Carbon allotropes

Introduction

These questions are designed to help you to develop your mental models (pictures in your head) of the different structures of carbon. Use the icon in the margin to find out which level of understanding the question is developing.

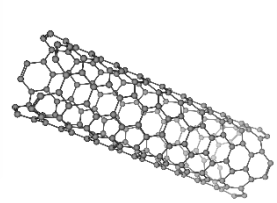
Macroscopic: what we can see. Think about the properties that we can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about the particle or atomic level.

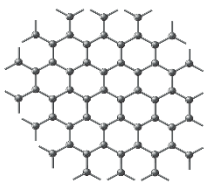
Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

Questions

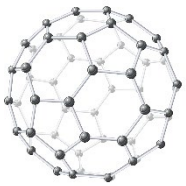
1. Covalently bonded carbon atoms can form a variety of different structures. Substances that are made of the same type of atom but with different structures are called allotropes.
The structures of some carbon allotropes are shown in the diagrams below.



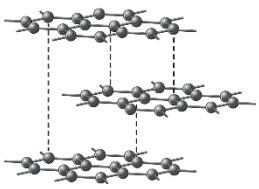
A



B



C



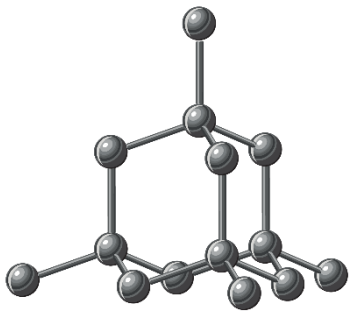
D

(a) Write the letter for the diagram that represents the structure of each allotrope of carbon:

- graphite ____
- graphene ____
- Buckminsterfullerene ____
- nanotube ____

(b) Nanoparticles have structures of about 1 to 100 nanometres, which is the size of a few hundred atoms. Use the diagram of the Buckminsterfullerene to explain why it is a type of nanoparticle.

The diagram below shows a representation of the structure of diamond.

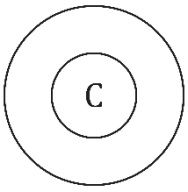


(c) Give one advantage of this way of representing the diamond structure.

(d) Give one disadvantage.

2. A carbon atom has six electrons.

(a) Complete the electronic structure diagram for a carbon atom.



(b) Circle the maximum number of covalent bonds that a carbon atom can form.

A 6 **B** 3 **C** 4 **D** 8

(c) A carbon atom can form covalent bonds with more carbon atoms.
Add more carbon atoms to the diagram in part (a) to show the maximum number of carbon atoms the central carbon atom can bond with.

(d) Circle the maximum number of carbon atoms that each carbon atom can bond with.

A 6 **B** 2 **C** 4 **D** 3

(e) Explain why carbon can form giant covalent structures.

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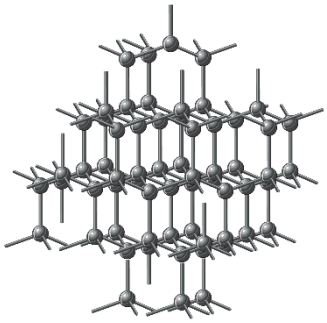
3. Diamond has a three-dimensional giant molecular structure.
The diagram below shows another representation of the structure of diamond.



(a) Which part of a carbon atom is represented by a line on the diagram?

A nucleus
B shared pair of outer electrons
C nucleus and inner electrons
D inner electrons

(b) Which part of a carbon atom is represented by a circle?

A nucleus
B shared pair of outer electrons
C nucleus and inner electrons
D inner electrons

(c) Explain why diamond **cannot** conduct electricity.

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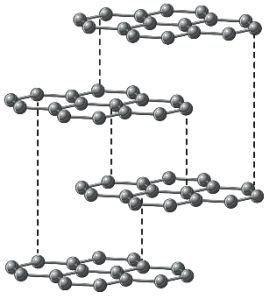
Graphite has a structure made up of layers of two-dimensional sheets.



(d) Give the number of electrons of each carbon atom that are involved in forming covalent bonds. _____

(e) Explain why graphite **can** conduct electricity.

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