Phys 202

Recitation 3

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Formulae

$$R = \frac{V}{I}.$$

Series :

$$R_{eq} = R_1 + R_2 + R_3 + \cdots.$$

Parallel:

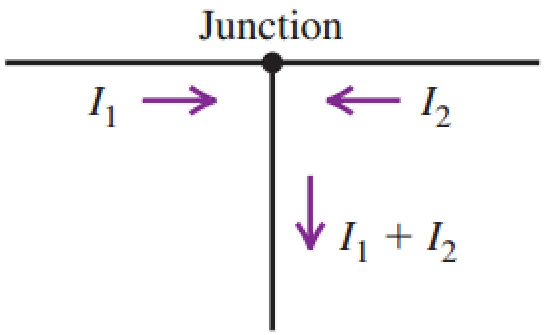
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots.$$

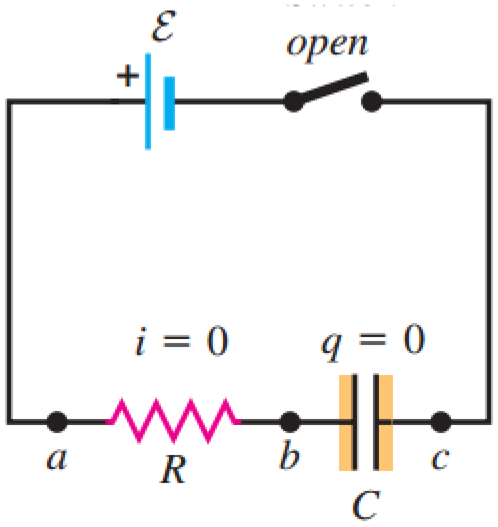
Kirchhoff's junction (or point) rule:
The algebraic sum of the currents into any junction is zero; that is,

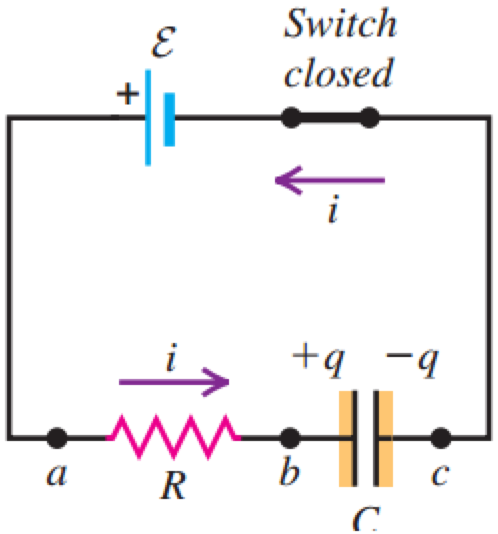
$$\sum I = 0.$$

Kirchhoff's loop rule:
The algebraic sum of the potential differences in any loop, including those associated with emf's and those of resistive elements, **must equal zero;** that is,

$$\sum_{\text{around loop}} V = 0.$$





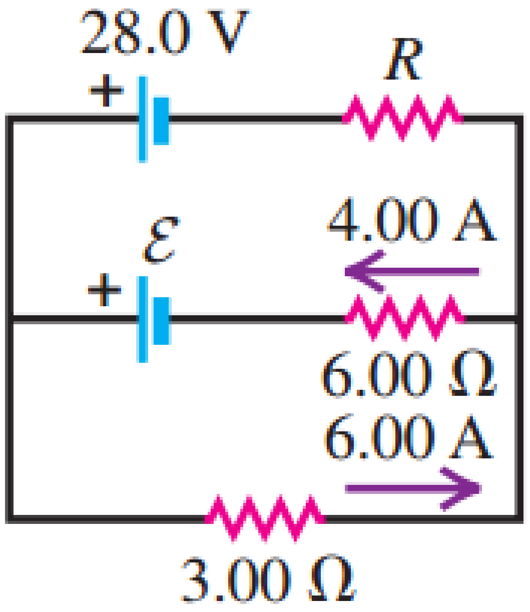


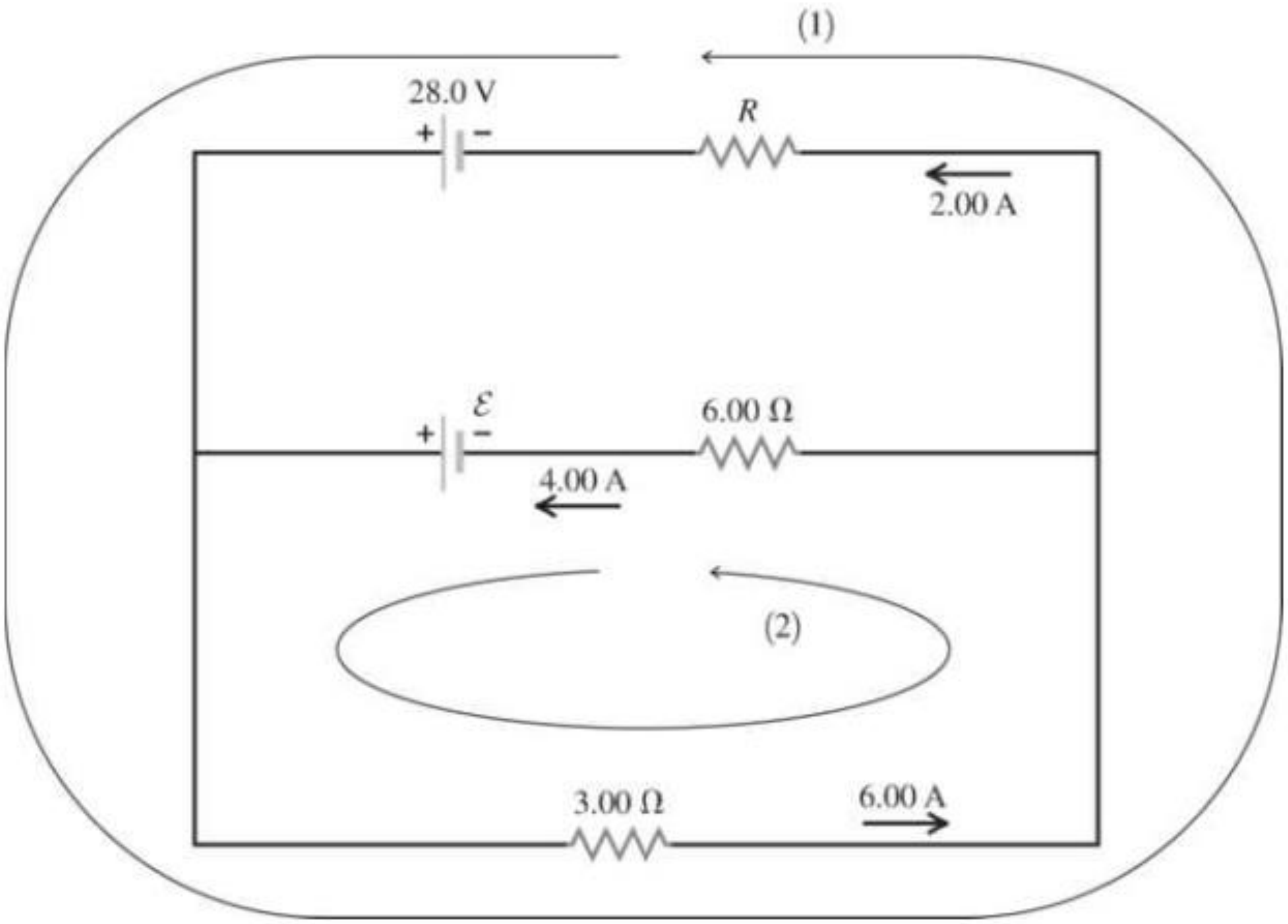
$$\mathcal{E} = iR + \frac{q}{C}.$$

$$\mathcal{E} = \frac{q}{C} \quad \text{and} \quad q = Q_{\text{final}} = C\mathcal{E}.$$

$$i = I_0 e^{-t/RC}, \qquad q = Q_{\text{final}}\left(1 - e^{-t/RC}\right).$$

•• In the circuit shown in Figure 19.60, find (a) the current in resistor R, (b) the value of the resistance R, and (c) the unknown emf $\mathcal{E}$.





(1)
28.0 V
+
−
R
2.00 A
ℰ
+
−
6.00 Ω
4.00 A
(2)
3.00 Ω
6.00 A

Solve: (a) The junction rule gives that the current in R is 2.00 A to the left.

(b) The loop rule applied to loop (1) gives:

$$-(2.00\ \text{A})R + 28.0\ \text{V} - (6.00\ \text{A})(3.00\ \Omega) = 0.$$

$$R = \frac{28.0\ \text{V} - 18.0\ \text{V}}{2.00\ \text{A}} = 5.00\ \Omega.$$

(c) The loop rule applied to loop (2) gives:

$$-(4.00\ \text{A})(6.00\ \Omega) + \mathcal{E} - (6.00\ \text{A})(3.00\ \Omega) = 0.$$

$$\mathcal{E} = 24.0\ \text{V} + 18.0\ \text{V} = 42.0\ \text{V}.$$

65. •• A 12.4 μF capacitor is connected through a 0.895 MΩ resistor to a constant potential difference of 60.0 V. (a) Compute the charge on the capacitor at the following times after the connections are made: 0, 5.0 s, 10.0 s, 20.0 s, and 100.0 s. (b) Compute the charging currents at the same instants. (c) Graph the results of parts (a) and (b) for t between 0 and 20 s.

Solve: **(a)** At $t = 0$ s: $q = C\mathcal{E}(1 - e^{-t/RC}) = 0.$

At $t = 5$ s: $q = C\mathcal{E}(1 - e^{-t/RC}) = (12.4 \times 10^{-6}\text{ F})(60.0\text{ V})(1 - e^{-(5.0\text{ s})/(11.1\text{ s})}) = 2.70 \times 10^{-4}\text{ C}.$

At $t = 10$ s: $q = C\mathcal{E}(1 - e^{-t/RC}) = (12.4 \times 10^{-6}\text{ F})(60.0\text{ V})(1 - e^{-(10.0\text{ s})/(11.1\text{ s})}) = 4.42 \times 10^{-4}\text{ C}.$

At $t = 20$ s: $q = C\mathcal{E}(1 - e^{-t/RC}) = (12.4 \times 10^{-6}\text{ F})(60.0\text{ V})(1 - e^{-(20.0\text{ s})/(11.1\text{ s})}) = 6.21 \times 10^{-4}\text{ C}.$

At $t = 100$ s: $q = C\mathcal{E}(1 - e^{-t/RC}) = (12.4 \times 10^{-6}\text{ F})(60.0\text{ V})(1 - e^{-(100\text{ s})/(11.1\text{ s})}) = 7.44 \times 10^{-4}\text{ C}.$

(b) The current at time t is given by: $i = \frac{\mathcal{E}}{R} e^{-t/RC}$.

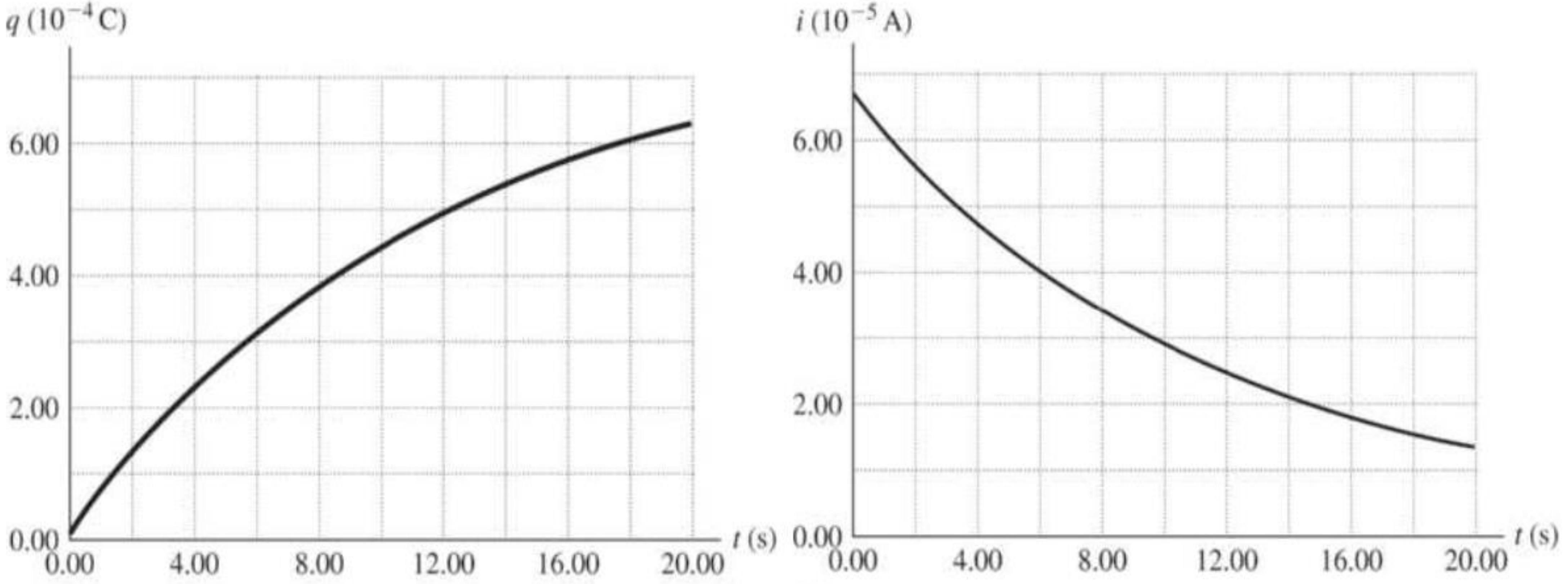
At $t = 0$ s: $i = \frac{60.0 \text{ V}}{8.95 \times 10^5 \ \Omega} e^{-0/11.1} = 6.70 \times 10^{-5}$ A.

At $t = 5$ s: $i = \frac{60.0 \text{ V}}{8.95 \times 10^5 \ \Omega} e^{-5/11.1} = 4.27 \times 10^{-5}$ A.

At $t = 10$ s: $i = \frac{60.0 \text{ V}}{8.95 \times 10^5 \ \Omega} e^{-10/11.1} = 2.72 \times 10^{-5}$ A.

At $t = 20$ s: $i = \frac{60.0 \text{ V}}{8.95 \times 10^5 \ \Omega} e^{-20/11.1} = 1.11 \times 10^{-5}$ A.

At $t = 100$ s: $i = \frac{60.0 \text{ V}}{8.95 \times 10^5 \ \Omega} e^{-100/11.1} = 8.20 \times 10^{-9}$ A.



q (10^-4 C)
6.00
4.00
2.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
t (s)
i (10^-5 A)
6.00
4.00
2.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
t (s)

(a) (b)

(5 pts) 11. Two resistors are connected to a 24 V battery as shown in the sketch. $R_1 = 3.0\ \Omega$ and $R_2 = 6.0\ \Omega$. What is the voltage across R_1 ?