Atkins - STEM School Pack

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Contents

STEM activities to inspire tomorrow's engineers

Introduction

STEM Activity Pack

Girls and boys naturally love figuring things out for themselves – and playing building games, like Lego. So this STEM pack is filled with activities that will have them imagining, designing, experimenting and creating. Or in short, discovering their inner engineers.

Resources

We developed this booklet alongside our STEM film Engine Ears. It shows all the different ways engineers make our world go round, from inventions that move us, to creations that keep us safe, and just thinking up better ways to protect our planet. Your pack has:

- 14 worksheets, designed to engage young minds
- Activities that just need easily sourced materials
- Relevant topics that will excite primary school children
- Simple, fun suggestions on running each activity
- Questions to help round off with a lively discussion

We wish you and your class a great time engineering!

Watch our film Engine Ears by visiting:
https://youtu.be/HoHGChziqeE

Water for Everyone Everywhere

Teacher Summary Sheet

Introduction

Water for Everyone Everywhere aims to educate students on where water comes from and how it is cleaned. Water, despite being a human right, is not necessarily available to everyone around the globe and this lesson aims to highlight what engineers can do to ensure clean water for everyone. This activity was developed by Engineers Without Borders to educate pupils on water resources.

Aims & Objectives

EDUCATIONAL ASPECT	
Incorporate global issues into the classroom	Highlight key facts about water around the globe through a "Did you know?" sheet.
Provide careers related learning to pupils	Highlight how engineering can help solve some of the major issues facing us today.
Use a hands on activity to develop teamwork within the class-room in an educational setting.	Develop practical skills and cement understanding of how engineers can provide power to people.

PUPIL LEARNING OBJECTIVE	ACTIVITY
Understand importance of water and that access to it is not equal	Discussion- why is water important to you? (use tips from "Did you know?")
Describe the role of the engineer in bringing about access to water	Discussion - What does an engineer do to ensure you get water? (use tips from "Did you know?")
Design a water filter	Plan, build and test using the activity sheet
Consider the challenges engineers face around the world	Discussion – using the filter activity and first two discussions, what may stop an engineer from helping communities get clean water?

Key Word Suggestions (to discuss with students)

Suggested Lesson Plan

ACTIVITY SUMMARY	NOTES	RESOURCES
Starter		
Use starter questions to get pupils thinking about water. They could either discuss, draw a picture or write answers.	Suggested questions include: Where does your water come from? What do you use water for?	Pens/Paper (optional) Answers: shower, drink, flush toilets, wash clothes, cook, wash the car, water plants.
Access Issues		
Get children to think about what it would be like if there was no access to water. For older pupils, use a case study (available on EWB website below).	Suggested questions include: What would you drink if you didn't have water? How would you wash if you didn't have water? Would we be healthy if we didn't have water? What if we had water but it was dirty?	Pens/paper (optional) Worksheets and case studies available on link below if you want further information. Answers: Poor health, poor sanitation, dirty clothes, hard to cook.
Role of Engineers		
Ask children to think about what an engineer is and how an engineer and water are connected. Discuss with students where water comes from and how engineers get it to the tap and keep it clean.	Suggested questions include: What does an engineer do? Why does an engineer get involved with water? Where does water come from? How do engineers get water to the tap? How do engineers keep water clean?	Pens/paper (optional) See the "Did you know?" sheet for statistics and key points.
Buiding a Water Filter		
Students to build a water filter to learn how water can be simply cleaned.	Students will be able to get practical and see how clean they can make very dirty water when pouring it through a filter. Teachers may wish to keep dirty water in one location and pour the water to avoid excessive mess in the classroom.	Use activity sheet.
Reflection Activity		
Ask children to reflect on the practical activity and what they learnt reinforcing that engineers help to provide clean water to communities.	Suggested questions include: What did we learn? What do engineers do? Why did some filters work better?	No resources required. Discussion with pupils.

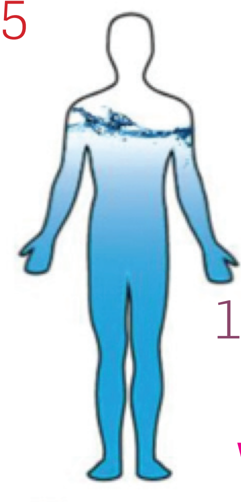
Further Learning Suggestions
For more detailed information, teachers can visit https://www.ewb-uk.org/our-initiatives/outreach-programme/water-for-everyone-everywhere/ .

Session Resources

Item	Number required
FOR PRESENTATION	
Laptop / Computer connected to projector	1
Water for Everyone Everywhere PowerPoint presentation (primary)	1
Flip chart, A3 or A4 paper for starter and power resources responses	2 per group (optional)
FOR ACCESS ACTIVITY: WHAT IF I LACK ACCESS TO WATER	
Water for Everyone Everywhere Access Activity Printouts (primary)	Print out 1 worksheet per person
FOR BUILD ACTIVITY: MAKE A WATER FILTER	
Water for Everyone Everywhere Activity Printouts (primary)	Print out 1 worksheet per group / person
Pens/ pencils	1 per pupil
Cut-off 2L plastic bottle	1 per group
Cups (plastic/card) to hold filtration materials	8 per group
Coarse gravel	Enough for 2 cups per group
Fine gravel	Enough for 2 cups per group
Coarse sand	Enough for 2 cups per group
Fine sand	Enough for 2 cups per group
Cheesecloth	2 x 10cm square per group
Rubber band	1 per group
Contaminated water	Enough to test all water filters
FOR EXPLORING ACCESS ACTIVITY: WATER	
Water for Everyone Everywhere Exploring Access Activity Printouts (primary)	Print out 1 set of sheets
Ball of string	1
Scissors	1
FOR REFLECTIONS ON LEARNING & GETTING PUPIL FEEDBACK	
Large sticky notes ('super' size if possible)	Enough for up to 4 per pupil
Large board for sticking the sticky notes on	1

Did you know?

We can only survive 1.5 days without drinking water.



We are 75% water

Water is a human right

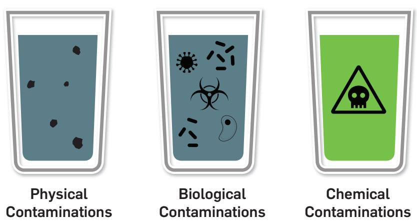
663 million people still lack access to water

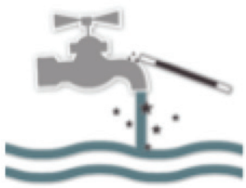
1 million people each year die from water related disease

1.5 billion are affected by unsafe water

Water sources include the rain, rivers, the oceans and ground water beneath our feet!

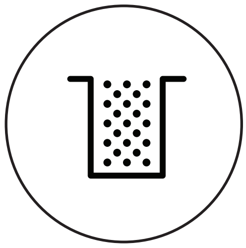
Contaminants such as physical, biological or chemical particles make water unsafe to drink





Engineers get clean water to your tap using rainwater harvesting systems, reservoir storage (through using dams), using wells to collect ground water. They also use a system of pipes and pumps to get the water through the tap.

Building a Water Filter



Teacher Summary Sheet

This activity will see you building your own water filter and working out what makes a good filter and what makes a bad filter.

Step 1: Design your filter
Make a labelled diagram of your filter and plan how you're going to build it using the materials in step 2.
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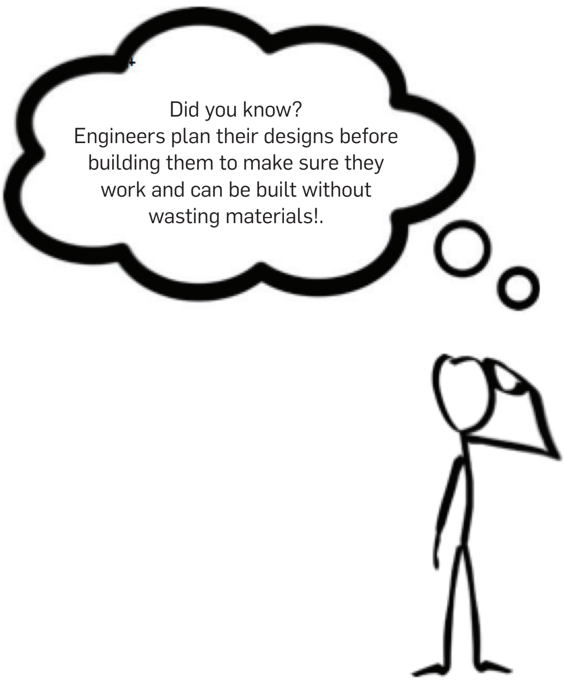

Step 2: Build your water filter
Using the materials below, build your water filter as your planning in Step 1.

Step 3: Test your water filter
Pour dirty water through your filter into a cup below....is it clean? What would help make the water cleaner?

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Build a Pipleline

Teacher Summary Sheet

Introduction
Lesson focuses on how engineers develop pipeline systems to transport oil, water, gas, and other materials over very long distances. Students work in teams of "engineers" to develop a pipeline system to transport both a golf ball and ping pong ball across the classroom terrain. Teams develop a plan, draw their pipe plan, anticipate part requirements, build their pipeline, evaluate other plans, and reflect on the activity.

Objectives
- Learn how civil engineers approach large scale problem solving.
- Learn how engineering teams address problem solving.
- Learn about teamwork and working in groups.

Resources
- Golf ball (or similarly sized rubber ball), ping pong ball, tape and scissors
- Piping set up (assuming a 15' x 15' room, allow for about 6m of cardboard or PVC tubing. These can be found in paper towel or toilet paper rolls using two rolls of strong plastic packing tape for connections. Angled pieces can be cut for the required turns.)

Why do we need pipelines?
- Transport materials such as water or oil
- Prevent flooding

Time
- Plan: 5 mins
- Build: 30 mins
- Test: 10 mins
- Evaluation: 10 mins

Suggested Lesson Plan
- Divide students into groups of 2-3 students, providing a set of materials per group.
- Explain that they are engineering teams that have been hired to design and test a pipeline to carry a golf ball and a ping pong ball across your classroom. The successful design will include four angles including one right angle (90 degrees), and a height difference of no more than 45cm from the beginning to the end of the pipeline. Be sure to identify environmentally protected areas, water, or other hazards in your classroom that the students will have to consider in their plan.
- Student teams develop the shape of their pipeline on paper, then build their pipeline with materials provided.
- Each student group evaluates the pipelines developed by other teams, and completes an evaluation/ reflection worksheet.

Student Worksheet

You are a team of engineers which has to tackle the challenge of developing a pipeline system to transport a golf ball and a ping pong ball from one side of your classroom to the other. But, it's not as simple as it sounds! You need to incorporate four angles in your design, one of which is a right angle (90 degrees) and the difference in height from one end of your pipe to the other can be no more than 45cm. Your teacher may identify environmentally protected areas, water, or other hazards in your classroom that you'll have to consider in your plan.

Planning Steps

1. As a team, develop a plan for your pipeline. Draw it in the box below, and include other identifying features of your classroom such as doors, desks, or other areas:

2. **Construction Stage**
   a. Build and test your pipeline using both a golf ball and a ping pong ball.
   b. Observe the pipelines constructed by other teams in your classroom

3. **Evaluation and Reflection**
   a. Complete the evaluation sheet and present the work of your team to the class.

Use this worksheet to evaluate the different pipelines developed by the "engineer" teams in your class.

1. What challenges did you face in executing your pipeline?
2. Did you find you needed to rework your original plan when you began building the real pipeline in the classroom? If so, how did your pipeline change?
3. Did you find your pipeline was more effective using the ping pong ball or the golf ball? Why do you think this was true?
4. Which pipeline developed by another "engineering" team did you think worked best? Why?
5. If your design were scaled up to a real pipeline, do you think you would need pumps to keep the materials flowing through your system? Why or why not? And, if so, how many pumps would you add, and where would you put them?
6. Do you think your pipeline design would work if you used it to transport water? Feathers? Butter? Why or why not?
7. Did you find that there were many ways to solve this challenge? If so, what does that tell you about the engineering designs of real pipelines?
8. Do you think you would have been able to create a successful pipeline as easily if you had not been working in a team? What are the advantages of teamwork vs. working alone?

Source: Try Engineering - http://tryengineering.org/lessons/pipelinechallenge.pdf

Power for Everyone Everywhere

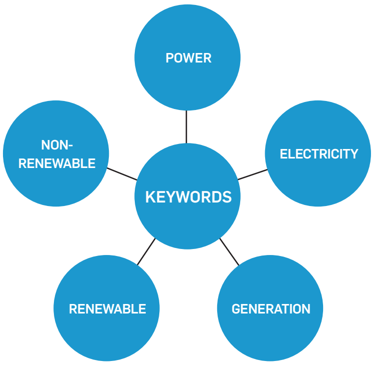
Teacher Summary Sheet

Introduction
Power for Everyone Everywhere aims to educate students on where power comes from and how it is equal for everyone. Power is not a human right and is not available to everyone around the globe. This lesson aims to highlight what engineers can do to ensure power is accessible. This activity was developed by Engineers Without Borders to educate pupils on power generation.

EDUCATIONAL ASPECT	
Incorporate global issues into the classroom	Highlight key facts about power generation around through a “Did you know?” sheet.
Provide careers related learning to pupils	Highlight how engineering can help solve some of the major issues facing us today.
Use a hands on activity to develop teamwork within the class-room in an educational setting.	Develop practical skills and cement understanding of how engineers can provide power to people.

PUPIL LEARNING OBJECTIVE	ACTIVITY
Understand importance of electricity and that access to it is not equal	Discussion- why is power important to you? (use tips from “Did you know?”)
Describe the role of the engineer in bringing about access to electricity	Discussion - What does an engineer do to ensure you get power? (use tips from “Did you know?”)
Design a model turbine	Plan, build and test using the activity sheet
Consider the challenges engineers face around the world	Discussion – using the turbine activity and first two discus-sions, what may stop an engineer from helping communities get power?

Key Word Suggestions (to discuss with students)



Suggested Lesson Plan

ACTIVITY SUMMARY	NOTES	RESOURCES
Starter		
Use starter questions to get pupils thinking about power. They could either discuss, draw a picture or write answers.	Suggested questions include: Where does your power come from? What do you use power for?	Pens/Paper (optional) Answers: wind, oil, gas, sun (solar), bio-gas, hydro-electric. Powering lights, TV, cars, ovens, fridges, xbox etc.
Access Issues		
Get children to think about what it would be like if there was no access to power. For older pupils, discuss global accessibility and how countries overcome lack of electricity (available on EWB website below).	Suggested questions include: How would you make dinner if you didn't have electricity? How would you travel without power? How can countries with little money generate electricity?	Pens/paper (optional) Worksheets and case studies available on link below if you want further information.
Role of Engineers		
Ask children to think about what an engineer is and how an engineer and power are connected. Discuss with students where power comes from and how engineers get it to you.	Suggested questions include: What does an engineer do? Why does an engineer get involved with power? How do we get power?	Pens/paper (optional) See the "Did you know?" sheet for statistics and key points.
Buiding a Wind Turbine		
Students to build a turbine to learn more about wind turbines.	Students will be able to get practical and to build a wind turbine which is a renewable source of power.	Use activity sheet.
Reflection Activity		
Ask children to reflect on the practical activity and what they learnt reinforcing that engineers help to provide power to communities.	Suggested questions include: What did we learn? What do engineers do? Why did some turbines work better?	No resources required. Discussion with pupils.

For more detailed information, teachers can visit https://www.ewb-uk.org/our-initiatives/outreach-programme/power-for-everyone-everywhere/ or visit for a prepared

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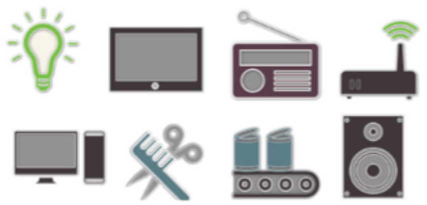
Session Resources

FOR PRESENTATION	
Laptop / Computer connected to projector	1
Power for Everyone Everywhere PowerPoint presentation (primary)	1
Hand Operated torch (suggestion)	1
Flip chart, A3 or A4 paper for starter and power resources responses	2 per group (optional)
FOR ACCESS ACTIVITY: WHAT IF I LACK ACCESS TO ELECTRICITY	
Power for Everyone Everywhere Access Activity Printouts (primary)	Print out 1 worksheet per person
FOR BUILD ACTIVITY: MAKE A WIND TURBINE	
Power for Everyone Everywhere Activity Printouts (primary)	Print out 1 worksheet per group / person
Pens/ pencils	1 per pupil
Straws	10 per group
Card (A4 suggested)	10 pieces per group
Cardboard (A4 size suggested)	5 pieces per group
Sellotape	1 per group
Safety scissors	At least 1 pair per group
Cotton reel (without cotton if possible)	1 per group
'Turbine Tower'	1
Hairdryer (you might need an extension cable)	1
FOR EXPLORING ACCESS ACTIVITY: ELECTRICITY	
Power for Everyone Everywhere Exploring Access Activity Printouts (primary)	Print out 1 set of sheets
Ball of string	1
Scissors	1
FOR REFLECTIONS ON LEARNING & GETTING PUPIL FEEDBACK	
Large sticky notes ('super' size if possible)	Enough for up to 4 per pupil
Large board for sticking the sticky notes on	1

Did you know?

Electricity can be generated from renewable sources including wind, water and the sun

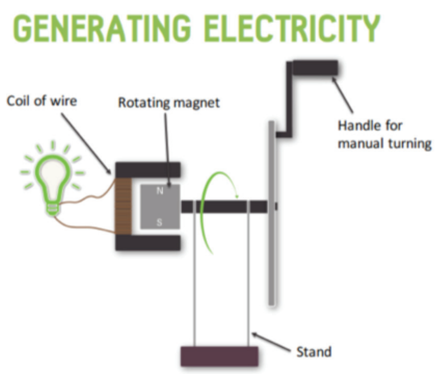


Electricity and power are used for most things in our everyday lives.

1.2 Billion people still lack access to electricity

Reliability of electricity depends on distance, difficulty to connect, money, materials and skill.

Electricity can also be generated from non-renewable sources including coal and natural gas.



It can even be generated from bio-gas! (that means animal waste)

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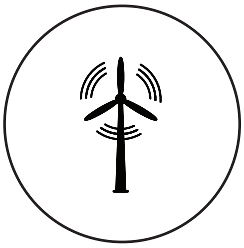
Building a Wind Turbine



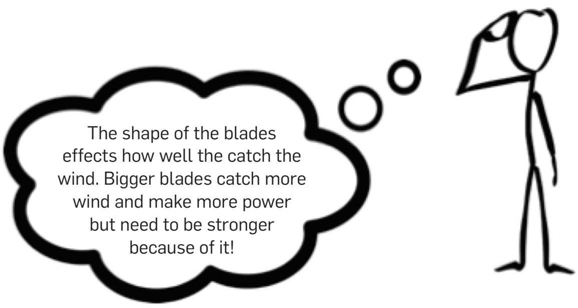
Teacher Summary Sheet

Create a labelled sketch of your turbine blades, around the cotton reel that will turn around. Make sure you follow the design checklist.

Remember to think about the size and weight of your blades and to keep the central hold of the cotton reel clear so we can test it.

DESIGN CHECKLIST	✓
Drawn blade design and labelled materials.	
Described key features of design. (e.g. shape, size, angle of blade)	
Explain why you have chosen this design.	

Building a Wind Turbine



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Code and Decode

Teacher Summary Sheet

Resources Required

- Whiteboard/Blackboard to help students crack code

Introduction

Astronauts communicate with Mission Control and their families using a network of satellites called the Tracking and Data Relay Satellite system. The first of these satellites was launched in 1983. Video links show Mission Control what is happening in space, and can be used to help guide astronauts through activities, if they need assistance.

There is even internet in space, which helps astronauts stay in touch with their families and friends. Unfortunately, the internet is very slow, but it is still an important link to Earth. Sometimes codes are used in space, so that the right message gets to the right person or organisation.

Running the Activity

In this activity we ask students to decode a message and to do this they will need lots of patience – just like the best astronauts! Some students will "crack" the code while others may work methodically through until they have filled in all the blanks. Either way this is a great primer for coding, problem solving and mathematical thinking.

To help students break the code, start by identifying the letters you already have (e.g. B = E, E = H, F = I etc). Write the alphabet up on the board and write the corresponding letters underneath as you decode them. Can you see a pattern forming? A visual intervention may help some pupils grasp this more easily, so ask one of the students to draw a line from the letter on the top to the same letter in the line below and see if they can see a visual pattern forming.

Here's an example:

Aha, it looks like each line is going in the same direction! Each letter of the alphabet has moved three spaces along. Now, can your students fill in the rest of the blanks and decode this mysterious message?

Answer:

Hello!

Is this Planet Earth? It's a beautiful view from up here.

Tim Peake,

Signing off!

Question for the Class

- How do astronauts stay in contact with Mission Control?
- Why do you think communication with Earth is so important for astronauts?
- Why would writing in code be useful?
- Is there internet in space? What would you use the internet for if you were an astronaut in space?
- Using the code in the activity, can you write a space message?

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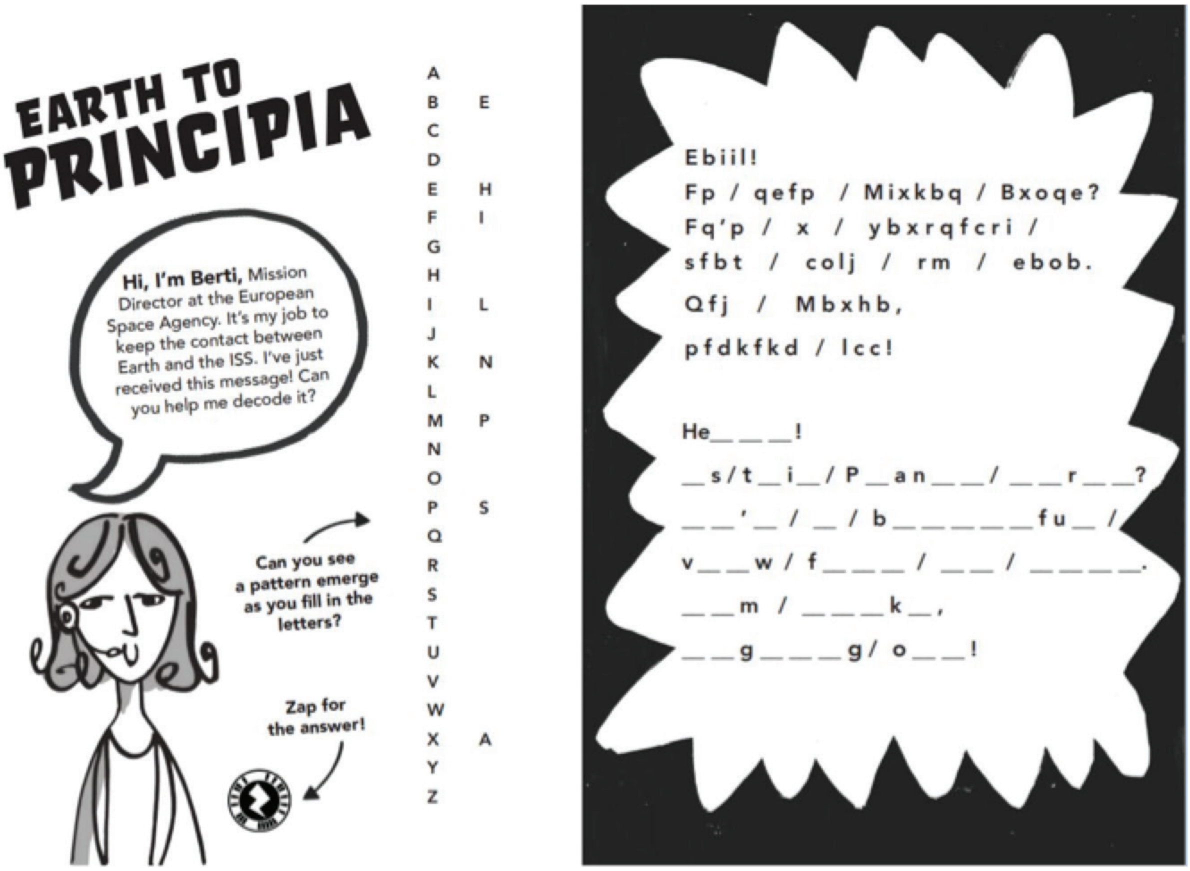
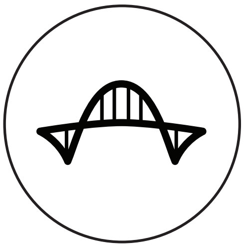


Source: Principia Space Diary - https://principiaspacediary.org/activities/earth-to-principia/

Build a Bridge Challenge



Teacher Summary Sheet

Introduction
Do you play with Lego? Have you ever thought about the process that you go through when you build with Lego? For example, imagine you want to build a bridge out of Lego. You will need to think about how you will use the bridge, how long you want it to be, and even what type of bricks you will need to make it durable and strong. Well, guess what? You're thinking just like an engineer!

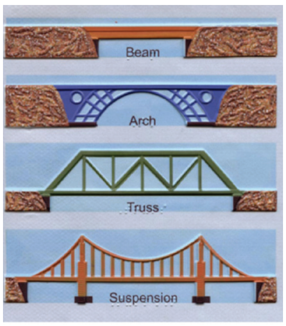
A special kind of engineer called a civil engineer designs and constructs bridges. When civil engineers set out to construct bridges they ask themselves several questions: where will it be built, how will it be used, and how long does it need to be?

Resources
- One roll of cellotape
- 10 straws
- 5 sheets of paper

Time
- Design time: 10 mins
- Build time: 30 mins
- Judging time: 5 mins

Suggested Lesson Plan
- Your team of engineers are tasked with designing and constructing a bridge to span over a 30cm gap!
- Your bridge must also be able to carry a weight in the middle of the bridge i.e. a pencil or coins.
- Points will be awarded for the bridge that carries the heaviest weight and also for the bridge which is most creative!

Types of Bridges




Suspension Bridge


Cantilever


Truss


Simple Span


Cable-stayed


Tower Bridge

Spaghetti Towers

Teacher Summary Sheet

Resources Required

- Spaghetti
- Marshmallows
- Measuring tape
- Chocolate egg

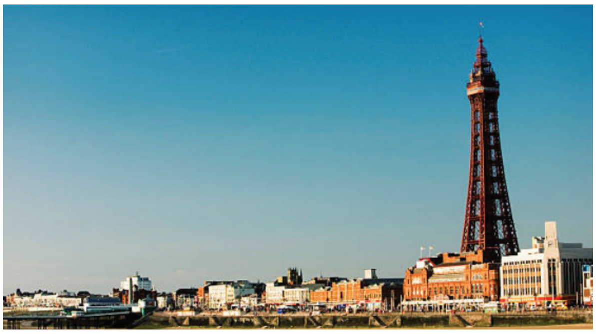
Introduction

This hands-on workshop is designed to challenge students to build the highest tower possible with limited supplies. When anything is being built – a building, a bridge, a road, or a pier – the architects and engineers have to design it carefully so that it is safe and fulfils the required purpose. This can be quite a challenge!

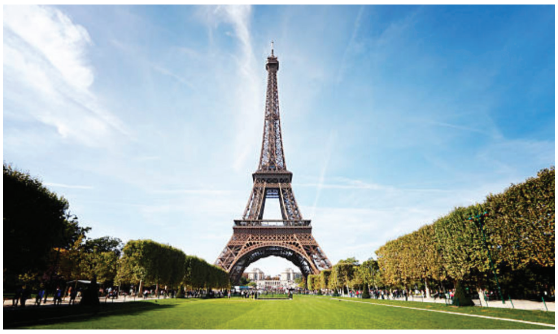
Background Information

First, let's look at some famous towers you might recognise. These can give your children / class inspiration for their design.

Clues for the class:



1. This tower is somewhere in England. It was opened to the public in 1894 and is 158 m*etres tall. There are lots of activities here including a circus and a dungeon.*
   Answer: *Blackpool Tower*



2. This tower inspired the design for the first of our three examples. It is somewhere in France and is the tallest building in the city where it stands. It is 324 metres high.
   Answer: *Eiffel Tower*

3. This tower is in Italy. It is actually a bell tower for the cathedral. The height of the tower is 55.86m on the low side and 56.7m on the high side. The tower has sunk on one side due to unsuitable foundations.
   Answer: *Leaning Tower of Pisa*

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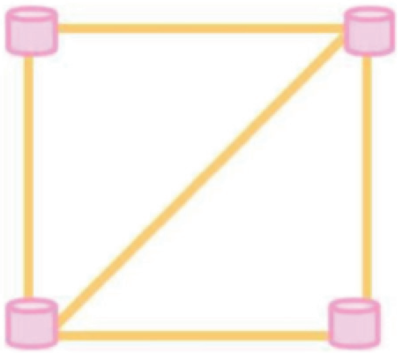
Suggested Lesson Plan

1. Split the children into teams of 3 – 5.
2. Give each team some spaghetti and marshmallows to test with.
3. Allow them to sketch, discuss and try ideas. They need to think about a few things. See 'hints and tips' below.
4. Then give the teams 50g of dried spaghetti and 25g of mini marshmallows.
5. Set a time limit (however long you feel appropriate) and set them the challenge to build as high a tower as they possibly can. Pieces of spaghetti can be broken to give desired lengths.

Hints and Tips

1. The spaghetti provides the framework and support for the tower and mini marshmallows are used to make the connectors.
2. The more the marshmallow can grip the spaghetti, the stronger the joint.
3. If there is a heavy load on the marshmallow, it may change shape until the joint fails so be careful!
4. Where you choose to use shortened pieces of spaghetti, make sure you cut them accurately. If you don't use pieces of equal length on each side, your tower may start to twist and topple.
5. Use shorter pieces of spaghetti or put in braces to strengthen squares and rectangles in your structure.



6. Think carefully about whether the spaghetti should pass all the way through the marshmallow or not. The strength of a joint depends on how well the marshmallow can grip the spaghetti.
7. There will be most strain on the base of the tower – think about how you can add strength here.

Judging

- You can simply make the winning team the one with the highest tower or you could use a points system, e.g.
- 1 point for every cm in height of the tower
- An extra 5 points if none of the marshmallows were eaten
- An extra 5 points if the tower looks good
- 5 points if the tower will support the weight (e.g. a chocolate egg).

Questions for the class

- What do you like and dislike about your current design?
- What was the biggest challenge you faced? How did you overcome it?
- If you had an opportunity to redesign your tower, what would you change?
- How similar is your design to others in the room?
- What things put a limit on how tall your tower could be?
- Time, amount of materials, have to combine strength and height.

When You Use Water, You Use Everything In It

Teacher Summary Sheet

What is ecology?
Ecology is the study of the relationships between living things and their surroundings, or environment. Scientists who work in ecology are called ecologists. Ecologists examine how living things depend on one another for survival. They also study how living things use such natural resources as air, soil, and water to stay alive.

Why is ecology important?
Ecology is important because it shows how changes in the environment affect the survival of living things. For example, when pollution kills certain living things, the animals that feed on them also may die. The work of ecologists has convinced many people to conserve, or protect, the environment and all the ecosystems that it supports.

Introduction to water pollution activity
Did you know that we eat water? We do! Water is inside the crops that we grow for food. What happens if the water we use on our crops is polluted? In this activity you will see how easily pollution can get into our water, our food and us.

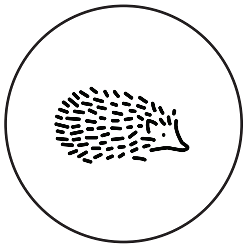
Resources
- A glass
- Tap water
- Red or blue food colouring
- A knife (get your parents or teacher to help you use the knife)
- A stick of fresh celery with the leaves still on it

Time
- Set up: 15 mins
- Activity: 4 hours to overnight

Suggested Lesson Plan
- Fill the glass with tap water.
- Add two or three drops of food colouring. Notice how it spreads through the water. Pollution spreads through water just like the food colouring does.
- Wash the piece of celery. Leave the leaves on.
- Being very careful, use the knife (or get your parents or teacher to do this) and cut off the bottom of the celery.
- Put the celery in the glass filled with coloured water.
- Let the celery stalk sit for at least three or four hours; you can even leave it overnight.
- When the time has passed, take the celery stalk out of the water.
- Use the knife (remember to get help from your parents or teacher) and cut a slice off the bottom of the stalk.
- Do this several times.

Questions to Answer
- How long did you leave the celery stalk in the water?
- Before you took the celery stalk out of the water, what did it look like?
- When you sliced off pieces from the celery stalk, what did you find?
- The food colouring is like pollution that gets into the water. If the food colouring moved all the way up into the celery stalk, what would happen if there was pollution in the water instead of food colouring?
- What does this tell you about polluted water?

Make a Hog House



Teacher Summary Sheet

Introduction
While you're awake, hedgehogs are asleep. Build the perfect snooze palace to keep a hog happy.

Resources
- Big, thick cardboard box
- Scissors
- Large, strong carrier bag
- Old newspapers
- Clean, dry straw or grass
- Twigs

Suggested Lesson Plan
1. Make an entrance to your box about 15cm square.

2. Cut slots at each side 15cm long and 5cm wide. These will be air vents.
3. Put torn newspapers together with dry grass or straw inside.
4. Tuck the box in a sheltered spot near a hedge or bush. The entrance needs to face south if possible. Rain doesn't often blow in from the south.
5. Cover the top of the box with the carrier bag.

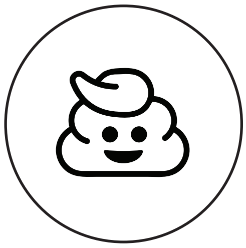
6. Stack twigs up all around the box and on top, so that the whole thing starts to look like a camel's hump. Fill in the gaps with more leaves and grass.

7. Now leave it well alone and hope that you get a hoggy visitor.

Though it's very tempting, don't look inside your hog house between May and September. If a mother has her babies there, she might abandon them.

Source: RSPB - https://www.rspb.org.uk/globalassets/downloads/kids--schools/teaching-resources/make-a-hog-house.pdf

Fact Sheet
Poop is Power



Teacher Summary Sheet

Biomass Energy
Did you know that poop can make power? It's true. Gas rising from the poop of 500 cows can create enough electricity to power 100 homes. That's some powerful poop!

Poop is a form of "biomass" which is the name for all living, or recently living materials coming from plants and animals that are a source of energy. The most common form of biomass energy on Earth is burning wood. We burn wood in fireplaces to keep us warm, or in woodstoves to cook our food. Besides wood and poop, biomass fuels can come from stalks of wheat, corn or sugar cane. It can also come from rice hulls, cooking oil, and other forms of garbage and food waste.

Biomass vs. Fossil Fuels
Biomass materials can be grown over and over again, so they are considered renewable resources. It takes them only months or years to grow and become fuel, unlike fossil fuels that take millions of years to become coal, oil, or gas. Biomass materials are also considered carbon neutral because they take carbon out of the air as they grown, but release about the same amount of carbon into the air when they are burned or used for energy.

Biomass and Biogas
Biogas energy is created from burning the gas that comes off animal poop and rotting plants. Rotting stuff gives off methane and carbon dioxide gases. When burned in an airtight container, these gases are collected in a process called gasification, and are used to produce energy. Biogas energy is used to heat water to create steam, which turns turbines, which generates electricity. The plant and animal waste that is left over is used as fertiliser for plants.

Keep Those Biomass Fires Burning
The best reasons for using biomass and biogas fuels are that they are sustainable; as long as people replant the fuel crops they harvest to create them. Also, plant and animal remains that were once considered waste and thrown in landfills are now being put to use as energy. The problem with biomass energy is that burning wood and garbage can still create air pollutants.

Humans have used biomass energy for thousands of years. Today, nearly one third of the planet still uses some form of biomass energy, proving it remains a long-lasting, inexpensive alternative energy choice.

Source: Ecology.com - http://www.ecology.com/2011/10/10/poop-power-biomass-energy/

Disaster Response: How can Engineers save lives after natural disasters?

Teacher Summary Sheet

Introduction

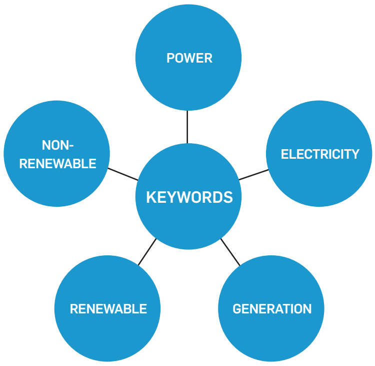
Disaster Response: How can Engineers save lives after natural disasters? Aims to educate students on what a natural disaster is and how engineers can work to save lives once an event happens. Natural disasters by nature are unpredictable, however, a certain level of planning can help reduce the effect of the event (earthquake resistant structures) and assist with the response effort (disaster management plan). This activity was developed by the Royal Academy of Engineering to highlight how engineers play a crucial part in saving lives after an event.

Aims & Objectives

EDUCATIONAL ASPECT	
Incorporate global issues into the classroom	Highlight key facts about natural disasters and how engineering can reduce the impact both in advance and after an event.
Provide careers related learning to pupils	Highlight how engineering can help solve some of the major issues facing us today.
Use a hands on activity to develop teamwork within the classroom in an educational setting.	Develop practical skills and cement understanding of how engineer can provide power to people.

PUPIL LEARNING OBJECTIVE	ACTIVITY
Understand what natural disasters are and the negative effects associated with them.	Discussion- what is a natural disaster and what are the effects of the events?
Describe the role of the engineer in saving lives both through preparation and response.	Discussion - What does an engineer do to protect people before and after an event?
Design a shelter	Plan, build and test using the activity sheet
Consider the challenges engineers face around the world	Discussion – using the activity and first two discussions, what challenges do engineers face?

Key Word Suggestions (to discuss with students)



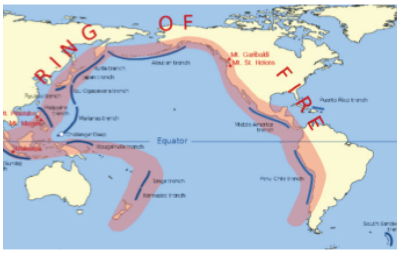
Suggested Lesson Plan

ACTIVITY SUMMARY	NOTES	RESOURCES
Starter		
Use starter questions to get pupils thinking about natural disasters. They could either discuss, draw a picture or write answers.	Suggested questions include: Can you name a natural disaster? After a disaster happens what happens to the people and the local area?	Pens/Paper (optional) Answers: hurricane, tornado, earthquake, volcanic eruption, flood, drought. Loss of homes, lack of food, blocked roads, no communication, disease, fire
Disaster Issues		
Get children to think about what it would be like if there was a disaster where they are. For older pupils, discuss specific case studies (either major events in history or recent events and how the impact varies depending on how developed the country is).	Suggested questions include: If an earthquake struck, what would we feel/do? How do you prepare for an earthquake? How can countries with little money cope with earthquakes?	Pens/paper (optional) Could be a discussion rather than written. Alternatively, an earthquake drill (common in Japan and other countries) could be simulated! See RAEng Activity 1a for an activity on warning times!
Role of Engineers		
Ask children to think about what an engineer is and how an engineer and natural disasters are connected. Discuss with students what engineers could do to help.	Suggested questions include: What does an engineer do? Why does an engineer get involved with disasters? What can an engineer do before a disaster? What can an engineer do after a disaster?	Pens/paper (optional) See the "Did you know?" sheet for statistics and key points. Answers: earthquake resistant structures, flood defences, water storage for droughts. Engineers can provide new roads, bridges, shelters and communications for people.
Buiding a Shelter		
Students to build a shelter for post-disaster response.	Students will be able to get practical and build models of a shelter.	Use activity sheet. Highlight shelter is a human right!
Reflection Activity		
Ask children to reflect on the practical activity and what they learnt reinforcing that engineers help to save lives before and after natural disasters.	Suggested questions include: What did we learn? What do engineers do?	No resources required. Discussion with pupils.

Further Learning Suggestions- Links to teacher and student work packs.
https://www.raeng.org.uk/RAE/media/Publications/Curriculum%20resources/Disaster%20Response/Disaster-Response-Teacher.pdf https://www.raeng.org.uk/RAE/media/Publications/Curriculum%20resources/Disaster%20Response/Disaster-Response-Student.pdf

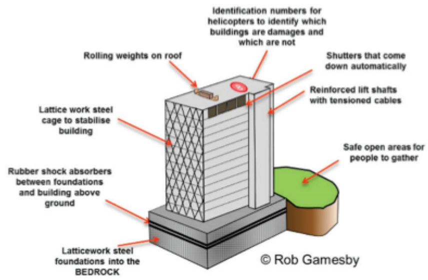
Did you know?

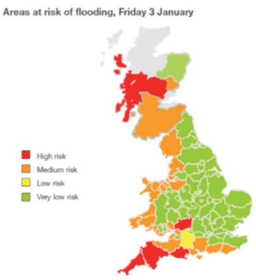
Natural disasters can be unpredictable and hard to plan for.



Earthquakes and volcanoes are mainly located on the Pacific Ring of Fire!

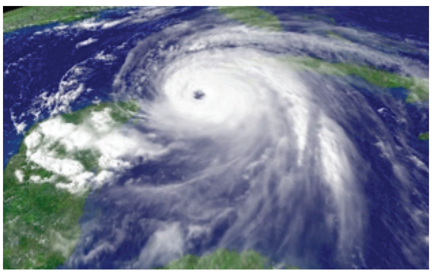
Engineers can design earthquake resistant structures to help prevent buildings from falling down!





Flooding is a natural disaster as well and the most common to occur in the UK. We build flood defences to protect critical infrastructure and people.

Poorer countries often have a worse impact from natural disasters as they cannot afford to protect themselves in advance.



Building a Shelter

Teacher Summary Sheet

The Situation

The organisation you work for wants to produce a new design for a shelter that could be built by two people using mostly scavenged materials, or using lightweight materials which are shipped in. The shelter should be as light as possible, but must keep people comfortably warm even in cold winter.

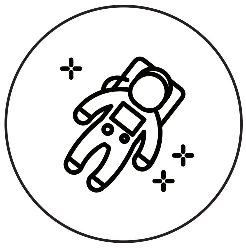
The Challenge

Design, construct and evaluate two model shelter solutions

1. Find out what material will be available
2. Your group must create and evaluate two model shelters. Decide which basic model structure(s) you are going to construct, and what modification, if any, you are going to make to the materials used in the construction. You will need to keep a record of your investigation as you work.
3. **Each shelter must have the same base area of 12 cm x 10.5 cm**
4. Check that your plan will allow you to carry out the text methods that you have been shown before you build the shelter.
5. Build and test your two models
6. Compare your results with those from other groups
7. Present a short report or presentation that gives brief details of :
   a. The materials and designs you used, with reasons why you chose them
   b. How you carried out the tests you used in your revaluations and what the results were
   c. What you discovered and what conclusions you reached

Note: Pages 7-9 of the following link provides a template for students or alternatively, allow students to be creative and make their own shelters without guidance! https://www.raeng.org.uk/RAE/media/Publications/Curriculum%20resources/Disaster%20Response/Disaster-Response-Student-support-sheets.pdf

Designing your Spacesuit



Teacher Summary Sheet

Resources Required
- Coloured pens or pencils
- Optional: Fact sheets on spacesuit materials – tin foil for reflection, cotton wool for insulation

Introduction
A spacesuit isn't just a uniform, it's like a personalised, human-shaped spacecraft designed to keep astronauts alive in space. There are two types of space suits: one for travelling to and from space, and one for doing spacewalks (EVAs).

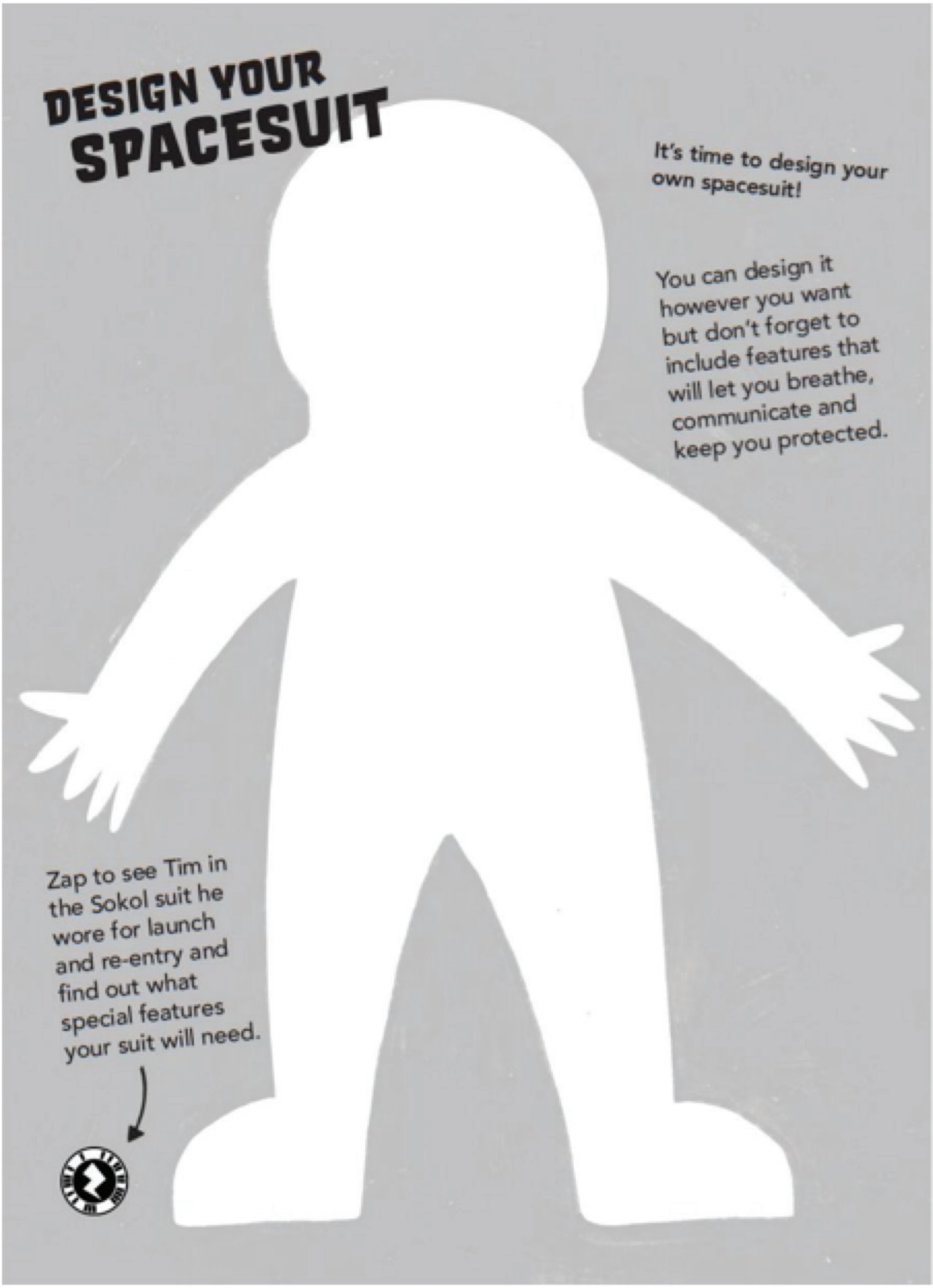
The EVA (Extravehicular activity) suits for space walks have lots of different jobs to do. They provide the astronaut with air to breathe, keep them warm or cool, protect from debris flying through space, allow the astronaut to move fairly freely and even have rocket boosters in case the astronaut gets into trouble! The suits are heavy on Earth but zero gravity in space makes them feel light.

When travelling back to Earth, Tim Peake wore a Sokol spacesuit, which is different to the one he used on his space walks. 'Sokol' means 'falcon' in Russian, and it is a rescue suit. This is the same design as the one that Helen Sharman wore when she went to the Mir Space Station. The main features of this type of space suit are:

- Two layers: the inner one is rubberised and the outer one is made of white nylon.
- Boots that are built into the suit and space gloves attached at the wrists by special aluminium fastenings.
- A helmet that is also part of the suit. To put the suit on you have to squeeze your head through a neck seal into the helmet, which has a visor on a hinge (so you can open it). The seal at the neck means you can float in water on landing and open your visor without your whole suit flooding!
- An air valve. An oxygen supply connected to the suit is activated in times of de-pressurisation.
- A radio and microphone to communicate.

Running the Activity
Encourage older pupils to use a range of material samples to design the suit. This works well fastened on as a 'swatch' using a treasury tag. Ideas:
Tin foil: to reflect radiation
Cotton wool: for insulation – to trap air
Black inside: to absorb heat
White outside: to reflect heat radiation

Questions for the Class
- What are the different parts of the spacesuit?
- Why is the spacesuit made like a onesie?
- How heavy will the spacesuit feel in space?
- How do you go to the toilet when you are in the spacesuit?



Source: Principia Space Diary - https://principiaspacediary.org/activities/design-your-spacesuit/

Squashed Tomato STEM Challenge

Teacher Summary Sheet

Introduction
Challenge your students to take on a real-life problem affecting people in Nepal.

In Nepal many farmers living on the mountainside grow fruit and vegetables, including tomatoes. To earn a living they need to sell these at the local market. The problem is getting to market involves a long, dangerous walk down the mountain side and over a river, at the end of which the tomatoes may well be a bit squashed.

Resources
Students will need a range of appopriate modeling material and equipment for the challenge. They include;

- Things to make a framework or basket from (e.g. Lego, Meccano, margarine tubs)
- A means to attach their basket/framework to the mode of transport and pulleys, ramps or similar to allow everything to move
- Ways to stick everything together (e.g. string, tape)
- String

Equipment

- K'Nex
- Lego
- Pulleys
- Paper-clips
- Newspaper
- Plastic nets (that hold fruit)
- Paper cups
- Dried spaghetti
- String/thread
- Tomatoes!
- Meccano
- Paper straws
- Split pins
- Sellotape
- Rulers
- Card
- Boxes
- Ramps with various surfaces
- Cardboard tubes
- Something to represent the river

Suggested Lesson Plan

Introduce the challenge by discussing the various ways in which food is transported from where it is produced to the local market or shop. Talk about rail, lorries, boats, planes, bicycles etc.

Set the context of the challenge by introducing the problem faced by farmers in Nepal. You could show the students some of the images from Nepal. The students work in small groups to design and build a model that can transport as many cherry tomatoes at the same time without squashing them.

Instead of moving full-size fruit and vegetables down a Nepalese mountain, we want the students to transport cherry tomatoes from a height set by the teacher to the floor.

If the tomatoes fall to the floor by themselves, don't count them. If they fall down a Nepalese mountainside, they'd be very, very squashed!

- The solution can be as simple or as complicated as the students like, but remember – think first, ask them to draw their ideas, check their materials and then choose one design to make.
  - Ask your student teams to draw three possible designs
  - Ask them to choose one to build and to justify their choice

- The bigger the container is the more tomatoes they'll be able to carry. But, the heavier something is the greater the force of the impact when they hit the ground, so there is more chance the tomatoes will get squashed.

- The tomatoes need to be transported a minimum of one metre along the ground from desk height. However, the challenge is more spectacular, and you are more likely to get squashed tomatoes if you set a height of more than two metres, and a horizontal distance of 2-2.5 metres. (This can be done by starting the run from the top of a chair, desk, stool or lab bench, taking care to ensure it's safely set up and supervised.

- The tomatoes cannot be touched whilst they are moving, catapulted or 'flown' in any way. They must be moved in a controlled way so they don't just crash into the ground and get squashed.

- You can also adapt the challenge by asking groups to either aim for the gresteast weight of tomatoes transported in one trip, or go for speed of operation and ask them to aim for the greatest weight moved in five minutes. In both cases, the group that transports the heaviest weight of tomatoes wins.

Questions for the students

After they've built it, ask them the following questions

- How well do they think it worked and why?
- What would they do differently if they had a chance to do it again?
- Having done it, do they still think they made the right choice of design?

Further Learning Suggestions

Show these YouTube videos from Nepal:
How a gravity ropeway works
How a gravity ropeway can make life better for families in Nepal

Extension Idea 1 – Communication: In a real-life situation the farmer needs to communicate to his colleagues at the bottom of the mountain when he has tomatoes ready to transport. Ask students to devise a communication method (other than verbal) that would be suitable for this, e.g. Morse code, traffc lights etc. In Nepal they use mobile phones or hit the wires to make them vibrate.

Extension idea 2 – Maths: Use the record sheet to calculate the best or average weight of tomatoes each group transported. From this deduce the class average. Maybe extend into a competition between classes within a year group. Use the information to discuss averages, produce graphs etc. If you reset the parameters of the challenge, so that students aim to transport the maximum weight of tomatoes with in a set time limit (e.g. 5 minutes) how would this affect the results? Can students work out how much they could move in 1, 5 or 10 hours (not forgetting the time needed to refill the containers and transport them back up the mountain)?

Extension Idea 3 – Payment: Having transported their goods to the bottom of the mountain, how do the farmers receive payment for what they do? Students could be asked to include a way in which payment for the tomatoes can go back up the mountain.

Extension idea 4 – Costing: Place a cost on labour, and on each different type of material used in construction, and ask students to calculate the cost of their design. Identify three ways to reduce the cost.

Extension idea 5 – Lateral Thinking: Ask the students to think about other areas of the World, and other situations, in which the technology they have been using could be useful. Ideas might include cable cars, cliff railways and water-powered engines. Are there any of these near your school?

Extension idea 6 – Art: Once they have finished the challenge ask students to slice their tomatoes in half then draw or paint the inside. You could slice open a range of different fruits and vegetables to compare.

Source: – STEM Learning - https://www.stem.org.uk/resources/elibrary/resource/27105/squashed-tomato-stem-challenge

Student Worksheet

NAME: .... **CLASS:**...

Please draw your design in the box below – **DESIGN 1**

Student Worksheet

NAME:.. **CLASS:**..

Please draw your design in the box below – **DESIGN 2**

The Squashed Tomato Challenge

Student Worksheet

NAME: .... **CLASS:** ....

Please draw your design in the box below – **DESIGN 3**

Student Worksheet

NAME: .... **CLASS:** ....

Tell us which design you chose to make, and why...

Tell us more about your final design...

How many tomatoes or what weight of tomatoes did your design carry?

Do you think it worked well?

What would you like to change in your final model?

What will you do differently next time you do a challenge like this?

Wildlife Watch

OCTOPUS

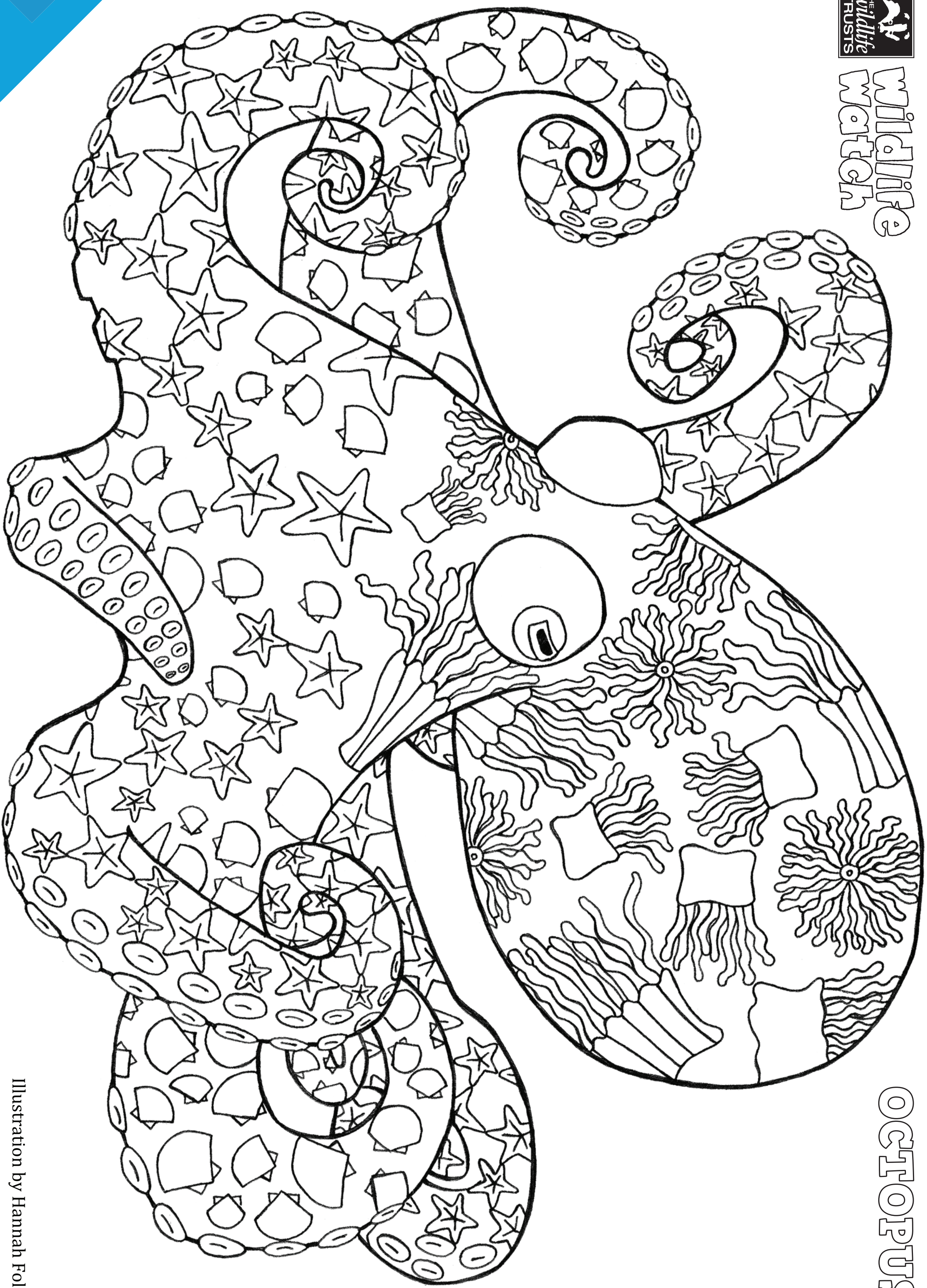


Illustration by Hannah Foley

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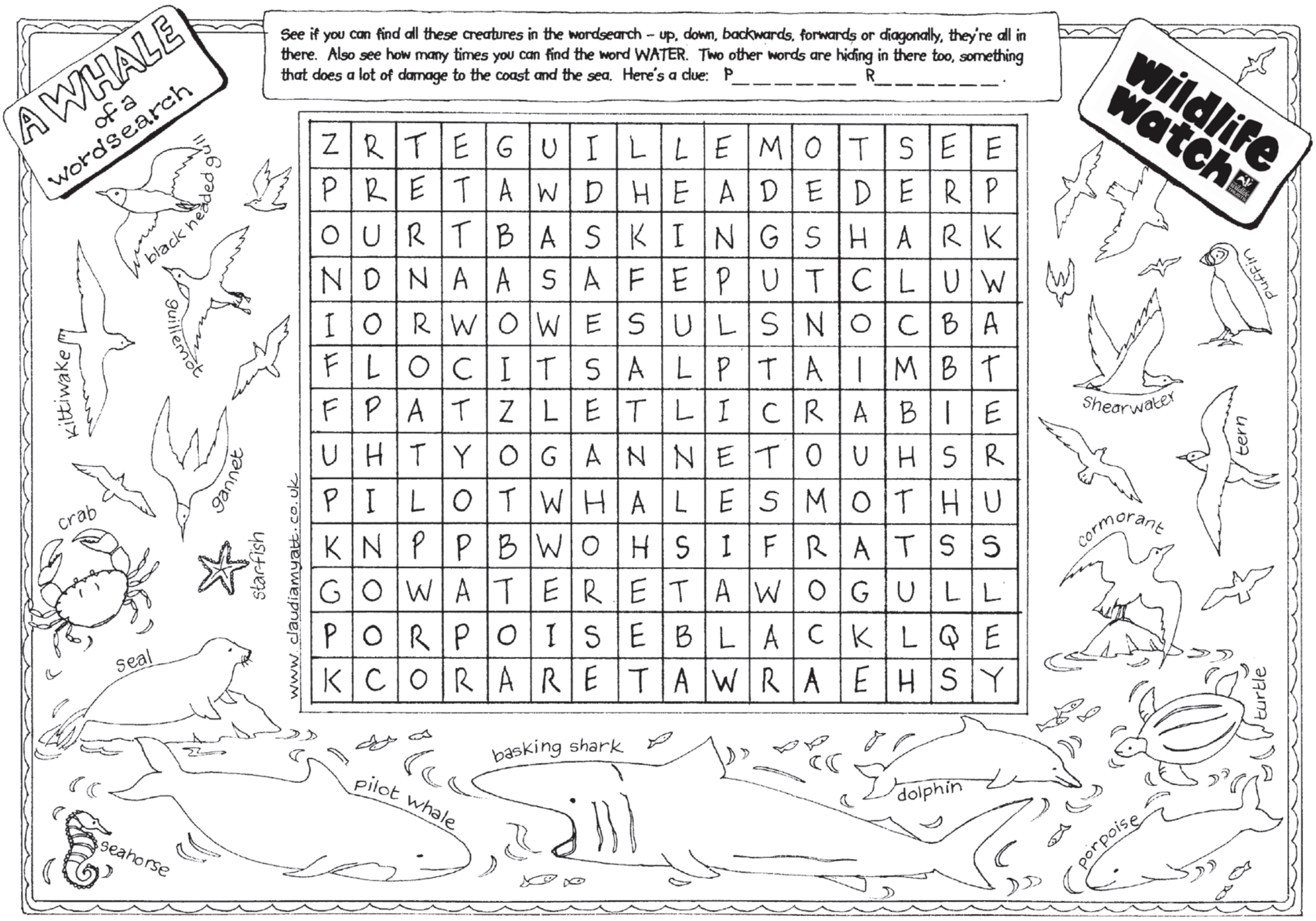
Marine Words



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