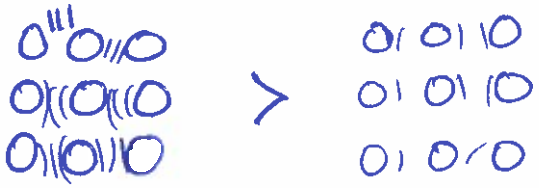
Key

Station 1: Thermochemistry & Calorimetry

A calorimetry experiment was performed that used a 10 g, 150°C sample of metal placed in a 100 g, 50°C sample of water. If the equilibrium temperature is 70°C, answer the following questions that follow.

1. Show the difference in the motion of the molecules of the metal before and after being placed in the calorimeter.



2. What direction is heat flowing once the metal and water are in contact?

metal → H_2O

3. What is the total amount of heat gained by the water?

$q = mc\Delta t$
$= 100 \cdot 4.184 \cdot 20 = 8368 J$

4. What is the specific heat of the metal?

$-8368 = 10 \cdot c \cdot -80$ $\quad c = 10.46 J/g \cdot °C$

5. How does the specific heat of the metal compare to the specific heat of the water?

metal > H_2O

6. Looking at the metal before and after being placed in the calorimeter, its change would be classified as an endothermic or exothermic change? Explain the reason behind your answer.

exothermic = lost heat to water

Station 2: Hess's Law

1. Calculate ΔH for the reaction $4\ NH_3\ (g) + 5\ O_2\ (g) \rightarrow 4\ NO\ (g) + 6\ H_2O\ (g)$, from the following data.

$N_2\ (g) + O_2\ (g) \rightarrow 2\ NO\ (g)$	$\Delta H = -180.5$ kJ x2
$N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$	$\Delta H = +91.8$ kJ x2
$2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g)$	$\Delta H = -483.6$ kJ x3
	-1628.2 KJ

2. Find ΔH° for the reaction $2H_2(g) + 2C(s) + O_2(g) \rightarrow C_2H_5OH(l)$, using the following thermochemical data.

$C_2H_5OH\ (l) + 2\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 2\ H_2O\ (l)$	$\Delta H = +875$ kJ
$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$	$\Delta H = -394.51$ kJ x2
$H_2\ (g) + \frac{1}{2}\ O_2\ (g) \rightarrow H_2O\ (l)$	$\Delta H = -285.8$ kJ x2
	-485.62 KJ

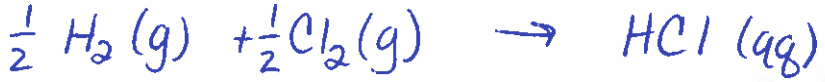
3. Calculate ΔH for the reaction $CH_4\ (g) + NH_3\ (g) \rightarrow HCN\ (g) + 3\ H_2\ (g)$, given:

$N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$	$\Delta H = +91.8$ kJ /2
$C\ (s) + 2\ H_2\ (g) \rightarrow CH_4\ (g)$	$\Delta H = +74.9$ kJ
$H_2\ (g) + 2\ C\ (s) + N_2\ (g) \rightarrow 2\ HCN\ (g)$	$\Delta H = +270.3$ kJ /2
	255.95 KJ

Station 3: Standard Heat of Formation

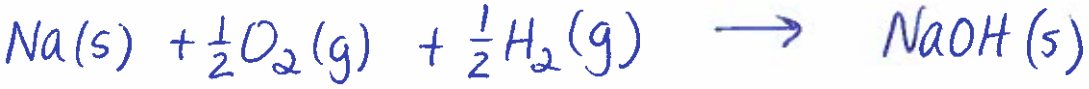
Write the standard enthalpy of formation equations for each of the following compounds and determine the enthalpy required to form each using the standard enthalpy chart on pages 1112-1114 in the back of the book.

1. Hydrochloric acid



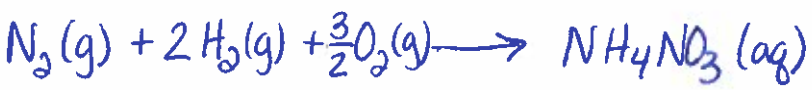
$$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(aq)$$

2. Solid Sodium hydroxide



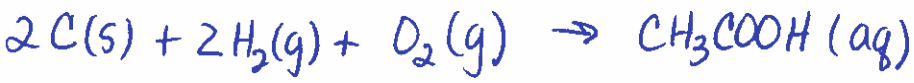
$$Na(s) + \frac{1}{2}O_2(g) + \frac{1}{2}H_2(g) \rightarrow NaOH(s)$$

3. Ammonium nitrate



$$N_2(g) + 2H_2(g) + \frac{3}{2}O_2(g) \rightarrow NH_4NO_3(aq)$$

4. Acetic acid

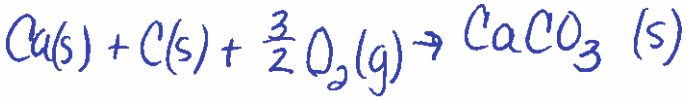


$$2C(s) + 2H_2(g) + O_2(g) \rightarrow CH_3COOH(aq)$$

5. Potassium bromide

$$K(s) + \frac{1}{2}Br_2(l) \rightarrow KBr(s)$$

6. Calcium carbonate



$$Ca(s) + C(s) + \frac{3}{2}O_2(g) \rightarrow CaCO_3(s)$$

Station 4: Energy of a system

1. What two factors determine the total energy of a system?

   heat & work

2. What does the First Law of Thermodynamics state about energy?

   Consened - energy is not created or destroyed

3. Determine whether the values of heat and work are positive or negative for the system and state whether the total energy of the system is always positive, always negative or whether more information about the heat and work values are needed to answer.
   a. Heat is released to the environment while work is being done on the system

      $q = -$ more info needed
      $w = +$

   b. Both heat is absorbed and work is done on the system

      $q = +$
      $w = +$
      $\Delta E = +$

   c. Work is being done on the surroundings while releasing heat

      $q = -$
      $w = -$
      $\Delta E = -$

   d. Work is being done on the surroundings while some heat is being absorbed

      $q = +$
      $w = -$
      ΔE more info needed

4. State whether each of the following statements is true or false:
   F a. All molecules at the same temperature have the same exact kinetic energy.
   T b. At absolute zero all molecules cease to move at all.
   T c. If the products have more energy than reactants, the reaction is endothermic at a constant pressure.
   T d. Chemical reactions forward and reverse have the same quantity for enthalpy just opposite signs.
   T e. All chemical reactions must absorb some energy in order to get started even if they are exothermic. (activation energy)