

Final Exam
TICHEM: INDUSTRIAL CHEMISTRY
Spring 2026

Points of attention:

- For each question, the maximum earned points are specified in the question.
- Write clearly! Answers that are not readable are not marked and don't earn marks!
- All answers should be written in English using **blue or black pens** only.
- Use the pencil only for diagrams and graphs.
- Show all the calculation steps in the given space.
- When finished, submit the question paper, together with the answer scripts and the signed cover page to the invigilator.
- Any cheating/copying may result in an instant failing of the examination.

Exam Duration: 2.5 hours
Instructor's Name: Dr. G. Chandrasekar
Exam Date: 11/05/2026
Program: PE

	40
	10

Student Information

Name:

ID:

Signature:

Invigilator

Initials:

☐ Student ID checked

Time received:

Instruction:

(i) Multiple answers for MCQ questions will not be accepted. Write the correct answer separately below the question.

(ii) Providing correct units is compulsory wherever a physical quantity is mentioned. Half a mark will be deducted if units are not included.

Question 1

[10 marks]

Answer all the questions below:

(10 x 1 = 10 marks)

(i). The hydrophilic part of a soap molecule is:

- | | |
|-----------------------|--------------------------------------|
| (a) Hydrocarbon chain | (b) Alkyl group |
| (c) Methyl group | (d) $\text{-COO}^- \text{Na}^+$ head |

(ii). Catalyst used in cracking petroleum Process:

- | | |
|--|-----------------------------|
| (a) CuSO_4 | (b) NaCl |
| (c) $\text{SiO}_2\text{-Al}_2\text{O}_3$ | (d) Fe_2O_3 |

(iii) If the hydrophilic head of a soap molecule is removed, what will be the result?

- | | |
|-------------------------------|--------------------------|
| (a) More foam formation | (b) Better cleaning |
| (c) No interaction with water | (d) Increased solubility |

(iv). TEL contains:

- | | | | |
|-----|--------|-----|------|
| (a) | Tin | (b) | Lead |
| (c) | Copper | (d) | Iron |

(v). Hardness expressed as:

- | | | | |
|-----|-------------------|-----|-------------------|
| (a) | CaO | (b) | MgCl ₂ |
| (c) | CaSO ₄ | (d) | CaCO ₃ |

(vi). Sodium aluminate forms:

- | | | | |
|-----|--------------------|-----|--------------------------|
| (a) | Shifts equilibrium | (b) | Decreases yield |
| (c) | Increases yield | (d) | No effect on equilibrium |

(vii). MgCl₂ causes:

- | | | | |
|-----|--------------------|-----|--------------------|
| (a) | Permanent hardness | (b) | Temporary hardness |
| (c) | Softness | (d) | Acidity |

(viii). Reaction in catalytic converter: $2SO_2 + O_2 \rightarrow 2SO_3$ is:

- | | | | |
|-----|-------------|-----|---------------|
| (a) | endothermic | (b) | Neutral |
| (c) | exothermic | (d) | Photochemical |

(ix). Why is common salt added during soap synthesis?

- | | | | |
|-----|----------------------------------|-----|----------------------|
| (a) | To increase reaction rate | (b) | To improve smell |
| (c) | To precipitate and separate soap | (d) | To neutralize alkali |

(x). In Haber process, increasing temperature decreases yield because:

- | | | | |
|-----|-------------------------|-----|------------------------|
| (a) | Reaction is endothermic | (b) | No equilibrium |
| (c) | Catalyst deactivates | (d) | Reaction is exothermic |

Question 2**[10 marks]**

(a) A laboratory prepares soap using vegetable oil and NaOH produces a valuable byproduct. The soap forms well but does not clean oily stains effectively in hard water.

(i). Explain the chemistry behind soap formation using chemical formula

(2 marks).

(ii). Draw and explain the structure of a soap micelle showing hydrophilic and hydrophobic parts.

(1 mark)

(iii). Show how grease is removed using soap in water.

(2 marks)

(b) The fixed bed catalytic cracking process is an important method used in petroleum refining for breaking down a wide range of hydrocarbon molecules into lighter fractions.

Explain the complete process starting from the feed preparation to fractional distillation. Include a neat labeled sketch and describe the working principle of each unit operation involved. (5 marks)

Question 3**[10 marks]**

- (a) (i) Explain the hot soda-lime process for the removal of hardness of water with a neat description. (3 marks)
- (ii) List at least four of the advantages and disadvantages of this process. ($4 \times \frac{1}{2} = 2$ marks)
- (b) Compare the techniques and efficiency of water softening using the cold lime–soda process, zeolite process, and ion-exchange resin method for the removal of temporary and permanent hardness of water. (5 marks)

Question 4**[10 marks]**

(a) Explain the Contact Process for the manufacture of sulphuric acid, including purification of gases, catalytic oxidation, and absorption stages. Also discuss the removal of arsenic impurities and the role of catalyst. (7 marks)

(b) A reversible chemical reaction at equilibrium is subjected to changes in concentration, pressure, and temperature. According to Le Chatelier's Principle, when a system at equilibrium is disturbed, it adjusts itself to partially oppose the change applied. For example, in the synthesis of ammonia by the Haber process ($\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$), changes in external conditions affect the yield of ammonia.

Explain Le Chatelier's Principle and discuss how changes in concentration, pressure, and temperature affect the equilibrium position of the ammonia synthesis reaction. (3 marks)

MLO and Bloom's Level of Complexity

Q #	MLO Addressed	Complexity Level	Mark	Remark
1	1, 2, 3, 4	Knowledge, Apply, Analyze, Evaluate	10	3 of 4 problems are required
2	1, 2, 3	Knowledge, Apply, Analyze	10	
3	1, 3, 4	Knowledge, Analyze, Evaluate	10	
4	3, 5	Analyze, Create	10	