14.2 Further Aspects of Bonding

Question Paper

Course	DP IB Chemistry
Section	14. Chemical Bonding & Structure (HL only)
Topic	14.2 Further Aspects of Bonding
Difficulty	Hard

Time allowed: 60

Score: /50

Percentage: /100

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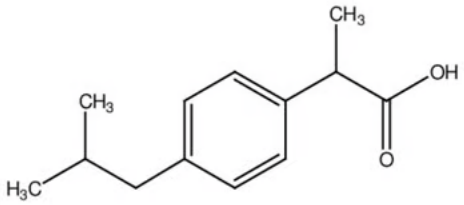
Question 1a

a)
Ibuprofen is a common non-steroidal anti-inflammatory drug (NSAID). It contains a benzene ring and a carboxylic acid at the end of one of the branches.



Deduce the number of resonance structures possible in the deprotonated form of ibuprofen.

[1]

[1 mark]

Question 1b

b)
Deduce the number of:

i)
Sigma (σ) bonds in ibuprofen

[1]

ii)
Pi (π) electrons in ibuprofen

[1]

[2 marks]

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Question 1c

c)
The ibuprofen molecule contains both sp^3 and sp^2 hybridised orbitals.

i)
Identify how many sp^3 hybrid orbitals are present.

[1]

ii)
Identify how many sp^2 hybrid orbitals are present.

[1]

[2 marks]

Question 1d

d)
Explain why the benzene ring is a regular, planar hexagon.

[3]

[3 marks]

Question 2a

a)
2-hydroxypropanenitrile, $CH_3CHOHCN$, is a hydroxynitrile that can be formed from ethanal in a nucleophilic addition reaction.

Deduce the number of sigma (σ) and pi (π) bonds in a molecule of 2-hydroxypropanenitrile.

[2]

[2 marks]

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Question 2b

b)
Deduce the number of sp^3, sp^2 and sp hybrid orbitals in a molecule of 2-hydroxypropanenitrile.

[3]

[3 marks]

Question 2c

c)
Describe how the concept of hybridisation can be used to explain the formation of the triple bond and C-C-N bond angle in 2-hydroxypropanenitrile.

[5]

[5 marks]

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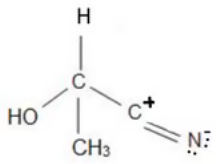
Question 2d

d)

Explain why, despite the high electron density in the triple bond, the triple bonded nitrile group is a more stable structure than the following alternative Lewis structure:



[3]

[3 marks]

Question 3a

a)

Predict whether ozone, O_3, is a polar or non-polar molecule. Explain your choice.

[4]

[4 marks]

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Question 3b

b)
Ozone can be both formed and depleted by reactions with an oxygen radical, which is an oxygen atom.
Draw a diagram to support an explanation of why an oxygen atom is a radical.

[2]

[2 marks]

Question 3c

c)
Ozone can be made and depleted in reactions involving other forms of oxygen only.

i)
Write one equation to show the natural formation of ozone in the atmosphere.

[1]

ii)
Write two equations to show the steps in the natural depletion of ozone in the atmosphere.

[2]

[3 marks]

Question 3d

d)
For each of the equations in part c), deduce whether the reaction is endothermic or exothermic and explain your choices.

[3]

[6 marks]

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Question 4a

a)
Trichlorofluoromethane is a banned CFC, as it can lead to accelerated ozone depletion.
Write equations to show the mechanism of catalysis of ozone depletion by trichlorofluoromethane.

[3]

[3 marks]

Question 4b

b)
It is possible for the chlorine radical to undergo a termination reaction where it joins with another organic radical available, and can reform the original molecule:

$$Cl^{\bullet}(g) + CCl_2F^{\bullet}(g) \rightarrow CCl_3F(g)$$

Explain why this is not a solution to the depletion of ozone.

[4]

[4 marks]

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Question 4c

c)
CFCs have been replaced by other inert compounds, including FCs, which are fluorocarbons.

Explain why these do not pose a threat to ozone depletion.

[3]

[3 marks]

Question 4d

d)
Compounds containing iodine and carbon are usually broken down lower in the atmosphere, beneath the ozone layer.
Suggest why iodocarbons are not popular alternatives to CFCs.

[4]

[4 marks]

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