



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF APPLIED CHEMISTRY

PRINCIPLES OF PROCESS ENGINEERING

SCH 2218

Second Semester Examination Paper

May 2015

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph paper

Examiner's Name: Mr. B. Nyoni

INSTRUCTIONS

1. Answer all questions in Section A and any other three questions from Section B.
2. Each question carries 20 marks.
3. Show steps clearly in any calculation.
4. Start the answers for each question on a fresh page.
5. Use of calculators is permissible.

MARK ALLOCATION

QUESTION	MARKS
1.	20
2.	20
3.	20
4.	20
5.	20
TOTAL POSSIBLE MARKS	100

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SCH 2218

SECTION A

1 (a) Define the following terms:

(i) Transport phenomena

(ii) Unit Operation

(iii) Specific gravity [6 marks]

(b) Give a half a page motivation as to why an Applied Biology/Biochemistry student should study the Principles of Process Engineering course. [6 marks]

(c) Define the term fluid statics. [3 marks]

(d) What do you understand by the term Newtonian fluid? Give two examples. [5 marks]

2 (a) What do you understand by the term 'a dimensionally consistent equation'. [3 marks]

(b) Check the dimensional consistency of the following equation for determining the velocity:

$$u = \sqrt{\frac{2g(\rho_m - \rho)\Delta z}{\rho}}$$

where

u – velocity

g – acceleration due to gravity

ρ_m – density

ρ – density

Δz – length

[14 marks]

(c) What is the velocity, given the following data:

$$g = 9.81 \text{ m/s}^2$$

$$\rho_m = 3200 \text{ kg/m}^3$$

$$\rho = 1000 \text{ kg/m}^3$$

$$\Delta z = 3.2 \text{ m}$$

[3 marks]

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SCH 2218

SECTION B

- 3 (a) Explain the difference between Newtonian and non-Newtonian fluid [4 marks]
- (b) Derive the equation of continuity for fluid flow. [8 marks]
- (c) A piping system is conveying $0.28 \text{ m}^3/\text{s}$ of alcohol. At a particular cross section of the system, section 1, the pipe diameter is 0.30 m, the pressure is 124 kPa, and the elevation is 42.7 m. At another cross section further downstream, section 2, the pipe diameter is 0.20 m, and the elevation is 32.3 m. What is the pressure at section 2? Assume that the specific gravity of the alcohol is 0.79. [8 marks]

- 4 (a) State two differences between batch and continuous distillation. [4 marks]
- (b) A distillation column is fed with a mixture of benzene and toluene, in which the mole fraction of benzene is 0.35. The column is to yield a product in which the mole fraction of benzene is 0.95, when working with a reflux ratio of 3.2, and the waste from the column is not to exceed 0.05 mole fraction of benzene. If the plate efficiency is 60 per cent, estimate the number of plates required. The relation between the mole fraction of benzene in liquid and in vapour is given in Table 1:

Table 1

Mole fraction of benzene in liquid (x)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Mole fraction of benzene in vapour (y)	0.20	0.38	0.51	0.63	0.71	0.78	0.85	0.91	0.96

[15 marks]

- (c) State any one material that is used for the construction of a distillation column. [1 mark]

- 5 (a) Describe and explain the difference between drying and evaporation. [3 marks]
- (b) With the aid of diagrams, explain the terms (i) single effect and (ii) multiple effect evaporators. [7 marks]
- (c) State one advantage of multiple effect evaporation compared to single effect evaporation. [2 marks]

(d) 2000 kg of a 5 per cent slurry of calcium hydroxide in water is to be prepared by diluting a 20 per cent slurry. Draw a block diagram describing this process. Perform mass balance calculations to determine the quantities required. The percentages are by weight.

[8 marks]

6 (a) State two reasons for drying products.

[4 marks]

(b) A wet solid is dried from 25 to 15 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?

[10 marks]

(c) Describe any two industrial equipments used for drying.

[6 marks]

End of Question Paper!!!