Circuits

1a. the initial charge is given by

$$Q_0 = CV_0 = 5.00\,\mu F \cdot 120\,V = 600\,\mu C.$$

$(= 6.00 \times 10^{-4}\,C)$

b. current given by ohm's law

$$I_0 = \frac{V_0}{R} = \frac{120\,V}{400\,\Omega} = 0.300\,A$$

c. $\tau = RC = 400\,\Omega \cdot 5.00\,\mu F = 2.00\,ms$

d. the charge Q as a function of time t is

$$Q(t) = Q_0 e^{-t/\tau}$$

$(= 0.812 \times 10^{-4}\,C)$

$$\Rightarrow Q(4.00\,ms) = 600\,\mu C \cdot e^{-\frac{4.00}{2.00}} = 81.2\,\mu C.$$

e. initial energy given by emf & capacitance

$$U_0 = \frac{1}{2} C\mathcal{E}^2 = \frac{1}{2} \cdot 5.00\,\mu F \cdot (120\,V)^2$$

$$= 36.0\,mJ. \quad (= 0.0360\,J)$$

f. energy as a function of time t is

$$u(t) = \frac{1}{2} C [V_C(t)]^2, \quad V_C(t) = \mathcal{E} e^{-t/\tau}$$

$$\Rightarrow u(t) = \frac{1}{2} C \left[\mathcal{E} e^{-t/\tau}\right]^2$$

$$= \frac{1}{2} C\mathcal{E}^2 e^{-2t/\tau}$$

$$\Rightarrow u(t) = U_0 e^{-2t/\tau}$$

g.