420.

Problem 33.49 (RHK)

We have to calculate time that would elapse in units of time constant in a RC circuit for the capacitor to get charged within 1.00% *of its equilibrium charge*.

Solution:

Let q_0 be the equilibrium charge. The equation for the charging of a capacitor is

$$q(t) = q_0\left(1 - e^{-t/\tau}\right),$$

where τ is the time constant of the *RC* circuit.

If the capacitor is to be charged to within 1.00% of its equilibrium charge,

$$\frac{q(T)}{q_0} = 0.99.$$

We, therefore, have

$$1 - e^{-T/\tau} = 0.99,$$

or

$$e^{-T/\tau} = 0.01 = 10^{-2}.$$

Taking the natural logarithm, i.e. with respect to base e, we have

$$-\frac{T}{\tau} = -2\ln_e(10) = -2 \times 2.3026 = 4.6052,$$

or

$$T = 4.60\tau.$$