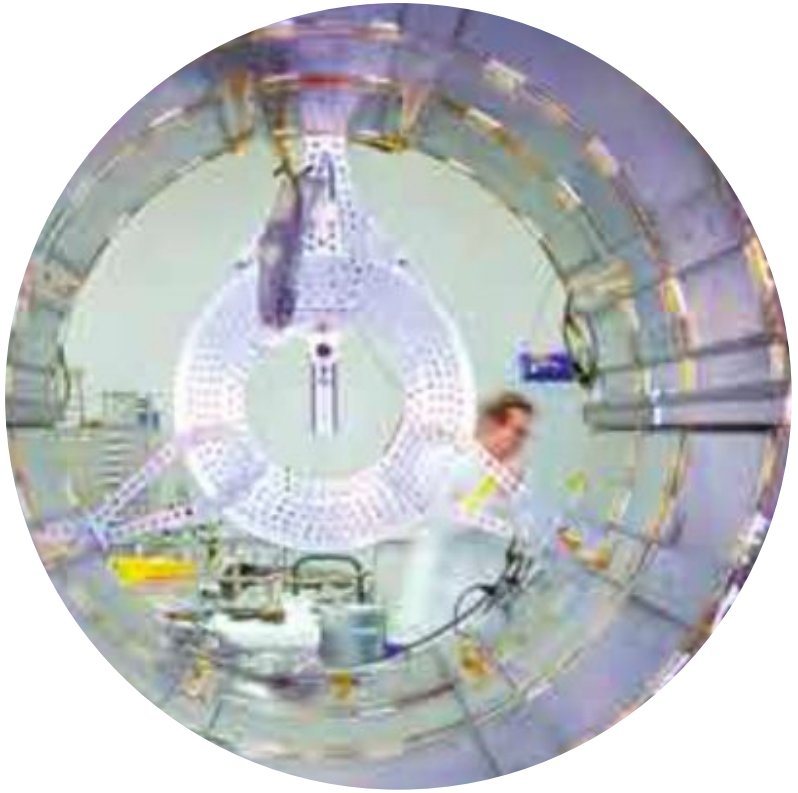
Topic 3.4: How are circuits used in practical applications?

- Voltage, current, and resistance in a circuit are related by Ohm's law.
- Loads can be connected in series or in parallel in a circuit.
- Parallel loads are practical for circuits in the home.



Concept 1: Voltage, current, and resistance in a circuit are related by Ohm's law.

Ohm's Law

The electrical potential difference between two points in a circuit is equal to the current times the resistance between those two points.

$$V = IR$$

V: electrical potential difference (voltage) in volts (V)

I: current in amperes (A)

R: resistance in ohms (Ω)

Using Ohm's Law

You can rearrange the variables in Ohm's law to calculate any of the other variables if you know the value of the other two.

$$V = IR$$

- To find resistance: $R = V/I$
- To find current: $I = V/R$

Using Ohm's Law: Sample Problem

The filament of a light bulb has a resistance of 20 Ω. A 5.0 V battery is used in the circuit. What is the current?

1) Rearrange Ohm's law ($V = IR$) into the formula to find current (I).

$$V = IR$$
$$I = V/R$$

2) Substitute the values for R and V into the formula:

$$I = 5.0 \text{ V} / 20 \ \Omega$$
$$\text{I} = 0.25 \text{ A}$$

The current is 0.25 A.

Discussion Questions

1. List the three symbols used in Ohm's law. Explain what each symbol represents and give the units for each of the variables.

Concept 2: Loads can be connected in series or in parallel in a circuit.

There are two main types of circuits:

- **Series circuit**: A circuit in which current can only flow along one path
- **Parallel circuit**: A circuit that has at least one branch point where the current splits into two or more pathways

Series Circuit: One Pathway

Series circuit: A circuit in which current can only flow along one path

Example: Figure 3.24

- All of the circuit components are connected in series
- Three light bulbs (loads) are connected in series
- There is only one path in which the current can flow through the battery, switch, and loads

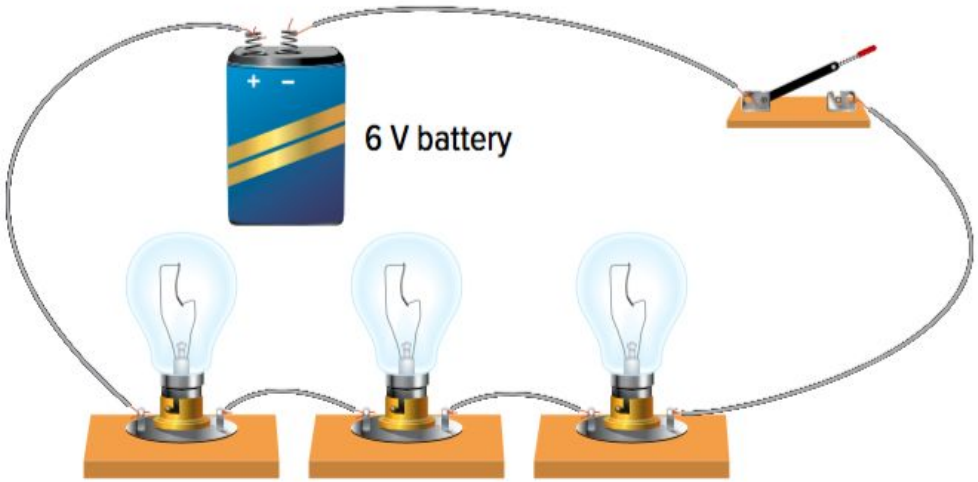


Figure 3.24

Parallel Circuit: Multiple Pathways

Parallel circuit: A circuit that has at least one branch point where the current splits into two or more pathways

Example: Figure 3.25

- The light bulbs (loads) are connected in parallel
- The battery and switch are connected in series
- At the branch point, the current splits into two pathways (the sum of the currents in the branches is the same as the current in the single conductor before the branch point)

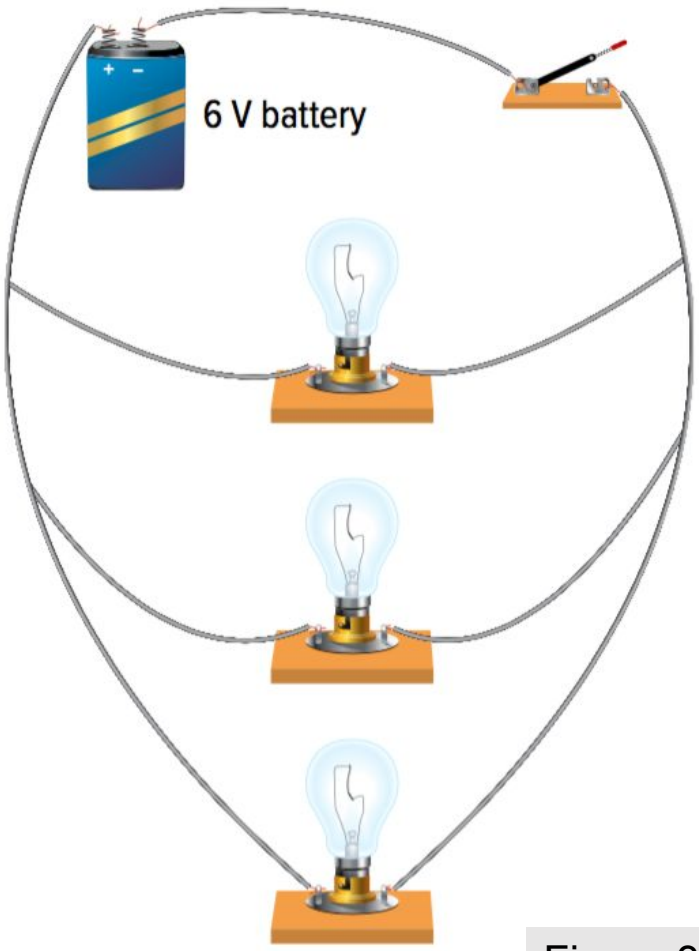


Figure 3.25

Comparison: Series Circuit and Parallel Circuit

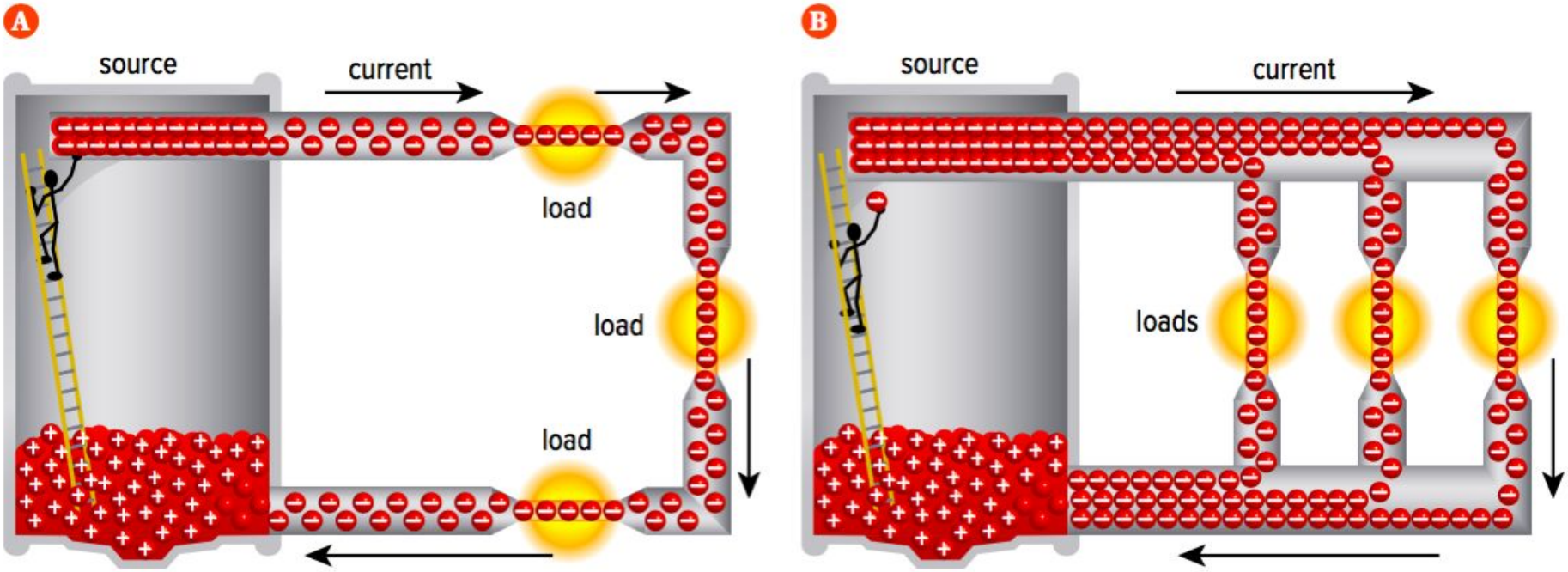


Figure 3.26

A) Series circuit: One pathway for current to flow; current is equal in all parts of the circuit

B) Parallel circuit: Current splits into three paths; current is reduced in each path

Loads

Series:

- Each time you add a load, they all get dimmer (less energy –shared)
- If one load burns out, all the rest go out (the circuit is broken/open)

Parallel

- When loads are added, brightness doesn't change (voltage is constant)
- If one load burns out, the others are unaffected

Sources

Series:

- Each time you add sources, voltage increases

Parallel

- When sources are added, volts stay constant, the sources last longer

Discussion Questions

1. Use the analogy of two different roads or rivers to compare a series and parallel circuit.

Concept 3: Parallel loads are practical for circuits in the home.

Series circuits are impractical for homes.

Example: Loads connected in series in a kitchen

If one load (ceiling lamp) burns out:

- The circuit will be open
- Charges stop moving
- No other loads (microwave, toaster) in the circuit will work

Parallel Loads: Household Circuits

Parallel circuits are practical because each appliance is controlled by its own switch without shutting off others.

Example: Figure 3.27

A) All of the appliances are running. A large amount of current is passing through the conductor wire (arrow).

When large amounts of current flow through a wire, it can overheat and start a fire.

B) The ceiling lamp and microwave are turned off, but the toaster and radio are still running

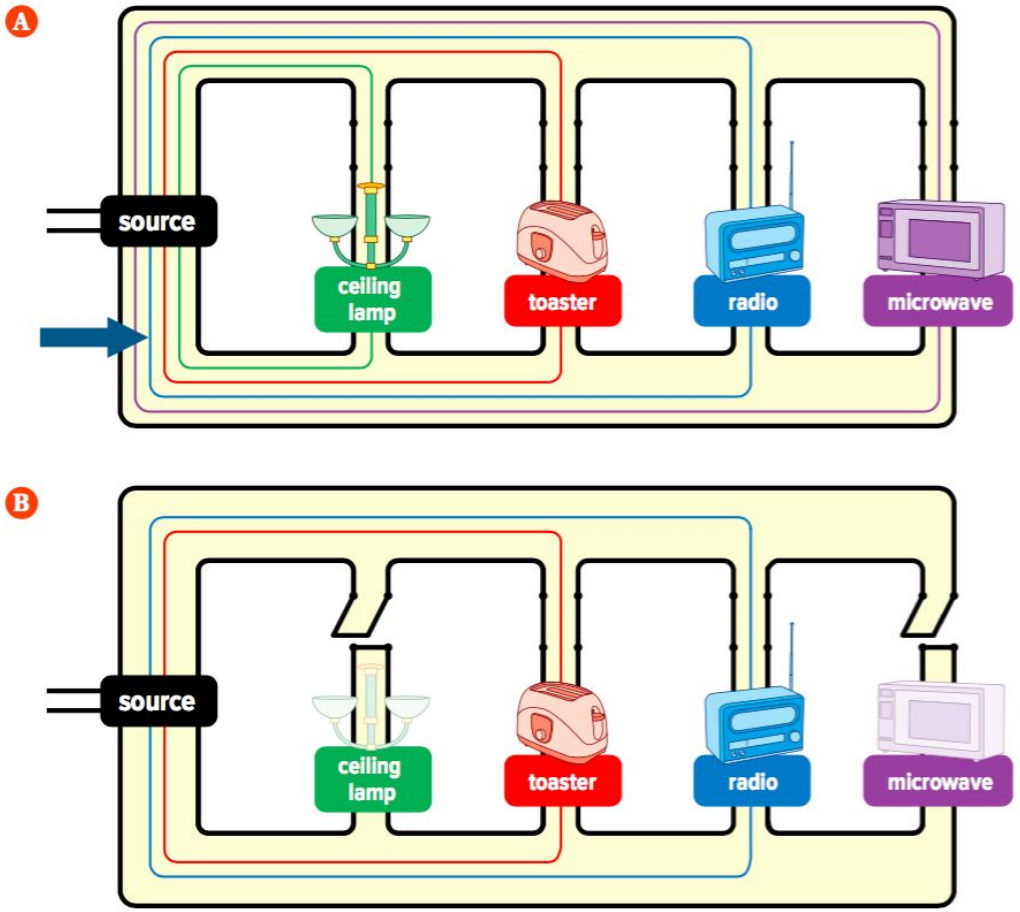


Figure 3.27

Multiple Circuits Within a Building

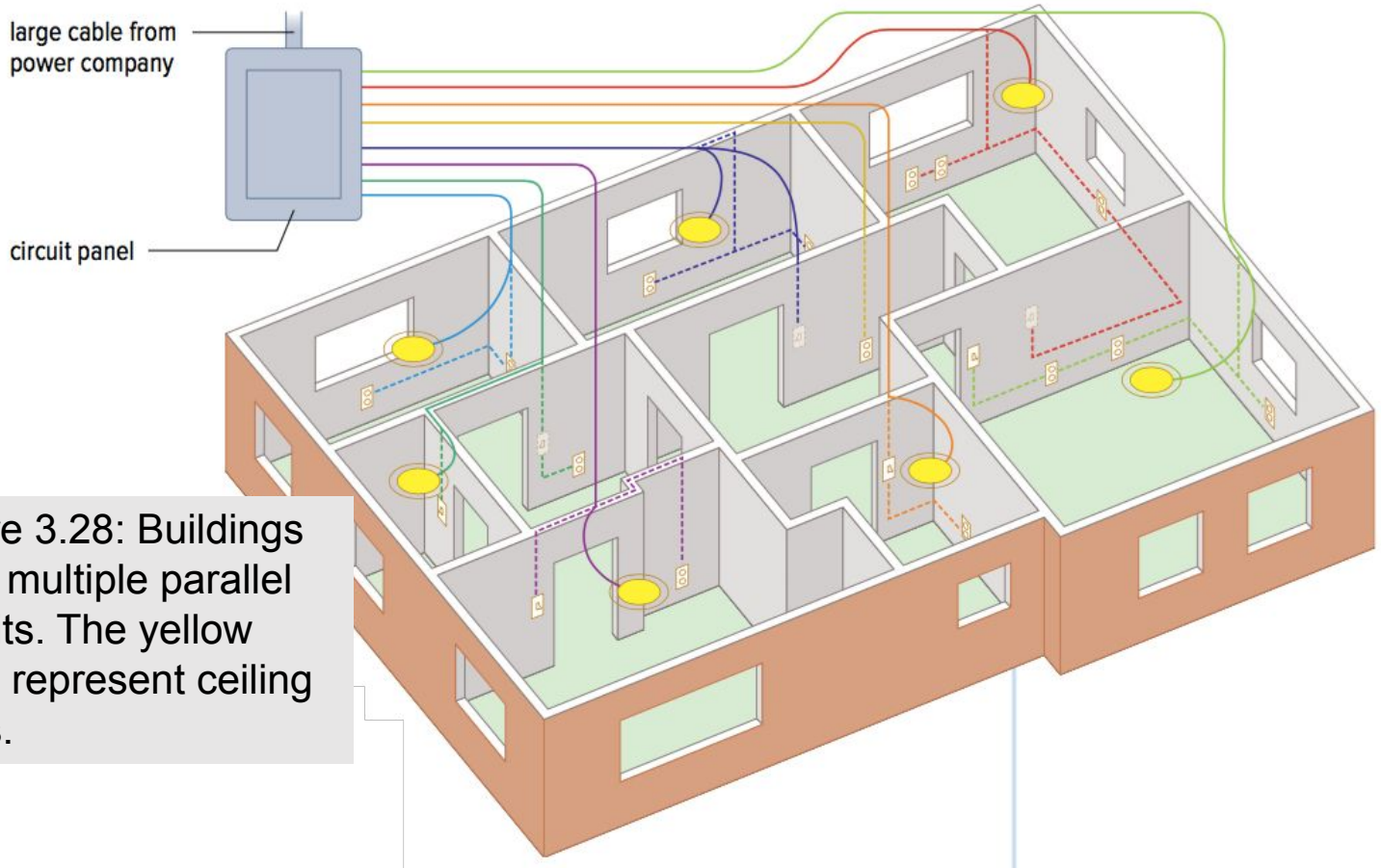


Figure 3.28: Buildings have multiple parallel circuits. The yellow disks represent ceiling lights.

Many separate parallel circuits are installed in buildings

- A large electrical cable carrying electrical energy branches out and is connected to each parallel circuit in a circuit panel

Discussion Questions

1. Explain why it would be impractical to wire a home with a circuit in which all loads were connected in series.

2. Explain why a parallel circuit with too many electrical devices connected to it is not safe.

Topic 3.4 Summary: How are circuits used in practical applications?

- Voltage, current, and resistance in a circuit are related by Ohm's law.
- Loads can be connected in series or in parallel in a circuit.
- Parallel loads are practical for circuits in the home.