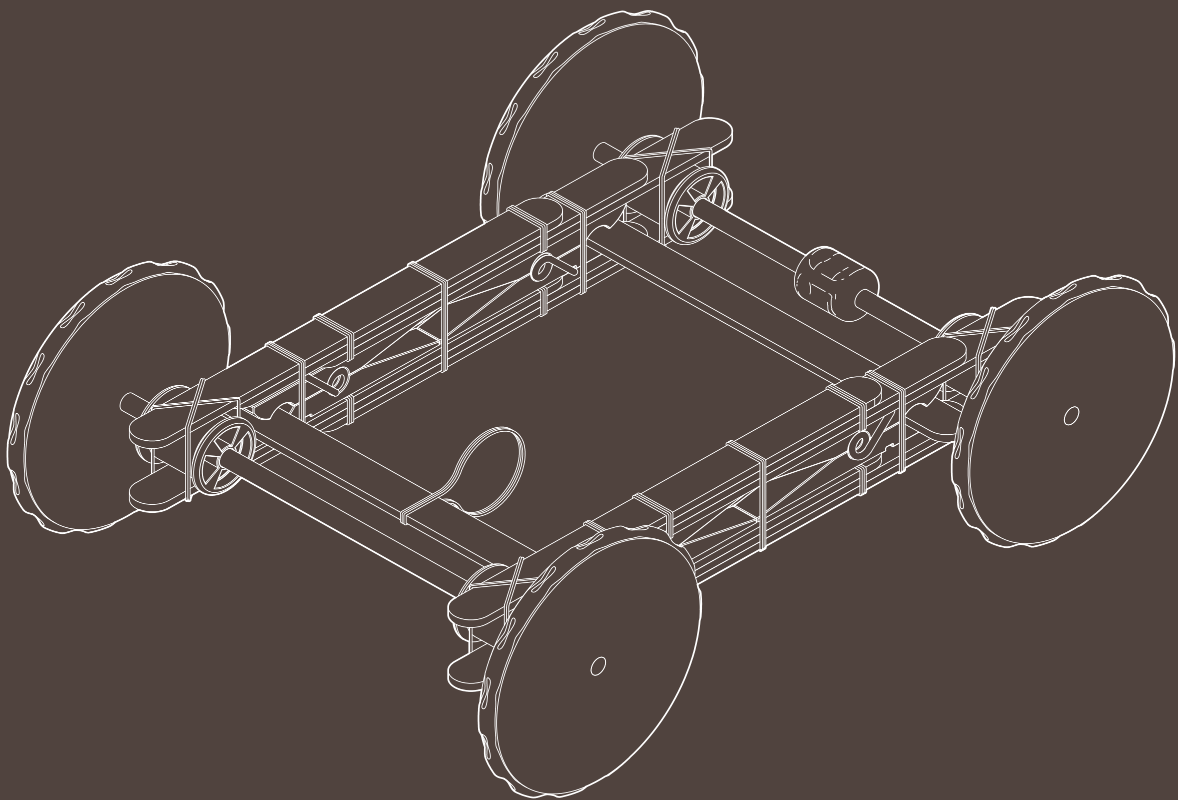
CHALLENGE 2

LUNAR ROVER

In this challenge, teams will work together to create a speedy Lunar Rover. First to cross the finish line wins!



TEACHING NOTES

SUMMARY

The Lunar Rover session challenges students to build a functioning rubber band car. They have the option to follow the build template provided, or if they're feeling adventurous they can design and build their very own.

In teams, students will use the craft materials provided to construct their creations, which they will showcase at the end of the session. The rover that travels the furthest distance wins!

Students will learn about potential and kinetic energy in this session, whilst also considering the relationship between mass, force and torque, and the effect they will have on their final design.

LESSON PLAN

ACTIVITY	DESCRIPTION	TIMING
Introduction	Introduce the goal of the session and hand out the student resource sheet. Divide students into teams of 4, providing a set of materials and worksheet to each.	5-10m
Warm-up Activity A	Introduce the warm-up activity and ensure that students have the required materials to complete it.	10-15m
Main Challenge	Explain to the students that their Lunar Rover has to travel as far as possible, whilst staying intact. They don't have to use all the materials provided and can design their own if they choose to.	30-40m
Measuring Up	When the teams have finished constructing, they will need to test their designs by measuring how far their Lunar Rovers can travel.	10-15m
Extension Activities	If any of your teams finish their build early, get them to try one of the extension activities.	5-15m
Extra Content	Additional educational content for those with enquiring minds.	10-15m
Quiz	Ask your students to complete this quick quiz to test their knowledge.	10-15m
Wrapping up	Cover the discussion points with the students to close the session.	10-15m

LEARNING OUTCOMES

Students will learn:

- How to identify the effects of friction that act between two moving surfaces
- How to test and refine their designs
- How to communicate their design process and results
- Newton's 1st, 2nd and 3rd Laws
- About small group work and teamwork, time management and working with limited resources

CURRICULUM

KS1 Design and Technology

- Evaluate their ideas and products against design criteria
- Build structures, exploring how they can be made stronger, stiffer and more stable

KS2 Design and Technology

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups
- Understand how key events and individuals in design and technology have helped shape the world
- Apply their understanding of how to strengthen, stiffen and reinforce more complex structures
- Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work

TOP TIP

Set up a designated testing area for teams before the session, so that everyone has the opportunity to test their makes throughout the build.

DOWNLOAD

Download and print student worksheets from imeche.org/stemtoolkit

WRAPPING UP

MEASURING UP

10-15m

This challenge culminates in each team testing their makes and recording their best distance out of three attempts. When teams finish their Lunar Rover, all they need to do is wind them up, and let them roll!

The team with the build that travels the furthest is the champion!

If a team has successfully completed their build ahead of time, why not get them to try one of the extension activities below.

EXTENSION ACTIVITIES

A

5-10m

Ask teams to alter their designs to increase the distance that their Lunar Rover will travel. Get them to think about the amount of potential energy they currently have and the weight of their build. They can refer to the additional education resource at the end of their worksheets if they need a helping hand.

B

10-15m

If you have two or more teams that have successfully completed their build, why not set up a race challenge. The fastest Lunar Rover wins!

DISCUSSION POINTS

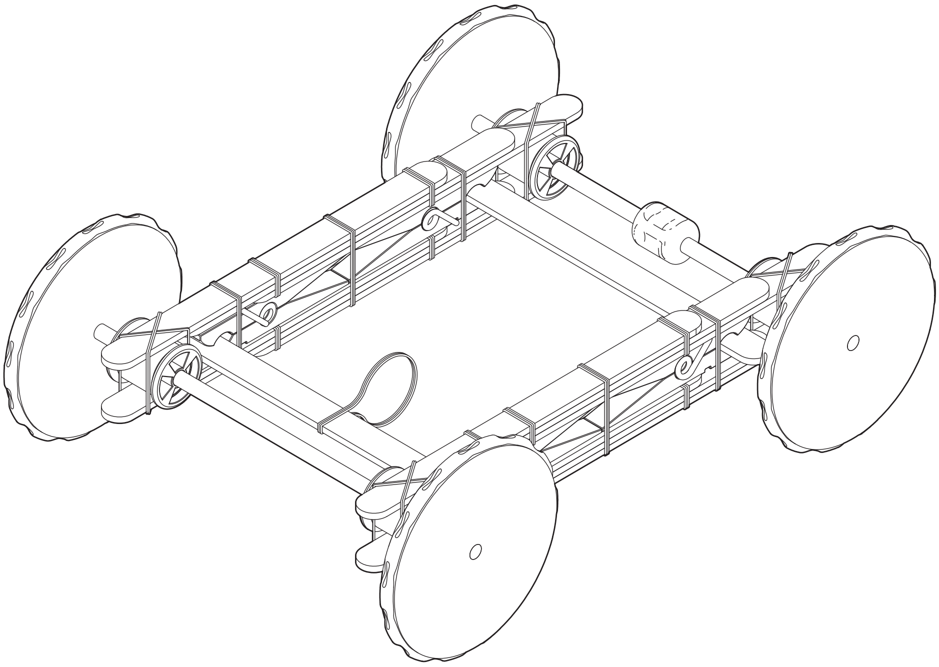
10-15m

To close the session, hold a class discussion and cover the following points:

- Was there a successful design amongst the teams?
- If not, why?
- Could the teams have used fewer materials?
- Did the teams have to deviate from their original designs?
- What do the teams like about their rivals' designs?
- Do the teams think it would have been easier to work alone?
- What would the teams change if they were to attempt the task again?

REMEMBER

Provide a recap or short summary to the class, highlighting the key engineering skills and what has been learnt during this activity.



LUNAR ROVER WORKSHEET

GETTING STARTED

5-10m

The Lunar Rover is a classic STEM based build that incorporates the science behind potential energy and kinetic energy, whilst having to think creatively and solve problems.

This build will require determination and perseverance, whilst simultaneously testing your ability to problem solve.

As a team, you'll need to build a working Lunar Rover that will remain intact and can travel unaided to the required distance.

VOCABULARY

Energy Conversion/Energy Transformation - The process of changing one form of energy to another.

Potential Energy - Energy that is stored in an object either by lifting it up or, if the object is elastic, due to it being stretched or compressed.

Kinetic Energy - The energy of motion.

Energy - The ability to do work.

Inertia - The resistance of any physical object to any change in its velocity.

Momentum - The force that causes an object to move in the direction it is already travelling.

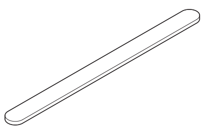
Friction - The resistance that one surface or object encounters when moving over another.

Precision - How close of two or more measurements are to each other.

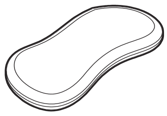
Accuracy - How close the result comes to the true value.

Torque - A force that tends to cause rotation about an axis.

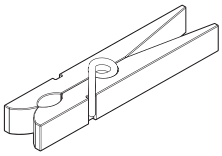
EACH TEAM WILL NEED



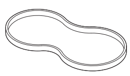
Lollipop Stick
30



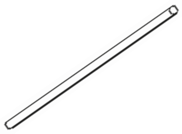
White Tac
1



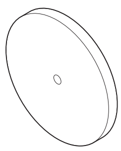
Clothes Peg
4



Elastic Band
20



Wooden Dowel
2



Wheel
4

WARM-UP ACTIVITIES

A

10-15m

Within your team, discuss the following principles. Read the description of each one carefully and consider what each means. Can you and your teammates think of any examples of each principle?

Newton's Laws of Motion

- Newton's First Law - An object either remains at rest, or continues to move at a constant velocity, unless acted upon by an external force.
- Newton's Second Law - The acceleration of an object is proportional to both the object's mass and the net force acting upon it. The bigger the mass of an object, the greater the force required to accelerate at a constant rate.
- Newton's Third Law - For every action, there is an equal and opposite reaction. For example, if you push against a tree (action), and the tree doesn't move, it will be pushing you back with the exact same force (reaction).

MAIN CHALLENGE

30-40m

In teams, you're going to build your very own Lunar Rover. You can follow the build instructions provided, or if you're feeling adventurous you can design and build your own unique rover.

As a team, we suggest you discuss and agree on your design before you start to build. This will give you the best chance of success.

Using the materials provided, your Lunar Rover must be stable enough to travel unaided and travel as far as possible. The team with the furthest recorded distance after three attempts wins!

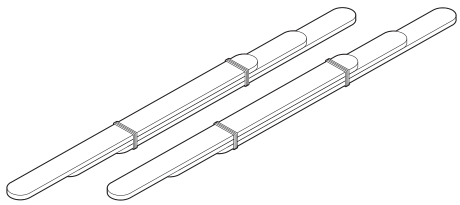
Remember to work closely as a team, and listen to everyone's ideas.

Once you've completed the challenge, there will be a quick quiz followed by a class discussion.

BUILDING YOUR LUNAR ROVER

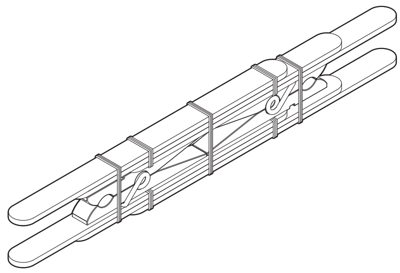
A

Lay three lollipop sticks on top of each other, with the top and bottom sticks slightly off centre. Use elastic bands to secure these in place. Now repeat this so you have two.



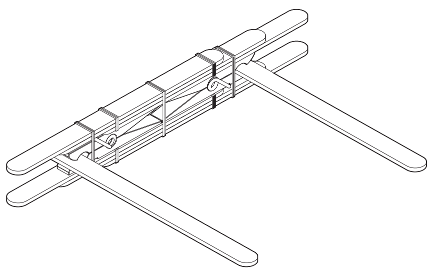
B

Next using the lollipop stick structures and two pegs, secure the pegs in between the two structures using elastic bands. You can use white tac in addition here for added stability.



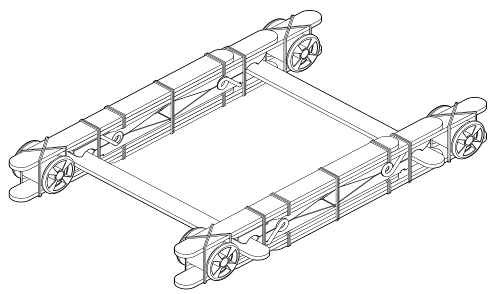
C

Take an additional lollipop stick and secure this in between each peg.



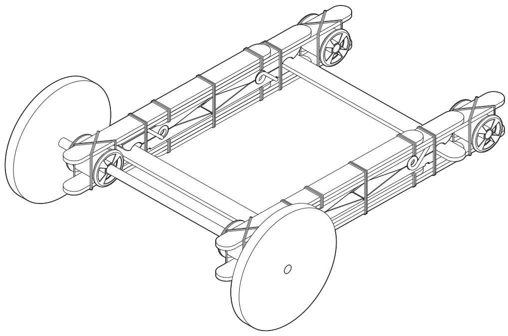
D

Next take two cotton reels and secure them in place as shown below, using white tac and elastic bands. Repeat steps **A** and **B** and secure the two structures together with the lollipop stick added in step **C**.



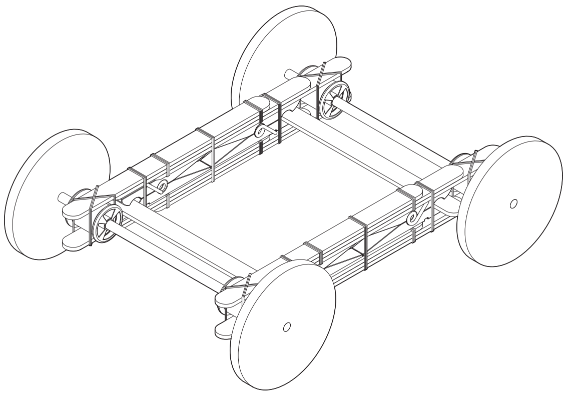
E

Next insert a wooden dowel through the cotton reel on both structures, so they are now connected. Attach a wheel to each end of the dowel, and secure with white tac or tape if the wheel isn't secure.



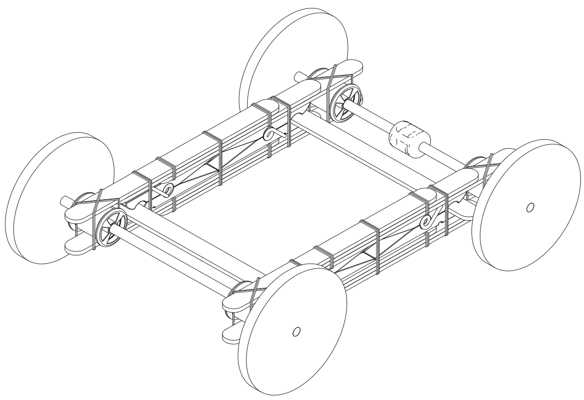
F

Repeat this with the other end so you have something that matches the image below.



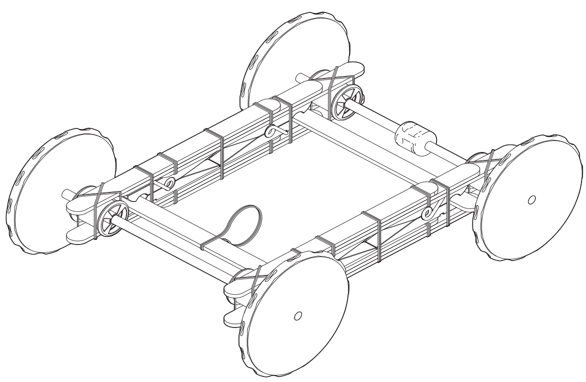
G

Take some white tac and attach this to the middle of the dowel at the rear of your Lunar Rover. You can choose which end you would like to be the front and back, but make sure it's central.



H

Tie an elastic band to the front dowel of your Lunar Rover, making sure it lines up with the white tac on the rear of the rover. To add friction you can add white tac to the rims of the wheels. Now you're ready to get going!



LUNAR ROVER

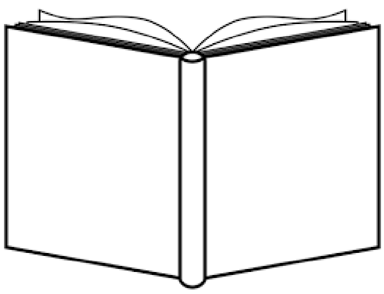
10-15m

MASS FORCE AND TORQUE

KS1/2 PROOF OF CONCEPT

Imagine there's a feather on the table in front of you, and you're trying to push it across the table with just one finger. Should be pretty easy, right?

Now imagine it's a book that you're trying to push across the table. That's going to be much harder! This is because the book is heavier than the feather, and the heavier an object is, the more force (or harder push) is required to move it.



How might this help explain why some of the Lunar Rovers are moving faster and easier than others?

KS3/4 DEEPER LEARNING

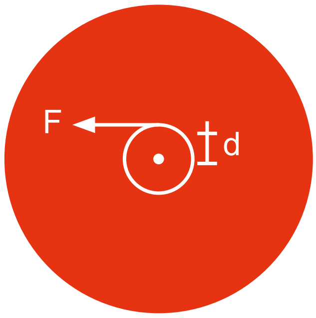
The above concept can be further explained using Newton's Second Law, which shows that the higher the mass, the higher the force required to move it.

$F = ma$ where F is the Force, m is the mass and a is the acceleration

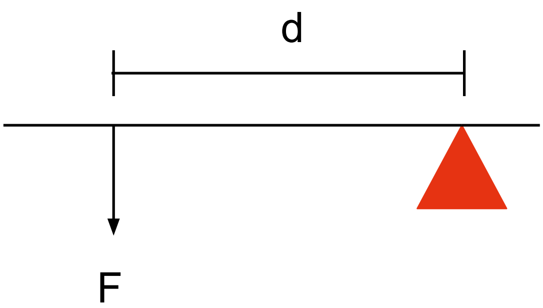
$F \propto m$ Force is directly proportional to mass

Another type of force to consider is a type of force called torque, which is a measure of the turning force of an object. If the torque is too high, and there isn't enough weight on the car to balance it, you might find that your car flips over instead of remaining stable.

$\tau = Fd$ τ is the Torque, F is the force acting on the axle and d is the distance



Where might be the best place to add mass in order to counteract this torque? For this you'll want to consider moments, which are similar to Torque, but don't act on a rotating object.



$M = Fd$ M is the moment, F is the force and d is the distance between the force and a pivot point.

In this diagram, the fulcrum, or pivot point, would be where your axle is. If you increase the distance, the mass required to result in the same force would decrease.

How could you reduce the mass of your Lunar Rover, whilst still counteracting the high torque required to make your vehicle move faster?

QUIZ

10-15m

What is force?

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What is energy conversion and why is it an important factor in your Lunar Rover designs?

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Is more or less force required to move a heavier object?

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How could you increase friction between your Lunar Rover and the surface it is racing on?

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What is friction?

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QUIZ

What would you need to do if your Lunar Rover flipped over, instead of remaining stable?

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What is the difference between precision and accuracy?

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What is Newton's Second Law?

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What is torque?

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What could happen if you generate too much torque on your driving axle?

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