

# Chemistry 1B | Lab 1: Properties of Sulfur

## 化学1B | 实验1: Sulfur的性质

### Experiment Purpose | 实验目的

This is an **investigative experiment** designed to help you:

- Explore the properties and reactions of sulfur through hands-on observation
- Investigate characteristic chemical reactions through systematic experimentation
- Develop understanding of elemental properties and reactivity
- Practice safe laboratory techniques with reactive elements

这是一个**探究性实验**, 旨在帮助你:

- 通过亲手观察探索硫的性质和反应
- 通过系统实验研究特征化学反应
- 培养对元素性质和反应性的理解
- 练习使用活泼元素的安全实验室技术

# Safety Learning | 安全学习

> Inquiry-Based Learning Prompt | 探究式学习提示 > Before starting this experiment, think about the following questions and research the answers. > 在开始实验前, 请思考以下问题并查阅资料。

## Pre-lab Safety Questions | 实验前安全问题

- **Question 1**

– What are the hazards of sulfur dioxide gas? – What are the hazards of sulfur dioxide gas?

- **Question 2**

– How should you safely burn sulfur? What precautions are needed? – How should you safely burn sulfur? What precautions are needed?

- **Question 3**

– What should you do if you inhale sulfur dioxide? – What should you do if you inhale sulfur dioxide?

- **Question 4**

– Why must sulfur combustion be done in a fume hood? – Why must sulfur combustion be done in a fume hood?

- **Question 5**

– How should sulfur-containing waste be disposed of? – How should sulfur-containing waste be disposed of?

## Safety Guidelines | 安全指南

## > CRITICAL SAFETY WARNINGS | 重要安全警告

### • Personal Protection | 个人防护

– Always wear safety goggles and lab coat – 始终佩戴护目镜和实验服 – Use gloves when handling chemicals – 处理化学品时使用手套

### • Chemical Handling | 化学品处理

– Read all labels carefully before use – 使用前仔细阅读所有标签 – Never taste or directly smell chemicals – 绝不可品尝或直接闻化学品

### • Emergency Procedures | 应急程序

– Know the location of safety equipment – 了解安全设备的位置 – Report all accidents immediately – 立即报告所有事故

### • Waste Disposal | 废物处理

– Dispose of chemicals in designated containers – 将化学品放入指定容器 – Never pour chemicals down the drain without permission – 未经许可绝不可将化学品倒入下水道

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## | Experimental Preparation | 实验准备

## Materials and Equipment | 材料与仪器

### Chemicals | 化学药品:

- Sulfur sample or compounds | Sulfur样品或化合物
- Various reagents for testing | 各种测试试剂
- Indicator solutions | 指示剂溶液
- Distilled water | 蒸馏水

## Equipment | 实验仪器:

- Test tubes and test tube holder | 试管和试管夹
  - Beakers (various sizes) | 烧杯 (各种尺寸)
  - Graduated cylinders | 量筒
  - Dropper pipettes | 滴管
  - Stirring rods | 搅拌棒
  - Alcohol lamp | 酒精灯
  - Watch glass | 表玻璃
  - pH paper | pH试纸
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## Experimental Procedure | 实验操作

> Inquiry-Based Learning | 探究式学习 > During the experiment, focus on careful observation of phenomena and think about the questions provided. > 在实验过程中，请仔细观察现象并思考提供的问题。

### Part 1: Initial Observations | 初步观察

#### Procedure | 操作步骤

- Observe the sample | 观察样品

– Examine the physical appearance – 检查物理外观 – Note color, state, and texture – 注意颜色、状态和质地

#### Observations | 观察与记录

Please carefully observe and record:

- Describe the appearance:

描述外观: Your observation | 你的观察: \_\_\_\_\_

## Inquiry Questions | 探究问题

- What can you infer about the substance from its appearance?

从外观你能推断出什么?

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## Part 2: Chemical Reactions | 化学反应

### Procedure | 操作步骤

- Perform test reactions | 进行测试反应

– Add appropriate reagents – 加入适当的试剂 – Observe and record changes – 观察并记录变化

### Observations | 观察与记录

Please carefully observe and record:

- What changes occur?

发生了什么变化? Your observation | 你的观察: \_\_\_\_\_

## Inquiry Questions | 探究问题

- What type of reaction is occurring?

发生了什么类型的反应?

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[Additional experimental parts would be added based on specific element]

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# Experimental Principles | 实验原理

Now that you have completed the experimental procedures and made observations, let's understand the underlying principles.

现在你已经完成了实验操作并进行了观察，让我们来理解其背后的原理。

## 1. Physical Properties | 硫的物理性质

### Allotropes | 同素异形体:

- Rhombic sulfur (斜方硫) – stable at room temperature (室温下稳定)
- Monoclinic sulfur (单斜硫) – stable above 95.5°C (95.5°C以上稳定)
- Plastic sulfur (弹性硫) – amorphous form (无定形)

### Appearance | 外观:

- Yellow solid (黄色固体)
- Brittle (脆的)
- Poor conductor (不良导体) of heat and electricity (热和电的不良导体)

### Melting Point | 熔点:

- 112.8°C (relatively low) (相对较低)

### Solubility | 溶解性:

- Insoluble (不溶) in water (不溶于水)
- Soluble (可溶) in carbon disulfide ( $\text{CS}_2$ ) (溶于二硫化碳)

## 2. Chemical Properties | 化学性质

### (1) Reaction with Oxygen | 与氧气反应

## Combustion in Air | 在空气中燃烧:



- Blue flame (蓝色火焰)
- Pungent odor (刺激性气味)
- Exothermic reaction (放热反应)

## In Pure Oxygen | 在纯氧中:

- More vigorous combustion (更剧烈的燃烧)
- Brighter blue–violet flame (更明亮的蓝紫色火焰)

## (2) Reaction with Metals | 与金属反应

### With Iron | 与铁:



- Must be heated (必须加热)
- Forms black iron sulfide (形成黑色硫化亚铁)

### With Copper | 与铜:



### With Mercury | 与汞:



- Can occur at room temperature (室温下可发生)
- Used to clean up mercury spills (用于清理汞泄漏)

### (3) Reaction with Hydrogen | 与氢气反应



- Requires heating (需要加热)
- Produces toxic H<sub>2</sub>S gas (产生有毒H<sub>2</sub>S气体)

## 3. Sulfur Dioxide (SO<sub>2</sub>) | 二氧化硫

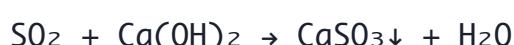
### Properties | 性质:

- Colorless gas (无色气体)
- Pungent, suffocating odor (刺激性窒息气味)
- Toxic (有毒)
- Soluble (可溶) in water (易溶于水)

### Reaction with Water | 与水反应:



### Acidic Oxide Reactions | 酸性氧化物反应:



### Oxidation | 氧化:



### Reducing Properties | 还原性:



- Decolorizes bromine water (使溴水褪色)

### Bleaching | 漂白:

- Bleaches by reduction (通过还原漂白)
- Temporary bleaching (暂时性漂白)
- Color may return (颜色可能恢复)

## 4. Uses of Sulfur and Its Compounds | 硫及其化合物的用途

### Sulfur | 硫:

- Vulcanization of rubber (橡胶硫化)
- Production of sulfuric acid (生产硫酸)
- Fungicides and pesticides (杀菌剂和杀虫剂)
- Gunpowder (火药)

### $\text{SO}_2$ :

- Bleaching agent (漂白剂)
- Food preservative (食品防腐剂)
- Disinfectant (消毒剂)

- Production of H<sub>2</sub>SO<sub>4</sub> (生产H<sub>2</sub>SO<sub>4</sub>)

## 5. Environmental Impact | 环境影响

### Acid Rain | 酸雨:



- Major cause of acid rain (酸雨的主要原因)
- Damages buildings, forests, aquatic life (损害建筑物、森林、水生生物)

### Control Measures | 控制措施:

- Desulfurization of fuels (燃料脱硫)
- Scrubbers in power plants (发电厂洗涤器)
- Use of low-sulfur coal (使用低硫煤)

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## Knowledge Summary | 知识点梳理

### I. Key Properties | 关键性质

#### Physical Properties | 物理性质:

- [Properties will be summarized based on observations]
- [根据观察总结性质]

## Chemical Properties | 化学性质:

- [Reactions will be summarized based on experiments]
- [根据实验总结反应]

## II. Important Reactions | 重要反应

[Key chemical equations from the experiment] [实验中的关键化学方程式]

## III. Applications | 应用

[Practical applications of the element/compounds] [元素/化合物的实际应用]

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## Post-lab Questions | 实验后思考

Based on your observations and understanding of the principles, answer these questions:

- **Observation Analysis | 观察分析**

– What were the most significant observations in this experiment? – 本实验中最重要的观察是什么?

- **Reaction Mechanisms | 反应机理**

– Explain the mechanisms behind the key reactions observed. – 解释观察到的关键反应的机理。

- **Safety Considerations | 安全考虑**

– What safety precautions were most important in this experiment and why? – 本实验中哪些安全预防措施最重要? 为什么?

- Practical Applications | 实际应用

– How are the properties observed in this experiment used in real-world applications? – 本实验中观察到的性质如何在实际应用中使用?

- Comparative Analysis | 比较分析

– How do the properties of this element compare to related substances? – 这个元素的性质与相关物质相比如何?

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### Experiment Completed | 实验完成

Remember to clean all equipment and properly dispose of all chemical waste according to safety guidelines.

记得清洁所有设备并按照安全指南正确处理所有化学废物。