 Year 12 Mathematics Standard 1

This document references the [Mathematics Standard Stage 6 Syllabus](https://syllabus.nesa.nsw.edu.au/mathematics-standard-stage6/) © 2017 [NSW Education Standards Authority (NESA)](http://syllabus.nesa.nsw.edu.au/copyright/) for and on behalf of the Crown in right of the State of New South Wales.

Unit title

Rates (MS-M4)

Duration

Approximately 5 hours

Rationale

Mathematics Standard 1 is designed to help students improve their numeracy by building their confidence and success in making mathematics meaningful. Numeracy is more than being able to operate with numbers. It requires mathematical knowledge and understanding, mathematical problem-solving skills and literacy skills, as well as positive attitudes. When students become numerate, they are able to manage a situation or solve a problem in real contexts, such as everyday life, work or further learning. This course offers students the opportunity to prepare for post-school options of employment or further training.

Topic focus

The principal focus of this subtopic is the use of rates to solve problems in practical contexts.

Students develop awareness of the use of rates and solve problems in everyday situations such as health sciences, travel and finance.

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.

Prior knowledge required

* Selects and uses the appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length (MA3-9MG)
* Converts between units of time: hours, minutes, seconds
* Converts between units of capacity and weight

Language considerations

The use of the word 'per', meaning 'for every', in rates should be made explicit to students. When solving ratio and rate problems, students should be encouraged to write a few key words on the left-hand side of the equals sign to identify what is being found in each step of their working, and to conclude with a statement in words. When describing distance/time graphs (travel graphs), supply a modelled story and graph first, or jointly construct a story with students before independent work is required. When constructing stories and interpreting distance/time graphs, students can use present tense, 'The man travels …', or past tense, 'The man travelled …'. Students should be aware that 'gradient' may be referred to as 'slope' in some contexts.

Students should be able to communicate using the following language: length, distance, kilometre, metre, centimetre, and millimetre.

When describing everyday examples involving proportion, teachers should model common words and language structures before independent work is required. For example:

* As the speed increases, the time taken to travel a particular distance decreases.
* The greater the speed, the less time is taken to travel a particular distance.
* The time taken to travel a particular distance is reduced when the speed is increased. (Mathematics K–10 Syllabus, page 27)

Outcomes

A student:

* MS1-12-3 interprets the results of measurements and calculations and makes judgements about their reasonableness
* MS1-12-9 chooses and uses appropriate technology effectively and recognises appropriate times for such use
* MS1-12-10 uses mathematical argument and reasoning to evaluate conclusions, communicating a position clearly to others

Assessment (including formative and summative)

Some strategies for formative assessment could include:

* Reflecting on students’ responses to a class discussion
* Beginning the lesson with a few questions on content from previous lessons before progressing
* Having students write their own questions on a topic or having them write a specific number of questions with the same answer
* [3-2-1 Exit slips](http://www.theteachertoolkit.com/index.php/tool/3-2-1)
* [Chalk Talk Routine](http://www.santeesd.net/cms/lib/CA01000468/Centricity/Domain/12/VT_ChalkTalk.pdf)
* [Red, Yellow, Green Cups](http://www.sstr2.org/Downloads/Cups%20as%20student%20feedback.pdf); students could also indicate beside the questions their level of understanding using the letters, R, Y or G.
* [Mindmaps](https://emedia.rmit.edu.au/learninglab/content/how-create-mind-map)

Summative assessment:

* Measurement Topic Assessment task
  + An assignment based on students using the knowledge, understanding and skills they have developed in this topic to solve problems involving rates in practical contexts.
* [Party planning activity](http://www.brighthubeducation.com/middle-school-math-lessons/128522-unit-rate-party-planning/)
  + Another option is an investigative task where students could plan a party given a $500 budget. They must use unit pricing to make informed choices to maximise their spending power, such as for food, drinks, chair and table hire, venue hire, and DJ.

| Content | Teaching and learning strategies and evidence of learning | Resources |
| --- | --- | --- |
| Use, simplify and convert between units of rates. For example, km/h and m/s, mL/min and L/h. (ACMEM071, ACMEM072) | Teachers could give a pre-test to revise converting units of length, time, weight and capacity.  Students are given the definitions:   * Rate is a comparison between two different quantities, such as distance/time, cost/weight, or capacity/time. * Unit rate is a rate where the second quantity is listed as one unit, such as 60km/h, $3.50/kg, or 55mL/min.   Some examples of where rates are used in everyday life:   * Car speed 60km/h * Price of food $5/kg * Heart rate 75 beats/min * Fuel consumption 11.2L/100km * Tradesperson rates $110/h * Fertiliser 100mL/m2   Students follow examples of how to convert rates, such as:   1. 60km/h to m/s 2. 150mL/min to L/h 3. 10m/s to km/h   Note – It is not advised that students learn a rule to convert a particular type of rate, such as converting km/h to m/s by multiplying by . Rather, students should understand how to convert each unit to the desired unit.  Students will then use rates to solve simple problems, such as:   * Laura wants to reseed her lawn with grass seed. Her lawn is 15 metres by 18 metres. She wants to buy packets of grass seed. The information on the packet states “one packet covers 6 square metres of lawn". Each packet costs $7.50. How much will it cost to completely cover her lawn in grass seed? | [Converting between units](https://mathslinks.net/faculty/mathematics-general-2-unit-conversion-summary)  [Introduction to rates and ratios](https://www.scu.edu.au/media/scueduau/current-students/study-resources/numeracy/Rates-and-Ratios.pdf) (Southern Cross University)   * This resource (pages 4 to 7) lists the definition of a rate, examples of rates in everyday life and step by step examples of how to convert rates. It contains links to videos explaining the concepts. * Answers to the questions start on page 24. |
| Use rates to solve practical problems AAM   * Use rates to make comparisons, such as using unit prices to compare best buys, or comparing heart rates after exercise (ACMEM016, ACMEM074) | Students are given an example of how unit rates can be used to make comparisons.  Students need to understand the value in unit pricing and have opportunities to use unit pricing to inform their decision-making around spending money.  Students work through examples of using rates to determine best buys.  Students could use a supermarket website to choose a product and use unit pricing to determine the best buy.  Students should also complete an investigation to show the effect of exercise on heart rate. | [Comparing rates example](https://www.khanacademy.org/math/pre-algebra/pre-algebra-ratios-rates/pre-algebra-rates/v/practice-computing-and-comparing-rates)  [Aldi, Coles or Woolworths? Getting the best deal for your groceries has never been harder](http://gomaths.net/4582)   * An article about best buy and how supermarkets are making it difficult to compare.   [Unit pricing](https://www.youtube.com/watch?v=sYbTBVDNHYE) (ACCC)  [Grocery unit prices](http://www.accc.gov.au/consumers/shopping-for-groceries/grocery-unit-prices) (ACCC)  [The unit rate jam](https://www.youtube.com/watch?v=l1JY3p-1BlQ)  [Introduction to rates and ratios](https://www.scu.edu.au/media/scueduau/current-students/study-resources/numeracy/Rates-and-Ratios.pdf) (Southern Cross University)   * Go to pages 8 to 10 in the PDF to work through ‘Calculations based on rates’. * Answers to questions for this topic start on page 26   Supermarket websites:   * [Woolworths](https://www.woolworths.com.au) * [Coles](https://www.coles.com.au) * [Aldi](https://www.aldi.com.au)   [Heart rate activity](https://mathsclass.net/comments/heart-rate-activity) (MathsLinks)  [Heart rate](http://www.nuffieldfoundation.org/sites/default/files/fsma-heart-rate-student-10996.pdf) (Nuffield Free-Standing Mathematics Activity) |
| * Use rates to determine costs, such as calculating the cost of a trade professional using rates per hour and call-out fees (ACMEM075) | Students investigate the cost of different trade professionals, such as a plumber, carpenter, electrician, or mechanic.  Read article on how tradespeople calculate their hourly rate.  Choose three trades to investigate using the pricing guides.  For each trade find three local tradespeople and compare their prices.  Students complete an exercise comparing the cost of fixing a furnace based on service fees and labour costs. As part of this activity, students will be required to construct equations and graph them to solve problems. | [Cost of hiring tradespeople in NSW increasing, with plumbers most pricey](http://www.smh.com.au/business/consumer-affairs/cost-of-hiring-tradespeople-in-nsw-increasing-with-plumbers-most-pricey-20170123-gtwzdp.html)  [How to price your building work competitively and still earn money](https://www.yourtradebase.com/blog/price-building-work-competitively-still-earn-money/) (Your Trade Base)  [Pricing Guides](https://www.serviceseeking.com.au/blog/pricing-guides/) (serviceseeking.com.au)  [Fixing the Furnace](https://www.illustrativemathematics.org/content-standards/tasks/472) (Illustrative Mathematics) |
| * Work with speed as a rate, including interpreting distance time graphs (travel graphs) and use them to solve problems related to speed, distance and time | Students should use speed rates to perform calculations including finding distance, time and average speed of a trip. Teacher may generate a worksheet at the appropriate level for their class.  Students complete a discussion activity on distance-time graphs.  Students complete an exercise matching a distance-time graph with a scenario.  Students complete worksheet interpreting distance-time graphs.  In pairs, students write a scenario and ask their partner to draw the appropriate distance-time graph. | [Speed, time and distance problems worksheets](http://www.homeschoolmath.net/worksheets/speed_time_distance.php)  [Distance-time graphs (TES)](https://www.tes.com/teaching-resource/distance-time-graphs-6126229?theme=3)   * Note – A Google account will be required to login to TES to access their resources.   [Distance Time Graphs Powerpoint (TES)](https://www.tes.com/teaching-resource/ks3-distance-time-graphs-powerpoint-6207394?theme=4)   * Note – A Google account will be required to login to TES to access their resources.   [Distance Time Graphs](http://www.3minutemaths.co.uk/wp-content/uploads/2014/05/69_distance-time-graphs.pdf) |
| * Calculate the amount of fuel used on a trip, given the fuel consumption rate, and compare fuel consumption statistics for various vehicles | Class discussion about why consideration of fuel economy is important. Consider environmental/sustainability factors.  Students should be made aware of online tools available to calculate cost of fuel for a trip.  Students could use this website to compare the fuel economy of different types of vehicles for a trip of their choosing.  Compare fuel efficiency of cars using their fuel consumption rate.  Extension – Class discussion about the decision-making process involved in buying a car. Brainstorm factors which may affect your choice of car, such as:   * Initial cost of car (new versus second-hand) * Running costs (fuel economy and insurance costs for different types of cars) * Use of car (urban driving, highway driving, tradespeople)   Students should then perform calculations to calculate the amount of fuel used for a trip given the fuel consumption rates. For example:   * Benji is planning a 2000 kilometre driving trip, traveling with four friends. The car’s fuel consumption rate is 9.6L/100km. Petrol costs $1.43 per litre. If they split the cost of petrol for the trip evenly, how much will Benji pay for petrol?  1. Calculate the total number of litres of petrol for the trip? 2. How much will it cost to buy 180 litres of petrol? 3. How much will Benji pay? Give you answer to the nearest cent. | [Why is fuel economy so important?](https://www.comparethemarket.com.au/car-insurance/guides/fuel-economy-important/)  [Estimating the cost of fuel for a trip](https://www.racq.com.au/cars-and-driving/cars/owning-and-maintaining-a-car/fuel-saving-tips/estimating-the-cost-of-fuel-for-a-trip)  [Petrol Cost Calculator](http://www.petrolcostcalculator.com.au/index.php?fldlitresper100km=0.00)  [Road Trip Fuel Cost Calculator](https://www.travellers-autobarn.com.au/backpacker-van-and-car-sales/fuel-calculator/)  [Fuel and Trip Calculator](https://www.bayswatercarrental.com.au/fuel-calculator)  [Green Vehicle Guide](https://www.greenvehicleguide.gov.au/)  [Fuel efficiency comparison testing](https://www.choice.com.au/transport/cars/general/articles/fuel-consumption-testing#table) |
| Solve problems involving heart rates and blood pressure AAM   * Describe heart rate as a rate expressed in beats per minute * Measure and graph a person’s heart rate over time under different conditions and identify mathematical trends * Calculate target heart rate ranges during training * Express blood pressure using measures of systolic pressure and diastolic pressure * Measure blood pressure over time and under different conditions * Use a blood pressure chart and interpret the ‘healthiness’ of a reading | Explain to students how to find their pulse. Ask students to take their pulse for 10 seconds. Convert this to beats per minute. This is your resting heart rate.  Each student completes an activity to graph their heart rate over time under different conditions.  Students could complete a graph by hand on a worksheet provided or use an online graphing tool to draw their graphs. Consideration should be given to the use of appropriate scales for graphing heart rates.  Compare the graphs of each student and identify any trends in the graphs. Discuss trends.  Students should be made aware of online tools available to calculate target heart rates. Students calculate their own target heart rate.  Target heart rates are calculated as a percentage of maximum heart rate (MHR). Maximum heart rate is an estimate of how fast your heart is beating when you are at maximum effort when exercising. Your maximum heart rate (MHR) is calculated by 220 minus your age.   * If you are 40, your maximum heart rate is  beats per minute. * Note that MHR is just a guide. Your actual MHR may vary from the calculation by as much as 15-20 bpm. The suggested range for your target heart rate in the calculator above is between 60% and 80% of your MHR. (Sourced from [MyDr](http://www.mydr.com.au/tools/heart-rate-calculator))   Read through the explanation of blood pressure:   * Blood pressure is measured using two numbers. The first number (systolic) represents the pressure in your blood vessels when your heart beats. The second number (diastolic) represents the pressure in your vessels when your heart rests between beats. If the measurement is 120 millimetres of mercury (mmHg) systolic and 80 mmHg diastolic, you would say “120 over 80” or write it as ‘120/80 mmHg’. (Sourced from [American Heart Association](http://www.heart.org/HEARTORG/HealthyLiving/HealthyKids/LifesSimple7forKids/Hey-Kids-Keep-Your-Blood-Pressure-Healthy_UCM_466607_Article.jsp#.WiYj6FWWaos))   Students complete an activity to measure blood pressure over time under different conditions.   * Note – A blood pressure monitor will be required to complete this activity.   Students look at a blood pressure chart and decide whether certain blood pressure readings are in the healthy range. | Heart rate activity worksheets:   * [Fitness Homework – Cardio Graph Worksheet](http://www.pecentral.org/lessonideas/Fitness_Homework_Cardio_Graph_Worksheet%20.pdf) * [Heart Zone](https://www.heart.org/idc/groups/heart-public/@wcm/@fc/documents/downloadable/ucm_451993.pdf) * [Marathon Challenge](https://www-tc.pbs.org/wgbh/nova/education/activities/pdf/3414_marathon_03.pdf)   Online graphing tool – [Heart Rate During Exercise](https://plot.ly/create/?fid=ChaseKull:1)  [Target Heart Rate](https://www.bupa.com.au/health-and-wellness/tools-and-apps/tools-and-calculators/ci.target-heart-rate-(thr).ovc) (Bupa)  [What happens to my heart rate and blood pressure when I exercise?](http://www.getinthezone.org.uk/media/26850/wellcometrust_16-19_lesson2_experimentd_teacher_sheet.pdf)  [Blood Pressure Chart](http://www.bloodpressureuk.org/BloodPressureandyou/Thebasics/Bloodpressurechart) |

Reflection and evaluation