EDUCATOR NOTES

S.C.R.A.P. Challenge

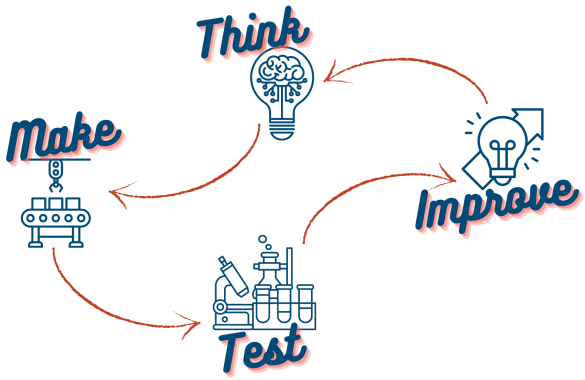
STUDENT ▪ CADET ▪ ROCKET ▪ ADVENTURE ▪ PROGRAM

plan

The S.C.R.A.P. Challenge is a paper rocket design challenge which invites students to set their own success criteria for their creations, then follow an iterative process to optimize their designs.

This workshop requires "air-puff" launchers for the rockets. These can be purchased from education and toy shops, usually sold as a "stomp rocket", "stomp flyer" or "air stomp launcher." Otherwise, students can make their own benchtop versions using the *S.C.R.A.P. Challenge: micro-launch supplement* included at the end of this document.

This document uses a simplified four-part cyclical engineering design process, intended to be broadly accessible to most STEM learners. It is generic enough that other design cycle models can be readily substituted, if desired.



The S.C.R.A.P. Challenge is intended to be easily adapted to STEM subjects across diverse year levels, and to create opportunities to align with the General Capabilities of Numeracy, Critical and Creative Thinking, and Personal and Social Capability, as well as the Cross-Curriculum Priority of Sustainability.

Concepts:

- ⇒ Forces
- ⇒ Newton's laws of motion
- ⇒ Air resistance and flight
- ⇒ Angles and projectile motion
- ⇒ Iterative design processes
- ⇒ Effect of materials' properties on the function of a designed product
- ⇒ Data collection and statistical analysis
- ⇒ Sustainable resource use in the classroom and beyond

Skills:

- ⇒ Using a design cycle process
- ⇒ Identifying a design goal or inquiry question, and conceptualizing a fair test or experiment to address it
- ⇒ Collecting and interpreting data from an investigation
- ⇒ Drawing conclusions about the fitness of a design for its intended purpose
- ⇒ Identifying and controlling variables
- ⇒ Identifying and selecting appropriate tools, components, and materials

S.C.R.A.P. Challenge

STUDENT ▪ CADET ▪ ROCKET ▪ ADVENTURE ▪ PROGRAM

Think

Vocabulary

Drag: the force that pushes back when something moves through a fluid like air or water.

To get away from the Earth, a rocket needs to travel extremely fast to overcome the pull of gravity.

When something tries to move quickly through air, the air provides resistance, or drag, which tries to slow it down. The strength of the drag force depends on the shape of the thing, as well as how fast it is trying to go.

The shape of the thing can also change how it moves through the air. You might have seen this if you have ever played with a paper aeroplane, where changing the shape of the wings can change the direction it goes when you throw it.

Nose Cone: the leading part of the rocket that goes through the air first.

Think: What can you change about this part? What effect might those changes have?

Fuselage: the main body of the rocket. Most of the space in the fuselage is taken up by the fuel tanks.

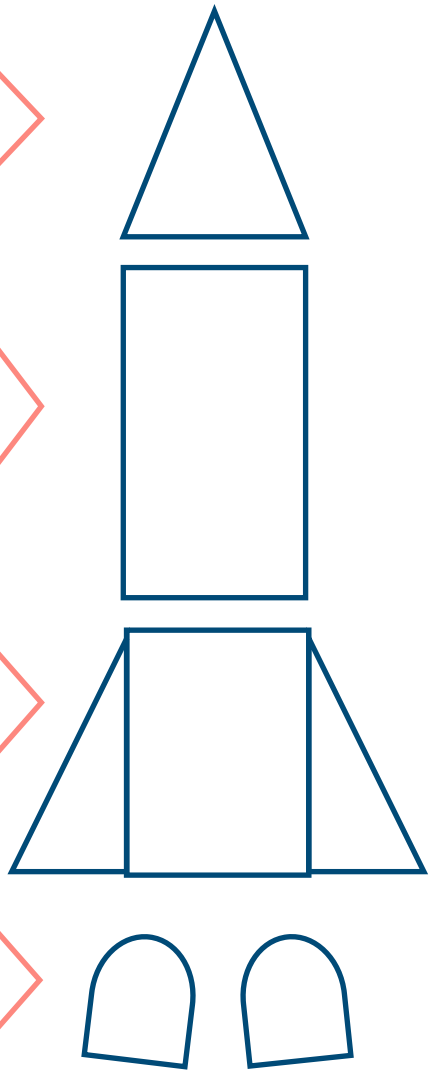
Think: For your air-powered model rocket, do you think changing the volume of this part will have a similar effect to changing the size of the fuel tank?

Fins: at the bottom of the fuselage, most rockets have three or more fins.

Think: What are the fins for? How could you change them, and what effect might that have?

Rocket nozzle: burning fuel pushes out through the rocket nozzle, creating the thrust that moves the rocket.

Think: How would the size of the nozzles change the



Think

Before you start making, take a moment to plan how you will build your rocket prototype. Remember that you can change this plan at any time!

What is your goal?

What will you try changing?

What materials will you need?

Sketch: What will your rocket look like, and how will you make the parts go together?

Based on your plan, collect your materials and start building! These questions might help you as you keep thinking, making, testing, and improving your design.

Depending on how you are testing it, you might not need to build the whole rocket — your prototype might just be one part.

Vocabulary

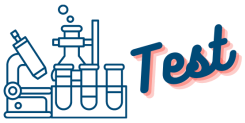
Prototype: a model made to test an idea before making the final product.

Sketch: What does your prototype look like?

Prototype Version __

Did you need any extra materials? If you did, what were they?

Is there anything you were going to do but decided to leave out?



After you make or change a prototype, you need to test it and observe how it works. There are different ways to test your prototype other than launching it. Try to come up with a second way to test your prototype to **validate** what you observed in your first test.

Vocabulary

***Validate**: to double-check your experiment measured the effect you think it did by testing for the effect in a different way.*

What were you trying to find out about your prototype?

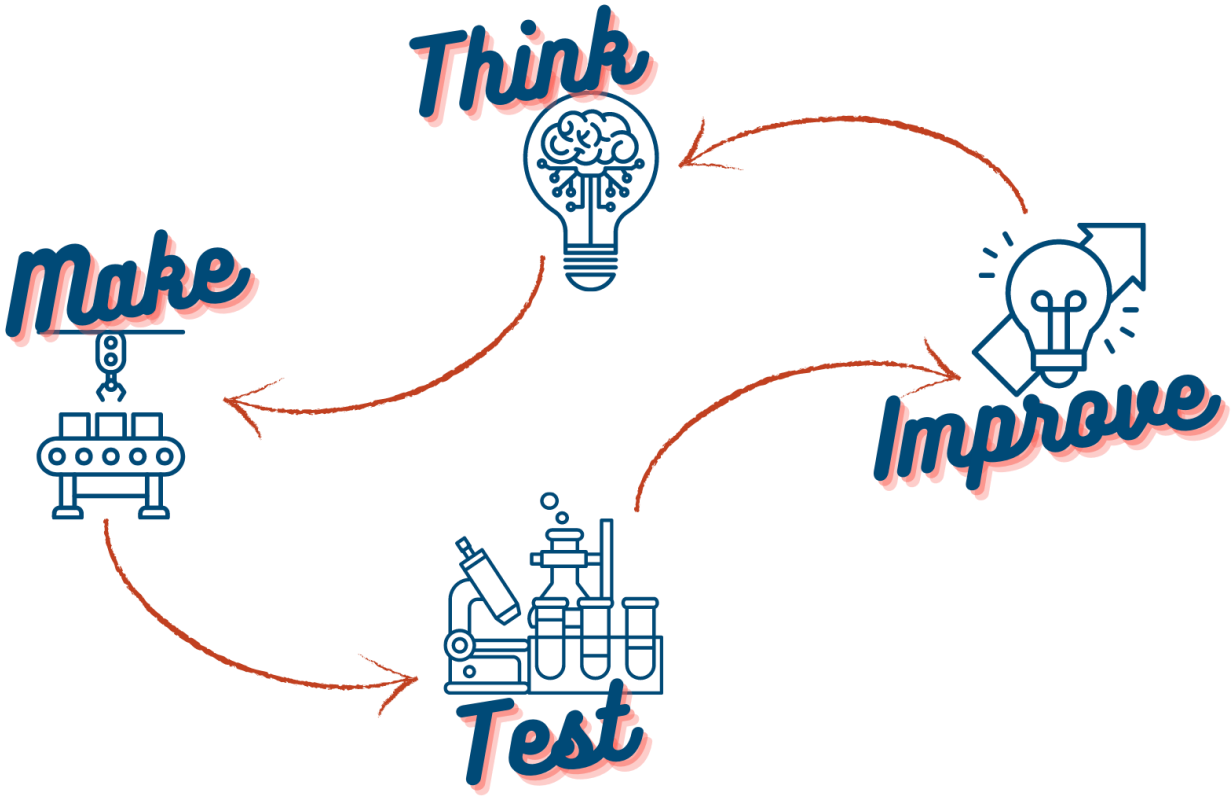
How did you test your prototype?

What did you notice?

Improve

Once you have tested your prototype, use what you have observed to improve it. Each time you improve your design, you go through the steps of thinking, making, testing, and improving again, until you have made the best rocket you can!

The next pages are another copy of the questions for these steps. If you would like more after that, please ask for an extra copy of the workbook.



This space for any notes

Think

Before you start making, take a moment to plan how you will build your rocket prototype. Remember that you can change this plan at any time!

What is your goal?

What will you try changing?

What materials will you need?

Sketch: What will your rocket look like, and how will you make the parts go together?

Based on your plan, collect your materials and start building! These questions might help you as you keep thinking, making, testing, and improving your design.

Depending on how you are testing it, you might not need to build the whole rocket — your prototype might just be one part.

Vocabulary

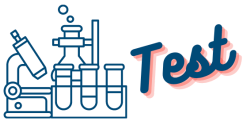
Prototype: a model made to test an idea before making the final product.

Sketch: What does your prototype look like?

Prototype Version ___

Did you need any extra materials? If you did, what were they?

Is there anything you were going to do but decided to leave out?



After you make or change a prototype, you need to test it and observe how it works. There are different ways to test your prototype other than launching it. Try to come up with a second way to test your prototype to **validate** what you observed in your first test.

Vocabulary

***Validate**: to double-check something has had the effect you think it did by testing it a different way.*

What were you trying to find out about your prototype?

How did you test your prototype?

What did you notice?

Australian Space Discovery Centre

EDUCATOR NOTES

S.C.R.A.P. Challenge: *micro-launch*

STUDENT ▪ CADET ▪ ROCKET ▪ ADVENTURE ▪ PROGRAM

plan

A typical rocket works by forcing hot gases at high pressure out of a narrowed opening on the bottom of the rocket. As Newton's laws of motion and the law of conservation of momentum predict, the gases escaping in one direction push the rocket in the other direction.

This is a hot, loud, fast, and high-energy process. It takes a lot of time to set up a launch, and a lot of time to reset afterwards, and the energy and speeds involved can make it difficult to take measurements and get data from a new, experimental rocket design.

Because of this, S.C.R.A.P. Challengers will use air-powered launchers to test and observe their rocket designs as they undergo projectile motion, rather than true rocket-powered flight.

While launch can be accomplished using a commercially-available air launcher, usually sold as a "stomp rocket", "stomp flyer" or "air stomp launcher," students can also design and build their own launchers using recycled and classroom crafting materials, outlined below.

Bellows

A mechanism to push air and launch the paper rocket.

Hose

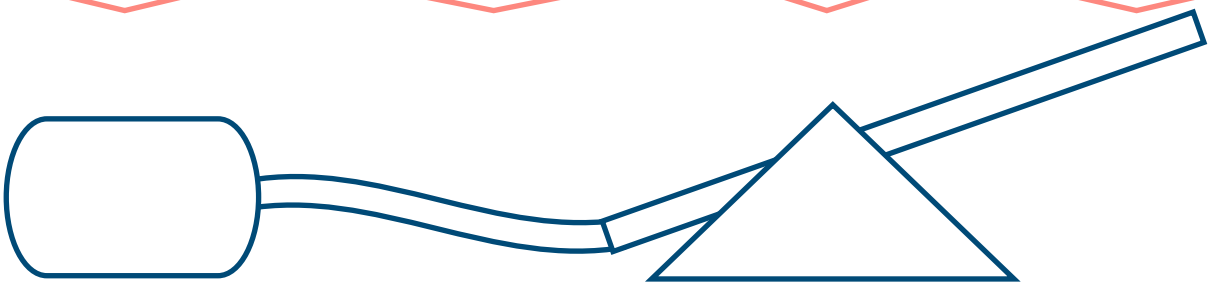
Irrigation tubing or similar to connect the bellows to the launcher tube.

Frame

To hold the launcher tube.

Tube

The component that the paper rocket sits on and is launched from.



You could try making this from:

- ⇒ Different types of plastic bottles, eg hand sanitizer, "pop tops", mini shampoo bottle, lotion tube
- ⇒ Paper "water balloons"
- ⇒ Squash ball or racquetball with a hole poked in it

The hose needs to make an airtight connection between the bellows and the tube. You could try:

- ⇒ Sticky tape
- ⇒ Blu-tak
- ⇒ Plasticine
- ⇒ Electrical tape

You could try making this from:

- ⇒ Popsticks
- ⇒ Cardboard
- ⇒ Pipe cleaners
- ⇒ Science lab equipment
- ⇒ Set squares
- ⇒ Lego

You could try making this from:

- ⇒ Drinking straw (try different diameters!)
- ⇒ Empty ballpoint pen
- ⇒ Irrigation tubing
- ⇒ Rolled paper or cardboard

S.C.R.A.P. Challenge: *micro-launch*

STUDENT • CADET • ROCKET • ADVENTURE • PROGRAM

Think

Vocabulary

Projectile: an object launched using a first push (initial force), which doesn't have any kind of engine to keep pushing it forward as it flies.

Powered flight: when an object pushes itself through the air as it flies, using a propeller, jet engine, rocket engine, or similar.

To launch a rocket, you will need a launch pad!

In the S.C.R.A.P. Rocket Challenge, you will be testing your rocket designs using an air-powered launcher. This means your rocket will be behaving as a projectile, rather than using powered flight like a missile.

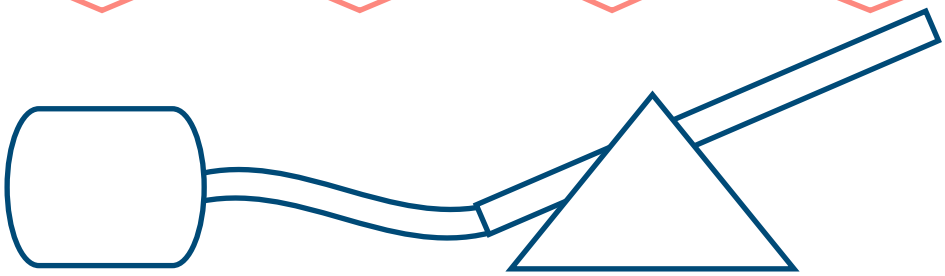
The diagram below shows the basic parts your air-powered launcher will need.

Bellows
Something to push air and launch the paper rocket.

Hose
A thin hose to connect the bellows to the launcher tube.

Frame
To hold the launcher tube.

Tube
The part that the paper rocket sits on and is launched from.



What materials could you use to make each part of the launcher?

Bellows	Hose	Frame	Tube	Connectors

S.C.R.A.P. Challenge: *micro-launch*

STUDENT • CADET • ROCKET • ADVENTURE • PROGRAM

Australian Space Discovery Centre

Think

Before you start making, take a moment to plan how you will build your launcher prototype. Remember, you can change this plan at any time!

What are two things could you change about each of these parts, and how do you think those changes might effect the launch?

Part	Possible Change	Possible Effect of Change
Bellows	1.	1.
	2.	2.
Hose	1.	1.
	2.	2.
Frame	1.	1.
	2.	2.
Tube	1.	1.
	2.	2.

What is your goal?

Sketch: Using the materials available, what could your first prototype launcher look like, and

S.C.R.A.P. Challenge: *micro-launch*

STUDENT • CADET • ROCKET • ADVENTURE • PROGRAM

Australian Space Discovery Centre

Make

Based on your plan, collect your materials and start building! These questions might help you as you keep thinking, making, testing, and improving your design.

Depending on how you are testing it, you might not need to build the whole launcher yet — your prototype might just be one part.

Vocabulary

Prototype: a model made to test an idea before making the final product.

Sketch: What does your prototype look like?

Prototype Version __

Did you need any extra materials? If you did, what were they?

Is there anything you were going to do but decided to leave out?

S.C.R.A.P. Challenge: *micro-launch*

STUDENT • CADET • ROCKET • ADVENTURE • PROGRAM

Australian Space Discovery Centre

Test

After you make or change a prototype, you need to test it and observe how it works. For fast and easy testing, make a test dart by rolling a strip of paper around the launch tube (or something with the same diameter), and seal one end by folding it over two or three times.

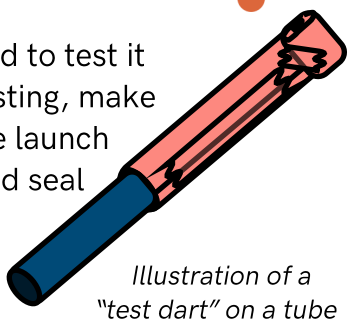


Illustration of a "test dart" on a tube

What were you trying to find out about your prototype?

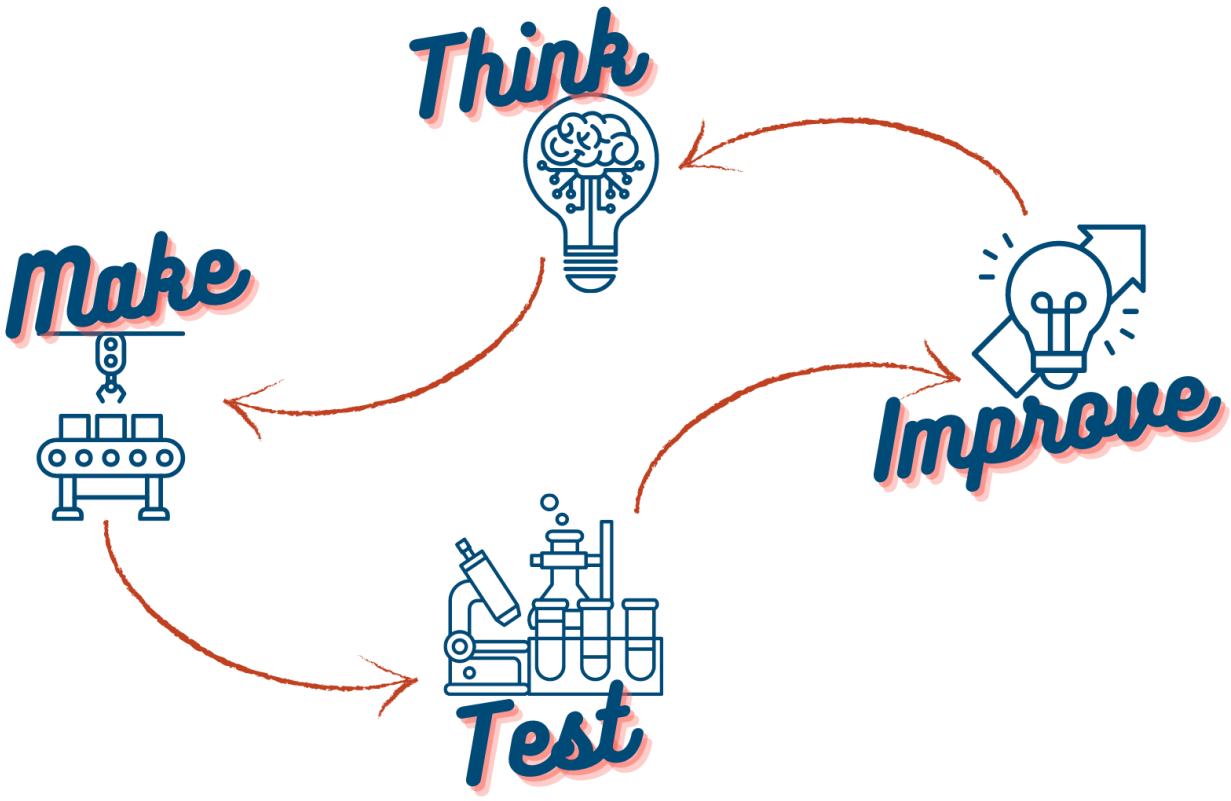
How did you test your prototype?

What did you notice?

Improve

Once you have tested your prototype, use what you have observed to improve it. Each time you improve your design, you go through the steps of thinking, making, testing, and improving again, until you have made the best launcher you can!

Once you are satisfied with your launcher, you will be ready to proceed to the next section of the S.C.R.A.P. Challenge.



This space for any notes