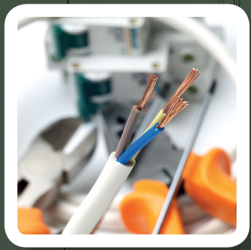
9TH EDITION

ELECTRICAL INSTALLATION WORK





COVERS LEVEL 2 AND 3 COURSES IN ELECTRICAL INSTALLATION WORK

BRIAN SCADDAN

ROUTLEDGE

Electrical Installation Work

This highly successful book is now updated in line with the 18th Edition of the Wiring Regulations. *Electrical Installation Work* provides a topic by topic progression through the areas of electrical installations, including how and why electrical installations are designed, installed and tested. Additional content in this edition includes detail on LED lighting and medical locations. A new appendix contains a glossary of electrical installation work terms, ensuring that readers of all levels of experience can easily grasp every topic.

Brian Scaddan's subject-led approach makes this a valuable resource for professionals and students on both City & Guilds and EAL courses. This approach also makes it easy for those who are learning the topic from scratch to get to grips with it in a non syllabus-led way.

The book is already widely used in education facilities across the UK. It has been published for almost 40 years, and in its current form since 1992.

Brian Scaddan, I Eng, MIET, is an Honorary Member of City & Guilds and has over 45 years' experience in further education and training. He was previously Director of Brian Scaddan Associates Ltd, an approved training centre offering courses on all aspects of electrical installation contracting, including those for City & Guilds and EAL. He is also a leading author of many other books on electrical installation.

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

Electrical Installation Work

Ninth Edition

Brian Scaddan

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

Ninth edition published 2019
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
52 Vanderbilt Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

First edition published by Newnes 1992
Eighth edition published by Routledge 2016

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
Names: Scaddan, Brian, author.
Title: Electrical installation work / Brian Scaddan.
Description: 9th edition. | Abingdon, Oxon : Routledge/Taylor & Francis, 2019. | Includes bibliographical references and index. |
Identifiers: LCCN 2018038945 (print) | LCCN 2018040521 (ebook) | ISBN 9780429681592 (ePub) | ISBN 9780429681608 (Adobe PDF) | ISBN 9780429681585 (Mobipocket) | ISBN 9780367023362 (hardback) | ISBN 9780367023348 (pbk.) | ISBN 9780429400124 (ebook)
Subjects: LCSH: Electric wiring, Interior. | Electrical engineering. | Electric apparatus and appliances--Installation. | Electric power systems.
Classification: LCC TK3271 (ebook) | LCC TK3271 .S267 2019 (print) | DDC 621.319/24--dc23
LC record available at https://lccn.loc.gov/2018038945

ISBN: 978-0-367-02336-2 (hbk)
ISBN: 978-0-367-02334-8 (pbk)
ISBN: 978-0-429-40012-4 (ebk)

Typeset in Univers LT Std
by Servis Filmsetting Ltd, Stockport, Cheshire

Contents

Preface

This book is intended for the trainee electrician who is working towards NVQs, gaining competences in various aspects of installation work.

It covers both installation theory and practice in compliance with the 18th edition of the *IET Wiring Regulations*, and also deals with the electrical contracting industry, the environmental effects of electricity and basic electronics.

The material in this book has been arranged to cater for student-centred learning programmes. Self-assessment questions and answers are provided at the end of chapters.

Since January 1995, the United Kingdom distribution **declared** voltages at consumer supply terminals have changed from 415 V/240 V +6%/–6% to 400 V/230 V +10%/–6%. As there has been no physical change to the system, it is likely that measurement of voltages will reveal little or no difference to those before, nor will they do so for some considerable time to come. However, I have used only the new values in the examples in this book.

Brian Scaddan

CHAPTER 1

Basic Information and Calculations

Units

A unit is what we use to indicate the measurement of a quantity. For example, a unit of **length** could be an **inch** or a **metre** or a **mile**, etc.

In order to ensure that we all have a common standard, an international system of units exists known as the SI system. There are seven basic SI units from which all other units are derived.

Basic units

Quantity	Symbol	Unit	Symbol
Length	l	Metre	m
Mass	m	Kilogram	kg
Time	s	Second	s
Current	I	Ampere	A
Temperature	t	Kelvin	K
Luminous intensity	I	Candela	cd
Amount of substance		Mole	mol

Conversion of units

Temperature

Kelvin (K) = °C + 273.15

Celsius (°C) = K − 273.15

$$\text{Celsius (°C)} = \frac{5}{9}(\text{°F} - 32)$$

$$\text{Fahrenheit (°F)} = \left(\frac{9 \times \text{°C}}{5}\right) + 32$$

Boiling point of water at sea level = 100°C or 212°F

Freezing point of water at sea level = 0°C or 32°F

Normal body temperature = 36.8°C or 98.4°F

Length

To Obtain	Multiply	By
mm	cm	10^{1}
	m	10^{3}
	km	10^{6}
cm	mm	10^{-1}
	m	10^{2}
	km	10^{5}
m	mm	10^{-3}
	cm	10^{-2}
	km	10^{3}
km	mm	10^{-6}
	cm	10^{-5}
	m	10^{-3}

mm: millimetre; cm: centimetre; m: metre; km: kilometre.

Area

To Obtain	Multiply	By
mm^2	cm^2	10^{2}
	m^2	10^{6}
	km^2	10^{12}
cm^2	mm^2	10^{-2}
	m^2	10^{4}
	km^2	10^{10}
m^2	mm^2	10^{-6}
	cm^2	10^{-4}
	km^2	10^{6}
km^2	mm^2	10^{-12}
	cm^2	10^{-10}
	m^2	10^{-6}

mm^2: square millimetre; cm^2: square centimetre; m^2: square metre; km^2: square kilometre; also, 1 km^2 = 100 hectares (ha).

Volume

To Obtain	Multiply	By
mm^3	cm^3	10^3
	m^3	10^9
cm^3	mm^3	10^{-3}
	m^3	10^6
m^3	mm^3	10^{-9}
	cm^3	10^{-6}

mm^3: cubic millimetre; cm^3: cubic centimetre; m3: cubic metre.

Capacity

To Obtain	Multiply	By
ml	cl	10^1
	l	10^3
cl	ml	10^{-1}
	l	10^2
l	ml	10^{-3}
	cl	10^{-2}

ml: millilitre; cl: centilitre; l: litre; also, 1 l of water has a mass of 1 kg.

Mass

To Obtain	Multiply	By
mg	g	10^3
	kg	10^6
	t	10^9
g	mg	10^{-3}
	kg	10^3
	t	10^6
kg	mg	10^{-6}
	g	10^{-3}
	t	10^3
t	mg	10^{-9}
	g	10^{-6}
	kg	10^{-3}

mg: milligram; g: gram; kg: kilogram; t: tonne.

Multiples and submultiples of units

Name	Symbol	Multiplier	Example
tera	T	10^{12} (1 000 000 000 000)	terawatt (TW)
giga	G	10^9 (1 000 000 000)	gigahertz (GHz)
mega	M*	10^6 (1 000 000)	megawatt (MW)
kilo	k*	10^3 (1000)	kilovolt (kV)
hecto	h	10^2 (100)	hectogram (hg)
deka	da	10^1 (10)	dekahertz (daHz)
deci	d	10^{-1} (1/10th)	decivolt (dV)
centi	c	10^{-2} (1/100th)	centimetre (cm)
milli	m*	10^{-3} (1/1000th)	milliampere (mA)
micro	μ*	10^{-6} (1/1 000 000th)	microvolt (mV)
nano	n	10^{-9} (1/1 000 000 000th)	nanowatt (nW)
pico	P*	10^{-12} (1/1 000 000 000 000th)	picofarad (pF)

**Multiples most used in this book.*

Mass (kg)

This is the amount of material that an object is made of. It remains constant. It is often confused with weight, in physics it is quite different.

Weight or force (newtons, N)

This is the effect of gravity on a mass. It is not constant, the gravity at different places on the Earth is not the same. Snooker balls travel horizontally in exactly the same way on a table on the moon as they do on the Earth but they will fall into the pockets more slowly.

Mass may be converted to force by multiplying by 9.81.

Force (newtons) = Mass (kg × 9.81)

Work (joules, J)

This is the process of moving objects over a distance using force. Work is force times distance.

Work (joules) = Force (newtons) × Distance (m)

Energy (joules)

This is the ability to carry out work. 100 joules of energy is required to do 100 joules of work.

Power (watts)

This is the rate at which energy is used or work is done. Power is energy divided by time.

$$\text{Power (watts)} = \frac{\text{Energy (joules)}}{\text{Time (seconds)}}$$

Indices

It is very important to understand what **indices** are and how they are used. Without such knowledge, calculations and manipulation of formulae are difficult and frustrating.

So, what are **indices**? Well, they are perhaps most easily explained by examples. If we multiply two identical numbers, say 2 and 2, the answer is clearly 4, and this process is usually expressed as

$$2 \times 2 = 4$$

However, another way of expressing the same condition is

$$2^2 = 4$$

The superscript 2 simply means that the online 2 is multiplied by itself. The superscript 2 is known as the indice. Sometimes this situation is referred to as 'two **raised to the power of** two'. So, 2^3 means 'two multiplied by itself **three** times',

i.e. $2 \times 2 \times 2 = 8$

Do not be misled by thinking that 2^3 is 2×3.

$$2^4 = 2 \times 2 \times 2 \times 2 = 16 \text{ (not } 2 \times 4 = 8)$$
$$24^2 = 24 \times 24 = 576 \text{ (not } 24 \times 2 = 48)$$

Here are some other examples:

$$3^3 = 3 \times 3 \times 3 = 27$$
$$9^2 = 9 \times 9 = 81$$
$$4^3 = 4 \times 4 \times 4 = 64$$
$$10^5 = 10 \times 10 \times 10 \times 10 \times 10 = 100\,000$$

A number by itself, say 3, has an invisible indice, 1, but it is not shown. Now, consider this: $2^2 \times 2^2$ may be rewritten as $2 \times 2 \times 2 \times 2$, or as 2^4 which means that the indices 2 and 2 or the invisible indices 1 have been added together. So the rule is, when multiplying, **add** the indices.

Examples

$$4 \times 4^2 = 4^1 \times 4^2 = 4^3 = 4 \times 4 \times 4 = 64$$
$$3^2 \times 3^3 = 3^5 = 3 \times 3 \times 3 \times 3 \times 3 = 243$$
$$10 \times 10^3 = 10^4 = 10 \times 10 \times 10 \times 10 = 10\,000$$

Let us now advance to the following situation:

$$10^4 \times \frac{1}{10^2} \text{ is the same as } \frac{10^4}{10^2} = \frac{10 \times 10 \times 10 \times 10}{10 \times 10}$$

Cancelling out the tens

$$\frac{\cancel{10} \times \cancel{10} \times 10 \times 10}{\cancel{10} \times \cancel{10}}$$

we get

$$10 \times 10 = 10^2$$

which means that the indices have been **subtracted**, that is 4 – 2. So the rule is, when dividing, **subtract** the indices.

How about this though: 4 – 2 is either 4 subtract 2 or 4 add –2, and remember, the addition of indices goes with multiplication, so from this we should see that 10^4 divided by 10^2 is the same as 10^4 multiplied by 10^{-2}.

So,

$$\frac{1}{10^2} \text{ is the same as } 10^{-2}$$

Example

$$\frac{1}{3^4} = 3^{-4} \qquad \frac{1}{2^6} = 2^{-6}$$

and conversely,

$$\frac{1}{10^{-2}} = 10^2$$

Hence we can see that indices may be moved above or below the line provided the sign is changed.

Example

1 $$\frac{10^6 \times 10^7 \times 10^{-3}}{10^4 \times 10^2} = \frac{10^{13} \times 10^{-3}}{10^6}$$

$$= \frac{10^{10}}{10^6} = 10^{10} \times 10^{-6} = 10^4 = 10\,000$$

2 $$\frac{10^4 \times 10^{-6}}{10} = 10^4 \times 10^{-6} \times 10^{-1}$$

$$= 10^4 \times 10^{-7} = 10^{-3} = \frac{1}{10^3}$$

$$= \frac{1}{1000} = 0.001$$

Self-Assessment Questions

1. Write, in numbers, 'eight raised to the power of four'.
2. Addition of indices cannot be used to solve $3^2 \times 2^3$. Why?
3. What is 10/10 equal to?
4. Replace 10/0 using the addition of indices. Write down the answer using indices.
5. What is the answer to $3^1 \times 3^{-1}$, as a single number and using indices?
6. What is 8^0 equal to?
7. Solve the following:
   (a) $\dfrac{3^2 \times 3^{-1} \times 3^3}{3^6 \times 3^{-2}}$
   (b) $10^{-6} \times 10^3 \times 10^4 \times 10^0$
   (c) $\dfrac{5^5 \times 5^{-7}}{5^{-4}}$

Simple algebra

Algebra is a means of solving mathematical problems using letters or symbols to represent unknown quantities. The same laws apply to algebraic symbols as to real numbers.

Hence: if **one ten times one ten** = 10^2, then **one X times one *X*** = X^2. That is,

$X \times X = X^2$

In algebra the multiplication sign is usually left out. So, for example $A \times B$ is shown as AB and $2 \times Y$ is shown as $2Y$. This avoids the confusion of the multiplication sign being mistaken for an X. Sometimes a dot (·) is used to replace the multiplication sign. Hence $3 \cdot X$ means 3 times X, and $2F \cdot P$ means 2 times F times P.

The laws of indices also apply to algebraic symbols. For example,

$$X \cdot X = X^2 \quad Y^2 \cdot Y^2 = Y^4 \quad \frac{1}{X} = X^{-1} \quad \frac{1}{Y^3} = Y^{-3}, \text{ etc.}$$

Addition and subtraction are approached in the same way. For example,

$$X + X = 2X$$
$$3X - X = 2X$$
$$10P - 5P = 5P$$
$$4M + 6M + 2F = 10M + 2F$$

Also with multiplication and division. For example,

$$X \cdot X = X^2$$
$$3M \cdot 2M = 6M^2$$
$$\frac{14P}{7} = 2P$$
$$\frac{10Y}{2Y} = 5$$

Formulae or equations

A formula or equation is an algebraic means of showing how a law or rule is applied. For example, we all know that the money we get in our wage packets is our gross pay less deductions. If we represent each of these quantities by a letter say W for wages, G for gross pay and D for deductions, we can show our pay situation as

$$W = G - D$$

Similarly, we know that if we travel a distance of 60 km at a speed of 30 km per hour, it will take us 2 h. We have simply divided distance (D) by speed (S) to get time (T), which gives us the formula

$$T = \frac{D}{S}$$

Manipulation or transposition of formulae

The equals sign (=) in a formula or equation is similar to the pivot point on a pair of scales (Fig. 1.1).

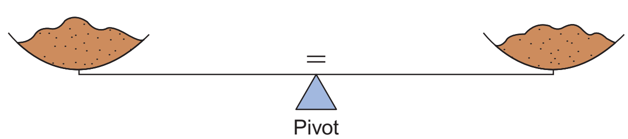


Figure 1.1 Balancing an equation.

If an item is added to one side of the scales, they become unbalanced, so an identical weight needs to be added to the other side to return the scales to a balanced condition. The same applies to a formula or equation, in that whatever is done on one side of the equals sign must be done to the other side.

Consider the formula $X + Y = Z$.

If we were to multiply the left-hand side (LHS) by, say, 2, we would get $2X + 2Y$, but in order to ensure that the formula remains correct, we must also multiply the right-hand side (RHS) by 2, hence $2X + 2Y = 2Z$.

Formulae may be rearranged (transposed) such that any symbol can be shown in terms of the other symbols. For example, we know that our pay formula is $W = G - D$, but if we know our wages and our gross pay how do we find the deductions? Clearly we need to transpose the formula to show D in terms of W and G. However, before we do this, let us consider the types of formula that exist.

There are three types:

1. Pure addition/subtraction
2. Pure multiplication/division
3. Combination of (1) and (2).

Points to Note

1. A symbol on its own with no sign is taken as being positive (i.e. K is $+K$).
2. Symbols or groups of symbols will be on either the top or the bottom of each side of an equation, for example

   $$\frac{A}{B}=\frac{M}{P}$$

   A and M are on the top, B and P are on the bottom. In the case of, say,

   $$X=\frac{R}{S}$$

   X and R are on the top line and S is on the bottom.
   (Imagine X to be divided by 1, i.e. $X/1$.)
3. Formulae are usually expressed with a single symbol on the LHS, for example $Y = P - Q$, but it is still correct to show it as $P - Q = Y$.
4. Symbols enclosed in brackets are treated as one symbol. For example, $(A + C + D)$ may, if necessary, be transposed as if it were a single symbol.

Let us now look at the simple rules of transposition.

(a) Pure addition/subtraction

Move the symbol required to the LHS of the equation and move all others to the RHS. **Any move needs a change in sign**.

Example

If $A - B = Y - X$, what does X equal?

Move the $-X$ to the LHS and change its sign. Hence,

$$X+A-B=Y$$

Then move the A and the $-B$ to the RHS and change signs. Hence,

$$X=Y-A+B$$

Example

If $M + P = R - S$, what does R equal?

We have

$$-R+M+P=-S$$
$$\therefore -R=-S-M-P$$

However, we need R, not $-R$, so simply change its sign, but remember to do the same to the RHS of the equation. Hence,

$$R=S+M+P$$

So we can now transpose our wages formula $W = G - D$ to find D:

$$W=G-D$$
$$D+W=G$$
$$D=G-W$$

(b) Pure multiplication/division

Move the symbol required **across** the equals sign so that it is on the **top** of the equation and move all other symbols away from it, **across** the equals sign but in the opposite position (i.e. from top to bottom or vice versa). Signs are not changed with this type of transposition.

Example

If

$$\frac{A}{B}=\frac{C}{D}$$

what does D equal?

Move the D from bottom RHS to top LHS. Thus,

$$\frac{A\cdot D}{B}=\frac{C}{1}$$

Now move A and B across to the RHS in opposite positions. Thus,

$$\frac{D}{1}=\frac{C\cdot B}{A} \text{ or simply } D=\frac{C\cdot B}{A}$$

Example

If

$$\frac{X\cdot Y\cdot Z}{T}=\frac{M\cdot P}{R}$$

what does P equal?

As P is already on the top line, leave it where it is and simply move the M and R. Hence,

$$\frac{X\cdot Y\cdot Z\cdot R}{T\cdot M}=P$$

which is the same as

$$P = \frac{X \cdot Y \cdot Z \cdot R}{T \cdot M}$$

(c) **Combination transposition**

This is best explained by examples.

Example

If

$$\frac{A(P+R)}{X \cdot Y} = \frac{D}{S}$$

what does S equal?

We have

$$\frac{S \cdot A(P+R)}{X \cdot Y} = D$$

Hence,

$$S = \frac{D \cdot X \cdot Y}{A(P+R)}$$

Example

If

$$\frac{A(P+R)}{X \cdot Y} = \frac{D}{S}$$

what does R equal?

Treat $(P + R)$ as a single term and leave it on the top line, as R is part of that term. Hence,

$$(P+R) = \frac{D \cdot X \cdot Y}{A \cdot S}$$

Remove the brackets and treat the RHS as a single term. Hence,

$$P + R = \left(\frac{D \cdot X \cdot Y}{A \cdot S}\right)$$

$$R = \left(\frac{D \cdot X \cdot Y}{A \cdot S}\right) - P$$

Self-Assessment Questions

1. Write down the answers to the following:

(a) $X + 3X =$

(b) $9F - 4F =$

(c) $10Y + 3X - 2Y + X =$

(d) $M \cdot 2M =$

(e) $P \cdot 3P \cdot 2P =$

(f) $\frac{12D}{D} =$

(g) $\frac{30A}{15} =$

(h) $\frac{X^3}{X^2} =$

2. Transpose the following to show X in terms of the other symbols:

(a) $X + Y = P + Q$

(b) $F - D = A - X$

(c) $L - X - Q = P + W$

(d) $2X = 4$

(e) $XM = PD$

(f) $\frac{A}{X} = W$

(g) $\frac{B}{K} = \frac{H}{2X}$

(h) $A \cdot B \cdot C = \frac{MY}{X}$

(i) $X(A + B) = W$

(j) $\frac{M+N}{2X} = \frac{P}{R}$

The theorem of Pythagoras

Pythagoras showed that if a square is constructed on each side of a right-angled triangle (Fig. 1.2), then the area of the large square equals the sum of the areas of the other two squares.

Hence: 'The square on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides.' That is,

$$H^2 = B^2 + P^2$$

Or, taking the square root of **both** sides of the equation

$$H = \sqrt{B^2 + P^2}$$

Or, transposing

$$B = \sqrt{H^2 - P^2}$$

or

$$P = \sqrt{H^2 - B^2}$$

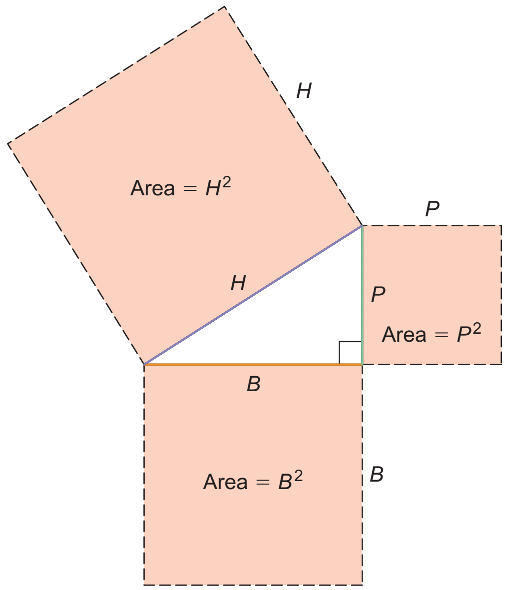


Figure 1.2 Pythagoras's theorem.

Example

1. From Fig. 1.3 calculate the value of H:

$$H = \sqrt{B^2 + P^2}$$
$$= \sqrt{3^2 + 9^2}$$
$$= \sqrt{9 + 81}$$
$$= \sqrt{90}$$
$$= 9.487$$

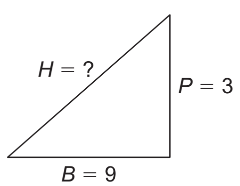


Figure 1.3

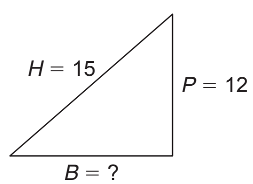


Figure 1.4

2. From Fig. 1.4 calculate the value of B:

$$B = \sqrt{H^2 - P^2}$$
$$= \sqrt{15^2 - 12^2}$$
$$= \sqrt{225 - 144}$$
$$= \sqrt{81}$$
$$= 9$$

Basic trigonometry

This subject deals with the relationship between the sides and angles of triangles. In this section we will deal with only the very basic concepts.

Consider the right-angled triangle shown in Fig. 1.5. *Note*: Unknown angles are usually represented by

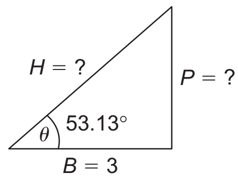


Figure 1.5

Greek letters, such as alpha (α), beta (β), phi (ϕ), theta (θ), etc.

There are three relationships between the sides H (hypotenuse), P (perpendicular), and B (base), and the base angle θ. These relationships are known as the **sine**, the **cosine** and the **tangent** of the angle θ, and are usually abbreviated to sin, cos and tan.

The **sine** of the base angle θ,

$$\sin\theta = \frac{P}{H}$$

The **cosine** of the base angle θ,

$$\cos\theta = \frac{B}{H}$$

The **tangent** of the base angle θ,

$$\tan\theta = \frac{P}{B}$$

The values of sin, cos and tan for all angles between 0° and 360° are available either in tables or, more commonly now, by the use of a calculator.

How then do we use trigonometry for the purposes of calculation? Examples are probably the best means of explanation.

Example

1. From the values shown in Fig. 1.5, calculate P and H:

$$\cos\theta = \frac{B}{H}$$

Transposing,

$$H = \frac{B}{\cos\theta} = \frac{3}{\cos 53.13^\circ}$$

From tables or calculator, $\cos 53.13^\circ = 0.6$

$$\therefore H = \frac{3}{0.6} = 5$$

Now we can use sin or tan to find P:

$$\tan\theta = \frac{P}{B}$$

Transposing,

$$P = B \cdot \tan\theta$$

$$\tan\theta = \tan 53.13° = 1.333$$

$$\therefore P = 3 \times 1.333 = 4(3.999)$$

2. From the values shown in Fig. 1.6, calculate α and P:

$$\cos\alpha = \frac{B}{H} = \frac{6}{12} = 0.5$$

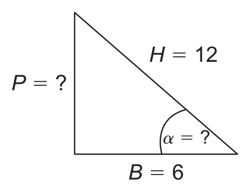


Figure 1.6

We now have to find the angle whose cosine is 0.5. This is usually written as $\cos^{-1} 0.5$. The superscript −1 is not an **indice**; it simply means 'the angle whose sin, cos or tan is …'

So the angle $\alpha = \cos^{-1} 0.5$.

We now look up the tables for 0.5 or use the INV cos or ARC cos, etc., function on a calculator. Hence,

$$\alpha = 60°$$

$$\sin\alpha = \frac{P}{H}$$

Transposing,

$$P = H \cdot \sin\alpha$$
$$= 12 \cdot \sin 60°$$
$$= 12 \times 0.866$$
$$= 10.4$$

Self-Assessment Questions

1. What kind of triangle enables the use of Pythagoras' theorem?
2. Write down the formula for Pythagoras' theorem.
3. Calculate the hypotenuse of a right-angled triangle if the base is 11 and the perpendicular is 16.
4. Calculate the base of a right-angled triangle if the hypotenuse is 10 and the perpendicular is 2.
5. Calculate the perpendicular of a right-angled triangle if the hypotenuse is 20 and the base is 8.
6. What is the relationship between the sides and angles of a triangle called?
7. For a right-angled triangle, write down a formula for:
   (a) The sine of an angle.
   (b) The cosine of an angle.
   (c) The tangent of an angle.
8. A right-angled triangle of base angle 25° has a perpendicular of 4. What is the hypotenuse and the base?
9. A right-angled triangle of hypotenuse 16 has a base of 10. What is the base angle and the perpendicular?
10. A right-angled triangle of base 6 has a perpendicular of 14. What is the base angle and the hypotenuse?

Areas and volumes

Areas and volumes are shown in Fig. 1.7.

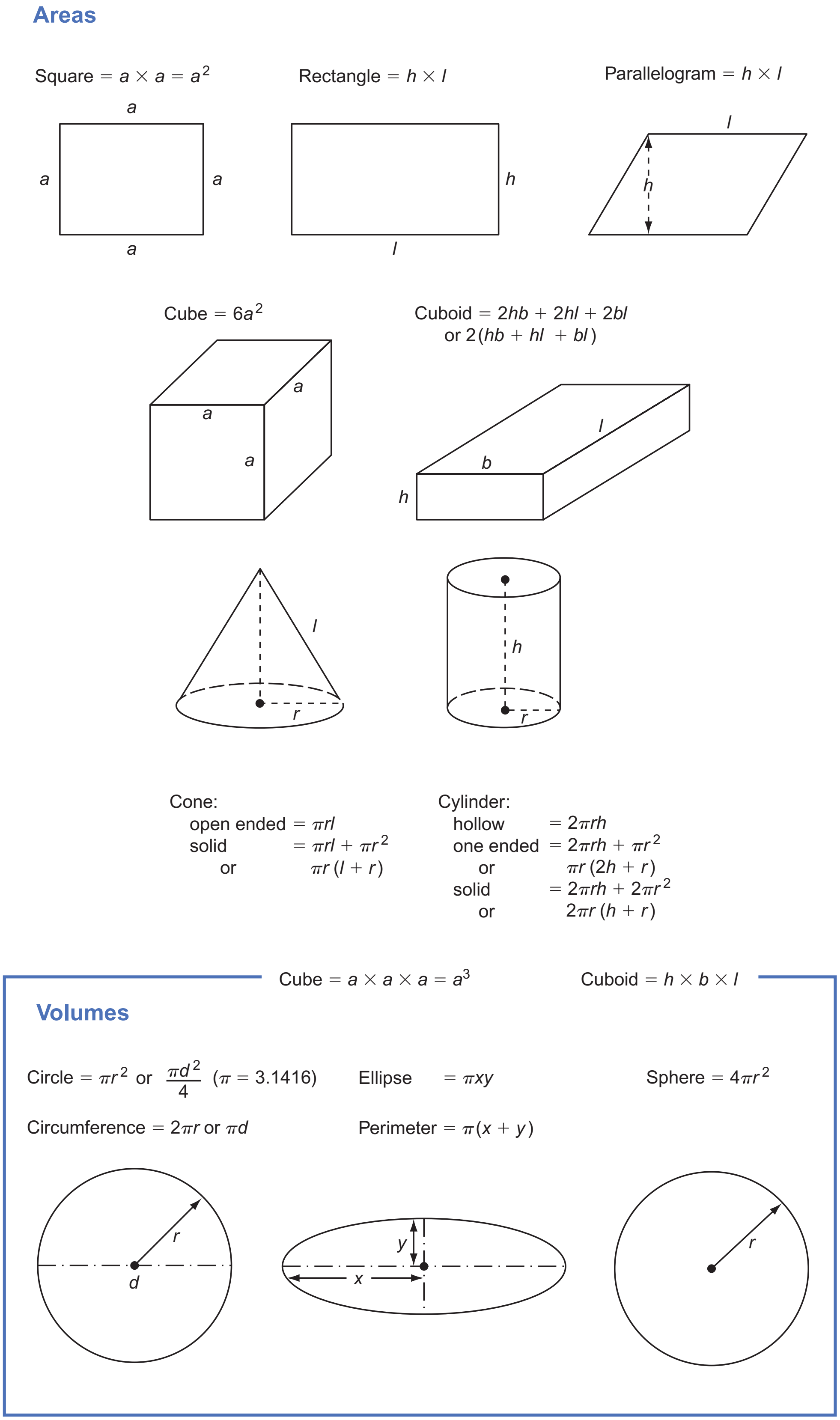


Figure 1.7 Areas and volumes.