

Mathematics Standard 1 Year 12

Measurement Topic Guidance

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# Topic focus

*Measurement* involves the application of knowledge, understanding and skills 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.

The study of measurement is important in developing students’ ability to solve problems related to two-dimensional and three-dimensional models and representations and to work effectively with a variety of rates and ratios.

# Terminology

|  |  |  |
| --- | --- | --- |
| angle of depressionangle of elevationbeats per minutebest buyblood pressurebuilding planscall-out feecompass bearingcultural mappingsdiastolic pressuredistance-time graph | elevation viewsfuel consumption rateheart ratelinear scale factormap scalenavigational methodsperimeterPythagoras’ Theoremrateratioscale drawing | similar trianglessimilaritysite planspeedsystolic pressureTargeted Heart RateTrapezoidal rule travel graphtrigonometric ratiotrue bearing |

# Use of technology

Students should be given the opportunity to use suitable geometry software to create both
two-dimensional (2D) and three-dimensional (3D) drawings and designs.

A spreadsheet can be created to compare measures of Target Heart Rate ranges.

The internet could be used as a source of suitable maps and plans for the estimation of distances as well as data and statistics on blood pressure.

Students could compare costs of different trade professionals using spreadsheets.

# Background information

Almost all early civilisations used the shadow cast by a vertically positioned stick to observe the motion of the Sun and tell time. This instrument is now called a Gnomon, the Greek name of an L-shaped instrument used to draw a right angle.

The foundations of trigonometry were laid as early Babylonian, Greek, Hellenistic, Indian, and Arabic mathematicians investigated astronomical problems using numerical and geometric techniques, specifically the geometry of the circle. The most literal meaning of ‘trigonometry’ comes from the Greek words for ‘triangle’ and ‘measure’. Trigonometry was established as a distinct branch of mathematics during the 12th and 13th centuries.

Herophilos (335–280 BC), a Greek physician and scientist was the first to publish information about heart rates. It was not until the invention of a stopwatch in 1707 that heart rates could be measured accurately.

# General comments

Students should be encouraged to ‘estimate and check’ to determine if results are reasonable. This is a skill that should be reinforced throughout the Measurement strand.

Learning and teaching should be supported through access to industry-standard house plans and maps. Students require access to house plans and other scale drawings during lesson time.

Practical applications of the concepts studied should be investigated, for example the costs involved in electricity and plumbing repairs.

Materials used for teaching, learning and assessment should include current information from a range of sources, including, but not limited to, newspapers, journals, magazines, real bills and receipts, and the internet.

# Future study

The skills and concepts students encounter in this topic will be further developed and applied practically in many of the post-school contexts and training areas that students may follow. This topic will also provide students with the skills they will need to solve the practical problems that arise when managing a household or engaging in leisure activities.

# Subtopics

* MS-M3: Right-angled Triangles 
* MS-M4: Rates
* MS-M5: Scale Drawings

## MS-M3: Right-angled Triangles Paperclip icon

### Subtopic focus

The principal focus of this subtopic is to solve problems involving right-angled triangles in a range of practical contexts using Pythagoras’ theorem and basic trigonometric ratios.

Students develop their ability to justify mathematical thinking and to communicate solutions.

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

* In this topic, the approximation of angles includes approximation to the nearest minute.
* Trigonometric ratios could be revised using similarity properties of right-angled triangles.
* When using the tangent ratio, students need to consider which angle should be used to ensure that the unknown is in the numerator.
* Diagrams should be provided for problems involving angles of elevation and depression and bearings.

### Suggested applications and exemplar questions

* Students could be given practical experiences in using clinometers for finding angles of elevation and depression and in using magnetic compasses for bearings.
* Students should be taught explicitly how to identify the location from where a bearing is measured and to locate and draw true north on a diagram.
* Students should have opportunities to translate a variety of phrases involving bearings into diagrams, for example:
	+ The bearing of Melbourne from Sydney is 230°.
	+ A plane flies to Melbourne on a bearing of 230°.
	+ A plane flies from Sydney to Melbourne on a bearing of 230°.
	+ A plane leaves Sydney and flies on a bearing of 230° to Melbourne.
* What is the length of the side $MN$ in the following triangle, correct to two decimal places?



## MS-M4: Rates

### Subtopic 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.

### Considerations and teaching strategies

* 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.
* Students should be shown how to compare rates by converting to equivalent units.
* Blood pressure graphed over time involves the introduction of three variables. Prepared graphs can be used if measuring equipment is unavailable. The appropriateness of different types of graphs to display this information should be discussed.
* Consideration should be given to using appropriate scales for graphing heart rates.

### Suggested applications and exemplar questions

* Calculate rates of application of chemicals used in agriculture, for example rates for pesticides and food additives.
* Calculate distances and travelling times from maps.
* Calculate the yearly fuel consumption and the yearly cost of petrol for various classes of vehicle, for example a car with a 4-cylinder, 1.6L engine compared to one with a 6-cylinder, 4L engine, given their fuel consumption rate in litres per *100* kilometres.
* Measure and record heart rate under different conditions, for example heart rate during different exercises (this could include both aerobic and non-aerobic activities), recovery rate after exercise, relationship between a person’s resting heart rate and heart rate after exercise or recovery time after exercise.
* Discussion could include:
	+ are the relationships linear or non-linear?
	+ expected differences between resting heart rate in non-stressful conditions versus stressful conditions
	+ other measures (factors) of health that may affect heart rate.
* Students calculate ranges of maximum heart rates.
* The amount of blood pumped by the heart over time, given different exercise conditions, could be investigated.
* Students investigate graphs of heart rate and temperature over time (as used in hospitals).
* 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?

## MS-M5: Scale Drawings

### Subtopic focus

The principal focus of this subtopic is to interpret and use scale drawings and use similarity in solutions to practical problems involving measurement.

Students develop their ability to interpret and use house plans, designs and maps in the calculation of a range of measurements and solve related problems.

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

* Teachers may find it necessary to revise calculating scale factors of objects and images.
* Scale diagrams should include house plans and maps. Online maps are readily available (with measurement tools) for extension activities.
* Students should be aware that the millimetre is the standard unit of length on building plans.
* The dimensions of the room and the width of the carpet should be considered when deciding in which direction to lay the carpet in order to minimise wastage and the number of joins.

### Suggested applications and exemplar questions

* Calculate the quantity of each component needed given the ratio of the components in the mixture, for example diluting a pesticide, mixing two-stroke lawnmower fuel or creating a fertiliser mixture.
* Calculate the scale factor of enlargements obtained using an overhead projector. Is there a relationship between the distance of the projector from the screen and the scale factor of the resulting projection?
* A sewer is required to have a fall of 1 in 40. How much deeper should one end be compared to the other in a 160-metre long trench?
* By measuring the shadow thrown by a metre-rule, students use similarity and shadow lengths to find the height of tall objects, for example a tree, flag pole.
* Students accurately construct a scaled floor plan of the classroom.
* Find ceiling heights from building plans.
* Use house plans to cost carpeting, tiling, painting rooms, etc.
* Calculation of area and volume based on information on a plan needs to include, for example:
	+ finding the area of a house to be carpeted and the cost of purchasing the carpet
	+ calculating the area to be painted and the cost of painting a room in a house
	+ calculating the volume of the rooms in a house and using a table to determine the appropriate-sized air conditioner for the house.
* Download a satellite map or other scale diagram from the internet and identify a geographical feature that has an irregular boundary, for example a lake or field. Use the scale of the map or diagram to estimate the actual dimensions of the feature.
* Jacques and a flagpole both cast shadows on the ground. The difference between the lengths of their shadows is 3 metres.



What is the value of $d$, the length of Jacques’ shadow?