Amateur Radio Technician Class Training (Question Pool July 2018 – June 2022)

Slideset created by Alan Wolke, W2AEW
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Based on the No-Nonsense Technician Class Study Guide by Dan Romanchik, KB6NU

Updates by Rebecca Mercuri, Ph.D., K3RPM

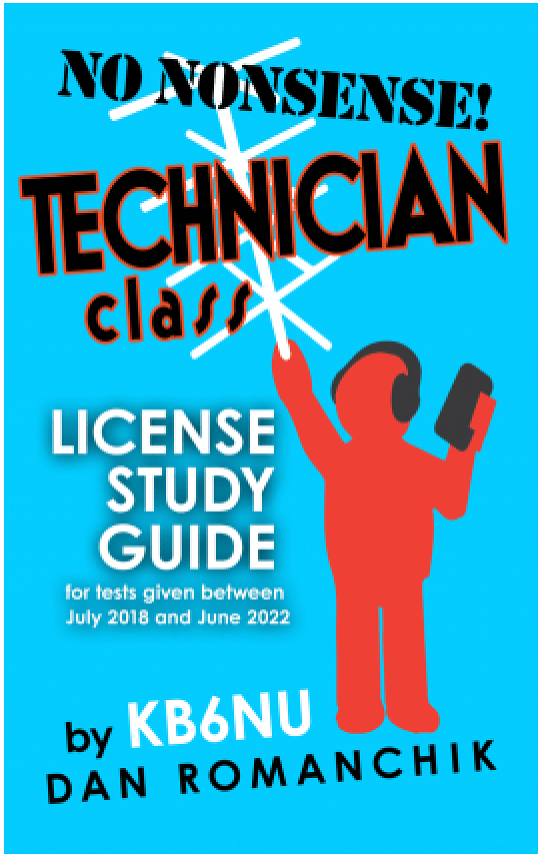
Make Operating Radio Easier

ARDC™
AMATEUR RADIO DIGITAL COMMUNICATIONS

PRINCETON / CENTRAL JERSEY SECTION
IEEE Advancing Technology for Humanity
Since 1947

Agenda – Session 1

- **Introduction**
- **Electrical Principles (EP)**
- Electronic Components and Circuits (ECCD)
- Radio Wave Characteristics (RWC)
- Antennas and Feed Lines (AFL)
- Amateur Radio Signals (ARS)
- Electrical Safety (ES)
- Radio Practices and Station Setup (RPSS)
- Station Equipment (SE)
- Operating Procedures (OP)
- Rules and Regulations (RR)



Welcome to the MORE Project!

- The Make Amateur Radio Easier (MORE) Project was proposed by Dr. Rebecca Mercuri, K3RPM to help increase the participation of under-represented groups (particularly youth and non-males) in Amateur Radio
- The Project was funded by the ARDC and is managed by the Institute of Electrical and Electronics Engineers, Princeton / Central Jersey Section, Broadcast Technology Chapter (IEEE PCJS BTC)
- Students (of all ages and genders) who successfully complete the training classes, and pass the Technician exam, will receive a hand-held radio and training on its proper use, so that they can Get On The Air

Introductions

Let's get to know each other!

- Teachers (Name, Callsign, Email Address)
  - How you got involved with Ham radio
  - Most exciting contact or experience
- Students (First and Last Name, Nickname)
  - How did you hear about this course?
  - Why are you interested in amateur radio?
- Special Guests & Visitors (Name, Callsign)
  - Why are you here today?

Characteristics of a Good Ham
Also of a Good Student!

- Eager to learn and experience new things
- Courteous and polite
  - Listen before you talk
- Asks questions
  - Use the raise hand feature in Zoom (try it now!)
  - Type questions and comments into the chat
- Able to follow rules and instructions
- Spends time studying
- Helps others

Course Materials

- Each of you should have received a link to our resource list when you enrolled in this class
- You can also find this list via the MORE Project website at: http://n2re.org/m-o-r-e-project
- Instructions on how to obtain the lecture slides and other course materials will be provided via email
- We will be following the No Nonsense! Technician Class License Study Guide
- Download the Study Guide and slidesets for each class – use for review and practice between classes

What is Amateur Radio?

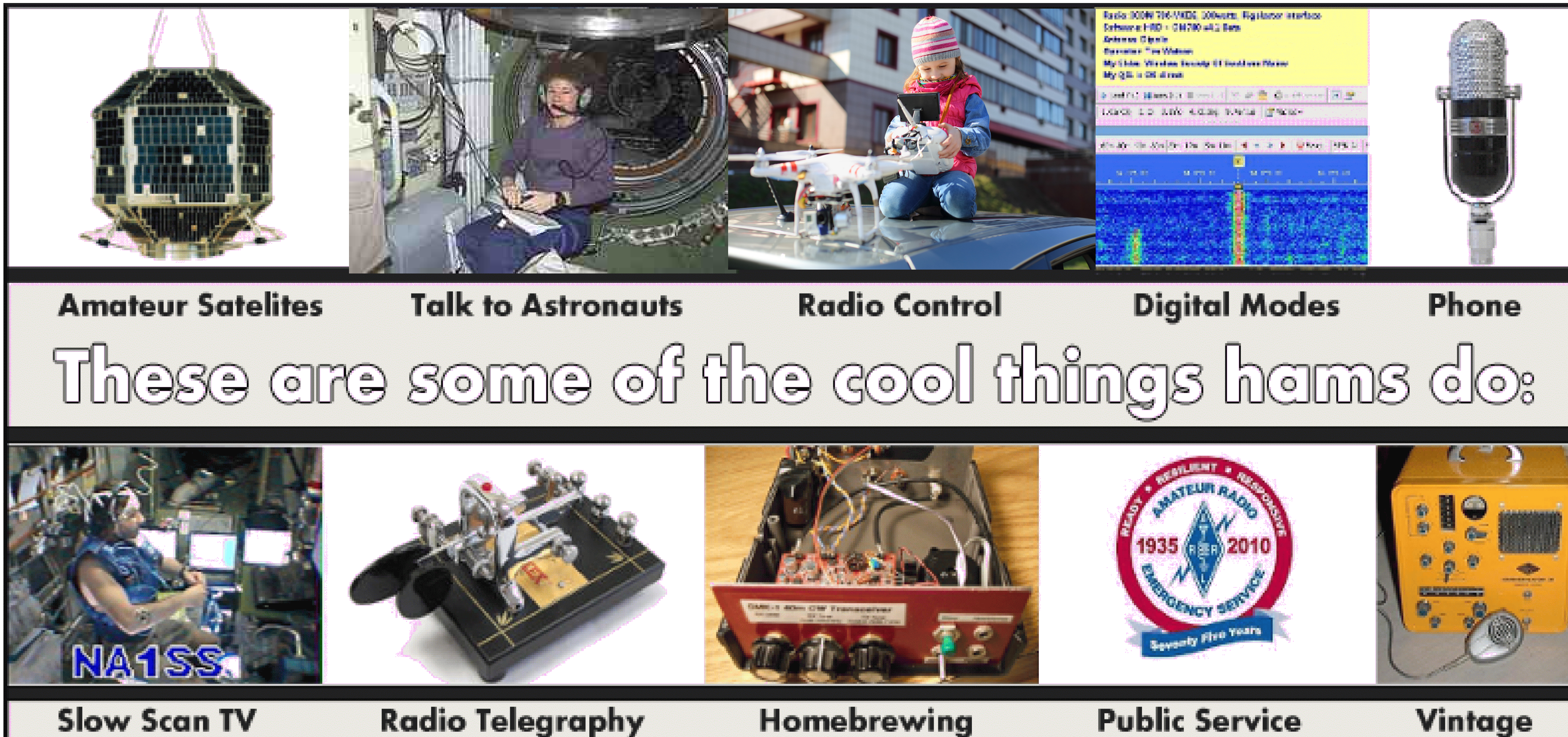
- Hobby
- Service
- STEM Field
- Way to Meet People
- Fun!

- It's what YOU make of it!

Communicate, Experiment, Serve, Interact, Compete

- Ham Radio is:
  - Regulated, but non-commercial
  - Experimentation (allowed & encouraged)
  - Community service
  - Technical learning & discovery
  - Contests & challenges
  - *Something for everyone!*

Cool things to do ...



End of Introduction

Questions?

Electrical Principles (EP)

- Units and Terms
- Ohm's Law
- Series & Parallel
- DC Power
- Math
- Decibels

Electrical Principles (EP)

Voltage

Current

Resistance

Amps

AC

DC

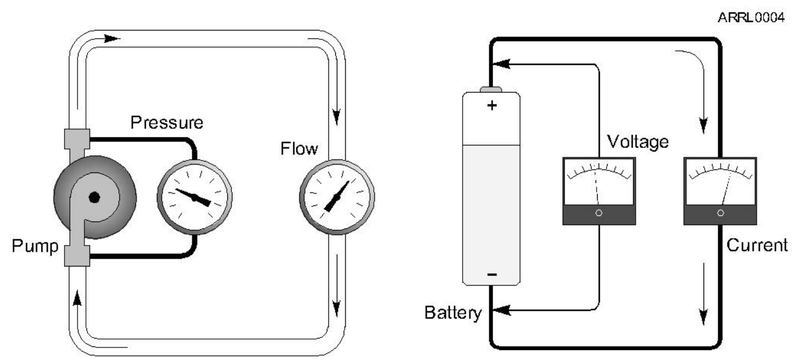
Volts

Insulator

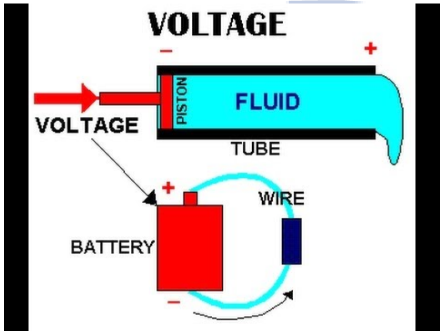
Ohms

Watts

Conductor

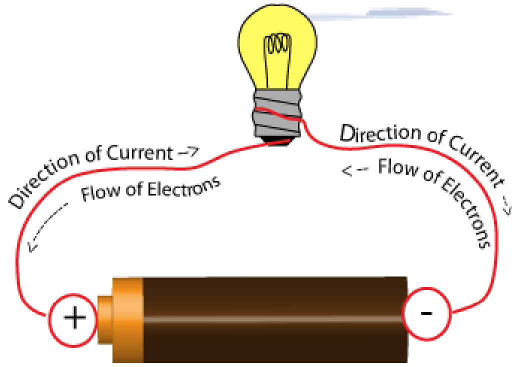


Voltage



- The **force** that pushes electrons around
- Also called Electro-Motive Force: **EMF**
- Measured in units called **VOLTS**
- Measured with a **Voltmeter**
- Symbol is **E**, unit symbol is **V**
- Typical mobile radios require 12 volts to operate

Current

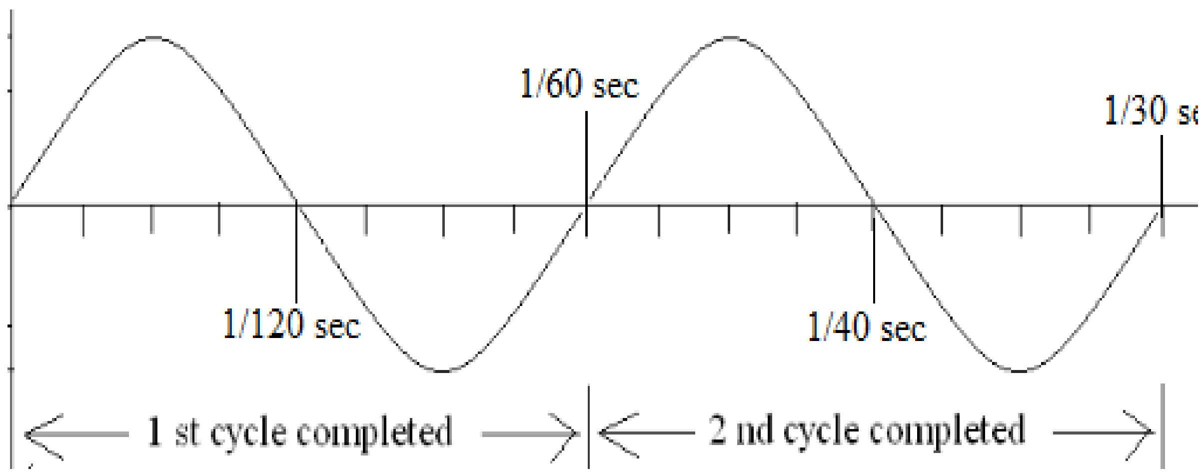


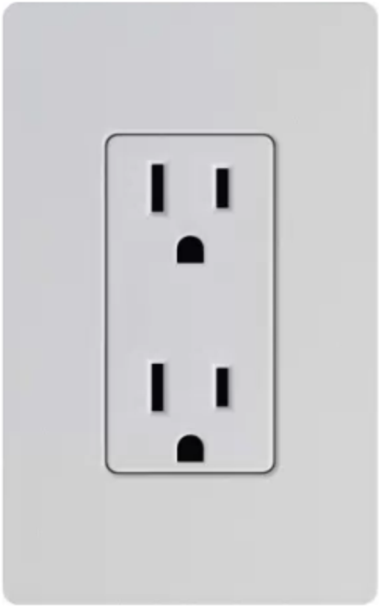
- The *flow of electrons* in a circuit
- Measured in units of **Amperes** (amps)
- Symbol is **I**, units symbol is **A**
- Measured with an **Ammeter**
- **DC**: Direct Current flows in one direction
- **AC**: Alternating Current flows back and forth, *changing direction on a regular basis*

AC = Alternating Current

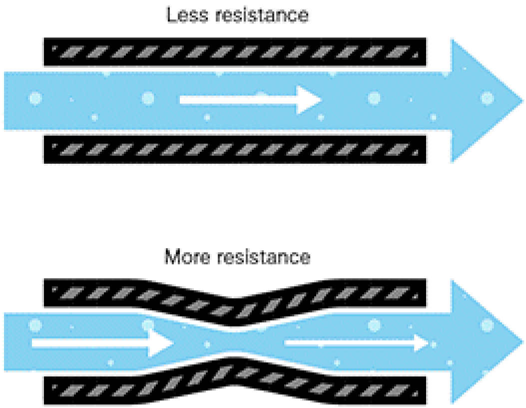
Frequency: number of times per second that an alternating current makes a complete cycle

Hertz: Unit of frequency



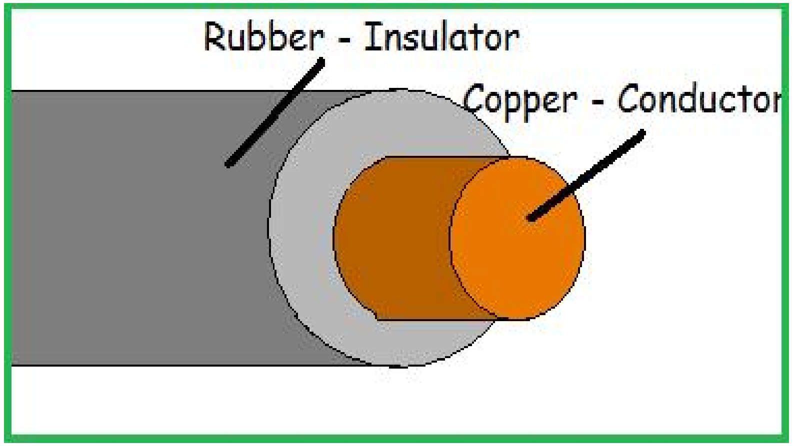


Resistance



- Opposes the flow of electrons
  - Higher resistance -> smaller current
- Measured in ***Ohms***
- Symbol is ***R*** Unit symbol is **Ω**
- Measured with an ***Ohmmeter***

Conductors & Insulators



- **Conductors**
  - Low resistance, allow current to flow
  - Copper, aluminum, gold, silver, etc.
- **Insulators**
  - High resistance, little/no current flow
  - Plastic, wood, glass, mica, paper, etc.

Power

- *Rate* at which electrical energy is used
- Measured in **Watts**
- Symbol is **P**   Unit symbol is **W**

- Often not measured directly, but calculated – *more on this shortly…*

Summary of Terms

- EMF (E) is measured in Volts (V)
- Current (I) is measured in Amps (A)
- Resistance (R) is measured in Ohms (Ω)
- Power (P) is measured in Watts (W)

Memorize this!

Ohm's Law

Relationship between:

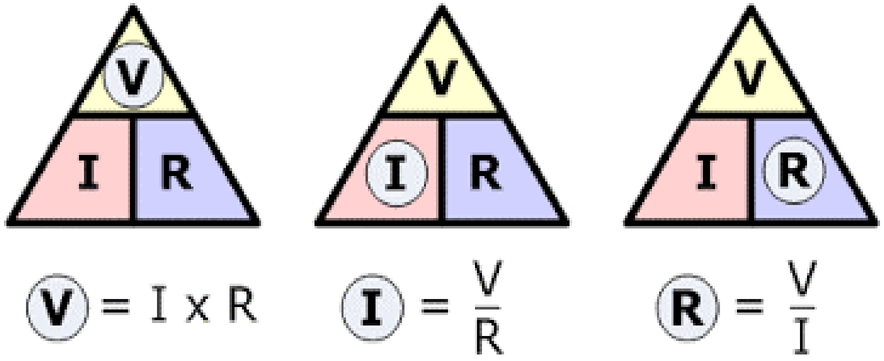
- Voltage
- Current
- Resistance

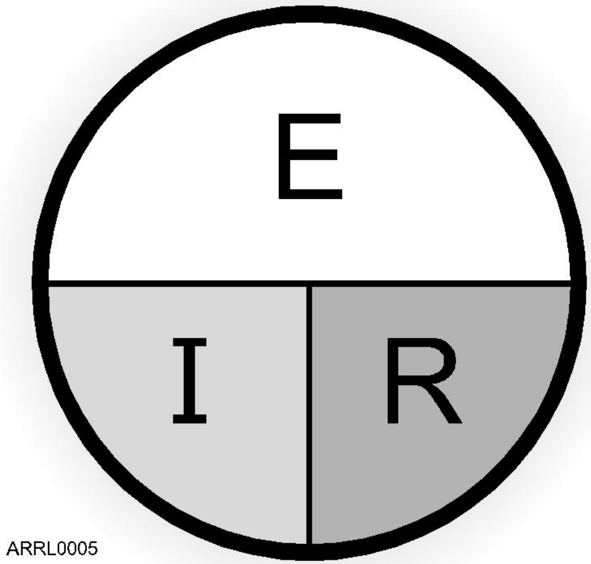
Voltage = Current x Resistance

$E = I \times R$

$I = E / R$

$R = E / I$





Ohm's Law Calculations

USING THE "MAGIC" FORMULA CIRCLE TO DO MATH.

TOP TO BOTTOM <u>DIVIDE</u>.

SUCH AS:

$12 \div 8 = 1.5$

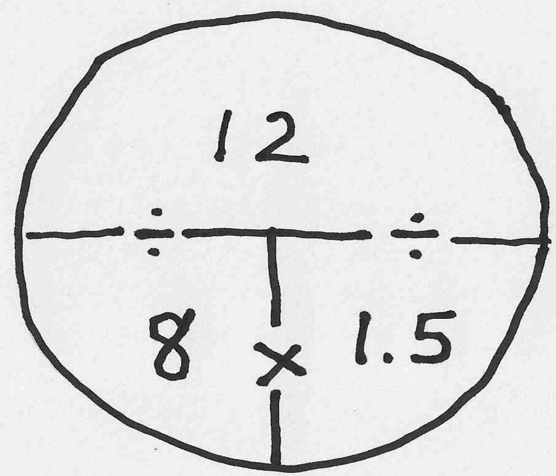
$12 \div 1.5 = 8$

SIDE TO SIDE <u>MULTIPLY</u>.

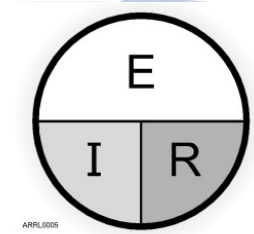
SUCH AS:

$8 \times 1.5 = 12$

$1.5 \times 8 = 12$



Ohm's Law Examples



- 90 volts is applied across a resistor resulting in 3 amperes of current. What's the resistance?

  R = E / I   90V/3A = **30Ω**

- 12 volts applied to a circuit with 8 ohms of resistance – how much current flows?

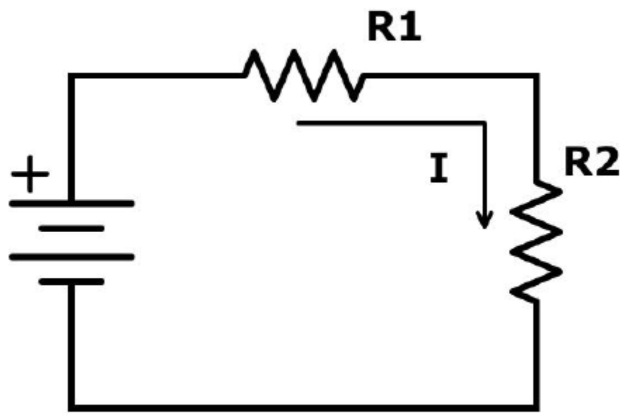
  I = E / R   12V/8Ω = **1.5 amperes**

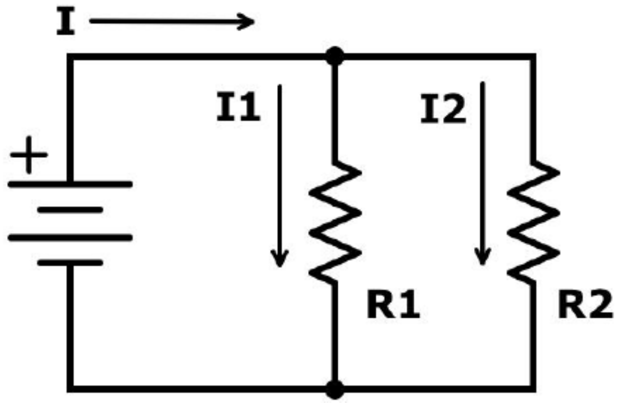
- 2A flowing through 10Ω resistor – what voltage appears across the resistor?

  E = I x R   2A x 10 Ω = **20 Volts**

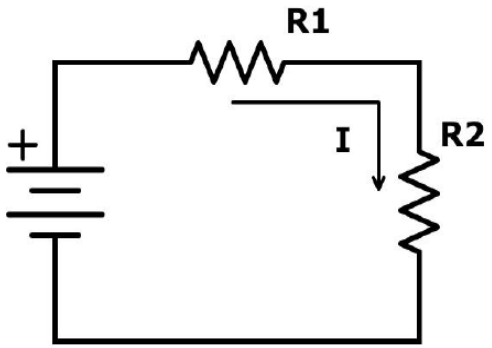
Series and Parallel Circuits

- **Series**: devices are end-to-end
- **Parallel**: devices are next to each other



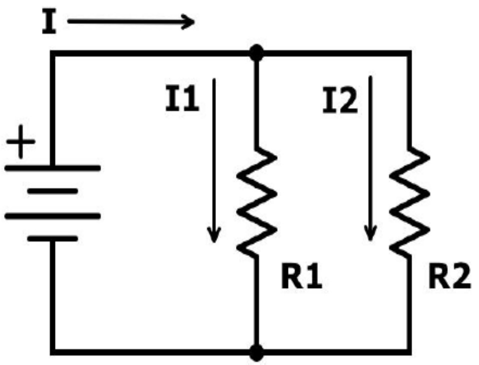


Series Circuits



- There is *one path* for current to flow
- **Current** is:
  - the *same through all components*
  - is *unchanged* at component junctions
- **Voltage** across each component is *determined by type and value* of each component.
- Sum of voltages across components equals the voltage source

Parallel Circuits



- Each component connected to voltage source (in this example)
- **Voltage** across each component is the *same*
- **Current** divides at component junctions, *dependent on component values*
- Sum of currents in each component equals total current from the source

Calculating Power

Relationship between:

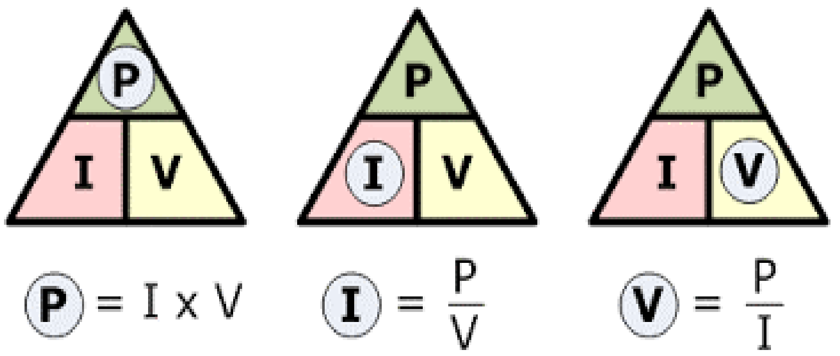
- Power
- Voltage
- Current

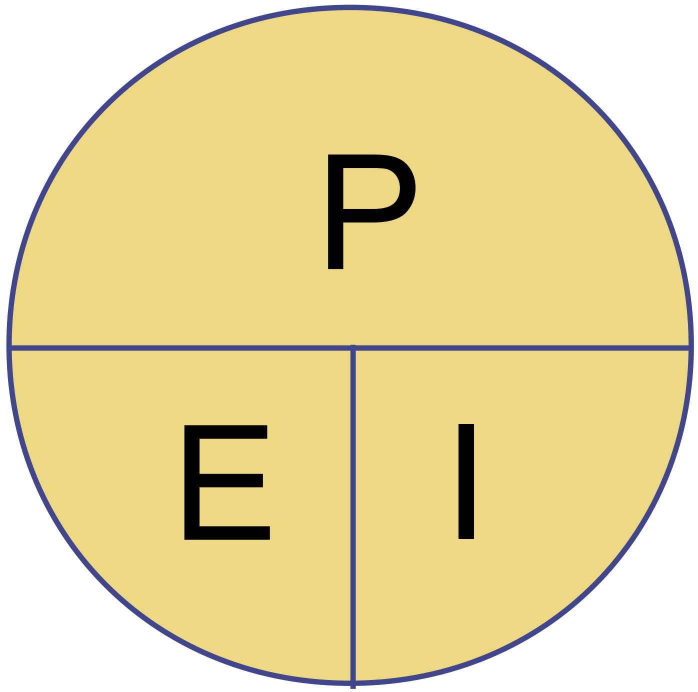
Power is Voltage x Current

P = E x I

E = P / I

I = P / E





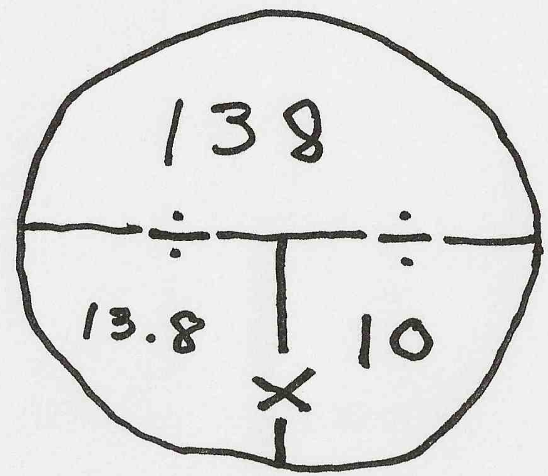
Power Law Calculations

USING THE "MAGIC" FORMULA CIRCLE TO DO MATH.

TOP TO BOTTOM DIVIDE.
SUCH AS:

138 ÷ 10 = 13.8

138 ÷ 13.8 = 10

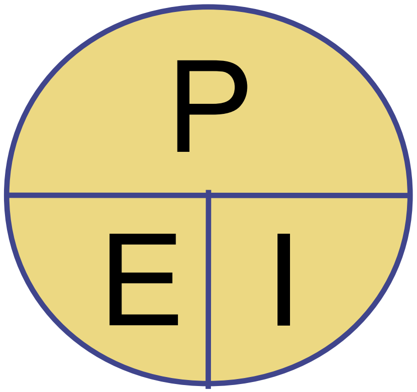


SIDE TO SIDE MULTIPLY.

13.8 × 10 = 138

10 × 13.8 = 138

Power Examples



- How much power is being used by a circuit that draws 10A from a 13.8V source?

  P = E x I   13.8V * 10A = **138 Watts**

- Applied voltage is 12V and current is 2.5A, what is the power?

  P = E x I   12V x 2.5A = **30W**

- With 12V applied and 120W used, what is the current?

  I = P / E   120W / 12V = **10 A**

Math for Electronics: Prefixes

Used with electrical quantities

milli = 1/1000th, such as 1**mA** is 1/1000th of an ampere, or 0.001A

micro = 1/1,000,000th (one millionth), such as 3**µV** which is 0.000003V

pico = 1 trillionth (millionth of a millionth) such as 5**pA** = 0.000005µA

Prefixes continued

kilo = 1000x, such as 1**kV** = 1000V

mega = 1 million times (1,000,000x)
such as 1**MΩ** = 1,000,000Ω

giga = 1 billion times, such as **2.4GHz**

Prefixes are often used on many different electrical quantities

Prefix Examples

- 1,500 milliamperes = 1.5 amperes
- 1,000 volts = 1 kilovolt (1kV)
- 1 millionth of a volt = 1 microvolt (1μV)
- 3000mA = 3A
- 3500 kilohertz = 3.5 megahertz (**MHz**)
- 2425 MHz = 2.425 GHz

Decibels (dB)

- When dealing with loudness and power ratios we use decibels
- Easy to express large ratios with small numbers
- Decibels use a logarithmic (log) scale
- Cascading ratios multiply or divide but cascading decibels add or subtract
- +dB represents an “increase”
  - dB represents a “decrease”

Decibel Ratios to Remember

- **3dB** is a factor of **2x**

  A change from 5W to 10W is a 3dB increase, a ratio of 2 to 1
- **6dB** is a factor of **4x**

  A change from 12W to 3W is a 6dB decrease
  (-6dB change), ratio of 4 to 1
- **10dB** is a factor of **10x**

  20W to 200W is a 10dB increase, ratio of 10 to 1
- Combinations (dB values add and subtract)

  13dB change is a factor of 20x (10 x 2)

Electrical Principles
Chapter End

Questions?

Let's Practice for the Exam!