UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. *M.Eng.*

Chemical Eng E875: Advanced Material Processes and Product Engineering

COURSE CODE	:	**CENGE875**
UNIT VALUE	:	**0.50**
DATE	:	**19-MAY-03**
TIME	:	**10.00**
TIME ALLOWED	:	**3 Hours**

03-C0198-3-40

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ANSWER question 1 from Part A (compulsory), one question from Part B and two questions from Part C. All questions carry a total of 25 marks, distributed as shown [ ]. **Only the first four answers will be marked.**

PART A

1.

i) Derive an equation for the solubility, expressed as mole-fraction (y_2), of a solid compound 2 in a supercritical fluid 1, as a function of the fugacity coefficient of this compound in the supercritical fluid phase. [10]

ii) Making reasonable assumptions simplify this equation. [2]

iii) Describe the procedure to solve this equation and calculate solubility. [7]

To solve this equation you would need to derive an expression for the fugacity coefficient. Which of the following two equations would you use and why?

$$ln\phi_2 = \int_0^P [\frac{\bar{v}_2}{RT} - \frac{1}{P}] dP$$

or

$$ln\phi_2 = \int_V^\infty [\frac{1}{RT}(\frac{dP}{dn_2})_{T,V,n_1} - \frac{1}{V}] dV - \ln\frac{PVm}{RT}$$ [2]

Making a reasonable assumption derive a short-cut method to solve the above problem. Use the following fugacity coefficient expression from the Peng-Robinson equation of state to demonstrate this. Describe the simplified procedure to solve the solubility equation.

$$ln\phi_2 = \frac{b_2}{b}(\frac{PV_m}{RT} - 1) - \ln\frac{P(V_m - b)}{RT}$$

$$- \frac{a}{2\sqrt{2}bRT}\left\{\frac{2[a_{12} + y_2(a_{22} - a_{12})]}{a} - \frac{b_2}{b}\right\}.\ln\frac{V_m + (1+\sqrt{2})b}{V_m + (1-\sqrt{2})b}$$ [4]

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PART B

2.

a) What is the kinetic effect of pressure on chemical reactions? Explain its origin and name the characteristic quantity that determines the kinetic effect. [5]

Explain the solvent effect of pressure on chemical reactions and its origin. Based on that, explain the dramatic effect of pressure on chemical reactions in near critical and supercritical media. [5]

b) In flame retardant chemistry, describe referring to the combustion cycle the terms solid phase inhibition and vapour phase inhibition. [6]

Describe the mechanism of intumescence in flame retardant coatings. [9]

3.

a) Present a schematic model of polymer dissolution and formulate the differential equations describing the process. [9]

b) Using an approximation, solve the system equations and calculate gel thickness. [13]

c) What is the maximum value for the gel thickness? Explain your answer. [3]

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PART C

4.

a) Name the phases of a generic product development process. Explain and discuss them. [7]

b) Expand the first phase of the product development process into the front end process. Name the front end activities and order them in a block diagram. Discuss each activity. [12]

c) Name the two extreme cases of product development organisations and discuss their strengths and weaknesses. Name the hybrid models and present all four types in a schematic explanatory diagram. [6]

5.

a) Name and discuss the six steps of the process of identifying customer needs. [9]

b) Name and discuss the four steps of establishing target specifications. [7]

c) Name and discuss the four steps of setting the final product specifications. [9]

6.

a) Explain the meaning of product architecture. Explain and discuss the properties of a modular product architecture vs. an integral architecture. Name and discuss the types of modularity. [8]

b) Name and discuss the implications of product architecture. [8]

c) Name and discuss the steps for establishing the product architecture. [9]

END OF PAPER