The Great *Exhibition* AT HOME

Welcome to the Great Exhibition at Home Challenge. Inspired by the Great Exhibition of 1851, we are exploring how engineers can help protect the planet.

This is the start of a 7 week STEM adventure. You can keep all the exhibits that you create in the first 6 weeks to display in your Great Exhibition at Home in week 7 – they may even feature in your challenge video!

Start by reading our introductory pages and then use the printable worksheets to take up the challenge! Each week, learn about 1 invention from the original Great Exhibition and 1 inspiring engineer from 2020, then take part in exciting engineering challenges.

Contents

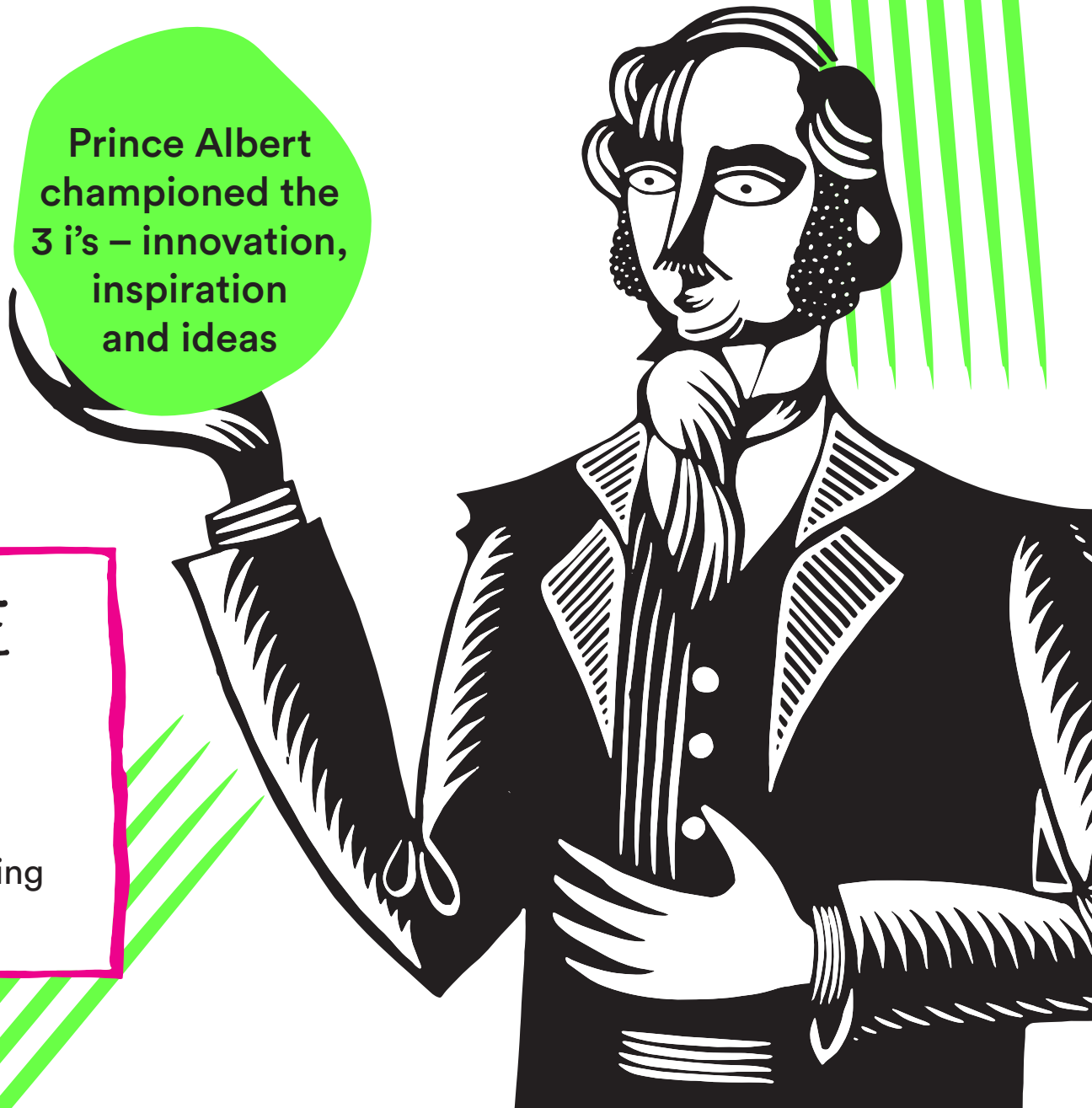
INTRODUCTION

TAKE UP THE CHALLENGE

What was the original Great Exhibition all about?

In 1851, Prince Albert and his team wanted to celebrate the advances in technology, science and design all around the world – they especially wanted to show that Britain had some of the best and brightest inventors and engineers around!

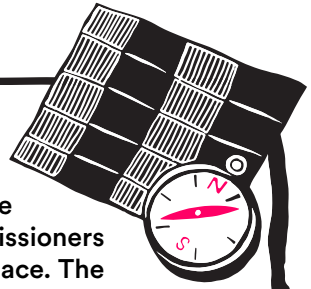
They decided to organise a huge showcase of modern technology from all over the globe to be judged as part of a huge competition – The Great Exhibition.



PRINCE ALBERT FACT FILE

- Born in Germany ***26 Aug 1819***
- Married to ***Queen Victoria***
- ***Loved photography***, Prince Albert's portrait from 1842 is the earliest surviving photograph of a royal family member

Albert's Ingredients *for making a Great Exhibition*



LOCATION, LOCATION, LOCATION!

There were no existing buildings large enough to house such a huge exhibition, so Prince Albert and his commissioners ordered the construction of the astounding Crystal Palace. The enormous glass structure was inspired by a greenhouse and designed by english gardener, Joseph Paxton. The entire Crystal Palace was erected in Hyde Park in under 5 months, an impressive feat of engineering. At 1,848 feet long, equivalent to 51 London buses, it became the largest building in the world at that time!

WORLDWIDE WONDERS

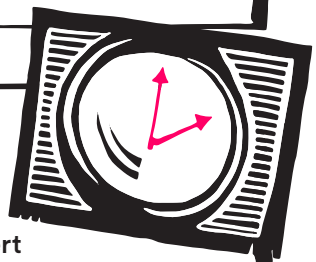
Such an amazing space needed plenty of exhibits to fill it. By the opening ceremony on the 1 May 1851, over 100,000 exhibits from 13,937 exhibitors had been transported across land and sea from all over the globe.

CURIOUS CROWDS

More than six million people – equivalent to a third of the entire population of Britain at the time – visited the exhibition during its opening period between 1 May and 11 October 1851. The Exhibition attracted an average daily attendance of 42,831 with a peak of 109,915 visitors on 7 October 1851!

ENGINEERING A BETTER WORLD

Visitors to the Great Exhibition marvelled at the cutting edge technology displayed, which hoped to revolutionise Victorian living. Prince Albert wanted his Exhibition to demonstrate how forward-thinking Britain was in 1851. He wanted to show how curiosity, research and progress could engineer a better world.



BUILDING A LEGACY

The Exhibition was a great success, making a profit of £186,000 (equivalent to £159 million today)! Prince Albert and his Commissioners used this money to buy a large plot of land in London and set up lots of important buildings such as the Natural History Museum and the Science Museum.

Introduction to engineering

The engineers of the Great Exhibition in 1851 hoped their inventions would influence the future. This is still the case for engineers today.

Engineers find solutions to problems, make things work and then make them work better. They apply Science and Maths to find solutions and use practical skills that can be learnt in Design and Technology to achieve this. Engineers need to be problem finders and solvers, think creatively and work well in a team. They can adapt their ideas and learn by making mistakes. Engineering is diverse and cutting edge. Engineering shapes the world around us.

To learn what engineering really looks like visit
thisisengineering.org.uk

There are lots of different types of engineering. Here are a few examples – you'll learn more about the work that all our engineers do very soon!

MATERIALS ENGINEERING

Meet our engineering trailblazer Lucy in week 6.

MECHANICAL ENGINEERING

Meet our engineering trailblazer Halvard in week 5.

CHEMICAL ENGINEERING

Meet our engineering trailblazer Enass in week 4.

CIVIL ENGINEERING

Meet our engineering trailblazer Millie week 2.

ENVIRONMENTAL ENGINEERING

Meet our engineering trailblazer Ben in week 3.

1851*der* Worksheet 1: *The Yacht Piano*

There were all manner of inventions, exhibits and curiosities shown inside the Crystal Palace at the original Great Exhibition - in fact there were more than 100,000 exhibits!

These inventions were cutting edge for their time and sought to revolutionize Victorian living.

Whatever the size of your yacht, it is not complete without a piano, or so William Jenkins, a British inventor and manufacturer, thought. His answer was to produce a folding piano complete with collapsible keyboard to squeeze into tight spaces such as a yacht, saloon or 'ladies' parlour'.

The clever design was exhibited at The Great Exhibition and inspired the manufacture of other Yacht Pianos to be stocked in London department stores. The first record player wasn't invented until 1877 so in 1851 musical instruments were an important source of entertainment – even at sea.

Take up the challenge!

Yacht pianos kept wealthy Victorians entertained. Today yachts are being used by climate campaigners, including Greta Thunberg, as way to travel between continents. But what about places that aren't near the sea?

Can you think of new and exciting ways to travel on land which don't harm the environment? Try drawing or writing about your ideas, you may even want to test them yourself – can you travel from one side of the room to the other in an innovative way?

On the next page, meet an engineer who is finding ways to harness human travel to help combat climate change…

Laurence Kemball-Cook

Laurence founded a company called Pavegen, which harnesses people's footsteps and turns them into energy. His invention has captured over 1/2 billion footsteps so far!

What is Laurence's invention?

Laurence developed a flooring system that has special tiles which, when stepped on, generate energy. It's a bit like a wind turbine which captures the power in the wind to make energy but for your feet. This means it can use the kinetic energy from people's footsteps to power things.

The special floor tiles can be used to power lights. Last year, they were installed in a running track in a Hong Kong office building. Workers could exercise during the day by running around the track. The energy from their footsteps was used to power lights inside the office.

Kinetic relates to motion, and means the energy that an object has because of its movement. Anything which moves has kinetic energy, like a ball rolling on the floor, or in this case a person walking.

How can kinetic floor tiles help the environment?

The world is running out of non-renewable energy sources. Non-renewable means something which cannot be replaced once it has been used, such as fossil fuels, that come from very old life forms buried in the ground. Pavegen gives people the power to make energy with their footsteps – giving everyone the opportunity to help their community!

NOW IT'S YOUR TURN

Can you imagine an exciting new way to generate renewable energy if you had no limits? What would it be powered by – weather, humans, machines or something new? You might like to draw or write about your idea or even make a poster advertising your new invention!

Get ready for week 2, where you can discover another inspiring engineer, intriguing inventions and extra challenges!

1851*der* Worksheet 2:
Tempest Prognosticator or Leech Barometer

This invention exhibited at The Great Exhibition by George Merryweather used live leeches to predict the weather.

It worked by keeping twelve leeches inside twelve small bottles inside the device. When the leeches became agitated by an approaching storm they would attempt to wriggle up and out of the bottles, dislodging a piece of whalebone and triggering a small hammer to strike a bell. The likelihood of a storm could then be predicted by how many times the bell was heard.

We may not use leeches in this way in the 21st Century, but predicting weather is just as important today. Engineers are working hard to find solutions to the complicated problems that extreme weather, caused by Climate Change brings to our communities. Learn about an inspiring engineer who is doing just that on the next page...

TAKE UP THE CHALLENGE!

Engineers are curious about the world around them. They make observations and use them to design innovative systems to solve problems. Think about George Merryweather:

1. He observed that leeches appear to become agitated before a storm

2. He tested his theory by observing and recording the leeches behaviour

3. He engineered a contraption which could utilise his observation

4. He built the leech barometer

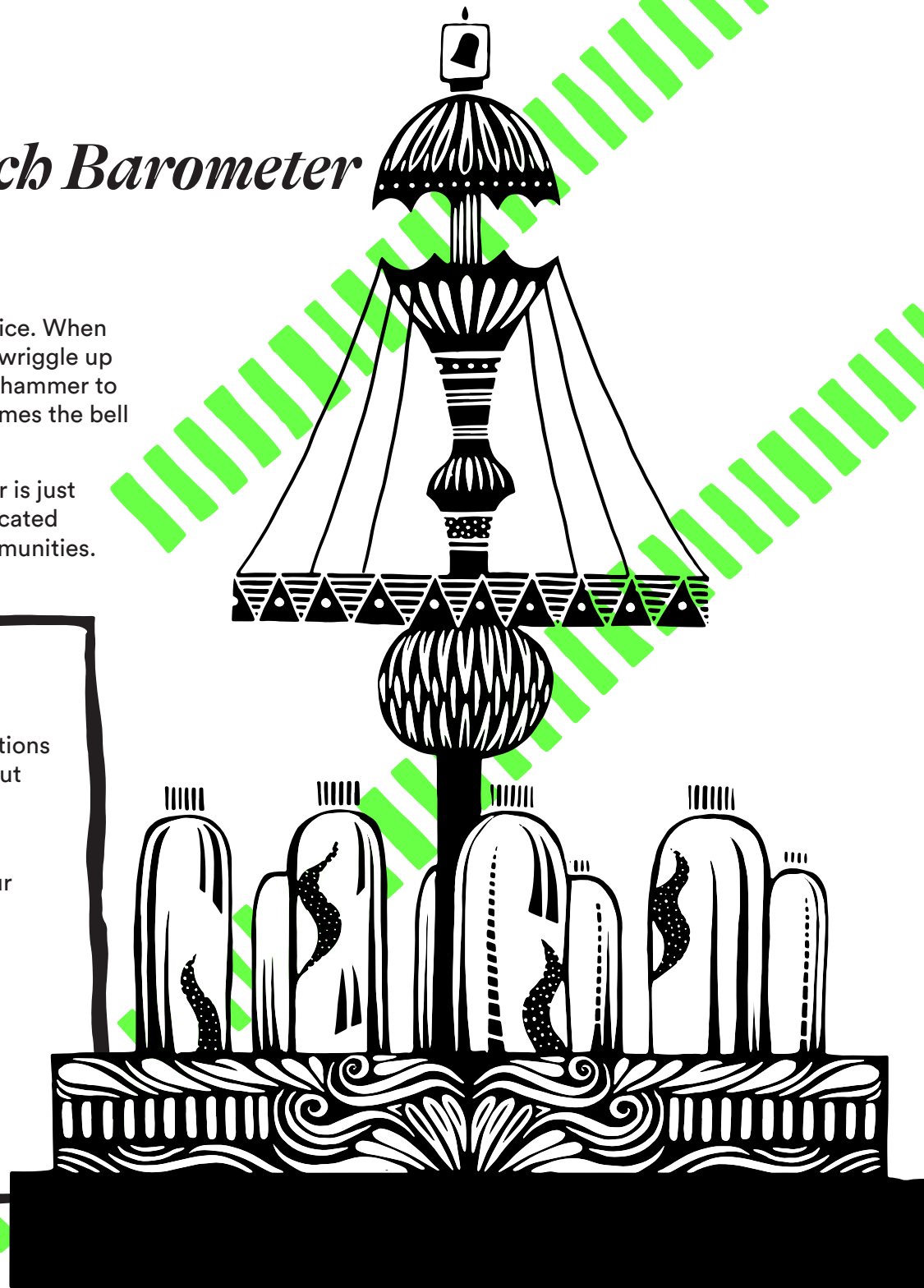
Follow these 4 steps to design your own invention:

1. Make an observation

2. Test your theory

3. Design a contraption

4. Draw or build a model



Milly Hennayake

Milly grew up living in Sri Lanka and the UK before going on to study civil engineering. She works keeping communities safe from flooding, at an engineering company called Arup.

What is a civil engineer?

Civil engineers work with things such as bridges, roads, railways, sewers, buildings - everything that a community needs! Milly designs drainage systems to help divert water, keeping people's houses safe and dry, even after big storms. She ensures that her designs have a minimal impact on the environment. Milly works with nature: from rivers and lakes, to trees protecting river banks to manage rainwater in storms.

Why is Milly's work important for the planet?

As global warming causes ice caps to melt, sea levels are rising and risks of flooding are higher. Finding clever ways to work with nature and live alongside this weather without disruption will help us all live comfortably.

Learn more from Milly at ***bit.ly/2ThzK76***

NOW IT'S YOUR TURN

Can you design and/or create a flood proof house? Think about the land around it, the material it's built from and how you can use nature to help you. You may even want to create a model and test it in your bath or sink!

Get ready for week 3, where you can discover a comical invention, a new inspiring engineer, and exciting challenges!

1851*der* Worksheet 3: *The Comical Creatures*

Some of the inventions exhibited at the Great Exhibition were more curious than others!

A particularly strange exhibit found within the Crystal Palace was by German taxidermist Hermann Ploucquet. Visitors to the exhibition could peer at a display of stuffed animals doing distinctly human things, such as a frog carrying an umbrella, a pair of sword fighting mice and hedgehogs on ice skates! The display captured the imagination of the Victorians and even Queen Victoria herself described Ploucquet's display as "really marvellous".

TAKE UP THE CHALLENGE!

Unfortunately even being able to sword fight wouldn't save animals from extinction in today's climate. See if you can find out more about different animals who are finding it increasingly hard to survive on the planet. Make a display or poster about the animal that interests you most and raise awareness of the challenges that it faces, can you think of any ways that engineers can help?

Ben Crowther

Ben is from Reading. He co-founded LettUs Grow, a company that reduces food waste and CO2 emissions through a new way of growing food.

How does it work?

Ben has developed a new method of farming which uses less water, needs no pesticides (chemicals used to destroy pests on plants such as weeds or insects) and can be set up anywhere in the world. Instead of growing plants in soil, Ben's system covers the roots of plants in a mist filled with nutrients (food), which is what most plants find in soil. Using mist means that plants need 95% less water to grow than traditional agriculture! In the mist, plants can be grown under the sun or LED lamps, so they can be grown in normally dark places - like basements.

How can growing plants in nutrient mist help the environment?

The number of people living on Earth is growing very quickly, we need to make more food to cope with that and find new ways to grow food using less land (and soil). Ben's method of growing without soil doesn't take up extra land, meaning that more food can be grown sustainably to feed people now and in the future.

Learn more from Ben at ***bit.ly/3asHglv***

NOW IT'S YOUR TURN

Can you try growing something of your own? You don't need soil or a garden to do this. Like Ben you can grow indoors too – follow our simple guide to growing cress in your home.

1. Get your parent or guardian to help you order some cress seeds online

2. Find a punnet, tray or egg box – this can be a great way to reuse and recycle

3. Line your container with wet kitchen roll or cotton wool and evenly sprinkle the cress seeds on top

4. Cover with cling film and place on a warm windowsill where it can access full sunlight

5. Keep an eye on your seeds, if they seem a little dry add small amounts of water. After about 5-7 days the cress shoots should be reading for harvesting. Snip off the shoots using a pair of scissors and add them to your sandwiches!

If you are not able to grow in your home why don't you try designing your own contraption which grows food more efficiently. How would it work and what would it grow?

Come back to discover week 4 – learn about a truly unique 1851*der*, our next inspiring engineer, and an extra special challenge!

1851*der* Worksheet 4: *The Stereoscope*

The stereoscope was an exciting new device for viewing photography. It transformed 2D pairs of images into 3D images before the viewer's eyes. The 'original' virtual reality.

The original stereoscopic apparatus was invented in 1838 by Sir Charles Wheatstone, however it was not until the Great Exhibition that stereographs gained international recognition and became a real craze with the Victorians! Queen Victoria was said to be a great fan and was greatly impressed by the Stereoscope display by Jules Duboscq, a pioneering French photographer at the Great Exhibition. Stereographs of inside the Great Exhibition still exist today and allow us to imagine what it might have been like inside the Crystal Palace.

The stereoscope helped to share the wonders of the Great Exhibition with Victorians who couldn't be there in person. Your Great Exhibition video will do the same - how will you make your exhibits as engaging as possible for people who may not be able to see them in person?

How to create a stereograph for static subjects

When the subject of your image is still, taking a stereoscopic photo is very simple. Two photographs need to be taken from slightly different perspectives, ideally offset by the same distance as your pupils (about 63mm). The simplest way to do this is the one-legged method which is as follows:

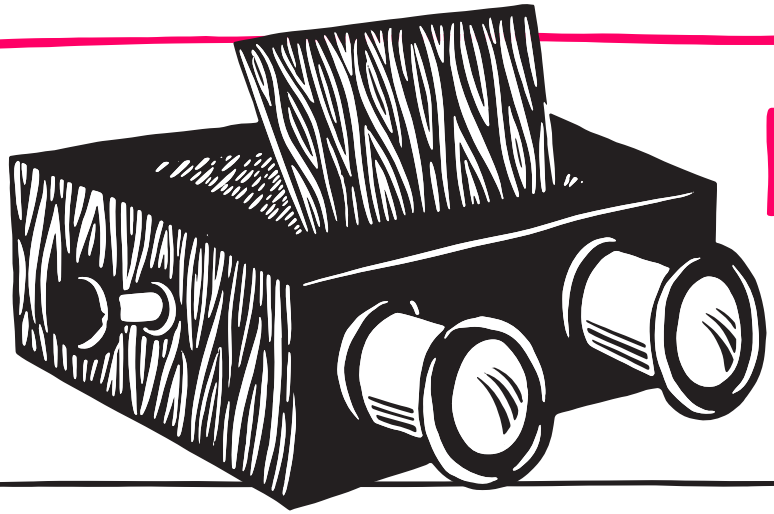
- Stand with the camera pointed at the subject of choice and transfer the weight of your body to one leg
- Click the shutter
- Keeping the camera pointed at the subject, transfer the weight of the body on to the other leg Click the shutter again
- This manoeuvre is the easiest way to capture two view of your subject from roughly the same distance apart as eyes.

For Moving Subjects

Creating a stereoscopic image of a moving subject is a little bit more difficult, but certainly doable. For this you will need two cameras (phone cameras may be easiest for this method).

- Stand facing your subject
- Take the two cameras (or mobile phones) and line each camera lens up with one of your eyes
- Click the shutter of both cameras at the same time

Once you have taken your stereoscopic photographs, please email them to **1851@big-ideas.org** to be in with a chance of featuring on the 1851*der* app!



TAKE UP THE CHALLENGE!

Create your own stereoscope! Research different stereographs from the 1851 exhibition and create your own stereograph inspired by the topic of the climate.

Dr Enass Abo-Hamed

Enass is from Palestine. At just 28 she created her own engineering company called H2GO, which is developing a battery to store renewable 'clean' energy that is better for the environment.

What does Enass do?

Enass has engineered a battery which is able to store renewable energy (that comes from sources that can be replaced) in the form of hydrogen for long periods of time. It is a way for people to access energy to power things such as lights in their home even if they live somewhere where it can be difficult to get gas and electricity. The battery is very large, at around 8ft tall and 20ft wide - that's just under the height and width of two cars put together!

Why did Enass' company create this battery?

During a trip to Africa, Enass saw that some hospitals only received power for 12 hours of the day, and households had to rush to do all their cooking and reading while electricity lasted. Electricity is a luxury in some countries and this can make people's lives very difficult. Enass saw this as a problem that engineering could fix, while helping to save lives and the environment too.

Learn more from Enass at ***bit.ly/2TBKSun***

NOW IT'S YOUR TURN

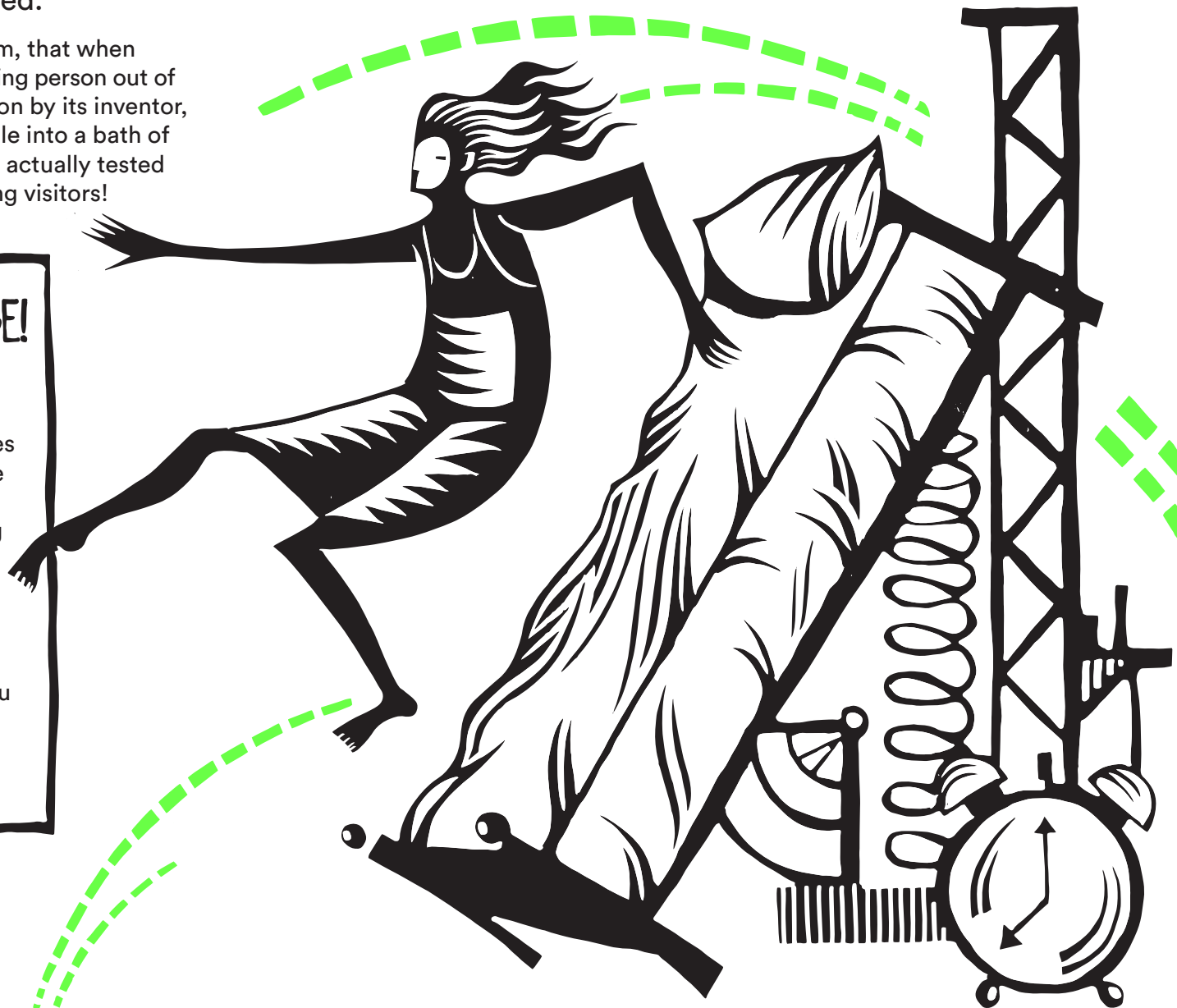
Can you identify a climate issue in another country and engineer a sustainable solution like Enass? Pick a country, do some research, and get designing!

Discover week 5, with a dynamic invention, futuristic engineer, and fun new challenges!

1851*der* Worksheet 5: *The Alarm Bed*

One of the most intriguing inventions at the Great Exhibition was a silent alarm bed.

This contraption worked through a mechanism, that when connected to an alarm clock would tip a sleeping person out of bed at a time of their choosing. One suggestion by its inventor, R.W. Savage, was that the bed might tip people into a bath of cold water. This slightly soggy method wasn't actually tested in the Crystal Palace – a relief for unsuspecting visitors!



TAKE UP THE CHALLENGE!

Although the Alarm Bed didn't take off, there are even more inventors in 2020 making weird and wonderful technologies to help improve our lives. Many of these gadgets can help us to be more eco-friendly day to day, for example a folding bicycle that helps people to drive less, or a reusable water bottle to cut down on plastic – all these things will have been designed by engineers.

Can you design a new gadget to help you be more eco friendly? Perhaps it would help you get to school, waste less food, or use less electricity.

Halvard Grimstad

Halvard is a robotics engineer from Norway. He decided to study mechanical engineering because he loves putting things together and knowing how things work. Halvard creates agricultural robots that can change the way we farm.

What does agriculture mean?

Agriculture describes the practice of growing crops or raising animals. Someone who works as a farmer is in the agriculture industry.

What do these robots do?

The robots that Halvard works on help with farming to grow food. They can do lots of tasks, from ploughing and weeding, to picking strawberries and testing the soil. The robots can work on lots of different types of land and can be quickly adapted to work in different settings such as greenhouses, tunnels, open fields or orchards. Halvard's work is different every day. He helps to design sensors and gadgets and gets to help build the robots in the workshop as well as test them out in the field.

How can agricultural robots help the environment?

Halvard's work uses robots that farm effectively and sustainably by precisely measuring water and soil. Farming is a difficult skill, the better we are at using the land and growing sustainably the healthier our fields will be.

Learn more from Halvard at ***bit.ly/2vzLybU***

Find out more about all our engineering trailblazers at **www.thisisengineering.org.uk**

NOW IT'S YOUR TURN

Think about the sustainability of your meals. All food has to travel from the farm it is grown on to arrive on your plate, the further that food travels on transport the more pollution it creates.

Can you calculate the food miles of your lunch this week? To do this, find out where all the food has come from – you should be able to find this information on the packet of most ingredients. Then use an online map to work out the number of miles it has taken to travel to you.

If you want to take this further you could even do some research on which foods we can grow here in the UK and plan an eco-lunch with as few food miles as possible.

Get ready for week 6, where you will learn about two final 1851*ders* and meet the last of our inspiring engineers!

1851*der* Worksheet 6:
Perfume Fountain & Public Toilets

PAID FOR PUBLIC TOILETS

In 1851, for the first time ever, individual cubicles with flushing toilets became available for members of the public to use. Before then, flushing public toilets for men were not available and public toilets for women didn't exist at all! Engineer George Jennings, a plumber from Brighton, installed the first paid-for flushing public toilet at the Great Exhibition, where visitors spent one penny for the luxury of a clean toilet seat, a towel, a comb and a shoe shine. This was the start of the phrase 'spend a penny' – although records show that during the original Great Exhibition 675,000 pennies were spent, an expensive trip to the loo!

TAKE UP THE CHALLENGE!

Although our services and hygiene have improved since 1851, waste disposal is still an issue we face today. From recycling to biodegradable plastic alternatives, engineers are working to reduce and reuse all the things we throw away. Can you use rubbish to create something new? Grab some plastic bottles and tin cans and create your own invention.

PERFUME FOUNTAIN

Eugene Rimmel, a perfume maker, who was born in France but lived in England for most of his life, created a giant fountain for The Great Exhibition. The fountain sat on top of a splendid base featuring glass cases filled with bottles of 'Great Exhibition Bouquet' perfume. If the stylish bottles didn't convince customers, then ladies could try the perfume on their handkerchiefs – by asking for a spritz from the fountain itself!

TAKE UP THE CHALLENGE!

You may recognise Eugene Rimmel's name. Although he died in 1887, the cosmetics brand that he created, Rimmel London, is still sold around the world today.

How can cosmetic brands be more sustainable? Chemical engineers are working to find Eco-friendly alternatives for beauty products. Can you create your own perfume using all non-toxic ingredients and 'waste smells'? For example, using discarded orange peel to create a citrus scent!

Lucy Hughes

Lucy Hughes is a 24 year old engineer from the UK. She has created an exciting new material called MarinaTex, which is causing waves in the engineering industry.

What is Lucy's material?

Unlike plastic, MarinaTex can biodegrade in just 4-6 weeks, this means it is able to decay and go back into the earth naturally without being harmful to the environment. Lucy's material is made using 100% organic materials, mainly from fish waste. Making fish ready to eat creates lots of waste and Lucy decided to tackle two problems at once, by finding a new use for this waste and using the materials to create MarinaTex.

How can Lucy's invention help the environment?

Lucy's material is an alternative to single use plastic, a huge part of life today - Many supermarkets have plastic on every shelf. Unfortunately most plastic is used once and then thrown away. It is estimated that a plastic bottle may take 450 years to biodegrade, with endless waste building up at landfill sites it is important to find new materials to replace plastic which do not have the same impact on the environment.

How did Lucy create her material?

Lucy did lots of research into the different materials she could find in fish waste. She discovered that fish skins and scales were flexible and strong. To turn these into a usable material Lucy had to find a 'binder' - this is a material or subject that holds other materials together.

It took Lucy over 100 different experiments to refine her material, most of which she did on the kitchen stove of her student accommodation.

NOW IT'S YOUR TURN

Think more carefully about the materials you can find in your house. Each material has been created to fit its purpose, for example the fabric of your clothes are made to be warm and comfortable, or a plastic chair is made to be sturdy and lightweight. There are lots of different ways to use materials. This week recreate something in your home out of newspaper, or any scrap paper – maybe your clothes, or even a bowl or table. Newspaper is a versatile material, if rolled up it can become strong, if kept flat it allows movement, if used for paper mache it can become a new material entirely – get creative and resourceful like Lucy and see what you can make.

You've learnt a lot over the past 6 weeks and are ready to start thinking about making your own Great Exhibition. We can't wait to see what you do. Join us next week for help with creating your own Great Exhibition at Home, as well as making your 1 minute video submission to be in with a chance of winning some exciting prizes.

The Great *Exhibition* AT HOME

Week 7

This is week 7 of The Great Exhibition at Home challenge. Congratulations, you have made it to the final week of the challenge. This week you are going to start creating your very own Great Exhibition at Home!

All the fantastic work you have done throughout the challenge can now become part of making a final exhibition which tackles the challenge question:

How can engineering help protect the planet?

Use this week's worksheets to learn a little bit more about all the ingredients which went into making it GREAT. Then use Albert's ingredients to think about making your own exhibition and 1-minute video submission to be in with a chance of winning some amazing prizes, including:

- £500, £300 or £100 worth of equipment to supersize STEM subjects in your school
- A 30 minute meeting or video chat with one of the inspiring engineers featured in this pack for your school
- 30 prizes for individual participants

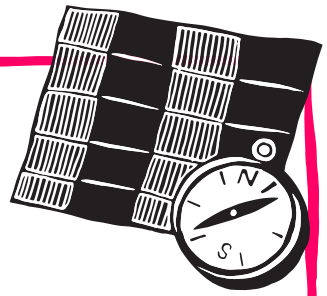
You have until the end of July to make your video the best it can be.

Let's get started!

How to make your own Great Exhibition at Home!

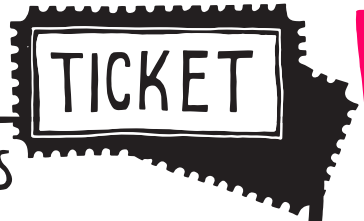
Now you have learnt all about our inspiring engineers and the original Great Exhibition it's time to start thinking about making your own, to present for your 1 minute film entry. Use Albert's key ingredients to make your exhibition truly Great!

LOCATION, LOCATION, LOCATION!



You may not be able to build your own Crystal Palace but think carefully about where you would want to hold your exhibition – you could hold it in one room, across lots of rooms in your home, in a garden or even design a new fantasy space!

CURIOUS CROWDS



The Victorians were truly amazed by everything they saw at The Great Exhibition. Think about who you could share yours with – you could video call a classmate, or family member and present your exhibition to them. Think about Curious Crowds when submitting your video entry - the judges will be excited to hear from you!

A LASTING LEGACY

Engineering is all about working to build a better future. The Great Exhibition had a huge and lasting impact and our engineers are working hard today for a better tomorrow. Consider what the impact of your Great Exhibition is, for you, your school and for the planet!

WORLDWIDE WONDERS

Prince Albert's exhibition included exhibits from all over the world. The different exhibits reflected the various skills, materials and resources of each nation.

You could even consider how engineering is used to address the different climate issues faced in different countries around the world.

ENGINEERING A BETTER WORLD

The original Great Exhibition was all about progress, developing technologies and using engineering to tackle problems of the day. Use your exhibition to create innovative solutions to one of the biggest challenges that our world faces today, climate change.

Learn more about trailblazing engineers who are already developing sustainable solutions in this pack.

Exhibition inspiration

When thinking about what a Great Exhibition in your Home might look like, always remember Albert's 3 i's – innovation, inspiration and ideas!

A Great Exhibition can be whatever you want it to be, but here are a few ideas to get you started...

- Hold an Exhibition in your bedroom, garden, even a shoebox!
- Showcase the work you have done over the past 7 weeks
- Create a display about one of our engineers
- Design or make your own own invention
- Conduct an experiment and display the results
- Create an animation about engineering and the environment
- Run a campaign to reduce plastic in your household
- Display posters in your window for the rest of your street

Documenting your Exhibition

To enter the challenge you will need to create a video, no more than 1 minute in length

The video should showcase your Great Exhibition at Home and explain how it tackles this year's challenge question:

How can engineering help protect the planet?

Once you have created your video ask a parent or guardian to send it to **1851@big-ideas.org** or submit online yourself at **big-ideas.org/athome** by the end of July.

If you are experiencing technical difficulties head to **www.big-ideas.org/teacher-support/** for more support.

Alternately please feel free to get in touch with us by emailing **1851@big-ideas.org**.

Thank you for taking part in The Great Exhibition at Home Challenge!