3. Chemical bonding

3.5 Shapes of molecules

Paper 2

Question Paper

1 Tellurium is an element in Group 16. The most common isotope of tellurium is ^{130}Te. Its electronic configuration is [Kr] $4d^{10}\ 5s^2\ 5p^4$.

(e) Te reacts with F_2 at 150 °C to form TeF_x. Molecules of TeF_x are octahedral with bond angles of 90°.

Explain why TeF_x is octahedral with bond angles of 90°.

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.....

..... [2]

2 Some of the common chlorides of Period 3 elements are shown in the list.

$NaCl$ $MgCl_2$ $AlCl_3$ $SiCl_4$ PCl_5

(d) Sulfur, S_8, reacts with chlorine to form several different chlorides. The most common are S_2Cl_2 and SCl_2. SCl_2 forms when sulfur reacts with an excess of chlorine.

reaction **1** $S_8(s) + 4Cl_2(g) \rightarrow 4S_2Cl_2(l)$ $\Delta H_r = -58.2\,kJ\,mol^{-1}$

reaction **2** $S_2Cl_2(l) + Cl_2(g) \rightleftharpoons 2SCl_2(l)$ $\Delta H_r = -40.6\,kJ\,mol^{-1}$

Fig. 3.1 shows the two structural isomers of S_2Cl_2.

isomer **I** isomer **II**

Fig. 3.1

(v) Suggest a value for the Cl–S–S bond angle in isomer **I**. Explain your answer.

bond angle = ... °

explanation .....

.....

.....

.....

[2]

3 Calcium nitrate, $Ca(NO_3)_2$, reacts with ammonia, carbon dioxide and water to form a mixture of ammonium nitrate and calcium carbonate.

$$Ca(NO_3)_2 + 2NH_3 + CO_2 + H_2O \rightarrow 2NH_4NO_3 + CaCO_3$$

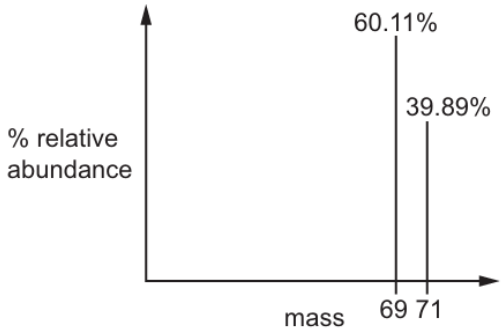
(c) Complete the table to name the shape and give the bond angle of each species.

	name of shape	bond angle / °
CO_2		
NH_3		
H_2O		

[3]

4 Gallium is an element in Group 13.

A sample of gallium is analysed using a mass spectrometer. The mass spectrum produced is shown.



(d) When gallium is heated in excess chlorine, gallium trichloride, $GaCl_3$, is made.

Draw the shape of the gallium trichloride molecule and suggest the Cl–Ga–Cl bond angle.

shape of molecule

bond angle .....

[2]

5 The reducing agent $LiAlH_4$ can be synthesised by reacting aluminium chloride with lithium hydride, LiH.

(a) (ii) At 1000 °C, aluminium chloride exists as $AlCl_3$(g).

State the bond angle in $AlCl_3$(g).

..... ° [1]

6 PCl_5, PCl_3 and NCl_3 are halides of Group 15 elements.

(d) NCl_3 is a yellow liquid that can be used to bleach flour.

(i) Predict the shape of the NCl_3 molecule and the Cl–N–Cl bond angle.

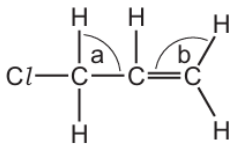
shape .....

bond angle .....

[2]

7 The structure of compound **Y** is shown.

Y



(b) Predict the values for the bond angles a and b shown in the diagram.

a .....

b .....

[2]

8 **(c)** Selenium is a Group 16 element which shows similar chemical reactions to sulfur.

(i) Selenium reacts with fluorine to form SeF_6 molecules.

Predict the shape of a molecule of SeF_6.

..... [1]