ANSWER KEY.

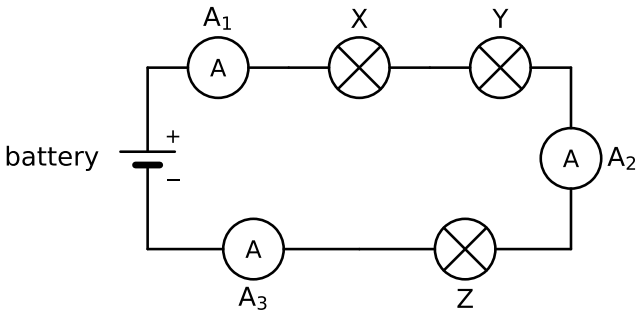
ZornScience
zornscience.org

Series Circuits

Physics | Answer Key

Part A: Concepts

1. Three identical bulbs X, Y, and Z are connected in series with a battery and three ammeters.



a. Ammeter A_1 reads 0.50 A. What do A_2 and A_3 read? Explain.

b. Bulb Y burns out. What happens to bulbs X and Z? Explain.

c. A fourth identical bulb is added in series. What happens to the total resistance, the current, and the brightness of each bulb?

a. Both read **0.50 A**. There is only one path, and charge is not used up, so the current is the same everywhere in a series circuit.

b. X and Z **go out**. The broken filament opens the only loop, so the current stops everywhere.

c. The total resistance **increases** (resistances add), so the current **decreases**, and every bulb gets **dimmer**.

Part B: Solving Series Circuits

Show your equations, substitutions, and answers with units.

2. A 12 V battery is connected in series with three resistors: 4.0 Ω, 8.0 Ω, and 12 Ω.

a. Find the total resistance.

b. Find the current through each resistor.

c. Find the voltage drop across each resistor, and check that the drops add to 12 V.

d. Which resistor has the biggest voltage drop? Why does that make sense?

a. R_T = 4.0 Ω + 8.0 Ω + 12 Ω = **24 Ω**

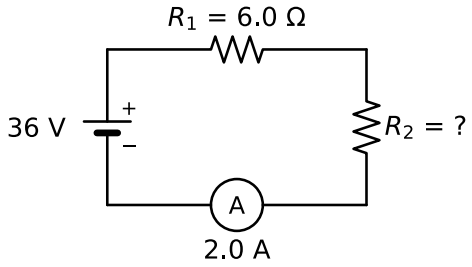
b. $I = V/R_T$ = 12 V / 24 Ω = **0.50 A**, the same through every resistor

c. V_1 = (0.50 A)(4.0 Ω) = **2.0 V**, V_2 = (0.50 A)(8.0 Ω) = **4.0 V**, V_3 = (0.50 A)(12 Ω) = **6.0 V**. Check: 2.0 V + 4.0 V + 6.0 V = 12 V.

d. The **12 Ω** resistor. Every resistor has the same current, so by $V = IR$ the biggest resistance gets the biggest share of the voltage.

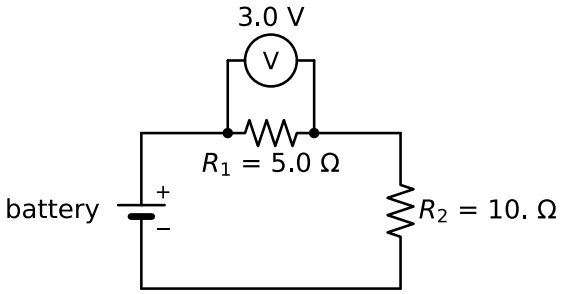
CC BY-NC-SA 4.0

3. Find the total resistance, the unknown resistance R_2, and the voltage drop across each resistor.



Total resistance: $R_T = V/I$ = 36 V / 2.0 A = **18 Ω**
Unknown: $R_2 = R_T - R_1$ = 18 Ω − 6.0 Ω = **12 Ω**
Drops: V_1 = (2.0 A)(6.0 Ω) = **12 V**, V_2 = (2.0 A)(12 Ω) = **24 V**. Check: 12 V + 24 V = 36 V.

4. A voltmeter across R_1 reads 3.0 V. Find the current in the circuit, the voltage across R_2, and the battery voltage.



Current: $I = V_1/R_1$ = 3.0 V / 5.0 Ω = **0.60 A** (the same everywhere)
Across R_2: $V_2 = IR_2$ = (0.60 A)(10. Ω) = **6.0 V**
Battery: $V = V_1 + V_2$ = 3.0 V + 6.0 V = **9.0 V**. (Or $V = IR_T$ = (0.60 A)(15 Ω) = 9.0 V.)

5. An old string of holiday lights has 40 identical 6.0 Ω bulbs connected in series to a 120 V outlet.

a. What is the current in the string?
b. What is the voltage across each bulb?
c. What is the power of each bulb?
d. One bulb burns out. How many bulbs stay lit? Explain.

a. R_T = 40 × 6.0 Ω = 240 Ω, so I = 120 V / 240 Ω = **0.50 A**
b. $V = IR$ = (0.50 A)(6.0 Ω) = **3.0 V** (also 120 V / 40 bulbs = 3.0 V)
c. $P = I^2R$ = (0.50 A)^2(6.0 Ω) = **1.5 W** (or $P = IV$ = (0.50 A)(3.0 V) = 1.5 W)
d. None. The burned-out bulb opens the only loop, so the current stops and all 40 bulbs go dark.

CC BY-NC-SA 4.0