Heat/Temperature Problems: (cp = specific heat)

1. If a mass of 200.0 grams of water is heated from 24.0° C to 100.0° C to make a cup of tea, how much heat must be added?
2. Which is more effective in cooling a drink, 10 grams of water at 0° C or 10 grams of ice at 0° C? Explain your answer quantitatively.
3. A sample of mercury metal is heated from 25.5° C to 52.5° C. In the process, 187 cal of heat are absorbed. What mass of mercury was in the sample? The specific heat of mercury is 0.033 cal/ g° C
4. A block of aluminum weighing 140.0 g is cooled from 98.4° C to 62.2° C with the release of 1080 cal of heat. From these data, calculate the specific heat of aluminum.
5. A total of 54.0 cal of heat are absorbed as 58.3 g of lead is heated from 12.0° C to 42.0° C. From these data, what is the specific heat of lead?
6. A piece of erbium metal weighing 100.0 g and heated to 95.0° C is dropped into 200.0 g of water initially at 20.0° C. The final temperature of the mixture is 21.5° C. What is the specific heat of erbium metal?
7. Copper has a density of 8.94 g/cm3 and a specific heat of 0.090 cal/g° C. A cube of copper is heated from 10.5° C to 214° C. The cube of copper has dimensions of 5.00 cm. How much heat would the copper cube absorb?
8. A block of rhenium metal (specific heat = 0.0329 cal/ g° C) is heated to 88.2° C and then dropped into 100.0 g of water initially at 26.4° C. The final temperature of the mixture is 32.4° C. What was the mass of the block of rhenium?
9. \*A 3.00 kg lead bar at 100.0° C is placed in 4.00 kg of water at 20.0° C. The final temperature of the lead bar would be \_\_\_\_\_\_\_\_\_\_\_. (cp of lead is 0.0305 cal/g° C)
10. \*Read Carefully! A 0.60 kg **copper kettle** holds 1.70 kg of water at 30.0° C. A 0.10 kg iron ball at 120.0° C is dropped into the water. What is the final temperature of the water? (cp of copper = 0.377 J/g° C and iron is 0.448 J/g° C)
11. \*A piece of iron with a mass of 20.50 grams at a temperature of 100.0° C is dropped into 140.00 grams of water at 40.0° C. What will be the final temperature of the system. The cp of iron is 0.45 J/g° C)
12. \*A cube of gold weighing 192.4 g is heated from 30.0° C to some higher temperature, with the absorption of 226 cal of heat. The specific heat of gold is 0.030 cal/ g° C. What was the final temperature of the gold?
13. \* Suppose a piece of iron (mass = 21.50 g at a temperature of 100.0° C) is dropped into an insulated container of water (mass of water = 132 g and the temperature before adding iron was 20.0° C). What will be the final temperature of the system (at thermal equilibrium)? The specific heat of iron is 0.113 cal/g° C.
14. When 258.6 g of benzene vapor is condensed to a liquid at its boiling point, 33 875 cal of heat are released. What is the heat of vaporization per gram for benzene?
15. A sample of ethyl alcohol is converted from a liquid to a vapor with no temperature change. In the process 30 640 cal of heat are absorbed. What mass of ethyl alcohol was in the sample? The heat of vaporization of ethyl alcohol is 210.0 cal/g.
16. The heat of combustion of methane is 13.3 kcal per gram. How much heat will be produced in the combustion of 100.0 g of methane?
17. The heat of combustion of toluene is 10.15 kcal per gram. How much heat will be released during the combustion of 250.0 g of toluene?
18. The specific heat of water is 4.185 J/g° C (1.00 cal/g° C). A piece of a pure metal with a mass of 24.0 g at a temperature of 45.0° C is added to 55 mL of water at 60.0° C. The final equilibrium temperature of the mixture is 95.4° C. Find the specific heat of the pure metal in both cal/g° C and J/g° C.
19. The specific heat of ice is 2.03 J/g° C. How much heat is needed to convert 550.0 g of ice at –15.0° C to 10.0° C?
20. What is the total amount of heat needed (in calories and joules) to convert 2.25 kg of ice at 0.0° C to steam at 200.0° C.
21. The specific heat of silicon is 0.057 cal/g° C and the density of silicon is 4.4 g/cm3. The volume of a cylinder formula is given as π r2 L. The addition of 6000. calories raises the temperature of the silicon cylinder 55.5° C. Find the radius of the cylinder.
22. A piece of metal with a mass of 75.5 g is heated to 84.5° C and added to 100.0 mL of water at 5.0° C. The final temperature of the mixture is 75.0° C. Find the specific heat of the metal.
23. Granite has a specific heat of 800. J/g° C. What mass of granite is needed to store 1.50 E 6 J of heat if the temperature of the granite is to be increased by 15.5° C?
24. A 55 kg block of granite has an original temperature of 15.0° C. What will be the final temperature of this granite if 4.5 E 4 kJ of heat energy are added to the granite?

MORE!

A given birthday candle has a mass of 0.84 g. The mass remaining after 1 minute of burning = 0.77 g. What would be the burnout time for that candle? Explain why your answer might not be exactly the same as the actual burnout time.

A 5.00 gram sample of motor oil is burned in a calorimeter. The calorimeter contained 720. mL of water initially at 21.4° C. After the oil was burned, the water temperature was measured at 33.9° C. What was the heat of combustion of the motor oil in J/g?

Extended Problem

You are given a block of wax that has a mass of 150.0 grams. The melting point is 95.0° C, the specific heat of the solid is 0.80 J/g° C, the specific heat of the liquid is 1.2 J/g° C; the heat of fusion is

60. J/g. The wax is heated on a stove that provides 6.0 E 3 J of heat per minute. The room temperature is 25 ° C.

a) How many joules of heat are required to heat the wax to melting?

b) How long will this take?

c) How many joules of heat are required to melt the wax and how long will this take?

d) How many joules of heat are required to heat the liquid wax to 245° C and how long will it take?

e) Sketch a graph of the data (heating curve). What do the slopes of the solid heating and liquid heating indicate about the relative specific heats?

f) At 245° C the wax will burst into flame and completely react with the air to produce CO2 and H2O. The heat of combustion is 42 kJ/g. How many joules of heat are produced with the wax burns? Is this enough to melt and heat to burning another block of wax of the same size?

 Refer to the Data Table below to answer questions:

|  |  |  |  |
| --- | --- | --- | --- |
| **Substance** | **Specific Heat** | **Heat of Fusion** | **Heat of Vaporization** |
|  | (J / g° C) | (J / g) | (J / g) |
| water (l) | 4.185 | 334 | 2260 |
| water (s) | 2.06 | 334 | 2260 |
| ethanol | 2.45 | 109 | 879 |
| aluminum | 0.895 | 376 | 11371 |
| copper | 0.387 | 205 | 4726 |
| silver | 0.233 | 88 | 2300 |
| granite | 0.803 | - | - |

1. How much heat is required to melt a sample of 550 grams of copper?

 2. How much heat is absorbed as a 95.0 gram sample of water is heated from 10.5° C to 48.2° C?

 3. How much heat is absorbed by 25 grams of ethanol as it evaporates?

 4. A 950. kg granite wall inside a solar house is used to absorb heat during the day. During the day it reaches a temperature of 24.0° C. At night, it will cool off to 17.0° C. How much heat will be released by the wall? How much heat would be released if the wall was made of 20.0 kg of aluminum filled with 180 kg of water and had the same temperature change?