Specific Heat Capacity Problems Answer Key

1. Mass of water, m = 250 mL

$$= 250\ \cancel{\text{mL}} \times \frac{1.00\ \text{g}}{1.00\ \cancel{\text{mL}}}$$

$$= 250\ \text{g}$$

Specific heat capacity of water, $c = 4.19 \frac{\text{J}}{\text{g}\bullet{}^\circ\text{C}}$

Final temperature, T_2 = 85.0 °C
Initial temperature, T_1 = 20.0 °C
Change of temperature, ΔT = 65.0 °C

$$Q = mc\Delta T$$

$$= (250\ \cancel{\text{g}})\left(4.19 \frac{\text{J}}{\cancel{\text{g}}\bullet{}^\circ\cancel{\text{C}}}\right)(65.0{}^\circ\cancel{\text{C}})$$

$$= 68\ 087.5\ \text{J}$$

$$\cong 6.8 \times 10^4\ \text{J}$$

It would take 6.8×10^4 J of energy to heat 250 mL of water from 20.0 ºC to 85.0 ºC.

2. Mass of water, m = 250 mL

$$= 250\ \cancel{\text{mL}} \times \frac{1.00\ \text{g}}{1.00\ \cancel{\text{mL}}}$$

$$= 250\ \text{g}$$

Specific heat capacity of water, $c = 4.19 \frac{\text{J}}{\text{g}\bullet{}^\circ\text{C}}$

Final temperature, T_2 = 75.0 °C
Initial temperature, T_1 = 85.0 °C
Change of temperature, ΔT = –10.0 °C

$$Q = mc\Delta T$$

$$= (250\cancel{\text{g}})\left(4.19 \frac{\text{J}}{\cancel{\text{g}}\bullet{}^\circ\cancel{\text{C}}}\right)(-10{}^\circ\cancel{\text{C}})$$

$$= -10\ 475\ \text{J}$$

$$\cong -1.05 \times 10^4\ \text{J}$$

The 250 mL of tea loses 1.05×10^4 J as it cools from 85.0 ºC to 75.0 ºC.

3. Q = 100.0 kJ = 1.000×10^5 J
m = 500.0 g
$c = 4.19 \frac{\text{J}}{\text{g}\bullet{}^\circ\text{C}}$

Specific Heat Capacity Problems Answer Key (cont'd)

$$Q = mc\Delta T$$

$$\Delta T = \frac{Q}{mc}$$

$$= \frac{1.000 \times 10^5\ \text{J}}{(500.0\ \cancel{\text{g}})\left(4.19 \frac{\cancel{\text{J}}}{\cancel{\text{g}} \bullet {}^\circ\cancel{\text{C}}}\right)}$$

$= 47.7327$ °C

$\cong 47.8$ °C

4. $Q = 35$ kJ $= 3.5 \times 10^4$ J

$m = 1.00$ kg $= 1.00 \times 10^3$ g

$c = 2.00 \dfrac{\text{J}}{\text{g} \bullet {}^\circ\text{C}}$

$T_1 = -25.0$ °C

$Q = mc\Delta T$

$\Delta T = Q/mc$

$$= \frac{3.5 \times 10^4\ \cancel{\text{J}}}{(1.00 \times 10^3\ \cancel{\text{g}})\left(2.00 \frac{\cancel{\text{J}}}{\cancel{\text{g}} \bullet {}^\circ\text{C}}\right)}$$

$= 17.5$ °C

$\Delta T = T_2 - T_1$

$T_2 = T_1 + \Delta T$

$= -25.0$ °C $+ 17.5$ °C

$= -7.5$ °C

5. The moist air will experience the greatest temperature change because it has the lowest specific heat capacity. (Less energy is needed to heat it the same amount, or the same number of degrees).

6. The aluminium pot will keep the water warm the longest. It will store more energy while heating to 100 °C because it has the highest specific heat capacity.

7. $m = 5.0$ g

$Q = 71$ J

$T_2 = 162$ °C

$T_1 = 125$ °C

$\Delta T = T_2 - T_1$

$\Delta T = 162$ °C $- 125$ °C

$= 37$ °C

Specific Heat Capacity Problems Answer Key (cont'd)

$$Q = mc\Delta T$$

$$c = \frac{Q}{m\Delta T}$$

$$= \frac{71\ \text{J}}{(5.0\text{g})\ (37\,°\text{C})}$$

$$= 0.38378\frac{\text{J}}{\text{g}\bullet°\text{C}}$$

$$\cong 0.38\frac{\text{J}}{\text{g}\bullet°\text{C}}$$

The specific heat capacity of the metal is similar to the specific heat capacity of copper, so the metal is most likely copper.

8. $Q = –300.0\ \text{MJ} = –3.000 \times 10^8\ \text{J}$

$c = 3.89\frac{\text{J}}{\text{g}\bullet°\text{C}}$

$T_2 = 33\ °\text{C}$

$T_1 = 75\ °\text{C}$

$\Delta T = 33\ °\text{C} – 75\ °\text{C} = –44\ °\text{C}$

$$Q = mc\Delta T$$

$$m = \frac{Q}{c\Delta T}$$

$$= \frac{–3.000\times10^8\ \cancel{\text{J}}}{\left(3.89\frac{\cancel{\text{J}}}{\text{g}\bullet°\cancel{\text{C}}}\right)(–44°\cancel{\text{C}})}$$

$$= 1\ 752\ 745.97\ \text{g}$$

$$\cong 1.8 \times 10^6\ \text{g}$$

9. $Q = 2.75 \times 10^6\ \text{J}$

$c = 4.19\frac{\text{J}}{\text{g}\bullet°\text{C}}$

$T_2 = 100.00\ °\text{C}$

$T_1 = 0.00\ °\text{C}$

$\Delta T = 100.00\ °\text{C}$

$$Q = mc\Delta T$$

$$m = \frac{Q}{c\Delta T}$$

$$= \frac{2.75 \times 10^6\ \cancel{\text{J}}}{\left(4.19\frac{\cancel{\text{J}}}{\text{g}\bullet°\cancel{\text{C}}}\right)(100.00°\cancel{\text{C}})}$$

$$= 6563.25\ \text{g}$$

$$= 6.56\times10^3\ \text{g}$$

$$= 6.56\ \text{kg}$$

Specific Heat Capacity Problems Answer Key (cont'd)

10. m = 100.0 g

Q = 45 kJ = –4.5 × 10^4 J

T_1 = 13.0 °C

T_2 = –15.0 °C

ΔT = –28.0 °C

$$Q = mc\Delta T$$

$$c = \frac{Q}{m\Delta T}$$

$$= \frac{-4.5 \times 10^4 \text{ J}}{(100.0g)(-28.0°\text{C})}$$

$$= 16.071\ 43 \frac{\text{J}}{\text{g}\bullet°\text{C}}$$

$$\cong 16 \frac{\text{J}}{\text{g}\bullet°\text{C}}$$