Wonder Project

Rocket Challenge
Student Mission Briefs

engineering new zealand
te ao rangahau

Mission Brief 13: **Blast off competition**

The challenge:

Create a video or poster that tells the story of your Rocket Challenge journey and go in the draw to win a sweet prize.

Be in it to win it

Each school can submit either:

1. A blast off video
2. Or a blast off poster

You could choose to:

- Create your entry together as a school, OR
- Create an entry with your crew and get Mission Command to select the best one

Schools who want to participate in the final blast off must have completed:

- All mission briefs
- Pre challenge and post challenge student surveys

Now let's get creative!

Here are some ideas of what you could include in your entry:

Introduce your crew

- Tell us about yourselves.
- What were your roles and responsibilities?
- How did you use teamwork to complete the challenge?

What have you learned in the challenge?

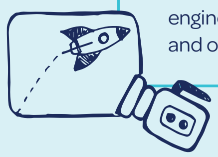
- Can you explain how STEM relates to rockets?
- Show us what you know about Newton's laws.
- How did you use the engineering design process?

Show us a launch

- Show us your most successful launch through pictures, drawings, or a video.
- Explain why this launch was a success.
- How did you keep your crew safe?

Showcase your rockets

- Show off your innovative and creative rocket designs.
- How did you think like an engineer to solve problems and optimise your rockets?



Send in your entry

- Get Mission Command to upload your competition entry to the Wonder Project community Facebook group, OR
- Send your entry to **hello@wonderproject.nz**

Good luck and may the best rocketeers win!

Conclusion

Space crews, you've collected heaps of data, learned lots of new things, and launched some out-of-this-world rockets. It's now time to use this information to answer our challenge pātai.

I wonder how rockets fly?

How do your conjectures from Mission Briefs 4, 10 and 12 compare to your final result?

Have you met your challenge goals? Why/why not?

Think about Newton's laws when doing your analysis!

Newton's first law	Newton's second law	Newton's third law
An object will remain at rest (not moving) or keep moving forever at the same speed and in a straight line unless there is another force acting on it	Force = mass x acceleration	For every action there is an equal and opposite reaction

Mission Brief 1: STEM roles quiz

To solve big problems with STEM, you need diverse thinkers and do-ers with lots of different skills and interests.

The best STEM rōpū bring a bunch of different people together to collaborate and draw inspiration from each other – and everyone has an important part to play!

Do you wonder which STEM role suits your skills and interests best? Take this quiz and write down the letter that matches your answer on a separate piece of paper. Then, add together the total amount of each letter you chose to find out!

What class do you always look forward to?

A. Science – I can't get enough experiments.

B. Technology – I'm creative with a computer.

C. English – I'm a poet and I know it.

D. Maths – I'm a natural with numbers.

What can you be found doing on the weekend?

A. I'll be enjoying the great outdoors – playing sport, hiking and staying active.

B. I'll be defeating bad guys in the latest video game.

C. I'll be creating the ultimate Lego tower.

D. I'll be mastering my baking skills to make the perfect cake.

Which kupu describes you best?

A. Curious.

B. Innovative.

C. Creative.

D. Inspiring.

Which project would you most like to work on?

A. Creating a farm to grow enough food for everyone.

B. Creating a new video game.

C. Creating the eighth wonder of the world.

D. Creating music that helps you with your homework.

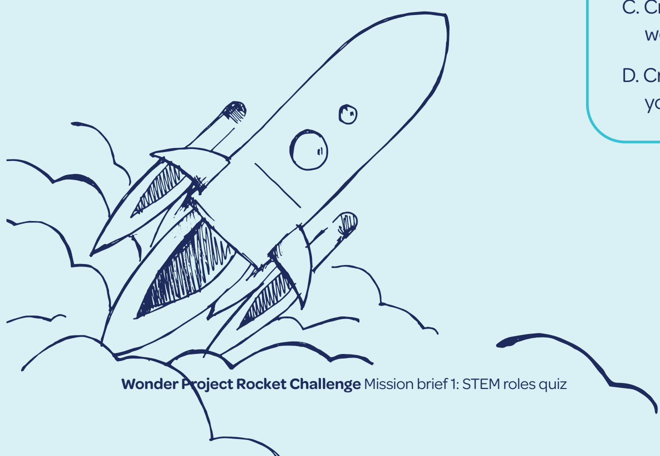
You've run into a problem that needs solving. What do you do first?

A. I'd hit the books and use knowledge from the experts.

B. I'd do a Google search to find some fun ideas.

C. I'd message a friend to help. Two heads are better than one!

D. I'd jump right in and give it a go.



Which one of these is your spirit animal?

A. Oo oo ah ah, I'm a monkey. I'm naturally curious and love playing with my friends.

B. I'm a lion, hear my roar! I use my courage and fearlessness to try new things and lead the pack.

C. Call me a bird. I enjoy thinking outside the box and building things to help my whānau.

D. I'm a cool cat. I'm clever and enjoy exploring the world around me.

If you could change one thing in the world, what would it be?

A. I would get rid of all diseases.

B. I would clean up the environment.

C. I would make a robot that could do my chores for me.

D. I would make sure everyone has enough money to care for their whānau.

What's your 'Most Likely'?

A. Most likely to save the planet.

B. Most likely to invent hovering cars.

C. Most likely to win a Nobel Peace Prize.

D. Most likely to crack an impossible code.

Your STEM role:

If you got mostly As:

Science: You've got what it takes to be a top tier scientist!

You're naturally curious and enjoy understanding the world around you. You use your patience and determination to find the best solutions to some of the world's biggest problems.

If you got mostly Bs:

Technology: You're a tech savvy superstar and you don't care who knows it!

You're a born leader with a creative mind and awesome communication skills. You'll be creating things that other people have never even dreamed of. A real-life magician.

If you got mostly Cs:

Engineering: You're a dreamer and achiever, set to engineer an extraordinary future.

Thinking outside the box is how you roll. A natural problem-solver and team player, you'll imagine solutions that will change the world for the better – and make heaps of friends along the way.

If you got mostly Ds:

Maths: You love numbers, and they love you – get ready to make a BIG difference with your skills.

You're a whizz with spotting patterns and analysing the trickiest problems. You've got a universal language up your sleeve which means you can explore the world and visit some cool countries.

If you've got a mix of everything

It's your lucky day! A lot of STEM jobs use a mix of science, technology, engineering and maths smarts which means your skills could be used anywhere. You were born to work in STEM.

Record your data

Flight	Crew name	Angle (°)	Air pressure (psi)	Water level (ml)	Time in air (s)	Distance (m)	Launch rating (1–5)
1		45°	60 psi				
2		45°	60 psi				
3		45°	60 psi				
4		45°	60 psi				
5		45°	60 psi				
6		45°	60 psi				
7		45°	60 psi				
8		45°	60 psi				

Double check your data!

Before you analyse your launch data, check it's accurate by comparing your results with another crew to see if they match up.

Does your data match?

Yes!

No

Figure out what the correct data is. Then, make sure the data in your table is accurate before starting your analysis.

Analysis:

The furthest distance our class achieved was ______

The longest airtime our class achieved was ______

______ **'s rocket flew the best because:**

(insert crew name)

Conjecture comparison:

Did your results match with your crew's conjecture? Why/why not?

Mission Brief 12: **Final flights**

You've made it to the final lift-off!

You've now test-launched your rocket enough times to determine the best water level and rocket design to use. This means your rockets are superpowered and ready to take on their final flights.

During your final flights, you'll be measuring the distance your rocket travels and timing how long it's in the air. With this data, you'll be able to determine which crew's rocket had the most successful flight and why.

All systems are go!

Set your launch angle to 45˚ and record your class's best flights.

What you'll need:

- Your improved rocket prototype
- Rocket launcher
- Bike pump – a foot pump is best
- Hi-vis vests and safety glasses
- Bucket of water and measuring cups
- Stopwatch
- Protractor to set launch angle
- Rolling distance counter, measuring tape or long rulers
- Phone or tablet for filming your final flights

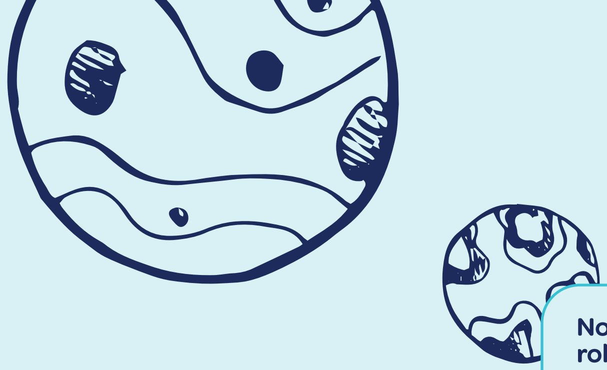
Measurements key	
psi	Pound-force per square inch
ml	Millilitres
m	Metres
s	Seconds
°	Degrees

Ask: How will our design improvements impact our rocket's flight?

Our conjecture:

We think our design improvements will impact our rocket's flight by:

We think this because:

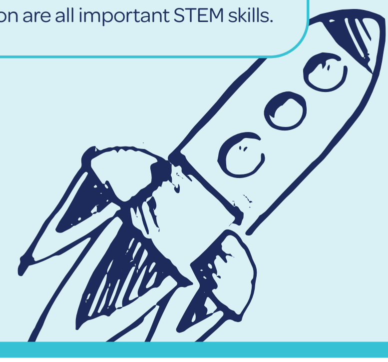


Now it's time to work out what roles you will play in the Rocket Challenge. Your quiz results may help you choose your role, or you might choose something totally different!

Remember each role is equally important.

Form your crew of 3 – 6 classmates, come up with a crew name and give out roles to each member.

If you've got more than 3 in your crew, you may have two people sharing one role. Remember – teamwork, sharing and collaboration are all important STEM skills.



Launchpad (your school):	
Crew name:	
Chief Scientist:	
Chief Engineer:	
Safety Officer:	

The **Chief Scientist** will measure and record the flights as well as help pump air into the water rockets.

The **Chief Engineer** will mount the rocket on the launcher and when ready, fire the rocket.

The **Safety Officer** will ensure all spectators and crew are at least 3 metres away from the launch site. When they are sure it's safe for blast off, they will give the thumbs up to the rest of the crew to start the launch.

Mission Command

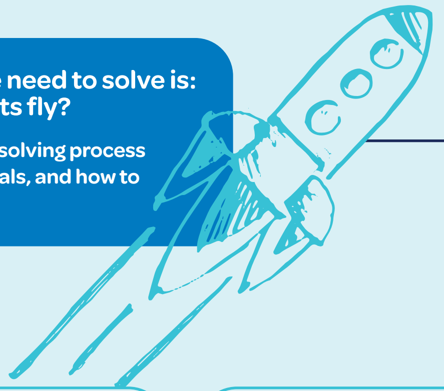
Kaiako:	
Ambassador:	

Mission Brief 2: Ask

Engineers love to solve problems. They use their curiosity and ask a lot of pātai to help them figure out why some things work, and why other things don't.

The big problem we need to solve is: I wonder how rockets fly?

Let's start the problem-solving process by thinking about our goals, and how to achieve them.



I wonder what our goals are?

For the Rocket Challenge, the main goal is to fly a rocket successfully.

As a crew, decide what a successful rocket flight means to you. Write your ideas in the box below.

E.g. Our goal is to get our rocket to fly higher than the goal posts on the school field.

I wonder what pātai to ask?

What do you need to know more about to achieve your goals?

Time to ask lots of pātai about why things work, to help us solve our problem.

E.g. I wonder how rockets lift off the ground?

I wonder what problems we'll need to overcome?

Thinking about potential problems now will help you find a solution faster.

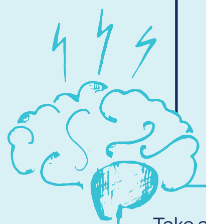
E.g. I wonder if our school field is big enough for launch?

Ka rawe!

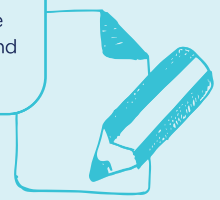
Keep your pātai handy as you work through the challenge. You never know when you'll discover an answer.

Mission Brief 11: Improve

The improvement stage is when STEM superstars work together to make their rocket the best it can be. They test and improve until they've engineered the ultimate super-powered rocket!



Take another look at everything you've learned across the challenge. Then, write down some things you could improve, and how you could improve them.



Tip! If your rocket design is already flying perfectly, why not try adding a parachute inside the nosecone? It will deploy after your nosecone falls off and bring your rocket safely back down to Earth.

What we've learned about force:	What we've learned about Newton's laws:	What we've learned about aerodynamic design variables:	What we've learned from testing our rockets:
We can use this information to improve our rocket by:	*We can use this information to improve our rocket by:*	*We can use this information to improve our rocket by:*	*We can use this information to improve our rocket by:*

Now you can create your improved design and finalise your super-powered rockets!

Optional Activity: **Measuring trajectory**

Now you've launched and filmed your prototype rockets, let's plot their trajectory to give you even more data on how to improve them.

Trajectory is the actual or expected path your rocket follows as it moves through the sky.

Step 1

Find the best video of your prototype rocket launch.

Step 2

Ask Mission Command to project the video onto the whiteboard.

Tip! If you don't have a projector, you can use tracing paper laid over a computer screen or tablet to plot the trajectory.

Step 3

Starting from the beginning of the launch, with the video paused, draw a mark over your rocket.

Step 4

Stop the video frame by frame, each time drawing a mark over your rocket. Stop when your rocket reaches the ground (or goes out of frame).

Step 5

Connect each mark to form your line of trajectory.

Ka rawe space crew!
You have now plotted your rocket's trajectory. You can keep each trajectory line on the board or plot it onto a graph.

Analysis:

In your crew, think about what your rocket trajectory means, and how you could use it to improve your prototypes. Write some ideas below.

Did your rocket fly high, but not long? Long, but not high? Wobble around and make a crash landing? What aerodynamic design variables could you change to fix this?

Optional Activity: **Health and safety relay**

Head outdoors and get ready to test your crew's skills in the ultimate health and safety relay!

What you'll need:

- A big outdoor area
- 3 hard hats (ask your ambassador if they have some at mahi you can borrow)
- 3 safety vests from your rocket kit
- 3 pairs of safety glasses from your rocket kit

Step 1

Whakarongo to your ambassador as they give you a quick run down on health and safety at mahi.

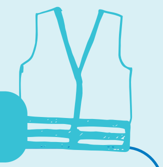
Step 2

Divide yourselves into three rōpū.

Tip: If you want to do smaller rōpū, you'll need extra hard hats, vests and safety glasses.

Step 3

Line up as a rōpū outside with one hard had, safety vest, and pair of safety glasses at the front of the line.



Step 4

When your kaiako says go, each rōpū member should take a turn to:

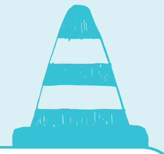
- Put on all three safety items
- Walk briskly to the designated end point and back
- Take the gear off and pass to the next person in line.

You must start your turn again if you:

- Run at any point in the relay
- Have not done your vest up properly
- Do not have your hard hat on securely
- Do not have the glasses on your face properly

The rōpū to finish their relay first are the ultimate health and safety champions!

Mission Brief 3: Launch hazards



Let's use your new health and safety knowledge to explore some launch hazards with your crew and work out how to reduce risk.

Step 1: Pre-launch

Hazard	Risk
Launcher not assembled correctly	Broken equipment, rocket won't fly properly
Rocket explodes due to too much air pressure, or wrong bottle used	Injury to self or others

What can you do to reduce the risk?

Step 2 Post-launch

Hazard	Risk
Rocket doesn't blast off and ākonga touch it	Rocket may explode when touched and hurt someone
Rocket launched near people or buildings	Rocket hits people or buildings
Rocket lands on a high building or in the trees	Lose rocket, block gutters

What can you do to reduce the risk?

Some ideas to improve our fin design are:

Conjecture comparison

Does this result match with your crew's conjecture? Why/why not?

Analysis:

Analyse your flight data to gather insights on how you could improve your rocket's fins – making sure you keep Newton's three laws in mind:

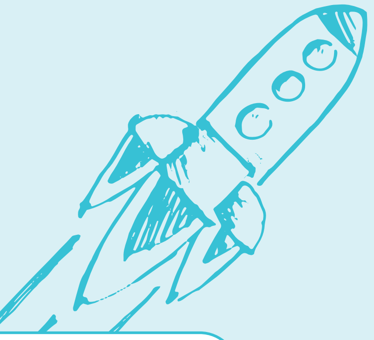
Newton's first law	Newton's second law	Newton's third law
An object will remain at rest (not moving) or keep moving forever at the same speed and in a straight line unless there is another force acting on it	Force = mass x acceleration	For every action there is an equal and opposite reaction

Our **basic rocket/prototype rocket** test flight was better because:
(circle one)

Fins worked well when:

Fins didn't work well when:

Mission Brief 4: First test flights



The countdown to blast off is on! This is your chance to test the best way to set up your rocket to send it sky-high.

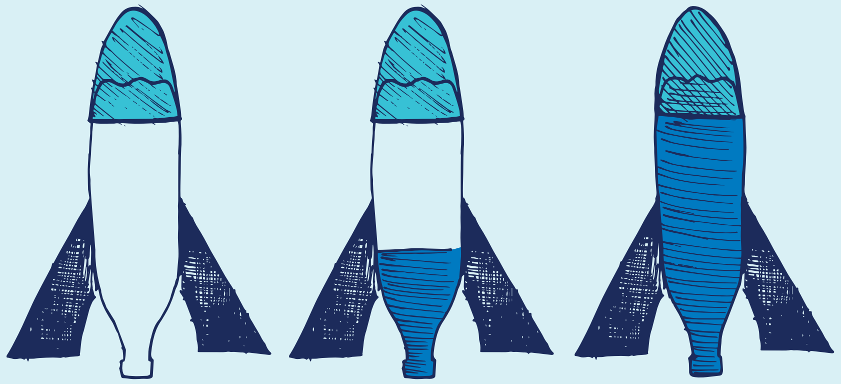
Time to test variables!

The variable you're testing is the **water level** in your bottle, and how different water levels impact your rocket's flight.

Remember: Variables are things that change or can be changed.

Water level

No water | 'Goldilocks' effect | Too much water



Not enough thrust | **Just right!** | **Too heavy**

Mission measurement

You'll need to measure the water level before each launch to get accurate results from your test flights.

What's the best unit of measurement to use? *(circle one)* **psi / g / ml**

What tool will you use to measure the water level?

Ask: How will the water level impact our rocket's flight?

Our conjecture:

We think our rocket will fly best when the water level is:

Amount | **unit**

We think this because:

All systems are go!

For this series of flights, you'll be launching a plain bottle. With each launch, change the water level and observe how it affects your rocket's flight.

Ready for lift-off?

What you'll need:

- Rocket – empty 1.5 litre soda bottle
- Rocket launcher
- Bike pump – a foot pump is best
- Hi-vis vests and safety glasses
- Bucket of water and measuring cups
- Phone or tablet for filming your test flights

Measurements key	
psi	Pound-force per square inch
ml	Millilitres

Record your data

For this flight, you'll be pumping the air pressure to 60 psi.

Test flight number	Water level (ml)	Air pressure (psi)	Observations	Launch rating (1–5)
Example	*10ml*	*60 psi*	*Not enough force, rocket didn't launch.*	*1*
1		60 psi		
2		60 psi		
3		60 psi		
4		60 psi		
5		60 psi		

Analysis:

Our rockets flew best when the **water level** was:

Conjecture comparison

Does this result match with your crew's conjecture? Why/why not?

Record your data

Test flight number	Crew name	Fin description	Observations	Launch rating (1–5)
Example	*Comet crew*	*Shape: Koru* *Size: Large* *Number: 5* *Materials: Wood*	*Fins were too heavy and unbalanced, rocket made a crash landing.*	*1*
1		Shape: Size: Number: Materials:		
2		Shape: Size: Number: Materials:		
3		Shape: Size: Number: Materials:		
4		Shape: Size: Number: Materials:		
5		Shape: Size: Number: Materials:		
6		Shape: Size: Number: Materials:		
7		Shape: Size: Number: Materials:		
8		Shape: Size: Number: Materials:		

Mission Brief 10: **Prototype test flights**

Space crew, prepare for lift-off. It's time to test how your rocket's fins affect its flight.

What you'll need:

- Your prototype rocket
- Rocket launcher
- Bike pump – a foot pump is best
- Hi-vis vests and safety glasses
- Bucket of water and measuring cups
- Stopwatch
- Phone or tablet for filming your flights

Test flight 2

Test each crew's rocket prototype and observe how their rocket's fins affect its flight. Remember to think about:

- Shape
- Size
- Number
- Materials

Like last time, you'll need to change one variable and keep the rest constant. So, keep your water level and air pressure the same for each launch.

Ask: How will our rocket's fins affect its flight?

Our conjecture:

We think our rocket's fins will affect its flight by:

We think this because:

Mission Brief 5: **Forces of flight**

Now we've learned Newton's first law, it's time to learn how it applies to rocketry!

Newton's first law

An object will remain at rest (not moving) or keep moving forever at the same speed and in a straight line, unless there is another force acting on it.

This means that your rocket will not lift off the ground without any force acting on it.

Step 1

Write the correct force of rocketry next to the definitions below:

Weight **Lift** **Thrust** **Drag**

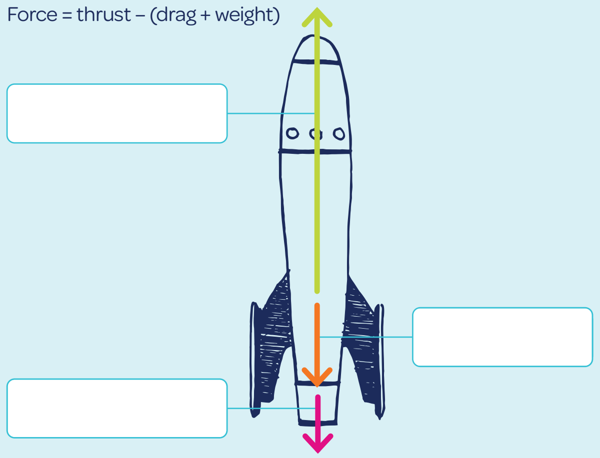
- **The force that makes your rocket move through the air**
- **The force on your rocket opposite to its movement through the air**
- **The force of gravity on your rocket**
- **The force that helps to keep your rocket stable**

Step 2

There are three main forces acting on this rocket diagram. Fill in the blank boxes with the correct force. You may even like to draw and label your own rocket on a piece of paper.

During launch

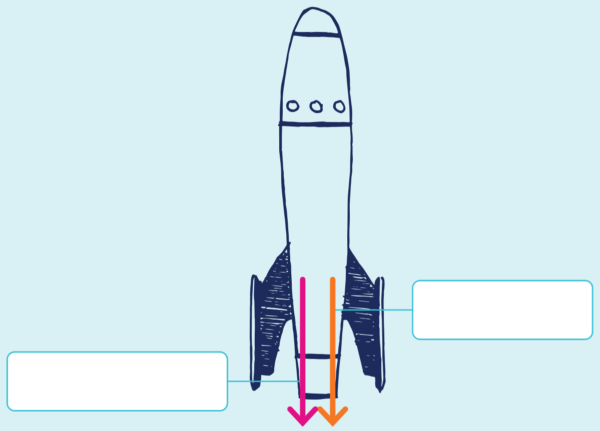
Force = thrust – (drag + weight)



- Rocket travels upwards.
- Speed becomes faster and faster.

After thrust has finished

Force = drag + weight



- Momentum keeps rocket moving upwards.
- Speed decreases.

Mission Brief 6: Imagine

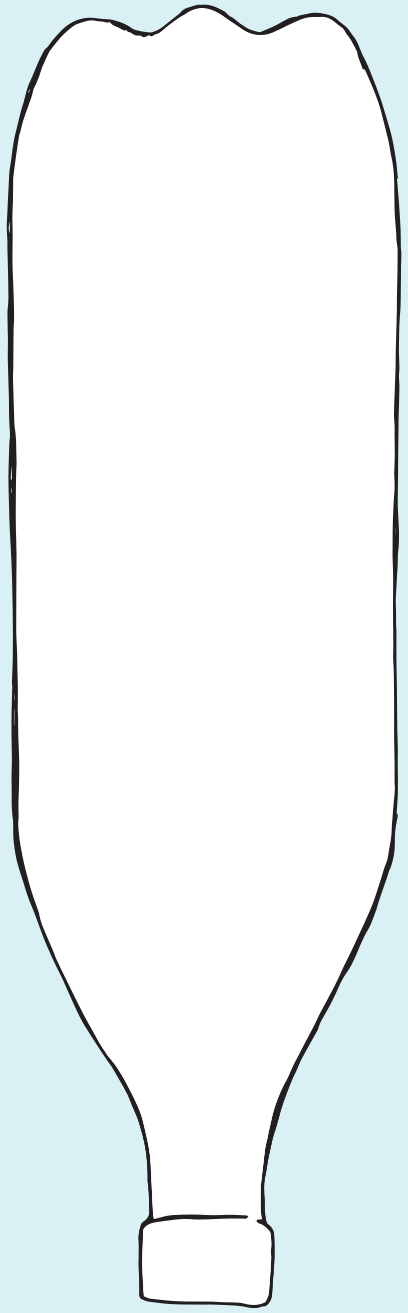
Are you ready to imagine an incredible high-powered extra awesome rocket design?

Brainstorm some ideas for your crew's rocket using this bottle outline and make it unique with epic designs.

Add some features to your rocket that will make it go super fast and travel super far. Make sure you label your features and think about what materials they could be made from.

Reminder!
Keep your forces of flight in mind:

- Thrust
- Drag
- Weight
- Lift



Mission Brief 9: Fact card frenzy!

You're almost expert rocketeers! Show off your Rocket Challenge knowledge by creating some handy fact cards with your crew.

You can use fact cards to test your crew and classmates on their rocketry smarts.

Get started

Step 1

Pānui each topic pātai and discuss the answers with your crew.

Step 2

Cut out each card along the dotted lines.

Step 3

Write the answer to the topic pātai on the back of each card. You could draw, list, or describe your answers.

Want a challenge?
Try out the bonus pātai!

Topic 1:
What are the forces of flight?

Bonus: Draw and label a rocket with the forces of flight.

Topic 2:
Describe one of Newton's laws.

Bonus: Add an example of this law in action.

Topic 3:
What are the four steps of the engineering design process?

Bonus: Give an example of when your crew used the engineering design process.

Topic 4:
What does STEM stand for?

Bonus: List some skills that STEM superstars have.

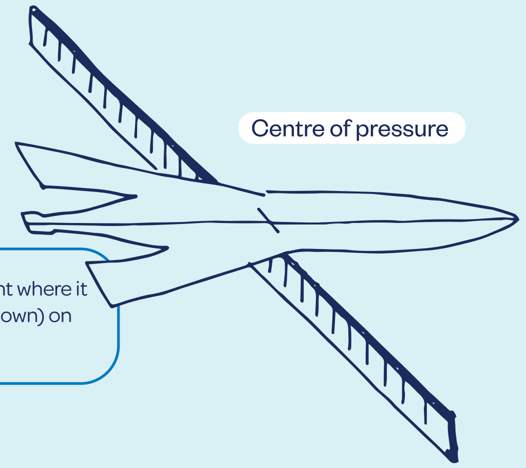
Test two: Centre of pressure

The centre of pressure is the place on your rocket where all the forces of flight are concentrated

Here's how to measure it:

Step 1

Draw the outline of your bottle rocket. Cut it out from card. It needs to be exactly the same shape and size as your rocket.



Step 2

Try and find the point where it balances (flat side down) on the edge of a ruler.

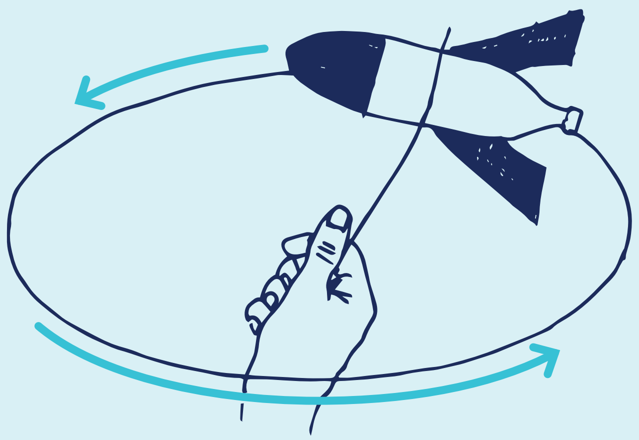
Tip! For a rocket to be stable, it's best if the centre of pressure is closer to the tail of the rocket. How could you achieve this?

Step 3

Mark the spot on your rocket as the centre of pressure.

Step 4

Record your results.



Extra time?

Check your rocket's stability by tying a string around its centre of mass. Then, find a clear space and start slowly swinging the rocket in a circle around you, nosecone first.

If the rocket is stable, the nosecone will stay at the front.

If it flies backwards or cartwheels, think about what you could do to adjust its centre of mass and centre of pressure.

Mission Brief 7: Create

It's time to create a rocket prototype!

To make a supercharged rocket design, you'll need to think about Newton's laws, and aerodynamics.

Newton's laws:

To recap, the laws you've learned so far are:

Newton's first law

An object will remain at rest (not moving) or keep moving forever at the same speed and in a straight line unless there is another force acting on it

Newton's second law

Force = mass x acceleration

Aerodynamics:

The study of how air moves around an object. A rocket's aerodynamics affects its forces of flight.

When it comes to creating an aerodynamic prototype, there are four things to keep in mind:

1. Rocket body

Rockets should have a streamlined body because:

Make sure your base bottle is in good condition with no lumps, bumps or holes and think about how to keep it smooth and curved.

2. Nosecone

A nosecone helps with flight by:

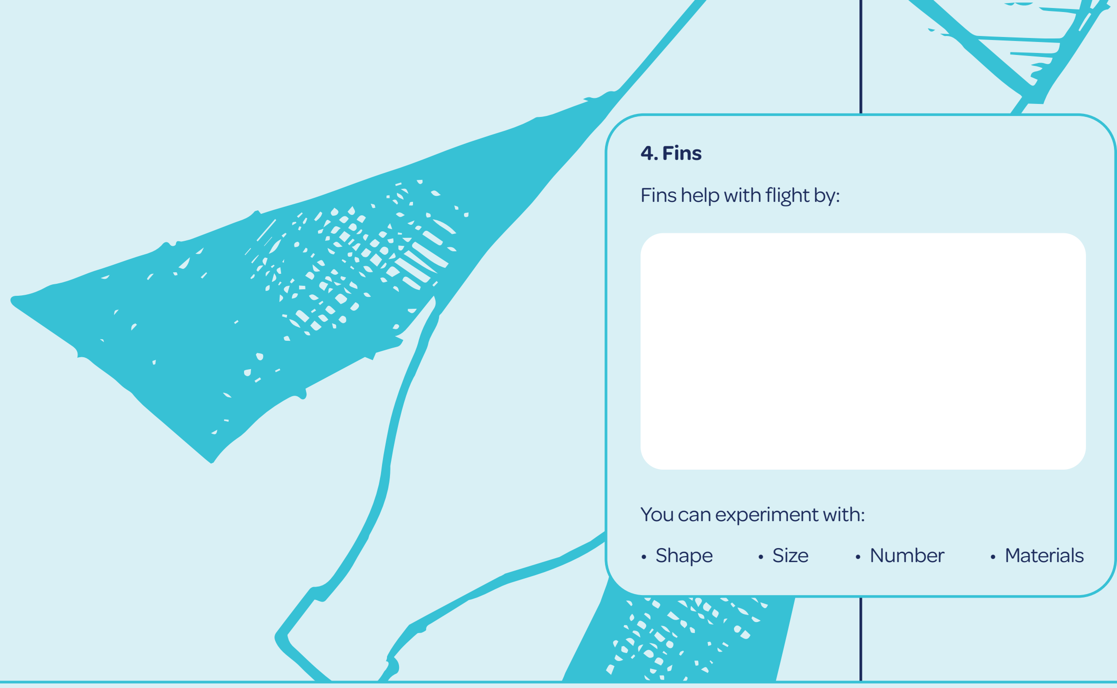
You can make a nosecone using another soda bottle. Simply cut off the top half of another bottle and place it on the bottom of your base bottle. This will become the top of your rocket.

Did you know you don't need to attach your nosecone? During lift-off, the air pressure will hold the nosecone in place. This is really helpful if you need to change your rocket's design to improve its flight.

3. Weight distribution

Rockets are more stable when:

Could you put something into the cap of your nosecone to add more weight?



4. Fins

Fins help with flight by:

You can experiment with:

- Shape
- Size
- Number
- Materials

Create a fin template

Using what you've learned about aerodynamics and Newton's laws, draw or describe a fin template for your rocket.

See if you can use your new knowledge to improve your fin design from Mission Brief 6.

Ok space crew! You can now create your first rocket prototype.

Karawhiua!

Mission Brief 8: **Rocket weight distribution**

Will your rocket design shoot for the stars or make a crash landing? Let's do some tests to see whether your rocket's weight distribution is aerodynamic.

Test one: Centre of mass

The centre of mass is the place on your rocket where all the mass is concentrated, and your rocket's weight is evenly balanced on both sides.

Here's how to measure it:

Step 1

Tie a string around the middle of your empty bottle rocket.

Step 2

Let it hang from the string. If the string is tied around the centre of mass, the rocket will hang horizontally, just like the diagram.

Step 3

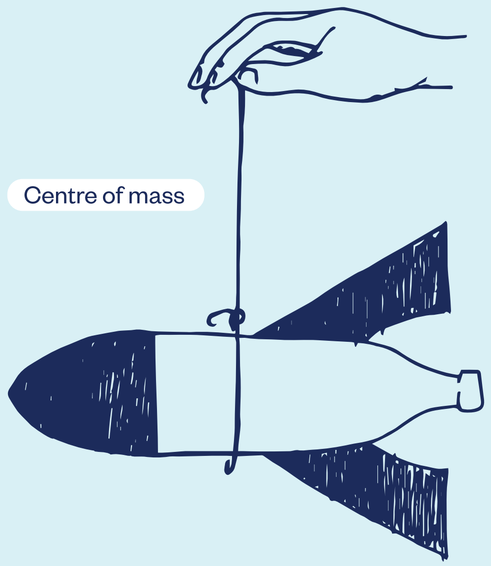
If your rocket doesn't hang horizontally, slide the string left or right until it does.

Step 4

Mark the spot on your rocket as the centre of mass.

Step 5

Record your results.



Tip! To make sure your rocket flies straight, it's best if the centre of mass is closer to the rocket's nose. How could you achieve this?