

BOWEN UNIVERSITY, IWO, OSUN STATE
COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE
INDUSTRIAL CHEMISTRY PROGRAMME
2022/2023 B.SC DEGREE FIRST SEMESTER EXAMINATION

Course Code: ICH 217 **Course Title:** Process Science I **Credit Unit:** 3
Date: Thursday, 16/03/2022 **Time Allowed:** 2½ hours

INSTRUCTIONS (a) Answer any FOUR (4) questions
(b) Answer each question on a fresh page

QUESTION ONE

- a. Define the following terms:
- i. Material cost
 - ii. Process science
 - iii. Conversion cost
 - iv. Optimization
 - v. Cost efficiency **10 marks**
- b. Manufacturing companies use different processes in getting their final products. Discuss using suitable examples the different process classifications that could be used in manufacturing companies. **8 marks**
- c. As a new Manager at Bowen Central Research Laboratory, explain in details the different methods of data analysis. **7 marks**

QUESTION TWO

- a. Industrial separation processes are technical procedures which are used in industries to separate a product from impurities or other products. List and explain any three of these methods. **9 marks**
- b. Explain the term “Process flow sheet” **6 marks**
- c. Briefly explain the importance of process flow sheet. **10 marks**

QUESTION THREE

- a. Write short notes on the following
- i. Energy Balance
 - ii. Stoichiometry
 - iii. Laminar flow
 - iv. Turbulent flow **10 marks**
- b. What are Pumps? What factors must one consider when choosing pumps. **8 marks**
- c. Write brief notes on any three of the following reciprocating pumps
- i. Piston pumps
 - ii. Plunger pumps
 - iii. Metering pumps and
 - iv. Diaphragm pumps **7 marks**

QUESTION FOUR

- a. State Fourier's Law **2 marks**
- b. List and explain in not more than three sentences, the various types of heat transfer process **5 marks**
- c. Let us consider two water columns at different temperatures, one being at 40°C and the other at 20°C. As both the water columns are separated by a glass wall of area 1m by 2m and a thickness of 0.003m. Calculate the amount of heat transfer. (Thermal conductivity of glass is 1.4W/mK) **8 marks**
- d. A spherical capsule of 4cm diameter is contained in an evacuated box with nearly black walls at 30°C. Heat radiates from the capsule to the walls. If the capsule emittance is 300milliwatts, what will be the capsule temperature?
- Bright aluminum
 - Bright iodized aluminum **10 marks**
- Hint:** $\sigma = 5.67 \times 10^{-8} \text{ Watt/m}^2 \text{ k}^4$, Bright aluminum material, $E_1 = 0.035$ and Bright oxidized aluminum material, $E_1 = 0.8$.

QUESTION FIVE

- a. Write briefly on differential distillation **5 marks**
- b. Highlight the major components of distillation process **5 marks**
- c. Hydrogen is produced by adding water to sodium. If sodium hydroxide is produced alongside hydrogen
- Write the stoichiometric equation for the reaction
 - What is the stoichiometric ratio of hydrogen to sodium?
 - How many grams of water will react to form 0.81 grams of hydrogen? **5 marks**
- d. About 1200 kg/hr of mixture of benzene and toluene containing 35% benzene by mass was separated by distillation into a top and bottom distillation. The mass flow rate of benzene in the top stream is 400 kg Benzene/hr (400 kg B/hr) and that of toluene in the bottom stream is 475 kg Toluene/hr. Assume the operation occurred at steady state, Determine the mass fraction and flow rate of all the components in the flow stream **10 marks**

QUESTION SIX

- a. State Newton's law of cooling and identify various head in the equation **5 marks**
- b. Highlight the factors affecting convective heat transfer **5 marks**
- c. A heat exchanger is required to cool 30 kg/s of water from 360 K to 340 K by means of 35 kg/s water entering at 300 K. If the overall coefficient of heat transfer is constant at 2 kW/m²K, calculate the surface area required in
- a countercurrent concentric tube exchanger
 - a co-current flow concentric tube exchanger **15 marks**