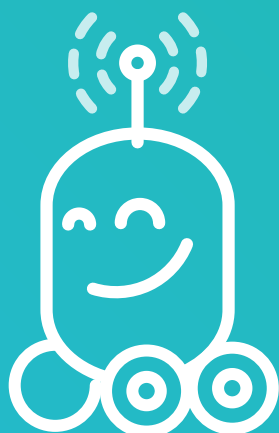




Science of the Future



Theme of the Lesson

This lesson looks at robots, how they learn, and how they can be used. We look at how a chemical reaction can be used to launch a small rocket and talk to a NASA datanaut about how STEM skills and subjects are used to launch real rockets. We end with a bang as Mark demonstrates a supersized physical reaction.

Curriculum Links

Strand: Materials: Energy and Forces; Environmental Awareness and Care

Strand Unit: Properties and characteristics of materials; Materials and change; Forces: Science and the Environment

Curriculum Objectives:

- Recognise that materials can be solid, liquid or gaseous
- Investigate how materials may be changed by mixing
- Explore the effects of heating and cooling on a range of solids, liquids and gases
- Explore how objects may be moved
- Recognise the contribution of scientists to society
- Appreciate the application of science and technology in familiar contexts

Background Science

Robots

A robot is a device that uses sensors to analyse different features of the environment, and then uses this information to make decisions. Some devices that we use every day are actually robots. A washing machine, for example, can sense the amount of clothes and adjust the amount of water to complete the job. We also have robot vacuum cleaners, robot lawnmowers and lots of other devices. Some are simple robots that are designed to perform a small number of functions while others are more complex and can perform lots of different functions. Street lights can have sensors built into them so they can sense when it is dark and turn on automatically. Some traffic lights monitor traffic flow and speeds and use this information to decide when to change.

Some robots can process information quickly and perform tasks very well, but they are working on information that is given to them and performing tasks that they have been programmed to perform. While robots can perform some tasks much quicker than humans, the human brain is far more complex than any robot and we can learn and

adapt and perform a wide range of different skills.

Robots with artificial intelligence or AI have been designed so that they are able to use information to learn new things.

Some companies around the world are making robotic self-driving cars which have lots of different sensors to tell them about roads and road signs, traffic, people, and other objects so that they can make decisions and drive themselves. Self-driving cars in Ireland would have to deal with Irish Road conditions so it is good that a team in NUI Galway are doing some research. Delivery drones are another example of artificial intelligence.



Studio Experiment

In the studio experiments, Mark demonstrates a chemical reaction. A chemical reaction occurs when two or more different substances mix and form a new substance. A chemical reaction cannot be reversed. In this case the reaction is between vinegar (acetic acid) and bread soda (sodium bicarbonate – a base). When mixed, the two materials react with each other to form carbonic acid which quickly breaks down to carbon dioxide and water. As the gas is produced, it causes the liquid to bubble up.

When we produce this chemical reaction in a bottle with a balloon over the top, the carbon dioxide gas that is produced fills the bottle. It displaces the air that was already in the bottle pushing it upwards into the balloon and then as more carbon dioxide gas is produced, there is enough to inflate the balloon.

The same chemical reaction can be used to launch a rocket made from a small upside down plastic bottle. As the chemical reaction occurs and carbon dioxide gas is produced, the cork is expelled from the neck of the bottle. This downward force causes an opposite force on the bottle which forces it upwards. This is an example of Newton's Third Law of Motion – for every action, there is an equal but opposite reaction. This is similar to what happens in a real rocket except in that case the chemical reaction is a combustion reaction when the rocket fuel is burned.

Supersize Experiment

The supersize experiment makes use of a different type of reaction. In this case, it is a physical reaction where extremely cold liquid nitrogen is mixed with hot water causing it to quickly change back to a gas. In the case of a physical reaction, no new substance is formed, and the reaction can be reversed.

Some of the physical reactions we are most familiar with are the changes of water from a liquid to a gas (evaporation), a gas to a liquid (condensation), a liquid to a solid (freezing) or a solid to a liquid (melting). Water boils at 100° Celsius and freezes at 0°C. Nitrogen gas which makes up 78% of the atmosphere can also exist in liquid form but it has to be cooled to below – 195°C to become liquid.

Equipment and Tips

for conducting the Studio Experiment in your school

Mark performs two simple studio experiments that can easily be carried out with your class. The first one can be done in the classroom but the second should be done outdoors where there is plenty of space. If you want to be ready to carry them out after watching the video you will need to collect the following equipment.

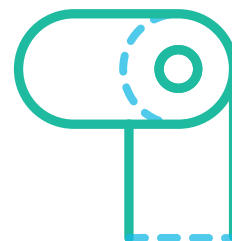
For the first part, you will need:

- Small plastic or glass bottle
- Vinegar
- Sodium bicarbonate (sold as bread soda or bicarbonate of soda)
- Balloon
- Teaspoon
- Small funnel
- Basin or tray

Note: This works very well as a group activity with each group of children having a set of equipment. Make sure to clear all books off the table and place everything in a basin or tray to contain any spills. A teaspoon and a small funnel can be used to put the sodium bicarbonate into the balloon, or a funnel can be made out of a small semicircle of paper. For a 500ml bottle, 100ml of vinegar and one teaspoon of sodium bicarbonate will produce enough Carbon dioxide to inflate an average balloon.

For the second part, you will need:

- Small plastic bottle
- 3 lollipop sticks (or paper straws)
- Tape
- Toilet paper
- A cork that fits tightly into the neck of the bottle
- A paper cone (if wished) to make it look like a rocket – can be made from a semicircle of paper
- Safety glasses for whoever is doing the launching.



Note: For safety reasons, this part is probably best done as a demonstration with one rocket being launched rather than multiple rockets. A similar but less dramatic reaction can be done with effervescent vitamin tablets and water in an empty tablet container. In this case, sodium bicarbonate is already mixed with dry citric acid powder in the tablet and the addition of water causes them to react with each other.

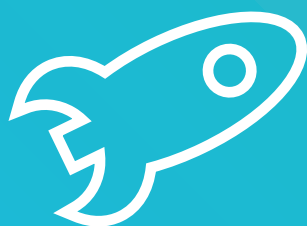
Tips for Further Investigations on Rockets, Reactions and Space

Use the Lesson Plans to help your class with brainstorming ideas and coming up with a question. Remember that the children may start out with very broad ideas around questions but working through the steps in the lesson plans will help them to refine it down and come up with a testable question. The children will be more invested in their project if they are investigating a question that they developed as a class rather than one that was set by the teacher although you might want to narrow it down to ideas based on a particular theme. They may do some smaller investigations on the way towards refining their project idea and the finished project may be quite different from the original idea, but this is all part of the process.

There are lots of ways to carry out a project. It might involve a fair test investigation, some gathering of data or even a design and make project. Remember to encourage the children to make predictions and to think about the best way to record and communicate their results. Encourage them to make use of maths where appropriate. As a datanaut, **Fionnghuala O'Reilly** spoke about the importance of maths in science investigations. She also spoke about the importance of creativity and collaboration

The themes in this episode could provide lots of inspiration for project ideas:

- Children could investigate the forces used to launch different types of rockets. www.primaryscience.ie has lots of inspiration for different investigation relating to rockets and there are lots of different variables that could be explored in launching a rocket.
- The children could investigate lots of questions related to travelling, eating and drinking in space, www.esero.ie has lots of inspiration for space themed investigations.
- There are lots of robotics themed programmes available to primary school pupils such as Beebots, Lego and Vex robotics. Children might discuss all of the different places they have seen robots in operation. Children's question might relate to the functions that a robot can perform, and they could investigate ways to design and make a robot. They might try to design and make a robot arm like the one used on the International Space Station.



Linkages

The children will obviously be spending some time on their ESB Science Blast project but remember that this is time well spent. They will not just be doing Science but depending on the project theme, it can cross over into lots of other subjects and become the focus for cross curricular work. There can also be linkages with other projects such as the SFI Discover Science and Maths Awards, Active Flag or Green Flag. Some possible linkages:

- **Language:** Written and oral language skills through recording and communicating about their project. **Fionnghuala O'Reilly** used her science communication skills to educate and inform people about the recent Mars mission..
- **Maths:** Data collection, recording of results, tables, graphs, calculations
- **History:** The history of space flight or the history of robotics.
- **Geography:** Planet Earth in Space.
- **PE:** Mission X: Train like an Astronaut (www.nasa.gov/tla).



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