Energy dissipated by a resistor

\[ P = IV \quad V = IR \]

\[ P = I^2 R \]

\[ P = \frac{V^2}{R} \]
Effective Resistance

- Parallel: \( \frac{1}{R_{\text{eff}}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \)

- Series: \( R_{\text{eff}} = R_1 + R_2 + \ldots \)
Four identical light bulbs are connected to a power supply as shown. Which light bulb consumes the most power?

1) B₁  9 times more power.
2) B₂
3) B₃
4) B₄
5) They all consume the same amount of power.
Electrostatic Equilibrium and Steady State

• Equilibrium – the charges in a conductor in equilibrium have stopped moving.
  – Potential is constant throughout a conductor in equilibrium.

• Steady state – the currents in a circuit are constant in time.
  – A wire carrying a steady-state current is not in equilibrium (unless the current is zero).
• Current:

\[ I = \frac{dQ}{dt} \]

• Capacitance:

\[ Q = CV \]
Discharging a Capacitor

\[ dQ < 0 \]

\[ \frac{Q}{C} - IR = 0 \]

\[ \frac{Q}{C} = +RI \]

\[ \frac{RdQ}{dt} = -RdQ = \frac{Q}{RC} \]

\[ Q(t) = Q_e e^{-t/RC} \]

\[ \frac{dQ}{dt} = \frac{-1}{RC} Q_e e^{-t/RC} \]

Figure 26.59
Charging a Capacitor

\[ \varepsilon - \frac{Q}{C} - IR = 0 \]

\[ \varepsilon - \frac{Q}{C} = IR = \frac{dQ}{dt} \]

\[ \frac{\varepsilon}{R} - \frac{Q}{RC} = \frac{dQ}{dt} \]

\[ Q = \varepsilon E (1 - e^{-t/RC}) \]

\[ V = \frac{Q}{C} = \varepsilon (1 - e^{-t/RC}) \]

Figure 26.17a
Which curve best represents the charge on the capacitor in a charging $RC$ circuit as a function of time?
Figure 26.17b
The switch $S$ is initially at position $a$ for a long time. It is then switched to position $b$. Describe what happens to the light bulb as a function of time after the switch is flipped from $a$ to $b$.

1) The light bulb goes on but goes off immediately.
2) The light bulb goes off and stays off.
3) The light bulb goes on but its brightness decreases with time and eventually goes off.
4) The light bulb goes on and stays on at a constant brightness.
5) The light bulb goes on but its brightness increases with time.
Figure 26.17c

A graph showing the current $I$ as a function of time $t$. The current decays exponentially over time. At $t = RC$, the current is $0.37 \varepsilon / R$. The time is marked at $RC$, $2RC$, and $3RC$. The graph is labeled as Figure 26.17c.