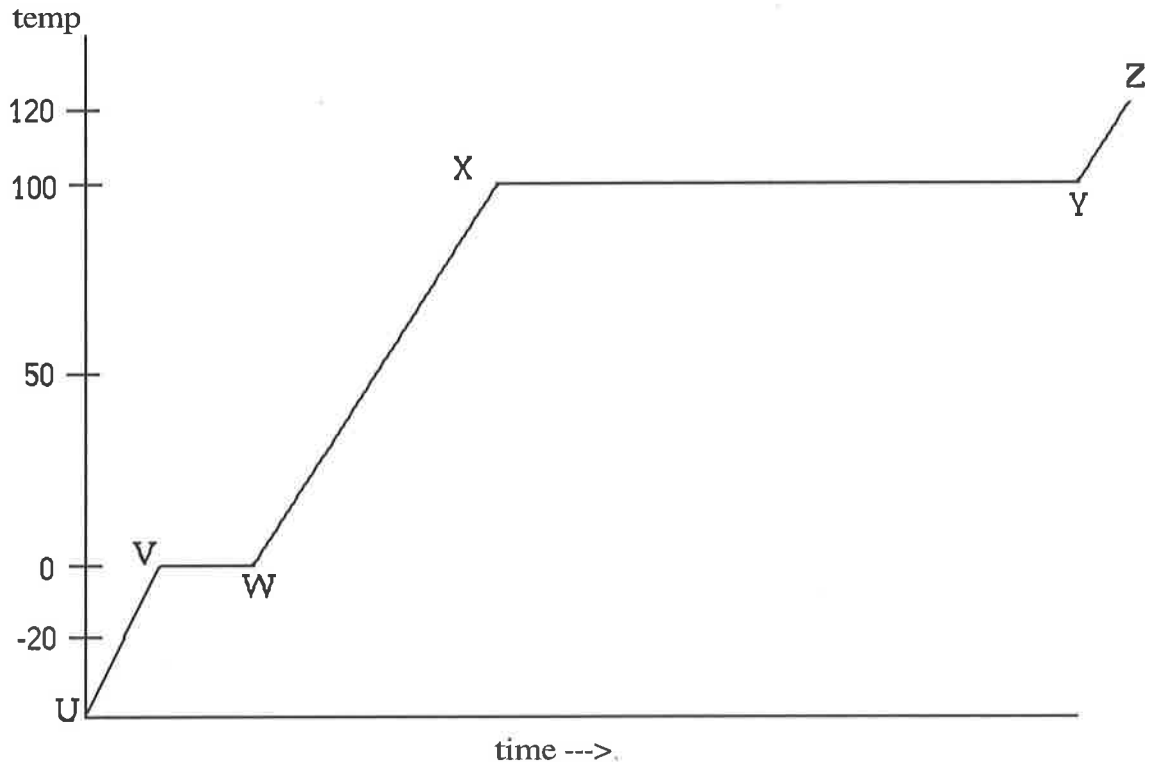
Thermochemistry Problems - Worksheet Number One (answers available on web site)

1. How much energy must be absorbed by 20.0 g of water to increase its temperature from 283.0 °C to 303.0 °C?
2. When 15.0 g of steam drops in temperature from 275.0 °C to 250.0 °C, how much heat energy is released?
3. How much energy is required to heat 120.0 g of water from 2.0 °C to 24.0 °C?
4. If 720.0 g of steam at 400.0 °C absorbs 800.0 kJ of heat energy, what will be its increase in temperature?
5. How much heat (in kJ) is given out when 85.0 g of lead cools from 200.0 °C to 10.0 °C? (C_p of lead = 0.129 J/g °C)
6. If it takes 41.72 joules to heat a piece of gold weighing 18.69 g from 10.0 °C to 27.0 °C, what is the specific heat of the gold?
7. It takes 333.51 joules to melt exactly 1 gram of H_2O. What is the molar heat of fusion for water, from this data?
8. A certain mass of water was heated with 41,840 Joules, raising its temperature from 22.0 °C to 28.5 °C. Find the mass of water.
9. How many joules of heat are needed to change 50.0 grams of ice at -15.0 °C to steam at 120.0 °C. Make a graph to indicate this change.
10. Calculate the number of joules given off when 32.0 grams of steam cools from 110.0 °C to ice at -40.0 °C. Make a graph to indicate this change.
11. You have a sample of H_2O with a mass 23.0 grams at a temperature of -46.0 °C. How many kilojoules of heat energy are necessary to carry out each step? Also, please calculate the total amount of energy needed and make a time-temperature graph.
    a) heat the ice to 0.0 °C?
    b) melt the ice?
    c) heat the water from 0.0 °C to 100.0 °C?
    d) boil the water?
    e) heat the steam from 100.0 °C to 109.0 °C?
12. Calculate the energy released when 10.0 g of steam at 120.0 °C are converted into ice at minus 20.0 °C.
13. How much energy is required to convert 100.0 g of water at 20.0 °C completely to steam at 100.0 °C?
14. What amount of ice must be added to 540.0 g of water at 25.0 °C to cool the water to 0.0 °C and have no ice remaining?
15. How many grams of ice could be melted by the energy obtained as 18.0 g of steam is condensed at 100.0 °C and cooled to 0.0 °C?
16. If 150.0 grams of iron at 95.0 °C, is placed in an insulated container containing 500.0 grams of water at 25.0 °C, and both are allowed to come to the same temperature, what will that temperature be? The specific heat of water is 4.18 J/g °C and the specific heat of iron is 0.444 J/g °C)
17. When 80.0 grams of a certain metal at 90.0 °C was mixed with 100.0 grams of water at 30.0 °C, the final equilibrium temperature of the mixture was 36.0 °C. What is the specific heat (Joules $gram^{-1}$ $°C^{-1}$) of the metal?
18. Calculate the specific heat of a metal if a 55.0 g sample of an unknown metal at 99.0 °C causes a 1.7 °C temperature rise when added to 225.0 g of water at 22.0 °C.
19. If 10.0 g water at 0.0 °C is mixed with 20.0 g of water at 30.0 °C, what is the final temperature of a mixture?
20. 15.0 g of water at 0.0 °C are added to 40.0 g of water at 40.0 °C. What is the final temperature of the mixture?

21. The graph below shows a pure substance which is heated by a constant source of heat supplying 2000.0 joules per minute. Identify the area described in the questions below and complete the necessary calculations.

UV = 0.36 min, VW = 3.6 min, WX = 3.6 min, XY = 19.4 min, YZ = 0.6 min



a. being warmed as a solid _____
b. being warmed as a liquid _____
c. being warmed as a gas _____
d. changing from a solid to a liquid _____
e. changing from a liquid to a gas _____
f. What is its boiling temperature? _____
g. What is its melting temperature? _____
h. How many joules were needed to change the liquid to a gas? _____
i. Where on the curve do the molecules have the highest kinetic energy? _____
j. If the sample weighs 10.0 g, what is its heat of vaporization in J/g? _____

22. The number of Joules needed to raise the temperature of 100 grams of water 10 °C. is the same as the number of Joules needed to raise the temperature of 1000 grams of water
a. 1 °C b. 0.1 °C c. 10 °C d. 100 °C
23. 10.0 g of a fuel are burned under a calorimeter containing 200.0 g of H_2O. The temperature of the water increases from 15.0 °C to 55.0 °C. Calculate the total heat produced (in joules) and the heat of combustion per gram of fuel.
24. Why does moisture condense on the outside of a glass of cold water?
25. Is it possible for a cup of water to completely evaporate in a room with a constant temperature?
26. Why does alcohol at room temperature feel cooler to the touch than does water at the same temperature?
27. If you put a very shallow dish of water in a pan of alcohol and blow air over it by means of a electric fan, the water will freeze...why?

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 cal = 4.184 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 °C to 39.2 °C.
    b. 35.0 g of water is cooled from 56.5 °C to 5.9 °C.
    c. 50.0 g of liquid water is heated from 0.0 °C to 100.0 °C.
    d. 25.0 g of ice is warmed from -25.0 °C to 0.0 °C, but does not melt.
    e. 30.0 g of steam heats from 373.2 K to 405.0 K.

3. Determine the energy required (in Joules) when the temperature of 3.21 grams of water increases by 4.0 °C while remaining liquid.
4. Determine the energy needed (in Joules) when 55.6 grams of water at 43.2 °C is heated to 78.1 °C.
5. Determine the energy required (in kilojoules) when cooling 456.2 grams of water at 89.2 °C to a final temperature of 5.9 °C.

6. Determine the energy required to:
    a. melt 5.62 moles of ice at 0 °C.
    b. melt 74.5 grams of ice at 0 °C.
    c. boil 0.345 moles of water at 100.0 °C.
    d. boil 43.89 grams of water at 100.0 °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 °C to steam at 100.0 °C.
    f. Convert 125.0 grams of ice at 0.0 °C to steam at 100.0 °C.
    g. Convert 25.9 grams of steam at 100.0 °C.to ice at 0.0 °C.

8. Determine the final temperature in each of the following problems:
   a. 32.2 g of water at 14.9 °C mixes with 32.2 grams of water at 46.8 °C.
   b. 139 g of water at 4.9 °C mixes with 241 grams of water at 96.0 °C.
   c. 2.29 g of water at 48.9 °C mixes with 3.65 grams of water at 36.1 °C.
   d. 56.3 grams of water at 12.3 °C mixes with 46.2 grams of water at 78.1 °C.
   e. 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.