STEM ACTIVITY BOOK

Raytheon UK

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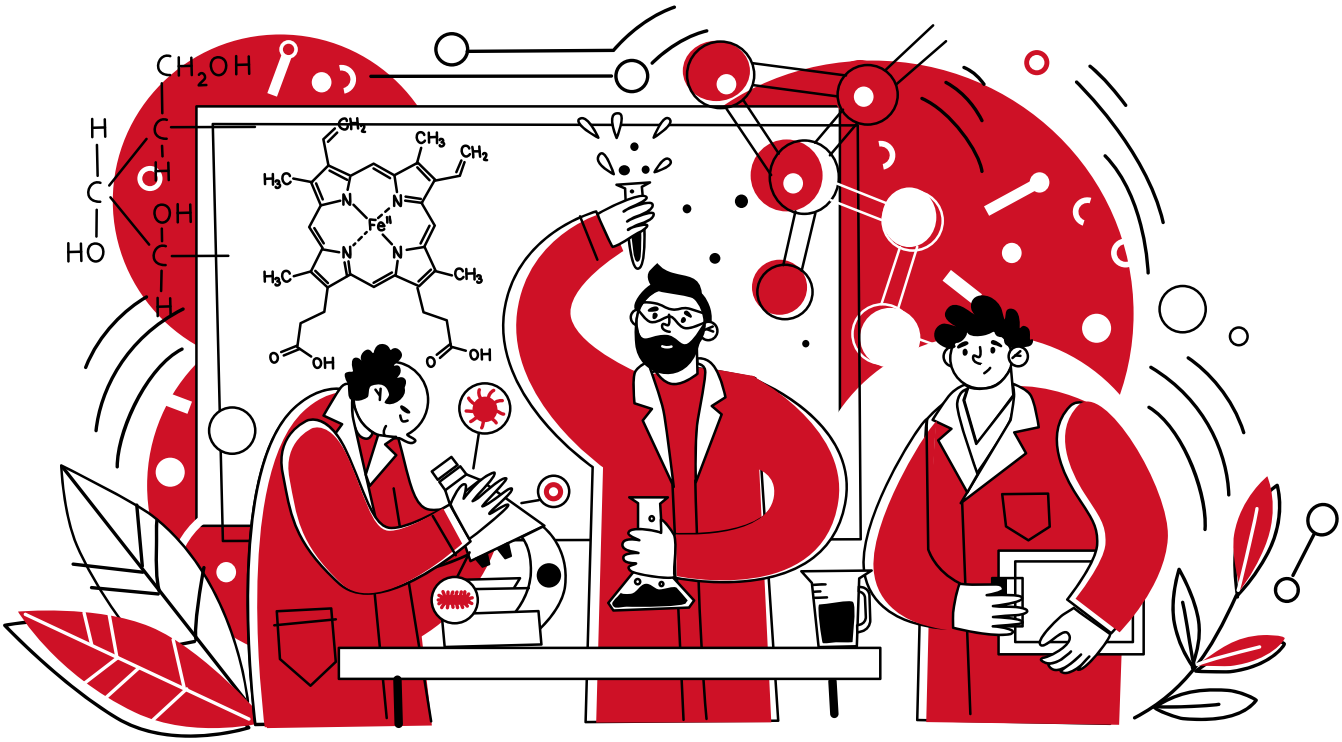
INTRODUCTION

These unprecedented times mean that more of us are having to adopt new ways of working, and for some of us, that means having to adapt to home teaching as well.

That's why we called on our fantastic Raytheon STEM Ambassadors to create an activity booklet designed to get students thinking about science, technology, maths and engineering. Our activities are perfect for teaching young students new things while they're away from the classroom, as well as keeping them occupied when lockdown boredom strikes!

We believe it's important to encourage students to become curious about STEM learning. Our recent collaboration with the Science Museum and our flagship STEM project, the Quadcopter Challenge, are just a couple of ways that Raytheon have helped to inspire kids outside of the classroom. We hope our STEM booklet is a small help at this challenging time too.



MEET RAYTHEON UK'S ENGINEERING DIRECTOR

Dr Alex Rose-Parfitt

In January 2017, Dr Alex Rose- Parfitt joined Raytheon UK as Engineering Director. As a technologist through and through, he is responsible for the Engineering function across Raytheon UK, encompassing England, Scotland, Wales and Elcan (Canada).

We caught up with Alex, who is the Executive STEM sponsor and an ardent STEM Ambassador, to discuss his career and the importance of STEM from a young age.

Why is STEM important to you and the wider community?

STEM stands for Science, Technology, Engineering, and Mathematics, a group of subjects that influence everything that we do. For me, it is important that we raise the awareness of STEM from a young age, as today's young people are the innovators and engineers of tomorrow. We need to ensure that we continue to support the understanding of these subjects through fun and interactive learning, like those included in this booklet.

By engaging in these interesting experiments, you will hopefully start to see the links between the different subjects and ultimately how they can develop a highly transferable set of skills, a way of problem solving and collaborating, which is central to what we do at Raytheon UK.

STEM is the foundation to a vast array of different careers across multiple types of industries. However, the UK has a critical skills shortage, with 73% of businesses stating that it is increasingly more difficult to hire staff in the last 12 months, and an estimated 173,000 vacancies require a background in a STEM subject.

How did you get into a STEM-based career?

After finishing my PhD, I joined the Materials Department of BAE Systems Advanced Technology Centre; I nearly did not turn up to the interview as recruitment had sent me the wrong job description. However, I had never had a proper interview, so I thought it would be a good experience even if I was not a particle physicist. Needless to say, I got the job and within six years was leading the Materials Division across three sites.

What is something you're proud of since becoming the Executive STEM sponsor?

Raytheon UK was recently recognised by STEM Learning as the Inspirational STEM Employer of the Year at the STEM Inspiration Awards, which was a great achievement. One of the factors contributing to this is the work we are doing to actively promote more females in engineering, with over a third of our amazing STEM ambassadors being female. There's still more work to be done, however it is a great step in the right direction!

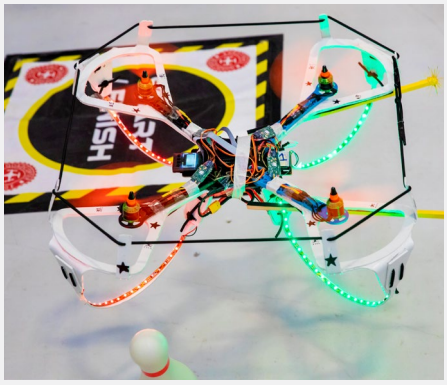
WHAT IS A STEM AMBASSADOR?

We know the importance of encouraging and supporting the next generation of STEM learners and helping to support future generations preparing to enter the UK workforce. That is why each year Raytheon UK invests in a variety of programmes to help cultivate the knowledge and valuable STEM skills that can support and inspire the next generation.

Our STEM ambassadors are integral to helping the business promote STEM learning and careers to students across the UK. They work with a number of our partners, including local and national charities, schools and universities to host a range of different events, including our flagship programme the Quadcopter Challenge.

Our Quadcopter Challenges enables students from up and down the country to design, build and remotely pilot a four-blade drone. The programme helps students to get hands-on experience with project management, presenting skills, design, engineering techniques and aerodynamics, and gain an insight into the real-world applications of STEM.

Our ambassadors also work to support the Royal Air Force (RAF) Engineering Competition to ensure the future pipeline of engineers, as well as working with universities to provide cyber workshops and coding classes to help tackle the shortage of cybersecurity professionals. We also support partners, such as the Science Museum and the RAF Museum, to host fun and innovative exhibitions that show the importance of STEM in everyday life.



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Learn about: Aerodynamics

HOW TO MAKE A PAPER PLANE

Easy to make and fun for all the family, follow our simple instructions on how to build the perfect paper airplane and watch it glide all day long!

You will need:

Paper (it's as simple as that!)

What to do:

1. This is an easy step. Just fold an A4 sheet of paper in half down the centre, and then open it up again so that it lays flat.
2. Fold the cockpit of your paper airplane so that the flap corners meet at the centre line.
3. Fold the cockpit down so that the point lines up with the centre fold line.
4. Fold your second cockpit by folding your two flaps down like the 2nd step.
5. Fold another two flaps down to the centre of the plane. Starting to look like a real paper airplane yet?
6. Flip the airplane over and fold each side in to line up with the centre fold of the plane.
7. Flip the plane over one last time and open up the folds so that you have the 'body' of the plane to hold on to.
8. You are now ready for a test flight. To fly well, fly inside and throw as hard as you can (careful not to crash into anything or anyone!).
9. Once completed, send a picture of your paper airplane to ForwardSteps@raytheon.co.uk

https://www.instructables.com/id/how-to-make-the-fastest-paper-airplane/

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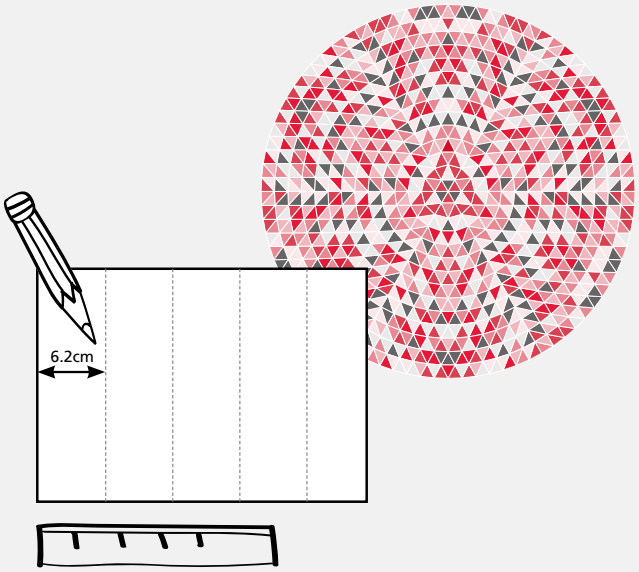
Learn about: Laws of reflection

HOW TO MAKE A KALEIDOSCOPE



Kaleidoscopes create changing patterns when a tube containing mirrors and pieces of coloured glass or paper is rotated.

Recommended for years 3 and above

You will need:

- A Pringles tube
- 2 Pringle tube lids
- A handful of transparent coloured sweet wrappers (or a set of coloured Sharpies)
- An A4 sheet of mirror card (or shiny silver card)
- Coloured card/paper/spray paints to decorate the outside of your kaleidoscope

What to do:

1. First, ask an adult to use a sharp knife to remove the end of the Pringles tube.
2. Next, take your piece of mirror card. Usually, the A4 card is the same width as the length of the tube - result!
3. Using a pencil and ruler, lay the card out so it's landscape (see pic) and mark every 6.2cm. Draw lines across the width of the card and cut with scissors. Fit your mirror panels into the tube (shiny side inwards) to make sure they fit nice and snug.
4. For this step, you've got several options:
   A. Use coloured marker pens to colour shapes and patterns on one plastic tube lid
   B. Glue and stick pieces of coloured transparent sweet wrappers onto the tube lid
   C. Glue dried flower petals onto the tube lid
5. Allow time to dry and fit the cap on the end of the tube. Hold it up to the light and twist the lid to see the kaleidoscope in action!
6. Once completed, send a picture of your kaleidoscope to **ForwardSteps@raytheon.co.uk**

https://www.instructables.com/id/Quick-cheap-and-easy-Kaleidoscope/

MEET OUR STEM AMBASSADOR

Stephanie

1. How do STEM subjects fit into your role at work?

My job as a test engineer is to find the things that are broken, fix them and make sure they don't break again. We need to make sure we stay ahead of competitors with the most up-to-date technology that's available. We create, design and engineer new solutions to problems to make sure we avoid them in future.

2. Have you found STEM working in unexpected places?

A lot of people find maths boring, but I find it fascinating. Once you learn how numbers fit and work together, you'll find that maths shows up in everything. Maths is money, time, logic, planning, and probability; maths isn't just numbers. Being good at maths gives you a massive advantage in life. Learn how to plan your time and manage your money.

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

Do what you enjoy. If you enjoy the work that you do, you will never have to work a day in your life.

4. Who is your STEM inspiration or role model, and why?

Matt Parker, the Numberphile. He has an excellent YouTube channel and writes hilarious books. He teaches maths in a funny way and makes it exciting and memorable. He often tours the country doing roadshows, so it's worthwhile watching out for him in your nearest city.

Learn about: Spelling

RAYTHEON UK STEM WORD SEARCH

What was your score?

14

Can you find the words we associate with STEM at Raytheon UK? Some are our key activities, others are our key events and some are how STEM outreach makes us feel!

N	D	E	A	I	E	C	E	A	L	N	R	C	I
N	R	T	M	O	C	O	U	D	W	B	E	C	C
S	O	E	B	I	N	D	E	R	I	P	S	N	I
S	N	A	A	E	E	H	A	I	R	S	H	O	W
K	E	M	S	R	I	H	R	P	R	K	E	L	L
I	S	W	S	S	C	K	H	S	R	B	S	E	E
L	A	O	A	S	S	R	E	Q	T	O	R	Y	A
L	F	R	D	S	E	I	B	U	C	E	U	A	R
S	E	K	O	C	U	E	R	A	B	E	M	D	N
E	T	T	R	P	Y	B	N	Y	A	T	A	D	I
S	Y	U	B	N	D	L	C	I	O	Y	I	P	N
N	O	I	T	A	R	O	B	A	L	L	O	C	G
C	O	D	C	O	M	M	U	N	I	T	Y	E	A
A	S	B	T	L	R	N	B	O	E	O	N	M	E

STEM
SKILLS
SCIENCE

AMBASSADOR
TEAMWORK
AIRSHOW
COLLABORATION

COMMUNITY
INSPIRED
CUBIES
PROUD

CYBER
DRONESAFETY
LEARNING

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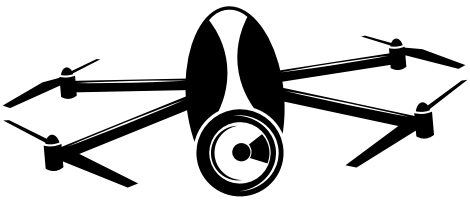
RAYTHEON UK STEM QUIZ

1 **What type of electromagnetic radiation waves are used to cook food quickly?**

- ☐ Radio Waves
- ☐ Microwaves
- ☐ Infrared Waves
- ☐ X-Rays

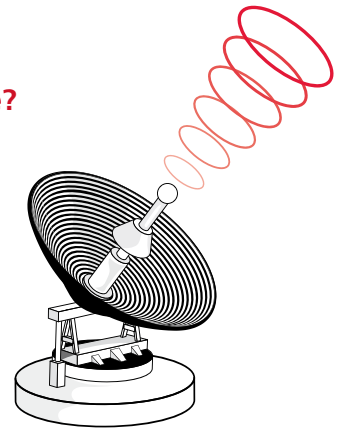
2 **How many parts make up <u>one</u> of the quadcopters we teach students to build in the Quadcopter Challenge?**

- ☐ 27
- ☐ 749
- ☐ 246
- ☐ 312



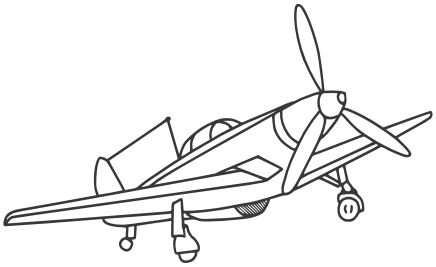
3 **Raytheon's radars monitor how much of the worlds' airspace?**

- ☐ 2/3
- ☐ 1/2
- ☐ 3/5
- ☐ 7/8



4 **Which of the following travels the fastest?**

- ☐ A car
- ☐ Sound
- ☐ An aeroplane
- ☐ Light



Raytheon UK

5 **Raytheon built the guidance system for the Apollo Mission, but where was the mission heading to?**

- [ ] Scotland
- [ ] Space
- [ ] The Sea
- [ ] South Africa

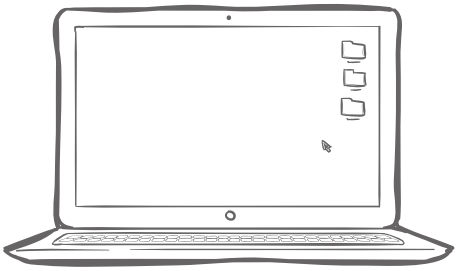
6 **Raytheon has almost how many STEM ambassadors?**

- [ ] 200
- [ ] 150
- [ ] 300
- [ ] 50

7 **How many propellers are there on a quadcopter?**

- [ ] 2
- [ ] 4
- [ ] 26
- [ ] 8

8 **Our LED cubes are programmed using an example of what?**



- [ ] Hardware
- [ ] Underwear
- [ ] Software
- [ ] Firmware

What was your score?

/ 8

Answers: 1) microwave 2) 246 3) 2/3 4) light 5) space 6) 200 7) 4 8) software

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MEET OUR STEM AMBASSADOR

Lewis

1. How do STEM subjects fit into your role at work?

As a project manager, it allows you to have a better grasp of the technical aspects within the programme; enabling you to understand the top-level detail better, which gives you more confidence in conversations, meetings and reviews with senior management.

2. Have you found STEM working in unexpected places?

I use engineering in everyday life - and I am always looking at things and how they can improve! I also look after the family cars and my motorbike.

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

Absolutely go for it! Even if you think a career in STEM is not for you, after your university or college course, you then have a highly respected qualification that will open up a lot of other opportunities. STEM qualifications are one of the most sought after for employers of all kinds.

4. Who is your STEM inspiration or role model and why?

My dad, who's a licenced aircraft engineer for many aircraft types, but he currently looks after a Gulfstream IV. I'm lucky enough to have my role model within the family and pushing me to improve. My childhood involved a lot of air shows and STEM-type events, joining the Air Cadets and whenever off school I would go to work with my dad and be in his shadow. This then extended to the family cars, getting my hands dirty and learning to service them.

Learn about: Addition

PIG

This is a game for two or more people. It is good practice for addition skills up to 50.

You will need

Two dice

Rules

Player 1 rolls the dice as many times as he/she likes, adding up the total as he/she goes.

If a 1 is thrown, the score for that turn is lost.

DON'T ROLL A 1!

The player may stop at any time and put his/her score in the bank the banked score can not be lost.

When a score has been banked the die is passed to the next player.

The winner is the first player to reach 50 or more.

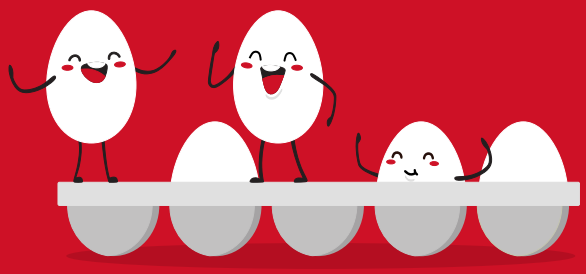
http://www.mathsphere.co.uk/downloads/board-games/board-game-11-pig.pdf

Learn about: Force, momentum and pressure

EGG DROP

All the family can join in this fun-for-all-ages activity, where you can engineer a protective case for an egg to drop from a height to avoid it breaking!

Recommended for all ages



You will need:

You can use anything you want! Listed below are just some examples of materials you could use.

- Eggs
- Cardboard tubes
- Newspaper
- Old boxes
- Paper
- Tape, glue, rubber bands
- Lollypop sticks
- Straws
- Feathers

Instructions

1. Sketch out a design which protects your egg if dropped from a height. Gather all the materials you will need to make the container. If you can, split into two teams.
2. Build your container with the materials you have collected and place the egg inside. Make sure it is secure to ensure your egg doesn't crack on the first drop!
3. Before you begin the egg drop, use the record sheet to keep score of your designs.
4. Place your egg into your container and find a height that you can drop your egg from. (Note: put some protective flooring down such as newspaper or bin bags to gather the egg in case it breaks)
5. Get one person to drop the egg from the height you have chosen and then have another at the bottom, checking if the egg is still intact. Continue to do two more drops to test whether your container remains an excellent protection for the egg!
6. Finally, send in your images of your designs and containers to ForwardSteps@raytheon.co.uk

https://buggyandbuddy.com/stem-kids-egg-drop-project/

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Name of individual/ team	Will their contraption protect the egg? Yes/No	Why/ why not?	Was your prediction correct?

MEET OUR STEM AMBASSADOR

Emma

1. How do STEM subjects fit into your role at work?

Working for a defence company means working very closely with engineers to understand what products do. But it is also common to use other STEM subjects on a daily basis. Examples include using maths to understand the price of materials and technology to plan projects for customers.

2. Have you found STEM working in unexpected places?

I recently joined the STEM team at Raytheon in delivering the Quadcopter Challenge across the UK. School teams are given quadcopter parts, guidance for designing/building it and fly days to practice before the finals. I never expected to be using problem solving and logic to inspire students and help them build and fly quadcopters!

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

As with anything you study or follow a career in, I think it's really important to like the subject and enjoy it! I studied Biology at university and found it interesting, especially doing experiments and learning about why animals behave in strange ways.

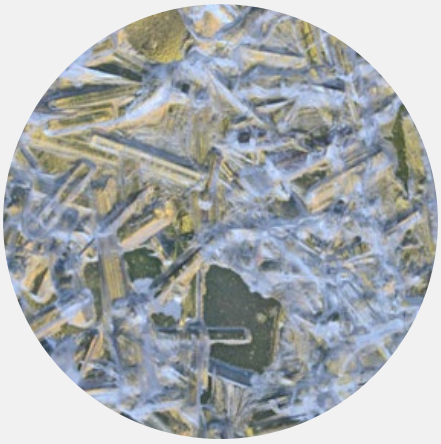
My experience of a STEM career is that jobs are very different and exciting. I've worked on a nature reserve in South Africa, led volunteers on an ethical trail through South East Asia and rescued sea turtles in Greece. A STEM career gives you the tools and skills to adapt to change, offers you the opportunity to do an unusual job and connects you with diverse and brilliant people.

4. Who is your STEM inspiration or role model and why?

My dad is both my STEM inspiration and a big role model for me. He studied Mathematics at university and went onto work as an accountant in a large business. His dedication, logical mind and amazing problem-solving skills have enabled him to succeed and become a well-respected leader. He always encouraged me to do my very best, follow my passion for science and see the positives in every situation (no matter how bad or difficult).

Learn about: Crystallization

HOW TO MAKE A CRYSTAL SUN CATCHER



For beginners, make rainbows with a beautiful crystal sun catcher!

Recommended for years 6 and above

You will need:

- Epsom salt
- Clear recycled plastic lids – use the clearest you can find
- Water
- Empty jar
- Bowl or glass measuring cup
- Fork
- Microwave (optional)
- Tray
- String
- Pin

What to do:

1. You will be using a ratio of 1:1 water to Epsom salt for this project. Add 1 cup of Epsom salt to an empty glass jar.
2. Add 1 cup of water to a microwave safe bowl. Heat the water in the microwave for 45 seconds or alternatively use very hot tap water and skip the microwave. (Ask an adult for help!)
3. Pour the water into the jar with the salt. Do this quickly so the water is warm. Stir the salt and water for 1-2 minutes and watch the salt dissolve.
4. Place several plastic lids on a flat-bottomed tray in a sunny location where they can remain undisturbed.
5. Pour off some of the excess liquid from your jar/crystal garden into the recycled plastic lids. Use just enough to cover the bottom of the lid. Do not overfill!
6. Place your lids in sunny location. Depending on how much liquid has been added it will take a few hours or a day to start crystallizing. It may look like the lid is full of water at first but be patient!
7. When the liquid has completely evaporated your crystal sun catcher is ready - you will be able to see lovely crystal structures from both side of the lid.
8. Ask an adult to carefully poke a small hole in the edge of the lid and thread a piece of string through the hole. Tie in a knot and hang your sun catcher up!
9. And finally…
   send an image of your sun catcher
   ForwardSteps@raytheon.co.uk

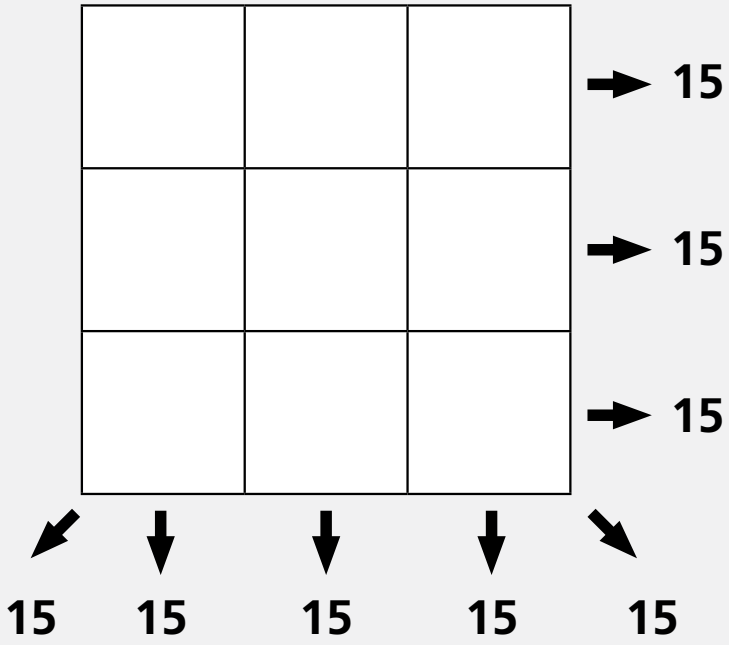
https://babbledabbledo.com/science-kids-crystal-suncatcher-craft/

photo ©babbledabbledo

Raytheon UK

Learn about: Problem-solving

CAN YOU SOLVE THE MAGIC SQUARE?



Every row adds up to 15

Every column adds up to 15

Every diagonal adds up to 15

HINTS

	9	
	5	7

	9	
	5	
8		

Solution on the next page

Raytheon UK

SOLUTION

4	9	2
3	5	7
8	1	6

Can you find any other solutions?

MEET OUR STEM AMBASSADOR

Laura

1. How do STEM subjects fit into your role at work?

Being an engineer is one of the core careers for STEM. It's super valuable as engineers build societies! Engineers have built everything around you in one way or another and without them society would not be what it is now. As an engineer all the STEM subjects help me to do my job. We use our knowledge of science, engineering and mathematics to create new technologies everyday.

2. Have you found STEM working in unexpected places?

What part of society you contribute to determines how much you exercise these skills. If you're working in finance you use mathematics and technology to create all sorts of ways to do your job better. You wouldn't think technology is a big part of finance but it is. Using excel, databases or other tools allow finance workers to do their jobs easier. Another example is journalists. You wouldn't think journalists use many STEM subjects but they do. Imagine the technology tools they would need to create their stories. Video and audio editing, computer applications, website design, the list goes on.

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

My path to engineering was not quite a straight road, but I got there in the end. I took all my GCSE's which included Maths, Science, English and Information Technology. I went on to do A-levels in Physics, Maths and Computer Science. From there I did a Bachelor of Engineering at Surrey University in Electronic Engineering and Space Systems. Then I did a Masters of Science in Astronautics and Space System Engineering. If you want to be an engineer, you can start as an engineering apprentice and learn and get paid at the same time. The main things to start with is maths and science at school. From there, you can do anything as an engineer.

4. Who is your STEM inspiration or role model, and why?

From a young age, I don't think I had a STEM inspiration or role model. I didn't have STEM clubs or anything like that, so I had to find out my own path and what I was passionate about. This is why I am so glad students have industry and organisations promoting STEM so they can learn about what opportunities are out there. Although later in life I found the inspirational stories of astronauts and scientists a true inspiration.

Learn about: Virtual Reality (VR) technology

TAKE PART IN AN EMOJI SCAVENGER HUNT

Identify emoji's in the real world with your phone's camera

Recommended for years 9 and above

Emoji Scavenger Hunt is an experiment that leverages the power of neural networks and your phone's camera to identify the real world versions of the emojis we use every day.

The aim of the game is to progress to as many levels as you can, by finding the real-life item displayed on your phone as an emoji.

Simply click on the below link to launch the experiment and find out your code.
https://experiments.withgoogle.com/emoji-scavenger

Happy emoji hunting!

https://emojiscavengerhunt.withgoogle.com/

Raytheon UK

Learn about: Programming

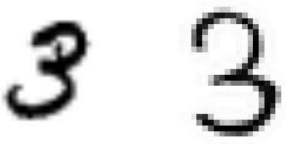
MACHINE LEARNING REAL OR NOT REAL

When we want computers to do something, we usually tell them how by giving them a specific set of actions to take. This is called programming.

Machine learning is a bit different - if we want a computer to learn something for itself we need to show it lots of examples of things and then it can learn from what it sees.

In this quiz, we've asked the machine to generate its own pictures. It's been shown lots of images and then created some new pictures for us. Can you tell which is the real one and which has been generated by a computer? (Answers at the end)

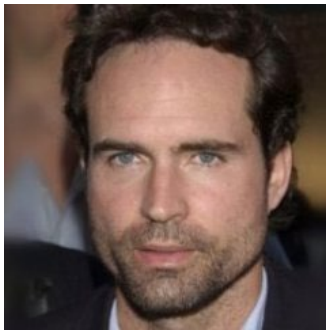
1 Let's start simple – Which of these numbers was drawn by a computer?



2 Which of these paintings is by Van Gogh?

3 Okay, what about birds? Which one is real?

4 Celebrities – One column includes the real actor, and the other includes a fake, but which one is the fake?



5 Food – This one is much harder – all of these burgers are real, except one... but which one?

Images sourced from:
https://arxiv.org/abs/1809.11096
https://arxiv.org/abs/1710.10196
https://arxiv.org/abs/1612.03242
https://arxiv.org/abs/1703.10593

Answers 1) b 2)a 3)a 4)b 5) Top Left

MEET OUR UK'S STEM LEAD

Sophie

We caught up with Sophie, Programme Manager at Raytheon, who leads the company's STEM programme across the UK to find out why she got involved in helping Raytheon promote STEM learning and careers.

Why did you get involved with STEM at Raytheon?

Initially, I got involved with STEM as it offered so many opportunities to attend exciting events and I met an array of interesting people from different sectors, but I found it to be so much more.

STEM opens up so many doors from a career perspective, for instance, I'm in charge of several multi-million-pound engineering programmes that support the Royal Air Force, I've visited lots of cities across the UK to attend a variety of events and met some fascinating and intelligent people, and I've watched the Red Arrows fly overhead at air shows for the past 3.5 years (and still don't get sick of it!).

Why do you think it is important that companies like Raytheon support STEM learning?

I don't think a lot of people realise how exciting STEM can be - I know I certainly didn't until I started working for Raytheon.

There are thousands of roles out there that give you the opportunity to travel, work on projects (ones that often make history) but more importantly give your job satisfaction day after day.

There is currently a huge skills shortage in the UK for specialist STEM roles. If those roles go unfilled, the industry will be unable to fulfil their contracts and support their customers, some who often play critical roles in our everyday lives whether that be in the defence, energy or health sectors. Although the Government do what they can to support STEM, it's essential for companies, like Raytheon, who have roles that require specialist STEM skills, to help inspire young people to get into STEM. We provide a programme of STEM activities at Raytheon to showcase the type of things anyone could do by following a STEM career path with the right education and training. We want to showcase that STEM is for everyone, and there are no barriers to a very exciting career in STEM.

Raytheon UK