4.2 Resonance, Shapes & Giant Structures

Question Paper

Course	DP IB Chemistry
Section	4. Chemical Bonding & Structure
Topic	4.2 Resonance, Shapes & Giant Structures
Difficulty	Easy

Time allowed: 70

Score: /51

Percentage: /100

Question 1a

a)
Yellow phosphorus reacts with chlorine to form phosphorus trichloride, PCl_3.
i)
Draw the Lewis (electron dot) structure of phosphorus trichloride.

[1]

ii)
Predict the Cl-P-Cl bond angle and molecular geometry of the phosphorus trichoride molecule.

[2]

[3 marks]

Question 1b

b)
Phosphorus trichloride, PCl_3, can form a co-ordinate bond with a hydrogen ion to form $HPCl_3^+$.
i)
Draw the Lewis (electron dot) structure of $HPCl_3^+$.

[2]

ii)
Predict the bond angle and molecular geometry of $HPCl_3^+$.

[2]

[4 marks]

Question 1c

c)
BCl_3 has three electron domains in a trigonal planar structure.
BCl_3 is not a polar molecule, but PCl_3 is.
Explain this difference using section 8 of the Data booklet.

[4]

[4 marks]

Question 1d

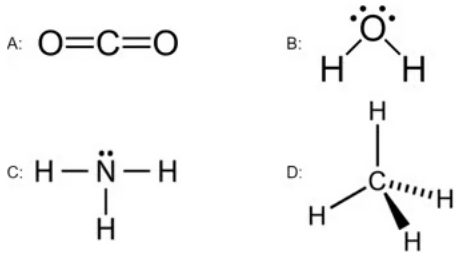
d)
PCl_4^+ has the same electron domain geometry as $HPCl_3^+$.
Explain why PCl_4^+ is not a polar molecule.

[2]

[2 marks]

Question 2a

a)
This question is about the geometry of a number of common molecules.



i)
Which molecule(s) has/ have tetrahedral structures with respect to the electron domain geometry?

[1]

ii)
What is the molecular geometry of CO_2?

[1]

iii)
Draw the 3D representation of ammonia, NH_3.

[1]

[3 marks]

Question 2b

b)
Estimate the H-O-H bond angle in water, H_2O, using VSEPR theory.
Explain your answer.

[3]

[3 marks]

Question 2c

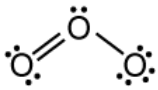
c)
Suggest a way in which the bond angle in ammonia / NH_3 could become 109.5° and explain your answer.

[3]

[3 marks]

Question 2d

d)
Ozone, O_3, is another simple molecule which has the following structure:



i)
Estimate the O-O-O bond angle in ozone using VSEPR theory.

[1]

ii)
Explain why the actual bond lengths present in ozone are equal.

[2]

[3 marks]

Question 3a

a)
Carbon has three naturally occurring allotropes; diamond, graphite and buckminsterfullerene, C_{60}.
State how many atoms each carbon is directly bonded to in each of the allotropes, explaining any differences.

[4]

[4 marks]

Question 3b

b)
Describe the differences in the structures of the three allotropes of carbon.

[3]

[3 marks]

Question 3c

c)
Describe and explain the differences in electrical conductivity between the three allotropes of carbon.

[4]

[4 marks]

Question 3d

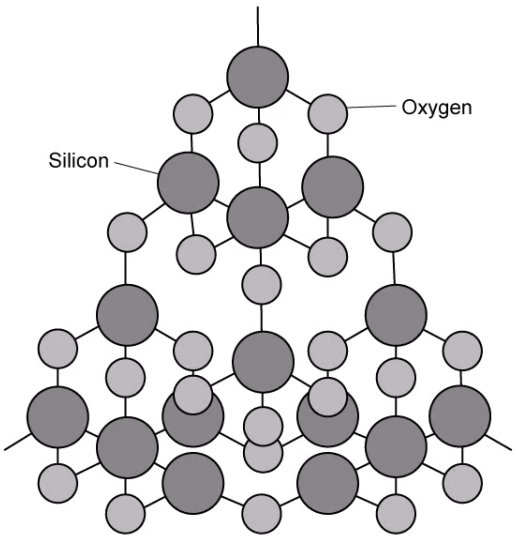
d)
Graphene can be made from graphite.
Describe a similarity and difference between these two structures.

[2]

[2 marks]

Question 4a

a)
Silicon and carbon are in the same group of the Periodic Table. They both form covalent bonds.



O=C=O (carbon dioxide)

Both silicon and carbon form dioxides, but silicon dioxide has a melting point of 1710 °C whilst carbon dioxide has a melting point of -78 °C.
Explain this difference with reference to the structure and bonding present in each dioxide.

[4]

[4 marks]

Question 4b

b)
How many oxygen atoms are bonded to each carbon and to each silicon?
Explain how this links to the formula of each compound.

[3]

[3 marks]

Question 4c

c)
Predict the O-C-O and O-Si-O bond angles respectively in CO_2 and in SiO_2.

[2]

[2 marks]

Question 4d

d)
Predict and explain the solubility of both SiO_2 and CO_2 in water.

[4]

[4 marks]