General Chemistry
Mr. MacGillivray
Thermochemistry Practice Problems

For each reaction, calculate the $\Delta H_{rxn}°$, classify the reaction as either endothermic or exothermic, and tell whether heat is released by the system or absorbed by the system. Put your answers here and attach your work on a separate sheet of paper.

1. I_2 (s) → I_2 (g)

2. 2Mg (s) + O_2 (g) → 2MgO (s)

3. $2NO_2$ (g) → 2NO (g) + O_2 (g)

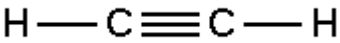
4. 2Fe (s) + $3CO_2$ (g) → Fe_2O_3 (s) + 3CO (g)

5. Hydrazine, N_2H_4, is used as a rocket fuel. It reacts with oxygen to form nitrogen and water.

   N_2H_4 (l) + O_2 (g) → N_2 (g) + $2H_2O$ (g)

   a. Given that <u>liquid</u> hydrazine has an enthalpy of formation of +50.42 kJ/mol, find the $\Delta H_{rxn}°$ for the above equation.
   b. Calculate the molar mass of hydrazine in g/mol.
   c. The answer to part (a) of this problem reveals how much energy is released when 1 mole of hydrazine reacts. Of course, even a small rocket requires more than one mole of fuel to be launched! Now calculate how much energy is released when 2,310 mol of hydrazine reacts.
   d. Calculate how much energy is released when 50.0 kg of hydrazine rocket fuel is burned during a rocket launch.

6. Acetylene gas (C_2H_2) is used as a fuel for welding torches. It releases a tremendous amount of heat when it burns (i.e., undergoes combustion in air) because there is a huge amount of energy stored in the C-C triple bond in each molecule. The flame produced when it burns is 3300°C!

   a. Write a <u>balanced</u> equation for the combustion of acetylene.
   b. Calculate the $\Delta H_{rxn}°$ in kJ/mol.
   c. Is the combustion of acetylene exothermic or endothermic? How did you know?
   d. Calculate how many kJ of heat are released when 50.0 g of acetylene are burned.

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Put your answers here and attach your work on a separate sheet of paper.

1. I_2 (s) → I_2 (g) $\Delta H°_{rxn} = [62.25] - [0] = 62.25$ KJ/mol, endoth., heat absorbed

2. 2Mg (s) + O_2 (g) → 2MgO (s) $\Delta H°_{rxn} = [2(-601.8)] - [(2)(0) + 0] = -1203.6$ kJ , exothermic, heat released

3. $2NO_2$ (g) → 2NO (g) + O_2 (g) $(90.37 \times 2) - (2)(33.84) = 113.06$ KJ/mol

4. 2Fe (s) + $3CO_2$ (g) → Fe_2O_3 (s) + 3CO (g) $[(-822.16) + (3)(-110.5)] - [(3)(-393.5)]$
-1153.66 -1180.5
$= +26.84$ KJ/mol
endo
abs.

5. Hydrazine, N_2H_4, is used as a rocket fuel. It reacts with oxygen to form nitrogen and water.

$$N_2H_4 (l) + O_2 (g) \rightarrow N_2 (g) + 2H_2O (g)$$

   a. Given that liquid hydrazine has an enthalpy of formation of +50.42 kJ/mol, find the $\Delta H_{rxn}°$ for the above equation. -534.06 KJ/mol
   b. Calculate the molar mass of hydrazine in g/mol. $28+4 = 32$ KJ/mol
   c. The answer to part (a) of this problem reveals how much energy is released when 1 mole of hydrazine reacts. Of course, even a small rocket requires more than one mole of fuel to be launched! Now calculate how much energy is released when 2,310 mol of hydrazine reacts. 2310 mol $\times (-534.06$ KJ/mol$) = 1.23 \times 10^6$ KJ/mol
   d. Calculate how much energy is released when 50.0 kg of hydrazine rocket fuel is burned during a rocket launch. $50.0 kg \times \frac{1000 g}{1 kg} \times \frac{1 mol}{32 g} = 1562.5$ mol $= -8.34 \times 10^5$ KJ

6. Acetylene gas (C_2H_2) is used as a fuel for welding torches. It releases a tremendous amount of heat when it burns (i.e., undergoes combustion in air) because there is a huge amount of energy stored in the C-C triple bond in each molecule. The flame produced when it burns is 3300°C!

formed (g)

$$H—C\equiv C—H$$

   a. Write a balanced equation for the combustion of acetylene.
   b. Calculate the $\Delta H_{rxn}°$ in kJ/mol.
   c. Is the combustion of acetylene exothermic or endothermic? How did you know?
   d. Calculate how many kJ of heat are released when 50.0 g of acetylene are burned.

$C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O$ or $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

226.7 -393.5 -241.82

-1255.5 KJ/mol exo; $-\Delta H$

$50.0 g C_2H_2 \times \frac{1 mol}{26 g} = 1.92$ mol

$1.92 mol \times \frac{-1255.5 KJ}{1 mol} = -2414$ KJ