NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF SECOND SEMESTER EXAMINATIONS – JUNE 2010
PRINCIPLES OF PROCESS ENGINEERING – SCH 2218
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.

SECTION A (40 Marks)

1) a) State the general rate of transport equation.   [2 marks]

   b) Copy and complete the table below

Transport Process	Driving force	Resistance
Fluid flow		Viscosity, density of liquid
Heat transfer		
		Diffusivity
	Density	Viscosity, density of liquids

[6 marks]

2) a) State the Buckingham Pi theorem.   [2 marks]

   b) Define the following terms

   i)   Shear stress   [2 marks]

   ii)   Viscosity   [2 marks]

   iii)   Newtonian fluid   [2 marks]

3) a) Define a black body. [2 marks]

   b) State the following

      i)   Newton's law of cooling [2 marks]

      ii)   Fourier equation [2 marks]

      iii) Stefan-Boltzmann equation [2 marks]

4) a) Calculate the greatest pressure in a spherical tank, of 2m diameter, filled with peanut oil

   of specific gravity 0.92, if the pressure measured at the highest point is 70 kPa. Density

   of water is 1000 kg/m^3. [4 marks]

   b) List the limitations of Bernoulli equation. [4 marks]

5)   Water flows at the rate of 0.4m^3/min in a 7.5 cm diameter pipe at a pressure of 70 kPa. If

      the pipe reduces to 5 cm diameter calculate the new pressure in the pipe.

                                                                          [8 marks]

SECTION B

6)   a)   The viscosity of a fluid can be measured using a number of techniques. With the

           aid of a diagram explain how viscosity of a fluid can be determined using the

           Saybolt method. [7 marks]

      b)   With the aid of a shear stress-shear rate graph and relevant examples explain

           i)   The difference between a dilatants and pseudoplastic. [5 marks]

           ii) The difference between a Bingham plastic and Newtonian fluid

                                                                          [5 marks]

      c)   State the Bernoulli equation. [3 marks]

7)   a)   In the concentration of orange juice, a fresh extracted and strained juice containing 7.08 wt % solids is 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 mounts of the outlet streams of concentrated juice and water.   [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:

          i.   crushed and pressed, which reduces oil content in beans to 6%;

          ii.   then extracted with hexane to produce a meal containing 0.5% oil;

          iii. 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   [12 marks]

8)   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]

9) 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]

END OF QUESTION PAPER!!!