hybridised orbitals of the two carbon atoms. Each carbon has two unhybridised p orbitals which are perpendicular to each other as well as to the plane of the C-C sigma bond. The 2p orbitals of one carbon atom are parallel to the 2p of the other carbon atom, which undergo lateral or sideways overlapping to form two pi (π) bonds between two carbon atoms.

3. Comment upon isomerism in alkynes

Ans: There are two possible structures for butyne (i) but-1-yne and (ii) but-2- yne. Since these two compounds differ in their structures due to the position of the triple bond, they are known as position isomers. Chain isomers are also possible.

4. Comment upon acidic character of terminal alkyne

Ans Due to the maximum percentage of s character (50%), the sp hybridised orbitals of carbon atoms in ethyne molecules have highest electronegativity; hence, these attract the shared electron pair of the C-H bond of ethyne to a

greater extent than that of the sp2 hybridised orbitals of carbon in ethene and the sp3 hybridised orbital of carbon in ethane. Thus in ethyne, hydrogen atoms can be liberated as protons more easily as compared to ethene and ethane.

Hence, hydrogen atoms of ethyne attached to triply bonded carbon atom are

acidic in nature. the hydrogen atoms attached to the triply bonded carbons are acidic

5. Write the addition of water to alkynes.

Ans Like alkanes and alkenes, alkynes are also immiscible and do not react with water. However, one molecule of water adds to alkynes on warming with

mercuric sulphate and dilute sulphuric acid at 333 K to form carbonyl compounds.

6. Discuss the polymerization reactions of alkynes

Linear polymerisation: Under suitable conditions, linear polymerisation of ethyne takes place to produce polyacetylene or polyethyne which is a high

molecular weight polyene containing repeating units of (CH = CH – CH = CH) and can be represented as —(CH = CH – CH = CH)n —

Cyclic polymerisation: Ethyne on passing through red hot iron tube at 873K undergoes cyclic polymerization. Three molecules polymerise to form benzene,

7. Write short notes on i) addition of halogens to alkynes ii) addition of hydrogen halide to alkynes

Ans i) Reddish orange colour of the solution of bromine in carbon tetrachloride is decolourised. This is used as a test for unsaturation. Propyne reacted with Br_2 gives 1,1,2,2-tetrabromopropane.

ii) Two molecules of hydrogen halides (HCl, HBr, HI) add to alkynes to form gem dihalides (in which two halogens are attached to the same carbon atom

8. Write how ethyne could be prepared.

Ans From calcium carbide: On industrial scale, ethyne is prepared by treating calcium carbide with water. Calcium carbide is prepared by heating quick lime with coke. Quick lime can be obtained by heating limestone.

From vicinal dihalides: Vicinal dihalides on treatment with alcoholic potassium hydroxide undergo dehydrohalogenation. One molecule of hydrogen halide is eliminated to form alkenyl halide which on treatment with sodamide gives alkyne.

9. What happens when calcium carbide is treated with water? Give chemical equations for the reaction.

Ans $CaC_2 + 2H_2O$ -------------------- $Ca(OH)_2 + C_2H_2$

CASE BASED QUESTIONS 4M------------------------------ (4)

1. Each carbon atom of ethyne has two sp hybridised orbitals. Carbon-carbon sigma (σ) bond is obtained by the head-on overlapping of the two sp hybridised orbitals of the two carbon atoms. The remaining sp hybridised orbital of each carbon atom undergoes overlapping along the internuclear axis with the 1s orbital of each of the two hydrogen atoms forming two C-H sigma bonds. H-C- C bond angle is of 180°. Each carbon has two unhybridised p orbitals which are perpendicular to each other as well as to the plane of the C-C sigma bond.

i) The number of types of bonds between two carbon atoms in calcium carbide is

a) One sigma, two pi b)one sigma ,one pi c)two sigma, one pi d)two sigma, two pi

ii) Alkynes contain two pi bond but does not show geometrical isomerism. Why?

iii) What is the impact of sp hybridisation on reactivity of alkynes?

ANS i) a

ii) Due to alkynes being linear molecules and -C≡C-H bond angle is 180.

iii) higher acidity of alkynes and easily electrophilic addition reactions take place.

2. Due to the maximum percentage of s character (50%), the sp hybridised orbitals of carbon atoms in ethyne molecules have highest electronegativity; hence, these attract the shared electron pair of the C-H bond of ethyne to a greater extent than that of the sp 2 hybridised orbitals of carbon in ethene and the sp 3 hybridised orbital of carbon in ethane. Thus, in ethyne, hydrogen atoms can be liberated as protons more easily as compared to ethene and ethane. Hence, hydrogen atoms of ethyne attached to triply bonded carbon atom are acidic in nature.

i) Among the following, the strongest acid is.

a) HC≡CH b) C_6H_6 c) C_2H_6 d) CH_3OH

II)Account for the decreasing order of acidity: ethyne, benzene, hexane

iii) Compare the melting point and boiling points of alkynes, alkene and alkanes. Write the reason for the difference.

Ans i) d

ii) due to sp hybridised C atom and hence higher elecronegativity, acidity is more in ethyne

iii) MP and BP of alkynes is more due to the presence of stronger triple bond.

3. The addition product formed depends upon stability of vinylic cation. Addition in unsymmetrical alkynes takes place according to Markovnikov rule. Majority of the reactions of alkynes are the examples of electrophilic addition reactions.

i) CH_3-C≡CH + 2HBr will give

a) 2,2-dibromopropane b) 1,2- dibromopropane c) 1,3-dibromopropane d) 2,3 -dibromopropane

b) What is expected product of reaction of propyne with bromine in CCl_4.

a) 2-bromopropenol b) bromoacetone c)2-bromo-2-propanol d) 1,1,2,2-tetrabromopropane

ii) How is Markonikov rule applicable to addition reaction in alkynes. Show with an example.
Ans i) a ii) d

iii) $CH_3-C\equiv CH + HBr \rightarrow CH_3-CBr=CH_2 \rightarrow CH-CBr_2-CH_3$

4. Ethyne on passing through red hot iron tube at 873K undergoes cyclic polymerization. Three molecules polymerise to form benzene, which is the starting molecule for the preparation of derivatives of benzene, dyes, drugs and large number of other organic compounds.

i) 1-Bromopropyne when reacted with sodamide and red hot iron tube at 873K will give major product as

a) toluene b) benzene c) 1,3,5-trimethylbenzene d)1,4- dimethyl benzene

ii) How will you convert ethyne into benzene?

iii) Suggest preparation of nitrobenzene from ethyne. ANS i) c ii)

cyclic polymerisation of ethyne

iii)ethyne + red hot Fe→ benzene + HNO_3→nitrobenzene

LONG ANSWER QUESTION ---5 MARKS --------------- (4)

1. An alkyl halide $C_5H_{11}Br$ (A) reacts with ethanolic KOH to give an alkene B, which reacts with Br_2 to give a compound C, which on dehydrobromination gives an alkyne D. On treatment with sodium metal in liquid ammonia, one mole of D gives one mole of sodium salt of D and half a mole of hydrogen gas. Identify A, B, C, D. Give the reaction involved.
Ans A- 1- bromopentane, B- 1-pentene C- 1,2-Dibromopentane D- 1- pentyne
2. How will you convert ethanoic acid into benzene? Ans refer to

intext question 13.14 with solution

3. Write structures of different isomers corresponding to the 5th member of alkyne series. Also write IUPAC names of all the isomers. What type of isomerism is exhibited by different pairs of isomers?
Ans: Refer to intext question 13.13 with solution
4. How will you convert 2-butyne to cis – and trans- 2 -butene. Give the names of the reagents and their mode of action.
ANS Alkynes on partial reduction with calculated amount of dihydrogen in the presence of palladised charcoal partially deactivated with poisons like sulphur compounds or quinoline give alkenes. Partially deactivated palladised charcoal is known as Lindlar’s catalyst. Alkenes thus obtained are having cis geometry. However, alkynes on reduction with sodium in liquid ammonia gives trans alkenes.

AROMATIC HYDROCARBONS

I. SECTION A (Multiple Choice Questions)

1. Find the true statement about benzene

(a) it possesses two types of C-C bonds
(b) three isomeric forms are possible in a monosubstituted benzene
(c) it readily undergoes addition due to unsaturation
(d) pi-electrons are delocalised in the ring

2. **Nitration of benzene is carried out by which of the following reactive species?**
   (a) NO_2^+
   (b) NO_2^-
   (c) HNO_3
   (d) NO_3
3. **In Chlorination of benzene, which of the following acts as an electrophile?**
   (a) Cl^+
   (b) Cl^-
   (c) Cl
   (d) $FeCl_3$
4. **Arenes do not show**
   (a) Delocalisation of pi-electrons
   (b) Greater stability
   (c) Resonance
   (d) Electrophilic additions
5. **Find the most stable carbonium ion among the following**
   (a) $CH_3CH_2^+$
   (b) $C_6H_5CH_2^+$
   (c) $C_6H_5CH_2CH_2^+$
   (d) $(C_6H_5)_2CH^+$
6. **Which of the following groups are most likely to be o, p directing?**
   (a) Deactivating
   (b) Neutral
   (c) Activating
   (d) All of the above
7. **The product formed predominantly in the reaction of toluene with chlorine in the presence of $FeCl_3$ is**
   (a) m-chlorotoluene
   (b) o- and p-chlorotoluene
   (c) Benzoyl chloride
   (d) Benzyl chloride
8. **Which of the following will not undergo Friedel-Craft's reaction readily?**
   (a) Toluene
   (b) Xylene
   (c) Cumene
   (d) Nitrobenzene
9. **The product formed, when benzene reacts with CH_3COCl in the presence of $AlCl_3$ is**
   (a) $C_6H_5CH_3$
   (b) C_6H_5Cl
   (c) $C_6H_5COCH_3$
   (d) C_6H_5COCl

10. Find the reactants other than $AlCl_3$ in Friedel-Craft's alkylation

(a) $C_6H_6 + CH_4$

(b) $C_6H_6 + NH_3$

(c) $C_6H_6 + CH_3Cl$

(d) $C_6H_6 + CH_3COCl$

11. Which of the following can be used as the halide component of a Friedel-Crafts reaction?
(a) Chlorobenzene
(b) Bromobenzene
(c) Chloroethene
(d) Isopropyl chloride

12. Benzene reacts with CH_3Cl in the presence of anhydrous $AlCl_3$ to form

(a) Chlorobenzene

(b) Benzyl chloride

(c) xylene

(d) toluene

13. Which among the following is not a carcinogen?

a) 1,2-Benzpyrene

b) Ethyl Alcohol

c) 3-Methylcholanthrene

d) 1,2-Benzanthracene

14. Which of the following is an example of ortho and para directing group?
a) $-SO_3H$
b) -COOR
c) $-OCH_3$
d) –CN

15. Which of the following is used to reduce phenol vapors to benzene?
a) Hydrogen gas
b) Oleum
c) Zinc dust
d) Anhydrous $AlCl_3$.

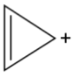
ANSWERS:

1. (d)	2. (a)	3. (a)	4. (d)	5. (d)
6. (c)	7. (b)	8. (d)	9. (c)	10. (c)
11. (d)	12. (d)	13. (b)	14. (c)	15. (c)

II. SECTION B (SHORT ANSWER QUESTIONS) (2 MARKS)

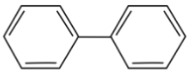
16. Four structures are given in options (i) to (iv). Examine them and select the aromatic structures.

(i)

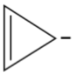


(ii)

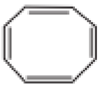
(iii)



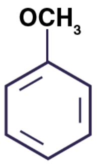
(iv)

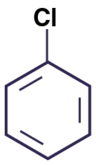


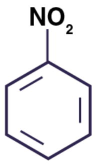
17. Unsaturated compounds undergo addition reactions. Why?
18. How will you convert benzene to iodobenzene? Give a chemical equation.
19. What do you understated by Resonance energy?
20. Explain why the system is not aromatic.



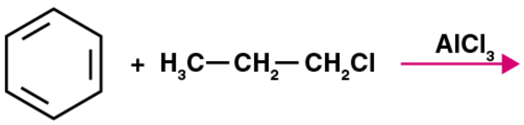
21. How will you convert benzene to toluene? Give chemical equation.
22. How will you distinguish between Ethene and benzene?
23. Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty?
24. Arrange the following set of compounds in the order of their decreasing relative reactivity with an electrophile. Give reason.







25. What will be the product obtained as a result of the following reaction and why?

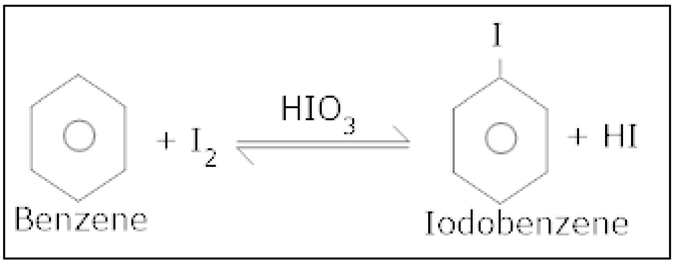


ANSWERS:

16. The structures I and III are aromatic.
In the given structures, structure I and III both follow Huckel's rules and they are planar i.e. they fulfill all the conditions of aromaticity hence they are aromatic. Structure II is non planar tub shaped and structure IV is anti aromatic.

17. Unsaturated hydrocarbon compounds undergo addition reactions because they contain carbon-carbon double or triple bonds. By addition reactions, these unstableπ-bonds get broken and makes stable saturated hydrocarbons.

18.



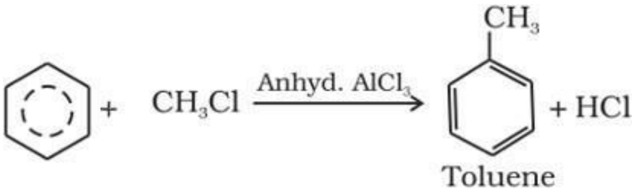
19. Resonance energy: The difference between the energy of the most stable contributing structureand the energy of the resonance hybrid is known as resonance energy. Example: The resonance energy of benzene is 147KJ/mole

20. For the given compound, the number of π-electrons is 8. By Huckel's rule,

$\Rightarrow 4n + 2 = 8$
$\Rightarrow 4n = 6$
$\Rightarrow n = 3/2$
For a compound to be aromatic, the value of n must be an integer (n = 0, 1, 2…).

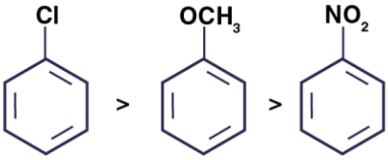
This is not true for the given compound as it is a fraction. Hence, it is not aromatic in nature.

21.



22. Ethene discharges bromine water colour and Baeyer's reagent colour. Benzene doesnot discharge bromine water colour and Baeyer's reagent colour.

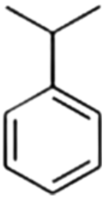
23. Due to the presence of an electron cloud containing 6 -electrons above and below the plane of the ring, benzene is a rich source of electrons. Consequently, it attracts the electrophiles (electron - deficient) reagents towards it and repels nucleophiles (electron rich) reagents. As a result, benzene undergoes electrophilic substitution reactions easily and nucleophilic substitutions with difficulty.



24.

The electron donating group increases the reactivity in electrophilic substitution reaction whereas the electron withdrawing group decreases the reactivity in electrophilic substitution.

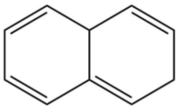
25.The benzene here would undergo Friedel-Crafts alkylation reaction where carbocation is formed as an intermediate, thus secondary carbocation is formed as an intermediate due to its greater stability than that of the primary carbocation.The final product obtained is



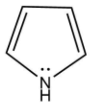
III. SHORT ANSWER QUESTIONS (3 MARKS)

26. Which of the following compounds are aromatic according to Huckel's rule?

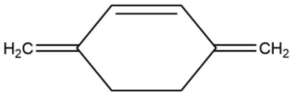
(A)



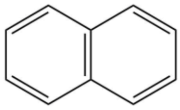
(B)



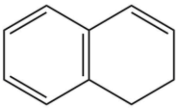
(C)



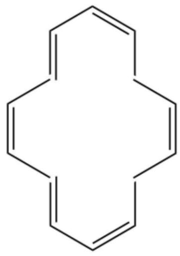
(D)



(E)



(F)

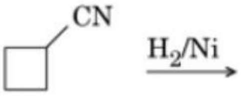


27. Describe the structure of benzene?

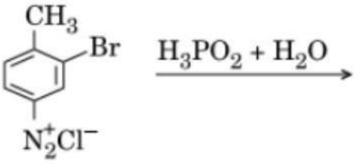
28. Define substitution reactions. Why does benzene undergo substitution reactions eventhough they contain double bonds?

29. Complete the following reactions:

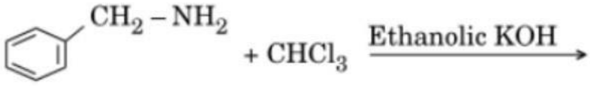
a.



b.



c.



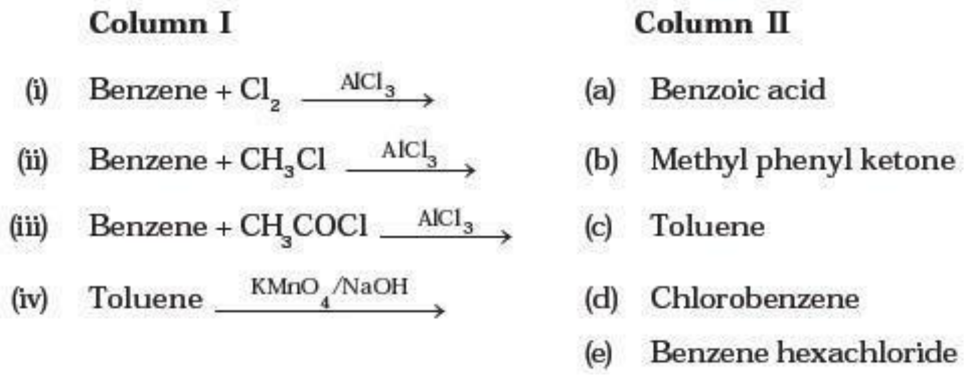
30. What is aromatization? How will you convert hexane into benzene?

31. How will you convert benzene into

(i) p – Nitrobromobenzene

(ii) m – Nitrobromobenzene

32. Match the following reactants in Column I with the corresponding reaction products inColumn II.



	Column I		Column II
(i)	Benzene + $Cl_2 \xrightarrow{AlCl_3}$	(a)	Benzoic acid
(ii)	Benzene + $CH_3Cl \xrightarrow{AlCl_3}$	(b)	Methyl phenyl ketone
(iii)	Benzene + $CH_3COCl \xrightarrow{AlCl_3}$	(c)	Toluene
(iv)	Toluene $\xrightarrow{KMnO_4/NaOH}$	(d)	Chlorobenzene
		(e)	Benzene hexachloride

33. Account for the following: a. Gabriel phthalimide synthesis is not preferred for preparing aromatic primary amines. b. On reaction with benzene sulphonyl chloride, primary amine yields product soluble in alkali whereas secondary amine yields product insoluble in alkali.

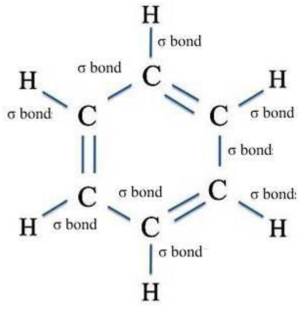
34. A hydrocarbon (Z) has molecular formula C_8H_{10}. It does not decolourise bromine water and is oxidised to benzoic acid on heating with $K_2Cr_2O_7$. It can also have three other isomers A, B and C. Write the structures of Z, A, B and C.

35. Why do alkenes prefer to undergo electrophilic addition reaction while arenes prefer electrophilic substitution reactions? Explain.

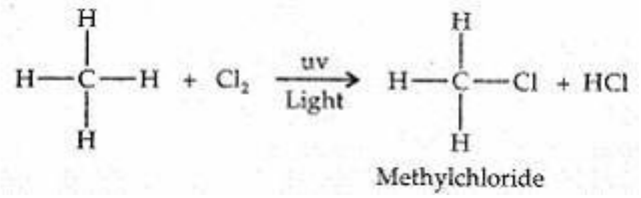
ANSWERS

27. According to Huckel's rule, it should satisfy $(4n+\pi)$ rule. Compound B, C, D and F are aromatic.

28. Benzene is a six carbon membered ring which includes three double bond. The double bonds within this structure are mainly separated by a single bond, hence this arrangement is recognizedto have conjugated double bonds. All of the carbon-carbon bonds in the benzene molecule are of the same length. The six carbon atoms in benzene are sp^2 hydridised. Two sp^2 hydrid orbitals of each carbon atom overlap with sp^2 hydrid orbitals of adjacent carbon atoms to form six C-C sigma bonds with are in the hexagonal plane. The remaining sp^2 hybrid orbital of each carbon atom overlaps with s-orbital of a hydrogen atom to form six C-H sigma bonds. Each carbon atomis now left with one unhybridized p-orbital perpendicular to the plane of the ring.



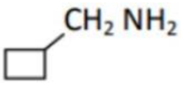
29. Substitution reactions are those reactions in which an atom or groups of atoms directly attached to carbon in the substrate molecule is replaced by another atomor group of atoms, for example



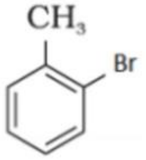
A hydrogen atom of the methane molecule is replaced by chlorine atom. Benzene undergoes electrophilic substitution reactions because benzene ring has delocalized electrons are an electron-rich system. It is attached by electrophiles giving substitution products.

30.

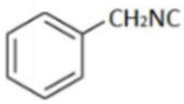
a.



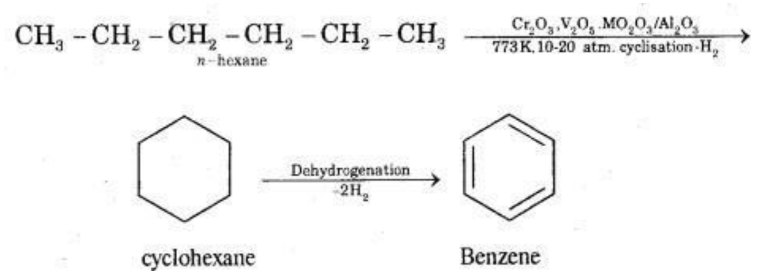
b.



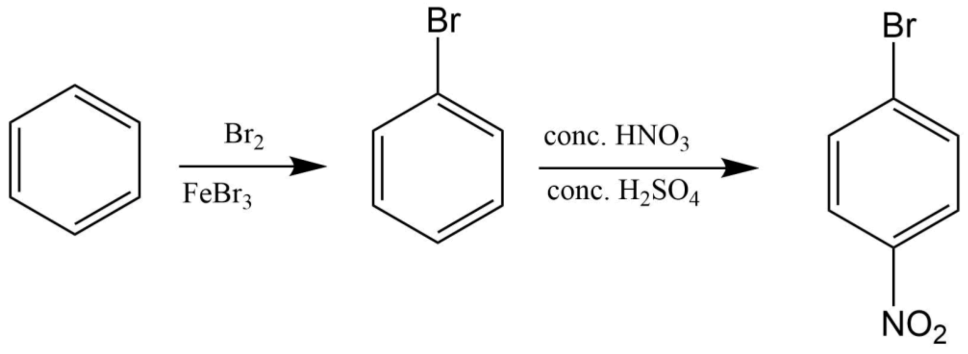
c.

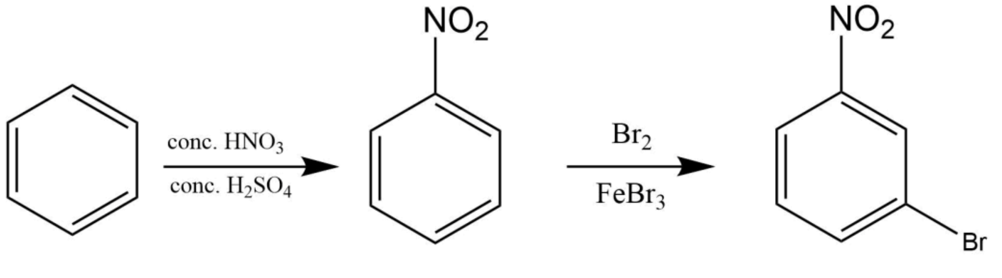


31.Aromatization. It is the process that involves cyclization, isomerization, and dehydrogenation with the application of heat and catalyst to convert alkanes containingsix or more carbon atoms into aromatic hydrocarbons.



32.





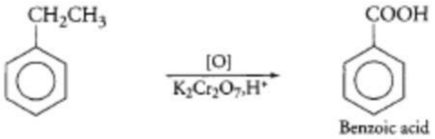
33.(i) d (ii) c (iii) b (iv) a

34. (a) Gabriel phthalimide synthesis involves nucleophilic substitution (SN2) of alkyl halides by the anion formed by the phthalimide but aryl halides do not undergo nucleophilic substitution with the anion formed by the phthalimide and thus aromatic primary amines cannot be prepared by this process.

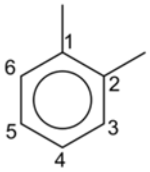
(b) The reaction of a primary amine with benzene sulphonyl chloride gives a corresponding N-alkyl benzene sulphonylamide. Owing to the presence of strong electron withdrawing sulphonyl group, attached to a nitrogen atom in N-alkyl benzene sulphonylamide is strongly acidic and dissolves in alkali.

On the other hand, a reaction of the secondary amine with benzene sulphonyl chloride gives corresponding N,N-dialkyl benzene sulphonylamide which do not contain acidic hydrogen and hence is insoluble in alkali.

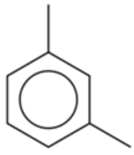
35. The given compound (Z) is arene (Ethylbenzene) as it does not decolourise bromine water.



The other three isomers of Ethylbenzene are:



1,2-dimethylbenzene
(*ortho*-xylene)



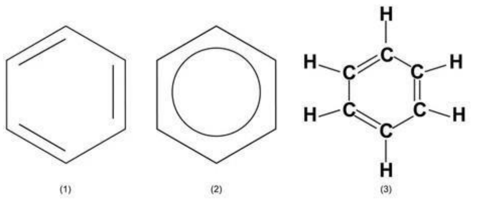
1,3-dimethylbenzene
(*meta*-xylene)

1,4-dimethylbenzene
(*para*-xylene)

IV. SECTION D (Case Based Questions)

36. Benzene (also called cyclohexatriene) is an organic chemical compound with the molecular formula C_6H_6. The benzene molecule is composed of six carbon atoms joined in a planar ring with one hydrogen atom attached to each. Because it contains only carbon and hydrogen atoms, benzene is classed as a hydrocarbon.

Benzene is a natural constituent of crude oil and is one of the elementary petrochemicals. Due to the cyclic continuous pi bonds between the carbon atoms, benzene is classed as an aromatic hydrocarbon. It is sometimes abbreviated PH. Benzene is a colorless and highly flammable liquid with a sweet smell and is partially responsible for the aroma around petrol (gasoline) stations. It is used primarily as a precursor tothe manufacture of chemicals with more complex structures, such as ethylbenzene and cumene, of which billions of kilograms are produced annually. Although a major industrial chemical, benzene finds limiteduse in consumer items because of its toxicity.



chemical structure of benzene

(a) What happens when benzene is treated with acetyl chloride in the presence of $AlCl_3$?
(b) Benzene undergoes electrophilic substitution reactions easily and nucleophilic substitutions with difficulty.Why?
(c) How would you convert Ethyne into benzene?
(d) How would you convert Ethene into benzene?

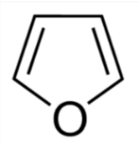
37. Aromatic compounds are those organic compounds that contain one or more rings with pi electrons delocalized all the way around them. The term "aromatic" was assigned before the physical mechanism determining aromaticity was discovered, and referred simply to the fact thatmany such compounds have a sweet or pleasant odour; however, not all aromatic compounds have a sweet odour, and not all compounds with a sweet odour are aromatic compounds.

The properties of aromatic hydrocarbons translate into their uses. One of the main uses for aromatic hydrocarbons is as a non-polar solvent for other molecules. Thus, aromatic hydrocarbons can be used as additives in gasoline, paints, lacquers, and other solutions. Their low reactivity also contributes to their use as a solvent. For example, toluene is an aromatic molecule that is used as a solvent in paint thinners.

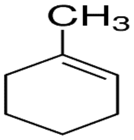
The aromatic compound benzene is used in high-octane fuel production as well as the productionof other chemicals, such as pesticides, detergents, dyes, and more. Benzene was once a commonadditive in gasoline, but due to the discovery of its carcinogenic nature in humans, it's use has been reduced to mainly high octane fuels.

(i) Which of the following is(are) not aromatic?

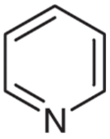
(i)



(ii)

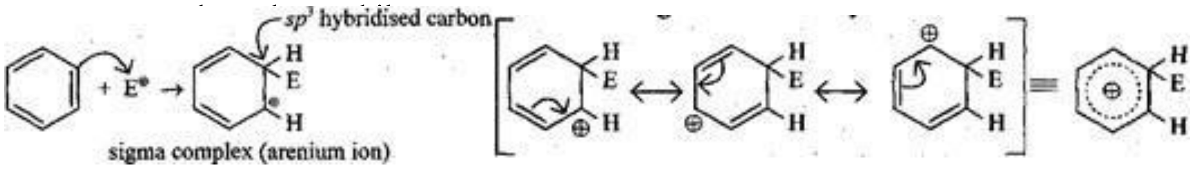


(iii)



a) Only (i)
b) Only (ii)
c) (i) and (ii)
d) (i) and (iii)

(ii)Benzene on treatment with methyl chloride in the presence of anhydrous AlCl3 producestoluene. The function of anhydrous AlCl3 is



(iii)The reaction of benzene with chlorine in the presence of anhydrous FeCl3 is classified as

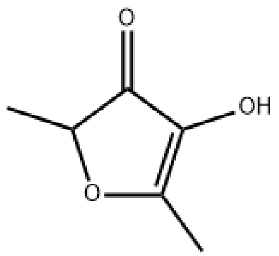
a) Nucleophilic substitution
b)Elecctrophilic substitution
c) Nucleophilic addition
d) Electrophilic addition

(iv)Which of the following is false about benzene?

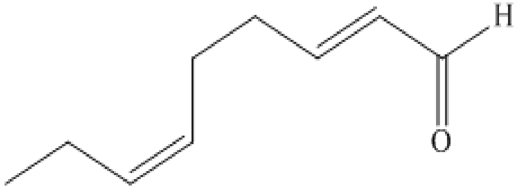
a) It is a planar molecule.
b) It can be converted into cyclohexane by hydrogenation in the presence of nickel catalyst.
c) The C atoms in a benzene ring are sp^2hybridised.
d) There are 6 isomeric dichlorobenzenes.

38. The sensation of flavour arises from a combination of both taste, detected by chemical receptors on the tongue, and smell, detected by chemical receptors in the nose. Some chemicals are commonly called after one particular flavour or aroma, such as: ‘strawberry furanone’ ‘cucumberaldehyde’

strawberryfuranone



cucumber aldehyde



However, a flavour such as strawberry is not created from just one chemical but can be from a mixture containing many different chemicals, all of which can interact with various receptors in the mouth and the nose. For example, one strawberry milkshake product contains 59 different ingredients in order to achieve the required strawberry flavour. In order to detect the different chemical components of a particular flavour, a number of chemical techniques can be employed.One such technique is GCMS, Gas Chromatography-Mass Spectometry. The volatile chemicals are first separated by gas chromatography and then detected and analysed by mass spectrometry.The flavour of various chemicals and their mixtures can be altered by the ways in which they areprocessed or cooked. For example, the Maillard reaction is promoted by heating and is responsible for the browning of bread and results in the formation of toast, which has a differentflavour to the uncooked bread.

(i) The molecular formula of ‘strawberry furanone’ is

a) $C_6H_{10}O_3$
b) $C_6H_8O_3$
c) $C_7H_8O_3$
d) $C_7H_{11}O_3$

(ii) The number of sigma and pi bonds in cucumber aldehyde is

a) $23\sigma, 3r$
b) $22\sigma, 3r$
c) $20\sigma, 6r$
d) $24\sigma, 2r$

(iii) Which of the following is not a product of complete oxidation of cucumber aldehyde by acidicpotassium permanganate?

a) HOOC-COOH
b) CH_3CH_2COOH
c) CH_3CH_2CHO
d) $HOOCCH_2CH_2COOH$

(iv)Which of the following statement(s) is(are) correct about strawberry furanone and cucumber aldehyde?

(i) Both strawberry furanone and cucumber aldehyde decolourise aqueous bromine.
(ii) Only cucumber aldehyde decolourises aqueous bromine.
(iii) Only strawberry furanone decolourises aqueous bromine.
(iv) Strawberry furanone undergoes dehydration on heating with concentrated sulphuric acid.

a) Only (i)
b) Only (ii)
c) (ii) and (iv)
d) (iii) and (iv)

39. Alkanes are relatively stable to common reagents at room temperature. This is due to the fact that the electronegativity difference between carbon and hydrogen is very less and the bond is almostnon-polar. In addition to this, C – C and C – H bonds are strong bonds. In fact, the alkanes undergo so few reactions that they are sometimes called *paraffins,* from the Latin *parumaffinis*, meaning “little affinity.”However alkanes undergo the reactions under certain conditions.

Alkenes are more reactive than alkanes. This is due to the loosely held pi electrons and pi bond isweaker than sigma bonds. Alkynes give same kind of addition reactions as do alkenes. However,with alkynes the addition may takes place in one step or two steps, depending upon conditions.

(i)Which intermediate ion is formed in the greatest amount during the addition of HBr topropene?
a) $CH3CH^{+}\ CH3$
b) $CH3CH2CH2^{+}$
c) $CH3CH^{-}CH2Br$
d) $CH3CHBrCH2^{-}$

(ii)The first propagation step in the reaction between methane and chlorine is shown.

$CH_4 + Cl^{\bullet} \rightarrow CH_3^{\bullet} + HCl$

How many different first propagation steps are possible in thereaction between pentane and chlorine?

a) 2
b) 3
c) 4
d) 5

$$\text{(iii)}CH \equiv CH \xrightarrow{\text{red hot iron tube, 873K}} X \xrightarrow[\text{Anhyd.AlCl3}]{\text{CH3COCl,}} Y$$

X and Y in the above sequence of reaction are
a) X = Benzene, Y = Acetophenone
b) X = Benzene, Y = Toluene
c) X = Cyclohexane, Y = Methylcyclohexane
d) X = Cyclohexene, Y = Toluene

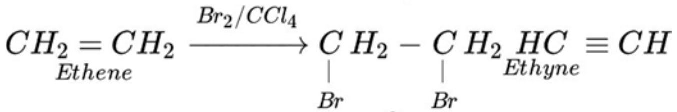
(iv)The addition of ozone to an alkene ‘X’ to form ozonide and then cleavage of ozonide by Zn-H2O to form pentan-3-one and methanal. The alkene ‘X’ is
a) Pent-2-ene
b) Hex-3-ene
c) 2-Ethylbut-1-ene
d) 2-Ethylpent-1-ene

ANSWERS:

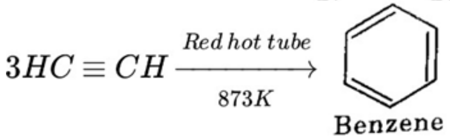
36. (i) **Ans.** Acetophenone is formed. (ii) **Ans.** The orbital structure of benzene shows that the π-electrons cloud lying above and below thebenzene ring is loosely held and is thus available to the π-electron seeking reagents i.e., electrophiles. Therefore, benzene undergoes electrophilic reactions readily and nucleophilic substitution reactions with difficulty.

(iii) **Ans.** Ethyne is converted into benzene by passing its vapours through red hot tube at 873 K.

(iv) **Ans.** Ethene is first converted into Ethyne and then to benzene as:



$$\underset{Ethene}{CH_2=CH_2} \xrightarrow{Br_2/CCl_4} \underset{Br}{\overset{}{C H_2}} - \underset{Br}{C H_2}\ \underset{Ethyne}{HC} \equiv CH$$



37. (i) c (ii) a (iii) b (iv) d

38. (i) b (ii) a (iii) c (iv) a

39. (i) a (ii) b (iii) a (iv) c

V. SECTION E (5 MARKS QUESTIONS)

40. Convert the following.

a) Acetylene to benzene
b) Benzene to cyclohexane
c) Benzene to Benzene hexachloride
d) Benzene to acetophenone
e) Benzene to m-nitrobromobenzene

41. (a) Despite their - I effect, halogens are o- and p-directing in haloarenes. Explain.

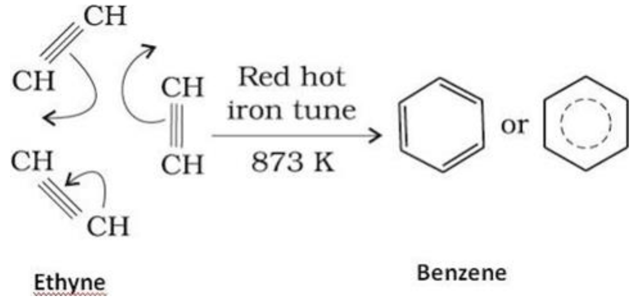
(b) Why do alkenes prefer to undergo electrophilic addition reaction while arenes prefer electrophilic substitution reactions? Explain.

42. Why does presence of a nitro group make the benzene ring less reactive in comparison to the unsubstituted benzene ring. Explain.

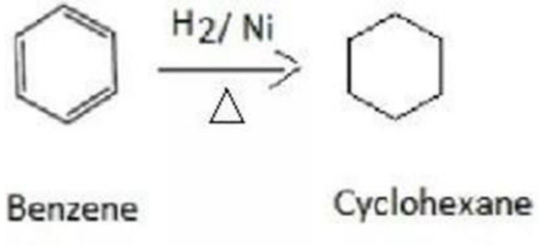
43. Suggest a route for the preparation of nitrobenzene starting from acetylene?

ANSWERS

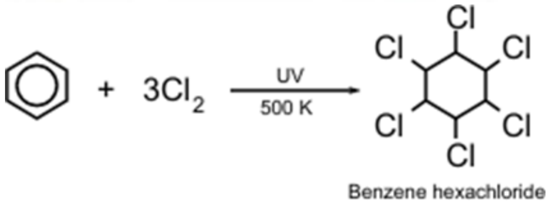
40.



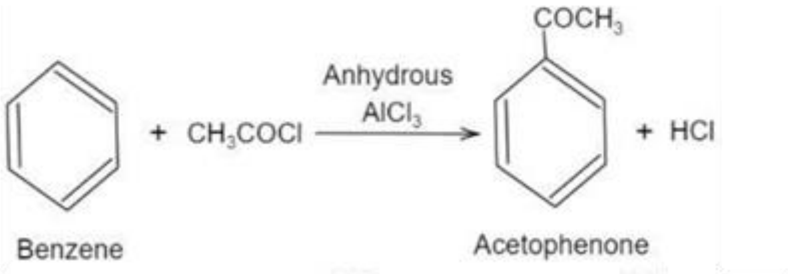
a)

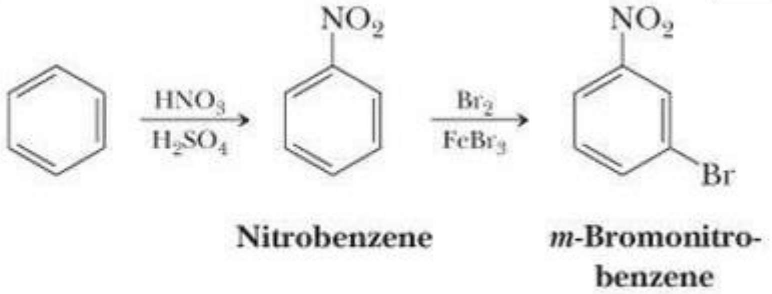


b)

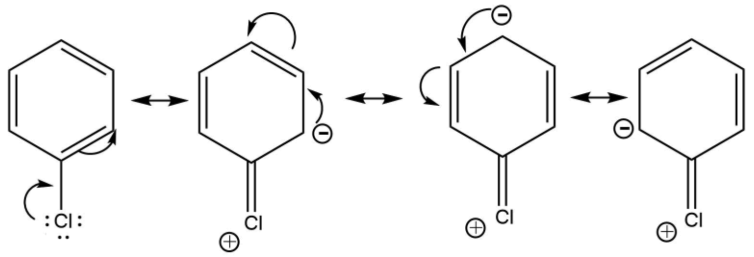


c)
d) e)

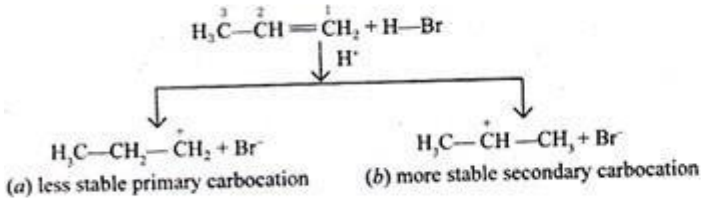




41. (a) Due to the +R effect halogens are ortho and para directing groups.

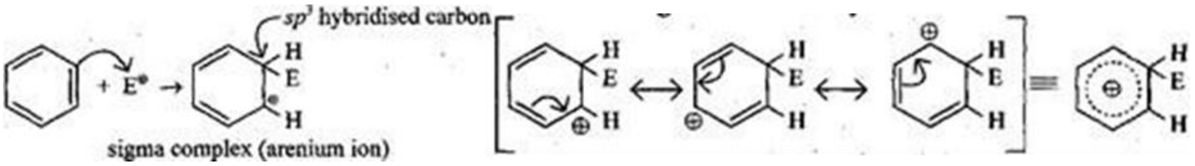


(b) Alkenes are rich source of loosely held pi(π) electrons, due to which they show electrophilic addition reaction. For example, HBr provides an electrophile H^+ which attacks the double bond to formcarbocation as shown below:

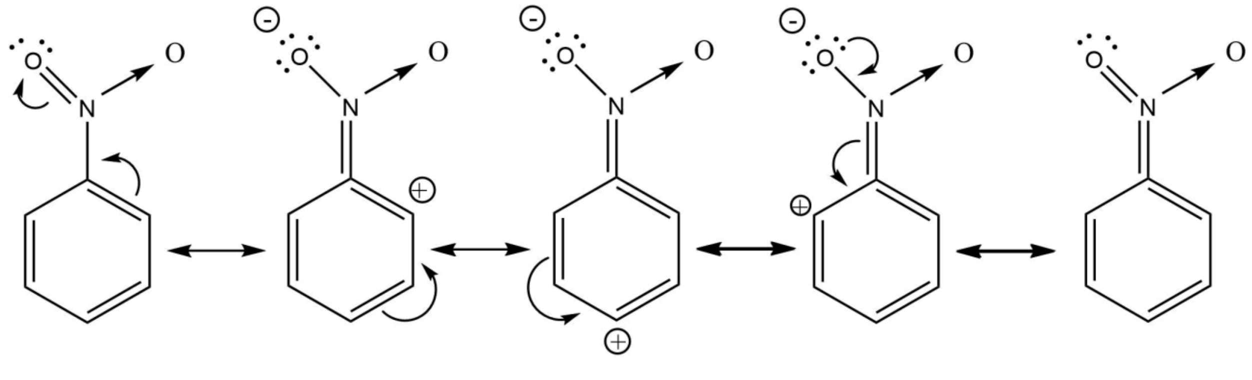


On the other hand, arenes have delocalized (4n+2)π electrons which gives to the great stability of thering systems by resonance.Therefore, electrophilic substitution take place.

The arenium ion gets stablished by resonance:

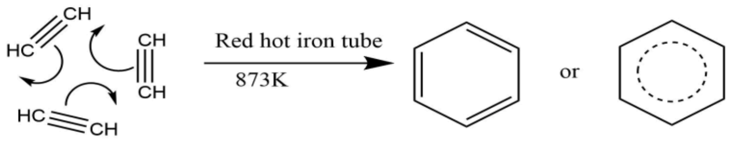


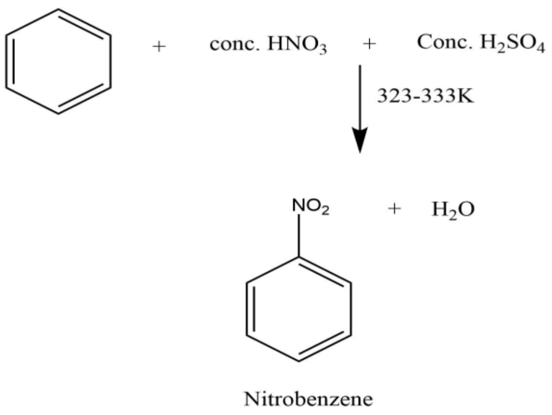
42. The nitro group strongly deactivate the benzene towards the electrophilic substitution reaction due to the -R and -I effect



I II III IV V

43.





SAMPLE PAPER- 1

CLASS – XI **SUBJECT- CHEMISTRY**

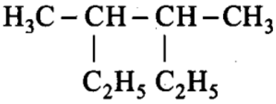
MM:70 **Time: 3 Hours**

General Instructions:

Read the following instructions carefully.

(a) There are 33 questions in this question paper with internal choice.
(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	What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL? (a) 4 mol L^{-1} (b) 20 mol L^{-1} (c) 0.2 mol L^{-1} (d) 2 mol L^{-1}	1
2	What is the mass per cent of carbon in carbon dioxide? (a) 0.034% (b) 27.27% (c) 3.4% (d) 28.7%	1
3	The number of radial nodes for 3p orbital is . (a) 3 (b) 4 (c) 2 (d) 1	1
4	Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is (a) F > Cl > Br > I (b) F < Cl < Br < I (c) Cl > F > Br > I (d) F < Cl < I < Br	1
5	Isostructural species are those which have the same shape and hybridization. Among the given species identify the isostructural pairs. (a) [NF_3 and BF_3] (b) [BF^-_4 and NH^+_4] (c) [$BC1_3$ and $BrCl_3$] (d) [NH_3 and NO_3^-]	1
6	Which of the following options represents the correct bond order? (a) $O_2^- > O_2 > O_2^+$ (b) $O_2^- < O_2 < O_2^+$ (c) $O_2^- > O_2^+ < O_2$ (d) $O_2^- < O_2 > O_2^+$	1
7	During complete combustion of one mole of butane, 2658 kJ of heat is released. The thermochemical reaction for above change is (a) $2\ C_4H_{10}\ (g) + 13O_2\ (g) \rightarrow 8\ CO_2\ (g) + 10\ H_2O\ (l)\ \Delta_C H^0 = -\ 2658$ KJ mol-1 (b) $C_4H_{10}\ (g) + 13/2\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 5\ H_2O\ (l)\ \Delta_C H^0 = -\ 1329$ KJ mol-1 (c) $C_4H_{10}\ (g) + 13/2O_2\ (g) \rightarrow 4\ CO_2\ (g) + 5\ H_2O\ (l)\ \Delta_C H^0 = -\ 2658$ KJ mol-1 (d) $C_4H_{10}\ (g) + 13/2\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 5\ H_2O\ (l)\ \Delta_C H^0 = 2658$ KJ mol-1	1
8	The entropy change can be calculated by using the expression $\Delta S = q_{rev} / T$. When water freezes in a glass beaker, choose the correct statement amongst the following: (a) $\Delta S_{(system)}$ decreases but $\Delta S_{(surroundings)}$ remains the same. (b) $\Delta S_{(system)}$ increases but $\Delta S_{(surroundings)}$ decreases. (c) $\Delta S_{(system)}$ decreases but $\Delta S_{(surroundings)}$ increases. (d) $\Delta S_{(system)}$ decreases but $\Delta S_{(surroundings)}$ also decreases.	1

9	Acidity of BF_3 can be explained on the basis of which of the following concepts? (a) Arrhenius concept (b) Bronsted Lowry concept (c) Lewis concept (d) Bronsted Lowry as well as Lewis concept	1
10	Which of the following is not an example of redox reaction? (a) $CuO + H_2 \rightarrow Cu + H_2O$ (b) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ (c) $2K + F_2 \rightarrow 2KF$ (d) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$	1
11	Correct IUPAC name for the following is-  $H_3C-\underset{\underset{C_2H_5}{\vert}}{CH}-\underset{\underset{C_2H_5}{\vert}}{CH}-CH_3$ (a) 2-Ethyl-3-methylpentane (b) 3,4-Dimethylhexane (c) 2-sec-Butylbutane (d) 2,3-Dimethylbutane	1
12	Arrange the following in decreasing order of their boiling points. (a) n-Butane (b) 2-Methylbutane (c) n-Pentane (d) 2,2-Dimethylpropane (a) A > B > C > D (b) B > C > D > A (c) D > C > B >A (d) C > B > D > A	1
13	Assertion (A): Generally, ionization enthalpy increases from left to right in a period. Reason (R): When successive electrons are added to the orbitals in the same principal quantum level, the shielding effect of inner core of electrons does not increase very much to compensate for the increased attraction of the electron to the nucleus. (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) Both A and R are false.	1
14	Assertion (A): Increasing order of acidity of hydrogen halides is HF<HCl<HBr<HI Reason (R): While comparing acids formed by the elements belonging to the same group of periodic table, H–A bond strength is a more important factor in determining acidity of an acid than the polar nature of the bond. (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) Both A and R are false.	1
15	Assertion (A): In a reaction, $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$, Zn is a reductant but itself get oxidized. Reason (R): In a redox reaction, oxidant is reduced by accepting electrons and reductant is oxidized by losing electrons. (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) Both A and R are false.	1
16	Assertion: Sodium acetate on Kolbe’s electrolysis gives methane. Reason: Methyl free radical is formed at anode. (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.	1

	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	One of the spectral lines of the cesium has a wavelength of 456 nm. Calculate the frequency of this line.	2
18	Define ionization enthalpy. List any two factors affecting ionization enthalpy of elements.	2
19	i) Write the IUPAC name of the element with atomic number 107. ii) Why Nitrogen shows comparatively higher first ionization enthalpy than Oxygen?	1+1
20	Distinguish between a sigma and a pi bond. **OR** Which among F^- ion or an I^- ion would be more polarizable and why?	2
21	Fluorine reacts with ice and results in the change: $H_2O(s) + F_2(g) \rightarrow HF(g) + HOF(g)$ Justify that this reaction is a redox reaction.	2
	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	(i) What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ spectrum? (ii) How many electrons in an atom may have the following quantum numbers? (a) $n = 4$, $s = -½$ (b) $n = 3$, $l = 0$	2+1
23	Write short notes on (i) Heisenberg uncertainty principle (ii) Hund's Rule (iii) Pauli's exclusion principle	1+1+ 1
24	(i) Write the geometry and shape of H_2O. (Draw also the shape) (ii) Infer the shape of SF_4 molecule and state type of hybridization of central atom. (iii) Why NH_3 has higher dipole moment than NF_3 though both are pyramidal? **OR** i) List two limitations of the octet rule. ii) Compare the relative stability, bond order and magnetic properties of the following species: O_2 and O_2^{2-}	1+1+ 1 1+2
25	Calculate the standard enthalpy of formation of CH_3OH (*l*) from the following data: $CH_3OH(l) + 3/2\ O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta_rH^o = -726$ kJ/mol $C(graphite) + O_2(g) \rightarrow CO_2(g)$ $\Delta_cH^o = -393$ kJ/mol $H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(l)$ $\Delta_fH^o = -286$ kJ/mol	3
26	0.2033g of an organic compound in Dumas method gave 31.7 mL of moist N_2 at 14°C and 758 mm pressure. Calculate the percentage of N_2 in the compound. (Aq. tension at14°C=14 mm).	3
27	(i) How $C_6H_5NH_2$ shows resonance? Draw all the resonating structures possible and Name type of resonance. (ii) Explain why is $(CH_3)_3C^+$ more stable than $CH_3CH_2^+$	2 1
28	Write short notes on (i) Markovnikov's rule (ii) Wurtz reaction (iii) Kolbe's electrolysis	1+1+ 1
	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 **Read the following paragraph carefully and answer the following questions:** 4

We can measure the transfer of heat from one system to another which cause change in temperature. The magnitude of change in temperature depends upon heat capacity of the substance. The enthalpy change of reaction remains the same irrespective of numberof steps is Hess's law. It helps to calculate enthalpy of formation, combustion and otherenthalpy changes. Enthalpy change can also be calculated by using bond enthalpies. First law gives law of conservation of energy but does not give direction of reaction. Second law states, entropy of universe is continuously increasing due to spontaneous processes taking place in it. ΔH and ΔS (entropy change) cannot decide spontaneity ofprocess. We need $\Delta\Delta G$ (free energy change) which is -ve for spontaneous, +ve for non-spontaneous. $\Delta G = 0$ for process in equilibrium. ΔG is related to equilibrium constant.If ΔG = -ve, 'K' is +ve and vice versa. Third law of thermodynamics states the entropyof perfectly crystalline substance is zero at zero kelvin.

(i) What are sign of ΔH and ΔS for process to be always spontaneous?
(ii) Write first law of thermodynamics with mathematical expression.
(iii) For the reaction at 298 K, $A + B \rightarrow C$, $\Delta H = 400$ kJ mol^{-1} and $\Delta S = 0.2$ kJ K^{-1} mol^{-1}. At what temperature will the reaction become spontaneous considering ΔH and ΔS to be constant over the temperature range.

OR

(i) Write Hess's law of constant heat summation with one example.
(ii) Differentiate between extensive and intensive property.
(iii) For the reaction, $2\,A(g) + B(g) \rightarrow 2D(g)$, $\Delta U^{o} = -10.5$ kJ and $\Delta S^{o} = -44.1$ JK^{-1}. Calculate ΔG^{o} for the reaction, and predict whether the reaction may occur spontaneously.

30 **Read the following paragraph carefully and answer the following questions:** 4

Organic compounds are formed by covalent bonding. The nature of covalent bonding can be described with the help of hybridization, sp, sp^2 and sp^3. The structure andreactivity depend upon type of bonds present in organic compounds. Organiccompound can be represented by various structural formulae. Wedge and Dash formula are 3-D representations. Organic compounds can be classified on the basis of functionalgroups.

Mechanism of organic reactions is based on structure of substrate and the attacking reagent. The intermediate formed can be free radical, carbocation, carbanion or carbene.The attacking reagent can be electrophile or nucleophile. The inductive, electrometric, resonance and hyper conjugative effect may help in polarization of covalent bond.

Organic reactions may be regarded as substitution, addition, elimination and rearrangement, oxidationand reduction reaction. After the compound is obtained in pure state, qualitative analysis helps to detect elements present in organic compounds whereas quantitative analysis helps to find percentage of various elements. Dumas and Kjeldahl method help to determine percentage of nitrogen, Carius method for halogens and sulphur. Carbon and hydrogenare estimated by the amount of CO_2 and H_2O formed. Phosphorus estimation is done byoxidizing it to H_3PO_4, Sulphur to H_2SO_4.

(i) What is a free radical? Give one example
(ii)Write the order of stability of carbanion. (For methyl, primary, secondary and tertiary Carbanion)
(iii) 0.395 g of an organic compound by Carius method for the estimation of sulphur gave 0.582g of $BaSO_4$. Calculate the percentage of Sulphur.

Or

(i) Which type of species can act as nucleophile. Give one example.
(ii) Define inductive effect. Give one example.
(iii) If an organic compound have both nitrogen and sulphur, which method can be used for detection of both elements? Write the steps with proper reactions.

	SECTION E The following questions are long answer type and carry 5 marks each. All questions have an internal choice.	
31	(i) Explain Le Chatelier's principle with one example. (ii) Explain common ion effect with one example. (iii) Calculate the pH of a 0.10M ammonia solution. Calculate the pH after 50.0 mL of this solution is treated with 25.0 mL of 0.10M HCl. The dissociation constant of ammonia,K_b =1.77 ×× 10^{-5} **OR** (i) What is solubility product constant? Give example. (ii) How buffer solution works? Explain with one example. (iii) Equilibrium constant K_c for the reaction, $N_2(g)+3H_2(g)\rightleftharpoons 2NH_3(g)$ at 500 K is 0.061. At a particular time, the analysis shows that the composition of the reaction mixture is: 3.0 mol L^{-1} of N_2, 2.0 mol L^{-1} of H_2 and 0.50 mol L^{-1} of NH_3. Is the reaction at equilibrium? If not, in which direction does the reaction tend to proceed to reach the equilibrium?	1 1 3 1 1 3
32	(i) State law of multiple proportion? (ii) Differentiate between precision and accuracy. (iii) How many moles of methane are required to produce 22 g CO_2 (g) after combustion? (iv)In the reaction 2A + 4B → 3C + 4D, if 5 moles of A react with 6 moles of B,then (a) Which is the limiting reagent? (b) Calculate the amount of C formed? **OR** (i) Which is better molality or molarity to represent the strength of stock solution and why? (ii) Define scientific notation with one example (iii) Calculate the charge on one mole of electrons. (iv) Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction, $CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$(aq) + CO_2(g) + H_2O(l) What mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl?	1 1 1 2 1 1 1 2
33	(i) How is the aromaticity of a compound judged by Huckel rule? Explain. (ii) Which is more polar out of cis-But-2-ene and trans-But-2-ene, why? (iii) Which is more acidic out of ethene and ethyne, why? (iv) How Friedel Craft Reaction helps in alkylation or arylation? (v) What will be the IUPAC names of the products obtained by the ozonolysis of Pent-2-ene? Write the reaction also. **OR** (i) What happens when (Give reactions also) (a) Sodium benzoate reacts with soda lime. (b) calcium carbide is reacted with water. (ii) How would you convert Ethyne into benzene? (iii) Write the reaction mechanism for nitration of benzene.	1 1 1 1 1 1 1 1 2

SAMPLE PAPER 1

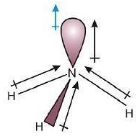
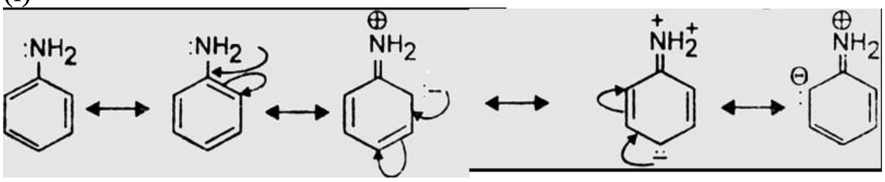
MARKING SCHEME

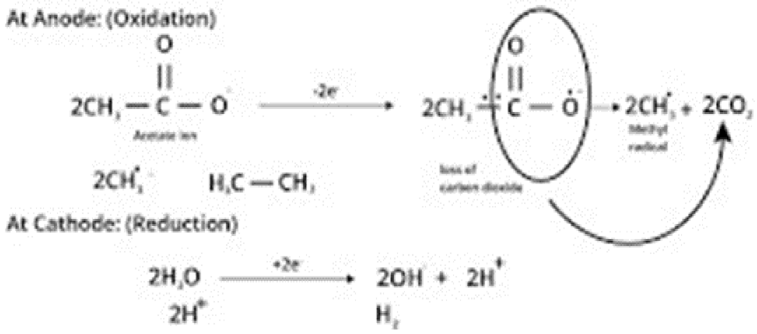
CLASS: XI SUBJECT: CHEMISTRY

MARKING SCHEME

	SECTION A	
1	C	1
2	B	1
3	C	1
4	C	1
5	B	1
6	B	1
7	C	1
8	C	1
9	C	1
10	D	1
11	B	1
12	D	1
13	A	1
14	A	
15	A	1
16	C	1
	SECTION B	
17	To calculate the frequency of the spectral line of cesium with a wavelength of 456 nm, we can use the following equation: $v = c / \lambda$ where: v is the frequency in Hz c is the speed of light in m/s (3×10^8 m/s) λ is the wavelength in m (456×10^{-9} m) Substituting the values into the equation, we get: $v = (3 \times 10^8 \text{ m/s}) / (456 \times 10^{-9} \text{ m}) = 6.58 \times 10^{14}$ Hz Therefore, the frequency of the spectral line of cesium with a wavelength of 456 nm is 6.58×10^{14} Hz.	1 1
18	Ionisation Enthalpy: The amount of energy required to remove an electron from an isolated gaseous atom in its gaseous state is defined as an element's ionization enthalpy. The following factors influence ionization enthalpy(any Two) 1. Atom size 2. Screening Effect 3. Nuclear charge Half-filled and fully-filled orbitals 4. Orbital shape	1 1
19	i) Unnilseptium ii) Nitrogen has stable half-filled configuration (Write configuration of both N and O)	2

<table>
<tr><td rowspan="5">20</td><td colspan="2">Difference Between Sigma and Pi bond (Any two)</td><td>2</td></tr>
<tr><td>Sigma Bond</td><td>Pi Bond</td><td></td></tr>
<tr><td>During sigma bond formation overlapping orbitals can either be one hybrid orbital and a single pure orbital, or two pure orbitals and two hybrid orbitals.
Linear overlapping</td><td>During pi bond formation overlapping must between two unhybridized orbitals.
Sidewise overlapping</td><td>1</td></tr>
<tr><td>Sigma bonds are known to exist independently and allow free rotation.</td><td>Pi-bond must always exist along with Sigma bond and the rotation is restricted.</td><td>1</td></tr>
<tr><td colspan="2">Or
The fact that polarizable anions are often big and strongly charged can be used to our advantage. An F^- ion is a single-charged, tiny particle. An I^- ion has the same charge as a proton but is much larger. As a result, an I- ion is more likely to be polarizable</td><td>2</td></tr>
<tr><td>21</td><td colspan="2">The reaction between fluorine and ice is a redox reaction because the oxidation states of fluorine change from 0 in the reactants to -1 and +1 in the products. This means that fluorine is both oxidized and reduced in the reaction. (Show with reaction)</td><td>2</td></tr>
<tr><td></td><td colspan="2">SECTION C</td><td></td></tr>
<tr><td>22</td><td colspan="2">(i)
For H; $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$
Since λ is same
$\therefore 2^2\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$
$[\because Z = 2 \text{ for } He^+]$
$\therefore \left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$
Therefore $n_1 = 1$, $n_2 = 2$.
(ii)
(a) For n = 4 and s = -½, there can be 16 electron.
(b) For n = 3 and l = 0, there can be 2 electrons.</td><td>2
½
½</td></tr>
<tr><td>23</td><td colspan="2">(i) Heisenberg Uncertainty Principle: It is impossible to simultaneously know the precise position and momentum of a subatomic particle. Correct mathematical expression.
(ii) Hund's Rule: Electrons fill degenerate orbitals singly before pairing up, and they maximize their total spin before pairing. Correct statement with one example.
(iii) Correct statement with one example.</td><td>1
1
1</td></tr>
<tr><td>24</td><td colspan="2">(i) Geometry- tetrahedral, shape- bent, angular, V-shape
(ii) Shape of SF_4 is see-saw (correct diagram) and hybridization of suplhur is sp^3d
(iii) In case of NH_3 the orbital dipole due to lone pair is in the same direction as the resultant dipole moment of the N-H bonds, whereas in NF_3 the orbital dipole is in the direction opposite to the resultant dipole moment of the three N bonds, which results in the low dipole moment.</td><td>1
1
1</td></tr>
</table>

	 OR i) incomplete octet of the central atom Ex: LiCl, BeH2 and BCl3; Odd-electron molecules ii) Description with MOT diagram	1 2
25	(i) $CH_3OH(l) + 3/2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; $\Delta rH^\circ = -726$ kJ mol^{-1} (ii) $C(g) + O_2(g) \rightarrow CO_2(g)$; $\Delta cH^\circ = -393$ kJ mol^{-1} (iii) $H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$; $\Delta fH^\circ = -286$ kJ mol^{-1} We aim at $C + 2H_2 + 1/2\ O_2 \rightarrow CH_3OH$ In order to get this thermochemical equation, multiply Eq. (ii) by 1 and Eq. (iii) by 2 and subtract Eq. (i) from their sum. $C + 2H_2 + 1/2O_2 \rightarrow CH_3OH$ $\Delta H = (-393) + 2(-286) - (-726) = -393 - 572 + 726 = -965 + 726 = -239$ kJ mol^{-1} Thus, the heat of formation of CH_3OH is $\Delta H_f = -239$ kJ mol^{-1}	1 1 1
26	Dumas method V_1=31.7 mL P_1=atmospheric pressure-tension +760-14=746 mm $T_1=14^\circ C=287$ K At STP V_2= ? P_2= 760 mm T_2= 273 K Applying the formula $P_1V_1/T_1 = P_2V_2/T_2$ Volume of N_2 at STP is 29.598 ml. Mass of nitrogen = 28 x volume of nitrogen at STP/22400 = 0.036 gram Percentage of N_2 = mass of nitrogen x 100 / mass of compound = 18.19%	1 1 1
27	(i)  Positive resonance (ii) Hyperconjugation interaction in $(CH_3)_3C^+$ is greater than in $CH_3CH_2^+$ has 9 C -H bonds. Correct explanation.	2 1
28	(i) correct statement with one example. (ii)Wurtz reaction. Alkyl halides on treatment with sodium in dry ether give higher alkanes, preferably containing an even number of carbon atoms. $R - X + 2Na + X - R' \xrightarrow{\text{Dry Ether}} \underset{\text{Alkane}}{R - R'} + 2NaX$ (iii) Kolbe's electrolytic method. An aqueous solution of sodium or potassium salt of a carboxylic acid on electrolysis gives alkanes containing an even number of carbon atoms at the anode.	1 1 1



SECTION D

29 (i) For a process to be spontaneous, ΔH (enthalpy change) should be negative (exothermic), and ΔS (entropy change) should be positive (increasing entropy). 1

(ii) Correct statement with mathematical expression 1

(iii) Assuming that equation at equilibrium then

$\Delta G = 0$ 2

$\Delta G = \Delta H - T\Delta S = 0$

$T = \Delta H/\Delta S = 400/0.2 = 2000K$.

For the reaction to be spontaneous ΔG must be negative. Therefore, temperature should be greater than 2000 K.

Or

(i) Correct statement with one example 1

(ii) Correct defining with one example 1

(iii) For the given reaction, $2\ A(g) + B(g) \rightarrow 2D(g)$ 2

$\Delta ng = 2 - (3) = -1$ mole

Substituting the value of ΔU^θ in the expression of ΔH:

$\Delta H^\theta = \Delta U^\theta + \Delta ngRT = (-10.5\ kJ) - (-1)\ (8.314 \times 10{-}3\ kJ\ K^{-1}\ mol^{-1})\ (298\ K)$

$= -10.5\ kJ - 2.48\ kJ\ \Delta H\theta = -12.98\ kJ$

Substituting the values of ΔH^θ and ΔS^θ in the expression of ΔG^θ :

$\Delta G^\theta = \Delta H^\theta - T\Delta S^\theta = -12.98\ kJ - (298\ K)\ (-44.1\ J\ K^{-1}) = -12.98\ kJ + 13.14\ kJ\ \ \Delta G^\theta = +\ 0.16\ kJ$

Since ΔG^θ for the reaction is positive, the reaction will not occur spontaneously.

30 (i) Free radicals are highly reactive chemical species with unpaired electrons. 1

(ii) Order of stability for carbanions: Primary > Secondary > Tertiary 1

(iii) Mass of $BaSO_4 = 0.582$ g

233g of $BaSO_4$ contain sulphur = 32g

0. 582 g of $BaSO_4$ contains sulphur

Percentage of sulphur

$$= \frac{wt.of\ \text{sulphur}}{wt.of\ \text{compound}} x100$$ 1

$$= \frac{32x0.582}{233x0.395} x100$$

20.24% 1

	OR (i) Correct statement with one example (ii) Correct statement with one example (iii) Lassaigne's test: $Na + C + N \rightarrow NaCN$ $2Na + S \rightarrow Na_2S$ In case, nitrogen and sulphur both are present in an organic compound, sodium thiocyanate is formed. It gives blood red colour and no Prussian blue since there are no free cyanide ions $Na + C + N + S \rightarrow NaSCN$ $Fe^{3+} + SCN^{-} \longrightarrow [Fe(SCN)]^{2+}$ Blood red	1 1 2
	SECTION E	
31	(i) Correct statement with one example (ii) Correct statement with one example (iii) $NH_3 + H_2O \longrightarrow NH_{4+} + OH^{-}$ $K_b = [NH_4^{+}][OH^{-}]/[NH_3]=1.77\times10^{-5}[NH_{4+}][OH^{-}]/[NH_3]=1.77\times10^{-5}$ Before neutralization, $[NH_3] = 0.10-x=0.10[NH_3]=0.10-x = 0.10$ $x^2 / 0.10 = 1.77 \times 10^{-5}$ Thus, $x = 1.33 \times\times 10^{-3} = [OH^{-}]$ Therefore, $[H^{+}] = K_w/[OH^{-}] = 10^{-14} / (1.33 \times\times 10^{-3}) = 7.51 \times\times 10^{-12}$ $pH = -\log(7.5 \times 10^{-12}) = 11.12$ On addition of 25 mL of 0.1M HCl solution (i.e., 2.5 mmol of HCl) to 50 mL of 0.1M ammonia solution (i.e., 5 mmol of NH_3), 2.5 mmol of ammonia molecules are neutralized. The resulting 75 mL solution contains the remaining unneutralized 2.5 mmol of NH_3 molecules and 2.5 mmol of NH_4 $NH_3 \quad + \quad HCl \quad \rightarrow \quad NH_4^{+} + Cl^{-}$ 2.5 2.5 0 0 At equilibrium 0 0 2.5 2.5 The resulting 75 mL of solution contains 2.5 mmol of NH+4NH4+ ions (i.e., 0.033 M) and 2.5 mmol (i.e., 0.033 M) of neutralised NH_3 molecules. This NH_3 exists in the following equilibrium: $NH_4OH \rightleftharpoons NH_4^{+} + OH^{-}$ $0.033M - y \quad y \quad y$ where, $y = [OH^{-}] = [NH_4^{+}]$ The final 75 mL solution after neutralization already contains 2.5 m mol NH_4^{+} ions (i.e. 0.033M), thus total concentration of NH^{+} ions is given as: $[NH^{+}] = 0.033 + y$ As y is small, $[NH_4OH] \simeq 0.033$ M and $[NH_4] \simeq 0.033$M. We know, $K_b=[NH_4][OH]/[NH_4OH]$ $= y(0.033)/(0.033) = 1.77 \times\times 10^{-5}$ M Thus, $y = 1.77 \times\times 10^{-5} = [OH^{-}]$ $[H^{+}]=10^{-14}/1.77\times10^{-5}=0.56\times10^{-9}$ Hence, pH = 9.24 **OR** (i) Correct statement with one example (ii) Correct statement with one example	1 1 3 1 1 3

	(iii) The given reaction is: $N_2(g)+3H_2(g)\rightleftharpoons 2NH_3(g)$ According to available data. $[N_2] = [3.0]$; $[H_2] = [2.0]$ and $[NH_3] = [0.50]$ $Qc=[NH_3(g)]^2 / [N_2(g)][H_2(g)]^3$ $=[0.50]^2/[3.0][2.0]^3$ 0.0104 The value of the reaction quotient is smaller than the value of the equilibrium constant. Since the value of Q_c is less than that of K_c (0.061), the reaction is not in a state of equilibrium. It will proceed in the forward direction till Q_c becomes the same as K_c.	
32	(i) Correct statement with one example (ii) Correct statement with one example (iii) 0.5 mole (iv) (a) B would be the limiting reagent as it gives the lesser amount of product. (b) Let B completely consumed 4 mol of B gives 3 mol of C 6 mol of B will give 3/4 *6 mol C =4.5 mol C Or (i) Molality. It does not change with temperature. (ii) Correct statement with one example. (iii) 96500 coulomb (iv) 1000 mL of 0.75 M HCl have 0.75 mol of HCl = 0.75×36.5 g = 24.375 g ∴ Mass of HCl in 25mL of 0.75 M HCl = 24.375/ 1000 × 25 g = 0.6844 g From the given chemical equation, $CaCO_3 (s) + 2HCl (aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ 2 mol of HCl i.e. 73 g HCl react completely with 1 mol of $CaCO_3$ i.e. 100g ∴ 0.6844 g HCl reacts completely with $CaCO_3$ = 100/73 × 0.6844 g = 0.938 g	1 1 1 2 1 1 1 2
33	(i) Explanation of Huckel rule (ii) Cis-But-2-ene, by drawing geometries of the two forms it is clear that in the trans-but-2-ene, the two methyl groups are in opposite directions, Therefore, dipole moments of C-CH_3 bonds cancel, thus making the trans form non-polar. (iii) Ethyne, hydrogen atoms in ethyne are attached to the sp hybridised carbon atoms whereas they are attached to sp^2 hybridised carbon atoms in ethene and sp^3 hybridised carbons in ethane. Due to the maximum percentage of s character (50%), the sp hybridised orbitals of carbon atoms in ethyne molecules have highest electronegativity correct explanation (iv) Reaction of either alkylation or arylation (v) Ethanal and propanal Or (i) (a) benzene is formed (b) ethyne is formed (ii) Cyclic Polymerization (reaction) (iii) Correct reaction mechanism	1 1 1 1 1 1 +1 1 2

SAMPLE PAPER 2

CLASS XI (CHEMISTRY)

Max.Marks:70 **Time: 3 hours**

General Instructions: Read the following instructions carefully.

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

(b) SECTION A consists of 16multiple-choice questions carrying 1mark 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 4marks 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. Which one is correct decreasing displacing order for given metals- (a) Al, Cu, Fe, Mg, Zn (b) Al, Zn, Fe, Cu, Mg (c) Mg, Al, Zn, Fe, Cu (d)Mg, Fe, Zn, Al, Cu ||

2. A + B H + CH3-CH=CH-CH=N-NH-C-NH2 (a) A=But-2-en-1-al, B=Semi carbazide (b)A=Butan-1-al, B=N-Aminoethamide (c) A=Butenal, B=Ethanamide (d)A=But -2yn-1-al, B=Hydrazine

3. Vitamin B6 is also known as- (a) Thiamine (c) Pyridoxine (b)Riboflavin (d) Ascorbic acid O 2

4. Write IUPAC name of organic compound ketone which gives addition product as When reacts with 2,4-DNP reagent. (a) Cyclohexane (c) 2-Methylhexanone (b) 2-Methylcyclohexanone (d) 2-methyl-N-(2,4-initrophenylhydrazine Cyclohexane)

5. Which of following is correct- (a) 0-and m- isomers have higher M.P. than p-dichlorobenzene. (b)Alkyl halides are miscible with water. (c) Grignard reagents should be prepared in presence of water. (d)Under SN2 condition C6H5CH2Cl hydrolyses more easily than C6H5CH Cl C6H5.

6. Match given properties with transition series elements or species. p) The species with reducing property q) The species with oxidising properties r) The transition element not showing variable O.S. s) Species having +ve E - value (a) p-(iii), q-(i), r-(ii), s-(iv) (b) p-(iv), q-(iii), r-(i), s-(ii) (c) p-(ii), q-(iii), r-(iv), s-(i) (d) p-(iv), q-(iii), r-(ii), s-(i)

7. Which of following statement is true? (a) Order of a reaction may not be a fraction. (b) Rate constant of a rean may change with change in rean condition. (c) With increase in temp of rea n mixture, the Ea value for rea n decreases. (d) The plot between lnk and 1/T has +ve slope as Ea /R.

8. In Which of following solvent, compound chloroform shows –ve deviation from Raoult’s law- (a) Bromine water (c) Water (b) Acetone (d) Ethanol O NHN 2N CH3 i. Sc ii. Cu iii. Mn3+ iv. Cr2+ M 2+/M 3

9. Which one compound does not give Iodoform test ? (a) tart butyl alcohol (c) Isopropyl Alcohol (b) Acetone (d) Ethyl alcohol

10.What will be order of reaction if its rate constant k has value as 2.3x10-5 Lmol-1 S -1 (a) 0 (b) 1 (c) 2 (d) 3

11. Anisole reacts with conc HI to form phenol not phenyl iodide- (a) Phenyl carbocation is less stable. (b)C6H5-O bond has partial double bond Character and does not cleave. (c) CH3 + carbocation formed is more stable. (d)Due to deactivation of benzene ring by OCH3 gp.

12. The irregular Variation of ionization enthalpies of first series transition elements occurs due to- (a) Increase in charge to radius ratio (b) Availability of more number of vacant d-orbitals. (c) Increase in shielding effect (d) Exceptionally more stabilities of dº, d5 and d 10 configurations. For Visually Challenged learners

12. Which metal in I st Transition series exhibits +1 0.S. most frequently ? (a) Sc (b) Cu (c) Cr (d) V

13. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): Alcohols are weaker acids than water

Reason (R): Alkoxide ion is weaker Bronsted base than hydroxide ion.

Select the most appropriate answer from the options 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 true but R is false. (d) A is false but R is true.

14. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): Carboxylic acids are higher boiling liquids than aldehydes ketones and alcohols of comparable molecular masses.

Reason (R): More extensive intermolecular H-bonding present in acids do not break even in vapour phase. 4

Select the most appropriate answer from the options 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 true but R is false. (d) A is false but R is true.

15.Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): Non-essential amino acids are not needed for growth and development of body. Reason (R): In zwitter ionic form amino acids show amphoteric behavior.

Select the most appropriate answer from the options 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 true but R is false. (d) A is false but R is true.

16. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): During electrolysis of AgNO3 solution either with Ag or Pt electrode, Silver metal deposits at cathode.

Reason (R): Due to over potential of O2 gas, halide ion undergoes oxidation at anode to produce halogen instead of O_2 gas. Select the most appropriate answer from the options 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 true but R is false. (d) A is false but R is true.

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. The decomposition of NH3 on Pt Surface follows zero order mechanism. What are rates of production of N2 and H2 gas if k=2.5 x10-4 mol-1 Ls-1 ?

18. A 5% solution (by mass) of cane sugar in water has freezing point of 271 K. Calculate the freezing point of 5 % glucose in water, if F.P. of pure water be 273.15 K.

19. (a) Arrange following in increasing order of B.P.- Bromomethane, Bromoform, chloromethane, Dichloromethane 5 (b) Haloalkanes react with KCN to form alkyl cyanides as main product while AgCN forms isocyanides as chief product.

20. Explain following- (a) There are two- NH2 groups in semicarbazide. However only one is involved in formation of semicarbazones. (b) Although phenoxide ion has more number of resonating structures than carboxylate ion but carboxylic acid is stronger acid than phenol. why? OR Convert following- (a) Benzyl alcohol to phenylethanoic acid (b) Benzaldehyde to Benzophenone

21. (a) What is the effect of denaturation on structure of protein? (b) The two strands in DNA are not identical but are complementary. Explain.

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) Write IUPAC name of following coordination compound- [Pt (NH3)2 Cl (NH2CH3)]Cl. (b) How many geometrical isomers are possible for co-ordination compound [Cr (C_2O4)3] 3- (c) [Fe (CN)6] 4- and [Fe(H2O) 6] 2+ are of different Colour in dilute solutions. Why?

23. (a) How would you determine standard electrode potential of system Mg2+/Mg? (b) Represent the cell in which following reaction takes place - Mg (s) + 2 Ag+ (0.0001M) — Mg2+ (0.130M) +2Ag(s) Calculate its E if E - =3.17V. (c) The electrical resistance of a column of 0.05 mol L -1 NaOH solution of diameter 1 cm and length 50cm is 5.55 x103Ω. Calculate its conductivity. Cell Cell 6

24. Write names of reagent and reaction for preparation of following (Any 2) (a) 2- Methoxy -2-methyl propane (b) CH3-CH-CH_2-CH2-CH3 from alkene. | OH (c) Butan-2-ol from ketone.

25. An organic comp A with molecular formula C8H8O forms an orange red ppt with 2,4 DNP reagent and gives yellow ppt on heating with iodine in presence of NaOH. It neither reduces Tollen's or feeling's reagent, nor does it decolorize bromine water or Baeyer's reagent. On drastic oxidation with chromic acid it gives a carboxylic acid B having molecular formula C7H6O_2. Identify compounds A and B with involved chemical equations.

26. (a) What products would be formed when a nucleotide from DNA containing thymine is hydrolysed? (b) When RNA is hydrolysed there is no relationship among quantities of different bases obtained. What does this fact suggest about structure of RNA? (c) How do you explain absence of aldehydic group in pentaacetate of Dglucose?

27. Give mechanism for reaction- Br | CH3 - CH - CH- CH3 HBr CH3 -C- CH_2 - CH3 | | | CH3 OH CH3

28. The rate constant for first order decomposition of H2O2 is given by following equationlog k = 14.34 -1.25 x 104 K/T Calculate Ea for this reaction. Also calculate at what temperature will its halflife period be 256 minutes.

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. Read the passage given below and answer the following questions: Products of electrolysis depend on the nature of material being electrolysed and the type of electrodes being used. If the electrode is inert (e.g., Platinum or gold), it does not participate in the chemical reaction and acts only as source or sink for electrons. On the other hand, if the electrode is reactive, it participates in the electrode reaction. Thus, the products of electrolysis may be different for reactive and inert electrodes. The products of electrolysis depend on different oxidising and reducing species present in the electrolytic cell and their standard electrode potentials. (a) On the basis of standard electrode potential values given below, predict whether Ti4+ species may be used to oxidise Fe(II) to Fe(III). Ti4+ + e- → Ti^3+ E° = +0.01V Fe^3+ + e- → Fe^2+ E° = +0.77V (b) Based on the data, arrange Fe^2+ , Mn^2+ and Cr2+ in the increasing order of stability of +2 oxidation state. (Give a brief reason) E° Cr3+/Cr2+ = -0.4V E° Mn3+/Mn2+ = +1.5V E° Fe3+/Fe2+ = +0.8V (c) (i) Name the cell which is generally used in hearing aids. (ii) On which factor do the product of electrolysis depends? OR Do inert electrodes participate in the reactions occurring on their surface? What is the role of inert electrode?

30. According to Valence Band Theory, metal atom or ion under influence of ligands can use its (n-1) d, ns, np or ns, np, nd, orbitals for hybridization to yield a set of equivalent orbitals of definite geometry such as octahedral, tetrahedral, square planar and so on (see table). These hybridized orbitals are allowed to overlap with ligand orbitals that can donate lone pairs of electrons for bonding. 8 Table – Number of orbitals and types of hybridization Coordination No. Type of hybridization Distribution of hybridised orbitals in space 4 sp 3 tetrahedral 4 dsp2 square planner 5 sp 3 d trigonal bi pyramidal 6 sp 3 d 2 octahedral 6 d 2 sp 3 octahedral Answer following questions- (a) Explain coordination polyhedron with one example. (b) The oxidation number of Cobalt in K [Co (CO)4] is - (i) +1 (ii) +3 (iii) -1 (iv) -3 (c) Find out nature of bonding, type of complex, geometry and magnetic behavior for complex [Co(NH3)6] 3+ or [CoF6]3-

SECTION E

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

31. Attempt any five of following (a) Predict which of following will be coloured in aqueous solution and why? Ti3+, V3+ , Cu+ , Sc3+, Mn2+, Fe3+ and Co2+ (b) The d1 configuration is very unstable in ions. (c) Co (II) is stable in aqueous solution but in presence of complexing reagents it is easily oxidized. (d) Of the d4 species Cr2+ is strongly reducing while Mn3+ is strongly oxidising. (e) The highest O.S. is exhibited in oxoanions by transition metals. (f) The lowest oxide of transition metal is basic but the highest is amphoteric or acidic. (g) The E - value for Cu metal is +ve in contrast to other members of Ist transition series. M 2+/M 9 32. (a) What are azeotropes? Give example. (b) The vapour pressure of pure liquid A and B are 450 and 700 mm Hg respectively. Find out composition of liquid mixture if total pressure is 600 mm Hg. (c) Calculate osmotic pressure in pascals exerted by a solution prepared by dissolving 100g of polymer of molar mass 185,000g mol-1 in 450 ml of water. OR (a) What is difference between hypotonic and hypertonic solutions. Give example of each one. (b) 200 cm3 of an aqueous solution of a protein contains 1.26g of protein. The osmotic pressure of such a solution at 300K is found to be 2.57 x 10-3 bar. Calculate molar mass of the protein. (c) If solubility product of CuS is 6 x 10- 16 Calculate maximum molarity of CuS in aqueous solution.

33. A colourless substance A (C6H7N) is sparingly soluble in water and gives a water soluble compound B on treatment with mineral acid. On reacting with CHCl3 and alc KOH 'A' produces pungent smell due to compound C. The reaction of A with benzene sulphonyl chloride gives compound D, which is soluble in alkali. With NaNO2 and HCl, A forms compound E, which reacts with phenol in an alkaline medium to give F which is orange dye. Identify compounds A,B,C,D,E and F with involved reactions.

OR

(a) Give chemical test to distinguish between following pairs of organic compounds. (i) Ethylamine and aniline (ii) CH3NH2 and (CH3)2 NH (b) Give structures of A, B and C in following reactions- (i) C6H5NO2 A B C (ii) CH3COOH A B C 273 K HCl Fe/HCl HNO2 C6H5O H NH3 NaOBr NaNO2 10 (iii) Br CH3 NH2 NaNO2/HCl A H3PO2 B 273 K H2O KMnO4 / OH C 11

SAMPLE PAPER-2 SOLUTION

CHEMISTRY THEORY (043)

SECTION- A

Q.1. c

Q.2. a

Q 3. b

Q 4. c

Q 5. d

Q 6. b

Q 7. b

Q 8. c

Q 9. a

Q 10. c

Q 11. b

Q 12. d or Q 12. b

Q 13. c

Q 14. a

Q 15. d

Q 16. b

SECTION-B

Q 17. Decomposition of NH_3 takes place as-

$$2NH_3(g) \longrightarrow N_2(g) + 3\,H_2\,(g)$$

Rate = $-\frac{1}{2}$ ——— $= +\frac{1}{3}$ H [——— d

$= k\,[NH_3]^0 = k = 2.5 \times 10^{-4}\ mol^{-1}LS^{-1}$

So rate of production of N_2 is –

——— d $= k = 2.5\ mol^{-1}LS^{-1}$

And rate of production of H_2 is –

——— d $= 3k = 3 \times 2.5 \times 10^{-4} = 7.5 \times 10^{-4}\ mol^{-1}LS^{-1}$

Q 18. 5% solution by mass means that 5g cane sugar is dissolved in 100g of solution.

Molar mass of cane sugar M $C_{12}H_2$

$= 342\ g\ mol^{-1}$

and Molar mass of glucose M $C_6H_{12}O_6$ $= 180\ g\ mol^{-1}$

Mass of solvent = 100-5

= 95 g

Now molality of sugar sol^n m= $\dfrac{w / M}{W\ (in\ kg)}$

$$= \frac{5 / 342}{95 / 1000} = 0.1537\ mol\ kg$$

ΔT_f for sugar sol^n = $T^0_f - T_f$

= 273.15 – 271 = 2.15 K

We have $\Delta T_f = K_f \times m$

So $K_f = \frac{\Delta}{\quad} = \frac{\quad}{0.1537} = 13.99\ \text{K kg mol}^{-1}$

Now molarity of 5% glucose solution

$$M = \frac{w / m}{W\ (\text{in kg})} = \frac{5 / 180}{95 / 1000}$$

= 0.2926 mol kg^{-1}

According to Raoult's Law –

$\Delta T_f = K_f . m$

= 13.99 x 0.2926 = 4.09 K

So F.P. of 5% glucose Sol^n

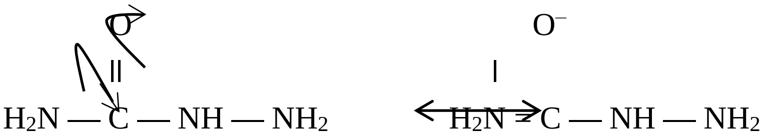
$T_f = T_f^0 - \Delta T_f$

= 273.15 – 4.09

= 269.06 K

Q 19. (a) B.P increases with increase in molecular mass. So correct order-chloromethane (CH_3Cl) < Bromomethane (CH_3Br) < Dibromomethane (CH_2Br_2) < Bromoform ($CHBr_3$).

(b) Due to more stability of C-C bond than C-N and ionic nature of KCN, attack takes place mainly through C atom to give alkyl cyanides while AgCN has covalent nature and N atom is free to donate ep forming isocyanide as main product.

Q 20. (a) 

$$H_2N — \overset{\overset{O}{||}}{C} — NH — NH_2 \longleftrightarrow H_2\overset{+}{N} = \overset{\overset{O^-}{|}}{C} — NH — NH_2$$

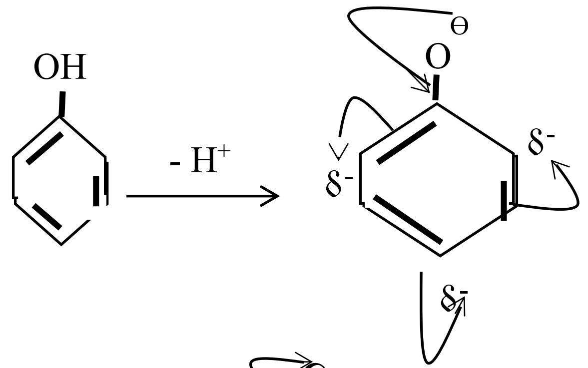
Due to unavailability of lp of e- on N atom of NH_2 group which is directly bonded

O

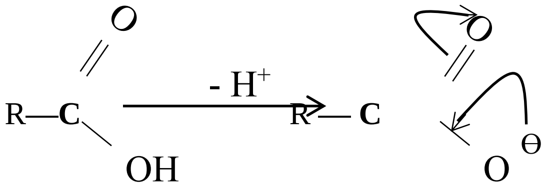
||

to carbonyl group (—**C**—).

(b)



5 Non-equivalent resonating structures

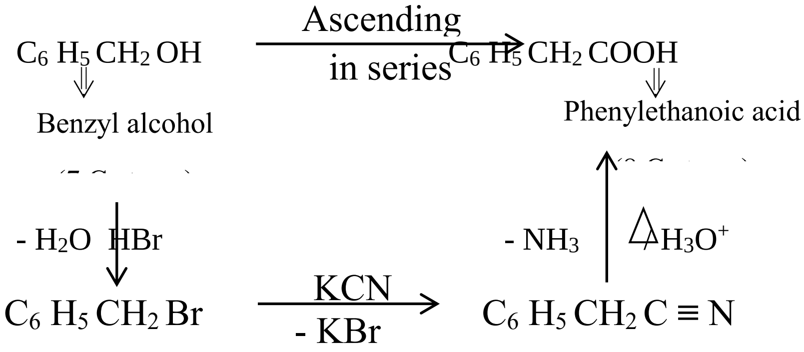


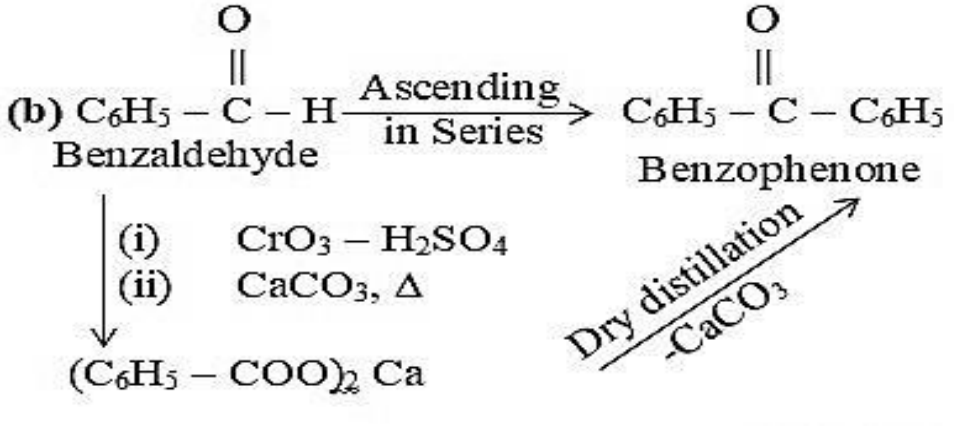
2 Equivalent resonating structures

Due to non-equivalent resonating structures of phenoxide ion, it is less stable than carboxylate ion as –ve charge is carried by less electronegative Csp2 atom of benzene ring.

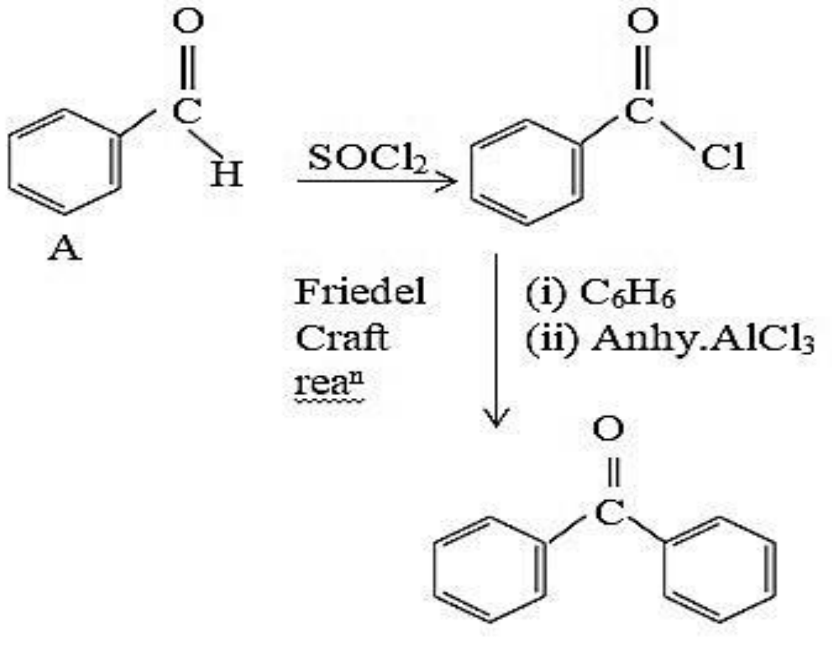
OR

(a) Required conversion -





OR 2nd method



Q 21. (a) It causes disruption of 2^0 and 3^0 structures while retaining 1^0 structure due to breaking of H – bonds.

(b) Due to specific base pairing as pairing as G ≡ C and A = T or vice-versa, the sequence of bases in one strand fixes sequence in other strand resulting into their complementary nature.

SECTION - C

Q 22. (a) Diammine chlorido (methylamine) platinum (II) chloride.

(b) No geometrical isomers

(c) Due to difference in CFSE values, different amount of energies are absorbed for d – d transition resulting into different colours.

Q 23. (a) By constructing a cell while coupling Mg / Mg SO_4 (1 M) with SHE and measuring E^{Θ}_{cell}.

Hence cell may be represented as-

Mg (s) / Mg^{2+} (1 M) || H^+ (1 M) | H_2 (g, 1 atm), Pt

$E^{\Theta}_{cell} = E^{\Theta}_{H+/H_2} - E^{\Theta}_{mg2+/mg}$

Since $E^{\Theta}_{H+/H2} = 0$, So $E^{\Theta}_{mg2+/mg} = - E^{\Theta}_{cell}$

(b) The cell can be represented as-

Mg / Mg^{2+} (0.130 M) || Ag^+ (0.0001 M) | Ag (s)

We have Nernst eq^n as- $E_{cell} = E^{\Theta}cell \; \frac{-0.0591}{n} \; \log Q_c$

$$E_{cell} = E^{\Theta}_{cell} \; \frac{0.0591}{n} \; \log \frac{[Mg^{2+}]}{[Ag^+]^2}$$

$$E_{cell} = 3.17 - \frac{0.0591}{2} \; \log \frac{0.130}{(0.0001)^2}122$$

= 2.96 V

(c) We have $A = \pi r^2 = 3.14 \times (1/2)^2$

$= 0.785\ cm^2 = 0.785 \times 10^{-4}\ m^2$

Now $R = \rho\ l/A$, so $\rho = \frac{R \times A}{l}$

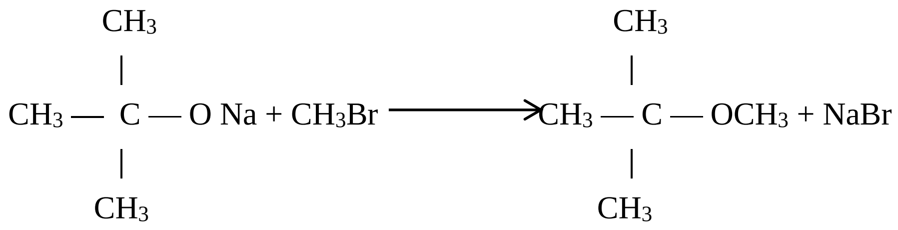
$$\rho = \frac{5.55 \times 10^3\ \Omega \times 0.785\ cm^2}{50\ cm}$$

$= 87.135\ \Omega\ cm$

Now conductivity **K** $= \frac{1}{\rho} = \frac{1}{87.135\ \Omega\ cm} = 0.01148\ S\text{-}cm^{-1}$

Now conductivity K = = = 0.01148 $S\text{-}cm^{-1}$

Q 24. (a) Required eq^n

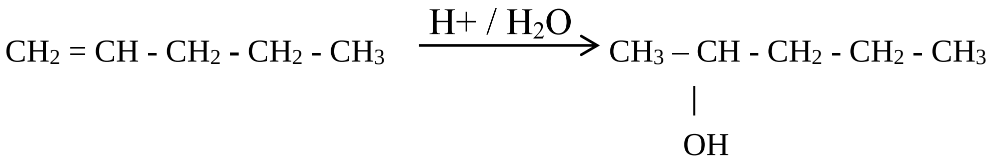


$$CH_3 — \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} — O\,Na + CH_3Br \longrightarrow CH_3 — \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} — OCH_3 + NaBr$$

Reagent = Sodium–2–methyl–2–propoxide and Bromomethane

Reaction = Williamson’s synthesis

(b) Required eq^n

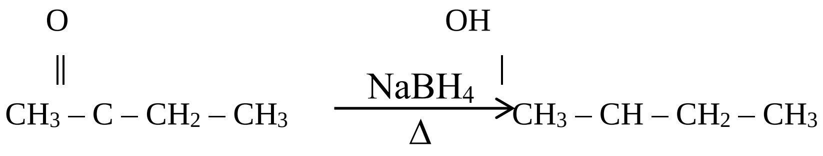


$$CH_2 = CH - CH_2 - CH_2 - CH_3 \xrightarrow{H+ / H_2O} CH_3 – \underset{\underset{OH}{|}}{CH} - CH_2 - CH_2 - CH_3$$

Reagent = Pent–1–ene and water

Reaction = Acid catalyzed hydration

(c) Required eq^n



$$CH_3 – \overset{\overset{O}{\|}}{C} – CH_2 – CH_3 \xrightarrow[\Delta]{NaBH_4} CH_3 – \overset{\overset{OH}{|}}{CH} – CH_2 – CH_3$$

Reagent = Butan–2–one and $NaBH_4$

Reaction = Reduction

Q 25. For compound A–

(i) A forms 2, 4 – DNP Derivatives = may be an aldehyde or Ketone

(ii) A does not reduce Tollen’s / Fehling

‖ ∨

So A must be Ketone

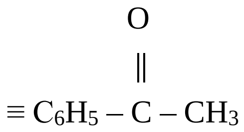
(iii) Since A responds to Iodoform test

‖ ∨

So A should be methyl Ketone

(iv) M.F. C_8H_8O does not fit to Aliphatic group, so it indicates presence of phenyl group. Thus we can infer as –

$C_8H_8O \equiv C_6H_5 . C_2H_3O \equiv C_6H_5 . CH_3 .CO$

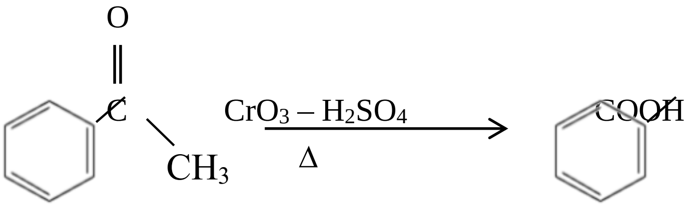


$$\equiv C_6H_5 - \overset{\overset{O}{\|}}{C} - CH_3$$

A = Acetophenone

Further for compound B –

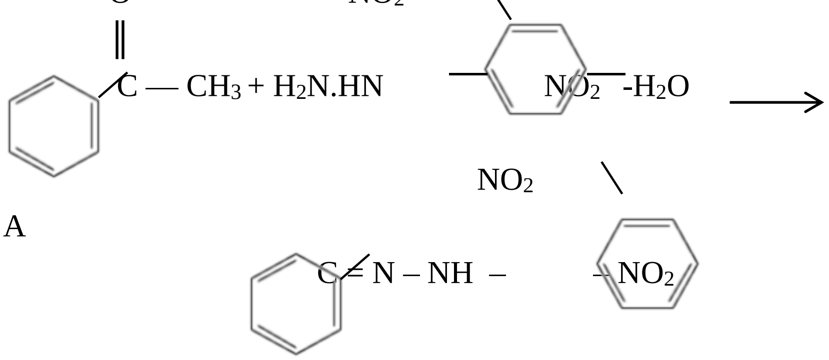
(i) On vigorous oxidation, Ketones form carboxylic acids with lesser number of carbon atoms, so it can be inferred as –



A B = Benzoic acid

Reactions can be written as –

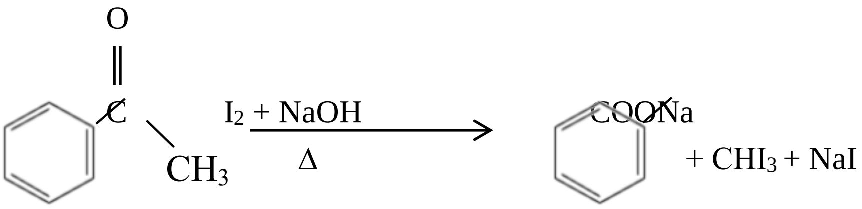
a.



Comp A

2, 4 – DNP derivative

b.



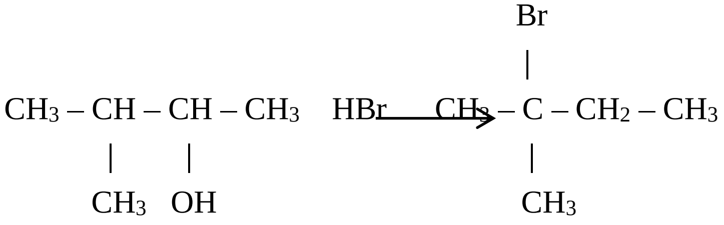
Comp A

Q 26. (a) On hydrolysis three products formed are –

- (i) 2 – deoxyribose sugar
- (ii) Phosphoric acid (H_3PO_4)
- (iii)Thymine base

(b) In RNA, base pairing principle i.e.
A = U and C ≡ G is not followed as it is not established by relationship among quantities of different bases obtained.

(c) Due to cyclisation between C_1 and C_5 through O atom in glucose, CHO group is not present at C_1 in pentaacetate form to give test with hydroxylamine.

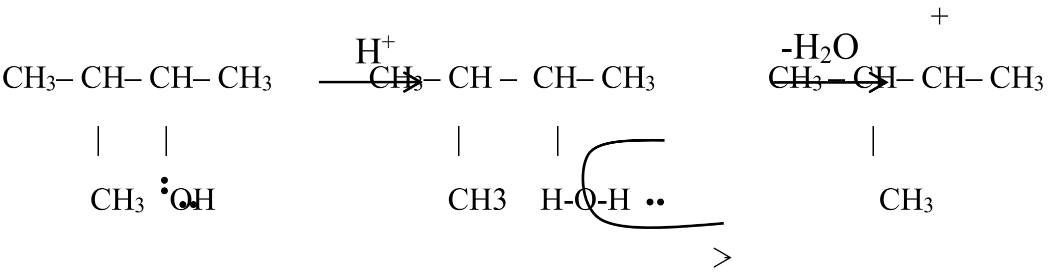
Q 27. 

$$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3 \quad \xrightarrow{HBr} CH_3-\overset{\displaystyle Br}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}-CH_2-CH_3$$

Mechanism –

Step – 1 Protonation followed by dehydration of substrate alcohol.

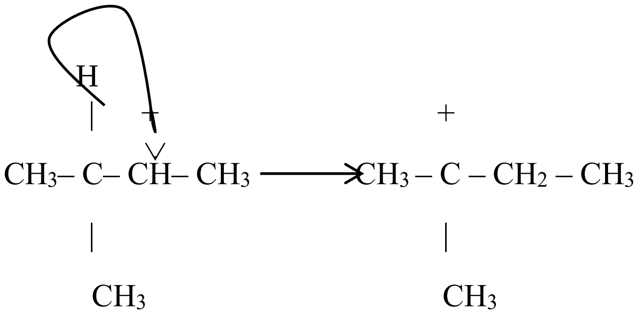
$$HBr \longrightarrow H^+ + Br^{\ominus}$$



$$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-\underset{\displaystyle \ddot{O}H}{\underset{|}{CH}}-CH_3 \xrightarrow{H^+} CH_3-\underset{\displaystyle CH3}{\underset{|}{CH}}-\underset{\displaystyle H\text{-}\ddot{O}\text{-}H}{\underset{|}{CH}}-CH_3 \xrightarrow{-H_2O} CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-\overset{+}{CH}-CH_3$$

2^0 Carbocation (Less Stable)

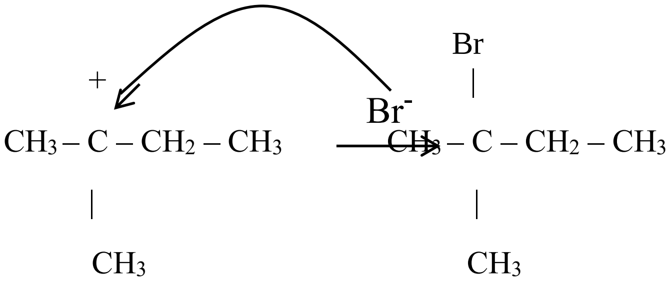
Step – 2 Conversion of less stable carbocation into more stable carbocation by 1,2-hydride shift.



$$CH_3-\overset{\overset{H}{|}}{\underset{\underset{CH_3}{|}}{C}}-\overset{+}{C}H-CH_3 \longrightarrow CH_3-\overset{+}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3$$

3^0 Carbocation (More Stable)

Step – 3 Attack of $Nu^{\ominus}$, Br^- on carbocation to form product.



$$CH_3-\overset{+}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3 \xrightarrow{Br^-} CH_3-\overset{\overset{Br}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3$$

3^0 Carbocation (More Stable)

Q. 28. We have Arrhenine eq^n as-

$$\log k = \log A - \frac{Ea}{2.303RT} \quad \text{——— (1)}$$

Given eq^n is —

$$\log k = 14.34 - 1.25 \times 10^4 \, K/T \quad \text{——— (2)}$$

Comparing eq^n (1) with (2) we get –

$$\frac{Ea}{2.303\,R\,\cancel{T}} = \frac{1.25 \times 10^4\,K}{\cancel{T}}$$

$Ea = 2.303 \times 1.25 \times 10^4 \, R\,K$

$= 2.303 \times 1.25 \times 10^4 \times 8.314 \, J\,mol^{-1}\,K^{-1}.K$

$= 2.39.34 \, k\,J\,mol^{-1}$

Given, $t_{1/2}$ = 256 min = 256 x 60 s

We have rate const $k = \frac{0.693}{t_{1/2}}$

$$k = \frac{0.693}{256 \times 60} \text{ s}^{-1}$$

$= 4.51 \times 10^{-s} \text{ s}^{-1}$

Putting value of k in eqn (1) we get-

$$\log (4.51 \times 10^{-5}) = 14.34 - \frac{1.25 \times 10^4 \text{ K}}{T}$$

$$\log 4.51 + (-5 \log 10) = 14.34 - \frac{1.25 \times 10^4 \text{ K}}{T}$$

$$0.6542 - 5 = 14.34 - \frac{1.25 \times 10^4 \text{ K}}{T}$$

$$-4.3458 = 14.34 - \frac{1.25 \times 10^4 \text{ K}}{T}$$

$$\frac{1.25 \times 10^4 \text{ K}}{T} = 14.34 + 4.3458$$

$$\frac{1.25 \times 10^4 \text{ K}}{T} = 18.6858$$

So $T = \frac{1.25 \times 10^4}{18.685} \text{ K} = 669 \text{ K}$

SECTION - D

Q. No. 29 (a) We have $E^{\Theta}_{Fe^{3+}/Fe^{2+}} = 0.77$ V
and $E^{\Theta}_{Ti^{4+}/Ti^{3+}} = 0.01$ V

Ti^{4+} species can not oxidise Fe^{2+} into Fe^{3+} because of smaller $E^{\Theta}_{Ti^{4+}/Ti^{3+}}$ value than $E^{\Theta}_{Fe^{3+}/Fe^{2+}}$.

(b) Decreasing order of stability of +2 O.S. of species will be same as decreasing order of $E^{\Theta}_{M^{3+}/M^{2+}}$ values.

Since 1.5 V > 0.8 V > -0.4 V

i.e. $E^{\Theta}_{M3+/Mn2+} > E^{\Theta}_{Fe3+/Fe2+} > E^{\Theta}_{Cr3+/Cr2+}$

i.e. $Mn^{2+} > Fe^{2+} > Cr^{2+}$

so increasing order of stability of +2 species-

$Cr^{2+} < Fe^{2} < Mn^{2+}$

(c) (i) Mercury cell

(ii) Products of electrolysis depends on following factors-

1. Nature and concentration of electrolyte.
2. Voltage applied across cell electrodes.
3. Nature of electrode

OR

Inert electrodes do not participate in reactions occurring on their surface. These electrodes provide surface only for occurance of electode reactions means loosing of e^- at anode and gaining of e^- at cathode.

Q. 30 (a) Co-Ordination polyhedron refers to spatial arrangement of ligands surrounding to central metal atom or ion.

Ex- $[Co(NH_3)_6]^{3+}$ has oct geometry.

(b) Given Complex $K[Co(CO)_4]$

$+1 + x + 4 \times 0 = 0$

So $x = -1$ ~~Ans-~~ (iii)

(C) For complex $[Co(NH_3)_6]^{3+}$

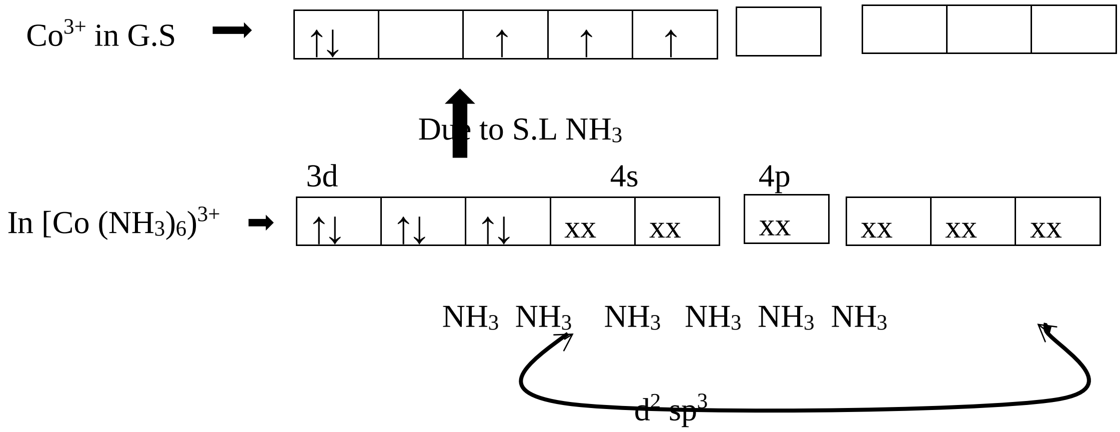
$x + 6 \times 0 = 3$

$x = 3$

So O.N of Co = 3

$_{27}$Co – $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^7$

In standing order $_{27}$Co – $3d^7, 4s^2, 4p^0$
↓$-3e^-$
Co^{3+}



Nature of bonding – 6 cordinate bonds with 6 liquids NH^3

Type of complex – Low spin or spin paired

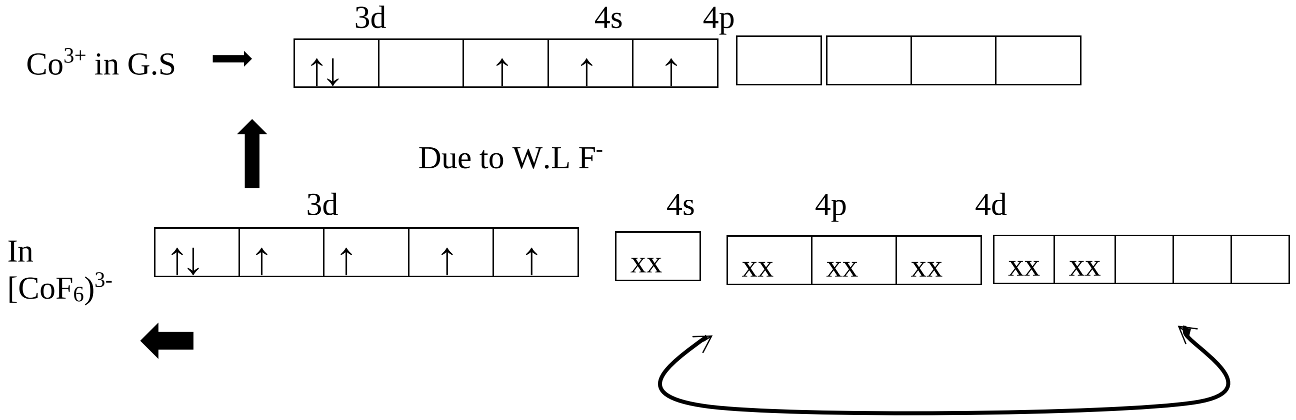
Geometry – Inner Orbital oct

Magnetic behaviour – Dianagnetic

For complex $[CoF_6]^{3-}$

x + 6 x – 1 = -3 or x = 3

O.S of Co = +3



NH_3 NH_3 NH_3 NH_3 NH_3 NH_3

Sp^3d^2

Nature of bonding –6 cordinate bonds with 6 ligand NH_3

Type of complex – High spin or spin free

Geometry – outer orbital oct

Magnetic behavior – Paramagnetic

SECTION - E

Q. 31 (a) Ti^{3+} ($3d^1$), V^{3+}($3d^2$), Mn^{2+} ($3d^5$) Fe^{3+} ($3d^5$) and Co^{2+} ($3d^7$) ions wiil be coloured due to presence of unpaired e^- d-orbitals.

(**b)** The ion with d^1 configuration has tendency to loose single e^- present in d- subshell to acquire full filled $(n-1)d^{10}$ ns^2 configuration by process of ox^n or disproportionation.

(c) Co (III) with $3d^6$ configuration has higher tendency to form complexes than Co (II) with $3d^7$ configuration resulting into easy ox^n in presence of ligands.

(d) $E^{\Theta}_{Cr3+/Cr2+}$ is –ve while $E^{\Theta}_{Mn3+/Mn2+}$ is +ve resulting into higher tendency of Cr^{2+} to undergo ox^n while for Mn^{3+} to undergo red^n. As a result species Cr^{2+} acts as reductant while Mn^{3+} as oxidant.

(e) Due to high electronegativity, more –ve $\Delta_{bond} H^{\Theta}$ and oxidizing action of O atom.

Ex- - +6 O.S. of Cr in $Cr_2O_7^{--}$ and +7 O.S. of Mn in MnO_4^-

(f) In lower oxides transition metals have low O.S. with low polarizing power making compound more ionic with basic character while in higher oxides, transition metal has higher O.S with higher polarizing power making compound more co-valent in nature which show amphoteric or acidic behavior.

(g) The $E^{\Theta}{}_{M}{}^{2+}{}_{/M}$ value for any metal depends on following enthalpies –

$M (s) \xrightarrow{\hspace{2cm}} M (g), \Delta aH = +ve$

$M (g) \xrightarrow{\hspace{2cm}} M^{2+}(g), \Delta iH = +ve$

$M^{2+}(g) \longrightarrow M^{2+}(aq)$, $\Delta_{hyd} H$ = -ve

For Cu metal high demand of energy as ΔaH and ΔiH is not compensated by low amount of energy released as Δ_{hyd} H, results into high tendency of Cu^{2+} ion to undergo red^n.

Q. 32 (a) The binary mixtures having same composition in liquid and vapour phase and boil at constant temp are called azeotropes.

Ex- (i) 95% C_2H_5OH + 5% H_2O (By volume)
(ii) 68% HNO_3 + 32% H_2O (By mass)

(b) Vapour pressure of pure liquid A, ($þ^0_A$) = 450mm

Vapour pressure of pure liquid B ($þ^0_B$) = 700mm

Total V.P of mixture, $þ_{Total}$ = 600 mm

We have $X_A = 1 - X_B$
or $X_B = 1 - X_A$
Acc. to Raoult's law-

$þ_{total} = þ^0_A X_A + þ^0_B . X_B$

$600 = 450 \text{ x } X_A + 700 \text{ x } (1- X_A)$

$600 = 450 X_A + 700 - 700X_A$

So $X_A = 0.40$

Now $X_B = 1- 0.40$
$= 0.60$

(c) Given : Mass of solute, w = 1.0 g
Molar mass M = 185000 gmal^{-1}

Volume of sol^n, V = 450ml

$T = 37^0C = 37 + 273 = 310$ K

$R = 0.0831 \text{ bar L mol}^{-1} \text{ K}^{-1}$

$= 0.0831 \times 10^5 \text{ Pa L mol}^{-1} \text{ K}^{-1}$

So osmotic pressure (π) = ?

We have formula for π as -

$$\pi = CRT$$

$$= \frac{w / M}{V(\text{inL})} \text{ x R x T}$$

$$\pi = \frac{1 / 185000}{450 / 1000} \text{ x } 0.0831 \text{ x } 10^5 \text{ x } 310 \text{ Pa}$$

$$= \frac{1}{185000} \text{ x } \frac{1000}{450} \text{ x } 0.0331 \text{ x } 10^5 \text{ x } 310 \text{ Pa}$$

$$= \frac{83.1 \text{ x } 310 \text{ x } 100000}{185000 \text{ x } 450} \text{ Pa}$$

$= 30.94$ Pa

OR

(a) A sol^n having higher conc^n of solute than another sol^n is called hypertonic while the sol^n having lower conc^n of solute than another sol^n is called hypotonic sol^n.

Ex- (i) Hypertonic Sol^n – NaCl Sol^n with conc^n higher than 0.9% (mass / volume) wrt blood cells.

(ii) Hypotonic sol^n – NaCl Sol^n with conc^n lower than 0.9% (mass/volume) wrt blood cells.

(b) Given : Volume of Sol^n, $V = 200 \text{ cm}^3$

$= 200$ ml

Mass of solute, $w = 1.26$ g

Temp, $T = 300$ K

Osmotic pressure, л = 2.57×10^{-3} bar

$R = 0.0831$ bar L mol^{-1} K^{-1}

To find, molar mass M = ?

Acc. to osmotic pressure expression

л = CRT

$$C = \frac{\pi}{RT}$$

$$\frac{w / M}{V(\text{inL})} = \frac{\pi}{RT}$$

$$\frac{1.26 / M}{200 / 1000} = \frac{2.57 \times 10^{-3}}{0.0831 \times 300}$$

$$\frac{1.26}{M} \times \frac{1000}{200} = \frac{2.57 \times 10^{-3}}{0.0831 \times 300}$$

$$\text{So } M = \frac{1.26 \times 5 \times 0.0831 \times 300}{2.57 \times 10^{-3}}$$

$$M = \frac{1.26 \times 5 \times 0.0831 \times 300 \times 10^{3}}{2.57}$$

$$M = \frac{157059}{2.57} = 61112.45 \text{ g mol}^{-1}$$

(c) Maximum molarity of CuS in aqueous sol^{n} means molar solubility of CuS.

Let molar solubility of CuS be S mol L^{-1}

Now CuS ionizes in water as-

$CuS\ (aq) \rightleftharpoons Cu^{2+}\ (aq) + S^{--}\ (aq)$ ———————— 1

Given : Solubility Product Ksp = 6×10^{-16}

We have Ksp = $[Cu^{2+}] . [S^{--}]$

$6 \times 10^{-16} = S \times S$

$S^2 = 6 \times 10^{-16}$

$S = \sqrt{6 \times 10^{-16}}$

$S = 2.45 \times 10^{-8}$ mol L^{-1}

So max molarity of CuS= 2.45×10^{-8} mol L^{-1}

Q. 33. M.F of comp A – C_6H_7N

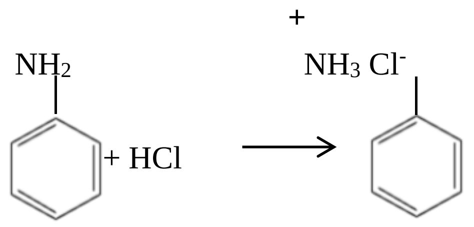
$$\downarrow \overset{CHCl_3 / \text{alc KOH}}{\Delta}$$

Comp C (has pungent smell)

If refers that comp A has NH_2 group. On rearranging given M.F of A, we get it aniline as-

$C_6H_7N \equiv C_6H_5 . NH_2$

Point 1



A B

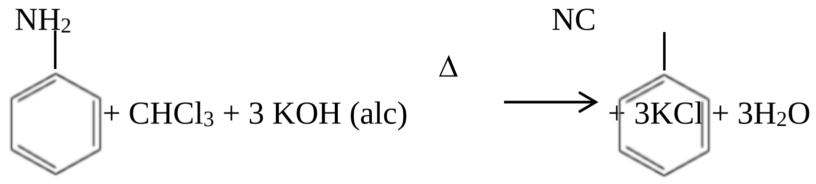
(Colourless liquid Sparingly soluble in water)

⇓

Anilinium chloride

⇓

Point 2



A

C Benzene isonitrile

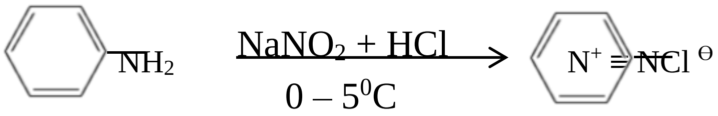
(Pungent Smell)

Point 3

A (D) N – Phenylbenzene sulphonamide

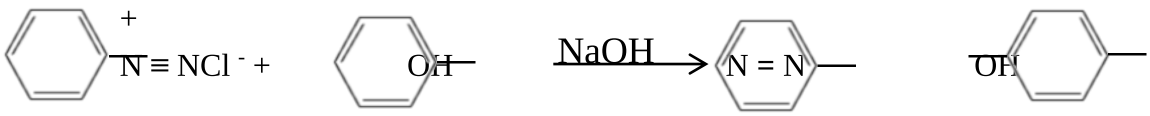
(Soluble in alkali)

Point 4



A (E) Benzenediazonium Chloride

Point 5



E (F) p-Hydroxy azobenzene

(Orange dye)

OR

(a) (i) By nitrous acid test

$$C_2H_5NH_2 \xrightarrow[0-5^0C]{NaNO_2 + HCl} \underset{\text{Unstable}}{[C_2H_5 - \overset{+}{N_2}Cl^-]} \xrightarrow{H_2O} C_2H_5OH + N_2 + HCl$$

$$C_6H_5NH_2 \xrightarrow[0-5^0C]{NaNO_2 + HCl} \underset{\text{Stable}}{C_6H_5\overset{+}{N_2}Cl^-} + NaCl + H_2O$$

(ii) By Hinsberg test-

$C_6H_5SO_2Cl + CH_3NH_2 \rightarrow C_6H_5SO_2\ NH - CH_3 + HCl$

N–Methylbenzenesulphonamide

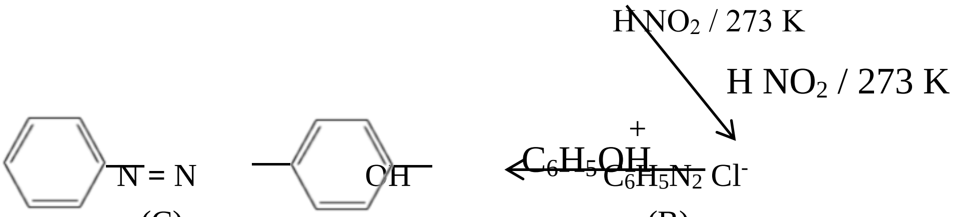
(Soluble in alkali)

$C_6H_5SO_2\ Cl + (CH_3)_2\ NH \rightarrow C_6H_5SO_2\ N(CH_3)_2 + HCl$

N, N'– Dimethylbenzenesulphonamide

(Insoluble in alkali)

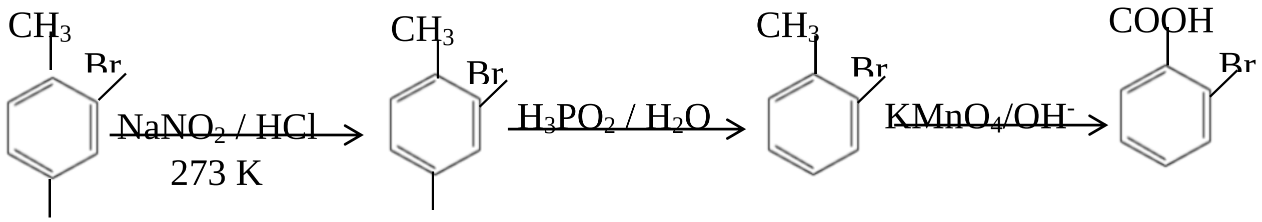
(b) (i) $C_6H_5\ NO_2 \xrightarrow{Fe + HCl} \underset{(A)}{C_6H_5NH_2}$



(C) (B)

(ii)
$$\begin{tikzcd} \underset{(A)}{CH_3\,COOH} \arrow[r, "NH_3", "\Delta"'] & \underset{(B)}{CH_3CONH_2} \arrow[r, "NaOBr"] & CH_3NH_2 \arrow[d, "NaNO_2\,/\,HCl"] \\ & & \underset{(C)}{CH_3OH} \end{tikzcd}$$

(iii)



SAMPLE PAPER -3 CHEMISTRY
CLASS XI

MM 70 **TIME 3 HRS**

General instruction:

Read the following instructions carefully.

a) There are 35 questions in this question paper with internal choice.

b) SECTION A consists of 18 multiple-choice questions carrying 1 mark each.

c) SECTION B consists of 7 very short answer questions carrying 2 marks each.

d) SECTION C consists of 5 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.

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.

Sr. No.	MCQs	Marks
1.	Formation of CO and CO_2 illustrates the law of ————. (a) Law of conservation of mass (b) Law of Reciprocal proportion (c) Law of Constant Proportion (d) Law of Multiple Proportion	1
2.	Which of the following pairs of gases contains the same number of molecules? (a) 8 g of O_2 and 7 g of N_2 (b) 8 g of O_2 and 4.4 g of CO_2 (c) 28 g of N_2 and 22 g of CO_2 (d) 32 g of O_2 and 14g of N_2	1
3.	Which of the Following Statements about a Compound is Incorrect One? (a) A molecule of a compound has atoms of different elements. (b) The ratio of atoms of different elements in a compound is fixed (c) A compound retains physical properties of its associated constituent elements (d) A compound cannot be separated into its constituent elements by physical methods of separation	1
4.	Molarity of a solution that prepared by dissolved 5.85 g of NaCl(s) in 100 mL is- (a) 3.65 mol/L (b) 10 mol/L (c) 0.1 mol/L (d) 1 mol/L	1
5.	One Gram Molecule of Benzene is Equal to_____? (a) 10 g C_6H_6 (b) 70 g C_6H_6 (c) 72 g C_6H_6 (d) 78 g C_6H_6	1

6.	Which of the following statements do not form a part of Bohr's model of hydrogen atom? (a) Energy of the electrons in the orbits are quantized (b) The electron in the orbit nearest the nucleus has the lowest energy (c) Electrons revolve in different orbits around the nucleus (d) The position and velocity of the electrons in the orbit cannot be determined simultaneously.	1
7.	How many unpaired electron present in Cu^+ ion a) 1 b) 6 c) 0 d) 10	1
8.	The last entering electron in an element has quantum number n = 3, l = 2, m = + 2 and s = + 1 /2. The atomic number of the element will be (a) 13 (b) 21 (c) 29 (d) 39	1
9.	The group number, number of valence electrons, and valency of an element with the atomic number 15, respectively, are: (a) 16, 5 and 2 (b) 15, 5 and 3 (c) 16, 6 and 3 (d) 15, 6 and 2	1
10.	The most polar bond is (a) C – F (b) C – O (c) C – Br (d) C – S	1
11.	Among the following the electron deficient compound is (a) BCl_3 (b) CCl_4 (c) PCl_5 (d) $BeCl_2$	1
12.	Which one of the following statement is false? (a) Work is a state function (b) Temperature is a state function (c) Change in the state is completely defined when the initial and final states are specified (d) Work appears at the boundary of the system	1
13.	One mole of which of the following has the highest entropy? (a) Liquid Nitrogen (b) Hydrogen Gas (c) Mercury (d) Diamond	1
14.	Based on the first law of thermodynamics, which one of the following is correct? (a) For an isothermal irreversible change , q = +w (b) For an isochoric process, $\Delta U = -q$ (c) For an adiabatic process, $\Delta U = -w$ (d) For isothermal irreversible change , q = -w	1
15.	Given below are two statements labelled as Assertion (A) and Reason (R) Assertion (A): The empirical mass of Ethene is half of its molecular mass. Reason (R) : The empirical formula represents the simplest whole number ratio of various atoms present in a compound Select the most appropriate answer from the options 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 true but R is false. d) A is false but R is true.	1
16.	Assertion (A): the atomic mass of most of the elements are fractional Reason (R): most of elements occurs as mixture of isotopes. Select the most appropriate answer from the options given below: a) Both A and R are true and R is the correct explanation of A	1

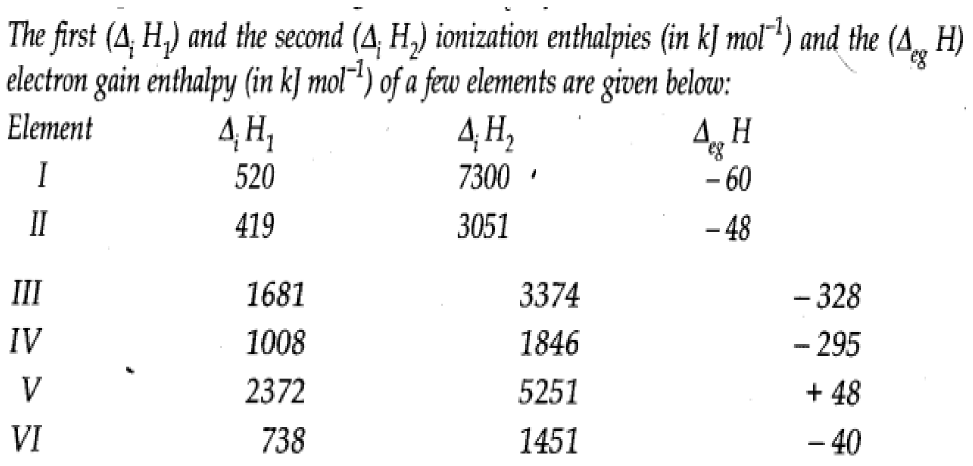
	b) Both A and R are true but R is not the correct explanation of A. c) A is true but R is false. d) A is false but R is true.	
17.	Assertion (A): Each orbital is designated by three quantum numbers labelled as n, l and m_l. Reason (R): 'n' is a positive integer with value of n = 1,2,3. Select the most appropriate answer from the options 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 true but R is false. d) A is false but R is true.	1
18.	Assertion (A): According to Mendeléev, the properties of elements are a periodic function of their atomic masses. Reason (R) : Atomic number is equal to the number of protons Select the most appropriate answer from the options 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 true but R is false. d) A is false but R is true.	1
	SECTION :B This section contains 7 questions with internal choice in two questions. The following Questions are very short answer type and carry 2 marks each.	
19.	a) How many seconds are there in 2 days (Unit method calculation)? b) How are 0.50 mol Na_2CO_3 and 0.50 M Na_2CO_3 different?	1+1
20.	**Calculate the energy of each of the photons which** **(a) correspond to light of frequency 3×10^{15} Hz** **(b) have wavelength of 0.50 ^{0}A**. OR Yellow light emitted from a sodium lamp has a wavelength of 580 nm. Calculate the frequency (v) and wave number (v-) of yellow light.	1+1 2
21.	**Consider the following species:** **$N^{3-,}$ $O^{2-,}$ F^{-}, Na^{+}, $Mg^{2+,}$ Al^{3+}** **(a) What is common in them?** **(b) Arrange them in order of increasing ionic radii?**	2
22.	Using the Periodic Table, predict the formulas of compounds which might be formed by the following pairs of elements; (a) silicon and bromine (b) aluminium and sulphur	2
23.	Calculate the standard enthalpy of formation of CH_3OH. from the following data: (i) $CH_3OH(l) + 3/2\ O_2 (g)$ ———> $CO_2 (g) + 2H_2O (l)$; $\Delta_r H^0 = – 726$kj mol^{-1}	2

	(ii) $C(s) + O_2(g)$ ——————>CO_2 (g); Δ_cH^0 = -393 kj mol^{-1} (iii) $H_2(g) + 1/2O_2(g)$ ——————>H_2O (l); Δ_fH^0 = -286 kj mol^{-1} OR The enthalpy of combustion of methane, graphite and di hydrogen at 298 K are -890.3 KJ mol^{-1}, – 393.5 KJ mol^{-1} and – 285.8 KJ mol^{-1} respectively. Calculate Enthalpy of formation of $CH_4(g)$	2
24.	a) Explain why BeH_2 molecule has a zero dipole moment although the Be—H bonds are polar. b) Which out of NH_3 and NF_3 has higher dipole moment and why?	1+1 =2
25.	(a) What is bond energy? Why is it called enthalpy of atomisation? (b) Write the Relationship between Cp and C_V for an Ideal Gas.	1+1 =2
	SECTION : C This section contains 5 questions with internal choice in two questions. The following questions are short answer type and carry 3 marks each	
26.	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. OR A compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formulas?	2+1 3
27.	(a) Write designation of an orbital having n = 5,1 = 3. (b) Name the spectral line series in the spectrum of H-atom obtained when an electron jumps from n = 4 to n = 2. (c) Define Zeeman effect.	1 1 1
28.	**a) energy of an electron in the ground state of hydrogen atom is- 2.18×10-18 J. Calculate the ionization enthalpy of atomic hydrogen in terms of Joule per mole** b) **Give the general electronic configuration of the transition elements.**	2 1
29.	**a) Geometries of NH_3 and H_2O molecules are distorted tetrahedral but bond angle in water is less than that of ammonia, why?** **b) Draw the resonance structures of carbonate (CO_3^{2-}) ion .** c) **Both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear, why?**	1 1 1
30.	(a) Out of 1 mole of $H_2O(g)$ and 1 mole of $H_2O(l)$ which one will have greater entropy? (b) what will be the value of $\Delta G°$ for boiling water? (c) What is meant by the term state function? Give one example. OR Define entropy. And prove that entropy is an extensive property.	3 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	

31.	The spectrum of radiation emitted by a substance that has absorbed energy is called an emission spectrum. Atoms, molecules or ions that have absorbed radiation are said to be “excited”. To produce an emission spectrum, energy is supplied to a sample by heating it or irradiating it and the wavelength (or frequency) of the radiation emitted, as the sample gives up the absorbed energy, is recorded. An absorption spectrum is like the photographic negative of an emission spectrum. A continuum of radiation is passed through a sample which absorbs radiation of certain wavelengths. The missing wavelength which corresponds to the radiation absorbed by the matter, leave dark spaces in the bright continuous spectrum. The study of emission or absorption spectra is referred to as spectroscopy. The spectrum of the visible light, as discussed above, was continuous as all wavelengths (red to violet) of the visible light are represented in the spectra. a) State dual nature of matter (de Broglie equation and statement) b) The Spectral Lines for Atomic Hydrogen shown in visible region are in --------------series c) Distinguish between an Emission spectrum and an Absorption spectrum.	[1] [1] [2]
32.	In order to explain the characteristic geometrical shapes of polyatomic molecules like CH_4, NH_3 and H_2O etc., Pauling introduced the concept of hybridisation. According to him the atomic orbitals combine to form new set of equivalent orbitals known as hybrid orbitals. Unlike pure orbitals, the hybrid orbitals are used in bond formation. The phenomenon is known as hybridisation which can be defined as the process of intermixing of the orbitals of slightly different energies so as to redistribute their energies, resulting in the formation of new set of orbitals of equivalent energies and shape. For example when one 2s and three 2p-orbitals of carbon hybridise, there is the formation of four new sp^3 hybrid orbitals. a) Why axial bonds are weaker than equatorial bonds in PCl_5 b) What is the shape of compound undergoing sp^3d hybridization? c) Explain conditions for Hybridisation (any two)	[1] [1] [2]
	SECTION :E The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.	
33.	(a) Explain Heisenberg’s Uncertainty Principle and its significance. (b) What is the maximum number of emission lines when the excited electron of a hydrogen atom in n = 6 drops to the ground state ? (c) What are degenerate orbitals ? (d) Arrange X-rays, cosmic rays and radio waves according to frequency. **OR** (a) State and explain the following: (i) Aufbau principle (ii) Pauli exclusion principle. (iii) Hund’s rule of maximum multiplicity. (b) (i) How many sub-shells are associated with n = 4 ?	1 +1 1 1 1 1+1 +1 1+1

<table>
<tr><td></td><td>(ii) How many electrons will be present in the sub-shells having ms value of -1/2 for n = 4 ?</td><td></td></tr>
<tr><td>34.</td><td>a) On the basis of MOT, find the bond order of the following and Compare their relative stability also indicate their magnetic properties.
O_2, O_2^+ O_2^- (Superoxide),O_2^{2-} (peroxide)
b) What is the total number of sigma and pi bonds in the following molecules?
(i) $C_2 H_2$ (ii) $C_2 H_4$
OR

(a) Draw diagrams showing the formation of a double bond and a triple bond between carbon atoms in $C_2 H_4$ and $C_2 H_2$ molecules.
(b) Is it possible for a non polar molecule to have polar bonds?, give one example.
(c) Use molecular orbital theory to explain why the Be_2 molecule does not exist.
(d) Write the structure and hybridisation in case of PCl_5.</td><td>3
2

2
1
1
1</td></tr>
<tr><td></td><td>
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:
<table>
<tr><th>Element</th><th>$\Delta_i H_1$</th><th>$\Delta_i H_2$</th><th>$\Delta_{eg} H$</th></tr>
<tr><td>I</td><td>520</td><td>7300</td><td>– 60</td></tr>
<tr><td>II</td><td>419</td><td>3051</td><td>– 48</td></tr>
<tr><td>III</td><td>1681</td><td>3374</td><td>– 328</td></tr>
<tr><td>IV</td><td>1008</td><td>1846</td><td>– 295</td></tr>
<tr><td>V</td><td>2372</td><td>5251</td><td>+ 48</td></tr>
<tr><td>VI</td><td>738</td><td>1451</td><td>– 40</td></tr>
</table>
Which of the above elements is likely to be:
(a) the least reactive element
(b) the most reactive metal
(c) the most reactive non-metal
(d) the least reactive non-metal
(e) the metal which can form a stable binary halide of the formula MX2(X = halogen)</td><td>1 x 5=5</td></tr>
</table>

SAMPLE PAPER -3
CHEMISTRY ANSWER KEY
CLASS XI

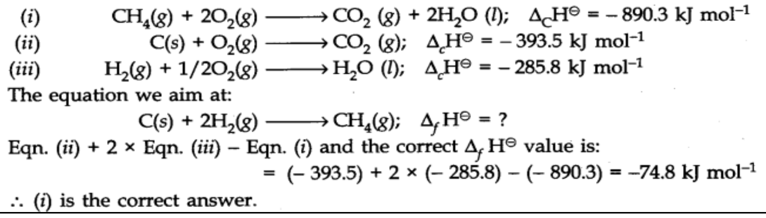
SECTION-A

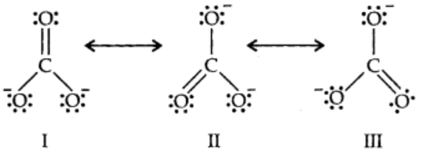
Sr.No.	MCQs	Marks
	1. D 2. A 3. C 4. D 5. D 6. D 7. C 8. C 9. B 10. A 11. A 12. A 13. B 14. D 15. A 16. A 17. B 18. B	

1.	D	2.	A	3.	C	4.	D
5.	D	6.	D	7.	C	8.	C
9.	B	10.	A	11.	A	12.	A
13.	B	14.	D	15.	A	16.	A
17.	B	18.	B				

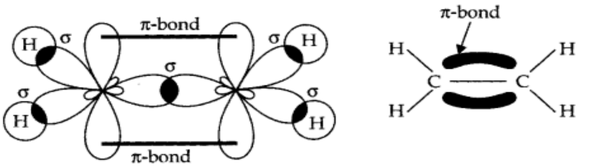
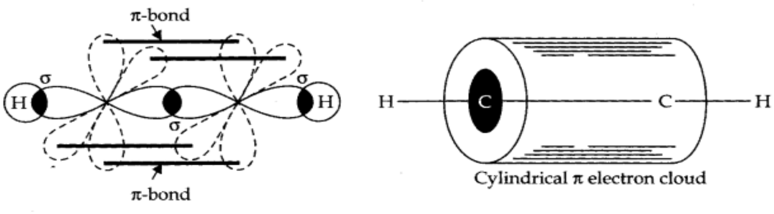
SECTION-B

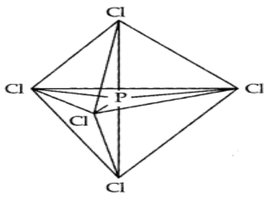
19.	a) The unit factors method = 2 × 24 × 60 × 60 s = 172800 s b)Molar mass of Na_2C0_3= 2 x 23 + 12 + 3 x 16 = 106g mol^{-1} 0.50 mol Na_2C0_3 means 0.50 x 105 g = 53 g 0. 50 M Na2C03 means 0.50 mol, i.e., 53 g Na_2C0_3 are present in 1 litre of the solution.	1+1
20.	20. Energy of photon (E) = hv h = 6.626 × 10^{-34} J s ; v = 3 × 10^{15} Hz = 3 × $10^{15}s^{-1}$ ∴ E = (6.626 × 10^{-34} J s) × (3 × 10^{15} s^{-1}) = 1.986 × 10^{18} J Energy of photon (E) = h v = h c/λ h = 6.626 × 10 34 J s; c = 3 × 10^8 m s^{-1} ; λ= 0.50 Å = 0.5 × 10^{-10} m. $E = \frac{(6{\cdot}626 \times 10^{-34} \mathrm{J\,s}) \times (3 \times 10^8 \mathrm{m\,s^{-1}})}{(0{\cdot}5 \times 10^{-10} \mathrm{m})} = \mathbf{3{\cdot}98 \times 10^{-15}\ J.}$ **OR** **Step I.** *Calculation of frequency of yellow light* We know that $\nu = \frac{c}{\lambda}$ $c = 3 \times 10^8 \mathrm{m\,s^{-1}}$; $\lambda = 580 \mathrm{nm} = 580 \times 10^{-9} \mathrm{m}$ ∴ $\nu = \frac{(3 \times 10^8 \mathrm{m\,s^{-1}})}{(580 \times 10^{-9} \mathrm{m})} = \mathbf{5{\cdot}17 \times 10^{14}\ s^{-1}}$ **Step II.** *Calculation of wave number of yellow light* Wave number $(\bar{\nu}) = \frac{1}{\lambda} = \frac{1}{(580 \times 10^{-9} \mathrm{m})} = \mathbf{1{\cdot}724 \times 10^6\ m^{-1}.}$	1 1 1 1
21.	(a) All of them are isoelectronic in nature and have 10 electrons each. (b) In isoelectronic species, greater the nuclear charge, lesser will be the atomic or ionic radius. $Al^{3+} < Mg^{2+} < Na^{+} < F^{-} < O^{2-} < N^{3-}$	1 1

22.	Silicon is group 14 element with a valence of 4; bromine belongs to the halogen family with a valence of 1. Hence the formula of the compound formed would be **SiBr4.** (b) Aluminium belongs to group 13 with a valence of 3; sulphur belongs to group 16 elements with a valence of 2. the formula of the compound formed would be **Al2 S3**.	1 1
23.	In the equation we aim at; $C(s) + 2H_2(g) + l/O0_2(g)$ ———> $CH_3OH\ (l);\Delta_f H^{-} = \pm?$ … (iv) Multiply eqn. (iii) by 2 and add to eqn. (ii) $C(s) + 2H_2(g) + 2O_2(g)$ ————->$CO_2(g) + 2H_20(l)$ ΔH = – (393 + 522) = – 965 kj/ mol Subtract eqn. (iv) from eqn. (i) $CH_3OH(aq) + 3/2O_2(g)$ ————> $CO_2(g) + 2H_2O(l)$; ΔH = – 726 kj mol^{-1} Subtract: $C(s) + 2H_2(g) + l/2O_2(g)$ ———-> $CH_3OH(aq)$; $\Delta_f Hf$ = – 239 kj mol^{-1} OR  (*i*) $CH_4(g) + 2O_2(g) \longrightarrow CO_2\ (g) + 2H_2O\ (l);\ \Delta_C H^{\ominus} = -890.3\ kJ\ mol^{-1}$ (*ii*) $C(s) + O_2(g) \longrightarrow CO_2\ (g);\ \Delta_c H^{\ominus} = -393.5\ kJ\ mol^{-1}$ (*iii*) $H_2(g) + 1/2O_2(g) \longrightarrow H_2O\ (l);\ \Delta_c H^{\ominus} = -285.8\ kJ\ mol^{-1}$ The equation we aim at: $C(s) + 2H_2(g) \longrightarrow CH_4(g);\ \Delta_f H^{\ominus} = ?$ Eqn. (*ii*) + 2 × Eqn. (*iii*) – Eqn. (*i*) and the correct $\Delta_f H^{\ominus}$ value is: $= (-393.5) + 2 \times (-285.8) - (-890.3) = -74.8\ kJ\ mol^{-1}$ ∴ (*i*) is the correct answer.	2 2
24.	24. a) BeH_2 is a linear molecular (H—Be—H), the bond angle = 180°. Be—H bonds are polar due to difference in their electronegativity but the bond polarities cancel each other. Thus, molecule has resultant dipole moment of zero. b) In NH3 and NF3, the difference in electronegativity is nearly same but the dipole moment of NH3 = (1.46D) For Example, NH3 = (0.24D) In NH3, the dipole moments of the three N—H bonds are in the same direction as the lone pair of electron. But in NF3, the dipole moments of the three N—F bonds are in the direction opposite to that of the lone pair. Therefore, the resultant dipole moment in NH_3 is more than in NF_3.	1 1
25.	25. (a) Bond energy is the amount of energy required to dissociate one mole of bonds present between the atoms in the gaseous phase. As the molecules dissociate completely into atoms in the gaseous phase therefore bond energy of a diatomic molecule is called enthalpy of atomisation b) Cp – CV = R	1 1
26.	Number of moles of H2 =4.96×103 mol Number of moles of N2 17.86×102 mol 3.30×103 mol NH3 (g) is obtained. 56.1 kg NH3 dihydrogen is the limiting reagent OR Step 1. Conversion of mass per cent to grams Since we are having mass per cent, it is convenient to use 100 g of the compound as the starting material. Thus, in the 100 g sample of the above compound, 4.07g hydrogen, 24.27g carbon and 71.65g chlorine are present.	½ ½ ½ ½ 1

	Step 2. Convert into number moles of each element Divide the masses obtained above by respective atomic masses of various elements. This gives the number of moles of constituent elements in the compound Moles of hydrogen =4.07 g/1.008g = 4.04 Moles of carbon = 24.27 g/12. 01g = 2 .021 Moles of chlorine = 71.65g/ 35 453 g = 2 021 Step 3. Divide each of the mole values obtained above by the smallest number amongst them Since 2.021 is smallest value, division by it gives a ratio of 2:1:1 for H:C:Cl . In case the ratios are not whole numbers, then they may be converted into whole number by multiplying by the suitable coefficient. Step 4. Write down the empirical formula by mentioning the numbers after writing the symbols of respective elementsCH_2Cl is, thus, the empirical formula of the above compound. Step 5. Writing molecular formula (a) Determine empirical formula mass by adding the atomic masses of various atoms present in the empirical formula. For CH_2Cl, empirical formula mass is 12.01 + (2 × 1.008) + 35.453 = 49.48 g (b) Divide Molar mass by empirical formula mass 98.96/49.48 = 2 = (n) (c) Multiply empirical formula by n obtained above to get the molecular formula Empirical formula = CH_2Cl, n = 2. Hence molecular formula is $C_2H_4Cl_2$.	3
27.	(a) 5f -orbital (b) Balmer Series (c) splitting of spectral lines in presence of magnetic field (fine splitting)	1 1 1
28.	a)The ionisation enthalpy is for 1 mole atoms. Therefore, ground state energy of the , atoms may be expressed as E (ground state) = (– 2.18 x 10-18 J) x(6.022 x 1023 mol-1)= -1.312 x 106 J mol-1 Ionisation enthalpy =E∞–E ground state = 0-(-1.312 x 106mol-1) = 1.312 x 106 J mol-1. b) electronic configuration =(n – 1) d^{1-10} ns^{1-2}	1 1 1
29.	a) Because of two lone pairs of electrons on O-atom, repulsion on bond pairs is greater in H_20 in comparison to NH_3 . Thus, the bond angle is less in H_20 molecules. b)  c) the net dipole moment of CO_2 molecule is zero	1 1 1
30.	(a) $H_2O(g)$ will have greater entropy. (b) at equilibrium ΔG° is zero (c) A state function is a thermodynamic property that depends upon the state of the system and is independent of the path followed to bring about the change. Internal	1 1 1

<table>
<tr><td></td><td>energy change (ΔU), enthalpy change (ΔH) entropy change (ΔS), and free energy change (ΔG) are examples.
OR
Entropy is a measure of randomness of a system
Any one example to show (as per NCERT book) that entropy is an extensive property .</td><td>1
2</td></tr>
<tr><td>31.</td><td>a) when the matter is moving it shows the wave properties (like interference, diffraction etc.) are associated with it and when it is in the state of rest then it shows particle properties
$\lambda = h/mv$
(b) Balmer series .
(c)
<table>
<tr><th>Emission Spectrum</th><th>Absorption Spectrum</th></tr>
<tr><td>1. Emission spectrum is obtained when radiations emitted by the excited substance are analyzed in a spectroscope.</td><td>1. Absorption spectrum is obtained when the white light is first passed through the substance (in a gaseous state or in solution) and the transmitted light is analyzed in a spectroscope.</td></tr>
<tr><td>2. Emission spectrum consists of bright colored lines separated by dark spaces.</td><td>2. Absorption spectrum consists of dark lines in an otherwise continuous spectrum.</td></tr>
</table></td><td>1
1
2</td></tr>
<tr><td>32.</td><td>a) more repulsions(VSEPR Theory)
b) trigonal bipyramidal
c)(i) The orbitals present in the valence shell of the atom are hybridised.
(ii) The orbitals undergoing hybridisation should have almost equal energy.
(iii) Promotion of electron is not essential condition prior to hybridisation.
(iv) It is not necessary that only half filledorbitals participate in hybridisation. Insome cases, even filled orbitals of valence shell take part in hybridisation
(ANY TWO)</td><td>1
1
2</td></tr>
</table>

33.	(a) It states that it is impossible to determine simultaneously, the exact position and	1
	exact momentum (or velocity) of an electron. It is significant only for microscopic	
	objects.	1
	(b) The maximum no. of emission lines = $n(n-1)2 = 6(6-1)2 = 3 \times 5 = 15$	1
	(c) Orbitals having same energy.	
	(d Cosmic rays > X-rays > radio waves.	1
	OR	1
	(a) (i) Aufbau Principle: In the ground state of the atoms, the orbitals are	
	filled in the order of their increasing energies	1
	(ii) Pauli Exclusion Principle: An orbital can have maximum of two	
	electrons and these must have opposite signs.	
	(iii) Hund’s Rule of Maximum Multiplicity: Electron pairing in p, d	1
	and/orbitals cannot occur until each orbital of a given subshell	
	contains one electron each or is single occupied.	1
	(b) **(i)** For n = 4 ; No. of sub-shells = (l = 0, l = 1, l = 2, l = 3) = 4.	
	(ii) Total number of orbitals which can be present = $n^2 = 4^2 = 16$.	
	Each orbital can have an electron with m_s = – 1/2 -‘. Total no. of electrons with m, =	1
	– 1/2 is 16	
34..	a) O_2— Bond order = 2, paramagnetic	½
	O_2^+— Bond order = 2.5, paramagnetic	½
	O_2^-— Bond order = 1.5, paramagnetic	½
	O_2^{2-} — Bond order = 1, diamagnetic	½
	Order of relative stability is	
	$O_2^+ > O_2 > O_2^- > O_2^{2-}$	1
	(2.5) (2.0) (1.5) (1.0)	
	b)	1
	i) in C_2H_2, Sigma bond = 3 Π bonds = 2	
	(ii) in C_2H_4, sigma bonds=5, pi bond = 1	1
	OR	
	a)	
		1
	Oribital picture of ethene molecule	1
		
	Oribital picture of ethyne molecule	

	b) in NH3, the dipole moments of the three N—H bonds are in the same direction as the lone pair of electron. But in NF_3, the dipole moments of the three N—F bonds are in the direction opposite to that of the lone pair. Therefore, the resultant dipole moment in NH_3 is more than in NF_3. c) E.C. of Be $= 1s^2\ 2s^2$ M.O.E.C. of Be_2 $= \sigma^2 1s\ \sigma^{*2} 1s\ \sigma^2 2s\ \sigma^{*2} 2s$ Bond order $= \frac{1}{2}(4-4)$ $= 0$ Hence, Be_2 does not exist. d)  sp3d hybridisation *Trigonal bipyramidal geometry of PCl_5 molecule*	1 1 1
35.	Answer: (a) The element V has highest first ionization enthalpy (Δ iH1) and positive electron gain enthalpy (b) The element II (c) The element III which has high first ionization enthalpy (d) The element IV has a high negative electron gain enthalpy (ΔegH) (e) The element VI has low first ionization	1 1 1 1 1

KENDRIYA VIDYALAYA SANGATHAN
SAMPLE PAPER 4 -2024-2025
CLASS :- XI SUBJECT :- CHEMISTRY THEORY

Time:- 3 Hours Max Marks:70

General Instructions:

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

(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.

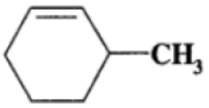
(e) SECTION D consists of 2 case - based questions carrying -4 marks each.

(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

Q 1	The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound? a) $C_9H_{18}O_9$ b) CH_2O c) $C_6H_{12}O_6$ d) $C_2H_4O_2$	1
Q 2	Number of angular nodes for 4d orbital is __________. (a) 4 (b) 3 (c) 2 (d) 1	1
Q 3	Which of the following atoms or atom/ion have identical ground state configuration? (a) Li^+ and He^+ (b) Cl^- and Ar (c) Na and K d) F^+ and Ne	1
Q 4	Find the oxidation state of I in $H_4IO_6^-$ (a) +7 (b) +5 (c) +1 (d) –1	1
Q 5	The quantum number m of a free gaseous atom is associated with: (a)The effective volume of the orbital (b) The shape of the orbital (c)The spatial orientation of the orbital (d)The energy of the orbital in the absence of the magnetic field.	1
Q 6	The Vander Waal's radii of O, N, Cl, F and Ne increase in the order (a) F, O, N, Ne, Cl (b) N, O, F, Ne, Cl (c) Ne, F, O, N, Cl (d) F, Cl, O, N, Ne	1
Q 7	For the same value of n, the penetration power of orbital follows the order (a) $s = p = d = f$ (b) $p > s > d > f$ (c) $f < d < p < s$ (d) $s < p < d < f$	1
Q 8	When NH_4Cl is added to NH_4OH solution the dissociation of ammonium hydroxide is reduced. It is due to: (a) common ion effect (b) hydrolysis (c) oxidation (d) reduction	1
Q 9	The pKa of acetic acid and pKb of ammonium hydroxide are 4.76 and 4.75 respectively. The pH of ammonium acetate solution will be (a)6.0 (b) 6.05 (c)7.05 (d)7.005.	1
Q10	Which one is the correct order of acidity? (a) $CH_2{=}CH_2 > CH_3\text{-}CH{=}CH_2 > CH_3C{\equiv}CH > CH{\equiv}C$ (b) $CH{\equiv}CH > CH_3\text{-}C{\equiv}CH > CH_2{=}CH_2 > CH_3CH_3$ (c) $CH{\equiv}CH > CH_2{=}CH_2 > CH_3\text{-}C{\equiv}CH > CH_3\text{-}CH_3$ (d) $CH_3\text{-}CH_3 > CH_2{=}CH_2 > CH_3\text{-}C{\equiv}CH > CH{\equiv}CH$	1
Q11	The I.U.P.A.C. name of 	1

	(a) 3–Methyl cyclohexene (b) 1–methyl cylohex–2–ene. (c) 6–methyl cyclohexene (d) 1–methyl cyclohex5–ene.	
Q12	Arrange the following in decreasing order of their boiling points. (A) n–butane (B) 2–methylbutane (C) n-pentane (D) 2,2–dimethylpropane a) A > B > C > D b) B > C > D > A c) D > C > B > A d) C > B > D > A	1
Q13	Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below. (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion. b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion (c) Assertion is correct, reason is incorrect (d) Assertion is incorrect, reason is correct. Assertion A: An orbital cannot have more than 2 electrons and their spin must be opposite. Reason R: No two electrons in an atom can have same set of all four quantum numbers.	1
Q14	Assertion A: F atom has a less negative electron affinity than Cl atom. Reason R: Additional electrons are repelled more effectively by 3p electron in Cl atom than by 2p electrons in F atom.	1
Q15	Assertion A: Tertiary carbonations are generally formed more easily than primary carbocations. Reason R: Hyperconjugation as well as inductive effect due to additional Alkyl groups stabilize tertiary carbocations	1
Q16	Assertion A: Addition of HBr on in presence of peroxide give as major product. Reason R: Addition of HBr on alkene proceed by carbocation intermediate.	1

SECTION B

Q17	Write the empirical formula of the following: (a)N_2O_4 (b)$_6H_{12}O_6$ (c) H_2O (d) H_2O_2	2
Q18	An atom of an element contains 29 electrons and 35 neutrons. Deduce (i) number of protons. (ii) electronic configuration of the element. (iii) number of paired electrons. (iv) number of unpaired electrons.	2
Q19	Which out of CH_3F and CH_3Cl has a higher dipole moment and why?	2
Q20	Given: $N_2(g) + 3H_2(g)$□□$2NH_3(g)$, $\Delta H_0 = –92.4KJ.mol^{–1}$. What is the standard enthalpy of formation of $NH_3(g)$.	2
Q21	Explain Why $(CH_3)_3 –C^+$ is more stable than CH_3-$CH_2{}^+$ and $CH_3{}^+$ is the least stable cations. **OR** Give the number of sigma and pi bond in the following molecules a) CH_3-NO_2 b) $HCONHCH_3$	2

SECTION C

Q 22	Yellow light emitted from a sodium lamp has a wavelength (λ) of 580 nm. Calculate the frequency (v) and wave number of yellow light.	3

Q 23	Among the elements of the second period Li to Ne pick out the element: (i) with the highest first ionisation energy (ii) with the highest electronegativity (iii) with the largest atomic radius Give the reason for your choice.	1+ 1+ 1
Q 24	Calculate the number of kJ of heat necessary to raise the temperature of 60.0 g of aluminium from 35°C to 55°C. Molar heat capacity of Al is 24 J mol^{-1} K^{-1}.	3
Q 25	Identify the oxidizing and reducing agents in the following equations: **(any 3)** (i) $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$ (ii)$H_2 + Cl_2 \rightarrow 2HCl$ (iii) $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$ (iv) $3Fe_3O_4$ (s) + 8 Al (s) → 9 Fe (s) + 4 Al_2O_3 (s)	1+ 1+ 1
Q 26	a) What are electrophiles? Give an example. b) What is the functional group of an aldehyde and an nitro compound. c) What is the state of hybridization of carbon atom in CH3-CH=CH-CH3.	1+ 1+ 1
Q 27	a) 0.546 g of silver Bromide is obtained from 0.5372 g of an organic .compd. Calculate the percentage of Bromine. (At. mass Br=80g/mol Ag =108g/mol) b) How is the presence of chlorine detected in an organic compound? **OR** Distinguish between inductive effect and resonance effect.	2+ 1
Q 28	Draw the cis- and trans-structures for hex-2-ene. Which isomer will have higher b.p and why?	3

SECTION D

Q 29	Many a time, reactions are carried out with the Amounts of reactants that are different than The amounts as required by a balanced chemical reaction. In such situations, one Reactant is in more amount than the amount required by balanced chemical reaction. The reactant which is present in the least amount gets consumed after sometime and after that further reaction does not take place whatever be the amount of the other reactant. Hence, the reactant, which gets consumed first, limits the amount of product formed and is called the limiting reagent. In performing stoichiometric calculations, this aspect is also to be kept in mind. A majority of reactions in the laboratories are carried out in solutions. Therefore, it is important to understand as how the amount of substance is expressed when it is present in the form of a solution. The concentration of a solution or the amount of substance present in its given volume can be expressed in molarity, molality, mass %,mole fraction. Concentration of reactants can be measured a) How are 0.2 mol NaOH and 0.2 M NaOH diffferent? b) How do temperature affect molarity? c) Calculate the amount of carbon dioxide that could be produced when 2 moles of carbon are burnt in 16 g of dioxygen. **OR** c) Chlorine is prepared in the laboratory by treating manganese dioxide(MnO_2) with aqueous hydrochloric acid according to the reaction. 4 HCl (aq)+MnO_2(s)————> 2 H_2O (l) +$MnCl_2$(aq)+Cl_2(g) How many grams of HCl react with 5.0gof manganese dioxide?(Atomic mass Of Mn=55u)	1 1 2
Q 30	Thermodynamics deals with energy changes in chemical or physical processes and enables us to study these changes quantitatively and to make useful predictions.	

	Chemical reactions are generally carried out at constant pressure. In thermodynamics, extensive & intensive properties can be observed. Values of some properties depend upon the quantity of matter present in a system while others do not depend upon. We also measure the heat transferred to a system. The increase of temperature is proportional to the heat transferred. The magnitude of the coefficient depends upon the size, composition and nature of the system. Change can be found out from the heat changes at constant pressure while entropy is a measure of degree of randomness. For a spontaneous process, total entropy change is positive. Answer the following questions: i) For an isolated system, $\Delta U = 0$ what will be ΔS? ii) Which of the following is an extensive property? (a) Volume (b) temperature (c) pressure (d) density iii) Derive the relation between Cp and Cv for an ideal gas **OR** iii) Identify the state functions and path functions out of the following : enthalpy, entropy, heat, temperature, work, free energy.	1 1 2

SECTION E

Q 31	What is meant by hybridisation of atomic orbitals? Describe the shapes of sp, sp2, sp3 hybrid orbitals. Name the shapes of the following molecules: CH_4, CO_2. **OR** What is meant by the term bond order? Calculate the bond order of N_2, O_2, O_2^{+}, O_2^{-}	5
Q 32	(i) What is Le Chatelier's principle? (ii) A solution of NH_4Cl in water shows pH less than 7.why? (iii) What is the effect of increasing pressure in the given reactions? Give reasons. (a)$PCl_5(g) \rightleftharpoons PCl_3(g)+Cl_2(g)$ (b)$N_2(g)+O_2(g) \rightleftharpoons 2NO(g)$ (iv) Which of the following are lewis acids?H_2O, BF_3,H^+,NH^{4+}. **OR** a.Calculate the pH of sample of a soft drink whose hydronium ion concentration is 3.8 X 10^{-3}M. (log 3.8 = 0.589) b. Explain - Buffer Solution, give one example for each type c.What is heterogeneous equilibrium , give one example	1 1 2 1 2 2 1
Q 33	Explain **any five** of the following with equation. (i) Decarboxylation reaction.. (ii) Polymerisation. (iii) Friedal craft s alkylation (iv) Elimination reaction. (v) Nitration of benzene. (vi) Wurtz reaction (vii) Nucleophilic substitution reaction	5

SAMPLE PAPER 5 CLASS XI

CHEMISTRY THEORY (043)

M M:70 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

***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. The peroxide effect proceeds via formation of—

a) carbocation
b) carbene
c) carbanion
d) free radical

2. In which of the following options does the order of arrangement not agree with the variation of property indicated against it?

a) $Al^{3+}<Mg^{2+}<Na^{+}<F^{-}$(increasing ionic size)
b) B<C< N<O (increasing first ionization enthalpy)
c) I <Br<F<Cl (increasing electron gain enthalpy)
d) Li<Na<K< Rb (increasing metallic radius)

3. When heat capacity(C) is large for a substance then:

a) A given amount of heat results in greater rise in temperature of a substance.
b) A given amount of heat results only in small rise in temperature of a substance.
c) Initially there is greater rise and decreases subsequently.
d) Temperature rise is not related to heat capacity.

4. In sulphur estimation, 0.24 g of an organic compound gave 0.48g of barium sulphate. Calculate the percentage of sulphur in the compound.

a) 2.746
b) 2.074

c) 27.46
d) 28.46
5. Select the non-polar molecule:
a) H_2O.
b) BF_3
c) NH_3
d) O_3
6. Which of the following cannot act as reducing agent?
a) ClO^-
b) ClO_2^-
c) ClO_3^-
d) ClO_4^-
7. Choose the compound that cannot be prepared by Kolbe’s electrolytic method:
a) Ethane
b) Butane
c) Methane
d) Hexane

8. Which of the following reactions is not an example of redox reaction:
a) $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
b) $2NaH(s) \rightarrow 2Na(s) + H_2(g)$
c) $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$
d) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

9. Brown colour gas NO_2 dimerises into a colourless gas N_2O_4 given by following reaction

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -57.2 \text{ KJMOL-1}$$

The intensity of brown colour in there action mixture can be increased by

a) increasing temperature
b) Decreasing pressure
c) Decreasing temperature
d) Both (a) and(b)

10. Select the compound that will show Cis -Trans isomerism:
a) $(CH_3)_2C{=}CH{-}C_2H_5$
b) $C_6H_5CH{=}CH{-}CH_3$
c) $CH_3CH{=}C(Cl)_2$
d) $Br_2C = C\,ClCH_3$

11. Identify the organic compound synthesized from an inorganic compound, ammonium cyanate, by F.Wohler.
a) Acetic acid
b) Methane
c) Urea
d) Methanol

12. Enthalpy of which of the following reactions represents the heat of formation of Carbon Dioxide.

a) $CH_4(g)+O_2(g) \rightarrow CO_2(g)+H_2O(g)$
b) $C(s)+1/2O_2(g) \rightarrow CO_2(g)$
c) $2C(s)+ 2O_2(g) \rightarrow 2CO_2(g)$
d) $C(s)+2O(g) \rightarrow CO_2(g)$

Question number 13 to16 are assertion reason types. Given below are two statements labelled as

Assertion(A)and Reason (R) select the most appropriate answer from the options 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 true but R is false.
d) A is false but R is true.

13. **Assertion(A)**: LiF has more covalent character than KF.
Reason(R): According to Fajan's rule, the smaller cation has less polarising power.

14. **Assertion(A)**:Increasing order of acidity of hydrogen halides is HF > HCl > HBr >HI
Reason(R): While comparing acids formed by the elements belonging to the same group of the periodic table, H–A bond strength is a more an important factor in determining the acidity of acid than the polar nature of the bond.

15. **Assertion(A)**: Carbocation always has planar geometry.
Reason(R): Carbon bearing positive charge is SP^3 Hybridised.

16. **Assertion**: The empirical mass of acetic acid is half of its molecular mass.
Reason: The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

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. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement.

18. a) Aluminium form $[AlF_6]^{3-}$ while Boron does not form$[BF_6]^{3-}$.
b) Assign the position of the element having atomic number 117.

19. Is Decrease in enthalpy, acriterion for spontaneity? Illustrate with an example.
20. Balance the following reactions:

$MnO_4^- + SO_3^{2-} + H^+ \rightarrow Mn^{2+} + SO^{2-} + H_2O$ (Acidic medium)

OR

$MnO_4^-(aq.) + I^-(aq.) \rightarrow MnO_2(s) + I_2(s)$ (Basic medium)

21. $FeCO_3(s)$ decomposes at constant pressure as $FeO(s) + CO_2(g)$ $FeCO_3(s) \xrightarrow{\Delta} FeO(s) + CO_2(g)$ at 25°C, The heat absorbed during the reaction is 80kJ. Calculate ΔH &ΔU for the reaction.

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. Commercially available concentrated HCI contains 36.5% HCI by mass.
a) What is the molarity of this solution? The density is 1.10g/mL?
b) What volume of concentrated HCl is required to make 1L of 0.10M HCl?

23. Account for the following:
a) MgO is a basic oxide and SO_2 is an acidic oxide.
b) Second Ionization enthalpy of sodium is more than that of second ionization enthalpy of Magnesium.
c) Lithium unlike other alkali metals form compounds with pronounced covalent character.

24. a) During the hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you, Which identification technique can give the best results?
b) A solution of potassium hydroxide is used to absorb carbon dioxide evolved during the estimation of carbon present in an organic compound. Give reason.

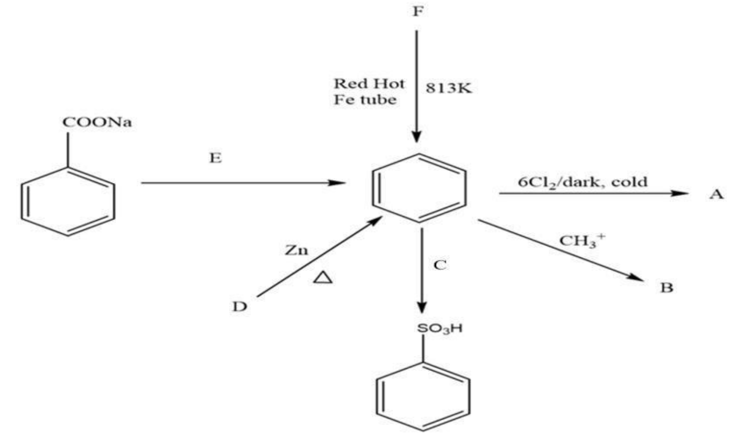
OR

Isomeric pentanes do not boil at same temperature. Justify Attempt **any two** questions.

25. According to deBroglie, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a bowler at a speed of 100 km/h. Calculate the wavelength of the ball and explain why it does not show wave nature.

26. 500 cm^3 of 0.200 M NaCl solution is added to 100 cm^3 of 0.500M $AgNO_3$ solution resulting in the formation of white precipitate of insoluble AgCl. How many moles and how many grams of AgCl are formed? Which is the limiting reagent?

27. Depict the structure of A-F.



28. a) Explain how reversible worked one is more than irreversible work done.
 b) Mass and volume both are extensive properties but density is an intensive property. Explain.

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. The photoelectric effect was discovered in 1887 by the German physicist Heinrich Rudolf Hertz. Inconnection with work on radiowaves, Hertz observed that, when ultraviolet light shines on two metal electrodes with a voltage applied across them, the light changes the voltage at which sparking takes place. This relation between light and electricity (hence *photoelectric*) was clarified in 1902 by another German physicist, Philipp Lenard. He demonstrated that electrically charged particles are liberated from a metal surface when it is illuminated and that these particles are identical to electrons, which had been discovered by the British physicist Joseph John Thomson in 1897. Further research by other physicist such as Einstein showed that the photoelectric effect represents an interaction between light and matter that cannot be explained by classical physics, which describes light as an electromagnetic wave

Answer the following questions.

a) Can light of any frequency cause a photoelectric effect? Give reason for your answer.
b) What is the meaning of intensity of light? What is the relationship between the intensity of light and photoelectric current?
c) Define Threshold frequency.What happens to the extra energy if a frequency higher than the threshold frequency is used?

OR

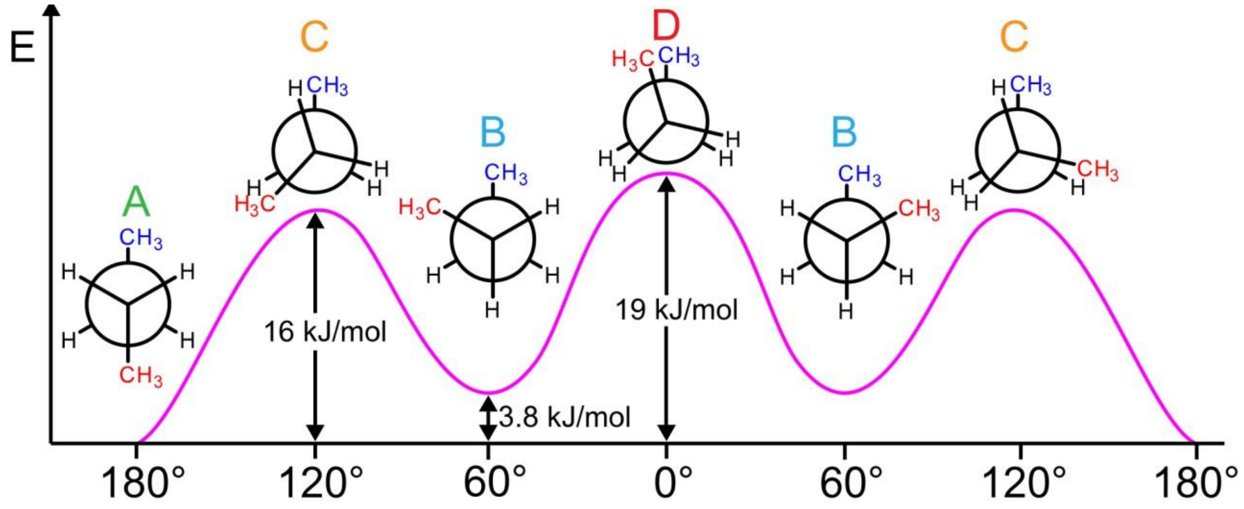
Observe the table given below carefully.

Metal	Li	Na	K	Cs	Mg	Cu	Ag

W_o/eV	2.42	2.3	2.25	1.9	3.7	4.8	4.3

Which metal will be most suitable for a photo electric cell. Give reason to support your answer.

30. Conformational isomerism is a form of stereoisomerism in which the isomers can be interconverted just by rotations about formally single bonds. The energies of different conformers changing with dihedral angles can be depicted by the following graph:



Based on your analysis of the graph, answer the following questions:

a) Select the isomer with maximum magnitude of torsional strain.
b) Identify the type of Rotamers shown as C and D.
c) Draw and label the two extreme forms of Newman projection of Ethane.

OR

Draw and label the two extreme forms of Sawhorse projections of Ethane.

SECTION E

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

31. Attempt any five of the following:
a) Explain Inductive effect.
b) Which electron displacement effect is responsible for o/p directive nature of toluene?
c) Write Structural formula of 4-Oxopentanal.

Give specific term for the ratio of distance travelled by one component of a mixture to distance travelled by solvent in separation techniques.

d) $(CH3)3C^{+}$ is more stable than $CH3CH2^{+}$and $CH3^{+}$is the least stable cation. Give appropriate reason.

e) In Which of the following compounds, presence of Nitrogen cannot be detected by Lassaigne's test
NH_2NH_2, CH_3NH_2, $C_6H_5NO_2$, CH_3CONH_2

32. (a) What is common ion effect? What will be the effect of extent of ionization of H_2S in the HCI solution?
(b) The solubility of $BaSO_4$ in water is 8×10^{-5}mol dm^{-3}, calculate its solubility in 0.01 mol dm^{-3} of H_2SO_4.

OR

(a)Arrange the following in decreasing order of the property indicated:

OH^-, RO^-, CH_3COO^-,Cl^- [basic strength]

KNO_3(aq), CH_3COONa (aq), NH_4Cl (aq) [pH]

(b)Calculate the pH of 0.08M solution of Hypochlorous acid HOCl . The ionization constant of the acid is 2.0×10^{-5}. Determine the percentage dissociation of HOCl. [log1.26= 0.10037]

33. (a) Consider the given molecules and identify the molecules with sp^3 hybridisation:
NH_3, BCl_3, H_2O, SF_4, XeF_4 and ClF_3.

(b)Draw Molecular orbital diagram to explain the paramagnetic nature of Oxygen. Calculate the bond order.

OR

(a)Differentiate between the shape and geometry of BrF_3 molecule using structure, on the basis of VSEPR theory.
(b) Show Lewis representation of Ozone molecule and calculate formal charge on each oxygen.

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