2024/FYUG/EVEN/SEM/
CHMDSM–151T/085

FYUG Even Semester Exam., 2024

CHEMISTRY

(2nd Semester)

Course No. : CHMDSM–151T

(Fundamentals of Chemistry)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer any *ten* questions : 2×10=20

1. Find an expression for first radius of H-atom applying Bohr's theory.

2. Calculate the number of unpaired electrons in the following gaseous ions : ½×4=2

Mn^{3+}, Cr^{3+}, V^{3+}, Ti^{3+}

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3. An electron and a proton are moving with same velocity. Compare their wavelengths.

4. With the help of MOT, show that He_2 molecule does not exist but He_2^+ exists.

5. Draw the resonance structure of NO_3^- ion.

6. Using VSEPR theory, predict and draw the shapes of the following molecules : 1+1=2

   (a) SF_4

   (b) ClF_3

7. Write down the basic postulates of kinetic theory of gases.

8. State the law of corresponding states.

9. Write down the SI unit of the van der Waals' constants *a* and *b*.

10. Briefly discuss the effect of temperature on surface tension.

11. What is the physical significance of lattice point?

12. Explain a method of determination of viscosity of a liquid.

13. What do you mean by inductive effect?

14. Define electrophile and nucleophile with one example each. 1+1=2

15. Which of the following carbanions is most stable and why?

   (i) $CH_2=CH-\overset{\ominus}{C}H_2$

   (ii)

   (iii) $CH_3-\overset{\ominus}{C}H-CH_3$

SECTION—B

Answer any *five* questions : 10×5=50

16. *(a)* Write the Schrödinger wave equation for hydrogen atom and explain each term in the equation. 1+2=3

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(b) Designate the orbitals bearing quantum numbers : 1+1=2

(i) $n = 2, l = 1$

(ii) $n = 3, l = 2$

(c) State Heisenberg's uncertainty principle. 2

(d) The mass of a moving electron is $9 \cdot 11 \times 10^{-31}$ kg and its wavelength is 7·27 Å. Find out its velocity. 3

17. (a) Calculate the frequency, energy and wavelength of radiation corresponding to the spectral line of lowest frequency in Lyman series in the hydrogen spectrum. 1+1+1=3

(b) Discuss the significance of ψ and ψ^2. 2

(c) Write the electronic configurations of the elements chromium and copper. 1+1=2

(d) Deduce the expression for de Broglie's equation. 3

18. (a) Write down the basic postulates of valence bond (VB) theory. 3

(b) $[FeF_6]^{3-}$ has a magnetic moment of 5·92 BM. Explain on the basis of VBT. 2

(c) Write the MO electronic configuration of O_2 and draw the MO energy level diagram for O_2 molecule. Comment on its bond order and magnetic properties. 1+2+½+½=4

(d) How do you express bond strength in terms of bond order? 1

19. (a) What are bonding and antibonding molecular orbitals? 1+1=2

(b) Distinguish between a inner-orbital complex and an outer-orbital complex with examples. 3

(c) Draw the MO energy level diagram of CO molecule. Comment on its bond order and magnetic properties. 2+½+½=3

(d) What are high- and low-spin complexes? Give examples. 2

20. (a) Write down van der Waals' equation for n gm mole of a real gas. 2

(b) Critical density of a substance having molecular weight 111 is 0·555 gm-cm^{-3} and $P_c = 48$ atoms. Calculate van der Waals' constants a and b. 2

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(c) Write down the values of most probable velocity, average velocity and RMS velocity. Compare their results. 3

(d) What is mean free path? How does it vary with temperature and pressure? 1+2=3

21. (a) Calculate the kinetic energy of 1 gm-mole of hydrogen gas and also calculate the temperature for 16 gm of oxygen which will give same kinetic energy. 2+1=3

(b) What is compressibility factor? What is the nature of curve when compressibility factor plotted against pressure for H_2 gas at a constant temperature? 1+2=3

(c) What is collision number? How does it vary with temperature and pressure? 1+2=3

(d) What is co-volume or effective volume in van der Waals' gas? 1

22. (a) Explain the following terms : 1½+1½=3

(i) Crystal lattice

(ii) Coefficient of viscosity

(b) At 20 °C, toluene rises 2 cm in a capillary tube of radius 0·4 mm. Calculate the surface tension of toluene. Density of toluene at 20 °C is 0·9 gm-cm^{-3}. 2

(c) Write down the Stokes' equation for the determination of viscosity of a liquid and explain the terms involved in it. 3

(d) Draw and discuss different types of Bravais lattice for cubic system. 2

23. (a) What is the effect of temperature on viscosity of a liquid? 2

(b) Mention the characteristic features of Schottky and Frenkel defects. 1½+1½=3

(c) Calculate the number of atoms present per unit cell in different types of cubic unit cell. 2

(d) Write the principles of the drop weight method for determination of surface tension. 3

24. (a) Write the homolytic and heterolytic bond fission products of CH_3—C along the bond shown. 2

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(b) What are carbocations? Explain the hybridization and stability of carbocations. 1+2=3

(c) What are free radicals? Explain the relative stabilities of various types of free radical. 1+2=3

(d) Give one example each of—

(i) nucleophilic substitution reaction;

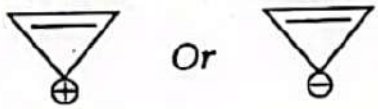
(ii) electrophilic addition reaction. 1+1=2

25. (a) What are carbanions? Explain, with orbital picture, the structure of methyl carbanion. 1+2=3

(b) What are carbenes? Write the different electronic states in which carbene exists. 1+2=3

(c) State Hückel's rule of aromaticity. 2

(d) Which ion in each of the following pair is more stable and why? 2



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