SCH4U

Energy Changes & Rates of Reactions

# Thermodynamics & Calorimetry

First Law of Thermodynamics:

System: Surroundings:

Universe:

Thermal Energy:

Heat, q:

Temperature, T:

Specific heat capacity, c:

1. If a gold ring with a mass of 5.5 g changes in temperature from 25.0°C to 28.0°C, how much heat energy, in Joules, has it absorbed? The value of the specific heat capacity of gold is 0.129.

2. What would be the final temperature if 250.0 J of heat were transferred into 10.0g of methanol (c = 2.9 J / g • °C) initially at 20°C?

3. When 1.02g of steric acid, $C_{18}H_{36}O_2$, was burned completely in a bomb calorimeter, the temperature of the calorimeter rose by 4.26°C. The heat capacity of the calorimeter was 9.43 kJ/°C. Calculate the total heat of combustion of steric acid in kJ / mol.

4. 175g of water was placed in a coffee cup calorimeter and chilled to 10°C. Then 4.90 g of sulfuric acid was added at 10°C and the mixture was stirred. The temperature rose to 14.9°C. Assume the specific heat capacity of the solution is 4.2 J/g • °C. Calculate the heat produced in kJ and the heat produced per mole of sulfuric acid.

5. A 26.6 g sample of mercury is heated to 110.0°C and then placed in 125 g of water in a coffee-cup calorimeter. The initial temperature of the water is 23.00°C. The specific heat capacity of water is 4.184 J/g•°C, and the specific heat capacity of mercury is 0.139 J/g•°C. What is the final temperature of the water and the mercury?

Homework:

1. How much heat in kJ must be removed from 175g of water to lower its temperature from 25.0°C to 15.0°C?

2. How much heat in kJ is needed to bring 1.0kg of water from 25°C to 99°C?

3. How many Joules are needed to increase the temperature of 15g of Fe from 20.0°C to 40.0°C? Specific heat capacity of Fe = 0.4498 J/g • °C.

4. The addition of 250 J to 30.0g of copper initially at 22.0°C will change its temperature to what final value? Specific heat capacity of Cu = 0.387 J/g • °C.

5. When a 20.0g sample received 47.0 J of energy, its temperature changed from 25.0°C to 35.0°C. Was this substance made from gold, lead or silver? (Research the specific heat capacities for each substance.)

6. Calculate the molar heat capacity of iron in J • $mol^{-1}$ • $°C^{-1}$. Its specific heat capacity is 0.4498 J • $g^{-1}$ • $°C^{-1}$.

7. Given the following reaction: $HNO_{3\,(aq)} + KOH_{(aq)} \rightarrow KNO_{3\,(aq)} + H_2O_{(l)}$
A student placed 55.0 mL of 1.3 M $HNO_3$ in a coffee cup calorimeter and noted the solution temperature at 23.5°C. To this 55.0 mL of 1.3 M KOH, at 23.5°C, was added. The reaction was stirred quickly and the temperature rose to 31.8°C.
a) Calculate the heat of the reaction in J. Assume the specific heat capacities and densities of all solutions are the same as water.
b) Calculate the heat of reaction per mol of acid in kJ / mol.

8. When a reaction was carried out in a bomb calorimeter, 17.61 kJ was released. The initial temperature was 22.418°C. The heat capacity of the system was 17.68 kJ/°C. Calculate the final temperature of the calorimeter.

Textbook Readings and Questions (Nelson, Chemistry 12):
Sections 5.1 (p298 – 305); p294 #3, 6, 7; p302 #10

**Answers:**
1. 7.35 kJ 2. $3.1 \times 10^2$ kJ 3. 135 J 4. 43.5°C 5. c = 0.235 J/g • °C 6. 25.91 J • $mol^{-1}$ • $°C^{-1}$ 7. a) $3.8 \times 10^3$ J b) 53 kJ/mol 8. 23.41°C