

# Top of the Bench 2025

## Younger Paper

Name: \_\_\_\_\_

School: \_\_\_\_\_

School year: \_\_\_\_\_

*Answer all questions in the spaces provided.*

*You are provided with a Periodic table.*

*You may use a scientific calculator.*

*Write your answers clearly. Show all working.*

*Section A contains questions about general chemical knowledge.*

*Section B contains questions about this year's theme: Air*

*The total marks allocated to the paper are 40 marks (Section A 10 marks, Section B 30 marks)*

*The time allocated to the paper is 40 minutes.*

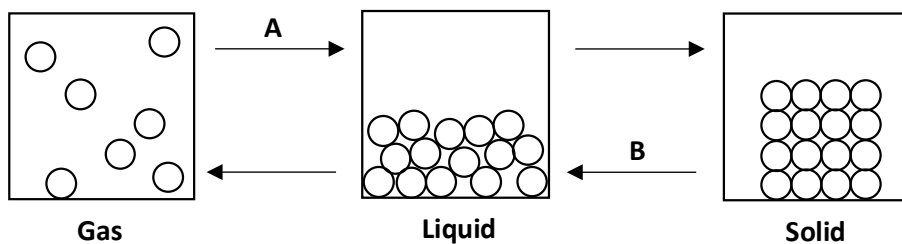
Question	Mark
Section A	
8	
9	
10	
11	
<b>TOTAL</b>	



## SECTION A General chemistry knowledge

1. Label the changes of state **A** and **B** represented by the arrows on **Figure 1**.

[2]



**A** = \_\_\_\_\_ **B** = \_\_\_\_\_

2. Describe the test for **hydrogen** gas.

[1]

---

---

---

3. Complete the word equations for the reactions;

[2]

sodium hydroxide + nitric acid  $\rightarrow$  \_\_\_\_\_ + water

iron oxide + carbon  $\rightarrow$  iron + \_\_\_\_\_

4. Zinc sulfate is a compound containing the elements zinc, sulfur and one other element.

Name the other element in zinc sulfate.

[1]

---

5. Match the chemical to the everyday item it is found in.

Draw **one line** from each chemical to where it is found.

[2]

Chemical	Found in
calcium carbonate, $\text{CaCO}_3$	baking soda
sodium hydrogencarbonate, $\text{NaHCO}_3$	bleach
Sodium hypochlorite, $\text{NaOCl}$	chalk

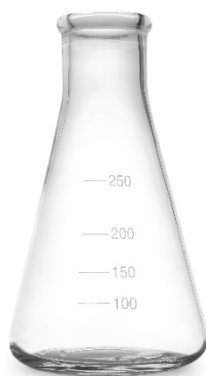
6. Which of the following is **not** a greenhouse gas?

[1]

- ☐ carbon dioxide
- ☐ argon
- ☐ water vapour
- ☐ methane

7. Name the piece of glassware in **Figure 2**.

[1]



**Figure 2**

---

**[Total: 10 marks]**

## SECTION B Questions linked to this year's theme of Air

8. This question is about hot air balloons.



(a) Air is a mixture of \_\_\_\_\_ gases.

One gas in air is oxygen.

Oxygen is an element.

(i) What is meant by 'an **element**'? [1]

---

---

(ii) Another element makes up 78% of air. Name the element. [1]

---

In a hot air balloon, air is trapped inside a balloon.

The air is heated with a burner positioned under the balloon.

(b) Complete the sentences to explain how heating the air causes the hot air balloon to rise.

Use words from the box.

You may use each word more than once. [3]

<b>increases</b>	<b>decreases</b>	<b>stays the same</b>
------------------	------------------	-----------------------

When the air is heated, the volume of the air \_\_\_\_\_ .

The mass of the air \_\_\_\_\_ .

As a result the density of the air \_\_\_\_\_ and the balloon rises.

[Total: 5 marks]

9. This question is about calculating the percentage of oxygen in air.

When iron rusts, water and oxygen in the air react with the iron to form hydrated iron oxide.

(a) Write a word equation for iron rusting.

[1]

---



---

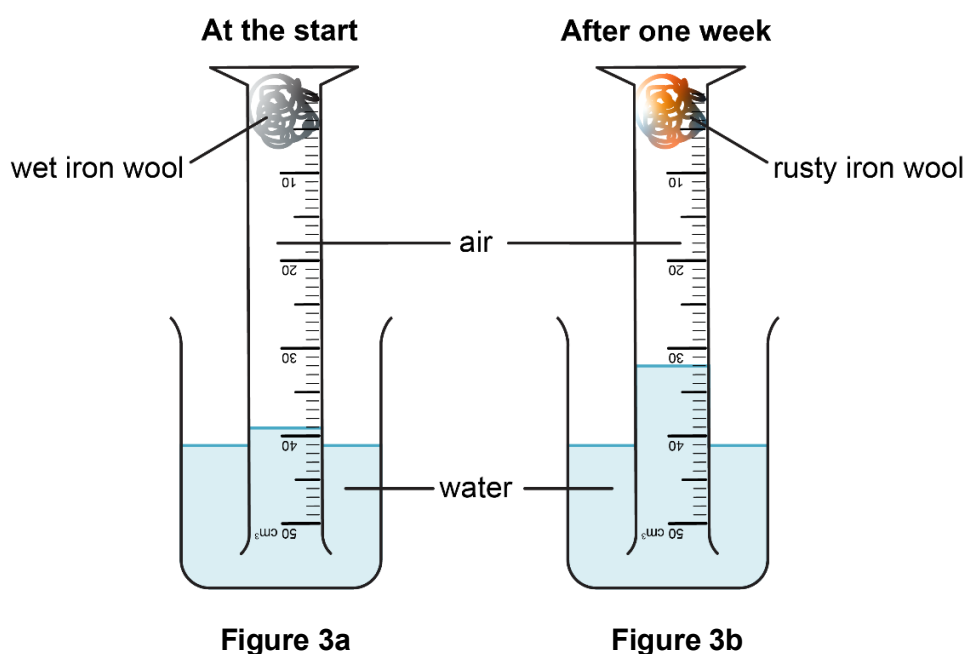
The rusting of iron can be used to find the percentage of oxygen in air.

A student set up the apparatus in **Figure 3a**.

As the iron wool rusts, oxygen is removed from the air and water is drawn up the measuring cylinder.

The student left the apparatus in **Figure 3a** for one week.

**Figure 3b** shows the apparatus after the week.



(b) (i) Complete **Table 1** to show the volume of air in the measuring cylinder in **Figure 3b**.

You can assume the volume occupied by the iron wool is zero.

[1]

	Volume of air in cm <sup>3</sup>
<b>Figure 3a</b> – at the start	39
<b>Figure 3b</b> – after one week	_____

**Table 1**

(ii) Calculate the percentage of oxygen in the air.

Use **Table 1**.

[2]

---

---

---

(c) A different student repeats the experiment.

Their results show that the percentage of oxygen in air is 12%.

The true value for the percentage of oxygen in air is 21%.

Suggest **one** reason why the student's results were below the true percentage.

[1]

---

---

---

**[Total: 5 marks]**

10. This question is about reactions involving oxygen.

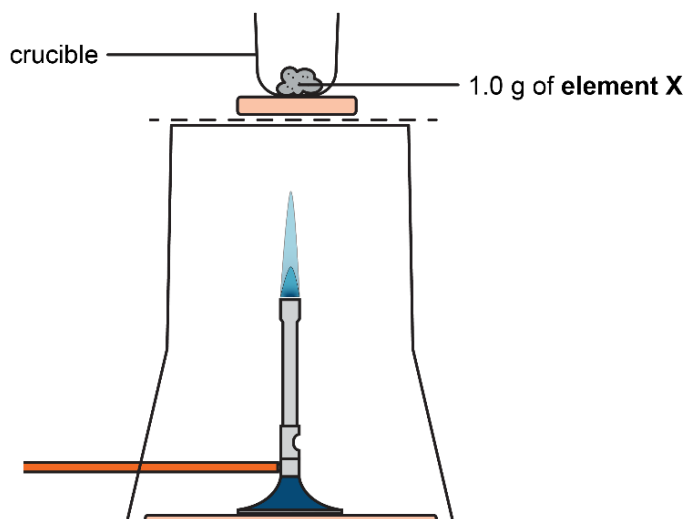


Figure 4

A student investigates the reaction of **three elements**, **X**, **Y** and **Z** with oxygen.

This is the method used;

1. Record the mass of an empty crucible.
2. Add 1.0 g of **element X** in powder form to the crucible.
3. Set up the equipment as in **Figure 4**.
4. Heat the crucible strongly for 5 min using a blue Bunsen flame.
5. Allow the crucible and contents to cool.
6. Record the mass of the crucible and contents.
7. Repeat the steps 1 to 6 with **element Y** and **element Z**.

The student's results are shown in **Table 2**:

	Element X	Element Y	Element Z
Mass of crucible empty in g	12.7	12.7	12.6
Mass of crucible plus 1.0 g of the element in g	13.7	13.7	13.6
Mass of crucible plus contents after heating for 5 min in g	13.0	13.7	14.1
Change in mass during reaction in g	-0.7	0.0	_____

Table 2



(a) Complete **Table 2** by calculating the change in mass when **element Z** was heated. [1]

(b) The student concludes that **Element Y** does **not** react with air.

What evidence from **Table 2** supports their conclusion? [1]

---

---

---

The two elements that did react were known to be magnesium and carbon.

(c) Which element is **carbon**?

Circle your choice. [3]

**Element X**

**Element Z**

Explain your answer.

---

---

---

---

(d) (i) Which element is **magnesium**?

Circle your choice. [2]

**Element X**

**Element Z**

Explain your answer.

---

---

---

(ii) Give **one** observation made during the reaction when magnesium is heated. [1]

---

---

**[Total: 8 marks]**

11. This question is about air pollution.



- (a) (i) A student visited a steam railway.

The steam engines burn coal to release energy as heat.

The heat produced is used to convert water into steam.

338000 MJ of energy is needed to convert 1 m<sup>3</sup> of water at 20 °C into steam.

The complete combustion of 1 kg of coal provides 16 MJ of energy.

The boiler of the steam train contains 35 m<sup>3</sup> of water.

Calculate the mass of coal needed to convert all the water in the boiler into steam.

You can assume no energy is lost.

[2]

Mass of coal needed = \_\_\_\_\_ kg

- (ii) More coal was needed than the engineer had calculated.

Suggest **two** reasons why.

[2]

Reason 1: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

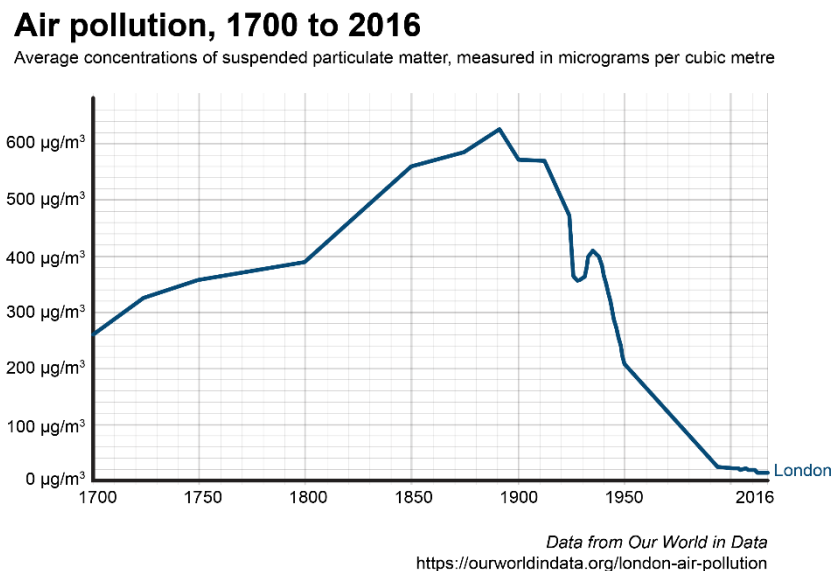
Reason 2: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Atmospheric chemists measure the amount of **particulate matter** suspended in the air. Particulate matter includes carbon (soot) and dust from roads and industry.

- (b) **Figure 5** shows how the levels of particulate matter in London changed between 1700 and 2016.



**Figure 5**

- (i) Determine the **increase** in particulate matter between 1700 and 1890. [2]

Increase = \_\_\_\_\_  $\mu\text{g} / \text{m}^3$

- (ii) Give one problem caused by increased levels of particulate matter in the environment. [1]

---

---

The levels of particulate matter dropped significantly after 1890.

- (iii) Which option could explain the changes shown in levels of particulate matter seen after 1890? [1]

- ☐ Businesses that produced excessive smoke were fined by the government.
- ☐ The industrial revolution.
- ☐ An increase in coal production from UK mines.

Fossil fuels such as coal contain sulfur impurities.

When the fossil fuels are burnt, the sulfur is released as sulfur dioxide, SO<sub>2</sub>.

- (c) (i) How many **atoms** are there in a single molecule of SO<sub>2</sub>? [1]
- 

- (ii) Once released into the atmosphere, sulfur dioxide reacts with water and air to form sulfuric acid.

Balance the symbol equation for the reaction; [1]



- (d) Sulfuric acid damages buildings made of limestone.

Limestone contains calcium carbonate.

The sulfuric acid in the rain water reacts with the calcium carbonate in the limestone.

Calcium sulfate, water and carbon dioxide are produced.

- (i) Complete the word equation for the reaction of sulfuric acid with calcium carbonate. [1]

calcium + sulfuric  
carbonate acid → + +

- (ii) Name the type of reaction that occurs.

Choose **one** option.

[1]

☐

neutralisation

☐

thermal decomposition

☐

oxidation

☐

combustion

**[Total: 12 marks]**

**END OF QUESTIONS**