Heat Capacity A Name_______________

1. When a driver brakes an automobile, friction between the brake disks and the brake pads converts part of the car's translational kinetic energy to internal energy (heat). If a 500kg automobile traveling at 40m/s comes to a halt after its brakes are applied, how much can the temperature rise in each of the four 2.0kg brake disks? Assume that the disks are made of metal with C = 500 J/kg C and that all of the kinetic energy is distributed in equal parts to the internal energy of the brakes

2. A hot water heater is operated by solar power. If the solar collector has an area of 10 square meters and the power delivered by sunlight is 420W/square meter, how long will it take to increase the temperature of 1.0 cubic meter of water from 20 degrees C to 50 degrees C? (W = J/s)
   (Cp of water ~ 4200 J/kg C)
   (1 cubic cm of water = 1 gram)

Answers to part B

1. Assume all of the kinetic energy is converted to energy as heat to the brake disks. $\frac{1}{2} m_a v^2 = C\, m_b\, \Delta T$. Solve for $\Delta T$. $\Delta T = (m_a v^2)/(2\, C\, m_b) = (600 \cdot 900)/(2 \cdot 500 \cdot 12) = 45$ degrees C.

2. The amount of energy needed to heat the water is $m \cdot C \cdot \Delta T$. Converting the volume to $cm^3$, $1m^3 = (10^2\ cm)^3 = 10^6\ cm^3$. Each $cm^3$ has a mass of 1g, so the mass is $10^6$g. $10^3$ g = 1kg, so $10^6$ g = $10^3$kg. So the energy needed = $10^3\ kg \cdot 4.2x10^3 j/kg \cdot 40$. The collectors collect $420 j/(s \cdot m^2) \cdot 12m^2$. If I divide the total energy needed by the energy per second available, I find the number of seconds needed to heat this much water to be $3.3x10^4$ s. There are 3600s/hour, for a total of 9.3 hours.

Heat Capacity B Name_______________

1. When a driver brakes an automobile, friction between the brake disks and the brake pads converts part of the car's translational kinetic energy to internal energy (heat). If a 600kg automobile traveling at 30m/s comes to a halt after its brakes are applied, how much can the temperature rise in each of the four 3kg brake disks? Assume that the disks are made of metal with C = 500 J/kg C and that all of the kinetic energy is distributed in equal parts to the internal energy of the brakes

2. A hot water heater is operated by solar power. If the solar collector has an area of 12 square meters and the power delivered by sunlight is 420W/square meter, how long will it take to increase the temperature of 1.0 cubic meter of water from 23 degrees C to 63 degrees C? (W = J/s)
(Cp of water ~ 4200 J/kg C)
(1 cubic cm of water = 1 gram)

Answers to part A

1. Assume all of the kinetic energy is converted to energy as heat to the brake disks. $\frac{1}{2}m_a v^2 = C\, m_b\, \Delta T$. Solve for $\Delta T$. $\Delta T = (m_a v^2)/(2\, C\, m_b) = (500 \cdot 1600)/(2 \cdot 500 \cdot 8) = 100$ degrees C.

2. The amount of energy needed to heat the water is $m \cdot C \cdot \Delta T$. Converting the volume to $cm^3$, $1m^3 = (10^2\ cm)^3 = 10^6\ cm^3$. Each $cm^3$ has a mass of 1g, so the mass is $10^6$g. $10^3$ g = 1kg, so $10^6$ g = $10^3$kg. So the energy needed = $10^3$ kg $\cdot$ $4.2\text{x}10^3$j/kg $\cdot$30. The collectors collect 420j/(s $\cdot m^2$) $\cdot$ $10m^2$. If I divide the total energy needed by the energy per second available, I find the number of seconds needed to heat this much water to be $3.0\text{x}10^4$ s. There are 3600s/hour, for a total of 8.3 hours.