Shapes of Molecules & Ions

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Shapes of Molecules & Ions
Booklet	Question Paper

Time Allowed: **38 minutes**

Score: /31

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 What are the shapes of the BF3 and PH3 molecules?

		BF_3	PH_3
☒	**A**	pyramidal	pyramidal
☒	**B**	pyramidal	trigonal planar
☒	**C**	trigonal planar	pyramidal
☒	**D**	trigonal planar	trigonal planar

(Total for Question 1 = 1 mark)

2 What are the C—C—C bond angles in diamond and graphite?

		Diamond	Graphite
☒	**A**	109.5°	109.5°
☒	**B**	109.5°	120°
☒	**C**	120°	109.5°
☒	**D**	120°	120°

(Total for Question 2 = 1 mark)

3 Which of these species has bond angles equal to 90°?

☒ **A** BeF_4^{2-}
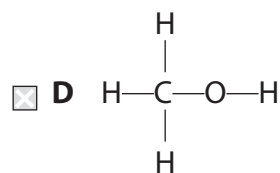
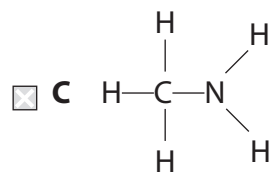☒ **B** $SiCl_4$

☒ **C** NH_4^+

☒ **D** SF_6

(Total for Question 3 = 1 mark)

4   Which of these species does **not** have a trigonal pyramidal shape?

☒   **A** BF_3

☒   **B** NH_3

☒   **C** H_3O^+

☒   **D** PH_3

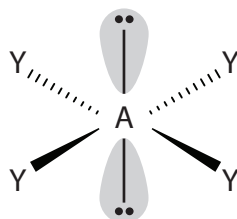**(Total for Question 4 = 1 mark)**

5   Which of the following molecules has the greatest number of lone pairs of electrons?

☒   **A**
```
    H
    |
H—C═O
```

☒   **B**
```
    H
    |
H—C—Cl
    |
    H
```

☒   **C**
```
    H    H
    |   /
H—C—N
    |   \
    H    H
```

☒   **D**
```
    H
    |
H—C—O—H
    |
    H
```
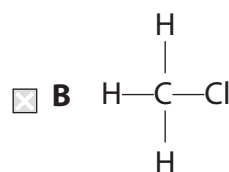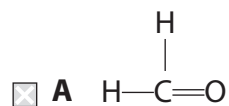
(Total for Question 5 = 1 mark)

6 This diagram represents a square planar structure:

Which of these species has this square planar shape?

☒ **A** SF_4

☒ **B** NH_4^+

☒ **C** XeF_4

☒ **D** AlH_4^-

(Total for Question 6 = 1 mark)

7 Which of the following species has the smallest bond angle?

☒ **A** CO_2

☒ **B** H_2O

☒ **C** SO_3

☒ **D** H_3O^+

(Total for Question 7 = 1 mark)

8 Diamond, buckminsterfullerene and graphite are all forms of carbon.
A significant difference between buckminsterfullerene and the other two forms is that only buckminsterfullerene

☒ **A**   has good electrical conductivity.

☒ **B**   has a precise molecular formula.

☒ **C**   is tough and rigid.

☒ **D**   has some carbon atoms with only three covalent bonds.

(Total for Question 8 = 1 mark)

9 Sulfur can combine with fluorine to form a number of different compounds, some of which are shown below. From the diagrams given, which compound will **not** be polar?

⊠ **A** Disulfur difluoride, S_2F_2
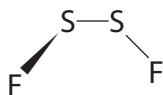
⊠ **B** Sulfur difluoride, SF_2

⊠ **C** Sulfur tetrafluoride, SF_4
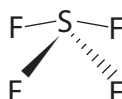
⊠ **D** Sulfur hexafluoride, SF_6
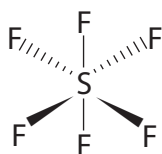
(Total for Question 9 = 1 mark)

10   The H–O–H bond angle in an oxonium ion, H_3O^+, is approximately

⊠ **A** 104.5°

⊠ **B** 107°

⊠ **C** 109.5°

⊠ **D** 120°

(Total for Question 10 = 1 mark)

11 The bond angles within a molecule of tetrachloromethane result from repulsion between

☒ **A** atoms.

☒ **B** bonded pairs of electrons.

☒ **C** atomic nuclei.

☒ **D** lone pairs of electrons.

(Total for Question 11 = 1 mark)

12 When using a solid to make a solution of accurately known concentration for use in a titration, the solid must

☒ **A** dissolve slowly.

☒ **B** have variable water of crystallization.

☒ **C** not absorb moisture from the air.

☒ **D** have a small molar mass to increase the accuracy of weighing.

(Total for Question 12 = 1 mark)

13 Iodine pentoxide, I_2O_5, is a white crystalline solid. It is formed by heating HIO_3 to about 200 °C in a stream of dry air. The reaction is shown below.
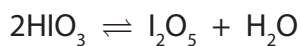
$$2HIO_3 \rightleftharpoons I_2O_5 + H_2O$$

(a) (i) Is this production of iodine pentoxide a redox reaction? Justify your answer by stating the oxidation number of iodine in both of these compounds.

(1)

....

....

(ii) Suggest why it is important to have a stream of **dry** air.

(1)

....

....

(iii) Above 300 °C, iodine pentoxide decomposes to form iodine and oxygen. Write the equation for this decomposition. State symbols are not required.

(1)

(iv) In iodine pentoxide, each iodine atom is bonded to three oxygen atoms and one of these oxygen atoms is bonded to both iodine atoms as shown in the layout below.

Complete the dot and cross diagram for the molecule, using dots for the oxygen electrons and crosses for the iodine electrons.

In this molecule, each iodine atom has twelve electrons in its outer shell. Show outer shell electrons only.

(2)

<div align="center">

O   O

I   O   I

O   O

</div>
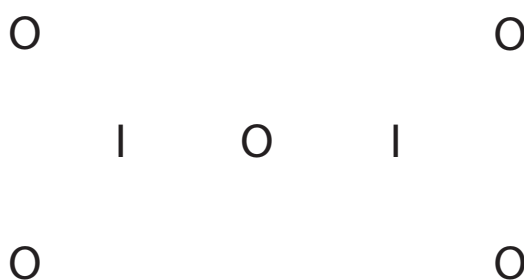
(v) The shape around the iodine is similar to that around the nitrogen in ammonia, NH_3. Suggest a value for the O – I – O bond angle and the name of the shape around the iodine atom.

(2)

O – I – O bond angle ....

Shape ....

(b) Iodine pentoxide is used as a reagent to determine the amount of carbon monoxide present in a gaseous sample. The sample is passed over heated iodine pentoxide. The products of this process are carbon dioxide and iodine.

The iodine formed is extracted and added to an excess of sodium thiosulfate solution of known concentration. The remaining sodium thiosulfate is then determined by titration with a solution of iodine of known concentration.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$
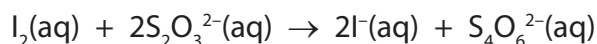
In an analysis, a 2.00 m³ sample of gas was used and the resultant iodine extracted and added to 20 cm³ of a 0.0400 mol dm⁻³ solution of sodium thiosulfate, an excess.

The resultant solution was then titrated against a solution of iodine of concentration 0.0100 mol dm⁻³. The volume of iodine solution required for complete reaction was 21.60 cm³.

(i) Calculate the number of moles of iodine present in 21.60 cm³ of the iodine solution. Give your answer to **three** significant figures.

(1)

(ii) Deduce the number of moles of sodium thiosulfate that reacted with this titrated amount of iodine.

(1)

(iii) Calculate the number of moles of sodium thiosulfate to which the iodine was **initially** added.

(1)

(iv) From your answers to parts (b)(ii) and (b)(iii), determine the number of moles of sodium thiosulfate that reacted with the extracted iodine.

(1)

(v) Use your answer to part (b)(iv) to determine the number of moles of extracted iodine.

(1)

(vi) Write the balanced equation for the reaction between iodine pentoxide and carbon monoxide. State symbols are not required.

(1)

(vii) Calculate the volume, in dm^3, of carbon monoxide in the original gaseous sample.

Assume that the molar gas volume of any gas under the experimental conditions is 24 dm^3 mol^{-1}.

(2)

(viii) State how this procedure could be amended to produce results that are more reliable.

(1)

....

....

*(c) Carbon monoxide is an atmospheric pollutant arising from the incomplete combustion of fossil fuels.

(i) State how motor vehicles have been adapted to reduce the production of this pollutant.

(1)

....

....

(ii) Explain the meaning of the term 'carbon-neutral' and give an example of a motor vehicle fuel that can be classified in this way.

(2)

....

....

....

....

(Total for Question 13 = 19 marks)