# Graphs: formulas and variables

|  |  |
| --- | --- |
| Year level  Strand(s)  Lesson length  CD Code | 7 / 8  Algebra/Number  60 mins  [AC9M7A06](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7A06&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick), [AC9M7N09](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7N09&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick), [AC9M8A02](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/content-description?subject-identifier=MATMATY8&content-description-code=AC9M8A02&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick) |
| Lesson summary | In this lesson, students use algebra and linear equations to model two real-world scenarios to find information to make the best choice. Students set the aim of saving for a mobile phone (or similar goal) and use linear equations to model the pay rates of two part-time jobs to help make the better decision. This lesson follows Patterns, rules and graphs, though it can also be taught in isolation. |
| Learning intention | Students can:  describe the effect of varying the values of variables in linear equations to determine the better job offer  manipulate formulas using spreadsheet software. |
| Success criteria | By the end of this lesson, students:  are confident using linear equations to represent real-world scenarios to make decisions  successfully use spreadsheet software to aid modelling, recognise patterns, and understand the effect of manipulation of linear equations on outcomes. |
| Why are we learning about this? | When we uncover efficient and accurate ways to solve real-world problems that affect us – like choosing between two similar objects, things or scenarios – we can find the better option, make timely predictions, find patterns and relationships, and understand the effect of one variable on another. |
| Prerequisite student knowledge and language | Students:   * identify the gradient and initial value of a linear rule * create and identifies algebraic equations from word problems involving one or more operations * identify and justifies equivalent algebraic expressions * interpret a table of values to plot points on a graph * analyse and visualise data using a range of digital tools to identify patterns and make predictions * select and use the core features of digital tools to efficiently complete tasks.   Definitions for linear function, linear equation, linear expression, growing patterns and the Cartesian plane can be found at [Version 9 mathematics glossary](https://v9.australiancurriculum.edu.au/downloads/learning-areas#accordion-b71b085f07-item-f1428171c5). |
| Resources | Teacher’s slides (PowerPoint)  Exit ticket (PDF) |

Curriculum information

|  |  |
| --- | --- |
| Achievement standard | [Students use mathematical modelling to solve practical problems involving rational numbers, percentages and ratios, in financial and other applied contexts, justifying choices of representation.](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10?view=quick&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0)  [Students make and test conjectures involving linear relations using digital tools.](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10?view=quick&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0) |
| Content description(s) | Students manipulate formulas involving several variables using digital tools, and describe the effect of systematic variation in the values of the variables. [AC9M7A06](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7A06&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)  Students use mathematical modelling to solve practical problems, involving rational numbers and percentages, including financial contexts; formulate problems, choosing representations and efficient calculation strategies, using digital tools as appropriate; interpret and communicate solutions in terms of the situation, justifying choices made about the representation. [AC9M7N09](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7N09&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)  Students graph linear relations on the Cartesian plane using digital tools where appropriate; solve linear equations and one-variable inequalities using graphical and algebraic techniques; verify solutions by substitution. [AC9M8A02](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/content-description?subject-identifier=MATMATY8&content-description-code=AC9M8A02&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick) |
| General capabilities  Cross-curriculum priority | **General capabilities**  Numeracy   * number patterns and algebraic thinking ([PL8](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A06&general-capability-code=N&element-code=NN&sub-element-index=0&sub-element-code=NNNPA&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * additive strategies ([PL10](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=N&element-code=NN&sub-element-index=0&sub-element-code=NNAdS&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * interpreting fractions ([PL8](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=N&element-code=NN&sub-element-index=1&sub-element-code=NNInF&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * multiplicative strategies ([PL9](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=N&element-code=NN&sub-element-index=2&sub-element-code=NNMuS&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * proportional thinking ([PL2](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=N&element-code=NN&sub-element-index=3&sub-element-code=NNPrT&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * understanding money ([P7](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY8&content-description-code=AC9M8A02&general-capability-code=N&element-code=NN&sub-element-index=0&sub-element-code=NNNPA&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick), [P8](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=N&element-code=NN&sub-element-index=4&sub-element-code=NNUnM&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick))   Critical and Creative Thinking   * draw conclusions and provide reasons ([PL5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A06&general-capability-code=CCT&element-code=CCTANA&sub-element-index=0&sub-element-code=CCTANAB&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * interpret concepts and problems ([PL5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=CCT&element-code=CCTANA&sub-element-index=0&sub-element-code=CCTANAA&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * draw conclusions and provide reasons ([PL5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7N09&general-capability-code=CCT&element-code=CCTANA&sub-element-index=1&sub-element-code=CCTANAB&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * create possibilities ([PL5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A06&general-capability-code=CCT&element-code=CCTGEN&sub-element-index=0&sub-element-code=CCTGENA&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick))   Digital Literacy   * create, communicate and collaborate ([P5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A06&general-capability-code=DL&element-code=DLC&sub-element-index=0&sub-element-code=DLCB&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * interpret data ([P5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A06&general-capability-code=DL&element-code=DLI&sub-element-index=0&sub-element-code=DLIC&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * select and operate tools ([P5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A06&general-capability-code=DL&element-code=DLMO&sub-element-index=0&sub-element-code=DLMOC&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick))   Related content  Economics and business: [AC9HE7K04](https://v9.australiancurriculum.edu.au/f-10-curriculum.html/learning-areas/economics-and-business-7-10/year-7/content-description?subject-identifier=HASECOY7&content-description-code=AC9HE7K04&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick) |
| Areas of challenge | Some students may:  feel overwhelmed by the problem and have difficulty starting  be unable to define the variables and question and consider what needs to be considered  define the goal to answer the question ‘how much a phone would cost?’ to find a solution to the problem.  It is recommended to guide students to breakdown the problem into smaller parts. Use questioning to help identify what they know and what they don’t know. The lesson encourages students to use tables and/or spreadsheets to help students make sense of the relationship between variables and to also recognise patterns.  Some students may:  not understand coordinate pairs correctly in relation to a linear rule and that *x* represents any input number, and *y* is the output; students may also confuse which figure to plug in  not understand the concept behind linear relationships and that the rule represents a rate of change  forget the meaning of c as a constant and that it represents the y intercept, and that y can be 0  find solving for unknowns, substituting or rearranging equations difficult.  Use the skill check to help identify calculation errors that students make. Identify any misconceptions and use graphing tools and digital platforms to help students visualise coordinates. Make small changes to show how they relate to the change in ‘rate’ when visualising the relationship. |
| Strategies | [Mathematics investigation](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/mathematics-investigation/)  [Classroom talks](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/classroom-talks/)  [Questioning](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/questioning/)  [Explicit teaching](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/explicit-teaching/) |

Lesson structure

|  |  |
| --- | --- |
| Lesson hook  5–10 mins | Note that the lesson plan Patterns, rules and graphs is the precursor to this lesson and sets up the scaffolding neatly. However, both lessons can be used as a standalone. Use the teacher’s slides with accompanying teaching notes to complement your lesson.  **Learning hook**   * Introduce the learning intention and success criteria for students and prepares students to tap into what they already know about the topic of algebra, linear relationships and number sense (slide 2). * Draw students in with the lesson hook (slide 3), which is exploring part-time job options to save for a phone. Feel free to use a different ‘want/goal’ to suit your class or take a tally in an earlier lesson and choose the common theme – then surprise them with this lesson.   **Skill check**  Take students through a skill check required to progress through this lesson (slide 4). Challenges or misconceptions students may hold are listed in the teaching notes specific to these questions. This slide also continues with the context of using geometric figures to create linear rules, which was the theme from the lesson Patterns, rules and graphs. Suggestions for specific support and extension are also given. |
| Explore  40 mins | * Introduce the main lesson (slide 6). Students are asked to choose between two jobs that offer different pay rates to save for a new phone (or any other object or goal of your choosing). This context is quite abstract for students at this age and given this, students are guided progressively through the mathematical-modelling process for this lesson. * Ask students to consider the notion of building dollars. Students define the variables and consider the information required to graph the rules. Specific notes on possible challenges for students in this investigation are given in slide 7.   **Differentiation** (expanding):If student/s are able to work independently on the problem without the scaffolded slides, use the information, ideas and prompts suggested in the teaching notes in the slides to question students as they work through the problem, but note that the intent behind the slides is to embed various skills needed for algebra, pattern recognition, understanding the linear relationship between abstract elements, tabling and graphing, and investigating ways to approach a real-world problem. Ensure your students are still meeting the success criteria of the lesson itself.   * Show students how they can use spreadsheets and the functionality of spreadsheet programs to help investigate the context and to show that by making comparisons in an efficient manner (digital) deeper connections to the algebra and linear equations are made. Note that students can draw up their own tables of values and undertake calculations by hand (slide 8). * Provides a series of prompt questions to help students reflect on the lesson thus far and prime thinking for the next part. Allow sufficient time for students to answer the questions and discuss answers as a class (slide 9). * Touch on financial literacy and policy: minimum wage. Students are shown the government’s [‘fairwork’ online calculator](https://calculate.fairwork.gov.au/). Have students think about this for when they will begin to earn money. You may even pose a question to think about: if you lived by yourself, could you live off this wage? (slides 10–11) * Explain to students that they have five new linear rules to consider. It should be obvious that the highest hourly rate will earn the most money. Explain it is a bit trickier to try to determine how much extra money you could make if you were applying the original goal of saving for an expensive phone. * Students have three more tasks. Ask students to create a new spreadsheet for each new rule and input the new hourly rate. Have students work out the hours of work it would take to reach their goal savings. Explain that it is likely, in their first job, they will work various hours (weekends, public holidays and so on). Task students with creating three new and differentwork schedules that would earn you enough money to buy the new phone. |
| Summary and reflection  10 mins | Bring up the learning intention and success criteria (slide 2) from the beginning of the lesson.   * Ask students to give a fist-to-five signal as to whether they have met the learning intention they initially selected and noted in their exercise books earlier, so you get an idea on how the lesson went. * Now ask students to write down the aspects of the lesson they were happy with and specifically the parts of the lesson they had trouble with. * Ask them to add any additional ‘feedback’ they might have to you as the teacher. These might be about using technology, arithmetic or finding the variables in a real-world problem. * For capable students who perhaps cruised through the lesson, ask them to complete the ‘spicy’ question in the exit ticket, and to re-reflect on any difficulties encountered (slide 12). |
| Assessment | The following formative assessment is suggested for this lesson.  Students complete the Exit ticket (either in the remainder of the class or as homework) on finding the linear rule that converts Celsius temperature to Fahrenheit. A milder version is also given, which is to provide the rule and then to practise substituting in values to make the connection between the two temperature scales. |