Name: KEY Date: Hr:

Thermochemistry Problems '12

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 = 4.18 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 $\frac{1.69\text{J}}{1} \times \frac{1.00\text{ cal}}{4.18\text{J}} = .404\text{ cal}$

b. 0.3587 J to cal $\frac{.3587\text{J}}{1} \times \frac{1.00\text{cal}}{4.18\text{J}} = 0.0858\text{ cal}$

c. 820.1 J to kilocalories .8201 KJ

d. 68 calories to kilocalories $\frac{68\text{ cal}}{1} \times \frac{.00418\text{J}}{1\text{ cal}} = 0.28424\text{ J}$

e. 423 calories to kilocalories .423 Kcal

f. 20.0 calories to Joules $\frac{20.0\text{cal}}{1} \times \frac{4.18\text{J}}{1\text{ cal}} = 83.6\text{J}$

g. 252 cal to J $\frac{252\text{ cal}}{1} \times \frac{4.18\text{J}}{1\text{ cal}} = 1053.4\text{J}$

h. 2.45 kilocalories to calories 2450 cal

i. 556 kilocalories to cal 556000 cal

j. 6.78 kilocalories to kilojoules $\frac{6.78\text{ Kcal}}{1} \times \frac{4.18\text{ KJ}}{1\text{ Kcal}} = 28.34\text{ KJ}$

2. Determine the temperature change when:

a. 20.0 g of water is heated from 16.8 °C to 39.2 °C. 22.4°C

b. 35.0 g of water is cooled from 56.5 °C to 5.9 °C. -50.6°C

c. 50.0 g liquid water is heated from 0.0 °C to 100.0 °C. 100°C

d. 25.0 g of ice is warmed from -25.0 °C to 0.0 °C, but does not melt. 25°C

e. 30.0 g of steam heats from 373.2 K to 405.0 K. 31.8K

3. Determine the energy required when the temperature of 3.21 grams of liquid water increases by 4.0 °C.

$q = m \times \Delta T \times C$

$m = 3.21\text{g}$

$\Delta T = 4°\text{C}$

$q = (3.21\text{g})(4°\text{C})(4.18\text{J/g°C}) = 53.7\text{J}$

4. Determine the energy needed when 55.6 grams of water at 43.2 °C is heated to 78.1 °C.

$m = 55.6\text{g}$

$\Delta T = 34.9°\text{C}$

$q = m \times \Delta T \times C$

$q = (55.6\text{g})(34.9°\text{C})(4.18\text{J/g°C}) = 8100\text{J or } 8.1\text{KJ}$

5. Determine the energy required when cooling 456.2 grams of water at 89.2 °C to a final temperature of 5.9 °C.

$m = 456.2\text{g}$

$\Delta T = -83.3$

$q = m \times \Delta T \times C$

$q = (456.2\text{g})(-83.3°\text{C})(4.18\text{J/g°C}) = 158.8\text{KJ}$

6. Determine the energy required to:

a. melt 74.5 grams of ice at 0 °C.

$q = \Delta H_{fus}\left(\frac{m}{m_m}\right)$

$q = 6.07\text{KJ/mol}\left(\frac{74.5\text{g}}{18\text{g/mol}}\right)$

$q = 24.9\text{ KJ}$

b. boil 43.89 grams of water at 100.0 °C.

$m = 43.89\text{g}$

$q = \Delta H_{vap}\left(\frac{m}{m_m}\right)$

$q = 40.7\text{KJ/mol}\left(\frac{43.89\text{g}}{18\text{g/mol}}\right)$

$q = 99.2\text{ KJ}$

7. Determine the energy change involved to:

a. Convert 16.2 grams of ice to liquid water.

$q = \Delta H_{fus}\left(\frac{m}{m_m}\right)$

$q = 6.01\ KJ/mol\left(\frac{16.2g}{18.01g/mol}\right) = \boxed{5.4\ KJ}$

b. Convert 5.8 grams of water to steam

$q = \Delta H_{vap}\left(\frac{m}{m_m}\right)$

$q = 40.7\ KJ/mol\left(\frac{5.8g}{18.01g/mol}\right) = \boxed{13.1\ KJ}$

c. Convert 98.2 grams of water to ice.

$q = \Delta H_{fus}\left(\frac{m}{m_m}\right)$

$q = 6.01\ KJ/mol\left(\frac{98.2g}{18.01g/mol}\right) = \boxed{32.9\ KJ}$

d. Convert 52.6 grams of steam to water

$q = \Delta H_{vap}\left(\frac{m}{m_m}\right)$

$q = 40.7\ KJ/mol\left(\frac{52.6g}{18g/mol}\right) = \boxed{118.9\ KJ}$

e. Convert 34.0 grams of water at 20.0 °C to steam at 100.0 °C.

$m = 34.0g$

① water 20° → water 100°

$q = m \times \Delta T \times C$

$q = (34.0g)(80°C)(4.18J/g°C)$

$q = 11.38KJ$

② water 100° → steam 100°

$q = \Delta H_{fus}\left(\frac{m}{m_m}\right)$

$q = 40.7\ KJ/mol\left(\frac{34g}{18g/mol}\right)$

$q = 76.88KJ$

$\boxed{q_{tot} = 88.26\ KJ}$

f. Convert 125.0 grams of ice at 0.0 °C to steam at 100.0 °C.

① ice 0° → water 0°

$q = \Delta H_{fus}\left(\frac{m}{m_m}\right)$

$q = 6.01\ KJ/mol\left(\frac{125g}{18g/mol}\right)$

$q = 41.78KJ$

② water 0° → water 100°

$q = m \times \Delta T \times C$

$q = (125g)(100°C)(4.18J/g°C)$

$q = 52.3KJ$

③ water 100° → steam 100°

$q = \Delta H_{vap}\left(\frac{m}{m_m}\right)$

$q = 40.7KJ/mol\left(\frac{125g}{18.01g/mol}\right)$

$q = 282.46\ KJ$

$\boxed{q_{tot} = 376.5KJ}$

g. Convert 25.9 grams of steam at 100.0 °C.to ice at 0.0 °C.

① steam 100° → water 100°

$q = \Delta H_{vap}\left(\frac{m}{m_m}\right)$

$q = 40.7\ KJ/mol\left(\frac{25.9g}{18.01g/mol}\right)$

$q = 58.5KJ$

② water 100° → water 0°

$q = m \times \Delta T \times C$

$q = (25.9g)(100°C)(4.18J/g°C)$

$q = 10.836KJ$

③ water 0° → ice 0°

$q = \Delta H_{fus}\left(\frac{m}{m_m}\right)$

$q = 6.01\ KJ/mol\left(\frac{25.9g}{18.01g/mol}\right)$

$q = 8.66KJ$

$\boxed{q_{tot} = 78KJ}$