



The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc. Degree Programme

Department : Chemistry
Level : 5
Name of the Examination : Final Examination
Course Code and Title : CYU5312 Industrial Chemistry
Academic Year : 2025/2026
Date : 02/ 12/2025
Time : 9.30 am – 11.30 am
Duration : 2 hours
Index number :

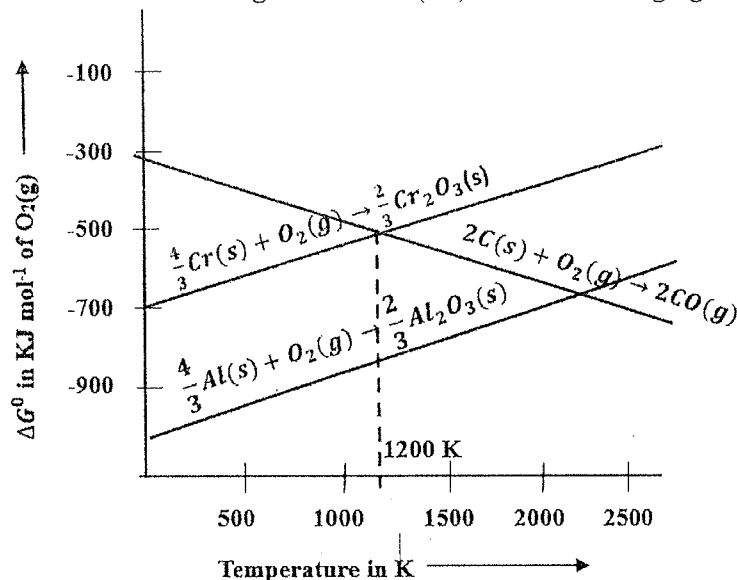
General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Four** questions in **five** pages.
- 3. Answer All FOUR (04) questions. All questions carry equal marks.**
4. Answer for each question should commence from a new page.
5. Draw fully labelled diagrams where necessary.
5. Relevant log tables are provided where necessary.
6. Having any unauthorized documents/ mobile phones in your possession is a punishable offense.
7. Use blue or black ink to answer the questions.
8. Circle the number of the questions you answered in the front cover of your answer script.
9. Clearly state your index number in your answer script.

1. (a) Chromium can be extracted from chromium(III) oxide (Cr_2O_3) using two different methods.

Method A: Using carbon (C) as the reducing agent

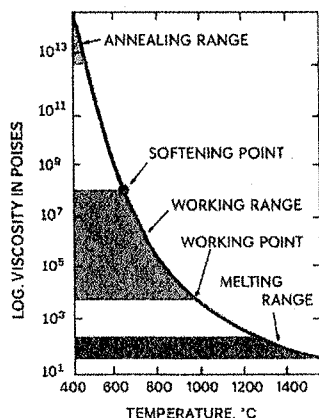
Method B: Using aluminum (Al) as the reducing agent.



Refer to the Ellingham diagram to answer the following:

- (i) Explain why the line for the formation of Cr_2O_3 shows positive slope as temperature increases on the Ellingham diagram. (10 marks)
 - (ii) Write balanced chemical reactions for the extraction of Cr from Cr_2O_3 using:
 - (a) Carbon (Method A)
 - (b) Aluminum (Method B) (10 marks)
 - (iii) (a) Calculate the percentage atom economy for each method (Use the following atomic masses: C = 12, O = 16, Al = 27, Cr = 52) (04 marks)
 - (b) Based on the byproducts produced and your calculated atom economies, explain which method A or B is more sustainable. (06 marks)
 - (iv) Why can Al be used to extract the Cr from Cr_2O_3 ? (10 marks)
- (50 marks)**
- (b) Briefly explain the methods applied for the following metal extractions, including relevant balanced chemical equations:
- (i) Extraction of Zn from ZnS (12 marks)
 - (ii) Extraction of Ti from TiO_2 by the Kroll Process (12 marks)
- (24 marks)**
- (c) To determine the throwing power of a silver-plating bath containing AgNO_3 , two identical co-cathodes, each weighing 0.2800 g, were placed 10 cm apart. A carbon (graphite) anode was positioned 4 cm from one of the cathodes. After 1 hour, the mass of that cathode increased to 0.3200 g.
- (Molar mass of Ag = 108 g mol^{-1} , Faraday constant = $96,500 \text{ C mol}^{-1}$).
- (i) What is meant by the throwing power of a solution? (08 marks)
 - (ii) Calculate the current supplied during this process in milliamperes (mA). (18 marks)
- (26 marks)**
- (Total Mark: 100)**

2. (a) Cation exchange capacity influences ceramic plasticity by affecting the negative surface charge of clay particles, which allows them to attract and hold water and cations.
- (i) What is meant by the terms cation exchange capacity and plasticity of soils? (08 marks)
- (ii) Briefly explain what you understand by isomorphic substitution in montmorillonite. (12 marks)
- (20 marks)**
- (b) (i) Glazing is a value addition step for ceramic articles. State **three (03)** purposes of glazing a ceramic article. (06 marks)
- (ii) The glaze has usually **three (03)** main components. State the main components of glaze and explain the role of each component in a glaze mixture. (12 marks)
- (18 marks)**
- (c) *Cement hydration* is the exothermic *chemical* reaction when *cement* mixes with *water*, involving dissolution and precipitation of *hydrated* phases.
- (i) Explain the role of each of the following clinker mineral in the overall hydration process
- α . Alite (C_3S)
 - β . Belite (C_2S)
 - γ . Tricalcium aluminate (C_3A)
 - λ . Tetra calcium aluminoferrite (C_4AF) (08 marks)
- (ii) Compare the relative rates of hydration of the four clinker minerals and their contribution to the early and later stage strength development of concrete. (16 marks)
- (iii) What is meant by the term "sulphur attack"? (04 marks)
- (iv) Giving an example, suggest a suitable method to reduce sulphur attack. (02 marks)
- (30 marks)**
- (d) Viscosity is an important physical parameter in glass industry. The melting behavior of glasses depend on their viscosity – temperature relationship. The relationship is shown in the graph given diagram below.



- (i) Briefly explain what is meant by the terms 'softening point', 'working range' and 'working point' shown in the above graph. (08 marks)

- (ii) Suggest the type of glass used for each of the following purposes. Give reasons for your answer.

- (α) Partitioning in a hospital radiology unit
- (β) Windscreen of a motorcar
- (γ) Display window of a shop
- (λ) Eye wear used in a laboratory

(24 marks)

(32 marks)

(Total Mark: 100)

3. (a) The most common methods of extracting essential oils are water distillation and steam distillation. Compare and contrast water distillation and steam distillation for the extraction of essential oils, focusing on their **principles, process, advantages and disadvantages**. (16 marks)

- (b) (i) What is meant by the term 'spice oleoresins'? (06 marks)

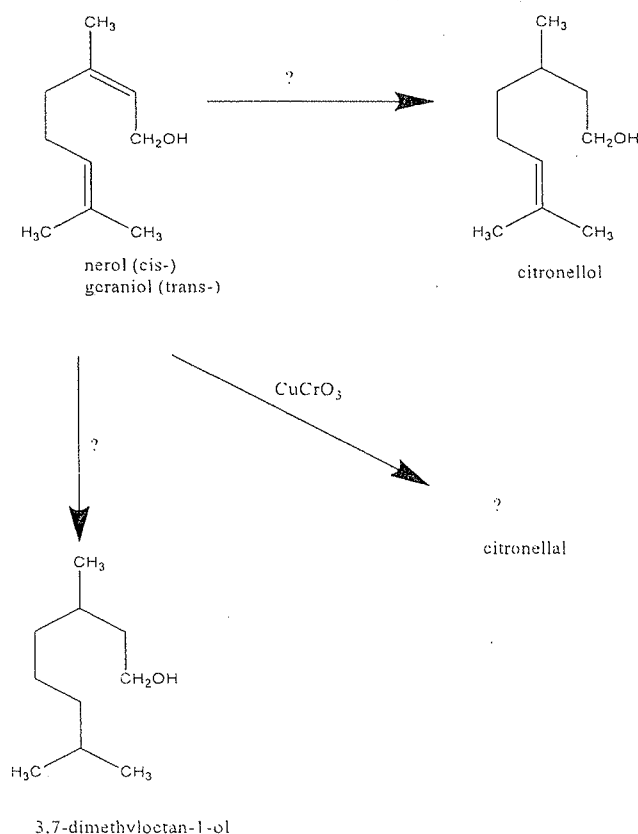
- (ii) How do spice oleoresins differ from essential oils? (08 marks)

- (iii) Black pepper and ginger oleoresins are widely used in the food industry. Give the names of the pungent compounds in black pepper and ginger. (04 marks)

(18 marks)

- (c) In general, geraniol and nerol, undergo the same reactions. They produce high value aroma compounds such as citronellol, 3,7- dimethyloctan – 1-ol and citronellal under different reaction conditions.

- (i) Complete the following reaction scheme with the reaction conditions and structure of citronellal. (15 marks)



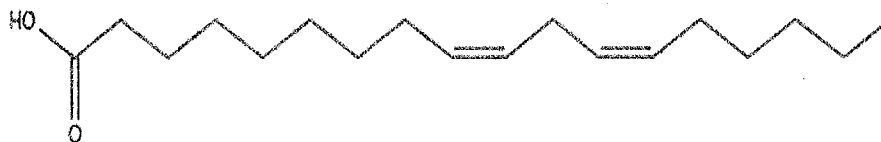
- (ii) Give **two (02)** industrial uses for each of geraniol and citronellol.

(05 marks)

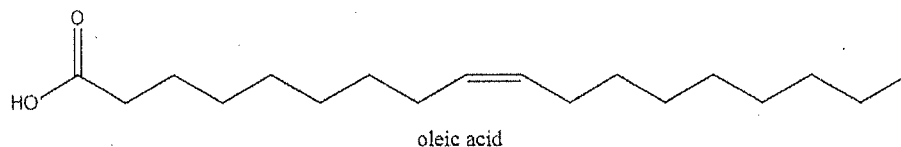
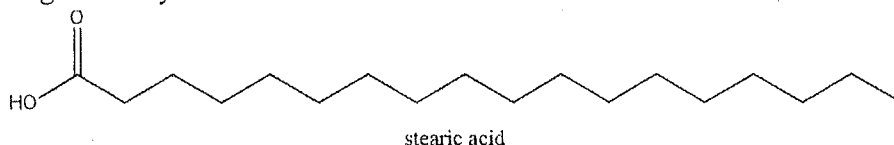
(20 marks)

(d) Edible fats and oils contain mainly glycerides which are fatty acid esters of glycerol.

Fatty acids are commonly denoted by shorthand notations and named according to IUPAC nomenclature.



- (i) Identify which ωx series the above fatty acid belongs (04 marks)
- (ii) Give its shorthand notation. (04 marks)
- (iii) Write its IUPAC name. (04 marks)
- (iv) Explain why the melting points of stearic acid (63 °C) and oleic acid (10 °C) are significantly different. (14 marks)



(26 marks)

- (e) (i) Briefly explain what is meant by the term 'autooxidation'. (10 marks)
- (ii) Briefly discuss the various factors that influence the rate of autooxidation. (10 marks)

(20 marks)

(Total Mark: 100)

4. (a) Briefly describe the following, related to the petroleum industry.

- (i) Carbide Theory
- (ii) Naphthene Series
- (iii) Refining of Petroleum
- (iv) Liquified Petroleum Gas (LPG)

(24 marks)

(b) Answer the following questions with reference to the thermal cracking of butane to produce various alkanes and alkenes:

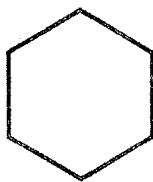
- (i) Define thermal cracking? (10 marks)
- (ii) Write balanced chemical equations representing the products formed during the thermal cracking of butane. (10 marks)
- (iii) State **three** advantages of catalytic cracking over thermal cracking. (06 marks)

(26 marks)

- (c) Hydrocracking is applied to increase the octane number of hydrocarbons P, Q and R shown below:



P



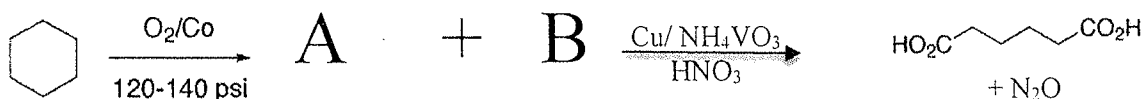
Q



R

- Arrange the hydrocarbons P, Q and R in order of increasing octane number. Justify your answer. (10 marks)
 - Define hydrocracking and briefly explain how it can increase the octane number of compound R, including balanced chemical equations. (12 marks)
 - Write the balanced dehydrogenation reaction for the compound Q that produces a product with a high-octane number. (08 marks)
- (30 marks)**

(D) Consider the reaction given below to produce adipic acid:



- Identify compounds A and B in the above reaction. (08 marks)
 - Name the petrochemical used to produce cyclohexane for the above reaction. (04 marks)
 - Write down two uses of adipic acid in polymer industry (08 marks)
- (20 marks)**
(Total Mark: 100)

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