 Year 12 Mathematics Standard 1

| MS-M4 Rates | Unit duration |
| --- | --- |
| Measurement involves the application of knowledge, skills and understanding of numbers and geometry to quantify and solve problems in practical situations.Knowledge of measurement enables an understanding of basic daily situations involving rates and ratios, such as speed and the interpretation of maps and plans, effectively in a variety of situations.Study of measurement is important in developing students’ ability to solve problems related to two and three-dimensional models and representations and to work effectively with a variety of rates and ratios. | 2 weeks |

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

Related Life Skills outcomes: MALS6-3, MALS6-13, MALS6-14 |

| Prerequisite knowledge | Assessment strategies |
| --- | --- |
| * Students should have completed MS-M1 in order to be able to convert between units of measurement. This topic also has links to interest rates and wages as examined in MS-F1 Money Matters.
 | Summative assessment* Mathematics and Farming investigative project
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All outcomes referred to in this unit come from [Mathematics Standard Stage 6](https://syllabus.nesa.nsw.edu.au/mathematics-standard-stage6/) Syllabus
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Glossary of terms

| Term | Description |
| --- | --- |
| Rates | A rate is a particular kind of ratio in which the two quantities are measured in different units. For example the ratio of distance to time, known as speed, is a rate because distance and time are measured in different units (such as kilometres and hours). The value of the rate depends on the units in which the quantities are expressed. |
| Unit rate | How much of something per 1 unit of something else.Examples:* 100 cars pass by in 2 hours. The unit rate is 50 cars per hour.
* You can paint 3 boards in half an hour. The unit rate is 6 boards per hour.
* 200 sausages were eaten by 50 people. The unit rate is 4 sausages per person.
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| Fuel consumption rate | The fuel consumption rate of a vehicle measures how much fuel it uses and is usually measured in litres per 100 kilometres (L/100 km). |
| Blood pressure | Blood pressure is the pressure exerted by circulating blood upon the walls of blood vessels. It is usually measured at a person's upper arm. Blood pressure is expressed in terms of the systolic (maximum) pressure over diastolic (minimum) pressure and is measured in millimetres of mercury (mm Hg). |
| Target heart rate | The target heart rate is defined as the minimum number of heartbeats in a given amount of time in order to reach the level of exertion necessary for cardiovascular fitness and is specific to a person's age, gender or physical fitness. An example of a target heart rate is 150 bpm to burn fat for a woman in her 30s. |
| Diastolic pressure | Diastolic pressure is the blood pressure in the arteries when the heart muscle is relaxed between beats. |

| **Sequence** | **Content** | **Suggested teaching strategies and resources**  | **Date and initial** | **Comments, feedback, additional resources used** |
| --- | --- | --- | --- | --- |
| Calculating with rates(2 lessons) | * 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.

Resource: [Converting between units](https://mathslinks.net/faculty/mathematics-general-2-unit-conversion-summary) poster**What is a rate?*** The use of the word 'per', meaning 'for every', in rates should be made explicit to students.
* Teacher to give students 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.
* Students could watch the videos ["What is a rate?"](https://www.youtube.com/watch?v=Tta9JVgMgmY&feature=youtu.be) and [What is a unit rate?](https://www.youtube.com/watch?v=XqNoOaSQfA0&feature=youtu.be)
* Teacher to discuss with students 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
* Student activity: Students to watch video [slow motion](https://vimeo.com/3830864) showing objects at 2500fps (frames per second) as an example of rates.
* Students may also be interested in the [World's fastest clapper](https://www.wimp.com/kent-toast-french-the-worlds-fastest-clapper/)

**Converting rates*** Students should be able to make conversions between units for rates over two dimensions, for example length and time, including km/h to m/s.
* Teacher to demonstrate how to convert rates, such as:
* 60km/h to m/s
* 150mL/min to L/h
* 10m/s to km/h

Resource: [How to convert rates](https://www.youtube.com/watch?v=lsuZkvZWEX0&feature=youtu.be)* 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 $\frac{5}{18}$ . Rather, students should understand how to convert each unit to the desired unit.
* Student activity: Students could look at questions from [Would you rather?](http://www.wouldyourathermath.com/) to practise converting rates to unit rates
* Teacher to demonstrate how to perform calculations involving ratesResource: [Rate calculations](https://www.youtube.com/watch?v=swHM4jSqz98&feature=youtu.be)

NESA exemplar question* An old washing machine uses 130 L of water per load. A new washing machine uses 50 L per load. How much water is saved each year if two loads of washing are done each week using the new machine?**Resource:** ms-m4-nesa-exemplar-questions-solutions.DOCX
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| Solving practical rates problems(4 lessons) | * 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) Critical and creative thinking icon Personal and social capability icon Civics and citizenship icon
 | * Links should be made to interest rates and wages as practical examples of rates.

**Burning Hot*** Student activity: Students solve the [Burning down](https://nrich.maths.org/497) problem, looking at the rate at which two different candles are burning.
* Students could also look at [Triathlon and fitness](https://nrich.maths.org/7586) where they try to work out which athlete has burned the most calories.

**Comparing best buys*** Students should be shown how to compare rates by converting to equivalent units
* Students need to understand the value in unit pricing and have opportunities to use unit pricing to inform their decision-making around spending money.
* Student activity: Students to read and discuss the article [Aldi, Coles or Woolworths? Getting the best deal for your groceries has never been harder](http://gomaths.net/4582)
* Student activity: students could watch the video from ACCC on [unit pricing](https://www.youtube.com/watch?v=sYbTBVDNHYE).
* Student activity: By using online/paper catalogues from supermarkets, check the prices of different items and determine the best buy for similar products.

**Resources:**[Coles](https://www.coles.com.au/), [Woolworths](https://www.woolworths.com.au/), [IGA](http://www.iga.com.au/), [ALDI](https://www.aldi.com.au/) How many locusts in a plague?* Student activity: Students watch the video [How many locusts in a plague?](http://education.abc.net.au/home#!/media/29763/?id=29763)
* Students then look at how many locust eggs can be laid in certain sized areas
* They then calculate how long it would take for locusts to devour a crop
* Students could then investigate and calculate rates of application of chemicals used in agriculture, for example rates for pesticides and food additives.

**Population growth*** Student activity: Students watch the video [What will the world's population be in 2050?](http://education.abc.net.au/home#!/media/29736/)
* Students plot the world’s population each decade and look at the trend.
* Students then use a population rate of 200 000 births per day to perform calculations predicting future population numbers.

**Comparing heart rates*** Student activity: Investigate the resting heart rate, targeted heart rate and heart rate zones for particular age groups.
* Test the resting heart rate of students in your class by asking them to sit/lie still for a few minutes and then measuring their pulse.
* Students then perform some form of exercise for 2 minutes before immediately taking their pulse again.
* Give reasons why the heart rate might be different between students and different depending on the activity.
* Determine their max heart rate. Maximum heart rate (MHR) is an estimate of how fast your heart is beating when you are at maximum effort when exercising.
* max=220−age
* Determine their aerobic and anaerobic thresholds ([Heart rate zones](https://www.aussiefitsport.com.au/training-heart-rate-zones/))
* After exercise, decrease in heart rate varies due to fitness levels (how fast it decreases). Students could continue to measure their heart rates for 5 – 10 minutes after exercise and then plot their heart rate over time. They can then compare the shape of their graph, to someone else.
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| Investigating heart rates and blood pressure(1 lesson) | * 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 Personal and social capability icon
* Calculate target heart rate ranges during training Personal and social capability icon
* 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 Personal and social capability icon
 | Targeted heart rates* Target heart rates are calculated as a percentage of maximum heart rate (MHR). Your actual MHR may vary from the calculation by as much as 15-20 bpm. The suggested range for your target heart rate is between 60% and 80% of your MHR.
* Student activity: Students could use the [heart rate calculator](http://tools.mydr.com.au/tools/heart-rate-calculator) to determine their targeted heart rate zone
* During the activity above, how much time was spent in this zone? Above this zone? Below this zone?
* Compare these times to others in the class

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))
* Student activity: If teachers are able to source a blood pressure monitor, students could complete the [What happens to my heart rate and blood pressure when I exercise? (Lesson 2, Experiment D)](https://www.stem.org.uk/resources/elibrary/resource/34282/ive-got-power-ages-16-19)
* Students could then look at a [Blood Pressure Chart](http://www.bloodpressureuk.org/BloodPressureandyou/Thebasics/Bloodpressurechart) and decide whether certain blood pressure readings are in the healthy range.
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| Investigating costs of trades(1 lesson) | * Use rates to solve practical problems AAM
* Use rates to determine costs, such as calculating the cost of a trade professional using rates per hour and call-out fees Critical and creative thinking icon Personal and social capability icon Civics and citizenship icon
 | **Cost of trades*** Student activity: Students investigate the cost of different trade professionals, such as a plumber, carpenter, electrician, or mechanic by reading articles on [How to price your building work competitively and still earn money](https://www.yourtradebase.com/blog/price-building-work-competitively-still-earn-money/) and [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)
* Students can then choose three trades to investigate using the [Pricing Guides](https://www.serviceseeking.com.au/blog/pricing-guides/).
* For each trade find three local tradespeople and compare their prices.
* Student activity: Students complete an exercise comparing the cost of [Fixing the Furnace](https://www.illustrativemathematics.org/content-standards/tasks/472) 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.
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| Solving practical speed problems(2 lessons) | * Use rates to solve practical problems AAM
* 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 Critical and creative thinking icon  Information and communication technology capability icon Literacy icon
 | * When describing distance/time graphs (travel graphs), teachers should supply a modelled story and graph first, or jointly construct a story with students before independent work is required.

**Comparing speeds*** Student activity: Introduction to different speed comparisons:
* Show [Boat vs Bike vs Car vs Public Transport – Top Gear](https://www.youtube.com/watch?v=dhlwNrZ4QIk) clip.
* Discuss the different speeds involved.
* Investigate/discuss differences between London and Sydney and the impact on speed in Sydney.
* Students could develop the same type of race between Parramatta and the Sydney CBD looking at travel times at different times of the day. Google Maps will allow you to input the day of time of travel and then adjusts the expected travel time accordingly.
* 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 using [Speed, time and distance problems worksheets](http://www.homeschoolmath.net/worksheets/speed_time_distance.php)
* Student activity: Students complete the [Distance-time graphs (TES)](https://www.tes.com/teaching-resource/distance-time-graphs-6126229?theme=3) activity where they interpret a number of graphs and write their own stories.
* Student activity: In pairs, students write a scenario and ask their partner to draw the appropriate distance-time graph.
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| Investigating fuel economy(1 lesson) | * Use rates to solve practical problems AAM
* Calculate the amount of fuel used on a trip, given the fuel consumption rate, and compare fuel consumption statistics for various vehicles
 | **Fuel Economy*** Teacher to lead a class discussion about why consideration of fuel economy is important. Consider environmental/sustainability factors as well as cost. [Why is fuel economy so important?](https://www.comparethemarket.com.au/car-insurance/guides/fuel-economy-important/)
* Factors that affect fuel economy could also be discussed
* Students could look at how fuel economy is calculated and how to read fuel economy stickers [Fuel efficiency comparison testing](https://www.choice.com.au/transport/cars/general/articles/fuel-consumption-testing#table)
* Student activity: Students could use an online tool [Fuel and Trip Calculator](https://www.bayswatercarrental.com.au/fuel-calculator) to calculate cost of fuel for a trip.
* Student activity: Students could use the [Green Vehicle Guide](https://www.greenvehicleguide.gov.au/) to compare the fuel economy of different types of vehicles
* Students could then work out how much they would save during an average week driving around town
* Have students choose two locations in NSW and determine the driving distance using Google Maps.
* Using the fuel consumption of the 2 cars that students researched above, determine the amount of fuel that would be used on the trip.
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Reflection and evaluation

Please include feedback about the engagement of the students and the difficulty of the content included in this section. You may also refer to the sequencing of the lessons and the placement of the topic within the scope and sequence. All ICT, literacy, numeracy and group activities should be recorded in the ‘Comments, feedback, additional resources used’ section.