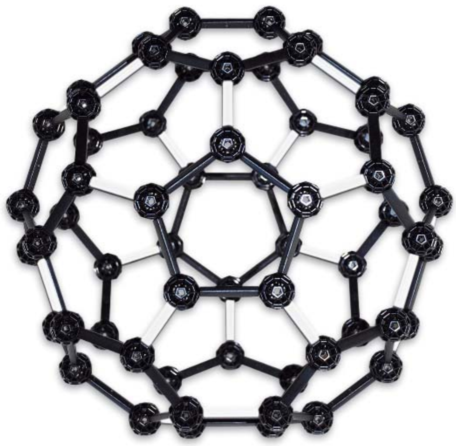


C60 Fullerene

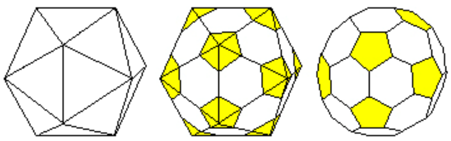
C60 is a spherical molecule made up of carbon atoms. It is a molecule of high symmetry; the roundest - and some say the most beautiful - of all molecules. Scientists believe that it is also one of the most useful... but more about this later.

C60 derives its name ‘Buckminster Fullerene’, or ‘Buckyball’ from the visionary architect R. Buckminster-Fuller, whose geodesic domes it closely resembles. It is by far the most well-researched fullerene.

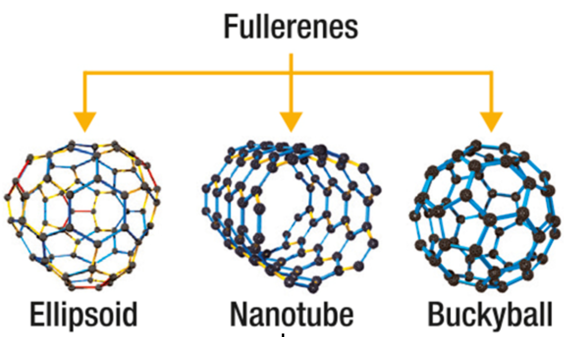
Richard Buckminster-Fuller, Le Biosphère, Montreal.
Constructed for the USA pavillion at the Expo 1967.

Buckminster-Fuller died in 1983, two years before Sir Harold Kroto, Richard Smalley, Robert Curl and colleagues discovered the buckyball. In acknowledgement of their achievement, Kroto and Smalley were awarded the Nobel prize for chemistry in 1996. An entire class of molecules, related to buckyballs, are now termed ‘fullerenes’.

The C60 consists of 12 pentagons and 20 hexagons, which together form a truncated icosahedron (one of the Archimedean solids).



Just like a football, the buckyball comprises 32 ‘flat’ shapes (polygons) and is indeed often referred to as the football molecule. It has 60 corners made of carbon atoms and 90 edges; the bonds between the carbons. Consisting entirely of carbon, the fullerenes form spheres (C60), ellipsoids (C70), or tubes (buckytubes or nanotubes).



How it’s all connected

‘Allotropes' are forms of the same element which, due to chemical bonding, are differently structured (Greek: ‘allos’ = variation and ‘tropos’ = manner or form). Diamond and carbon are the most commonly- known allotropes of carbon.
In a diamond, each carbon atom is joined to four neighbouring carbons by single bonds in a tetrahedral formation. This structure forms a strong 3D molecular lattice; diamond is in fact the hardest naturally occurring substance on earth.

Like diamond, graphite is pure carbon, but its form and properties are completely different. Graphite atoms are arranged in sheets of hexagonal ‘tiles’, each sheet only one atom strong. Within each sheet, the atoms are tightly bonded, but between sheets only loosely attracted. Thus the graphite sheets glide over each other, a property which renders graphite useful in the fields of lubrication - or writing: the ‘lead’ of a pencil is actually carbon!
Just as the same Zometool components can be used to construct models which are either strong or weak, so the different structures of diamond and graphite produce substances which are respectively either hard or soft.
C60 fullerenes are a further allotrope of carbon. They are more closely related to graphite than to diamond, since buckyballs and nanotubes are essentially sheets of graphite, folded or wrapped into 3D shapes.

What a coincidence!

As with many scientific breakthroughs, the discovery of the C60 fullerene happed by chance. While studying carbon stars (red giants), Dr. Kroto, Smalley and Curl discovered C60 in a 4.6 billion year-old meteorite.
The nuclear physicist Wolfgang Krätschmer from Heidelberg developed a method of producing C60 samples in quantities of grams.
This was a quantum leap in the scientific study of fullerenes. The enormous potential of C60 as a building block within the ‘nano’world became apparent:

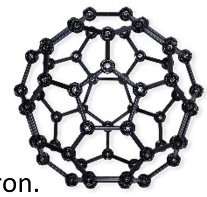
- truncated icosahedra C60 (twice as hard as diamonds) are utilised in the field of commercial drilling
- fullerenes are employed as high-performance lubricants,
- innovative fuels,
- modern superconductors and magnets, as well as
- polymers for the collection and saving of data.

Zometool Kit „C60 Fullerene“

Article No.: 42608
222 Parts:
B0 Black 90
B0 White 60
Zometool Nodes Black 60
Zometool Nodes White 12

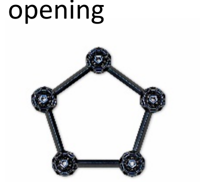
Box: 13 x 13 x 6.5 cm
Weight: 291 grams

Building instructions / Step-by-Step



With this kit you can build:
- an all-black buckyball (after all, it's carbon!)
- or a buckyball with white struts which represent the double-bonds
- an (integrated) icosahedron, to explore the relationship between C60 and icosahedron.

1. Build a pentagon. Take care to position each of the five black balls with a pentagonal opening uppermost.



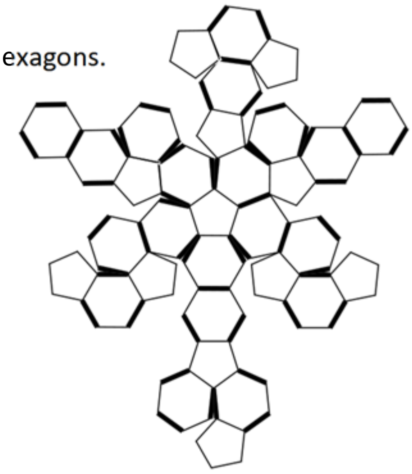
2. A white strut is attached to each of these five black connecting balls (carbon atoms): the white struts represent the double-bonds. Attach a black ball to the end of each of these white struts and then connect these balls, using two black struts and a white strut...

3. ... thus creating hexagons.

The pentagon is now enclosed by hexagons and a lightly domed shape emerges.

Continuing with this pattern, you can now construct an entire C60 fullerene, complete with double-bonds.

This 2D grid of C60 shows the arrangement of the double-bonds on the hexagons.

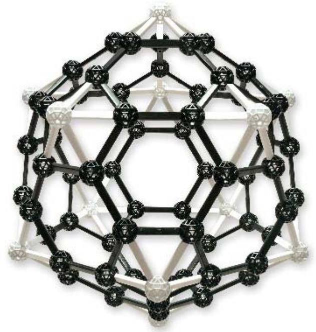


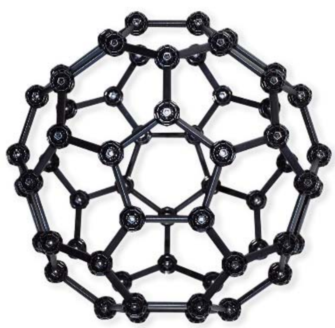
In a double-bond, both atoms are connected by two pairs of shared bonding electrons. Double-bonds are stronger than single bonds.

Once you have completed your all-black buckyball, you can discover why this form is termed ‘truncated icosahedron’.

Attach a white strut to each of the connecting balls of a pentagon and connect these struts with a white ball.

An icosahedron emerges!





Now we can see that a carbon molecule, with its 60 carbon atoms, is actually an icosahedron whose corners have been ‘cut off’: an example of how Zometool can be used to depict natural forms and reveal the relationships between them.