

B.Sc. Chemistry Sem III Assignment (2026-27)

Paper: Physical Chemistry

Instructions:

- **Major: Answer all the questions**
 - **Minor: Answer only the questions from *Gaseous State* topic**
 - **Use a fair register to write your answers**
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Gaseous State:

Q 1. Explain the deviation of real gases from ideal behaviour. Discuss the effect of pressure on the deviation and represent the variation of compressibility factor (Z) with pressure using suitable diagrams.

Q 2. Derive the van der Waals equation of state for real gases

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

(i) Explain the physical significance and units of the van der Waals constants a and b

(ii) Discuss the applicability and limitations of van der Waals equation

(iii) Using the van der Waals equation, calculate the pressure exerted by 20.0 g of carbon dioxide in 1 dm³ vessel at 25 °C and compare this with the ideal gas value.

Q 3. (a) Explain Andrew's isotherms and the van der Waals isotherms for real gases.

(b) Define the terms critical temperature, critical pressure and critical volume. Derive their relationship with van der Waals constants.

(c) The van der Waals constants for HCl are a=371.843 kPa dm⁶ mol⁻² & b = 40.8 cm³ mol⁻¹. Find the critical constants of this substance.

(d) Write a short note on continuity of state.

Q 4. What is the law of corresponding states? Derive the reduced equation of state for van der Waals equation of state.

- Q 5.** (a) State Maxwell's law for the distribution of speeds (or velocities) among molecules of a gas. How does a change in temperature or pressure of a gas influence this distribution?
- (b) Following the Maxwell distribution of molecular speeds, derive the expressions for (i) root mean square speed, (ii) average speed, and (iii) most probable speed. Arrange these three speeds in order of increasing magnitude.
- (c) Following the Maxwell distribution of molecular speeds, derive the expressions for average kinetic energy.
- (d) Calculate the v_{rms} of H_2 and N_2 gas at 300K. (Given $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$)
- (e) Calculate temperature at which average speed of oxygen equals that of hydrogen at 20K.
- Q 6.** (a) Derive and explain the terms collision diameter (σ), mean free path (λ), collision number (Z_1) and collision frequency (Z_{11}). Discuss the effects of temperature and pressure on these terms.
- (b) The collision diameter for helium is 207 pm and for methane, 414 pm. How does the mean free path for He compare with that for CH_4 , under the same conditions?
- (c) Calculate the value of σ , λ , Z_1 and Z_{11} for nitrogen molecules at 25°C and at pressure of 10^{-3} mmHg . given that b for nitrogen is $39.1 \text{ cm}^3 \text{ mol}^{-1}$

Chemical Kinetics and Catalysis:

- Q 1.** Distinguish between: Order and molecularity.
- Q 2.** (a) What is a second order reaction? Derive expression for the rate constant and half-life period for reactions of second order of the type $2\text{A} \longrightarrow \text{Product}$.
- (b) Derive an expression for the rate constant for a second order reaction of the type $\text{A} + \text{B} \longrightarrow \text{Product}$, starting with different initial concentration of A and B.
- Q 3.** What are Pseudo-first order reactions? Give two examples.
- Q 4.** Briefly outline the experimental methods of studying chemical kinetics viz. conductometric, potentiometric, optical methods, polarometry and spectrophotometry
- Q 5.** (a) What effect does temperature have on the rate of chemical reactions?

- (b) Write Arrhenius equation giving the effect of temperature on the rate constant of a reaction.
- (c) What type of graph do you expect between $\log k$ and $1/T$? What is its slope?
- Q 6.** From bimolecular collision theory, derive expression for rate, rate constant and frequency factor for (i) Like molecules (ii) Unlike molecules.
- Q 7.** (a) Describe the activated complex theory (transition state theory).
 (b) Using transition state theory, derive expression for frequency factor and enthalpy of activation.
- Q 8.** (a) What is meant by the term catalyst? Give general characteristics of catalytic reactions.
 (b) What are buffer solutions? Derive Henderson's equation
 (c) What is hydrolysis of salt? Explain the hydrolysis of different types of salts
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Assignment Submission and Viva Dates:

Students	Time	Date	Roll No.
Major	(11:00 – 1:00 PM)	07.10.2026	2530014010006 - 10179
		08.10.2026	2530014010185 - 10381
		09.10.2026	2530014010383 - 10584
		10.10.2026	All Maths (Major)
Minor	(11:00 – 12:30 PM)	07.10.2026	2530014010003 - 10328
		08.10.2026	2530014010329 - 10583
		10.10.2026	All Maths (Minor)



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