

# Electro Critical Skills Resource Suite



## Entry Level Literacy and Numeracy Assessment for the Electrotechnology Trades

### Enrichment Resource

#### UNIT 8: Ratios



managing apprentice progression

An E-Oz Energy  
Skills Australia project.



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## RATIOS

An understanding of ratios is required for many areas of electrical theory.

Examples of the application of ratios in the electrical trade include:

- calculating the value of current flow in a circuit. This is dependent upon the ratio between applied voltage and circuit impedance
- determining power factor. This is calculated by forming a ratio between true power and apparent power.
- calculating the output voltage of a transformer given the ratio between the input and output voltages.

## LEARNING OUTCOME

- Can make comparisons using the mathematical expression of ratio.

## PERFORMANCE CRITERIA

- Uses a stated order to express ratio.
- Expresses ratio in its simplest form.
- Uses ratio to determine a specific quantity by working backwards.
- Understands the relationship between common and decimal fractions and percentages.

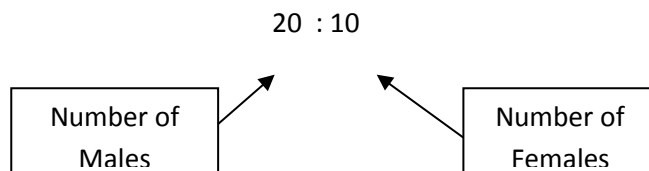


## WHAT IS A RATIO?

A ratio is a mathematical way of comparing quantities. This comparison is made in a stated order.

### Example 1

In an electrical company there are 30 employees. 20 are male and 10 are female. Form a ratio of male to female staff by completing this ratio.



Statements that can be used to express this ratio are:

- There are twice as many males as females
- There are half as many females as males
- For every 20 males there are 10 females

## EXPRESSING A RATIO IN ITS SIMPLEST FORM

### Example 2

Two light globes are rated at 80W and 40W. The ratings are in the ratio 80:40. However, it is usual to express ratios, like fractions, in their lowest terms.

Therefore  $80 : 40$   
is the same as  $8 : 4$  (dividing both sides by 10)  
and  $2 : 1$  (dividing both sides by 4)

The ratio of the power ratings of the globes, when expressed in its simplest form becomes 2: 1.

### Example 3

If one motor rotates at 300rpm (revolutions per minute) and the other at 750rpm, what is the ratio of their speeds?

$$\begin{aligned} & 300 : 750 \\ = & \quad 6 : 15 \quad \text{(cancelling by 50)} \\ = & \quad 2 : 5 \quad \text{(cancelling by 3)} \end{aligned}$$

Sometimes it may be clearer to have one side of the ratio to 1.

$$2 : 5$$

$$1 : 2.5 \quad \text{(dividing both sides by 2)}$$

Therefore, for every one revolution of the first machine the second machine makes 2.5 revolutions.

### EXERCISE 1

Express the following ratios as simply as possible:

a)  $25\text{A to }100\text{A}$  (A = amperes)

b)  $100\text{V to }12.5\text{V}$  (V = volts)

c)  $300 \text{ mins to } 6 \text{ mins}$

### EXERCISE 2

A torch globe draws 150mA. A transistor radio draws 600mA. Express the ratio of the radio current to the globe current.

### EXERCISE 3

A transformer has an input voltage of 240 volts and an output voltage of 12 volts.

- a) Express the transformer ratio in its simplest form.
  
- b) Complete the statement  
For every .....volts applied at the input to the transformer  
one volt is produced at the output.

### EXERCISE 4

On a clear day the earth receives 1200 watts of power for every square metre of surface area. A bank of one square metre of cells generates 120 watts.

- a) What is the ratio of sun power to solar cell power?
  
  
  
  
  
  
  
  
  
  
- b) Complete the statement:  
For every 1 watt of solar cell power we need.....watts of  
sun power.



Use the answer sheet to check your work.

## METRIC EQUIVALENTS

If you are forming a ratio between units of the same type e.g. length, power, weight or current, then convert them into the same form.

The table below gives the metric equivalents commonly used in the electrical trade.

W = watts

M = mega

V = volts

k = kilo

A = amperes

m = milli

$\Omega$  = ohms

### Metric Equivalents

1 MW = 1000 kW

1 MA = 1000 kA

1 kW = 1000 W

1 kA = 1000 A

1 W = 1000 mW

1 A = 1000 mA

1 MV = 1000 kV

1 M $\Omega$  = 1000 k $\Omega$

1 kV = 1000 V

1 k $\Omega$  = 1000  $\Omega$

1 V = 1000 mV

1  $\Omega$  = 1000 m $\Omega$

### Example 4

What is the ratio between 20 Volts (V) and 5 kilovolts (kV)?

Before cancelling down the ratio it is necessary to express both parts of the ratio in the same terms by converting the kilovolts to volts.

$$\begin{aligned} & 20 \text{ V} : 5 \text{ kV} \\ = & 20 \text{ V} : 5000 \text{ V} && \text{(changing kV to V)} \\ = & 1 : 250 && \text{(dividing both sides by 20)} \end{aligned}$$

## EXERCISE 5

Express the following ratios as simply as possible using only whole numbers:

a) 800 W to 550 kW

b) 45 seconds to 1 minute  
30 seconds

c) 24 kW to 84 MW

d) 24 m $\Omega$  to 25  $\Omega$

e) 5 mV to 2.5 V.



## EXERCISE 6

The rated power input of a device is the maximum power at which the device is designed to operate.

The headphone of the walkman has a rated power input of 120 mW.

The rated power input of a small stereo speaker is 8 W.

- a) What is the ratio of the rated power inputs of the speakers to the headphones?
  
- b) Complete the statement:  
In the above example .....headphones would  
consume the same amount of power as one stereo speaker?

## EXERCISE 7

A multimeter is an instrument used to measure voltage, current and resistance. To find a fault in a circuit a multimeter is used to check the resistances. The multimeter measured  $6.8 \text{ k}\Omega$  at one place in the circuit and  $400 \text{ }\Omega$  at another place in the same circuit.

What is the ratio between the two resistances?

## USING RATIOS – WORKING BACKWARDS

If a ratio is known then calculations can be made to determine a specific quantity. The most common application of ratios in electrical theory is in calculating input and output voltages of transformers.

- The input voltage is also called the primary voltage
- The output voltage is also called the secondary voltage

### Example 5

A step-down transformer has an input/output ratio of 2 : 1. If the output voltage is 60 volts, what is the input voltage?

$$\begin{array}{ccc} 2 & : & 1 \\ \text{Input} & & \text{Output} \\ = & & \\ 120\text{V} & : & 60\text{V} \\ (2 \times 60) & : & (1 \times 60) \\ \text{input} & & \text{output} \end{array}$$

**Answer:** The input or primary voltage of the step-down transformer is 120 Volts.

### Example 6

A step-down transformer has an input/output ratio of 20: 1. If the input voltage is 240 volts, what is the output voltage?

$$\begin{array}{ccc} 20 & : & 1 \\ \text{Input} & & \text{Output} \\ = & & \\ 240\text{V} & : & 12\text{V} \\ & & (240 \div 20) \\ \text{Input} & & \text{Output} \end{array}$$

**Answer:** The output or secondary voltage of the transformer is 12 volts.

### EXERCISE 8

A **step-down** transformer has a ratio of 6 : 1. If the output voltage is 40V, what is the input voltage?

**Answer:** The input voltage of the transformer is.....volts.

### EXERCISE 9

A **step-down** transformer is operated from a 120 volt line. If the voltage ratio of the transformer is 10 : 1, what is the secondary voltage.

**Answer:** The secondary voltage of the transformer is.....volts.

### EXERCISE 10

A **step-up** power transformer has a ratio of 1 : 7 and is operated from a 115 volt line. What is the secondary voltage?

**Answer:** The secondary voltage of the transformer is .....volts.

### EXERCISE 11

A **step-up** power transformer has an output voltage of 480V. If the ratio of the transformer is 1 : 12, what is the voltage of the line that operates the transformer?



Use the answer sheet to check your work.

## RATIOS / FRACTIONS / PERCENTAGES

Ratios can be expressed as common and decimal fractions and as percentages.

Decimal fractions are special fractions whose denominators are always 10 or multiples of ten.

Percentages are special fractions whose denominators are always 100.

### RATIOS: EQUIVALENT FRACTIONS AND PERCENTAGES

RATIO	COMMON FRACTION	DECIMAL FRACTION		PERCENTAGE	
1:2	$\frac{1}{2}$	0.5	$\frac{5}{10}$	50%	$\frac{5}{100}$
1:4	$\frac{1}{4}$	0.25	$\frac{25}{100}$	25%	$\frac{25}{100}$
1:8	$\frac{1}{8}$	0.125	$\frac{125}{1000}$	12.5%	$\frac{12.5}{100}$
3:4	$\frac{3}{4}$	0.75	$\frac{75}{100}$	75%	$\frac{75}{100}$
1:3	$\frac{1}{3}$	0.33	$\frac{33.3}{100}$	33.3%	$\frac{33.3}{100}$
2:3	$\frac{2}{3}$	0.66	$\frac{66.6}{100}$	66.6%	$\frac{66.6}{100}$
1:10	$\frac{1}{10}$	0.1	$\frac{1}{10}$	10%	$\frac{10}{100}$
1:20	$\frac{1}{20}$	0.05	$\frac{5}{100}$	5%	$\frac{5}{100}$
1:5	$\frac{1}{5}$	0.2	$\frac{2}{10}$	20%	$\frac{20}{100}$
2:5	$\frac{2}{5}$	0.4	$\frac{4}{10}$	40%	$\frac{40}{100}$
3:10	$\frac{3}{10}$	0.3	$\frac{3}{10}$	30%	$\frac{30}{100}$

## ANSWERS:

### EXERCISE 1

- a)  $25:100 = 1:4$
- b)  $100:12.5$  (dividing both sides by 12.5)  
 $= 8:1$
- c)  $300:6$   
 $= 50:1$

### EXERCISE 2

radio current: globe current

$$= 600:150$$

$$= 4:1 \text{ (dividing both sides by 150)}$$

### EXERCISE 3

- a)  $240:12$  (dividing both sides by 12)  
Input output  
 $= 20:1$
- b) For every **20** volts applied at the input to the transformer, 1  
volt is produced at the output.

### EXERCISE 4

- a) sun power: solar cell power  
 $= 1200:120$  (dividing both sides by 120)  
 $= 10:1$
- b) For every 1 watt of solar cell power we need **10** watts of sun power.

## EXERCISE 5

- a) 800W:550kW  
= 800W:550000W (changing kW to W)  
= 8:5500 (dividing both sides by 100)  
= 2: 1375 (dividing both sides by 4)
- b) 45 secs:1 min 30 secs  
= 45 secs:90 secs (changing mins to secs)  
= 1:2 (dividing both sides by 45)
- c) 24kW: 84 MW  
24:84000 (changing MW to kW)  
1:3500 (dividing both sides by 24)
- d) 24mΩ:25Ω  
24mΩ:25000mΩ (changing Ω to mΩ)  
3: 3125 (dividing both sides by 8)
- e) 5mV: 2.5V  
5mV: 2500mV (changing V to mV)  
1:500 (dividing both sides by 5)

## EXERCISE 6

- a) 8W: 120mW  
= 8000mW: 120mW  
= 200:3
- b)  $66\frac{2}{3}$  headphones would consume the same amount of power as one stereo speaker

### EXERCISE 7

$$6.8\text{k}\Omega:400\Omega$$

$$= 6.8 \times 1000\Omega:400\Omega$$

$$= 6800:400$$

$$= 17:1$$

### EXERCISE 8

The input voltage of the transformer is **240** volts

$$6:1$$

Input: Output

$$240\text{V}:40\text{V}$$

### EXERCISE 9

The secondary voltage of the transformer is **12** volts

$$10: 1$$

Input : Output

$$120\text{V}: 12\text{V}$$

### EXERCISE 10

The secondary voltage

$$1:7$$

Input: Output

$$115\text{V}: 805\text{V}$$

### EXERCISE 11

$$1:12$$

Input Output

$$40\text{V} : 480\text{V}$$