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Discover STEM

Classroom Resource

Make a Rocket and Investigate its Flight Path

Science Foundation Ireland For what's next

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Design Challenge

Make a Rocket and Investigate its Flight Path

Class Level - Senior

Curriculum Links

Strand:	Energy and Forces
Strand Unit:	Forces
Curriculum Objectives:	Identify and explore how objects and materials may be moved
Skills Development:	Design and Make - Explore, Plan, Make and Evaluate; Working Scientifically – Questioning, Observing, Predicting, Investigating and Experimenting, Estimating and Measuring, Analysing, Recording and Communicating
New words / vocabulary:	Angle of launch, force, trajectory, projectile
Focail nua:	Roicéad (Rocket), Lainseáil (Launch)
Cross curricular links:	Maths – 2D and 3D shapes, measurements, angles; History of flight; PE – throwing and kicking balls
Equipment / materials	• For foam rockets: foam pipe insulation, wide rubber band, duct tape, cardboard (for fins), scissors, ruler • Other materials such as cardboard tubes, plastic bottles etc. can be substituted for pipe insulation • For launching and measuring: metre stick (and launcher quadrant pattern provided), long tape measure / trundle wheel

Engage

Trigger questions / wondering:

- What are rockets? Cylinders full of materials which produce gases.
- How do they work? Gases going out the back of the rocket push it forward, like an untied blown-up balloon goes forward when you let it go and the air goes out the back.
- What are rockets used for? Sending objects into the air with great force to escape Earth's gravity.
- If you sent your rocket straight up into the air, where do you think it would land?
- If you want to throw or kick a ball a very long distance, how would you throw or kick it?
- Does the angle matter?
- What force will send our rocket up?
- What force will bring it down again? Gravity.

Background information:

This foam rocket is based on stored energy. When you pull back the elastic band, the elastic band stores this energy. When you let it go, it releases this energy as it returns to its original length. The foam rocket is stabilised by the fins, which keep it pointed in the desired direction.

Technically the foam rocket is a rocket in appearance only. Real rockets get their energy when burning fuels emit gases from the back, which, in turn, send the rocket in the opposite direction. Things that are sent into the air, and that have no energy source of their own (e.g., a ball, javelin) are called projectiles. Gravity gradually brings them down.

Real-world application:

The flight path or trajectory of the rocket depends on the angle of launch and the force applied (the amount of energy stored in the elastic by pulling it back). These same factors apply in the case of any object that is thrown or kicked, such as a ball.

Design Challenge

Explore

Show the learners a foam rocket and demonstrate how it works. Either show them how to make the basic model as suggested below or provide some pre-made ones. One rocket per group should be enough for initial exploration.

Making the Rocket

- Using scissors, cut one 30 cm length of pipe insulation for each rocket.
- Cut four equally-spaced slits, each about 8 cm long, at one end of the tube. This will be the tail of the rocket. The fins will go into these slits.

Front of rocket

- Cut a 12 cm length of duct tape down the middle to make two pieces. Place one piece over the other, sticky to shiny side, to make the tape extra-strong.
- Place a single strand of a rubber band across the top of the foam tube.
- Tape the rubber band down to the tube, using the double strength duct tape at right angles to the rubber band.
- Press the tape down to the sides of the tube.
- Reinforce this tape with another length of tape wrapped around the top end of the side of the tube.

Back of rocket

- Cut four fins from cardboard. A suggested way is as follows: Cut a 10 cm square, draw a diagonal and cut along the diagonal (forming two isosceles triangles).
- Cut halfway down the height of one triangle and halfway up the other. Now nest the fins together and place them in the slit.
- Close off the slits with another piece of duct tape wrapped around the foam tube.

Launching the rocket

- Loop the rubber band at the top of the rocket over the end of the metre stick.
- Pull on the bottom end of the rocket, holding it below the fins as you point it up into the air.
- Now let the rocket go.
- What happened to the rocket?

Allow the learners to explore with the rockets. The best place for launching is outdoors on a calm day as the rockets will travel quite far. Alternatively, a school hall can be used: the larger the better. Learners should explore how they can make their rocket travel as far as possible. Could they improve the design to make it travel further? Could they change something about the way it is launched?

Plan

Learners should look at the rocket they have been exploring with. How could they improve the rocket's design to make it travel further while still using the elastic band to launch it? In planning, they might consider:

- The materials used – they may decide to construct their rocket from recycled materials such as a toilet roll / kitchen towel tube, an empty plastic bottle or even an old sock.
- The fins – they may decide to use a different material for the fins, to make them a different size or different shape or to place them in a different position.
- The size – they may decide to make their rocket shorter or to use a different pipe insulation diameter.

Once they have decided on materials, the learners should draw a plan of their rocket with materials and measurements. This will be useful if they want to adapt their design.

Make

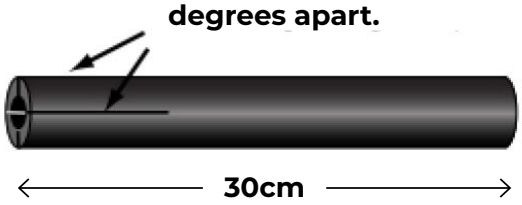
Groups make their rocket according to their plans.

Evaluate

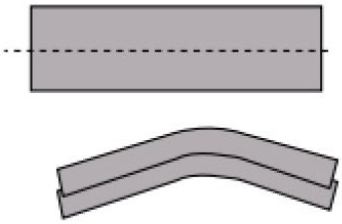
The following questions may help with rocket testing and evaluation:

- How far can your rocket travel? Can it travel further than the first foam rocket you tried?
- Is your rocket strong enough? Does it stay together when you pull back the elastic to launch it?
- Are you happy with your design? What do you think you could do to improve it?
- If you want to improve your rocket, use your initial plan to make a new rocket. Change one variable at a time and retest.

1 Cut four slits 12 cm long 90 degrees apart.



2 Cut 12 cm strip of duct tape in half lengthwise. Place one strip on top of other.



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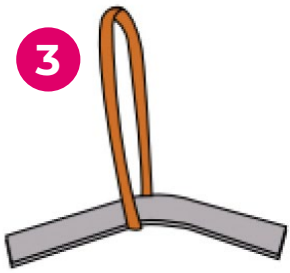
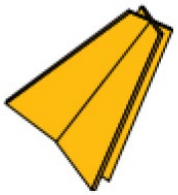


4 Tape launcher rubber band to nose end of rocket.

Add tape strip around the nose to strengthen the attachment.

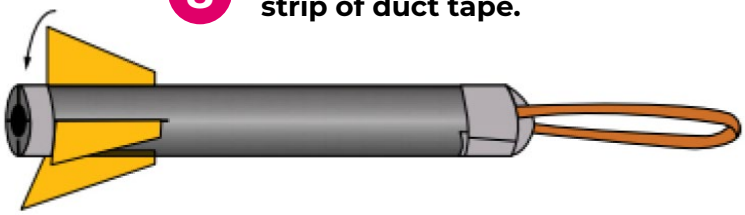
5 Cut out fins with notches.

6 Slide fins together.



7 Slide fins into slits.

8 Close fin slits with narrow strip of duct tape.



Ready for flight!

Investigate

Use your rocket to design a fair test investigation. Each group should come up with a starter question and change one thing about the way their rocket is made or launched. Some possible starter questions are suggested below. For fair testing, remember to only change one variable at a time, e.g., if changing a design feature such as rocket length, all other design features and all launch conditions should be kept the same.

Starter questions

Launch conditions

- How does the angle of launch affect the distance travelled?
- How does the force (the amount of stretch on the elastic) affect the distance travelled?
- How does the wind direction affect the distance travelled (launched with the wind, against the wind, across the wind)?
- How does the position of launch (standing, sitting, kneeling) affect the distance travelled?

Design Features

- How does the size of the fins affect the distance travelled?
- How does the length of the rocket affect the distance travelled?
- How does the position of the fins affect the distance travelled?

Prediction

Groups should make a prediction based on their chosen question, e.g., "I predict that the rocket will travel furthest at an angle of 30^0".

Conducting the investigation

- Groups should discuss how to carry out their investigation and how to make it a fair test. They should record their data in some way (tables, graphs, video).

The following is a suggested way to compare the launch angle to the distance the rocket travels:

- Print out the launcher quadrant pattern provided onto card.
- Cut out the pattern and fold it on the dashed line.
- Tape the quadrant to the metre stick so that the black dot lies directly over the 60 cm mark on the stick and the long arm points towards the 10 cm mark.
- Press a drawing pin into the black dot.
- Tie a string to the drawing pin and hang a small weight (e.g., plasticine) to the string. Make sure the string hangs freely.
- Loop the rubber band over the end of the metre stick. Pull on the fin end of the rocket until the nose is aligned with the 30 cm mark.
- Tilt the launcher up at the chosen angle as indicated with the string and weight on the quadrant.
- Release the rocket and measure the distance travelled. To help measure long distances, the learners can measure and place markers at 1 metre intervals, starting at 5 metres and going up to 20 metres.
- The launch should be repeated three times for each angle to determine an average distance.

How will you make this a fair test?

- What will you keep the same? – use the same rocket each time, stretch the rubber band the same distance each time, e.g., the nose is aligned with the 30 cm mark on the metre stick, start from the same position, launch in the same direction.
- What will you change? The angle of launch.
- What will you measure and record? The distance travelled (measured along the ground).

Sharing data/results

Groups should present their findings to the rest of the class.

Take the Next Step

Adapt for home:

The rocket could easily be constructed and tested at home using readily available materials such as toilet roll inserts.

Adapt for junior/senior level:

The rocket can be quite challenging to construct, especially the attachment of the elastic band and the cutting of evenly spaced slits in the foam. Younger classes may need help with construction or to be given pre-cut slits and/or fins.

For testing, younger classes could be challenged to hit a particular target, such as a hula hoop on the ground, an empty bucket or a particular line on the basketball court. They could discuss pointing the metre stick in a different direction or pulling back the rocket further without having to measure. Leaning the metre stick against the seat and back of an infant chair can be a good way to keep the angle the same without having to measure.

Follow-up challenge/project/citizen science link:

- Look at people playing sports such as ball sports, such as archery, javelin, darts or watch videos. Look at the trajectory of the ball/arrow/dart. How does it compare to your rocket launch?
- Research how real rockets are launched. How much fuel is used? Where are they launched from and why? What are rockets used for?

Launch Quadrant Pattern

(Actual Size)