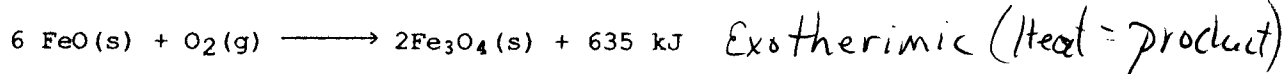


1. How much heat is lost when 35.5 g of iron cools from 429°C to 18.6°C? (The specific heat of iron is 0.450 J/(g · °C)).

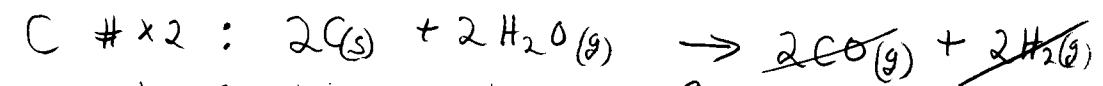
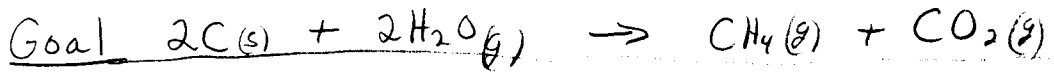
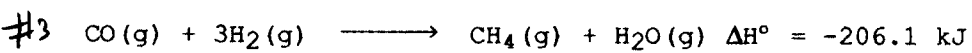
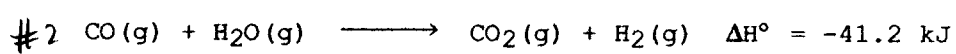
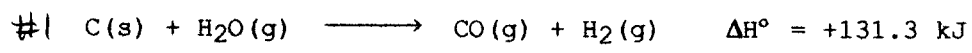
$$\frac{0.450 \text{ J}}{\cancel{\text{g} \cdot ^\circ\text{C}}} \times \frac{35.5 \text{ g}}{\cancel{\text{g}}} \times (429 - 18.6) \cancel{^\circ\text{C}} = 6556 \text{ J}$$

2. What is the change in enthalpy for the reaction of 58.3 grams of iron(II) oxide?

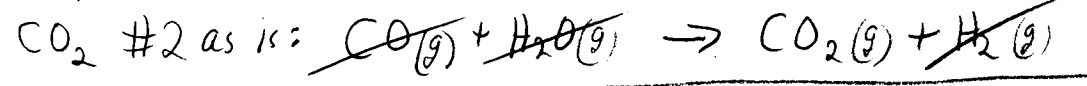
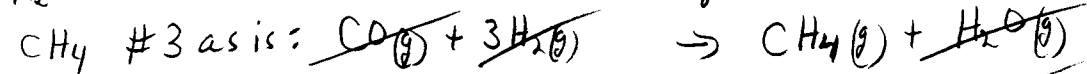


$$\frac{58.3 \text{ g FeO}}{\cancel{\text{g}}} \times \frac{\text{mol}}{71.85 \text{ g}} \times \frac{-635 \text{ kJ}}{6 \text{ mol FeO}} = -85.9 \text{ kJ} = \Delta H$$

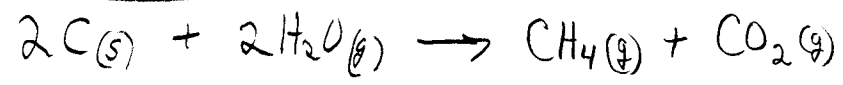
3. Using the following data, calculate the heat of reaction for the coal gasification process 2C(s) + 2H₂O(g) → CH₄(g) + CO₂(g).



H₂O skip found in more than one Equation.



| |
|----------------------------|
| <u>ΔH° (kJ)</u> |
| 262.6 |
| -206.1 |
| -41.2 |
| <hr style="width: 100%;"/> |
| 15.3 kJ |



4. Given the following enthalpies of formation, ΔH°: N₂H₄(l), 50.4 kJ/mol; H₂O(l), -286 kJ/mol; N₂O(g), 81.5 kJ/mol; NO₂(g), 33.8 kJ/mol;.

What is ΔH in kJ for the reaction below?



ΔH_{Rxn}° = Σ nΔH_f° products - Σ nΔH_f° reactants

ΔH_{Rxn}° = [2(81.5) + 2(-286)] - [50.4 + 2(33.8)]

2N₂O
2H₂O
N₂H₄
2NO₂

ΔH_{Rxn}° = -409 - 118 = -527 kJ

Key

5. Given the following table of thermodynamic data, substance ΔH_f° S°

| | | |
|-----------------------|---------------|---------------|
| TiCl ₄ (g) | -763.2 kJ/mol | 354.9 J/mol-K |
| TiCl ₄ (l) | -804.2 | 221.9 |

Equilibrium @ Boiling pt
 $TiCl_4(l) \rightleftharpoons TiCl_4(g)$

$$\Delta G = \Delta H - T\Delta S$$

@ Eq. $\Delta G = 0$

So: $\Delta H = T_B \Delta S$

and: $\frac{\Delta H}{\Delta S} = T_B$

determine the normal boiling point (in °C) of TiCl₄.

$$\Delta H = -804.2 - (-763.2) = -41.0 \text{ kJ}$$

$$\Delta S = 221.9 - 354.9 = -133.0 \text{ J/K}$$

$$T_B = \frac{\Delta H}{\Delta S} = \frac{-41.0 \times 10^3 \text{ J}}{-133 \frac{\text{J}}{\text{K}}} = 308 \text{ K} \approx 35^\circ\text{C}$$

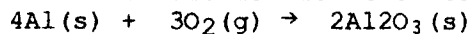
6. ΔS° will be positive for the reaction (d).

- a) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ (-) b) $2NO_2(g) \rightarrow N_2O_4(g)$ (-) c) $H^+(aq) + F^-(aq) \rightarrow HF(aq)$ (-)
 d) $BaF_2(s) \rightarrow Ba^{2+}(aq) + 2F^-(aq)$ (+) e) $2Hg(l) + O_2(g) \rightarrow 2HgO(s)$ -

Provide an explanation for your answer.

$BaF_2(s)$ dissociates into two ions which are more disordered.

7. Calculate ΔS° for the reaction below at 25°C.



| Substance | ΔS° (J/mol·K) |
|------------------------------------|----------------------------|
| Al(s) | 28.32 |
| Al ₂ O ₃ (s) | 51.0 |
| O ₂ (g) | 205.0 |

$$\Delta S^\circ = \sum n \Delta S^\circ_{\text{products}} - \sum n \Delta S^\circ_{\text{reactants}}$$

$$\Delta S^\circ = [2(51.0)] - [4(28.32) + 3(205.0)]$$

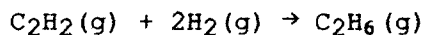
$\frac{2 Al_2O_3(s)}{\quad\quad\quad}$
 $\frac{4 Al(s)}{\quad\quad\quad}$
 $\frac{3 O_2(g)}{\quad\quad\quad}$

$$\Delta S^\circ = -626.3 \text{ J/K}$$

8. Consider the following table of thermodynamic data. All values are tabulated for 25°C.

| Substance | ΔG_f° (kJ/mol) | S° (J/mol·K) |
|-----------------------------------|-----------------------------|---------------------|
| C ₂ H ₂ (g) | 209 | 201 |
| C ₂ H ₆ (g) | -33 | 230 |
| H ₂ (g) | 0 | 131 |

What is the value of ΔH° (in kJ) for the reaction described below? Assume the reaction is performed at 25°C.



$$\Delta G^\circ = [-33] - [209 + 2(0)] = -242 \text{ kJ}$$

$$\Delta S^\circ = [230] - [201 + 2(131)] = -233 \frac{\text{J}}{\text{K}}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta H^\circ = \Delta G^\circ + T\Delta S^\circ$$

$$\Delta H^\circ = -242 \text{ kJ} + 298 \text{ K} \left(\frac{-0.233 \text{ kJ}}{\text{K}} \right)$$

$$\Delta H^\circ = -311 \text{ kJ}$$

Key

9. Consider the reaction: $\text{FeO}(s) + \text{Fe}(s) + \text{O}_2(g) \rightarrow \text{Fe}_2\text{O}_3(s)$

Given the following table of thermodynamic data,

| substance | ΔH_f° | S° |
|------------------------------------|--------------------|---------------|
| FeO(s) | -271.9 kJ/mol | 60.75 J/mol-K |
| Fe(s) | 0 | 27.15 |
| O ₂ (g) | 0 | 205.0 |
| Fe ₂ O ₃ (s) | -822.16 | 89.96 |

determine the temperature (in °C) above which the reaction is nonspontaneous.

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta H^\circ = -822.16 - (-271.9) = -550.3 \text{ kJ}$$

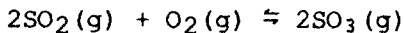
$$\Delta S^\circ = (89.96) - [60.75 + 27.15 + 205.0] = -202.94 \text{ J/K}$$

@ Eq $\Delta G = 0$, so: $0 = \Delta H - T\Delta S$

$$T = \frac{\Delta H}{\Delta S} = \frac{-550.3 \text{ kJ}}{-0.20294 \text{ kJ/K}} = 2711 \text{ K}$$

2711 K - 273 = 2438 °C SO \rightarrow 2438 °K
for + ΔG and non spou

10. Calculate the equilibrium constant of the reaction below at 25°C.



| Substance | ΔH_{of} (kJ/mol) | $\Delta^\circ S$ (J/mol·K) |
|---------------------|--------------------------|----------------------------|
| SO ₂ (g) | -297 | 249 |
| O ₂ (g) | 0 | 205 |
| SO ₃ (g) | -395 | 256 |

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta H^\circ = [2(-395)] - [2(-297)] = -196 \text{ kJ}$$

$$\Delta S^\circ = [2(256)] - [2(249) + 205] = -191 \text{ J/K}$$

$$\Delta G^\circ = -196 \text{ kJ} - 298 \text{ K} \left(\frac{-0.191 \text{ J}}{\text{K}} \right) = -139 \text{ kJ}$$

@ Eq $\Delta G^\circ = -RT \ln K$

$$\frac{-139 \times 10^3 \text{ J}}{-8.314 \text{ J/K} (298 \text{ K})} = \ln K$$

$$56.103 = \ln K$$

$$2.32 \times 10^{24} = K$$