

# Electronic Devices

A computer uses electric current to process information.

A toaster uses electric current to change electrical energy into thermal energy.



# Electronic Signals



**How do electronic signals convey information?**



**Electronics conveys information with electrical patterns called analog and digital signals.**

# Electronic Signals

The science of using electric current to process or transmit information is **electronics**.

- Information is carried by an **electronic signal**, patterns in the controlled flow of electrons through a circuit.
- If a voltage source is connected to a circuit, electrons flow through the wire.
- Controlling the electron flow—by either altering the voltage or turning the current on and off—produces a coded signal.

# Electronic Signals

## Analog Signals

An **analog signal** is a smoothly varying signal produced by continuously changing the voltage or current in a circuit.

Information is encoded in the strength or frequency of the analog signal.

# Electronic Signals

## Digital Signals

A **digital signal** encodes information as a string of 1's and 0's.

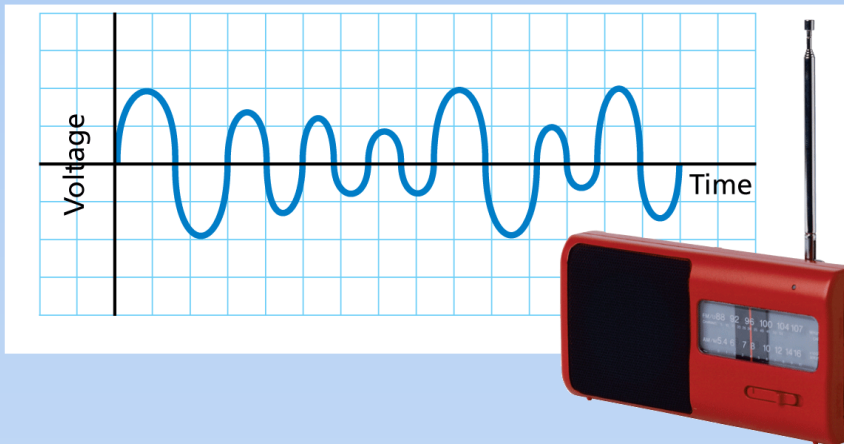
When the current is off, it represents a "0." When the current is on, it represents a "1."

# Electronic Signals

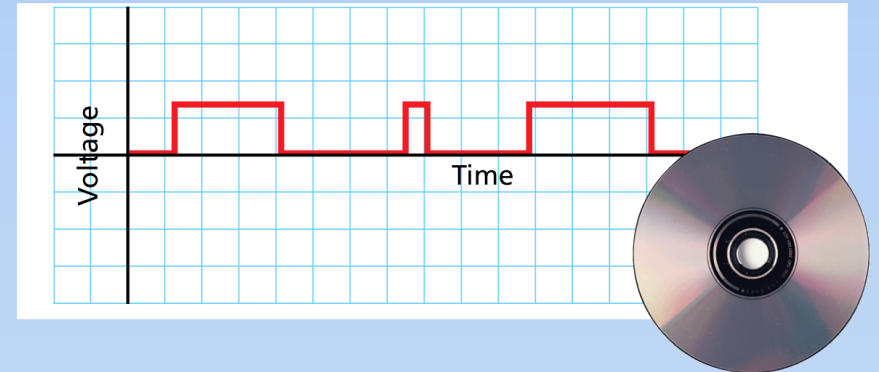
Electronic signals convey information by changing voltage or current in a circuit.

- A. An analog signal can be produced by smoothly changing voltage.
- B. A digital signal can be produced by pulsing a current on and off.

**A**



**B**



## Vacuum Tubes



**How do vacuum tubes control electron flow?**



**Vacuum tubes can change alternating current into direct current, increase the strength of a signal, or turn a current on or off.**

## Vacuum Tubes

A vacuum tube was used to control electron flow in early electronic devices.

Vacuum tubes have many useful features, but some types burn out frequently and need to be replaced. They are also much too large for use in small electronic devices.



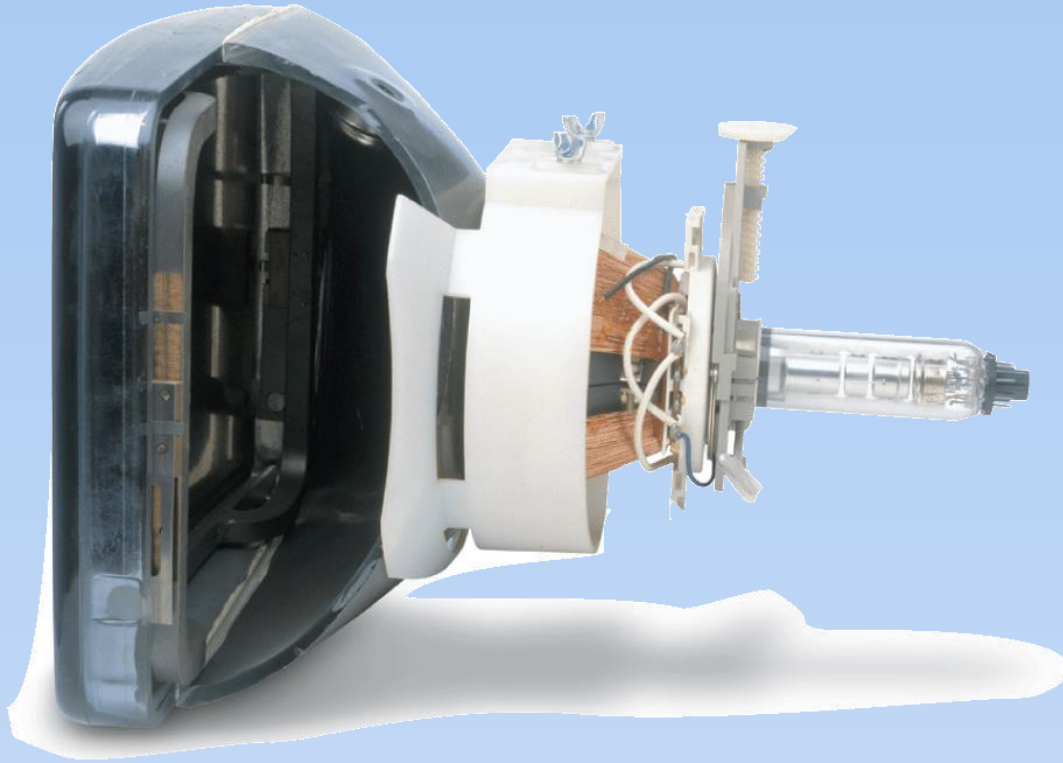
## Vacuum Tubes

One useful type of vacuum tube is a cathode-ray tube (CRT).

- Three metal plates in the CRT emit electron beams.
- The electrons strike a glass surface on the other end of the tube.
- The glass is coated with phosphors that glow red, green, or blue in response to the electron beams.

## Vacuum Tubes

A cathode-ray tube is used in many computer monitors and television sets.



# Semiconductors



**What are two types of semiconductors?**



**In n-type semiconductors, the current is a flow of electrons. In p-type semiconductors, it appears as though positive charge flows.**

# Semiconductors

A **semiconductor** is a crystalline solid that conducts current only under certain conditions.

- Most semiconductors are made with silicon or germanium. In pure form, these elements are poor conductors.
- When trace amounts of other elements are added, it becomes possible to control the current inside the crystals.

## Semiconductors

- A p-type semiconductor can be made by adding a trace amount of boron to silicon. Spaces called holes occur at each boron atom. The holes are positively charged.
- An n-type semiconductor can be made by adding phosphorus to silicon. Phosphorus atoms provide weakly bound electrons that can flow.

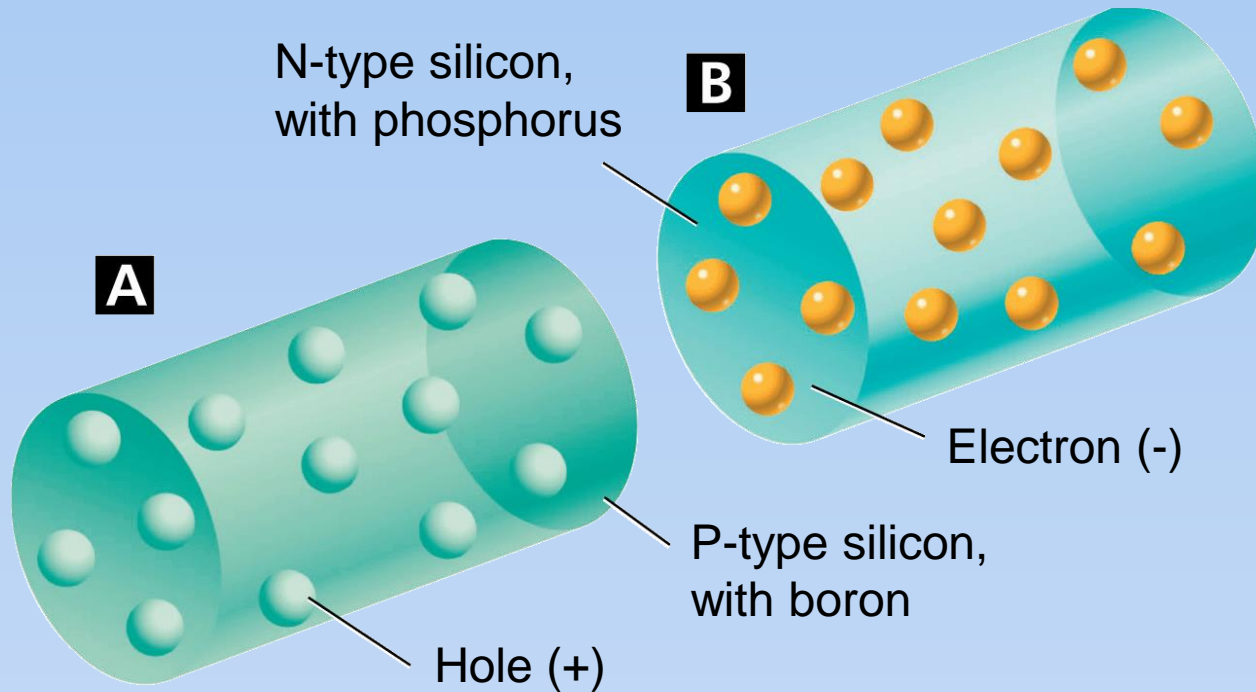
# Semiconductors

By themselves, n-type and p-type semiconductors cannot do much.

- When joined together, electrons in the n-type semiconductor are attracted toward the positively charged holes in the p-type semiconductor.
- As electrons jump from hole to hole, it looks like a flow of positive charge because the locations of the holes change.

# Semiconductors

A semiconductor becomes a good conductor of charge if trace amounts of elements are added to it.



## Solid-State Components



**How are semiconductors used?**



**Most modern electronic devices are controlled by solid-state components.**



## Solid-State Components

Semiconductor devices were first used in the late 1940s.

These devices were named solid-state components because they used solids rather than vacuum tubes to control current.

# Solid-State Components

## Diodes

A **diode** is a solid-state component that combines an n-type and p-type semiconductor.

- When a voltage is applied across a diode, electrons flow from the n-type to the p-type semiconductor.
- There is no current if voltage is applied in the opposite direction.
- A diode can change alternating current to direct current.

# Solid-State Components

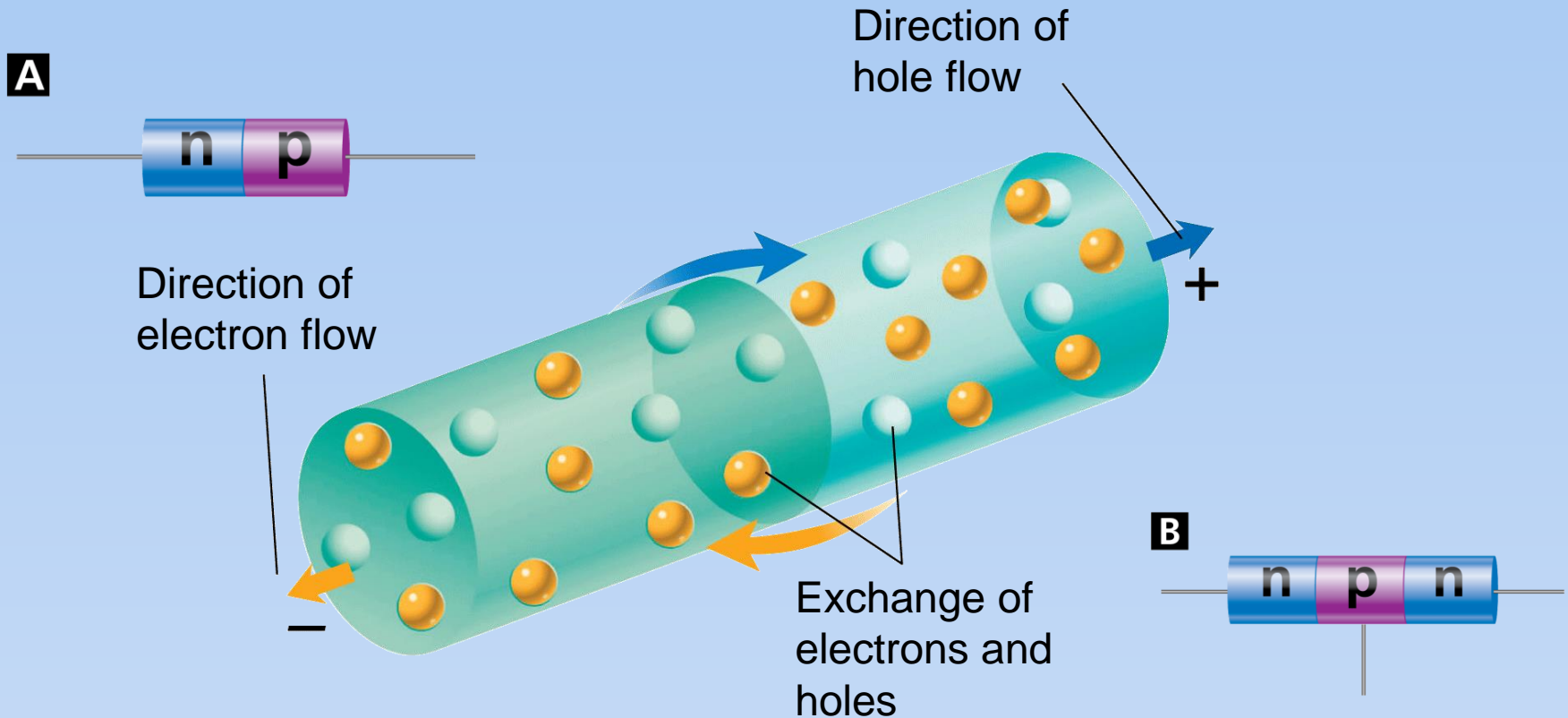
## Transistors

A **transistor** is a solid-state component with three layers of semiconductors.

- A small current flowing through its center layer changes its resistance.
- A transistor can be a switch—the small current can turn another current on or off.
- A transistor can be an amplifier—a small voltage applied to one side produces a large voltage on the other side.

# Solid-State Components

- A. A diode is two different semiconductors joined in one component.
- B. A transistor is three semiconductors with the middle one different from the outer ones.



# Solid-State Components

## Integrated Circuits

An **integrated circuit** is a thin slice of silicon that contains many solid-state components. Integrated circuits are sometimes called chips or microchips.

They perform as well as a network of vacuum tubes, but they need only a tiny fraction of the space.

# Communications Technology



**What are the benefits of using microchips in communication devices?**



**Communication devices use microchips to make them more portable, reliable, and affordable.**

## Communications Technology

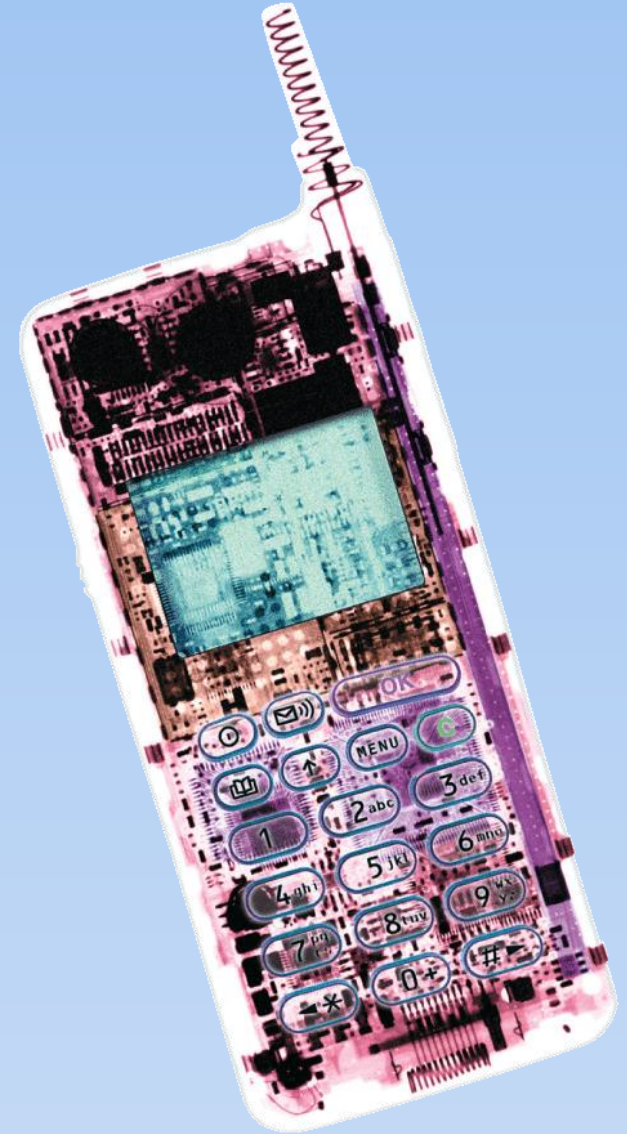
A **computer** is a programmable device that can store and process information.

A mobile phone contains many solid-state components.

- Transistors amplify the phone's incoming signal.
- Capacitors store electric charge.
- Diodes maintain proper voltage levels in the circuits.

# Communications Technology

A mobile phone uses many solid-state components.





## Assessment Questions

1. What is the function of a transistor in an electronic device?
  - a. allows current flow in one direction but not the other
  - b. stores electrical charges until they are needed
  - c. acts as a current switch or amplifier
  - d. converts analog signals into digital signals

## Assessment Questions

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ANS: C

## Assessment Questions

2. What is the structure of a diode?
  - a. a combination of an n-type semiconductor and a p-type semiconductor
  - b. a combination of two n-type semiconductors
  - c. an n-type semiconductor layer between two p-type semiconductors
  - d. any combination of three semiconductors

## Assessment Questions

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  - b. a combination of two n-type semiconductors
  - c. an n-type semiconductor layer between two p-type semiconductors
  - d. any combination of three semiconductors

ANS: A

## Assessment Questions

3. Why are devices using integrated circuits smaller than comparable devices that do not use solid-state components?
  - a. Many components can be built on a single silicon microchip.
  - b. Solid-state devices do not need as many circuit components.
  - c. Each vacuum tube is replaced by one microchip that is much smaller.
  - d. Solid-state devices are smaller because they don't need to hold as much electricity.

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  - d. Solid-state devices are smaller because they don't need to hold as much electricity.

ANS: A

## Assessment Questions

1. In electronic devices, a digital signal conveys information by converting it into a string of 1's and 0's.

True

False

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True

False

ANS: T