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	Medium

Time allowed: 80

Score: /61

Percentage: /100

Question 1a

a) Draw the structure of silicon dioxide and state the type of bonding present.

[2 marks]

Question 1b

b) Describe the similarities and differences you would expect in the properties of silicon and diamond.

[3 marks]

Question 1c

c) The boiling point of diamond is 3550 ℃, but for carbon dioxide it is -78.5 ℃. Both are covalent substances.

Explain this difference with reference to structure and bonding.

[4 marks]

Question 1d

d) Silicon dioxide has a similar name to carbon dioxide, but its boiling point is 2230 °C.

Briefly outline the reason for this difference.

[2 marks]

Question 2a

a) In 1996 the Nobel prize in Chemistry was awarded for the discovery of a new carbon allotrope, known as fullerenes.

Outline the structure of buckminsterfullerene.

[2 marks]

Question 2b

b) Like carbon dioxide, graphite is also a covalent substance, but it is a solid at room temperature. Graphite has a melting point of around 3600 °C.

Describe the structure and bonding of graphite and explain why it has such a high melting point.

[5 marks]

Question 2c

c) Graphite is made purely of carbon, a non-metal, yet it conducts electricity. Diamond, which is also made purely of carbon, cannot conduct electricity.

(i) Explain this difference in electrical conductivity between graphite and diamond.

(ii) Give one other difference in the properties of graphite and diamond.

[4 marks]

Question 2d

d) Graphite is soft and so is used as a lubricant, whereas diamond is hard and so is used in many cutting tools. Both are giant covalent structures.

Explain this difference with reference to structure and bonding.

[4 marks]

Question 3a

a) The Valence Shell Electron Pair Repulsion Theory (VSEPR) is used to predict the shapes of many chemical molecules.

Describe the main features of the VSEPR theory for predicting shapes of molecules.

[3 marks]

Question 3b

b) State and explain the bond angle F-O-F in OF_2.

[3 marks]

Question 3c

c) Deduce whether each of the three molecules oxygen difluoride, OF_2, phosphorus trifluoride, PF_3, and boron trichloride, BCl_3, are polar or non-polar.
Give a reason in each case.

[3 marks]

Question 3d

d) Predict and explain the shapes and bond angles of the following molecules:

(i) BF_3

(ii) NBr_3

[4 marks]

Question 4a

a) Ethene, C_2H_4, and hydrazine, N_2H_4, are hydrides of adjacent elements in the periodic table.

State and explain the H—C—H bond angle in ethene and the H—N—H bond angle in hydrazine.

[5 marks]

Question 4b

b) Hydrazine can be oxidised to form diimide, which is a useful compound used in organic synthesis.

Deduce the molecular geometry of diimide, N_2H_2, and estimate its H–N–N bond angle.

[2 marks]

Question 4c

c) Explain whether ethene and hydrazine are polar or non-polar.

[4 marks]

Question 4d

d) Hydrazine forms a cation with an ethane-like structure called hydrazinediium, $N_2H_6^{2+}$.

Predict the value of the H–N–H bond angle in $N_2H_6^{2+}$.

[1 mark]

Question 5a

a) Draw the resonance structures for the following ions:

(i) Methanoate, $HCOO^-$.

(ii) Nitrate(III), NO_2^-.

[2 marks]

Question 5b

b) Deduce the resonance structures of the carbonate ion, giving the shape and the oxygen-carbon-oxygen bond angle.

[3 marks]

Question 5c

c) In December 2010, researchers in Sweden announced the synthesis of N,N–dinitronitramide, $N(NO_2)_3$. They speculated that this compound, more commonly called trinitramide, may have significant potential as an environmentally friendly rocket fuel oxidant.

Deduce the N–N–N bond angle in trinitramide and explain your reasoning.

[3 marks]

Question 5d

d) Predict, with an explanation, the polarity of the trinitramide molecule.

[2 marks]