6.9: Direct-Current Circuits (Answers)

Conceptual Questions

1. Some of the energy being used to recharge the battery will be dissipated as heat by the internal resistance.

3. $P = I^2R = (\frac{\varepsilon}{r+R})^2R = \varepsilon^2R(r+R)^{-2}, \frac{dP}{dR} = \varepsilon^2[(r+R)^{-2} - 2R(r+R)^{-3}] = 0 \quad [\frac{(r+R)-2R}{(r+R)^3}] = 0, r = R$

5. It would probably be better to be in series because the current will be less than if it were in parallel.

7. two filaments, a low resistance and a high resistance, connected in parallel

9. It can be redrawn.

$$R_{eq} = [\frac{1}{R_6} + \frac{1}{R_1} + \frac{1}{R_2 + (\frac{1}{R_4} + \frac{1}{R_3+R+5})^{-1}}]^{-1} .$$

11. In series the voltages add, but so do the internal resistances, because the internal resistances are in series. In parallel, the terminal voltage is the same, but the equivalent internal resistance is smaller than the smallest individual internal resistance and a higher current can be provided.

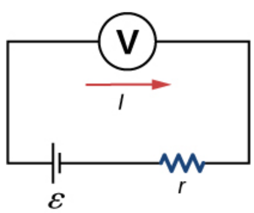
13. The voltmeter would put a large resistance in series with the circuit, significantly changing the circuit. It would probably give a reading, but it would be meaningless.

15. The ammeter has a small resistance; therefore, a large current will be produced and could damage the meter and/or overheat the battery.

19. Not only might water drip into the switch and cause a shock, but also the resistance of your body is lower when you are wet.

Problems

21. a.



b. 0.476W;

c. 0.691 W;

d. As R_L is lowered, the power difference decreases; therefore, at higher volumes, there is no significant difference.

23. a. 0.400Ω;

b. No, there is only one independent equation, so only r can be found.

25. a. 0.400Ω;

b. 40.0 W;

c. $0.0956^\circ C/min$

27. largest, 786Ω, smallest, 20.32Ω

29. 29.6 W

31. a. 0.74 A;

b. 0.742 A

33. a. 60.8 W;

b. 3.18 kW

35. a. $R_s = 9.00\Omega$;

b.$I_1 = I_2 = I_3 = 2.00A$;

c. $V_1 = 8.00V, V_2 = 2.00V, V_3 = 8.00V$;

d. $P_1 = 16.00W, P_2 = 4.00W, P_3 = 16.00W$;

e. $P = 36.00W$

37. a. $I_1 = 0.6mA, I_2 = 0.4mA, I_3 = 0.2m$;

b. $I_1 = 0.04mA, I_2 = 1.52mA, I_3 = -1.48mA$;

c. $P_{out} = 0.92mW, P_{out} = 4.50mW$;

d. $P_{in} = 0.92mW, P_{in} = 4.50mW$

39. $V_1 = 42V, V_2 = 6V, R_4 = 18\Omega$

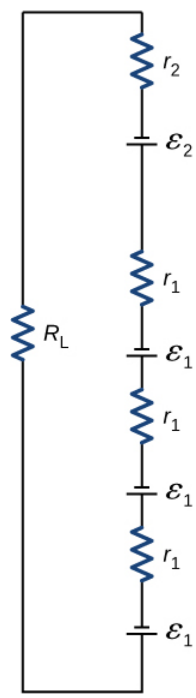
41. a. $I_1 = 1.5A, I_2 = 2A, I_3 = 0.5A, I_4 = 2.5A, I_5 = 2A$;

b. $P_{in} = I_2V_1 + I_5V_5 = 34W$;

c. $P_{out} = I_1^2R_1 + I_2^2R_2 + I_3^2R_3 + I_4^2R_4 = 34W$

43. $I_1 = \frac{2}{3}\frac{V}{R}, I_2 = \frac{1}{3}\frac{V}{R}, I_3 = \frac{1}{3}\frac{V}{R}$

45. a.



b. 0.617 A;

c. 3.81 W;

d. 18.0Ω

47. $I_1r_1 - \varepsilon_1 + I_1R_4 + \varepsilon_4 + I_2r_4 + I_4r_3 - \varepsilon_3 + I_2R_3 + I_1R_1 = 0$

59. 12.0 V

61. 400 V

63. a. 6.00 mV; .

b. It would not be necessary to take extra precautions regarding the power coming from the wall. However, it is possible to generate voltages of approximately this value from static charge built up on gloves, for instance, so some precautions are necessary.

65. a. $5.00 \times 10^{-2} C$;

b. 10.0 kV;

c. $1.00 k\Omega$;

d. $1.79 \times 10^{-2} {}^{\circ}C$

Challenge Problems

89. a. 0.273 A; b. $V_T = 1.36 V$

91. a. $V_s = V - I_M R_M = 9.99875 V$;

b. $R_S = \frac{V_P}{I_M} = 199.975 k\Omega$

93. a. $\tau = 3800 s$;

b. 1.26 A;

c. $t = 2633.96 s$

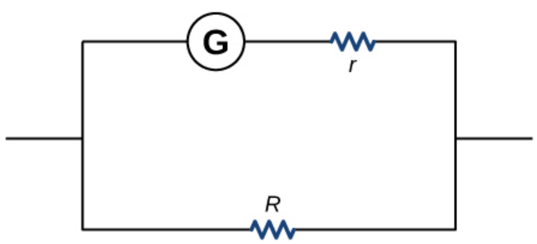
95. $R_{eq} = (\sqrt{3} - 1)R$

97. a. $P_{imheater} = \frac{1cup(\frac{0.000237m^3}{cup})(\frac{1000kg}{m^3})(4186\frac{J}{kg^{\circ}C})(100^{\circ}C - 20^{\circ}C)}{180.00s} \approx 441W$,

b. $I = \frac{441W}{120V} + 4(\frac{100W}{120V}) + \frac{1500W}{120V} = 19.51A$; Yes, the breaker will trip.

c. $I = \frac{441W}{120V} + 4(\frac{18W}{120V}) + \frac{1500W}{120V} = 13.47$; No, the breaker will not trip.

99. $2.40 \times 10^{-3} \Omega$



Contributors and Attributions

Samuel J. Ling (Truman State University), Jeff Sanny (Loyola Marymount University), and Bill Moebs with many contributing authors. This work is licensed by OpenStax University Physics under a Creative Commons Attribution License (by 4.0).