**Chemistry 118**
Exam 2
January 22, 2009

Part I- Multiple Choice (2 points each). Please choose the **single** best answer.

1. For which of the following does hydrogen bonding **NOT** contribute to intermolecular forces?
   a) H_2O　　　　　b) NH_3　　　　　c) CH_4　　　　　d) HF

2. Which of the following is a heterogeneous mixture?
   a) Jello　　　　　b) Air　　　　　c) Tomato soup　　　　　d) Salad

3. Many medicines have a bitter taste that manufacturers attempt to disguise. These medicines are probably
   a) salts　　　　　b) acids　　　　　c) bases　　　　　d) radioactive

4. Cleaning up oil paints with turpentine illustrates which chemical principle?
   a) Oil is thicker than water.　　　　　b) Matter is conserved in chemical reactions.
   c) Like dissolves like.　　　　　d) The 2nd Law of Thermodynamics.

5. Given these two energy diagrams for Reaction 1 and Reaction 2, which of the following is true?
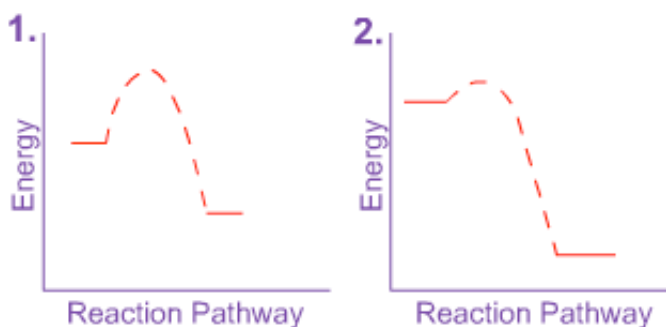
   a) Reaction 1 is more thermodynamically favorable and faster.
   b) Reaction 1 is more thermodynamically favorable but slower.
   c) Reaction 2 is more thermodynamically favorable and faster.
   d) Reaction 2 is more thermodynamically favorable but slower.

6. Given the balanced equation for the detonation of TNT below, which of the following statements is true?
   $$2\ C_6H_2(NO_2)_3CH_3\ (l) \rightarrow 12\ CO\ (g) + 5\ H_2\ (g) + 3\ N_2\ (g) + 2\ C\ (s) + 6800\ kJ$$
   a) The reaction is exothermic, and entropy increases.
   b) The reaction is endothermic, and entropy decreases.
   c) The reaction is exothermic, and entropy decreases.
   d) The reaction is endothermic, and entropy increases.

7. Which of these biological molecules are not polymers of simple building blocks?
   a) Proteins　　　　　b) Lipids　　　　　c) DNA　　　　　d) polysaccharides

8. A chemist who has just moved from rural Montana to New York City is surprised to find that her automobile collision insurance has quadrupled in price. She calls her insurance agent to complain, saying that she is the same driver she has always been. How can the agent justify the increased insurance cost in a way that will best satisfy the chemist?

a) Explain using the First Law of Thermodynamics.
b) Explain that New Yorkers have a lower energy of aggravation.
c) Explain using the collision theory of reaction rates.
d) Explain using the chemists' rule of thumb for temperature and reaction rates.

9. Why is a saturated fat called a "saturated" fat?

a) The fatty acid carbon chains are saturated with hydrogen.
b) The fatty acid chains are saturated with double bonds.
c) The fatty acid chains are saturated with water.
d) The fatty acid chains saturate the body with fat when eaten.

10. The most important feature that distinguishes one DNA molecule from another is

a) the type of phosphate bonds   b) the type of sugar
c) the groups involved in hydrogen bonding   d) the sequence of nitrogenous bases

11. Which of the following is *not* an example of a carbohydrate?

a) Cellulose   b) Starch   c) Cholesterol   d) Sucrose

12. Forensic scientists use restriction enzymes

a) to test for the presence of cocaine hydrochloride and other acids
b) to separate mixtures
c) to cut DNA at specific locations
d) to determine blood type

13. Which of the following is *not* true of DNA profiling?

a) RFLP's are the result of variable numbers of tandem repeats within a site.
b) DNA profiling can be done only on blood samples.
c) DNA profiling is useless to distinguish between identical twins.
d) Post-conviction DNA testing has exonerated many wrongly convicted individuals.

14. Under what circumstances would mitochondrial DNA be most useful in identification of a criminal?

a) If the suspect is in CODIS.
b) If the suspect's brother's sequence is known.
c) If the suspect is female.
d) If the suspect is very old.

15. Why does DNA forensic analysis generally not require analysis of the entire DNA molecule?

a) Forensic analysts can charge more that way.
b) DNA varies between individuals primarily at the non-coding regions.
c) Modern comparative techniques are so good that only a small amount of DNA is needed.
d) Only in the case of close relatives do forensic scientists need to analyze the whole molecule.

Part II- Short Answer.

1. (11 pts) My daughter Erzsie goes out to the unheated barn every morning to feed her horse. He gets 1 cup of corn oil mixed with his grain for breakfast. During January, Erzsie has noticed that his water is frozen each morning but the corn oil is frozen only on the coldest days.

   a) Which has the stronger intermolecular forces? Circle one: **Water**   **Corn Oil**
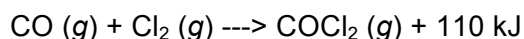
   b) What type of intermolecular forces predominate in water? **Hydrogen bonds**

   c) What type of intermolecular forces predominate in corn oil? **London forces**

   d) Briefly explain why water freezes more readily than corn oil.
   Water has stronger intermolecular forces; therefore, it has a higher melting/freezing point. In other words, water requires more energy to go from the solid to the liquid phase than does corn oil.

2. (16 pts) Carbon monoxide gas reacts with chlorine gas to form deadly phosgene gas:
$$CO\ (g) + Cl_2\ (g) \longrightarrow COCl_2\ (g) + 110\ kJ$$
   a) If this reaction takes place in a closed container at room temperature, what effect on the rate will each of the following changes have? (circle one for each condition)

   i) doubling the initial number of CO molecules   **Increase**   **Decrease**   **No effect**

   ii) doubling the initial number of CO molecules   **Increase**   **Decrease**   **No effect**
       while halving the number of Cl_2 molecules

   iii) doubling the size of the flask,   **Increase**   **Decrease**   **No effect**
       with all other factors constant

   b) Briefly describe how a catalyst would increase the rate of this reaction.
   Catalysts decrease the activation energy of a reaction.

   c) This reaction is (circle one):   **Endothermic**   **Exothermic**

   d) During this reaction, entropy (circle one):   **Increases**   **Decreases**

3. (12 pts) Circle whether each solution is most likely to be acidic, neutral, or basic.

One that tastes sour	**acidic**	neutral	basic
1.0 M H_2SO_4	**acidic**	neutral	basic
Pure water at 25°C	acidic	**neutral**	basic
One in which the concentration of $H^+ = 8 \times 10^{-4}$ M	**acidic**	neutral	basic
1.0 M NaOH	acidic	neutral	**basic**
Salt water	acidic	**neutral**	basic

4. (12 pts) For each type of DNA analysis below, briefly describe an actual case that used that type of analysis.

   a) mitochondrial DNA analysis **Identification of the last Tsar and his family; proving that Anna Anderson was not Anastasia; identification of many of the remains found at the World Trade Center.**

   b) RFLP analysis **The murders at Enderby, in which Colin Pitchfork was linked to the rape and murder of two 15-year-old girls in England; immigration case in which a boy from Ghana was trying to join his mother in the U.K.**

   c) PCR-STR analysis **The O.J. Simpson case; linking President Clinton to Monica Lewinsky; the Janet Baxter murder; the exoneration of Roy Criner.**

5. (12 pts) For each pair of molecules, *first* circle the one with the higher expected boiling point and *second* circle the one that should be more soluble in H_2O.

	higher boiling point?			*more soluble in H_2O?*	
a)	NaCl	Cl_2		NaCl	Cl_2
b)	C_2H_6	$C_{20}H_{42}$		C_2H_6	$C_{20}H_{42}$
c)	C_2H_6	C_2H_5OH		C_2H_6	C_2H_5OH

6. (12 pts) For each of the following molecules of life, fill in the letter(s) of the appropriate function(s). (A molecule may have more than one function, and a function may be used more than once.)

		Functions:
B, D	Lipid	A) Genes
B, E	Carbohydrate	B) Energy storage
C	Protein	C) Cellular catalysts
A	Nucleic Acid	D) Structural basis of cell membranes
		E) Origin of "blood type"

7. (12 pts) The biological target of the poison carbon monoxide is hemoglobin.

   a) To what class of biological molecule does hemoglobin belong? **proteins**

   b) What molecule does hemoglobin bind for its normal function? **O_2**

   c) In this case, carbon monoxide acts as a(n) [circle]   **inhibitor**   hormone   substrate

   d) What would be a logical treatment for carbon monoxide poisoning? **Administering O_2 to compete with the CO**
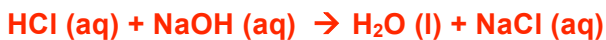
Part III- Problems (8 points each). <u>You must show your work for full credit</u>.

1. Hydrochloric acid (HCl), a strong acid, ionizes completely in water.

   a) What is the pH of HCl at a concentration of 0.1 M?

   -log (0.1 M) = 1.0

   b) Write the neutralization reaction of HCl with NaOH.

   HCl (aq) + NaOH (aq) → H$_2$O (l) + NaCl (aq)

   c) What mass of NaOH must be added to 1.0 L of 0.1 M HCl for complete neutralization?

   Equal molar amounts of NaOH and HCl are needed.
   Moles of HCl = 0.1 mol/L x 1.0 L = 0.1 moles
   Molar mass of NaOH = 40 g/mol
   0.1 mole NaOH x 40 g/mol = 4 grams NaOH

2. During fermentation, yeast convert glucose (C$_6$H$_{12}$O$_6$) to ethanol (C$_2$H$_6$O) and CO$_2$ in the following unbalanced reaction:
$$C_6H_{12}O_6 → C_2H_6O + CO_2$$

   a) Balance this reaction.

   C$_6$H$_{12}$O$_6$ → 2 C$_2$H$_6$O + 2 CO$_2$

   b) During fermentation, 118 kJ are released for every mole of glucose. How much energy is released during the fermentation of 90 grams of glucose?

   Molar mass of glucose = 180 g/mol
   90 grams glucose x 1 mol/180 g = 0.5 moles glucose
   0.5 moles glucose x 118 kJ/mole glucose = 59 kJ

3. While traveling in England, you discover the joys of Fry's Turkish Delight. The package states that one bar of this tasty delight contains 775 kJ of energy. How many Calories is this, *with the correct number of significant figures*? (4.184 J = 1.000 cal)

   775 kJ x 1000 J/kJ x 1 cal/4.184 J x 1 Cal/1000 cal = 185 Cal (3 sig figs)