Name: 01/20/12

Assignment #1: Specific Heat

Table of some common specific heats:

Substance	J/kg°C
Aluminum	900
Copper	387
Gold	130
Ice	2093
Iron/Steel	452
Lead	128
Mercury	138
Silver	236
Steam	2009
Water	4180

1. How much energy would it take to heat a 0.25 kg block of lead from 10°C to 40°C?

$Q = m\,c\,\Delta T = 0.25\,kg \cdot 128\,J/kg°C \cdot 30°C = \boxed{960\,J}$

2. You leave a 0.1 kg piece of Iron in a fire. Its temperature increases from 15°C to 200°C. How much heat does the iron absorb?

$Q = m\,c\,\Delta T = 0.1\,kg \cdot 452\,J/kg°C \cdot 185°C = \boxed{8362\,J}$

3. You have a 3-kg pot of water. You add 4.25 x 10^3 J of energy to it. What is the increase in temperature of the water?

$Q = m\,c\,\Delta T \qquad \Delta T = \frac{Q}{mc} = \frac{4.25 \times 10^3\,J}{3\,kg \cdot 4180\,J/kg°C} = \boxed{0.339°C}$

4. You are using steam to turn a turbine to generate electricity. If 7 Kg of steam is cooled from 150°C to 120°C, what is the maximum amount of work can the steam do?

$W = -Q = -m\,c\,\Delta T = -7\,kg \cdot 2009\,J/kg°C \cdot (-30°C) = \boxed{421\,890\,J}$

5. A 2-gram silver bullet is shot into the air at a speed of 75 m/s. It travels in a parabolic trajectory, then hits the ground. If its initial temperature is 40ºC, what is the temperature of the bullet after it hits the ground if all its energy becomes heat?

$KE = Q$

$\frac{1}{2}mv^2 = mc\Delta T$

$\Delta T = \frac{v^2}{2c} = \frac{(75\,m/s)^2}{2(236\,J/kg°C)} = 11.917°C$

$T_f = T_i + \Delta T = 40°C + 11.917°C = \boxed{51.917°C}$

6. A block of ice is cooled from -5ºC to -15ºC. 15,000 Joules of thermal energy was removed from the block of ice. What is the mass of the ice?

$Q = mc\Delta T$

$m = \frac{Q}{c\Delta T} = \frac{-15000\,J}{2093\,J/kg°C\,(-10°C)} = \boxed{0.717\,kg}$

7. While sitting by the fireplace, Jose presents a 0.15 carat diamond to his girlfriend. She is offended that he did not get her a bigger one, and throws the diamond into the fire. The diamond absorbs 10.18 Joules of Energy, and heats up from 20ºC to 120ºC. What is the specific heat of diamond? (Hint: 1 carat = 0.0002 kg)

$Q = mc\Delta T$

$c = \frac{Q}{m\Delta T} = \frac{10.18\,J}{(0.15\,ct)(2\times10^{-4}\,\frac{kg}{ct})(100°C)} = \boxed{3393.3\overline{3}\,J/kg°C}$

8. You have a copper coin with a mass of 0.25 kg. Its initial temperature is 90ºC. It is dropped into 0.5 kg of 10ºC water. What is the final equilibrium temperature?

$-Q_c = Q_w$

$-m_c c_c \Delta T_c = m_w c_w \Delta T_w$

$-m_c c_c (T_f - T_{ic}) = m_w c_w (T_f - T_{iw})$

$-m_c c_c T_f + m_c c_c T_{ic} = m_w c_w T_f - m_w c_w T_{iw}$

$m_c c_c T_{ic} + m_w c_w T_{iw} = m_w c_w T_f + m_c c_c T_f$

$m_c c_c T_{ic} + m_w c_w T_{iw} = T_f(m_w c_w + m_c c_c)$

$T_f = \frac{m_c c_c T_{ic} + m_w c_w T_{iw}}{m_w c_w + m_c c_c} = \frac{0.25\,kg \cdot 387\,J/kg°C \cdot 90°C + 0.5\,kg \cdot 4180\,J/kg°C \cdot 10°C}{0.5\,kg \cdot 4180\,J/kg°C + 0.25\,kg \cdot 387\,J/kg°C}$

$T_f = \boxed{13.539°C}$

9. At the US Mint, 1-kg Gold bars are rolled into sheets for making coins. As the gold is rolled, its temperature increases due to internal friction of the metal. If 14,000 Joules of energy are lost to friction, what is the temperature increase of the gold?

$Q = mc\Delta T$

$\Delta T = \frac{Q}{mc} = \frac{14000\,J}{1kg \cdot 130\,J/kg°C} = \boxed{107.692°C}$