Home work (Heat Capacity)

1. How much heat energy is needed to raise the temperature of 58.4 g of water from 25.0°C to "blood heat" 36.9°C, if $C = 4.18\ \mathrm{J\,g^{-1}K^{-1}}$ for water in this temperature range?

2. The heat capacity of graphite is $8.6\ \mathrm{J\,mol^{-1}\,K^{-1}}$. How much heat energy is needed to heat 7.4 g of graphite from 28°C to 375°C?

3. A 5.8-g sample of a new mineral X at a temperature of 99.6°C is rapidly put into 49.0 g of H_2O at 24.4°C in a calorimeter. The final temperature reached by the system is 29.2°C. Calculate the heat capacity C of X in $\mathrm{J\,g^{-1}\,K^{-1}}$. (Neglect any heat energy taken up by the calorimeter itself.)

4. An 83-g sample of Hg ($C = 27.8\ \mathrm{J\,mol^{-1}\,K^{-1}}$) at 215°C is poured into 100.0 g of H_2O at 18°C. Calculate the final temperature of the mixture, assuming no heat energy is lost.

5. Calculate the heat energy needed to heat a copper frying pan of mass 1.30 kg from 25°C to 190°C. The heat capacity of Cu is 24.5 J/mol K.

Home work (Heat Capacity)

KEY

1\. How much heat energy is needed to raise the temperature of 58.4 g of water from 25.0°C to "blood heat" 36.9°C, if $C = 4.18\ J\,g^{-1}K^{-1}$ for water in this temperature range?

2.9 kJ = 2.9×10^3 J

$q = mC\Delta T$

$(58.4g)\left(4.18\frac{J}{gK}\right)(36.9-25)$

2\. The heat capacity of graphite is $8.6\ J\,mol^{-1}K^{-1}$. How much heat energy is needed to heat 7.4 g of graphite from 28°C to 375°C?

$7.4g \times \frac{1mol}{12g} = .616 mol$

$q = (.616mol)\left(\frac{8.6J}{molK}\right)(347K)$

$= 1.8 \times 10^3 J$

1.8 kJ

3\. A 5.8-g sample of a new mineral X at a temperature of 99.6°C is rapidly put into 49.0 g of H_2O at 24.4°C in a calorimeter. The final temperature reached by the system is 29.2°C. Calculate the heat capacity C of X in $J\,g^{-1}K^{-1}$. (Neglect any heat energy taken up by the calorimeter itself.)

$q_{H_2O} = mC\Delta T = (49g)\left(4.18\frac{J}{gK}\right)(4.8K) = 9.8 \times 10^2 J$

q_{H_2O} gained $= q_X$ lost

$9.8 \times 10^2 J = C(5.8g)(70.4K)$

$C = 2.4\frac{J}{gK}$

4\. An 83-g sample of Hg ($C = 27.8\ J\,mol^{-1}K^{-1}$) at 215°C is poured into 100.0 g of H_2O at 18°C. Calculate the final temperature of the mixture, assuming no heat energy is lost.

$q_{Hg} = q_{H_2O}$

$83g \times \frac{1mol}{200.6g} = .414 mol\ Hg$

The new temp is in between 215 − T — 18°

$(.414mol)\left(27.8\frac{J}{molK}\right)(215K - T) = (100g)\left(4.18\frac{J}{gK}\right)(T - 18K)$

$2.47 \times 10^3 - 11.5T = 418T - 75$

$2.47 \times 10^3 = 429.5T - 7524$

$\frac{9994}{429.5} = T$

$= 23.2°C$

5\. Calculate the heat energy needed to heat a copper frying pan of mass 1.30 kg from 25°C to 190°C. The heat capacity of Cu is 24.5 J/mol K.

$1.30 \times 10^3 g \times \frac{1mol}{63.5g} = 20.47 mol$

$(20.47mol)\left(24.5\frac{J}{molK}\right)(190-25)$

$8.27 \times 10^4 J$

82.7 kJ

Heat capacity

1) $q = mc\Delta T = (58.4g)\left(4.18\frac{J}{gK}\right)(36.9-25)$

$= 2.9\times10^{3}J$

$= 2.9\ kJ$

2) $7.4g\ C \times \frac{1\ mol}{12g} = .616\ mol$

$q = (.616\ mol)\left(8.6\frac{J}{mol\ K}\right)(347K)$

$= 1.8\times10^{3}J = 1.8\ kJ$

3) $q_{H_2O\ gained} = q_{x\ lost}$ $q_{H_2O} = mc\Delta T$

$(49g)\left(4.18\frac{J}{gK}\right)(4.8K)$

$= 9.8\times10^{2}J$ gained by H_2O

$9.8\times10^{2}J_{\text{lost by x}} = c(5.8g)(70.4K)$

$c = 2.4\ J/gK$

4) $q_{\text{lost by Hg}} = q_{\text{gained by } H_2O}$ $83\,g\,Hg \cdot \frac{1\,mol}{200.6\,g} = .414\,mol$

$$(.414\,mol)(27.8\,\frac{J}{mol\,C^\circ})(215\,C^\circ - T) =$$

$$(100\,g)(4.18\,\frac{J}{g\,C^\circ})(T - 18\,C^\circ)$$

$$2.47\times10^3 - 11.5T = 418T - 7524$$

$$2.47\times10^3 = 429.5T - 7524$$

$$T = \frac{9994}{429.5}$$

$$T = 23.2\,^\circ C$$

5) $1.30\times10^3\,g\,Cu \times \frac{1\,mol}{63.8\,g} = 20.47\,mol\,Cu$

$$q = (20.47\,mol)(24.5\,\frac{J}{mol\,k})(190 - 25)$$

$8.27\times10^4\,J$

82.7 kJ