Practice Problems: Heat Capacity

1. Why is the climate more constant (not as hot in the summer and not as cold in the winter) for places near the ocean?

The ocean stores energy from the sun. It takes a long time for the heat to be released from the ocean, even when the sun is not shining as long during the day (in the winter). This means that it is always releasing some amount of heat, which means it never gets quite as cold.

2. When you turn on hot water to wash dishes, the water pipes have to heat up. How much heat is absorbed by a copper water pipe with a mass of 2.3 kg when the temperature is raised from 20.0°C to 80.0°C?

$m = 2.3\ kg$

$T_i = 20.0\,°C$

$T_f = 80.0\,°C$

$C = 385.5\ J/kg\,°C$

$Q = ?$

$Q = mC\Delta T = mC(T_f - T_i)$

$= (2.3\ kg)(385.5\ J/kg\,°C)(80.0\,°C - 20.0\,°C)$

$= (2.3\ kg)(385.5\ \frac{J}{kg\,°C})(60.0\,°C)$

$\boxed{= 5.3 \times 10^4\ J}$

3. How much heat, in kilojoules, has to be removed from 225 g of ~~ethanol~~ METHANOL to lower its temperature from 25.0°C to 10.0°C?

$m = 225\,g \times \left(\frac{1\ kg}{1000\,g}\right) = 0.225\ kg$

$T_i = 25.0\,°C$

$T_f = 10.0\,°C$

$C = 2450\ J/kg\,°C$

$Q = ?$

$Q = mC\Delta T = mC(T_f - T_i)$

$= (0.225\ kg)(2450\ \frac{J}{kg\,°C})(10.0\,°C - 25.0\,°C)$

$= (0.225\ kg)(2450\ \frac{J}{kg\,°C})(-15.0\,°C)$

$= -8.27 \times 10^3\ J \left(\frac{1\ kJ}{1000\ J}\right)$

$\boxed{= -8.27\ kJ}$ (−) means heat removed

4. What is the specific heat of silicon if it takes 192 J to raise the temperature of 45.0 g of Si by 6.0°C?

$Q = 192\ J$

$m = 45.0\,g \times \left(\frac{1\ kg}{1000\,g}\right) = 4.5 \times 10^{-2}\ kg$

$\Delta T = 6.0\,°C$

$C = ?$

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

$C = \frac{Q}{m\Delta T} = \frac{192\ J}{(4.5 \times 10^{-2}\ kg)(6.0\,°C)}$

$\boxed{= 7.1 \times 10^2\ J/kg\,°C}$

5. The cooling system of a car engine contains 20.0 L of water (1 L of water has a mass of 1 kg). What is the change in the temperature of water if the engine operates until 836.0 kJ are added?

$V = 20.0\,L \rightarrow m = 20.0\,L \times \left(\frac{1\,kg}{1\,L}\right) = 20.0\,kg$

$Q = 836.0\,kJ \times \left(\frac{1000\,J}{1\,kJ}\right) = 8.360 \times 10^5\,J$

$\Delta T = ?$

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

$$\Delta T = \frac{Q}{mC} = \frac{8.360 \times 10^5\,J}{(20.0\,kg)(4180\,J/kg\,°C)} = 10.0\,°C$$

6. Assuming that Coca Cola has the same specific heat as water, calculate the amount of heat in kJ transferred when one can (about 355 g) is cooled from 25°C to 3°C.

$m = 355\,g = 0.355\,kg$

$T_f = 3\,°C$

$T_i = 25\,°C$

$Q = ?$ in kJ

$Q = mC\Delta T$

$= (0.355\,kg)(4180\,J/kg\,°C)(3°C - 25°C)$

$= (0.355\,kg)(4180\,J/kg\,°C)(-22\,°C)$

$= -3.3 \times 10^4\,J$

$= -33\,kJ$ ← transferred out