

KEY

Thermochemistry Unit Review

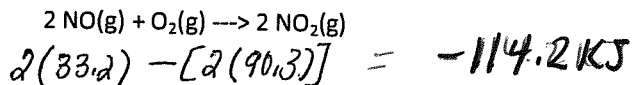
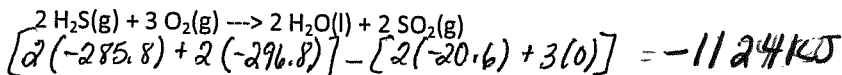
1. It takes 78.2J to raise the temperature of 45.6 grams of lead by 13.3 °C. What is the specific heat of lead? $q = mc\Delta T$

$$78.2 \text{ J} = (45.6 \text{ g})(c)(13.3^\circ\text{C}) = \boxed{.129 \text{ J/g}^\circ\text{C}}$$

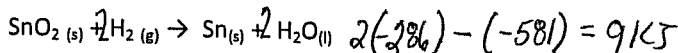
2. A sample of nickel metal is heated to 100.0 °C and dropped into 55.0g of water, initially at 23 °C. When the two were combined the final temperature of both of them was 20.7 °C. Assuming that all the heat lost by the nickel is absorbed by the water, calculate the mass of the nickel. (The specific heat of nickel is 0.444 J/°C g and water is 4.18 J/°C g) Hints: Energy in = Energy out & the final temperature of the metal and water are the same

$$m c \Delta T = m c \Delta T \quad m(0.444 \text{ J/g}^\circ\text{C})(79.3) = (55.0 \text{ g})(4.18 \text{ J/g}^\circ\text{C})(2.3^\circ\text{C}) \quad m = 15.9 \text{ g}$$

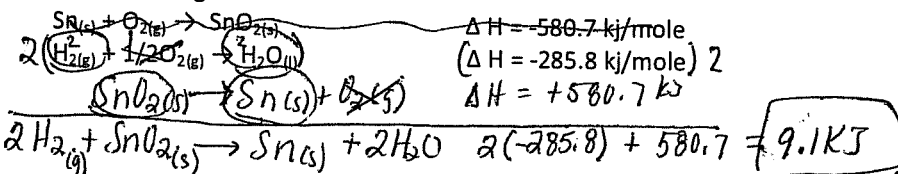
3. Calculate the enthalpy of the following reactions. Use your Thermochemical Data reference sheet for specific enthalpy of formation values



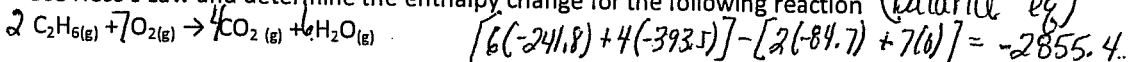
4. Use Hess's Law and determine the enthalpy change for the following reaction (Balanced eq)



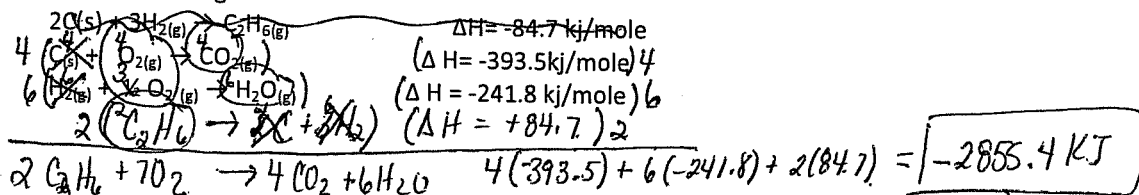
Use the following:



5. Use Hess's Law and determine the enthalpy change for the following reaction (Balance eq)



Use the following:



6. If 2 moles of $\text{C}_4\text{H}_{10}(\text{g})$ will produce 330KJ of energy. If you had 6.47g of $\text{C}_4\text{H}_{10}(\text{g})$ how much energy would you produce? Show work. $\frac{6.47 \text{ g C}_4\text{H}_{10}}{58 \text{ g}} \cdot \frac{1 \text{ mol C}_4\text{H}_{10}}{1 \text{ mol C}_4\text{H}_{10}} \cdot \frac{330 \text{ KJ}}{2 \text{ mol C}_4\text{H}_{10}} = \boxed{18.4 \text{ KJ}}$
7. When the temperature of a sample drops, this indicates that C the sample.
- cold is entering
 - energy is entering
 - energy is leaving
 - energy remains the same in

8. Which of the following equations is correctly associated with the standard enthalpy of formation of $\text{Fe}(\text{CO})_5$? *from its elements in standard state*

- a. $\text{Fe}_{(s)} + 5\text{CO}_{(g)} \rightarrow \text{Fe}(\text{CO})_{5(g)}$
 b. $\text{Fe}(\text{CO})_{5(g)} \rightarrow \text{Fe}_{(s)} + 5\text{C}_{(s)} + 5\text{O}_{(g)}$
 b. $\text{Fe}_{(g)} + 5\text{C}_{(g)} + 5\text{O}_{(g)} \rightarrow \text{Fe}(\text{CO})_{5(g)}$
 c. $\text{Fe}_{(s)} + 5\text{C}_{(s)} + 2.5\text{O}_{2(g)} \rightarrow \text{Fe}(\text{CO})_{5(g)}$

9. One calorie is equal to 4.18 joules.

10. Determine whether the following reactions show an increase or decrease in entropy (positive ΔS or negative ΔS).

- a) $2\text{KClO}_3(s) \rightarrow 2\text{KCl}(s) + 3\text{O}_2(g)$ +
 b) $\text{H}_2(g) + \text{Cl}_2(g) \rightarrow 2\text{HCl}(g)$ -
 c) $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(s)$ -
 d) $\text{Ag}^+(aq) + \text{Cl}^-(aq) \rightarrow \text{AgCl}(s)$ -
 e) $\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)$ -
 f) $2\text{N}_2\text{O}_5(g) \rightarrow 4\text{NO}_2(g) + \text{O}_2(g)$ +
 g) $\text{NaCl}(s) \rightarrow \text{Na}^+(aq) + \text{Cl}^-(aq)$ +
 h) $\text{KCl}(s) \rightarrow \text{KCl}(l)$ +

11. Find ΔS° for the following reactions. Use the values from your *Thermochemical Data* reference sheet

- a) $\text{Zn}(\text{NO}_3)_2(aq) + 2\text{NaOH}(aq) \rightarrow \text{Zn}(\text{OH})_2(s) + 2\text{NaNO}_3(aq)$
 $(2(207) + 81.2) - [(18 + 2(119))] = 290.4 \text{ J/mol}\cdot\text{K}$
 b) $2\text{NO}_2(g) + \text{H}_2\text{O}(l) \rightarrow \text{HNO}_2(aq) + \text{HNO}_3(aq)$
 $[53.5 + 46.1] - [2(240) + 69.9] = -450.3 \text{ J/mol}\cdot\text{K}$
 c) $\text{Mg}(s) + 2\text{HNO}_3(aq) \rightarrow \text{Mg}(\text{NO}_3)_2(aq) + \text{H}_2(g)$
 $[131 + 175] - [325 + 2(53.6)] = 166.5 \text{ J/mol}\cdot\text{K}$

12. Complete the following table for the sign of ΔG : +, -, or undetermined. When undetermined, the temperature determines the sign of ΔG .

ΔH	ΔS	ΔG
-	+	-
+	-	+
-	-	undetermined
+	+	undetermined

13. Consider the following reactions. Determine the signs for ΔH and ΔS . Then decide whether the reaction is sometimes, always, or never spontaneous.

- a) $\text{NaOH}(s) \rightarrow \text{Na}^+(aq) + \text{OH}^-(aq) + \text{energy}$ *35KJ*
 $\Delta H = -$ $\Delta S = +$ $\Delta G = -$ *always* spontaneous
 b) $\text{energy} + 2\text{H}_2(g) + \text{O}_2(g) \rightarrow \text{H}_2\text{O}(l)$
 $\Delta H = +$ $\Delta S = -$ $\Delta G = +$ *never* spontaneous
 c) $\text{energy} + \text{H}_2\text{O}(s) \rightarrow \text{H}_2\text{O}(l)$
 $\Delta H = +$ $\Delta S = +$ $\Delta G = ?$ *Sometimes* spontaneous

14. a) What is the value of ΔG if $\Delta H = -32.0 \text{ kJ}$, $\Delta S = +25.0 \text{ kJ/K}$, and $T = 20^\circ\text{C}$? *293*

$$\Delta G = -32.0 \text{ kJ} - (293 \text{ K})(25 \text{ kJ/K}) = -7337 \text{ kJ}$$

b) Is the reaction described in problem 14 spontaneous?

Spont.

15. a) What is the value of ΔG if $\Delta H = +12.0 \text{ kJ}$, $\Delta S = -5000 \text{ J/K}$, and $T = 290. \text{ K}$? ^{-5. kJ}

$$\Delta G = 12.0 \text{ kJ} - (290 \text{ K})(-5 \text{ kJ/K}) = +1462 \text{ kJ}$$

b) Is the reaction described in problem 15 spontaneous?

non spontaneous

16. Distinguish between enthalpy and entropy.

→ energy → disorder

17. In your best judgment, which of the following in each pair has the highest entropy?

A. (A) messy room

(B) neat room

B. (A) ice

(B) steam

C. (A) solid salt crystals

(B) salt dissolved in water

D. (A) iron filings & sulfur powder

(B) solid iron sulfide

18. Indicate whether the following describes **endothermic** or **exothermic** reactions.

(A) reactants have higher enthalpy than products ~~endo~~ *exo*

(B) produces energy as it proceeds *exo*

(C) products have very high enthalpy *endo*

(D) ΔH is always positive *endo*

(E) needs a continuous energy supply as they proceed *endo*

19. a) What is meant by a spontaneous reaction? *goes by itself*

b) What is meant by a nonspontaneous reaction? *needs help to proceed.*

20. What is the "direction" or trend most chemical reactions move toward in terms of energy and disorder?

low energy high disorder

21. What do the following symbols represent:

(A) ΔH

(B) ΔS

(C) ΔG

enthalpy

entropy

free energy

D) What is the general formula for determining the free energy of a chemical reaction?

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

22. a) What does a + ΔG value indicate about a reaction?

non spontaneous

b) What does a - ΔG value indicate about a reaction? *spontaneous*

23. Match the following:

B + ΔH

(A) spontaneous reaction

C - ΔH

(B) endothermic reaction

A - ΔG

(C) exothermic reaction

D + ΔG

(D) nonspontaneous reaction

F endothermic

(E) energy moves from system to surroundings

E exothermic

(F) energy moves from surroundings to system