# STEM Olympiad program – Stage 4

## Summary

This resource pack provides teachers with a range of curriculum-aligned, mini-STEM challenges that can be delivered in a range of formats. Students complete the challenges, record evidence of completion and return to their teacher for feedback. Successful completion of the challenges will qualify students for a gold, silver or bronze STEM Olympiad award.

### Duration

10 learning activities of approximately one hour each.

### Outcomes

* **SC4-8WS** Selects and uses appropriate strategies, understanding and skills to produce creative and plausible solutions to identified problems

[Science Years 7-10 Syllabus (2018)](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science/science-7-10-2018) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2018.

* **TE4-1DP** designs, communicates and evaluates innovative ideas and creative solutions to authentic problems or opportunities

[Technology Mandatory Years 7-8 Syllabus (2017)](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/technologies/technology-mandatory-7-8-new-syllabus) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2017.

## Unit overview

This unit is a collection of individual STEM challenges that help students develop their problem-solving skills through solution ideation and refinement. The focus is on the improvement of the performance of the individual’s solution rather than peer-to-peer competition.

These challenges can be delivered in a range of formats. Examples include:

* one weekly challenge during class for five weeks
* all challenges in one day as an extracurricular event
* one challenge each lunchtime for a week with a STEM club

Students earn a STEM Olympiad award by reaching the following benchmarks:

* gold award – all challenges successfully completed with solution refinement demonstrated
* silver award – more than six challenges successfully completed with solution refinement demonstrated
* bronze award – more than four challenges successfully completed with solution refinement demonstrated
* participants award – at least two challenges attempted

## Resources overview

The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to or substitute these resources as required for remote delivery with their classes. Teachers may ask students to source the required materials at home or supply them in an activity pack.

### Resources

* Challenge 1 Slender tower
	+ STEM Challenge 1 document
	+ Five sheets A4 paper
	+ 30cm sticky tape
	+ Ruler or measuring tape
	+ Scissors
	+ [Google Maps](https://goo.gl/maps/SgfjA1nPVWT2) - Streetview VR
* Challenge 2 Paper bridge
	+ STEM Challenge 2 document
	+ One sheet A4 paper
	+ Two thick books or similar
	+ A ruler
	+ Masses (like baking beads, metal washers or coins of the same size)
	+ ABC Splash video [Design a bridge](https://abcspla.sh/m/2208772)
* Challenge 3 Straw water tower
	+ STEM Challenge 3 document
	+ Drinking straws
	+ 20cm of sticky tape
	+ A ruler
	+ A golf ball or similar
* Challenge 4 Paper parachute
	+ STEM Challenge 4 document
	+ A sandwich sizes paper bag
	+ String
	+ A mass that can be tied to string, like a metal washer
	+ A device for timing the fall
	+ A ruler
* Challenge 5 Paper gyrocopter
	+ STEM Challenge 5 document
	+ One A4 piece of paper
	+ Scissors
	+ A device for timing the fall
	+ A ruler
* Challenge 6 Build a box
	+ STEM Challenge 6 document
	+ 2 pieces of A4 paper per student
	+ Scissors
	+ Sticky tape
	+ Ruler
	+ Packing peanuts (or something similar to measure the volume)
	+ Teach Engineering video [volume and data](https://www.youtube.com/watch?v=NTrxt99akTk)
	+ Optional: glue sticks.
* Challenge 7 Spoon catapult
	+ STEM Challenge 7document
	+ Plastic spoon
	+ Paddle pop sticks
	+ Rubber bands
	+ Masking tape
	+ Scissors
	+ A drink can or soup can
	+ Marshmallow, cotton balls or some suitable projectile
	+ A target
	+ Teach Engineering video [right on target](https://www.youtube.com/watch?v=Kq4YVAgj9IQ)
* Challenge 8 Rubber band powered vehicle
	+ STEM Challenge 8 document
	+ Corrugated cardboard or paddle pop sticks
	+ 2 straws
	+ 2 wooden skewers (or suitable rods for the axles if you have them)
	+ 4 wheels (these can be cardboard, CD’s, bottle caps or purpose made wheels if you have them)
	+ An assortment of rubber bands
	+ Paper clip
	+ Masking tape
	+ Scissors
	+ Optional: hot glue gun
	+ NASA video [kinetic and potential energy](https://www.nasa.gov/stemonstrations-energy.html)
* Challenge 9 Mini greenhouse
	+ STEM Challenge 9 document
	+ empty plastic bottles, plastic containers or egg cartons
	+ other materials such as paper rolls, straws, paddle pop sticks, cardboard
	+ soil
	+ thermometer
	+ ABC Education video [how to create a mini greenhouse](https://education.abc.net.au/home#!/media/3374530/how-to-create-a-mini-greenhouse).
* Challenge 10 Gravity pinball machine
	+ STEM Challenge 10 document
	+ Cardboard
	+ Optional cardboard box/lid
	+ Masking tape
	+ Scissors
	+ A marble
	+ Optional: paper rolls, straws, paper plates, paddle pop sticks, PVC pipe

Table 1 – Challenge 1-10

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| --- | --- | --- |
| ContentTeaching and learning | Evidence of learning | Adjustments and registration |
| **Challenge 1: Slender tower****Students:*** Complete the glossary definitions task to help with understanding
* Using [Google Maps](https://goo.gl/maps/SgfjA1nPVWT2), navigate to 432 Park Avenue in New York. Use the satellite view and street view to explore an example of a new build tall tower built on a small existing block of land
* Construct the tallest tower possible from the supplied materials
* Ensure that the tower can stand for 30 seconds without falling over
* Capture evidence of the design - either a digital photo or pencil sketch
* Record the standing height of the tower in centimetres
* Complete the recount and learning reflection activity
* Submit evidence of completion to your teacher for feedback

**Adjustments/Extension:*** Set a minimum expected tower height
* Set a goal height to be reached with limited materials
* Test tower strength by standing a desk fan 1m away
* Use a different material, such a cardboard or newspaper
 | * Either a digital photo or a sketch of a completed freestanding paper tower.
* Students’ recount should be in correct sequence and include the correct naming of items and techniques.
* Students’ reflection of learning should indicate that they have evaluated their design and suggested strategies to improve it.
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| **Challenge 2: Paper bridge****Students:*** Complete the glossary definitions task to help with understanding
* Watch the ABC Splash video ['Design a bridge' – 1:42 min](https://abcspla.sh/m/2208772) to see what civil engineers must take into consideration when building bridges
* Set up the two thick books 25 centimetres apart on a desk or on the floor to act as bridge piers
* Construct a bridge beam from one A4 sheet of paper that spans the 20cm gap between the books. Paper can be folded or twisted but must be able to hold the masses without falling off. The bridge cannot be secured to the books
* Slowly load the bridge with your masses counting as you go. Load until the beam fails or the first mass falls off
* Capture evidence of the design - either a digital photo or pencil sketch
* Record the number off masses held before collapse
* Complete the recount and learning reflection activity
* Submit evidence of completion to your teacher

**Adjustments/Extension:*** Increase paper size and distance between piers
* Set a goal of a maximum or minimum mass to be supported
* Use a different material, such a cardboard or newspaper
 | * Either a digital photo or a sketch of a completed paper bridge.
* Students’ recount should be in correct sequence and include the correct naming of items and techniques.
* Students’ reflection of learning should indicate that they have evaluated their design and suggested strategies to improve it.
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| **Challenge 3: Straw water tower****Students:*** Complete the glossary definitions task to help with understanding
* Construct a tower using as few drinking straws as possible for the vertical truss members
* It must hold the golf ball at least 10cm above the ground without it falling off
* The tower cannot be secured to the surface it stands on
* Capture evidence of the design - either a digital photo or pencil sketch
* Record the number off straws used to hold the ball
* Complete the recount and learning reflection activity
* Submit evidence of completion to your teacher for feedback

**Adjustments/Extension:*** Change the size and shape of the ball being supported
* Set a different height from the desk goal
* Substitute drinking straws for another material
* Give example photos of truss water towers
 | * Either a digital photo or a sketch of a completed straw tower holding the golf ball or object.
* Students’ recount should be in correct sequence and include the correct naming of items and techniques.
* Students’ reflection of learning should indicate that they have evaluated their design and suggested strategies to improve it.
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| **Challenge 4: Paper parachute****Students:*** Complete the glossary definitions task to help with understanding
* Construct a parachute using the paper bag as a canopy, string as the suspension lines and mass as the cargo.
* Test the parachute by dropping it from your outstretched arm as high as you can reach. Adjust the design until the parachutes arrests the falls as much as possible
* Use the ruler to measure 1.5m from the ground. Practise dropping your cargo from 1.5m high. Time how long it takes for fall 1.5m. Repeat the drop test ten times. Calculate the average fall time by adding the ten results and divide by ten
* Capture evidence of the design - either a digital photo or pencil sketch
* Record the average fall time
* Complete the recount and learning reflection activity
* Submit evidence of completion to your teacher for feedback

**Adjustments/Extension:*** Change the size or shape of the of the mass used as cargo
* Use a different material for a canopy
* Adjust the test height
* Test the parachute indoors and outdoors and compare results.
* Present test results in a graph
* Give example photos of a cargo parachute
 | * Either a digital photo or a sketch of a completed paper parachute.
* Students’ recount should be in correct sequence and include the correct naming of items and techniques.
* Students’ reflection of learning should indicate that they have evaluated their design and suggested strategies to improve it.
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| **Challenge 5: Paper gyrocopter****Students:*** Complete the glossary definitions task to help with understanding
* Construct a paper gyrocopter
	+ Fold the A4 paper in half lengthways, the fold in half widthways twice.
	+ Unfolder the paper
	+ Use the scissor to cut halfway down along the centre lengthways fold
	+ Cut along the widthways fold one quarter from each side.
	+ Create the gyrocopter fuselage by folding each of the bottom panels towards the horizontal centre fold line, each on an opposite side.
	+ Create the rotors by folding the two top quarter panels down at the vertical centre fold line in opposite directions
* Test the gyrocopters ability to glide by dropping it from an outstretched arm as high as students can reach. It is unlikely to rotate as the fuselage is not heavy enough. Add weight by experimenting with additional small folds in the bottom of the fuselage.
* Adjust the design until the gyrocopter spins to arrest the fall as much as possible

**Adjustments/Extension:*** Change the size of paper used for construction
* Change the thickness of paper used
* Allow the use of a different weight to improve flight, such as a paperclip
* Test the parachute indoors and outdoors and compare results.
* Present test results in a graph
 | * Evidence of a completed paper gyrocopter – digital photo or sketch submitted
* Completed recount and reflection of learning and submitted
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| **Challenge 6: Build a box****Students:*** Complete the glossary definitions task to help with understanding
* Watch Teach Engineering video [Volume and data – 2:16 min](https://www.youtube.com/watch?v=NTrxt99akTk)
* Construct a box with five rectangular sides and an open top using only one A4 piece of paper and sticky tape or glue.
* Cut out each face and join them together with tape or glue to form a rectangular prism (does not have to be a single piece of paper.)
* Measure the length, width and height of the paper box, document the data in the table provided and calculate the volume.
* Pour packing peanuts and then weigh the amounts each box holds.
* Compare results as with the class. Redesign the paper box, changing the dimensions of the length, width or height to increase the volume.
* Capture evidence of the design, either a digital photo or pencil sketch.
* Complete the recount and learning reflection activity.
* Submit evidence of completion to the teacher for feedback.

**Adjustments/Extension:*** Experiment with other three-dimensional shapes and compare the volume of these with a prism.
 | * Evidence of a completed three dimensional shape – digital photo or sketch submitted
* Completed recount and reflection of learning and submitted
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| **Challenge 7: Spoon catapult****Students:*** Complete the glossary definitions task to help with understanding
* Watch the video [Right on target – 1:31 min](https://www.youtube.com/watch?v=Kq4YVAgj9IQ)
* Build the catapult using these suggested instructions (students can change the design following the first launch)
	+ Wrap a rubber band around one end of two paddle pop sticks that are stacked on top of each other approximately 1cm from the end.
	+ Wrap two rubber bands around five paddle pop sticks stacked together.
	+ Open the two joined paddle pop sticks and wedge the stack in between them to form a ‘t’ shape. The stack of paddle pop sticks will be the pivot point also known as the fulcrum. (The catapult can also be made using the can as a base.)
	+ Secure the spoon to the upper paddle pop stick using a rubber band. The combined upper paddle pop stick and spoon will be the arm (or lever) of the catapult that can flex over the fulcrum when a force is applied.
	+ To test the catapult, place the projectile (marshmallow, cotton ball or some similar small object) onto the spoon. Hold the t-shape frame in place and push down on the upper paddle pop stick and spoon (pushing the tip of the spoon may cause it to flex but it may also break).
	+ Release the upper paddle pop stick (and spoon) and let it fling the projectile forward.
* Design and create a suitable target. An example target could be three concentric circles with different points assigned to each circle. (An alternative could be three separate targets arranged in a line.)
* Line the catapult up to shoot at the target.
* Refine the design to improve the accuracy and consistency.
* Capture evidence of the design, either a digital photo or pencil sketch.
* Record the number of times the target is hit. Add up the points.
* Complete the recount and learning reflection activity.
* Submit evidence of completion to your teacher for feedback.
 | * Evidence of a completed catapult – digital photo or sketch submitted
* Completed recount and reflection of learning and submitted
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| **Challenge 8: Rubber band powered vehicle****Students:*** Complete the glossary definitions task to help with understanding
* Watch the NASA video on [Kinetic and potential energy – 2:49 min](https://www.nasa.gov/stemonstrations-energy.html) to learn about the energy that will propel your vehicle.
* Construct a rubber band vehicle using these suggested instructions (students can change the design following the first speed test).
	+ Create a chassis for the vehicle in a rectangular shape. This can be modified later but the important thing to have is two places for the axles to be attached parallel to each other.
	+ Cut a straw into four equal pieces each about three centimetres long. Two pieces at each end of the chassis will house each axle. Positioning the straws near the edge of the chassis may help ensure the two axles will be parallel to each other. Attach them with masking tape to the underside of the chassis.
	+ Thread a skewer through them to create axles. Attach the axles to the body of your car by taping the straw (not the skewer) to the underside of the chassis.
	+ Attach the wheels to the end of the skewers. Make sure they are secure and not wobbly. (Note: if using CDs for wheels, a piece of sponge or cardboard may be needed to secure the axles to the middle of the CD. A rubber band around the drive wheels may be added if testing on a smooth surface.)
	+ Attach a paper clip to be an anchor point for the rubber band. Depending on what is used to make your chassis, if the chassis is made from cardboard, cut a small hole in the middle of the cardboard and bend a paper clip through the hole and secure. Or if the chassis is made from paddle pop sticks glue or tape a paper clip firmly to some point on the chassis. The important thing here is to attach the paper clip equally at a distance from the drive axle.
	+ Attach the rubber band using a loop from the axle to the paper clip.
	+ Wind and rotate the wheels (and the axle) that the rubber band is attached to until the rubber band is taut and is wrapped around the axle a number of times.
	+ Put the car down on the ground and make sure the area is clear before releasing the car.
	+ If the vehicle moved forward, wind the axle up again and get ready to take measurements. If not, check the construction making sure everything is connected and that the rubber band is connected correctly to the drive axle.
* Capture evidence of the design, either a digital photo or pencil sketch.
* Record the distance your vehicle travelled. Repeat to get three sets of measurements and calculate the average.
* Complete the recount and learning reflection activity.
* Submit evidence of completion to your teacher for feedback.
 | * Evidence of a completed rubber band powered vehicle – digital photo or sketch submitted.
* Completed recount and reflection of learning and submitted.
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| **Challenge 9: Mini greenhouse****Students:*** Complete the glossary definitions task to help with understanding
* Watch the ABC Education video [How to create a mini greenhouse – 4:44 min](https://education.abc.net.au/home#!/media/3374530/how-to-create-a-mini-greenhouse).
* Assess what materials are have available and consider their shape and properties. Items like plastic bottles or containers might be more useful in a design if cut in half.
* Use items like half plastic bottles or an egg carton as the base of a greenhouse and fill with soil.
* Water the soil with a small amount of water as if you were growing seedlings.
* Create a three-dimensional shape from the transparent plastic items that are available that can cover your soil and trap heat from the sun’s rays to produce an optimal temperature.
* Capture evidence of the design, either a digital photo or pencil sketch.
* Record the temperatures inside and outside the greenhouse.
* Measure and calculate the maximum surface area of all transparent surfaces of your greenhouse.
* Complete the recount and learning reflection activity.
* Submit evidence of completion to your teacher for feedback.
 | * Evidence of a completed mini greenhouse – digital photo or sketch submitted
* Completed recount and reflection of learning and submitted
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| **Challenge 10: Gravity pinball machine****Students:*** Complete the glossary definitions task to help with understanding.
* Create a pinball machine from a piece of rectangular cardboard (or this could be made from a box so the marble doesn’t run off the sides). If using a flat piece of cardboard, add sides.
* Add obstacles using different pieces of cardboard or other materials like paper rolls, straws, paper plates, paddle pop sticks, pvc pipe. Make a maze for the marble to run through from the top of the rectangle to the bottom.
* Hold the cardboard pinball machine with both hands. Have a peer drop the marble at the top of the maze. Make the marble go from start to finish.
* Capture evidence of the design - either a digital photo or pencil sketch.
* Record the time taken for the marble to travel through the pinball machine.
* Complete the recount and learning reflection activity.
* Submit evidence of completion to your teacher for feedback.
 | * Evidence of a completed gravity pinball machine – digital photo or sketch submitted
* Completed recount and reflection of learning and submitted
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## Evaluation

Evaluation of learning activities should be an ongoing process that happens throughout the delivery of this unit. Teachers should document their evaluation of learning activities throughout the program. The space provided below is to evaluate the overall unit of work.