Sample Assignment

Question 1

You are given a sample of metal and asked to determine its specific heat. You weigh the sample and find that it has a mass of $5\,\text{kg}$ You carefully add $7.2504 \times 10^2\,\text{J}$ of heat energy to the sample and find that its temperature rises by $18\,°\text{C}$ What is the specific heat of the metal?

Solution

The specific heat capacity is the energy required to raise the temperature of a unit mass of a substance by one degree:

$$
\begin{aligned}
C &= \frac{E}{m\Delta T} \\
&= \frac{7.250 \times 10^2}{5 \times 18} \\
&= 8.056
\end{aligned}
$$

So, the specific heat capacity is $C = 8.056\,\text{J}\,\text{kg}^{-1}\,\text{K}^{-1}$

Question 2

In an effort to stay awake for an all-night study session, a student makes a cup of coffee by first heating $0.15\,\text{kg}$ in a $200\,\text{W}$ kettle. How much heat must be added to the water to raise its temperature from $24\,°\text{C}$ to $49\,°\text{C}$?

Solution

The specific heat capacity of water is $C = 4180\,\text{J}\,\text{kg}^{-1}\,\text{K}^{-1}$ The energy required to raise the temperature of a substance is given by:

$$
\begin{aligned}
E &= mC\Delta T \\
&= 0.15 \times 4180 \times 25 \\
&= 1.57 \times 10^4
\end{aligned}
$$

So, the total amount of energy needed is $1.57 \times 10^4\,\text{J}$, or $15.7\,\text{kJ}$

Question 3

In the previous problem, how much time is required to heat the water? Assume that all of the kettle's power goes into heating the water

Solution

The power is given as $200\,\text{W}$ The time required to heat the water is given by:

$$
\begin{aligned}
t &= \frac{E}{P} \\
&= \frac{15675}{200} \\
&= 78\,\text{s}
\end{aligned}
$$

Or, $1\,\text{min}$ and $18\,\text{s}$.