Technician License Course

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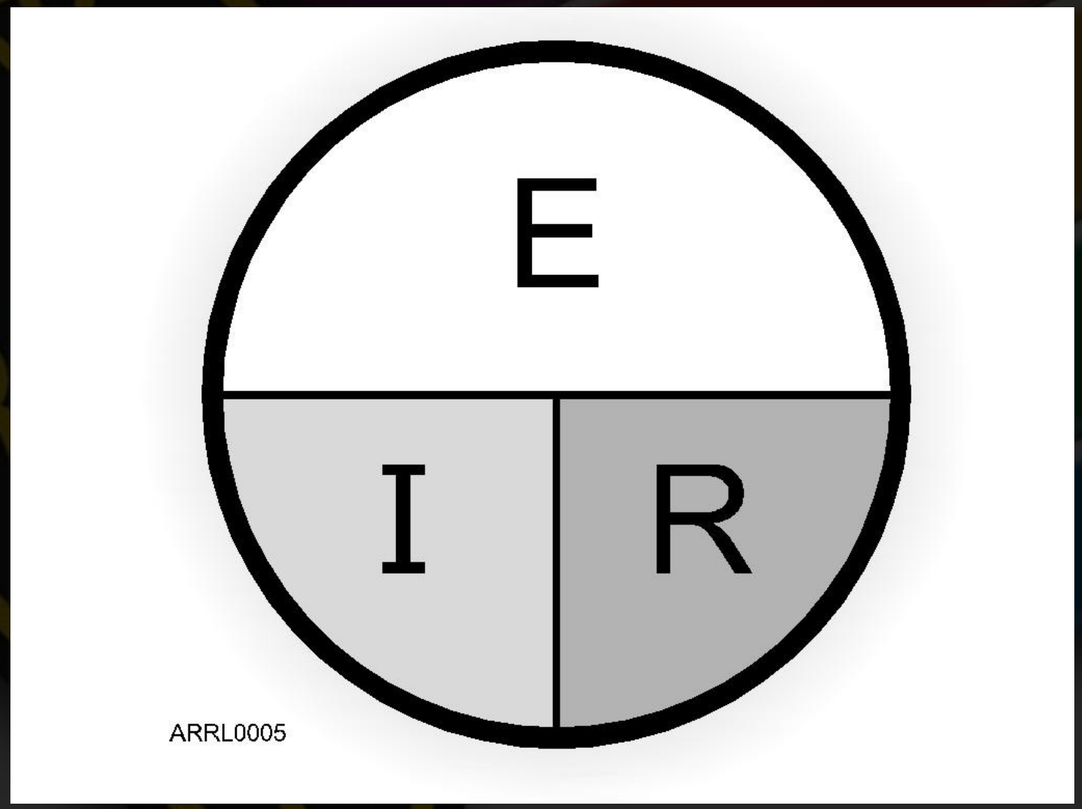
Chapter 3

Lesson Plan Module - 5

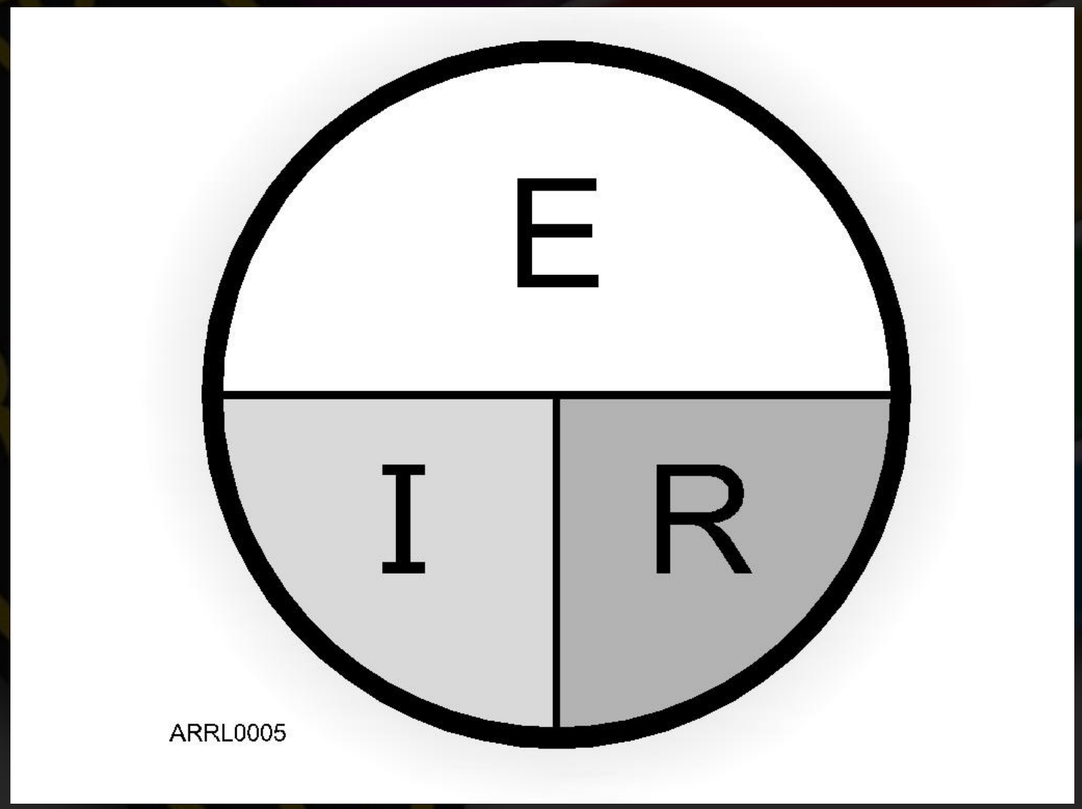
Ohm's Law, Power and the Metric System

Ohm's Law

Ohm's Law

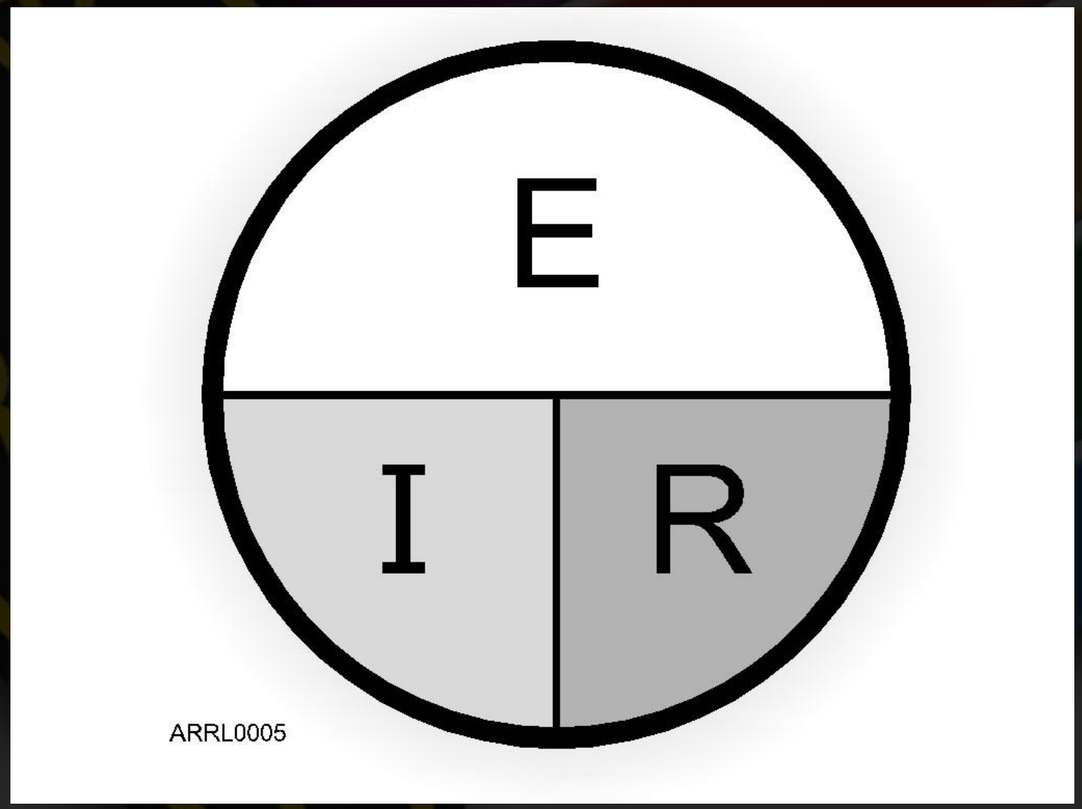


Ohm's Law



- E represents voltage
  - –Units – volts (V)
- I represents current
  - –Units – amperes (A)
- R represents resistance
  - –Units – ohms (Ω)

Ohm's Law



- E represents voltage
  - –Units – volts (V)
- I represents current
  - –Units – amperes (A)
- R represents resistance
  - –Units – ohms (Ω)

$R = E / I$

$I = E / R$

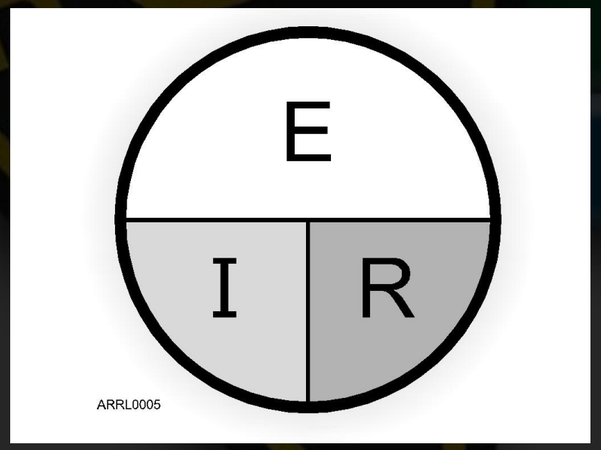
$E = I \times R$

Practice Questions

What formula is used to calculate current in a circuit?

What formula is used to calculate current in a circuit?

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

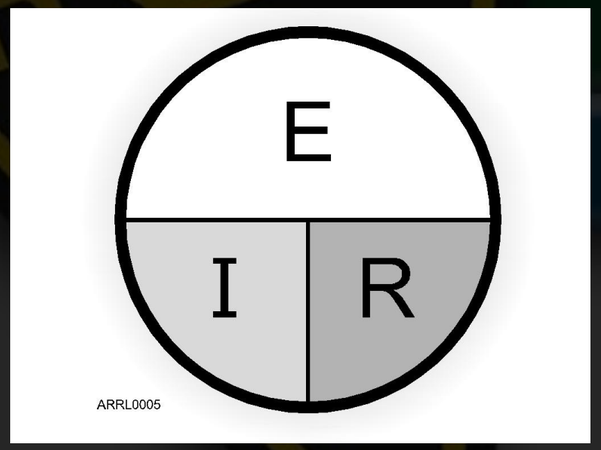


I = E / R

What formula is used to calculate voltage in a circuit?

What formula is used to calculate voltage in a circuit?

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

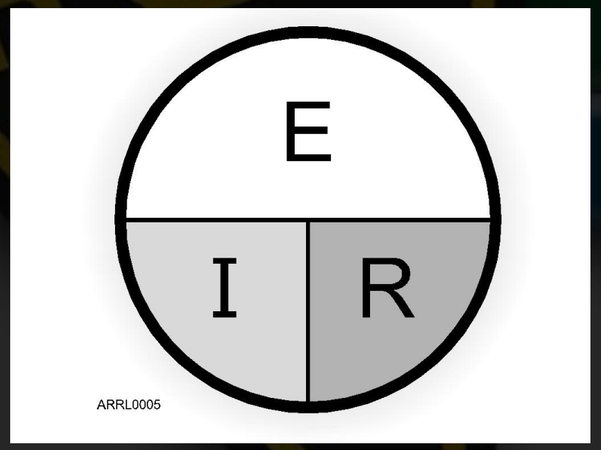


E = I * R

What formula is used to calculate resistance in a circuit?

What formula is used to calculate resistance in a circuit?

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

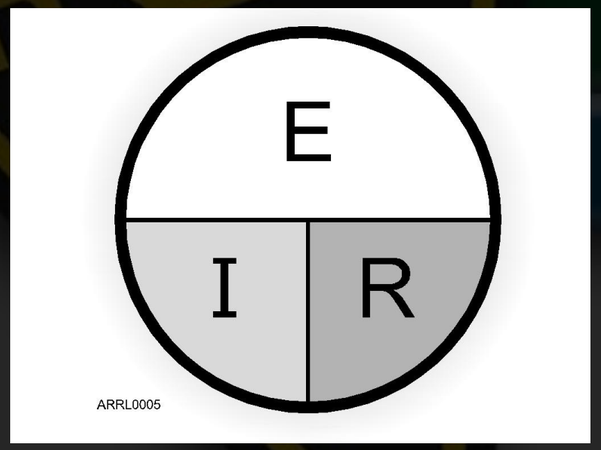


R = E / I

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

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

30 ohms

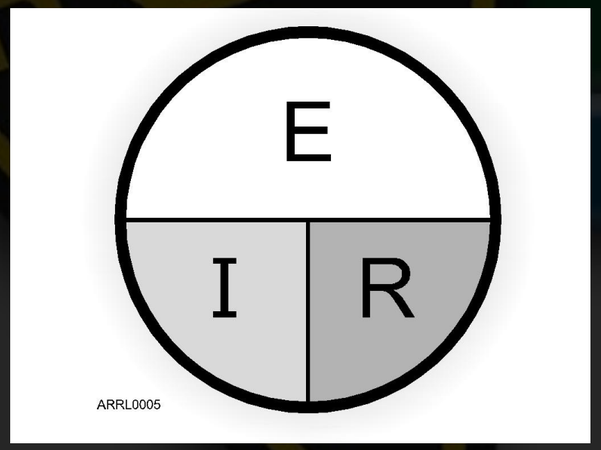


I = 3 amps
E = 90 V
R = E / I
R = 90 / 3 = 30 Ω

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

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

8 ohms

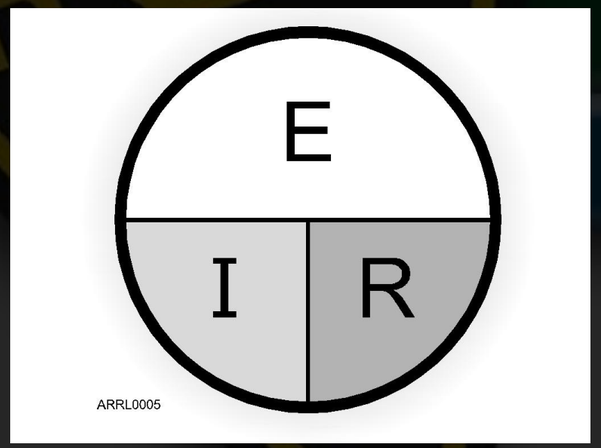


E = 12 V
I = 1.5 A
R = E / I
R = 12 / 1.5=8 Ω

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

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

3 ohms

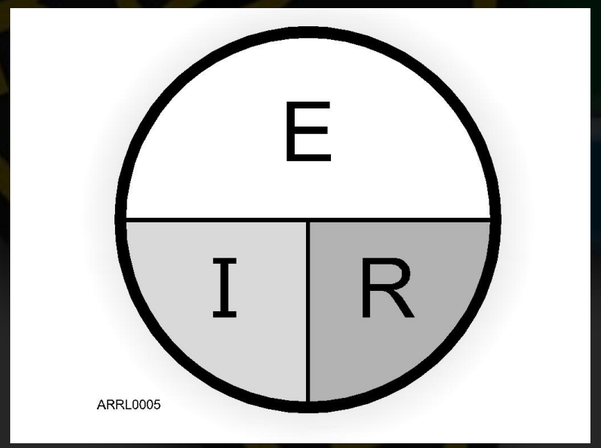


I = 4 A
E = 12 V
R = E / I
R = 12 / 4 = 3 Ω

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

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

1.5 amperes

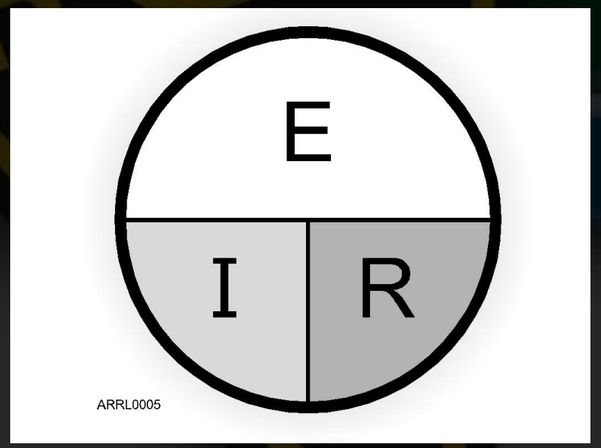


E = 120 V
R = 80 Ω
I = E / R
I = 120 / 80 = 1.5 A

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

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

2 amperes

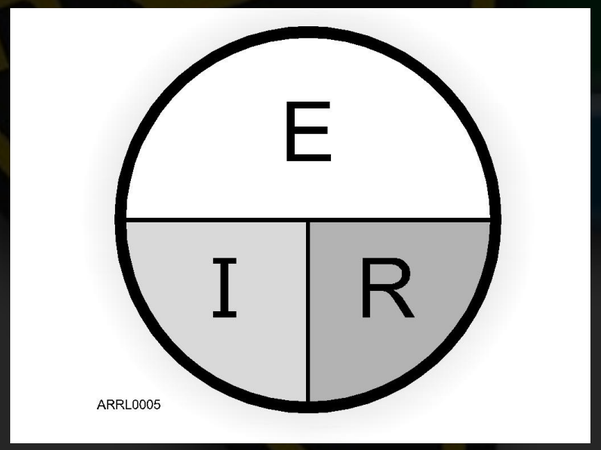


R = 100 Ω
E = 200 V
I = E / R
I = 200 / 100 = 3 A

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

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

10 amperes

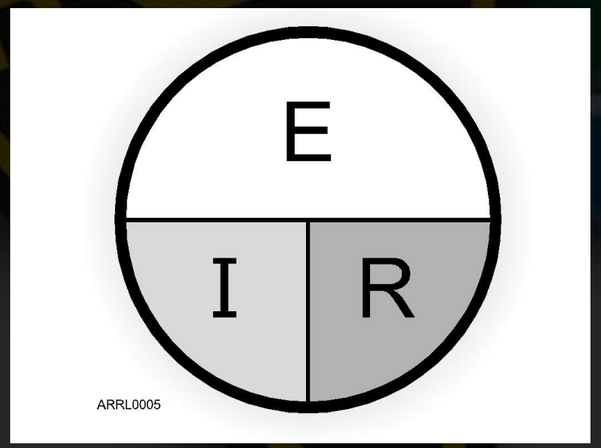


R = 24 Ω
E = 240 V
I = E / R
I = 240 / 24 = 10 A

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

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

1 volt

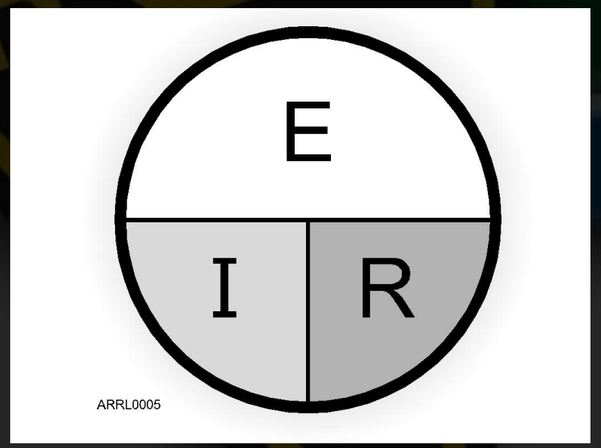


R = 2 Ω
I = 0.5 A
E = I * R
E = 2 * 0.5 = 1 V

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

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

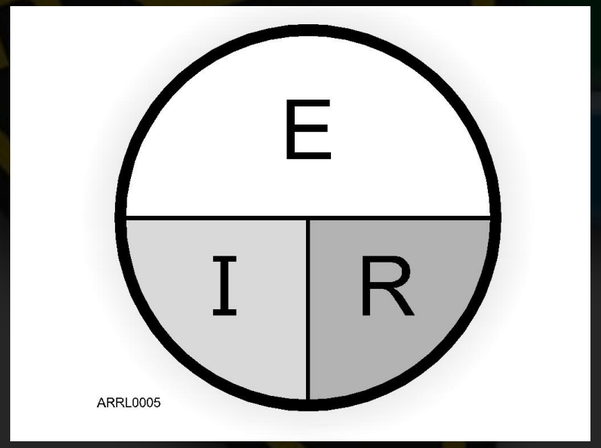
10 volts



R = 10 Ω
I = 1 A
E = I * R
E = 1 * 10 = 10V

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

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



20 volts

R = 10 Ω
I = 2 A
E = I * R
E = 2 * 10 = 20 V

Power

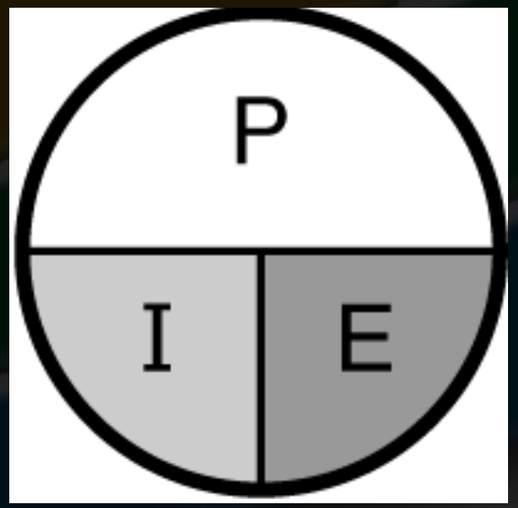
Power - Electrons Doing Work and Expending Energy

Power - Electrons Doing Work and Expending Energy

- Any time energy is expended, power is consumed.
- Electrons moving through resistance expend electrical energy and consume power.
- Power is the rate at which energy is consumed.
- Power is measured in units of watts (W).

Power Equation

- Power is calculated as the product of voltage and current



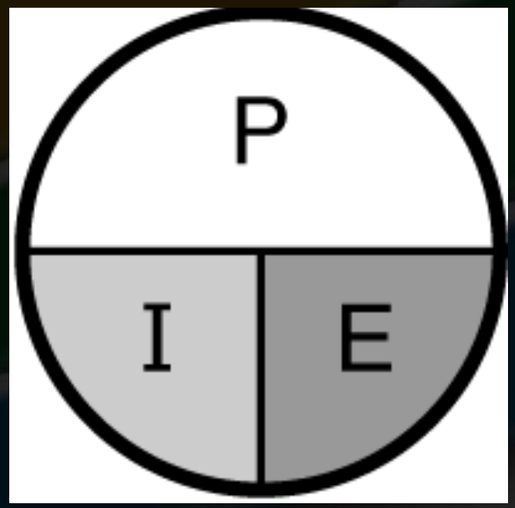
Power Equation

- Power is calculated as the product of voltage and current

  $P = E \times I$

  $E = P / I$

  $I = P / E$



- Like Ohm's Law, if you know two of the values, you can calculate the third.

Practice Questions

Electrical power is measured in what units?

Electrical power is measured in what units?

Watts

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

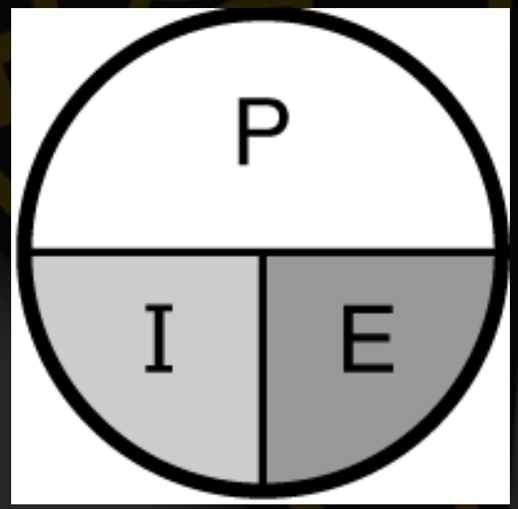
What term describes the rate at which electrical energy is used?

Power

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

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

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

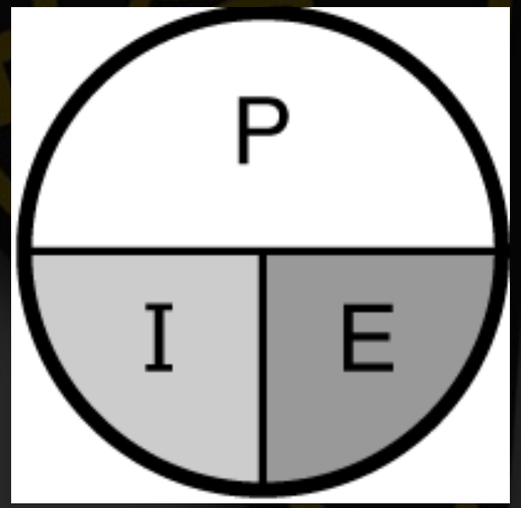


P = I * E

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

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

138 watts

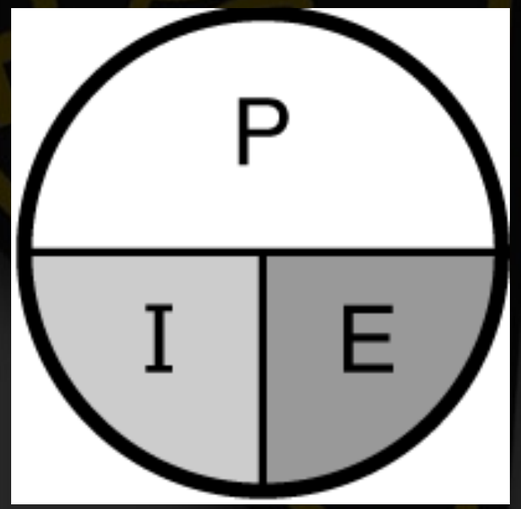


I = 10 A
E = 13.8 V
P = I * E
P = 10 * 13.8 = 138 W

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

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

30 watts

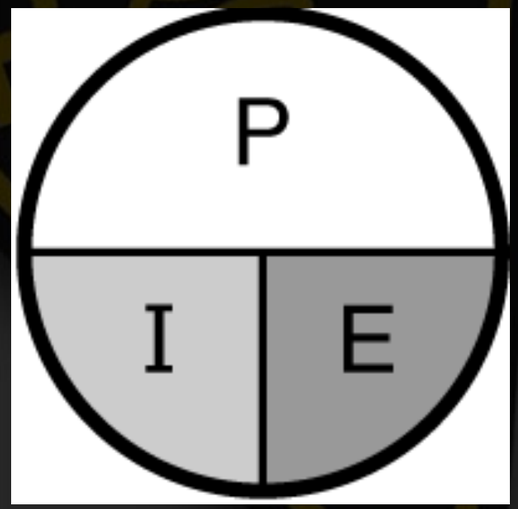


I = 2.5 A
E = 12 V
P = I * E
P = 2.5 * 12 = 30 W

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

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

10 amperes



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

Units

Metric Prefixes

Table 2-1
International System of Units (SI)—Metric Units

Prefix	*Symbol*	*Multiplication Factor*
Tera	T	$10^{12} = 1{,}000{,}000{,}000{,}000$
Giga	G	$10^{9} = 1{,}000{,}000{,}000$
Mega	M	$10^{6} = 1{,}000{,}000$
Kilo	k	$10^{3} = 1000$
Hecto	h	$10^{2} = 100$
Deca	da	$10^{1} = 10$
Deci	d	$10^{-1} = 0.1$
Centi	c	$10^{-2} = 0.01$
Milli	m	$10^{-3} = 0.001$
Micro	μ	$10^{-6} = 0.000001$
Nano	n	$10^{-9} = 0.000000001$
Pico	p	$10^{-12} = 0.000000000001$

Electrical Units

Electrical Units and Their Namesakes

Unit	*Measures*	*Named for*
Ampere	Current	Andree Marie Ampere (1775 – 1836)
Coulomb	Charge	Charles Augustin Coulomb (1736 – 1806)
Farad	Capacitance	Michael Faraday (1791 – 1867)
Henry	Inductance	Joseph Henry (1797 – 1878)
Hertz	Frequency	Heinrich Hertz (1857 – 1894)
Ohm	Resistance	George Simon Ohm (1787 – 1854)
Watt	Power	James Watt (1736 – 1819)
Volt	Voltage	Alessandro Giuseppe Antonio Anastasio Volta (1745 – 1827)

Practice Questions

How many milliamperes is 1.5 amperes?

How many milliamperes is 1.5 amperes?

1,500 milliamperes

$I = 1.5\ A$

$1\ A = 1000\ mA$

$I = 1.5\ A * 1000\ mA/1A = 1500\ mA$

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Specify a radio signal frequency of
1,500,000 hertz in kHz?

Specify a radio signal frequency of 1,500,000 hertz in kHz?

1500 kHz

f = 1500000 Hz
1 kHz = 1000 Hz
f = 1500000 Hz * 1 kHz/1000 Hz = 1500 kHz

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Nano	n	10^{-9} = 0.000000001
Pico	p	10^{-12} = 0.000000000001

How many volts are equal to one kilovolt?

How many volts are equal to one kilovolt?

One thousand volts

$E = 1\ kV$

$1\ kV = 1000\ V$

$E = 1kV * 1000\ V / 1\ kV = 1000\ V$

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International System of Units (SI)—Metric Units

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Nano	n	10^{-9} = 0.000000001
Pico	p	10^{-12} = 0.000000000001

How many volts are equal to one microvolt?

How many volts are equal to one microvolt?

One one-millionth of a volt

E = 1 V

1 µV = 1 V / 1,000,000

E = one-millionth V

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Deca	da	10^{1} = 10
Deci	d	10^{-1} = 0.1
Centi	c	10^{-2} = 0.01
Milli	m	10^{-3} = 0.001
Micro	µ	10^{-6} = 0.000001
Nano	n	10^{-9} = 0.000000001
Pico	p	10^{-12} = 0.000000000001

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

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

3 amperes

I = 3000 mA

1000 mA = 1A

I = 3000 mA * 1 A / 1000 mA = 3 A

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Pico	p	10^{-12} = 0.000000000001

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

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

3525 kHz

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Nano	n	10^{-9} = 0.000000001
Pico	p	10^{-12} = 0.000000000001

f = 3.525 MHz
1 MHz = 1000 kHz
f = 3.525 MHz * 1000 kHz / 1 MHz = 3525 kHz

How many microfarads are 1,000,000 picofarads?

How many microfarads are 1,000,000 picofarads?

1 microfarad

$C = 1{,}000{,}000\ pF$

$1\ \mu F = 1{,}000{,}000\ pF$

$C = 1{,}000{,}000\ pF * 1\mu F / 1{,}000{,}000 pF = 1\mu F$

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

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

2.425 GHz

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Nano	n	10^{-9} = 0.000000001
Pico	p	10^{-12} = 0.000000000001

f = 2425 MHz
1 GHz = 1000 MHz
f = 2425 MHz * 1GHz/1000MHz = 2.425 GHz

End of Module 5