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**CLASS: XI (CUMULATIVE EXAMINATION 2023-24)**

**SUBJECT: CHEMISTRY THEORY (043)**

**DURATION: 3 Hrs**

**MAXIMUM MARKS: 70**

***General Instructions:***

***Read the following instructions carefully.***

- a) There are 33 questions in this question paper with internal choice.***
- b) SECTION A consists of 12 multiple-choice questions carrying 1 mark each.***
- c) SECTION B consists of 4 assertion reasons-based questions carrying 1 mark each.***
- d) SECTION C consists of 5 very short answer questions carrying 2 marks each.***
- e) SECTION D consists of 7 short answer questions carrying 3 marks each.***
- f) SECTION E consists of 2 case- based questions carrying 4 marks each.***
- f) SECTION F consists of 3 long answer questions carrying 5 marks each.***
- g) All questions are compulsory. However, internal choice is given in question number 28 & 32.***
- h) Use of log electronic gadgets and calculators are 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 total number of ions present in 111 g of  $\text{CaCl}_2$  is**
  - (a) One Mole
  - (b) Two Mole
  - (c) Three Mole
  - (d) Four Mole
- 2. A measured temperature on Fahrenheit scale is 200F. What will this reading be on the Celsius Scale?**
  - (a) 40  $^{\circ}\text{C}$
  - (b) 94  $^{\circ}\text{C}$
  - (c) 93.3  $^{\circ}\text{C}$
  - (d) 30  $^{\circ}\text{C}$
- 3. Which of the following pairs represents isobars?**
  - (a)  $^3\text{He}_2$  and  $^4\text{He}_2$
  - (b)  $^{24}\text{Mg}_{12}$  and  $^{25}\text{Mg}_{12}$
  - (c)  $^{40}\text{K}_{19}$  and  $^{40}\text{Ca}_{20}$
  - (d)  $^{40}\text{K}_{19}$  and  $^{39}\text{K}_{19}$
- 4. Principal, Azimuthal and magnetic quantum numbers are respectively related to:**
  - (a) Size, shape and orientation
  - (b) Shape, size and orientation
  - (c) Size, orientation and shape
  - (d) None of the above

5. The electronic configuration of chromium ( $Z=24$ ) is:  
(a)  $[\text{Ne}] 3s^2 3p^6 3d^4 4s^2$   
(b)  $[\text{Ne}] 3s^2 3p^6 3d^5 4s^1$   
(c)  $[\text{Ne}] 3s^2 3p^6 3d^1 4s^2$   
(d)  $[\text{Ne}] 3s^2 3p^6 4s^2 4p^4$
6. The element with atomic number 26 will be found in group:  
(a) 2  
(b) 8  
(c) 6  
(d) 10
7. The elements of group 17 are called———  
(a) noble gases  
(b) chalcogens  
(c) halogens  
(d) alkali metals
8. The total number of sigma (s) and pi (p) bonds in ethene molecule is  
(a) 1 sigma (s) and 2 pi (p) bonds  
(b) 3 sigma (s) and 2 pi (p) bonds  
(c) 4 sigma (s) and 1 pi (p) bonds  
(d) 5 sigma (s) and 1 pi (p) bonds
9. The ion which is iso-electronic with CO is —————  
(a)  $\text{N}_2^+$   
(b)  $\text{O}_2^-$   
(c)  $\text{CN}^-$   
(d)  $\text{O}_2^+$
10. In which of the following process, a maximum increase in entropy is observed.  
(a) Dissolution of Salt in Water  
(b) Condensation of Water  
(c) Sublimation of Naphthalene  
(d) Melting of Ice
11. Internal energy of a substance/system is  
(a) State function  
(b) Path function  
(c) Neither state function nor path function  
(d) Both state function as well as path function
12. In a group of the periodic table the Ionization enthalpies of the elements decreases from top to bottom because of —————  
(a) increase in densities  
(b) decrease in chemical reactivities  
(c) increase in atomic sizes  
(d) decrease in electronegativities

### SECTION B (Assertion and Reason based Questions)

*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.

**13. Assertion:** One atomic mass unit is defined as one twelfth of the mass of one carbon-12 atoms.

**Reason:** Carbon-14 isotope is the most abundant isotope of carbon and has been chosen as standard.

**14. Assertion:** According to Mendeleev, periodic properties of elements is a function of their atomic number.

**Reason:** Atomic number is equal to the number of protons.

**15. Assertion:** Entropy of system increases for a spontaneous reaction.

**Reason:** Enthalpy of reaction always decreases for spontaneous reaction.

**16. Assertion:** Shape of  $\text{NH}_3$  molecule is tetrahedral.

**Reason:** In  $\text{NH}_3$  nitrogen is  $\text{sp}^3$  hybridized.

### SECTION C (Very Short Answer Type Questions)

**17.** What is the law of multiple proportion explain with one example?

**18. (a)** What is IUPAC name and symbol of atomic number 120?

(b) Explain Diagonal relationship.

**19.** Among the elements B, Al, C and Si,

(i) which element has the highest first ionisation enthalpy?

(ii) which element has the most metallic character?

Justify your answer in each case.

**20. (a)** What is First Law of Thermodynamics explain?

(b) Calculate the work done when an ideal gas expands from 2L to 4L isothermally into vacuum?

**21.** The enthalpy of atomisation for the reaction  $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$  is  $1665 \text{ kJ mol}^{-1}$ . What is the bond energy of C–H bond?

### SECTION D (Short Answer Type Questions)

**22.** A compound contains 4.07 % hydrogen, 24.27 % carbon and 71.65 % chlorine. Its molar mass is 98.96 what are its empirical and molecular formula?

**23.** If 4 g of NaOH dissolves in 36 g of  $\text{H}_2\text{O}$ , calculate the mole fraction of each component in the solution. Also, determine the molarity of solution (specific gravity of solution is  $1 \text{ g ml}^{-1}$ )

**24. i.** How does metallic character change in a group?

ii. Explain why cations are smaller and anions are larger in radii than their parent atom?

**25.** Indicate the number of unpaired electrons in:

(a)P (b)Si (c)Cr (d)Fe (e)Kr (f)Cl

(Atomic No, P=15, Si=14, Cr=24, Fe=26, Kr=36, Cl=17)

26. (a) Why does nitrogen have higher ionisation energy than oxygen?  
(b) Why is the electron gain enthalpy of chlorine more negative than fluorine?  
(c) Why do noble gases have zero electron gain enthalpy values?

27. (a) Among  $\text{NH}_3$  and  $\text{NF}_3$  which one has higher dipole moment and why ?  
(b) Why  $\text{H}_2\text{O}$  is a liquid while  $\text{H}_2\text{S}$  is a gas?

28. (a) Define lattice energy.

- (b) What is Born-Haber cycle and How does it helps in calculating the lattice energy?

**OR**

- (a) What do you mean by heat capacity?  
(b) Derive the relation between  $C_p$  and  $C_v$ ?

### **SECTION E (Case-based Answer Type Questions)**

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

Orbitals are regions or spaces where there is a 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 the probability of finding the electron is maximum. Atomic orbitals can be distinguished by quantum numbers. Each orbital is designated by three quantum numbers  $n$ ,  $l$ , and  $m_l$  (magnetic quantum number) which define energy, shape, and orientation but these are not sufficient to explain spectra of multi-electrons atoms. Spin quantum number ( $m_s$ ) determines the spin of electrons. Spin angular momentum of the electron has two orientations relative to the 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?  
(d) What is the shape of 's' and 'p' orbitals?

30. In chemistry, orbital hybridisation (or hybridization) is the concept of mixing atomic orbitals to form new hybrid orbitals (with different energies, shapes, etc., than the component atomic orbitals) suitable for the pairing of electrons to form chemical bonds in valence bond theory. For example, in a carbon atom which forms four single bonds the valence-shell s orbital combines with three valence-shell p orbitals to form four equivalent  $sp^3$  mixtures in a tetrahedral arrangement around the carbon to bond to four different atoms. Hybrid orbitals are useful in the explanation of molecular geometry and atomic bonding properties and are symmetrically

disposed in space. Usually hybrid orbitals are formed by mixing atomic orbitals of comparable energies. Hybrid orbitals are assumed to be mixtures of atomic orbitals, superimposed on each other in various proportions. For example, in methane, the C hybrid orbital which forms each carbon-hydrogen bond consists of 25% s character and 75% p character and is thus described as  $sp^3$  (read as s-p-three) hybridised.

1. Isostructural species are those which have same shape and hybridization. Among the following species identify the isostructural pair
  - a.  $NF_3$  and  $BF_3$
  - b.  $BF_4^-$  and  $NH_4^+$
  - c.  $BCl_3$  and  $BrCl_3$
  - d.  $NH_3$  and  $NO_3^-$
2. The types of hybrid orbitals of nitrogen in  $BF_3$ ,  $BeCl_2$  and  $CH_4$  respectively are expected to be
  - a.  $sp$ ,  $sp^2$  and  $sp^3$
  - b.  $sp$ ,  $sp^3$  and  $sp^2$
  - c.  $sp^2$ ,  $sp$  and  $sp^3$
  - d.  $sp^3$ ,  $sp^2$  and  $sp$
3. Which of the following angle corresponds to  $sp^2$  hybridization?
  - a.  $90^\circ$
  - b.  $180^\circ$
  - c.  $120^\circ$
  - d.  $109^\circ$
4. In which of the following bond angle is  $109.5^\circ$ .
  - a.  $sp$
  - b.  $sp^2$
  - c.  $sp^3$
  - d.  $sp^3d$

### SECTION F (Long Answer Type Questions)

**31. (a)** Uncertainty in the position of an electron (mass =  $9.1 \times 10^{-31}$  kg) moving with a velocity of 300 m/s accurate upto 0.001% will be?

(b) Write the name of the spectrum series when electron jumps from  $n=6$  to  $n=3$ .

(c) What is the quantum number of last electron of sodium?

**32. (a).** Draw the molecular orbital diagram of  $O_2$ ? Write the bond order of  $O_2$ .

(b). Arrange the given species in the decreasing order of stability  $O_2$ ,  $O_2^-$ ,  $O_2^+$ , and  $O_2^{2-}$ .

**OR**

(a). Define the term hybridization and explain the shape and geometry of  $ClF_3$  and  $SF_4$ ?

(b). Identify the hybridisation of the underlined atom.

(i)  $\underline{P}Cl_5$       (ii)  $H_2\underline{O}$       (iii)  $\underline{S}F_6$       (iv)  $\underline{B}F_3$

**33. (a)** What is Hess's law explain?

(b). Calculate the enthalpy of combustion of benzene from the following data

(i)  $6C(s) + 3H_2(g) \rightarrow C_6H_6(l)$ ;  $\Delta H = +45.9$  kJ

(ii)  $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ ;  $\Delta H = -285.9$  kJ

(iii)  $C(s) + O_2(g) \rightarrow CO_2(g)$ ;  $\Delta H = -393.5$  kJ

**OR**

(a), Differentiate the Extensive and intensive properties citing suitable example.

(b). Define enthalpy ? Prove the following relation  $\Delta H = \Delta U + \Delta nRT$

