SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR – 603 203

DEPARTMENT OF CHEMISTRY

QUESTION BANK

I SEMESTER

CH3124-Engineering Chemistry

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Prepared by

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2	II	CHEMICAL THERMODYNAMICS	Dr. N. Jayaprakash Dr. S. G. Gunasekaran
3	III	CHEMICAL KINETICS	Dr. L. Devaraj Stephen
4	IV	SURFACE CHEMISTRY AND CATALYSIS	Mr. V. Arivalagan Dr. J. Krishnamurthi
5	V	NANOCHEMISTRY	Ms. M. Meera Dr. M. Soundarrajan

UNIT I - WATER TECHNOLOGY

Introduction-sources of water-impurities present in water-hard water and hardness - types, Municipal water treatment: primary treatment and disinfection - Desalination of brackish water: Reverse Osmosis, Boiler troubles: scale and sludge, caustic embrittlement, boiler corrosion priming and foaming, Treatment of boiler feed water -Internal treatment (phosphate, colloidal, sodium aluminate and Calgon conditioning). External treatment: Ion exchange process, cooling waters (Langelier index).

S.No	PART-A (2 Marks)	BTL	Competence	CO
1.	Define hardness of water.	1	Remembering	CO1
2.	Name the salts responsible for scale and sludge.	1	Remembering	CO1
3.	Outline the disadvantages of using hard water in boilers.	2	Understanding	CO1
4.	Explain the processes involved in disinfection.	2	Understanding	CO1
5.	List out the requirements of boiler feed water.	1	Remembering	CO1
6.	What are scales and sludges?	1	Remembering	CO1
7.	Indicate the reasons for boiler corrosion.	2	Understanding	CO1
8.	What is reverse osmosis?	1	Remembering	CO1
9.	Give some examples for cation and anion exchange resin.	1	Remembering	CO1
10.	What are the advantages of ion-exchange process?	1	Remembering	CO1
11.	How does carbon dioxide cause boiler corrosion?	1	Remembering	CO1
12.	Name the gases dissolved in water that causes corrosion.	1	Remembering	CO1
13.	Why is Calgon conditioning better than phosphate conditioning?	1	Remembering	CO1
14.	Explain the term “blow-down operation”.	2	Understanding	CO1
15.	Demonstrate desalination of brackish water.	2	Understanding	CO1
16.	Examine Calgon conditioning.	2	Understanding	CO1
17.	Explain the role of phosphates in internal treatment of water.	2	Understanding	CO1
18.	Demonstrate caustic embrittlement. How is it prevented?	2	Understanding	CO1
19.	What is the Langelier index (LSI)?	1	Remembering	CO1
20.	Explain priming and foaming in boilers.	2	Understanding	CO1

S.No	PART-B (13 Marks)		BTL	Competence	CO
1.	(i)	How is the temporary and permanent hardness of water determined?	4	Analyzing	CO1

	(ii)	Discuss the causes and prevention of priming and foaming.	4	Analyzing	CO1
2.		Explain the demineralization of water by ion-exchange process.	3	Applying	CO1
3.		Construct internal conditioning or internal treatment for boiler feed water.	3	Applying	CO1
4.	(i)	What are boiler troubles? Discuss causes, effects and prevention methods to minimize the boiler troubles.	3	Applying	CO1
	(ii)	Demonstrate phosphate and colloidal conditioning in water softening.	3	Applying	CO1
5.		Compose municipal water treatment with suitable diagram with reactions.	3	Applying	CO1
6.	(i)	What is reverse osmosis? Explain desalination of water by reverse osmosis method and its advantages.	3	Applying	CO1
	(ii)	Explain primary treatment and disinfection process in municipal water treatment.	2	Understanding	CO1
7.		Define the term desalination. Describe desalination by reverse osmosis method.	4	Analyzing	CO1
8.	(i)	How can scale formation be prevented by phosphate and Calgon conditioning?	1	Remembering	CO1
	(ii)	Describe colloidal and sodium aluminate conditioning.	1	Remembering	CO1
9.	(i)	Analyze the causes and prevention of caustic embrittlement.	4	Analyzing	CO1
	(ii)	What is the effect of dissolved oxygen in boiler feed water? How can it be removed?	3	Applying	CO1
10.		Examine how the municipal water is purified and disinfected.	4	Analyzing	CO1
11.	(i)	Construct the process to regenerate the exhausted cationic and anionic resins.	3	Applying	CO1
	(ii)	Differentiate scales and sludges.	2	Understanding	CO1
12.		Draw a suitable diagram and examine the ion exchange process for the softening of boiler water.	4	Analyzing	CO1
13.		Correlate the different internal treatment process of boiler	4	Analyzing	CO1

		feed water.			
14.	(i)	Construct the process of caustic embrittlement and boiler corrosion in boiler feed water.	3	Applying	CO1
15.	(i)	Apply internal conditioning methods on the treatment of boiler feed water.	3	Applying	CO1
	(ii)	Explain in detail about Langelier Saturation Index (LSI).	4	Analyzing	CO1

UNIT II - CHEMICAL THERMODYNAMICS

Introduction-terminology of thermodynamics, the first law of thermodynamics: enthalpy, second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions: Clausius inequality. Free energy and work function: Helmholtz and Gibbs free energy functions, Criteria of spontaneity; Gibbs-Helmholtz equation, Clausius-Clapeyron equation, Maxwell relations, Van't Hoff isotherm and isochore.

S.No	PART-A (2 Marks)	BTL	Competence	CO
1.	Compare open, closed and isolated system.	2	Understanding	CO2
2.	Define entropy for an ideal gas.	1	Remembering	CO2
3.	Classify adiabatic process and isothermal process.	2	Understanding	CO2
4.	What is the first law of thermodynamics?	1	Remembering	CO2
5.	Show the term 'enthalpy'.	1	Remembering	CO2
6.	Outline a cyclic process.	1	Remembering	CO2
7.	Identify the limitations of 1^{st} law of thermodynamics.	2	Understanding	CO2
8.	Summarize the need for 2^{nd} law of thermodynamics.	2	Understanding	CO2
9.	Demonstrate any two statements of 2^{nd} law of thermodynamics.	2	Understanding	CO2
10.	State the 2^{nd} law of thermodynamics in terms of entropy.	1	Remembering	CO2
11.	What is a spontaneous process?	1	Remembering	CO2
12.	Explain Gibb's free energy with example.	2	Understanding	CO2
13.	State any two applications of Gibb's Helmholtz equation.	2	Understanding	CO2
14.	Classify any two Maxwell relations.	2	Understanding	CO2
15.	Explain reversible process and irreversible process.	2	Understanding	CO2
16.	Classify the criteria for spontaneity of the system.	2	Understanding	CO2
17.	List the relation between (i) ΔH & ΔG, (ii) EMF & ΔG	1	Remembering	CO2
18.	Illustrate how ΔG determine the nature of the process.	1	Remembering	CO2
19.	Explain intensive and extensive property with example.	1	Remembering	CO2
20.	Write down the Van't Hoff equation.	1	Remembering	CO2

S.No	PART-B (16 Marks)		BTL	Competence	CO
1.		Find an expression for entropy change of an ideal gas at constant temperature.	1	Remembering	CO2

2.		Sketch out Gibb's Helmholtz equation and explain.	3	Applying	CO2
3.	(i)	State the applications of Gibb's Helmholtz equation.	1	Remembering	CO2
	(ii)	Inspect the criteria for chemical reaction to be spontaneous.	4	Analyzing	CO2
4.		Derive Clausius-Clapeyron equation. Mention its significance.	3	Applying	CO2
5.		Construct Maxwell relations with respect to ΔH, ΔE, ΔA & ΔG.	3	Applying	CO2
6.		Examine Van't Hoff's isotherm? Derive the expression for an isotherm reaction, aA+bB→cC+dD.	4	Analyzing	CO2
7.		Outline the entropy of reversible and irreversible process.	1	Remembering	CO2
8.		Derive Van't Hoff's isochore equation.	2	Understanding	CO2
9.	(i)	Examine the various criteria for spontaneity.	4	Analyzing	CO2
	(ii)	Explain in detail about Clausius inequality.	2	Understanding	CO2
10.		Solve Gibb's Helmholtz equation and explain.	3	Applying	CO2
11.		Deduce the expression for Van't Hoff's isochore.	4	Analyzing	CO2
12.		Contrast in detail about the derivation of Gibbs Helmholtz equation. State its applications.	3	Applying	CO2
13.		Investigate by driving the Clausius-Clapeyron equation with importance.	4	Analyzing	CO2
14.		Analyze Maxwell relations on the basis of thermodynamics state of the relation.	4	Analyzing	CO2
15.		Deduce the expression for Van't Hoff's isotherm with help of general reaction, aA+bB→cC+dD.	4	Analyzing	CO2

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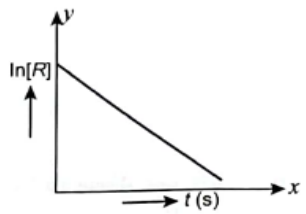
UNIT III - CHEMICAL KINETICS

Introduction-factors influencing the rate of reaction, order and molecularity of a reaction, kinetic equations of different orders (first, second and third order) - determination of the order of a reaction, the temperature dependence of reaction rates, unimolecular reactions, photochemical reactions and chain reactions, Theories of reaction rates, lasers in chemistry, fast reactions.

S.No	PART-A (2 Marks)	BTL	Competence	CO
1.	Define the order of a reaction.	1	Remembering	CO3
2.	Extend the term molecularity of a reaction.	2	Understanding	CO3
3.	Illustrate the factors that influence the rate of reaction.	2	Understanding	CO3
4.	Select the conditions for the order of a reaction.	2	Understanding	CO3
5.	Why does temperature affect the rate of a chemical reaction?	1	Remembering	CO3
6.	Compare order with the molecularity of a reaction.	2	Understanding	CO3
7.	Recall the methods for determining the order of a reaction.	1	Remembering	CO3
8.	Outline the kinetic equations for first and second-order reactions.	2	Understanding	CO3
9.	Extend the pseudo-first-order reaction with a suitable example.	2	Understanding	CO3
10.	Explain the half-life period for first-order reaction.	2	Understanding	CO3
11.	For a reaction, $A+B \rightarrow P$, the rate law is given by $r=k[A]^{1/2}[B]^2$. What is the order of this reaction?	2	Understanding	CO3
12.	How does a catalyst influence the rate of a reaction?	1	Remembering	CO3
13.	If the concentration of a reactant is doubled and the reaction rate quadruples, what is the order of the reaction with respect to that reactant?	2	Understanding	CO3
14.	Write the equation on the temperature dependence of the rate of a chemical reaction and expand its terms.	1	Remembering	CO3
15.	Label unimolecular reaction with examples.	1	Remembering	CO3
16.	Contrast photochemical reaction with examples.	3	Applying	CO3
17.	Name the theories of reaction rates.	1	Remembering	CO3
18.	What do you mean by chain reaction? Give an example.	2	Understanding	CO3
19.	What are lasers used for in chemistry?	2	Understanding	CO3
20.	Outline fast reactions with suitable examples.	2	Understanding	CO3

S.No	PART-B (13 Marks)		BTL	Competence	CO
1.	(i)	Identify the factors affecting the rate of a reaction.	3	Applying	CO3
	(ii)	Distinguish the order and molecularity of a reaction.	4	Analyzing	CO3
2.		Construct the integrated rate equations for first-order reaction and prove that the decomposition of N_2O_5 in CCl_4 follows first-order.	3	Applying	CO3
3.		Categorize the integrated rate equations for second-order reaction and mark that the hydrolysis of the ester by NaOH follows second-order.	4	Analyzing	CO3
4.		Organize the integrated rate equation for third-order reaction with suitable examples.	3	Applying	CO3
5.		Simplify the integration of rate expression for second-order reaction when both the reactants are the same.	4	Analyzing	CO3
6.		Explain the half-life period of a reaction and calculate the half-life of a first-order reaction.	2	Understanding	CO3
7.		Discuss the mechanism of chain reaction and provide a detailed example of a chain reaction, including its initiation, propagation, and termination steps. Explain how the rate of a chain reaction is affected by different factors.	3	Applying	CO3
8.		Identify the characteristics, applications and damaging effects of photochemical reactions.	4	Analyzing	CO3
9.		Discuss the Lindemann theory of unimolecular reactions.	3	Applying	CO3
10.		Construct the activated complex theory (ACT) of bimolecular reactions.	4	Analyzing	CO3
11.	(i)	For a particular chemical reaction variation in the concentration ln[R] vs. time plot,  (i) What is the order of a reaction?	4	Analyzing	CO3

		(ii) Give the relation between k and $t_{1/2}$ (half-life). (iii) What is the slope of the curve? (iv) Draw the plot of $\log[R]_0/[R]$ vs. time (in sec).			
	(ii)	The half-life of a substance in a first-order reaction is 10 minutes. Calculate the rate constant.	4	Analyzing	CO3
12.		Extend the kinetics of photochemical reactions using the H_2-Cl_2 reaction.	3	Applying	CO3
13.		Discuss the usage of lasers in chemistry.	2	Understanding	CO3
14.	(i)	Derive integrated Arrhenius equation with suitable equations.	2	Understanding	CO3
	(ii)	Discuss the limitations of the collision theory.	2	Understanding	CO3
15.		Describe how lasers are used in chemical reactions and analysis. Discuss their applications in determining reaction rates and studying fast reactions. Provide specific examples of laser techniques used in chemistry.	2	Understanding	CO3

UNIT IV - SURFACE CHEMISTRY AND CATALYSIS

Adsorption: classification - adsorption of gases on solids - adsorption from solutions adsorption isotherms - applications of adsorption - Freundlich's adsorption isotherm Langmuir's adsorption isotherm, B.E.T isotherm. Catalysis: introduction - types of catalysis - criteria - autocatalysis - catalytic poisoning and catalytic promoters - acid base catalysis - enzyme catalysis - Michaelis - Menten equation.

S.No	PART-A (2 Marks)	BTL	Competence	CO
1.	Define the term adsorption.	1	Remembering	CO4
2.	Illustrate few important characteristics of adsorption.	2	Understanding	CO4
3.	What is physical adsorption? Give an example.	1	Remembering	CO4
4.	Describe chemisorption with suitable examples	2	Understanding	CO4
5.	Give the limitations of Freundlich's adsorption isotherm.	2	Understanding	CO4
6.	What is BET adsorption isotherm?	2	Understanding	CO4
7.	Define the terms adsorbent and adsorbate with suitable example.	1	Remembering	CO4
8.	List out postulates of Langmuir adsorption isotherm.	1	Remembering	CO4
9.	Define adsorption isotherm.	1	Remembering	CO4
10.	Correlate physical adsorption and chemical adsorption.	2	Understanding	CO4
11.	Write short note on promoters and inhibitors.	2	Understanding	CO4
12.	Illustrate auto catalysis with an example.	2	Understanding	CO4
13.	Demonstrate acid-base catalysis with an example.	2	Understanding	CO4
14.	What is 'enzyme catalysis'? Give an example.	1	Remembering	CO4
15.	Write the BET isotherm equation.	1	Remembering	CO4
16.	Write a short note on enzymatic reaction.	2	Understanding	CO4
17.	Why is rate of reaction speeded up in presence of a catalyst?	1	Remembering	CO4
18.	List out the applications of adsorption.	1	Remembering	CO4
19.	List out limitations of Langmuir adsorption isotherm.	1	Remembering	CO4
20.	Discuss homogeneous and heterogeneous catalysis.	2	Understanding	CO4

S.No		PART-B (13 Marks)	BTL	Competence	CO
1.	(i)	Explain in detail about physical and chemical adsorption with suitable examples.	2	Understanding	CO4
	(ii)	Examine positive and negative adsorptions with examples.	3	Applying	CO4

2.		Discuss various factors that affect the adsorption of a gas on a solid adsorbent.	1	Remembering	CO4
3.		Explain the BET adsorption isotherm at various pressures.	3	Applying	CO4
4.		Demonstrate the adsorption of solutes from solutions.	2	Understanding	CO4
5.		Derive and explain Langmuir adsorption isotherm in detail.	3	Applying	CO4
6.		Analyze the factors affecting the adsorption of gases on solids.	4	Analyzing	CO4
7.		State the postulates and derive Langmuir adsorption isotherm in various pressure conditions and limitations.	3	Applying	CO4
8.		Derive Michaelis-Menten equation and explain the order of reaction with respect to substrate concentration.	3	Applying	CO4
9.	(i)	Differentiate physical adsorption and chemical adsorption.	1	Remembering	CO4
	(ii)	Explain the equation of BET adsorption isotherm and its applications.	2	Understanding	CO4
10.	(i)	What is catalyst and explain its general characteristics.	1	Remembering	CO4
	(ii)	Examine the categories of catalysis with examples.	2	Understanding	CO4
11.	(i)	Write a short note on autocatalysis.	2	Understanding	CO4
	(ii)	Differentiate homogeneous and heterogeneous catalysis.	4	Analyzing	CO4
12.	(i)	Examine catalytic promoters with examples.	4	Analyzing	CO4
	(ii)	Discuss the action of catalytic poisons and its types.	2	Understanding	CO4
13.		Examine the kinetics of enzyme catalyzed reaction by deriving Michaelis-Menten equation.	4	Analyzing	CO4
14.	(i)	Illustrate acid-base catalysis.	2	Understanding	CO4
	(ii)	Mention any four enzymes with their enzymatic reactions.	3	Applying	CO4
15.	(i)	What are acid-base catalyst reactions? Give examples.	1	Remembering	CO4
	(ii)	Show the mechanism of auto catalysis with illustration.	3	Applying	CO4

UNIT V – NANOCHEMISTRY

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties; Types of nanomaterials: Definition, properties and uses of-nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electrospinning. Applications of nanomaterials in medicine, agriculture, food science and energy resources.

S.No	PART-A (2 Marks)	BTL	Competence	CO
1.	What are nanomaterials?	1	Remembering	CO5
2.	Explain the size dependent property of nanoparticles.	2	Understanding	CO5
3.	Relate the differences between nanoparticles and bulk materials.	2	Understanding	CO5
4.	Outline any four nanomaterials.	2	Understanding	CO5
5.	State nanoclusters.	1	Remembering	CO5
6.	Explain nanorods. Mention their applications.	1	Remembering	CO5
7.	Define nanowires.	1	Remembering	CO5
8.	What are carbon nanotubes?	1	Remembering	CO5
9.	Interpret the different types of CNTs.	2	Understanding	CO5
10.	Identify few applications of nanomaterials.	2	Understanding	CO5
11.	Defend magic number.	1	Remembering	CO5
12.	Clarify laser ablation method.	2	Understanding	CO5
13.	Explain CVD method.	2	Understanding	CO5
14.	Describe electrodeposition method.	1	Remembering	CO5
15.	Define electrospinning process.	1	Remembering	CO5
16.	Explain the solvothermal synthesis of nanomaterials.	2	Understanding	CO5
17.	List out the applications of nanomaterials in medical field.	2	Understanding	CO5
18.	Write a note on the applications of nanomaterials in agriculture field.	1	Remembering	CO5
19.	What are the significance of nanomaterials in food science?	2	Understanding	CO5
20.	Outline the uses of nanomaterials in biology.	1	Remembering	CO5

S.No	PART-B (13 Marks)		BTL	Competence	CO
1.	(i)	Compare molecules, nanoparticles and bulk materials.	4	Analyzing	CO5

	(ii)	Examine the size dependent properties of nanomaterials.	3	Applying	CO5
2.		Illustrate the various properties of nanomaterials.	4	Analyzing	CO5
3.		What are carbon nanotubes? Explain their types along with its applications.	4	Analyzing	CO5
4.		Inspect laser ablation method for the synthesis of nanomaterials.	4	Analyzing	CO5
5.		Briefly clarify chemical vapour deposition (CVD) method of preparing nanoparticles.	4	Analyzing	CO5
6.		Construct the solvothermal process for the preparation of nanomaterials.	3	Applying	CO5
7.		Write a note on nanoclusters and nanowires. Devise their properties and applications.	4	Analyzing	CO5
8.		Elucidate the electrodeposition method for the synthesis of nanomaterials.	4	Analyzing	CO5
9.		Explore in detail about bottom-up and top-down approaches in nanomaterial synthesis.	4	Analyzing	CO5
10.		Relate nanorods, nanotubes, nanowires and nanoclusters.	3	Applying	CO5
11.		Discover the medicinal and agriculture applications of nanomaterials.	4	Analyzing	CO5
12.		Interpret the applications of nanomaterials in food science and energy resources.	2	Understanding	CO5
13.		Classify the various applications of nanomaterials in different fields.	4	Analyzing	CO5
14.		Select the sol-gel synthesis for producing nanomaterials with a neat sketch.	3	Applying	CO5
15.		Examine the preparation of nanomaterials by electro-spinning technique.	4	Analyzing	CO5