Allotropes (Diamond and Graphite) – Revision Pack (C3)

Allotropes:

Allotropes are different forms of the same element in the same physical state; the atoms are bonded differently.

Carbon has allotropes:

- Diamond
- Graphite
- Buckminsterfullerene

Diamond Properties vs. Graphite Properties:

Diamond	Graphite
- Colourless and Transparent - Very Hard - Very High Melting Point - Does NOT conduct electricity - Lustrous with a brilliant shine	- Black and opaque - Soft and Slippery - High Melting Point - Conducts Electricity - Lustrous

They are both made of ONLY carbon, yet they have very different properties...

Structure of Diamond:

Each carbon atom in diamond is held in place by four strong covalent bonds.

These bonds require significant amounts of energy to break. This means that they have a high melting point of 3750°C.

Diamond has NO FREE ELECTONS so cannot conduct electricity.

Structure of Graphite:

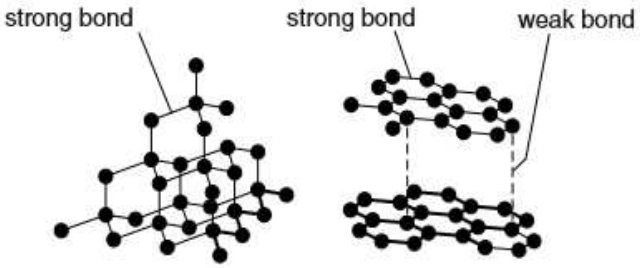
The carbon atoms in graphite are arranged in layers; within each layer there are strong covalent bonds – this means that it has a high melting point.

Between layers there are much weaker forces – this means that they are soft and slippery and can slide over each other; this is what allows us to write with a pencil.

Between the layers the electrons are delocalised (they can moved freely and gain a charge) meaning that they can conduct electricity.

PPQ(1):

5 Look at the diagrams. They show the structures of diamond and graphite.



diamond **graphite**

(a) Diamond is used in cutting tools.

Explain why.

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..... **[2]**

(b) Graphite is slippery.

Explain why.

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..... **[1]**

[Total: 3]

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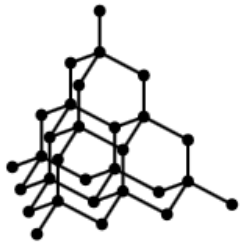
PPQ(2):

12 Diamond is a form of carbon.

Look at the structure of diamond.



Scientists use the structure **and** bonding of a substance to explain its properties.

(a) Diamond has a very high melting point.

Explain why.

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..... **[2]**

(b) Diamond does not conduct electricity.

Explain why.

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..... **[1]**

[Total: 3]

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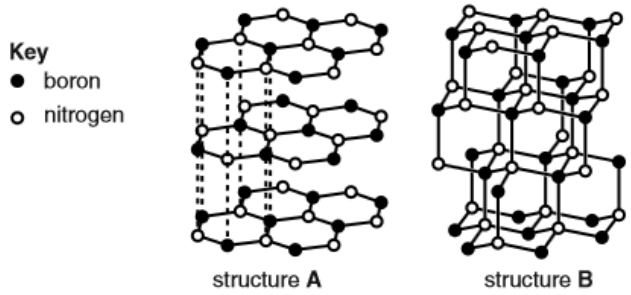
PPQ(3):

12 Boron nitride, BN, exists in two physical forms.

The structures of these forms are shown below.



These two forms of boron nitride resemble graphite and diamond, the two allotropes of carbon.

(a) Boron nitride, with structure **A**, is slippery.

Explain why, in terms of structure and bonding.

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..... **[2]**

(b) Boron nitride, with structure **B**, has a very high melting point.

Explain why, in terms of structure and bonding.

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..... **[2]**

[Total: 4]

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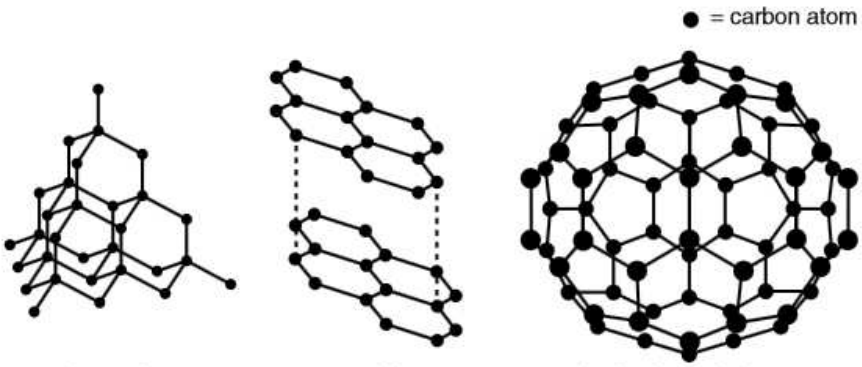
PPQ(4):

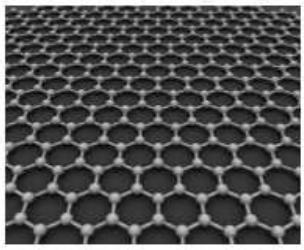
9 Carbon can exist in different solid forms.



(a) What is the name given to these three forms?

.....[1]

(b) Look at the diagram.



It shows the structure of a new solid form of carbon called graphene.

Graphene contains **one layer** of carbon atoms.

Graphene is made from graphite.

Graphene is harder than graphite.

Explain, using ideas about structure and bonding, why **graphene** is **hard** and **graphite** is **slippery**.

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.....[2]

(c) Diamond and graphite have different properties and different uses.

Look at the table.

It shows some information about the properties of diamond and graphite.

Property	Diamond	Graphite
State at room temperature	solid	solid
Appearance at room temperature	transparent	black
Melting point	very high	very high
Hardness	very hard	soft
Electrical conductivity	does not conduct	good conductor

Diamond is used to make cutting tools.

The picture shows a drill bit with diamonds on its end.

This drill is used to cut through rock.

Explain why diamond is used to make cutting tools.

Use the table to help you.

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..... **[2]**

[Total: 5]

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Mark Schemes:

PPQ(1):

Question			Answer	Marks	Guidance
5	(a)		hard (1) high melting point (1)	2	**allow** hard wearing / it can't be scratched **ignore** durable / hard to break / good at cutting things **ignore** strong / sharp / dense **allow** it will not melt **as an extra marking point** **allow** (good) thermal conductor
	(b)		weak bonds between layers / layers can slide over each other (1)	1	**allow** references to weak (intermolecular) forces between layers **not** (weak) covalent bonds between layers **allow** sheets for layers / plates for layers
			Total	**3**	

PPQ(2):

Question			Answer	Marks	Guidance
12	(a)		has many strong bonds between atoms / has many covalent bonds between atoms (1) takes lots of energy to break bonds present (1) – this mark is dependent on the correct bond being broken	2	many bonds / it has covalent bonds is **not** sufficient **allow** each carbon atom is covalently bonded or strongly bonded to 4 other (carbon) atoms **not** has many ionic bonds **not** references to intermolecular bonding **allow** has a giant structure for one mark if no other marking point has been awarded
	(b)		does not contain free electrons / all electrons are in bonds (1)	1	**allow** does not have delocalised / spare electrons
			Total	**3**	

PPQ(3):

Question			Answer	Marks	Guidance
12	**(a)**		weak forces between the layers (1) which are easy to break (so layers can slide over each other) (1)	2	**allow** van der Waals' forces between layers / weak intermolecular forces **not** weak covalent bonds between layers
	(b)		large number of strong (covalent) bonds (1) needs lots of energy to break / AW (1)	2	**allow** giant molecular structure or giant covalent structure / large number of strong bonds (between atoms) **allow** heat for energy but **ignore** high temperature **any mention of intermolecular bonds / forces scores 0**
			Total	**4**	

PPQ(4):

Question			Answer	Marks	Guidance
9	(a)		allotropes (1)	1	**allow** allotropy (1) **allow** giant structures or giant molecules (1)
	(b)		graphene only contains strong (carbon to carbon) covalent bonds (1) graphite contains weak forces or bonds between the layers (of carbon atoms) (1)	2	**allow** graphene only allows strong bonds between atoms (1) **not** strong ionic bonds / strong intermolecular forces **allow** van der Waals' forces between layers or (weak) intermolecular forces (1) **not** weak covalent bonds between layers **ignore** graphite has layers held loosely together
	(c)		**any two from:** (diamond) has a high melting point (1) (diamond) is very hard (1)	2	 **ignore** other properties from the table **allow** (diamond) is a good thermal conductor (1)
			Total	**5**	