

Mathematics Standard Year 11

Algebra Topic Guidance

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# Topic focus

*Algebra* involves the use of symbols to represent numbers or quantities and to express relationships, using mathematical models and applications.

Knowledge of algebra enables the modelling of a problem conceptually so that it is simpler to solve.

The study of algebra is important in developing students’ reasoning skills and logical thought processes, as well as their ability to represent and solve problems.

# Prior learning

The material in this topic builds on content from the Number and Algebra Strand of the K–10 Mathematics syllabus, including the Stage 5.2 substrands of Equations and Linear Relationships.

# Terminology

|  |  |  |
| --- | --- | --- |
| algebraic expression  axis  blood alcohol content (BAC)  braking distance  changing the subject  Clark’s formula  concentration  constant  constant of variation  conversion graph  dependent variable  direct variation  dosage | dosage strength  equation  evaluate  formulae  Fried’s formula  gradient  independent variable  intercept  linear  linear function  linear model  linear relationships | medication  non-linear  origin  pronumeral  solution  solve  standard drink  stopping distance  straight-line graph  subject of a formula  substitution  Young’s formula |

# Use of technology

Suitable graphing software may be used in investigating the similarities and differences between the graphs of a variety of linear and non-linear expressions. Alternatively, students may use a spreadsheet to generate a table of values and produce the associated graph.

The internet may be used as a source of up-to-date information on the effects of blood alcohol content and medication dosages.

Students will require access to appropriate technology to create graphs of functions used in investigating the similarities and differences between the graphs of a variety of linear relationships and to observe the effect on the graph of a function when the value of a constant is changed.

# Background information

There is evidence that algebra was used in ancient Egypt to solve linear equations with one unknown quantity.

The prolific use of as the unknown variable in algebra has been attributed to René Descartes who, in his 1637 treatise *La Géométrie*, used letters from the beginning of the alphabet to represent known quantities and those from the end to represent unknown quantities. The choice of over may have been due to the practical issue of typographical fonts available at the time.

The ability of mankind to visualise and manipulate abstract symbols in the mind has enabled us to create new relationships and produce new concepts. With algebra, we have a method of representing problems, methods and processes in an abstract form. Without algebra, the technology we have today would not exist.

# General comments

Algebraic skills should be developed through a range of practical contexts.

When evaluating expressions, there should be an explicit direction to replace the pronumeral with the number to ensure a full understanding of notation occurrences.

Students can develop an understanding of a function as: input, processing, output. Some students may appreciate a more formal definition of a function.

Using the equation of the straight line as ensures consistency across all mathematics courses and contexts.

# Future study

The solution of equations is extended to include simultaneous equations in the Year 12 Mathematics Standard courses. In Mathematics Standard 1, students will further explore the graphs that represent practical situations. In Mathematics Standard 2, students will use exponential, quadratic and reciprocal functions to model practical situations and solve real-life problems.

# Subtopics

* MS-A1: Formulae and Equations
* MS-A2: Linear Relationships Paperclip icon

## MS-A1: Formulae and Equations

### Subtopic focus

The principal focus of this subtopic is to provide a solid foundation in algebraic skills, including for example finding solutions to a variety of equations in work-related and everyday contexts.

Students develop awareness of the applicability of algebra in their approach to everyday life.

Within this subtopic, schools have the opportunity to identify areas of Stage 5 content which may need to be reviewed to meet the needs of students.

### Considerations and teaching strategies

* Substitution into expressions should include substitution into expressions containing multiple variables, positive and negative values, powers and square roots.
* Examples of algebraic expressions for substitution of numerical values should include expressions such as:   
  , , , ,
* Emphasis should be placed on evaluating the subject of formulae.
* Changing the subject of a formula should be limited to linear formulae.
* Appropriate formulae should be selected from practical contexts including, but not limited to, formulae students will encounter in other topics, for example, if , find given
* Use formulae to solve a range of problems related to the safe operation of motor vehicles:
* The average speed of a journey is calculated using the formula:



* Stopping distance can be calculated using the formula:

* Reaction time is the time period from when a driver decides to brake to when the driver first commences braking.
* Investigate the meaning of a ‘standard drink’.
* Blood Alcohol Content (BAC) is the measure of alcohol concentration in the bloodstream. It is measured in grams of alcohol per 100 millilitres of blood. A BAC of 0.02 means that there are 0.02 grams (20 milligrams) of alcohol in every 100 millilitres of blood.
* Discuss why blood alcohol content (BAC) is a function of body weight and other factors (or variables) that affect BAC including gender, fitness, health and liver function.
* Discuss the limitations to the estimation of BAC, including that the formulae are based on average values and will not apply equally to everyone.
* Zero BAC is an important consideration for young drivers in NSW, as the state’s laws require a zero BAC limit for all learner and provisional drivers.
* Use formulae in a range of calculations related to child and adult medication and apply various formulae in the solution of practical problems.
* Examples of dosage panels from over-the-counter medications should be examined.
* Students should develop a clear understanding of formulae used to calculate required dosages for children and the variables included in the various formulae:

Fried’s Formula:

Young’s Formula:

Clark’s Formula:

### Suggested applications and exemplar questions

Students could:

* use formulae such as those below to find the values of pronumerals following substitution:

|  |  |  |
| --- | --- | --- |
|  |  |  |

* investigate and make comparisons of legal blood alcohol limits in different countries.
* investigate stopping distances for different speeds, road conditions, and weather conditions.
* investigate the safety aspects of stopping distances in relation to speed limits, for example, calculate by formulae the difference in stopping distance if travelling 5 km/h over the speed limit
* make calculations from dosage panels, including the amount per dose and the frequency of dosage.
* calculate dosages for different medication types, eg oral medication in liquid or tablet form.

*Example for medication in liquid form*

* A patient is prescribed 1000 mg of a mild painkiller. The medication available contains 100 mg in 5 mL. How much medication should be given to the patient?

*Solution 1(using a formula)*:

*Solution 2 (using a ratio approach)*:

*Example for medication in tablet form*

* A patient is prescribed 750 mg of a medication. Tablets, each of 500 mg, are available. How many tablets should be given?

*Solution*:

## MS-A2: Linear Relationships Paperclip icon

### Subtopic focus

The principal focus of this subtopic is the graphing and interpretation of practical linear and direct variation relationships.

Students develop fluency in the graphical approach to linear modelling and its representativeness in common facets of their life.

Within this subtopic, schools have the opportunity to identify areas of Stage 5 content which may need to be reviewed to meet the needs of students.

### Considerations and teaching strategies

* Students determine the gradient (or slope) of a straight line by forming a right-angled triangle.
* Graphs of straight lines in the form could be sketched by first constructing a table of values.
* Students use graphing technology to graph a straight line and then observe the effects of changing values of and . Later, the graph of could be drawn after first recognising and recording the important features.
* Students recognise the limitations of linear models in practical contexts, for example a person’s height as a function of age may be approximated by a straight line for a limited number of years. Students should be aware that models may apply only over a particular domain.
* Graphing technology can be used to construct graphical representations of algebraic expressions.
* Students develop a linear graph of the form from a description of a situation in which one quantity varies directly with another and use this graph to establish the value of (the gradient).
* The formula for converting degrees Celsius to degrees Fahrenheit could be graphed, along with the formula arising from the ‘rule of thumb’: double and add 30°. This question could also be investigated using a spreadsheet and/or a graphing technology.
* Students solve problems related to a given variation context and interpret linear functions as models of physical phenomena, including understanding the meaning of the gradient and the −intercept in various practical contexts

### Suggested applications and exemplar questions

* Students may test theories about how large or small the right-angled triangle should be to determine the gradient of a straight line. The sign of the gradient should be determined as positive or negative by inspecting whether it is ‘uphill’ or ‘downhill’ when looking from left to right.
* Students may investigate the question: Does the approximation method ‘Double and add 30° ’ for converting from degrees Celsius to degrees Fahrenheit always give an answer close to the correct answer?
* Given the graph of life expectancy over time, students calculate the gradient. Explain the meaning of the gradient in this context.
* Which of the following is the graph of ?

There are four number planes labelled A, B, C and D. Each one illustrates a line.

For A: the line passes through -1 on the x-axis and -2 on the y-axis.

For B: the line passes through -2 on the x-axis and 2 on the y-axis.

For C: the line passes through -2 on the x-axis and -1 on the y-axis.

For D: the line passes through 1 on the x-axis and -2 on the y-axis.


* The weight of an object on the moon varies directly with its weight on Earth. An astronaut who weighs 84 kg on Earth weighs only 14 kg on the moon. A lunar landing craft weighs 2449 kg when on the moon. Calculate the weight of this landing craft when on Earth.