NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF SECOND SEMESTER EXAMINATIONS – MAY 2014
PRINCIPLES OF PROCESS ENGINEERING – SCH 2218
TIME: 3 HOURS

Instructions to candidates:

1. Answer all questions in Section A and any three questions in Section B.
2. Show all your steps clearly in any calculation
3. Start the answers for each question in a new page

Extra material

1. Graph paper
2. Conversion Factors Chart

SECTION A

1 (a) Define the term ***Transport Phenomena*** and ***Unit Operation,*** *and* give one example of each. [6]

(b) In Junior Certificate Science, *Diffusion* was defined as the movement of molecules from a region of high, to a region of low concentration. Using analogy, define the following terms:

(i) fluid fow

(ii) heat transfer [4]

(c) Explain how the colour from a piece of dye placed at the bottom of a water filled beaker spreads throughout the beaker on its own. [5]

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

2 (a) What do you understand by the term *'a dimensionally consistent equation'*. [4]

(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 [13]

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

$g = 9.81\ m/s^2$
$\rho_m = 3200\ kg/m^3$
$\rho = 1000\ kg/m^3$
$\Delta z = 3.2\ m$ [3]

SECTION B

3 (a) Explain the difference between Newtonian and non-Newtonian fluid [4]

(b) Derive the equation of continuity for fluid flow [8]

(c) A piping system is conveying 0.28 m^3/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]

4 (a) What do you understand by the term distillation. Give two types of distillation [4]

(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]

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

5 (a) State the three methods of operating evaporators. [3]

(b)With the aid of diagrams, explain the terms (i) single effect and (ii) multiple effect evaporators. [8]

(c) State one advantage of multiple effect evaporation compared to single effect evaporation. [1]

(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]

6 (a) Describe and explain the difference between drying and evaporation. [6]

(b) 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? [8]

(c) Describe any two industrial equipment used for drying. [6]

END OF QUESTION PAPER!!!