

## Thermochemistry Problems - Worksheet Number Two (answers available on web site)

The older energy unit of calories has not been discussed in class. You may see it from time to time. The conversion is  $1.000 \text{ cal} = 4.184 \text{ J}$ . All the calculation techniques are the same regardless of using calories or Joules.

1. Convert from one unit to the other:

- a. 1.69 Joules to calories
- b. 0.3587 J to cal
- c. 820.1 J to kilocalories
- d. 68 calories to kilocalories
- e. 423 calories to kilocalories
- f. 20.0 calories to Joules
- g. 252 cal to J
- h. 2.45 kilocalories to calories
- i. 556 kilocalories to cal
- j. 6.78 kilocalories to kilojoules
- k. 59.6 calories to kcal
- l. 449.6 joules to kilojoules
- m. 9.806 kJ to J
- n. 5.567 cal to J
- o. 5467.9 kcal to J

2. Determine the temperature change when:

- a. 20.0 g of water is heated from  $16.8 \text{ }^\circ\text{C}$  to  $39.2 \text{ }^\circ\text{C}$ .
- b. 35.0 g of water is cooled from  $56.5 \text{ }^\circ\text{C}$  to  $5.9 \text{ }^\circ\text{C}$ .
- c. 50.0 g of liquid water is heated from  $0.0 \text{ }^\circ\text{C}$  to  $100.0 \text{ }^\circ\text{C}$ .
- d. 25.0 g of ice is warmed from  $-25.0 \text{ }^\circ\text{C}$  to  $0.0 \text{ }^\circ\text{C}$ , but does not melt.
- e. 30.0 g of steam heats from  $373.2 \text{ K}$  to  $405.0 \text{ K}$ .

3. Determine the energy required (in Joules) when the temperature of 3.21 grams of water increases by  $4.0 \text{ }^\circ\text{C}$  while remaining liquid.

4. Determine the energy needed (in Joules) when 55.6 grams of water at  $43.2 \text{ }^\circ\text{C}$  is heated to  $78.1 \text{ }^\circ\text{C}$ .

5. Determine the energy required (in kilojoules) when cooling 456.2 grams of water at  $89.2 \text{ }^\circ\text{C}$  to a final temperature of  $5.9 \text{ }^\circ\text{C}$ .

6. Determine the energy required to:

- a. melt 5.62 moles of ice at  $0 \text{ }^\circ\text{C}$ .
- b. melt 74.5 grams of ice at  $0 \text{ }^\circ\text{C}$ .
- c. boil 0.345 moles of water at  $100.0 \text{ }^\circ\text{C}$ .
- d. boil 43.89 grams of water at  $100.0 \text{ }^\circ\text{C}$ .

7. Determine the energy change involved to:

- a. Convert 16.2 grams of ice to liquid water.
- b. Convert 5.8 grams of water to steam
- c. Convert 98.2 grams of water to ice.
- d. Convert 52.6 grams of steam to water
- e. Convert 34.0 grams of water at  $20.0 \text{ }^\circ\text{C}$  to steam at  $100.0 \text{ }^\circ\text{C}$ .
- f. Convert 125.0 grams of ice at  $0.0 \text{ }^\circ\text{C}$  to steam at  $100.0 \text{ }^\circ\text{C}$ .
- g. Convert 25.9 grams of steam at  $100.0 \text{ }^\circ\text{C}$  to ice at  $0.0 \text{ }^\circ\text{C}$ .

8. Determine the final temperature in each of the following problems:
- 32.2 g of water at 14.9 °C mixes with 32.2 grams of water at 46.8 °C.
  - 139 g of water at 4.9 °C mixes with 241 grams of water at 96.0 °C.
  - 2.29 g of water at 48.9 °C mixes with 3.65 grams of water at 36.1 °C.
  - 56.3 grams of water at 12.3 °C mixes with 46.2 grams of water at 78.1 °C.
  - 14.2 grams of ice at -16.2 °C is placed in 250.0 grams of water at 70.0 °C.
9. A student places 42.3 grams of ice at 0.0 °C in an insulated bottle. The student adds 255.8 grams of water at 90.0 °C. Determine the final temperature of the mixture.
10. A student places 21.4 grams of ice at 0.0 °C and 13.1 grams of steam at 100.0 °C in a sealed and insulated container. Determine the final temperature of the mixture.
11. Determine the specific heat of a 150.0 gram object that requires 62.0 cal of energy to raise its temperature 12.0 °C.
12. Determine the heat required to convert 62.0 grams of ice at -10.3 °C to water at 0.0 °C. The specific heat capacity of ice is 2.02 J/g °C.
13. Determine the energy released when converting 500.0 g of steam at 100.0 °C to ice at -25.0 °C.
14. Determine the energy required to convert 32.1 grams of ice at -5.0 °C to steam at 100.0 °C.
15. Determine the energy required to raise the temperature of 46.2 grams of aluminum from 35.8 °C to 78.1 °C. Specific heat capacity of aluminum is 0.089 J/g °C.
16. Determine the final temperature when 450.2 grams of aluminum at 95.2 °C is placed in an insulated calorimeter with 60.0 grams of water at 10.0 °C.
17. Determine the mass of iron heated to 85.0 °C to add to 54.0 grams of ice to produce water at 12.5 °C. The specific heat of iron is 0.045 J/g °C.
18. Determine the final temperature when 45.8 grams of aluminum at -5.2 °C is added to a mixture of 45.0 grams of ice at 0.0 °C and 2000.0 grams of water at 95.0 °C.