Phase 1- Shelters | Stage 2 | Science and Technology K-6

Summary	Duration
Students will investigate the relationship between the 'purpose' of built environments and the 'features' required to meet the purpose. Students identify an area in their school that needs a shelter and design a suitable model. They write a design brief, and include a budget set by the school.	Sample term 9 weeks Detail: End of stage

Teacher Background Information

This unit provides students with an opportunity for an integrated STEM approach to teaching and learning. They will apply mathematical calculations, scientific skills and a process of design to identify a need, research and develop a design solution, work collaboratively, and to document, present and evaluate their solution.

Students investigate current shelters in use, research the need, area and size requirements for a shelter, and research and test suitable materials for the design. Students use skills in measurement, including length, width, area and perimeter, and use multiplication and division to draw to scale. Students provide labelled diagrams and a three-dimensional model for their design, along with a short persuasive proposal or submission. They jointly develop criteria for assessing learning and providing feedback to their peers.

Key inquiry questions	Vocabulary
▪ In what ways does the design of locally built environments meet the needs of users? ▪ What are the factors that need to be considered when designing and constructing built environments? ▪ How can built environments be modified to suit the needs of users? ▪ How can we apply the processes of Working Technologically to better meet our needs in a built environment at our school?	access, aesthetic, analyse, angle, approximate, architect, area, brainstorm, brief, budget, built, categories, centimetres, collated, community, consideration, construction, cost, criteria, design, dimension, drawing, engineer, environment, expert, features, feedback, impact, issue, length, map, measure, metres, millimetres, mind, model, movement, perimeter, potential, predict, purpose, refine, ruler, scale, scaled, scientist, sketch, solution, storyboard, strategy, structure, table, tape, trundle, typical, wheel

Outcomes

Science K-10 (inc. Science and Technology K-6)

- › ST2-4WS investigates their questions and predictions by analysing collected data, suggesting explanations for their findings, and communicating and reflecting on the processes undertaken
- › ST2-5WT applies a design process and uses a range of tools, equipment, materials and techniques to produce solutions that address specific design criteria
- › ST2-13MW identifies the physical properties of natural and processed materials, and how these properties influence their use
- › ST2-14BE describes how people interact within built environments and the factors considered in their design and construction

Mathematics K-10

- › MA2-1WM uses appropriate terminology to describe, and symbols to represent, mathematical ideas
- › MA2-2WM selects and uses appropriate mental or written strategies, or technology, to solve problems
- › MA2-3WM checks the accuracy of a statement and explains the reasoning used
- › MA2-5NA uses mental and written strategies for addition and subtraction involving two-, three-, four- and five-digit numbers
- › MA2-6NA uses mental and informal written strategies for multiplication and division
- › MA2-9MG measures, records, compares and estimates lengths, distances and perimeters in metres, centimetres and millimetres, and measures, compares and records temperatures
- › MA2-10MG measures, records, compares and estimates areas using square centimetres and square metres

Content	Teaching, learning and assessment	Student diversity
Stage 2 - Built Environments People interact in varying ways within built environments. ▪ observe how people interact within a built environment and describe how its design meets the needs of the users, eg the ways people use and interact in a local shopping centre or playground ▪ survey a range of places and spaces in local built environments and identify how people interact within them for a range of purposes for social and cultural reasons, eg use of the local hall for a school play or use of local playing fields for sport A range of factors needs to be considered when designing and constructing built environments. Students: ▪ examine some built environments, eg a local playground or shopping centre, and identify some factors that have been considered in the design, such as purpose, access, aesthetic	**Lesson 1: Built environments at school** **Teacher background information** *Students identify built environments in the school and identify the factors for consideration in their design. Prior to the lesson they should demonstrate appropriate knowledge, understanding and skills in posing suitable questions and data collection. Built environments may include halls, tiered learning spaces, libraries, classrooms, computer rooms, playgrounds, basketball court shade shelters, outdoor classrooms, amphitheatres, playground equipment.* **Whole-class activity** Students complete a short tour around the school and either take photographs of the various built environments OR sketch three or four built environments and label key features. Students make notes about the following questions as they complete the tour. Students pose suitable questions and create categories in a table for data collection. These may include: ▪ How is each built environment used? ▪ How does the capacity of each built environment vary and what can be done to manage the number of	**Support** ▪ Students can discuss the features of each of the structures and record their observations using a recording device rather than record in written form.

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and environmental considerations, and movement within the space ▪ describe how the design and construction of a built environment may be modified to better suit the needs of users Stage 2 - Data 1 Students: Identify questions or issues for categorical variables; identify data sources and plan methods of data collection and recording (ACMSP068) ▪ recognise that data can be collected either by the user or by others ▪ pose questions about a matter of interest to obtain information that can be recorded in categories ▪ predict and create a list of categories for efficient data collection in relation to a matter of interest, eg 'Which breakfast cereal is the most popular with members of our class?' Collect data, organise it into categories, and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies (ACMSP069) ▶ use computer software to create a table to organise collected data, eg a spreadsheet (Communicating)	occupants? ▪ What are the key features of each built environment and do the designs enhance the features? ▪ What aesthetic and environmental considerations need to be considered? ▪ What two main features make them different from other built environments and why? Use computer software to create a table and record ideas. **Concluding discussion** Was the data collection efficient? What could have been improved? **Home activity** Students find an image of a shelter from their local environment in preparation for the next lesson. Examples include: ▪ shopping centre ▪ dog kennels ▪ tent ▪ pool or aquatic centre ▪ playing fields ▪ playground ▪ community hall.	
Stage 2 - Built Environments People interact in varying ways within built environments. Students: ▪ observe how people interact within a built environment and describe how its design meets the needs of the users, eg the ways people use and interact in a local shopping centre or playground ▪ survey a range of places and spaces in local built environments and identify how people interact within them for a range of purposes for social and cultural reasons, eg use of the local hall for a school play or use of local playing fields for sport	**Lesson 2: Built environments in the local community** **Teacher background information** *Students identify the needs of built environments. They describe how the design meets certain needs of users as they interact:* ▪ *in different ways with the space* ▪ *for different purposes (social and cultural).* **Whole-class activity** Students share the shelter images brought from home. Explore how the design of each space meets its purpose.	**Support** ▪ Teachers should provide some shelter images to students who do not have the ability to collect images themselves. ▪ Students may search the internet to access images of a range of shelters.

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A range of factors needs to be considered when designing and constructing built environments.
Students:
▪ examine some built environments, eg a local playground or shopping centre, and identify some factors that have been considered in the design, such as purpose, access, aesthetic and environmental considerations, and movement within the space
▪ describe how the design and construction of a built environment may be modified to better suit the needs of users
Stage 2 - Material World
Natural and processed materials have a range of physical properties which influence their use. (ACSSU074)
Students:
▪ identify the properties of some natural and processed materials
▪ describe how a range of common natural and processed materials are used in everyday life
▪ generate ideas about how the physical properties of some natural and processed materials influence their use
	Group activity
	▪ Establish teams of three or four
	▪ Present a local community-built environment to each team
	▪ Students describe the ways people interact in their allocated built environment and consider how the design addresses its purpose:
	  ▪ What are the key features? What features could be improved?
	  ▪ What are the aesthetic and environmental considerations?
	  ▪ Modification. How could the design and construction of the built environment be modified to better suit its purpose?
	
	Whole-class activity
	▪ Discuss how these built environments were designed and constructed with their purpose in mind. What modifications will better meet the needs of users?
	▪ Who might be involved in designing and constructing built environments at school and in the community?
	▪ What Mathematics and Science skills would they use?
	▪ View the *What is Engineering* video by the University of Newcastle, to clarify ideas and motivate students. Can be found: http://splash.abc.net.au/home#!/media/2061575/what-is-engineering
	
	Design challenge
	▪ Recap the key ideas in the video, highlighting that engineering is about solving problems to make life better.
	▪ Explain to students they need to think like engineers to complete their own design challenge.
	▪ The challenge is to design a shelter for a part of the school.
	
	Concluding thoughts
	▪ What questions might engineers and designers ask before they start a project?
	▪ How can questions be helpful in setting criteria?	

Stage 2 - Built Environments People interact in varying ways within built environments. Students:	**Lesson 3: Our built environment needs** **Teacher background information**	**Optional** If possible, a guest speaker (a builder or the school general

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▪ observe how people interact within a built environment and describe how its design meets the needs of the users, eg the ways people use and interact in a local shopping centre or playground ▪ survey a range of places and spaces in local built environments and identify how people interact within them for a range of purposes for social and cultural reasons, eg use of the local hall for a school play or use of local playing fields for sport Stage 2 - Working Technologically Students explore and define a task by: ▪ exploring design situations and/or existing solutions relevant to the needs and wants of themselves and others ▪ working individually and collaboratively to develop a design brief that identifies simple design criteria relating to requirements that make the proposed solution useful and attractive while having minimal impact on the environment Students generate and develop ideas by: ▪ using creative thinking techniques, including brainstorming, mind-mapping, sketching and modelling ▪ using techniques, including labelled drawings, modelling and storyboarding, for documenting and communicating design ideas Stage 2 - Working Scientifically Students plan investigations by: ▪ working collaboratively and individually, to suggest ways to plan and conduct investigations to find answers to questions (ACSIS054, ACSIS065) ▪ identifying where Working Scientifically might inform or test elements of Working Technologically in relation to established criteria Students process and analyse data and information by: ▪ using a range of methods including tables and simple column graphs to represent data and to identify patterns and trends,	*Students are placed into groups of three for STEM groups. This is similar to what would happen in a real-life engineering situation. Identify a built environment suitable for the activity. As this is a design project the area does not need to be constructed. However, finding an area that could be constructed may encourage greater engagement and motivation from the students.* *Examples may include: a covered bus shelter, shaded picnic area, herb garden, greenhouse, undercover sandpit/play area, shaded play area, safer bus area.* **Design challenge** Students select a location for a shelter and design a suitable model Students will: ▪ work in small groups ▪ have a set criteria/design brief ▪ adhere to a budget ▪ be judged, using jointly developed criteria, by the teacher/principal/executive/qualified builder or school general assistant. **Design planning** As a class identify the following information about the shelter: ▪ purpose ▪ needs ▪ wants ▪ materials ▪ location Access the selected site and identify other needs (eg protection from falling tree debris, rain, sun, wind, visibility so teachers can see students). What common natural and processed materials are used here? Why? **STEM group activity** Divide the class into groups of three. Discuss the concept of team work and social conventions of collaborative group work, including: ▪ developing friendly and polite relationships	assistant) may be invited to speak to students about the best materials to use and to answer any design questions.

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using digital technologies as appropriate (ACSIS057, ACSIS068) Stage 2 - Material World Natural and processed materials have a range of physical properties which influence their use. (ACSSU074) Students: ▪ identify the properties of some natural and processed materials ▪ describe how a range of common natural and processed materials are used in everyday life ▪ generate ideas about how the physical properties of some natural and processed materials influence their use	▪ turn-taking and listening to the ideas of others ▪ how to clarify and extend on the ideas of others ▪ taking notes of all ideas and agreeing on ideas as a group ▪ sharing roles to divide and conquer. Plan ideas for the shelter design. Planning activities should include: ▪ brainstorming ▪ mind mapping ▪ labelled sketches ▪ storyboarding. Provide students with graph paper to record their ideas. Students may wish to use ICT resources to plan and document their ideas. Ipad apps: ▪ Geometry Pad By Bytes Arithmetic LLC ▪ bubbl.us By LKCollab LLC ▪ Popplet Lite By Notion ▪ MindMeister By MeisterLabs ▪ SimpleMind+ By xpt Software & Consulting B.V. Links: ▪ Gliffy https://www.gliffy.com/ ▪ Bubbl.us https://bubbl.us/ ▪ Text2mindmap https://www.text2mindmap.com/	
Stage 2 - Built Environments People interact in varying ways within built environments. Students: ▪ observe how people interact within a built environment and describe how its design meets the needs of the users, eg the ways people use and interact in a local shopping centre or playground ▪ survey a range of places and spaces in local built environments and identify how people interact within them for a range of purposes for social and cultural reasons, eg use of the local hall	**Lesson 4: The design brief** **Teacher background information** *Information about writing a design brief: http://www.technologystudent.com/designpro/problem1.htm* **Whole-class activity** Referring to last week's lesson, discuss the purpose and key requirements of the design. Explain again the importance of designing to suit a purpose. For a shelter this may include: ▪ shelter from sun/rain	**Support** ▪ Provide a scaffolded design brief for students to elaborate on.

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for a school play or use of local playing fields for sport Stage 2 - Working Technologically Students explore and define a task by: ▪ working individually and collaboratively to develop a design brief that identifies simple design criteria relating to requirements that make the proposed solution useful and attractive while having minimal impact on the environment Stage 2 - Working Scientifically Students plan investigations by: ▪ working collaboratively and individually, to suggest ways to plan and conduct investigations to find answers to questions (ACSIS054, ACSIS065) Students process and analyse data and information by: ▪ using a range of methods including tables and simple column graphs to represent data and to identify patterns and trends, using digital technologies as appropriate (ACSIS057, ACSIS068) Stage 2 - Data 1 Students: Identify questions or issues for categorical variables; identify data sources and plan methods of data collection and recording (ACMSP068) ▪ recognise that data can be collected either by the user or by others ▪ identify possible sources of data collected by others, eg newspapers, government data-collection agencies, sporting agencies, environmental groups ▪ pose questions about a matter of interest to obtain information that can be recorded in categories ▪ predict and create a list of categories for efficient data collection in relation to a matter of interest, eg 'Which breakfast cereal is the most popular with members of our class?'	▪ protection from tree debris ▪ teacher and student visibility ▪ seating ▪ environmentally considered materials ▪ plants ▪ entertainment **Developing the design brief** ▪ Clearly identify the need (problem). ▪ Outline the process that will be followed to achieve a design solution. ▪ Propose a range of solutions and identify the best solution. ▪ Test the solution, make the necessary modifications then retest. ▪ Evaluate the solution. Writing a design brief http://www.technologystudent.com/designpro/problem1.htm Brainstorm the design brief elements, such as: ▪ the need (problem) ▪ identify the issues the design solution needs to address ▪ the key features of the proposed solution to suit the purpose (including safety, general size, functions, budget, general properties and descriptions of the materials needed) ▪ how the proposed solution addresses the need identified in the design brief ▪ the proposed solution's environmental impact. Students write their design brief. Start the brief with, *'I am going to design and make...'* **Investigation** In groups: ▪ What are the limitations to consider when we begin our design? (For example, seating/ furniture, sunlight exposure / position of planting, size restrictions.) As a class, discuss options. ▪ Consider existing amenities in the school. For example, seating. What is the main type of seating we use outdoors? Why do you think we use this? What features make it suitable?	

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	STEM group activity Students draw a table or use appropriate ICT tools to list ideas, websites, costs, dimensions, notes etc. Students' research features for their design, using appropriate resources, including ICT tools. They should: ▪ consider the cost compared to the quality ▪ take note of dimensions ▪ recognise the importance of size and budget (*The bigger it is, the greater the cost of materials eg roofing*). **Concluding activity** Students: ▪ review their design brief ▪ edit and add any additional information from the lesson How might scientists and engineers organise their design information and questions? ▪ How can tables clearly display data? ▪ How does setting data out in a table make it more effective/easier to read, find data, record data? Students modify their tables if appropriate.	
Stage 2 - Length 1 Students: Measure, order and compare objects using familiar metric units of length (ACMMG061) ▪ measure lengths and distances using metres and centimetres ▪ record lengths and distances using metres and centimetres, eg 1 m 25 cm ▪ compare and order lengths and distances using metres and centimetres ▪ estimate lengths and distances using metres and centimetres and check by measuring ▶ explain strategies used to estimate lengths and distances, such as by referring to a known length, eg 'My handspan is 10 cm and my desk is 8 handspans long, so my desk is about 80 cm long' (Communicating, Problem Solving)	**Lesson 5: Dimension investigation** **Teacher background information** *Students use their skills in measurement to plan the dimensions of the shelter. It is essential they have accuracy in using centimetres, metres and millimetres.* **Pre-investigation** Provide students with appropriate learning activities to develop skills in measurement (metres, centimetres and millimetres) using metre rulers or tape measures. Activities may include: ▪ strategies for measuring and estimating ABC Splash '*Ruler or tape measure*' ▪ appropriate tools for measuring ABC Splash *'Measuring length and distance'* ▪ measuring cm and mm http://www.e-learningforkids.org/math/lesson/food-market-centimetres-millimetres/ ▪ ensuring students line up the zero on the ruler/tape with the object being measured, not just the end of the	

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▪ recognise the need for a formal unit smaller than the centimetre to measure length ▪ recognise that there are 10 millimetres in one centimetre, ie 10 millimetres = 1 centimetre ▪ use the millimetre as a unit to measure lengths to the nearest millimetre, using a ruler ▶ describe how a length or distance was measured (Communicating) ▪ record lengths using the abbreviation for millimetres (mm), eg 5 cm 3 mm or 53 mm ▪ estimate lengths to the nearest millimetre and check by measuring Stage 2 - Length 2 Students: Use scaled instruments to measure and compare lengths (ACMMG084) ▪ use a tape measure, ruler and trundle wheel to measure lengths and distances ▶ select and use an appropriate device to measure lengths and distances (Problem Solving) ▪ select and use an appropriate unit to estimate, measure and compare lengths and distances	ruler or measuring device ▪ measuring lengths and distances using metres and centimetres and recording lengths and distances as metres and centimetres, eg 1 m 25 cm ▪ comparing and ordering a range of lengths ▪ estimating different lengths and distances using metres and centimetres and checking by measuring ▪ explaining strategies used to estimate lengths and distances, such as by referring to a known length, eg *'My hand span is 10 cm and my desk is 8 hand spans long, so my desk is about 80 cm long'* ▪ measuring and explaining how a unit smaller than the centimetre is needed when measuring length ▪ measuring and recording lengths using millimetres ▪ estimating lengths to the nearest millimetre and checking by measuring. **Ruler or tape measure?** TFL-ID M017975: http://www.scootle.edu.au/ec/resolve/view/M017975 **Centimetres** TFL-ID M012310: http://www.scootle.edu.au/ec/resolve/view/M012310 **Site investigation** Visit the proposed area for the shelter. Students: ▪ estimate the size of the area ▪ estimate the size limitations of the shelter ▪ share strategies to help them estimate, eg *'1 large step is around 1 m so if the shelter is going to be 6 big steps, I estimate that will be about 6 metres'* ▪ photograph the area and label the dimensions for the shelter. Students work in their STEM groups to accurately measure the length and width of the shelter using trundle wheels and/or metre rulers and measuring tapes **Concluding discussion** Students reflect and consider: ▪ How accurate were we in estimating the dimensions? ▪ What strategies were helpful? Which strategies could we try next time?	

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Stage 2 - Built Environments People interact in varying ways within built environments. Students: ▪ observe how people interact within a built environment and describe how its design meets the needs of the users, eg the ways people use and interact in a local shopping centre or playground A range of factors needs to be considered when designing and constructing built environments. Students: ▪ describe how the design and construction of a built environment may be modified to better suit the needs of users Stage 2 - Working Technologically Students generate and develop ideas by: ▪ using creative thinking techniques, including brainstorming, mind-mapping, sketching and modelling ▪ using a range of research techniques to access information relevant to the task ▪ using techniques, including labelled drawings, modelling and storyboarding, for documenting and communicating design ideas	**Lessons 6: Generating ideas** **Teacher background information** *Provide students with examples of similar shelters to support students to develop their Working Technologically skills. Students should make models out of simple materials such as cardboard and paddle pop sticks in order to investigate the construction of their shelter.* **Whole-class activity** Develop the criteria for assessing the shelter. Students should refer to the design brief to determine key elements and the criteria for assessing learning when designing and making their shelter. **STEM group activity** Students generate a mind map that incorporates all ideas from the group. Consider having headings for the points on the design brief to ensure all requirements are met. How are opposing ideas addressed? (Include both ideas and later select the better design.) Students may wish to use ICT resources to plan and document their ideas. .iPad apps: ▪ Geometry Pad By Bytes Arithmetic LLC ▪ bubbl.us By LKCollab LLC ▪ Popplet Lite By Notion ▪ MindMeister By MeisterLabs ▪ SimpleMind+ By xpt Software & Consulting B.V. Links: ▪ Gliffy https://www.gliffy.com/ ▪ Bubbl.us https://bubbl.us/ ▪ Text2mindmap https://www.text2mindmap.com/ Students: ▪ use a range of resources for the shelter design ▪ investigate different methods of construction by making 3D models of their shelter ▪ add new ideas to their mind map and discuss which are the most appropriate ▪ sketch and annotate (make notes on) the design. Refer to the design brief and the budget ▪ research other items for the shelter eg seating, materials etc.	

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Stage 2 - Built Environments A range of factors needs to be considered when designing and constructing built environments. Students: ▪ examine some built environments, eg a local playground or shopping centre, and identify some factors that have been considered in the design, such as purpose, access, aesthetic and environmental considerations, and movement within the space ▪ describe how the design and construction of a built environment may be modified to better suit the needs of users Stage 2 - Length 1 Students: Measure, order and compare objects using familiar metric units of length (ACMMG061) ▪ measure lengths and distances using metres and centimetres ▪ record lengths and distances using metres and centimetres, eg 1 m 25 cm ▪ estimate lengths and distances using metres and centimetres and check by measuring ▶ explain strategies used to estimate lengths and distances, such as by referring to a known length, eg 'My handspan is 10 cm and my desk is 8 handspans long, so my desk is about 80 cm long' (Communicating, Problem Solving) ▪ recognise the need for a formal unit smaller than the centimetre to measure length ▪ recognise that there are 10 millimetres in one centimetre, ie 10 millimetres = 1 centimetre ▪ use the millimetre as a unit to measure lengths to the nearest millimetre, using a ruler ▶ describe how a length or distance was measured (Communicating)	**Lesson 7: Investigating environmental conditions** **Teacher background information** *Students investigate the impact and effects of wind and rain.* *Water can be represented with a piece of ribbon tied on a pole positioned next to a pedestal fan. The class could then observe the impact on the ribbon (angles) when the fan is increased in intensity. This links to the impact of wind on the direction of the rain. Given that rain always falls straight down, the only variable that affects its direction is the wind.* *An extension activity uses a spray bottle in front of and above a fan and looking at the impact. Students can then potentially test their models with this technique.* *Equipment:* ▪ *rain resource sheets* ▪ *ribbon* ▪ *pedestal fan* ▪ *spray bottle.* *Provide students with appropriate learning activities to review skills in measurement (metres, centimetres and millimetres), using metre rulers or tape measures as appropriate.* **Whole-class discussion** ▪ What environmental impacts should be considered? ▪ How would modifications to our shelter reduce the impact of weather? For example, roof widths and overhang. **Whole-class activity** How can we use Working Scientifically skills to investigate this problem? Students: ▪ suggest appropriate tools and equipment *(prompt students to use everyday items such as pedestal fan and ribbon)* ▪ suggest how they might conduct an investigation *(see teacher background information)* ▪ identify questions that can be investigated ▪ determine how they will collect data.	**Extension** ▪ Students research typical/recommended roof overhangs in different settings and consider this in their own design. **Extension** ▪ Students use a spray bottle in front of and above a fan and look at the impact. Students can then test their models with this technique.

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▪ record lengths using the abbreviation for millimetres (mm), eg 5 cm 3 mm or 53 mm Stage 2 - Working Scientifically Students question and predict by: ▪ using curiosity, prior knowledge, experiences and scientific information with guidance, identifying questions in familiar contexts that can be investigated scientifically (ACSIS053, ACSIS064) Students plan investigations by: ▪ working collaboratively and individually, to suggest ways to plan and conduct investigations to find answers to questions (ACSIS054, ACSIS065) ▪ suggesting appropriate materials, tools and equipment they could use in conducting their investigations and recording their findings, identifying appropriate safety rules	Using the pedestal fan and ribbon, students: ▪ discuss the distance the roof would have to overhang to stop people from getting wet inside the shelter (gain understanding of necessary overhang for the roof).	
Stage 2 - Working Technologically Students generate and develop ideas by: ▪ using a range of research techniques to access information relevant to the task ▪ using techniques, including labelled drawings, modelling and storyboarding, for documenting and communicating design ideas ▪ using digital technologies and multimedia for communicating design ideas ▪ refining ideas in responding to feedback from others Stage 2 - Material World Natural and processed materials have a range of physical properties which influence their use. (ACSSU074) Students: ▪ generate ideas about how the physical properties of some natural and processed materials influence their use	**Lesson 8: Seeking expert advice** **Teacher background information** *Optional: invite guest speakers and experts in the field such as the school general assistant to:* ▪ *develop student understanding* ▪ *provide advice on the shelter design* ▪ *answer student questions.* **Whole-class discussion** Discuss the: ▪ importance of speaking to experts in the field to gain advice/design tips ▪ value of constructive criticism.(*Remind students that designs frequently change, sometimes numerous times, to achieve a final design that is accepted by all involved. This is a learning process.)* Students could email relevant questions to appropriate 'experts' to seek information and feedback. **STEM group activity**	**Option** ▪ Invite a guest speaker to talk about the design process and the choice of possible materials. Students: ▪ prepare questions for the guest speaker ▪ take notes using a mind map ▪ ask questions about the design and the possible materials ▪ consider the guest speaker's ideas and decide if they want to use them to improve the design ▪ show some of their sketches and ask questions about which materials or designs the expert

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	Students use the knowledge gained from the guest speaker to review and amend the design and mind map.	would recommend Expert: ▪ identifies potential issues ▪ reviews students' design plans.
Stage 2 - Working Technologically Students explore and define a task by: ▪ working individually and collaboratively to develop a design brief that identifies simple design criteria relating to requirements that make the proposed solution useful and attractive while having minimal impact on the environment Students generate and develop ideas by: ▪ using creative thinking techniques, including brainstorming, mind-mapping, sketching and modelling ▪ using a range of research techniques to access information relevant to the task ▪ using techniques, including labelled drawings, modelling and storyboarding, for documenting and communicating design ideas ▪ using digital technologies and multimedia for communicating design ideas ▪ refining ideas in responding to feedback from others	**Lesson 9: Designing and researching** **Teacher background information** *Students research bus shelters, car ports, awnings, gazebos, etc. The teacher may determine shelter sizes that cover most of the students' designs and request quotes. Students could use the quotes to choose the one appropriate for their needs and budget.* **STEM group activity** ▪ Students continue to research ideas/costs/dimensions/materials, referring to the design brief. ▪ They begin to complete the research phase and have a final product in mind. ▪ Students take notes and amend designs in response to feedback. **Concluding discussion** Presentations must include: ▪ a scaled drawing including the dimensions of the design ▪ the proposed budget breakdown ▪ a 3D model ▪ their mind map(s) ▪ additional visual aids, eg poster, model, digital drawing ▪ a one-minute presentation/speech ready to 'sell' their design to the judges/buyers, explaining how the design solution satisfies the needs identified in the design brief. ICT options: ▪ SketchUp Make free 3D sketch program. Student examples are in the resource pack. Available for most computers including iPads.	**Support:** ▪ Provide a presentation template to help students identify required content and structure their presentation. **Extension** ▪ Students create their designs in SketchUp Make and use the animation tools to create a fly-through/over.
Stage 2 - Working Technologically Students generate and develop ideas by:	**Lessons 10/11: Drawing to scale**	**Extension** ▪ Demonstrate the formula to draw something to your own

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▪ using creative thinking techniques, including brainstorming, mind-mapping, sketching and modelling Stage 2 - Length 1 Students: Measure, order and compare objects using familiar metric units of length (ACMMG061) ▪ record lengths and distances using metres and centimetres, eg 1 m 25 cm ▪ recognise that there are 10 millimetres in one centimetre, ie 10 millimetres = 1 centimetre ▪ use the millimetre as a unit to measure lengths to the nearest millimetre, using a ruler ▸ describe how a length or distance was measured (Communicating) ▪ record lengths using the abbreviation for millimetres (mm), eg 5 cm 3 mm or 53 mm	**Whole-class activity** Review the millimetre and discuss: ▪ 10 millimetres in one centimetre, ie 10 millimetres = 1 centimetre ▪ strategies to measure using centimetres and millimetres ▪ strategies to measure lengths of objects in the shelter, eg a chair, table, plant height, etc. to the nearest millimetre ▪ smaller units of measurements when drawing the shelter to scale. **Whole-class discussion** Ask students how they will accurately draw their design. Explain to students that engineers, architects and scientists use scaled drawings. ▪ View examples of scaled drawings, such as maps, house plans, and identify common features. ▪ Why do we need scaled drawings? Discuss the need for architects to draw accurate plans and builders needing to follow the plan and accurately build the final product. ▪ What problems will occur from inaccurate scaled drawings? For example, If your scale is 1cm=1m and you draw an object 1cm too small on your plan it results in 1m too small in real life. **STEM group activity** ▪ How will we produce a scaled drawing of the shelter? ▪ Refer to the scaled drawing resource sheet. Find the key. What does this mean? How can we use this? ▪ Students draw their shelter to scale.	scale. Divide the final measurement that you want your drawing to be by the actual measurement in your design (eg if you want your picture to fit on your page you may wish it to be no longer than 20cm. Imagine that your actual design is 4m or 400cm long. Calculate 20 divided by 400 = 0.05. 0.05 is now the unit we use to multiply every measurement by. If our next length is 250cm we would work out how long to draw it by 250 x 0.05 = 12.5 so we will draw the length on our page at 12.5cm).
Stage 2 - Length 1 Measure, order and compare objects using familiar metric units of length (ACMMG061) ▪ measure lengths and distances using metres and centimetres ▪ record lengths and distances using metres and centimetres, eg 1 m 25 cm Stage 2 - Area 1 Students: Recognise and use formal units to measure and estimate the areas of rectangles	**Lesson 12: The size of our shelter** **Teacher background information** *Ask students to consider other mathematical skills they can use when working with the known dimensions of the shelter. Encourage them to think about the size and shape of the shelter and the terms 'perimeter' and 'area'.* **Think, pair, share activity** ▪ What is the difference between perimeter and area? ▪ What is perimeter? How do we know? ▪ What is area? How do we know? ▪ Why might it be useful to know the perimeter and area of different aspects of the shelter?	**Support** ▪ Interact with the learning object 'Area and Perimeter'. This interactive resource defines the term 'perimeter', describes how perimeter is calculated and provides opportunities to practise calculating the perimeters of a variety of shapes. There is a link to a

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recognise the need for a formal unit larger than the square centimetre to measure area
construct a square metre and use it to measure the areas of large rectangles (including squares), eg the classroom floor or door

explain where square metres are used for measuring in everyday situations, eg floor coverings (Communicating, Problem Solving)
recognise areas that are 'less than a square metre', 'about the same as a square metre' and 'greater than a square metre' (Reasoning)
recognise that an area of one square metre need not be a square, eg cut a 1 m by 1 m square in half and join the shorter ends of each part together to create an area of one square metre that is rectangular (two metres by half a metre) (Problem Solving, Reasoning)

record areas in square metres using words and the abbreviation for square metres (m^2), eg 6 square metres, 6 m^2
estimate the areas of rectangles (including squares) in square metres

discuss strategies used to estimate area in square metres, eg visualising repeated units (Communicating, Problem Solving)

Stage 2 - Length 2
Use scaled instruments to measure and compare lengths (ACMMG084)

recognise the features of a three-dimensional object associated with length that can be measured, eg length, height, width, perimeter
use the term 'perimeter' to describe the total distance around a two-dimensional shape
estimate and measure the perimeters of two-dimensional shapes

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STEM group activity
Perimeter focus

Students calculate the perimeter of their design using repeated addition, showing all working.
Students construct a square metre and use it to measure the areas of large rectangles, eg desks, tote tray, shelves, classroom floor or door.
They organise these areas into categories: that are 'less than a square metre', 'about the same as a square metre' and 'greater than a square metre'.
Students visualise the square metre and estimate the area of their shelter design.
Pose the question, 'Does the square metre always have to be a square?' Investigate.
Students record the square metre using the abbreviation, eg 6 square metres, 6m^2.
Discuss an alternative method to work out the area by multiplying length by width.
Students calculate the area of their design and show all working.

Scootle Resources:
Lengths and areas TFL-ID M013355: http://www.scootle.edu.au/ec/resolve/view/M013355
Area explorer TFL-ID M012001: http://www.scootle.edu.au/ec/resolve/view/M012001
Area counting with Coco TFL-ID L139: http://www.scootle.edu.au/ec/resolve/view/L139
Finding the area of rectangles TFL-ID L384: http://www.scootle.edu.au/ec/resolve/view/L384

Concluding reflection
Students reflect on the ways area and perimeters are used in everyday life.

How are the values of area and perimeter applied to the design.

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video that demonstrates the measurement and calculation of the perimeter of a rectangle. Students are led through a sequence of activities from calculating the perimeters of rectangles, regular polygons and composite shapes through to distinguishing between perimeter and area. The final quiz tests student understanding of the difference between perimeter and area and provides immediate feedback.
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▶ describe when a perimeter measurement might be used in everyday situations, eg determining the length of fencing required to enclose a playground (Communicating)		
Stage 2 - Working Technologically Students produce solutions by: ▪ exploring a range of materials appropriate for the task ▪ developing and applying a plan and sequence for production that considers, where relevant, time and resources ▪ safely and correctly using a range of tools and equipment, materials and techniques, eg cutting, combining, joining, shaping, assembling and finishing materials	**Lessons 13/ 14: Produce the design** **STEM group activity** Students: ▪ finish their 3D models and designs using the available resources ▪ refer to the established criteria for assessing learning when preparing the design ▪ use the criteria to 'sell' to the prospective buyers/judges. Presentations must include: ▪ a scaled drawing including the dimensions of the design ▪ the proposed budget and finance plan ▪ a 3D model (model-making materials needed) ▪ a mind map(s) ▪ additional visual aids, eg poster, model, digital drawing ▪ a one-minute presentation/speech ready to 'sell' their design to the judges/buyers, explaining how the design solution satisfies the needs identified in the design brief. Models may be partially constructed at home and completed in class. Students to work as a team – plan the presentation of the design and how this will be achieved: ▪ delegate roles that suit team members' strengths ▪ communicate with your team – what are you doing, where are you up to in your task, do you need any ideas/help?	
Stage 2 - Working Technologically Students evaluate by: ▪ reflecting on the process followed and what could be done differently to ensure that the solution meets the needs of the user/audience ▪ using established design criteria to evaluate the process, product or solution, and suggesting how their design solution could be improved ▪ reflecting on findings to identify what they could find out next	**Lessons 15: Feedback** Students provide feedback using the design brief and criteria for assessing learning (Lesson 6). Discuss with students that it is never too late to make changes to designs. Scientists and engineers are constantly seeking feedback to improve their designs and use research to guide the process. Students refer to the design brief and: ▪ critique the feedback and consider which is helpful ▪ apply appropriate changes to improve their designs. Students complete their designs and incorporate feedback.	

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through the processes of Working Technologically and Working Scientifically		
Stage 2 - Working Technologically Students evaluate by: ▪ reflecting on findings to identify what they could find out next through the processes of Working Technologically and Working Scientifically	**Lesson 16: Reflection** Students: ▪ reflect on their designs ▪ reflect on the processes involved in creating it ▪ present and sell ideas to a prospective buyer. **Presentation** Students prepare a one-minute presentation to present to the judges. They refer a display of: ▪ their designs ▪ sketches and final scaled drawing ▪ models ▪ mind maps ▪ budgets ▪ posters **Assessment and feedback** ▪ Judges use the criteria for assessing learning as well as their overall approval of the design to score each STEM group's design. **Evaluation** Students evaluate their design and the processes followed to create it. ▪ What worked well in the design process? What didn't work so well? ▪ What would you do differently next time? ▪ What did you learn from working in STEM groups? Students share their reflections in small groups.	Option ▪ Score cards and any comments will be given to the students to discuss and reflect upon. ▪ Should any teams be scored equally, the judges will vote together on their preferred design. ▪ They may decide on a tie in which two teams will be named as winners and they will both present their designs to the appropriate school body. Option ▪ The winning team of the challenge will receive an award, have their photo and design featured on the school website and newsletter, if appropriate, and have their design submitted to the appropriate school body for consideration.

Assessment overview

- Students produce a variety of work samples, including designated assessment activities. These should be evaluated to determine students' level of achievement and understanding.
- Students engage in peer assessment, based on jointly derived criteria for activity completion.
- Additionally, student understanding may be assessed through the use of observational checklists, anecdotal records and analysis of contributions to class discussions.

Evaluation

Questions to guide reflection:

- To what level did students achieve the learning outcomes?
- How effective were the activities in helping students to understand key concepts and achieve the learning outcomes?
- How did teaching strategies and activities facilitate student engagement?
- How could the unit be improved to enhance student engagement and learning?