WORKSHEET 3

EXPERIMENT: COMPARING ALLOTROPES OF CARBON

Syllabus reference 8.5.2

INTRODUCTION

Carbon is an amazing element. An entire scientific discipline called organic chemistry is based on the compounds it forms. More than 90 per cent of all known chemical compounds are based on carbon, including carbohydrates, proteins, fats and DNA, which form the basis of living matter.

Carbon also exists in pure forms. Until 1985 it was thought only two pure forms of carbon occurred; these were diamond and graphite.

In 1985, Harry Krob, Richard Smalley and Robert Curl analysed carbon clusters produced from the vaporisation of graphite by a powerful laser in an atmosphere of helium gas. They found many previously unknown carbon molecules, the most common of which was a roundish molecule made up of 60 carbon atoms (C_{60}). It was named buckminsterfullerene (abbreviated to fullerene or buckyball) after Buckminster Fuller, an architect who designed the geodesic dome.

AIM

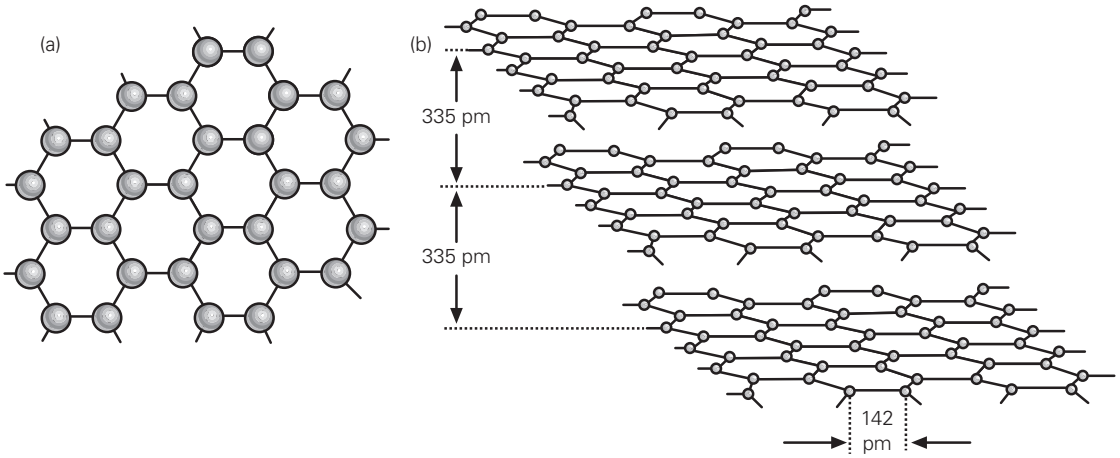
To make a model of each of the three forms of elemental carbon.

EQUIPMENT

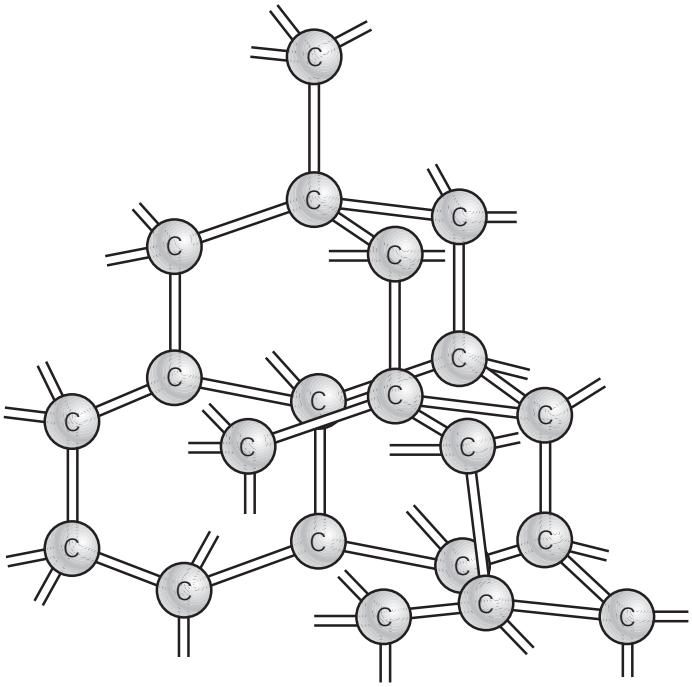
- molecular model kit or plasticine™ and straws or toothpicks to model diamond and graphite
- graphite powder or pencil refill (2B) or carbon rod from a dry cell
- diamond glass cutter
- Fullerene pattern and instructions (available from http://www.slb.com, type 'buckyball' in the search space at the top right hand corner of the home page.)
- sticky tape and scissors
- glass microscope slide
- electrical conductivity kit or 2 pieces of metal, ammeter or bulb, 4 leads and 4 alligator clips
- powerpack

PROCEDURE

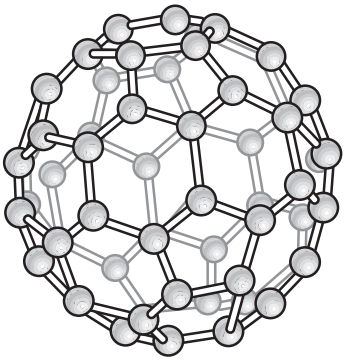
1 Use the diagram below to construct a model of graphite. Note that graphite forms a planar covalent network structure that consists of flat six-membered rings in which each carbon is bonded to only three other carbon atoms within the plane.



2 Use the diagram below to construct a model of diamond. Note that diamond forms a tetrahedral covalent network structure with each carbon bonded to four other carbon atoms.



3 Use the information and pattern downloaded from the website provided to construct a C_{60} fullerene.



4 Test for hardness by scratching paper, copper, a plastic ruler, lead and glass with graphite and a diamond glass cutter.

5 Test for electrical conductivity of graphite and diamond using the conductivity kit or a simple circuit containing two pieces of metal and an ammeter or bulb connected to a power pack.

RESULTS

Record your results in the following table.

SUBSTANCE	BONDING TYPE	SHAPE	HARDNESS	ELECTRICAL CONDUCTIVITY
Graphite				
Diamond				
Buckyball			Used as a molecular ball bearing	

QUESTIONS

1 Explain, in terms of the chemical bonding involved, why graphite, diamond and buckyballs have different conductivity.

2 Give one use of graphite as an electrical conductor.

3 Explain in terms of bonding why graphite is soft and diamonds are hard.

4 Give one use each for graphite and diamond based on their hardness or softness.

5 Buckyballs are extremely stable and can withstand very high temperatures and pressures. They spring back to their original shape when bent. Using this information, explain why scientists believe they could be used as lubricants.