NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

TRANSPORT PHENOMENA

SCH 2108

Supplementary Examination Paper

July 2016

This examination paper consists of 4 pages

Time Allowed: 3 hours
Total Marks: 100
Special Requirements: None
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**
6.	**20**
TOTAL POSSIBLE MARKS	**100**

SECTION A

1 (a) Define the term *'dimension'* and list the seven basic quantities and their SI units. [10]

(b) What are the physical meanings of the following dimensionless groups:

(i) Reynolds number

(ii) Prandtl number

(iii) Nusselt number [10]

2 (a) What do you understand by the term *'a dimensionally consistent equation'*. [5]

(b) Check the dimensional consistency of the following empirical equation for a heat-transfer coefficient.

$$h_i = 0.023G^{0.8}k^{0.67}c_p^{0.33}D^{-0.2}\mu^{-0.47}$$

given h_i = heat transfer coefficient ($W/m^2.^oC$)

G = mass velocity ($kg/s.m^2$)

k = thermal conductivity ($W/m.^oC$)

c_p = specific heat ($J/g.^oC$)

D = diameter

μ = absolute viscosity (kg/m.s) [12]

(a) What is the heat transfer coefficient, given the following data:

$G = 54\ kg/s.m^2$

$k = 0.12\ W/m.^oC$

$c_p = 4.2\ J/g.^oC$

$D = 0.11\ m$

$\mu = 0.034\ kg/m.s$ [3]

SECTION B

3 (a) Define the following terms;

i) Viscosity

ii) Density [4]

(b) Describe and explain the difference between a Newtonian and non-Newtonian fluid and give an example of each. [6]

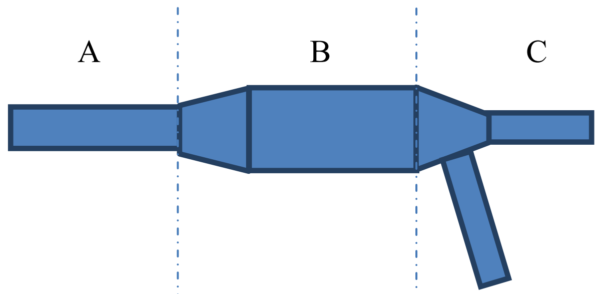
(c) Prove that the resistance (F) of a sphere with diameter (D) moving at a constant speed (u) through a fluid of density (ρ) and viscosity (μ) is given by:

$$F = \left(\frac{\mu}{\rho^2}\right) f\left(\frac{\rho u D}{\mu}\right)$$ [10]

4 (a) Derive the basic equation of fluid statics. [8]

(b) Crude oil, specific gravity = 0.887, flows through the piping shown, where pipe A is 50 mm, pipe B is 75 mm, and each of pipes C is 38 mm. An equal quantity of liquid flows through each of the pipes C. The flow through pipe A is 6.65 m^3/h. Calculate (a) the mass flowrate through each pipe, (b) the average linear velocity through each pipe.

[Take π =3.142]



[12]

5 (a) Discuss the mechanisms of heat transfer by which the sun transfers its energy to the earth's surface. [6]

(b) Describe any two heat exchanger types of your choice. [4]

(c) Calculate the rate of heat transfer by solar radiation on a flat concrete roof of a building, 8 m by 9 m, if the surface temperature of the roof is 330 K. The emissivity of concrete at 330 K is 0.89, whilst the total absorptivity of solar radiation (sun temperature = 5500 K) at this temperature is 0.60. [10]

6 (a) State Fick's law of diffusion. [3]

(b) Describe any two mass transfer equipment of your choice. [4]

(b) A mixture of He and N_2 is contained in a pipe at 298K and 1 atm total pressure which is constant throughout. At one end of the pipe at Point 1, the partial pressure P_{A1} of He is 0.60 atm and at the other end 0.2 m, P_{A2} is 0.20 atm.

Calculate the flux of He if D_{AB} is $0.687 \times 10^{-4} m^2/s$.

$R = 82.057 m^3 atm/kmolK$.

[10]

(c) Explain the concept of equimolar diffusion. [3]

End of Question Paper!!!