Thermochemistry Practice

1. 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. (6 points)

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.) (4 points)
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) (8 points)

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. Methyl hydrazine (CH6N2) is commonly used as a liquid rocket fuel. The combustion of methylhydrazine with oxygen produces nitrogen, carbon dioxide and water. (9 points)

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.

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

1. 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

ΔH = Σ(bonds broken) –Σ(bonds formed)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 4 CO + | 8 H2 | 🡪 | 3 CH4 + | CO2 + | 2 H2O |
| Broken Bonds | |  | Bonds Formed | | |
| 4(C≡O) =4 mol\* (1072 kJ/ mol) | |  | 3(4(C-H)) =12 mol \*(414 kJ/ mol) | | |
| 8(H-H) = 8 mol\* (436 kJ/ mol) | |  | 2(C=O) = 2 mol \*(736 kJ/ mol) | | |
|  | |  | 2(2(O-H)) = 4 mol \*(464 kJ/ mol) | | |