49. (a) The charge on the positive plate of the capacitor is given by

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

where $\mathcal{E}$ is the emf of the battery, C is the capacitance, and τ is the time constant. The value of τ is $\tau = RC = (3.00 \times 10^6\,\Omega)(1.00 \times 10^{-6}\,\mathrm{F}) = 3.00\,\mathrm{s}$. At $t = 1.00\,\mathrm{s}$, $t/\tau = (1.00\,\mathrm{s})/(3.00\,\mathrm{s}) = 0.333$ and the rate at which the charge is increasing is

$$\frac{dq}{dt} = \frac{C\mathcal{E}}{\tau}\,e^{-t/\tau} = \frac{(1.00 \times 10^{-6})(4.00\,\mathrm{V})}{3.00\,\mathrm{s}}\,e^{-0.333} = 9.55 \times 10^{-7}\,\mathrm{C/s} .$$

(b) The energy stored in the capacitor is given by

$$U_C = \frac{q^2}{2C} .$$

and its rate of change is

$$\frac{dU_C}{dt} = \frac{q}{C}\frac{dq}{dt} .$$

Now

$$q = C\mathcal{E}\left(1 - e^{-t/\tau}\right) = (1.00 \times 10^{-6})(4.00\,\mathrm{V})(1 - e^{-0.333}) = 1.13 \times 10^{-6}\,\mathrm{C} ,$$

so

$$\frac{dU_C}{dt} = \left(\frac{1.13 \times 10^{-6}\,\mathrm{C}}{1.00 \times 10^{-6}\,\mathrm{F}}\right)(9.55 \times 10^{-7}\,\mathrm{C/s}) = 1.08 \times 10^{-6}\ \mathrm{W} .$$

(c) The rate at which energy is being dissipated in the resistor is given by $P = i^2R$. The current is $9.55 \times 10^{-7}\mathrm{A}$, so

$$P = (9.55 \times 10^{-7}\mathrm{A})^2(3.00 \times 10^6\,\Omega) = 2.74 \times 10^{-6}\ \mathrm{W} .$$

(d) The rate at which energy is delivered by the battery is

$$i\mathcal{E} = (9.55 \times 10^{-7}\mathrm{A})(4.00\,\mathrm{V}) = 3.82 \times 10^{-6}\,\mathrm{W} .$$

The energy delivered by the battery is either stored in the capacitor or dissipated in the resistor. Conservation of energy requires that $i\mathcal{E} = (q/C)\,(dq/dt) + i^2R$. Except for some round-off error the numerical results support the conservation principle.