Graphite, diamond and BN

A Level

Part A Graphite and diamond

Which statement(s) concerning the lattice structures of graphite and diamond are correct?

1 The shortest carbon-carbon bond occurs in diamond.

2 The $\mathrm{C-C-C}$ bond angle between nearest neighbours is smaller in diamond than in graphite.

3 All bonds in diamond are of the same strength but those in graphite are not.

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct

Part B Boron nitride

Which properties is this compound likely to have?

1 It can act as a lubricant.

2 It has a high melting point.

3 It is very hard.

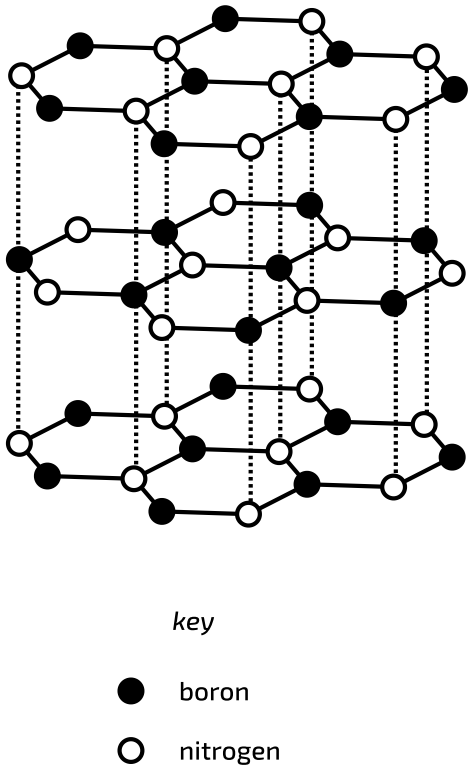

Figure 1: The diagram shows the structure of boron nitride which is similar to that of graphite.

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

Part A adapted with permission from UCLES A-Level Chemistry November 1996, Paper 3, Question 36;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 4, Question 35

Physics. You work it out.

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Boron nitride

A Level

A boron atom has one fewer electron than a carbon atom, and a nitrogen atom has one more. Some BN compounds are known which are isoelectronic with $\mathrm{C}-\mathrm{C}$ compounds. One form of boron nitride, a colourless electrical insulator, has a planar hexagonal layered structure of alternating boron and nitrogen atoms as shown below.

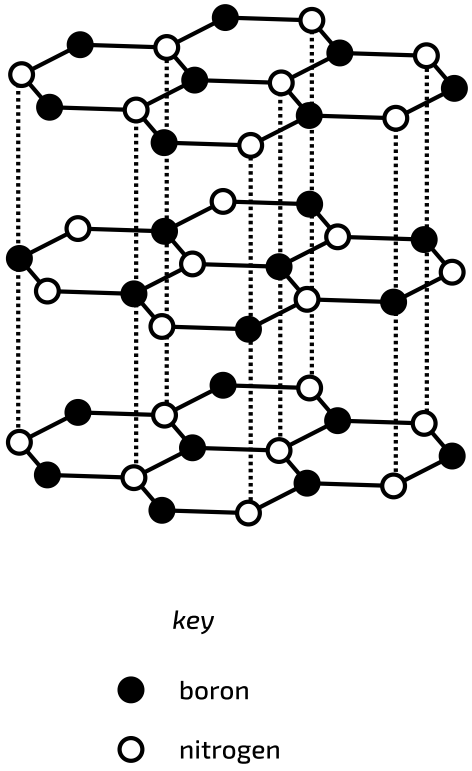

Figure 1: Boron Nitride structure

Part A Isoelectronic

Isoelectronic is when two species have the same number of [...**A**...] and the same electronic [...**B**...].

Fill in the blanks for **A** and **B**.

A:

B:

Part B Bonding within layers

Suggest the type of bonding which is present within the layers.

Part C Bonding between layers

Suggest the type of interaction between the layers.

Part D Use of boron nitride

Suggest a possible use in which this compound would behave similarly to the corresponding carbon compound.

Part E Boron nitride under high pressure

When heated under high pressure this form of boron nitride is converted into another form which is an extremely hard solid.

Suggest the carbon allotrope this type of structure will be similar to.

Adapted with permission from OCSEB, A-Level Chemistry, June 1995, Paper 3/4, Question 3

Copper and graphite

A Level

Part A Conductivity of copper

Which of the following statements explains why copper conducts electricity when a potential difference is applied?

- Copper(II) ions move to the cathode.
- The crystal lattice breaks down.
- The bonding becomes covalent
- Electrons combine with copper(II) ions.
- Bonding electrons in the crystal lattice move.

Part B Graphite as lubricant

Graphite can be used as a lubricant; diamond cannot. This is because graphite has

- mobile ions.
- delocalised electrons.
- a hexagonal arrangement of atoms in the layers.
- covalent bonds between atoms in the layers.
- van der Waals' forces between the layers of atoms.

Part A adapted with permission from UCLES, A-Level Chemistry, November 1991, Paper 1, Question 7;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1991, Paper 4, Question 18

Silicon

A Level

Part A Structure of silicon

What type of structure and bonding would you expect for the element silicon its solid state?

- pure covalent
- ionic
- polar covalent
- metallic

Part B Manufacture of silicon

Pure silicon is required for microchips. It can be manufactured by heating silicon tetrachloride with zinc to produce zinc(II) chloride as a byproduct.

Construct a balanced equation for this reaction, using the lowest integer stoichiometric coefficients. State symbols are not required.

Part C Mass of pure silicon

A sample of silicon tetrachloride contained 10%, by mass, of unreactive material as impurity.
Calculate the mass of pure silicon that could be obtained by heating $8.50\,\mathrm{g}$ of the impure tetrachloride with an excess of zinc.

Adapted with permission from UCLES, A-Level Chemistry, November 1991, Paper 2, Question 4

Diamond and graphite

A Level

Which structural feature is common to both diamond and graphite?

- delocalised electrons
- each carbon atom bonded to four others
- a carbon-carbon bond length equal to that in ethane
- covalent bonds between carbon atoms
- van der Waals forces

Adapted with permission from UCLES, A-Level Chemistry, November 1993, Paper 4, Question 17

Lattices and molecules

A Level

Part A Discrete molecules

Which element exists as discrete small molecules in the solid state?

- sodium
- iodine
- carbon
- aluminium

Part B Non-ionic giant lattice

Which set of properties could apply to a non-ionic compound which has a giant lattice?

	physical state at room temperature	*electrical conductivity of the molten compound*	*melting point/ °C*
A	liquid	does not conduct	-114
B	liquid	does not conduct	melts over a temperature range
C	solid	conducts well	808
D	solid	does not conduct	1610

- **A**
- **B**
- **C**
- **D**

Part A adapted with permission from UCLES, A-Level Chemistry, November 1997, Paper 3, Question 5;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 7

Graphite and molecular oxides

A Level

Part A Graphite lattice

In the graphite lattice, what is the number of nearest neighbours for each carbon atom?

- 3
- 4
- 5
- 6
- 12

Part B Molecular or giant structure

Which one of the following oxides has a molecular structure as distinct from a giant structure?

- Na_2O
- MgO
- Al_2O_3
- SiO_2
- SO_2

Part A adapted with permission from UCLES, A-Level Chemistry, June 1989, Paper 3, Question 6;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1989, Paper 3, Question 14

Metals and delocalised electrons

A Level

Part A Group 2 metals

The Group 2 metals have higher melting points than Group 1 metals.

Which factors could contribute towards the higher melting points?

1 There are smaller interatomic distances in the metallic lattices of the Group 2 metals.
2 Two valence electrons are available from each Group 2 metal atom for bonding the atom into the metallic lattice.
3 Group 2 metals have the higher first ionisation energies.

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct

Part B Delocalised electrons

Which of the following systems contain delocalised electrons?

1 cyclohexane
2 graphite
3 sodium

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, June 1997, Paper 3, Question 35;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1989, Paper 3, Question 31