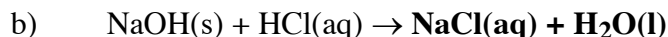
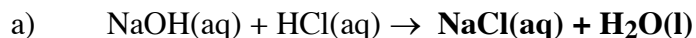


Hess' Law

Name _____

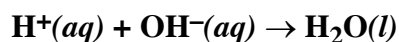
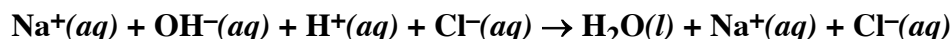
Section _____

1. Predict the product for the following reactions

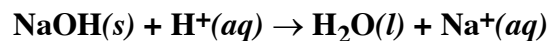
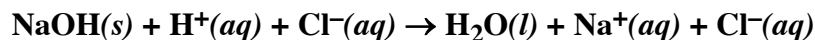


2. Predict the product for the following reactions

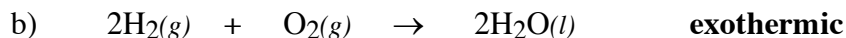
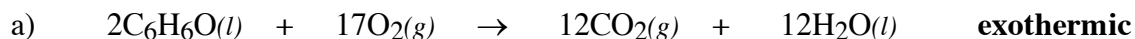
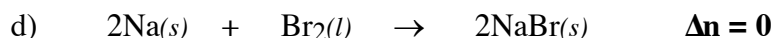
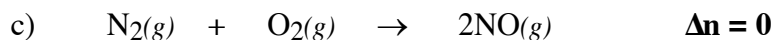
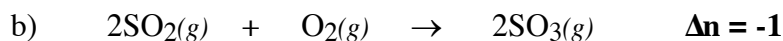
a)



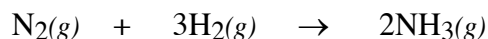
b)



3. For each of the following chemical equations predict whether the reaction is exothermic or endothermic.

4. Calculate Δn (the change in the moles of gaseous substances) for each of the following balanced chemical equations.

5. When 8.50 g of NH₃ are formed, according to the following balanced chemical equation,



- 23.1 kJ of heat are released.
a) How many kJ of heat are released when 1 mol of N₂ reacts with excess H₂?

$$8.50 \text{ g NH}_3 \left(\frac{1 \text{ mol NH}_3}{17.0 \text{ g NH}_3} \right) = 0.500 \text{ mol NH}_3$$

$$\frac{23.1 \text{ kJ}}{0.5 \text{ mol NH}_3} = \frac{46.2 \text{ kJ}}{1 \text{ mol NH}_3}$$

- b) How many kJ of heat are released when 2 mol of NH₃ are formed?

$$2 \text{ mol NH}_3 \left(\frac{46.2 \text{ kJ}}{1 \text{ mol NH}_3} \right) = + 92.4 \text{ kJ}$$

- c) How many kJ of heat are released when 4 mol of N₂ reacts with 4 mol H₂?

(moles N ₂) _o 4 mol	(moles H ₂) _{required} 12 mol	(moles H ₂) _o 4 mol	Conclusion H₂ limiting
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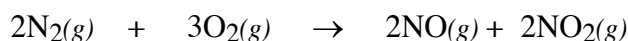
$$4 \text{ mol N}_2 \left(\frac{3 \text{ mol H}_2}{1 \text{ mol N}_2} \right) = 12 \text{ mol H}_2$$

$$4 \text{ mol H}_2 \left(\frac{92.4 \text{ kJ}}{3 \text{ mol H}_2} \right) = 123.2 \text{ kJ released}$$

6. Use Hess' Law and the following chemical equations

Chemical Equation	ΔH (kJ mol ⁻¹)
$\frac{1}{2} \text{N}_2(g) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{NO}(g)$	30.0
$\frac{1}{2} \text{N}_2(g) + \text{O}_2(g) \rightarrow \text{NO}_2(g)$	46.0

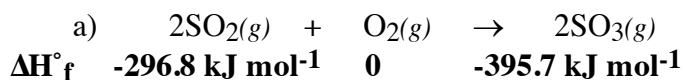
Calculate the ΔH_{rxn} for the equation.



Chemical Equation	ΔH (kJ mol ⁻¹)
$2 \cdot \left(\frac{1}{2} \text{N}_2(g) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{NO}(g) \right)$	2 · (30.0)
$2 \cdot \left(\frac{1}{2} \text{N}_2(g) + \text{O}_2(g) \rightarrow \text{NO}_2(g) \right)$	2 · (46.0)

$$\Delta H = 60 \text{ kJ mol}^{-1} + 92 \text{ kJ mol}^{-1} = 152 \text{ kJ mol}^{-1}$$

7. Calculate ΔH_{rxn} for the following reactions

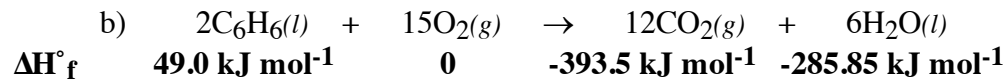


$$\Delta H_{\text{rxn}}^\circ = \sum m \Delta H_f^\circ (\text{products}) - \sum n \Delta H_f^\circ (\text{reactants})$$

$$\Delta H_{\text{rxn}}^\circ = 2\Delta H_f^\circ (\text{SO}_3) - [2\Delta H_f^\circ (\text{SO}_2) - \Delta H_f^\circ (\text{O}_2)]$$

$$\Delta H_{\text{rxn}}^{\circ} = 2(-395.7 \text{ kJ mol}^{-1}) - [2(-296.8 \text{ kJ mol}^{-1}) - (0)]$$

$$\Delta H_{\text{rxn}}^{\circ} = -197.8 \text{ kJ mol reaction}^{-1}$$



$$\Delta H_{\text{rxn}}^{\circ} = \sum m \Delta H_f^{\circ} (\text{products}) - \sum n \Delta H_f^{\circ} (\text{reactants})$$

$$\Delta H_{\text{rxn}}^{\circ} = 12\Delta H_f^{\circ} (\text{CO}_2) + 6\Delta H_f^{\circ} (\text{H}_2\text{O}) - [2\Delta H_f^{\circ} (\text{C}_6\text{H}_6) + 15\Delta H_f^{\circ} (\text{O}_2)]$$

$$\Delta H_{\text{rxn}}^{\circ} = 12(-393.5 \text{ kJ mol}^{-1}) + 6(-285.85 \text{ kJ mol}^{-1}) - [2(49.0 \text{ kJ mol}^{-1}) + 15(0)]$$

$$\Delta H_{\text{rxn}}^{\circ} = -6535 \text{ kJ mol}^{-1}$$