Answer on Question #44319-Physics-Molecular Physics-Thermodynamics

For water its temperature is 50°C and room temperature is 30°C just after 5 minutes excess temperature reduce to half its value, calculate temperature of water next 2.5 minutes

Solution

Let's use Fourier's law for heat flow:

$$\dot{q} = k(T_w - T_r),$$

where T_w is the temperature of the water, T_r is the room temperature, k is the thermal conductivity coefficient.

Solving this equation gives:

$$T_w - T_r = Ae^{-Bt},$$

where A and B are constants.

When $t = 0$

$$T_w - T_r = Ae^{-B\cdot 0} = A = 50°C - 30°C = 20°C.$$

When $t = 5$ minutes

$$T_w - T_r = \frac{20°C}{2} = 10°C = 20°Ce^{-B\cdot 5\ \text{min}} \to B = \frac{\ln 2}{5}\ \text{min}^{-1}.$$

The temperature of water next 2.5 minutes is

$$T_w(7.5\ min) = 30°\text{C} + 20°C \cdot e^{-\frac{\ln 2}{5}\cdot 7.5} = 30°\text{C} + 20°C \cdot (e^{-\ln 2})^{1.5} = 30°\text{C} + 20°C \cdot \left(\frac{1}{2}\right)^{1.5} = 37°C.$$

Answer: $37°C$.