

# UNITS and POWERS OF TEN

## Names of Units and their Symbols

Where a unit is named after a real scientist, the unit is upper case, and where the name came from somewhere else it is lower case. It turns out that practically all electrical units are named after scientists who made significant discoveries in the field.

Quantity	Unit	Symbol	Named after
Length	metre	m	
Mass	gram	g	
Time	second	s	
Energy	joule	J	Joule
Power	watt	W	Watt
Current	ampere	A	Ampere
Voltage (pd)	volt	V	Volta
Resistance	ohm	$\Omega$	Ohm
Charge	coulomb	C	Coulomb
Capacitance	farad	F	Faraday
Inductance	henry	H	Henry (to do with coils)

## Larger and Smaller Units

Often the base units listed above are inconveniently large or small. Multiples and sub-units are made using standard prefixes. These mostly go up or down by factors of 1000 ( $10^3$  or  $10^{-3}$ ).

Prefix	Symbol	Multiplier	Example
nano	n	$10^{-9} = 0.000000001$	1nF = 0.000000000 F
micro	$\mu$	$10^{-6} = 0.000001$	1 $\mu$ A = 0.000001 A
milli	m	$10^{-3} = 0.001$	1ms = 0.001 s
kilo	k	$10^3 = 1,000$	1kg = 1,000 g
mega	M	$10^6 = 1,000,000$	1M $\Omega$ = 1,000,000 $\Omega$

## Examples

Convert 12.6 m to a) km b) mm c)  $\mu\text{m}$

a) kilometers are a bigger unit than metres, 1000 times bigger. Therefore divide by 1000.

$$12.6 \text{ m} = (12.6/1000) \text{ km} = 0.0126 \text{ km}$$

Hint: move the decimal point three places to the left.

b) millimetres are a smaller unit than metres, 1000 times smaller. Therefore multiply by 1000.

$$12.6 \text{ m} = (12.6 \times 1000) \text{ mm} = 12,600 \text{ mm}$$

b) micrometres are 1000 times smaller again.

$$12.6 \text{ m} = (12,600 \times 1000) \mu\text{m} = 12,600,000 \mu\text{m} \text{ (or } 12.6 \times 1,000,000\text{)}.$$

## Standard Form

Large numbers of zeros are inconvenient (This is the main reason for using the multiple and sub units). Large or small units can be converted to standard form, where there is just ONE digit in front of the decimal point.

To convert the above numbers to standard form, count how many places the decimal point must be moved.

$$0.0126 \text{ km} = 1.26 \times 10^{-2} \text{ km} \quad (\text{move decimal point two places to the right})$$

$$12,600 \text{ mm} = 1.26 \times 10^4 \text{ mm} \quad (\text{move decimal point four places to the left})$$

$$12,600,000 \mu\text{m} = 1.26 \times 10^7 \mu\text{m}$$

## Handling Powers of Ten

To multiply, you add the powers of ten. To divide, you subtract the powers of ten.

$$\text{For example } 10^5 \times 10^3 = 10^8. \quad 10^5 \div 10^3 = 10^2.$$

## Examples

1) A current of  $25.3 \mu\text{A}$  flows through a resistor of  $67 \text{ k}\Omega$ . What is the p.d. across the resistor?

$$V = IR = 25.3 \times 10^{-6} \times 67 \times 10^3 = 25.3 \times 67 \times 10^{-6+3} = 1695 \times 10^{-3} = 1.69 \text{ V}$$

2) A current of  $152 \text{ mA}$  flows through a resistor, and the p.d. is  $19.6 \text{ kV}$ . What is the value of the resistor?

$$R = \frac{V}{I} = \frac{19.6 \times 10^3}{152 \times 10^{-3}} = \frac{19.6}{152} \times 10^{3-(-3)} = 0.1289 \times 10^6 = 0.129 \text{ M}\Omega = 1.29 \times 10^5 \Omega$$

Note that answers are usually rounded off to **THREE** significant figures.

## Problems

1. Write a thumbnail biography of each of the scientists listed above. Which person measured the temperature difference of the water between the top and bottom of a waterfall on his honeymoon? What did his new wife think about it? Who performed the critical experiments which led to the development of electrical generators?

2. Convert  $0.15 \text{ A}$  to a)  $\text{mA}$             b)  $\mu\text{A}$

3. Convert  $680 \Omega$  to a)  $\text{k}\Omega$             b)  $\text{M}\Omega$

4. Express answers to Qu. 2 in standard form.

5. Express answers to Qu. 3 in standard form.

6. Evaluate  $10^5 \times 10^4 \div 10^{-2}$

7. Repeat Qu. 5 showing plain numbers, e.g.  $10^5 = 100,000$

8. Use the formula  $V = IR$  to complete the following table for four resistors. Give your answers in standard form rounded to 3 significant figures.

<b>V</b>	<b>I</b>	<b>R</b>
$1.62 \text{ V}$	$0.35 \text{ A}$	$R_1$
$V_2$	$56.0 \text{ mA}$	$0.19 \text{ M}\Omega$
$18 \text{ mV}$	$I_3$	$82 \text{ k}\Omega$
$240 \text{ kV}$	$0.22 \text{ A}$	$R_4$