> Love of goodness without
> the will to learn casts a
> shadow called foolishness.
> --Confucius

Unit 5 Sample Test

The test will be similar in format to previous tests. There will be a true/false section among the options, as well as two required problems. Recall that you will still have a choice of two out of four reactions to complete and write balanced net-ionic equations for. You will also need to identify the type of reaction. This time the *first four* solubility rules will be missing from the test.

The following are representative of typical multiple choice questions but do not necessarily indicate topics to be addressed on your actual test.

_____1. Ionic bonds form between
    a. non-metals with high electron affinity and metals with low ionization energy
    b. non-metals with low electron affinity and metals with high ionization energy
    c. metals with high electron affinity and non-metals with high ionization energy
    d. metals with low electron affinity and non-metals with low ionization energy

_____2. Consider the reaction below:

$$1.7 \text{ kJ} + NaCl(s) + H_2O(\ell) \rightarrow Na^+(aq) + Cl^-(aq)$$
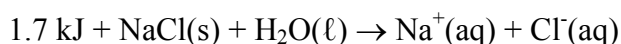
Which of the following combinations for ΔH and ΔS is correct?
    a. +,-   b. -,+   c. -,-   d. +,+

_____3. The change in enthalpy, ΔH, is equal to the heat gained or lost by the system when
    a. pressure is constant   b. volume is constant   c. temperature is constant
    d. none of these

For the following question, compare the assertion (top) and the reason (bottom) and select the appropriate answer from the options given below:
    a. both are true and reason fits the assertion
    b. both are true but reason does not explain assertion
    c. only the assertion is true
    d. only the reason is a true statement
    e. both are false

_____4. The vaporization of water at room temperature is not a "spontaneous" process
                    BECAUSE
        the temperature is such that $T\Delta S$ is less than ΔH.

_____5. Which of the following reactions is likely to have the greatest increase in entropy?
    a. $2 \text{ Na}(s) + Cl_2(g) \rightarrow 2 \text{ NaCl}(s)$
    b. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$
    c. $2 \text{ Mg}(s) + O_2(g) \rightarrow 2 \text{ MgO}(s)$
    d. $NaCl(s) + H_2O(\ell) \rightarrow Na^+(aq) + Cl^-(aq)$

The next section consists of representative problems which might be found in the required

section. All students are expected to work on both of the required problems.

6. a. For the burning of 1 mole of C_2H_4 to form carbon dioxide and <u>liquid</u> water, write the balanced molecular equation and calculate ΔH^o_{rxn} using tables in Appendix 2 (p. 722-725).

b. If 15.4 grams of C_2H_4 is burned instead of the 1 mole, how many kJ will be released?

c. The entropy change (ΔS^o_{rxn}) for the reaction in (a) is -267.45 J/mol·K. Calculate ΔG^o_{rxn} at 298 K.

 d. Explain how this reaction can be spontaneous at 298 K even though ΔS_{sys} is negative.

_____

_____
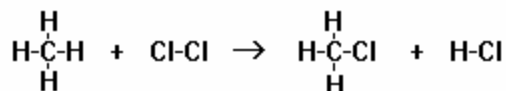
_____

7. A sample of carbon with a mass of 0.463 g was placed in a bomb calorimeter containing 2500 g of water (specific heat = 4.184 J/g°C). As a result of burning the carbon, the temperature of the water rose from 22.54°C to 23.82°C. The calorimeter constant is 1460 J/°C.

a. Write the reaction of the carbon combining with oxygen.

b. What is ΔH_{rxn} ? (don't forget the sign!!!)

The next section consists of representative problems such as might be found in the "options" section. Each student is expected to select one problem from this section to work on.
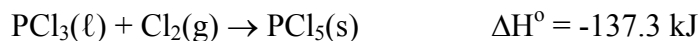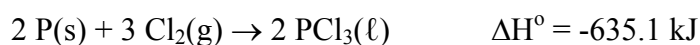
8. Calculate ΔH°_{rxn} for the reaction shown below using bond enthalpies and heats of formation. Discuss briefly the reason(s) for the differences in the values you obtain for ΔH°_{rxn} using each method.

$$\begin{array}{c} H \\ | \\ H\text{-}C\text{-}H \\ | \\ H \end{array} + Cl\text{-}Cl \rightarrow \begin{array}{c} H \\ | \\ H\text{-}C\text{-}Cl \\ | \\ H \end{array} + H\text{-}Cl$$

Bond	Enthalpy, kJ/mol
C-H	414
Cl-Cl	243
C-Cl	339
H-Cl	432

Substance	ΔH°_f, kJ/mol
CH_4	-74.9
Cl_2	0
CH_3Cl	-82
HCl	-92.3

9. Given the following reactions:

$$2\ P(s) + 3\ Cl_2(g) \rightarrow 2\ PCl_3(\ell) \qquad \Delta H^\circ = \text{-635.1 kJ}$$

$$PCl_3(\ell) + Cl_2(g) \rightarrow PCl_5(s) \qquad \Delta H^\circ = \text{-137.3 kJ}$$

calculate the **heat of formation**, ΔH°_f, for solid PCl_5 under the same conditions [*hint*: you must first write the formation reaction for PCl_5]

10. Indicate whether each of the following statements is true (**T**) or false (**F**). **If it is false, correct it**.

_____a. Reactions for which energy must be supplied from outside the system to carry out the processes are spontaneous.

_____b. Spontaneous processes always occur very rapidly.

_____c. The entropy of a substance in the gas phase is always greater than the entropy of the same substance in the liquid phase.

_____d. According to the second law of thermodynamics, when $\Delta S_{sys} > 0$, the process is spontaneous.

_____e. A reaction that is spontaneous in one direction is non-spontaneous in the reverse direction under the same conditions.

11. For each of the following, complete the word equation, write a balanced net-ionic reaction and tell what type of reaction it is. (*b, c and d occur in water solution*)

a. carbon monoxide + oxygen → (one product)_____

_____

_____

type:_____

b. sodium chloride + lead(II) nitrate → _____

_____

_____

type:_____

c. potassium metal + water → _____

_____

_____

type:_____

*d. dichromate ion reacts with ethanol (C_2H_5OH) in an acidic solution; chromium(III) ions and carbon dioxide are among the products.

_____

_____

_____

The final section of the test will consist of one essay question selected from the following topics:

    effects of experimenter errors in calorimetry
    enthalpy, entropy and spontaneity: how are they connected?

Answers