



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF SECOND SEMESTER EXAMINATIONS – JUNE 2010
UNIT OPERATIONS – SCH 2208
TIME: 3 HOURS

Instructions and notes to Candidates

1. There are two sections to this paper: A and B.
 2. Answer ***all*** questions in Section A (40 marks).
 3. Answer ***any three*** questions in Section B (60 marks).
 4. Section A carries 5 questions while Section B carries 4 questions.
 5. Show all your working steps logically.
 6. Write legibly.
 7. Start answers for each question on a fresh page.
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SECTION A (40 Marks)

1. a) State two scientific principles and techniques which are basic to the treatment of unit operations. [2 marks]
- b) Copy and complete the diagram below.

Difference of Evaporation with other unit operations

Other unit operation	Evaporation
1. Drying	
2. Distillation	
3. Crystallizations	

[6 marks]

2. a) State the objective of evaporation. [2 marks]
- b) Define the following terms
 - i) Evaporator capacity [2 marks]

- ii) Evaporator economy [2 marks]
 - iii) Boiling point elevation [2 marks]
3. a) State the following laws:
- i) Conservation of mass [2 marks]
 - ii) Conservation of energy [2 marks]
- b) List four uses of material balances. [4 marks]
4. a) What is vacuum distillation? [2 marks]
- b) Compare and contrast washing to leaching. [4 marks]
- c) State the Van't Hoff equation. [2 marks]
5. In a single-stage, continuous distillation column used for enriching alcohol/water mixtures, the feed contains 12% of alcohol, and 25% of the feed passes out with the top product (the "vapour" stream) from the still. Given that, at a boiling temperature of 95.5°C, 1.9 mole% of alcohol in the liquid is in equilibrium with 17 mole% of alcohol in the vapour, estimate the concentration of alcohol in the product from the still. [8 marks]

SECTION B

6. a) With the aid of diagrams, compare and contrast flash distillation to flash evaporation. [8 marks]

b) 1000 kg of soya beans, of composition 18% oil, 35% protein, 27.1% carbohydrate, 9.4% fibre and ash, 10.5% moisture, are:

- crushed and pressed, which reduces oil content in beans to 6%;
- then extracted with hexane to produce a meal containing 0.5% oil;
- finally dried to 8% moisture.

Assuming that there is no loss of protein and water with the oil, set out a mass balance for the soya-bean constituents.

Basis 1000 kg [7 marks]

c) Give five types of contact equilibrium separation processes and an example for each. [5 marks]

7. a) Explain the meaning of the following terms as applied in liquid extraction (solvent extraction).

- i. Fractional extraction
- ii. Raffinate
- iii. Extract [3 marks]

b) Discuss the five quantities that need to be considered when making a choice for solvent in liquid extraction. [10 marks]

c) After precipitation and draining procedures, it is found that 100 kg of fresh casein curd has a liquid content of 66% and this liquid contains 4.5% of lactose. The curd is washed three times with 194 kg of fresh water each time. Calculate the residual lactose in the casein after drying. Also calculate the quantity of water that would have to be used in a single wash to attain the same lactose content in the curd as obtained after three washings. Assume perfect washing, and draining of curd to 66% of moisture each time. [7 marks]

8. a) With the aid of a diagram, explain what is freeze drying. Give examples of its industrial application. [7 marks]

b) Discuss the effect of feed temperature in the economy of the evaporator effect, with the aid of diagrams and reference to Webre's experiment, on forward feed multiple effect evaporators in contrast to backward feed multiple effect evaporators . [8 marks]

c) A wet solid is dried from 25 to 10 per cent moisture under constant drying conditions in 15 ks (4.17 h). If the critical and the equilibrium moisture contents are 15 and 5 per cent respectively, how long will it take to dry the solid from 30 to 8 per cent moisture under the same conditions? [5 marks]

9. Identify a chemical process industrial plant in Zimbabwe involved in exportation of its products. Describe and explain the unit operations involved in their sequential order. Draw a process flow chart of the plant. Explain the role of a chemical engineer in the plant. [20 marks]