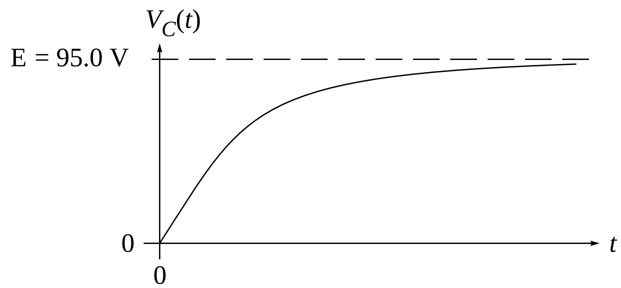
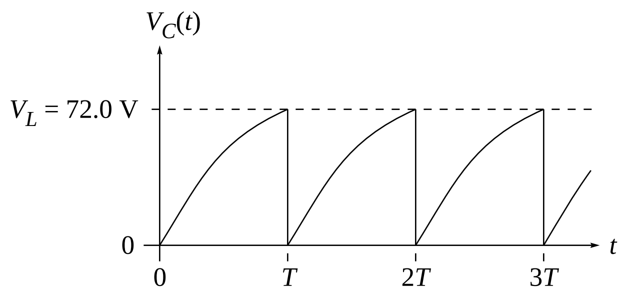
An application for RC circuits

A capacitor charging (no lamp)



This circuit (with lamp)



During the rise (that is, for $0 < t < T$) the voltage across the capacitor is (see LSM, page 456, last equation in caption for figure 10.39)

$$V_C(t) = \mathcal{E}\left(1 - e^{-t/RC}\right).$$

I select the period T by demanding that

$$V_L = \mathcal{E}\left(1 - e^{-T/RC}\right).$$

Solve for R:

$$\begin{aligned} \frac{V_L}{\mathcal{E}} - 1 &= -e^{-T/RC} \\ -\frac{T}{RC} &= \ln\left(1 - \frac{V_L}{\mathcal{E}}\right) \\ R &= -\frac{T}{C\ln\left(1 - V_L/\mathcal{E}\right)}. \end{aligned}$$

Using $V_L = 72.0$ V, $\mathcal{E} = 95.0$ V, $C = 0.150$ μF, and $T = 0.500$ s, we find

$$R = 2.35 \text{ M}\Omega.$$

Grading: Starting off (e.g. a graph like these or a circuit diagram): 2 points
Exponential growth equation: 2 points
Solve for R: 2 points
Number: 2 points
Units: 1 point
Three significant figures: 1 point