

A Teacher's Guide to Hidden Current Electricity Misconceptions

Why marks can hide shaky understanding — and what class-level misconception heatmaps reveal across current, potential difference, series and parallel networks, sources, resistance and power

For physics teachers and department leads

A field guide to persistent misconceptions in direct-current circuits — from the current a bulb is thought to use up, through series and parallel read off the shape of the drawing, to the cell mistaken for a current supply and the rating taken as what a bulb always dissipates — that survive conventional teaching and hide behind good test scores. Includes example diagnostic output and details on how to run a free classroom pilot using the Current Electricity diagnostic.

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Why Marks Can Hide Shaky Understanding

A student scores 75% on a circuits test. They can add resistors in series and in parallel, use $I = \Delta V/R$ without prompting, and get the right number for the current through a bulb. Their mark says they understand circuits.

Ask a different kind of question — one that tests the picture behind the calculation rather than the calculation itself — and it often comes apart. Put an ammeter either side of a bulb and ask what the two will read. Draw the same circuit twice, in two different shapes, and ask whether they are the same circuit. Add a resistor part way round and ask what changes. Put a sixty-watt and a hundred-watt bulb in series and ask which is brighter.

These are not trick questions. Each one has a documented wrong answer that students give in numbers, and each wrong answer follows from a belief that the calculation never tested: that a component consumes current, that series and parallel are read off the drawing, that an effect travels with the current, that a rating is what a bulb always dissipates. A student can hold any of these and still score well, because the standard question type does not go near them.

They matter later. The belief that current is used up survives into potential dividers and internal resistance and quietly wrecks both. Reading arrangement off the picture defeats a student the first time a network is drawn unfamiliarly, however well they can recite the definition of parallel. And treating a cell as a current supply makes every prediction about changing a load come out wrong in the same direction, which looks like carelessness and is not.

The diagnostic is built to find those beliefs. Twenty-four questions, about twenty-seven minutes. On each question the wrong answers that carry a reasoning difficulty are ones the research records students actually giving, not invented alternatives; the rest are there to make the question work. What comes back is not a mark. It is a set of named difficulties the class's answers point to, and what to do about them on Monday.

Five Current Electricity Misconceptions Worth Tracking

These are five persistent and instructionally important conceptual errors in direct-current circuits, documented across decades of published research. Each survives conventional teaching and produces correct answers often enough to stay hidden. The tag on each trap is the misconception band that tracks it. The diagnostic reports twelve; these five are the ones teachers most often tell us they had not seen coming.

Trap 1: The Bulb Uses the Current Up CUR-1

Charge is conserved: the current leaving a component equals the current entering it, and what the component takes from the circuit is energy. Students say the bulb spends some of the current, or that every component takes a little, and the belief is reasonable — something visibly is being used up. It attaches to the wrong quantity. Correcting it by insisting that nothing is used up makes matters worse, because something is; the distinction to draw is *what*. This is the load-bearing idea in the topic: almost every later argument about a network rests on it.

Trap 2: Series and Parallel Are Read Off the Drawing NET-1

Two components are in parallel when both ends join the same two points, however the wires are routed to get there. Students classify from the shape of the picture instead: components drawn end to end are called series, an unfamiliar arrangement is called neither, and a circuit redrawn without changing a single connection is called a different circuit. A student can recite the definition correctly and still fail to see the connection in a drawing they have not met before — which is exactly what the diagnostic separates.

Trap 3: The Cell Supplies a Fixed Current BAT-1

A source holds a potential difference across whatever is connected to it — exactly so for an ideal source, and closely enough for a fresh cell driving a modest current — and the circuit then decides how much current flows. Students treat the cell as a current supply — it has a number printed on it, after all — so halving the resistance is expected to change nothing. Every prediction about changing a load then comes out wrong in the same direction, which reads as carelessness and is not.

Trap 4: An Effect Travels With the Current NET-5

A circuit is one system: insert a resistor part way round and the whole thing is solved again, so a change can affect any part of it, including parts the current reaches first. Students expect only what lies after the insertion to change, because current is pictured as travelling and influence is expected to travel with it. Some quantities may genuinely not move, and that is a result of solving rather than a rule about direction.

Trap 5: The Rating Is What the Bulb Always Does PWR-1

A rating states what a component dissipates at its rated operating point, not what it dissipates wherever it is put. Take two bulbs rated at the same mains voltage, sixty watts and a hundred watts, and put them in series: the same current passes through both, so the one with the greater resistance — the sixty-watt bulb — is the brighter. Filament resistance climbs with temperature, so treat it as a direction of change rather than a calculation. The result is a surprise to most classes, which is what makes it a useful five minutes.

Example Heatmap Using Simulated Data

Illustrative data (n = 26)

Simulated dataset, shown to illustrate the output format and the kinds of pattern a diagnostic can reveal. Informed by documented misconception patterns in the research literature. Not drawn from a classroom or pilot cohort.

Mean: 13.0/24 (54%) Group sizes: A 5, B 6, C 7, D 8 All percentages rounded to whole numbers

This heatmap shows the **Current Electricity** diagnostic: 24 questions across 16 reasoning difficulties, twelve of which are reported at class level. Columns group students by total score. Rows marked * are asked and scored, but carry no class-level statement, because the evidence behind them does not support one.

Q#	Concept Tested	Overall	A (20-24)	B (15-19)	C (10-14)	D (0-9)	Band
Q01	Changing the source	85%	100%	100%	86%	62%	BAT-1
Q02	A resistor inserted partway along	35%	80%	50%	14%	12%	NET-5
Q03	A resistor above a dividing junction	50%	100%	83%	29%	12%	NET-1
Q04	Two rated bulbs in series	27%	60%	33%	29%	0%	PWR-1
Q05	Two drawings of one circuit	54%	100%	67%	29%	38%	NET-1
Q06	Changing the load	54%	80%	83%	14%	50%	BAT-1
Q07	Three bulbs in series, terminals marked	42%	60%	50%	71%	0%	CUR-1
Q08	A fixed power delivered at two voltages	38%	80%	67%	14%	12%	RES-2
Q09	A wire across a resistor	50%	80%	83%	43%	12%	NET-2
Q10	Two choices of reference	58%	80%	100%	71%	0%	POT-1
Q11	Four quantities in one situation	46%	80%	83%	29%	12%	QTY-1*
Q12	Inside a calculation	42%	60%	33%	43%	38%	POT-2
Q13	Two resistors in an unusual drawing	58%	80%	83%	86%	0%	NET-1
Q14	A real cell under increasing load	88%	80%	100%	100%	75%	BAT-3*
Q15	A wire and an electrolyte	54%	100%	67%	57%	12%	CUR-4
Q16	Conventional current with known drift	96%	100%	100%	100%	88%	DIR-1*
Q17	"Electricity has been used up"	46%	80%	83%	14%	25%	CUR-1
Q18	Adding a third parallel resistor	38%	80%	50%	14%	25%	NET-3
Q19	Current at two points either side of a bulb	50%	100%	50%	43%	25%	CUR-1
Q20	What drives what	31%	60%	33%	43%	0%	POT-2
Q21	Closing a switch that adds a third bulb	54%	100%	83%	29%	25%	NET-5
Q22	A filament cold and hot	88%	100%	100%	100%	62%	RES-1*
Q23	Potential difference across a gap	88%	100%	100%	100%	62%	NET-4
Q24	The same gap, with the reason	27%	60%	17%	29%	12%	NET-4

% correct under 20 20-49 50-69 70-89 90-100

Reading it: the first column is the share of the answers actually given to that question that were right — blanks are left out of it. The four to its right split that by how the students did overall. A question the strongest group also gets wrong is a different problem from one only the weakest group misses, and that split is usually where the useful information is.

What Teachers Receive from a Classroom Pilot

Within 48 hours of your class completing the diagnostic, a complete misconception analysis is delivered to your inbox. The Current Electricity diagnostic produces a self-contained set of materials:

Class-level misconception heatmap

Performance by question and by student performance band (A–D), with each question tagged to the reasoning difficulty it tests. It is an aggregate: one row per question, none per learner. Scored against the 24-question total.

Cohort summary

Two pages. What to do about it, then what the data shows. Each reported difficulty is given with its correctness figure, the counts behind it, and whether it is flagged — along with the share that guessing alone would produce, so nothing is read as more than it is. Written for a head of department to act on without re-deriving anything.

Mistake Museum

Thirteen exhibits. Each states a trap in a student's own voice, says why the wrong answer tempts, and gives the correction in one line. As useful in front of a class as in preparation: a trap named out loud is easier to argue with than one that stays unspoken.

Words That Hurt

Thirteen phrases that are easy to say and teach the wrong thing, each with a replacement that is no longer, only more careful about the one word doing the damage. Most are said in good faith, as shorthand, in every classroom.

Remediation worksheet and teacher key

Thirteen sections, each assignable on its own, each asking the student to predict before calculating. The key gives the answers, what the wrong answer reveals, and a five-minute classroom move to open each one — an ammeter either side of a bulb, a bulb unscrewed with a voltmeter across the gap.

Everything is class-level, apart from one short list. The cohort summary names two to five students for you to look at — the ones whose answers sit under the gaps the class has — because that is the part of the report a teacher acts on first. Nothing else names, ranks or describes an individual, no per-student report is produced, and nothing identifying a student leaves your school.

How to Run a Pilot

Step 1. Request a pilot.

Visit fundafirsths.com or email admin@fundafirsths.com. If your class is partway through — or just past — a circuits unit and you want to find out where understanding has actually settled, this is the right instrument; if you are earlier in the sequence, we will recommend the right starting point.

Step 2. We send the diagnostic link.

You receive a class-specific link and a short setup message you can paste directly to your students. No student accounts, no logins, no software installs needed. The form asks for a name or student ID. Names are optional — anonymised IDs work as well — and what is typed there is used for two things: chasing non-submissions, and the short students-to-watch list on page one of the summary.

Step 3. Students complete the diagnostic.

Share the link with your class. The Current Electricity diagnostic takes about 27 minutes (24 questions) and is best done in class. A calculator is not required; the arithmetic is deliberately light.

Step 4. You receive the full analysis.

We generate your class heatmap, cohort summary, priority reasoning difficulties, and remediation toolkit, and email everything to you — typically within 48 hours of class completion.

There is no charge for the classroom pilot. No payment information is collected. No subscription is created. No ongoing commitment.

The Current Electricity diagnostic covers the steady-current content taught in IB DP Physics (electric cells, current, potential difference, resistance and electrical power), AP Physics 1 and 2 (DC circuits, resistance and Kirchhoff's rules), AP Physics C: Electricity and Magnetism (DC circuits and internal resistance), A-Level & AS Physics (current of charge, e.m.f. and internal resistance, resistivity, and D.C. circuits), and IGCSE Physics (electric circuits, current, voltage, resistance and electrical energy). **One diagnostic — 24 questions across 16 reasoning difficulties** — twelve of which are reported at class level, the remaining four scored but held back where the evidence does not support a class-level statement.

The Static Electricity diagnostic covers the electrostatics that precedes this topic; Motion (two diagnostics), Newton's Laws (six modules), Projectile & Circular Motion, Energy, Momentum, and Oscillations & Waves diagnostics are also available — together they cover the kinematics–forces–momentum–energy–waves–electromagnetism arc.

Request a classroom pilot

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