C water = 4.18 J/g x °C
C steam = 2.01 J/g x °C
C ice = 2.03 J/g x °C

Name ANSWER KEY Hour ______

Thermochemical Equations

Honors Chemistry

For questions 1-6, use dimensional analysis to show the enthalpy change

1. How much heat is released when 113.6-g of C_3H_8 is burned?
    - $C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$ (ΔH_{comb} = -2219 kJ/mol)

$$\frac{113.6\text{ g } C_3H_8}{} \times \frac{1\text{ mol } C_3H_8}{44\text{ g } C_3H_8} \times \frac{-2219\text{ kJ}}{1\text{ mol } C_3H_8} = \boxed{-5729.1\text{ kJ}}$$

2. How much heat is released when 456.3-g of CO_2 forms?
    - $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$ (ΔH_{comb} = -891 kJ/mol)

$$\frac{456.3\text{ g } CO_2}{} \times \frac{1\text{ mol } CO_2}{44\text{ g } CO_2} \times \frac{-891\text{ kJ}}{1\text{ mol } CO_2} = \boxed{-9240.1\text{ kJ}}$$

3. How much heat (in kJ) is needed to decompose 4.44 mol of $NaHCO_3$?
    - $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$ (ΔH = +129 kJ)

$$\frac{4.44\text{ mol } NaHCO_3}{} \times \frac{+129\text{ kJ}}{2\text{ mol } NaHCO_3} = \boxed{286.4\text{ kJ}}$$

4. How much heat is released when 2.5 mol of NaOH is dissolved in water? ($\Delta H_{solution}$ = -445.1 kJ/mol)
    - $NaOH(s) + H_2O(l) \rightarrow NaOH\ (aq)$

$$\frac{2.5\text{ mol NaOH}}{} \times \frac{-445.1\text{ kJ}}{1\text{ mol NaOH}} = \boxed{-1112.8\text{ kJ}}$$

5. How much heat is absorbed when 5.66 g CS_2 forms?
    - $C(s) + 2S(s) \rightarrow CS_2(s)$ (ΔH = +89.3 kJ)

$$\frac{5.66\text{ g } CS_2}{} \times \frac{1\text{ mol } CS_2}{76\text{ g } CS_2} \times \frac{+89.3\text{ kJ}}{1\text{ mol } CS_2} = \boxed{6.7\text{ kJ}}$$

6. How much heat (in kJ) is absorbed when 476.5-g of water vapor is produced?
    - $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$ (ΔH = +129 kJ)

$$\frac{476.5\text{ g } H_2O}{} \times \frac{1\text{ mol } H_2O}{18\text{ g } H_2O} \times \frac{+129\text{ kJ}}{1\text{ mol } H_2O} = \boxed{3414.9\text{ kJ}}$$

7. What is the enthalpy change (in kJ) when you heat 74.6 g of ice at -15.0 °C until it reaches steam at 115.0 °C.

T change: -15 → 0 °C

$q = (74.6 g)(2.03 J/g \cdot C)(15 °C) = 2.3 kJ$

melting

$74.6 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{6.01 kJ}{1 mol} = 24.9 kJ$

T change: 0 → 100 °C

$q = (74.6 g)(4.18 J/g \cdot C)(100 °C) = 31.2 kJ$

Total Energy = +229.3 kJ

vaporizing

$74.6 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{40.7 kJ}{1 mol} = 168.7 kJ$

T change: 100 → 115 °C

$q = (74.6 g)(2.01 J/g \cdot C)(15 °C) = 2.2 kJ$

8. The 75.6 g of ice at 0.0 °C absorbs heat until steam forms at 130.0 °C. Calculate the enthalpy change in kilojoules.

melting

$75.6 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{6.01 kJ}{1 mol} = 25.2 kJ$

Total Energy = +232.3 kJ

vaporizing

$75.6 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{40.7 kJ}{1 mol} = 170.9 kJ$

T change: 0 → 100 °C

$q = (75.6 g)(4.18 J/g \cdot C)(100 °C) = 31.6 kJ$

T change: 100 → 130 °C

$q = (75.6 g)(2.01 J/g \cdot C)(30 °C) = 4.6 kJ$

9. What is the enthalpy change (in kJ) when 74.0 g of steam at 114.0 °C becomes ice at -13.0 °C.

T change: 114 → 100 °C

$q = (74.0 g)(-2.01 J/g \cdot C)(14 °C) = -2.1 kJ$

Total Energy = -227.0 kJ

freezing

$74.0 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{-6.01 kJ}{1 mol} = -24.7 kJ$

condensing

$74.0 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{-40.7 kJ}{1 mol} = -167.3 kJ$

T change: 0 → -13 °C

T change: 100 → 0 °C

$q = (74.0 g)(-4.18 J/g \cdot C)(100 °C) = -30.9 kJ$

$q = (74.0 g)(-2.03 J/g \cdot C)(13 °C) = -2.0 kJ$

10. 43.8 g of steam at 100.0 °C becomes ice at -5.0 °C. Calculate the enthalpy change in kilojoules?

condensing

Total Energy = -132.3 kJ

$43.8 g \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{-40.7 kJ}{1 mol} = -99.0 kJ$

freezing

$43.8 g H_2O \times \frac{1 mol H_2O}{18 g H_2O} \times \frac{-6.01 kJ}{1 mol} = -14.6 kJ$

T change: 100 → 0 °C

$q = (43.8 g)(-4.18 J/g \cdot C)(100 °C) = -18.3 kJ$

T change: 0 → -5 °C

$q = (43.8 g)(-2.03 J/g \cdot C)(5 °C) = -0.4 kJ$