Charge and current: measuring a steady flow

Student activity • investigation and reasoning

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The question

How much charge passes a point in a circuit during a measured time?

Measure current in a simple low-voltage lamp circuit and calculate charge using the measured interval.

Equipment

- Matched low-voltage battery and lamp, switch, ammeter and insulated leads
- Timer; staff prepared LED and series resistor circuit

Use only the staff-matched low-voltage battery circuit. Never connect an ammeter directly across the battery. Disconnect before moving leads; prevent short circuits and stop if components warm. No mains or high-voltage generator is used.

Course coverage: Shared Physics / Double Award: 2.12, 2.14–2.16. Current, charge and Q = It.

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. Work in ten groups of three. With the battery disconnected, build one series loop containing a staff-matched battery, switch, lamp and ammeter. Ask staff to check the circuit before closing the switch.

2. Choose the meter range and polarity specified by staff. Close the switch briefly and record the steady current with its unit; open it if anything becomes warm or behaves unexpectedly.

3. Run the checked circuit for 10 s and record the current near the start and end. Calculate Q = It using a representative steady current and label it an estimate if the current changes.

4. Repeat for 20 s and 30 s, opening the switch between runs. Compare charge with elapsed time rather than assuming charge is used up in the lamp.

5. With the battery disconnected, move the ammeter to another position in the same series loop. Reconnect only after checking; compare the steady readings.

6. Distinguish conventional current direction from electron motion in the metal wires. Observe a staff-prepared LED circuit with a correctly rated series resistor as a second current indicator.

Cleanup

- Open switches, disconnect batteries and return meters and lamps after cooling.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Current is charge flow per unit time: 1 A = 1 C s^{-1}. Q = It assumes constant current, or an appropriate average current. Practice example only: 0.20 A for 30 s corresponds to 6.0 C. Electrons already present in the circuit move; they are not consumed in the lamp.

Time / s	Current start / A	Current end / A	Estimated Q / C
10			
20			
30			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What does current measure?

2. Find charge for 0.20 A over 30 s.

3. What happens to Q if time doubles at fixed current?

4. Where is the ammeter connected?

5. How do electron and conventional-current directions compare?

6. Why must the LED have an appropriate series resistor?