



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF SECOND SEMESTER EXAMINATIONS – MAY 2011
PRINCIPLES OF PROCESS ENGINEERING – SCH 2218
TIME: 3 HOURS

Instructions and notes to Candidates

1. There are three sections to this paper: A and B.
2. Answer ***all*** questions in Section A (40 marks).
3. Answer ***any two*** questions in Section B (40 marks).
4. Answer ***all questions*** in Section C (20 marks).
5. Section A carries 5 questions, Section B carries 3 questions and Section C carries 1 question.
6. Show all your working steps logically.
7. Write legibly.
8. Start answers for each question on a fresh page.
9. Graph Paper is required.

SECTION A (40 Marks)

1. Fill in the table below:

Transport Process	Driving force	Resistance	Industrial Application
Heat transfer		Conductivity	
Momentum transfer			
Mass transfer			

[8 marks]

2. Fill in the blanks

a) A _____ is any part of potentially multiple-step process which can be considered to have a single function for example _____ and _____

[3 marks]

- b) _____ is a process which is generally used to separate a mixture of two or more liquids based on their boiling points but _____ is used for concentrating solutions. [2 marks]
- c) In evaporation, _____ evaporator is used for producing condensed milk, whilst a _____ evaporator is widely used for concentrating heat sensitive materials such as orange juice because the hold up time is very small. [2 marks]
- d) The general transport equation is given by _____. [1 mark]
3. a) List four conservation laws. [4 marks]
- b) State the following equations;
- i) Newton's Law of Viscosity.
- ii) Stefan-Boltzmann equation. [4 marks]
4. a) With the aid of a shear stress- shear rate graph and relevant examples, explain the difference between:
- i) Dilatants and pseudo-plastics.
- ii) Bingham plastic and Newtonian fluid. [4 marks]
- b) State the following;
- i) Buckingham Pi theorem.
- ii) Newton's law of viscosity. [4 marks]
5. a) Compare and contrast pasteurization and sterilization. [6 marks]
- b) State Fick's Law. [2 marks]

SECTION B (40 marks)

6. a) Derive the continuity equation of an incompressible fluid. [5 marks]
- b) With the aid of a diagram, compare and contrast;
- i) Laminar and turbulent flow.
- ii) Absolute and gauge pressure. [10 marks]
- c) Derive the Bernoulli equation, with the aid of a diagram. [5 marks]
7. a) With the aid of a diagram, explain the principle of operation of a Bollmann
Extractor, and give examples of its industrial application. [8 marks]
- b) Calculate the greatest pressure in a spherical tank, of 3.50m radius, filled with
linseed oil of specific gravity 0.87, if the pressure at the highest point is 760kPa.
Density of water is 1000kg/m^3 . [6 marks]
- c) Water flows at the rate of $0.4\text{m}^3/\text{min}$ in a 7.5cm diameter pipe at a pressure of
70kPa. If the pipe reduces to 5cm diameter, calculate the new pressure.
[6 marks]
8. a) With the aid of a diagram, explain what is freeze drying. Give examples of its
industrial application. [7 marks]
- b) In 1922, Webre examined the effect of feed temperature on the economy and the
evaporation in each effect, for the case of a liquor fed at the rate of 12.5 kg/s to a
triple-effect evaporator in which a concentrated product was obtained at a flow
rate of 8.75 k g/s. Using the results obtained by Webre, explain the relationship
between evaporator economy and initial feed temperature for backward feed triple
effect evaporator. [8 marks]

c) In the concentration of orange juice a fresh extracted and strained juice containing 7.08 wt % solids are fed to a vacuum evaporator. In the evaporator, water is removed and the solids content increased to 58 wt % solids. For 1000 kg/h entering, calculate the amounts of the outlet streams of concentrated juice and water. [5 marks]

SECTION C (20 marks)

8. One of the Millennium Development Goals is having eradication of diseases such as malaria by around 2030. Understanding transport processes and unit operations (separation processes) can be of importance in eradicating diseases. The Ministry of Health and Child Welfare (MHCW) is facing a number of problems in achieving this MDG in Zimbabwe. Advise MHCW on the role of transport phenomena and unit operations in disease eradication.

[20 marks]

END OF QUESTION PAPER!!!