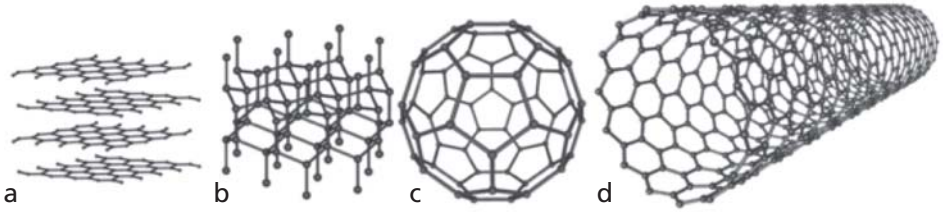
What is a buckyball?

A buckyball is a tiny football-shaped molecule made of 60 carbon atoms arranged in 20 regular hexagons and 12 regular pentagons. Buckyballs are only one nanometre in diameter. The chemical formula of a buckyball is C_{60}.
Buckyballs were discovered in 1985 and named buckminsterfullerenes after the architect Richard Buckminster Fuller, who was famous for his characteristic dome structures. The name was later shortened to 'buckyball'. Buckyballs were the first molecule of the fullerene family to be discovered. All members of this family are cage-like molecules made entirely of carbon atoms arranged in hexagonal and pentagonal shapes, like a football. Carbon nanotubes, hollow tubular structures made up of carbon atoms, also belong to this family. Fullerenes have special properties due to the way their carbon atoms are arranged.

Forms of carbon

Carbon exists in numerous forms, one of which is fullerenes, which includes buckyballs and nanotubes. Carbon nanotubes are one of the most electrically and thermally conductive materials known. Other forms of carbon include diamond, the hardest natural material known on Earth, and graphite, one of the softest materials. These different forms are called allotropes, which refers to the fact that they are made of just one element, but that their structure is different.
Carbon allotropes have different properties because the carbon atoms are arranged differently at the nanoscale. In graphite (a), the carbon atoms are arranged in layered sheets of hexagons, with only weak bonds between the layers. The lead of drawing pencils is made of graphite: when using a pencil, the weak bonds are broken easily and the carbon layers are deposited on to the paper. In contrast, diamond (b) is the hardest material on earth. In the diamond structure, each carbon atom is bonded to four other carbon atoms, creating a rigid three-dimensional lattice which gives diamond its hardness. Buckyballs are ball-shaped molecules (c) and carbon nanotubes (d) are essentially a single layer of graphite rolled into a tube.



http://commons.wikimedia.org/wiki/File:Eight_Allotropes_of_Carbon.png

Applications

Buckyballs and carbon nanotubes occur naturally. They can be found in very small amounts in soot and in outer space, and they are also created by lightning strikes. Scientists are studying how to make these tiny particles and how to use them to build other things.

Buckyballs are good lubricants because of their spherical shape. Researchers are investigating whether their hollow structure could be used for delivering medicine in the future. By attaching antibodies to a buckyball it might be possible to design treatments which will target areas of disease, delivering medications to just the right place.

Carbon nanotubes are very strong and light and can act as semiconductors or conductors. Research is being conducted into their use in flat screens where they would replace the current LCD and plasma technologies. Carbon nanotubes could also be used to store hydrogen, allowing the production of hydrogen–oxygen fuel cells, which could be used in emission-free cars.

'Buckypaper' is a paper made of carbon nanotubes and has potential for being used as an electromagnetic shield, for fire and lightning protection, or even as an artificial muscle that can potentially produce up to 100 times the force of a human muscle the same size.

Nanotubes can be used as very sensitive gas sensors for security and environmental applications. Finally, they are also used to strengthen composite materials.

These are just a few examples; fullerenes have many more potential applications and are expected to be an essential material in the future.

Ideas for conducting the activity or discussion

- Ask participants to gently squeeze the buckyball so that they can see how resistant it is.
- Ask them to guess about potential applications of buckyballs.

Learning objectives or school curriculae

- Fullerenes are among the first discovered and the most studied nano-objects.
- Fullerenes have a lot of different applications.
- Some elements, like carbon, can exist in different forms (allotropes).