Circuit Fundamentals — Lab Worksheet

MICRO TRAINER BASIC · WORK THE BOARD AND THE SIMULATOR SIDE BY SIDE

NAME _____ DATE _____ CLASS / PERIOD _____

How to use this sheet. Every part of this worksheet matches a panel in the Circuit Fundamentals Simulator. Work them in order, and work each one twice — once on the screen and once on the board in front of you.

1. Read the part heading and find the named panel in the simulator.
2. **Predict first.** Where a table has a Predicted column, fill it in before you touch a probe. A prediction you got wrong teaches more than a reading you copied.
3. Take the reading on the simulator, then take the same reading on your board. They should agree to within a few hundredths of a volt.
4. If they do not agree, do not change your answer — write down what you measured and say why you think the two differ.

What you need: the Micro Trainer Basic board, one digital multimeter (two more if you have them, for Part E), and the simulator open on a phone, tablet or computer.

Which way does the current go? This worksheet and the simulator both use **conventional current** — drawn from positive to negative, the way every wiring diagram and every schematic arrow on the board is drawn. The electrons themselves drift the other way, negative to positive. It makes no difference to a single reading you are about to take; it only matters that you know which convention a diagram is using before you read it.

A The simple circuit — one path, one current

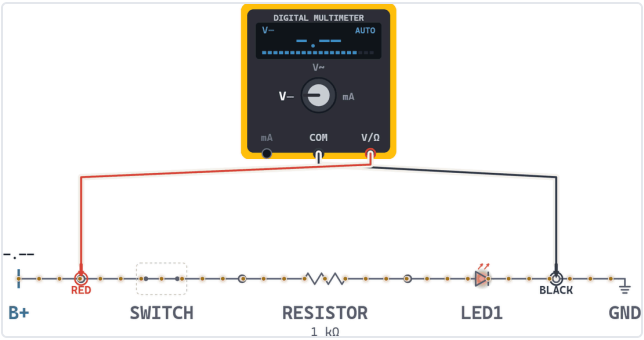
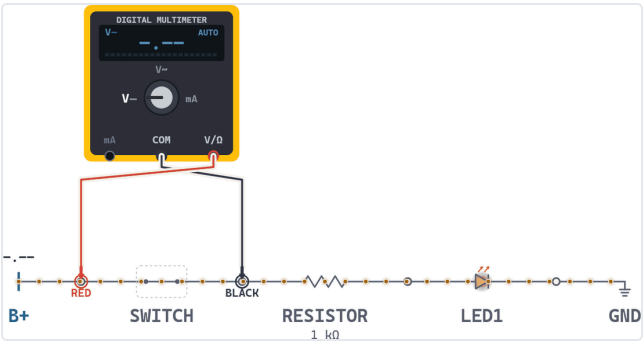
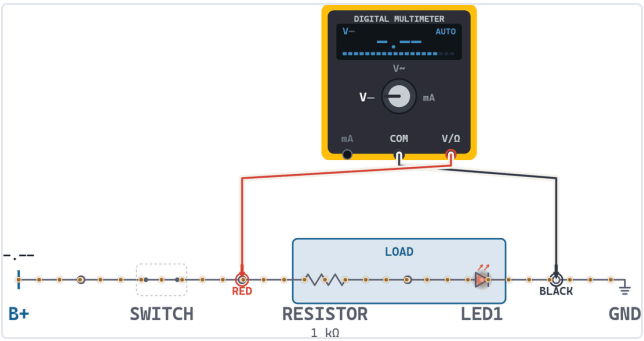
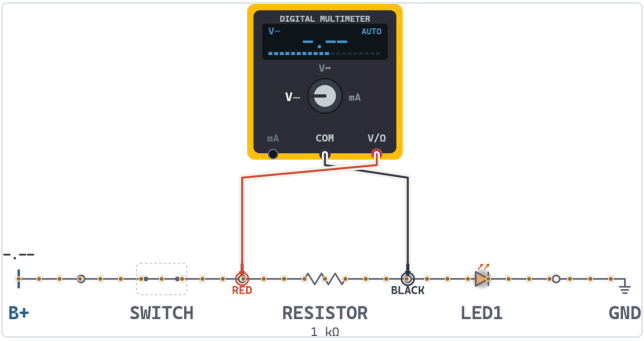
18 pts

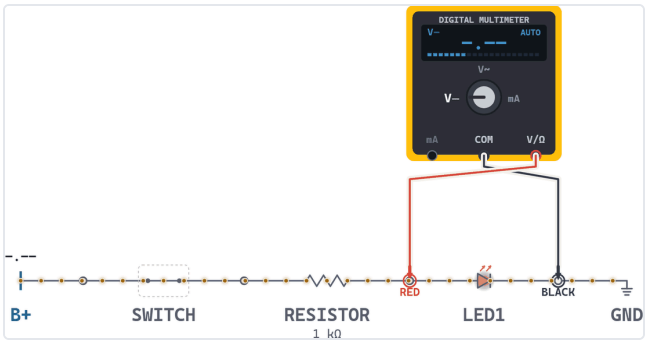
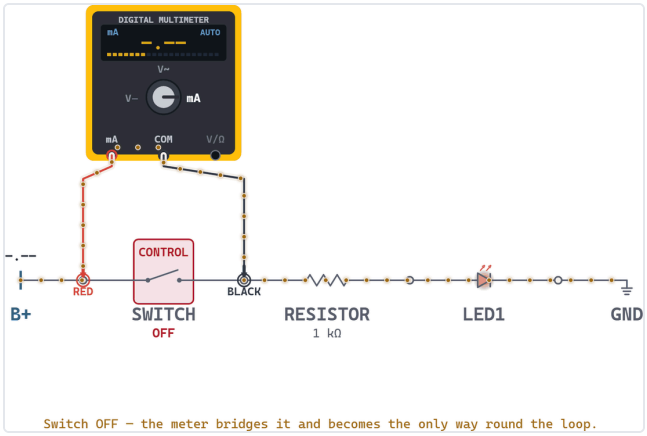
In the simulator: Functional Schematic and Where The Leads Go

B+ → SWITCH → RESISTOR → LED → GND. One path, so every electron that leaves B+ goes through the resistor, through the LED, and back to ground. Use the first circuit in the simulator.

Supply **5.00 V** · series resistor **1 kΩ** · one red LED.

1. Predict each reading **before** you measure anything, then take the five readings. The simulator's Where The Leads Go panel shows you exactly where the two probes touch for each one. (6 pts)

READING	WHERE THE LEADS GO	PREDICTED	MEASURED	
Source	 B+ test point ↔ GND			V
Across switch	 B+ test point ↔ after switch			V
Load	 after switch ↔ after LED			V
Across R	 before R ↔ after R			V

READING	WHERE THE LEADS GO	PREDICTED	MEASURED	
Across LED	 LED + ↔ LED −			V
Current	 switch OFF, meter bridges it			mA

2. Add your two drops together: $V_R + V_{LED}$ = ___ . What else on this sheet does that equal? (1 pt)

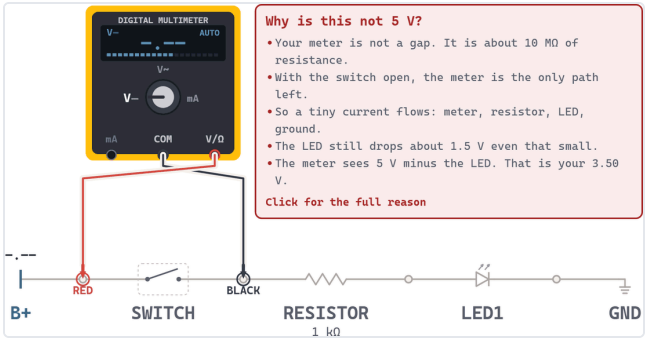
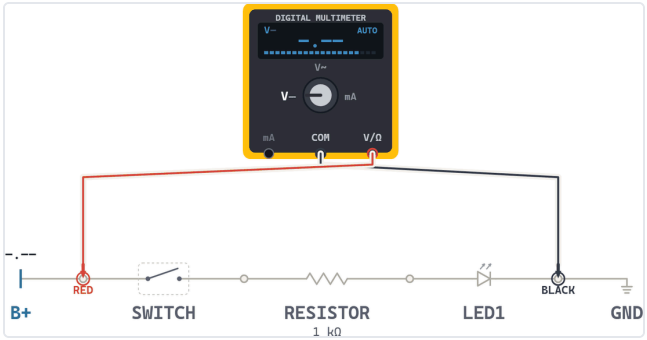
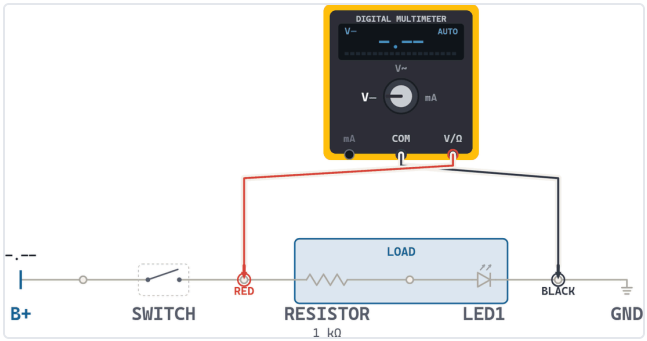
_____ V

3. You never cut into this circuit, yet you can still work out its current. Use Ohm's law on the resistor: $I = V_R \div R$ = ___ (3 pts)

Use the voltage you just measured across the resistor, and its 1 kΩ value. Give the answer in milliamps.

_____ mA

4. Now open the switch and take two readings again. (2 pts)

READING, SWITCH OPEN	WHERE THE LEADS GO	MEASURED	
Across switch	 B+ test point ↔ after switch		V
Source	 B+ test point ↔ GND		V
Load	 after switch ↔ after LED		V

5. The supply is still making 5 V and the load now has none of it. Where did those 5 volts go? (1 pt)

_____

6. Turn on every zone in the simulator's **Functional Schematic** panel, then match each zone to the job it does. Write the letter in the box. (5 pts)

_____	**Source**
_____	**Switched source**
_____	**Ground**
_____	**Control**
_____	**Load**

CHOOSE FROM

A. What actually uses the voltage.

B. Battery feed — hot whenever the master switch is on.

C. The return path, whatever the switch is doing.

D. Hot only once the switch is made.

E. What makes and breaks the circuit.

B The series circuit — one current, shared voltage

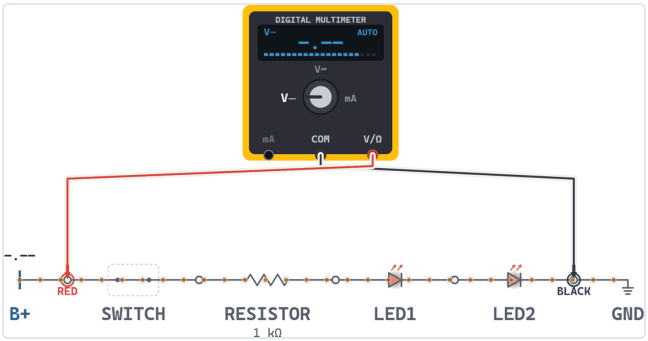
15 pts

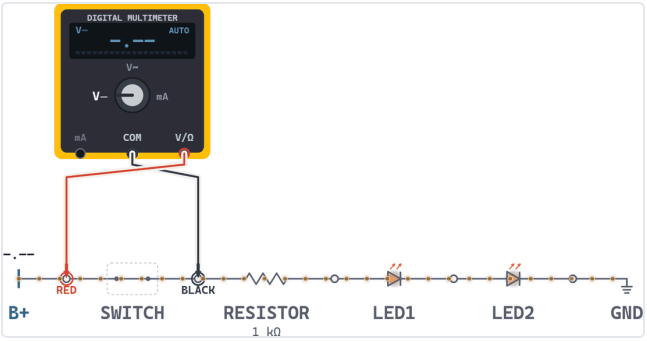
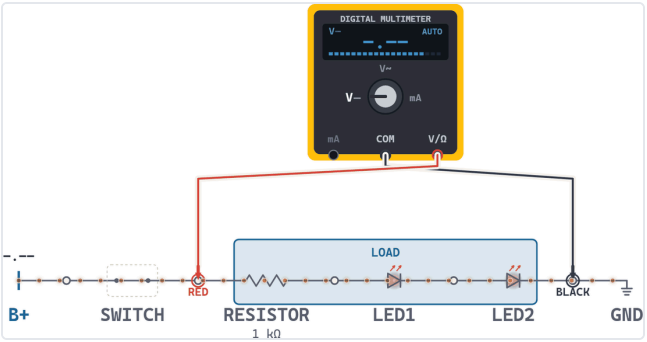
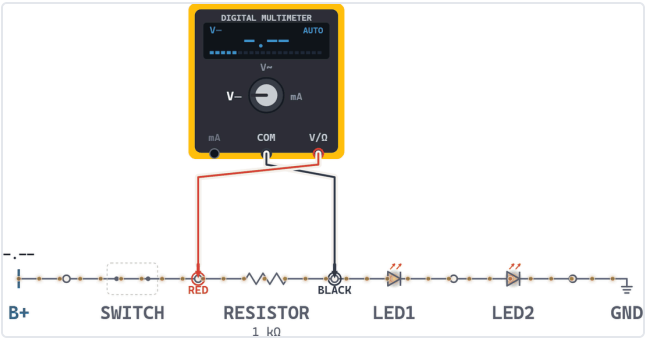
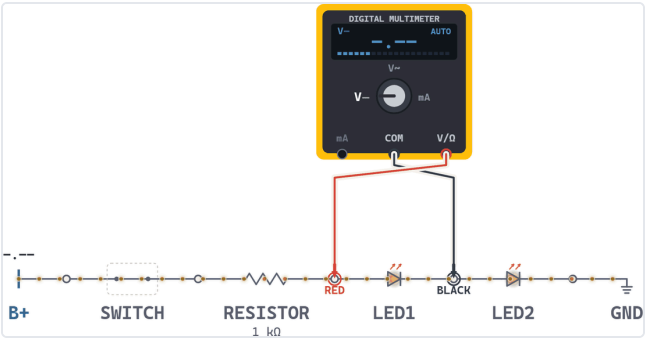
In the simulator: Functional Schematic and Where The Leads Go

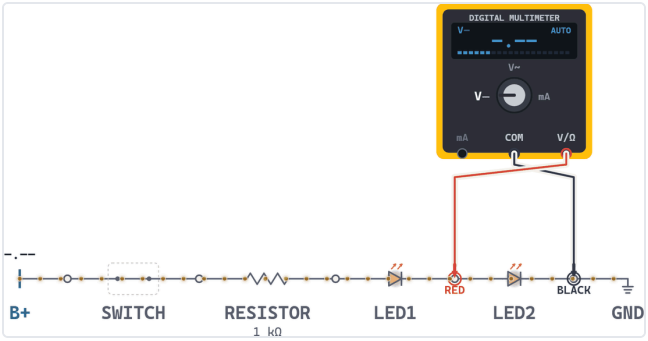
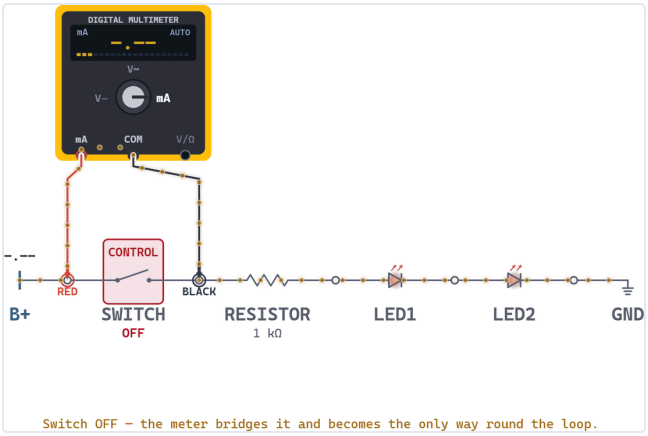
B+ → SWITCH → RESISTOR → LED → LED → GND. Same single path, but now there are two LEDs in it. Use the second circuit in the simulator.

Supply **5.00 V** · series resistor **1 kΩ** · two red LEDs in line.

1. Take all six readings on the simulator and on your board. (6 pts)

READING	WHERE THE LEADS GO	MEASURED	
Source	 B+ test point ↔ GND		V

READING	WHERE THE LEADS GO	MEASURED	
Across switch	 B+ test point ↔ after switch		V
Load	 after switch ↔ after LED2		V
Across R	 before R ↔ after R		V
Across LED1	 LED1 + ↔ LED1 –		V

READING	WHERE THE LEADS GO	MEASURED	
Across LED2	 LED2 + ↔ LED2 −		V
Current	 switch OFF, meter bridges it		mA

2. Add all three drops: $V_R + V_{LED1} + V_{LED2}$ = ___ (2 pts)

_____ V

3. Work the current out from the resistor again: $I = V_R \div R$ = ___ (2 pts)

_____ mA

4. Finish the two rules for a series circuit. (2 pts)

Current is _____ through every part. Voltage _____ across the parts.

5. Compare the current you measured here with the one you measured in Part A. Adding a second LED cut it by **more** than half — halving your Part A figure would have predicted a larger current than you actually got. Explain why it did not simply halve. (3 pts)

C The parallel circuit — shared voltage, split current

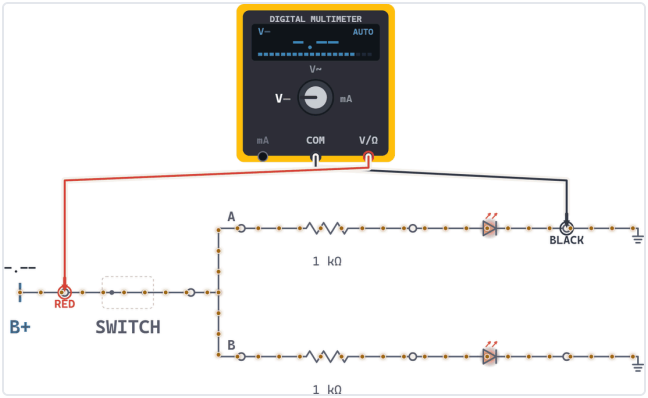
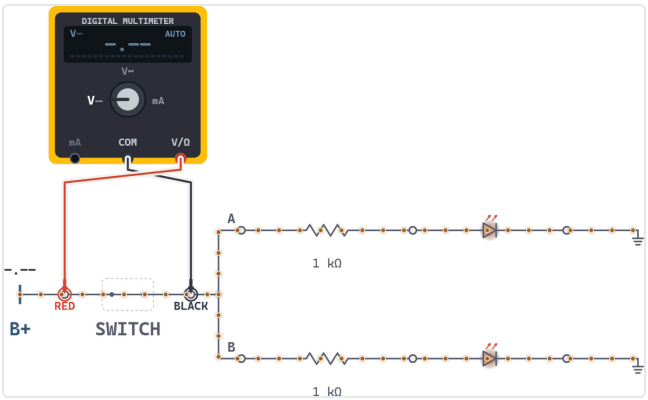
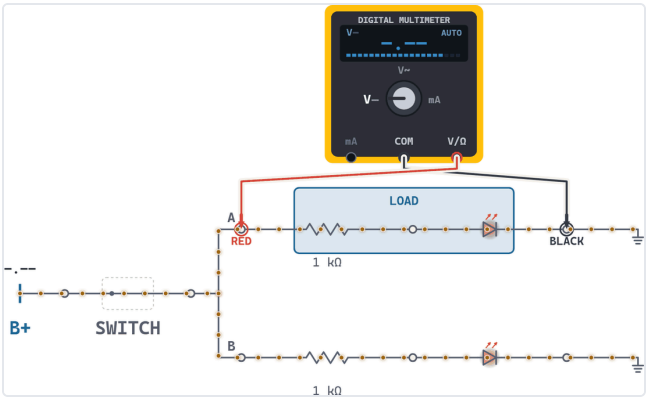
15 pts

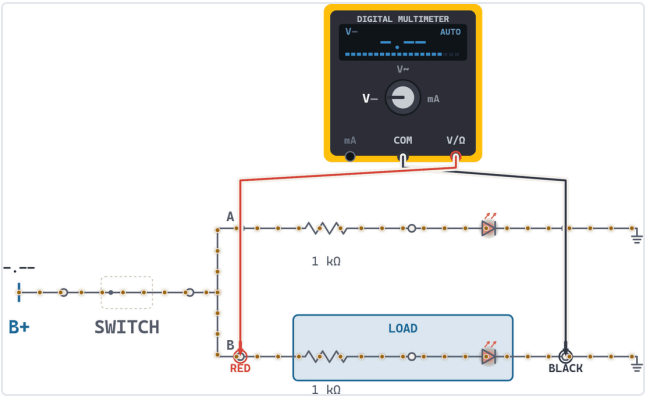
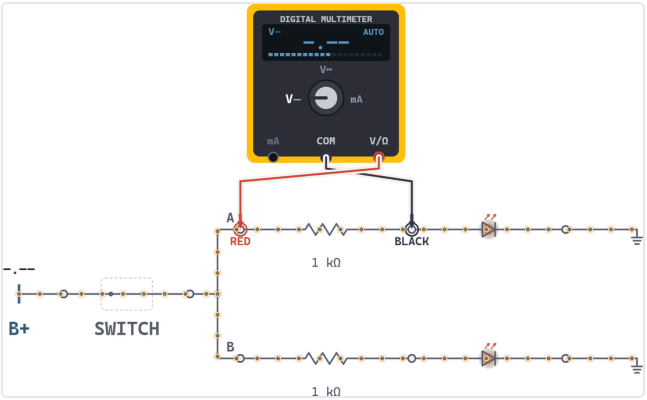
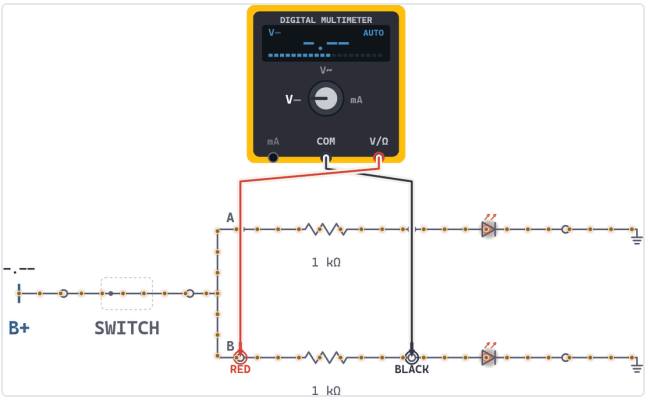
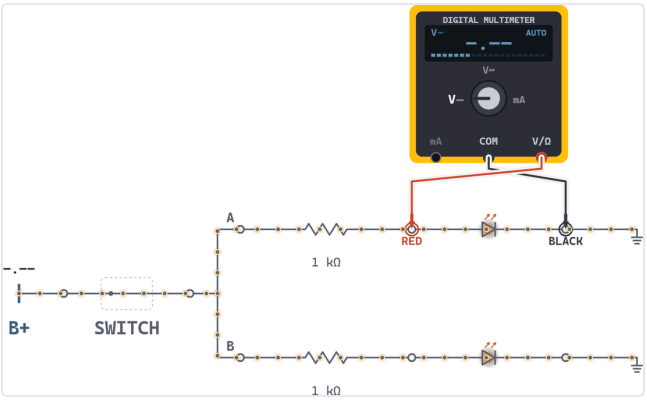
In the simulator: Functional Schematic and Where The Leads Go

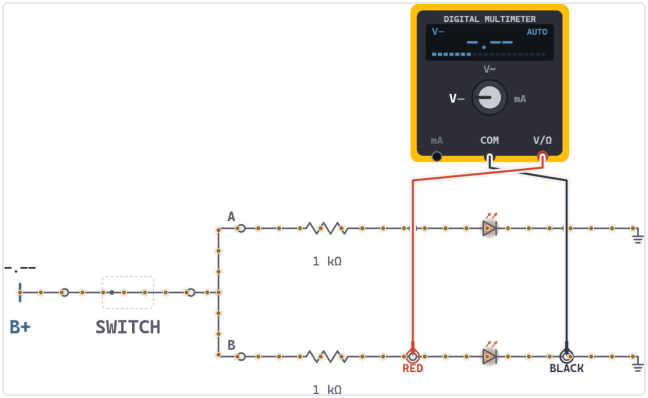
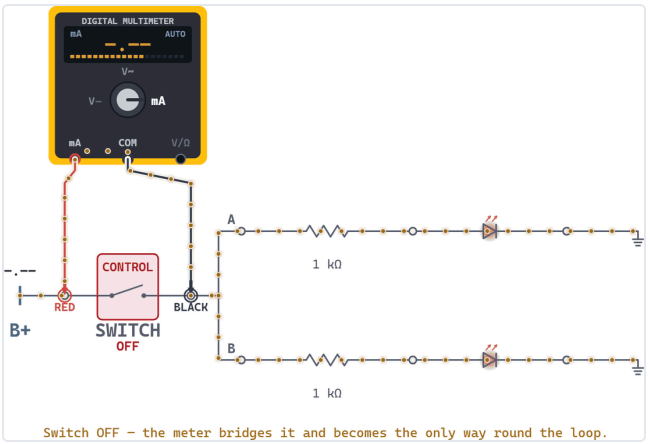
B+ → SWITCH → two branches, each a RESISTOR and an LED → GND. Two separate paths from the same supply. Use the third circuit in the simulator.

Supply **5.00 V** · two branches, each **1 kΩ** and one red LED.

1. Take all eight readings. Compare branch A with branch B as you go. (8 pts)

READING	WHERE THE LEADS GO	MEASURED	
Source	 B+ test point ↔ GND		V
Across switch	 B+ test point ↔ after switch		V
Load A	 branch A in ↔ branch A GND		V

READING	WHERE THE LEADS GO	MEASURED	
Load B	 branch B in ↔ branch B GND		V
R drop A	 before R ↔ after R		V
R drop B	 before R ↔ after R		V
LED drop A	 LED + ↔ LED –		V

READING	WHERE THE LEADS GO	MEASURED	
LED drop B	 LED + ↔ LED –		V
Total current	 switch OFF, meter bridges it		mA

2. You cannot get an ammeter into a single branch on this board, so use the resistor drops instead. Work out each branch current with Ohm's law, then add them, and check the total against your Total current reading. (3 pts)

Use the resistor drop you measured in each branch, against that branch's own 1 kΩ resistor.

BRANCH A _____ **mA**

BRANCH B _____ **mA**

A + B _____ **mA**

3. Finish the two rules for a parallel circuit. (2 pts)

Voltage across every branch is _____ . Current _____ between the branches.

4. Work out the total resistance of the whole circuit from your own readings: R_T = source voltage ÷ total current = ___ . Is that more or less than one branch on its own? (2 pts)

_____ **Ω**

D Continuity — is there a path at all?

11 pts

In the simulator: Continuity

You have just spent three circuits reading volts and amps off a live board. The rest of this worksheet is the other half of a meter's job — what it can tell you with the power off. It starts with one question: can I get from this lead to that one? Step down the list in the simulator and watch what happens to the reading, the dots and the verdict.

1. Put the leads across each of these in turn. Record the reading, then say whether there is a path. (4 pts)

LEADS ACROSS	READING	IS THERE A PATH? (Y / N)
Just wire no part in the way at all		
1 Ω		
10 Ω		
100 Ω		

2. Now press **Cut it**. What appears on the display? (1 pt)

_____

3. What is the meter telling you when it shows OL? (1 pt)

- ◯ **A.** The resistance is very, very high but the meter can still see it
- ◯ **B.** There is no complete path between the two leads
- ◯ **C.** The resistance is zero
- ◯ **D.** The meter's battery is flat

4. Finish the rule. (2 pts)

A sound path measures _____ resistance. A broken path measures _____ .

5. You expect a plain wire between two points and your meter reads 100 Ω. Is there continuity? Is the circuit good? Explain the difference between those two questions. (3 pts)

E Where the ohmmeter's current comes from

11 pts

In the simulator: The Meter's Own Voltage and The Meter's Own Current

An ohmmeter does not sense resistance. It pushes its own current through the part, measures the voltage that current makes, and divides one by the other. These two panels let you measure both halves of that for yourself. Needs three meters to do fully on the bench — do what you can and read the rest off the simulator.

1. Set meter 1 to ohms and meter 2 to volts, and put both sets of leads on the **same two points**. What does meter 2 read? (1 pt)

_____ V

2. Nothing on the board is powered. So where is that voltage coming from? (2 pts)

_____

3. Break a third meter into the path, set to mA. What current is the ohmmeter sending? (1 pt)

_____ mA

4. Divide your E1 reading by your E3 reading: volts ÷ amps = ___ . On the lines below, say how that compares with what meter 1 is showing. (2 pts)

Watch the units — milliamps have to become amps before you divide.

_____ Ω

5. Finish the rule for hooking up each meter. (2 pts)

An ammeter goes _____ the circuit. A voltmeter goes _____ the circuit.

6. Using what you just measured, explain why the power must be off before you measure resistance. (3 pts)

F Measuring resistance — working the instrument

11 pts

In the simulator: Measuring Resistance

Six known values sit along the bottom edge of the board, each on its own pads with nothing else wired to it. The answer is printed beside the part, so what you are really checking here is the meter and your own technique.

1. Measure each value on the reference ladder and write down exactly what the display shows, including the units it chose. (6 pts)

PRINTED BESIDE THE PART	WHAT YOUR METER SHOWS
100 mΩ	
1 Ω	
100 Ω	
1 kΩ	
10 kΩ	
10 MΩ	

2. One of those six is the one your hand-held meter cannot really read. Which, and why? (1 pt)

- ◯ **A.** 10 MΩ — it is past the top of the meter's range
- ◯ **B.** 100 mΩ — the lowest ohms range steps in tenths, and the test leads add about as much again
- ◯ **C.** 1 kΩ — the meter has to change range to reach it
- ◯ **D.** 100 Ω — it is between two ranges

3. Why is there nothing to switch off before measuring any of these six? (1 pt)

_____

4. A circuit on a vehicle is never like that. What two things do you have to do before an ohms reading on a real circuit means anything? (3 pts)

_____

_____

_____

G Total resistance — predict it, then measure it

11 pts

In the simulator: Total Resistance

Two 100 Ω resistors, wired two ways. Work out each total on paper before you put the leads on it. A reading that disagrees with the arithmetic is how you find out a circuit is not wired the way you thought.

Both resistors are **100 Ω**.

1. **Series pair.** Work out the total: $R_T = R_1 + R_2 =$ ___ (2 pts)

_____ Ω

2. Now put the leads across the series pair. What does the meter read? (1 pt)

_____ Ω

3. **Parallel pair.** Work out the total: $R_T = (R_1 \times R_2) \div (R_1 + R_2) =$ ___ (2 pts)

Show your working on the lines. With two equal resistors there is a shortcut — see if you can spot it.

_____ Ω

4. Put the leads across the parallel pair. What does the meter read? (1 pt)

_____ Ω

5. Leave the leads where they are and press **Break the circuit** to open one branch of the parallel pair. What does the meter read now? (1 pt)

_____ Ω

6. That broken parallel pair still reads a healthy 100 Ω, and a continuity check would pass it. Explain what has actually failed, and what that tells you about trusting a continuity check. (3 pts)

7. Finish the rule. (1 pt)

The total resistance of a parallel network is always _____ than the smallest single branch in it.

H Putting the three together

8 pts

Look back at the readings you wrote down in Parts A, B and C — the same 5 V supply and the same 1 kΩ resistors in all three. Fill this in from what you actually measured, not from memory.

1. Summarise what you measured. (3 pts)

CIRCUIT	LEDS LIT	CURRENT DRAWN FROM THE SUPPLY	VOLTS ACROSS ONE RESISTOR
Simple			
Series			
Parallel			

2. Look at your two totals. Series wiring lit two LEDs on the current you recorded in Part B; parallel wiring lit the same two on more than four times that. So why is almost everything on a vehicle wired in parallel anyway? (3 pts)

3. Name one thing the simulator showed you that the board could not, and one thing the board showed you that the simulator could not. (2 pts)