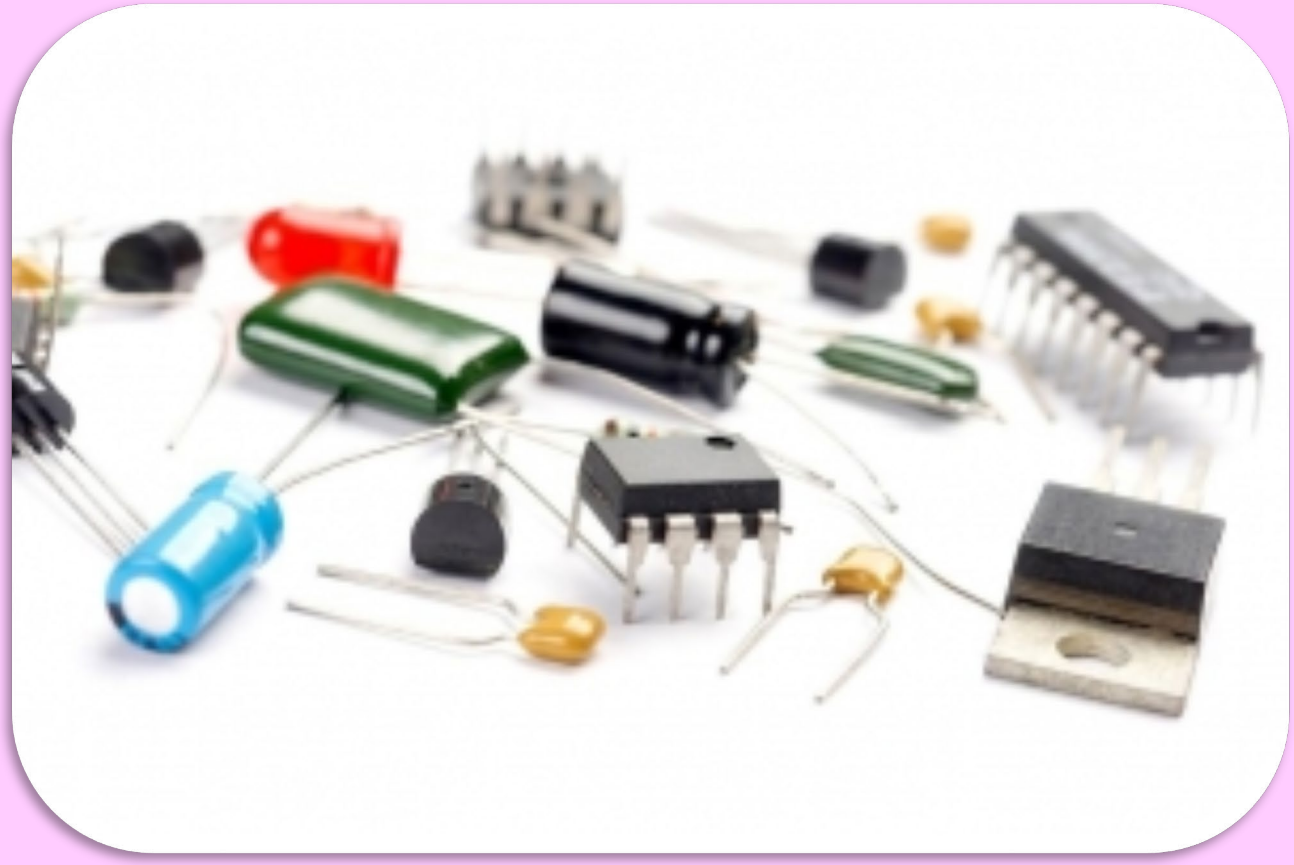
A LEVEL DESIGN ENGINEERING

6.6 CIRCUIT BASICS

Starter

How many electronic components can you name?

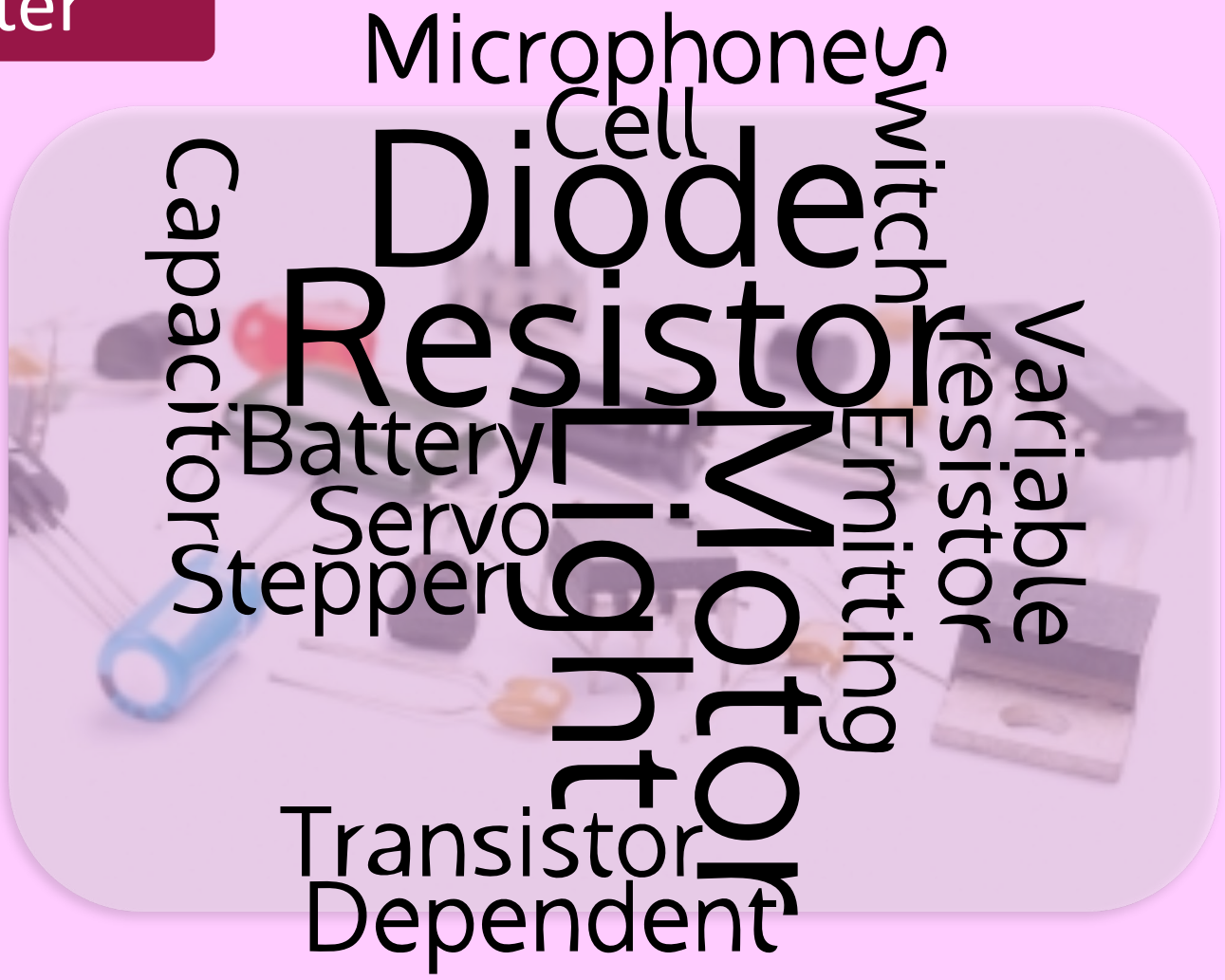


Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Starter

How many did you think of?



Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Learning objectives

- Which terms will we have to use when we design circuits?
- What are standard units?
- What types of components are used in circuit design?
- How are components used in systems?

Key words:

Components, active, passive, device, input, output, standard units, system, input, process, output

Learning objectives:

- Which terms are used in circuit design and construction?
- What are the types of electronic component?

Explanation

Which terms are used in circuit design and manufacture?

		Which units are used?...	
Current (I)	The flow of electrical charge in a circuit	**Ampere (Amp)**	**A**
Resistance (R)	The measure of the difficulty of passing an electrical current.	**Ohms**	**Ω**
Voltage (V)	The difference in charge between two points in a circuit.	**Volts**	**V**
Power (P)	The rate at which electrical energy is transferred.	**Watts**	**W**
Capacitance (C)	The amount of electrical energy stored.	**Farad**	**F**

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

What are "SI" units?

International System of Units

Amps

1A
1 mA = 0.001 A
1000 mA = 1 A

Ohms

1Ω
1KΩ = 1000Ω
1MΩ = 1,000,000Ω

Volts

1V
1mV = 0.001 V
1KV = 1000V

Watts

1W
1mW = 0.001 W
1KW = 1000W

Farad

1F **1µF = 0.000,001 F**

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

How are measurements taken?

Current: Amps… Ammeter

Resistance: Ohms… Ohmmeter

Voltage: Volts… Voltmeter

Power: Watts… Wattmeter

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

Which standard prefixes are often used when working with electronic circuits?

Prefixes	Value	Standard form	Symbol
Tera	1 000 000 000 000	10^{12}	T
	1 000 000 000	10^{9}	
	1 000 000	10^{6}	
	1 000	10^{3}	
Deci	0.1	10^{-1}	d
Centi	0.01	10^{-2}	c
	0.001	10^{-3}	
	0.000 001	10^{-6}	
	0.000 000 001	10^{-9}	
Pico	0.000 000 000 001	10^{-12}	p

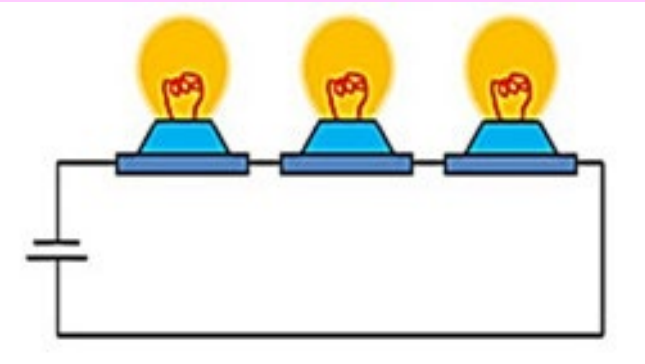
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

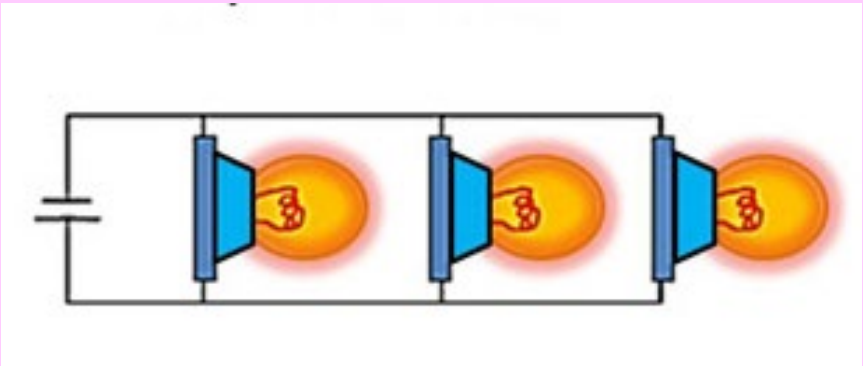
Explanation

How are circuit layouts described?

Series…



Parallel…



Why would you use each type of circuit?

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

What types of display are there?

Analogue

Digital

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

What is a multi-meter? What can it measure?

Voltage

Resistance

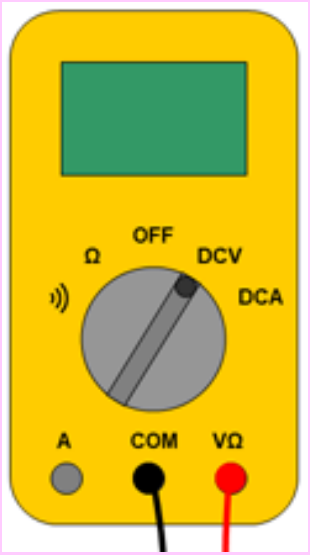
Current

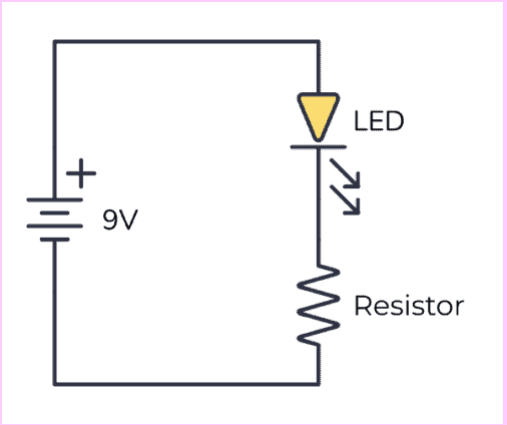
Learning objectives:

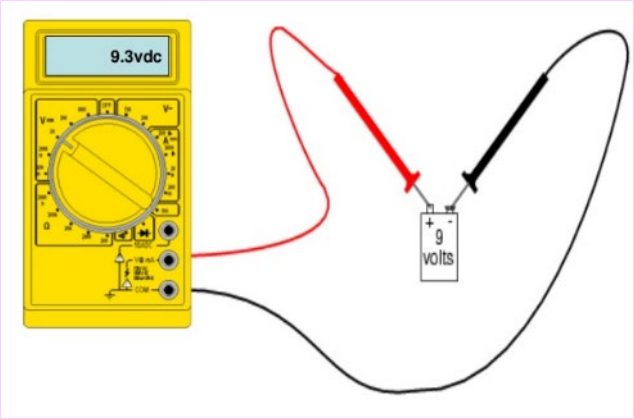
- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

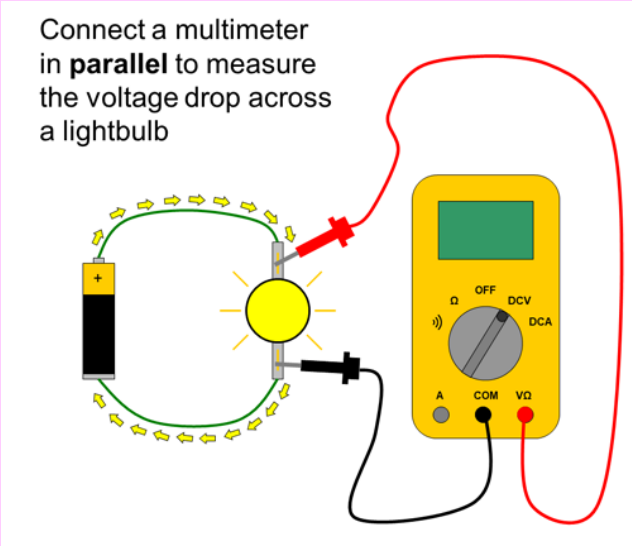
Explanation

How do we measure **voltage**?







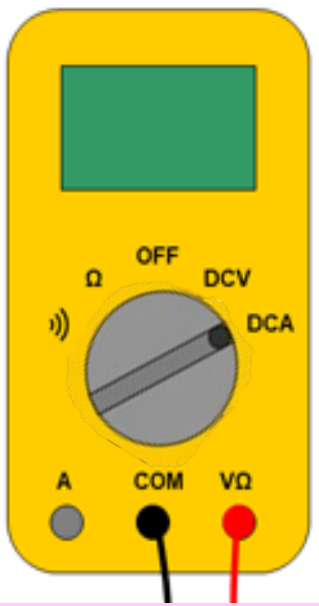


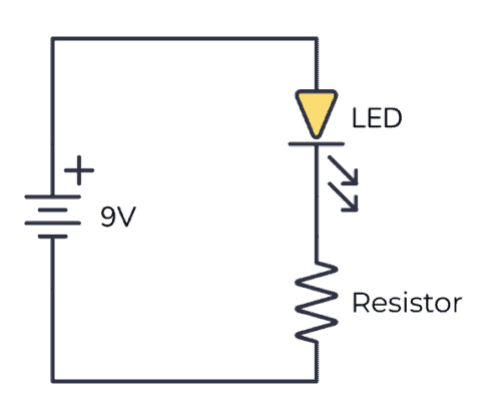
Learning objectives:

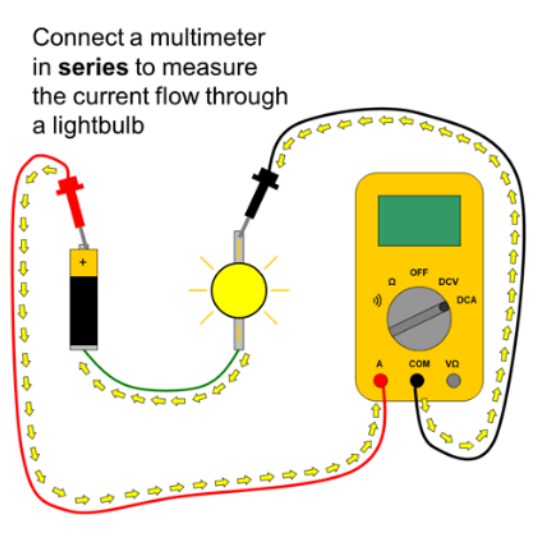
- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

How do we measure **current**?





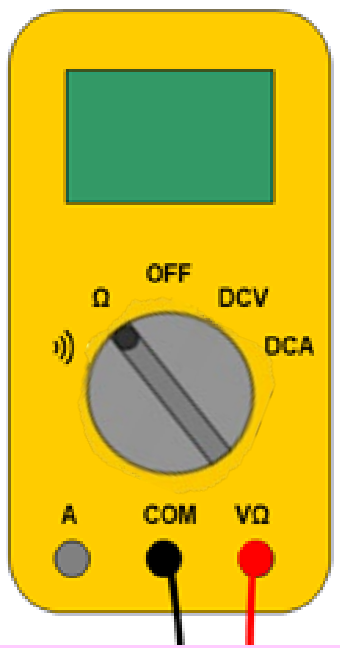


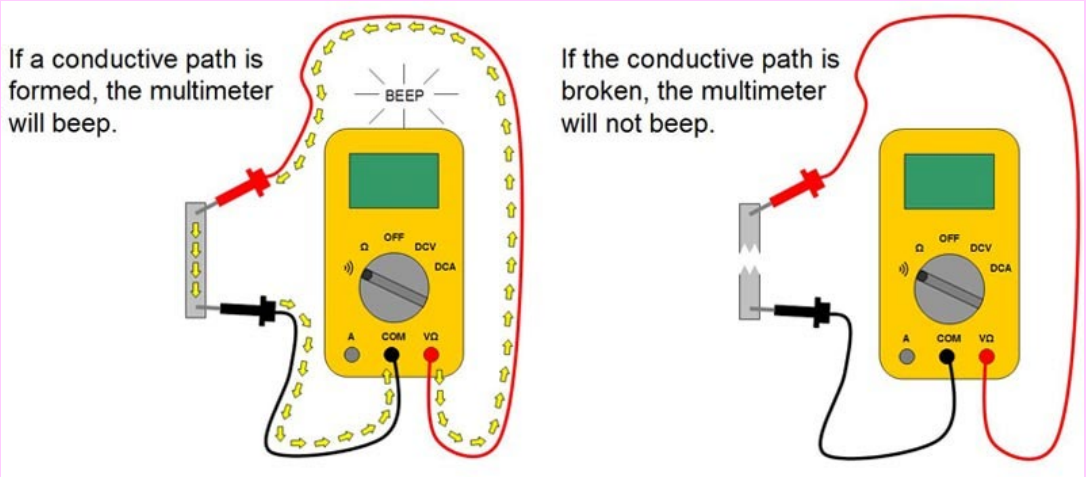
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

How do we measure **resistance**?



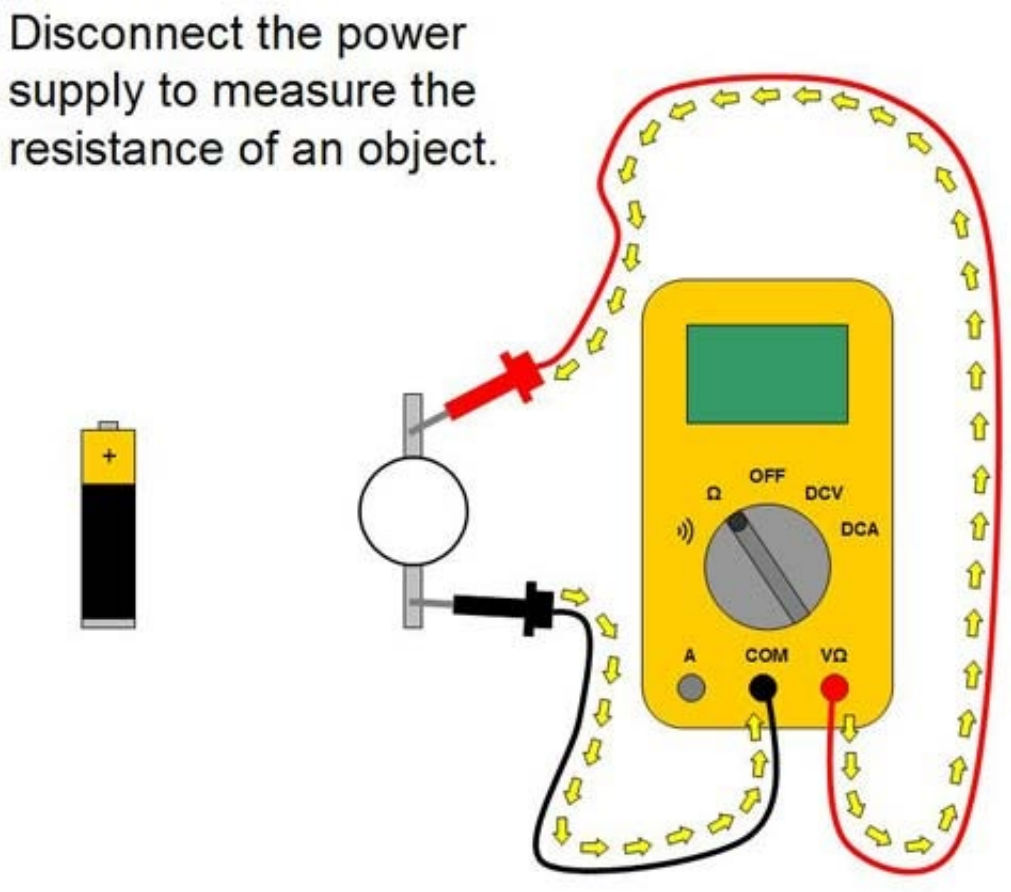


Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

How do we measure **resistance**?



Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

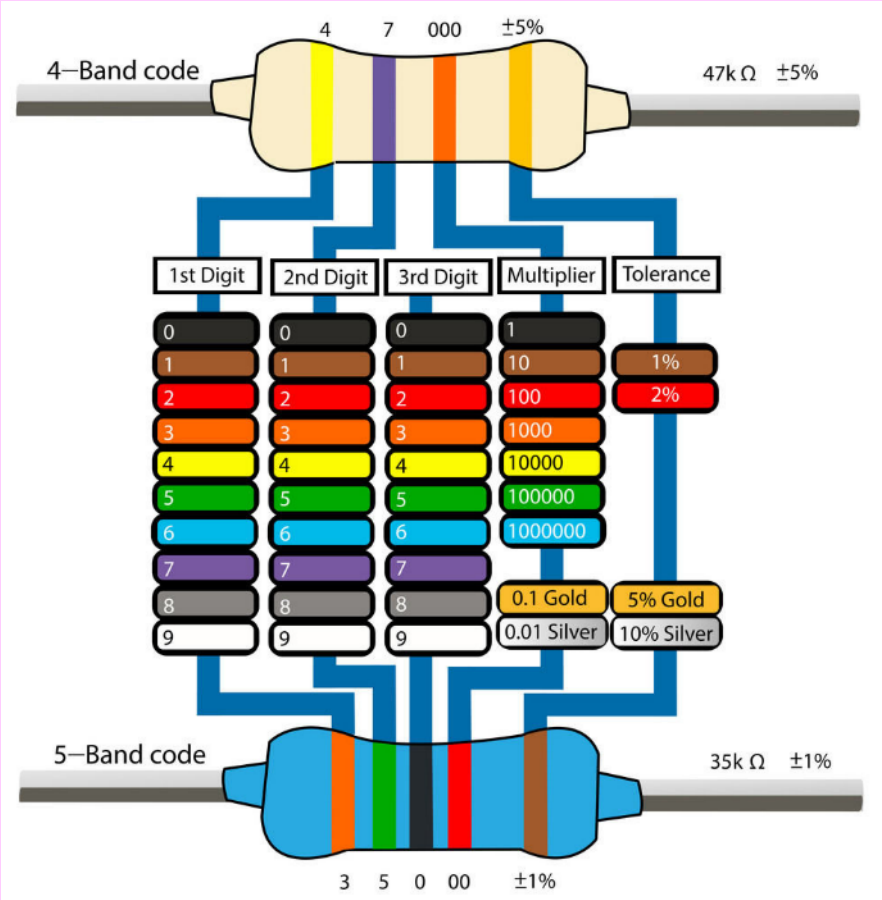
How else can we identify a resistor value?

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

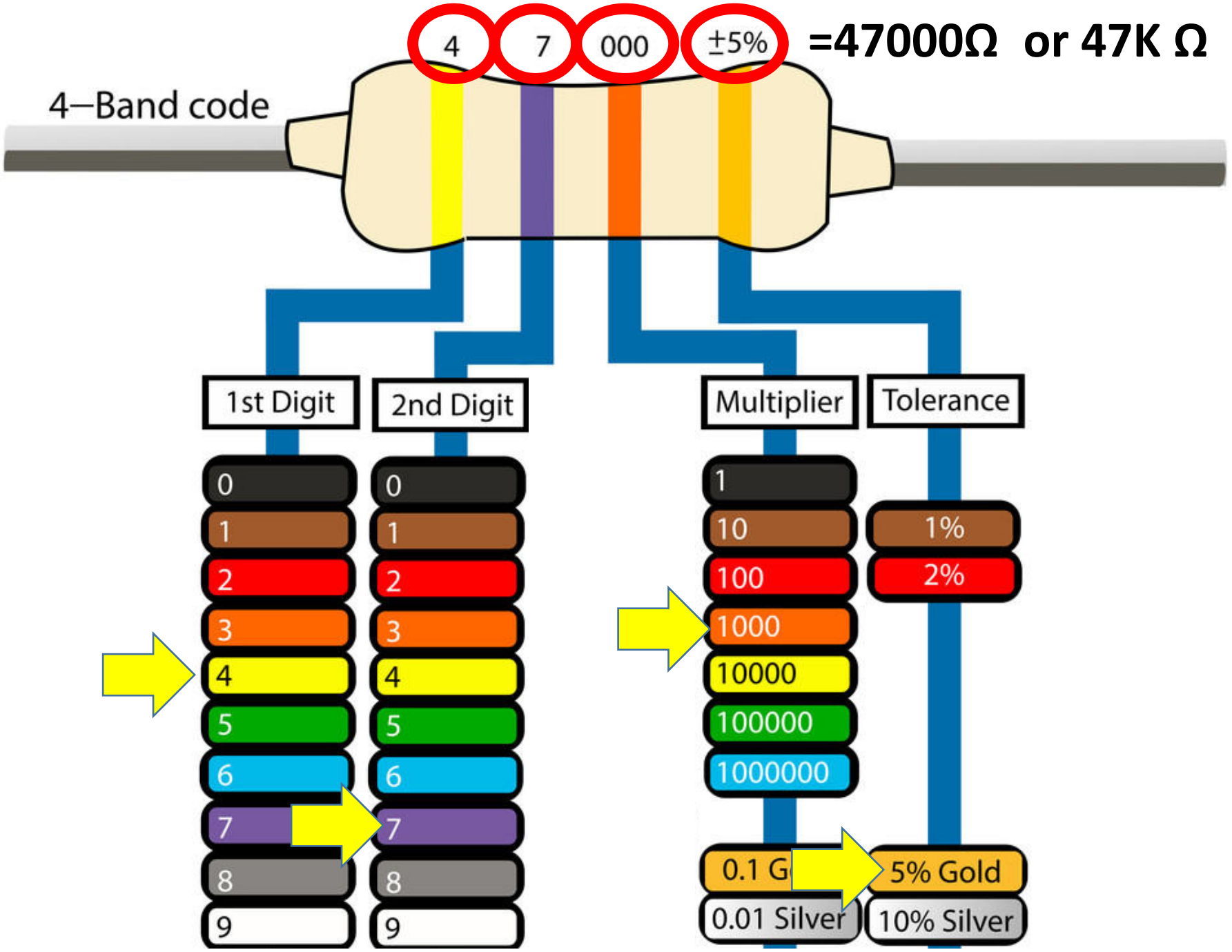
Explanation

How does the colour code chart work?



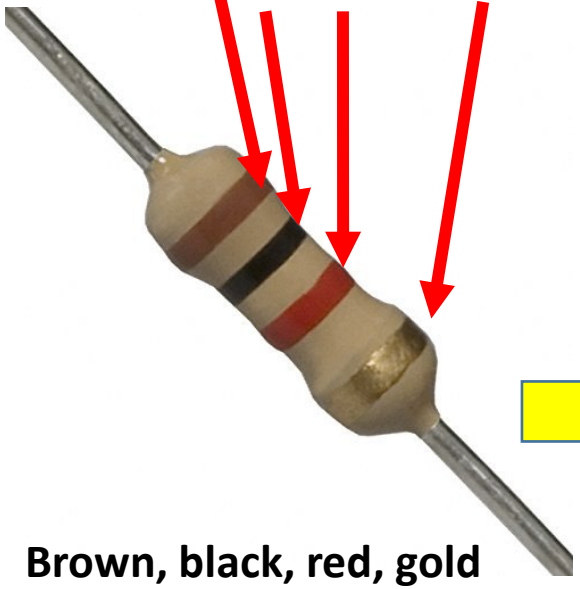
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?


4
7
000
±5%
=47000Ω or 47K Ω
4–Band code
1st Digit
2nd Digit
Multiplier
Tolerance
0
1
2
3
4
5
6
7
8
9
1
10
100
1000
10000
100000
1000000
0.1 G
0.01 Silver
1%
2%
5% Gold
10% Silver

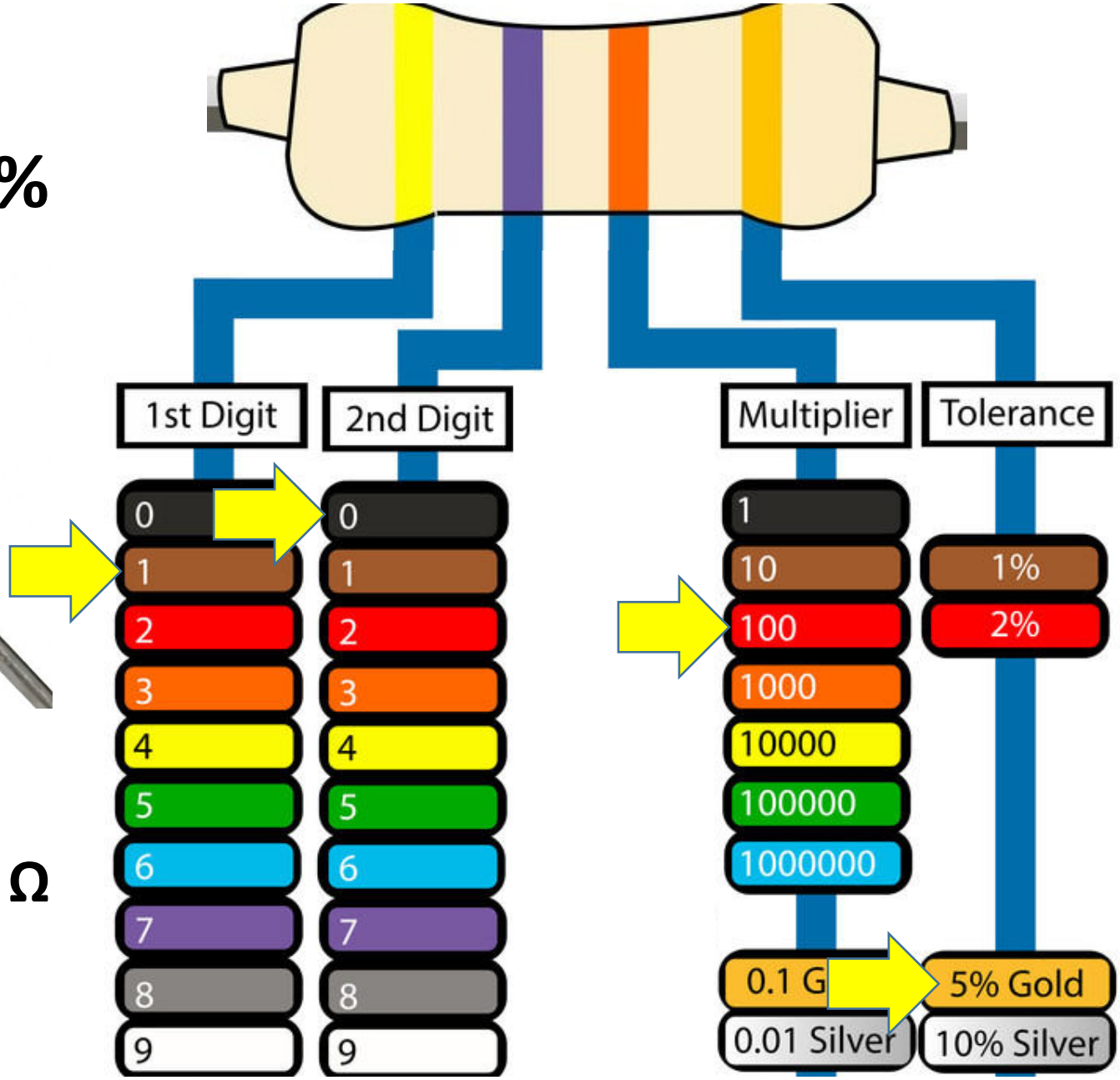
Can you work out the value of this resistor?

1000 5%



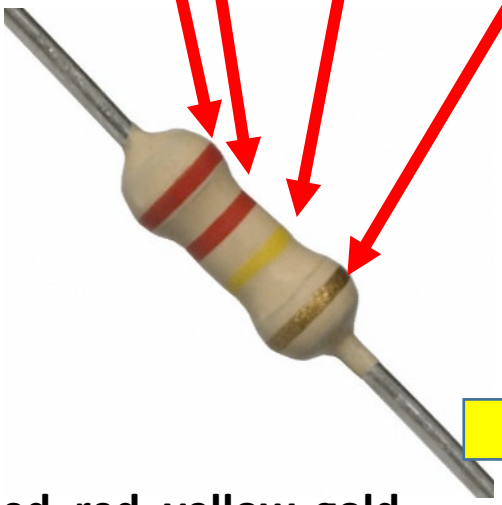
Brown, black, red, gold

=1000Ω or 1K Ω



Can you work out the value of this resistor?

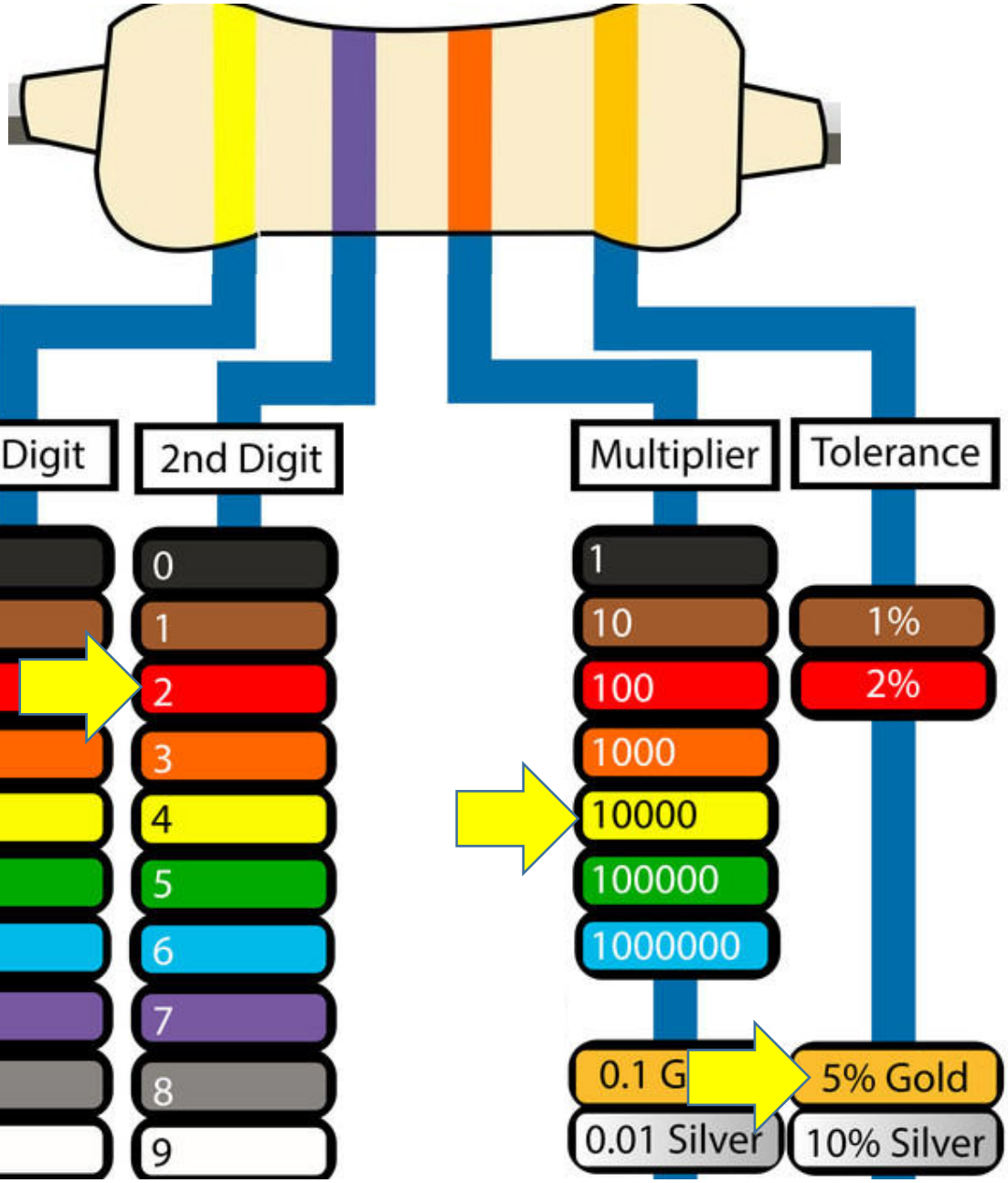
22 0000 5%



Red, red, yellow, gold

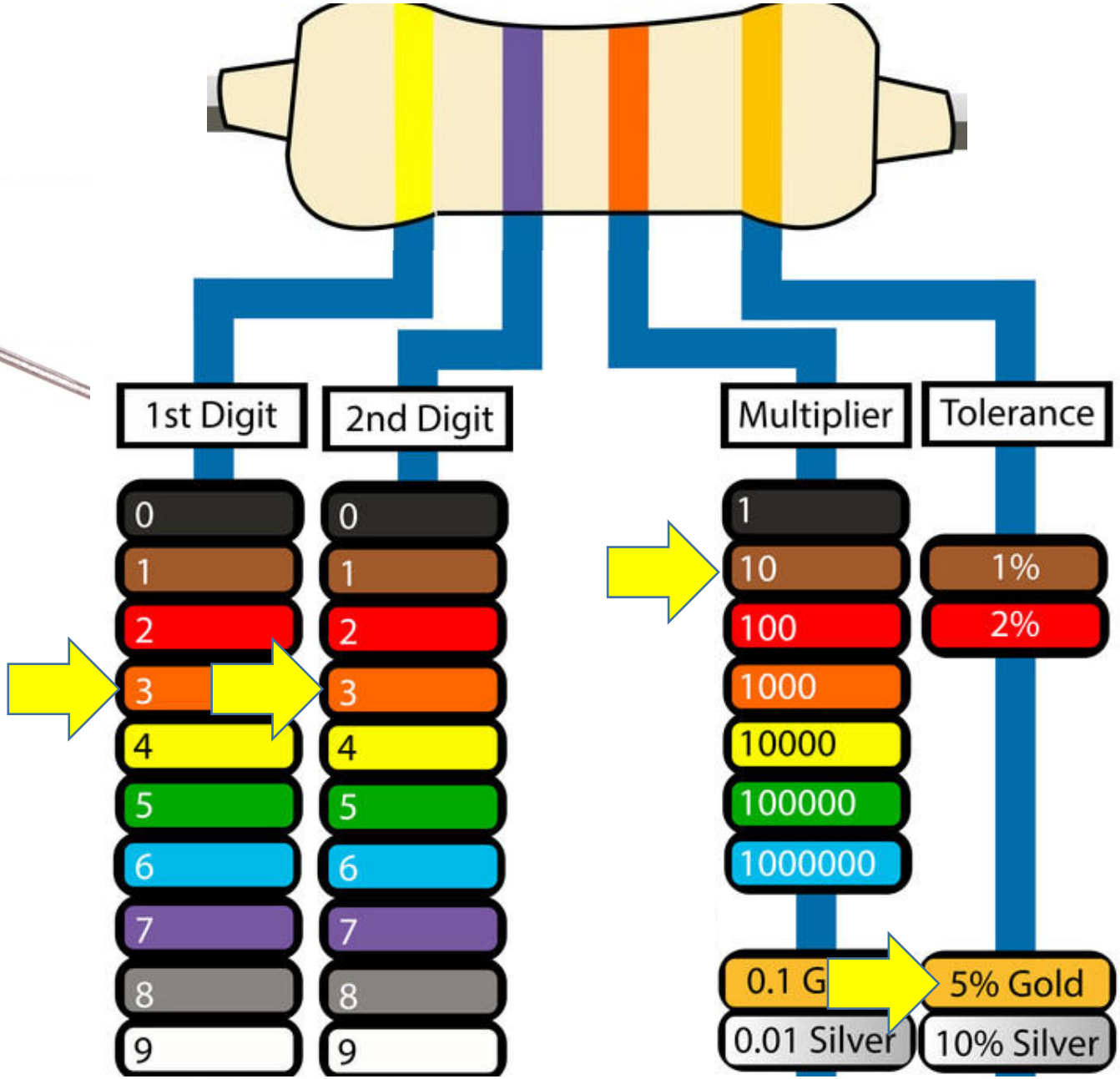
=220000Ω

or 220K Ω



What would the colour bands of a 330 Ω resistor be?

Orange, orange, brown

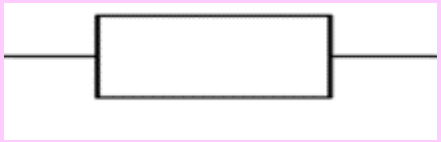


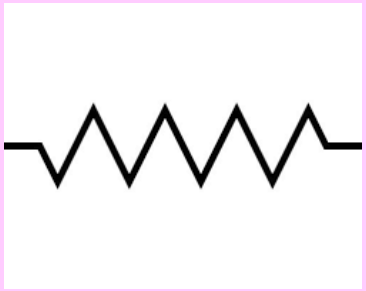
Explanation

Resistors – Fixed

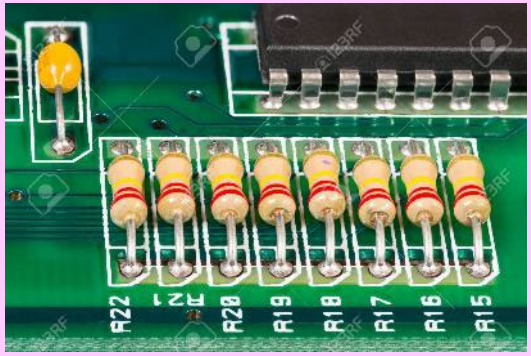
Resists current flow in a circuit

What are the circuit symbols?





What are the applications?



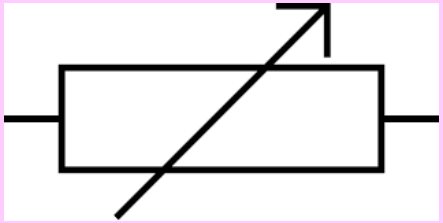
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

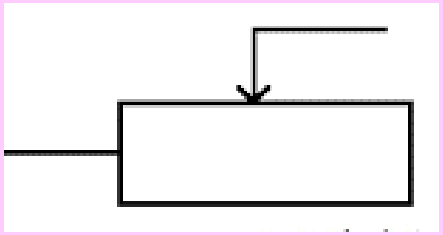
Explanation

Resistors – Variable

Changes resistance when moved/adjusted



Variable



Potentiometer

What are the applications?

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

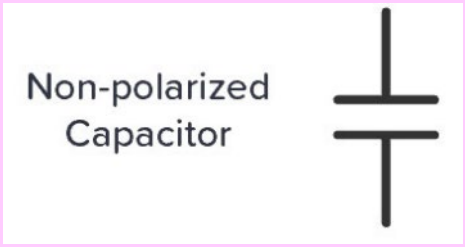
Explanation

Capacitors

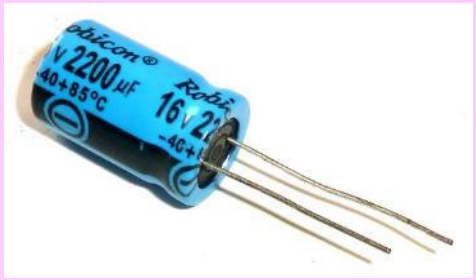
Stores electrical charge

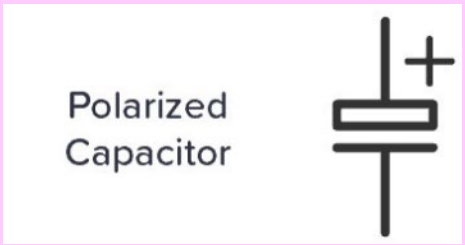
Farads (F)
µF or nF

Capacitor

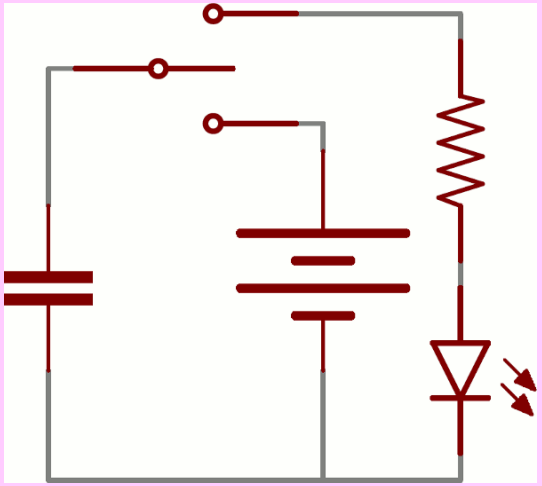


Polarised capacitor





Capacitor application…

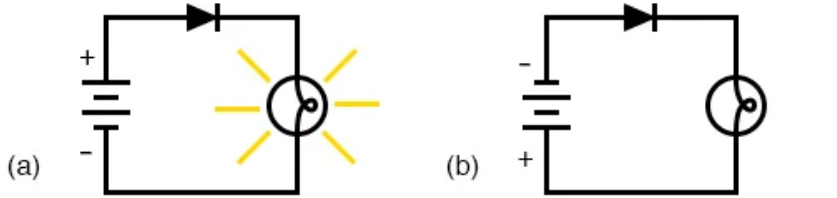


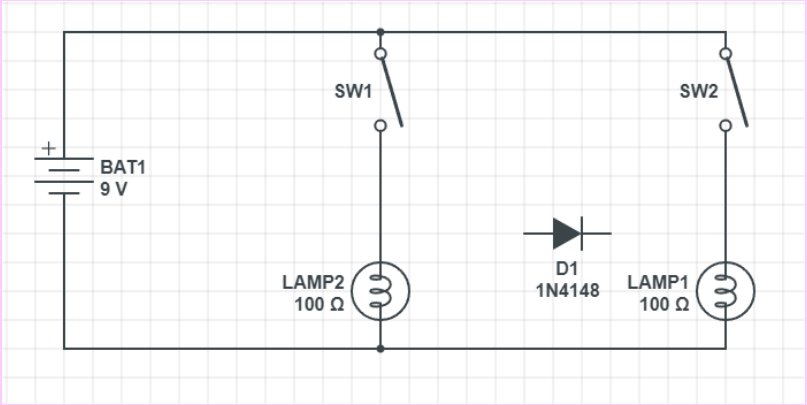
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

Diode Allows the flow of current in one direction only



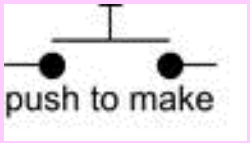


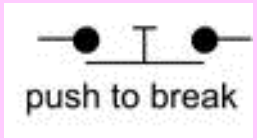
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

Switches – Momentary or non-momentary





Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

What are the applications of the common types of switch?

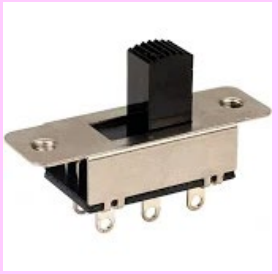
Rocker

Rotary

Toggle

Push button

Slide

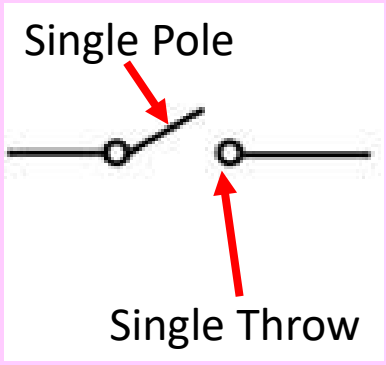


Learning objectives:

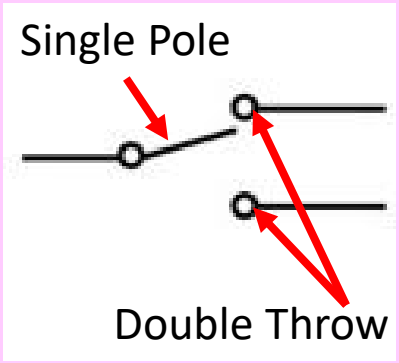
- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

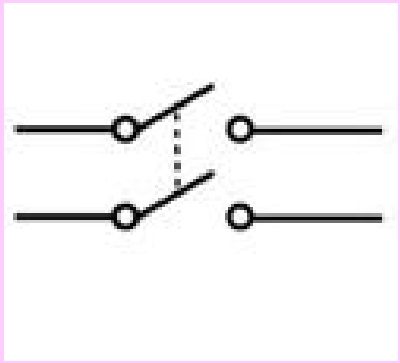
Switches – How are switches represented in circuits?



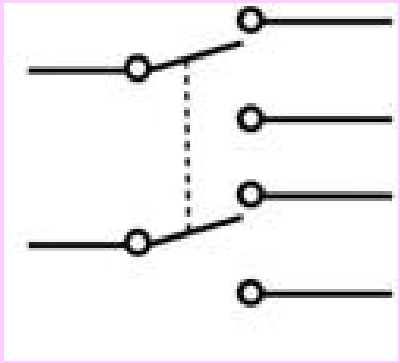
SPST



SPDT



DPST



DPDT

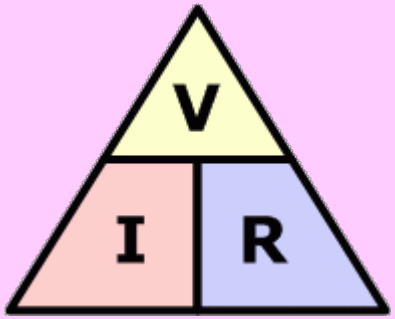
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

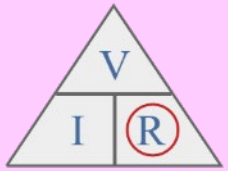
What is Ohm's law

States that electric current is proportional to voltage and inversely proportional to resistance.



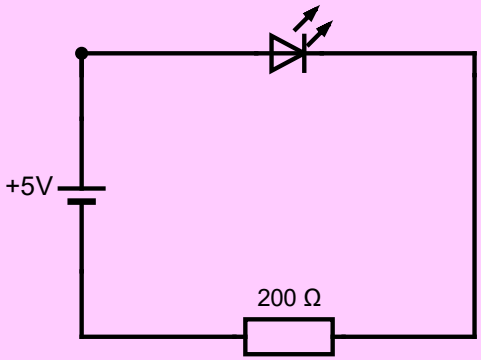
$V = I\,R$

$I = \frac{V}{R}$



$R = \frac{V}{I}$

How do we apply Ohm's law?



$$V = 5V$$
$$R = 200\Omega$$
$$I = ?$$

$$I = \frac{V}{R}$$

$$I = \frac{5}{200}$$

$$I = 0.025A$$

Circuit simulator

https://everycircuit.com/app

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

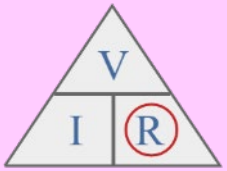
Explanation

What is a typical application of Ohm's law?

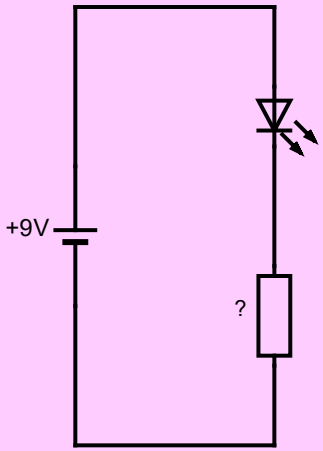
Description
Our Colour Changing 5mm Diffused LEDs slowly cycle through various colours, making it ideal for mood lighting, toys or ornaments. They have a forward voltage drop of 4.5V at a 20mA output

Calculate the value of the current limiting resistor required if a 9V battery is used.

$$Resistance = \frac{supply\ voltage - LED\ voltage\ drop}{current}$$



$R = \frac{V}{I}$



$R = ?$

$V_{supply} = 9V$

$V_{LED} = 4.5V$

$I = 20mA \quad I = 0.02A$

$$R = \frac{9 - 4.5}{0.02}$$

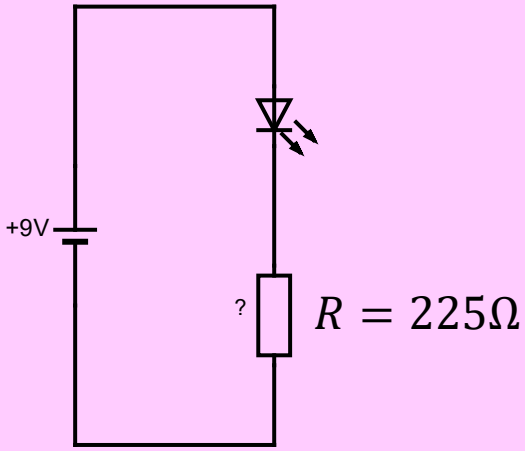
$R = 225\Omega$

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

What are the common resistor values?



3.9	43	470	5.1 k	56 k	620 k
4.3	47	510	5.6 k	62 k	680 k
4.7	51	560	6.2 k	68 k	750 k
5.1	56	620	6.8 k	75 k	820 k
5.6	62	680	7.5 k	82 k	910 k
6.2	68	750	8.2 k	91 k	1.0 M
6.8	75	820	9.1 k	100 k	1.2 M
7.5	82	910	10 k	110 k	1.5 M
8.2	91	1.0 k	11 k	120 k	1.8 M
9.1	100	1.1 k	12 k	130 k	2.2 M
10	110	1.2 k	13 k	150 k	2.4 M
11	120	1.3 k	15 k	160 k	2.7 M
12	130	1.5 k	16 k	180 k	3.3 M
13	150	1.6 k	18 k	200 k	3.6 M
15	160	1.8 k	20 k	220 k	3.9 M
16	180	2.0 k	22 k	240 k	4.7 M
18	200	2.2 k	24 k	270 k	5.6 M
20	220	2.4 k	27 k	300 k	6.8 M
22	240	2.7 k	30 k	330 k	8.2 M

Which resistor would we select?

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

What are the power limitations of resistors?

Most common resistors have a power rating between 0.125W and 1 watt .
Resistors with higher power ratings are usually referred to as power resistors and used specifically to dissipate power.

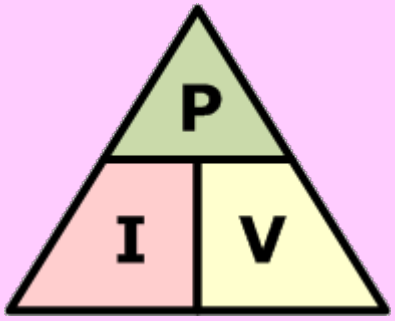
Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

How do we calculate power in a circuit?

$$P = IV$$

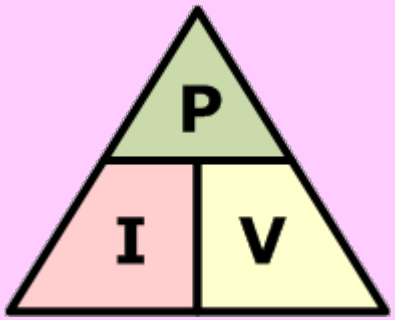


Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

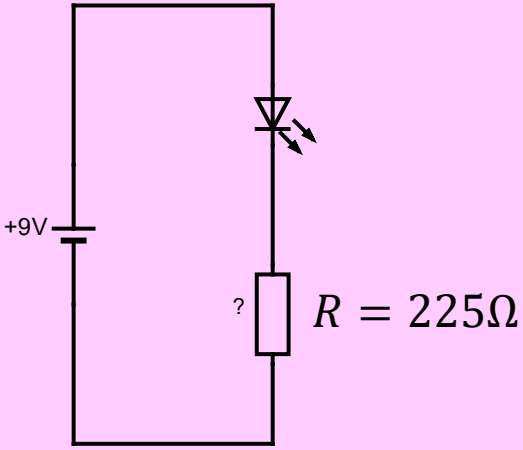
Explanation

What would the power requirements of the resistor be?



$$V = 4.5V$$

$$I = 0.02A$$



$$P = IV$$

$$P = 0.02 \times 4.5$$

$$P = 0.09W$$

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

How can we combine Ohms law and the power formula?

Ohms law

$$V = IR$$

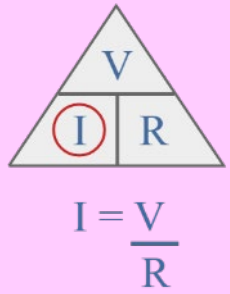
Power formula

$$P = IV$$

How do we calculate power with only voltage and resistance readings?

$$P = IV \Rightarrow P = \left(\frac{V}{R}\right)V \Rightarrow P = \frac{V^2}{\mathrm{R}}$$

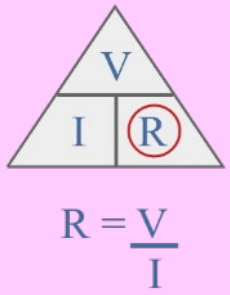
$$I = \frac{V}{R}$$



How do we calculate power with only current and resistance readings?

$$P = IV \Rightarrow P = I(\mathrm{I} \times R) \Rightarrow P = I^2\mathrm{R}$$

$$V = IR$$



Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?

Explanation

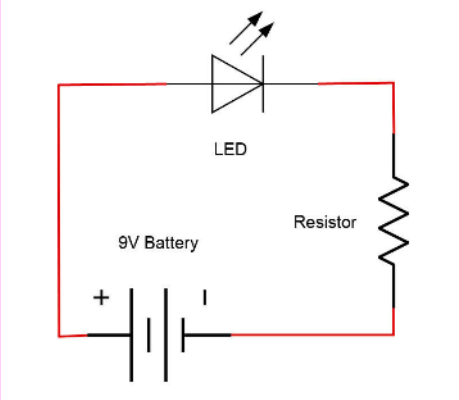
What is a typical application of Ohm's law?

Description

Our Colour Changing 5mm Diffused LEDs slowly cycle through various colours, making it ideal for mood lighting, toys or ornaments.

They have a forward voltage drop of 4.5V and at 20mA output 330mCd in red, 500mCd in blue and 750mCd in green, and have a 25 degree viewing angle.

Calculate the value of the current limiting resistor required.



V(Source) = 9

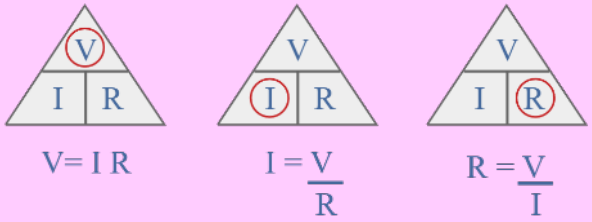
V(Res) = 9 – 4.5

V=4.5

I = 20mA

I= 0.02A

R=?



R=V/I

R=4.5/0.02

R=225 Ω

https://kitronik.co.uk/collections/leds-lamps/products/3527-colour-changing-5mm-diffused-led-750mcd

https://ohmslawcalculator.com/led-resistor-calculator

Learning objectives:

- ❑ Which terms are used in circuit design and construction?
- ❑ What are the types of electronic component?