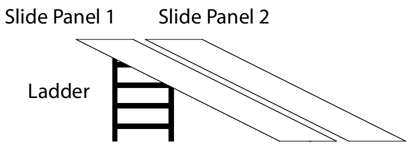
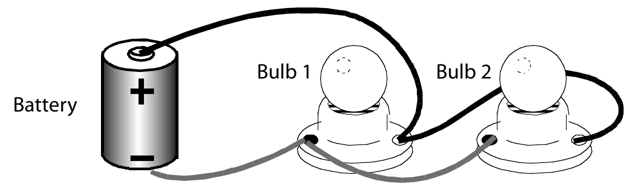
PhyzGuide: Parallel Circuits

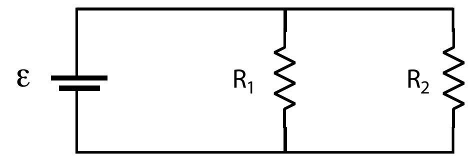
TWO EQUAL RESISTORS IN PARALLEL

SLIDER CIRCUIT



ELECTRIC CIRCUIT





CONFIGURATION • One ladder, two equal slide panels—side by side (in *parallel*).

ELEVATION • The elevation is "provided" by the ladder. This is the same ladder as in the **"Simple Circuit"** guide.

RUN LENGTH • The run length is the slide's horizontal distance. Each individual slide panel has the same run length as that in the original **simple circuit**. But notice that having two panels side by side makes a slide that would be the same as one made with a single slide panel that was able to handle twice the flow. A slide panel that could handle twice the flow (without being twice as wide) is one that is twice as steep. A slide panel that is twice as steep is one that has half the run length.

FLOW RATE • Flow rate of the circuit is determined by the relation: $I = \varepsilon/R_{EQ}$ (incline = elevation / equivalent run length). Since we have the same elevation and half the run length of the **simple circuit**, the flow is twice of what the **simple circuit** flow is.

BUN-BURNING • The bun-burning factor is determined by $BB = I\varepsilon$ (bun-burning = flow rate x drop distance; drop distance is equal to elevation). Since the flow rate is twice of what it was in the **simple circuit**, the bun-burning ability of this slide is twice that of the **simple circuit**.

NOTICE • Once each rider is at the high elevation, he or she has a choice to go down panel 1 or panel 2. A rider cannot go down both panels on one trip down.

Also, each rider drops through the full elevation as he or she traverses either slide panel. In other words, the rider loses all of his or her potential energy while sliding down either panel.

CONFIGURATION • One battery, two equal light bulbs—side by side (in *parallel*).

EMF • Electric potential (voltage) is provided by the battery. This is the same battery as in the **"Simple Circuit"** guide.

RESISTANCE • Resistance is due to the devices in the circuit—in this case the light bulbs. Each individual bulb has the same resistance as that in the original **simple circuit**. But notice that having two bulbs side by side makes a circuit that would be the same as one made with a single bulb that allows twice the current for the same voltage. A bulb that allows twice the current for the same voltage is one that has half the resistance.

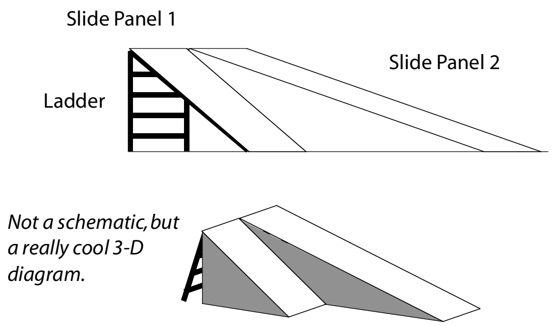
CURRENT • Current in the circuit is determined by the relation: $I = \varepsilon/R_{EQ}$ (current = emf / equivalent resistance). Since we have the same emf and half the resistance of the **simple circuit**, the current is twice of what the **simple circuit** current is.

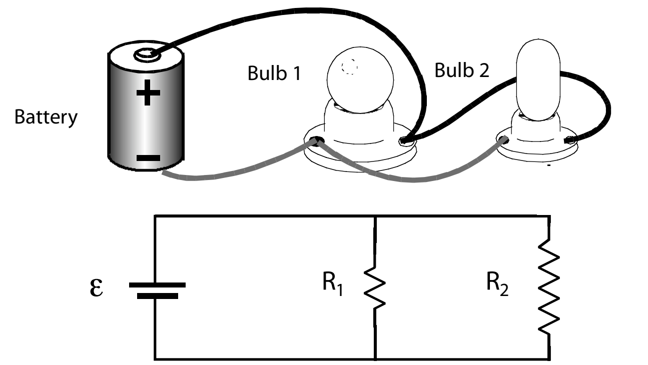
POWER • Power dissipation in the circuit is determined by $P = I\varepsilon$ (power = current x voltage drop across the resistor; voltage drop in this case is equal to the battery's emf). Since the current is twice of what it used to be, the power delivered in this circuit is twice the power output in the **simple circuit**.

NOTICE • Charge at the high potential can pass through either bulb 1 or bulb 2. Charge cannot go through both bulbs on one journey from the + to – terminal of the battery.

Also, each bit of charge drops through the full potential as it passes through either bulb. In other words, the charge loses all of its potential energy while passing through either bulb.

TWO UNEQUAL RESISTORS IN PARALLEL





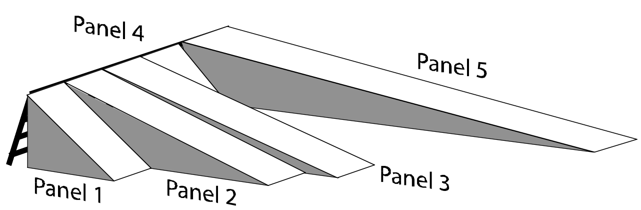
CONFIGURATION - Two unequal panels in parallel.

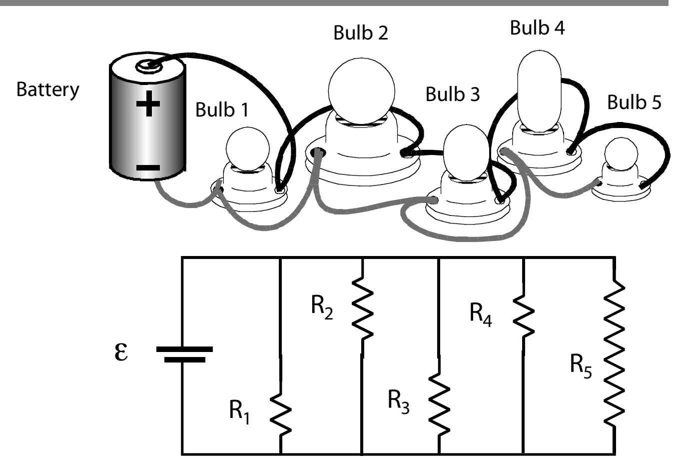
NOTICE - The flow rate is greater than if the slide consisted of either panel individually. The flow rate will be greater on the shorter (smaller run-length) panel since riders travel faster along it.
• Riders lose all of their potential energy as they traverse either panel.
• More bun-burning occurs on the shorter (smaller run-length) panel because there are more riders flowing down it per second; all riders lose the same potential energy regardless of which panel they slide down.

CONFIGURATION - Two unequal bulbs in parallel.

NOTICE - The current is greater than if the circuit consisted of either bulb individually. The current will be greater through the low-resistance bulb.
• Moving charge loses all its potential energy as it traverses either bulb.
• More power is dissipated in the low-resistance bulb because there is a higher current passing through it; all charge loses the same potential energy regardless of which bulb it passes through.

MANY RESISTORS IN PARALLEL





CONFIGURATION • Several panels connected in parallel.

NOTICE • As more slide panels are added, the flow rate increases (since more slide paths are opened up). The flow rate along the short run-length panels will be high; flow rate on long run-length panels will be low. The total flow rate is the sum of all the individual flow rates.
• Riders lose all their potential energy as they traverse any single panel.
• The overall bun-burning ability of the slide system increases as more panels are added since the elevation drop is the same along all panels and the total flow increases (recall that $BB = I\mathcal{E}$).

CONFIGURATION • Several bulbs connected in parallel.

NOTICE • As more bulbs are added, the current increases (since more current paths are opened up). The current through the low-resistance bulbs will be high; current through the high-resistance bulbs will be low. The total current is the sum of all the individual currents
• Moving charge loses all its potential energy as it passes through any single bulb.
• The overall power dissipation in the circuit increases as more bulbs are added since the voltage drop is the same across any bulb and the total current increases (recall that $P = I\mathcal{E}$).