# Answer on Question#82064 - Physics - Molecular Physics - Thermodynamics

An Erlenmeyer flask of surface area 0.8 $m^2$ and wall thickness 2 cm is filled with water at 0 ˚C. The Erlenmeyer flask is then immersed in a glass beaker filled with water at a temperature of 30 ˚C. What is the heat current? How long does it take for 12 J of heat energy to be transferred to the water in the Erlenmeyer flask?

Solution:

The heat conduction equation is given by

$$q = -\kappa \frac{\Delta T}{\Delta h},$$

Where $q$ – is the heat flux density ($\mathrm{W} \cdot \mathrm{m}^{-2}$), $\kappa$ – is the materials conductivity ($\mathrm{W} \cdot \mathrm{m}^{-1} \cdot \mathrm{K}^{-1}$), $\Delta T$ – is the temperature difference between wall faces (K) and $\Delta h$ – is the thickness of the wall (m).

Heat current is given by

$$J = q \cdot A,$$

Where $A$ – is the area of the surface.

Since $\Delta T = 30°\mathrm{C} - 0°\mathrm{C} = 30°\mathrm{C}$, $\Delta h = 0.02\ \mathrm{m}$, $A = 0.8\ \mathrm{m}^2$ and the thermal conductivity of a common glass is $\kappa = 0.96 \frac{\mathrm{W}}{\mathrm{m \cdot K}}$, we obtain

$$J = -\kappa \frac{\Delta T}{\Delta h} A = -0.96 \frac{\mathrm{W}}{\mathrm{m} \cdot \mathrm{K}} \cdot \frac{30°\mathrm{C}}{0.02\ \mathrm{m}} \cdot 0.8\ \mathrm{m}^2 = -1152\ \mathrm{W}$$

Since the heat current is defined as the energy loss during time $J = \Delta E / \Delta t$, we get the following

$$\Delta t = \frac{\Delta E}{J}$$

Since it is given that $\Delta E = -12$ J, we obtain

$$\Delta t = \frac{-12\ \mathrm{J}}{-1152\ \mathrm{W}} = 0.01\ \mathrm{s}$$

Answer: $J = -1152$ W, $\Delta t = 0.01$ s.