Introduce

Lesson 1
Teacher notes
Carbon – the source of our energy

Years 7 to 8

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INQuIRY

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Open education
An xpand Foundation initiative

Carbon – the source of our energy

Lesson 1: Teacher notes

This document provides the teacher with the details of the lesson.

At a glance

To capture students' interest and find out what they think they know about carbon as an element and an energy store, the different global spheres it occupies (including the biosphere, hydrosphere, lithosphere and atmosphere) and how we can use carbon in these sphere to provide us with our energy.

To develop an essential question about carbon and energy that students can investigate.

Students:

> Record what they think they know about carbon as an element and an energy store, as well as the different spheres on Earth in which it is present
> Discuss these understandings with others, including the reasons they have for these understandings
> Summarise the key understandings of the class using a number of different thinking routines.

Lesson focus

The focus of the *Introduce* phase is to spark students' interest and engagement, stimulate their curiosity, and elicit their existing beliefs about the topic. Students' existing ideas and questions can then be taken into account in future lessons.

Assessment guide

This assessment guide supports teachers in identifying the types of assessment that are appropriate for this lesson.

Diagnostic assessment is an important aspect of the *Introduce* phase. In this lesson you will elicit what students already know and understand about:

> the basic elemental structure of carbon and observing, discussing, representing and sharing their ideas about the carbon cycle and carbon's various forms on the Earth.

Key lesson objectives

Science

Students will be able to represent their current understanding as they:

> describe an atom and its atomic structure
> explain what an element is and how it relates to an atom
> explain how carbon is an atom and an element and describe its atomic structure
> Explain how energy is stored and released from carbon
> Describe how carbon occupies Earth's different spheres.

Literacy

Students will be able to:

> contribute to discussions about the structure of carbon

> record predictions, observations, explanations and ideas using words, drawings or photographs.

This lesson also provides opportunities to monitor the development of students' general capabilities.

Teacher background information

First and foremost, carbon is an atom and an element. An atom is the smallest part of a chemical element that can exist. It is a structure that contains both protons – positively charged particles – in a central nucleus surrounded by orbiting electrons, which are much, much smaller than the protons, and negatively charged. The atom can also contain a number of neutrons – uncharged particles – that occupy the nucleus, alongside the protons.

Atoms vary in the number of protons and electrons they possess. This variation gives rise to elements. For example, the element helium contains 2 protons, 2 electrons (and 2 neutrons), whereas the element carbon contains 6 protons and 6 electrons (and 6 neutrons). In any atom, the number of protons must always equal the number of electrons. This means that the element will always be electrically uncharged. As the neutron has no electrical charge, the number of neutrons that an atom contains can vary, without affecting the type of element that is produced. Therefore, the same element, for example carbon, can possess anywhere between 6, 7 and 8 neutrons. The forms of an element possessing a different number of neutrons are known as isotopes. Typically one isotope for an element is present in much greater abundance on the Earth's surface, or in the universe, than the other existing isotopes of that element.

Atomic carbon contains 6 protons, 6 electrons, and typically, 6 neutrons. Carbon can contain either 7 or 8 neutrons, with the 8-neutron form (carbon-14) being radioactive. As an element, pure carbon is a non-metal, but unlike other non-metals, is able to conduct electricity in certain forms. It has many allotropes (forms) that it can take, ranging from a black rock or powder formation, to graphite and diamond. As an element and when chemically bonded with other elements to form molecules, carbon is particularly abundant on the Earth's surface. Carbon's versatility is its ability to form chemical bonds with other elements resulting in many different molecules with a variety of different properties. Some of the more common molecules include carbon dioxide and methane (both greenhouse gases), carbon monoxide, many different types of sugars (including glucose) and, when bound to hydrogen, all forms of hydrocarbons (including butane – a petroleum gas, and polyethylene – a plastic).

Carbon can be found in its many different forms throughout the different spheres of the carbon cycle - the biosphere (as sugar), the lithosphere (as minerals and non-renewable resources, such as coal and oil), the hydrosphere (dissolved in water), and the atmosphere (most commonly as carbon dioxide and methane gases).

As carbon cycles through these spheres, the chemical bonds that bind it to other atoms can be made or broken, increasing the energy stored by carbon or releasing energy into the atmosphere. When energy is released into the atmosphere it often does so as heat. However, with the intervention of humans, this energy can be captured and harnessed for electricity generation. This energy stored in carbon can only be effectively used once, and the result is, that while the carbon continues to cycle (in the first instance as carbon dioxide – a greenhouse gas), the energy has been used. Thus, carbon-based energy resources (e.g. fossil fuels) are non-renewable.

The resultant greenhouse gas produced during electricity generation is the main contributor to climate change. Therefore, there is much interest in reducing human dependence on non-renewable resources, and instead looking to renewable (non-carbon based) forms, such as solar and wind energy, as our main power source.

To a certain level each individual, child, student, or adult, has some control over how much energy from non-renewable resources they wish to consume. Changes in the use of non-renewable resource use affect an individual's carbon footprint, and as a result, the individual's contribution to climate change.

Equipment

For the Class

> Large sign saying CARBON on coloured poster paper which is stuck onto a whiteboard or cleared wall area (with blue tack for example).

For the Group

> Approximately 10-15 sticky notes per student with more available if a student requires them
> Coloured pencils.

For each Student

> *KWHL* chart *Student worksheet*
> Approximately 3–5 sticky notes (with more available if a student requires them)
> Coloured pencils
> *Carbon on my mind … map Student worksheet.*

Preparation

> Prepare the CARBON sign according to instructions in the Equipment section above
> Organise enough sticky notes for the entire class

Lesson steps

This lesson can be conducted by the teacher without providing any student worksheets.

Activity 1: Generate – Sort – Connect – Elaborate

NOTE: This is an adaptation of the Generate – Sort – Connect – Elaborate Thinking Routine from Making Thinking Visible by the Project Zero Team at Harvard.

More information can be found at: Visible Thinking 2013, *GSCE Routine*, viewed 30 November 2013, <http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/GSCE/GSCE_Routine.html>

Throughout the process, the teacher is to facilitate the general discussion, and tease out student understanding through questioning, as well as identifying any misconceptions that arise. Misconceptions may not necessarily need to be broken down until students reach the *Investigate* stage of the *INQuIRY* process. These misconceptions could even form part of the questions students generate and agree on in the *Question* stage of the *INQuIRY* process.

1. Show students the word CARBON written on a large a piece of coloured cardboard and place it in the centre of a whiteboard, wall or any other clear vertical space that can be marked. Draw a circle around the word CARBON
2. Provide students with a chunk of about 10 to 15 sticky notes (with more available for students who need them)
3. **GENERATE**: Individually students are required to GENERATE as many ideas related to the word carbon as they can. Ideas can be provided in any form – word, picture, symbol, phrase, process, diagram, etc. Each idea should be written on a separate sticky note.
4. Draw concentric circles (like ripples) around the word CARBON

5. **SORT**: Students to select their top three favourite ideas from their set of sticky notes and place them on the CARBON circles according to how central or tangential they think they are to what carbon is
6. Students to each view the whole map and contribute to a class discussion on two main questions:
   a. Are the sticky notes in the correct places? Why/why not?
   b. What should the main theme(s) for each section (or ripple) of the map be? (Some suggestions are: carbon - the element, carbon chemistry, carbon and life, carbon biology, carbon and climate change, etc.)
7. Students to contribute to the rearranging of the notes based on the class consensus of 6b. above
8. **CONNECT**: Students to analyse the map and identify any connection between different notes on the map. Connections can be between notes within a ripple and between ripples. Students to write a short sentence about how the ideas are connected
9. Using lines, students can draw in the connections (from Step 8) between the ideas on the map. They can also write in their explanations for these connections onto the lines
10. **ELABORATE**: Students to review the whole map with the connections and contribute any further ideas and thoughts that are stimulated by the connections.

Activity 2: Colour-Symbol-Image (CSI)

NOTE: This is an adaptation of the Colour-Symbol-Image Thinking Routine from Making Thinking Visible by the Project Zero Team at Harvard.

More information can be found at: Visible Thinking 2013, *Colour, Symbol, Image Routine*, viewed 30 November 2013, <http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/ColourSymbolImage/ColourSymbolImage_Routine.html>

1. Introduce the idea of CSI to students by describing each of the features – Colour, Symbol, Image
2. In groups of 3, students to consider the first activity (Generate – Sort – Connect – Elaborate) and identify:
   a. a symbol that they feel best represents or captures the essence of carbon
   b. an image that they feel best represents or captures the essence of carbon

   Explain to students that they can also identify different CSIs for carbon in different contexts if they feel that this is more useful to summarise their understanding
3. Students to share their CSI ideas with the class. The class may like to agree on a particular CSI or CSIs that they can use to represent the learning of their class throughout the unit (i.e. as a team carbon motto or logo).

Sources:

Visible Thinking 2013, *GSCE Routine*, viewed 30 November 2013, <http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/GSCE/GSCE_Routine.html>

Visible Thinking 2013, *Colour, Symbol, Image Routine*, viewed 30 November 2013, <http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/ColourSymbolImage/ColourSymbolImage_Routine.html>