Mini Mock Exam

CHE-2C2Y COURSE TEST 2

Name: ___________________________________

There are five little random questions in this booklet from the entire course.

Read through the question carefully and answer in full.

No cheating!

Question	**Maximum Mark** (%)	**Your Mark** (%)
1	20	
2	20	
3	20	
4	20	
5	20	
	Total Percentage	

Question 1

Thermodynamics I

1. Calculate ΔS, ΔS_{surr} and ΔS_{tot} for:

(a) the isothermal, reversible expansion

(b) the isothermal, free expansion

of one mole of ideal gas molecules from 8.00 L to 20.00 L and 292 K. Explain any differences between the two paths.

[20%]

Question 2

Thermodynamics 2

2. a. Draw a pressure – temperature phase diagram for a single component mixture ensuring that you show any phase boundaries and label the triple point, critical point, and region of supercritical fluid.

[10%]

b. At 276 K the osmotic pressure of a protein solution is 172 N m^{-2}. The concentration is 1 g in 200 cm^3 of solution. Assuming ideal behaviour calculate:

i. the concentration of the protein in mol m^{-3}

[5%]

ii. the molar mass of the protein in g mol^{-1}

[5%]

Question 3

Complex Kinetics

3. The following Rice-Herzfeld mechanism is shown:

$CH_3CHO \rightarrow CH_3^{\bullet} + CHO^{\bullet}$	k_1	☐
$CH_3CHO + CH_3^{\bullet} \rightarrow CH_3CO^{\bullet} + CH_4$	k_2	☐
$CH_3CO^{\bullet} \rightarrow CH_3^{\bullet} + CO$	k_3	☐
$2\ CH_3^{\bullet} \rightarrow C_2H_6$	k_4	☐

a. Label which reaction steps are Initiation, Propagation and Termination steps by placing I, P or T respectively in the boxes.

[5%]

b. Apply a suitable approximation to show that the rate of formation of methane can be expressed as:

$$\frac{d[CH_4]}{dt} = k_2\sqrt{\frac{k_1}{2k_4}}[CH_3CHO]^{3/2}$$

[15%]

Question 4

Theories of Chemical Reactions

4. a. In a temperature jump the relaxation time, τ, is measured. Show that for the reaction

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} C + D$$

the relaxation time is given by

$$\frac{1}{\tau} = \{k_1([\bar{A}] + [\bar{B}]) + k_{-1}([\bar{C}] + [\bar{D}])\}$$

[10%]

b. For an ion combination reaction, $A^+ + B^- \rightarrow AB$, calculate d_{eff} with a dielectric constant of 80.

$d_{AB} = 4 \times 10^{-10}$ m, $e = 1.6 \times 10^{-19}$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$ J^{-1} C^2 m^{-1},

$k_B = 1.38 \times 10^{-23}$ J K^{-1} mol^{-1}, $T = 300$ K

[10%]

Question 5

Surface Chemistry

5. a. When contained in the cylindrical pores of a porous material the vapour pressure of CO_2 drops from the normal vapour pressure at 25 °C of 64.0 bar to a lower value of 62.0 bar. Estimate the pore size of the porous material.

Take the molar volume of CO_2 at 25 °C to be 61.6 cm^3 mol^{-1} and the surface tension to be 1.16 mN m^{-1}, R = 8.314 J K^{-1} mol^{-1}.

[15%]

b. The chemisorption of a gas is described by the Languir isotherm with K = 8.5 x 10^{-4} Pa^{-1}. What gas pressure would be required to obtain a surface coverage of 0.5?

[5%]

END OF PAPER