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| QP Code: D 123064   | Total Pages: 2  | Name:                    |
|   |   | Register No.             |
| <b>SECOND SEMESTER (CUFYUGP) DEGREE EXAMINATION APRIL 2025</b>                          |   |                          |
| <b>(CHEMISTRY)</b>  |   |                          |
| <b>CHE2MN101: QUANTUM MECHANICS, SOLID STATE AND GASEOUS STATE</b>                      |   |                          |
| <b>2024 Admission onwards</b>   |   |                          |
| <b>Maximum Time: 2 Hours</b>  |   | <b>Maximum Marks: 70</b> |
| <b>Section A</b>  |   |                          |
| <b>All Questions can be answered. Each Question carries 3 marks (Ceiling: 24 Marks)</b> |   |                          |
| 1   | Write and explain the Schrodinger equation of the hydrogen atom in spherical polar coordinates.   |                          |
| 2   | Set up the Schrodinger wave equation for a simple harmonic oscillator, and give the energy eigen values.  |                          |
| 3   | Explain briefly about i) atomic orbitals ii) angular momentum.  |                          |
| 4   | How many atoms are present in the unit cell of bcc and fcc lattices?  |                          |
| 5   | Explain the term 'Super conductor'.   |                          |
| 6   | Explain the terms collision diameter, collision number and mean free path.  |                          |
| 7   | Explain i) viscosity of gases ii) Compressibility factor iii) Boyle temperature.  |                          |
| 8   | Carefully explain the causes of deviation from ideal behaviour.   |                          |
| 9   | Express the van der Waals equation in virial form.  |                          |
| 10  | Calculate the Boyle temperature $T_B$ for $\text{CO}_2$ gas, assuming it to be van der Waals gas. The van der Waals constants for $\text{CO}_2$ gas are $a = 3.59 \text{ dm}^6 \text{ atm mol}^{-2}$ , $b = 0.0427 \text{ dm}^3 \text{ mol}^{-1}$ . |                          |
| <b>Section B</b>  |   |                          |
| <b>All Questions can be answered. Each Question carries 6 marks (Ceiling: 36 Marks)</b> |   |                          |
| 11  | State and explain the postulates of quantum mechanics.  |                          |
| 12  | Explain the Stern - Gerlach experiment.   |                          |
| 13  | How will you distinguish between ferromagnets, antiferromagnets and ferrimagnets with the help of electron spins?   |                          |
| 14  | What do you know about defects in crystals? Explain briefly.  |                          |
| 15  | Starting from the basic postulates of the kinetic theory of gases, derive the kinetic gas equation.   |                          |
| 16  | Describe the variation of viscosity with temperature and pressure.  |                          |

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| 17  | For hydrogen gas, calculate i) the root mean square velocity ii) the average velocity and iii) the most probable velocity at 0°C.  |
| 18  | A certain gas has the following values of its critical constants : $P_c = 45.6 \text{ atm}$ , $V_{m,c} = 0.0987 \text{ dm}^3 \text{ mol}^{-1}$ and $T_c = 190.6 \text{ K}$ . Calculate the van der Waals constants of this gas. Also, estimate the radius of the gas molecules assuming that they are spherical. |
| <b>Section C</b>  |  |
| <b>Answer any ONE. Each Question carries 10 marks (1×10 = 10 Marks)</b> |  |
| 19  | Derive an expression for the energy of a particle in one dimensional box.  |
| 20  | a) Explain i) Crystalline and amorphous solids ii) seven crystal systems<br>b) Explain briefly about P – V isotherms of a real gas.  |