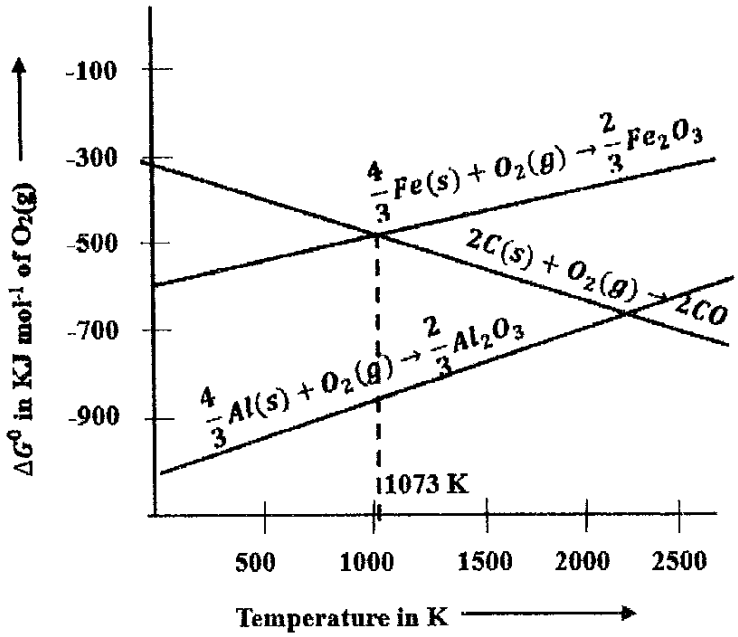
The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc. Degree Programme

Department	: Chemistry
Level	: 5
Name of the Examination	: Final Examination
Course Code and Title	**: CYU5312 Industrial Chemistry**
Academic Year	: 2024/2025
Date	: 08/12/2024
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 **four** 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) The following Ellingham diagram illustrates the formation of ferric oxide from iron and the formation of CO from cork. The two lines intersect at 1073 K.



(i) Using the Ellingham diagram, briefly explain which temperature the formation of iron is favorable by cork. (10 marks)

(ii) Write down the balanced chemical reaction for ion extraction from cork and calculate the percentage of atom economy for iron.
(Fe-56, C-12, O-16) (20 marks)

(iii) Can you extract iron by electrolyzing it with Al? Justify your answer. (10 marks)

(40 Marks)

(b) In hydrometallurgy, metal recovery is done by electrowinning (one of electrometallurgical process).

(i) Briefly explain about hydrometallurgy. (10 marks)

(ii) Write down how the metal recovery is done by electrowinning. (10 marks)

(iii) How many grams of Cu will be deposited from a solution of Cu^{2+} ions by a flow of 1.80 A current for 30.0 minutes? (Cu-63.5) (15 marks)

(35 Marks)

(c) The slope of the Tofel plot maintains the throwing power of the solution during electroplating.

(i) Briefly explain the setup used for electroplating. (10 marks)

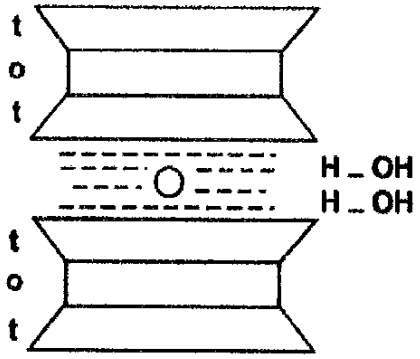
(ii) What do you mean by throwing power? (10 marks)

(iii) Write **one (01)** factor that increases the slope of the Tafel plot. (05 marks)

(25 Marks)

2. (a) The ceramic industry is one of the major crafting industries in the world where science and art meet, each contributing equally to its development.
   (i) Define the word 'ceramics' as applied to industrial chemistry. (05 marks)
   (ii) In general, ceramic materials used for applications can be divided into two major categories; traditional ceramic materials and advanced (new) ceramic materials. State **three (03)** characteristics of traditional ceramics and **three (03)** characteristics of advanced ceramics. (15 marks)
   (iii) What is meant by polymorphism in clay minerals? Name **two (02)** polymorphic varieties of kaolin. (10 marks)
   (30 Marks)

   (b) The traditional ceramics industry is largely based on various combinations of clay minerals. Kaolinite is one such mineral used to produce high quality domestic ceramic ware.
   (i) Name **two (02)** properties of clay minerals which would make them a useful raw material in ceramic industry. (05 marks)
   (ii) Differentiate between cation exchange capacity (CEC) and isomorphous substitution in clay minerals. (10 marks)
   (iii) Describe the structure and discuss the expanding/swelling property and CEC of the clay mineral shown in the figure below. (10 marks)



t	- Tetrahedral layer
o	- Octahedral layer
(O)	- Interlayer cation
(H-O-H)	- Absorbed water

(25 marks)

   (c) Linear thermal expansion coefficient values of two types manufactured glass are given below.

Glass type	Liner thermal expansion coefficient/ °C
Type 1	9.3×10^{-6}
Type 2	3.3×10^{-6}

   (i) What is 'Linear thermal expansion coefficient'? (05 marks)
   (ii) Giving reasons explain which type of glass is more suitable for manufacturing laboratory ware used at high temperatures? (05 marks)
   (iii) Glasses of different colours are produced by adding transition metal oxides. State what metal oxides should be added to bring about the glasses of colours,
   a. green b. red c. violet (05 marks)
   (15 marks)

(d) The following are the four major phases formed during the clinkering process. C_3S, C_2S, C_3A and C_4AF.

(i) What is a hydraulic cement? (05 marks)

(ii) What are the roles of each cement phase in the properties of concrete? (10 marks)

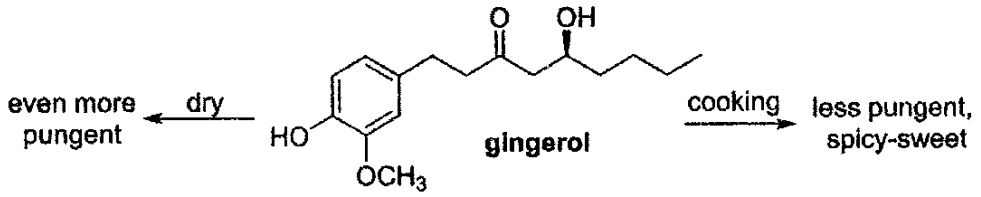
(iii) What are the products of the hydration process of the C_3S and C_2S phases? (05 marks)

(iv) What is meant by the term 'sulphate attack'? (10 marks)

(30 marks)

3. (a) (i) Briefly describe the terms 'Essential oils' and 'spices'. (05 marks)

(ii) Gingerol is the chemical compound responsible for the pungent aroma of ginger. Cooking ginger reduces its pungency, making it less spicy and sweeter. However, when ginger is dried, it becomes more pungent than fresh ginger.



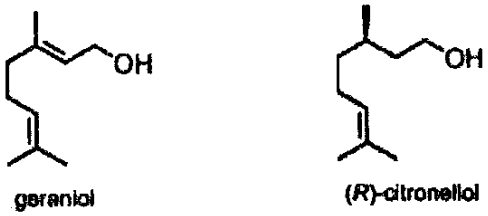
I. What are the two reactions that gingerol could undergo during cooking and drying? (10 marks)

II. Propose structures for the reaction products. (10 marks)

(25 marks)

(b) (i) Define the term 'value addition' as applied in oil industries. (05 marks)

(ii) Citronellal and citronellol are the major constituents of value-added citronella oil exported from Sri Lanka. Show how you would obtain citronellol from geraniol?



(05 marks)

(10 marks)

(c) Steam distillation is the most widely used method for the large-scale extraction of essential oils from aromatic plant materials.

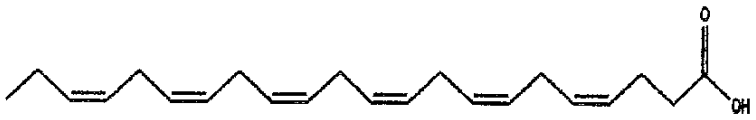
(i) Briefly describe the steam distillation technique of extracting an essential oil. (10 marks)

(ii) What is the difference between steam distillation and hydrodiffusion? (10 marks)

(iii) State **two (02)** examples of aromatic plant materials that could be used to extract essential oils by steam distillation. (10 marks)

(30 marks)

(d) Structure of a fatty acid, docosahexaenoic acid is given below.



(i) Classify the above acid according to the position of double bond from the methyl end. (05 marks)

(ii) Write the IUPAC name and the shorthand notation of the docosahexaenoic acid. (10 marks)

(iii) The melting point of fats is an important parameter in preparing fats of the desired texture from oils. The melting point depends on the structures of fatty acids found in the glycerides. Explain the trend in the melting points for the fatty acids given in the following table. (20 marks)

Fatty acid	Melting point (°C)
Stearic acid (18:0)	70
Oleic acid (18:1, cis - 9)	13
Linoleic acid (18:2 cis, cis – 9. 12)	-5

(35 Marks)

4. (a) Heavy and vapor components of petroleum are used during hydrocracking to produce gasoline.

(i) What is hydrocracking? (10 marks)

(ii) Give an example each for acidic and metallic components used to facilitate hydrocracking and identify the reactions facilitated by each component. (10 marks)

(20 Marks)

(b) According to the chemical composition, refined petroleum is categorized into different series such as paraffin, olefin, etc.

(i) Write down the chemical composition of the paraffin series and olefin series using suitable examples. (10 marks)

(ii) Briefly explain the major refining method of petroleum. (20 marks)

(30 marks)

(c) The octane number of butane is increased by catalytic reforming.

(i) Describe catalytic reforming and provide an example of a catalyst used in the process. (10 marks)

(ii) Using a balanced chemical equation, show how it increases the octane number of butane during catalytic reforming. (10 marks)

(iii) Briefly explain why petroleum feedstock is passed through a Co-Mo catalyst bed in the presence of H_2 during the refining process. (10 marks)

(30 marks)

(d) Propylene produced by the thermal cracking of butane is used to produce isopropanol by hydration.

(i) Write down the balanced chemical reaction producing propylene from butane. (08 marks)

(ii) Including reagent and conditions, write down the balanced chemical reaction producing isopropanol from propylene. (12 marks)

(20 marks)

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