AMBER
Advancing Materials for Impact

03

nano WOW

graphene

Introduction

This lesson looks at the super material graphene. It explores what graphene is made of, when it was discovered and what it can be used for. Will graphene have a major impact on our world? It definitely has the potential! This lesson has a PowerPoint and two activities.

ICT links

Introducing Graphene
2 minutes 48 seconds.
This is an animation with information about graphene; when, who and how it was discovered along with details about its exciting properties.
www.youtube.com/watch?feature=player_embedded&v=dTSnnlITsVg

Graphene: Strongest Material on Earth
1 minute 43 seconds
www.youtube.com/watch?feature=player_embedded&v=we3kWMkSGtg

Curriculum links

Science:
Strand: Materials

Maths:
2D, 3D shapes, angles and shape

Cross curricular links

Art: Construction, drawing
English: New scientific vocabulary

WALT

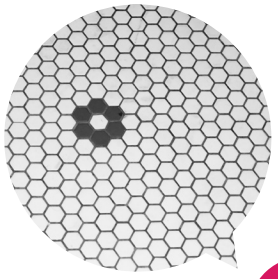
- **Know what graphene is and why nanoscientists all over the world are investigating it**
- **Understand that the properties of graphene can be used to create products that will have a major impact on our world**
- **Understand what graphene looks like (its structure)**
- **Draw a regular hexagon with specific measurements and angles**
- **Make a model of a sheet of graphene**

Trigger questions

These questions can be used before the presentation to recap what properties of materials are and to introduce the idea of new materials.

- Name some important materials we use every day?
- What do we use materials for?
- What might a ‘super’ material mean?

If children have completed the ‘Properties’ lesson, this could be an opportunity to recap on what the word ‘properties’ means and to recall some of the properties of materials.



Journal suggestions

Make a page about GRAPHENE and include:

- What graphene is.
- A drawing of a sheet of graphene.
- A list of the properties of graphene.
- 3 potential ways that graphene could be used in the future.
- A drawing of a sheet of accurate hexagons using a ruler and a protractor
- A photo of your child making atomic structures (sheets of graphene) for your journal

Background information

A pencil contains graphite (not lead, which is toxic!) and this is the part of the pencil we use to write with. Graphite is very appropriate for use in pencils as it is a soft material. When we write with a pencil layers of graphite are removed from the pencil and end up on our page. If we zoom into the graphite in a pencil at, or below, the nanoscale we find a very different, very interesting material called graphene – which is just one single layer of graphite.

- Graphene was only discovered in 2004.
- Graphene is a one atom thick layer of carbon and is one of the most interesting materials ever discovered.
- Graphene is the thinnest, stiffest, hardest, material known and it is 200 times stronger than structural steel. Graphene is also very good at conducting electricity; it can carry electricity more efficiently, precisely, and faster than any other material.

But if a pencil has graphene in it–why does it break so easily? Every time we write with a pencil we are removing layers of graphite from that pencil. Graphite is made up of many, many individual sheets of graphene that are stacked one on top of the other. Each sheet of graphene inside the graphite is held together by very weak forces. An everyday analogy for these weak forces occurs when we use cling film to cover food, it easily sticks and it is easily removed.

It is these weak forces holding the graphene sheets together inside the graphite that makes graphite a weak material. However, graphene all by itself is a very strong material because it is not held together by weak forces–the forces that hold graphene together are very strong. It's a little bit like having a stack of paper on your desk–you can remove individual sheets of paper very easily from the stack but it's very hard to pull a single sheet apart.

Nanoscientists all over the world, including our own Irish nanoscientists are investigating graphene as a potential problem solver for major global issues such as the generation of clean drinking water, cleaner environment and the development of improved structural materials.

Graphene can be added to materials that we are familiar with; like plastics, to make them stronger and lighter. Using this kind of process to make better plastic bottles means that we can use less plastic in their manufacture and reduce the impact that waste plastic has on our environment. Nanomaterials such as graphene may yet play a role in transforming our society in areas such as electronics, communication and renewable energy. Materials like graphene are allowing us to imagine what the future might hold. Do you think rolling up your smart phone and sticking it behind your ear like a pencil is a plausible idea? Would you like a super thin, unbreakable touchscreen that means never worrying about shattering your phone ever again? Would you like to be able to charge your computers, phones and cameras completely in five seconds? Have no fear; nanoscientists are working on similar projects for our convenience.

Activity 1
Drawing graphene
The hexagon

Useful resources

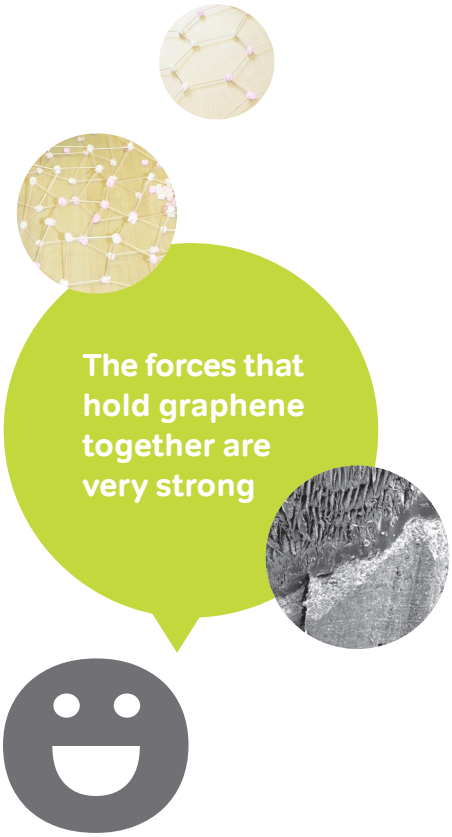
www.graphene-flagship.eu/

www.graphene.manchester.ac.uk/

https://blogs.windows.com/devices/2013/02/07/hero-material-10-fascinating-facts-about-graphene/

www.zdnet.com/the-10-strangest-facts-about-graphene-3040093050/

www.physics.org/article-questions.asp?id=67



Equipment

Paper, ruler, protractor, compass (for each child)

Activity

- Draw a hexagon with sides of 7 cm and angles of 120 degrees in the centre of a page

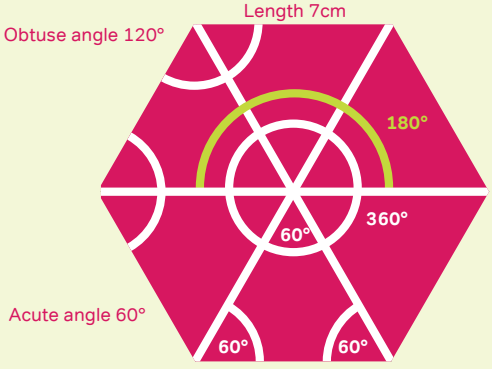
Divide the hexagon into sections as follows:

- Using a compass, draw a circle around the centre point.
- Measure the angles around the centre point.
  Hint: they all should measure the same!
- Discuss how this hexagon could represent the fact that 3 angles in a triangle add up to 180 degrees
- Discuss how a full rotation is 360 degrees and how a half rotation in 180 degrees

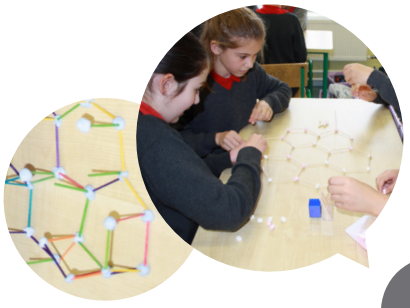
Extension Activity

- Draw (as accurately as possible) hexagons joined to all sides of the original hexagon

This is what a single sheet of our new super material GRAPHENE looks like down on the nanoscale, it looks like a sheet of chicken wire! Remember graphene is 2D and only one layer of atoms thick!
The children should end up with a hexagon like this:



Activity 2
Model building of graphite and graphene



Equipment

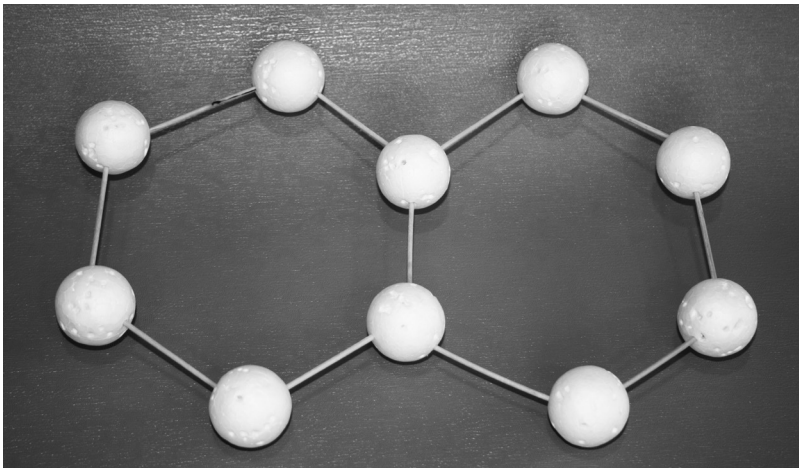
- **Mini marshmallows**
  Alternatives: plasticine balls (similar size) blue tack balls (similar size) raisins or jellies e.g. midget gems
- **Cocktail sticks**
  Alternatives: match/art sticks, broken pasta sticks

Activity

- Model building of graphite and graphene will help the children understand the structures of these materials, how carbon atoms can be joined together and the difference between 2D and 3D structures.
- Learners can follow the diagrams below to replicate the structure of graphite and graphene.
- To build graphene, create a honeycomb structure with your materials, as shown below.

Extension Activity

- To build graphite, layer graphene models one on top of the other, you can use pasta sticks to separate out the layers.
- Ask individuals or groups to join together to create graphite. This is a model of the 3D structure your pencil is made out of. The difference in the 3D structure is that it now has height, length and width, not just width and length, which defines a 2D structure.



Worksheet
Drawing graphene
The hexagon

Graphene is a new 2D material. It is made up of hexagon shapes

Name:

Instructions

1. Draw a 5cm line from point A to point B
2. Check that the angle from B to C is a 120 degree angle
3. Join the line B to C
4. Continue to draw a hexagon measuring each angle as a 120 degree angle and drawing 5cm lines
5. Join the diagonal points, see example below
6. Use a compass or a coin to draw a circle around the centre point
7. Draw a 180 degree angle over the centre point, connecting the centre line
8. Find and label:

- An obtuse angle
- An acute angle
- A full rotation (360 degrees)
- A 180 degree angle
- 3 angles in a triangle that add up to 180 degrees

A

B

C

Join the diagonal points