Born to Engineer teaching resources

Teachers' notes –

# Bubbles

## Curriculum links

This lesson focuses on the use of bubbles to deliver drugs to cancerous tissue. The science of bubbles is complex, as can be seen in some of the video references. However, this lesson is appropriate to students aged 12 to 14, as an aspect of states of matter.

The properties of different states of matter feature in the science programmes of study: Key Stage 3 (2013) in the chemistry section under 'The particulate nature of matter'.

States of matter appears in the Scottish N3 Chemistry curriculum under 'Chemical structure'.

This resource would also work well as a science club activity.

## The science of bubbles

Dr Eleanor Stride is developing a treatment for cancer that encloses cancer-treating drugs in bubbles that can be directed by magnetic fields to the cancer site before releasing the drug. This targeted approach avoids some of the damaging side effects of traditional chemotherapy, which is untargeted, and results in healthy cells being destroyed.

Most children will be familiar with bubbles that can be created by blowing air into a film of soapy water. These bubbles consist of a volume of air enclosed by a membrane of liquid. The bubble is held as a sphere by forces between the liquid molecules, until the liquid membrane is either punctured, or the liquid evaporates into the surrounding air.

The bubbles used to deliver drugs in cancer treatment differ in that the bubble consists of a volume of liquid surrounded by a membrane of gas. In this activity, such bubbles are known as 'antibubbles'.

## Expected outcomes

Students will be able to:

- explore the behaviour of matter in gaseous and liquid state
- describe how scientific principles can be used to create engineering solutions
- recognise the personal attributes and motivations of people choosing a career in engineering

## Introducing the activity

Use the video clip of biomedical engineer Eleanor Stride on the STEM Learning website.

Video clips are an effective way of familiarising students with a topic, and can provide a useful introduction at the start of a lesson. You could choose one of these four activities to help to direct attention to specific points, or to ensure that students have an opportunity to consider key messages.

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## 1. Adapting for different audiences

Working in small groups of two to three students, suggestions are made on how the video clip could be repurposed for a different audience, such as a class of children in primary school, aged 10 and 11.

Watch the entire video clip as a class, and then set the task to small groups, asking them to consider different modifications, such as:

- What content needs to be removed?
- What additional content could be helpful?
- What changes should be made to the language used?
- What additional images would help convey the key messages?

The video clip should then be made available for groups to review whilst making their suggestions. Set a time limit for the activity after which groups feed back their main points.

## 2. Going further

Generate questions that could be put to the presenter to find out more about the topic.

Watch the entire video as a class, and then ask students individually to generate one question that they would like to ask the presenter. In addition, you could ask individuals to generate one question that could be answered from the video clip. Students could then exchange questions with a partner, and attempt to answer each other's questions after watching the clip a second time.

## 3. Designing a quiz

Individual students generate questions and these are used as a quiz for the class.

Watch the video clip as a class. Set each student the task of generating one question that can be answered from the clip, and which has a single word answer.

Collect up the questions and insert the initial letter from each answer into a cell in the Blockbuster grid template. This will work best if each student is allocated a different letter of the alphabet as the initial letter of their answer.

To play the quiz, you take on the role of question master. Divide the class into teams. Two teams can take part in the quiz at once – one team moves from A to B on the grid, the other from C to D. The team that reaches their destination first is the winner. To move on the grid the team select a letter, and you read out the corresponding question. If they answer correctly, they 'own' that cell, which can be filled in in a specific colour to indicate ownership. A team's cells must touch to make a pathway from their start point. Use presentation software such as Keynote to display the grid to the class and to fill cells with different colours.

## 4. Supporting evidence

Does the presenter use evidence (verbal, visual, implied) to give the key messages credibility?

Watch the video clip as a class, and then ask the class to suggest the key messages that they took from the video. Refine the list of suggestions using discussion to reach a class consensus, and agree on a list of no more than three key messages.

Watch the video for a second time, and ask the class to note any evidence used to support the three key messages. Finally, have a brief class discussion to share views on the evidence presented.

A poster featuring Eleanor Stride is available for download from the Royal Academy of Engineering.

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# Student activity

## Introduction

Play the video clip – The science of microbubbles (2.54) – of Eleanor Stride explaining how and why she is developing the use of microbubbles to treat cancer.

Explain that the bubbles being investigated can be used to improve ultrasound scan images of the body by delivering gas to the tissue being studied. A second use of microbubbles is to deliver drugs to specific parts of the body. The drug is contained inside the bubble which is burst open to release the drug when it arrives at the target site.

Most children will be familiar with soapy bubbles consisting of gas surrounded by a film of moisture. This lesson looks at the formation of bubbles that contain liquid surrounded by a 'membrane' of gas, giving rise to the name 'antibubbles'. The purpose of the practical student activity is to explore the behaviour of matter in a novel situation, and to encourage students to offer explanations for their observations.

## Making antibubbles

The following video clip – Anti-bubbles (10.03) – introduces the idea of antibubbles and shows how these can be made. As well as practical details on how to make antibubbles, the presenter explains something about the complexity of this topic using ideas about density and surface area.

An additional Physics Girl video – What are antibubbles? (6.46) – is available showing how antibubbles can be made, and how electrostatic forces are responsible for maintaining the integrity of bubbles.

Students could work individually or in small groups to practise making antibubbles.

Initially, make antibubbles using a dilute solution of detergent and a plastic pipette.

Once the technique has been mastered, create a density gradient so that antibubbles are suspended in liquid rather than sinking, as explained in the video.

Finally, extract some of the detergent solution and mix with a drop of food colouring. This solution can then be made to create coloured antibubbles suspended in liquid.

Once students can successfully make antibubbles they should be able to compare and contrast them with the more familiar bubbles created by blowing a film of soapy water. The video clips offer different explanations of what holds the liquid in an antibubble rather than letting it mix with the surrounding liquid medium.

Ask students to offer a range of different explanations for the behaviour of antibubbles, and to evaluate the different explanations against their own observations.

## Materials required

- 250cm3 glass/pyrex beaker of cold water
- A few drops of washing up liquid (referred to as 'Dawn' on the video)
- Diluted glucose syrup, golden syrup or a concentrated sucrose solution to form a density gradient in the beaker (in place of corn syrup used in the video)
- Plastic disposable 2–5cm3 pipette
- A few drops of food colouring
- Small beaker for mixing food colouring with detergent solution
- Eye protection

## Health and safety issues

Although the chemicals used in this activity are low hazard, there is a risk of damage if liquids are in direct contact with the eye. Appropriate eye protection, such as goggles, should be worn.

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## Extension

The video clip – The Walking Water Mystery (12.09) – describes a scientific approach to investigating antibubble phenomena, both on Earth and on the International Space Station (ISS). It supports the teaching of 'Working Scientifically' in the English national curriculum.

There is also a useful video clip of an interview with Dr Eleanor Stride – Encouraging more young people into science and engineering (4.53) – encouraging young people to consider a career in science and engineering.

## Summary activity

A suggested summary activity is included to help focus students on the characteristics of this sort of engineering career.

Provide students with the sheet with Eleanor's photo in the centre and three coloured pens. You may find it useful to print this in A3, or stick the photograph in the centre of a larger sheet.

Working in small groups or pairs, give students five minutes to discuss and write down what they think they know about biomedical engineering and Eleanor's career in one colour around the photo.

Watch the film of Eleanor again and see if they can add anything to their sheets.

Then give students a further five minutes to discuss and write down what they would like to find out in another colour.

Draw out some of the ideas about her career/work as a biomedical engineer. Ask groups to feed back some of the questions they would like to find out more about. Elicit ideas of how and where they could find this out. They can then carry out research to find out what they wanted to know.

You could provide prompt questions to scaffold the activity:

- Eleanor does not work in isolation. What are the jobs involved in developing new cancer treatments?
- What do you think excites Eleanor about her job?
- What qualifications do you need to be a biomedical engineer?
- How much do engineers earn?
- What personal skills do you think Eleanor uses in her job?
- How is biomedical engineering changing people's lives?

## Useful sources of information on careers in engineering include:

https://www.borntoengineer.com

http://www.tomorrowsengineers.org.uk/students/career-finder/

http://faraday.theiet.org/careers/case-studies/index.cfm

http://www.raeng.org.uk/education/what-is-engineering/engineer-case-studies