Answer Question #64823 – Physics – Astronomy – Astrophysics

Determine the quantity of heat needed to raise the temperature of a 10 kg piece of steel from 0°C to 100°C. Compare this to the amount of heat needed to raise the temperature of the same mass of water through the same temperature difference. The specific heat capacity of steel is 450 J per kilogram per degree Celsius.

Solution. Specific heat capacities provide a means of mathematically relating the amount of thermal energy gained (or lost) by a sample of any substance to the sample's mass and its resulting temperature change. The relationship between these four quantities is often expressed by the following equation.

$$Q = Cm\Delta T$$

where Q is the quantity of heat transferred to or from the object, m is the mass of the object, C is the specific heat capacity of the material the object is composed of, and ΔT is the resulting temperature change of the object.

According to the condition of the problem $m = 10kg$, $C = 450\frac{J}{kg \cdot K}$, $\Delta T = 100 - 0 = 100K$ the temperature difference in Celsius and Kelvin are the same.

Hence $Q = 450\frac{J}{kg \cdot K} \cdot 10kg \cdot 100K = 450000J = 0.45MJ$.

The specific heat capacity of water $C = 4180\frac{J}{kg \cdot K}$ therefore the quantity of heat needed to raise the temperature of a 10 kg water from 0°C to 100°C equal to

$Q_w = 4180\frac{J}{kg \cdot K} \cdot 10kg \cdot 100K = 4180000J = 4.18MJ$.

Comparing the obtained values of the amount of heat will note that the amount of heat required raise the temperature of a 10 kg water from 0°C to 100°C at approximately 9.30 times more than quantity of heat needed to raise the temperature of a 10 kg piece of steel from 0°C to 100°C.

Answer. $Q = 450000J; \frac{Q_w}{Q} \approx 9.3$ times.