

YEAR

9

Mathematics

STUDENT COMPANION

Pearson Secondary Teaching Hub Maths 9 Student Companion

Lead author

Nicola Silva

Contributing authors

Greg Carroll, David Coffey, Grace Jefferson and Garthe Jones

Pearson acknowledges the Traditional Custodians of the lands upon which the many schools throughout Australia are located.

We respect the living cultures of Aboriginal and Torres Strait Islander peoples and their ongoing connection to Country across lands, sky, seas, waterways and communities. We celebrate the richness of Indigenous Knowledge systems, shared with us and with schools Australia-wide.

We pay our respects to Elders, past and present.

Pearson Australia

(a division of Pearson Australia Group Pty Ltd)
459–471 Church Street
Level 1, Building B
Richmond, Victoria 3121
www.pearson.com.au

Copyright © Pearson Australia 2024
(a division of Pearson Australia Group Pty Ltd)
First published 2024 by Pearson Australia
2027 2026 2025 2024
10 9 8 7 6 5 4 3 2 1

Reproduction and communication for educational purposes

The Australian *Copyright Act 1968* (the Act) allows a maximum of one chapter or 10% of the pages of this work, whichever is the greater, to be reproduced and/or communicated by any educational institution for its educational purposes provided that that educational institution (or the body that administers it) has given a remuneration notice to the Copyright Agency under the Act. For details of the copyright licence for educational institutions contact the Copyright Agency (www.copyright.com.au).

Reproduction and communication for other purposes

Except as permitted under the Act (for example any fair dealing for the purposes of study, research, criticism or review), no part of this book may be reproduced, stored in a retrieval system, communicated or transmitted in any form or by any means without prior written permission. All enquiries should be made to the publisher at the address above.

This book is not to be treated as a blackline master; that is, any photocopying beyond fair dealing requires prior written permission.

Project Leads: Julian Lumb, Lindy Sharkey, Jack Sagar,
Natalie Bennett

Development Editor: Anna Pang

Schools Programme Manager: Michelle Thomas

Production Editors: Maddy Higginson, Jaimi Kuster

Rights & Permissions Editor: Amirah Fatin Binte Mohamed
Sapi'ee

Illustrators: QBS Learning

Proofreader: Lucy Bates, Scott Vandervalk

Series Design: Watershed Art

Typesetters: Integra Software Services

Desktop Operator: Jit-Pin Chong

Printed in Australia by Pegasus

ISBN 978 0 6557 1384 5

Pearson Australia Group Pty Ltd ABN 40 004 245 943

Disclaimer

Any internet addresses (URLs) provided for this Student Companion were valid at the time of publication and were chosen as being appropriate for use as a secondary education research tool. However, due to the dynamic nature of the internet, some addresses may have changed, may have ceased to exist since publication, or may inadvertently link to sites with content that could be considered offensive or inappropriate. While the authors and publisher regret any inconvenience this may cause readers, no responsibility for any such changes or unforeseeable errors can be accepted by either Pearson Australia or the authors.

Attributions

COVER

Shutterstock: BetterPhoto, basketball; Crusitu, Robert Lucian (microchip); empics, graphs and calculator; Retouch man, diamond.

123RF: Mino21, p. 154t.

FIFA: Extracts from FIFA Women's World Cup Australia & New Zealand 2023™ - Beyond Greatness™, pp. 158-61.

Fortune Business Insights: Based on data from www.fortunebusinessinsights.com, p. 163.

Fresh Property Management Group: Based on data from www.valuewalk.com via Fresh Property Management Group, p.172.

Savings.com.au: Based on data from Macrotrends via savings.com.au, p. 168t.

Shutterstock: LStockStudio, p 154b.

Contents

1	Real numbers	1	4	Linear relationships and graphs	37
	Identify and define irrational numbers	1		Determine the gradient of straight-line graphs	37
	Apply irrational numbers	4		Sketch and analyse linear graphs	40
	Plot and locate irrational numbers on a number line by estimation and by construction	6		Determine the equation of a straight line	43
2	Exponents	9		Model practical contexts with linear equations	45
	Establish and apply the exponent law for multiplication	9		Determine the distance between points and the coordinates of the midpoint	47
	Establish and apply the exponent law for division	11		Transform linear graphs	52
	Establish and apply the exponent law for raising a power to a power	13		Interpolate and extrapolate	56
	Establish and apply the exponent law for raising to the power of 0	15	5	Quadratic relationships and graphs	57
	Apply exponent laws to numerical expressions with negative integer exponents	17		Understand solutions to simple quadratic equations	57
	Apply exponent laws to simplify numerical expressions	19		Solve monic quadratic equations using the Null Factor Law	59
	Choose and apply efficient strategies to exponent laws of numerical expressions	21		Identify and plot the key features of quadratic graphs	63
	Apply exponent laws to simplify algebraic expressions	23		Determine transformations of parabolas	66
3	Algebra	26		Solve quadratic equations graphically	70
	Understand and use the distributive law	26		Model and solve practical problems with quadratic equations	72
	Recognise, expand and factorise special binomial products	29	6	Surface area and volume	75
	Understand algebraic factorisation	32		Determine the volume of right prisms	75
	Factorise simple quadratics	35		Solve problems involving the volumes and capacities of right prisms and right pyramids	77
				Solve problems involving the surface areas and nets of right prisms	80

Contents

7	Circles and cylinders	84	10	Pythagoras and geometry	108
	Calculate circumference and area in terms of π	84		Apply Pythagoras' theorem to solve problems	108
	Determine the radius of a circle from the area or circumference	86		Calculate the distance between two points on a Cartesian plane	111
	Determine the surface area of cylinders	88		Understand when right-angled triangles are similar	117
	Solve problems involving the surface area of cylinders	90		Use the triangle inequality theorem	123
	Volume and capacity of cylinders	91			
	Understand the relationship between the volume and dimensions of cylinders	93	11	Modelling situations with measurement and rates	125
				Model direct proportion	125
				Use formulas that model rates	129
8	Measurement and scientific notation	95	12	Trigonometry	131
	Identify and describe very small and very large measurements	95		Understand right-angled triangle trigonometry	131
	Express numbers in scientific notation and decimal form	97		Use trigonometry to solve an unknown side length in a right-angled triangle	134
	Order and perform calculations using numbers in scientific notation	99		Use trigonometry to solve an unknown angle in a right-angled triangle	138
	Estimate and round numbers to a specified degree of accuracy	101		Define a right-angled triangle	141
9	Percentage error in measurement	103	13	Ratios and proportion in space	143
	Determine the precision and absolute error of measurements	103		Understand the effect of the enlargement transformation	143
	Estimate the degree of accuracy	105		Calculate the area of a shape or the volume of an object using a scale factor	147
	Determine the percentage error in measurements and calculations	106		Use images and proportion to estimate lengths	153
				Ascertain compliance involving horizontal and vertical distances	156

14 Analysing and interpreting statistics 158

Analyse statistical reports in digital media 158

Question the view presented in media reports 162

15 Displaying and comparing statistical data 164

Represent data using statistical displays 164

Justify the selection of particular data displays 170

16 Probability (compound events, relative frequencies) 175

Use tables and tree diagrams to represent two- and three-step chance events 175

Calculate the probability of compound events 180

Estimate the probability of events 184

Design and conduct experiments and simulations 187

SAMPLE PAGES

How to use this Student Companion

The *Student Companion* is a complementary resource that offers a print medium for corresponding lessons in *Pearson Secondary Teaching Hub*. It is designed to support teaching and learning by providing learners with a place to create a portfolio of learning to suit their individual needs, whether you are:

- supporting a blended classroom using the strengths of print and digital
- preparing for exams by creating a study guide or bound reference
- needing a tool to differentiate learning or
- looking for meaningful homework tasks.

Learners can develop their portfolio of learning as part of classroom learning or at home as an additional opportunity to engage and re-engage with the knowledge and skills from the lesson.

This could be done as prior learning in a flipped classroom environment or as an additional revision or homework task.

Learning intention and success criteria

Apply irrational numbers

Learning intention: To be able to apply irrational numbers

Success criteria:

- SC 1: I can write approximate values for irrational numbers.
- SC 2: I can apply irrational numbers in the solution of problems.

SC 1: I can write approximate values for irrational numbers

Worked example: Writing a decimal approximation for an

Learning intentions are provided for every lesson. The learning intentions are goals or objectives that align to the corresponding digital lesson. They describe what learners should know, understand or be able to do by the end of the lesson.

Success criteria clarify expectations and describe what success looks like. The success criteria are specific, concrete and measurable so learners can actively engage with and reflect on their evidence of learning within each lesson.

Worked examples

Worked examples provide learners with a step-by-step solution to a problem. The worked examples in the *Student Companion* correspond to those in the digital lesson and are provided for each skill to:

- scaffold learning
- support skill acquisition
- reduce the cognitive load.

The **worked examples** are an effective tool to demonstrate what success looks like. The 'try yourself' format of the worked examples in the *Student Companion* support the gradual release of responsibility. Learners can view a completed worked example and a video walkthrough of the worked example in the corresponding digital lesson and then apply the scaffolded steps themselves to solve a unique problem.

Practice questions are provided in the *Student Companion* so that learners can apply the knowledge and skills obtained in the worked example given. These questions are designed to ensure learners build confidence and demonstrate efficiency. They follow on from the Check your understanding questions beside the corresponding worked example in the digital lesson.

Each lesson in the *Student Companion* contains a space for students to reflect on their understanding. The simple and intuitive design of the **lesson reflection tool** allows students to scale their confidence, reflect on their learning and identify areas in which they need support.

Real numbers

SC 2: I can apply irrational numbers in the solution of problems

Worked example: Calculating exact lengths that have irrational values and then give a decimal approximation

Calculate the following lengths in exact form, then approximate the lengths correct to 1 decimal place.

- (a) The exact circumference of a circle of diameter 8 cm

Thinking	Working
Recall the formula for the circumference of a circle.	
Substitute the known values and simplify.	
Write the answer.	

- (b) The exact length of the diagonal of a square of side length 6 cm

Thinking	Working
Draw a diagram showing a right-angled triangle, marking the length to be calculated as x .	
Recall Pythagoras' theorem for right-angled triangles.	
Substitute the known values and simplify.	
Take the square root of the number, ignoring the possibility of a negative value, since lengths are positive.	
Write the answer.	

- 1 For the circle shown, use the following rules.

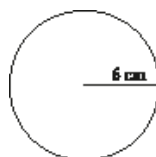
(a) $C = 2\pi r$ to calculate the circumference

(b) $A = \pi r^2$ to calculate the area

Give your answers

(i) in exact form, and

(ii) accurate to 2 decimal places.



(a) _____ (b) _____

RATE MY LEARNING

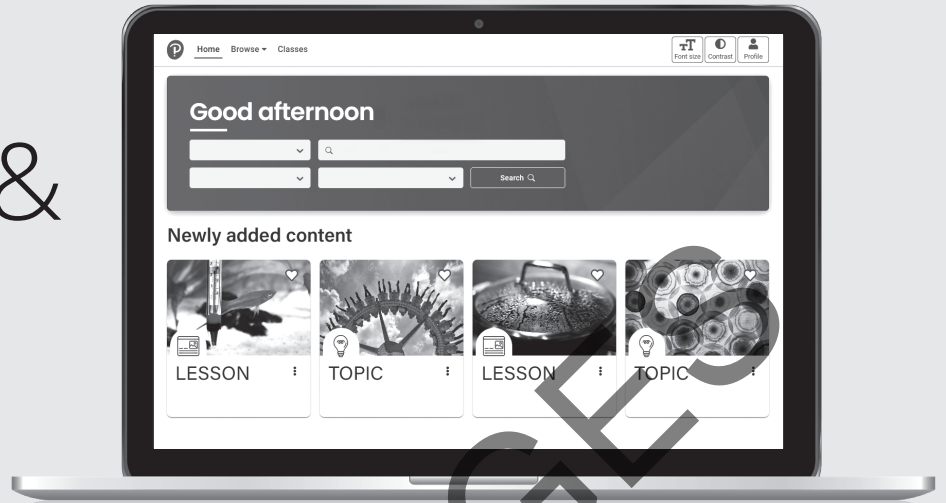
I need some help

I am getting there

I get it

I am confident

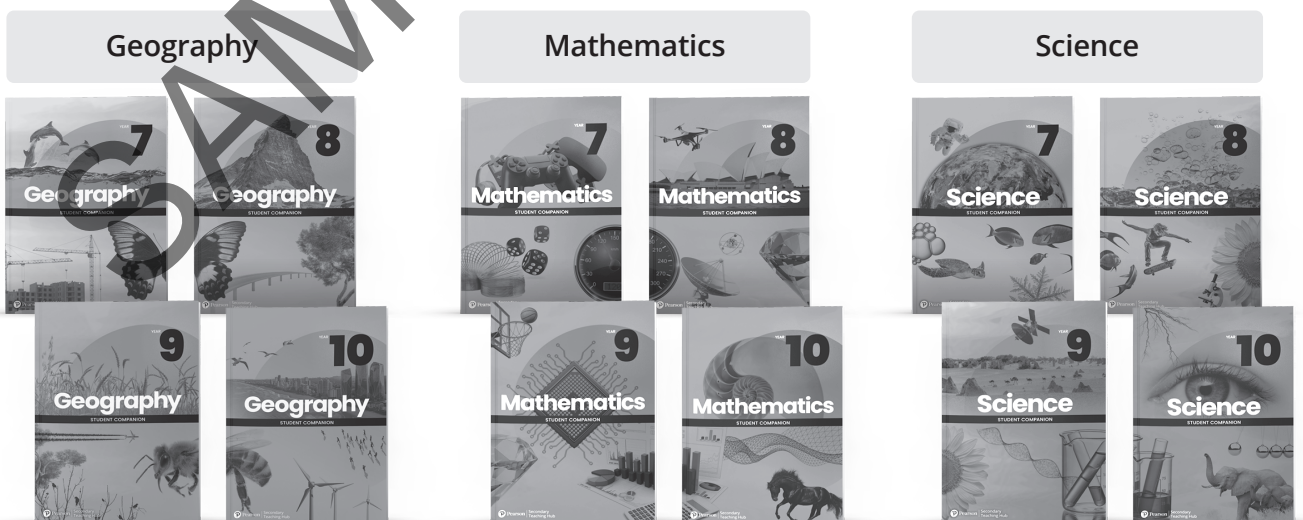
Simplify teaching & energise learning



Discover *Pearson Secondary Teaching Hub* for years 7 to 10.

Pearson Secondary Teaching Hub has been designed to simplify teaching and energise learning across multiple subjects. Every *Secondary Teaching Hub* subject offers best-practice learning design delivered in flexible formats for the modern classroom, plus uniquely developed content structures and features for each subject.

This solution provides continuity for students from one class to the next and a rare whole-school view for school leadership while still delivering the rigour and support teachers need to help students meet the specific outcomes of their curriculum area.



Discover Pearson Secondary Teaching Hub
pearson.com.au/teaching-hub



Real numbers

Identify and define irrational numbers

Learning intention: To be able to identify and define irrational numbers

Success criteria:

- SC 1: I can define a rational number and determine whether a number is rational or irrational.
- SC 2: I can use a number line to indicate the solution interval for inequalities.

SC 1: I can define a rational number and determine whether a number is rational or irrational

Worked example: Identifying rational numbers in a list

Label each of the following numbers as either rational or irrational.

$\sqrt{64}$, 15π , -5.27 , $2.\dot{7}$, $\sqrt{125}$ and $\sqrt[3]{-27}$

Thinking	Working
Recall the definition of a rational number.	A number that is rational can be written in the form $\frac{a}{b}$.
Examine the square roots.	
Examine the cube root.	
Identify any recurring and terminating decimals. Recurring and terminating decimals are rational.	
Identify any terms that contain transcendental numbers (π or e), which are irrational.	

1 Label each of the following numbers as rational or irrational. For the rational numbers, show the value expressed in the form $\frac{a}{b}$, where a and b are integers.

(a) $5\frac{1}{3}$

(b) $\sqrt{1000}$

(c) $\sqrt[3]{800}$

(d) 58π

(e) $6.\dot{2}$

(f) $-\sqrt{400}$

2 Express each of the following numbers in the form $\frac{a}{b}$, thus confirming they are rational. In each case, express the fraction in simplest form.

(a) $3.2525\dots$

(b) $0.7\dot{2}$

(c) $6.\overline{003}$

(d) $1.5\dot{2}0\dot{2}$

RATE MY LEARNING



I need some help



I am getting there



I get it



I am confident

Real numbers

SC 2: I can use a number line to indicate the solution interval for inequalities

Worked example: Showing a solution interval on a number line

Show the following intervals on a number line.

(a) $-2 \leq x < 3$

Thinking	Working
<p>Plot the endpoints on the number line using a closed circle for an included value and an open circle if it is not included.</p> <p>Complete the number line with a line segment between the plotted points.</p>	

(b) $x + 5 < 3$

Thinking	Working
<p>Solve the inequality to determine the value of the unknown.</p>	
<p>Plot the endpoint on the number line using an open circle because the end value is not included.</p> <p>Complete the number line with a line and arrow.</p>	

(c) $-4x \leq 6$

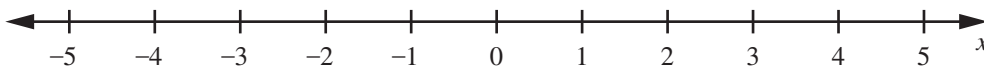
Thinking	Working
<p>Solve the inequality to determine the value of the unknown.</p> <p>Note that when multiplying or dividing by a negative number, the inequality sign is reversed.</p>	
<p>Plot the endpoint on the number line using a closed circle for the included end value.</p> <p>Complete the number line with a line and arrow.</p>	

1 Draw and label the following solution intervals on the number line below.

(a) $x < -1$

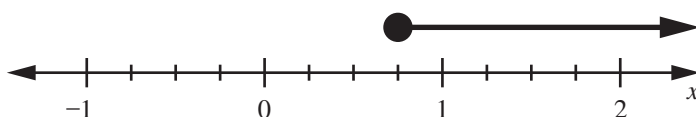
(b) $x \geq 3$

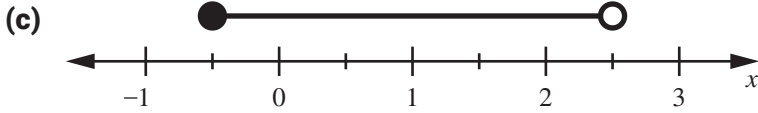
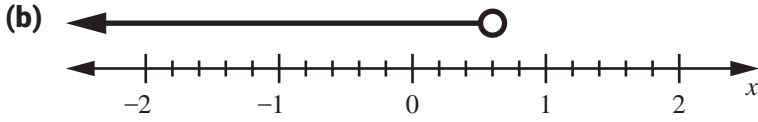
(c) $-1 < x \leq 2$



2 State the solution interval shown in each of the following diagrams.

(a)





3 Solve each of the following inequalities and show the solution interval on a number line.

(a) $2x + 1 \geq 4$ _____

(b) $6x + 12 \leq -3$ _____

(c) $5 - 4x > -2$ _____

RATE MY LEARNING I need some help I am getting there I get it I am confident

Apply irrational numbers

Learning intention: To be able to apply irrational numbers

Success criteria:

- SC 1: I can write approximate values for irrational numbers.
- SC 2: I can apply irrational numbers in the solution of problems.

SC 1: I can write approximate values for irrational numbers

Worked example: Writing a decimal approximation for an irrational number

Write the value of $\sqrt{8}$ correct to 2 decimal places and 4 decimal places.

Thinking	Working
Use your calculator to obtain a value for the irrational number. Examine the third digit after the decimal point. If the digit is 0–4, round down. If the digit is 5–9, round up. Examine the fifth digit after the decimal point and round as before.	

1 Write each of the following irrational numbers as a decimal correct to

- (i) 1 decimal place
- (ii) 4 decimal places.

(a) $\sqrt{13}$

(b) $\sqrt{40}$

(c) $\sqrt[3]{16}$

(d) $\sqrt[3]{75}$

2 Write each of the following irrational numbers as a decimal correct to

- (i) 1 decimal place
- (ii) 4 decimal places.

(a) $5\pi + 9$

(b) $\frac{7\pi}{8}$

(c) $e + 6$

(d) $\frac{5e + 2}{4}$

RATE MY LEARNING

I need some help

I am getting there

I get it

I am confident

SC 2: I can apply irrational numbers in the solution of problems

Worked example: Calculating exact lengths that have irrational values and then give a decimal approximation

Calculate the following lengths in exact form, then approximate the lengths correct to 1 decimal place.

(a) The exact circumference of a circle of diameter 8 cm

Thinking	Working
Recall the formula for the circumference of a circle.	
Substitute the known values and simplify.	
Write the answer.	

(b) The exact length of the diagonal of a square of side length 6 cm

Thinking	Working
Draw a diagram showing a right-angled triangle, marking the length to be calculated as x .	
Recall Pythagoras' theorem for right-angled triangles.	
Substitute the known values and simplify.	
Take the square root of the number, ignoring the possibility of a negative value, since lengths are positive.	
Write the answer.	

1 For the circle shown, use the following rules.

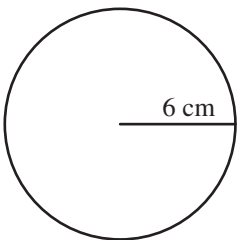
(a) $C = 2\pi r$ to calculate the circumference

(b) $A = \pi r^2$ to calculate the area

Give your answers

(i) in exact form, and

(ii) accurate to 2 decimal places.



(a) _____ (b) _____

RATE MY LEARNING

I need some help I am getting there I get it I am confident

Plot and locate irrational numbers on a number line by estimation and by construction

Learning intention: To be able to plot and locate irrational numbers on a number line by estimation and by construction

Success criteria:

- SC 1:** I can estimate the location of irrational numbers on a number line.
- SC 2:** I can use construction techniques to accurately locate irrational numbers on a number line.

SC 1: I can estimate the location of irrational numbers on a number line

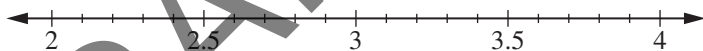
Worked example: Plotting an approximate value for an irrational number on a number line

Write the value of 2π correct to 2 decimal places and plot its position on a number line.

Thinking	Working
Write the approximate value of the irrational number.	
Identify more rounded values above and below the approximation.	
Draw a number line showing the approximate value.	

1 Plot each of the following irrational numbers on the number line below.

$$\sqrt{10}, \sqrt{5}, \frac{3\pi}{4}, \frac{e^2}{2}$$



2 List the following irrational numbers $\sqrt{12}, \sqrt[3]{-15}, -\frac{5\pi}{2}, \sqrt{14}, -\sqrt[3]{20}, \sqrt[3]{6}, -\frac{3e}{2}$ in

(a) ascending order

(b) descending order.

RATE MY LEARNING

I need some help

I am getting there

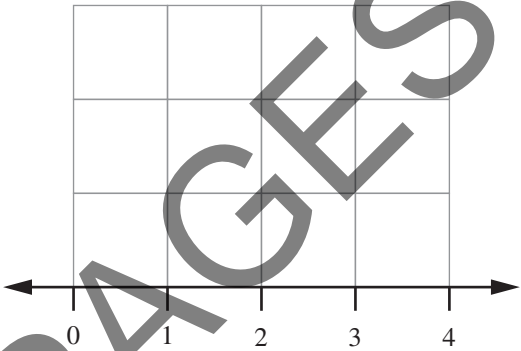
I get it

I am confident

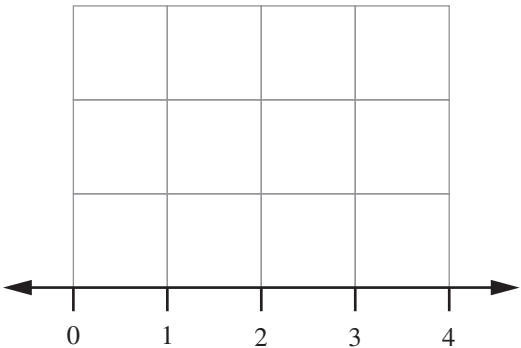
SC 2: I can use construction techniques to accurately locate irrational numbers on a number line

Worked example: Using construction to show the location of an irrational number on a number line

(a) Construct a right-angled triangle on a number line and use the construction to plot the position of $\sqrt{5}$.

Thinking	Working
Write 5 as the sum of two square numbers.	
Use Pythagoras' theorem to determine the side lengths.	
Draw a right-angled triangle on grid paper, with base 2, height 1 and hypotenuse $\sqrt{5}$.	
Set the compass radius to the length of the hypotenuse ($\sqrt{5}$ units). With the compass point at 0, draw an arc from the vertex to the number line. Mark the point at which the arc intersects the number line as the location of $\sqrt{5}$.	

(b) Use the construction in (a) to plot the position of $\sqrt{10}$ on the number line.

Thinking	Working
Write 10 as the sum of two squares of either whole numbers, or lengths on the original construction.	
Draw a right-angled triangle on grid paper, with base $\sqrt{5}$, height $\sqrt{5}$ and hypotenuse $\sqrt{10}$.	
Set the compass radius to the length of the hypotenuse ($\sqrt{10}$ units). With the compass point at 0, draw an arc from the vertex to the number line.	
Mark the point at which the arc intersects the number line as the location of $\sqrt{10}$.	

1 Write each of the following numbers as the sum of two positive square numbers, and hence write the side lengths of a right-angled triangle for which the lengths of the shorter sides are whole numbers of units and the length of the hypotenuse involves a surd.

(a) 26

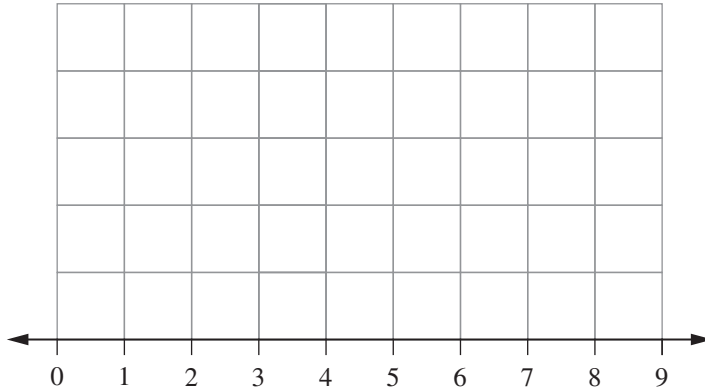
(b) 32

(c) 34

Real numbers

2 On the number line and grid below:

- (a) construct a right-angled triangle with a hypotenuse of $\sqrt{45}$ units and draw an arc to the number line
- (b) use the construction in part (a) to form a right-angled triangle to enable $\sqrt{61}$ to be plotted on the number line.



3 (a) Write your own instructions for how you can construct a length of $\sqrt{130}$ cm using a ruler and a compass.

(b) Draw the construction from part (a).

SAMPLE PAGES

RATE MY LEARNING

I need some help

I am getting there

I get it

I am confident