Mathematics standards

Grade 9

Summary of students' performance by the end of Grade 9

Reasoning and problem solving

Students solve routine and non-routine mathematical problems in a range of contexts. They represent, interpret, analyse and synthesise information presented in numeric, algebraic, geometric or graphical form. They solve more complex problems by breaking them down into smaller tasks. They choose and use appropriate mathematical techniques and tools to solve each part of a problem, including ICT. They explain and justify the steps taken to solve a problem or arrive at a conclusion, orally and in writing. They recognise when an exact solution to a problem is required and when an approximate solution is sufficient, and give answers to a specified degree of accuracy. They develop simple proofs. They generalise where possible and identify exceptional cases. They seek alternative solutions to problems.

Number and algebra

Students choose and use appropriate strategies to solve a range of routine and non-routine problems, using a calculator efficiently and appropriately. They use the four operations and numbers of any size, estimating by rounding to one significant figure and calculating mentally. They use the laws of indices and write numbers in the standard form $A \times 10^n$, where n is an integer and $1 \le A < 10$. They calculate simple interest. They add, subtract, multiply and divide simple algebraic fractions and evaluate formulae and expressions, including quadratic expressions, by substituting integers. They change the subject of a simple formula. They multiply expressions of the form $(x \pm a)(x \pm b)$. They factorise linear expressions by removing common factors and recognise the factors of expressions of the form $a^2x^2 - b^2y^2$ and $x^2 \pm 2ax + a^2$. They write and solve simple quadratic equations, and simultaneous linear equations with two unknowns, including finding approximate solutions by graphical methods. They use trial and improvement methods to solve equations such as $x^3 + x = 20$. They find the gradient of the lines $y = mx + c$, and of lines parallel and perpendicular to $y = mx + c$. They interpret and sketch graphs of functions representing practical situations.

Geometry and measures

Students solve problems by identifying congruent or similar triangles and their corresponding angles or sides. They use their knowledge of angles and properties of 2-D shapes to deduce properties in a given plane figure. They use Cartesian coordinates to find the mid-point and length of a line segment, and the point that divides a line segment in a given ratio. They identify a single transformation mapping a shape onto its image, and enlarge shapes by a fractional scale factor, recognising the similarity of the resulting shape. They draw and use plans and elevations of 3-D objects. They solve simple problems in two dimensions by applying Pythagoras' theorem and finding the side or angle of a right-angled triangle using trigonometric ratios. They calculate areas of 2-D shapes related to circles and volumes and surface areas of right prisms and cylinders.

Data handling

Students solve problems by selecting, using and evaluating methods of collecting, organising, representing, analysing and interpreting data. They represent continuous data in frequency diagrams, choosing appropriate class intervals, on paper and using ICT. They calculate the mean, range and median of small sets of continuous data; they identify the modal class and estimate the mean, median and range for sets of grouped data, choosing the statistic that is most appropriate to their enquiry. They draw conclusions from scatter diagrams, have a basic understanding of correlation, and draw a line of best fit on a scatter diagram, by inspection. They know that if A and B are mutually exclusive, the probability of A or B is the sum of the probabilities of A and of B. They understand relative frequency as an estimate of probability and use this to compare outcomes of experiments. They compare experimental and theoretical probability in different contexts.

Content and assessment weightings for Grade 9

The mathematics standards for Grades K to 9 are grouped into four strands: reasoning and problem solving; number and algebra; geometry and measures; and data handling.

The reasoning and problem solving strand cuts across the other three strands and should be integrated with them in teaching and assessments. For Grade 9, at least 70% of the teaching and assessment of each of the other three strands should be devoted to reasoning and problem solving.

For Grades 7 to 9, the proportion of algebra in the number and algebra strand increases as the proportion of number decreases, and so is shown separately in the table below. The weightings of the content strands relative to each other are as follows:

	Number	Algebra	Geometry and measures*	Data handling
Grade 7	30%	25%	27.5%	17.5%
Grade 8	25%	30%	27.5%	17.5%
Grade 9	15%	40%	27.5%	17.5%

* including trigonometry in Grade 9

The standards are numbered for easy reference. Those in shaded rectangles, e.g. 1.2, are the performance standards for all students. The national tests for mathematics will be based on these standards.

Grade 9 teachers should review and consolidate Grade 8 standards where necessary.

Mathematics standards

Grade 9

Reasoning and problem solving

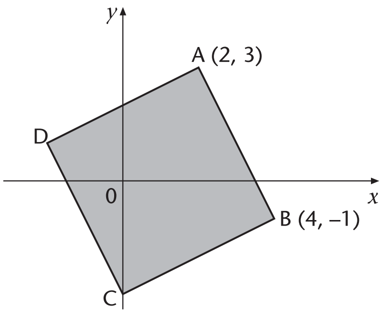
By the end of Grade 9, students solve routine and non-routine mathematical problems in a range of contexts. They represent, interpret, analyse and synthesise information presented in numeric, algebraic, geometric or graphical form. They solve more complex problems by breaking them down into smaller tasks. They choose and use appropriate mathematical techniques and tools to solve each part of a problem, including ICT. They explain and justify the steps taken to solve a problem or arrive at a conclusion, orally and in writing. They recognise when an exact solution to a problem is required and when an approximate solution is sufficient, and give answers to a specified degree of accuracy. They develop simple proofs. They generalise where possible and identify exceptional cases. They seek alternative solutions to problems.

Students should:

1 Use mathematical reasoning to solve problems

1.1 Represent, interpret, analyse and synthesise information presented in numeric, algebraic, geometric or graphical form.

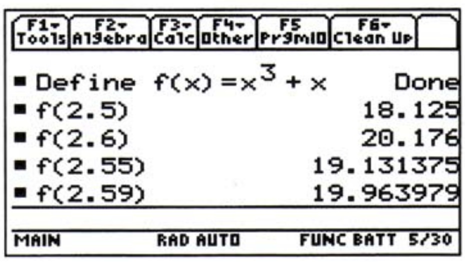
The shaded shape ABCD is a square. What are the coordinates of D?



1.2 Solve more complex problems by breaking them down into smaller tasks.

1.3 Choose and use appropriate mathematical techniques and tools to solve each part of a problem, including ICT.

Find an approximate solution to $x^3 + x = 20$.



Key standards

Key performance standards are shown in shaded rectangles, e.g. 1.2.

Cross-references

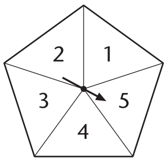
Standards are referred to using the notation RP for reasoning and problem solving, NA for number and algebra, GM for geometry and measures and DH for data handling, e.g. standard NA 2.3.

Examples of problems

The examples of problems in italics are intended to clarify the standards, not to represent the full range of possible problems.

1.4 Explain and justify the steps taken to solve a problem or arrive at a conclusion, orally and in writing.

Here is a spinner with five equal sections.



Rasha and Sahar play a game. They spin the pointer many times.
If it stops on an odd number, Rasha gets 2 points.
If it stops on an even number, Sahar gets 3 points.
Is this a fair game? Circle YES or NO.
Explain your answer.

1.5 Recognise when an exact solution to a problem is required and when an approximate solution is sufficient, and give answers to a specified degree of accuracy.

A bus company has 62 minibuses.
On average, each minibus travels 19 km on 5 litres of fuel and goes 284 km each day.
The company says it needs about 5000 litres of fuel every day.
Is what the company says about right?
Explain how you got your answer.

Circle the best estimate of the answer to 32.7 × 0.48.

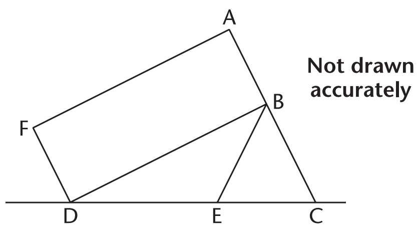
1.2   1.6   12   16   120   160

1.6 Develop a simple proof.

Prove that any two-digit whole number is divisible by 9 if the sum of its digits is divisible by 9.

In the diagram, ABDF is a rectangle and triangle BCE is equilateral.
ABC and DEC are straight lines.

Prove that triangle BED is isosceles.



1.7 Generalise where possible and identify exceptional cases.

Equations may have different numbers of solutions.
Tick (✓) the correct box for each algebraic statement below.

	Correct for no values of x	Correct for one value of x	Correct for all values of x
$3x + 7 = 8$			
$3(x + 1) = 3x + 3$			
$x + 3 = x - 3$			
$5 + x = 5 - x$			

1.8 Seek alternative solutions to problems.

Number and algebra

By the end of Grade 9, students choose and use appropriate strategies to solve a range of routine and non-routine problems, using a calculator efficiently and appropriately. They use the four operations and numbers of any size, estimating by rounding to one significant figure and calculating mentally. They use the laws of indices and write numbers in the standard form $A \times 10^n$, where n is an integer and $1 \le A < 10$. They calculate simple interest. They add, subtract, multiply and divide simple algebraic fractions and evaluate formulae and expressions, including quadratic expressions, by substituting integers. They change the subject of a simple formula. They multiply expressions of the form $(x \pm a)(x \pm b)$. They factorise linear expressions by removing common factors and recognise the factors of expressions of the form $a^2x^2 - b^2y^2$ and $x^2 \pm 2ax + a^2$. They write and solve simple quadratic equations, and simultaneous linear equations with two unknowns, including finding approximate solutions by graphical methods. They use trial and improvement methods to solve equations such as $x^3 + x = 20$. They find the gradient of the lines $y = mx + c$, and of lines parallel and perpendicular to $y = mx + c$. They interpret and sketch graphs of functions representing practical situations.

Students should:

2 Solve numerical problems

Use of ICT

Function graph plotters, graphics calculators and spreadsheets help to explore ideas in number and algebra.

2.1 Round whole numbers and decimals, including measures, to a given number of significant figures; use rounding to make mental estimations of calculations.

Estimate the answer to $\frac{8.62 + 22.1}{5.23}$.

Give your answer to one significant figure.

2.2 Use index notation and the laws of indices to evaluate expressions with integral powers, including positive and negative powers of 10.

Given that $64 = 8^2 = 4^k = 2^m$, *what are the values of k and m?*

Given that $2^{15} = 32\,768$, *what is* 2^{14}?

Indices

Include the terms *power* (*index* or *exponent*) and *base*. Include:

$a^m \times a^n = a^{m+n}$

$a^m \div a^n = a^{m-n}$

$(a^m)^n = a^{mn}$

$(ab)^m = a^m b^m$

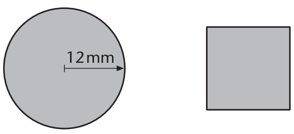
$a^0 = 1$ $(a \ne 0)$

$a^1 = a$

2.3 Read and write numbers in the standard form $A \times 10^n$, where n is a positive or negative integer and $1 \le A < 10$; interpret numbers in standard form on a calculator display; use standard form in calculations and to estimate.

2.4 Use the x^2, $\sqrt{x}$, x^y and $x^{1/y}$ keys of a scientific calculator, distinguishing between the root and the decimal approximation.

The diagram shows a circle with radius 12 mm and a square.



Not drawn accurately

The ratio of the area of the circle to the area of the square is approximately 2 : 1.
What is the area of the square to the nearest square millimetre?
What is the side length of the square?

2.5 Find the value of a square root or cube root to a given degree of accuracy using a calculator or spreadsheet. (See also standard NA 3.9.)

2.6 Use the four operations to solve problems involving whole numbers, decimals, money or measures.

The diameter of a red blood cell is 0.000 714 cm and the diameter of a white cell is 0.001 243 cm. Use a calculator to work out the difference between the diameter of a red blood cell and the diameter of a white cell. Give your answer in millimetres.

Calculations

Exclude tedious calculations when use of a calculator is not allowed.

2.7 Solve problems involving fractions, percentages, ratios and proportions.

What is 70 increased by 9%?
A. 70×0.9 B. 70×1.9 C. 70×0.09 D. 70×1.09

The table shows the land area of each of the world's continents.

Continent	Land area (in 1000 km^2)
Africa	30 264
Antarctica	13 209
Asia	44 250
Europe	9 907
North America	24 398
Oceania	8 534
South America	17 793
World	**148 355**

Which continent is approximately 12% of the world's land area?
What percentage of the world's land area is Antarctica?

About 30% of the world's area is land. The rest is water.
The amount of land in the world is about 150 million km^2.
What is the approximate total area (land and water) of the world?

Here are the labels from two pots of yoghurt.

Yoghurt A	125 g
Each 125 g provides	
Energy	430 kJ
Protein	4.5 g
Carbohydrates	11.1 g
Fat	4.5 g

Yoghurt B	150 g
Each 150 g provides	
Energy	339 kJ
Protein	6.6 g
Carbohydrates	13.1 g
Fat	0.2 g

A boy eats the same amount of yoghurt A and yoghurt B.
Which yoghurt provides him with more carbohydrate?

2.8 Calculate simple interest.

2.9 Check answers for accuracy and reasonableness, and round answers appropriately.

3 Write, simplify and evaluate algebraic expressions and formulae and solve equations

3.1 Expand expressions of the form $a(x \pm b)$, $(x + a)^2$, $(x - a)^2$, $(x + a)(x - a)$, $(x \pm a)(x \pm b)$, where a and b are positive or negative integers.

Algebraic expressions

Include use of the terms *coefficient, variable, constant, linear, quadratic.*

Multiply out and simplify these expressions.
$3(x - 2) - 2(4 - 3x)$
$(x + 2)(x + 3)$
$(x + 4)(x - 1)$
$(x - 2)^2$

3.2 Evaluate algebraic expressions and formulae for given integer values of the variables.

Find the values of a and b when p = 10.

$a = \frac{3p^3}{2}$ $\quad b = \frac{2p^2(p-3)}{7p}$

Evaluating expressions

Include evaluating quadratic and cubic expressions.

3.3 Factorise algebraic expressions:

- by removing common factors from expressions such as:
  $ax \pm ay$
  $ax + bx + ay + by$
- by recognising the factors of expressions such as:
  $a^2x^2 - b^2y^2$
  $x^2 \pm 2ax + a^2$

where *a* and *b* are positive or negative integers.

3.4 Add, subtract, multiply and divide algebraic fractions.

Simplify:

1. $\frac{3a}{4} \times \frac{5ab}{3}$ 2. $\frac{3a}{4} \div \frac{9a}{10}$ 3. $\frac{1}{x-2} + \frac{2}{x-3}$

Algebraic fractions

Include simple cases of linear algebraic denominators.

3.5 Change the subject of a simple formula.

Rearrange this equation to make e the subject.
$p = 2(e + f)$

Rearrange this equation to make R the subject.
$V = IR$

Changing the subject of a formula

Link to work on Ohm's law $V = IR$ in science.

3.6 Write and solve linear equations, including simple cases of fractional linear equations, and apply these skills to solving problems; verify the solution.

Solve:

1. $\frac{x}{3} + \frac{x-2}{4} = 3$ 2. $\frac{5}{x} = 10$ 3. $\frac{3}{x-2} = 6$

Linear equations

Include the forms

$a(bx + c) + d(ex + f) = gx$
$x/a + x/b = c$
$(x + a)/b + (x + c)/d = e$
$a/x = b$
$a/(x + b) = c$

where *a*, *b*, *c*, *d*, *e*, *f*, *g* are integers.

3.7 Write and solve simultaneous linear equations with two unknowns by elimination and by substitution, and apply these skills to solving problems; verify the solution. (See also standard NA 4.3.)

Solve these simultaneous equations to find the values of x and y.

$x + 8y = 48$
$4x + 4y = 52$

3.8 Solve quadratic equations of the form $a^2x^2 - b^2 = 0$ or $x^2 \pm 2ax + a^2 = 0$ by factorisation; verify the solutions by substituting in the original equation.

3.9 Find the approximate solutions of equations such as $x^3 + x = 20$ using ICT and trial and improvement methods. (See also standard NA 2.5.)

A rectangle has an area of 34 cm².
Its sides are x cm and (12 – x) cm, so that $x(12 - x) = 34$.
Between which numbers (to one decimal place) does x lie?
Use the table.

x	12 – *x*	Area
3	9	27

ICT opportunity

Use a spreadsheet or graphics calculator.

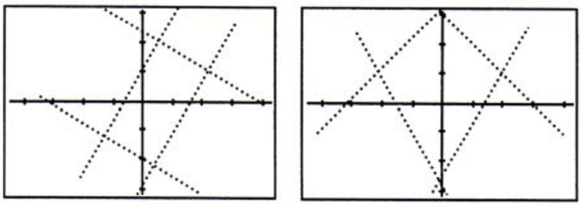
4 Plot and interpret graphs of functions

4.1 Use a graphics calculator and a function graph plotter to plot graphs.

4.2 Find the gradients of lines given by $y = mx + c$; understand the idea of slope; find the gradients of lines parallel and perpendicular to $y = mx + c$.

Write the equation of the straight line which goes through the point $(0, -1)$ *and is parallel to the straight line* $y = 3x$.

Use a graphics calculator to draw these quadrilaterals.

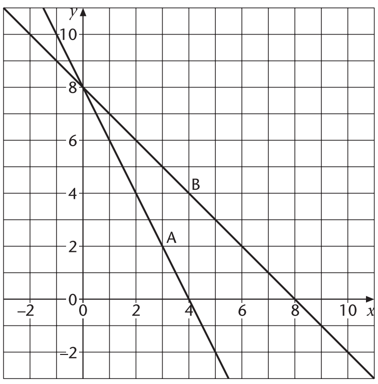


Gradient and slope

Link to work on ratio.

Use a graphics calculator or graph plotting software for plotting graphs of functions.

4.3 Use graphical methods to find the approximate solution of a pair of simultaneous linear equations with two unknowns, on paper and using ICT. (See also standard NA 3.7.)



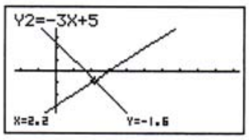
Look at this graph.

Show that the equation of line A is $y = 8 - 2x$.
Write the equation of line B.
On the graph, draw the line whose equation is $y = 2x + 1$. *Label this line C.*

Use the graph to find the approximate solution of these simultaneous equations.

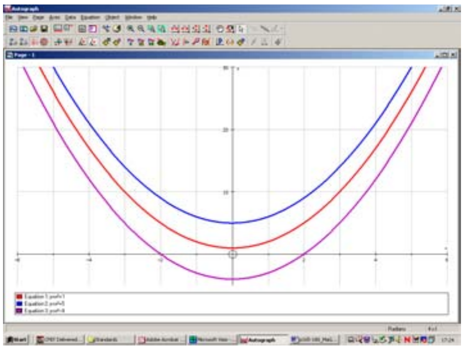
$y = 2x + 1$
$y = 8 - 2x$

ICT opportunity

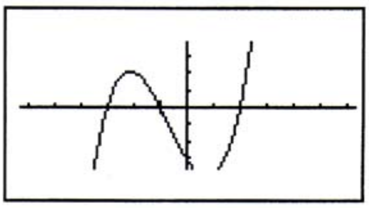


4.4 Generate points and plot graphs of simple quadratic and cubic functions, e.g. $y = 3x^2 + 4$, $y = x^2 - 2x + 1$; use graphical methods to find approximate solutions of quadratic equations, on paper and using ICT.

Create a display like this using a function graph plotter.

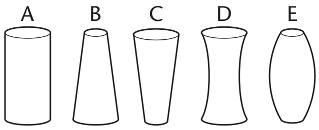


Find a possible equation for this curve.

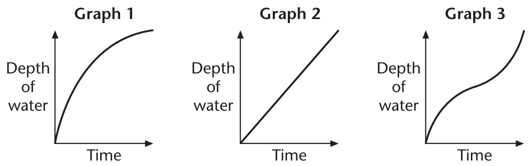


4.5 Sketch and interpret graphs of functions based on practical situations.

Water is poured at a constant rate into three of these five containers.



The graphs show the depth of water as the containers fill up.



Fill in the gaps below to show which container matches each graph.

Graph 1 matches container ....
Graph 2 matches container ....
Graph 3 matches container ....

Geometry and measures

By the end of Grade 9, students solve problems by identifying congruent or similar triangles and their corresponding angles or sides. They use their knowledge of angles and properties of 2-D shapes to deduce properties in a given plane figure. They use Cartesian coordinates to find the mid-point and length of a line segment, and the point that divides a line segment in a given ratio. They identify a single transformation mapping a shape onto its image, and enlarge shapes by a fractional scale factor, recognising the similarity of the resulting shape. They draw and use plans and elevations of 3-D objects. They solve simple problems in two dimensions by applying Pythagoras' theorem and finding the side or angle of a right-angled triangle using trigonometric ratios. They calculate areas of 2-D shapes related to circles and volumes and surface areas of right prisms and cylinders.

Students should:

5 Identify properties of and relationships in geometric shapes

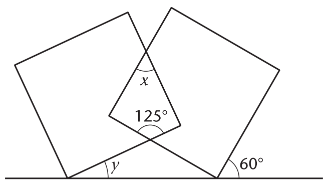
Use of ICT

Geometry is enhanced with use of a dynamic geometry system, or DGS, which provides an interactive means for investigating and hypothesising results that can then be proved.

Angles, shapes and geometric reasoning

5.1 Use knowledge of angles and properties of 2-D shapes to conjecture or deduce properties in a given plane figure.

The diagram shows two overlapping squares and a straight line.



Calculate the value of angle x and the value of angle y.

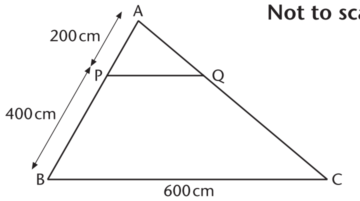
5.2 Find coordinates of points determined by geometric information; given the coordinates of A and B, find:

- the mid-point of line segment AB;

- the length of line segment AB;
- the point that divides line segment AB in a given ratio.

5.3 Identify similar triangles and their corresponding angles and sides.

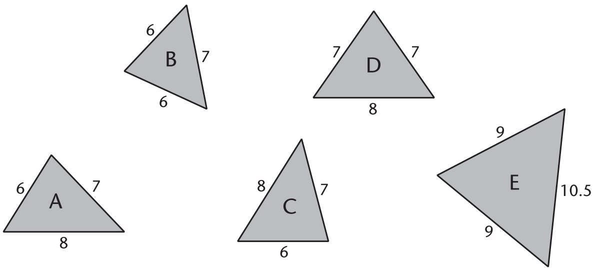
In the diagram, PQ is parallel to BC.



Calculate length PQ.

5.4 Identify congruent triangles and their corresponding angles and sides; know the conditions of congruence and determine whether two triangles are congruent.

The diagram shows five triangles. All lengths are in centimetres.



Write the letters of two triangles that are congruent to each other.
Explain how you know they are congruent.

Write the letters of two triangles that are mathematically similar to each other but not congruent. Explain how you know they are mathematically similar.

5.5 Use the properties of congruence or similarity of triangles to solve problems, e.g. find unknown sides or angles of similar or congruent triangles.

Congruence

Stress that the conditions of congruence are:

SSS
three corresponding sides

SAS
two sides and the included angle

ASA
two angles and the included side

RHS
right angle, hypotenuse, side

Transformations

5.6 Identify a single transformation mapping a 2-D shape onto its image: reflection, rotation, translation or enlargement by a positive integer scale factor; find a line of reflection, centre or angle of rotation, scale factor or centre of enlargement in simple cases.

5.7 Identify and draw, on paper and using ICT, the enlargement of a simple plane figure by a positive fractional scale factor; identify the scale factor as the ratio of two corresponding line segments.

Reema has a photograph that measures 21.25 cm by 13.75 cm.
She wants a smaller copy that will fit exactly in a 8.5 cm by 5.5 cm photograph frame.
What scale factor should she use to make the copy?

5.8 Use ICT to explore transformations.

Transformations

Include the terms *line of reflection (mirror line), angle and centre of rotation, centre of enlargement, scale factor*.

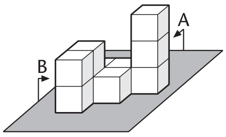
ICT opportunity

Transformations are best developed through the use of a dynamic geometry system (DGS).

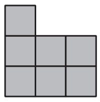
Constructions

5.9 Recognise 3-D objects from 2-D representations; draw the plan and elevation of a 3-D object from sketches and models; sketch or build a 3-D object given its plan and elevation.

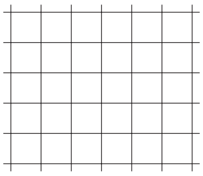
Here is a model made from 10 cubes.



From direction B, it looks like this.



On the grid, draw how the model looks from direction A.

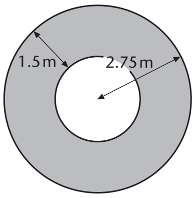


6 Solve problems involving area and volume

6.1 Find the area of plane shapes related to circles.

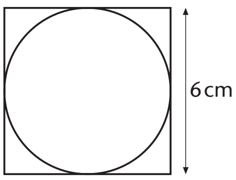
A very large round table has a radius of 2.75 metres.
Assume that to sit at the table one person needs 45 cm around the circumference.
Is it possible for 50 people to sit around the table?

Assume that people sitting around the table can reach 1.5 m.



Calculate the area of the table that can be reached.

The diagram shows a square and a circle. The circle touches the edges of the square.



What percentage of the diagram is shaded?

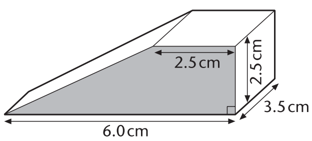
6.2 Find the volume and surface area of right prisms and cylinders and related solids.

Volume and surface area of prisms and cylinders

Use the formula that the volume is:

area of base × height

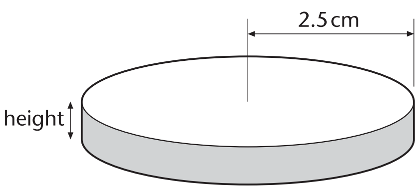
This door wedge is the shape of a prism.



Not to scale

The shaded face of the door wedge is a trapezium.
Calculate the volume of the door wedge.

A cylinder has a radius of 2.5 cm.
The volume of the cylinder is 4.5 cm^3.

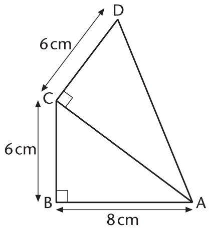


What is the height of the cylinder?

7 Solve problems involving right-angled triangles

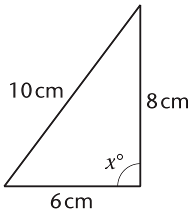
7.1 State and apply Pythagoras' theorem (not proof).

ABC and ACD are both right-angled triangles.



Explain why the length of AC is 10 cm.
Calculate the length of AD.

Look at this triangle.



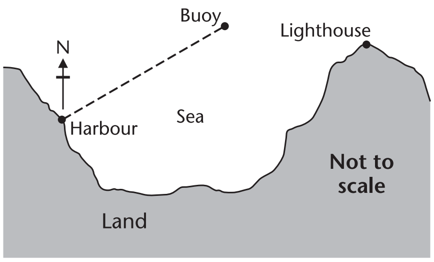
Explain why angle x ***must*** *be a right angle.*

Pythagoras' theorem

Include finding a side of a right-angled triangle, and using the relationship between the three sides of a triangle to show than an angle is a right angle.

7.2 Solve problems involving finding a side of a right-angled triangle.

A boat sails from the harbour to the buoy.
The buoy is 6 km to the east and 4 km to the north of the harbour.



Calculate the shortest distance between the buoy and the harbour.
Give your answer to one decimal place.

Right-angled triangle problems

Exclude angles expressed in degrees and minutes.

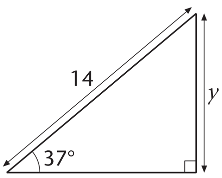
Exclude problems involving bearings or angles of elevation and depression.

7.3 Know the sine, cosine and tangent ratios for a right-angled triangle.

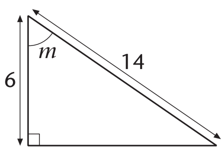
7.4 Use a scientific calculator to:

- find the values of trigonometric ratios;
- find an angle using the inverse trigonometric function keys.

Calculate the value of y.

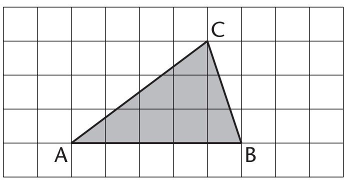


Calculate the value of angle m.



ABC is an isosceles triangle drawn on a square grid, with AC = AB.

Find the size of angle CAB.
Calculate angle ABC.



Trigonometric ratios

Exclude angles measured in radians.

Data handling

By the end of Grade 9, students solve problems by selecting, using and evaluating methods of collecting, organising, representing, analysing and interpreting data. They represent continuous data in frequency diagrams, choosing appropriate class intervals, on paper and using ICT. They calculate the mean, range and median of small sets of continuous data; they identify the modal class and estimate the mean, median and range for sets of grouped data, choosing the statistic that is most appropriate to their enquiry. They draw conclusions from scatter diagrams, have a basic understanding of correlation, and draw a line of best fit on a scatter diagram, by inspection. They know that if A and B are mutually exclusive, the probability of A or B is the sum of the probabilities of A and of B. They understand relative frequency as an estimate of probability and use this to compare outcomes of experiments. They compare experimental and theoretical probability in different contexts.

Students should:

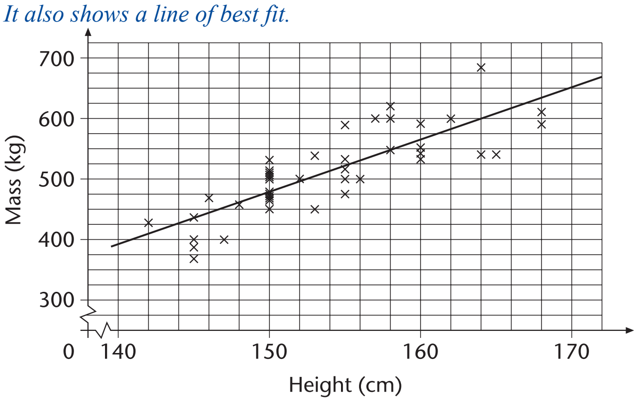
8 Collect, process, represent and interpret data and draw conclusions

Statistics

8.1 Identify questions or problems that can be answered or solved by collecting, organising, representing, analysing and interpreting data.

8.2 Construct and interpret scatter diagrams, and lines of best fit by eye, understanding what these represent.

The scatter diagram shows the heights and masses of some horses.
It also shows a line of best fit.



What does the scatter diagram show about the relationship between the height and mass of horses?

A horse has a mass of 625 kg. Use the line of best fit to estimate the height of the horse.

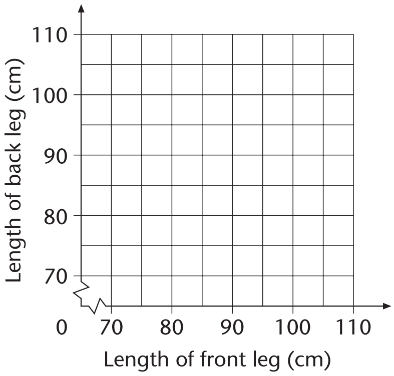
A teacher asks his class to investigate this statement: 'The length of the back leg of a horse is always less than the length of the front leg of a horse.'
What might a scatter graph look like if the statement is correct?
Use the axes below to show your answer.

Data handling and ICT

Data handling provides many opportunities to use ICT applications to present statistical tables and graphs. The Internet is an excellent source of real data of interest to students.

Scatter diagrams

Include the use of ICT, e.g. using a spreadsheet and graph drawing package.



8.3 Calculate the mean, range and median of small sets of discrete or continuous data; identify the modal class and estimate the mean, median and range for sets of grouped data.

The table shows the numbers of peas in a sample of 50 pea pods.

Number of peas in a pod	Number of pods
3	2
4	7
5	14
6	12
7	10
8	5

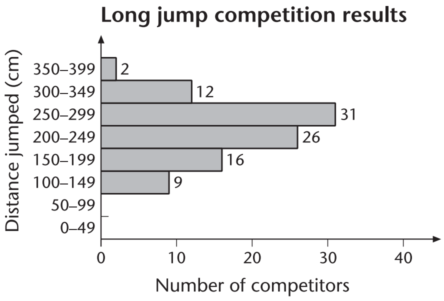
What is the mode for the number of peas in a pod in the sample?
What is the median number of peas in a pod in the sample?

Work out the mean number of peas in a pod in the sample.
Estimate the number of peas in 200 pods.
Explain how you made your estimate.

About how many pods out of 200 would you expect to have 3 or 4 peas?

8.4 Construct and interpret frequency diagrams, choosing appropriate equal class intervals.

Here are some long jump competition results, measured to the nearest centimetre.



Ahmed jumped 315 cm. He says: 'Only 2 people jumped further than me.'
Could Ahmed be correct? Circle YES or NO.
Explain your answer.

Tarik says: 'The median jump was 275 cm.'
Explain how the graph shows that Tarik is not correct.

Hussain collects information about how long the phone calls are in his house.
He makes a frequency table using class intervals of 30 seconds.
Here is part of the table.

Length of call in seconds	0–29	30–59	60–89	90–119	
Number of calls	3	25	35	19	

The longest call was 175 seconds.
Which class interval does this fit into?

Altogether Hussain recorded 91 calls.
Hussain makes a rough estimate that half the calls lasted less than 75 seconds.
Explain how he could make this estimate.

Probability

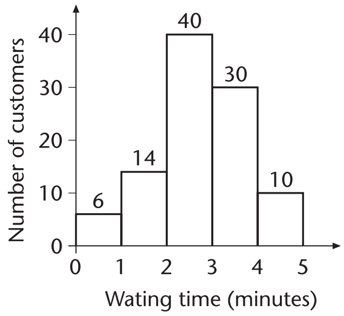
8.5 Use relative frequency as an estimate of probability and use this to compare outcomes of experiments.

Relative frequency

Include grouped data.

The manager records the waiting times of 100 customers at a supermarket checkout.

Results of survey of waiting time at checkout



Use the graph to estimate the probability that a customer chosen at random will:

- *wait for 2 minutes or longer;*
- *wait for 2.5 minutes or longer.*

The manager wants to improve the survey.
She records the waiting times of more customers.
Give a different way the manager could improve the survey.

8.6 Know that if A and B are mutually exclusive, the probability of A or B is the sum of the probabilities of A and of B.

A special dice has the numbers 1 to 6 on it.
It is biased so that a 6 or a 1 is less likely to come up than a 2, 3, 4 or 5.
The probability of rolling a 6 is 0.1.
The probability of rolling a 1 is 0.1.
The numbers 2, 3, 4 or 5 each have an equal probability of coming up.
Calculate the probability of rolling a 5 with this dice.

8.7 Compare experimental and theoretical probability in different contexts.

The manufacturers of a computer game claim that the probability of winning each game is 0.65.
Sara plays this game 200 times and wins 124 times.
She says: 'The manufacturers must be wrong.'
Do you agree with her? Circle YES or NO.
Explain your reasons.

Some students threw three fair dice, each numbered from 1 to 6.
They recorded how many times the numbers on the dice were the same.

Name	Number of throws	Results		
		all different	2 the same	all the same
Masood	40	26	12	2
Saleh	140	81	56	3
Walid	20	10	10	0
Ali	100	54	42	4

Which student's data are most likely to give the best estimate of the probability of getting each result? Explain your answer.

The next table shows all the students' results collected together. Use these data to estimate the probability of throwing three different numbers.

Number of throws	Results		
	all different	2 the same	all the same
300	171	120	9

The theoretical probability of each result is shown below:

	all different	2 the same	all the same
Probability	$\frac{5}{9}$	$\frac{5}{12}$	$\frac{1}{36}$

Use the theoretical probabilities to calculate, for 300 throws, how many times you would expect to get each result.

Number of throws	Theoretical results		
	all different	2 the same	all the same
300	....	....	....

Explain why the students' experimental results are not the same as the theoretical results.