

Circuit Construction Kit: DC — Lab Worksheet

Name: _____ Class: _____ Date: _____

Open the free **Circuit Construction Kit: DC** simulation by PhET (eolclassroom-online.com/classroom-simulations/ or phet.colorado.edu) and choose the **Intro** screen. Drag parts from the toolbox on the left. Click a battery or resistor to change its value. Turn on **Values** in the display options so every part shows its number.

Part A — Make a bulb light

1. Build a circuit with one battery, one light bulb and wires. Draw your working circuit below.

2. Disconnect one wire. What happens to the bulb? Why?

3. Add a switch. Explain in one sentence what a switch does to the circuit.

Part B — Ohm's law

Build a circuit with a battery, a **10 Ω resistor** and wires. Drag the **non-contact ammeter** out of the sensor toolbox and place its probe over a wire. Change the battery voltage and record the current.

Battery voltage (V)	Current with 10 Ω (A)	Current with 20 Ω (A)	Voltage $\div$ current (Ω)
3			
6			
9			
12			

4. What happens to the current when you double the voltage?

5. What happens to the current when you double the resistance?

6. Write the relationship between voltage (V), current (I) and resistance (R) as an equation.

7. Use your equation: what current flows through a $30\ \Omega$ resistor connected to a 9 V battery?

Part C — Series and parallel

Set the battery back to **9 V**. Build the three circuits below and record the current leaving the battery.

Circuit	Current from battery (A)	Brightness of each bulb (compare to one bulb)
One bulb		
Two bulbs in series (one loop)		
Two bulbs in parallel (two branches)		

8. Remove one bulb from the **series** circuit. What happens to the other bulb?

9. Remove one bulb from the **parallel** circuit. What happens to the other bulb?

10. Use the voltmeter to measure the voltage across one bulb in each circuit. Series: _____ V. Parallel: _____ V. Explain the difference.

11. Homes are wired in parallel, not in series. Give two reasons why.

Part D — Conductors and insulators

Keep the 9 V battery and one bulb. Replace one wire with each item from the toolbox (scroll the toolbox pages) and record what happens.

Item	Does the bulb light? (bright / dim / off)	Current (A)	Conductor or insulator?
Coin			
Paper clip			
Pencil			
Thin pencil			
Eraser			
Dollar bill			

12. The pencil "lead" is actually graphite. Why does the bulb glow more dimly with the pencil than with the coin?

13. Why does the thin pencil let less current through than the regular pencil?

Part E — Reflect

14. A voltmeter is connected *across* a part, but an ammeter measures current *in* the path of the circuit. Why do they need to be connected differently?

Answer Key (Teacher Copy)

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Values below assume the simulation defaults: ideal battery, light bulb $10\ \Omega$. The meters show two decimal places.

Part A

1. A complete loop: battery $\rightarrow$ wire $\rightarrow$ bulb $\rightarrow$ wire $\rightarrow$ back to the battery.
2. The bulb goes out. Current can only flow around a complete (closed) circuit.
3. A switch opens or closes the circuit, so it starts or stops the current.

Part B

Battery voltage (V)	Current with $10\ \Omega$ (A)	Current with $20\ \Omega$ (A)	Voltage $\div$ current (Ω)
3	0.30	0.15	10 and 20
6	0.60	0.30	10 and 20
9	0.90	0.45	10 and 20
12	1.20	0.60	10 and 20

4. The current doubles (current is proportional to voltage).
5. The current halves (current is inversely proportional to resistance).
6. $V = I \times R$ (Ohm's law), or $I = V \div R$.
7. $I = 9\text{ V} \div 30\ \Omega = 0.30\text{ A}$.

Part C

Circuit	Current from battery (A)	Brightness of each bulb
One bulb	0.90	Normal
Two bulbs in series	0.45	Dimmer (each gets a quarter of the power of a single bulb)
Two bulbs in parallel	1.80	Same as one bulb

8. The other bulb goes out, because there is only one path and it is now broken.
9. The other bulb stays lit at the same brightness, because its branch is still a complete loop.

10. Series: 4.5 V across each bulb (the 9 V is shared). Parallel: 9 V across each bulb (each branch gets the full battery voltage).
11. Any two of: each device gets the full supply voltage; one device can be switched off or fail without turning off the others; adding devices does not dim the others.

Part D

Item	Bulb	Current (A)	Type
Coin	Bright	0.90	Conductor
Paper clip	Bright	0.90	Conductor
Pencil	Dim	0.26	Conductor (resistance 25 Ω)
Thin pencil	Dimmer	0.15	Conductor (resistance 50 Ω)
Eraser	Off	0.00	Insulator
Dollar bill	Off	0.00	Insulator

12. Graphite conducts, but it has much more resistance (25 Ω in the simulation) than metal, so less current flows: $9\text{ V} \div (10\text{ } \Omega + 25\text{ } \Omega) \approx 0.26\text{ A}$.
13. A thinner conductor has a smaller cross-section, so it has more resistance (50 Ω in the simulation): $9\text{ V} \div 60\text{ } \Omega = 0.15\text{ A}$.

Part E

14. A voltmeter measures the difference in electric potential between two points, so its probes go on either side of a part. It has (ideally) infinite resistance, so it does not change the circuit. An ammeter measures the current flowing through one point, so the current must pass through it (or, for a non-contact ammeter, the wire must pass under its probe). An ideal ammeter has zero resistance.