Thermochemistry Practice

1. What is the change in internal energy (in J) of a system that releases 575 J of heat to its surroundings and has 425 cal of work done on it?
2. A 79.3 L sample of a gas, at a constant pressure of 2.05 atm, absorbs 0.695 kJ of heat and expands to 82.1 L. What is the change in internal energy of the gas in joules?
3. Consider the reaction of nitrogen dioxide and water to form aqueous nitric acid and nitrogen monoxide gas.

3NO2(*g*) + H2O(*l*) → 2HNO3(*aq*) + NO(*g*) ΔH° = ?

1. Calculate the ΔH° for this reaction of nitrogen dioxide and water, using the following equations and their ΔH°s.

2NO(*g*) + O2(*g*) → 2NO2(*g*) ΔH° = −173kJ

2N2(*g*) + 5O2(*g*) + 2H2O(*l*) → 4HNO3(*aq*) ΔH° = −255 kJ

N2(*g*) + O2(*g*) → 2NO(*g*) ΔH° = 181 kJ

1. How much heat is evolved or absorbed when 750.0 mL of 3.50 M HNO3 is formed? (If you are unable to get an answer to part *a*, you should still set up this part.)
2. Calculate ΔHrxn, in kJ, for the following reaction:

PCl5(g) → PCl3(g) + Cl2(g)

Given:

P4(s) + 6Cl2(g) → 4PCl3(g)            ΔH = -2439 kJ
4PCl5(g) → P4(s) + 10Cl2(g)         ΔH = 3438 kJ

1. A 50.0 g sample of iron (specific heat capacity = 0.444 J/g°C) is heated to 75.2°C and placed into a calorimeter holding 70.0 g of water (specific heat capacity = 4.184 J/g°C) at a temperature of 25.0°C. Assuming no heat loss to the calorimeter, what will be the final temperature reached in the calorimeter?
2. In the last step of the copper experiment you react metallic aluminum with a water solution of copper (II) chloride to form solid copper and aqueous aluminum chloride. The heat capacity of the calorimeter is 315 J/oC. In the reaction 210.0 g of water and 0.534 g of Al is reacted with excess CuCl2 (aq). The temperature rises from 22.33 oC to 27.69 oC. (csolution = 4.07 J/g\* oC)

2 Al (s) + 3 CuCl2 (aq) 🡪 2 AlCl3 (aq) + 3 Cu (s)

1. Determine q of reaction
2. Determine ∆H rxn (in terms of Al)
3. In a calorimetry experiment, the temperature of 500.0 mL of water rose from 19.78 ºC to 23.61 ºC when 1.0 g of sodium metal reacted according to the following balanced equation

Na (s) + ½ H2O (*l*) → NaOH (aq) + ½ H2 (g)

The calorimeter also was affected in this experiment and absorbed 2.4 x 10-3 kJ/oC, (specific heat of water =4.184 J/(g K)), calculate qrxn, and ΔHrxn (in kJ/mol Na) for the reaction.

1. Methyl hydrazine (CH6N2) is commonly used as a liquid rocket fuel. The combustion of methylhydrazine with oxygen produces nitrogen, carbon dioxide and water.

2CH6N2 + 5O2 🡪 2N2 + 2CO2 + 6H2O ∆H = -2340.0 kJ

* 1. How much energy is released when 25.0 g of methylhydrazine burns in excess oxygen?
	2. Determine ∆H f of Methylhydrazine (CH6N2)
	3. Write the chemical equation that represents the ∆H f of Methylhydrazine
1. A cup of coffee you ordered at McDonald's spilled in your lap and you suffered third degree burns to 6 percent of your body. McDonald's says that it serves its coffee at 85°C, but acknowledged that a burn hazard exists with any food substance served above 60°C.

If you had wanted to make the coffee safer, how much ice ***(at a temperature of 0°C)*** would you have had to add to the cup (let's say it was a 12 oz or 340 g cup) to bring the temperature down from 85°C to 60°C? Let's assume that 1.) Coffee has the same heat capacity as water, and 2.) No heat is lost to the coffee cup or surroundings.

b) In the process of melting ice, is the ice experiencing positive or negative enthalpy (explain)?

1. Kerosene, a common space heater fuel, is a mixture of hydrocarbons whose “average” formula is C12H26.
	1. Write a balanced equation, using the simplest whole-number coefficients, for the complete combustion of kerosene to gases.
	2. If ΔHocomb (kerosene) = -1.5000 x 104 kJ for the equation as written in part (a), determine ΔHof of kerosene.
	3. Calculate the heat produced by combustion of 0.4000 L of kerosene (density of kerosene = 0.749 g/mL)
	4. If the heat produced by the kerosene is used to heat a block of ice with a mass of 25.00 kg at -20.0oC, what will be the state of the products and the temperature? If there is more than one state present, indicate the mass of each state present.
2. Substitute natural gas (SNG) is a mixture containing methane gas that can be use as a fuel. One reaction for the production of SNG is shown below.



Calculate the ΔHo rxn for the above process based on the table of bond dissociation energies given