

# Chapter 13: Nitrogen and sulfur

## Homework questions

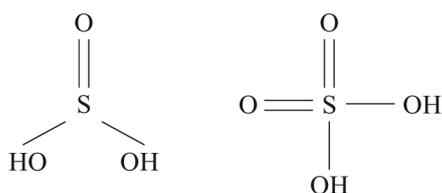
- 1 a Hydrazine has the formula  $\text{N}_2\text{H}_4$ . It is a colourless volatile liquid and has been used as a propellant (fuel) in rockets.
- Draw a dot-and-cross diagram for a molecule of hydrazine,  $\text{H}_2\text{N}-\text{NH}_2$ . [3]
  - What is the  $\text{H}-\text{N}-\text{H}$  bond angle in hydrazine? [1]
  - Hydrazine has the same relative molecular mass as oxygen. However, hydrazine is a liquid at room temperature whilst oxygen is a gas. Explain this difference in properties. [3]
  - When hydrazine burns in air it forms water and nitrogen. Write the balanced symbol equation for this reaction. [1]
  - Using the data for bond enthalpies given in the table below, find the enthalpy change for the reaction in part iv. [4]

Bond	N–N	N–H	O=O	$\text{N}\equiv\text{N}$	O–H
Bond enthalpy / $\text{kJ mol}^{-1}$	160	390	496	994	460

- Give the energy produced when 6.4 kg of hydrazine is burned in oxygen. [3]
  - Give **two** reasons why hydrazine would make a good fuel. [2]
- b Explain why hydrazine reacts with acids. [3]
- c Hydrazine forms a positive ion  $\text{N}_2\text{H}_5^+$  with acids. Explain why there are two  $\text{H}-\text{N}-\text{H}$  bond angles in this ion. [4]

Total = 24

- 2 The element sulfur forms different oxides and oxy-acids. Two of these acids are sulfuric(IV) acid ( $\text{H}_2\text{SO}_3$ ) and sulfuric(VI) acid ( $\text{H}_2\text{SO}_4$ ).
- a The structures of both acids are given below:



- Draw a dot-and-cross diagram showing the electrons around the central sulfur atom in  $\text{H}_2\text{SO}_3$ . [3]
  - Draw the molecule of  $\text{H}_2\text{SO}_3$  and state the bond angle present. [3]
- b
- Draw a dot-and-cross diagram showing the electrons around the central sulfur atom in  $\text{H}_2\text{SO}_4$ . [2]
  - Draw the molecule of  $\text{H}_2\text{SO}_4$  and state the bond angle present. [2]

- c** In order to investigate the reaction between chlorine and the sulfate(IV) ion ( $\text{SO}_3^{2-}$ ), a student bubbled chlorine through a solution of sodium sulfate(IV) and then divided the resulting solution into three portions.

He then carried out the following tests:

- I** To the first portion he added aqueous silver nitrate solution acidified with nitric acid. A white precipitate was obtained which was soluble in ammonia.
- II** To the second portion he added aqueous barium chloride solution acidified with hydrochloric acid. A white precipitate was produced.
- III** To the third portion he added universal indicator solution. The solution turned red.

Using the above information:

- i** Identify the ions produced in this reaction. Give reasons for your answers. [6]
- ii** Write equations to show what happened in tests I and II. [4]
- iii** Write an ionic equation for the overall reaction and explain why it is a redox reaction. [4]
- d** In the presence of copper metal, concentrated sulfuric(VI) acid acts as an oxidising agent. One of the products of the reaction is sulfur dioxide.
- i** Complete the ionic half equations below:
- $\text{Cu} \rightarrow \underline{\hspace{1cm}} + 2\text{e}^-$  [1]
- $\text{H}_2\text{SO}_4 + \text{H}^+ + \underline{\hspace{1cm}}\text{e}^- \rightarrow \underline{\hspace{1cm}} + \text{SO}_2$  [1]
- ii** Write the complete balanced ionic equation for the reaction. [2]

Total = 28