06/07/24

How many joules of heat energy are required to heat 1.0 gallons of water from 20°C to 85°C?

$$1.0 \text{ gallons} \times \frac{3.7\ L}{1\ gal} \times \frac{1000\ mL}{1\ L} \times \frac{1\ g\ H_2O}{1\ mL\ H_2O} = 3700\ g\ H_2O$$

$$q = (3700g)(4.184 \frac{J}{gK})(85°C - 20°C) = 1.01 \times 10^6\ J$$

You have 125.0 grams of gold, that has a specific heat capacity of 0.13 J/g•K, and it is at a temperature of 37°C (i.e. a gold necklace that you just took off). You use a hair dryer to blow hot air on the gold, eventually adding a total of 3.2 kJ of heat to the gold. What is the temperature of the gold after this amount of heat energy has been added?

$$3200\ J = (125g)(0.13 \frac{J}{gK}) \Delta T$$

$$\Delta T = 196.9\ K$$

$$37°C = 310\ K \longrightarrow \Delta T = T_f - T_i$$

$$196.9 = T_f - 310\ K$$

$$T_f = 506.9\ K \text{ or } 233.6\ °C$$

If the addition of 735 J of heat to 200.0 grams of a liquid causes its temperature to go from 31.5°C to 34.2°C, what is the specific heat capacity of that liquid?

$$\Delta T = 34.2°C - 31.5°C = 2.7°C$$

$$735\ J = (200.0g)(C_p)(2.7°C)$$

$$C_p = 1.36 \frac{J}{g\ K}$$

or °C

The temperature inside your freezer is -20°C. You remove a chunk of ice from the freezer that weights 750 grams. How much energy is required to turn all this ice into gaseous water?

$750g \times 4.184\frac{J}{gK}(0°C - {}^{-}20°C) = 62760\ J$ to warm ice to 0°C

$750g \times 333\frac{J}{g} = 249750\ J$ to melt ice

$750g \times 4.184\frac{J}{gK}(100°C - 0°C) = 313800\ J$ to warm water to 100°C

$750g \times 2256\frac{J}{g} = 1692000\ J$ to evaporate

Total = 2,318,310 J

You have a cube of iron (Fe) that measures 1.35 inches on a side. The density of iron is 7.86g/cm^3 and the specific heat capacity of iron is 0.45 J/g•K. Using a furnace, you heat the cube of iron to a temperature of 750°C and then drop it into a bucket containing 2.5 L of water originally at room temperature (20°C). What will the temperature of the water be when everything has equilibrated?

$1.35\ \text{inches} \times \frac{2.54cm}{1in} = 3.43cm$ ← length of side of cube

Volume of cube $= (3.43cm)^3 = 40.35cm^3$

Mass of cube $= 40.35cm^3 \times \frac{7.86g}{cm^3} = 317.2g\ Fe$

$q_1 + q_2 = 0$

$$\left[(317.2g)(0.45\frac{J}{gK})(T_f - 750°C)\right] + \left[(2500g)(4.184\frac{J}{gK})(T_f - 20°C)\right] = 0$$

$142.74J T_f - 107055J + 10460J T_f - 209200J = 0$

$10603J T_f = 316255J$

$T_f = 29.8°C$