141

RAJARATA UNIVERSITY OF SRI LANKA

FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences

Third Year - Semester I Examination – November/December 2016

CHE 3206 – THEORITICAL FUNDAMENTALS OF CHEMICALINDUSTRY /

CHEMICAL AND PROCESS TECHNOLOGY

All symbols carry standard meanings.

Standard symbols may be used without a definition

Graph sheets will be provided

Time allowed two hours

All questions carry equal marks

Answer all questions **Time: TWO (02) hours**

---

1. (a). State the meaning of "sustainable development".

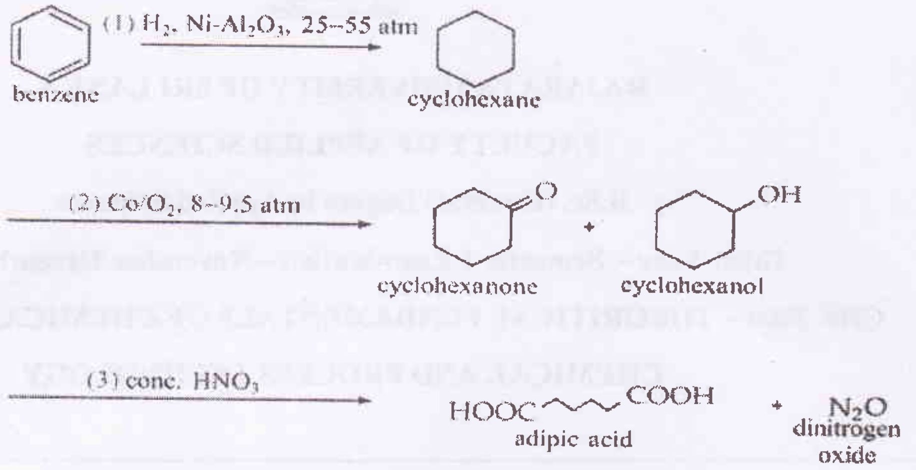
   (b). State any five principles of green chemistry. Discuss their relevance to sustainable development programs.

   (c). State two chemical accidents occurred in past highlighting possible reasons.

   (d). State the importance of President Green Chemistry Challenge Awards for the development of new industries.

142

2. (a) Industrial synthesis of adipic acid is shown below.



(i). State two uses of adipic acid.

(ii). Discuss the environmental problems encountered by this process.

(iii). Suggest a green chemical synthesis route for adipic acid production.

(b) State the meaning of ionic crystals as applied to industrial chemical process. Discuss their industrial uses giving relevant examples.

3. (a) Define following terms as applied to chemical industry

(i) Conversion (ii). Yield (iii). Selectivity (iv). Limiting species

(b) The trimerization

$$3A(g) \rightarrow A_3(g,l)$$

is carried out isothermally and without pressure drop in a PFR at 298 K and 2 atm. As the concentration of A3 increases down the reactor and A3 begins to condense. The vapor pressure of A3 at 298 K is 0.5 atm. An equal molar mixture of A and inert, I, is fed to the reactor system.

(i). State the condition for condensation of A_3.

(ii). State the limiting species in the reaction. Develop a stoichiometry table.

(iii). Calculate the conversion where A begins to condense.

4. (a) Prove that for a given species A, $F_{A,O} - F_A + \int rdV = \frac{dN_A}{dt}$. All symbol carries standard meanings

(b). Using the equation shown in section (a), derive design expressions for following ideal reactors.

(i) Batch reactor (ii). CSTR (iii). PFR

(c). The gas phase irreversible reaction

$$A + B \rightarrow C$$

is elementary. The entering flow rate of A is 10 mol/min and is equal molar in A and B. Thè entering concentration of A is 0.4 mol/dm^3.

(i) What is the CSTR reactor volume necessary to achieve 90% conversion?

(ii) What PFR volume is necessary to achieve 90% conversion?

Additional Information

$$k = 2 \text{ dm}^3/\text{mol}\bullet\text{min}$$
$$T_0 = 500 \text{ K.}$$

5. (a). State the Fick's Laws of diffusion identifying all terms.

(b). Define following terms:

(i). Vacancy diffusion
(ii). Steady state diffusion
(iii). Self diffusion

(c). To increase its corrosion resistance, chromium (Cr) is diffused into steel at 980°C. If during diffusion the surface concentration of chromium remains constant at 100%, how long will it take (in days) to achieve a Cr concentration of 1.8% at a depth of 0.002 cm below the steel surface? (D_o = 0.54 cm^2/s; E_A = 286 kJ/mol)

(d). The energy of vacancy formation, ΔH_v, in palladium (Pd) is 1.5 eV. At 888°C there is one vacancy for every million (10^6) atomic sites. Is it possible, by simply raising the temperature and ***not exceeding the melting point of the metal***, to achieve a vacancy fraction of one vacancy for every thousand (10^3) atom sites? Hint: $f_v = exp\left(-\frac{\Delta H_v}{k_B T}\right)$