Reaction between zinc powder and sulfur

Learning objectives

1. Recall the definitions of elements, mixtures and compounds
2. Describe the changes that take place during a chemical reaction
3. Write chemical equations for the reactions
4. Use energy changes to decide if a reaction is exothermic or endothermic

Introduction

When chemical reactions occur, atoms are rearranged to form different substances. The original elements, once combined, have different chemical and physical properties than when they were reactants.

Teacher demonstration

In this demonstration, you will observe an exothermic reaction of two elements, zinc and sulfur, to form the compound zinc sulfide. The two solids are mixed and heated in a test tube (or ignition tube) and changes in their properties can be observed. Careful observations will also reveal that some by-products are formed.

Complete the table.

Substance	Observations
Zinc	
Sulfur	
Zinc + sulfur mixture being heated	
Zinc sulfide	

Questions

1. Choose the correct word to complete the sentences below:

Before heating, zinc is coloured **light blue / yellow** and sulfur is coloured **light blue / yellow**.

After heating, the colour of the product is **pale yellow / white**. This is a sign of a **chemical / physical** change. A mixture of two **elements / compounds** have reacted together to form a new **mixture / compound**.

2. In the reaction you observed, zinc (Zn) reacted with sulfur (S) to produce zinc sulfide (ZnS).

(a) Write a word equation for this reaction.

_____ + _____ → _____ _____

(b) Write a symbol equation for this reaction. Include state symbols.

$Zn(s)$ + _____ → _____

3. The reaction between zinc and sulfur is exothermic.

(a) Describe the observations that support this statement. *Hint: Exothermic means that energy is given out during the reaction.*

_____

_____

(b) Use the words to complete the sentences.

A word may be used more than once,

energy **heat** **atoms** **break** **formed**

At the start of the reaction _____ was needed to _____ the bonds in the reactants.

The _____ rearranged and _____ was given out as the new bonds _____.

During the reaction _____ and sound _____ were given out to the surroundings. Therefore, the reaction was exothermic.

(c) Complete the sentence.

The reaction needed to be heated at the start _____

_____

_____

4. During the zinc and sulfur reaction, two by-products were formed, zinc oxide, ZnO, and sulfur dioxide, SO_2.

(a) State the meaning of the term by-product.

_____

(b) Circle all the compounds present in the solid mixture at the end of the main chemical reaction.

zinc **sulfur** **zinc sulfide**

zinc oxide **sulfur dioxide**

(c) Write a word equation for the formation of each by-product.

_____ + _____ → zinc oxide

sulfur + _____ → _____

(d) Identify the reactants for each by-product and explain where each reactant came from.

Hint: The reactants come before the arrow.

_____

_____

_____

_____

5. The percentage yield of a reaction is calculated using the equation:

$$\%\ \text{yield} = \frac{\text{actual yield}}{\text{theoretical yield}}$$

Suggest why this reaction has a yield of less than 100%.

_____

_____

6. Zinc can be obtained from zinc sulfide by a smelting process.

Step 1 The zinc ore is roasted in air, converting it to zinc oxide.

Step 2 Coke and the roasted ore are fed into the top of the furnace, and air is blasted in at the bottom. The zinc oxide is reduced to zinc by carbon monoxide gas.

Step 3 To prevent the hot zinc from being re-oxidised, it is sprayed with molten lead, forming a mixture. As the mixture cools, the zinc separates out.

(a) Explain why it is so difficult to extract zinc from zinc sulfide.

_____

_____

(b) Write a word equation to show the process occurring in **step 1**.

_____ + _____ → _____ + sulfur dioxide

_____ _____

(c) Write a word equation to show the process occurring in **step 2**.

_____ + _____ → _____ + carbon dioxide

_____ _____

(d) Explain why the zinc can be easily separated out in **step 3**.

_____

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