

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

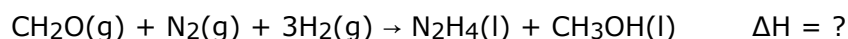
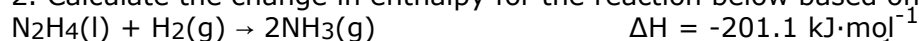
$$q = m \cdot c \cdot \Delta T$$

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

$$\Delta T = 15 \text{ K}$$

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

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

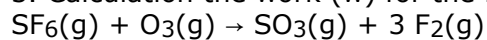


1.  $\Delta H = -28.4 \text{ kJ} \cdot \text{mol}^{-1}$
2.  $\Delta H = -207.7 \text{ kJ} \cdot \text{mol}^{-1}$
3.  $\Delta H = 194.5 \text{ kJ} \cdot \text{mol}^{-1}$
4.  $\Delta H = -378.1 \text{ kJ} \cdot \text{mol}^{-1}$
5.  $\Delta H = 24.1 \text{ kJ} \cdot \text{mol}^{-1}$

In order for the three provided reactions to cancel to result in the unknown reaction (the combustion of graphite), 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:

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

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



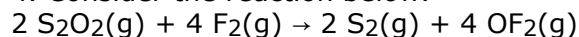
1. 21.2 kJ
2. -21.2 kJ
3. 16.6 kJ
4. -16.6 kJ

$$T = 1000 \text{ °C} + 273 = 1273 \text{ K}$$

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

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

4. Consider the reaction below.



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,  $\Delta n_{\text{gas}}$  and  $\Delta n_{\text{system}}$  are both zero. Consequently the sign of  $\Delta S_{\text{rxn}}$  cannot be predicted accurately and the magnitude will most likely be small.

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

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

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

When the change in entropy and change in enthalpy for a given reaction have the same sign, there will be a temperature dependence 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  $\text{CO}_2$ ,  $\text{O}_2$  and  $\text{O}_3$ ?

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

The molecules  $\text{CO}_2$ ,  $\text{O}_2$  and  $\text{O}_3$  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.