

$$C_{\text{water}} = 4.18 \text{ J/g} \times ^\circ\text{C}$$

$$C_{\text{steam}} = 2.01 \text{ J/g} \times ^\circ\text{C}$$

$$C_{\text{ice}} = 2.03 \text{ J/g} \times ^\circ\text{C}$$

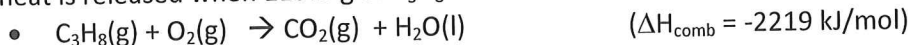
Name ANSWER KEY Hour \_\_\_\_\_

# Thermochemical Equations

## Honors Chemistry

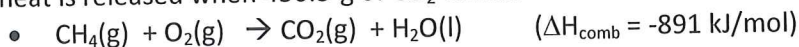
For questions 1-6, use dimensional analysis to show the enthalpy change

1. How much heat is released when 113.6-g of  $\text{C}_3\text{H}_8$  is burned?



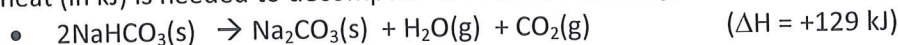
$$\frac{113.6 \text{ g C}_3\text{H}_8}{44 \text{ g C}_3\text{H}_8} \times \frac{1 \text{ mol C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} \times -2219 \text{ kJ} = \boxed{-5729.1 \text{ kJ}}$$

2. How much heat is released when 456.3-g of  $\text{CO}_2$  forms?



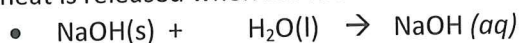
$$\frac{456.3 \text{ g CO}_2}{44 \text{ g CO}_2} \times \frac{1 \text{ mol CO}_2}{1 \text{ mol CO}_2} \times -891 \text{ kJ} = \boxed{-9240.1 \text{ kJ}}$$

3. How much heat (in kJ) is needed to decompose 4.44 mol of  $\text{NaHCO}_3$ ?



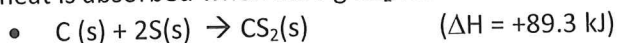
$$\frac{4.44 \text{ mol NaHCO}_3}{2 \text{ mol NaHCO}_3} \times +129 \text{ kJ} = \boxed{286.4 \text{ kJ}}$$

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



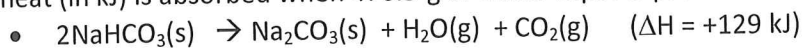
$$\frac{2.5 \text{ mol NaOH}}{1 \text{ mol NaOH}} \times -445.1 \text{ kJ} = \boxed{-1112.8 \text{ kJ}}$$

5. How much heat is absorbed when 5.66 g  $\text{CS}_2$  forms?



$$\frac{5.66 \text{ g CS}_2}{76 \text{ g CS}_2} \times \frac{1 \text{ mol CS}_2}{1 \text{ mol CS}_2} \times +89.3 \text{ kJ} = \boxed{6.7 \text{ kJ}}$$

6. How much heat (in kJ) is absorbed when 476.5-g of water vapor is produced?



$$\frac{476.5 \text{ g H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol H}_2\text{O}} \times +129 \text{ kJ} = \boxed{3414.9 \text{ kJ}}$$

7. What is the enthalpy change (in kJ) when you heat 74.6 g of ice at  $-15.0^{\circ}\text{C}$  until it reaches steam at  $115.0^{\circ}\text{C}$ .

T change:  $-15 \rightarrow 0^{\circ}\text{C}$

$$q = (74.6\text{g})(2.03\text{ J/g}\cdot\text{C})(15^{\circ}\text{C}) = \boxed{2.3\text{ kJ}}$$

melting

$$\frac{74.6\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{6.01\text{ kJ}}{1\text{ mol}} = \boxed{24.9\text{ kJ}}$$

T change:  $0 \rightarrow 100^{\circ}\text{C}$

$$q = (74.6\text{g})(4.18\text{ J/g}\cdot\text{C})(100^{\circ}\text{C}) = \boxed{31.2\text{ kJ}}$$

vaporizing

$$\frac{74.6\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{40.7\text{ kJ}}{1\text{ mol}} = \boxed{168.7\text{ kJ}}$$

T change:  $100 \rightarrow 115^{\circ}\text{C}$

$$q = (74.6\text{g})(2.01\text{ J/g}\cdot\text{C})(15^{\circ}\text{C}) = \boxed{2.2\text{ kJ}}$$

8. The 75.6 g of ice at  $0.0^{\circ}\text{C}$  absorbs heat until steam forms at  $130.0^{\circ}\text{C}$ . Calculate the enthalpy change in kilojoules.

melting

$$\frac{75.6\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{6.01\text{ kJ}}{1\text{ mol}} = \boxed{25.2\text{ kJ}}$$

T change:  $0 \rightarrow 100^{\circ}\text{C}$

$$q = (75.6\text{g})(4.18\text{ J/g}\cdot\text{C})(100^{\circ}\text{C}) = \boxed{31.6\text{ kJ}}$$

vaporizing

$$\frac{75.6\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{40.7\text{ kJ}}{1\text{ mol}} = \boxed{170.9\text{ kJ}}$$

T change:  $100 \rightarrow 130^{\circ}\text{C}$

$$q = (75.6\text{g})(2.01\text{ J/g}\cdot\text{C})(30^{\circ}\text{C}) = \boxed{4.6\text{ kJ}}$$

9. What is the enthalpy change (in kJ) when 74.0 g of steam at  $114.0^{\circ}\text{C}$  becomes ice at  $-13.0^{\circ}\text{C}$ .

T change:  $114 \rightarrow 100^{\circ}\text{C}$

$$q = (74.0\text{g})(-2.01\text{ J/g}\cdot\text{C})(14^{\circ}\text{C}) = \boxed{-2.1\text{ kJ}}$$

condensing

$$\frac{74.0\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{-40.7\text{ kJ}}{1\text{ mol}} = \boxed{-167.3\text{ kJ}}$$

T change:  $100 \rightarrow 0^{\circ}\text{C}$

$$q = (74.0\text{g})(-4.18\text{ J/g}\cdot\text{C})(100^{\circ}\text{C}) = \boxed{-30.9\text{ kJ}}$$

10. 43.8 g of steam at  $100.0^{\circ}\text{C}$  becomes ice at  $-5.0^{\circ}\text{C}$ . Calculate the enthalpy change in kilojoules?

condensing

$$\frac{43.8\text{g}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{-40.7\text{ kJ}}{1\text{ mol}} = \boxed{-99.0\text{ kJ}}$$

T change:  $100 \rightarrow 0^{\circ}\text{C}$

$$q = (43.8\text{g})(-4.18\text{ J/g}\cdot\text{C})(100^{\circ}\text{C}) = \boxed{-18.3\text{ kJ}}$$

**Total Energy =  $-227.0\text{ kJ}$**

freezing

$$\frac{74.0\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{-6.01\text{ kJ}}{1\text{ mol}} = \boxed{-24.7\text{ kJ}}$$

T change:  $0 \rightarrow -13^{\circ}\text{C}$

$$q = (74.0\text{g})(-2.03\text{ J/g}\cdot\text{C})(13^{\circ}\text{C}) = \boxed{-2.0\text{ kJ}}$$

**Total Energy =  $-132.3\text{ kJ}$**

freezing

$$\frac{43.8\text{g H}_2\text{O}}{18\text{g H}_2\text{O}} \left| \frac{1\text{ mol H}_2\text{O}}{1\text{ mol}} \right| \frac{-6.01\text{ kJ}}{1\text{ mol}} = \boxed{-14.6\text{ kJ}}$$

T change:  $0 \rightarrow -5^{\circ}\text{C}$

$$q = (43.8\text{g})(-2.03\text{ J/g}\cdot\text{C})(5^{\circ}\text{C}) = \boxed{-0.4\text{ kJ}}$$