Circuit Theater: Embodied learning for simple circuits

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Goals of Circuit Theater

- Develop a physical picture of current flow in circuits
- Relate voltage to energy
- Differentiate parallel and series connections
- Motivate power as P = IV

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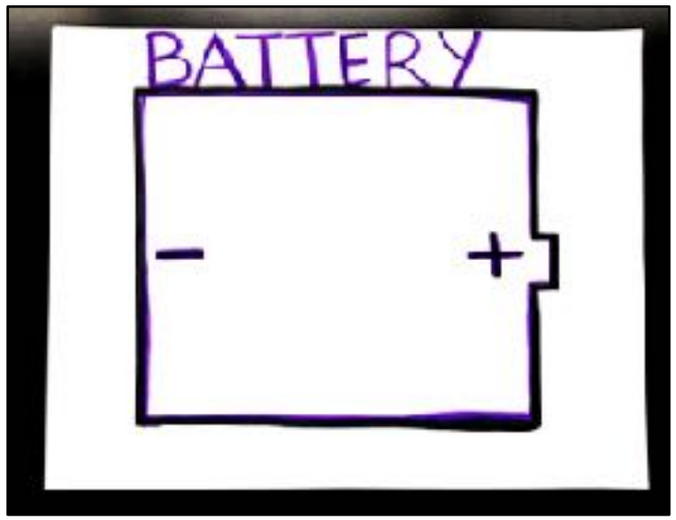
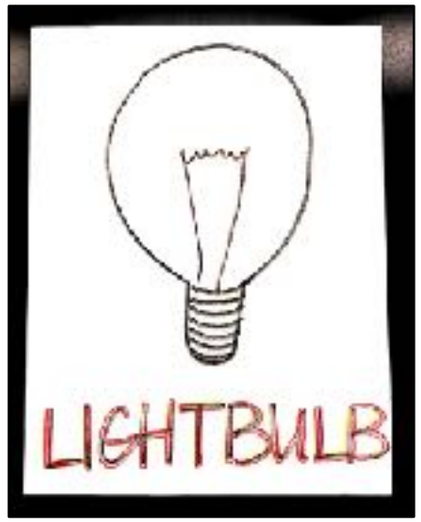
Components of Circuit Theater

Batteries



Light Bulbs



Energy

Charges

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Rules of Circuit Theater

1. The battery voltage tells you how many beans of energy to pick up each time you pass through the battery.

2. The speed at which a charge moves through a light bulb is determined by how much energy the charge transfers to the light bulb.

3. Charges cannot bunch together anywhere in the circuit.

4. Charges must use up all of their energy during each trip around the circuit.

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Basic Circuits

- One battery and one bulb - Demo

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Basic Circuits

- One battery and one bulb - Demo
- One battery and two bulbs in series
- One battery and two bulbs in parallel
- Two batteries in series with one bulb
- Two batteries in parallel with one bulb

Energy transferred to each bulb?

Speed of charges?

Bulb brightness?

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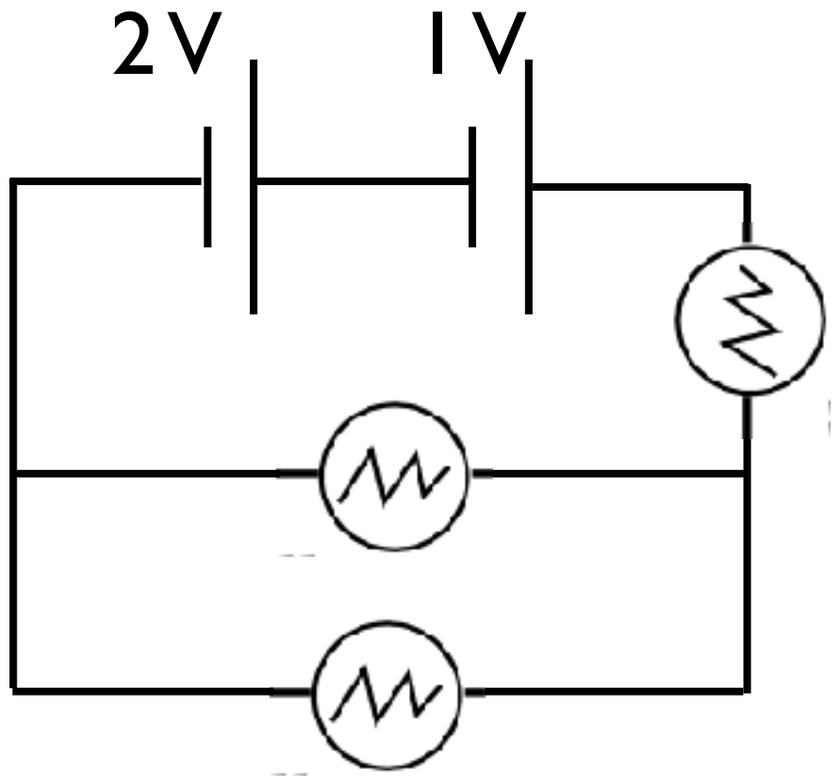
Challenge Circuit



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Circuit Theater Supports:

- Conceptual understanding
- Mechanistic reasoning & deep questions
- Mental models

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Circuit Theater Ignores:

- Thermal motion
- Distinguishing energy flow vs. matter flow
- Surface charges

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Food for thought:

Sherwood & Chabay, *A unified treatment of electrostatics and circuits*, white paper, 1999.

Galili & Goihbarg, *Energy transfer in electrical circuits: A qualitative account*, Am. J. Phys. **73**, 141, 2005.

Atkins et al., Animating energy: *Stop-motion animation and energy tracking representations*, The Phys. Teach. **52**, 152, 2014.

Daane, Wells, & Scherr, *Energy Theater*, The Phys. Teach. **52**, 291, 2014.

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