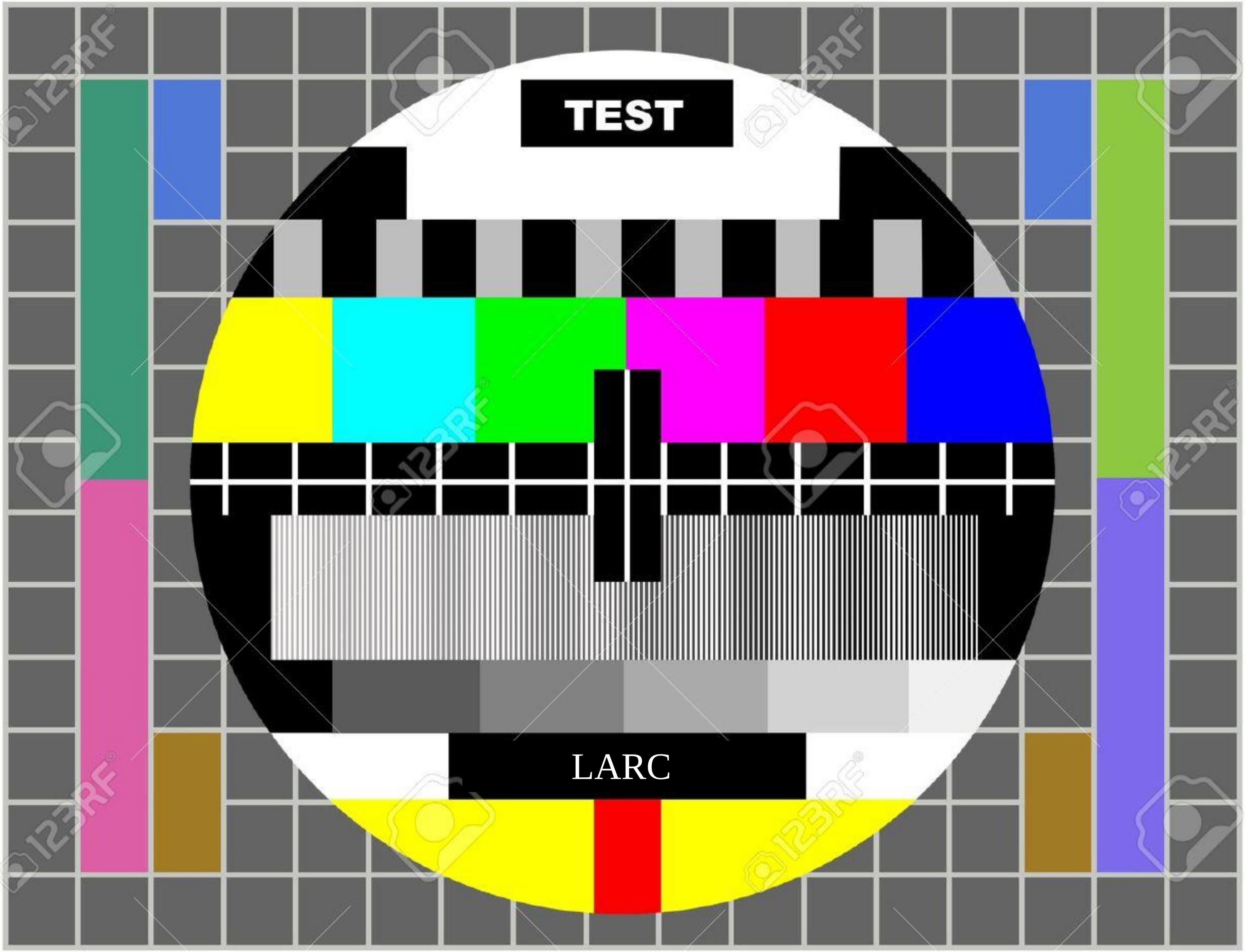
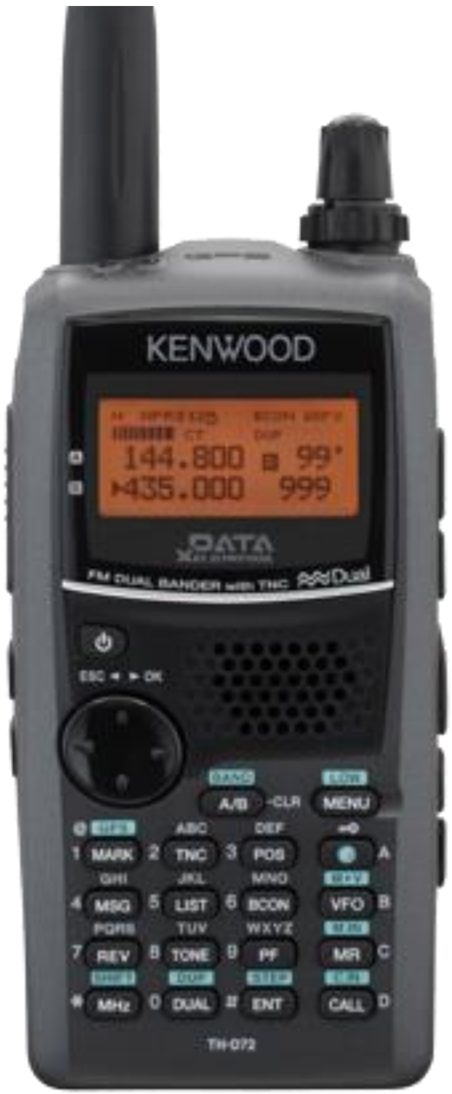

TEST
LARC

Amateur Radio Map of the World
N7CAL.COM
How Ya'll Are?
VOODOO N7CAL AUDIO
EPSON
DELL
ALPHA 76A
ANTENNA TUNER
Bellari
FURMAN

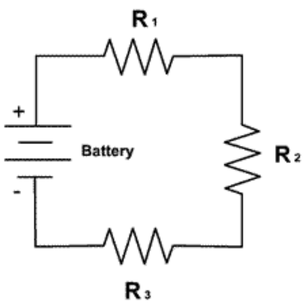
ELECRAFT KX3 TRANSCEIVER
14.285000
USB
SPLT
ANT1
PRE
AGC-S
XFIL
RX
TX
BAND+
M ► V
BAND-
V ► M
FREQ ENT
SCAN
MSG
REC
ATU TUNE
ANT
XMIT
TUNE 0
PRE
NR 1
ATTN
NB 2
APF
NTCH 3
SPOT
CWT 4
CMP
PITCH 5
DLY
VOX 6
TX
MON
NORM
PWR
KEYER
MODE
ALT
A / B
REV
DATA
TEXT
SPLIT
RIT
PF1
XIT
PF2
CLR
RATE
KHZ
DISP
MENU

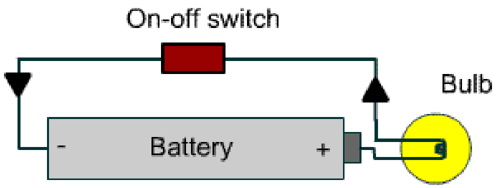

KENWOOD
144.800 99
435.000 999
DATA
FM DUAL BANDER with TNC
Dual
ESC ◄ ► OK
BAND
A/B
CLR
LOW
MENU
1 MARK
ABC
2 TNC
DEF
3 POS
A
GHI
4 MSG
JKL
5 LIST
MNO
6 BCON
VFO B
PQRS
7 REV
TUV
8 TONE
WXYZ
9 PF
MR C
* MHz
0 DUAL
ENT
CALL D
TH-D72

LARC BASIC AMATEUR RADIO COURSE - 2019

CURRENT, VOLTAGE, RESISTANCE, POWER, OHM'S LAW (Chapters 2 & 3)

Mike Cook© VE3ZMC





London Amateur Radio Club, 2019 Ham License Course

Date	Chapter	Topic	Location	Instructor
Sep 07	1	Introduction and Overview	Trinity Lutheran Church	Doug Elliott, & guests
Sep 14	2	Current, Voltage, Resistance	Trinity Lutheran Church	Mike Cook
	3	Ohms Law, Power		
Sep 21	4	Inductors, Capacitance, transformers, reactance, impedance, resonance	Trinity Lutheran Church	Mike Cook
Sep 28	5	Waves, wavelength, frequency & bands	Trinity Lutheran Church	Mike Cook
	6	Propagation		
Oct 05	7	Transmission Lines	Trinity Lutheran Church	Mitch Powell
	8	Antennas		
Oct 12	* no class *	No Class - Thanksgiving Weekend	NO CLASS	
Oct 17	9	active devices, diodes, transistors, and tubes	Trinity Lutheran Church	Mark Bramwell
Oct 26	10	Power Supplies	Trinity Lutheran Church	Mark Bramwell
	11	Establishing & equipping a ham station		Doug Elliott
Nov 02	12	Routine Operation of an amateur station	Trinity Lutheran Church	Jim Spicer Tom Pillon Dave Lambert
Nov 09	13	Modulation and Transmitters	Trinity Lutheran Church	Dave McCarter
Nov 16	14	Receivers	Trinity Lutheran Church	Dave McCarter
Nov 23	16	Safety	Trinity Lutheran Church	Mike Watts
	17	Regulations		
Nov 30	15	Radio Frequency Interference	Trinity Lutheran Church	Mike Watts
Dec 07	Exam	100 Multiple Choice Questions	Trinity Lutheran Church	Examiners

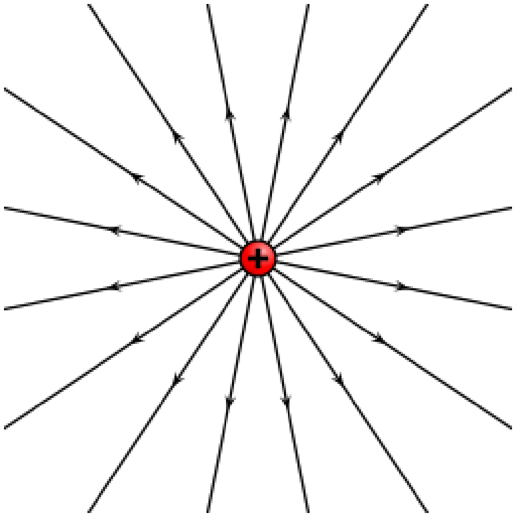
Notes:

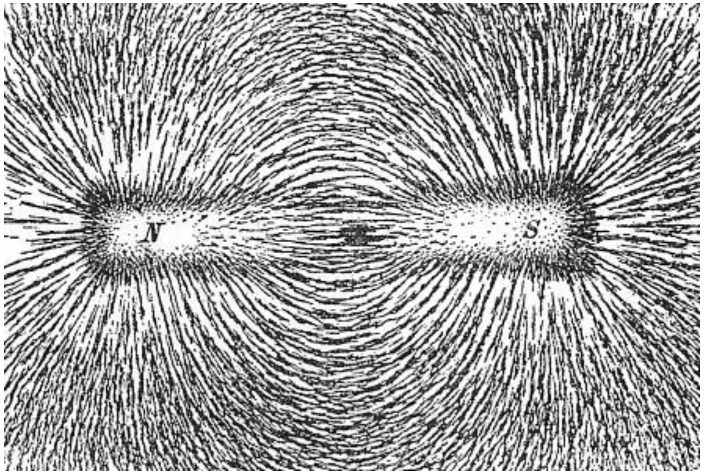
- Labour Day is Monday Sept 2
- Thankgiving is Monday October 14
- Trinity Lutheran Church is at 746 Colborne St

Radio is a consequence of a very fundamental property of matter

That property is called “Charge”

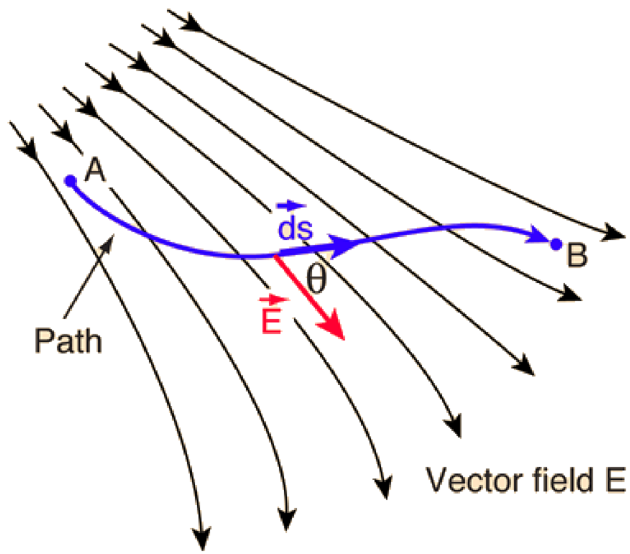
We think about a charge generating a “field” around it





Magnets generate a “field” too

Charges create an electric field, which is a vector field

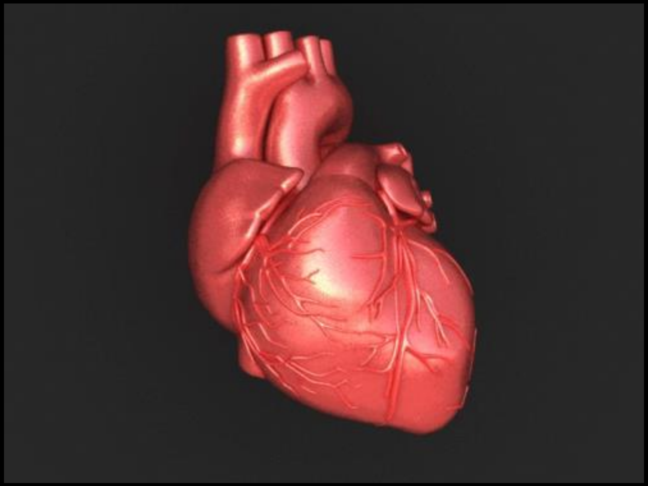


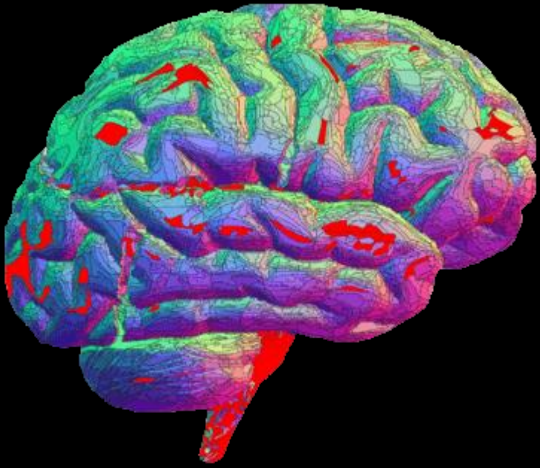
We don’t really know what charge is.

But we have learned how to use it

We need to understand something about “Charge” and “Electricity” in order to understand how radio works.

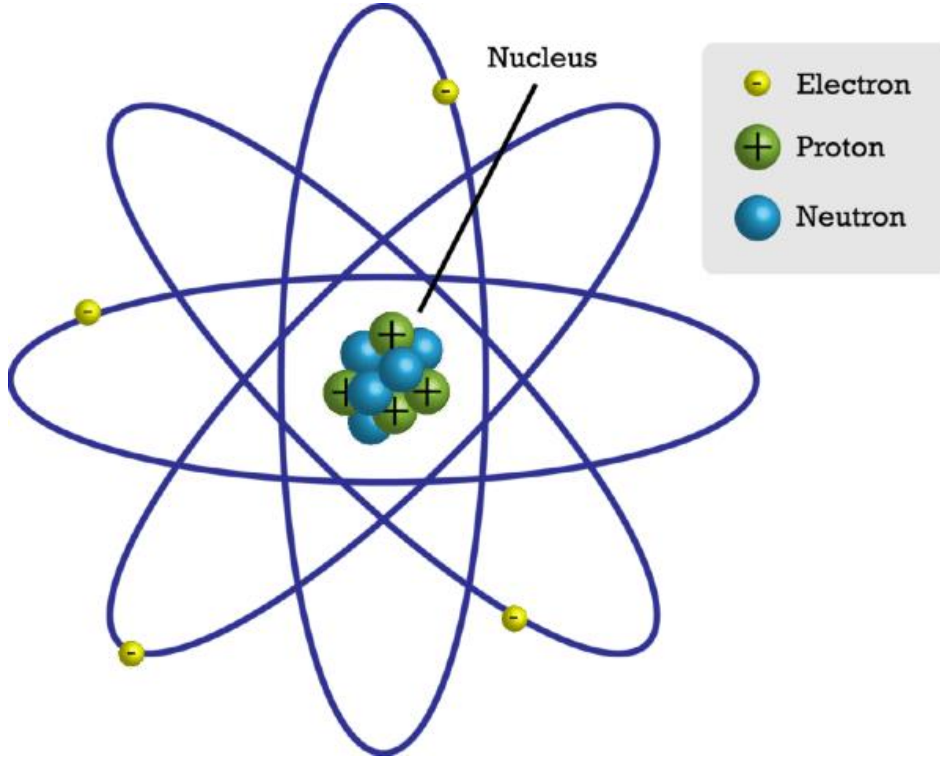
***Electricity is all around us, and within us*….**

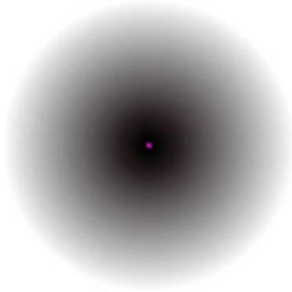





SAMSUNG
ZTE
LG

So where does electricity come from?





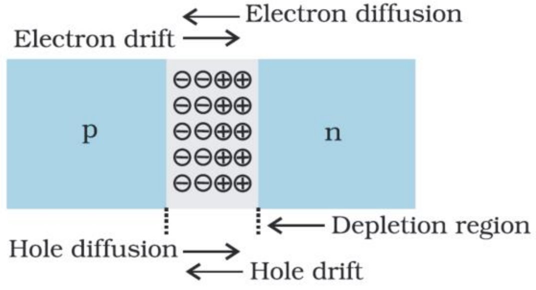
The + and – indicate electric charge.

Charge is carried by a charge carrier which can be electrons, protons, ions or holes.

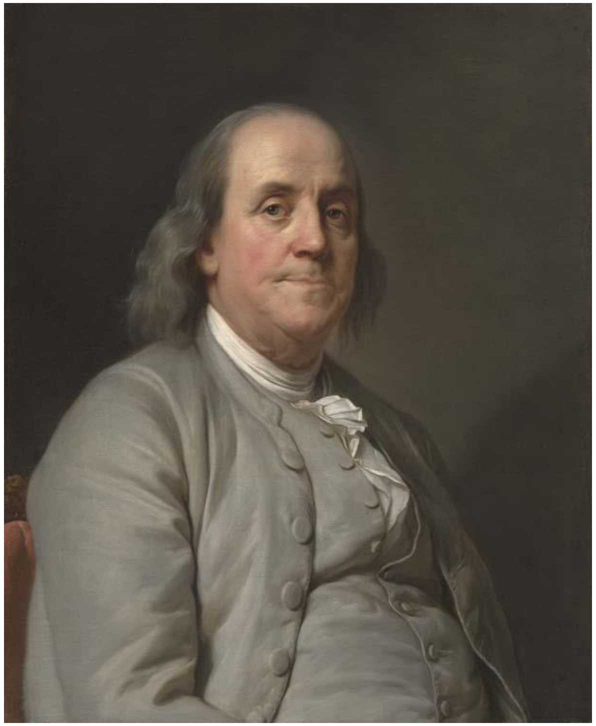
Electrons are the charge carriers in metals and are responsible for charge movement in electrical and electronic applications.

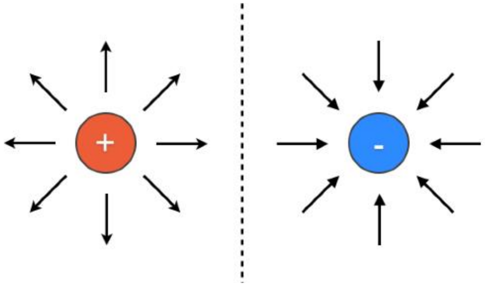
Ions are the charge carriers in a plasma and in biological systems.

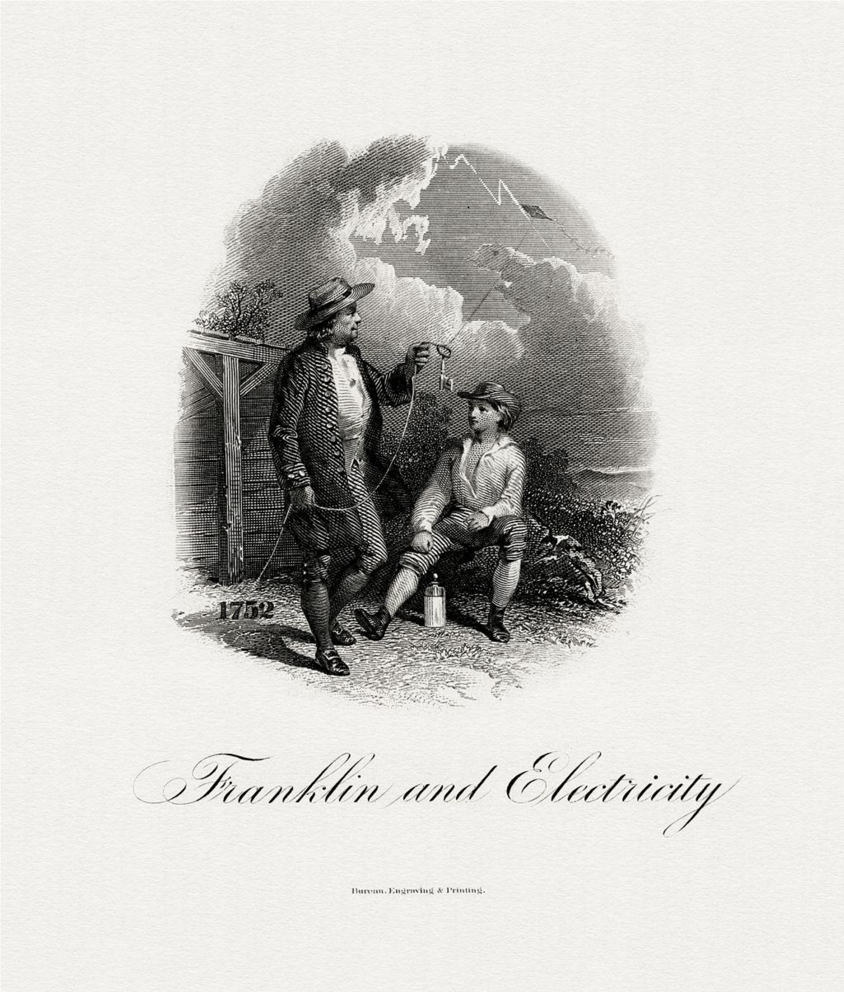
Holes (and electrons) are the charge carriers in semiconductors.

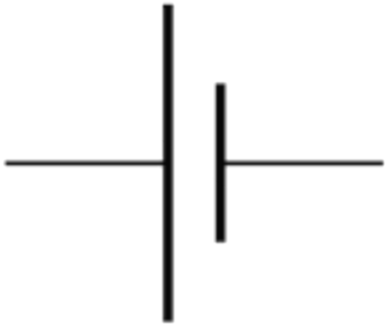


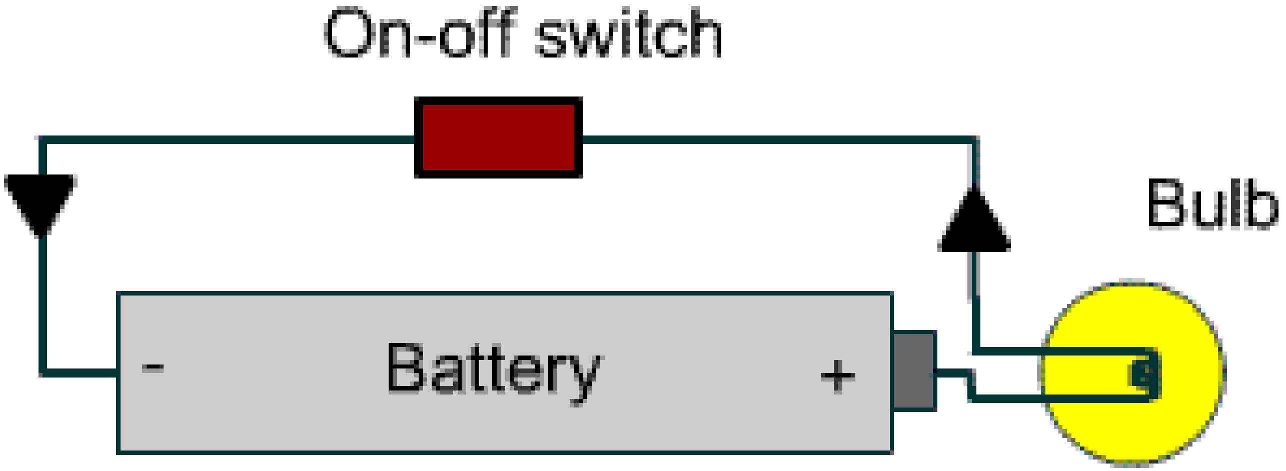
So we have two kinds of charge – positive and negative.





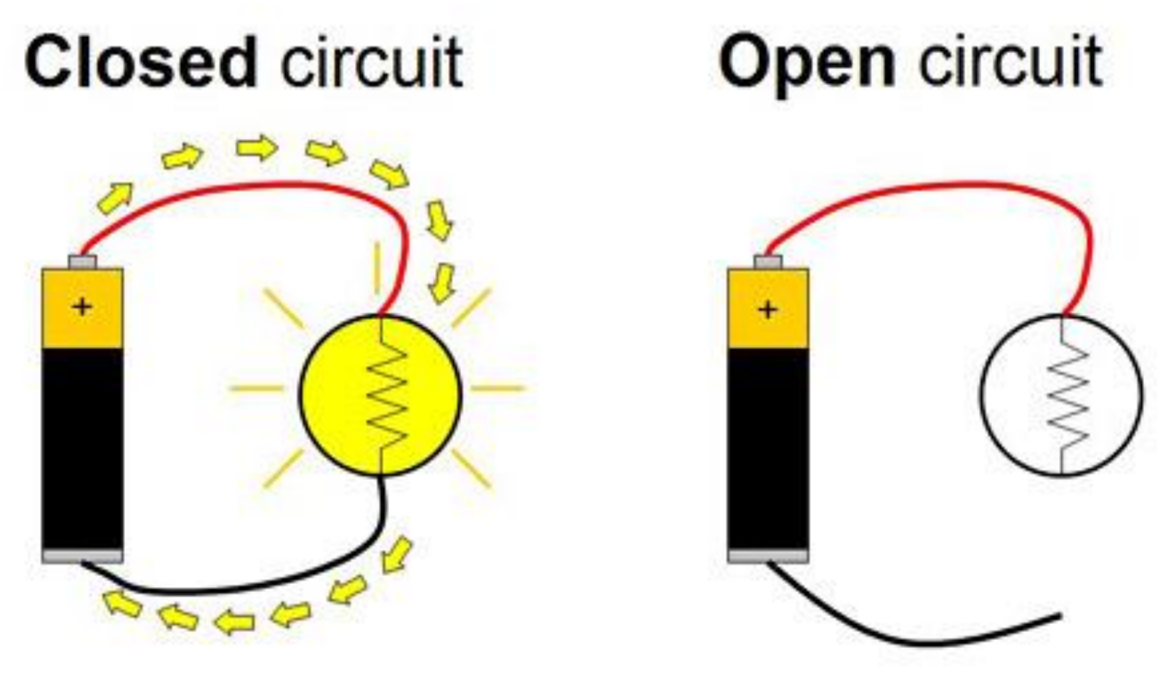




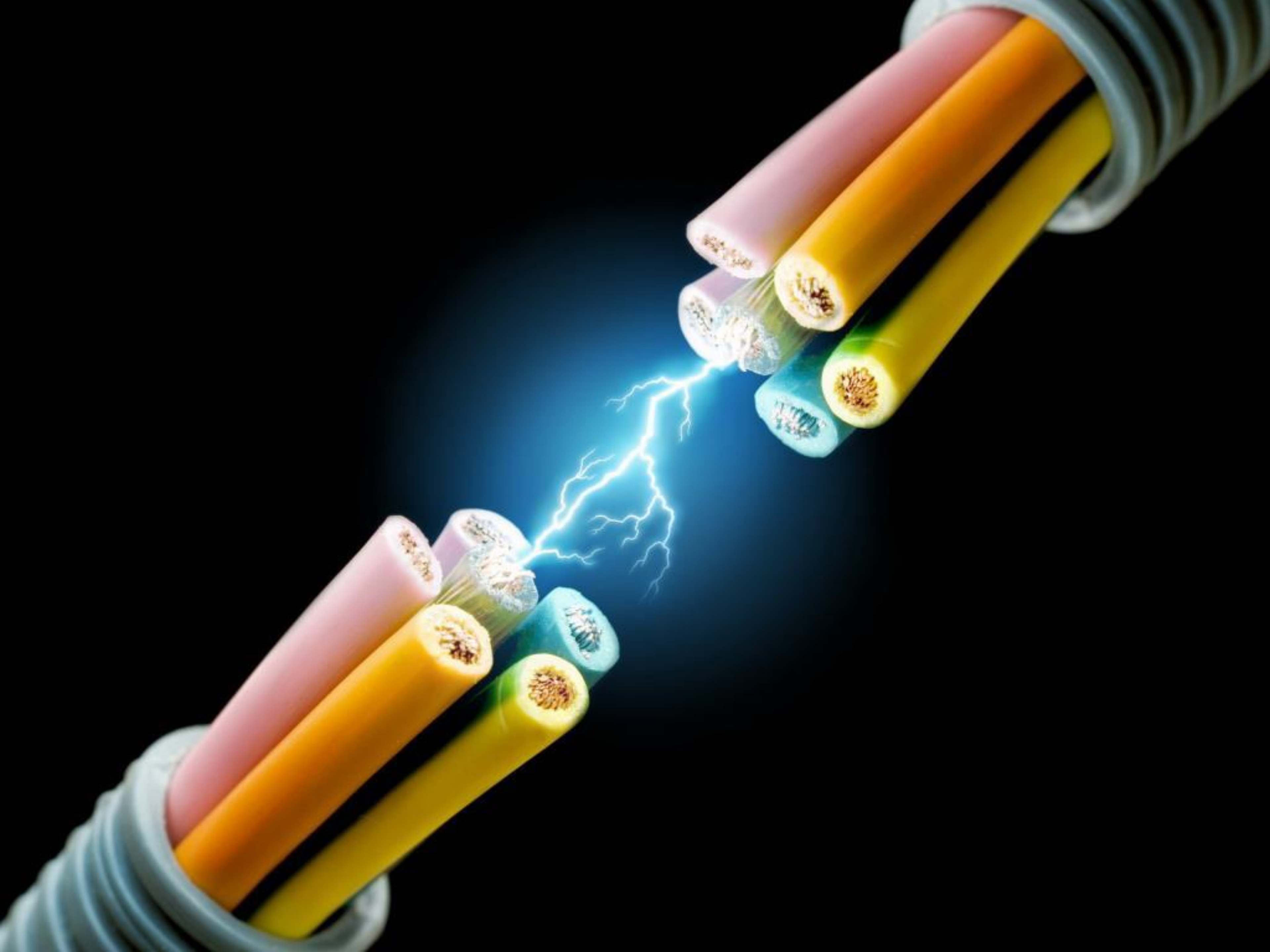


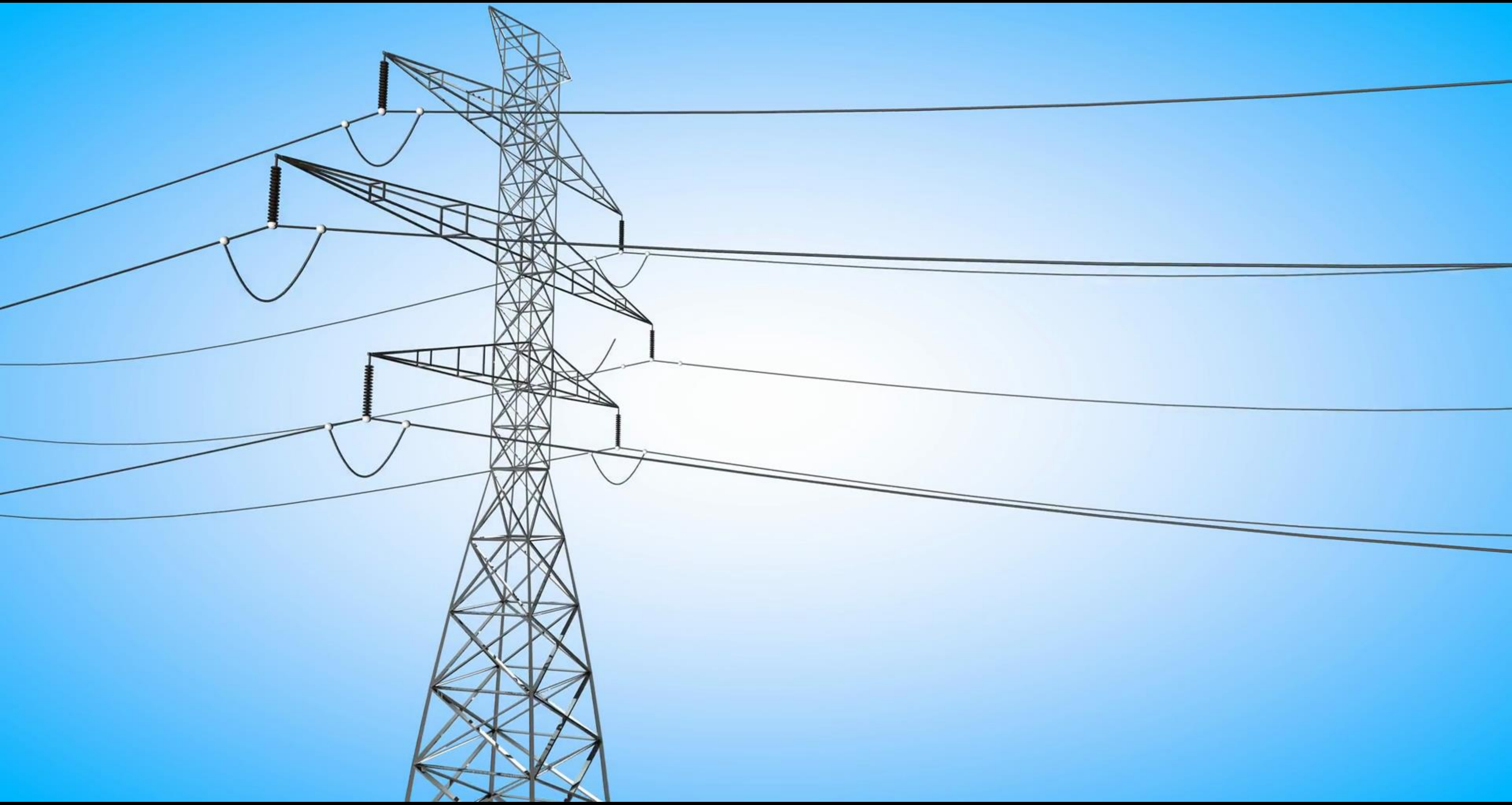
So what is current?

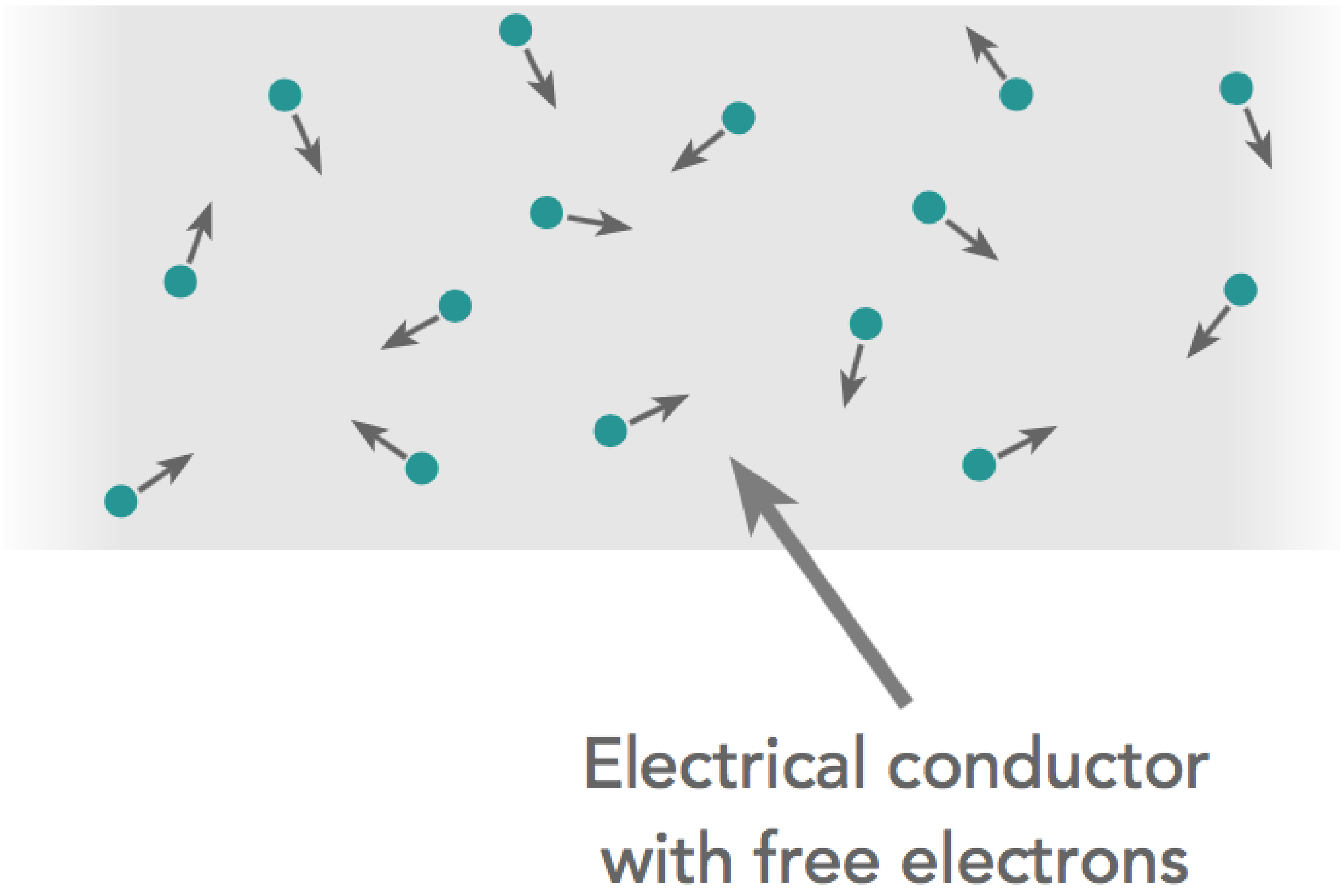
Current in a conductor must involve something moving because:

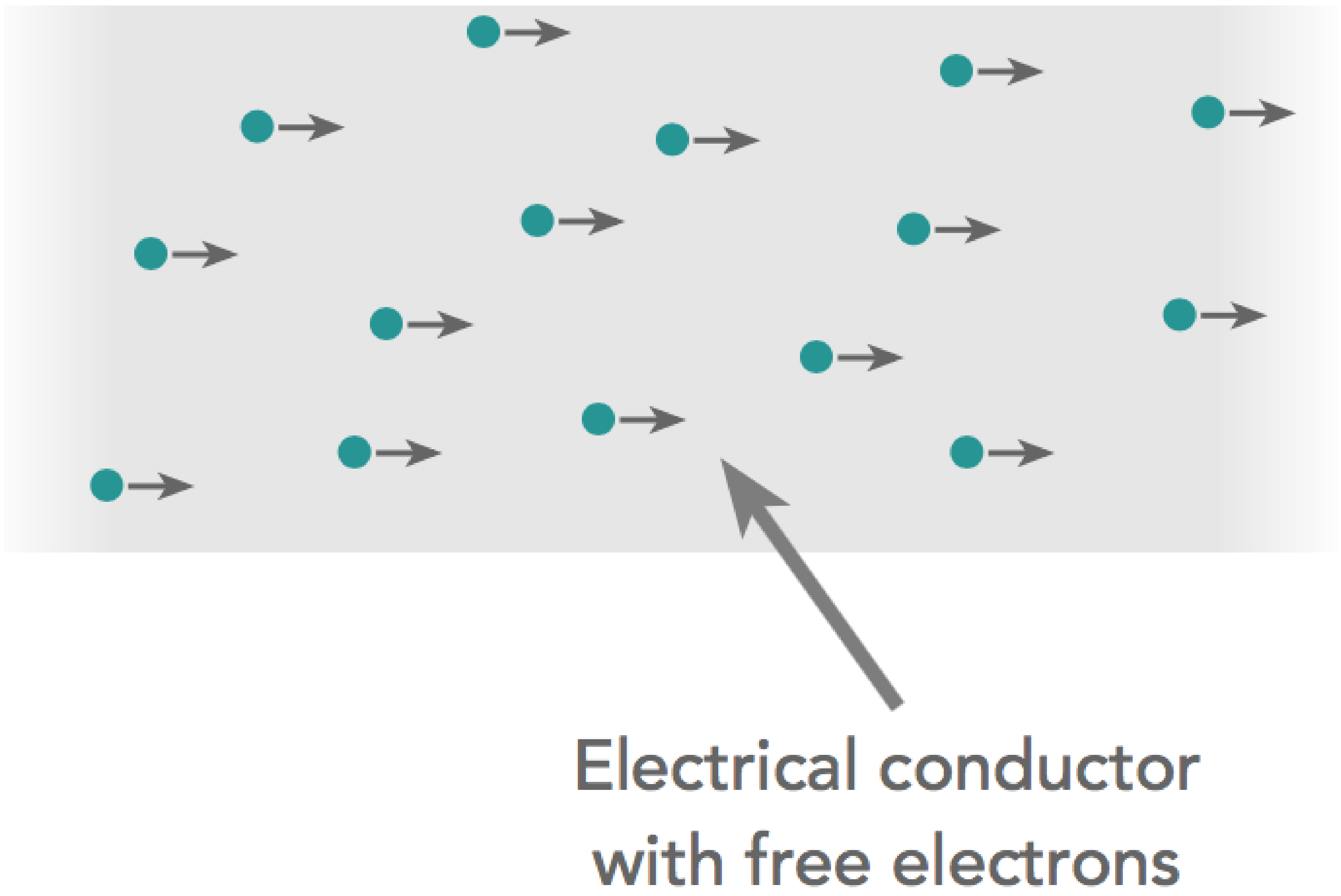


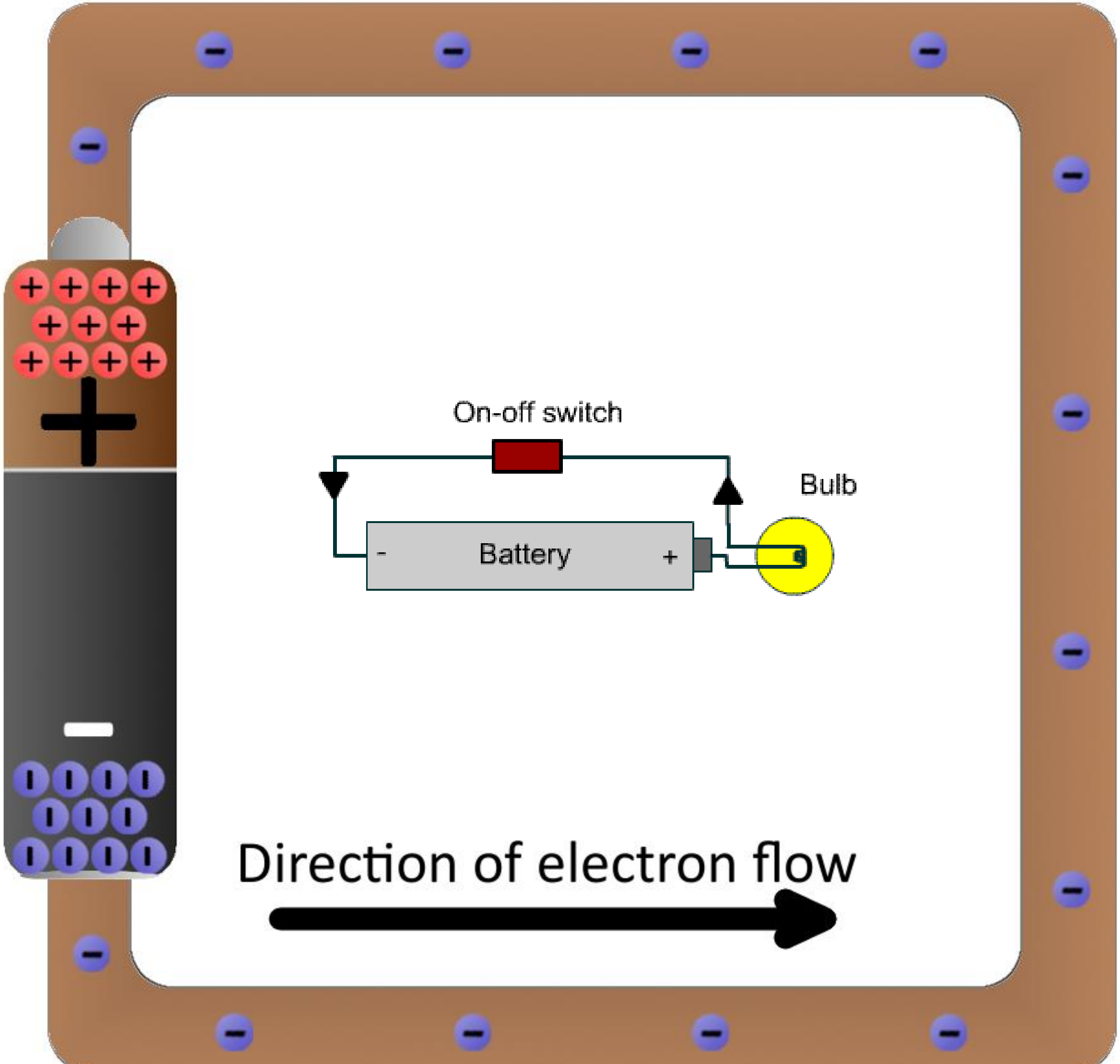
No connection, no current flow

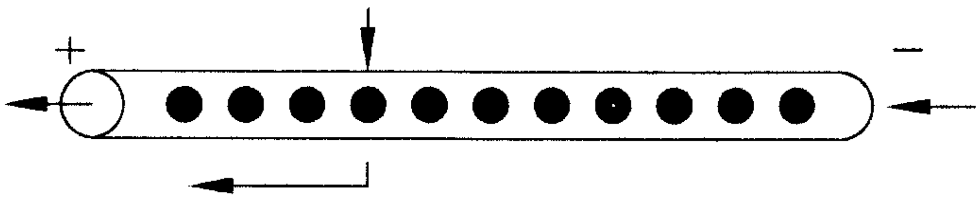





Electrical conductor
with free electrons

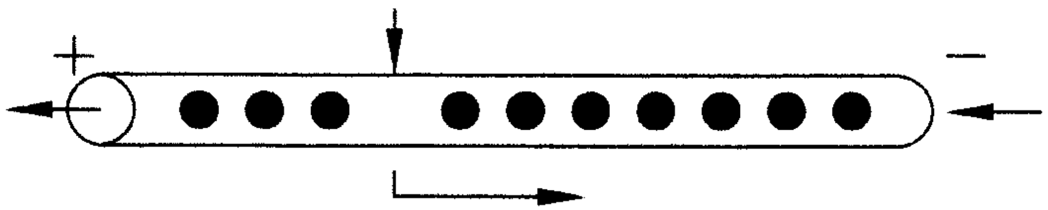

Electrical conductor
with free electrons


On-off switch
Bulb
-
Battery
+
Direction of electron flow



B020205

Electron current



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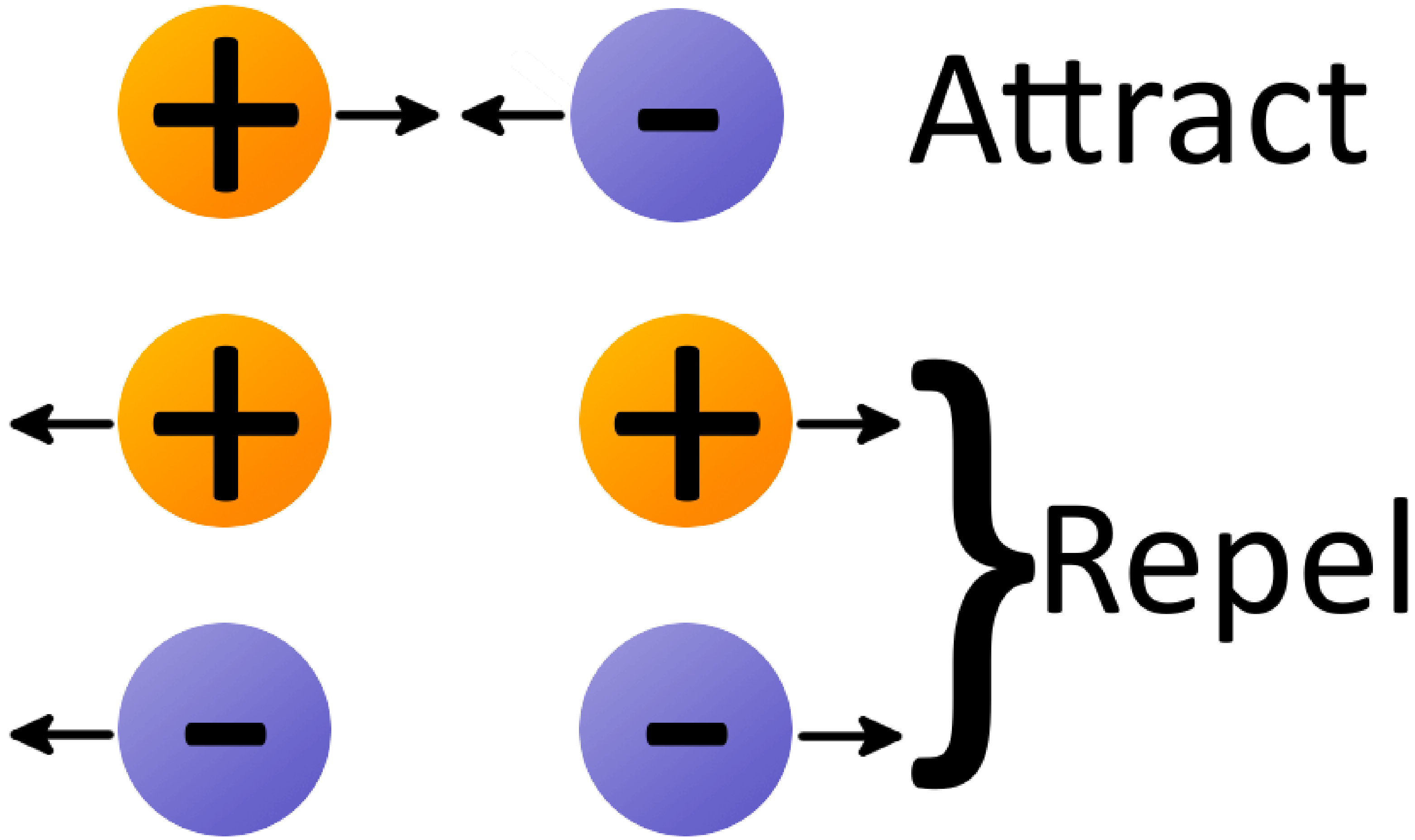
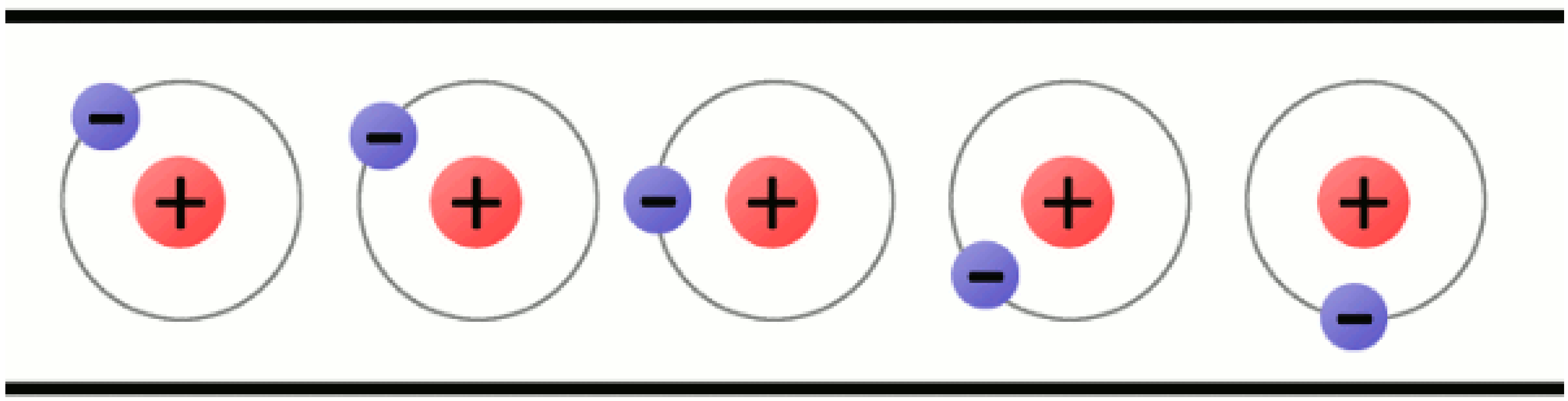
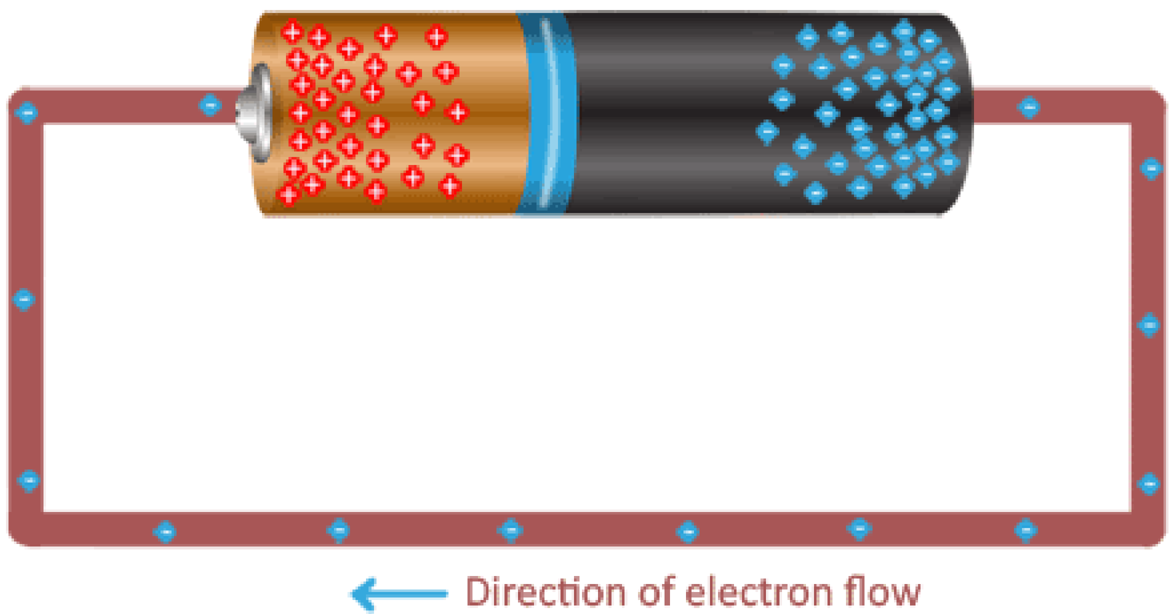
Conventional current

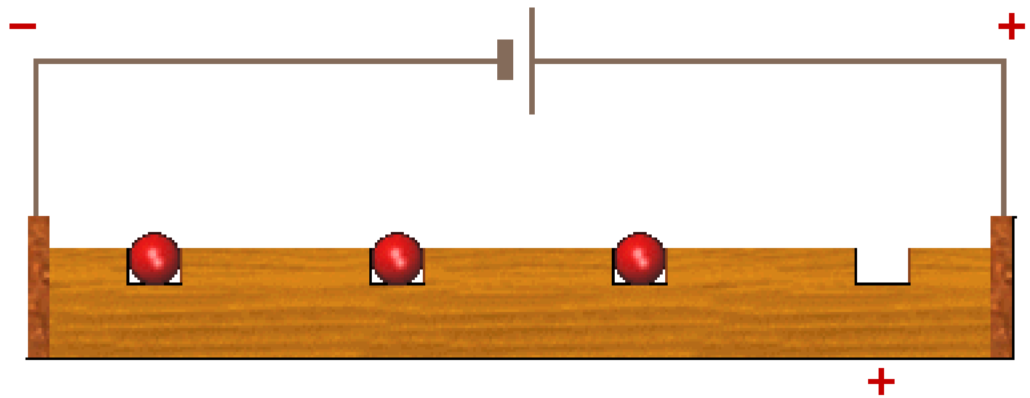
So why do the electrons line up and move?

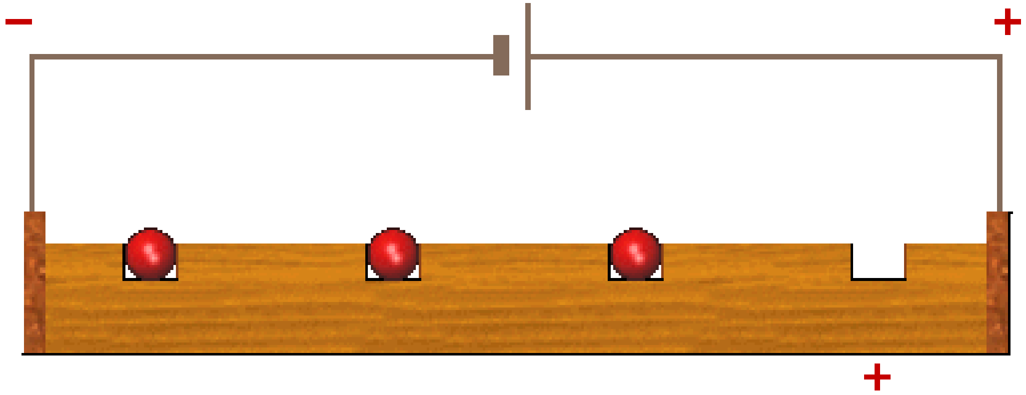




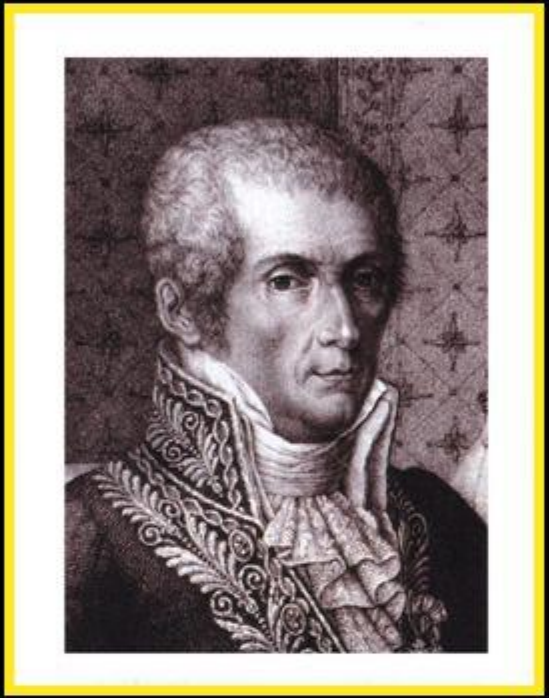


(Conventionally, direction of current is shown from positive to negative)





Electrical Circuits



ALESSANDRO VOLTA
(1745-1827)

ANDRE MARIE AMPERE
(1775-1836)

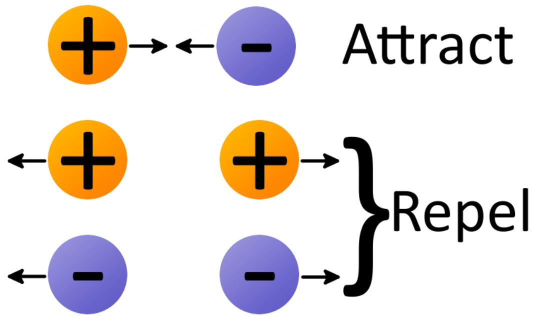
GEORG SIMON OHM
(1789-1854)

So what exactly is current?

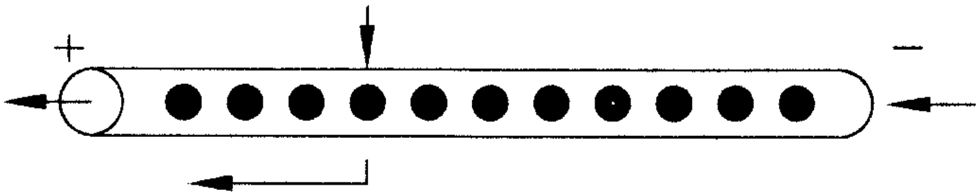
Current is the flow of electric charge

So current is really the movement (flow) of electrons along a conductor

We measure current flow in Amperes (Amps) and use the symbol I (or i)



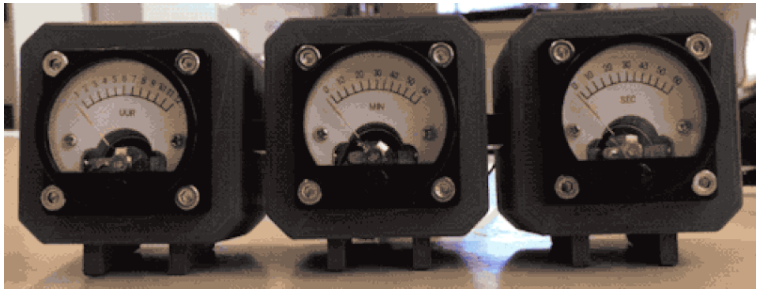
So what makes the electrons move?



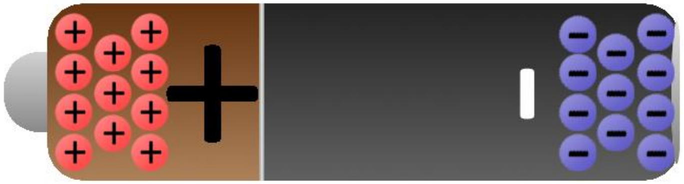
B020205

It takes work to push an extra electron in…

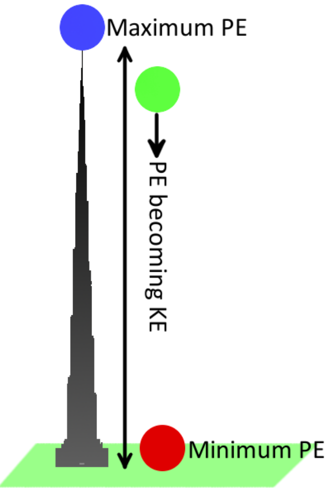
We call that work voltage and use the symbol V



That work can be mechanical (friction or pressure), chemical, photovoltaic (light) or magnetic.



Voltage is really a measure of the energy of electrons.

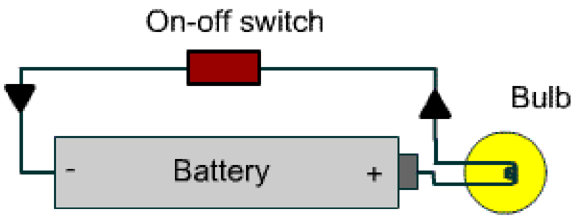


Electrons have potential energy and will flow from a point of high potential energy to a point of lower potential energy.

The difference in energy levels is referred to as the potential difference

Since it makes electrons move, it is also called the Electromotive Force (<u>E</u>MF).
E and V both mean essentially the same thing.

Why did the light bulb light?

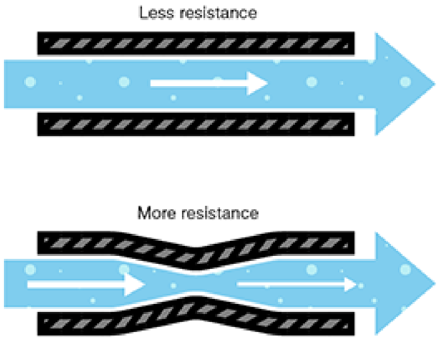


The repulsion of that extra electron by one already there resists its movement, i.e. there is resistance

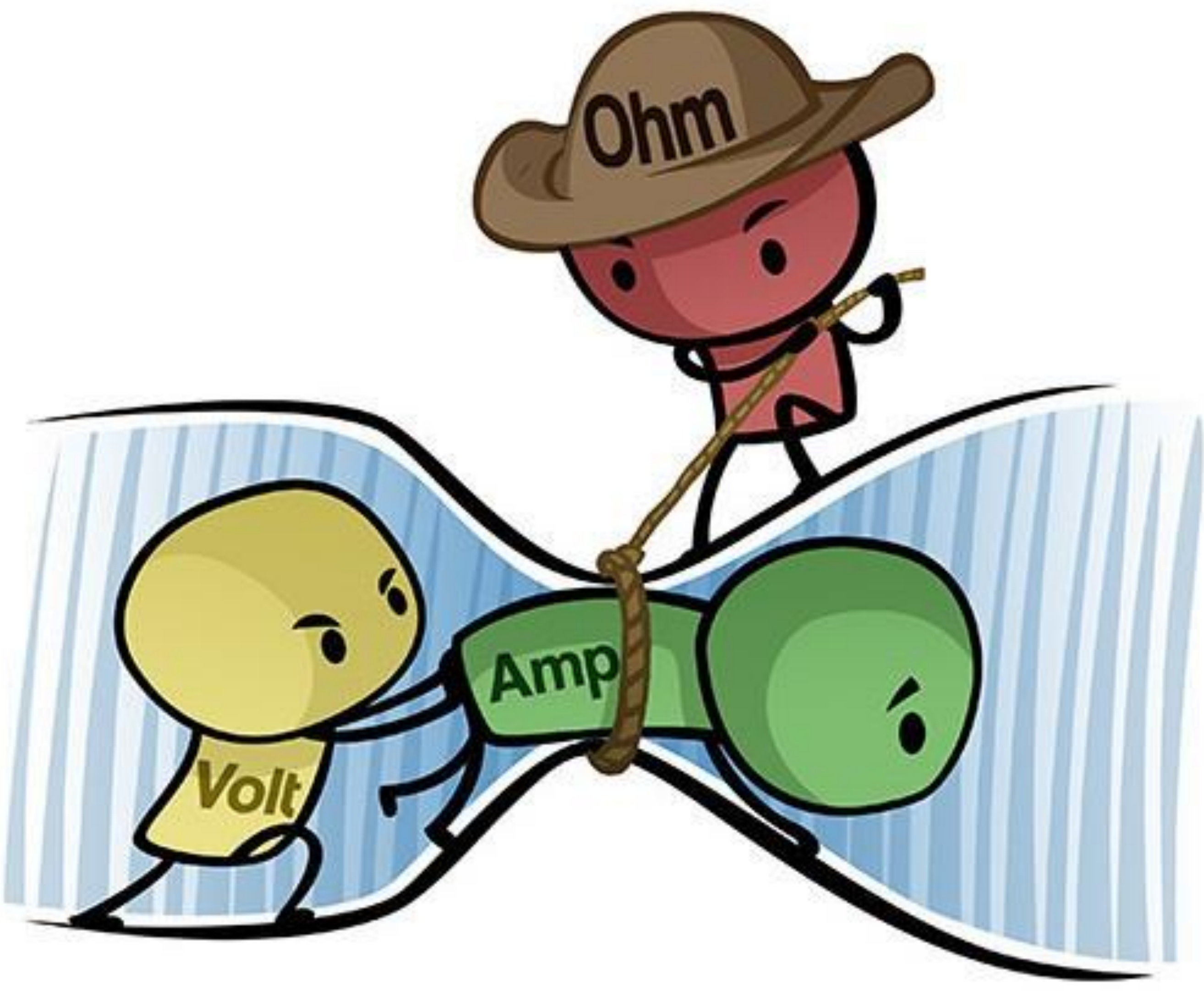
Resistance depends on the composition of a conductor, it’s length, diameter and the temperature.

It is measured in Ohms (Ω)

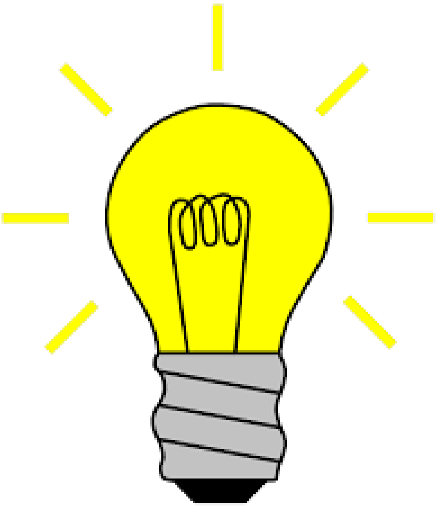
1 Ω permits 1 V to push 1 A along a conductor



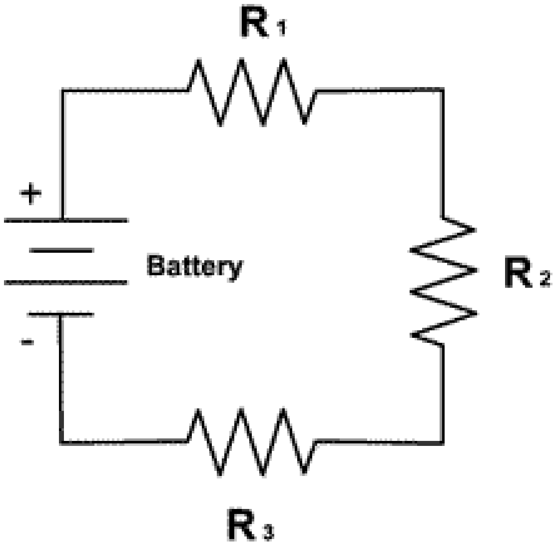
1 Ω permits 1 V to push 1 A along a conductor



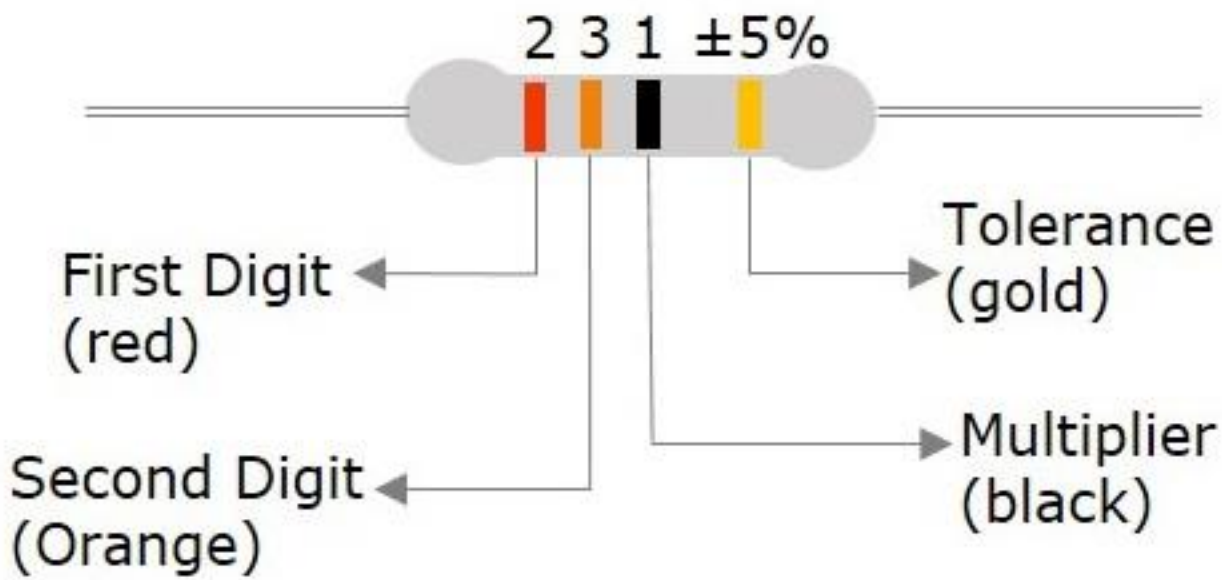
Resistance to electron flow results in conversion of energy to heat and light



Resistance is present in every electrical circuit. We use known resistance in the design of circuits.



Color coding of Resistors



A 23Ω resistor

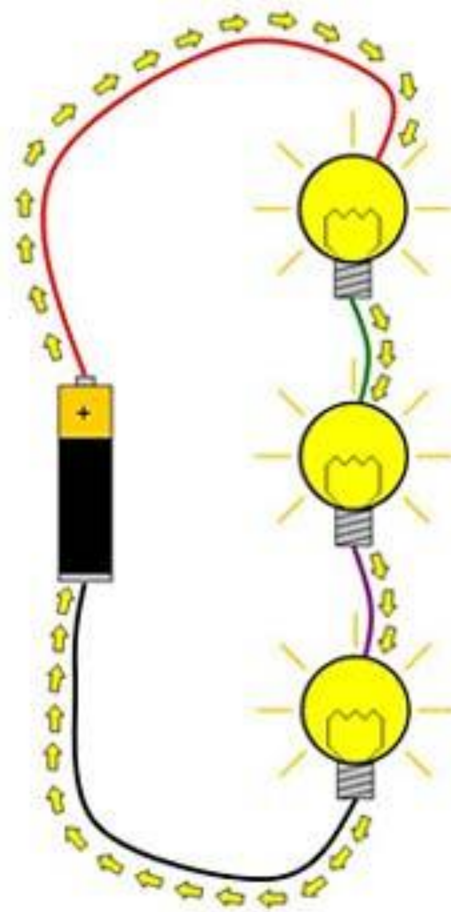
23 x 1 ohms with a tolerance rating of ±5%

4 band color code resistor

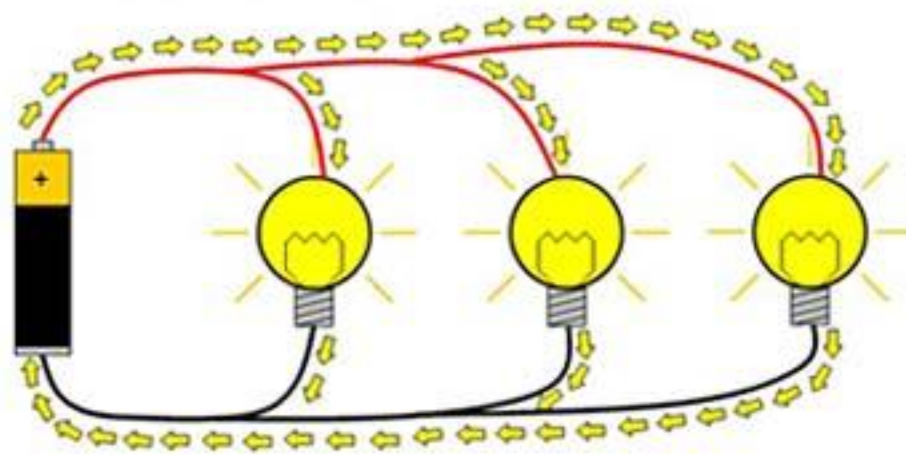
Color	1st digit	2nd digit	Multiplier	Tolerance
Black	0	0	10^0	
Brown	1	1	10^1	1% (F)
Red	2	2	10^2	2% (G)
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	0.5% (D)
Blue	6	6	10^6	0.25% (C)
Violet	7	7	10^7	0.10% (B)
Gray	8	8	10^8	0.05%
White	9	9	10^9	
Gold			10^{-1}	5% (J)
Silver			10^{-2}	10% (K)

Bad Booze Rots Our Young Guts But Vodka Goes Well.

Series circuit



Parallel circuit



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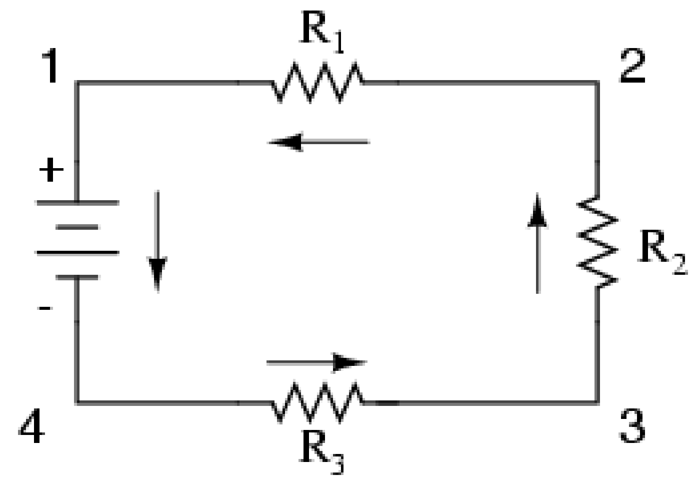
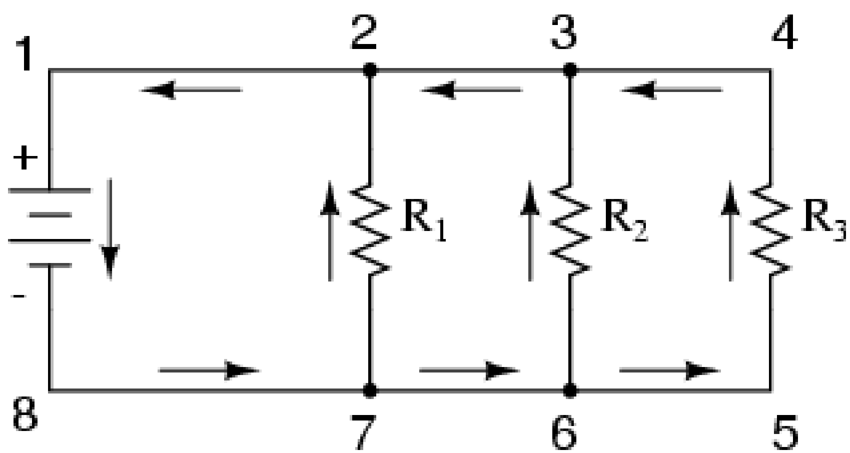
Series connection

only one path for electrons to flow!

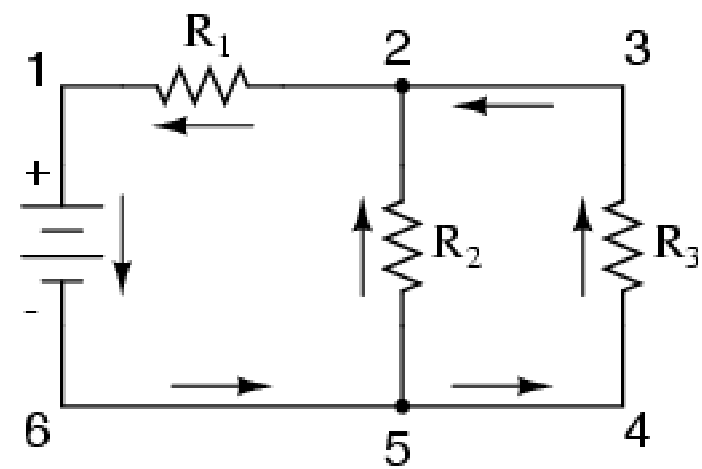
Series



Parallel

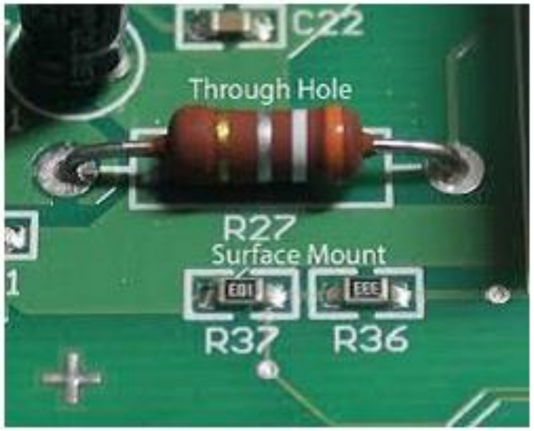


Series-parallel

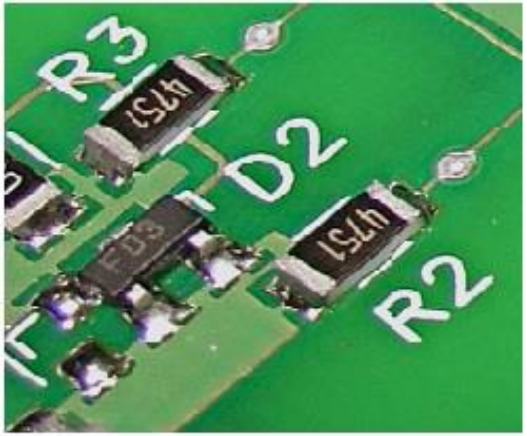


Types of resistors

Fixed



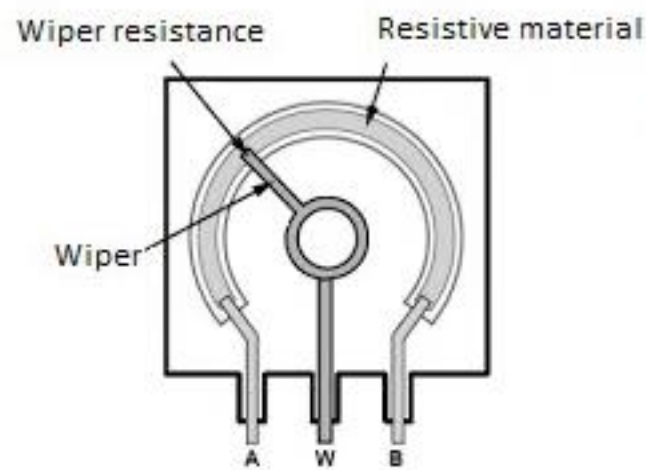
Surface mount resistor when compared to the size of a normal resistor



Surface mount resistors mounted on a PCB

Variable resistors

Image of a Potentiometer

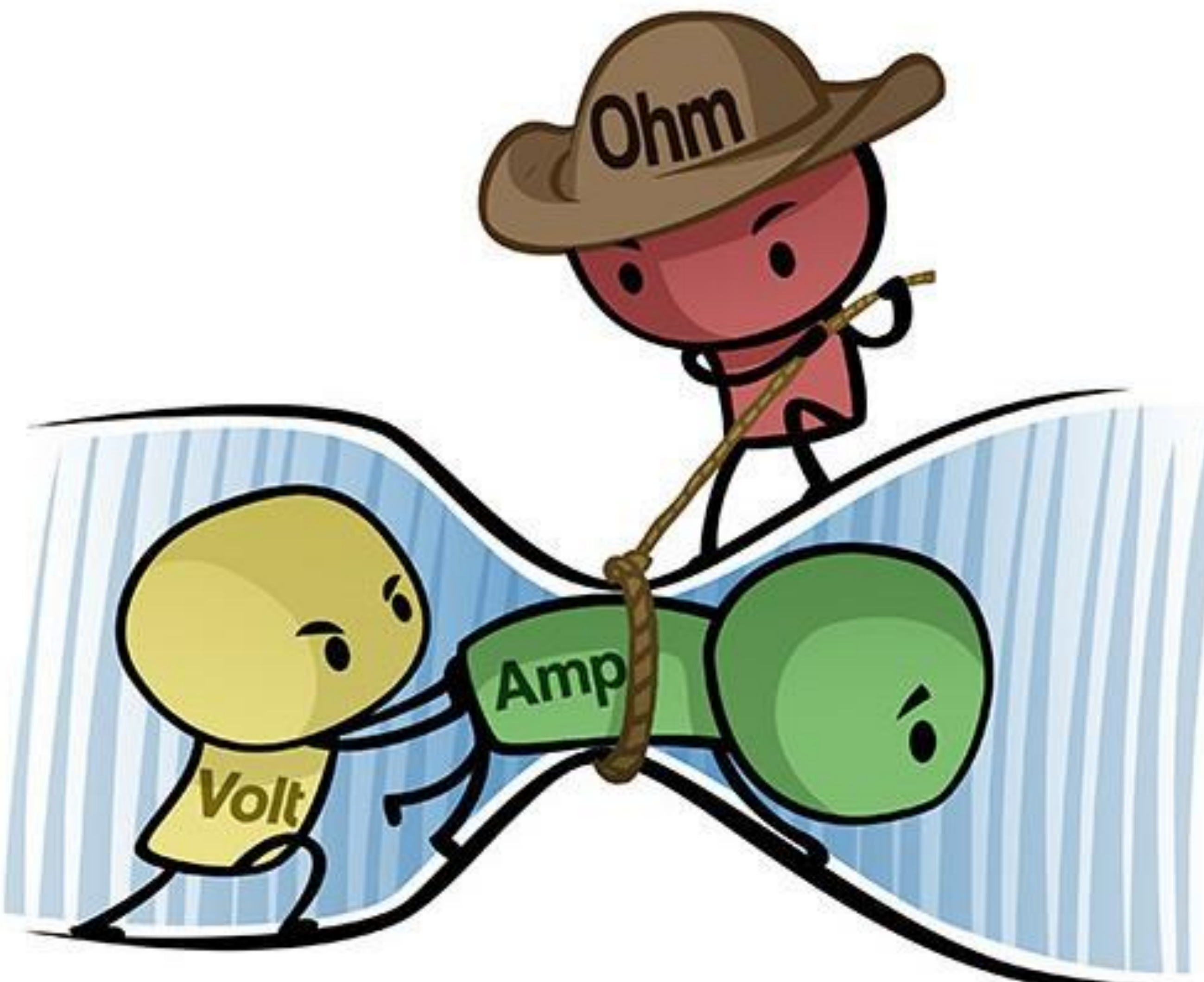


Internal structure of a Pot

Single tube Rheostat

Double tube Rheostat

Images showing different types of Trim Pots


Ohm
Amp
Volt

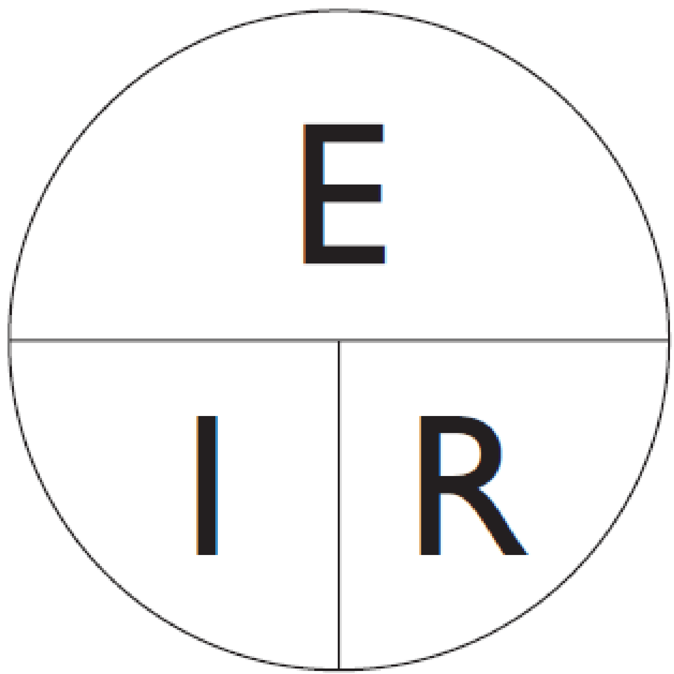
Ohm's Law

"Ohm, Ohm on the range"

$$E = I \times R$$

$$I = E \div R$$

$$R = E \div I$$



Pressure	=	increase	**Voltage**	=	increase
Flow rate	=	increase	**Current**	=	increase
Resistance	=	same	**Resistance**	=	same

$$\overset{\uparrow}{E} = \overset{\uparrow}{I}\ R$$

If the resistance to water flow stays the same and the pump pressure increases, the flow rate must also increase.

Pressure	= same	**Voltage**	= same
Flow rate	= decrease	**Current**	= decrease
Resistance	= increase	**Resistance**	= increase

$$E = \underset{\downarrow}{I}\ \overset{\uparrow}{R}$$

If the pressure stays the same and the resistance increases (making it more difficult for the water to flow), then the flow rate must decrease:

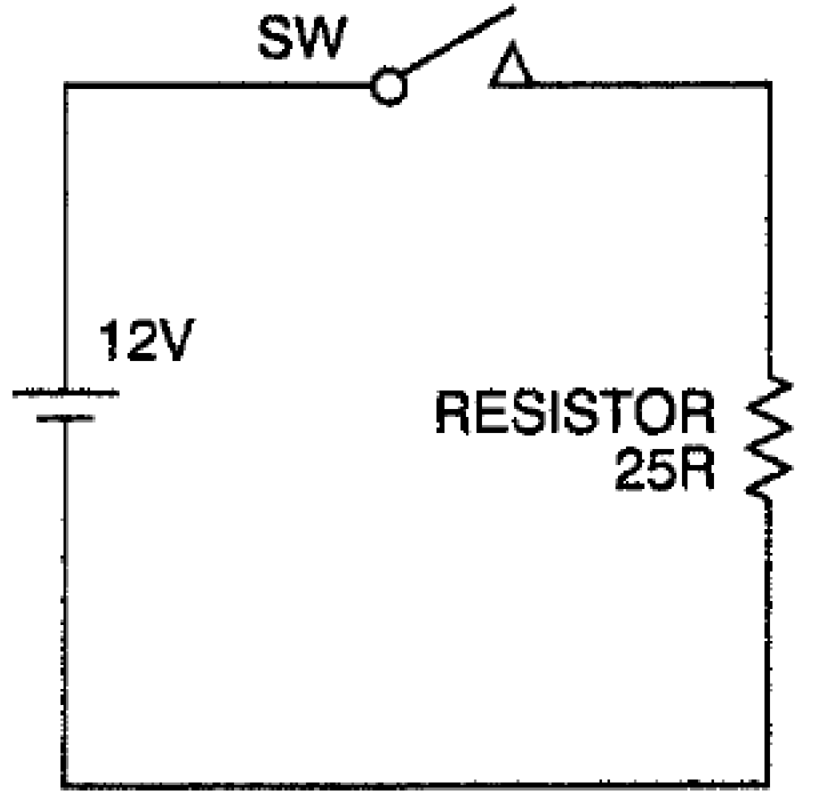
Pressure = decrease		**Voltage** = decrease	
Flow rate = same		**Current** = same	
Resistance = decrease		**Resistance** = decrease	

$$E = I\ R$$

$$\downarrow \qquad\quad \downarrow$$

If the flow rate were to stay the same while the resistance to flow decreased, the required pressure from the pump would necessarily decrease:

Calculations



i = 0.48A

= 480 mA

PREFIX	SYMBOL	MULTIPLIER	EXPONENT FORM
exa	E	1, 000, 000, 000, 000, 000, 000	10^{18}
peta	P	1, 000, 000, 000, 000, 000	10^{15}
tera	T	1, 000, 000, 000, 000	10^{12}
giga	G	1, 000, 000, 000	10^{9}
mega	M	1, 000, 000	10^{6}
kilo	k	1, 000	10^{3}
hecto	h	100	10^{2}
deca	da	10	10^{1}
Basic Unit	Basic Unit	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0. 001	10^{-3}
micro	μ	0. 000, 001	10^{-6}
nano	n	0. 000, 000, 001	10^{-9}
pico	p	0. 000, 000, 000, 001	10^{-12}
femto	f	0. 000, 000, 000, 000, 001	10^{-15}
atto	a	0. 000, 000, 000, 000, 000, 001	10^{-18}

Practice the calculations in the book both in Chapter 3 and in the Appendix and at IC *NB

B-005-1-6 A kilohm is:

1. 0.1 ohm
2. 0.001 ohm
3. 10 ohms
4. 1000 ohms

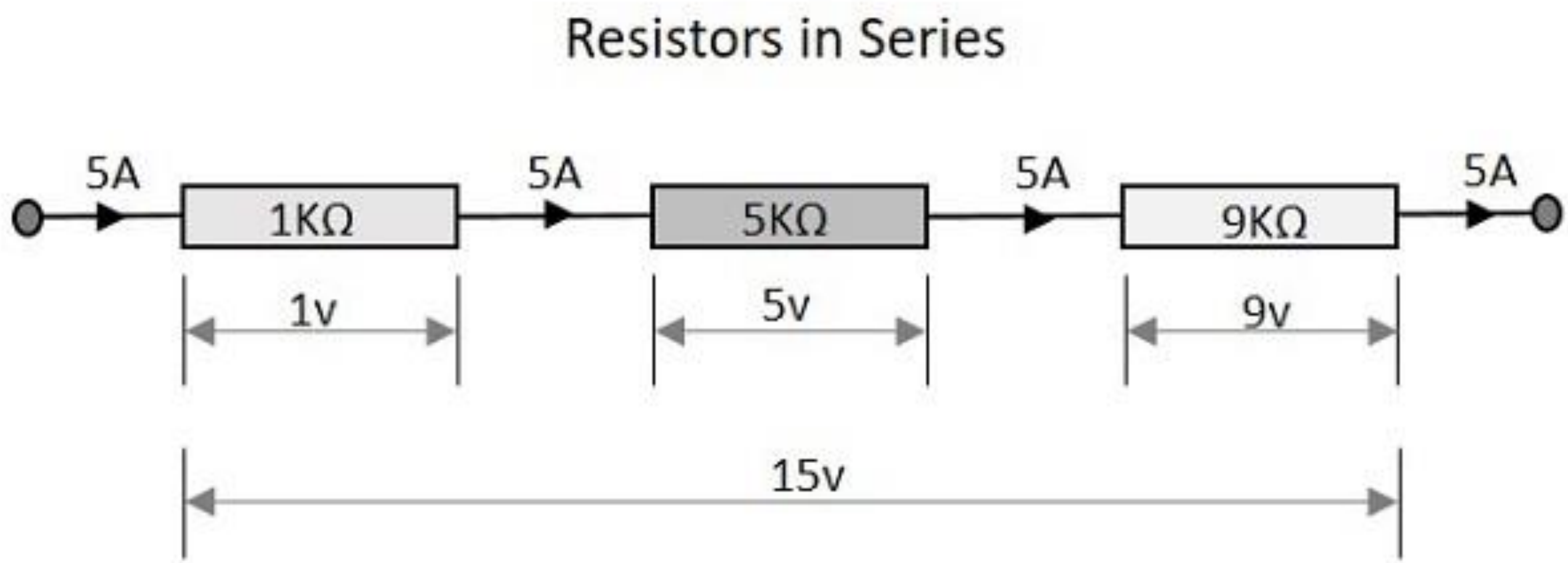
B-005-1-9 How many millivolts are equivalent to two volts?

1. 0.000002
2. 2 000
3. 2 000 000
4. 0.002

B-005-1-2 If an ammeter marked in amperes is used to measure a 3000 milliampere current, what reading would it show?

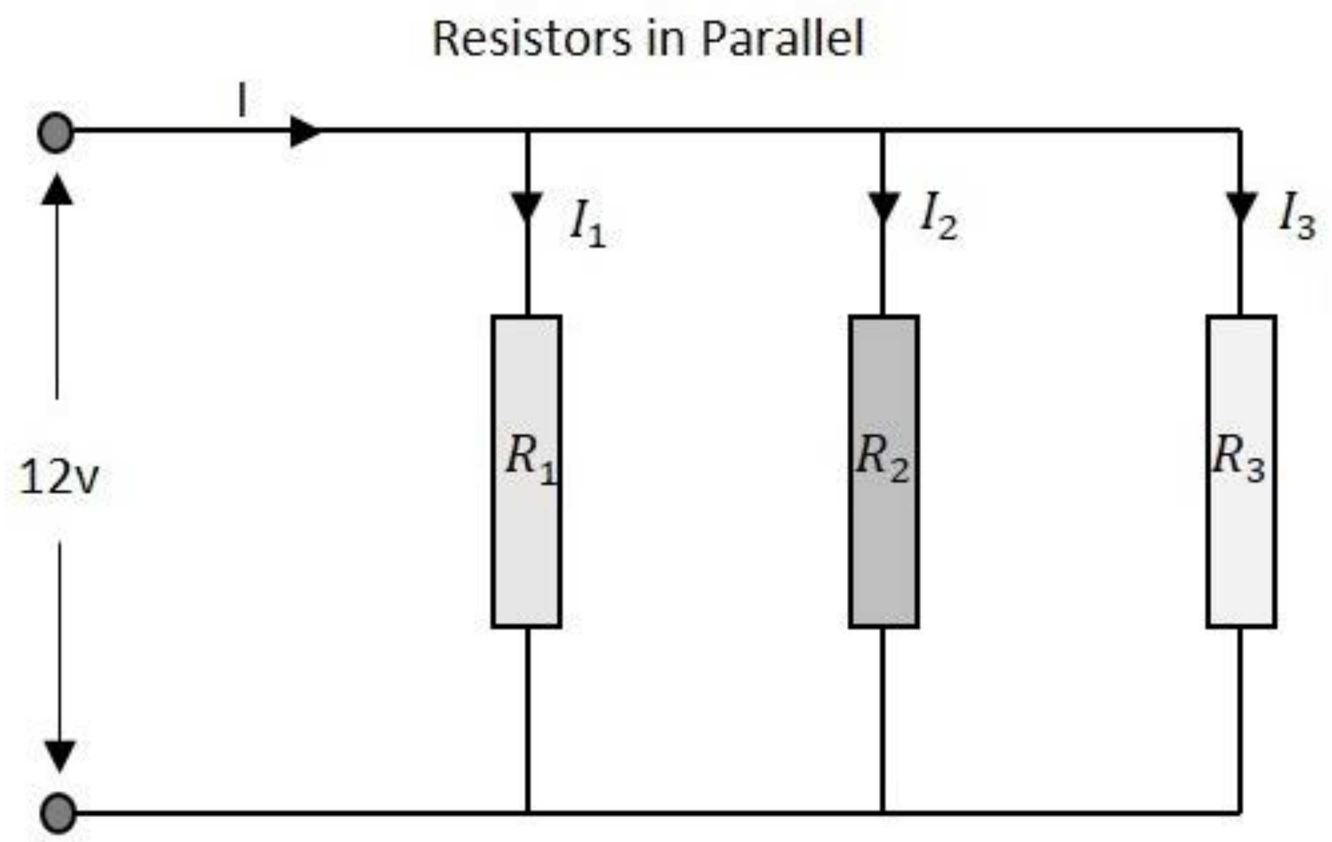
1. 3 amperes
2. 0.003 ampere
3. 0.3 ampere
4. 3 000 000 amperes

Series and Parallel calculations



$$R_T = R_1 + R_2 + R_3 + \ldots \qquad \text{Eqn 3-4}$$

$$E_T = E_1 + E_2 + E_3 + \ldots \qquad I_T = I_1 = I_2 = I_3 \ldots$$

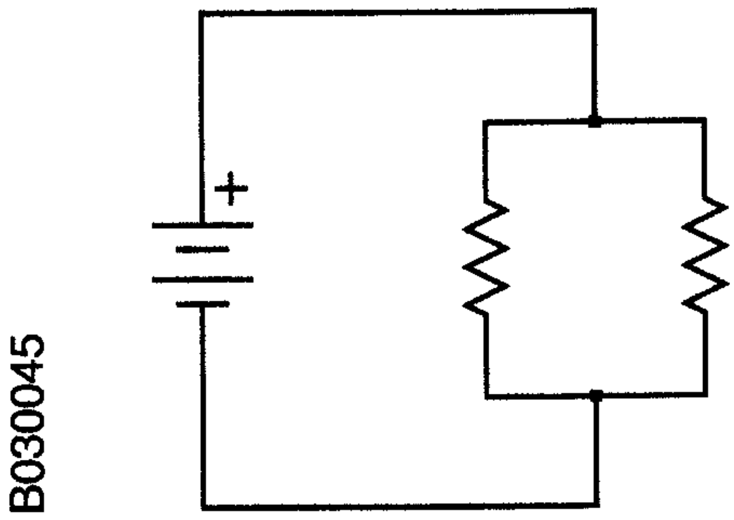


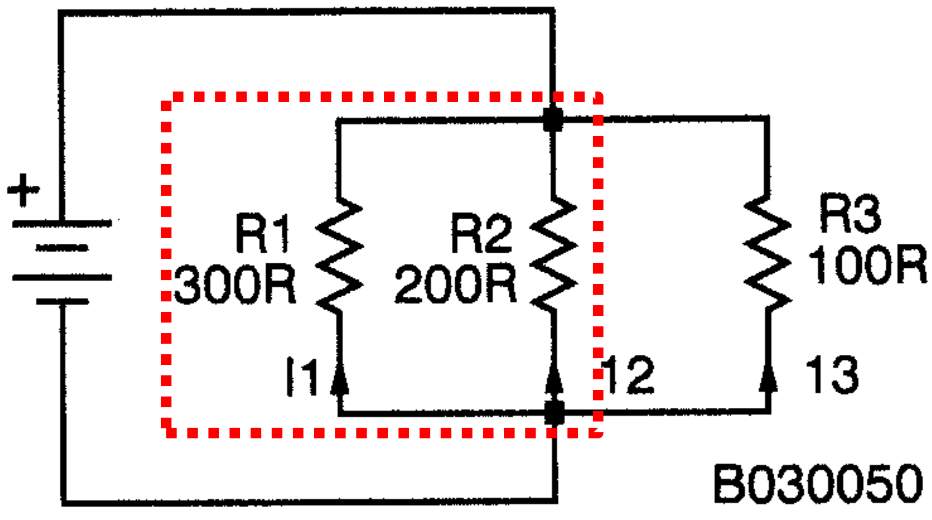
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \qquad \text{Eqn 3-7}$$

$$E = E_1 = E_2 = \ldots \qquad I_T = I_1 + I_2 + I_3 + \ldots$$

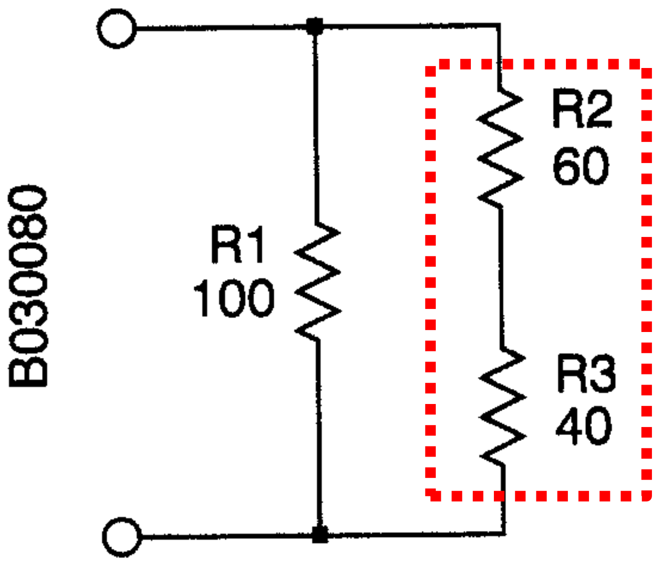
For two in parallel:

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$

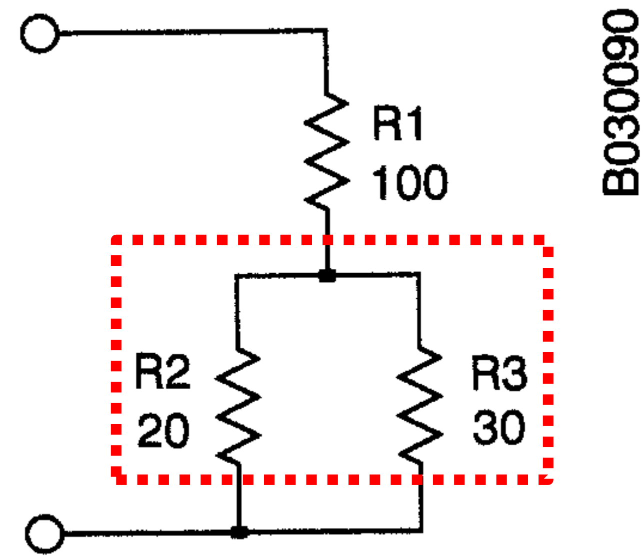




For mixed series and parallel circuits:



Series first



Parallel first

Power

Power is the rate of doing work

$$P = E \times I \qquad \text{Eqn 3-11}$$

$$P = \frac{E^2}{R} \qquad \text{Eqn 3-12}$$

$$P = I^2 \times R \qquad \text{Eqn 3-13}$$

If, $1 = \frac{E}{R}$ *and* $P = 1\,E$

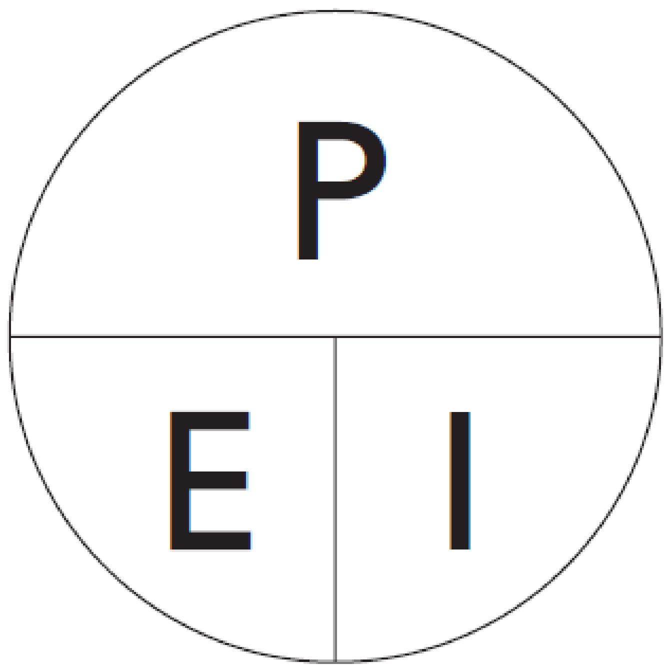
Then, $P = \frac{E}{R}\,E$ *or* $\mathbf{P = \frac{E^2}{R}}$

If, $E = 1\,R$ *and* $P = 1\,E$

Then, $P = 1(1\,R)$ *or* $\mathbf{P = I^2 R}$

Power equations

$$P = IE \qquad P = \frac{E^2}{R} \qquad P = I^2R$$



B-005-6-2 How many watts of electrical power are used by a 12-VDC light bulb that draws 0.2 ampere?

1. 2.4 watts
2. 60 watts
3. 24 watts
4. 6 watts

B-005-6-3 The DC input power of a transmitter operating at 12 volts and drawing 500 milliamps would be:

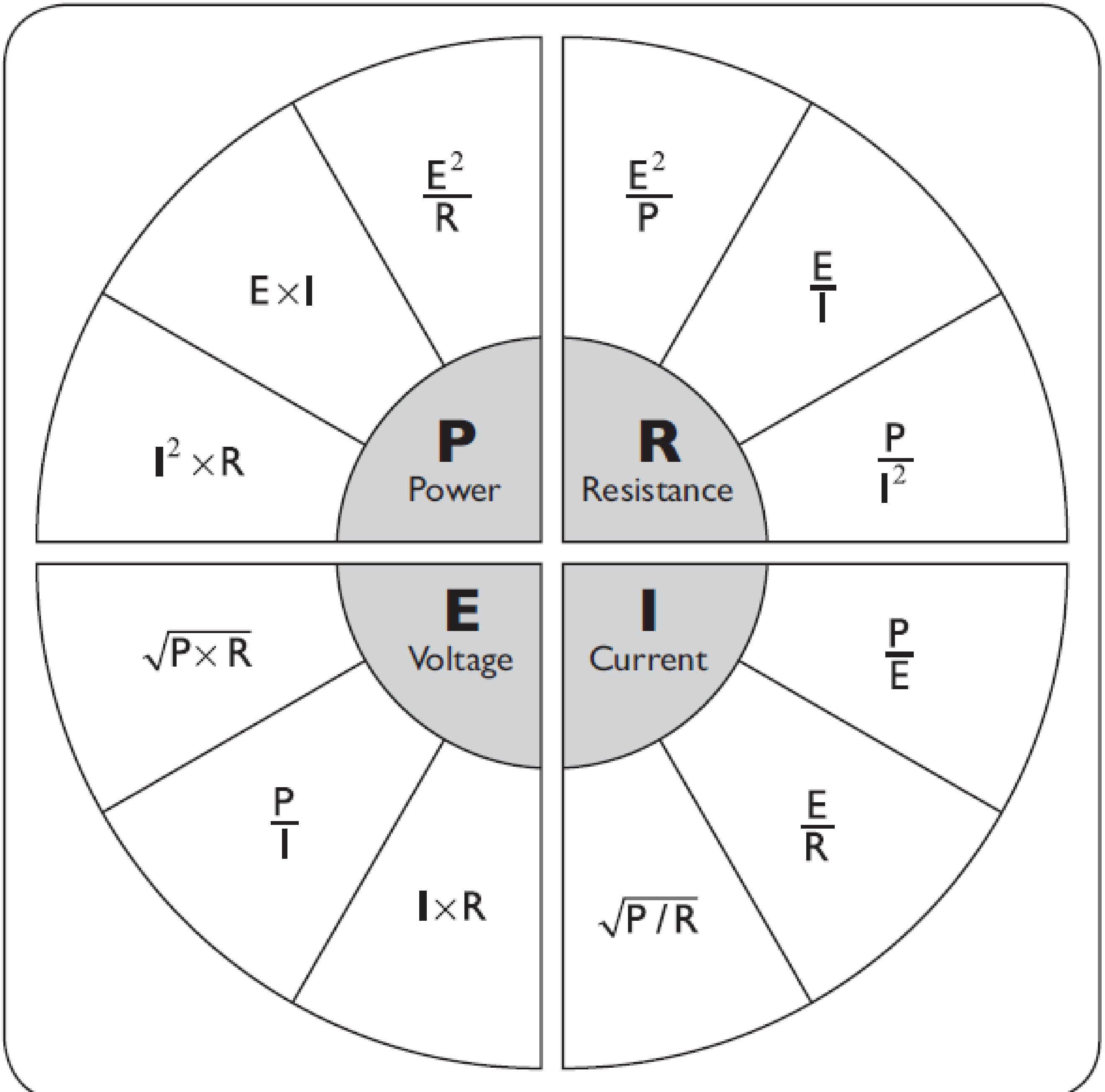
1. 20 watts
2. 6 watts
3. 500 watts
4. 12 watts

B-004-6-10 A resistor with a colour code of brown, black and red would have a value of:

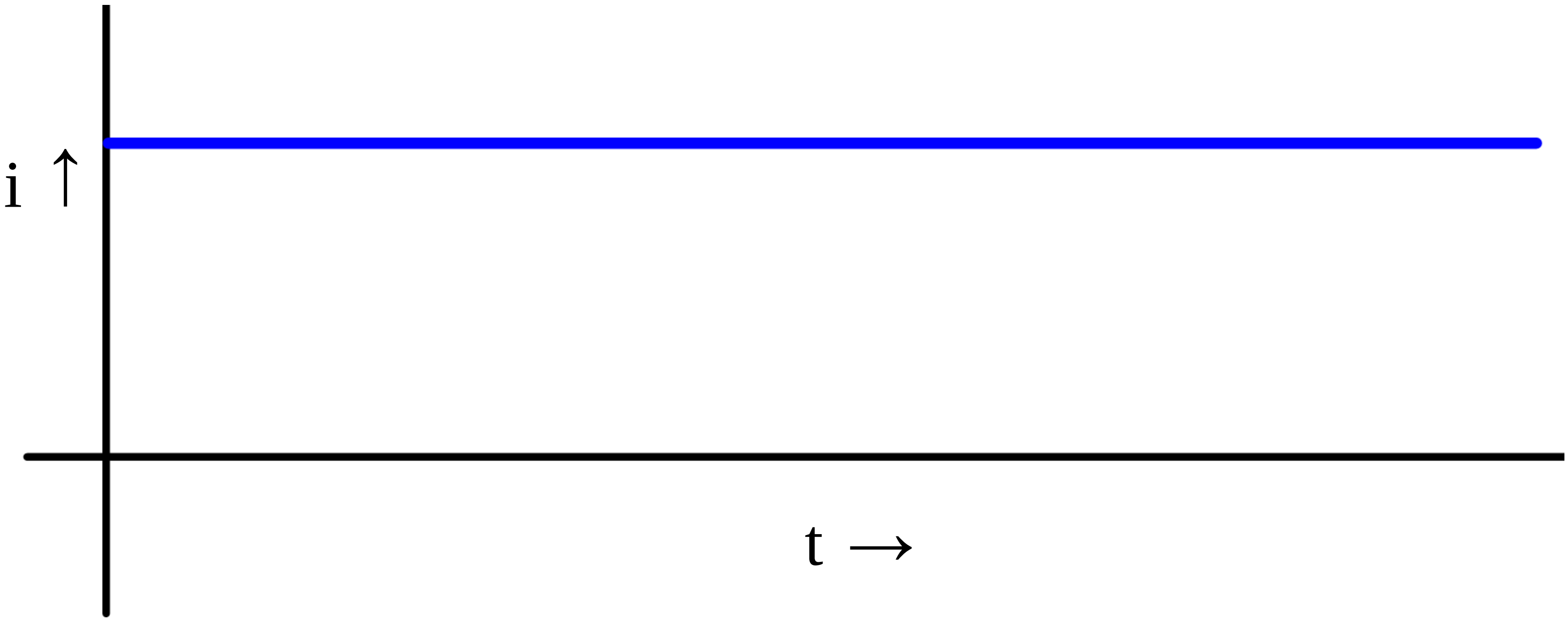
1. 1000 ohms
2. 100 ohms
3. 10 ohms
4. 10 000 ohms

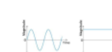
4 band color code resistor

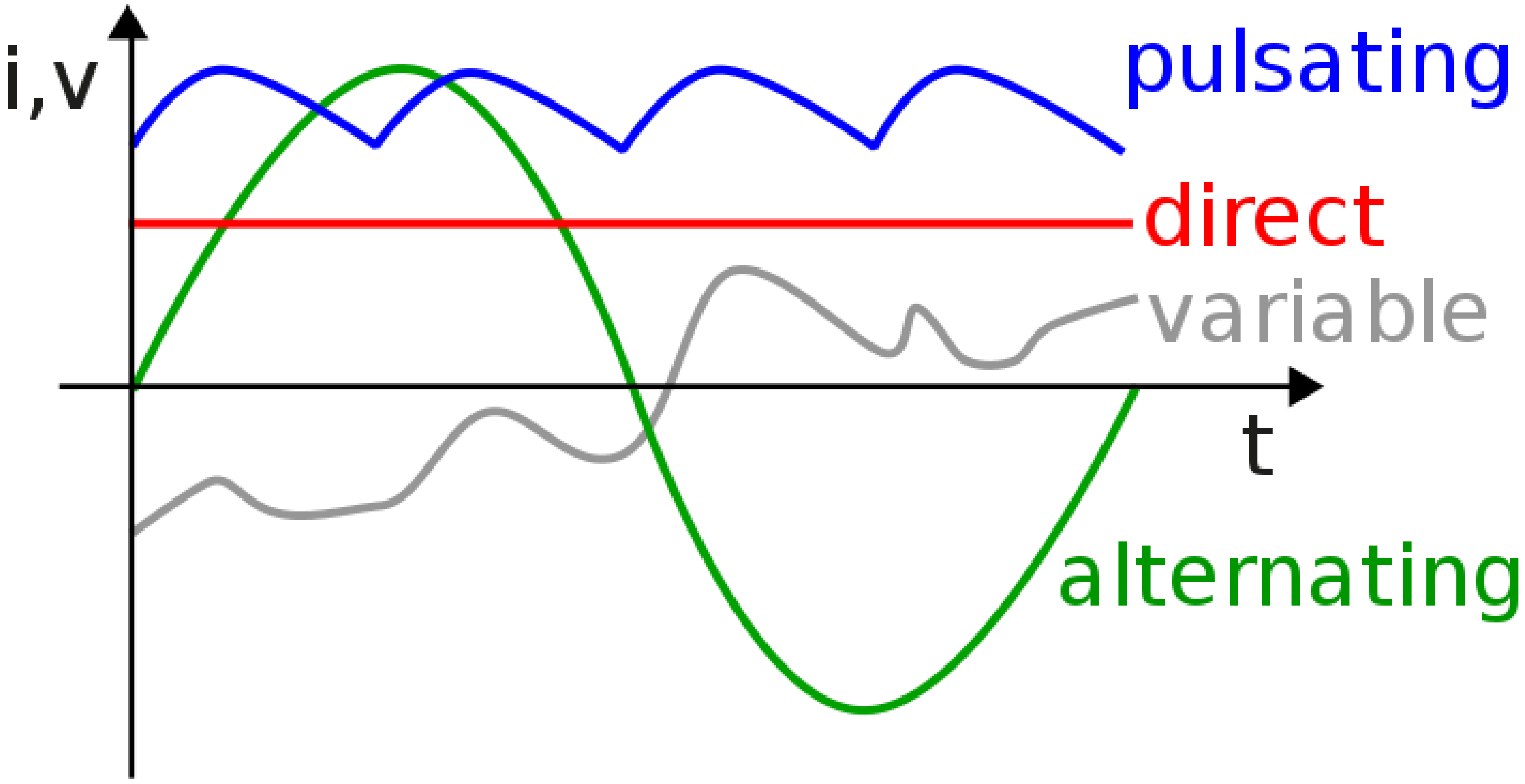
Color	1st digit	2nd digit	Multiplier	Tolerance
Black	0	0	10^0	
Brown	1	1	10^1	1% (F)
Red	2	2	10^2	2% (G)
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	0.5% (D)
Blue	6	6	10^6	0.25% (C)
Violet	7	7	10^7	0.10% (B)
Gray	8	8	10^8	0.05%
White	9	9	10^9	
Gold			10^{-1}	5% (J)
Silver			10^{-2}	10% (K)


P
Power
$\frac{E^2}{R}$
$E \times I$
$I^2 \times R$
R
Resistance
$\frac{E^2}{P}$
$\frac{E}{I}$
$\frac{P}{I^2}$
E
Voltage
$\sqrt{P \times R}$
$\frac{P}{I}$
$I \times R$
I
Current
$\frac{P}{E}$
$\frac{E}{R}$
$\sqrt{P / R}$

Now we need to look at different types of current.

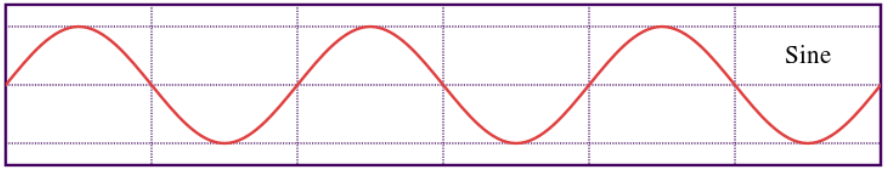


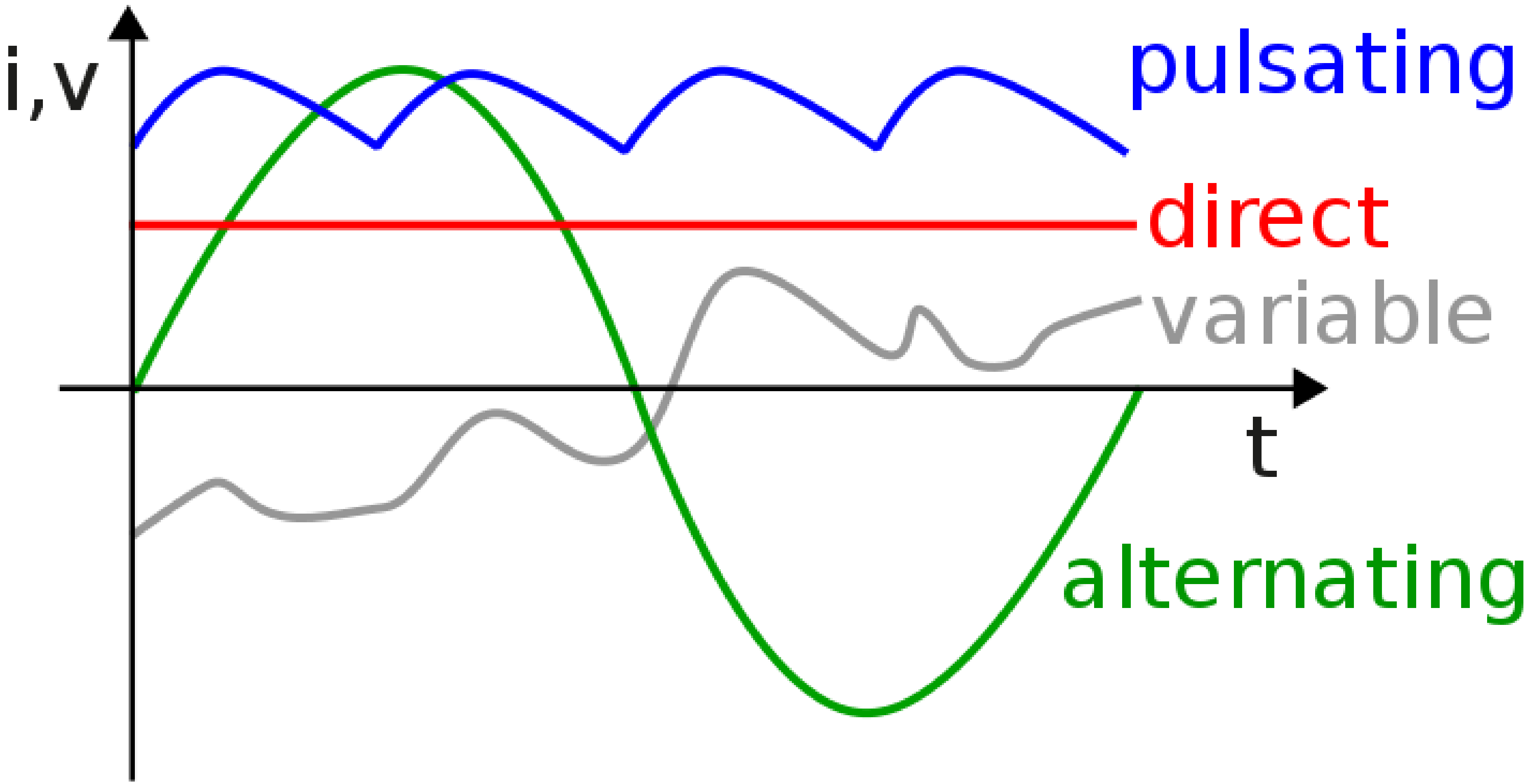



i,v
pulsating
direct
variable
t
alternating

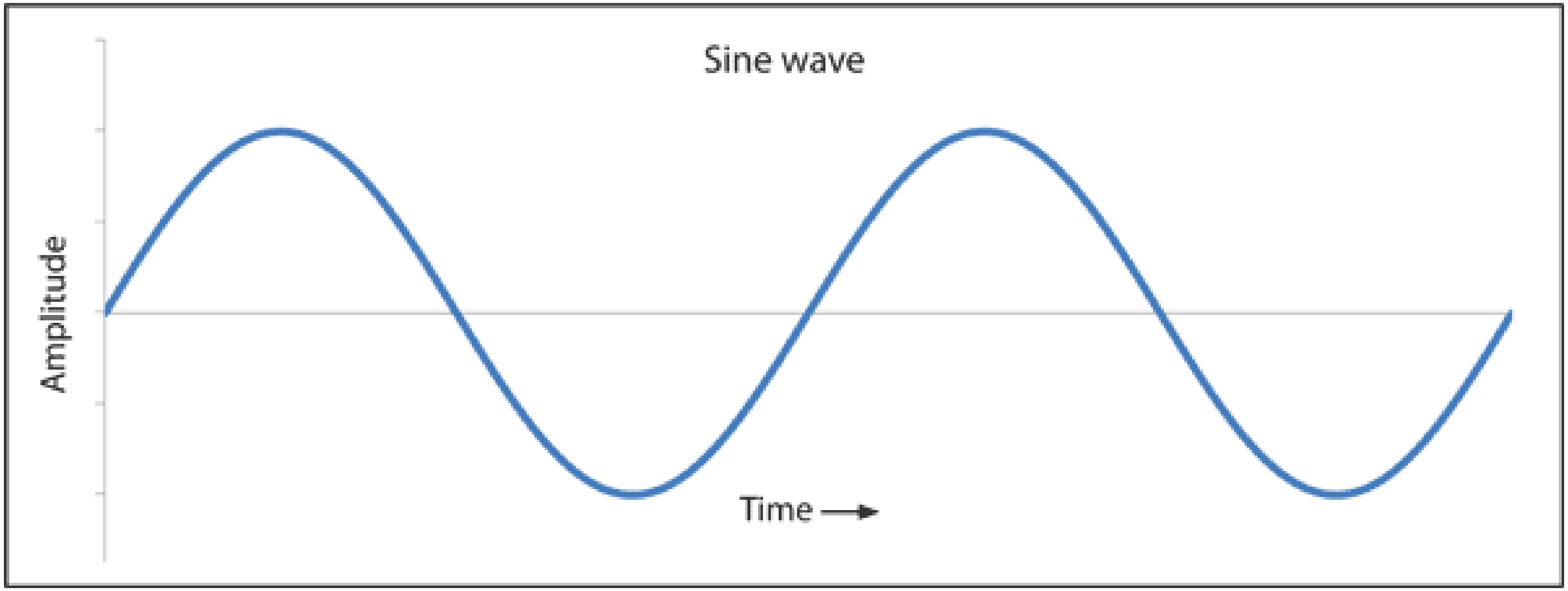
We have been dealing with Direct Current. The important property of DC is that current flows in one direction only.

Now we need to understand Alternating Current (AC) which reverses direction periodically.





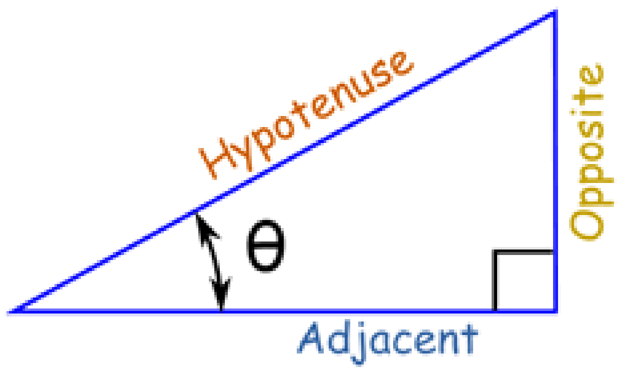
How many of these four types of current are AC?

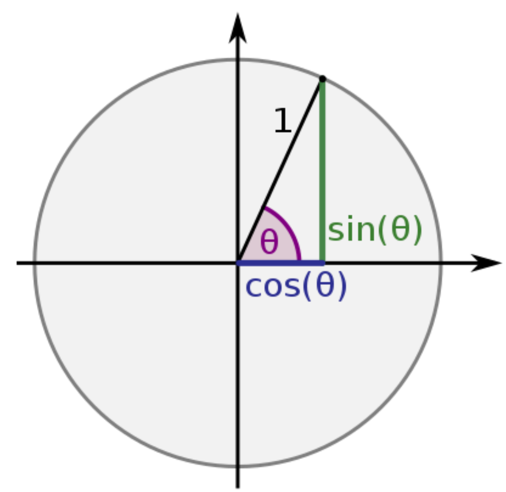


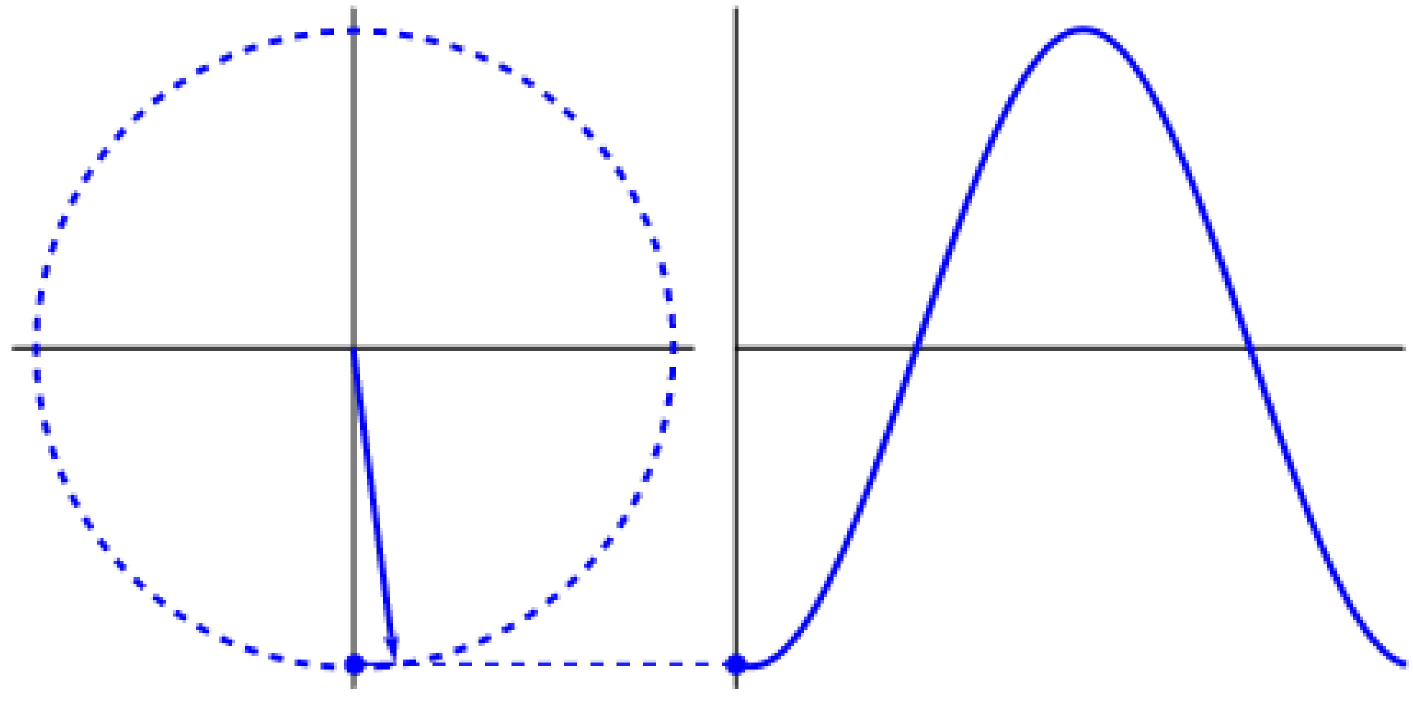
$$\sin\theta = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

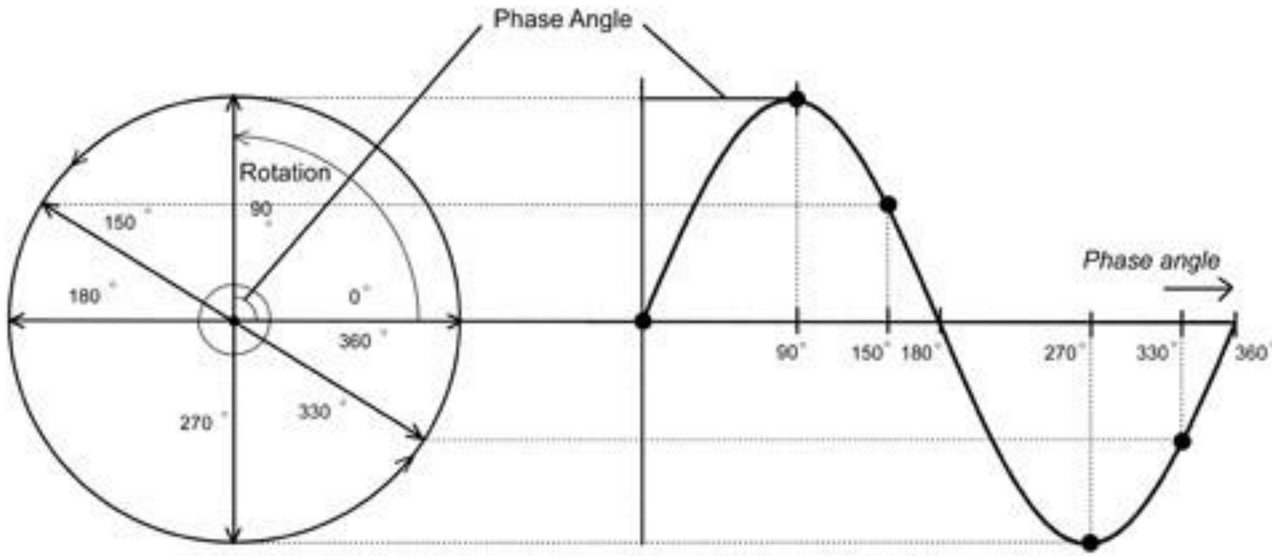
$$\cos\theta = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

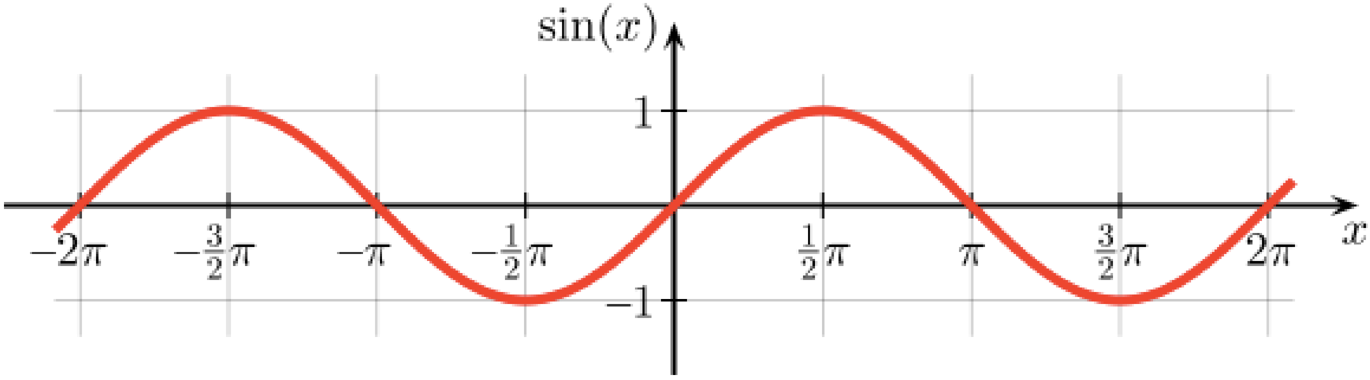
$$\tan\theta = \frac{\text{Opposite}}{\text{Adjacent}}$$

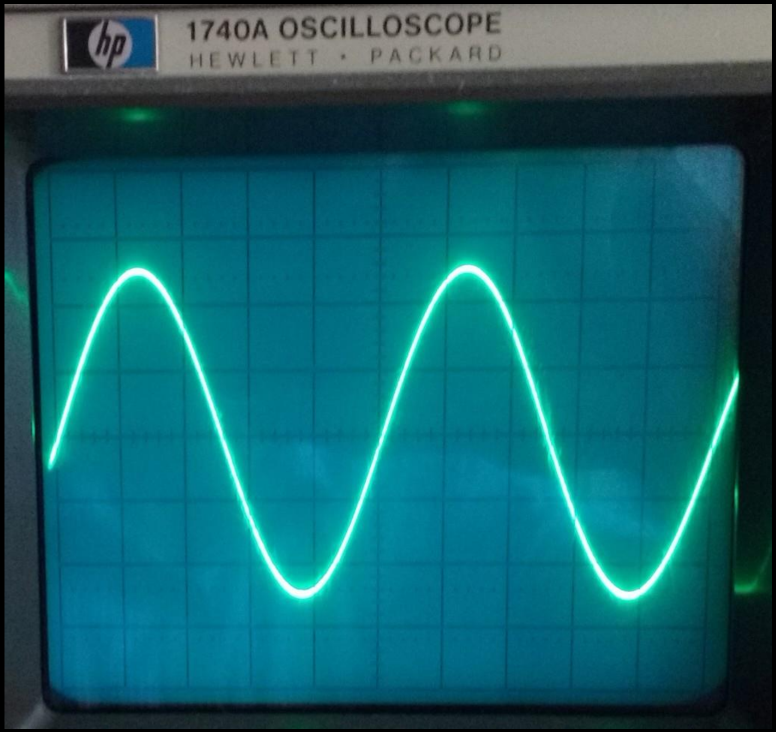


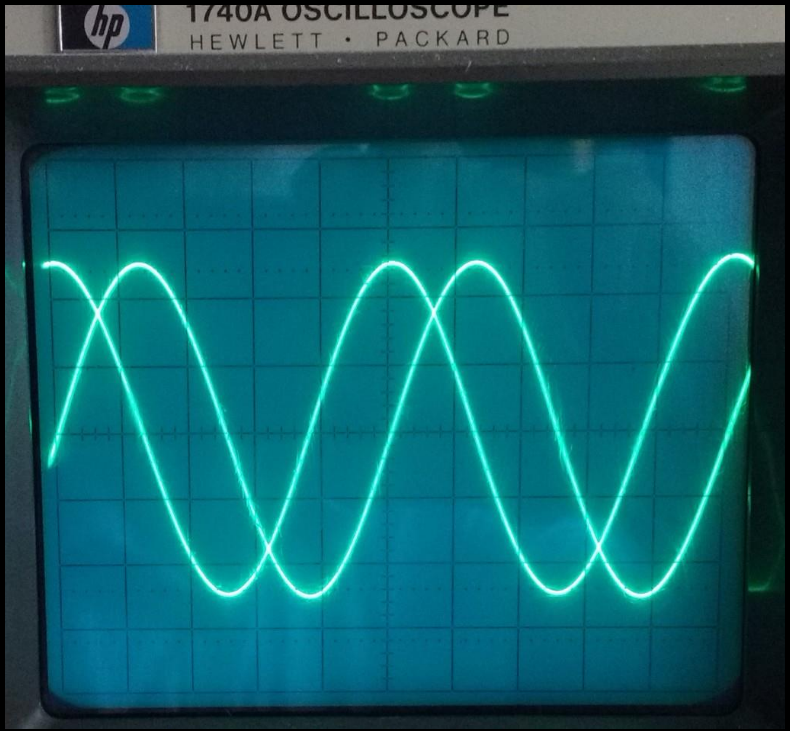




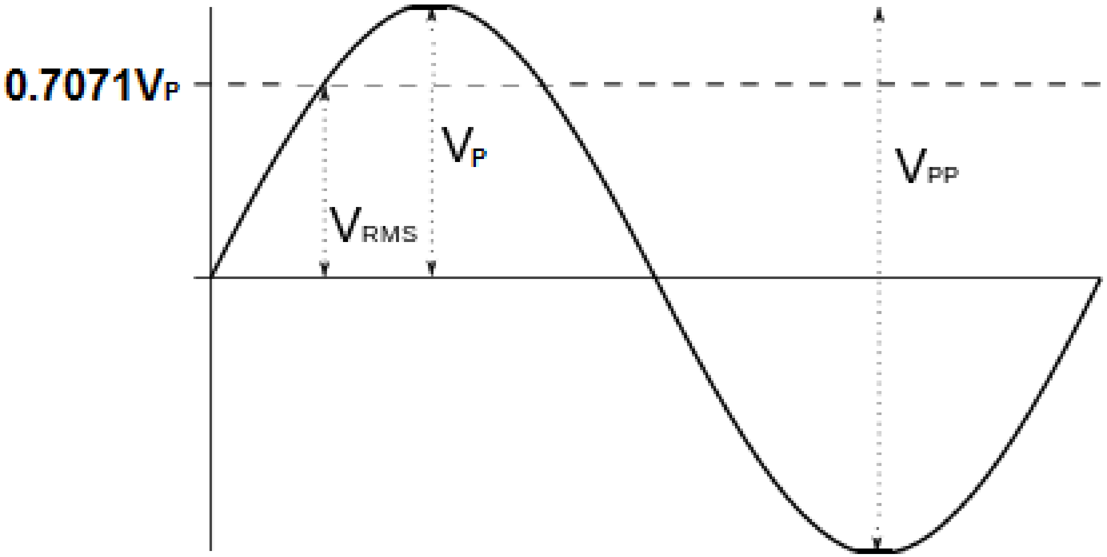

Phase Angle
Rotation
90°
150°
180°
0°
360°
270°
330°
Phase angle
90°
150°
180°
270°
330°
360°


sin(x)
1
−1
x
−2π
−3/2π
−π
−1/2π
1/2π
π
3/2π
2π





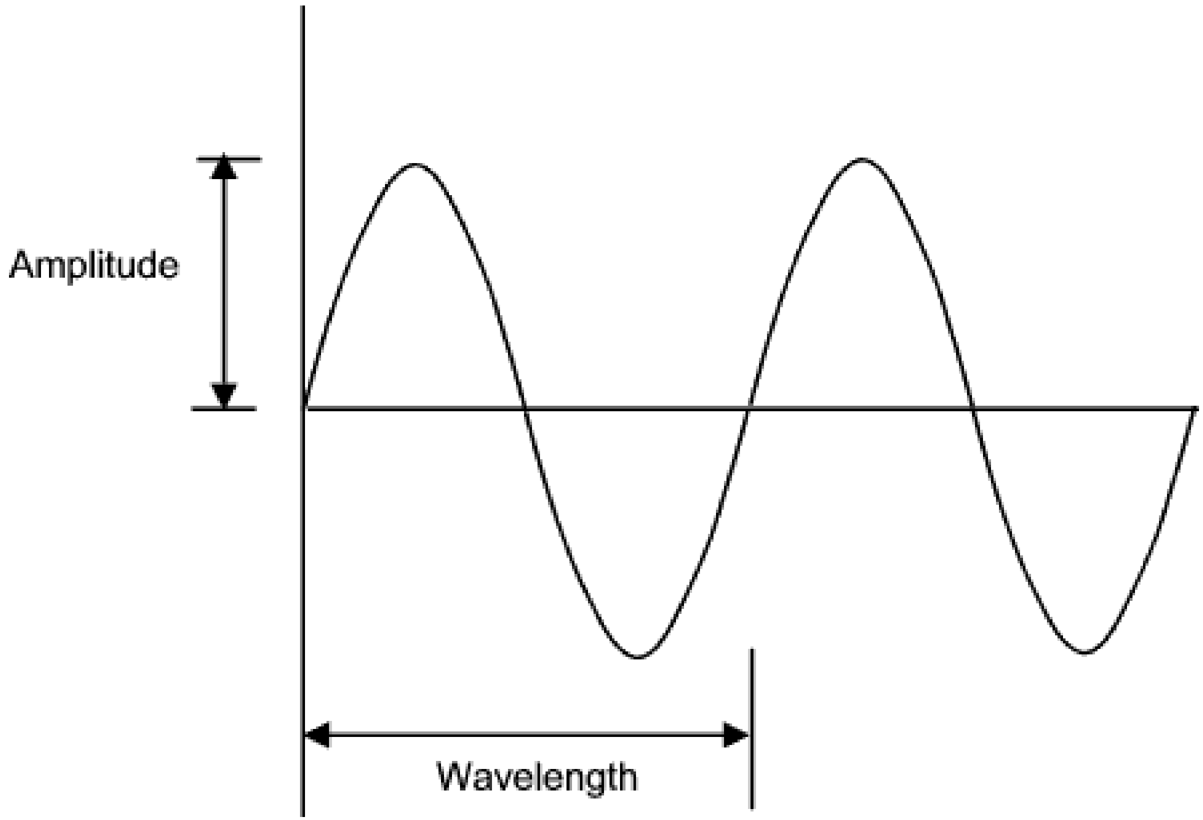
https://www.youtube.com/watch?v=h_7d-m1ehoY

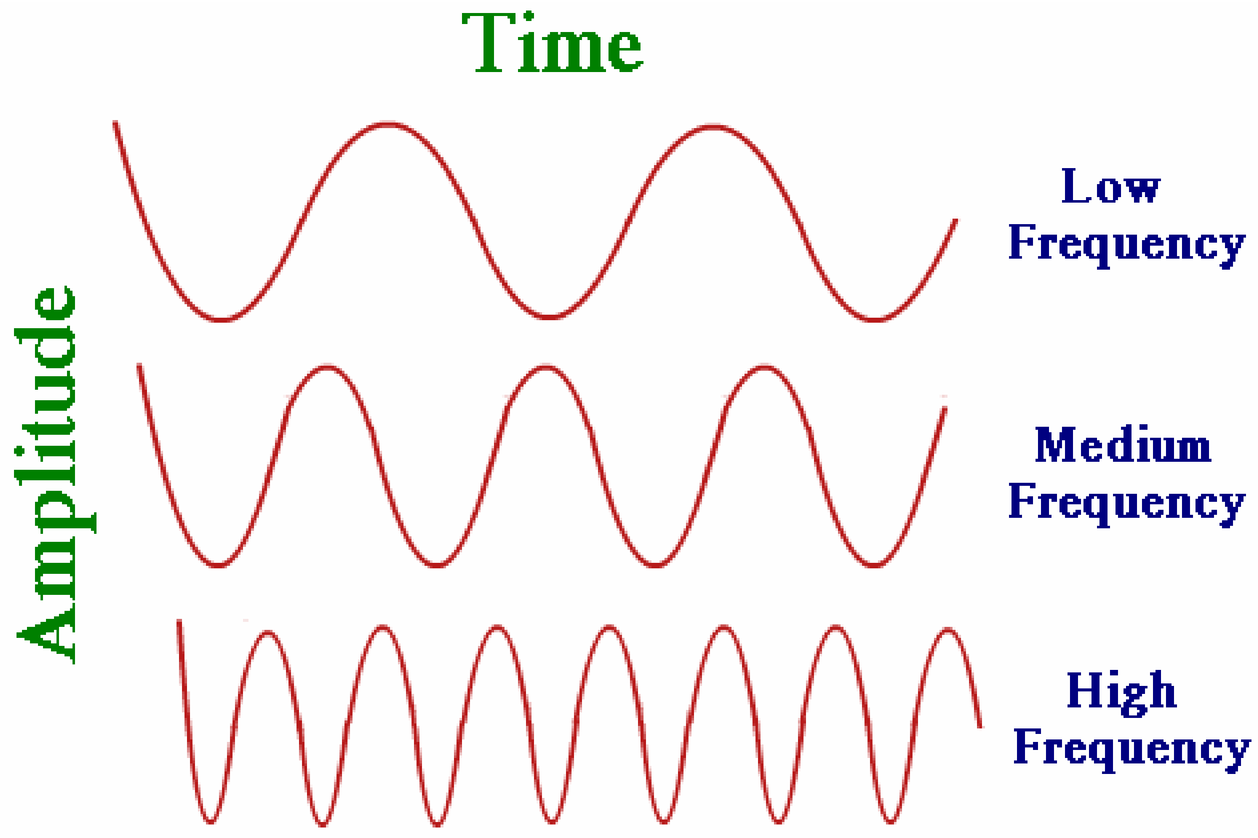


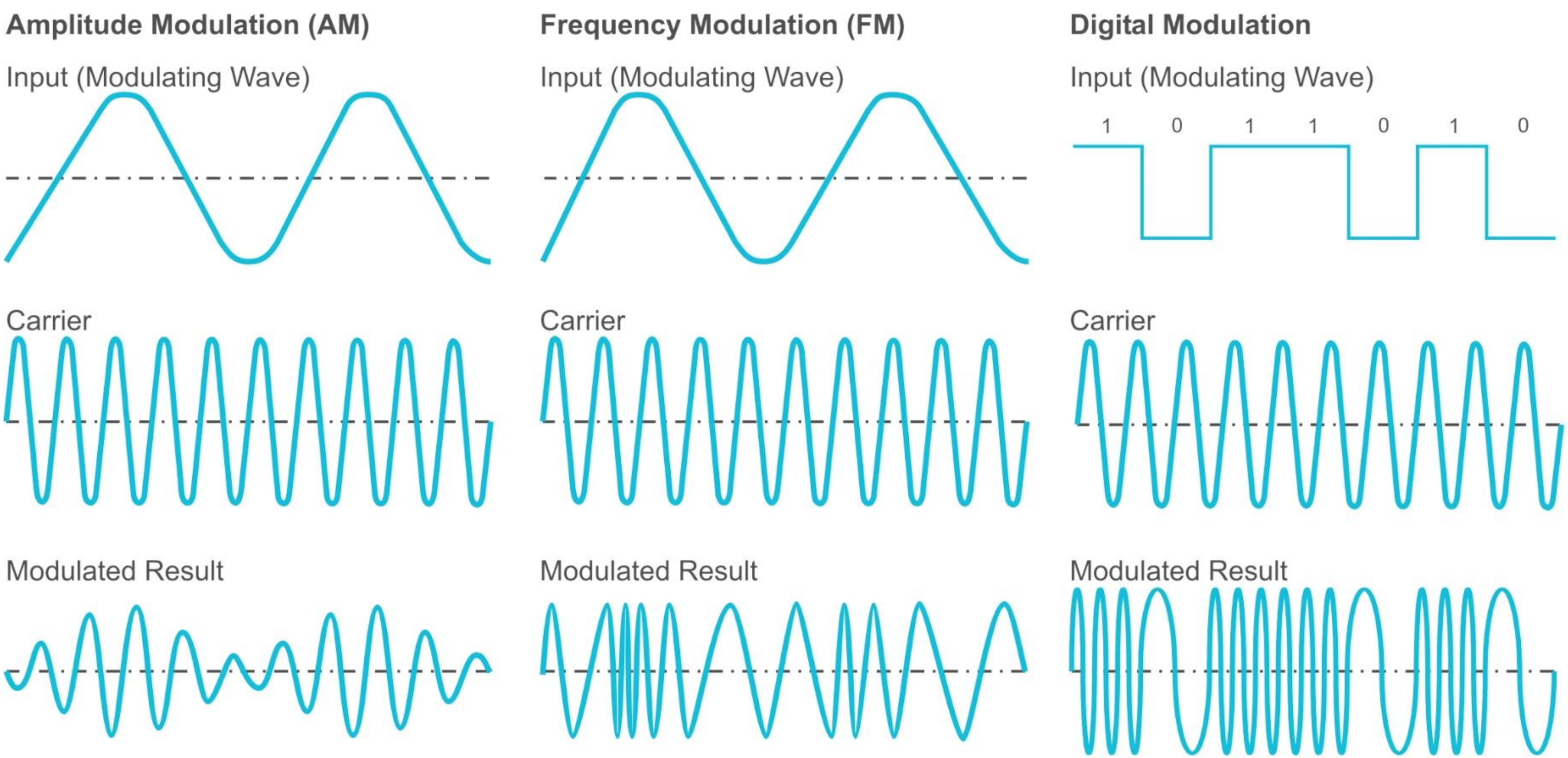
The equivalent DC voltage is the Root Mean Square (RMS) voltage.

If the RMS = 110v, Vp = ~155v, Vpp = ~310v

[*Vp/√2*]

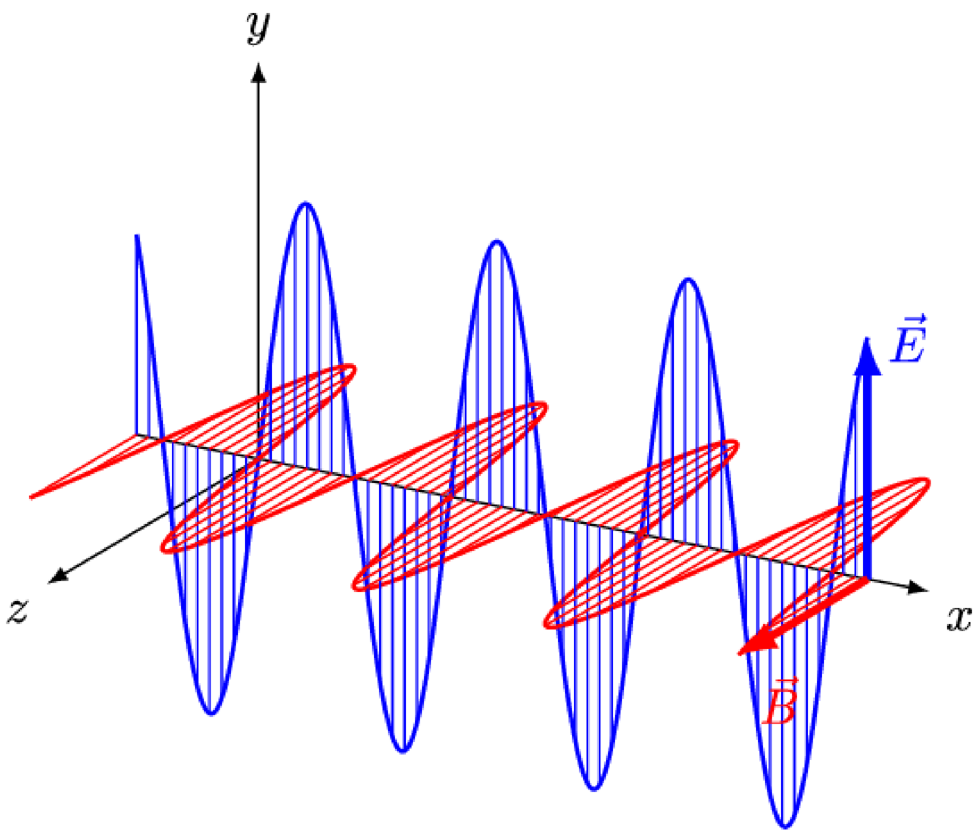

Amplitude
Wavelength

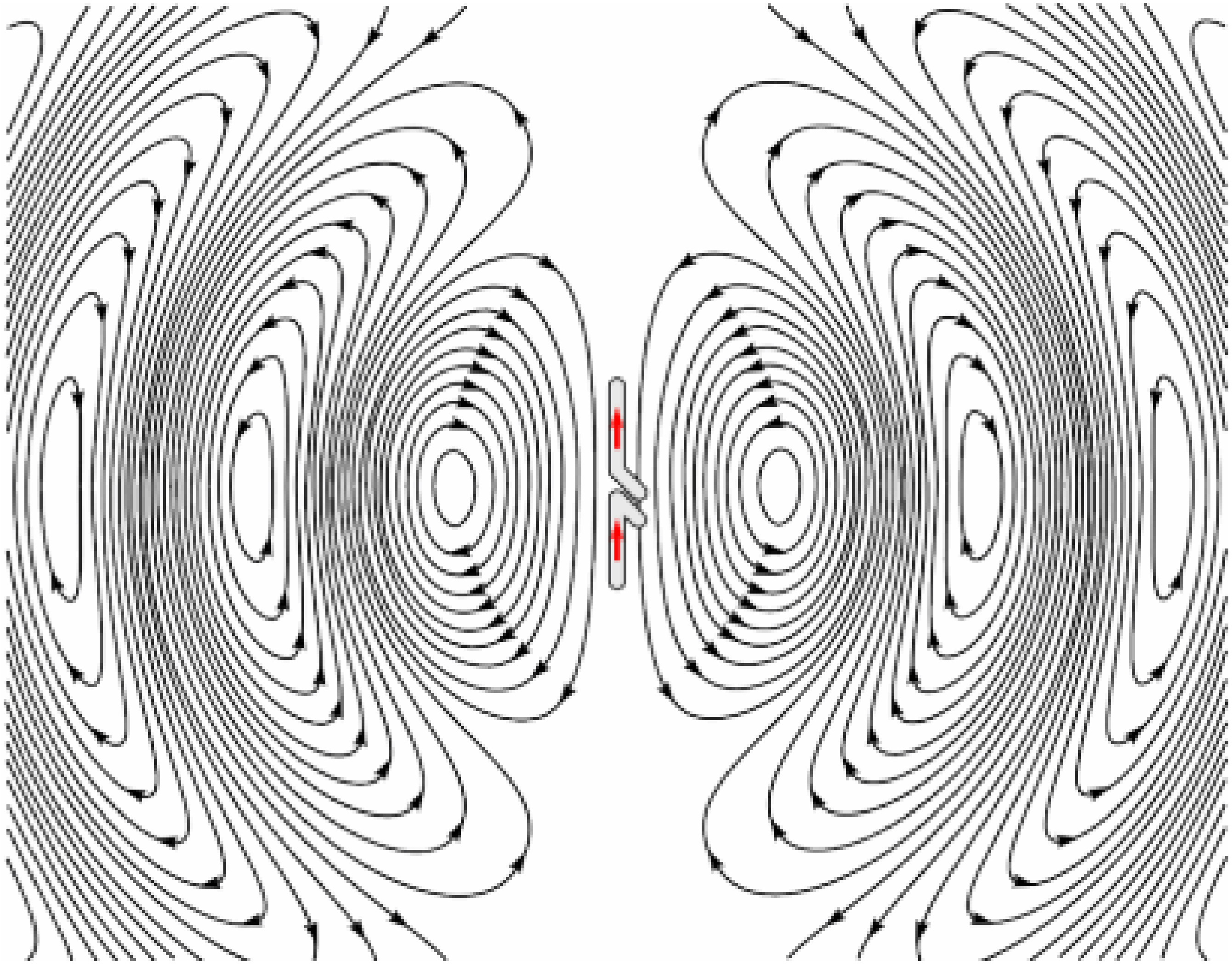

Time
Amplitude
Low Frequency
Medium Frequency
High Frequency


Amplitude Modulation (AM)
Input (Modulating Wave)
Carrier
Modulated Result
Frequency Modulation (FM)
Input (Modulating Wave)
Carrier
Modulated Result
Digital Modulation
Input (Modulating Wave)
1 0 1 1 0 1 0
Carrier
Modulated Result

Magnetism

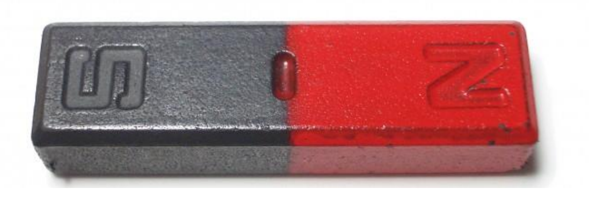
Radio waves are electromagnetic waves

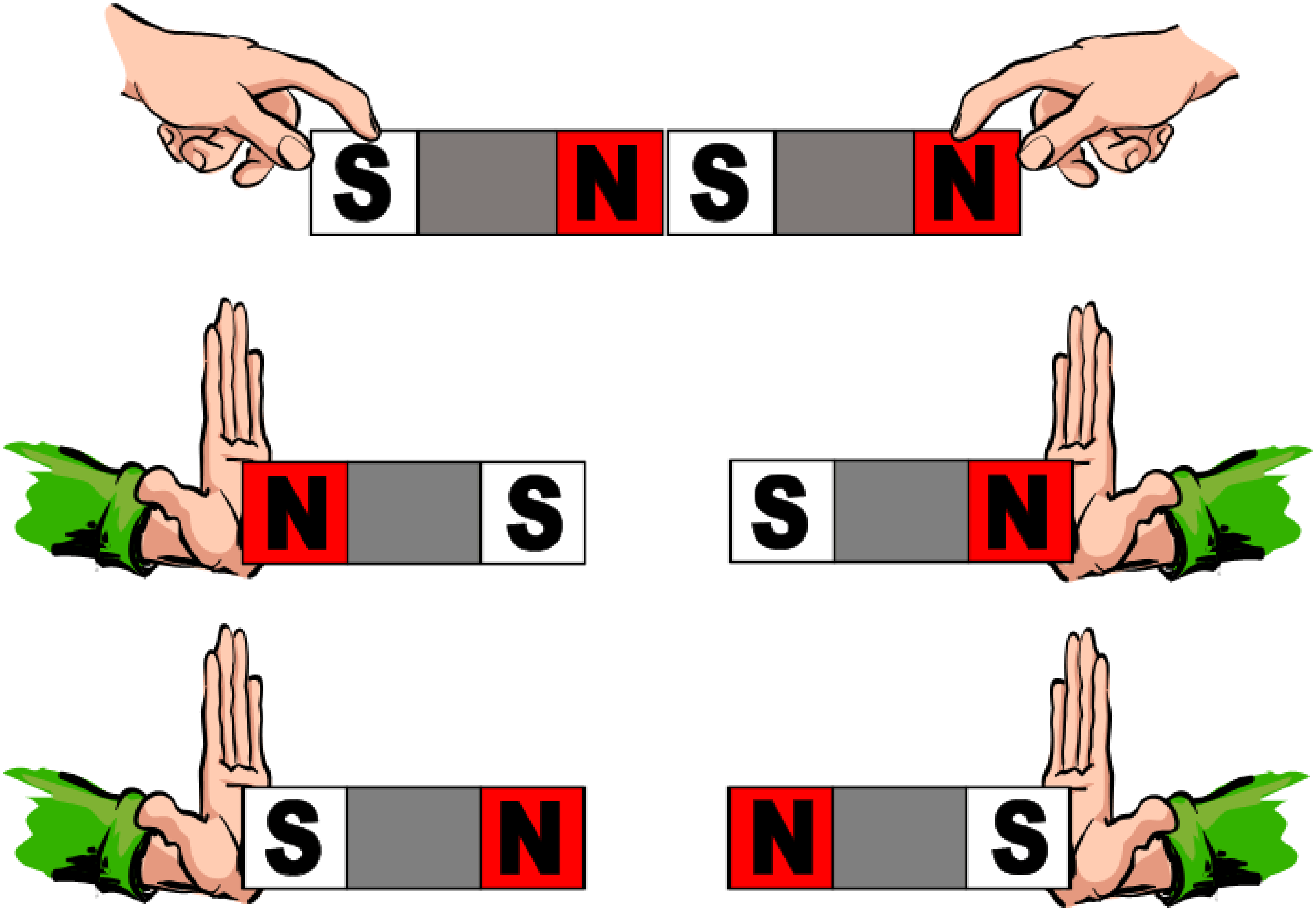


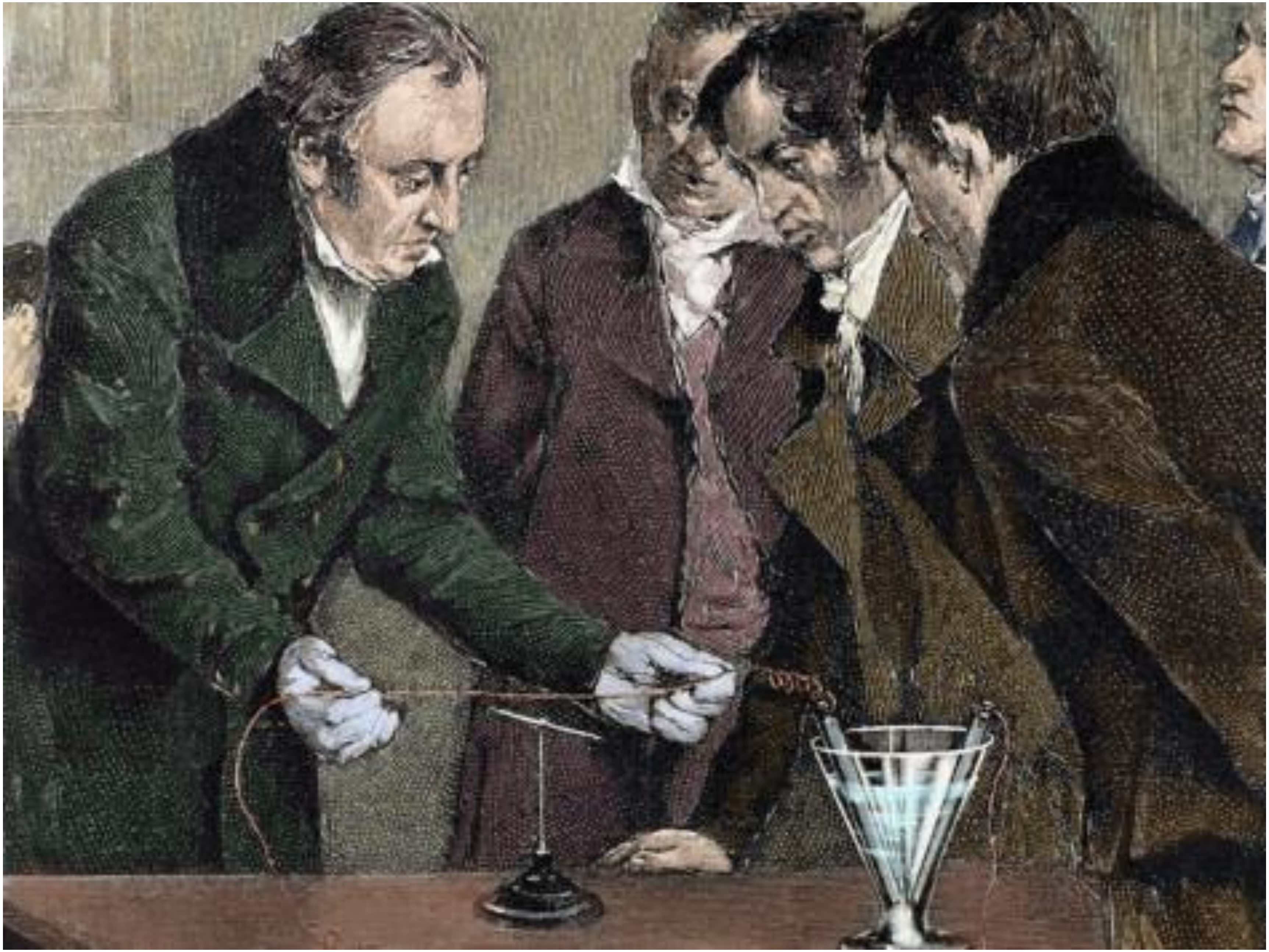


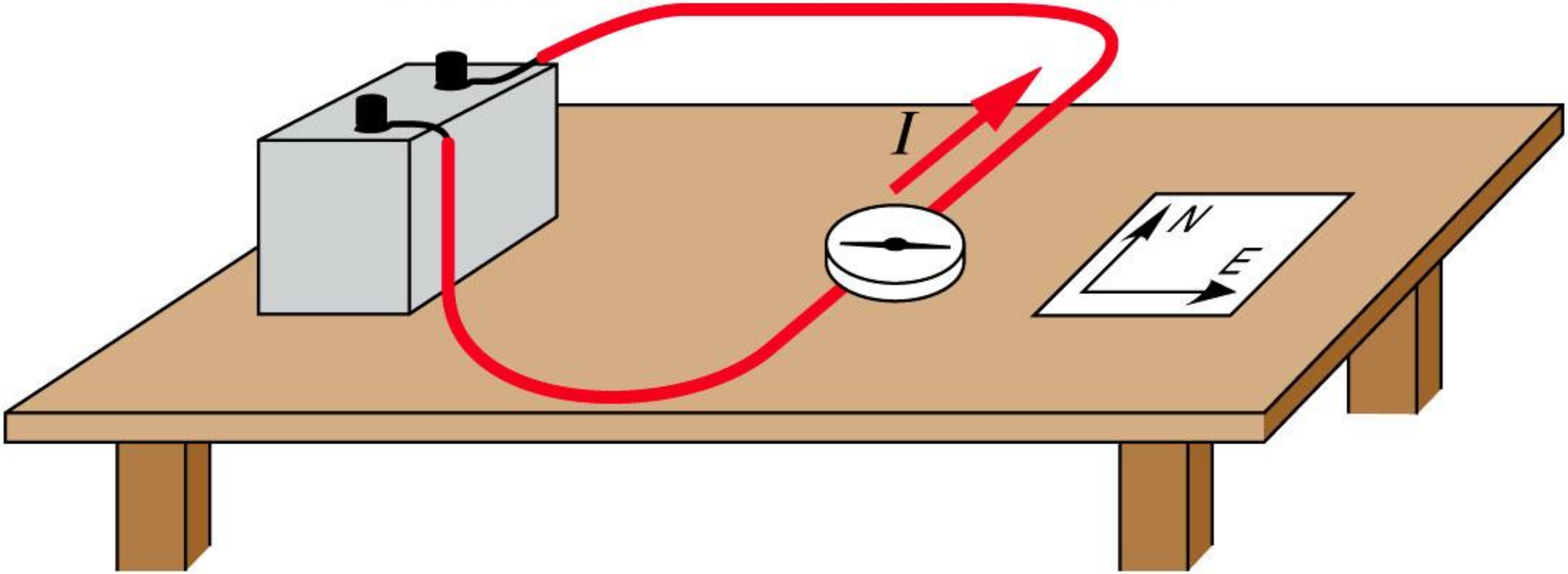
Magnetism is one of the fundamental forces of nature

A magnetic field is what a electric field looks like when the charge is moving relative to the observer

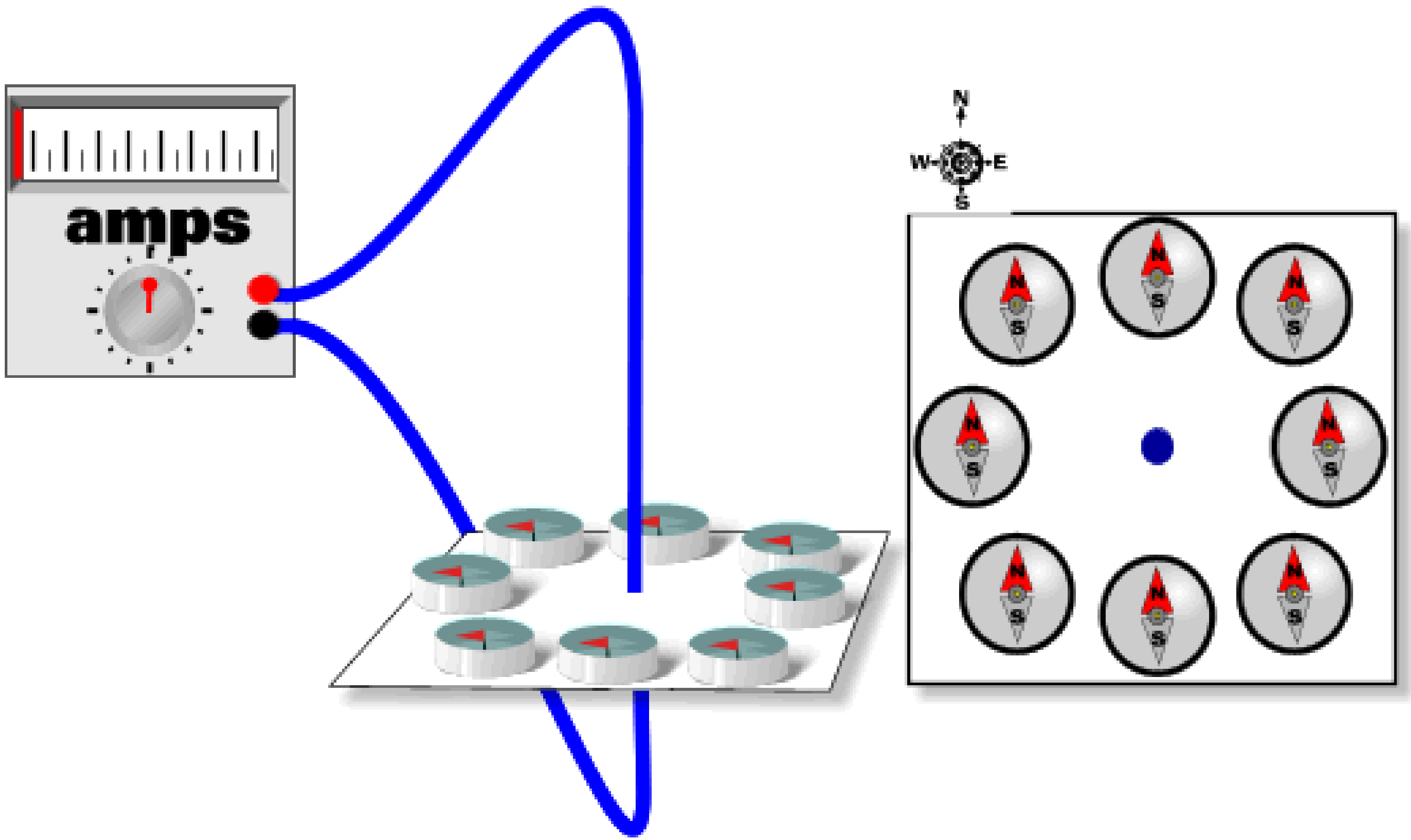


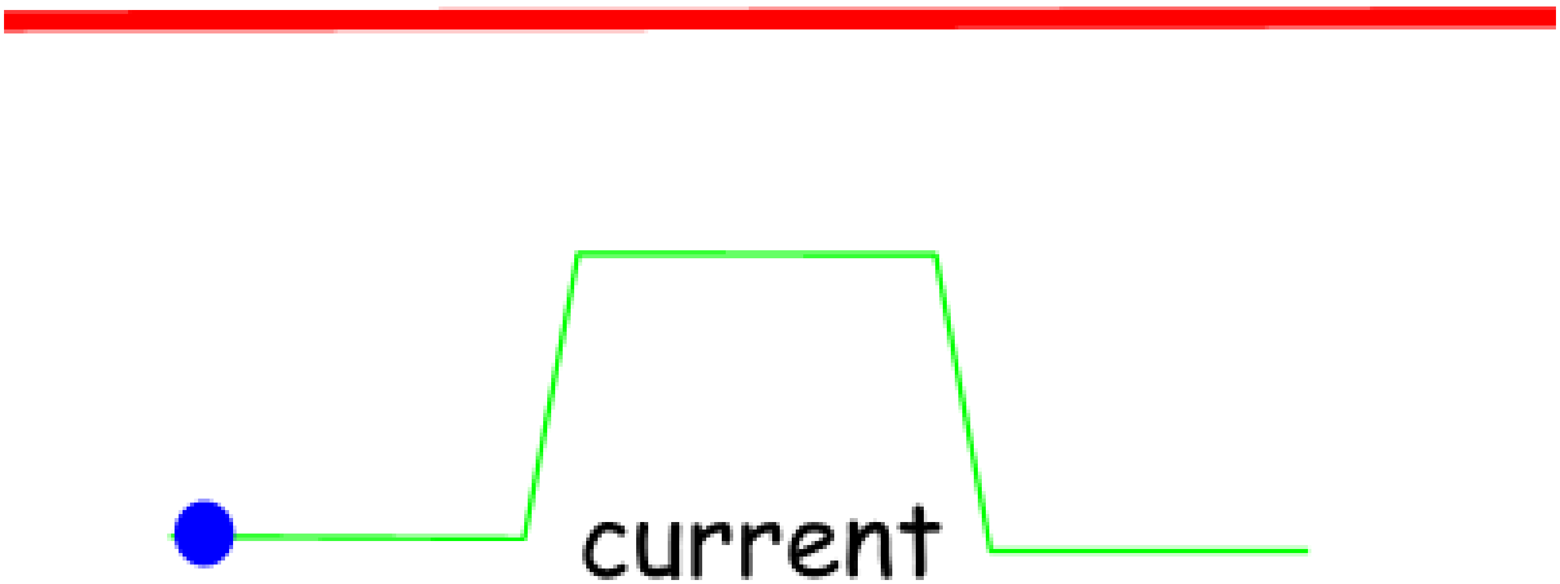

S
N
S
N
N
S
S
N
S
N
N
S





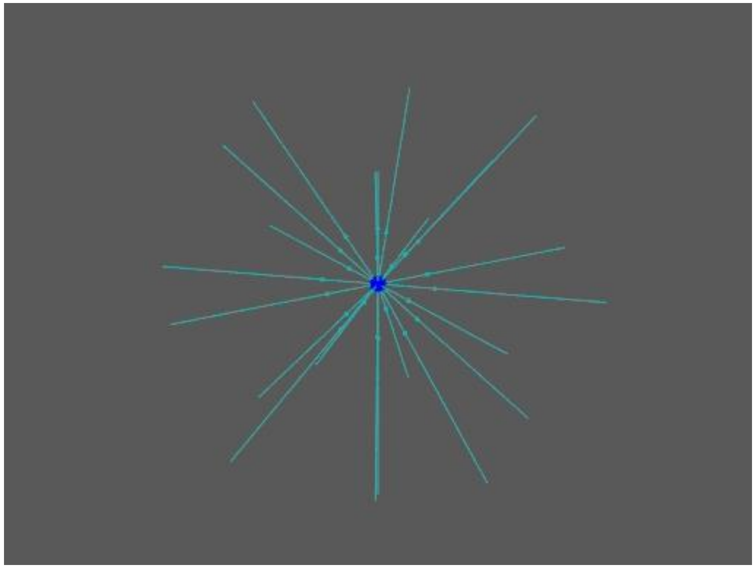
Oersted’s experiment in 1820 may have been the most important experiment ever because it showed a connection between magnetism and electricity

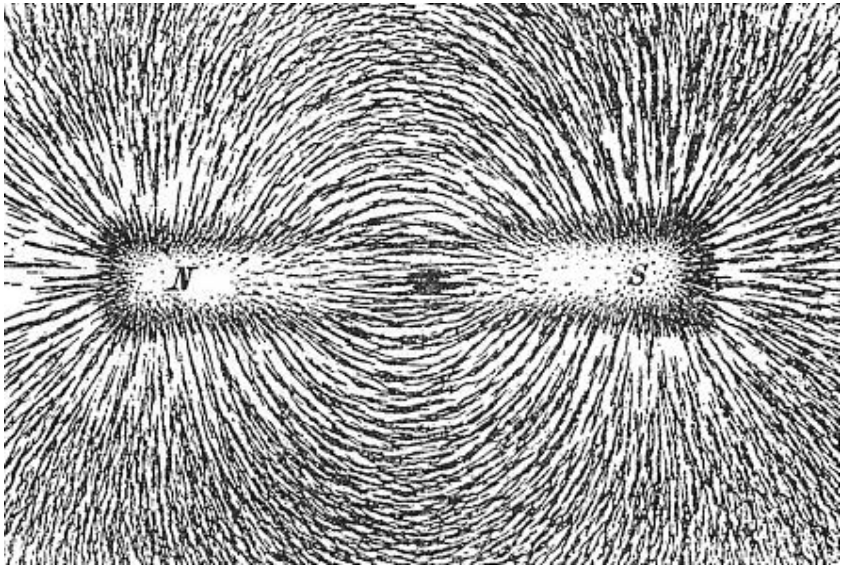

amps
N
W
E
S



Notice that the magnetic field is perpendicular to the direction of the current

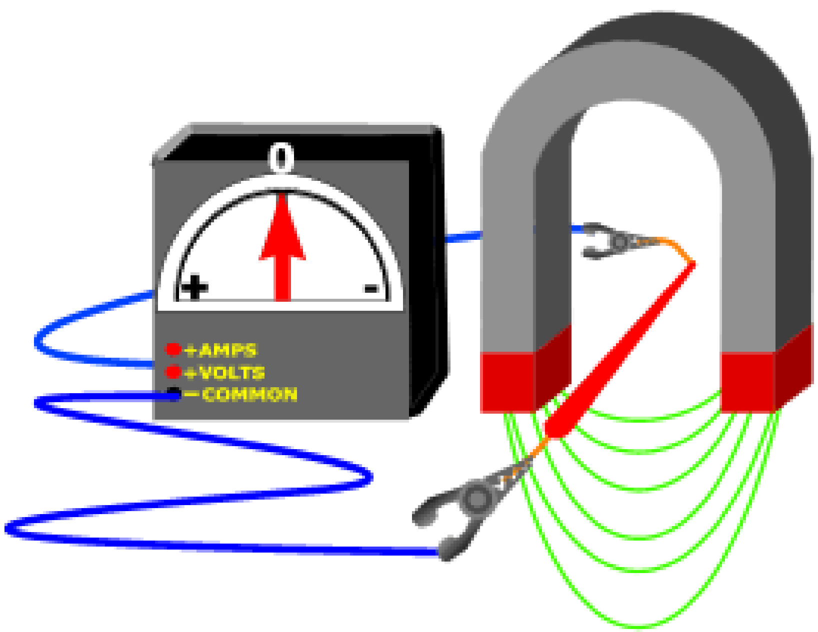
Magnetic field lines always loop. They never end the way electric field lines do

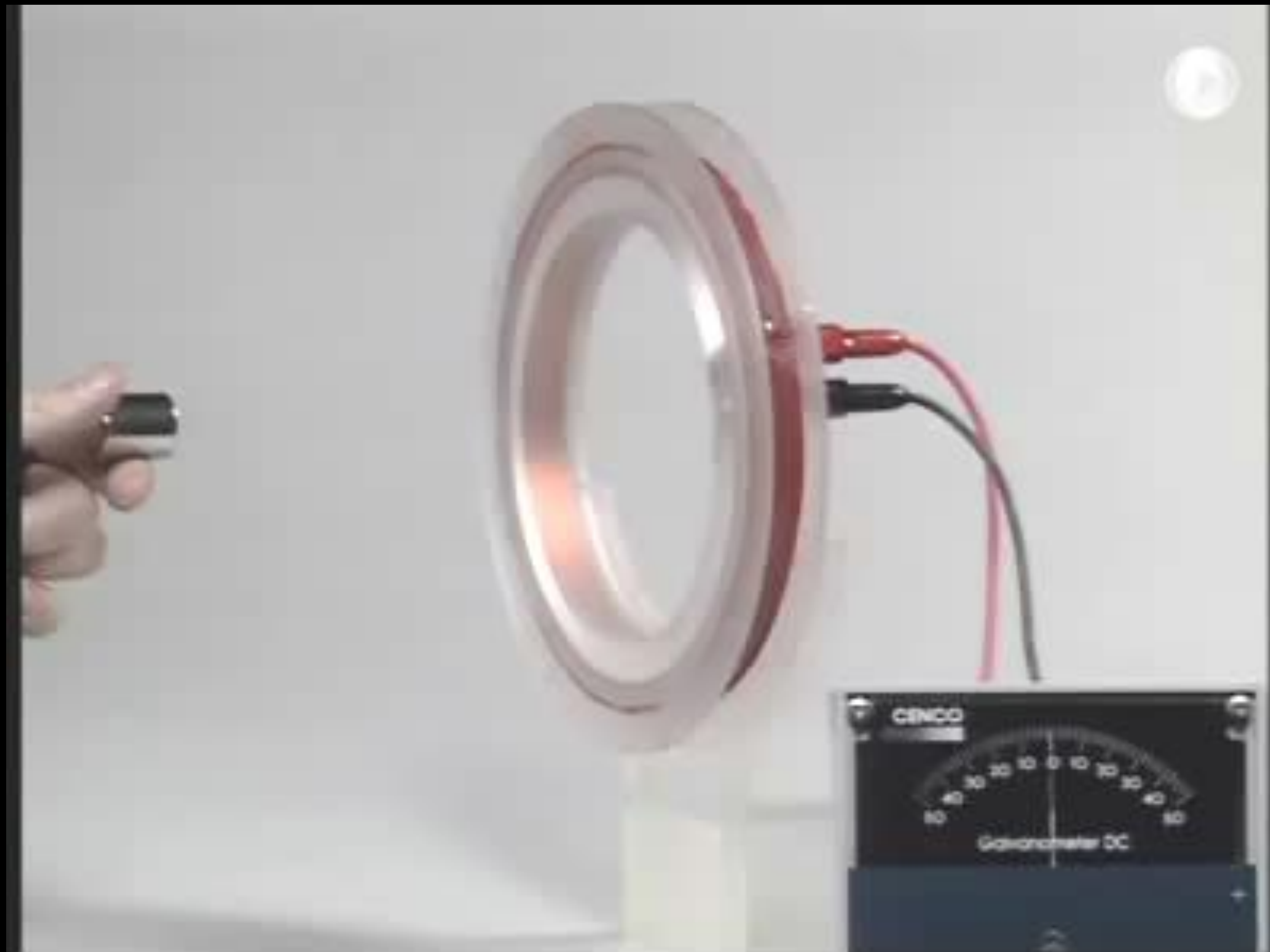




So a current creates a magnetic field….

Does a magnetic field create an electric current….?





This is the basis of our economy!

We will need to think about magnetic fields when we look at inductance…

Next time…