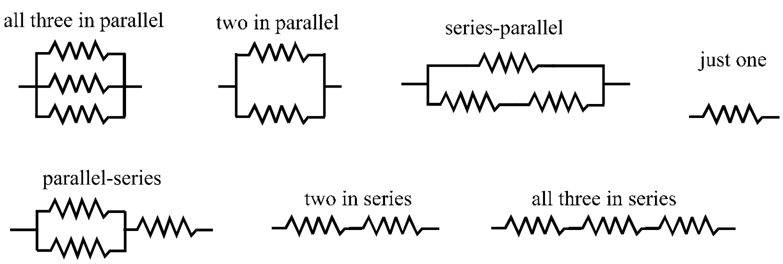
In this chapter, the following convenient calculation of equivalent resistance for two resistors in parallel is used in many exercises. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$, ☞ $R_p = \frac{R_1 R_2}{R_1 + R_2}$.

1. (b).
2. (a).
3. (b).
4. (b).
5. (a).
6. (b).
7. $\boxed{\text{No}}$, not generally. However $\boxed{\text{if all resistors are equal}}$, the voltages across them are the same.
8. $\boxed{\text{No}}$, not generally. However $\boxed{\text{if all resistors are equal}}$, the currents through each is the same.

16. (a) You can get $\boxed{\text{(3) seven}}$ different values of equivalent resistance.



(b) All three in parallel: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = 3\,\frac{1}{4.0\ \Omega} = \frac{3}{4.0\ \Omega}$, $R_p = \boxed{1.3\ \Omega}$.

Two in parallel: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = 2\,\frac{1}{4.0\ \Omega} = \frac{2}{4.0\ \Omega}$, $R_p = \boxed{2.0\ \Omega}$.

Two in series-parallel: $\frac{1}{R_p} = \frac{1}{R_s} + \frac{1}{R} = \frac{1}{R+R} + \frac{1}{R} = \frac{3}{2(4.0\ \Omega)}$, $R_p = \boxed{2.7\ \Omega}$.

Just one alone: $R = \boxed{4.0\ \Omega}$.

Two in parallel-series: $R_s = R + R_p = R + \frac{R\,R}{R+R} = \frac{3R}{2} = \frac{3(4.0\ \Omega)}{2} = \boxed{6.0\ \Omega}$.

Two in series: $R_s = R_1 + R_2 = 4.0\ \Omega + 4.0\ \Omega = \boxed{8.0\ \Omega}$.

All three in series: $R_s = R_1 + R_2 + R_3 = 3(4.0\ \Omega) = \boxed{12\ \Omega}$.

$\boxed{26}$. R_1 and R_2 are in series: $R_s = 2.0\ \Omega + 2.0\ \Omega = 4.0\ \Omega$.

R_s, R_3, and R_4 are in parallel: $\frac{1}{R_p} = \frac{1}{4.0\ \Omega} + \frac{1}{2.0\ \Omega} + \frac{1}{2.0\ \Omega} = \frac{5}{4.0\ \Omega}$.

So $R_p = \frac{4.0\ \Omega}{5} = \boxed{0.80\ \Omega}$.

$\boxed{27}$. R_2 and R_3 are in series: $R_s = 6.0\ \Omega + 4.0\ \Omega = 10\ \Omega$.

R_s, R_1, and R_4 are in parallel: $\frac{1}{R_p} = \frac{1}{10\ \Omega} + \frac{1}{6.0\ \Omega} + \frac{1}{10\ \Omega} = \frac{22}{60\ \Omega}$, ☞ $R_p = \boxed{2.7\ \Omega}$.

28. R_2, R_3, and R_4 are in series: $R_s = 20\ \Omega + 5.0\ \Omega + 5.0\ \Omega = 30\ \Omega$.

R_s and R_1 are in parallel: $R_p = \dfrac{(30\ \Omega)(10\ \Omega)}{30\ \Omega + 10\ \Omega} = \boxed{7.5\ \Omega}$.

$\boxed{36}$. (a) $I_1 = \dfrac{V}{R_1} = \dfrac{6.0\ \text{V}}{6.0\ \Omega} = \boxed{1.0\ \text{A}}$ R_2 and R_3 are in series. $R_s = 4.0\ \Omega + 6.0\ \Omega = 10\ \Omega$.

So $I_2 = I_3 = \dfrac{6.0\ \text{V}}{10\ \Omega} = \boxed{0.60\ \text{A}}$, $I_4 = \dfrac{6.0\ \text{V}}{10\ \Omega} = \boxed{0.60\ \text{A}}$.

(b) $P_1 = I_1^2 R_1 = (1.0\ \text{A})^2 (6.0\ \Omega) = \boxed{6.0\ \text{W}}$, $P_2 = (0.60\ \text{A})^2 (4.0\ \Omega) = \boxed{1.4\ \text{W}}$,

$P_3 = (0.60\ \text{A})^2 (6.0\ \Omega) = \boxed{2.2\ \text{W}}$, $P_4 = (0.60\ \text{A})^2 (10\ \Omega) = \boxed{3.6\ \text{W}}$.

(c) $P_{\text{sum}} = 6.0\ \text{W} + 1.44\ \text{W} + 2.16\ \text{W} + 3.6\ \text{W} = 13\ \text{W}$.

From Exercise 18.27, $P_{\text{total}} = \dfrac{(6.0\ \text{V})^2}{2.7\ \Omega} = 13\ \text{W}$. Therefore $\boxed{P_{\text{sum}} = P_{\text{total}} = 13\ \text{W}}$.

43. (a).

44. (a).

45. (d).

46. (b).

55. Around the loop in a counterclockwise direction, $20\ \text{V} - I(20\ \Omega) - 10\ \text{V} - I(10\ \Omega) = 0$,

so $I = I_1 = I_2 = 0.33\ \text{A}$. Therefore $\boxed{I_1 = 0.33\ \text{A (left)}}$ and $\boxed{I_2 = 0.33\ \text{A (right)}}$.

60. (a). The voltage across the resistor decreases exponentially when a capacitor is discharged.

61. (c). The current in the circuit decreases exponentially when a capacitor is charged.

62. (c). $\tau = RC$.

63. (b). $\tau = RC$, independent of charges.

71. (a) $\tau = RC$, ☞ $R = \dfrac{\tau}{C} = \dfrac{1.50\ \text{s}}{1.00 \times 10^{-6}\ \text{F}} = 1.50 \times 10^6\ \Omega = \boxed{1.50\ \text{M}\Omega}$.

(b) $V_C = V_o\left(1 - e^{-t/\tau}\right) = (12.0\ \text{V})\left(1 - e^{-3}\right) = \boxed{11.4\ \text{V}}$.

76. (a).

77. (b).

78. (b).

86. An ammeter is connected in series. $I = \dfrac{V}{R + R_a} = \dfrac{6.0\ \text{V}}{10\ \Omega + 1.0 \times 10^{-3}\ \Omega} = \boxed{0.59994\ \text{A}}$.

87. A voltmeter is connected in parallel. $I = \dfrac{V}{R_v} = \dfrac{6.0\ \text{V}}{30 \times 10^3\ \Omega} = 2.0 \times 10^{-4}\ \text{A} = \boxed{0.20\ \text{mA}}$.

90. (a).

91. (c).

92. $\boxed{\text{The fuse and the switch are on the ground side of the circuit}}$. An open switch or blown fuse would potentially leave the motor at a high voltage if it were touched by a person.

93. **No, a high voltage can produce high harmful current, even if resistance is high**, because current is caused by voltage (potential difference).

94. A conductor has very low resistance. The resistance of the wire between the feet is very small; so **the voltage between the feet is small**. Therefore the current through the bird is also small.

107. (a) $V_C = V_o e^{-t/\tau}$, ☞ $20.0\ \text{V} = (10\,000\ \text{V})\, e^{-t/\tau}$.

$e^{-t/\tau} = 0.00200$ so $\dfrac{t}{\tau} = 6.215$. Therefore $\tau = \dfrac{t}{6.215} = \dfrac{75.1 \times 10^{-3}\ \text{s}}{6.215} = 12.08\ \text{ms} = \boxed{12.1\ \text{ms}}$.

(b) $\tau = RC$, ☞ $R = \dfrac{\tau}{C} = \dfrac{12.08 \times 10^{-3}\ \text{s}}{10.0 \times 10^{-6}\ \text{F}} = 1.208\ \text{k}\Omega = \boxed{1.21\ \text{k}\Omega}$.

(c) Because $U_C = \frac{1}{2} CV^2$, loosing 90% of its energy means the remaining energy is 10% = 0.10.

The remaining voltage is then $\sqrt{0.10} = 0.316$ (31.6%) of its maximum voltage.

$0.316 = e^{-t/\tau}$, ☞ $\dfrac{t}{\tau} = -\ln(0.316) = 1.15$.

Therefore $t = 1.15\tau = 1.15(12.08\ \text{ms}) = \boxed{13.9\ \text{ms}}$.