



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY

END OF SEMESTER EXAMINATIONS – APRIL 2009

TRANSPORT PHENOMENA – SCH 2108

TIME – (3) THREE HOURS

INSTRUCTIONS TO CANDIDATES

Answer ALL questions from Section A and ANY THREE questions from Section B.

SECTION A

1. (a) Define the following terms:
 - (i) Hydrostatic paradox
 - (ii) Absolute pressure
 - (iii) Gauge pressure (6 marks)
- (b) With the aid of a sketch diagram represent absolute and gauge pressures. (14 marks)
2. (a) State the Buckingham PI theorem. (2 marks)
- (b) Define the following terms:
 - (i) Conduction
 - (ii) Convection
 - (iii) Radiation (6 marks)
3. (a) State the continuity equation. (3 marks)
- (b) Define what is called *Shear Stress*. (2 marks)
- (c) By means of a diagram, or if you prefer by simply describing in words, how are fluids classified? (2 marks)

- (d) Explain the difference between the mass of an object and the weight of an object. (2 marks)
4. In a plant you have purchased out of the United States, the following designations are used for values on the equipment:
- (i) psi (1 mark)
 - (ii) psig (1 mark)
 - (iii) psia (1 mark)
5. State the equation of the total energy. (4 marks)

SECTION B (Answer Any Three Questions)

1. (a) Explain the forces acting on the flowing fluid at a steady state without friction losses. Illustrate your answer by drawing a diagram. (5 marks)
- (b) Derive the Bernoulli's equation. (12 marks)
- (c) What does each term represent in the Bernoulli Equation. (3 marks)
2. (a) Name some five pressure sensing devices that are used? (5 marks)
- (b) At low speeds, fluids tend to flow in a steady and reproducible manner.
- i. What is the term used in fluid mechanics to describe the type of flow described above (b)? (2 marks)
 - ii. Draw the velocity profile that will result from the flow pattern described under (b). (3 marks)
 - iii. State the critical Reynolds region. Explain the significance of the region. (5 marks)
- (c) What is Fourier's law of thermal conductivity? (2 marks)

- (d) Why is thermal insulation used in industry? (3 marks)
3. (a) A 0.02m thick steel pipe of thermal conductivity 43W/mK with an inside diameter of 0.06m is used to carry steam at 115°C from a boiler to a process point 6 m away. If the pipe is covered with 0.05m thick insulation of thermal conductivity 0.07W/mK . What is the heat loss if the temperature is 24°C ? (12 marks)
- (b) Sketch a temperature versus distance graph for a co-current heat exchanger. (2 marks)
- (c) Write down the formulae of the following indicating the meaning of the symbols:
- (i) Prandtl number (3 marks)
- (ii) Nusselt number (3 marks)
4. (a) Natural convection and radiation cool an electronic cabinet made of anodised aluminium. The surface area of the cabinet is 0.368m^2 , the temperature of the surrounding fluid and surface is 25°C , and $h=6.8\text{W}/(\text{m}^2\text{C})$. Estimate the rate of heat transfer from the cabinet if its surface temperature is to be maintained at 125°C . Draw a sketch diagram depicting the cabinet and label it. Comment on the individual results. (12 marks)
- (b) Define a blackbody. (2 marks)
- (c) Define the following terms:
- i. Local mass transfer coefficient
 - ii. Overall mass transfer coefficient
 - iii. Give the relationships between local and overall mass transfer coefficients
- (6 marks)

END OF QUESTION PAPER!!!