Parallel circuits: current splitting and energy per charge

Student activity • investigation and reasoning

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The question

How are current and voltage distributed between parallel branches?

Measure a two-branch resistor circuit and connect voltage with energy transferred per unit charge.

Equipment

- 0–3 V current-limited source, switch, ammeter, voltmeter and leads
- 100 Ω and 220 Ω resistors, each ≥0.5 W

Disconnect before moving the ammeter or opening a branch. Keep source at or below 3.0 V with a 0.06 A current limit. An ammeter must be inserted in series with the measured path, never directly across the source.

Course coverage: Shared Physics / Double Award: 2.1, 2.7, 2.17, 2.18, 2.20, 2.21. Parallel circuits and E = QV.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. With the source disconnected, build two parallel branches, one containing 100 Ω and the other 220 Ω, each rated at least 0.5 W. Include a main switch and ask staff to check the wiring.

2. Use a source at or below 3.0 V with a 0.06 A current limit. Measure the voltage across each branch and across the source.

3. Disconnect before inserting the ammeter in the main path, then in each branch in turn. Reconnect only after checking; record actual current at each location.

4. Compare total current with the sum of branch currents. Record source voltage again to check for drift between the separate measurements.

5. Open one branch with the source disconnected, then observe that the other branch still conducts after reconnection. Explain why this is useful for independently controlled loads.

6. Use the original practice example: 5.0 C passes through a 3.0 V component. Calculate energy with E = QV and explain the meaning of one volt.

Cleanup

- Switch off and disconnect all circuits before returning components.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Voltage is energy transferred per unit charge: 1 V = 1 J C^{-1}. Parallel branch voltages are equal when connected across the same two points. At a junction, steady incoming current equals total outgoing current. Practice energy: 5.0 C at 3.0 V gives 15 J.

Location	Voltage / V	Current / A
Source / main path		
100 Ω branch		
220 Ω branch		
Sum of branch currents	—	

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. How do parallel branch voltages compare?

2. How do branch currents combine?

3. Must unequal branch resistors carry equal currents?

4. What is one volt?

5. Calculate the practice energy.

6. Why check source voltage during sequential measurements?