GENERAL CHEMISTRY II
MIDTERM TEST

Note to students:
This exam covered Ch.6, 9.8, 19.1-19.6, 13.1-13.5, 14 & 15.1-15.2.

INSTRUCTIONS: ***PLEASE READ THIS PAGE WHILE WAITING TO START YOUR EXAM.***

This test paper includes 4 pages (both sides); some potentially useful information is given on back of the periodic table. Check that your paper is complete before starting. You can remove the periodic table if you wish. Answer all questions inside the space provided. Calculators are permitted; cell phones and electronic dictionaries are not allowed. You have 75 min to complete the test. *I suggest you scan the whole test quickly before starting & do the 'easy' stuff 1st.*
GOOD LUCK! *Suggestion: spend 1 min / mark ⇨ 25 min left to finish uncertain problems & check.*

LAST NAME: _____ FIRST NAME: _____

STUDENT NUMBER: _____

Mark breakdown:

Page 2.	/ 11
Page 3.	/ 11
Page 4.	/ 8
Page 5.	/ 10
Page 6.	/ 11
TOTAL:	/ 50 (max. = 51)
PERCENT:	%
EARNED toward FINAL GRADE:	/ 20

CHEM 206 Winter 2006 Section 01 MIDTERM TEST ID #:_____

 # 1. (__/ 11 marks) ***True or False?*** **Circle T or F to correctly describe each statement; you do not need explain your answers.**

T / F According to the first law of thermodynamics, any system's internal energy is constant.

T / F A solution containing an ionic compound will have a lower vapour pressure than a solution containing the same concentration of a molecular compound.

T / F A sample of iron powder will oxidize more quickly in air than a single block of iron of the same mass.

T / F Colloidal dispersions appear cloudy because of light scattering off of the solvent molecules.

T / F Hydrophobic substances are not very soluble in water because the London dispersion forces between the hydrophobic molecules are much stronger than the dipole–induced-dipole interactions between the water and the hydrophobic molecules.

T / F When a gas-forming reaction occurs in a system, the surroundings perform work on the system.

T / F For the reaction below, gold ions will form 4x more quickly than H^+ ions are consumed.

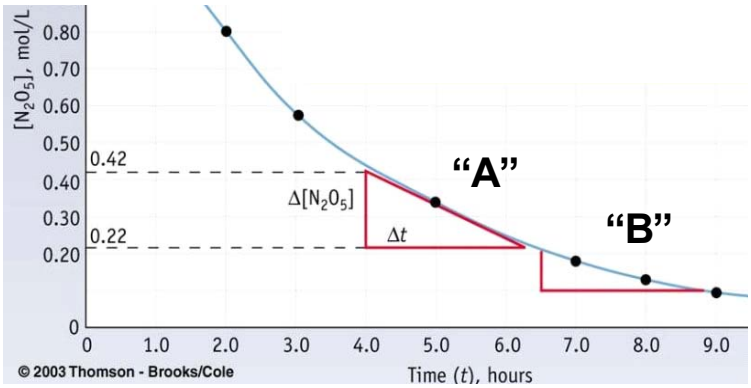
$$Au(s) + NO_3^-(aq) + 4H^+(aq) \rightarrow Au^{3+}(aq) + NO(g) + 2H_2O(l)$$

T / F If the dissolution of a particular salt releases heat but requires a net increase in organization, the salt will have a lower solubility at higher temperatures than at lower temperatures.

T / F The vapour pressure above a mixture of two volatile liquids depends only on the vapour pressure of the liquid that is more volatile.

T / F Gibbs free energy is an example of a state function.

T / F On the graph, triangles "A" & "B" represent ways to calculate instantaneous reaction rates for different moments during the reaction.



 # 2. (__/ 11 marks) Scientists investigating the origins of life have spent considerable efforts attempting to synthesize amino acids such as glycine directly from the simple compounds ammonia, methane and oxygen:

$$NH_3(g) + 2\,CH_4(g) + {}^5/_2\,O_2(g) \rightarrow NH_2CH_2COOH(s) + 3\,H_2O(l)$$

a) **(2 marks)** Using <u>logic only</u>, explain how the system's entropy would change if this reaction occurred.

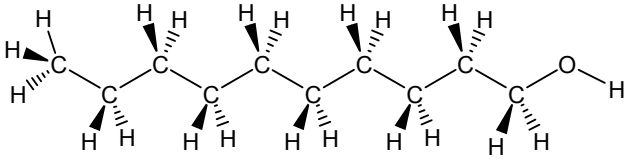
Substance	ΔH^o_f (kJ/mol)	S^o_f (J/mol·K)
$NH_3(g)$	-46.11	192.34
$CH_4(g)$	-74.81	186.15
$O_2(g)$	0	205.03
$NH_2CH_2COOH(s)$	-528.1	103.51
$H_2O(l)$	-285.83	69.91

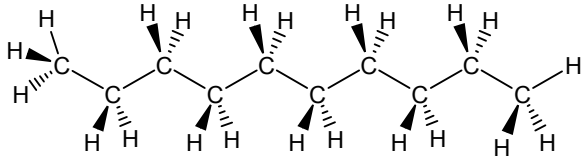
b) **(2 marks)** Calculate ΔS^o_{rxn} for this reaction at 298 K; does this value agree with your prediction in (a)?

c) **(4 marks)** Thermodynamically speaking, should this reaction proceed spontaneously at 298 K if all substances are in their standard states? Include calculations to support your answer.

d) **(3 marks)** If this reaction were indeed practically feasible, would it give a higher yield of products at higher temperatures or at lower temperatures? Explain.

 # 3. (__/ 8 marks) Methanol (CH_3OH; bp 65°C) boils nearly 230°C higher than methane (CH_4; bp -164°C), but decanol (shown on left; bp 229°C) boils only 55°C higher than decane (shown on right; bp 174°C).





a) **(4 marks)** Briefly explain (in point form) what causes methanol and methane to have such different boiling points.

b) **(4 marks)** Why is the bp <u>difference</u> is so much smaller for decanol and decane? Explain briefly (point form is ok).

 # 4. (__/ 10 marks) Imagine you are sitting in a hot sauna. The stove (heater) in the sauna has a layer of rocks on top, so that you can pour water onto them to create steam, which makes the sauna feel hotter.

a) **(6 marks)** Imagine you poured 225 mL of 45°C water onto the hot rocks, and it all evaporated to form steam. How much heat was absorbed from the hot rocks?

Note: $\Delta H°_{vap}$ of $H_2O(l)$ at 100°C = 40.68 kJ/mol; other data is given on the information sheet.

b) **(4 marks)** If 15% of the steam from part (a) condensed onto 12500 cm^2 of your skin (about half your body's surface area), by how many degrees would the temperature of your skin rise?

Assume that: (1) the heat is transferred quantitatively into the outer 0.10 cm of skin.
(2) the density and heat capacity of skin are the same as water.

[If you could not do part (a), use 15% of 750 kJ…which is not correct...]

 # 5. (__/ 11 marks) A 0.6 mL teardrop has a density of 1.0 g/mL and contains 0.67% NaCl by mass.

a) **(7 marks)** If NaCl is the only solute present in the teardrop, what is the osmotic pressure exerted by the solution at 37°C?

b) **(4 marks)** If we assume that teardrops are isotonic with the liquid inside your eyes, what would happen if you applied a solution with a lower concentration of solutes to your eyes? That is, can you explain using basic molecular-level arguments (and appropriate diagrams) what might cause the pain you feel when you get clean water in your eyes in the shower?

POTENTIALLY USEFUL INFORMATION

Constants:

$R = 8.314\ J \cdot mol^{-1}K^{-1} = 0.08206\ L \cdot atm \cdot mol^{-1}K^{-1}$

1 atm = 760 mm Hg = 760 torr = 101.325 kPa

Data:

Properties of liquid water:

bp (at 1 atm) = 100.00°C

$C_{H_2O(l)} = 4.184\ J \cdot g^{-1}K^{-1}$

$d_{H_2O(l)} = 1.00\ g \cdot mL^{-1}$

$K_{f\ H_2O} = 1.86\ °C \cdot kg \cdot mol^{-1}$

$K_{b\ H_2O} = 0.52\ °C \cdot kg \cdot mol^{-1}$

Properties of solid water:

mp (at 1 atm) = 0.00°C

$C_{H_2O(s)} = 2.06\ J \cdot g^{-1}K^{-1}$

$d_{H_2O(s)} = 0.917\ g \cdot mL^{-1}$

Formulae:

$\Delta G^o = \Delta H^o - T\Delta S^o$

$PV = nRT$

$C = k\ P$ (or, $S = k\ P$)

$P = \chi\ P^o$

$\Delta T = K\ m$