SUBELEMENT T5

Electrical principles: math for electronics; electronic principles; Ohm’s Law

4 Exam Questions - 4 Groups

T5A –

Electrical principles, units, and terms: current and voltage; conductors and insulators; alternating and direct current

While one does not have to be an Electronic Engineer to pass the Technician Class ham license (That comes later with the General and Extra Class ham licenses……

(Just kidding!), you do have to know a few of the basics. That is what this course will cover. Just the basics.

- **Voltage** is the force that causes electrons to flow in an electrical circuit. **The Volt** is also called EMF for Electro Motive Force and is measured with a volt meter. The volt is the basic unit of EMF. In a schematic or block drawing, the letter “V” is used to indicate volts. In an electronic formula, the letter “E” is used to indicate voltage.

- Electrical current is measured in **amperes. Current** is the name for the flow of electrons through an electrical circuit in which voltage causes to flow. An ammeter is used to measure current. The letter “I” is used in electrical formulas to indicate the amount of current being used.

- Electrical power is measured in **watts.** **Power** is the rate at which electrical energy is consumed. Example: A 100 watt light bulb consumes 100 watts of power to generate light.

T5A01

Electrical current is measured in which of the following units?

A. Volts

B. Watts

C. Ohms

D. Amperes

T5A01

Electrical current is measured in which of the following units?

D. Amperes

T5A02

Electrical power is measured in which of the following units?

A. Volts

B. Watts

C. Ohms

D. Amperes

T5A02

Electrical power is measured in which of the following units?

B. Watts

T5A03

What is the name for the flow of electrons in an electric circuit?

A. Voltage
B. Resistance
C. Capacitance
D. Current

T5A03

What is the name for the flow of electrons in an electric circuit?

D. Current

T5A10

Which term describes the rate at which electrical energy is used?

A. Resistance

B. Current

C. Power

D. Voltage

T5A10

Which term describes the rate at which electrical energy is used?

C. Power

T5A05

What is the electrical term for the electromotive force (EMF) that causes electron flow?

A. Voltage

B. Ampere-hours

C. Capacitance

D. Inductance

T5A05

What is the electrical term for the electromotive force (EMF) that causes electron flow?

A. Voltage

T5A11

What is the basic unit of electromotive force?

A. The volt

B. The watt

C. The ampere

D. The ohm

T5A11

What is the basic unit of electromotive force?

A. The volt

- **Direct current** is the name for a current that flows only in one direction. Examples of Direct Current or DC is a 12 volt car battery, Flashlight batteries, and etc.

- **Alternating current** is the name for a current that reverses direction on a regular basis. An example of Alternating Current, or AC is the typical house electrical outlet.

- **Frequency** is the term that describes the number of times per second that an alternating current reverses direction.

A mobile transceiver usually requires about 12 volts. This is true for most modern day ham equipment.

To use a mobile transceiver, or other 12 volt radio in the house, one would usually use a Power Supply.

A power supply simply converts the 117 Volts AC house outlet to 12 Volts DC that the radio needs to operate properly.

T5A04

What is the name for a current that flows only in one direction?

A. Alternating current
B. Direct current
C. Normal current
D. Smooth current

T5A04

What is the name for a current that flows only in one direction?

B. Direct current

T5A06

How much voltage does a mobile transceiver usually require?

A. About 12 volts

B. About 30 volts

C. About 120 volts

D. About 240 volts

T5A06

How much voltage does a mobile transceiver usually require?

A. About 12 volts

T5A09

What is the name for a current that reverses direction on a regular basis?

A. Alternating current
B. Direct current
C. Circular current
D. Vertical current

T5A09

What is the name for a current that reverses direction on a regular basis?

A. Alternating current

T5A12

What term describes the number of times per second that an alternating current reverses direction?

A. Pulse rate

B. Speed

C. Wavelength

D. Frequency

T5A12

What term describes the number of times per second that an alternating current reverses direction?

D. Frequency

There are many metals that make good conductors: silver, gold, copper, aluminum, etc.

You will only need to remember one though. Copper is a good electrical conductor.

There are many good insulators as well: Glass, plastic, even air. Again, you will only need to remember one for the exam.

Glass is a good electrical insulator

T5A07

Which of the following is a good electrical conductor?

A. Glass

B. Wood

C. Copper

D. Rubber

T5A07

Which of the following is a good electrical conductor?

C. Copper

T5A08

Which of the following is a good electrical insulator?

A. Copper
B. Glass
C. Aluminum
D. Mercury

T5A08

Which of the following is a good electrical insulator?

B. Glass

T5B –
Math for electronics: conversion of electrical units; decibels; the metric system

An ampere is a very large unit for most of our electrical work. Hams usually measure currents using the smaller scale of milliamperes.

Milliamperes is simply 1 one-thousandth of an ampere. 1 ampere is 1000 milliamperes.

The easiest way to convert an ampere is to simply move the decimal place to the right by three spaces.

1 ampere equals 1000 milliamperes. 1.5 ampere equals 1,500 milliamperes.

Or you can do it the hard way and multiply amperes by 1,000:
1 X 1,000 = 1,000 milliamperes.
1.5 X 1,000 = 1,500 milliamperes.

If an ammeter calibrated in amperes is used to measure a 3000-milliampere of current, the reading would be 3 amperes.

To convert milliamperes to amperes, simply move the decimal place to the left by three. Or do the math: 3,000 / 1,000 equals 3 ampere.

Here are some other need to know conversions:

- Milli (as in above): 1 one-thousandth of a quantity. Divide or multiply by 1,000 or simply move the decimal place to the right or left by 3 places.
- Micro: is 1 millionth of a quantity. Divide by or multiply by 1,000,000 or simply move the decimal place to the right or left by 6 places.

- Pico: 1 trillionth of a quantity.
- Kilo: 1 thousand of a quantity.

1,000 volts is 1 KV (Kilovolt) 1,000 hertz is 1 Khz. (Kilohertz) To convert 1 Kilovolt to volts, simply move the decimal place to the right by 3. To convert Volts to Kilovolts, simply move the decimal place to the left by three.

- **Mega: 1 million of a quantity. 1 MHz is 1,000,000 Hertz. To convert from Hertz to Mega Hertz (Mhz) simply move the 6 spaces to the left. To convert from Mega Hertz to Hertz, simply move the decimal place to the right 6 spaces.**

- **1500 kHz** is another way to specify a radio signal frequency of 1,500,000 hertz.
- **One thousand volts** are equal to one kilovolt.
- **One one-millionth of a volts** is equal to one microvolt.

- **0.5 watts is equivalent to 500 milliwatts.**
- **One microfarads is equal to 1,000,000 picofarads.**

T5B01

How many milliamperes is 1.5 amperes?

A. 15 milliamperes
B. 150 milliamperes
C. 1,500 milliamperes
D. 15,000 milliamperes

T5B01

How many milliamperes is 1.5 amperes?

C. 1,500 milliamperes (move the decimal place to the right by 3 spaces.) or (1.5 x 1000 = 1500)

T5B02

What is another way to specify a radio signal frequency of 1,500,000 hertz?

A. 1500 kHz

B. 1500 MHz

C. 15 GHz

D. 150 kHz

T5B02

What is another way to specify a radio signal frequency of 1,500,000 hertz?

A. 1500 kHz (move the decimal place to left 3 spaces) or (1,500,00 / 1000 = 1500)

T5B03

How many volts are equal to one kilovolt?

A. One one-thousandth of a volt

B. One hundred volts

C. One thousand volts

D. One million volts

T5B03

How many volts are equal to one kilovolt?

C. One thousand volts

T5B04

How many volts are equal to one microvolt?

A. One one-millionth of a volt

B. One million volts

C. One thousand kilovolts

D. One one-thousandth of a volt

T5B04

How many volts are equal to one microvolt?

A. One one-millionth of a volt

T5B05

Which of the following is equivalent to 500 milliwatts?

A. 0.02 watts

B. 0.5 watts

C. 5 watts

D. 50 watts

T5B05

Which of the following is equivalent to 500 milliwatts?

B. 0.5 watts (move the decimal place to the left 3 places) or (500/1,000 = .5)

T5B06

If an ammeter calibrated in amperes is used to measure a 3000-milliampere current, what reading would it show?

A. 0.003 amperes

B. 0.3 amperes

C. 3 amperes

D. 3,000,000 amperes

T5B06

If an ammeter calibrated in amperes is used to measure a 3000-milliampere current, what reading would it show?

C. 3 amperes (move the decimal place to the left 3 places) or (3,000 / 1,000 = 3)

T5B08

How many microfarads are 1,000,000 picofarads?

A. 0.001 microfarads

B. 1 microfarad

C. 1000 microfarads

D. 1,000,000,000 microfarads

T5B08

How many microfarads are 1,000,000 picofarads?

B. 1 microfarad (1 million = 1 micro)

- **If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, it would show 3525 kHz if it were calibrated in kilohertz.**

- **The following frequency is equal to 28,400 kHz: 28.400 MHz**

- A frequency readout showing a reading of 2425 MHz is 2.425 GHz

T5B07

If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, what would it show if it were calibrated in kilohertz?

A. 0.003525 kHz
B. 35.25 kHz
C. 3525 kHz
D. 3,525,000 kHz

T5B07

If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, what would it show if it were calibrated in kilohertz?

C. 3525 kHz (move the decimal place to the right 3 places) or (3.525 x 1,000 = 3525)

T5B12

Which of the following frequencies is equal to 28,400 kHz?

A. 28.400 MHz

B. 2.800 MHz

C. 284.00 MHz

D. 28.400 kHz

T5B12

Which of the following frequencies is equal to 28,400 kHz?

A. 28.400 MHz

T5B13

If a frequency readout shows a reading of 2425 MHz, what frequency is that in GHz?

A. 0.002425 GHZ

B. 24.25 GHz

C. 2.425 GHz

D. 2425 GHz

T5B13

If a frequency readout shows a reading of 2425 MHz, what frequency is that in GHz?

C. 2.425 GHz

We use decibels when we are describing power ratios. A good example in ordinary life would be a rock band at the local high school. It is really loud! What high school rock band wouldn't be!

If you lower the loudness by half, you would be lowering the loudness by 3 decibels, or db for short.

If, heaven forbid, you wanted to make the band twice as loud, you would need to up the volume by 3 db!

- The approximate amount of change, measured in decibels (dB), of a power increase from 5 watts to 10 watts is 3dB.
- The approximate amount of change, measured in decibels (dB), of a power decrease from 12 watts to 3 watts is -6dB. (take it in steps: 3db would be 6 watts, then another 3db would be 3 watts.)
- The approximate amount of change, measured in decibels (dB), of a power increase from 20 watts to 200 watts is 10dB.

T5B09

What is the approximate amount of change, measured in decibels (dB), of a power increase from 5 watts to 10 watts?

A. 2 dB

B. 3 dB

C. 5 dB

D. 10 dB

T5B09

What is the approximate amount of change, measured in decibels (dB), of a power increase from 5 watts to 10 watts?

B. 3 dB

T5B10

What is the approximate amount of change, measured in decibels (dB), of a power decrease from 12 watts to 3 watts?

A. -1 dB

B. -3 dB

C. -6 dB

D. -9 dB

T5B10

What is the approximate amount of change, measured in decibels (dB), of a power decrease from 12 watts to 3 watts?

C. -6 dB

T5B11

What is the approximate amount of change, measured in decibels (dB), of a power increase from 20 watts to 200 watts?

A. 10 dB

B. 12 dB

C. 18 dB

D. 28 dB

T5B11

What is the approximate amount of change, measured in decibels (dB), of a power increase from 20 watts to 200 watts?

A. 10 dB

T5C - Electronic principles: capacitance; inductance; current flow in circuits; alternating current; definition of RF; DC power calculations; impedance

The ability to store energy in an electric field is called capacitance.

A capacitor consists of two or more conductors separated by some sort of insulator.

The basic unit of capacitance is the farad.

The ability to store energy in a magnetic field is called inductance.

The basic unit of inductance is the **Henry.**

An inductor is often made by wrapping wire around a “coil form”. Sometimes however, self- supporting wire can simply be formed into a coil of 1 or more turns.

The greater the number of turns, the greater the inductance.

A resistor is used to oppose the flow of current in a DC circuit and is measured in ohms.

Resistors can be of fixed value or variable. An example of a variable resistor would be the volume control on a radio.

A variable resistor is also called a potentiometer.

T5C01

What is the ability to store energy in an electric field called?

A. Inductance

B. Resistance

C. Tolerance

D. Capacitance

T5C01

What is the ability to store energy in an electric field called?

D. Capacitance

T5C02

What is the basic unit of capacitance?

A. The farad

B. The ohm

C. The volt

D. The henry

T5C02

What is the basic unit of capacitance?

A. The farad

T5C03

What is the ability to store energy in a magnetic field called?

A. Admittance

B. Capacitance

C. Resistance

D. Inductance

T5C03

What is the ability to store energy in a magnetic field called?

D. Inductance

T5C04

What is the basic unit of inductance?

A. The coulomb

B. The farad

C. The henry

D. The ohm

T5C04

What is the basic unit of inductance?

C. The henry

Hertz is the unit of frequency. The hertz is one cycle of Alternating Current. The voltage outlet of your house is 117 Volts AC.

The frequency of the AC is 60 Hertz, meaning the current alternates at a rate of 60 times per second.

RF is the abbreviation that refers to radio frequency signals of all types. Radio waves is the usual name for electromagnetic waves that travel through space.

T5C05

What is the unit of frequency?

A. Hertz

B. Henry

C. Farad

D. Tesla

T5C05

What is the unit of frequency?

A. Hertz

T5C06

What does the abbreviation “RF” refer to?

A. Radio frequency signals of all types

B. The resonant frequency of a tuned circuit

C. The real frequency transmitted as opposed to the apparent frequency

D. Reflective force in antenna transmission lines

T5C06

What does the abbreviation “RF” refer to?

A. Radio frequency signals of all types

T5C07

What is a usual name for electromagnetic waves that travel through space?

A. Gravity waves
B. Sound waves
C. Radio waves
D. Pressure waves

T5C07

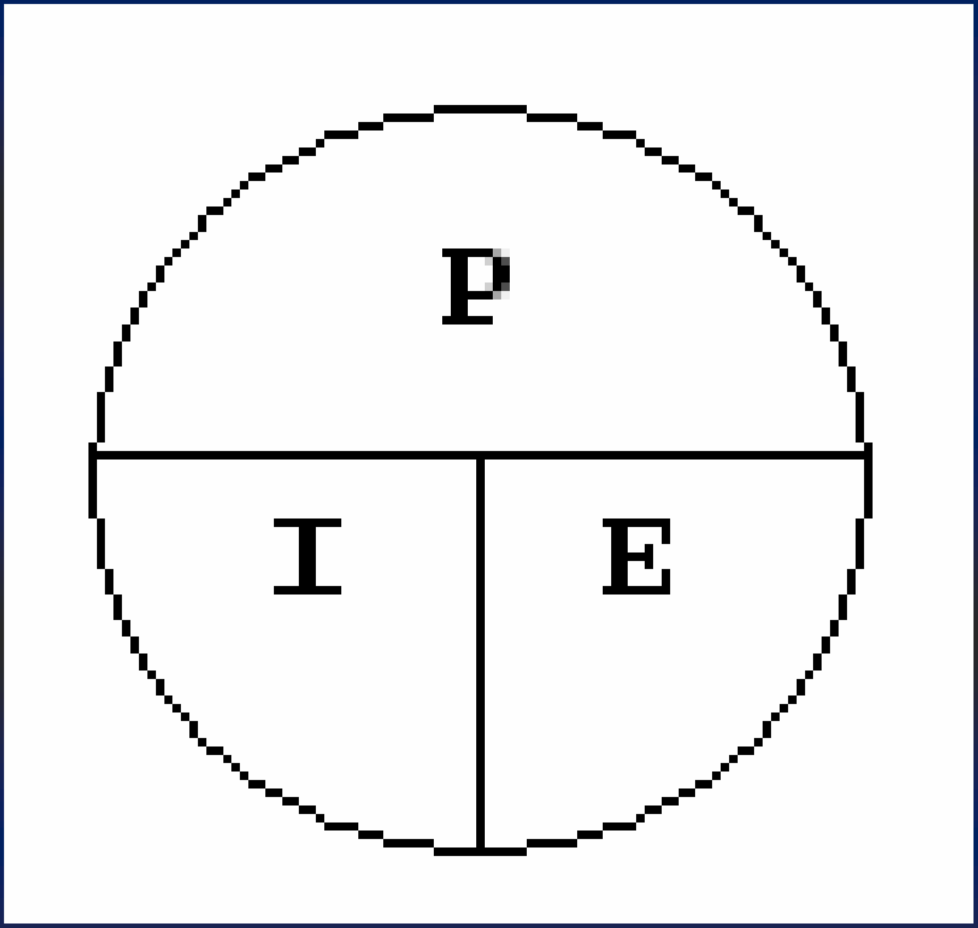
What is a usual name for electromagnetic waves that travel through space?

C. Radio waves

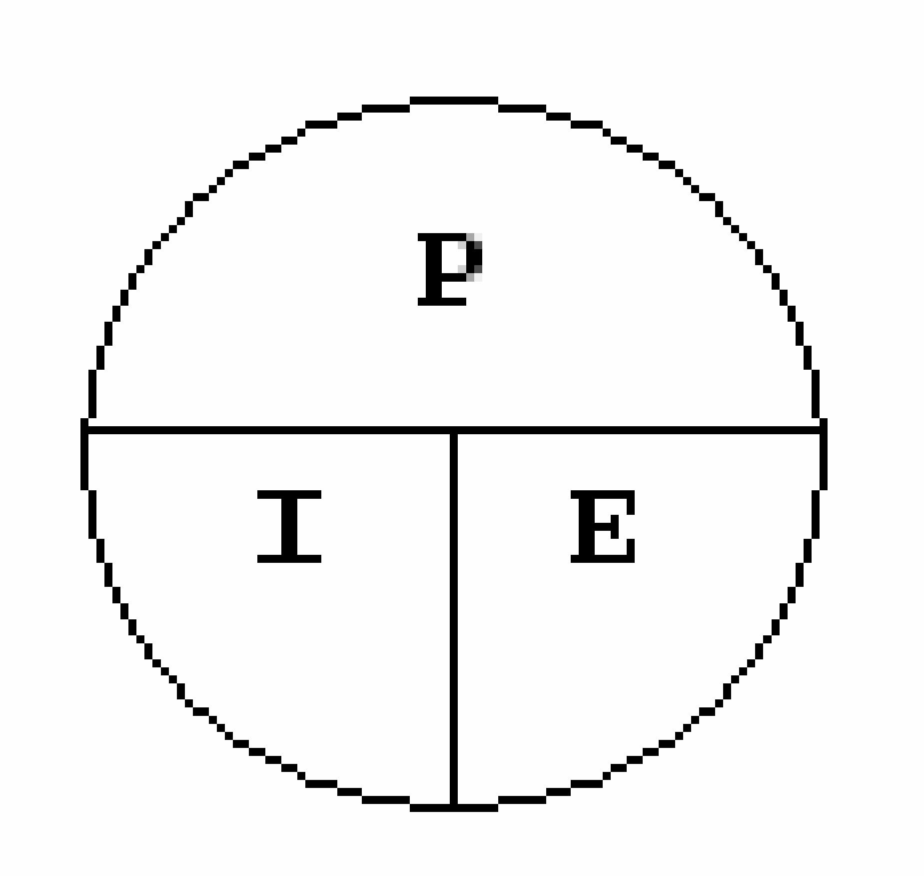
You will need to know the power formulas for the test. Using the pie chart is one of the easiest ways to remember these three formulas.

During the exam will be given a blank page of paper in which you may do your calculations on. When the exam begins, you may draw this pie chart.

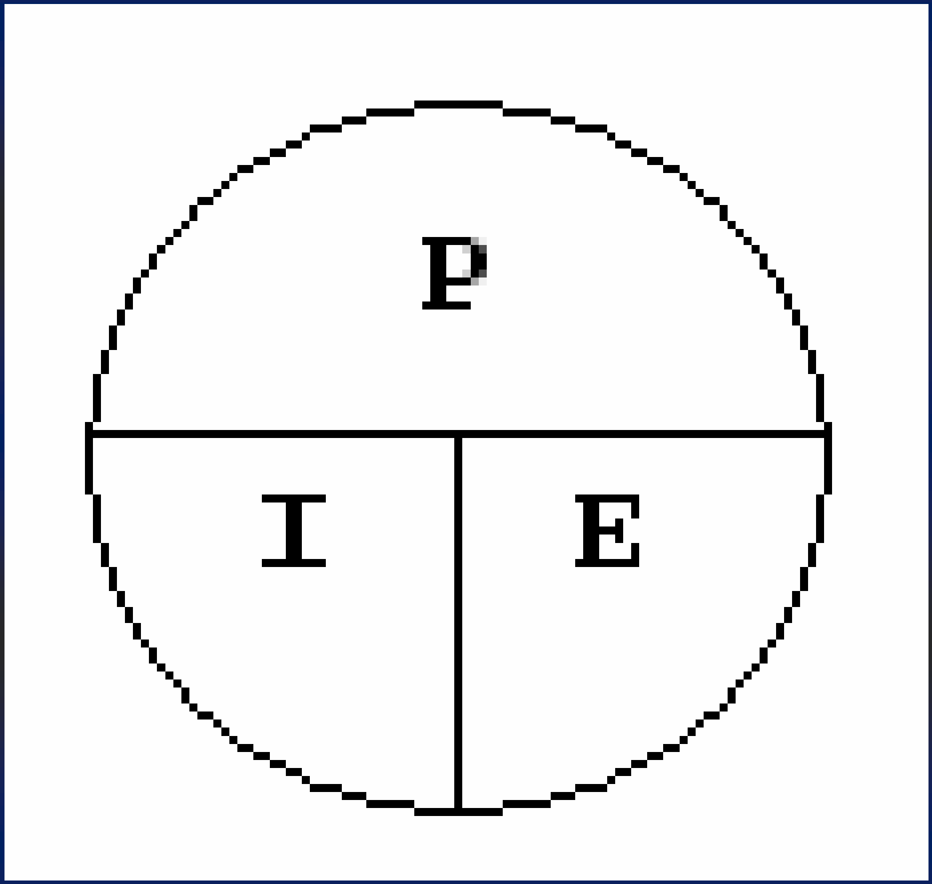
The pie chart itself is easy to remember because it actually spells “PIE”. All you need to remember is that the P goes on top and the I and E goes on the bottom.


P
I
E

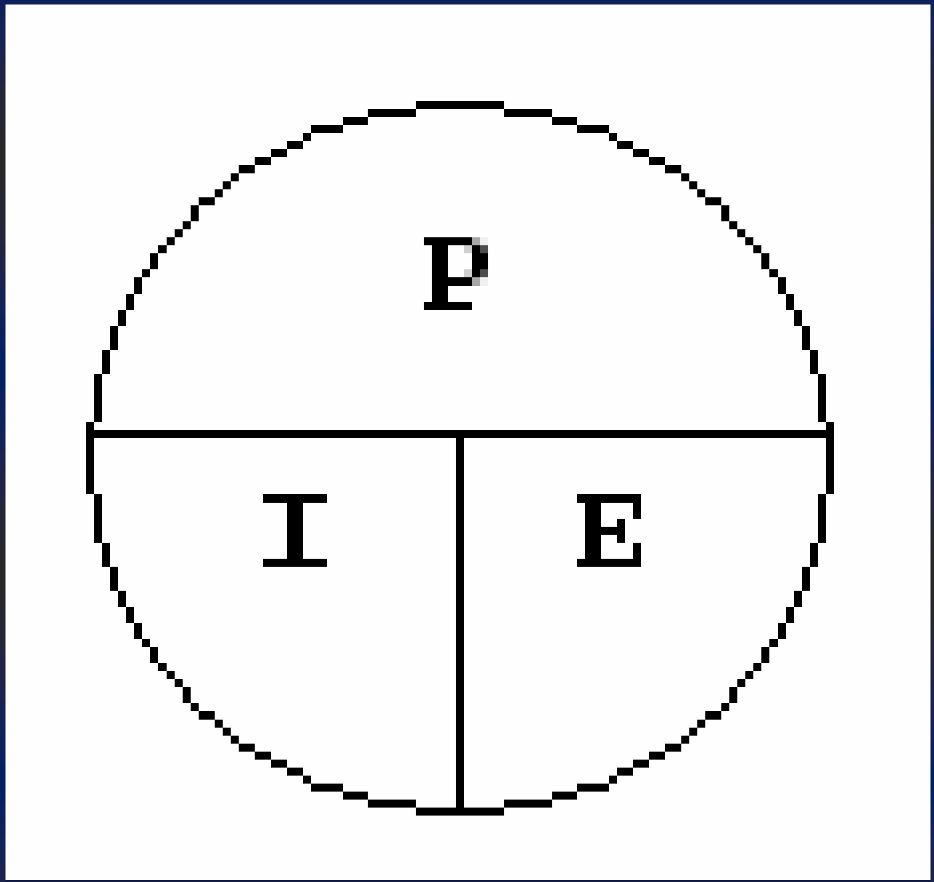
Power (P) equals voltage (E) multiplied by current (I) is the formula used to calculate electrical power in a DC circuit. (Here are the power formulas:: P = E X I
E = P / I   I = P / E)



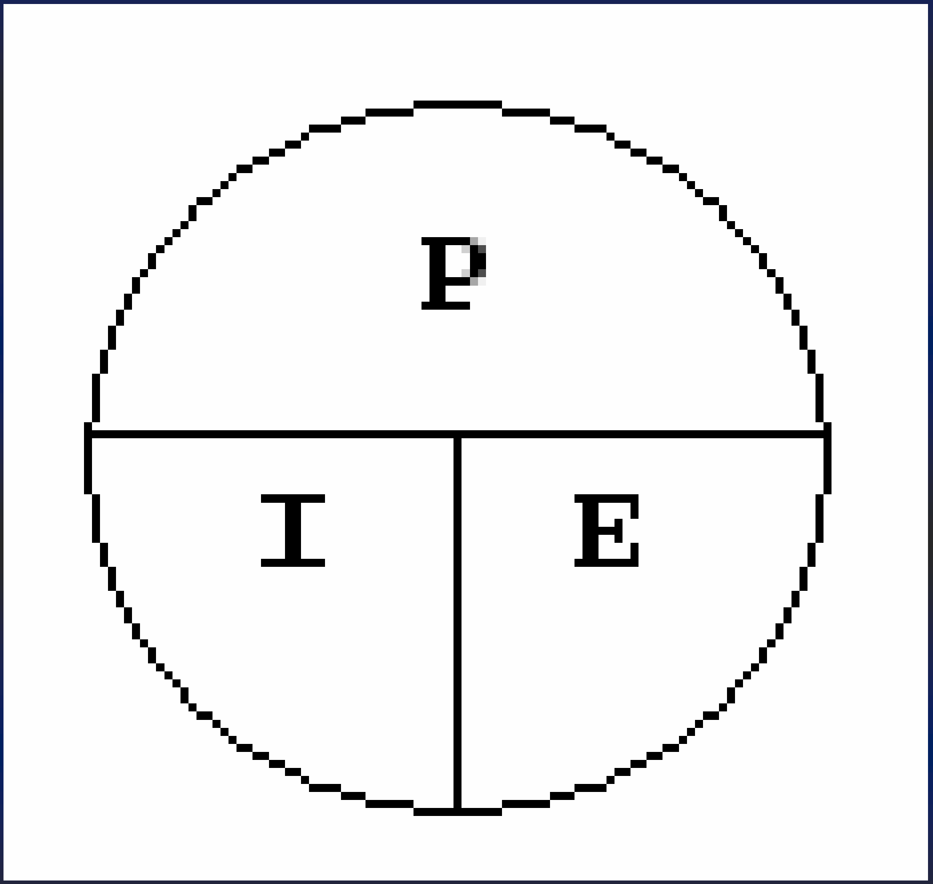
If one needs to know the power, just cover up "P" and you will see: I X E.



Looking for the Current? Cover up “I” and you will see: P / E.



For Volts, cover up "E" and you will see: P / I.



- **138 watts** of power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes (13.8 x 10 = 138)

- **30 watts** of power is being used in a circuit when the applied voltage is 12 volts D and the current is 2.5 amperes. (12 x 2.5 = 30)

- **10 amperes are flowing in a circuit when the applied voltage is 12 volts and the load is 120 watts. (120 / 12 = 10)**

T5C08

What is the formula used to calculate electrical power in a DC circuit?

A. Power (P) equals voltage (E) multiplied by current (I)

B. Power (P) equals voltage (E) divided by current (I)

C. Power (P) equals voltage (E) minus current (I)

D. Power (P) equals voltage (E) plus current (I)

T5C08

What is the formula used to calculate electrical power in a DC circuit?

A. Power (P) equals voltage (E) multiplied by current (I)

T5C09

How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes?

A. 138 watts

B. 0.7 watts

C. 23.8 watts

D. 3.8 watts

T5C09

How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes?

A. 138 watts

T5C10

How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes?

A. 4.8 watts

B. 30 watts

C. 14.5 watts

D. 0.208 watts

T5C10

How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes?

B. 30 watts

T5C11

How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 120 watts?

A. 0.1 amperes

B. 10 amperes

C. 12 amperes

D. 132 amperes

T5C11

How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 120 watts?

B. 10 amperes

Impedance is a measure of the opposition to AC current flow in a circuit and is measured in Ohms.

T5C12

What is meant by the term impedance?

A. It is a measure of the opposition to AC current flow in a circuit

B. It is the inverse of resistance

C. It is a measure of the Q or Quality Factor of a component

D. It is a measure of the power handling capability of a component

T5C12

What is meant by the term impedance?

A. It is a measure of the opposition to AC current flow in a circuit

T5C13

What are the units of impedance?

A. Volts

B. Amperes

C. Coulombs

D. Ohms

T5C13

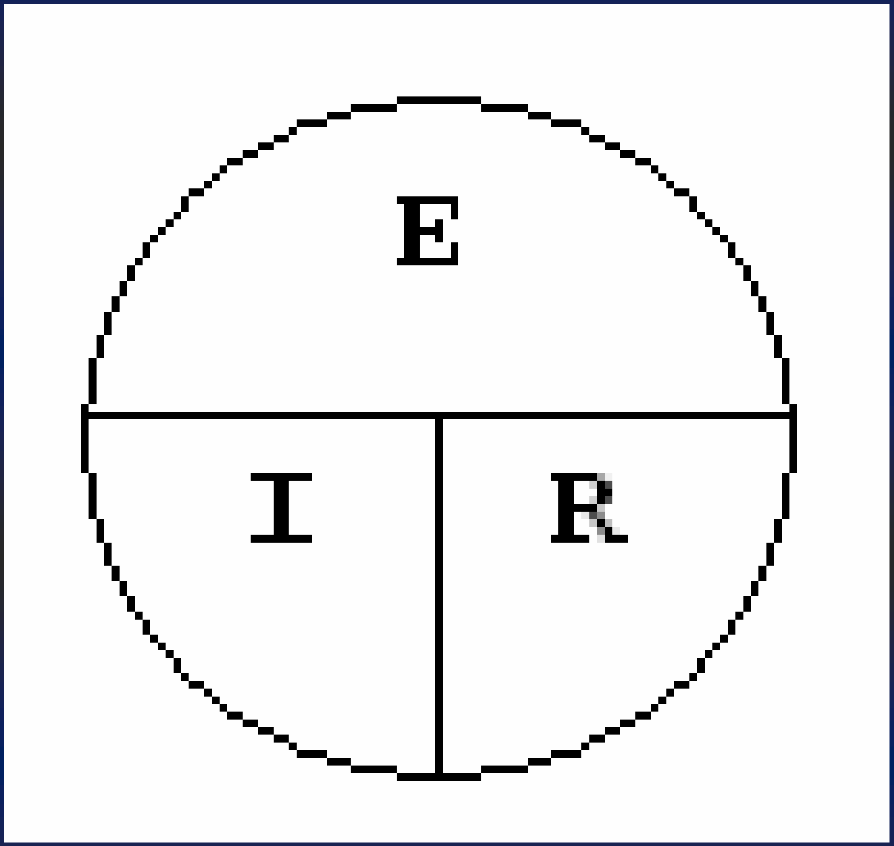
What are the units of impedance?

D. Ohms

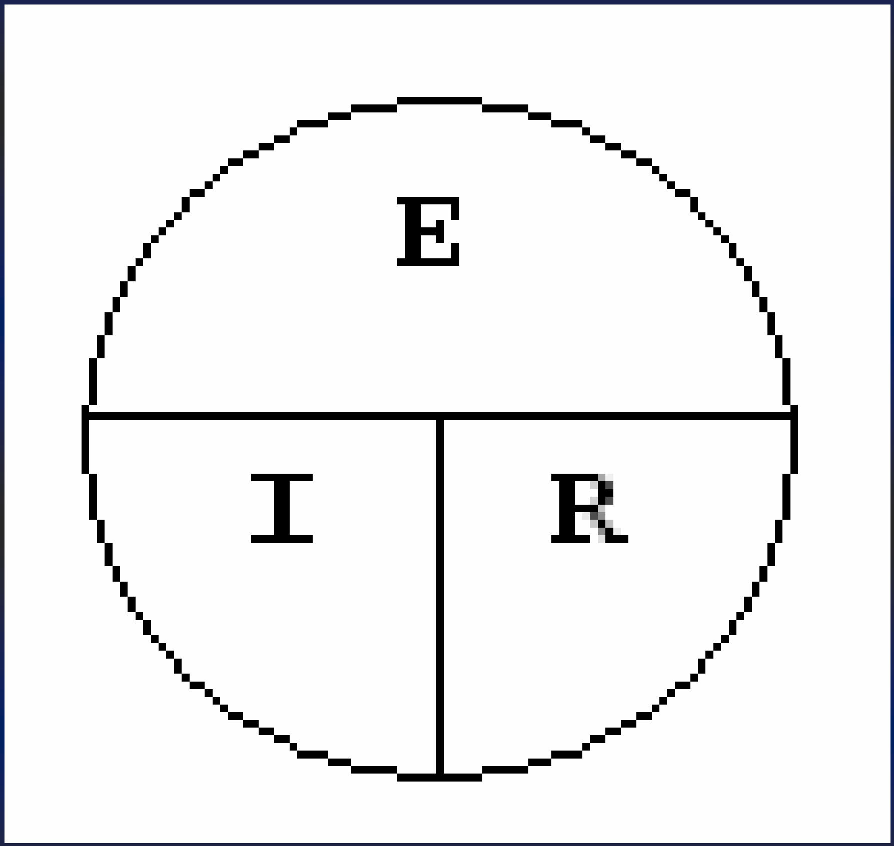
T5D –
Ohm’s Law: formulas and usage

Using Ohm's law, one can calculate the value of Resistance, Current, or Voltage as long as two of the values are known.

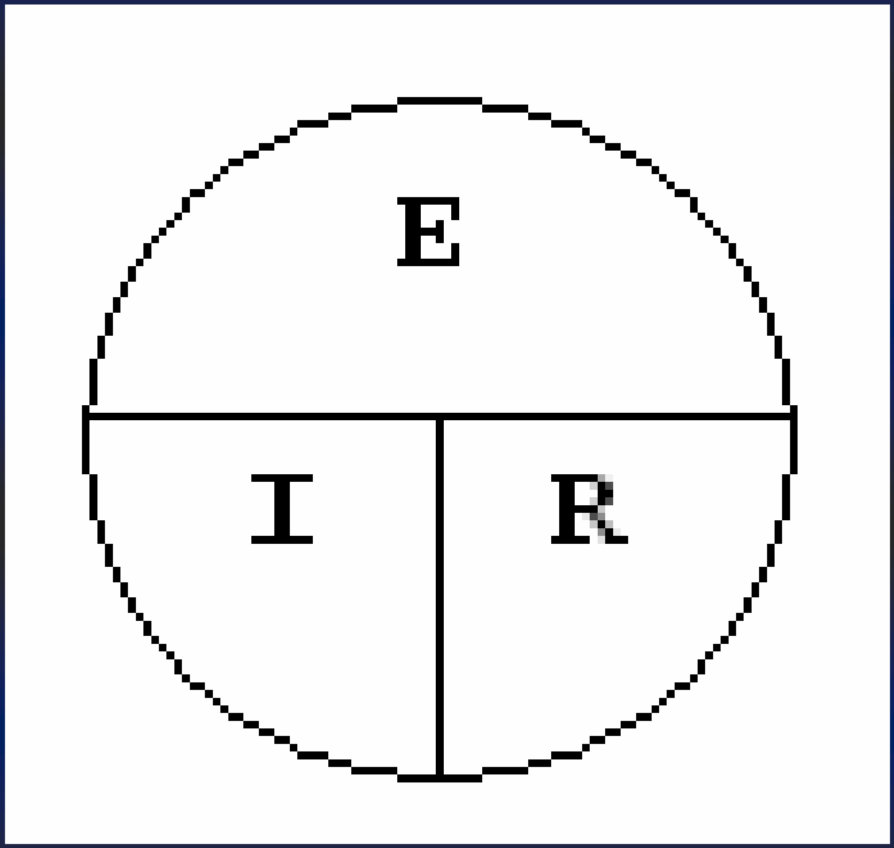
- The formula Current (I) equals voltage (E) divided by resistance (R).is used to calculate current in a circuit.



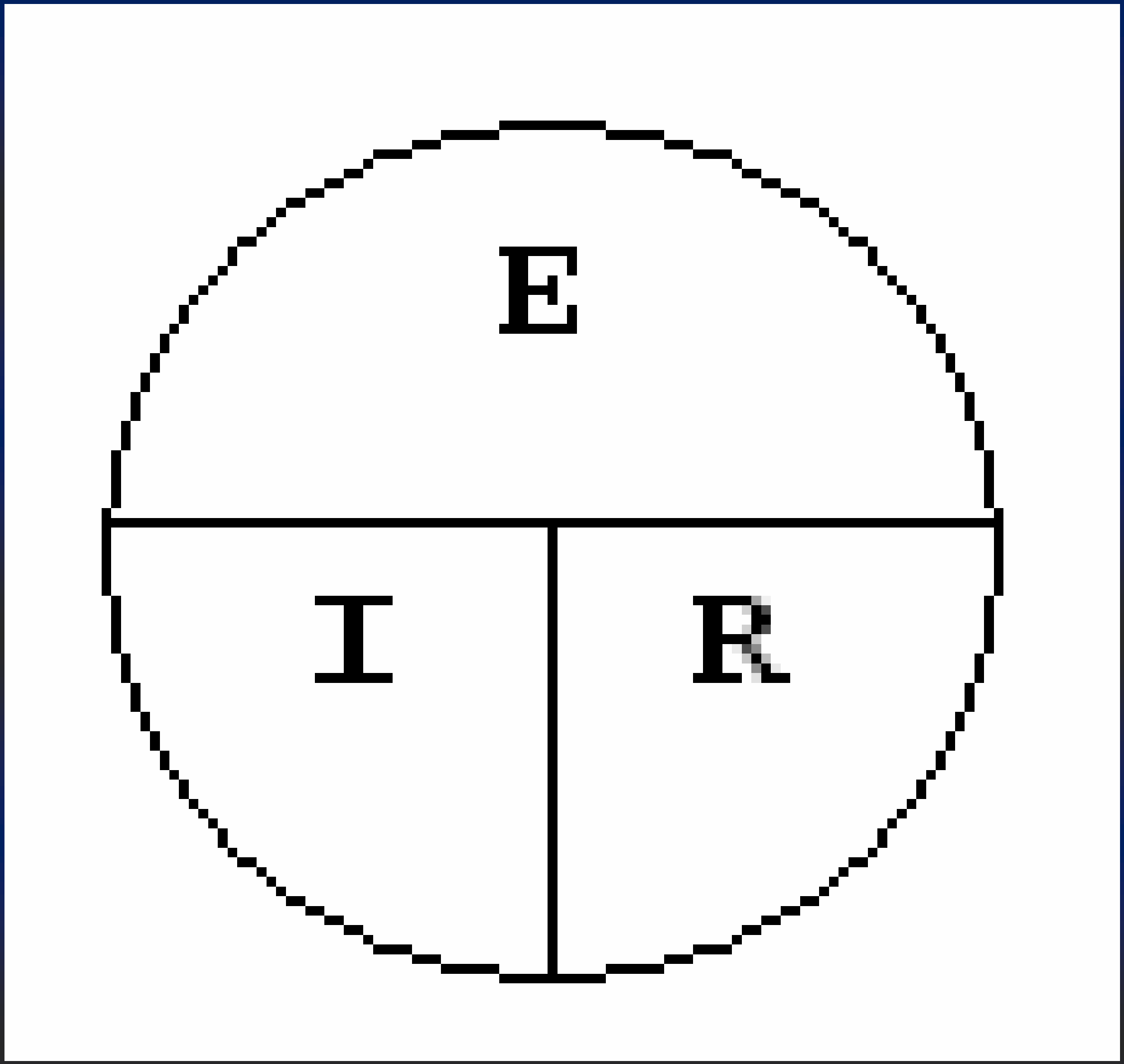
- The formula Voltage (E) equals current (I) multiplied by resistance (R) is used to calculate voltage in a circuit.



The formula Resistance (R) equals voltage (E) divided by current (I) is used to calculate resistance in a circuit.



Just as in the Power calculations, Ohm’s law is easy to remember by using a pie chart:


E
I
R

An easy trick to remember this chart is to realize that the letters E, I, and R are in a alphabetical order and the first Letter E is on top.

As with the power chart, one may draw this chart on your scratch paper once the test begins.

Similar to the Power chart, just cover up the missing item to see how to solve the problem.

- **The resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts is 30 ohms.**

(R = E / I: 90 / 3 = 30 Ohms)

- The resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes is 8 ohms.

(R = E / I: 12 / 1.5 = 8 Ohms)

- The resistance of a circuit that draws 4 amperes from a 12-volt source is **3 ohms.**

(R = E/I: 12 / 4 = 3 Ohms)

- **The current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms is 1.5 amperes.**

(I = E / R: 120 / 80 = 1.5 Amps)

- The current flowing through a 100-ohm resistor connected across 200 volts is **2 amperes.**

(I = E / R: 200 / 100 = 2 Amps)

- **The current flowing through a 24-ohm resistor connected across 240 volts 10 amperes.**

(I = E / R: 240 / 24 = 10 Amps)

- The voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it is **1 volt.**

(E = I X R: 0.5 X 2 = 1 Volt)

- **The voltage across a 10-ohm resistor if a current of 1 ampere flows through it is 10 volts.**

(E = I X R: 1 X 10 = 10 Volts)

- **The voltage across a 10-ohm resistor if a current of 2 amperes flows through it 20 volts.**

(E = I / R: 2 X 10 = 20 Volts)

T5D01

What formula is used to calculate current in a circuit?

A. Current (I) equals voltage (E) multiplied by resistance (R)

B. Current (I) equals voltage (E) divided by resistance (R)

C. Current (I) equals voltage (E) added to resistance (R)

D. Current (I) equals voltage (E) minus resistance (R)

T5D01

What formula is used to calculate current in a circuit?

B. Current (I) equals voltage (E) divided by resistance (R)

T5D02

What formula is used to calculate voltage in a circuit?

A. Voltage (E) equals current (I) multiplied by resistance (R)

B. Voltage (E) equals current (I) divided by resistance (R)

C. Voltage (E) equals current (I) added to resistance (R)

D. Voltage (E) equals current (I) minus resistance (R)

T5D02

What formula is used to calculate voltage in a circuit?

A. Voltage (E) equals current (I) multiplied by resistance (R)

T5D03

What formula is used to calculate resistance in a circuit?

A. Resistance (R) equals voltage (E) multiplied by current (I)

B. Resistance (R) equals voltage (E) divided by current (I)

C. Resistance (R) equals voltage (E) added to current (I)

D. Resistance (R) equals voltage (E) minus current (I)

T5D03

What formula is used to calculate resistance in a circuit?

B. Resistance (R) equals voltage (E) divided by current (I)

T5D04

What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts?

A. 3 ohms

B. 30 ohms

C. 93 ohms

D. 270 ohms

T5D04

What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts?

B. 30 ohms

(R = E / I: 90 / 3 = 30 Ohms)

T5D05

What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?

A. 18 ohms

B. 0.125 ohms

C. 8 ohms

D. 13.5 ohms

T5D05

What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?

C. 8 ohms

(R = E / I: 12 / 1.5 = 8 Ohms)

T5D06

What is the resistance of a circuit that draws 4 amperes from a 12-volt source?

A. 3 ohms

B. 16 ohms

C. 48 ohms

D. 8 Ohms

T5D06

What is the resistance of a circuit that draws 4 amperes from a 12-volt source?

A. 3 ohms

(R = E / I: 12 / 1.5 = 8 Ohms)

T5D07

What is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?

A. 9600 amperes

B. 200 amperes

C. 0.667 amperes

D. 1.5 amperes

T5D07

What is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?

D. 1.5 amperes

(I = E / R: 120 / 80 = 1.5 Amps)

T5D08

What is the current flowing through a 100-ohm resistor connected across 200 volts?

A. 20,000 amperes

B. 0.5 amperes

C. 2 amperes

D. 100 amperes

T5D08

What is the current flowing through a 100-ohm resistor connected across 200 volts?

B. 2 amperes

(I = E / R: 200 / 100 = 2 Amps)

T5D09

What is the current flowing through a 24-ohm resistor connected across 240 volts?

A. 24,000 amperes

B. 0.1 amperes

C. 10 amperes

D. 216 amperes

T5D09

What is the current flowing through a 24-ohm resistor connected across 240 volts?

C. 10 amperes

(I = E / R: 240 / 24 = 10 Amps)

T5D10

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

A. 1 volt

B. 0.25 volts

C. 2.5 volts

D. 1.5 volts

T5D10

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

A. 1 volt

(E = I X R: 0.5 X 2 = 1 Volt)

T5D11

What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?

A. 1 volt

B. 10 volts

C. 11 volts

D. 9 volts

T5D11

What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?

B. 10 volts

(E = I X R: 1 X 10 = 10 Volts)

T5D12

What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?

A. 8 volts

B. 0.2 volts

C. 12 volts

D. 20 volts

T5D12

What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?

D. 20 volts

(E = I X R:2 X 10 = 20 Volts)