02

The Smallpeice Trust

ENGINEERING @SCHOOL

The Paddle Boat Project

Year group: 3-6

smallpeice
Dare to imagine

#EngineeringAtSchool

PADDLE BOAT TEACHER GUIDANCE

This activity can be used as one of eight towards students obtaining the CREST SuperStar Award.

What Is CREST?

CREST is a nationally recognised scheme for student-led project work in the STEM subjects (science, technology, engineering and maths).

CREST gives young people aged 5–19 the chance to choose their own subject and methodology when completing their hands-on investigation.

CREST provides activities and project ideas for a range of ages, group size and abilities. From off-the-shelf, one-hour long challenges through to large-scale, student-led projects of over 70 hours work or more, CREST can be done by anyone.

What is CREST SuperStar?

SuperStar level is designed to be easy-to-run and low-cost for children typically aged 7-11 years. Children gain an Award by completing eight challenges.

You can download a CREST SuperStar passport template for your students to track their progress once you create an account via

www.crestawards.org/crest-superstar

ENTRY FEE per child: £1 UK / £4 International*

Within four weeks of payment, you will receive certificates and fabric badges to give out to your class.

LENGTH OF LESSON: 1-2 HOURS

How to make your Paddle Boat:

https://bit.ly/2Wk3ikN

LESSON OVERVIEW

The "paddle boat" lesson explores the design of rubber band powered paddle boat. Students work in teams of "engineers" to design and build their own paddle boat out of everyday items. They test their paddle boat, evaluate their results, and present to the class.

Learning Objectives

During this lesson, students will:

- Design and construct a paddle boat
- Measure distance and calculate velocity
- Test and refine their designs
- Communicate their design process and results

Learning Outcomes

- To consolidate the concept of speed
- To use "metres per second" (m/s) as the unit of speed
- To understand the efficient transfer of mechanical energy into kinetic potential energy and the interaction between energy and materials
- To design and build models by using different materials and to test selected functional characteristic of the model built with the chosen materials

Key Vocabulary:

FORCES, UPTHRUST, BUOYANCY, KNOTS, ENERGY, TRANSPORT, SPEED/VELOCITY, MEASUREMENT

Curriculum links

SCIENCE KEY STAGE 2

- Identify the effects of air resistance, water resistance and friction, that act between moving surfaces
- (Non-Statutory) They might explore resistance in water by making and testing boats of different shapes
- Working scientifically: asking relevant questions and using different types of scientific enquiries to answer them
- Working scientifically: setting up simple practical enquiries, comparative and fair tests
- Working scientifically: making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers
- Working scientifically: gathering, recording, classifying and presenting data in a variety of ways to help in answering questions
- Working scientifically: recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables
- Working scientifically: using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions

MATHS KEY STAGE 2

- Measure, compare, add and subtract lengths (m/cm/mm); mass (kg/g); volume/capacity (l/ml)
- Convert between different units of measure [for example, kilometre to metre; hour to minute]

DESIGN & TECHNOLOGY KEY STAGE 2

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at individuals or groups
- Generate, develop, model and communicate their ideas through discussion, annotated sketches, cross-sectional and exploded diagrams, prototypes, pattern pieces and computer-aided design
- Select from and use a wider range of tools and equipment to perform practical tasks [for example, cutting, shaping, joining and finishing], accurately
- Apply their understanding of how to strengthen, stiffen and reinforce more complex structures

INTRODUCTION

What is a Marine Engineer?

Explain to students that: A marine engineer is someone who designs, builds, tests and repairs ships, boats, underwater craft, offshore platforms, and drilling equipment. They often work closely with naval architects to design everything from small yachts and fishing boats to submarines and aircraft carriers.

How do boats float on water?

Explain to students that: When a boat is in the water, there are two forces acting on it: 1) weight (pushing down) and 2) buoyancy (pushing up). The boat floats in the water because the two forces are balanced (weight = buoyancy). The "weight" force exists because of gravity acting on the boat. The "buoyancy" force is a little more complicated- it exists because the boat takes the place of some of the water it is floating in. The weight of this water is more than the weight of the boat (even if the boat is made of steel!), so the boat floats.

What speed do boats move?

Explain to students that: Boats measurement of speed is known as a Knot; a Knot is equal to one nautical mile per hour (approximately 1.15 statute miles per hour). Thus, a ship moving at 20 knots is traveling as fast as a land vehicle at about 23 mph (37 km/hr). The term knot derives from its former use as a length measure on ships' log lines, which were used to measure the speed of a ship through the water. Such a line was marked off at intervals by knots tied in the rope.

Energy

Explain to students that: Energy is the ability to do work. All forms of energy fall into two basic categories: potential energy and kinetic energy. Potential energy is mechanical energy which is due to a body's position. It is also known as stored energy. A paddle boat at rest has potential energy. Kinetic energy is mechanical energy that is due to a body's motion. For a paddle boat to move, potential energy must be transformed into kinetic energy.

Newton's Laws of Motion (taught at key stage 3)

Explain to students that: Sir Isaac Newton was a brilliant mathematician, astronomer and physicist who was one of the most influential figures in human history. Newton studied a wide variety of phenomena during his lifetime, one of which included the motion of objects and systems. Based on his observations he formulated Three Laws of Motion. Newton's First Law – An object at rest will remain at rest and an object in motion will remain in motion at a constant speed unless acted on by an unbalanced force (such as friction or gravity). This is also known as the law of inertia. Newton's Second Law – An object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the applied net force. Newton's Second Law can be expressed as: $F = ma$. Newton's Third Law – For every action there is an equal and opposite reaction.

What is a paddle boat?

Explain to students that: A rubber band is a really simple way to power a paddle boat. By stretching a rubber band, you are turning your mechanical energy into elastic potential energy. When you let the paddle boat go, this is then turned back into mechanical energy.

Paddle boat designs

Explain to students that: There are a huge variety of designs for paddle boats. Usually they are made up of a hull (base of the boat) and a propeller which is located at the stern (rear of the boat). The propeller will rotate allowing the boat to move forward. Another feature of many paddle boats is the rudder which is also located at the stern of the boat. A rudder is used to help the boat steer in the right direction.

Materials

CARDBOARD • STRAWS • SELLOTAPE
RUBBER BAND • SCISSORS • WATER TANK OR POND FOR TESTING

MAIN ACTIVITY

1. Students can work alone or in pairs for this activity.

2. Explain that students must develop a paddle boat powered by rubber bands from everyday items, and that the paddle boat must be able to travel in a straight line as far as possible. The paddle boat that can travel in a straight line for the greatest distance is the winner.

3. Ask students to develop a plan for their paddle boat. They will need to decide and agree on the materials they will use, write/draw their plan, and present their plan to the class.

4. Show students the student activity sheet and explain that they will need to follow the instructions to make their paddle boat.

5. Student groups next execute their plans and build their paddle boat using the materials they have chosen. They may need to rethink their plan, request other materials, or start again if the materials chosen are not working.

6. Next, teams will test their paddle boat.
To ensure that the paddle boat travels in a straight line

7. Teams complete an evaluation / reflection worksheet, and present to the class.

PLENARY (QUESTIONS TO ASK STUDENTS)

1. Did you succeed in creating a paddle boat?
   If so, how far did it travel? If not, why did it fail?

2. What is the average speed your paddle boat achieved?

3. How did you make sure that your boat could float?

4. Did you decide to revise your original design or request additional materials while in the construction phase? Why?

5. If you could have had access to materials that were different than those provided, what would your team have requested? Why?

6. Do you think engineers have to adapt their original plans during the construction of systems or products? Why might they?

7. If you had to do it all over again, how would your planned design change? Why?

8. What designs or methods did you see other teams try that you thought worked well?

9. Do you think you would have been able to complete this project easier if you were working alone? Explain…

STEM Day Risk Assessment

Risk Assessment for	**Engineering at School Projects**
Assessment undertaken on	31/03/2020
Assessment undertaken by	Jessica Lee
Signed	

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
1	General Activity and Workspace	**Slips, trips and falls:** Injury due to tripping over items	Students and adults	Activity supervised by adult supervisor. Deliverer reminds students about safety in video introduction.	M	Students and adults
2	Use of Materials: paper/card, plastic containers	**Injuries:** Injury due to paper cuts, cuts from sharp edges **Injuries:** Injury due to misuse	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
3	Use of materials: elastic bands, sellotape, glue stick, blu-tack, small toys, paper fasteners, LEGO pieces, nuts & bolts or equivalent.	**Injuries:** Injury due to use as a missile **Slips, trips and falls:** Injury due to slipping on dropped items **Injuries:** Ingestion risk of choking.	Students and adults Students and adults Students and adults	Activity supervised by adult supervisor. Activity supervised by adult supervisor. Activity supervised by adult supervisor.	L	Students and adults
4	Use of materials: plastic, corrugated carboard	**Injuries:** Cuts from sharp edges	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
5	Use of sharp tools: Scissors, craft knives	**Injuries:** Cut to self	Students	Activity supervised by adult supervisor.	M	Students and adults
		Behaviour: Cut to others	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
		Behaviour: Vandalism of property	School or home	Activity supervised by adult supervisor.	L	Students and adults
6	Testing of projects: bathtub, drop from height, items on floor	**Spillage of water on floor**: damage and injury due to slip	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
		Slip, trip or fall: Injury due to falling from testing area, tripping over items in testing space	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

The Smallpeice Trust

ENGINEERING @SCHOOL

02

The Paddle Boat Challenge

#EngineeringAtSchool

Suitable for ages: **6+**

Time needed: **1hr+**

smallpeice

Dare to imagine

DESIGN A PADDLE BOAT

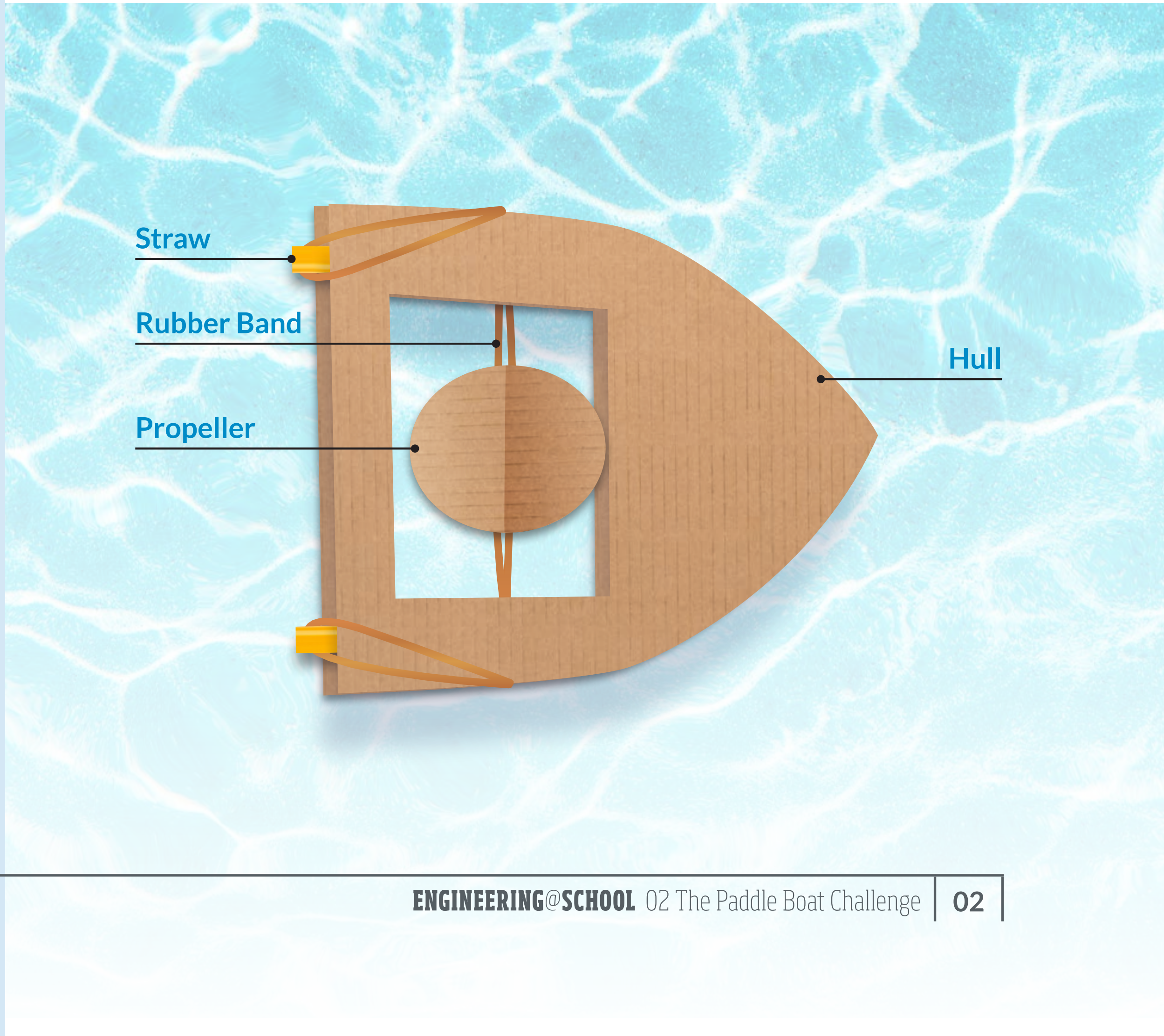
You are a team of engineers who have been given the challenge to design your own paddle boat out of everyday items. The paddle boat needs to be able to travel in a straight line as far as possible.

The paddle boat that can travel the furthest distance is the winner.

smallpeice
Dare to imagine

What is a Paddle Boat?

A rubber band is a really simple way to power a paddle boat. By stretching a rubber band, you are turning your mechanical energy into elastic potential energy. When you let the paddle boat go, this is then turned back into mechanical energy as it turns the propeller, powering the boat forward.



PLANNING STAGE

In your team, discuss the problem you need to solve. Then develop and agree on a design for your paddle boat. You'll need to decide and agree what materials you want to use.

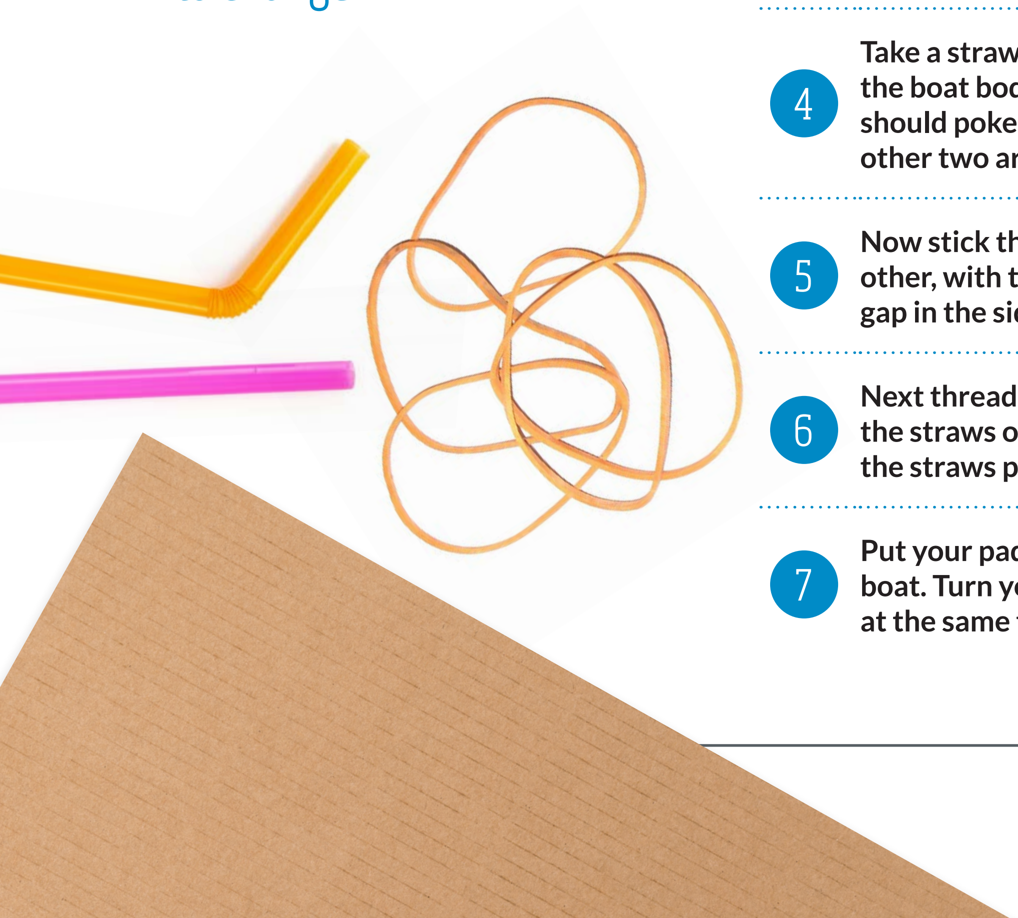
Draw your design in the box shown on the right and label the different parts and materials you plan to use.
Present your design to the class.

You may choose to revise your teams' plan after you receive feedback from class.

PADDLE BOAT DESIGN & MATERIALS

BUILDING STAGE

Build your paddle boat. During building you may decide you need additional materials or that your design needs to change.



1. Build your paddle boat. During building you may decide you need additional materials or that your design needs to change

2. Use some old cardboard to cut out two identical shapes to make the main body of your boat.
   Cut a window out of the middle of each shape

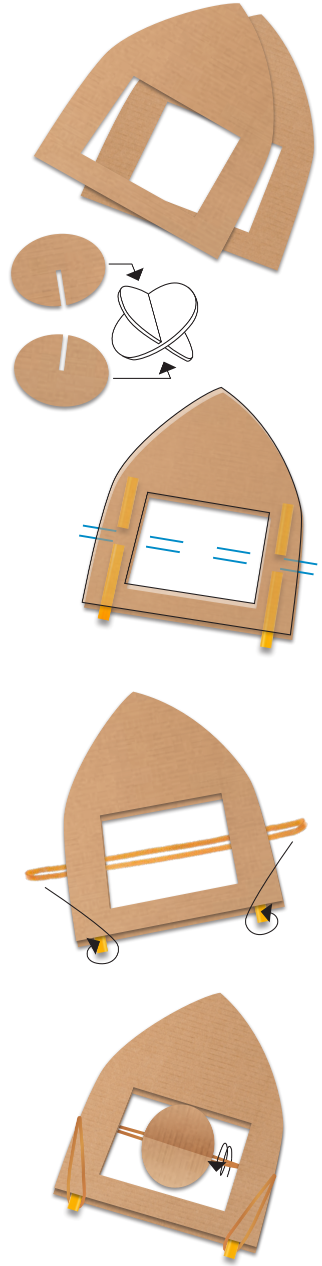
3. From another piece of card cut two identical ovals with a slit half-way through. Slot these together to make your paddle

4. Take a straw, cut it into four pieces. Stick these to one of the boat body pieces like this picture. Two of the straws should poke out the bottom of your boat, make sure the other two are stuck down with a gap in the middle

5. Now stick the other boat body shape on top of the other, with the straws in the middle. Make to leave a gap in the sides where the gap in the straws is

6. Next thread the elastic band through the gap in the straws on each side and wrap each end around the straws poking out at the bottom

7. Put your paddle onto the elastic band in the window of your boat. Turn your paddle and make sure the elastic band is twisting at the same time, when you let go your paddle will spin!



TESTING STAGE

Each team will test their paddle boat. Calculate your paddle boat speed (distance traveled per unit of time).

Be sure to watch the tests of the other teams and observe how their different designs worked.

PADDLE BOAT DATA

	Distance Travelled	Time Travelled	Speed (m/s)
Test 1			
Test 2			
Test 3			
Average			

EVALUATION STAGE

Evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results in the Paddle Boat Challenge.

1. **Did you succeed in creating a paddle boat? If so, how far did it travel? If not, why did it fail?**

2. **What is the average speed your paddle boat achieved?**

3. **How did you make sure that your boat could float?**

4. **Did you decide to revise your original design or request additional materials while in the construction phase? Why?**

5. **If you could have had access to materials that were different than those provided, what would your team have requested? Why?**

6. **Do you think engineers have to adapt their original plans during the construction of systems or products? Why might they?**

7. **If you had to do it all over again, how would your planned design change? Why?**

8. **What designs or methods did you see other teams try that you thought worked well?**

9. **Do you think you would have been able to complete this project easier if you were working alone? Explain...**

ADDITIONAL CHALLENGES

If you complete your paddle boat and want to challenge yourself further...

1. **Try and find some materials which may be more waterproof than cardboard or find a way to make your cardboard waterproof by protecting it?**

2. **Add a seat to your boat and see if it can safely carry a passenger?**

3. **Draw a force diagram and see if you can label all the forces acting on your boat?**