Reaction Engines

STEM Adventures

ENGINEERING AND STEM ACTIVITIES FOR YOUNG MINDS

At Reaction Engines we use our knowledge of rocket science to improve technologies used on Earth and create technology to help access space. We are experts in removing heat from aircraft, motorsport cars, electric vehicles, and much more. We have put some activities together so that you could try out using some of the key engineering principles, logic, and sciences we use every day at work.

Once you complete some of these activities, you'll be an engineer or scientist already!

1. Binary Blast! A Computer Coding Challenge
2. Chemical Rockets Experiment
3. Newton's 3rd Law Experiment
4. Shape Your Imagination with Tangrams
5. Open the Lock Puzzle

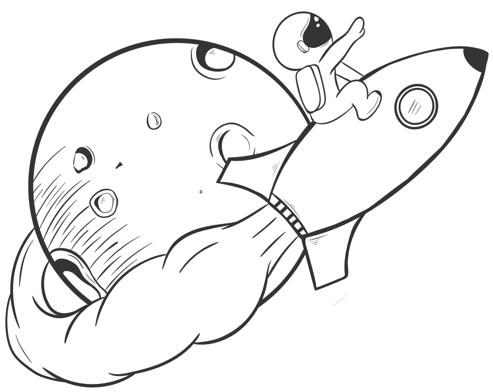
Binary Blast!

Computer coding is a huge part of STEM and it is what creates all the software, apps, and websites we use every day. When using any computer programme, we don't even consider what computers do in the background.

In fact they use a language called binary to perform any tasks.

This language consists of only 1's and 0's and combinations of these two numbers form letters and even numbers!

One of the most famous computer scientists in history is Margaret Hamilton. Back in the 1960s, amongst many other interesting programmes, she lead the development of the onboard flight software for Apollo mission that took humans to the Moon.



Let's learn how to tell a computer what our name is!

Binary Alphabet for capital letters (note – lower case letters have different binary symbols)

A	1000001	N	1001110
B	1000010	O	1001111
C	1000011	P	1010000
D	1000100	Q	1010001
E	1000101	R	1010010
F	1000110	S	1010011
G	1000111	T	1010100
H	1001000	U	1010101
I	1001001	V	1010110
J	1001010	W	1010111
K	1001011	X	1011000
L	1001100	Y	1011001
M	1001101	Z	1011010

Use the first column to write your name vertically in standard alphabet and then use the remaining columns to code your name in binary. You can either write 1's and 0's or choose two colours to represent these and colour the squares accordingly. You are a computer scientist now!

A	1	0	0	0	0	0	1
B	1	0	0	0	0	1	0
B	1	0	0	0	0	1	0
E	1	0	0	0	1	0	1
Y	1	0	1	1	0	0	1

Letters of your name	**Each letter in binary code**						

If you have any beads and string, you can also make a bracelet of your initials in binary code. You will need beads of two different colours for 0's and 1's – lay them out in order to represent the first letter of your name and then the first letter of your surname and thread them onto a string.

Chemical Rockets

Believe it or not, we can all be rocket scientists! With this activity, you will create a chemical rocket (similar in operation to that used by NASA) using only domestic products.

<u>Materials Required</u>

Plastic 'Sipper' bottle (0.4/0.5l)
Citric acid
Sodium bicarbonate
Kitchen roll
Water
Large mug

<u>Facilities</u>

This outdoor activity requires a healthy amount of space for launching the rockets (preferably 10m x 5m), and a table for the assembly of the components for experiment. Warm water is advantageous for the endothermic reaction, but cold water will suffice. A mug is recommended to house the launching rockets, minimising both mess and uncertainty in their trajectory direction.

Chemical Rockets

1 Mix your ingredients.

Mix 1 tablespoon of citric acid with 1 tablespoon of sodium bicarbonate (for further experiments you can also try higher and lower amounts of each of these with the equal amounts of each, or you could experiment with different ratios – see how your rocket behaves then!). Use a dry bowl for that.

2 Test your rocket powder

Test out your 'rocket powder' by putting a small amount of it into a bowl of water – it should start fizzing immediately. Take your time doing these tests as they are loads of fun for kids (and adults!).

3 Gather materials

Lay a piece of kitchen roll on a table and put the rocket powder you made in the middle of the sheet.

4 Make your structure

Roll the sheet with the powder inside it into a cylinder and fold one end so that you could hold the powder inside the paper without it falling out. This paper structure will stop the powder from getting wet long enough for you to put the lid on before the rocket shoots off!

5 Fill with water

Fill your plastic sipper bottle to about a third with water. It is important to leave some air inside the bottle for the pressure to build up, you also don't want too much water as the rocket might be too heavy to lift off.

Chemical Rockets

6 Fuel up

Put the fuel load (powder in the paper) inside the bottle and, if you can, avoid it getting wet.

7 Prepare to launch

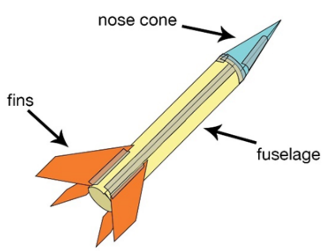
Close the sipper lid and put the lid on tightly. Now get ready to launch! Shake the bottle and put it upside down in the mug. Tilt the bottle in the direction you want it to fly. Pressure should build up inside the bottle and thus open the sipper lid and thrust the rocket into the air.

8 No launch?

If the rocket hasn't launched, carefully pick it up and pop the sipper lid open – the rocket might still launch. If not, try a different amount of powder and water.

9 Congratulations!

You're now officially a rocket scientist! Reuse the bottle for future launches – simply empty the bottle of paper and water and repeat all previous steps. You can also redesign your rocket to make it more stable or aerodynamic - for instance, trying out sipper bottles of different shapes or adding some additional body features to the rocket such as fins or nose cone seen in the image and observing the effect it has on the speed and operation of your rockets.



Newton's 3rd Law

This experiment shows Newton's Third Law in practice – all forces come in pairs.

<u>Materials Required</u>

2 skateboards Rope	Or	2 pairs of roller skates Rope

Facilities

This activity requires a flat and level surface, preferably with low friction. The amount of space required is not large (approx. 2m x 5m).

Newton's 3rd Law

What is Newton's 3rd Law?

Newton's third law states that if one object exerts a force on another object, then that other object must exert a force of equal magnitude and opposite direction back on the first object. This law represents a certain symmetry in nature: forces always occur in pairs, and one body cannot exert a force on another without experiencing a force itself. An example of this is throwing a ball to a wall – it will bounce off immediately. This is because the force with which the ball hit the wall (action) causes the wall to 'hit' the ball back with equal force (reaction), but in the opposite direction - the ball bounces back off it. Even a simple example of accidentally tripping and falling to the ground can illustrate this law. You have just hit the ground quite hard and the reason it hurts is because the ground 'hits' you back with an equal force. This law describes the fact that every interaction between two bodies results in pairs of forces between the two interacting bodies. Think about other such examples you've seen before – you are sure to have many!

This is especially relevant to rocket science. Conventional rockets carry fuel and oxidizer on board. The combustion chamber (the part of rocket engine where 'explosion' happens) mixes these two under a high pressure which results in a chemical combustion reaction. The product of combustion is gas which is exhausted (pushed out) from the back of the rocket. Since the rocket exerts a force on the gas by pushing it out, the gas exerts an equal force on the rocket but in the opposite direction and thus propels it to space.

Activity

Two people simply sit on two opposing skateboards, or wear roller skates, holding an end of a rope each. First experiment is for one person to pull the rope and see where both people meet. Then try again but switch who is pulling on the rope. The second experiment is for both people to pull the rope (on each end). Both pull simultaneously and see what happens again!

Shape Your Imagination

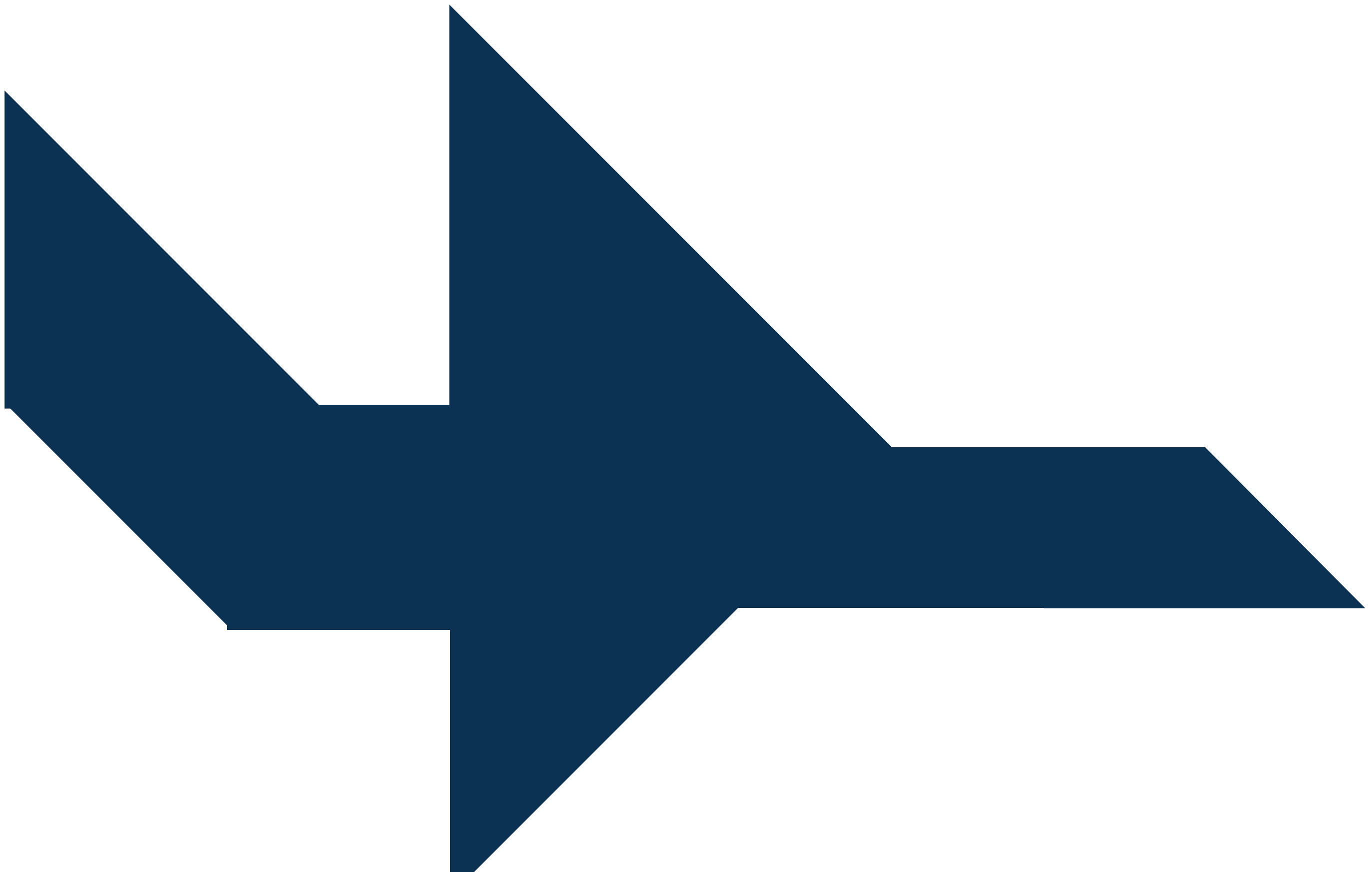
Have you ever thought about how engineers design things big and small? From cars to airplanes to rockets, you might be surprised to learn it's not just about maths and science. Imagination and problem solving plays a big role!

Imagination is the ability to visualise things that don't exist yet and it's an important part of the engineering process. Engineers use their imagination to come up with creative solutions to problems and to think outside the box.

A tangram is a puzzle that can help you use your imagination and problem solving skills. There are seven shapes, or "tans", that you can arrange to create different pictures.

We've made some shadows for you to fill in and figure out how the shapes go fit together without overlapping.

When you've learnt how to make these shapes, use your engineering imagination to see what else you can create!



Can you open the lock and find the prize?

? ? ?

6	7	5	One number is correct and in the right place
8	0	3	One number is correct but in the wrong place
5	1	8	Two numbers are correct but in the wrong place
9	4	7	Nothing is correct
3	7	2	One number is correct but in the wrong place

And the answer is: 285