كلية الهندسة بشبرا
Shoubra faculty of Engineering

2nd year Mech. 2017/2018

Electronics Engineering

Lecture 1

Introduction to Electric Circuits

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Electronics in Hand

Course Information

Title	Electronics Engineering
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Assessment (100)	▪ Final Exam (70) ▪ Course work (30) • Midterm (12) • Section work (10) • Quiz/assignments (8)

Course Schedule

	Topics	(# Lectures)
Part (1)	Introduction to Electric Circuits	1
	Ohms law, Energy and Power	1
	Series and Parallel Circuits	1
	Series-Parallel Circuits	1
	Circuit Theorems and Conversions	1
	Introduction to AC current and Voltage	1
	RC, RL, RLC circuits	1
	Midterm Exam	
Part (2)	Introduction to Electronics	1
	Diode and its applications	1
	Bipolar Junction Transistor and its applications	1
	Logic Gates	1
	Quiz and course closeout	1

References

- “Principles of Electric Circuits-Conventional Current Version”, 9th Edition, Floyd
- “Electronic Devices”, 9th Edition, Floyd
- “Digital Fundamentals”, 9th Edition, Floyd

Quantities and Units

Electrical Quantities

QUANTITY	SYMBOL	SI UNIT	SYMBOL
Capacitance	C	Farad	F
Charge	Q	Coulomb	C
Conductance	G	Siemens	S
Energy (work)	W	Joule	J
Frequency	f	Hertz	Hz
Impedance	Z	Ohm	Ω
Inductance	L	Henry	H
Power	P	Watt	W
Reactance	X	Ohm	Ω
Resistance	R	Ohm	Ω
Voltage	V	Volt	V

Metric Prefixes

METRIC PREFIX	SYMBOL	POWER OF TEN	VALUE
femto	f	10^{-15}	one-quadrillionth
pico	p	10^{-12}	one-trillionth
nano	n	10^{-9}	one-billionth
micro	μ	10^{-6}	one-millionth
milli	m	10^{-3}	one-thousandth
kilo	k	10^{3}	one thousand
mega	M	10^{6}	one million
giga	G	10^{9}	one billion
tera	T	10^{12}	one trillion

Metric Unit Conversions

- How to Convert from one unit with a metric prefix to another

Example Convert 0.15 milliampere (0.15 mA) to microamperes (μA).

$$\text{mA} \xrightarrow{\times 10^3} \mu\text{A}$$

- $0.15\ mA = 0.15 \times 10^3\ \mu A = 150\ \mu A$

Example Convert 47,000 picofarads (47,000 pF) to microfarads (μF).

$$\text{pF} \xrightarrow{\times 10^{-6}} \mu\text{F}$$

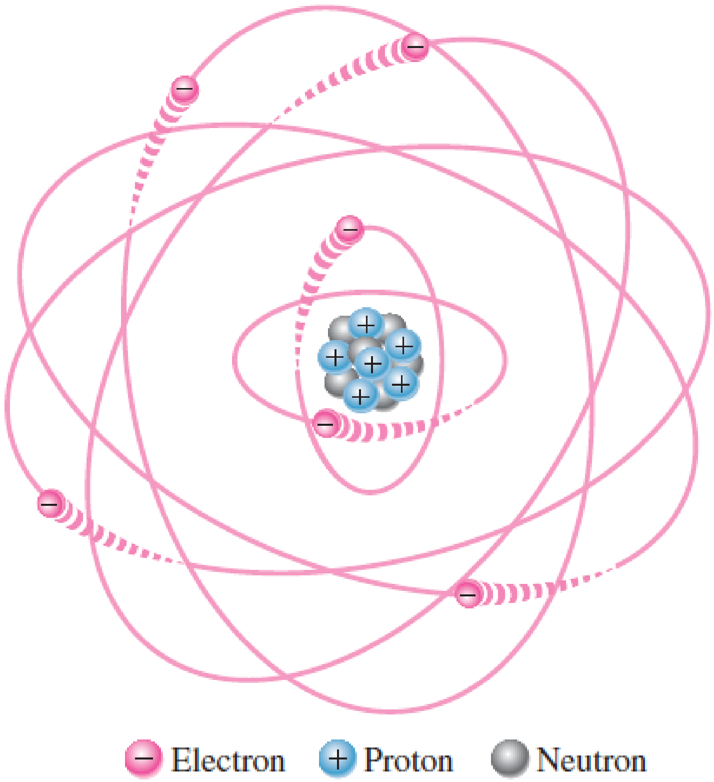
- $47000\ pF = 47000 \times 10^{-6}\ \mu F = 0.047\ \mu F$

$$\text{Metric Prefix: } 10^{x} \xrightarrow{\times 10^{(x-y)}} \text{Metric Prefix: } 10^{y}$$

Voltage, Current, and Resistance

Atomic Structure

- An **atom** is the smallest particle of an element that retains its characteristics.
- An **atom** consists of central nucleus surrounded by orbiting electrons.
- The **nucleus** consists of positively charged particles called protons and uncharged particles called neutrons.
- The basic particles of negative charge are called electrons, which orbit the nucleus.



Atomic Structure (cont'd)

Atomic Number

- The atomic number equals the number of protons in the nucleus.
- For example, hydrogen has an atomic number of 1.

- In the normal (or neutral) state, all atoms of a given element have the same number of electrons as protons; the positive charges cancel the negative charges, and the atom has a net charge of zero.

Shells, Orbits, and Energy Levels

- Electrons orbit the nucleus of an atom at certain distances from the nucleus called Orbits.
- Each orbit corresponds to a different energy level called shell
- Maximum number of electrons in each shell = $2N^2$, N=1,2,3.. is number of shell (i.e., Max. number of electrons 2, 8, 18, 32, ….)

Valance Electrons

- Electrons in the outermost shell of an atom
- Have highest energy levels
- Relatively loosely bound to the atom
- Contribute to chemical reactions
- Determine the material's electrical properties

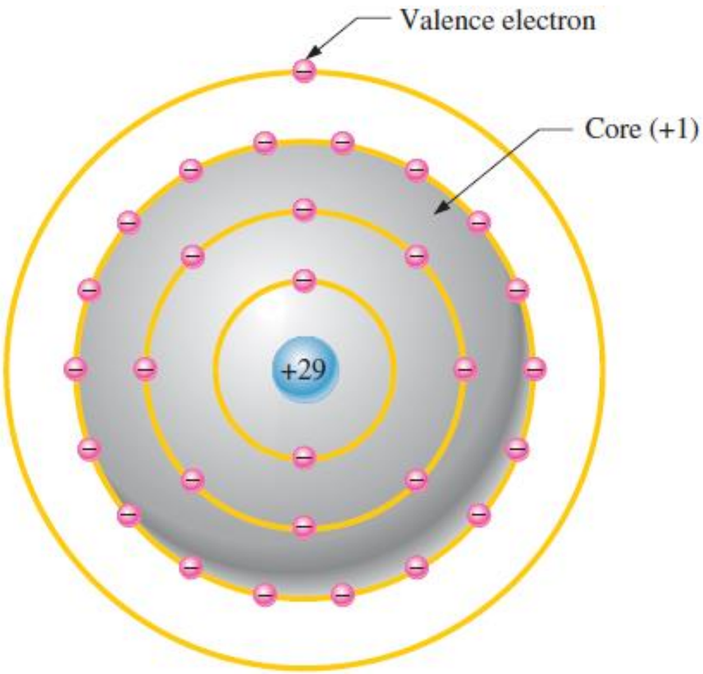


Fig. The copper atom

The Copper Atom

- Atomic number of Cu=29
- The outermost shell (the valence shell) has only one valence electron.
- When the valence electron gains sufficient thermal energy, it can leave its atom and become a free electron.

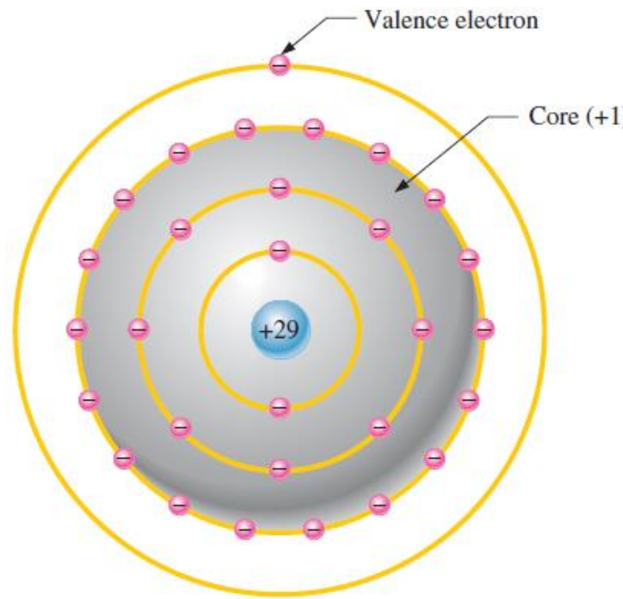


Fig. The copper atom

- In a piece of copper at room temperature, a “sea” of free electrons is present.
- These electrons are not bound to a given atom but are free to move in the copper material.
- Free electrons make copper an excellent conductor and make electrical current possible.

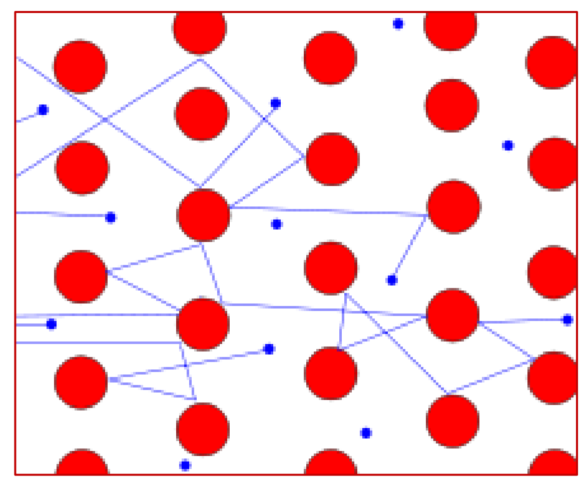


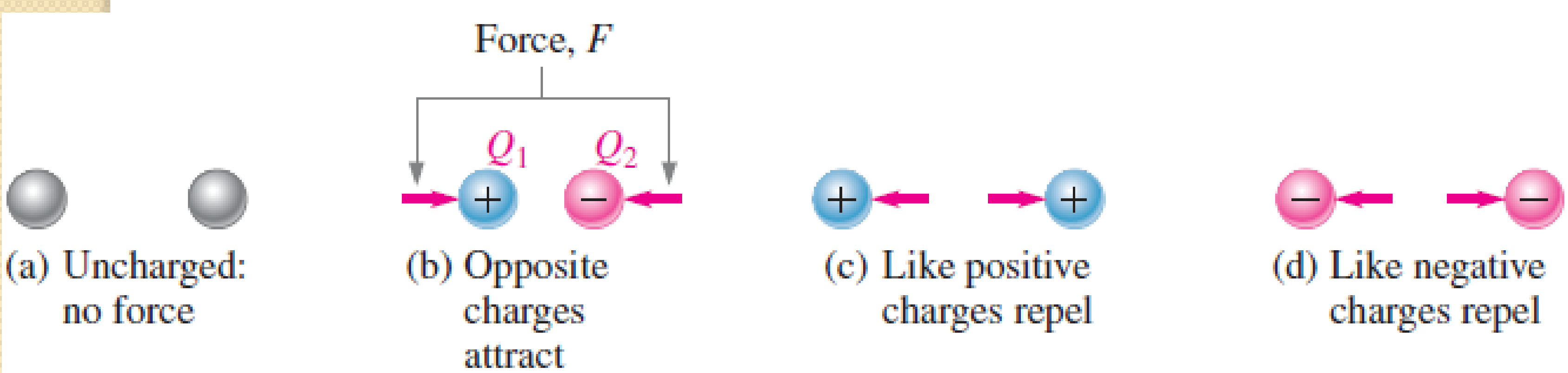
Fig. Copper Crystal

Electrical Charge

- Electrical charge (Q) is an electrical property of matter that exists because of an excess or deficiency of electrons.

- *Static electricity is the presence of a net positive or negative charge in a material.*

- Charges of opposite polarity are attracted (attraction force) to each other, and charges of the same polarity are repelled (repulsion force).
- This force, called an electric field.



Coulomb: The Unit of Charge

- Electrical charge (Q) is measured in coulombs (C).
- One coulomb is the total charge of 6.25×10^{18} electrons.
- A single electron has a charge $e = 1.6 \times 10^{-19}$ C

Example

How many coulombs do 93.8×10^{16} electrons represent?

Q= Number of Electrons × e= $93.8 \times 10^{16} \times 1.6 \times 10^{-19} = 0.15$ C

Example

How many electrons does it take to have 3 C of charge?

The Voltage

- The voltage is defined as the work done per unit charge to move a charge between two points.
- *The voltage is also known as potential difference or electromotive force (emf).*

$$V = \frac{W}{Q}$$

where V is voltage in volts (V), W is energy in joules (J), and Q is charge in coulombs (C).

Example

If 50 J of energy are required to move 10 C of charge, what is the voltage?

$$V = \frac{W}{Q} = \frac{50\,\text{J}}{10\,\text{C}} = \mathbf{5\,V}$$

The Current

- Voltage provides energy to electrons, allowing them to move through a circuit. This movement of electrons produces current.

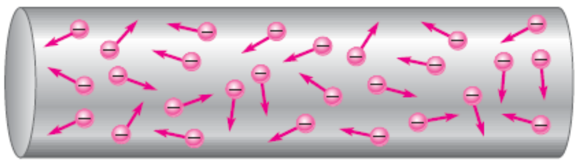


Fig. Random motion of free electrons in a material. (when no voltage applied)

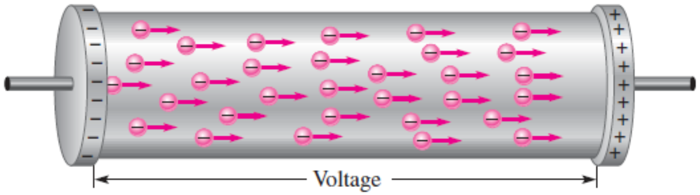
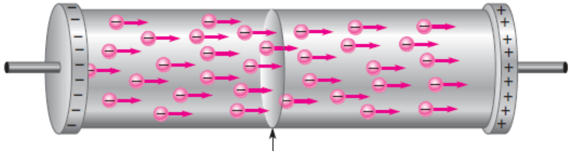


Fig. Electrons flow from –ve to +ve when a voltage is applied across a conductive material.

- Electrical current (I) is the rate of flow of charge.

$$I = \frac{Q}{t}$$



I is current in amperes (A), Q is charge in coulombs (C), and t is time in seconds (s).

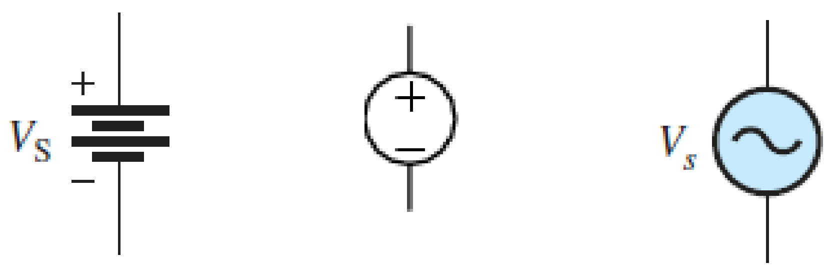
Example

Ten coulombs of charge flow past a given point in a wire in 2 s. What is the current in amperes?

$$I = \frac{Q}{t} = \frac{10\text{ C}}{2\text{ s}} = \mathbf{5\text{ A}}$$

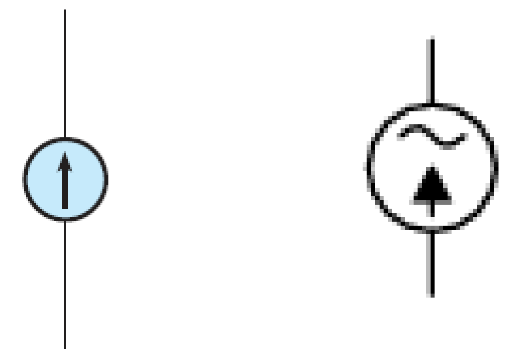
The Voltage Source and Current Source

- An ideal voltage source can provide a constant voltage for any load.
- An ideal current source can provide a constant current for any load.



DC Voltage source DC Voltage source AC Voltage source

Fig. Symbols of Voltage source



DC Current source AC Current source

Fig. Symbols of Current source

- *Batteries, Solar Cells, DC generator, power supply… are examples of DC voltage source*

Resistance and Conductance

- Resistance (R) is the opposition to current.
- The unit of Resistance is ohms (Ω)

- Conductance (G) is the reciprocal of resistance.
- The unit of conductance is the Siemens (S)

$$G = \frac{1}{R}$$

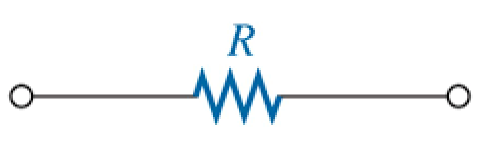


Fig. Symbol of resistance

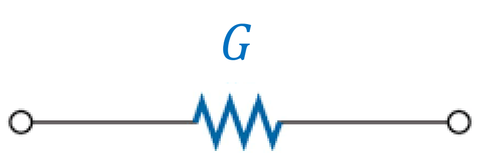


Fig. Symbol of conductance

The Resistors

- A component that is designed to have a certain amount of resistance is called a resistor.
- Resistors are use to *limit current* in a circuit, to *divide voltage*.

Fixed Resistors

Their resistance values are fixed

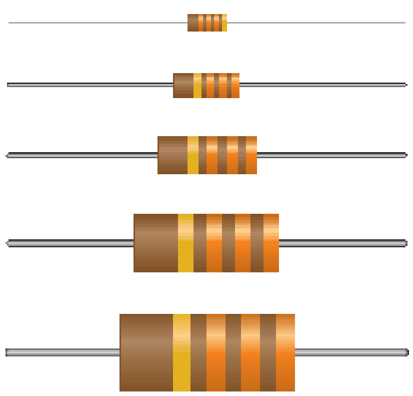
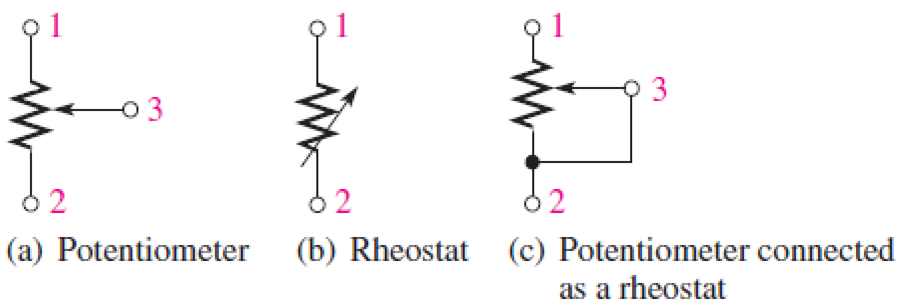


Fig. Carbon-composition resistors

Variable Resistors

Their resistance values can be changed easily.



Potentiometer	**3 Terminals**	**Divide voltage**
Rheostat	**2 Terminals**	**Control current**

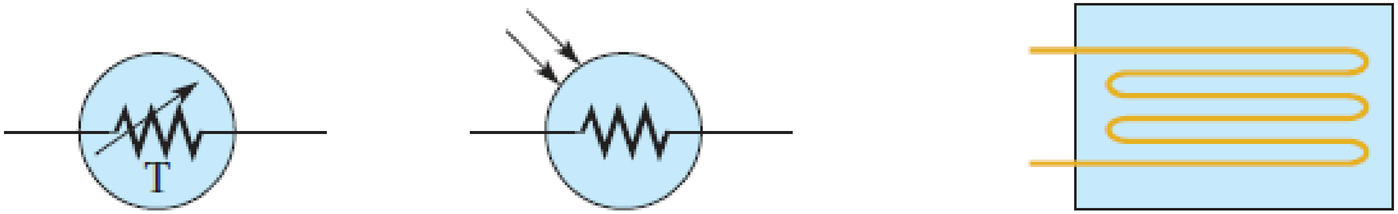
Resistors (Cont'd)

Variable Resistance sensors

- Many sensors operate on the concept of a variable resistance, in which a physical quantity alters the electrical resistance.

Examples:

- Thermistors: the resistance is a function of temperature
- Photoconductive cells: the resistance is a function of light
- Strain gauges: the resistance is function of force applied



(a) Thermistor (b) Photoconductive cell (c) Strain gauge

The Electric Circuit

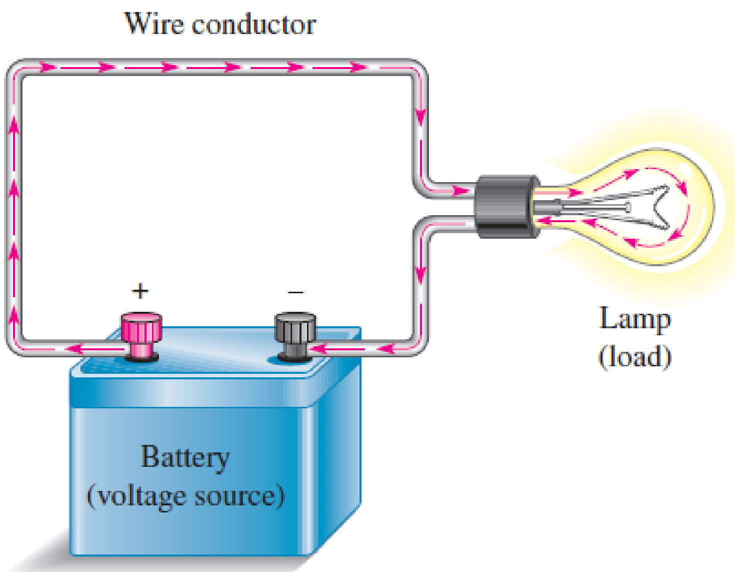


Fig. (a) Simple electric circuit

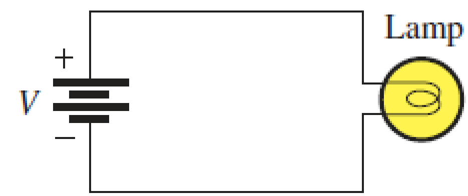


Fig. Schematic for the circuit in (a)

The Electric Circuit (cont'd)

Closed Circuit

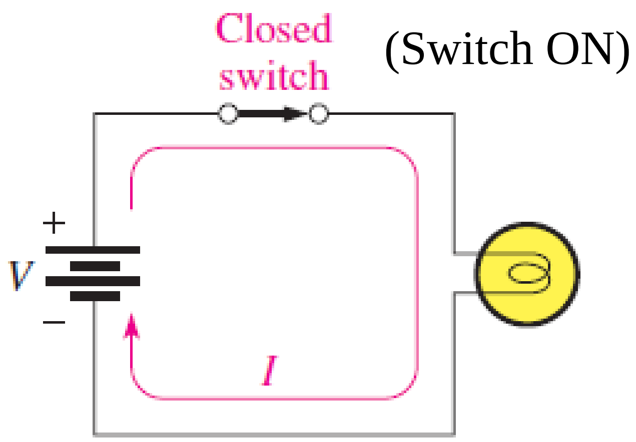


Fig. There is current *I* because there is a complete current path.

Open Circuit

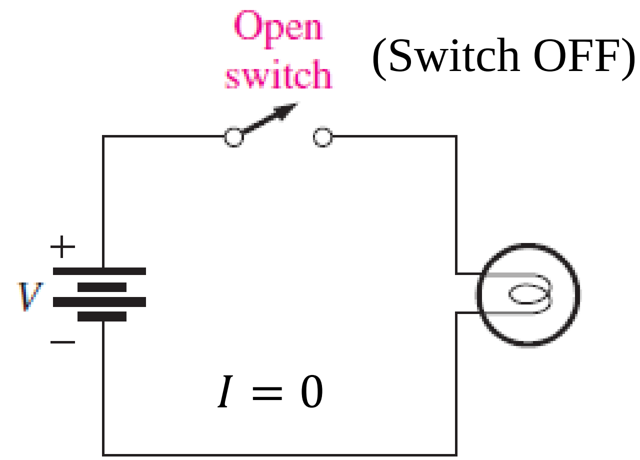
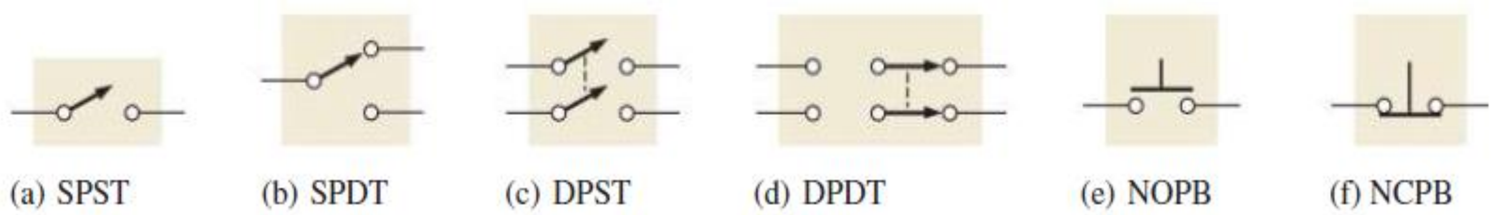


Fig. There is no current because the path is broken.

The Electric Circuit (cont'd)

Types of Switches



- SPST: Single Pole Single Through
- SPDT: Single Pole Double Through
- DPST: Double Pole Single Through
- DPDT: Double Pole Double Through
- NOPB: Normally Opened Push Button
- NCPB: Normally Closed Push Button

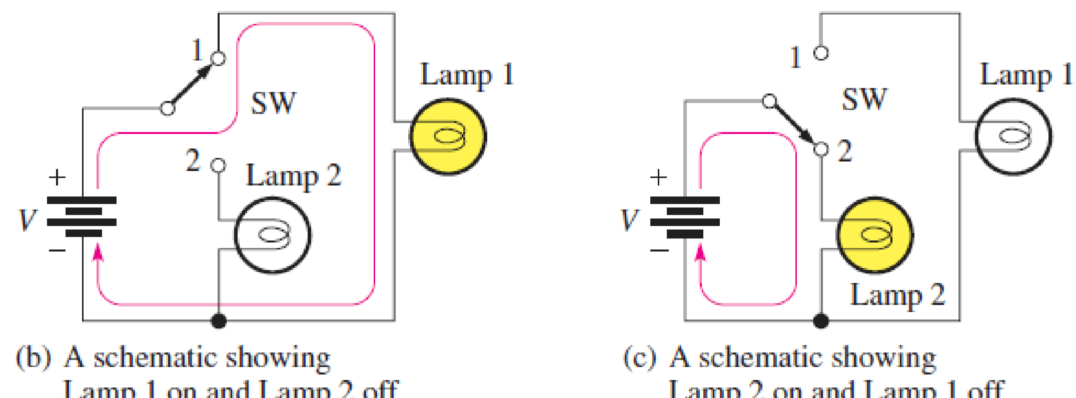
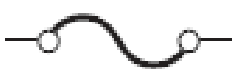


Fig. An example of an SPDT switch controlling two lamps.

The Electric Circuit (cont'd)

Protective Devices

- Fuses and circuit breakers are used to create an open circuit when the current exceeds a certain value due to an abnormal condition in a circuit.



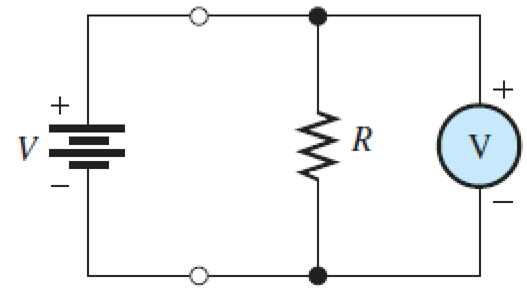
(d) Fuse symbol

(e) Circuit breaker symbol

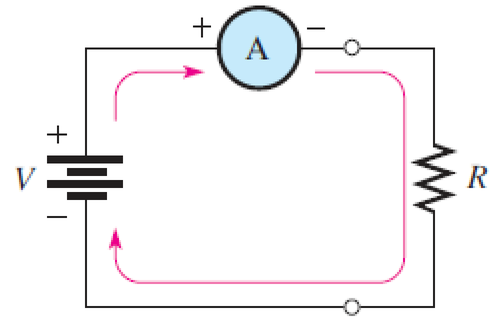
- When a fuse is "blown," it must be replaced; but when a circuit breaker opens, it can be reset and reused repeatedly.

Measuring Instruments

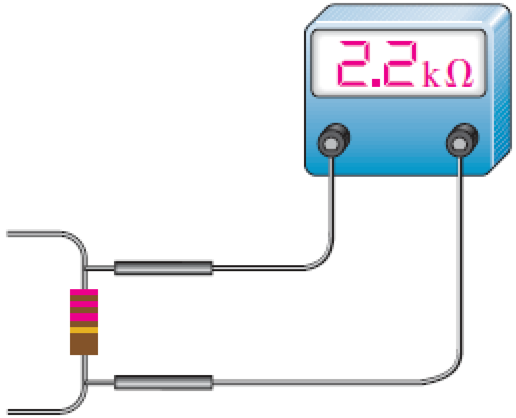
Voltmeter: Measure Voltage



Ammeter: Measure Current



Ohmmeter: Measure Resistance



Thanks for attention