University of Canterbury

End of Year Examinations 2007

Prescription Number(s):	CHEM 323 CHEM 468
Paper Title:	Applied Physical Chemistry Special Topic

Time Allowed:	TWO HOURS
Number of pages:	FIVE

Answer **ALL** questions

All questions are of equal value

TURN OVER

1. (40 marks)

(a) For either the Ravensdown contact process plant or the Hexion formaldehyde plant, describe **TWO** of the following:

(i) Environmental controls;

(ii) Energy use and temperature control;

(iii) Safety concerns.

(b) Using the thermodynamic data below:

(i) **calculate** the adiabatic reaction temperature (~900-1200 K) with a stoichiometric amount of air (20% by volume O_2) for the reaction:

$$CH_3OH(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2CO(g) + H_2O(g)$$

(ii) **explain** the effect of adding water vapour to the methanol and air mixture;

(iii) **calculate** the equilibrium constant at 800 K for the reaction:

$$SO_2(g) + \tfrac{1}{2}O_2(g) \rightarrow SO_3(g)$$

Thermodynamic Data

Table 1: $\Delta H°_{f\,298.15\,K}$ /kJ mol^{-1}

$CH_3OH(g)$	$O_2(g)$	$H_2CO(g)$	$H_2O(g)$	$N_2(g)$	$SO_2(g)$	$SO_3(g)$
-201.1	0.0	-115.9	-241.83	0.0	-296.84	-395.77

Table 2: $H° - H°_{298.15\,K}$ /kJ mol^{-1}

T /K	$O_2(g)$	$H_2CO(g)$	$H_2O(g)$	$N_2(g)$
900	19.29	28.75	21.94	18.32
1000	22.71	34.82	26.00	21.55
1100	26.18	41.14	30.19	24.83
1200	29.70	47.69	34.51	28.15

Table 3: $\frac{-(G° - H°_{298.15\,K})}{T}$ /J K^{-1} mol^{-1}

T /K	$O_2(g)$	$SO_2(g)$	$SO_3(g)$
800	216.2	264.2	278.0

2. (a) (6 marks)

"One of the definitions of nanotechnology is that structural and physical properties of a substance change due to size alone. The changes in properties with size can be attributed to the role of surface atoms."

In a paragraph, explain the statements above.

(b) (6 marks)

Considering that the presence of a surface requires energy, and that substances will try to minimize their surface area, explain how colloids can be stable for long periods of time.

(c) (8 marks)

Calculate the thickness of the diffuse double layer ($1/\kappa$) adjacent to a gold colloid in water at 298 K when there is 1 mM NaCl as electrolyte. Assume that the dielectric constant for water is 78.

Given information: dielectric constant $= \frac{\varepsilon}{\varepsilon_o}$; $\varepsilon_o = 8.85419 \times 10^{-12}$ J^{-1} C^2 m^{-1};

electron charge, $e = 1.602 \times 10^{-19}$ C; Boltzmann constant, $k = 1.381 \times 10^{-23}$ J K^{-1}.

(d) (6 marks)

Describe the key features of self-assembly.

(e) (8 marks)

"The formation of micelles at a given concentration of surfactant is a balance between attractive and repulsive forces."

Explain this statement by giving a discussion of the repulsive and attractive forces that dictate micellisation in a surfactant system. Include in your discussion how and why salt concentration and the length of the alkyl chain of the surfactant influence the critical micelle concentration (CMC).

(f) (6 marks)

From a thermodynamic perspective, describe the features of a surface-active molecule that determine whether it will form a self-assembled monolayer on a solid surface.

3. (NOTE: All parts worth 5 marks.)

Write brief notes on **ALL** of the following:

(a) nylon-6,10;

(b) coordination polymerization;

(c) random copolymer;

(d) suspension polymerization;

(e) weight-molecular weight distribution;

(f) polydispersity index;

(g) chain transfer to polymer;

(h) vulcanization.

END OF PAPER