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WEST BENGAL STATE UNIVERSITY
B.Sc. Major 1st Semester Examination, 2023-24

CEMDSC101T-CHEMISTRY (MAJOR)

Time Allotted: 2 Hours

Full Marks: 50

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

GROUP-A

1. Answer any *ten* questions from the following:

$2 \times 10 = 20$

(i) Indicating the meaning of each term involved, write down the expression for energy (E) of an electron rotating in 'nth' Bohr orbit.

(ii) What are the values of four quantum numbers of the valence electron of sodium atom [Na = 11]?

(iii) Find out the number of unpaired electrons in the ground state of Mn^{4+} ($Z = 25$).

(iv) Describe two merits of Bohr model.

(v) State Pauli Exclusion principle.   2

(vi) Write IUPAC name and structure of A and B respectively.   2

(A)
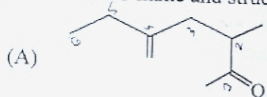
(B) 3-chloro-4-nitrilobutanoic acid   1+1

(vii) Calculate the D.B.E. of molecular formula $C_7H_6O_2$ and write one probable structure.   1+1

(viii) CH_3(methyl) radical is trigonal planar but CF_3 (trifluoromethyl) radical is pyramidal in shape. Explain.

(ix) Compare the acidity of salicylic acid and 4-hydroxy benzoic acid with reasons.

(x) Why orthonitrophenol is steam volatile while *p*-nitrophenol is not?

(xi) Write Van der Waals equation for n gm moles real gas.

(xii) Discuss the effect of temperature on the viscosity of a gas.   2

(xiii) Calculate the temperature at which root mean square speed of Helium is same as most probable speed of H_2 at 27°C.   2

(xiv) Critical temperature of a Van der Waals' gas is 126K. Calculate its Boyle temperature.   2

(xv) How does the mean free path of a gas molecule change on increasing the pressure by two times at constant temperature?   2

GROUP-B

Answer any *six* questions taking *two* questions from each unit

Unit-1

Answer any *two* questions

5×2 = 10

2. Write down the postulates of Bohr's theory for H-atom. Mention its limitations. How was it modified by Sommerfeld? 2+1+2

3. Write down the electronic configurations of Cu and Cr and hence find out the number of unpaired electrons for Cu^{+2} and Cr^{+3} ions. $1\frac{1}{2}+1\frac{1}{2}$ +1+1

4. (a) Calculate the wavelength associated with an electron having kinetic energy 5.76×10^{-15} J. Given: mass of electron, $m = 9.11\times10^{-31}$ kg and Planck's constant, $h = 6.626\times10^{-34}$ Js. 3
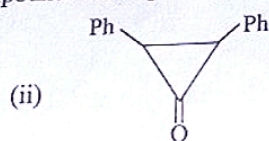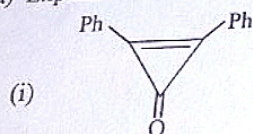
(b) State the electronic configuration of noble gas and discuss their position in the periodic table. 2
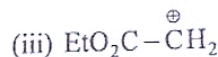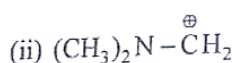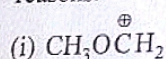
Unit-2

Answer any *two* questions

5×2 = 10

5. (a) Explain which of the following compounds has higher dipole moment. $2\frac{1}{2}$

Ph $\diagdown$ /Ph   Ph$\diagdown$ /Ph

(i)   (ii)

(b) Arrange the following carbocations in the order of increasing stability. Give reasons. $2\frac{1}{2}$

(i) $CH_3O\overset{\oplus}{C}H_2$ (ii) $(CH_3)_2N-\overset{\oplus}{C}H_2$ (iii) $EtO_2C-\overset{\oplus}{C}H_2$
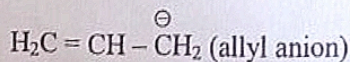
6. (a) Classify the following compounds as aromatic, non-aromatic or antiaromatic. Explain your answer. 3

(b) In the following compound which C–N bond (*a* or *b*) has a shorter bond length? Explain. 2

O_2N ... *a* NO_2 ... *b* NO_2
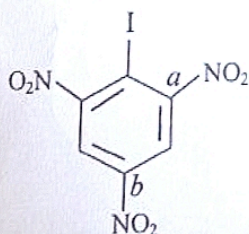
7. (a) Draw the π-MO diagram of allyl anion indicating HOMO and LUMO in the diagram. $2\frac{1}{2}$

$H_2C = CH - \overset{\ominus}{C}H_2$ (allyl anion)

(b) Addition of singlet carbene to alkene is stereospecific whereas addition of triplet carbene to alkene is non-stereospecific. — Explain with suitable example.　　$2\frac{1}{2}$

Unit-3

Answer any *two* questions　　$5\times2 = 10$

8. (a) Write down Maxwell's expression for the distribution of molecular speed in three dimensions and obtain an expression for the distribution of translational kinetic energy.　　1+2

(b) Calculate the number of binary collisions per c.c per second in Helium gas at 27°C and 1 atm. Diameter of Helium atom is 2 Å.　　2

9. (a) Plot the Maxwell speed distribution profile of He (g) at temperature T K. Will there be any changes in the plot if the temperature is doubled? Give reason for your answer.　　2

(b) Find an expression for the most probable speed from the Maxwell speed distribution formula clearly stating the conditions involved.　　3

10. (a) The expression for the distribution of molecular speed of an ideal gas is　　3

$$f(c) = 4\pi c^{n}\left(\frac{m}{2\pi k_{B}T}\right)^{3/2} e^{-\frac{mc^2}{2k_{B}T}}$$

Using dimensional arguments to find out the value of 'n'.

(b) The equipartition value of γ of a nonlinear ideal gas is 1.167. Find out the atomicity of the gas molecule.　　2

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