1. Assuming the apparatus itself absorbs no heat, what will be the final temperature of a bomb calorimeter's heat sink consisting of 100 mL of water at 15 °C if the reaction releases 6.276 kJ of heat?

1. 30 K
2. 303 °C
3. 30 °C
4. 0 °C
5. -303 °C
6. 273 K

$q = m \cdot c \cdot \Delta T$

$6{,}276\ J = 100\ g \cdot 4.184\ j \cdot g^{-1} \cdot K^{-1} \cdot \Delta T$

$\Delta T = 15\ K$

$T_f = \Delta T + T_i = 15\ K + 288 = 303\ K = 30\ °C$

2. Calculate the change in enthalpy for the reaction below based on the provided data.

$N_2H_4(l) + H_2(g) \rightarrow 2NH_3(g)$ $\Delta H = -201.1\ kJ \cdot mol^{-1}$

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H = -91.8\ kJ \cdot mol^{-1}$

$CH_3OH(l) \rightarrow CH_2O(g) + H_2(g)$ $\Delta H = 85.2\ kJ \cdot mol^{-1}$

$CH_2O(g) + N_2(g) + 3H_2(g) \rightarrow N_2H_4(l) + CH_3OH(l)$ $\Delta H = ?$

1. $\Delta H = -28.4\ kJ \cdot mol^{-1}$
2. $\Delta H = -207.7\ kJ \cdot mol^{-1}$
3. $\Delta H = 194.5\ kJ \cdot mol^{-1}$
4. $\Delta H = -378.1\ kJ \cdot mol^{-1}$
5. $\Delta H = 24.1\ KJ \cdot mol^{-1}$

In order for the three provided reactions to cancel to result in the unknown reaction (the combustion of grahpite), the first reaction needs to be reversed, the second needs will remain unchanged, and the third needs to be reversed. Consequently, the overall change in enthalpy for the reaction is:

$\Delta H_{rxn} = -1 \times -201.10 + -91.80 + -1 \times 85.20 = 24.1\ kJ \cdot mol^{-1}$

3. Calculation the work (w) for the following reaction conducted at 1000 °C:

$SF_6(g) + O_3(g) \rightarrow SO_3(g) + 3 F_2(g)$

1. 21.2 kJ
2. -21.2 kJ
3. 16.6 kJ
4. -16.6 kJ

$T = 1000\ °C + 273 = 1273\ K$

$\Delta n_{gas} = n_{gas,final} - n_{gas,initial} = 4\ mol - 2\ mol = 2\ mol$

$w = -\Delta n_{gas} \cdot R \cdot T = -2\ mol \cdot 8.314\ J \cdot mol^{-1} \cdot K^{-1} \cdot 1273 = -21.2\ kJ$

4. Consider the reaction below.

$2\ S_2O_2(g) + 4\ F_2(g) \rightarrow 2\ S_2(g) + 4\ OF_2(g)$

Its change in entropy would likely be (positive/negative/either) and (large/small)

1. either, small
2. negative, small
3. positive, small
4. either, large
5. negative, large
6. positive, large

For this reaction, Δn_{gas} and Δn_{system} are both zero. Consequently the sign of ΔS_{rxn} cannot be predicted accurately and the magnitude will most likely be small.

5. Which of the follwing reactions would spontaneous at some temperatures and non-spontaneous at other temperatures?

rxn	ΔS_{rxn}($J{\cdot}mol^{-1}{\cdot}K^{-1}$)	ΔH_{rxn} ($kJ{\cdot}mol^{-1}$)
I	-25.20	2.45
II	1.15	879.23
III	13.93	-367.10
IV	-4.76	-98.04

1. I ans II
2. I and III
3. I and IV
4. II and III
5. II and IV
6. III and IVß

When the change in entropy and change in enthalpy for a given reaction have the same sign, there will be a temperature dependance to the reaction's spontaneity.

6. What would be the total energy associated with the motion of a gaseous system composed of 1 mole each of CO_2, O_2 and O_3?

1. 12 RT
2. 24 RT
3. 18RT
4. 9RT
5. 6RT
6. 15RT

The molecules CO_2, O_2 and O_3 each have 9, 6 and 9 modes respectively, and a mole of each would have 9/2RT, 6/2RT and 9/2RT worth of energy; 12RT total.