Coordinator Notes:

Module 1.2 Air & Flight – Rockets & the Laws of Motion

This Module explores Rockets, Space and Newton's Laws of Motion!

- Students will expand on their understanding of aerodynamics and the forces of flight gained in Module 1.1
- Students will further explore Newton's Laws of Motion.
- Students will utilise this knowledge in experiments and a Bottle Rocket Challenge.

Session Length:

This Module can be presented in different session durations per your needs.

Lesson plans are provided for:

- A 120 minute session, or, 2 x 60 minute sessions
- 45 minute, 75 minute, and 90 minute sessions

Technology:

PowerPoint: If you do not have access to a data projector and cannot display the PowerPoint presentation, we recommend that you print the most important slides before the session, and either enlarge them onto cardboard to use in place of slides, or create a booklet that students can share in small groups. The most important slides have been included as a 'Reduced Slides' PowerPoint file, and an easily printable pdf version of these slides is also provided. If you choose this option, we recommend that you still read and use the slide notes included in the full PowerPoint for the session.

The session can be conducted without slides all together, but they offer visual aid in explanation of scientific concepts. We recommend at the very least that instructions for each experiment are printed for the students.

Videos links: The suggested links to online videos within the session can be helpful with explanation. Notes have been included in the slides if there is an essential component to a video which the facilitator should discuss or demonstrate, if the video cannot be played.

Video files: A video file for each Module has been provided to aid explanation and instruction for some experiments and challenges. It is recommended coordinators view video files prior to delivering sessions, if the experiments and challenge activities are unfamiliar.

Please read the Module 1 Risk Assessment before proceeding with the session

The Bottle Rocket Challenge must be completed outside in a large open space, and is weather dependent. Module 1.3 can be delivered before session 1.2 if needed.

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Module 1.2 Air & Flight – Rockets & the Laws of Motion: Overview

Welcome back participants and welcome new participants!

Begin the session by recapping Module 1.1. In Module 1.1, we explored air, aerodynamics and the forces of flight. We also explored the 'Scientific Method', the steps scientists use to learn about the world: observing, questioning, forming hypothesis, researching & experimenting, analysing, forming conclusions, communicating results.

Encourage students to use the scientific method and form hypotheses for their experiments.

Content overview:

Concept / Activity	Session Duration (minutes)			
	120	90	75	45
Rocket Launch Video Share the NASA video clip of the SpaceX CRS-12 Falcon 9 rocket launching to the International Space Station in August 2017.	*	*	*	
Aerodynamics and Rockets Recap aerodynamics, the science of how air moves around objects. Encourage students to share what they remember. Explore and compare aerodynamics for planes and rockets.	*	*	*	*
Four Forces of Flight Recap the forces of flight: Weight, Lift, Thrust, and Drag. Compare similarities and differences for aeroplanes and rockets.	*	*	*	*
Newton's Laws of Motion Introduce / recap and discuss Newton's three laws of motion. 1st Law: Objects remain stationary, or move in a straight line at a constant speed, until acted on by an external force. 2nd Law: Force = Mass x Acceleration 3rd Law: Every action has an equal and opposite reaction.	*	*	*	
Experiment E1.2.1 Egg Drop This experiment explores Newton's 1st Law.	*			
Experiment E1.2.2 Accelerating Balls This experiment explores Newton's 2nd Law.	*			
Experiment E1.2.3 Balloon Rockets This experiment explores Newton's 3rd Law.	*			
Thrust Discuss with students ideas for how rockets generate thrust. Rockets can be propelled in lots of different ways.	*	*	*	*
Experiment E1.2.4 Alka-Seltzer Rocket This experiment explores Newton's 3rd Law, and demonstrates thrust created through a chemical reaction.	*	*		
Bottle Rocket Challenge Explore rocket building using plastic bottles, water, air and pressure. Which designs fly the furthest?	*	*	*	*

Slides:

PowerPoint Slides are available to support the delivery of this module. Slides explain concepts visually, and include short, engaging videos relevant to the topic.

A full list of slides and recommended inclusions for each session duration are provided in the table below. Appropriate slides are also noted in lesson plans for each duration.

PowerPoint Presentation: 'M 1.2 - Master Slides 120 minute Session Duration'		Session Duration (minutes)			
Slide	**Content**	**120**	**90**	**75**	**45**
1	Introductory title page for Module 1.2	*	*	*	*
2	Video link to NASA SpaceX Falcon rocket launch	*	*	*	-
3	Prompt for discussion about aerodynamics and rockets	*	*	*	*
4	Introduces the four forces of flight for rockets	*	*	*	*
5	Introduces Newton's Laws of Motion	*	*	*	-
6	Outlines Newton's 1st Law	*	*	*	-
7	Outlines Experiment 1.2.1 'Egg Drop'	*	-	-	-
8	Outlines Newton's 2nd Law	*	*	*	-
9	Outlines Experiment 1.2.2 'Accelerating Balls'	*	-	-	-
10	Outlines Newton's 3rd Law	*	*	*	-
11	Outlines Experiment 1.2.3 'Balloon Rockets'	*	-	-	-
12	Prompt for discussion about how rockets create thrust	*	*	*	*
13	Outlines Experiment 1.2.4 'Alka-Seltzer Rocket'	*	*	-	-
14	Provides information on Alka-Seltzer. Prompt for discussion about Air Pressure, chemical reactions.	*	-	-	-
15	Introduces Challenge 1.2 'Bottle Rocket Challenge'	*	*	*	*
16	Video link to 'Liquifly' water powered bottle rocket	*	*	*	*
17	Outlines Bottle Rocket world records	*	*	*	*
18	Rules for Challenge 1.2 'Bottle Rocket Challenge'	*	*	*	*
19	Design prompts for Challenge 1.2	*	*	*	*
20	Session references, online links	*	*	*	*

Module 1.2 AIR & FLIGHT – Rockets & the Laws of Motion Lesson Plan

120 minute session or 2 x 60 minute sessions

High Tech: Use PowerPoint Presentation 'M1.2 - Master Slides 120 minute Session Duration'
Low Tech: Print PowerPoint 'M 1.2 - Reduced Slides for Printing'. Use slide notes from the ENTIRE 120 minute presentation, adapting discussion to cover omitted slides.

Key Learning Area			**Topic**
Physics			Rockets
Timing	**Running Time (hh:mm)**	**Procedure**	**Materials**
5 min	00:05	**Lesson Introduction** Recap on we remember from last session. Watch Rocket Launch Video	PowerPoint M1.2 (Slides 1-2)
5 min	00:10	**Body of Lesson** **(Lesson 1, 2 x 60 minute sessions)** Recap four forces of flight, discuss how rockets work & introduce Newton's Laws	PowerPoint M1.2 (slides 3-5)
15 min	00:25	Explore Newton's 1st Law. Discuss hypothesis and conduct Experiment 1.2.1 Egg Drop, discuss results	PowerPoint M1.2 (slides 6-7), Toilet rolls, eggs*, cups, water, chopping boards or cardboard ***Eggs can be replaced by golf balls**
15 min	00:40	Discuss hypothesis and conduct Experiment 1.2.2 Accelerating Balls, discuss results	PowerPoint M1.2 (slides 8-9), Light and heavy balls
15 min	00:55	Discuss hypothesis and conduct Experiment 1.2.3 Balloon Rockets, discuss results	PowerPoint M1.2 (slides 10-11), String, tape, straws, balloons
5 min	01:00/ 1 HOUR	Discuss hypothesis and share ideas on how rockets generate thrust. **(Break for 2 x 60 minute sessions)**	PowerPoint M1.2 (slide 12)

		Body of Lesson **(Lesson 2, 2 x 60 minute sessions)**	
10 min	00:10/ 01:10	Discuss hypothesis and demonstrate Experiment 1.2.4, Alka-Seltzer Rocket, discuss results.	PowerPoint M1.2 (slides 13-14), film canisters, water, Alka-Seltzer, paper towels
5min	00:15/ 01:15	Introduce challenge and watch bottle rocket video (If video is unable to be played, the coordinator should discuss with students how a bottle rocket works. Coordinator should watch the video prior to the session)	PowerPoint M1.2 (slides 15-17)
5min	00:20/ 1:20	Discuss challenge aim and rules	PowerPoint M1.2 (slides 18-19)
20 min	00:40/ 1:40	Design and build bottle rockets.	M1.2 Planning Sheet, M1.2 Score Sheet, PET bottles, tape, rulers, plastic, Styrofoam, cardboard, bike pump, markers, water
15 min	00:55/ 1:55	Rocket testing.	Measuring tape, stopwatch, rocket launcher
		Lesson Conclusion	
5 min	00:60/ 2:00 END.	Clean up. Discussion about the session and which characteristics made good rockets.	

Module 1.2 – Rockets & the Laws of Motion Experiments

E1.2.1: Egg Drop

Aim: To observe Newton's laws of motion.

Equipment: (per group)

- 1 x eggs (or 1 golf ball)
- 1 x toilet rolls
- 1 x chopping board or 1 piece of thick cardboard
- 1 x cups, partially filled with water

Procedure:

1. Form into groups of 3 to 4 students.

In groups:

2. Fill the cup up to 3 quarters full of water (just past half way).
3. Place the chopping board (or cardboard) on top of the cup.
4. Place the egg (or ball) on top of the end of toilet roll (length ways) and place the toilet roll and egg (or ball) on top of the chopping board.
5. Ensure the toilet roll and egg are lined up directly above the cup.
6. Swiftly pull the board out from under the toilet roll.
7. Observe where the egg (or ball) lands

Extension: Repeat the experiment with 2 cups side by side and (2 eggs, 2 toilet rolls). Place the chopping board over both cups. See if you can get both eggs in the cups.

Expected Result:

The egg (or ball) should have fallen directly down into the cup of water.

Explanation:

Due to Newton's 1st law of motion (The law of Inertia) the egg remains stationary until acted on by an external force. Although the force of gravity is always acting on the egg, the objects below the egg stop from moving downwards, and it remains at rest. When the board is pulled away, the egg is no longer supported, and begins to fall downwards (due to the force of gravity). The egg continues to fall until it is brought to a stop when it encounters the water.

Notes:

- ***This experiment should be performed on a surface which can get wet.***
- ***Ensure paper towel / towels are available to clean up spills.***
- ***Be aware of potential allergies. Eggs can be removed from the experiment, and replaced with a golf ball (or similar).***

Note: This experiment is included in the Module 1.1 Video

E1.2.2: Accelerating Balls

Aim: To observe Newton's laws of motion.

Equipment: (per group)

- 1 x heavy ball (e.g. golf ball, pool ball or marble)
- 1 x light ball (e.g. ping pong ball, cotton ball)

Procedure:

1. Form into groups of 2 to 3 students.

In groups:

2. Place the light ball on a table, and push it carefully across the table.
3. Have a group member count how long it takes the light ball to get to the other side of the table. Record the result.
4. Place the heavy ball on the same table.
5. Push the heavy ball carefully across the table, using the same amount of force as you used for the light ball.
6. Have a group member count how long it takes the heavy ball to get to the other side of the table. Record the result.
7. Compare the time it took for each ball to travel to the other side of the table.

Expected Result:

The light ball will roll across the table faster than the heavy ball.

Explanation:

Newton's 2st law of motion states that: **Force = Mass x Acceleration**

When a force acts on an object, it will tend to move in the direction of the force.

The larger the force on an object, the greater it's acceleration will be.

The more massive (or heavy) an object it, the greater the force needed to accelerate it.

If the same amount of force is applied to a light object as to a heavy object, the light object will experience greater acceleration, and will move faster than the heavy object.

E1.2.3: Balloon Rockets

Aim: To observe the effect of a sudden release of air on a balloon

Equipment: (as a group)

- Balloons
- Tape (masking tape)
- String, with enough length to span the room (up to three spans)
- 1 straw per string line

Procedure:

1. Measure out enough string to span between the walls of the room (create 1 to 3 stringlines, depending on number of students).
2. Thread a short straw onto each string line.
3. Set up the stringline(s) by taping either end of the string to opposite walls of the room using masking tape.
4. Inflate a balloon but don't tie it closed. Pinch the end of the balloon closed by hand.
5. Tape the middle of the inflated balloon onto the straw which has been threaded onto the stringline.
6. Ensure the stringline is secured to the wall at each end.
7. Count down (3, 2, 1) and release the balloon.
8. Observe the effect on the balloon. Document your observations!

Extensions: Repeat the experiment with different balloon inflation levels. Test if the amount of air inside a balloon changes the distance it travels before fully deflating. Test the time it takes for balloons of varying inflation to travel a set distance along a stringline.

Expected Result:

The balloon (and straw) will accelerate along the stringline when the air is allowed to escape from the balloon. The direction of travel will be in the opposite direction to the open end of the balloon.

Explanation:

As per Newton's 3rd law of motion, every action has an equal and opposite reaction.

Air inside the balloon is compressed when the balloon is inflated. When the end of the inflated balloon is released, the air inside the balloon expands and rushes quickly out of the balloon into the room. The force of the air rushing out of the open end of the balloon pushes the balloon in the opposite direction.

Note: This experiment is included in the Module 1.1 Video

E1.2.4: Alka-Seltzer Rocket

Aim: To observe the effect of pressure on a film canister.

Equipment: (For group, coordinator to demonstrate, students assist.)

- 1 to 3 x film canisters
- 3-6 x Alka-Seltzer tablets
- Bottle of water
- Paper towel for cleaning up

Procedure:

1. Set up a demonstration table with empty film canisters, Alka-Seltzer and a bottle of water. Have paper towel nearby.
2. Ensure canister lids are dry, then place half a tablet of Alka-Seltzer (broken into 2 or more pieces) onto each lid.
3. Ask students to think about a hypothesis before you commence the experiment.
4. Ensure all students are observing from a minimum of 1 metre away.
5. Fill one canister approximately 1/3 full with water.
6. Drop the Alka-Seltzer pieces into the water-filled canister, quickly place the lid on (you should hear a click). Quickly turn the canister over and put it down on the table (lid side down) and walk briskly away (at least 1 metre).
7. Stand back and observe the reaction. Discuss the results and compare to hypothesis!

Expected Result:

The film canister lid pops off and the canister tube flies vertically into the air.

Explanation:

Newton's 3rd Law of Motion states that for every action (force), there is an equal and opposite reaction (force in the opposite direction). Alka-Seltzer tablets contain chemical energy. When we put an Alka-Seltzer tablet into water, a chemical reaction occurs, releasing energy and producing carbon dioxide gas. As the canister fills with gas, the pressure inside the canister increases. When a certain pressure is reached the lid is pushed off, causing the film canister to fly up into the air.

Notes:

- ***The rockets should take around five seconds to launch, but have been known to go slightly quicker or much slower.***
- ***Never assume a canister won't go off – they have been known to remain stable for five minutes or more before launching.***
- ***Never have the canisters pointing sidewards or at participants.***
- ***Never stand over or allow a student to stand over and look down at a canister.***
- ***If a canister does not launch, approach it FROM BELOW AND TO THE SIDE. Grab firmly hold of the tube and use your thumb to pop the lid off in a downward direction.***
- ***This experiment should be performed on a surface which can get wet.***

Student Participation:

Students may be instructed on how to perform the experiment, and supervised to safely undertake the activity. Ask student to repeat the experiment instructions back to you before they perform the experiment.

Ensure students don't run or move backwards fast when retreating from the table after turning canisters over lid side down for launch; this can lead to tripping or collisions.

Extensions:

- Observe how the experiment changes if the half tablet of Alka-Seltzer remains in one piece.

  You should see that the rocket launch takes much longer, as there is less surface area of the tablet in contact with the water, slowing the chemical reaction.

- Observe how the experiment changes if you use warm water.

  You should see a faster rocket launch with warm water, as the heat causes the chemical reaction to occur more rapidly.

Note: This experiment is included in the Module 1.1 Video

Challenge M1.2 – Bottle Rocket Challenge

Coordinator Notes

Scoring:

A scoring mechanism is included, so the element of 'competition' may challenge all students to participate to their fullest. You may remove the scoring system all together if it does not work with your group of students.

When scoring it is important to only announce the distance travelled by the furthest flying rocket - so there will be no 'losers' or last place. It is important to highlight the good strategies of each rocket so all feel like they have done a good job.

Consider asking students how they might approach the task differently if asked to do it again, or how they might teach the same things they learned during the club to a younger student.

**** If you choose not to use a scoring system modify the slides that reference a 'score'****

Activity Notes:

- This activity needs to be done outside. A sports field would be perfect.
- The students should either draw, make notes or think of a plan for their bottle rocket design before starting construction.
- Ensure there are no very sharp edges on the bottle rocket designs that could injure someone.
- Clearly designate a launch area and landing zone.
- The bottle rocket launcher needs to be at one end of the field, propped to an angle of approximately 45 degrees.
- An angled launch will enable rockets to travel across the field, simplifying scoring to measurement of horizontal distance travelled (instead of altitude).
- The rocket must be pumped, with a foot or bike pump, to a high pressure on the launcher, before the release cord is pulled and the rocket launched. The launcher used should have a pressure release valve to minimise risk of over pressurising.
- Students may like to work individually, or in groups of 2 to 4. For a 45 minutes session, small groups are recommended.
- If time permits, enable rockets to be trial tested and minor adjustments to be performed by students prior to official testing.
- During official testing, encourage students to watch, support and cheer for each rocket.
- Support students to perform the official measuring, and to help record results.

Suggested rules / guidelines:

- Bottle rockets are to be made from plastic soft-drink bottles.
- Other materials may be used to improve the aerodynamics of the rocket.
- The bottle rocket must only be fuelled with water and pressurised air from a bike or foot pump.
- The rocket launch pad must be in a large open space outdoors, propped to an angle of approximately 45 degrees.
- Distance measurements will be taken from the front of the launch pad to the middle of the rocket (where it lands).
- The best distance out of three* official attempts will be the final score for each rocket.
- No rocket launch will take place until everyone is standing behind the launch pad, out of the rocket's path.
- Do not allow a rocket to be launched while anyone is standing in the landing zone.
- All rocket launches must be supervised by the coordinator.

* *Adjust the number of official attempts to suit the time available, aiming to ensure all rockets are able to be tested at least once.*

45 minute session adjustment:

- Encourage all students to form into small groups to reduce the number of bottle rockets to be tested (and increase time available for testing).
- Offer each group only one official attempt for testing / scoring. Once all groups have completed their official attempt, offer a second if time permits.

Notes on pressure:

Water bottle rockets work on the same principles as other rockets, with the energy for launch coming from water and air pressure. The action of pumping air into the bottle filled with water creates high pressure which forces the water through the restricted opening at high velocity. This creates the thrust needed to launch the bottle high into the air. Water bottle rockets demonstrate Newton's Third Law of Motion: "every action has an equal and opposite reaction".

Planning Sheet M1.2: Bottle Rocket Challenge

To design your bottle rocket, keep in mind the four forces of flight!

WEIGHT – how much will your rocket weigh, what materials will you use?

THRUST – how much fuel (water) will you fill into your rocket?

LIFT – how will you stabilise your rocket (to stop it spinning during flight)?

DRAG – how will you make your rocket aerodynamic (reduce drag)?

Thinking about these forces, sketch ideas for your bottle rocket design below!

Score Sheet: M 1.2 – Bottle Rocket Challenge

Team, Rocket or Individual Name	Distance 1	Distance 2	Distance 3	Best Score

Team, Rocket or Individual Name	Distance 1	Distance 2	Distance 3	Best Score

Module 1.2 AIR & FLIGHT – Rockets & the Laws of Motion Lesson Plan

90 minute session

High Tech: Adapt 'M 1.2 - Master Slides 120 minute Session Duration'. Hide slides 7, 9, 11, and 14. Alternately, this option has been provided for you as PowerPoint 'M 1.2b – 90 minute session full slides'.
Low Tech: Print PowerPoint 'M 1.2b – 90 minute session Reduced Slides'. Use slide notes from the ENTIRE 90 minute presentation, adapting discussion to cover omitted slides.

Key Learning Area	**Topic**
Physics	Rockets

Timing	Running Time (hh:mm)	Procedure	Materials
5 min	00:05	**Lesson Introduction** Recap on we remember from last session. Watch Rocket Launch Video	PowerPoint M1.2b (Slides 1-2)
5 min	00:10	**Body of Lesson** Discuss aerodynamics, forces of flight for rockets, and introduce Newton's Laws of Motion	PowerPoint M1.2b (slides 3-8)
5 min	00:15	Discuss rocket propulsion and hypothesise how rockets can generate thrust	PowerPoint M1.2b (slide 9)
10 min	00:25	Discuss hypothesis and demonstrate Alka-Seltzer Rocket Experiment 1.2.4, discuss results.	PowerPoint M1.2b (slide 10), film canisters, water, Alka-Seltzer, paper towels
5 min	00:30	Introduce challenge and watch bottle rocket video (If video is unable to be played, the coordinator should discuss with students how a bottle rocket works. Coordinator should watch the video prior to the session)	PowerPoint M1.2b (slides 11-13)

5 min	00:35	Discuss challenge aim and rules	PowerPoint M1.2b (slides 14-15)
20 min	00:55	Design and build bottle rockets	M1.2 Planning Sheet, M1.2 Score Sheet, PET bottles, tape, rulers, plastic, Styrofoam, cardboard, bike pump, markers, water
25 min	**01:20**	Rocket Testing	Measuring tape, stopwatch, rocket launcher
10 min	01:30 END.	**Lesson Conclusion** Clean up. Discussion about the session and which characteristics made good rockets.	

Module 1.2 AIR & FLIGHT – Rockets & the Laws of Motion Lesson Plan

75 minute session

High Tech: Adapt 'M 1.2 - Master Slides 120 minute Session Duration'. Hide slides 7, 9, 11, 13, and 14. Alternately, this option has been provided for you as PowerPoint 'M1.2c - 75 minute session Full Slides'
Low Tech: Print PowerPoint 'M 1.2c – 75 minute session Reduced Slides'. Use slide notes from the ENTIRE 75 minute presentation, adapting discussion to cover omitted slides.

Key Learning Area	**Topic**
Physics	Rockets

Timing	Running Time (hh:mm)	Procedure	Materials
		Lesson Introduction	
5 min	00:05	Recap on we remember from last session. Watch Rocket Launch Video	PowerPoint M1.2c (Slides 1-2)
		Body of Lesson	
5 min	00:10	Discuss aerodynamics, forces of flight for rockets, and introduce Newton's Laws of Motion	PowerPoint M1.2c (slides 3-8)
5 min	00:15	Discuss rocket propulsion and hypothesise how rockets can generate thrust	PowerPoint M1.2c (slide 9)
5 min	00:20	Introduce challenge and watch bottle rocket video (If video is unable to be played, the coordinator should discuss with students how a bottle rocket works. Coordinator should watch the video prior to the session)	PowerPoint M1.2c (slides 10-12)
5 min	00:25	Discuss challenge aim and rules	PowerPoint M1.2c (slides 13-14)

20 min **25 min**	00:45 **01:10**	Design and build bottle rocket Rocket Testing	M1.2 Planning Sheet, M1.2 Score Sheet, PET bottles, tape, rulers, plastic, Styrofoam, cardboard, bike pump, markers, water Measuring tape, stopwatch, rocket launcher
5 min	01:15 END.	**Lesson Conclusion** Clean up. Discussion about the session and which characteristics made good rockets.	

Module 1.2 AIR & FLIGHT – Rockets & the Laws of Motion Lesson Plan

45 minute session

High Tech: Adapt 'M 1.1 - Master Slides 120 minute Session Duration'. Hide slides 2, 5, 6, 7, 8, 9, 10, 11, 13, and 14. Alternately, this option has been provided for you as 'M1.2d - 45 minute session Full Slides'.
Low Tech: Print PowerPoint 'M 1.2d – 45 minute session Reduced Slides'. Use slide notes from the ENTIRE 45 minute presentation, adapting discussion to cover omitted slides.

Key Learning Area	**Topic**
Physics	Rockets

Timing	Running Time (hh:mm)	Procedure	Materials
		Lesson Introduction	
5 min	00:05	Recap on we remember from last session.	PowerPoint M1.2d (Slide 1)
		Body of Lesson	
5 min	00:10	Discuss aerodynamics, forces of flight for rockets. Discuss rocket propulsion and hypothesise how rockets can generate thrust	PowerPoint M1.2d (Slides 2-4)
5 min	00:15	Intro to challenge and bottle rocket video. Discuss challenge aim and rules. (If video is unable to be payed facilitator should discuss with students how a bottle rocket works – this can be seen in the video prior to the session).	PowerPoint M1.2d (slides 5-9)
15 min	00:30	Design and build bottle rocket	M 1.2 Planning Sheet, PET bottles, tape, rulers, styrofoam, plastic, cardboard, bike pump, markers, water

10 min	00:40	Rocket Testing	Measuring tape, stopwatch, rocket launcher
5 min	00:45 END.	**Lesson Conclusion** Clean up. Discussion about the session and which characteristics made good rockets.	

Module 1.2 – References

NASA SpaceXrocket launch

https://www.nasa.gov/multimedia/videogallery/index.html

Aerodynamics of Rockets

https://spaceflightsystems.grc.nasa.gov/education/rocket/rktfor.html

Newton's Laws of Motion & the Forces of Flight

https://www.britannica.com/science/Newtons-laws-of-motion

https://www.grc.nasa.gov/www/k-12/UEET/StudentSite/dynamicsofflight.html#lawofmotion

Bottle Rocket Launch Video

http://liquifly.com.au/ or https://youtu.be/P3Lwjx19hZw

Bottle Rocket Design ideas

http://www.rokit.com/rokit-labs/water-rocket-experiments/

Australian Aeronautical Velocity Challenge

http://iiate.asn.au/events/aeronautical-velocity-challenge

The Water Rocket Achievement World Record Association

http://www.wra2.org/index.php

Module 1.2 - Required Materials

- Pens, pencils and writing paper are generally required every session.
- Students may like to bring a note pad to record their observations and ideas.
- A group usually refers to 2 - 4 students.

Activity	Material	Amount	Where can I find it?
All sessions	PowerPoint Slides* (digital, or printed)	1 per coordinator	Coordinator Package
All sessions	Printed PowerPoint* Slide Notes	1 per coordinator	Coordinator Package
All sessions	Printed Lesson Plan	1 per coordinator	Coordinator Package
All sessions	Printed Module 1 Risk Assessment	1	Coordinator Package
All sessions	Computer, Data Projector, Screen	1	Venue
120 minute or 2 x 60 minute sessions Experiments	Eggs (or replace with golf ball)	1 per group	Supermarket (or sporting store)
	Plastic cups	1 per group	Supermarket
	Toilet roll	1 per group	Recycled or supermarket
	Chopping board or thick cardboard	1 per group	Supermarket / Stationary Shop
	Heavy ball (e.g. golf ball, marble)	1 per group	
	Light ball (e.g. ping pong ball)	1 per group	
	Balloons	1 packet (10)	
	String	1 ball	
	Masking tape	1 roll	
	Scissors	1 pair	
	Straws	3 to 5	
	Paper Towel	1 roll	
120 minute, 2 x 60 minute and 90 minute session experiments	Film canisters	1 to 3	Recycled or see link list, next page
	Alka-Seltzer Tablets	3 – 6 tablets	Pharmacy / chemist or supermarket
	Water	Approximately 500ml per group	Venue / supermarket
	Paper towel	1 roll	Supermarket

Required materials list continues next page

*Slide sets:

- 120 minute session or 2x60 minute sessions: Slides 1.2a (M 1.2 Master Slides)
- 90 minute session: Slides 1.2b
- 75 minutes session: Slides 1.2c
- 45 minutes session: Slides 1.2d

Activity	Material	Amount	Where can I find it?
Bottle Rocket Challenge (all sessions)	Water Bottle Rocket Launcher	1 or 2	**See link list below**
	Measuring Tape	1 or 2	Sporting store or hardware store
	Scissors	1 per group	Supermarket / Stationary Shop
	Water	Approximately 1 litre per group	Venue / supermarket
	Plastic PET (1.25L) bottles (empty)	1-2 per group	Recycled or supermarket
	Styrofoam	1 piece per group (approx. 20cm / 20cm)	Recycled, or Stationary Shop
	Tape (masking tape or clear sticky tape)	2 – 3 rolls, shared between groups	Supermarket / Stationary Shop
	Cardboard	1 piece per student (approx. 20cm / 20cm)	Supermarket / Stationary Shop
	Bike pump	1 or 2	Sporting store
	Paper towel	2 rolls	Supermarket

Online shopping links:

Film canisters (from $0.95):

https://shop.geostuff.com.au/products/35mm-film-container

Bottle Launchers (from $35):

Liquifly:
https://www.questacon.edu.au/qshop/Liquifly-Water-Powered-Rocket-Kit/

https://www.madaboutscience.com.au/shop/liquifly-deluxe-water-powered-rocket-kit.html/

Rokit:
http://au.rokit.com/the-product/

Aquapod:
https://www.jaycar.com.au/aquapod-bottle-rocket-launcher/p/GT3014