CH301 Worksheet 11

1. What is the second law of thermodynamics? How does this apply to someone exploding a hydrogen balloon? $2\ H_2(g) + O_2(g) \rightarrow 2\ H_20(g)$

2. Let's talk about signs. What does a positive or negative value mean for change in enthalpy (ΔH), work (w), and change in Gibb's free energy (ΔG)? Remember, be the system! And try to do this one from memory. Don't just copy it directly from the notes.

3. A bomb calorimeter is filled with 2 L of water. After a reaction, the temperature of the water raises from 25.0 °C to 28.3 °C. The density and heat capacity of water are 1 g/mL and 4.184 J/(g·K), respectively. The heat capacity of the calorimeter is 85 J per K. Determine ΔH of the reaction.

4. The same bomb calorimeter is filled with 2 L of a liquid that has a density of 1.7 grams per mL. A reaction releases 250 kJ of heat, and the temperature of the liquid increases from 25 °C to 27 °C. What is the heat capacity of the liquid?

5. The liquid is allowed to cool down to 25 °C. The calorimeter is equipped with another reaction that releases 400 kJ of heat. What is the final temperature of the liquid after the reaction is complete?

6. Balance the following reaction of hydrazine with methanol. Calculate the work done.
$N_2H_2(l) + CH_3OH(l) \rightarrow CH_2O(g) + N_2(g) + H_2(g)$

7. If the work done on a system is 5.7 kJ, and the external pressure is equal to 3.5 atm. Is the volume of the system increasing or decreasing?

8. In your own words, what is Hess's Law?

9. Use the following data to calculate the change in enthalpy.
Overall reaction: $H_2S\ (g) + 2\ O_2(g) \rightarrow S0_3(g) + H_2O(l)$
1. $H_2SO_4(l) \rightarrow H_2S(g) + 2\ O_2\ (g)$ $\Delta H = 78.5$ kJ

2. $H_2SO_4(l) \rightarrow SO_3(g) + H_2O(g)$ $\Delta H = 20.5$ kJ
3. $H_2O(g) \rightarrow H_2O(l)$ $\Delta H = -11$ kJ

10. Use the following data to calculate the change in enthalpy.
Overall reaction: $N_2H_4(l) + H_2(g) \rightarrow 2NH_3(g)$
1. $N_2H_4(l) + CH_4O(l) \rightarrow CH_2O(g) + N_2(g) + 3H_2(g)$ $\Delta H=-185$KJ
2. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H=-230$KJ
3. $CH_4O(l) \rightarrow CH_2O(g) + H_2(g)$ $\Delta H=-325$KJ

11. Determine the $\Delta H_{rxn}$for the reaction using the provided bond energies:

$CH_4(g) + I_2(g) \rightarrow CH_3I(g) + HI\ (g)$

Bond energies:
C-H : 416 kJ/mol H-I: 299 kJ/mol
I-I: 151 kJ/mol C-I: 213 kJ/mol
Is the reaction endothermic or exothermic?

12. Determine the boiling point for iron. ΔH_{vap} = 349.6 kJ/mol and ΔS_{vap} = 111.55 J/(mol·K)

13. Calculate the amount of heat given off when 11 grams of manganese (Mn) is oxidized to $Mn_2O_3(s)$ at standard state conditions. $\Delta H_{f,Mn2O3}(s) = -962.3$ kJ/mol

14. Calculate the work done on the systems with only one mole of reactant:

a. $2NO2\ (g) \rightarrow N2O4\ (g)$ at 30 °C

b. $2NO\ (g) \rightarrow N2\ (g) + O2\ (g)$ at 300 °C

15. Calculate $\Delta S_{universe}$ after the completion of the following reaction:

$2NiS(s) + 3O_2(g) \rightarrow 2SO_2(g) + 2NiO(s)$ at 25 °C $\Delta H = -890$ kJ

Substance	S(J/Kmole)
SO_2	248
NiO	38
O_2	205
NiS	53

16. Determine the ΔG when:
$\Delta S_{universe}$ = 1303 J/K
ΔS_{surr} = 1.300 kJ/K
T = 25 °C

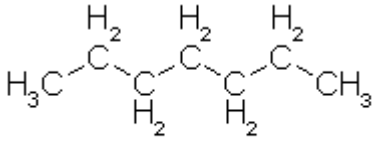
17. Balance the following combustion reaction and determine the ΔH_{rxn}.

$C_7H_{16} + O_2 \rightarrow CO_2 + H_20$

Bond Energies

C-C: 346 kJ/mol O=O: 498 kJ/mol
C-H: 413 kJ/mol C=O: 799 kJ/mol
H-O: 463 kJ/mol C-O: 358 kJ/mol
O-O: 146 kJ/mol

If the reaction is carried out at 25 °C what is the ΔS_{surr}?



18. Determine the minimum temperature for a reaction with ΔH = 271 kJ and ΔS = 195 J/K to be spontaneous.

19. Consider the reaction: $CO(g) + Cl_2(g) \rightarrow COCl_2(g)$
Calculate ΔG_{rxn} at 25 °C

Substance	ΔHf (kJ/mol)	S (J/ mol K)
CO	-110.5	197.6
Cl2	0.0	223.0
COCl2	-223.0	289.2

20. Determine ΔG_f for $SO_2(g)$. Assume 25 °C for all reactions.

$\Delta H_{f,SO2}$ (g) = -297 kJ/mol
$S_{m,SO2}$ (g) = 248 J/(K mol)

Then determine ΔG_{rxn} of the following reaction:

ΔGf Cu_2S (s) = -86.2 kJ/mol

$Cu_2S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)} + 2Cu_{(s)}$