

# Carbon – the element with several identities

## Teachers' notes

### Objectives

- To know that carbon has three allotropes.
- To understand that the physical properties of each allotrope are dependent on the molecular structure.

### Outline

The student worksheet includes information about Sir Harry Kroto, who is one of the team who discovered the third allotrope of carbon, buckminsterfullerene, and received a Nobel Prize for his work in 1996. It also includes general information about the three allotropes.

## Teaching topics

This activity is suitable for 14–16 year olds and should be included when teaching about simple molecular structures and giant structures.

## Sources of information

The story of the discovery of fullerenes can be read in the following books.

- *The Age of the Molecule*, London: The Royal Society of Chemistry, 1999.
- *Cutting Edge Chemistry*, London: The Royal Society of Chemistry, 2000.

## Teaching tips

This activity could be used in lessons to create a wall display or as a homework exercise as it contains text, pictures, diagrams and questions.

The Fullerene Gallery

<http://nobelprize.org/chemistry/laureates/1996/fulleren/index.html> (accessed September 2005), shows eight different molecules and allows students to appreciate the structure by rotating the molecules and zooming in on different parts of the structure.

Students could try and make their own models using ball and stick kits. This should help to distinguish between the different allotropes of carbon.

## Resources

- Molecular model kits (for model kits see eg <http://www.molymod.com>) (accessed June 2001).
- Access to the Internet.
- Student worksheets  
– Carbon – the element with several identities.

## Adapting resources

It is hoped that the format of the student worksheet given here will be adopted and that teachers will use it to make up their own pages, tailored to meet the needs of their own students and the topic being studied.

## RS•C

**Opportunities for using ICT**

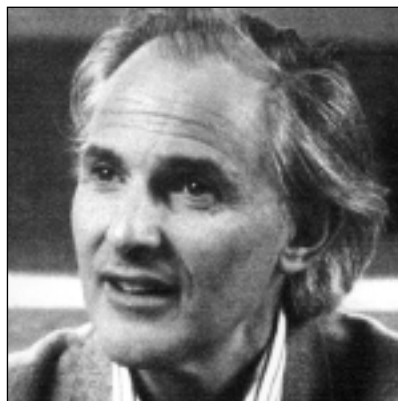
- Using the Internet to view molecular models of fullerenes.

**Answers**

1. An element that can exist in different physical forms which have different physical properties. Often confused with isotopes.
2. Diamond, graphite and fullerenes.
3. a) All contain carbon atoms and covalent bonds.  
b) Diamond and graphite have giant molecular structures whereas fullerenes form simple molecules. Diamond has a three dimensional tetrahedral structure, graphite is formed in layers with a delocalised electron,  $C_{60}$  is football shaped, with a cage structure.
4. a) Diamond  
b) Graphite  
c) Buckminsterfullerene  
d) Graphite
5. a) Strong three dimensional tetrahedral structure.  
b) Delocalised electron can move throughout the structure.  
c) Small covalent molecules will dissolve in covalently bonded solvents.  
d) The weak force between the layers is broken when it is rubbed against a surface leaving the top layer of carbon atoms behind.

# Carbon – the element with several identities

Until 1985 there were two known allotropes of carbon, diamond and graphite, and now there are three. Sir Harry Kroto is one of the team who discovered the third allotrope, the fullerenes, and received a Nobel Prize for his work in 1996.



**Sir Harry Kroto**

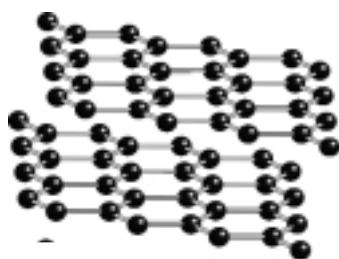
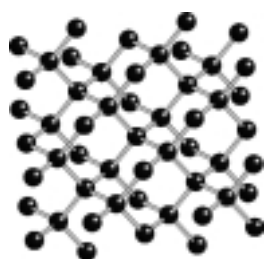
(Reproduced courtesy of the Nobel Foundation)

rights for all. Some words of advice from the Nobel Laureate: *“Do something which interests you or which you enjoy and do it to the best of your ability. Having chosen something worth doing – never give up and try not to let anybody down.”*

Harry was born in Cambridgeshire. His father (a Jew) and mother fled from Berlin in the late 1930s. The family eventually settled in Bolton, where his father once again set up his balloon printing factory, in 1955. Harry worked in the factory during the school holidays.

At school, Harry enjoyed playing tennis, gymnastics and design, but he choose to take chemistry, physics and mathematics in the sixth form. The smells, bangs and flashes of chemistry attracted him to the subject, which he went on to study at Sheffield University. After gaining a first class degree, he carried on studying for a PhD, which he got in 1964. Student life was very busy, and, like all students in the 60s, playing the guitar and singing songs at parties was a must!

Harry married and his first son, Stephen was born while they were living in Ottawa in Canada, David was born when they returned to England. Harry, a humanist, is a supporter of Amnesty International and strongly believes in a secular democratic society with equal



**Diamond, Graphite and Buckminsterfullerene**

$C_{60}$  is the same shape as a football, but is 100 million times smaller!

Try making some carbon models.

## Questions

1. What does the word allotrope mean?
2. Name the three different allotropes of carbon.
3. In what ways are the three structures a) similar b) different?
4. Which type of carbon; a) is the hardest, b) conducts electricity. c) will dissolve in oil, d) is used to write with?
5. Explain your answers to question 4.

Want to see more? Visit the Fullerene Gallery at

<http://nobelprize.org/chemistry/laureates/1996/fulleren/index.html> (accessed September 2005)

