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 8 kg. You carefully add 1.5468×10^3 J of heat energy to the sample and find that its temperature rises by 24 K. 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:

$$\begin{aligned} C &= \frac{E}{m\Delta T} \\ &= \frac{1.5468 \times 10^3 \text{ J}}{8 \text{ kg} \times 24 \text{ K}} \\ &= 8.056 \text{ J K}^{-1} \text{ kg}^{-1} \end{aligned}$$

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

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 kg of water in a 350 W kettle. How much heat must be added to the water to raise its temperature from 27 °C to 83 °C?

Solution

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

$$\begin{aligned} E &= mC\Delta T \\ &= 0.15 \text{ kg} \times 4180 \text{ J K}^{-1} \text{ kg}^{-1} \times 56 \text{ K} \\ &= 3.511 \times 10^4 \text{ J} \end{aligned}$$

So, the total amount of energy needed is 3.511×10^4 J, or 35.11 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 350 W. The time required to heat the water is given by:

$$\begin{aligned} t &= \frac{E}{P} \\ &= \frac{3.511 \times 10^4 \text{ J}}{350 \text{ W}} \\ &= 100.3 \text{ J W}^{-1} \end{aligned}$$

Or, 1 min and 40 s.