Exercise 89

The flash unit on a camera operates by storing charge on a capacitor and releasing it suddenly when the flash is set off. The following data describe the charge Q remaining on the capacitor (measured in microcoulombs, μC) at time t (measured in seconds).

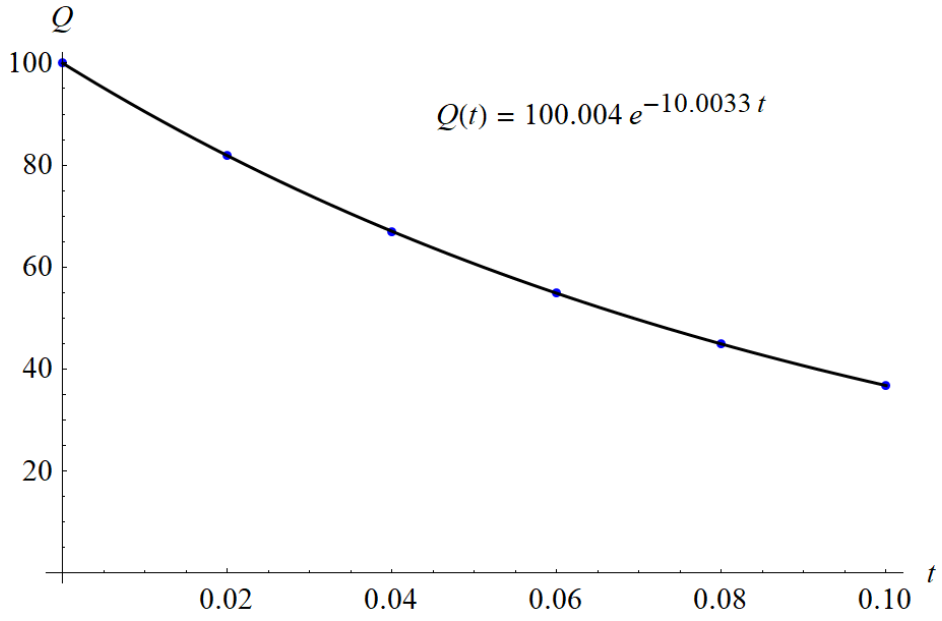
t	0.00	0.02	0.04	0.06	0.08	0.10
Q	100.00	81.87	67.03	54.88	44.93	36.76

(a) Use a graphing calculator or computer to find an exponential model for the charge.

(b) The derivative $Q'(t)$ represents the electric current (measured in microamperes, μA) flowing from the capacitor to the flash bulb. Use part (a) to estimate the current when $t = 0.04$ s. Compare with the result of Example 2.1.2.

Solution

Plot the given data in Mathematica and use the FindFit function to determine the function $Q(t) = Ae^{-kt}$ that best fits the data.



Differentiate the charge to get the current.

$$\begin{aligned} i(t) = \frac{dQ}{dt} = \frac{d}{dt}[100.004e^{-10.0033t}] &= 100.004e^{-10.0033t} \cdot \frac{d}{dt}(-10.0033t) \\ &= 100.004e^{-10.0033t} \cdot (-10.0033) \\ &\approx -1000.37e^{-10.0033t} \end{aligned}$$

Evaluate it at $t = 0.04$.

$$i(4) \approx -1000.37e^{-10.0033(0.04)} \approx -670 \ \mu\text{A}$$