Answer on Question #64867, Physics / Other

A body cools from 50 degree Celsius to 49.9 in 5 sec. how long will it take to cool from 40 to 39.9 degree Celsius. temp of surrounding is 30 Celsius. Newton's law is valid

Solution:

Newton's Law of Cooling states that:

The rate of loss of heat by a body is directly proportional to the temperature difference between system and surroundings, provided the difference is small.

The Newtons law of cooling is given by

$$\frac{dT}{dt} = k(T_t - T_s)$$

Where T_t is the temperature at time t and T_s is the temperature of the surrounding, k is a constant.

The Newton s Law of Cooling Formula is given by

$$T(t) = T_s + (T_0 - T_s)e^{-kt}$$

Where t is the time taken, T(t) is the temperature of the given body at time t, Ts is the surrounding temperature, To is the initial temperature of the body, k is the constant.

Given:

Ts = 30°C,

T_0 = 50°C,

t = 5 s,

T(5) = 49.9 °C

$$T(t) = T_s + (T_0 - T_s)e^{-kt}$$

$$\frac{T(t) - T_s}{T_0 - T_s} = e^{-kt}$$

$$-kt\ln e = ln\left(\frac{T(t) - T_s}{T_0 - T_s}\right)$$

$$-kt = \ln\left(\frac{49.9 - 30}{50 - 30}\right) = \ln 0.995 = -0.005$$

$$k = \frac{0.005}{5} = 0.001$$

The time of cooling is

$$t = -\frac{ln\left(\frac{T(t) - T_s}{T_0 - T_s}\right)}{k} = -\frac{ln\left(\frac{39.9 - 30}{40 - 30}\right)}{0.001} = -\frac{-0.01}{0.001} = 10 \text{ s}$$

Answer: 10 s