1.One of the components of polluted air is NO (g). It is formed in the high-temperature environment of internal combustion engines by the following reaction:
N_2 (g) + O_2 (g) ----------> 2NO (g) $\Delta H = 180$ kJ

Why are high temperatures needed to convert N_2 and O_2 to NO?

2. Are the following processes exothermic or endothermic?
A. When solid KBr is dissolved in water, the solution gets colder.
B. Natural gas (CH_4) is burned in a furnace.
C. When concentrated H_2SO_4 is added to water, the solution gets very hot.
D. Water is boiled in a tea kettle.

3. The overall reaction in commercial heat packs can be represented as:
4Fe (s) + $3O_2$ (g) ------> $2Fe_2O_3$ (s) $\Delta H = -1652$ kJ

A. How much heat is released when 4.00 mol of iron is reacted with excess oxygen?
B. How much heat is released when 1.00 mol Fe_2O_3 is produced?
C. How much heat is released when 1.00 gram of Fe is reacted with excess oxygen?
D. How much heat is released when 10.00 grams of iron and 2.00 grams of oxygen are reacted?

4. In a coffee cup calorimeter, 50.0 mL of 0.100 M $AgNO_3$ and 50.0 mL of 0.100 M HCl are mixed to yield the following reaction:
Ag^+ (aq) + Cl^- (aq) ----------> AgCl (s)

The two solutions were initially at 22.60 °C, and the final temperature is 23.40 °C. Calculate the heat that accompanies this reaction in kJ/mol of AgCl formed. Assume that the combined solution has a mass of 100.0 g and a specific heat of 4.18 J/g°C.

5. Consider the dissolution of $CaCl_2$:
$CaCl_2$(s) ----------> Ca^{2+}(aq) + $2Cl^-$(aq)
$\Delta H = -81.5$ kJ/mol

An 11.0 gram sample of $CaCl_2$ is dissolved in 125 g water with both substances at 25.0 °C. Calculate the final temperature of the solution assuming the solution has no heat loss to the surroundings and assuming that the solution has a specific heat of 4.18 J/g °C.

6. The combustion of 0.1584 g benzoic acid increases the temperature of a bomb calorimeter by 2.54 °C. Calculate the heat capacity of this calorimeter. (The energy released by combustion of benzoic acid is 26.42 kJ/g). A 0.2130 g sample of vanillin ($C_8H_8O_3$) is then burned in the same calorimeter, and the temperature increases by 3.25 °C. What is the energy of combustion per gram of vanillin? Per mole of vanillin?

7. The first step in the industrial recovery of zinc from zinc sulfide ore is roasting, that is, the conversion of ZnS to ZnO by heating:

2ZnS(s) + $3O_2$(g) ----------> 2ZnO(s) + $2SO_2$(g)
$\Delta H°rxn = -879$ kJ

Calculate the heat evolved (in kJ) per gram of ZnS roasted.

8. From the following data:

C(graphite) + O_2(g) ----------> CO_2(g)
$\Delta H°rxn = -393.5$ kJ

H_2(g) + $1/2O_2$(g) ----------> H_2O(l)
$\Delta H°rxn = -285.8$ kJ

$2C_2H_6$(g) + $7O_2$(g) --------> $4CO_2$(g) + $6H_2O$(l)
$\Delta H°rxn = -3119.6$ kJ

Calculate the enthalpy change for the reaction.
2C(graphite) + $3H_2$(g) ----------> C_2H_6(g)

9. Calculate the standard enthalpy change for the reaction:

2Al(s) + $1/2O_2$(g) ----------> Al_2O_3(s)
$\Delta H°rxn = -1601$ kJ

2Fe(s) + $1/2O_2$(g) ----------> Fe_2O_3(s)
$\Delta H°rxn = -821$ kJ

10. Suggest ways (with appropriate equations) that would allow you to measure the $\Delta H°f$ values of Ag_2O(s) and $CaCl_2$(s) from their elements. No calculations are necessary.

11. A 44.0 g sample of an unknown metal at 99.0°C was placed in a constant-pressure calorimeter containing 80.0g of water at 24.0°C. The final temperature of the system was found to be 28.4°C. Calculate the specific heat of the metal. (The heat capacity of the calorimeter is 12.4J/°C).

KEY

1. Endo. You need heat to provide energy for the rxn.
2. A. endo B. exo C. exo D. endo
3. A. -1650 kJ B. -826 kJ C. -7.39 kJ D. -34.4 kJ
4. -66.9 kJ/mol
5. 40.5 °C
6. 1.65 kJ/°C, -25.2 kJ/g, -3830 kJ/mol
7. -4.51 kJ/g
8. -84.6 kJ
9. -780 kJ
10. 2Ag(s) + $1/2O_2$(g) -----> Ag_2O(s)
    Ca(s) + Cl_2(g) -----> $CaCl_2$(s)
11. 0.492 J/g°C