14.1 More Structures & Shapes

Question Paper

Course	DP IB Chemistry
Section	14. Chemical Bonding & Structure (HL only)
Topic	14.1 More Structures & Shapes
Difficulty	Medium

Time allowed: 60

Score: /45

Percentage: /100

Question 1a

a)
Phosphorus tribromide and sulfur tetrafluoride are two colourless compounds which both react with water to form toxic products.

Deduce the Lewis(electron dot) structure of both molecules.

[2 marks]

Question 1b

b)
Predict the shapes of the two molecules of phosphorus tribromide and sulfur tetrafluoride

[2 marks]

Question 1c

c)
Explain why both phosphorus tribromide and sulfur tetrafluoride are polar.

[2 marks]

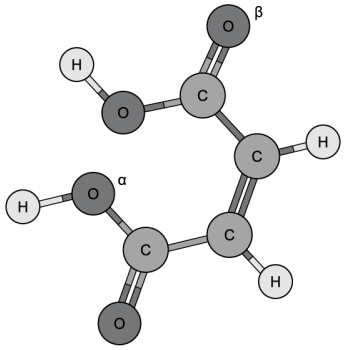
Question 1d

d)
Compare the formation of a sigma (σ) and a pi (π) bond between two carbon atoms in a molecule.

[2 marks]

Question 2a

a)
But-2-ene-1,4-dioic acid exists as both cis and trans isomers. The cis isomer is shown below



Describe the type of covalent bond between carbon and hydrogen in the molecule shown above and how it is formed.

[2 marks]

Question 2b

b)
Identify how many sigma bonds and how many pi (π) bonds are present in cis but-2-ene-1,4-dioc acid.

[2 marks]

Question 2c

c)
Draw the Lewis structures, predict the shape and deduce the bond angles for xenon tetrafluoride.

[3 marks]

Question 2d

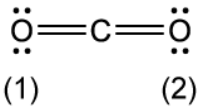
d)
Compare the polarity of xenon tetrafluoride with chlorine trifluoride.

[3 marks]

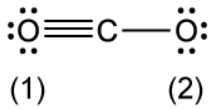
Question 3a

a)
Carbon dioxide can be represented by at least two resonance structures, **I** and **II**.

I



II



Calculate the formal charge on each oxygen atom in the two structures.

Structure	**I**	**II**
O atom labelled (1)		
O atom labelled (2)		

[2 marks]

Question 3b

b)
Deduce, giving a reason, the more likely resonance structure from part a)

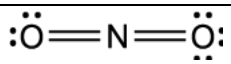
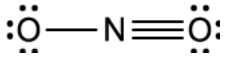
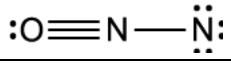
[2 marks]

Question 3c

c)
Nitrous oxide can be represented by different Lewis (electron dot) structures.

Deduce the formal charge (FC) of the nitrogen and oxygen atoms in three of these Lewis (electron dot) structures, **A**, **B** and **C**, represented below.

LHS: atom on the left-hand side; RHS: atom on the right-hand side

	Lewis (electron dot) structure	FC of O on LHS	FC of central N	FC of N on RHS
A				
B				
C				

[3 marks]

Question 3d

d)
Based on the formal charges assigned in part c), deduce which Lewis (electron dot) structure of N_2O (A, B, or C) is the preferred.

Explain another factor that also must be taken into account in determining the preferred structure.

[3 marks]

Question 4a

a)
Use the concept of formal charge to explain why BF_3 is an exception to the octet rule.

[2 marks]

Question 4b

b)
Compounds containing two different halogen atoms bonded together are called interhalogen compounds. They are interesting because they contain halogen atoms in unusual oxidation states. One such compound is BrF_3.

Deduce the electron domain geometry and molecular geometry of BrF_3.

[2 marks]

Question 4c

c)
Give the approximate bond angle(s) and a valid Lewis (electron dot) structure for BrF_3.

[2 marks]

Question 4d

d)
Explain why bromine trifluoride, BrF_3 has its lone pairs of electrons located in equatorial positions.

[2 marks]

Question 5a

a)
Draw two different Lewis (electron dot) structures for SO_4^{2-}, one of which obeys the octet rule for all its atoms, the other which has an octet for S expanded to 12 electrons.

[2 marks]

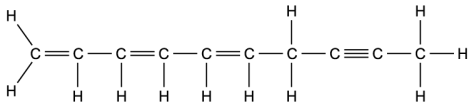
Question 5b

b)
Explain which of the two SO_4^{2-} structures is preferred using formal charges.

[2 marks]

Question 5c

c)
Consider the molecule shown below.

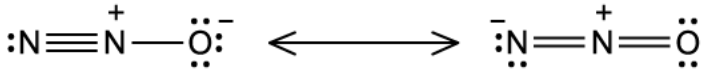


Identify the number of sigma and pi bonds in this molecule.

[2 marks]

Question 5d

d)
One of the intermediates in the reaction between nitrogen monoxide and hydrogen is dinitrogen monoxide, N_2O. This can be represented by the resonance structures below



Analyse the bonding in dinitrogen monoxide in terms of sigma and pi bonds.

[3 marks]