 Year 11 Mathematics Standard

| MS-M1 Applications of Measurement | 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 completion of daily tasks such as making time estimations, measuring medicine, finding weights and understanding areas of materials or substances.Study of measurement is important in developing students’ ability to make reasonable estimates for quantities, apply appropriate levels of accuracy to particular situations, and apply understanding of aspects of measurement such as length, area, volume and similarity to a variety of problems. | 7 weeks |

| Subtopic focus | Outcomes |
| --- | --- |
| The principal focus of this subtopic is to develop an awareness of the inherent error in measurements and to become competent in solving practical problems involving energy, mass, perimeter, area, volume and capacity.Students develop knowledge of the concepts of measurement and demonstrate fluency with its application.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:* solves problems involving quantity measurement, including accuracy and the choice of relevant units MS11-3
* performs calculations in relation to two-dimensional and three-dimensional figures MS11-4
* uses appropriate technology to investigate, organise and interpret information in a range of contexts MS11-9
* justifies a response to a given problem using appropriate mathematical terminology and/or calculations MS11-10

**Related Life Skills outcomes**: MALS6-3, MALS6-4, MALS6-13, MALS6-14 |

| Prerequisite knowledge | Assessment strategies |
| --- | --- |
| Students will build on the prior knowledge, from Stage 5, of Pythagoras’ Theorem, Surface Areas of prisms and cylinders, Scientific Notation and volumes of composite shapes. | * MS-M1 Applications of Measurement – Solar panels and swimming pools

Students utilise their understanding of the various measurement applications, including their knowledge of surface area, volume and capacity to design a swimming pool. They also research the efficiency of solar panels and calculate energy usage based on the size of panels and the output of energy. |

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 |  |
| --- | --- |
| Absolute error | The absolute error of a measurement is half of the smallest unit on the measuring device. The smallest unit is called the precision of the device. |
| Limits of accuracy | The limits of accuracy for a recorded measurement are the possible upper and lower bounds for the actual measurement. |
| Percentage error | The percentage error of a measurement is the absolute error expressed as a percentage of the recorded measurement. |
| Trapezoidal rule | The Trapezoidal rule uses trapezia to approximate the area of an irregular shape, often with a curved boundary. Given a transverse line of length $h$ and two perpendicular offset lengths $d\_{f}$ and $d\_{l}$ ,one application of the Trapezoidal rule is given by: $Area≈\frac{h}{2}(d\_{f}+d\_{l})$ |
| Standard form | A real number is expressed in standard form when it is written in the form a×10nwhere 1≤a<10 and n is an integer. Also known as scientific notation. |

| Lesson sequence | Content | Suggested teaching strategies and resources  | Date and initial | Comments, feedback, additional resources used |
| --- | --- | --- | --- | --- |
| Convert between units of length, area, volume and capacity(3 lessons) | M1.1 Practicalities of Measurement* review the use of different metric units of measurement including units of area, take measurements, and calculate conversions between common units of measurement, for example kilometres to metres or litres to millilitres ◊
 | Review of metric units* Metric units are used with the exception of calories. Care should be taken to specify a metric tonne (1000 kg) rather than imperial tons. Watch the video [Monumental measurement mess ups](http://splash.abc.net.au/media/-/m/1566108) to see what happens when you mix up units.
* List the different units of measurement that students are familiar with (add to it if necessary but students should know mm, cm, m, km, mL, L, kL, mg, g, Kg, Tonnes) Resource: [Commonly used metric system units, symbols and prefixes](http://www.us-metric.org/commonly-used-metric-system-units-symbols-and-prefixes/)

Converting and measuring with metric units* Students should be encouraged to estimate and then measure a variety of objects, including tables, classrooms (length, width and height), as well as larger distances such as the oval or playground. This will develop their ability to select which metric unit is appropriate for different scenarios.
* Student activity: Students to use the measuring tool on Google Maps or Google Earth to determine their distance from school to home.
* Student activity: Students are asked to convert between millimetres, centimetres and metres in the process of building a garden shed. **Resource:** [Build a shed](http://www.bbc.co.uk/skillswise/game/ma22leng-game-build-a-shed)
* Student activity: To help with estimation and visualisation of area, students can create a metre square using newspaper/recycled paper and sticky tape.
* Using their square metre, students can estimate and then calculate the size of classrooms.
* Students can then estimate and calculate the number of square centimetres in the square metre to determine the correct conversion between the two units.
* Student activity: Aluminium foil prank – show students the photo of the foil print and then pose the question: How much would it cost to cover the whole classroom in aluminium foil?Resource: [Foil activity](http://robertkaplinsky.com/work/foil-prank/)
* Student activity: Explore just how big a cubic metre really is. See how small a cubic centimetre looks when compared with a cubic metre.**Resource:** [How big is a cubic metre?](http://fuse.education.vic.gov.au/Resource/ByPin?Pin=92959P&SearchScope=All)
* Student activity: Measuring Stations – set up a series of stations (tables) where students are provided with the task of measuring length, area, mass and volume at each station. Students are provided with a 2-column worksheet where one is labelled “guess” and the other is labelled ‘actual size’. This is a hands on activity to get students to familiarise themselves with the metric system and appropriate sizes. Resource: [Teaching the metric system](http://www.us-metric.org/tips-to-educators-for-teaching-the-metric-system-and-ideas-for-schools-celebrating-national-metric-week/)

**Additional Resource:** [Mathematics Curriculum Companion](http://fuse.education.vic.gov.au/Resource/ByPin?Pin=K5QYF2&SearchScope=All)  |  |  |
| Calculates absolute and percentage error(3 lessons) | * calculate the absolute error of a reported measurement using Absolute error = ½ x Precision and state the corresponding limits of accuracy ◊
* Find the limits of accuracy as given by:upper bound = measurement + absolute errorlower bound = measurement – absolute error
* investigate types of errors, eg human error or device limitations Critical and creative thinking icon
* calculate the percentage error of a reported measurement usingpercentage error = $\frac{absolute error}{measurement}×100\%$
 | **What are errors in measurement?*** Students typically hold the misconception that error means “mistake”, rather than a limitation of the instrument. This should be dealt with explicitly, such as in the suggested Slideshow. Students should recognise that error in measurement arises from both human error and limitations of measuring device.Resource [Errors in measurement](https://www.slideshare.net/rjarewal/errors-in-measurement)
* Discusswith students types of errors that can occur in a measured value:
* Systematic error – this occurs to the same extent in each measurement of a series of measurements. For example when the needle of a bathroom scale is not correctly adjusted to read zero when no weight is present (also known as device or measurement tool limitations)
* Random error – this occurs in any measurement as a result of variations in the measurement technique. Such errors may include:
	+ Parallax error – when a person views the scale of a measuring instrument at an angle rather than from directly in front of it (note that if this is done consistently then it becomes a systematic error)

**Resource:** [Parallax error](http://aphysicsteacher.blogspot.com.au/2009/12/what-is-parallax-error.html)* + Limit of reading – the smallest unit on a measuring instrument can limit the accuracy of the reading, that is, if the wrong instrument was used then the measurement obtained would have an error
* Student Activity: Students use a non-standard method of measurement, for example, one student lying on the floor as a “Tyler”. They use this measurement/person to measure the length of the room and find that it is 3.2 “Tylers”, however because you can’t measure with part of a person, the room becomes 3 “Tylers”, as you can’t measure with something that you don’t know, there is no marking that shows .2 of a “Tyler”
* They then measure the hall which they find is 14.7 “Tylers”, which this time is estimated up to 15 “Tylers”
* Ask students question such as:
	+ What do we know about the length of the hallway?
	+ (They know that it is more than 14.5 “Tylers” because otherwise they would have rounded down.)
	+ Could it be 15.4 “Tylers” and still be measured as 15?
	+ Could it be 15.5?
	+ Advance the questions to say: If “Tyler” could accurately be portioned into tenths, how much more accurate could your measurement be?
	+ If I told you the hallway was 11m long, what could you tell me about that?
	+ Emphasise the following to students - We cannot be completely accurate when measuring anything, we can only say that something is closer to 6 “Tylers” than it is to 5 or 7 “Tylers”**Resource:** [Accuracy of measurements teachers notes](https://www.stem.org.uk/resources/elibrary/resource/30826/accuracy-measurements)

Calculating absolute error* Student activity: Students can watch the video [Limits of reading](https://www.youtube.com/watch?v=bAuuMr5pCwk) to learn about errors in measurement.
* Student activity: Students to choose a convenient object available to them that can reasonably be measured in metres, centimetres and/or millimetres, for example a desk or whiteboard.
* Have students measure the object with 3 separate measuring instruments. For example: a metre ruler, a 30cm ruler and a tape measure.
* For each measurement instrument, have students calculate the limits of accuracy.
* Teacher to demonstrate how to calculate [Percentage error](https://www.youtube.com/watch?v=9zZUGJEzPCk)
* Using the measurements taken with each instrument, calculate the percentage error.
* Have students evaluate/assess the different things they have discovered: What instrument gave the most accurate measurement? What instrument has the smallest/biggest limits of accuracy? What instrument gave the smallest percentage measurement and why? How does the percentage error relate to/impact the instrument and limits of accuracy?
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| Writes numbers in standard form to a required number of significant figures(2 lesson) | * use standard form and standard metric prefixes in the context of measurement, with and without a required number of significant figures ◊  Information and communication technology capability icon
* standard prefixes include nano-, micro-, milli-, centi-, kilo-, mega-, giga- and tera-
 | Review of Standard Form* “Standard Form” is used in this topic in place of “Scientific Notation” which is used in Stage 5.

**Review of significant figures*** Teacher to have a discussion with students on the importance of using significant figures. Answers can include:
* To make sure that our answer does not appear to be more precise than it actually is
* This is important when working with measurement as there are varying degrees of certainty and precision
* Teachers can show [YouTube – why are significant figures important?](https://www.youtube.com/watch?v=VAuslY-Uuf4) to students for a visual demonstration of significant figures
* Teacher to explain the difference between decimal places and significant figures and the basic rules of significant figures
* Any non-zero digit is significant.
* Zeros between non-zero digits are always significant. Example: 3,606 has 4 significant figures.
* Zeros that indicate the decimal point are not significant. Example: 360,600 has 4 significant figures.
* Zeros following a decimal are significant. Example: 3.60 has 3 significant figures but 3.6 has 2.
* Zeros appearing before a non-zero digit are not significant. Example: 0.009 only has 1 significant figure.

**Writing numbers in Standard Form using significant figures*** Student activity: Student groups compete with each other to generate answers to questions about significant figures (also called significant digits). Each student holds a card with a single digit (0 to 9), decimal, or negative sign. Students organize themselves so that their cards show the correct answers. **Resource:** [Racing for significant figures](http://www.carolina.com/teacher-resources/Interactive/significant-figures-game/tr10849.tr)
* Student activity: Students are given the dominoes (already cut out) and they have to link it based on the idea of estimating or rounding numbers to one significant figure.Resource: [Dominoes](https://www.tes.com/teaching-resource/significant-figures-6293139)
* Student activity: Students complete the worksheet and then order the cards so that the answer on the top of the card matches the question on the bottom of another cardResource: [Connecting cards – significant figures worksheet](https://www.tes.com/teaching-resource/maths-significant-figures-worksheet-6266264)
* Student activity: Students read the rules for writing numbers to a given significant figure and create a quiz (5 questions) with answers Resource: [Create a quiz](http://www.staff.vu.edu.au/mcaonline/units/numbers/numsig.html)
* Student activity: Students place the numbers in appropriate boxes matching to the corresponding significant figures. Students round off given 4 numbers to 1, 2, 3 and 4 significant figures and write them in respective boxes. Resource: [Gridlocks](http://www.rsc.org/learn-chemistry/resources/gridlocks/teachers-area.html) (worksheets – Level 3)
* Student activity: From [The Scale of the Universe website](http://htwins.net/scale2/) ([Non-interactive version](https://youtu.be/uaGEjrADGPA)) students choose two objects with greatly varying dimensions (one very large and one very small) and, through discussion in groups, develop the ways to compare those two measurements.
* Students investigate the standard metric prefixes that are part of S.I. unitsResource: [Commonly used metric system units, symbols and prefixes](http://www.us-metric.org/commonly-used-metric-system-units-symbols-and-prefixes/)
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| Solves perimeter and area problems involving plane shapes(4 lessons) | M1.2 Perimeter, area and volume* review and extend how to solve practical problems requiring the calculation of perimeters and areas of triangles, rectangles, parallelograms, trapezia, circles, sectors of circles and composite shapes ◊ Critical and creative thinking icon Literacy icon
 | **Perimeter*** Student activity: Students can arrive at the estimation of value of π from measuring the perimeter of polygons inscribed in a circle. The suggested Geogebra file shows this process using a slider for the number of sides of the polygons.Resource: [Pi Derivation Activity using Geogebra](https://www.geogebra.org/m/GSpKDukt)

**Area formulas*** Student activity: Students use Geogebra to derive the formulas for area of plan shapesResource: [Deriving Area Formula using Geogebra](https://www.geogebra.org/m/ChMJ32XM)
* Student activity: Students can use the manipulative to derive the formula for parallelograms, triangles and trapeziums**Resource:** [NCTM Interactive Activity for Area Formulae](https://illuminations.nctm.org/Activity.aspx?id=3567)
* Teacher to review formulae of plane shapes - squares, rectangles, triangles, parallelograms, trapezia, circles, sectors and composite shapes based on these shapes (including annuluses).

Resource: [Math playground](http://www.mathplayground.com/mathvideos.html)* Students watch the video [Area of circle derivation](https://www.youtube.com/watch?v=YokKp3pwVFc) to see where $πr^{2}$comes from.
* Student activity: In this proportional reasoning activity, students explore the relationship between circle area, sector area, and sector angle. The final screens provide an opportunity for students to experience the power of algebraic expressions.**Resource:** [Sector area](https://teacher.desmos.com/activitybuilder/custom/58d92ba29623f50ba8d7f2af)
* Student activity: Students develop strategies to manipulate and break up the plane shapes of triangle, parallelogram and trapezium to relate them back to the area of rectangle. Students then arrive at the necessary formulae for those plane shapes. This can be done by hands on activity of cutting and pasting or using digital technology (for example, using the Geogebra or NCTM links provided).
* Student activity: Students use Desmos and quadratic models to optimize the area of a field for a given perimeter. **Resource**: [Build a bigger field](https://teacher.desmos.com/activitybuilder/custom/56e19b4183ba3908118725dd)

Additional Resources* The Improving Mathematics Education in Schools (TIMES) Project by the Australian Mathematical Sciences Institute has produced a series of lessons which review the areas and perimeters of various plane shapes. These lessons could assist teachers in gaining a more detailed knowledge of the reasoning behind the course content.
* [Rectangles and Parallelograms](http://amsi.org.au/teacher_modules/Paralleograms_and_rectangles.html)
* [Other Plane Quadrilaterals](http://amsi.org.au/teacher_modules/Rhombuses_Kites_and_Trapezia.html)
* [Area, Surface Area and Volume](http://amsi.org.au/teacher_modules/area_volume_surface_area.html)
 |  |  |
| Uses Pythagoras’ theorem to solve problems(2 lessons)  | * + review the use of Pythagoras’ theorem to solve problems involving right-angled triangles
 | **History of Pythagoras’ Theorem*** Teacher to lead a discussion of the recent discovery that Pythagoras’ Theorem was used a long time before Pythagoras livedResource: [Pythagoras’ Theorem older than Pythagoras](https://newsroom.unsw.edu.au/news/science-tech/mathematical-mystery-ancient-clay-tablet-solved)
* The YouTube video link provided relates squares to the lengths of the sides of a triangle. The video could be shown or could be used by teachers as the start of an investigation where students can use unit or pattern blocks to establish the Pythagorean pattern.

Resource: [Pythagoras in 2 minutes](https://www.youtube.com/watch?v=uaj0XcLtN5c)* Teachers could also show [Pythagoras’ theorem water demo](https://www.youtube.com/watch?v=CAkMUdeB06o) or [Visual proof of Pythagoras’ theorem](https://www.youtube.com/watch?v=KHJRDSP5I8E) as alternative proofs of Pythagoras’ Theorem

Using Pythagoras’ Theorem to find lengths* It is important for students to experience the three different types of Pythagoras problems.
* If I have a cabinet with a 55cm x 40cm opening, what is the maximum size TV that will fit? (Finding the hypotenuse)
* My ladder is 4.2m long and the base sits 1.3m away from the wall. Is my ladder long enough to reach the window that is 3.7m up the wall? (Proof question)
* If a roof rafter is 10m in length and extends 7m over the horizontal ceiling beams. How high above the ceiling does the roof extend? (Finding the shorter side)
* Student activity: Students calculate different heights that a 5 metre ladder can reach. Students then discuss the practicality of different ladder positions with regards to the angle of inclination.

Resource: [The Ladder at the Wall Discussion](https://www.geogebra.org/m/MY4Ytr2A)* Teacher to guide students through worded problems by using the following steps
* If a diagram has not been provided, draw one to represent the worded problem
* Identify whether the unknown side is a hypotenuse or a short side
* Apply the formula: $c^{2}=a^{2}+b^{2}$ if the unknown side is the hypotenuse and consider using the formula $a^{2}=c^{2}-b^{2}$ if the hypotenuse is given and the unknown side is one of the short sides
* Conclude the problem with a worded answer

**Resource:** [Sample of word problems](http://www.math-only-math.com/word-problems-on-pythagorean-theorem.html)* Students could apply algebraic and/or geometric skills to find a missing dimension of a shape in order to find its perimeter.

Additional ResourcesThis is another useful resource that could assist teachers in gaining a more detailed knowledge of the reasoning behind the course content.* TIMES Lessons – [Pythagoras’ Theorem](http://amsi.org.au/teacher_modules/pythagoras_theorem.html)
 |  |  |
| Calculate unknown lengths in similar figures(2 lessons) | * + review the use of a scale factor to find unknown lengths in similar figures
 | Review similar shapes* Compare the sizes and angles of a range of triangles, squares and rectangles. Notice that 'similar shapes' in the mathematical sense have the same shape and possibly different sizes. Corresponding sides are in proportion, and corresponding angles are equal. [Similar shapes](http://www.scootle.edu.au/ec/viewing/L2309/index.html)

Using scale factors* Compare the areas of squares, rectangles and triangles before and after being scaled up (enlarged) [Scaling up](http://www.scootle.edu.au/ec/viewing/L2310/index.html)
* Compare the surface area of cubes and rectangular prisms before and after being scaled up (enlarged) or scaled down (reduced). [Scaling surface area](http://www.scootle.edu.au/ec/viewing/L2315/index.html)
* Compare the volumes of cubes and rectangular prisms before and after being scaled up (enlarged).[Scaling up solids](http://www.scootle.edu.au/ec/viewing/L2313/index.html)
* Students could apply geometric skills to find a missing dimension of a shape in order to find its perimeter, area or volume. This may involve applying the scale factor to find an unknown side in similar triangles.
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| Calculate the surface area of solids(3 lessons) | * solve problems involving surface area of solids including prisms, cylinders, spheres and composite solids
 | **Surface area of prisms*** Students need to understand that the surface area is the addition of the area of each face of a solid. To do this they need to be able to draw or recognise a two-dimensional net of a three-dimensional shape, in order to derive the plane shapes required and select appropriate area formulae.
* Linked to the previous section, students must recognise that Pythagoras’ Theorem may be needed to solve some surface area problems that involve right-angled triangles.
* Student activity: Students make a prism (example rectangular prism).
* Colour in faces that are equal in size the same colour.
* Unfold the shape into its net.
* Discuss the concept that there are 3 matching faces.
* Calculate area of each colour.
* Add all 6 faces up for the total surface area.
* Repeat with other prisms including triangular, pentagonal, and composite prisms.Resource: [Surface Area of a Rectangular Prism](http://www.learner.org/interactives/geometry/area_surface.html)
* Student activity: Students could alternatively use online interactives to explore Prisms and their netsResource: [Prisms](http://www.learner.org/interactives/geometry/3d_prisms.html)
* Student activity: Students determine the number of bricks in 1 square metre of a brick wall. They then use their findings to estimate how many bricks are used in the whole building
* Student activity: Students calculate the painted surface area of a room and determine how much paint needs to be purchased for a particular coverage rate eg 1 litre covers 14 m2

**Surface area of a cylinder*** Teacher to develop the formula for surface area of a cylinder by drawing its net (Use a physical cylinder that you can show the net of the rectangle section). Write the formula for the area of a circle in each circle. Discuss that the rectangle dimensions are actually the circumference of the circles times the height of the cylinder. Use this fact to derive the formula $SA=2πr^{2}+2πrh$ . Discuss how this formula changes with “an open cylinder” or “a pipe”.

Resource: [Surface Area of a Cylinder](http://www.learner.org/interactives/geometry/area_surface2.html)**Surface area of a sphere*** Student activity: Students to investigate the formula for surface area of a sphere, by peeling an orange and arranging the peel into 4 circlesResource: [Surface area of an orange](https://www.youtube.com/watch?reload=9&v=jaL8Kuv6YHo)
* Students could apply algebraic and/or geometric skills to find a missing dimension of a shape in order to find its area or surface area.
* Student activity: Students work in small groups to design cost-effective packaging, eg given four table-tennis balls, design two different boxes to package them and determine the better of the two designs in terms of minimisation of material used. Students should consider not just prisms for their packaging.

Additional Resources* This is another useful resource that could assist teachers in gaining a more detailed knowledge of the reasoning behind the course content.
* [Cones, pyramids and spheres](http://amsi.org.au/teacher_modules/Cones_Pyramids_and_Spheres.html)
* [Pyramids](http://www.learner.org/interactives/geometry/3d_pyramids.html)

Exemplar question: * Calculate how many kilograms of chicken manure would be required to fertilise a football field 100 m $×$ 50 m if it is required that 8 g/m2 be applied

**Resource**: ms-m1-nesa-exemplar-question-solutions.DOCX |  |  |
| Calculates the volume and capacity of solids(3 lessons) | * solve problems involving volume and capacity of solids including prisms, cylinders, spheres and composite solids
* convert between units of volume and capacity
 | **Introducing volume and capacity*** Students to watch the [Visible human](https://www.youtube.com/watch?v=iWP2HnPSMyo) to see how adding slices will “build” a solid and can help to determine volume. This is the method used by 3D printers, or building a brick wall, layer by layer. Eventually conclude that the volume of a prism is the area of the cross section multiplied by the amount of layers it’s made up of i.e. $V=Ah$.

Resource: [Volume of Rectangular Prism](http://www.learner.org/interactives/geometry/area_volume.html)* Teacher to discuss the difference between volume and capacity. Volume is the amount of space taken up by an object, while capacity is the measure of an object's ability to hold a substance, like a solid, a liquid or a gas. Volume is measured in cubic units, while capacity can be measured in almost every other unit, including litres and grams.

**Volume of a prism*** Student activity: Students use the National Library of Virtual Manipulatives interactive activity “How high?” to predict the height of liquid when it is poured into a different container. This activity leads to the conclusion that the volume is the essentially the product of three numbers. For the volume given as a whole number, the measurements of the solids must be the factors of the volume number.Resource: [How high?](http://nlvm.usu.edu/en/nav/frames_asid_275_g_4_t_4.html?from=category_g_4_t_4.html)
* Student activity: Students compare the surface area of rectangular prisms, with the same volume.
* Students are to build as many as possible rectangular prisms with given volume, using unit cubes.
* Students then discuss in groups and derive the process to determine minimum surface area required for any given volume.
* This activity leads to the issue of packaging where the minimum amount of paper/cardboard can be used. Surface area is also important in living organisms including maximising nutrient transferal in the stomach, and oxygenation of the blood in the lungs or gills.
* Student activity: Students investigate the greatest volume you can get for a cuboid parcel with whole centimetre dimensions?**Resource:** [Sending a parcel](https://nrich.maths.org/2650)
* Student activity: Students investigate the capacity warnings of lifts. Could you really fit that many people in the lift? How much would each person then weight?**Resource:** [Capacity of lifts](http://www.scootle.edu.au/ec/viewing/R11198/index.html)

**Volume of a cylinder*** Student activity: Students fill up a 10cm cube with liquid and pour it into a measuring container.
* Find that $10cm×10cm×10cm=1000cm^{3}$ which = 1L or 1000mL so $1cm^{3}=1mL$ , $1m^{3}=1000L$ or $1kL$.
* Attempt to fill up a cylinder with centicubes, discuss the problem of why we can’t accurately do it. Then fill up cylinder with water. Pour it into a rectangular prism to accurately measure it. Discuss again that it is still the area of the cross section (circle) multiplied by how many layers (height) $V=πr^{2}h$ Resource: [Volume of a Cylinder](http://www.learner.org/interactives/geometry/area_volume2.html)

**Volume of a sphere*** Students to watch the video [Visualising the Volume of a Sphere Formula](https://www.youtube.com/watch?v=YNutS8eIhEs&feature=youtu.be) to derive the formula for volume of a sphere.
* Student activity: Students build two or more basic solids from their nets or using Lego or unit blocks.
* They calculate the surface area and volume of each shape.
* Next, they create a composite solid of their choice (made from their basic solids).
* Students then calculate the surface area and the volume of the composite solid.
* In pairs, students discuss the similarities and differences in these calculations.
* Students then present their solids to the class, for a whole class discussion.
* In this activity, students learn to recognise that the volume of a composite solid is equal to the addition of its component shape, while the surface area of a composite solid cannot be found with straight addition due to the “invisible” surfaces.
* Students could apply algebraic and/or geometric skills to find a missing dimension of a shape in order to find its volume.
* Student activity: Students to investigate how much rainwater can be collected from their roof in a year and determine the most suitable size tank for a given roof.
* Data is widely available on the internet. For example, useful information and data regarding rainfall can be found at the [Australian Bureau of Meteorology](http://www.bom.gov.au/) and [Sydney Water](http://www.sydneywater.com.au/SW/index.htm) websites.
* The catchment area of a roof is the ‘plan view area’ of the roof and not the actual area of the roofing material. It should be noted that the roof catchment area for single-storey houses is usually greater than the floor area if the house has eaves.
* Compare their findings to the following rule-of-thumb approach to estimating the collection capacity of a roof: every 1 millimetre (mm) of rain = 1 litre (L) of water per square metre (m2) of roof area, and then allow for a 15% wastage factor
* Compare the amount of water used by their household and the amount of rainfall that could be collected over a given period
* Student activity: Perform calculations to compare the amount of water used by products with various ratings, eg dishwashers and washing machines
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| Use Trapezoidal rule to approximate the area and volume or irregular shapes(3 lessons) | * calculate perimeters and areas of irregularly shaped blocks of land by dissection into regular shapes including triangles and trapezia **AAMPaperclip icon**
* derive the Trapezoidal rule for a single application,

$$A≈\frac{h}{2}(d\_{f}+d\_{l})$$* use the Trapezoidal rule to solve a variety of practical problems with and without technology, eg the volume of water in a swimming pool  Information and communication technology capability icon
* solve problems involving perimeters, area, surface area, volumes and capacity in a variety of contexts **AAM**
 | **Area of irregular shapes*** Use a map of a residential land estate that involves irregular shapes. Discuss how to dissect a specific land area into regular shapes.
* Student activity: Students take the measurements of an irregular block of land in their community (their house, a local park, etc.). They can create a scale plan of this area and break up the area into triangles, rectangles and trapezia. Students then calculate the total perimeter and area, discuss the measurement errors, limitations and approximations and may compare with the official measurements (the known area of their block of land, the area of the park taken from the council records etc., measurements from [Google Earth](https://earth.google.com/static/) , [Google maps](https://www.google.com.au/maps) or [Six Maps](https://maps.six.nsw.gov.au/)
* This activity can be extended into, for example, calculating the ratio of the built in areas and green areas in their suburb.
* An alternative extension activity if using the area that they have found to calculate the volume of rain that falls over this area in a ‘typical’ month. This can then be converted into the volume of runoff that would be generated if an area was changed from green space to concrete. Rainfall data is available at the [Bureau of Meteorology](http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp).

**Exemplar Question*** The diagram below represents a field.

The diagram shows a field divided into strips.Use the Trapezoidal rule to find the area of the field.Resource: ms-m1-nesa-exemplar-question-solutions.DOCX |  |  |
| Convert between units of mass(1 lesson) | M1.3 Units of energy and mass* review the use of metric units of mass in solving problems, including grams, kilograms and tonnes, their abbreviations and how to convert between them ◊ Literacy icon
 | **Review units of mass*** Discuss appropriate ways to describe the weight of different objects. E.g. a dump truck can carry tonnes, but the removal of dirt for the North West Sydney Metro tunnel would be measured in Megatonnes.
* Student activity: Quizzes to review units of mass [Kahoot game](https://play.kahoot.it/#/k/621114c2-d836-421e-9ce8-d9e45dc6d82d) and [MathLinks](https://mathsstarters.net/quickquiz)

**Measuring and converting units of mass*** Student activity: Students bring one object from home which they estimate to have a mass of 1kg.
* Students then use the kitchen scales and scientific scales to check the actual weight of the object, express the weight in grams and kilograms and determine the error of measurement.
* Student activity: Students check the advertised weight of different items eg cans of food, packets of chipsResource: do-supermarkets-lie.DOCX

Exemplar QuestionA machine piece called a cam is in the form of a truncated cone as illustrated in the diagram. 6 cm9 cm$x$ cm21 cmNOT TOSCALE* 1. Use similar triangles to find the dimension labelled$ x$.
	2. Find the volume of the cam.
	3. It is known that the mass of steel is 7 850 kg/m3. Use this information to find the mass of the cam correct to the nearest gram.

Resource: ms-m1-nesa-exemplar-question-solutions.DOCX |  |  |
| Converts between units of energy(1 lesson) | * use metric units of energy to solve problems, including calories, kilocalories, joules and kilojoules, their abbreviations and how to convert between them ◊
 | Introducing units of energy* Joules and watts are SI units which students may not have encountered before.
* Scientifically, a calorie is the energy required to raise the temperature of 1 gram of water through 1°C. This is a very small amount of energy and is usually referred to as kilocalories (kcal or Cal). Note that cal and Cal are two different abbreviations. Cal=kilocalorie whereas cal=calorie and 1 Cal = 1000 cal. This is a good opportunity to link abbreviations and their size to prior learning. (kilo, Mega, Giga etc).
* Due to the confusion between energy from food (energy in) being measured in calories and energy use (energy out) being measured in joules, it is useful for students to be able to convert between the two measures. There are many websites dealing with calorie and joule conversions. Linking teaching to PDHPE units of work may also be useful.
* Student activity: Students research the required [daily energy intake of males and females](http://www.nutritionaustralia.org/national/resource/balancing-energy-and-out) of different ages in different countries. They can compile their findings in a table and discuss the reasons and implications for differences between different cultures.
* Students then bring one item of packaged food with the energy description (or use a fitness application on their mobile phones) and calculate what percentage of daily intake it represents for different cultures.
* This activity can be carried out in different units of energy and used for practical applications of energy unit conversions.
* It can also be extended to research into the required energy intake for different athletes (see article on [Usain Bolt’s energy intake](https://theconversation.com/what-food-does-it-take-to-fuel-athletes-like-usain-bolt-to-olympic-success-64074)). Students can focus on the sports discipline that they are most interested in and then compare their results in class discussion.
 |  |  |
| Calculate the energy and mass of different foods(3 lessons) | * use units of energy and mass to solve problems related to food and nutrition, including calories ◊ Personal and social capability icon
 | Calories vs kilojoules* Although the kilojoule (kJ) is the Australian measure of the energy value of food or drink, many nutritional information panels on Australian food labels also include information about what we call ‘calories’ (Cal) but which are actually kilocalories (kcal). This can be confusing and so the following conversions are provided:
* 1 cal $≈$ 4.186 8 J
* 1000 cal $=$ 1 kcal $=$ 1 Cal $≈$ 4.186 8 kJ**Resource:** [You Say Calorie, We Say Kilojoule: Who’s Right?](http://www.coca-colajourney.com.au/stories/you-say-calorie-we-say-kilojoule-whos-right)

Energy in food* There are many websites with information relating to food and nutrition. This is an excellent opportunity to use Excel to generate graphs to compare any data collected during research.
* If a significant number of students complete PDHPE, links with course content would be helpful.
* Student activity: Students use the [Find your ideal figure](https://www.8700.com.au/) website to research their daily kilojoule needs.
* Student activity: Compare different food groups and calculate their rate of energy consumption compared to their mass using [Find your ideal figure](https://www.8700.com.au/)
* Student activity: Students research different sources of nutritional information (see resources list). For example, students can research the nutritional value of a [Subway](https://www.subway.com/en-AU/MenuNutrition/Nutrition) foot long and compare it to a [McDonald’s](https://mcdonalds.com.au/maccas-food/nutrition) item.
* Is Subway really a healthy alternative? Discussion points could include: What extra calculations were required to find the content of your particular meal? Could these calculations be misleading? Do these differ between countries? If so, why?
* Student activity: Students research appropriate online or mobile applications that can assist in the converting of units.
* Student activity: Students calculate a particular food item’s RDI (Recommended Dietary Intake) percentage.
* Student activity: Students investigate the menu of the school canteen. They choose an item each and calculate its nutrition and energy value. Those calculations can then be used to display in the canteen and to determine what percentage of daily intake a chosen canteen meal represents.
* Student Activity: Students record their energy in and energy out for a 5 day period using the MyFitnessPal website/appResources
* energy-in-versus-energy-out.DOCX
* [Using MyFitnessPal with my students](https://www.theedublogger.com/2016/01/29/myfitnesspal/)
 |  |  |
| Calculate the amount of energy expended when completing different activities(2 lessons) | * use units of energy to solve problems involving the amount of energy expended in activities, for example kilojoules ◊ Personal and social capability icon
 | **Energy in exercise*** Reinforce and extend the concept $Weight loss/gain=energy in-energy out$ so students are able to work with rates such as energy used per hour of an activity.
* Student activity: If students have access to fitness trackers, they could record the calories burnt whilst all completing the same activity for the same period of time.
* Discussion points could include: The range of calories burned by different students and the reason for this; the average number of calories burned
* Students could then compare this energy output, with the energy burnt whilst completing a different type of activity.
* Students could compare the energy used whilst running compared to lifting weights for the same period of time.
* Student activity: If fitness trackers are not available, students could use the [BUPA energy burned calculator](https://www.bupa.com.au/healthlink/health-tools/energy-burned-calculator) or [8700 activity comparison](https://www.8700.com.au/balance-and-burn/kj-activity-comparison/) websites to look at the energy burned from different activities.
 |  |  |
| Calculate the energy consumption of various appliances(2 lessons) | * use units of energy to solve problems involving the consumption of electricity, for example kilowatt hours, and investigate common appliances in terms of their energy consumption **AAM** ◊ Sustainability icon Literacy icon
 | Energy in household appliances* The watt is the International System of Units (SI) derived unit of power and is equal to one joule per second. By definition, power is a rate. The symbol for the watt is W.
* One watt-hour is the amount of energy (usually electrical) expended by a one-watt load (eg a light bulb) drawing power for one hour. The watt-hour (symbol W·h or Wh) is a unit of energy. It is most commonly used on household electricity meters in the form of the kilowatt-hour (kW·h or kWh), which is 1000 watt-hours.
* Quantities and units may be expressed in both decimal form and standard form eg 6.8 $×$ 103 MW or 6 800 000 kW.
* Conversion of units is to be based on the table of units below:

Table of units of power from milliwatts to gigawatts.**Energy usage in the home*** Use different energy rates to calculate the cost of electricity.
* Use two way tables to interpret energy consumption/production with varying factors. E.g. air cons with heating and cooling, solar panel production direction and angle.
* Student activity: Students investigate the requirements for [Energy Efficient Homes](http://splash.abc.net.au/res/i/L895/index.html). They could then compare this to the BASIX requirements for a [Single dwelling](https://www.basix.nsw.gov.au/iframe/getting-started/dwelling-types/single-dwelling.html)
* Student activity: Students to read [Reduce energy bills](https://www.energy.gov.au/household-guides/reduce-energy-bills) and write a list of ways they can save money on their energy bill.
* Student activity: Students investigate the cost of electricity in different states of Australia.
* The [Office of the Chief Economist](https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Australian-energy-statistics.aspx) publishes a range of annual reports and statistics about Australian Energy use which can be used to link this topic to the Statistics outcomes. There is a lot of data available on this site. Teachers should use it as a teaching resource, rather than a site to direct students towards.
* Student activity: Students make a list of electric appliances which they personally use every day (an iron, a hairdryer, a laptop etc.). They can attempt to order appliances based on their assumed electricity consumption, and then research the actual electricity consumption of this item.
* This can be done for one day, one week or each year.
* Students can then calculate their annual personal energy usage and expenditure.
* Students could compare their personal usage to national statistics of [home appliance usage](http://www.yourhome.gov.au/energy/appliances)

**Energy ratings and labels*** Student activity: Students to research energy labels and [Energy rating](http://www.energyrating.gov.au/)s.
* They could then research the cost of an appliance, such as a washing machine, and calculate how long it would take to pay back the extra cost of buying a higher rated machine.
* Student activity: Students could investigate the cost of purchasing and installing solar panels [Solar Choice](https://www.solarchoice.net.au/) . They could then determine how long it would take to re-coop these costs.
* Students could discuss the question “Which way should solar panels point?” They could check their answers by referring to the [Solar panel direction](https://www.solarquotes.com.au/panels/direction/) website

**Exemplar Questions**1. Calculate the cost of running a 200-watt television set for six hours if the average peak rate for domestic electricity is $0.15/kWh.
2. Calculate the cost of running a 2400-watt (2.4 kW) fan heater for eight hours per day for 30 days. Assume electricity is charged at $0.18/kWh.

Resource: ms-m1-nesa-exemplar-question-solutions.DOCX  |  |  |

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.