

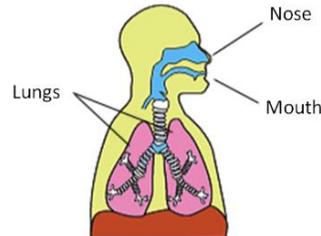
# Percent Oxygen in Air

## Percent Oxygen in Air

### Lab Challenge

We get oxygen needed for respiration from the air around us. We hear on the news that the amount of greenhouse gases in the air is increasing. Obviously, air isn't only oxygen, but a mixture of different gases.

What percent of the molecules in air is oxygen?

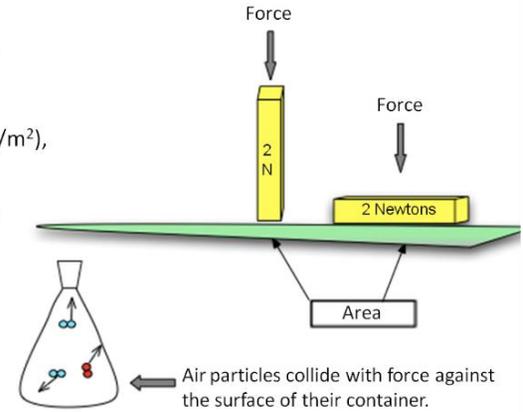


1 - Challenge

## Percent Oxygen in Air

### ...Background

- Pressure is the average force spread over an area and is measured in the SI unit of Newton per square meter ( $\text{N}/\text{m}^2$ ), also known as a Pascal (Pa).
- Air exerts pressure when the particles collide with their container.



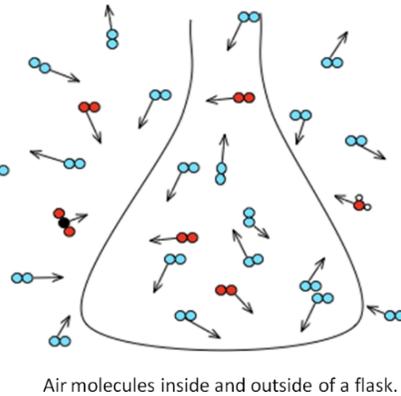
3 - Background

## Percent Oxygen in Air

### Background

- Air is a mixture made of nitrogen molecules, oxygen molecules and a very small amount of other molecules such as carbon dioxide and water.
- Gas molecules are in constant motion zipping through space and colliding into things.

-  oxygen,  $\text{O}_2$
-  nitrogen,  $\text{N}_2$
-  carbon dioxide,  $\text{CO}_2$
-  water,  $\text{H}_2\text{O}$



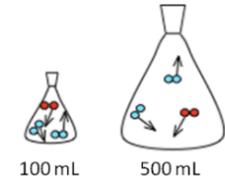
2 - Background

## Percent Oxygen in Air

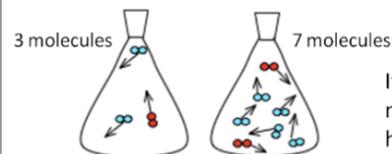
### ...Background

2) Volume:

When the volume of a container holding a gas increases, the pressure decreases. This is because the particles have more space to move around in and therefore collide with the container less often.



3) Amount of Air Particles:



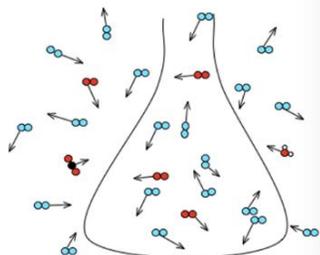
If more particles are added, there will be more collisions and a correspondingly higher pressure.

4 - Background

## Percent Oxygen in Air

### Self-Check

1. Air is a \_\_\_\_\_.
- mixture
  - pure substance
  - compound
  - element



SNAPSHOT

The best choice is...

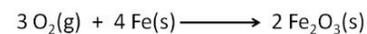
5 - Self-Check

## Percent Oxygen in Air

### ...Background

In this lab oxygen gas molecules will be removed from a container through the following reaction:

Oxygen gas ( $O_2$ ) from the air reacts with iron (Fe) in steel wool to form rust ( $Fe_2O_3$ ).

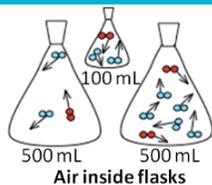


7 - Background

## Percent Oxygen in Air

### Self-Check

2. Which of the following does not affect air pressure?
- temperature
  - the number of gas particles
  - the color of the gas
  - gas particles colliding with their container
  - the volume of the container



SNAPSHOT

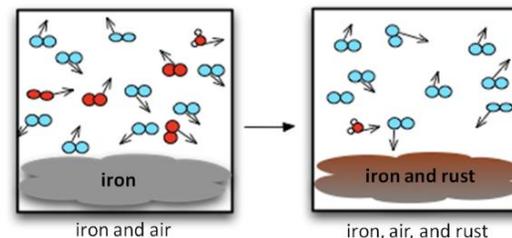
The best choice is...

6 - Self-Check

## Percent Oxygen in Air

### ...Background

Oxygen as a reactant is a gas and contributes to the total pressure.



After the reaction, oxygen combined with the iron to become a new substance, rust, which is a solid. This removal of oxygen will affect the gas pressure. Nitrogen and the other molecules in the air do not react with iron and just bounce off unchanged.

8 - Background

## Percent Oxygen in Air

### Safety

- Follow all common laboratory safety procedures.
- Vinegar is a weak acid. Avoid contact with the eyes and wash hands after handling glassware, steel wool, and equipment.



**BE SAFE**

Always wash hands to remove residue before leaving

9 - Safety

## Percent Oxygen in Air

### Materials and Equipment

Collect all of these materials before beginning the lab.

- Stir rod
- Beaker, 150-mL
- Beaker, 500-mL
- Steel wool, fine mesh, 1.0 g
- White vinegar, 50-60mL
- Glycerin, 2 drops
- Paper towels



11 - Materials

## Percent Oxygen in Air

### Materials and Equipment

Collect all of these materials before beginning the lab.

- Data collection system
- Absolute pressure sensor
- Sensor extension cable
- Quick-release connector
- Tubing connector
- Tubing (1-2 cm)
- Test tube, 25-mm x 150-mm
- One-hole stopper to fit test tube



10 - Materials

## Percent Oxygen in Air

### Sequencing Challenge

**A.** Create a closed container with air and steel wool and then start to collect pressure data.

**B.** Measure the initial and final pressure values and use them to calculate the percent oxygen in air.

**C.** Clean the steel wool with vinegar so that oxygen can react with the iron.

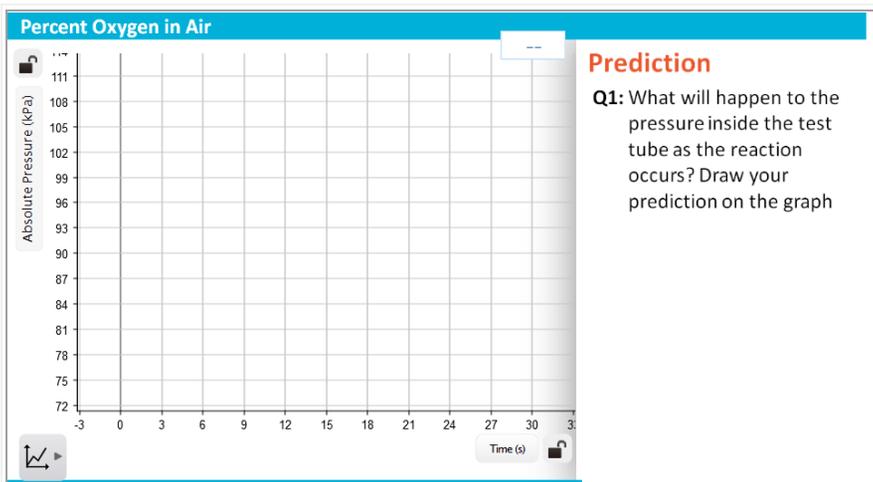
**D.** When the pressure stabilizes, stop collecting data.

The steps to the left are part of the procedure for this lab activity. They are not in the right order. Determine the correct sequence of the steps, then take a snapshot of this page.

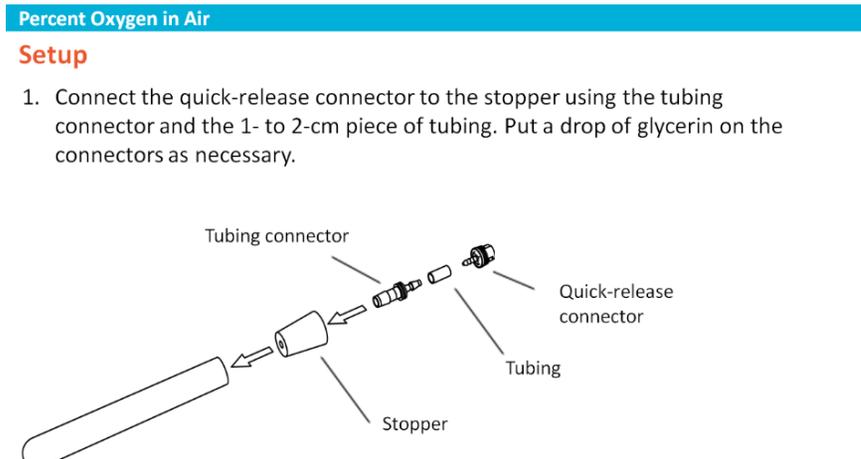
**SNAPSHOT**

The correct sequence of steps is...

12 - Sequencing

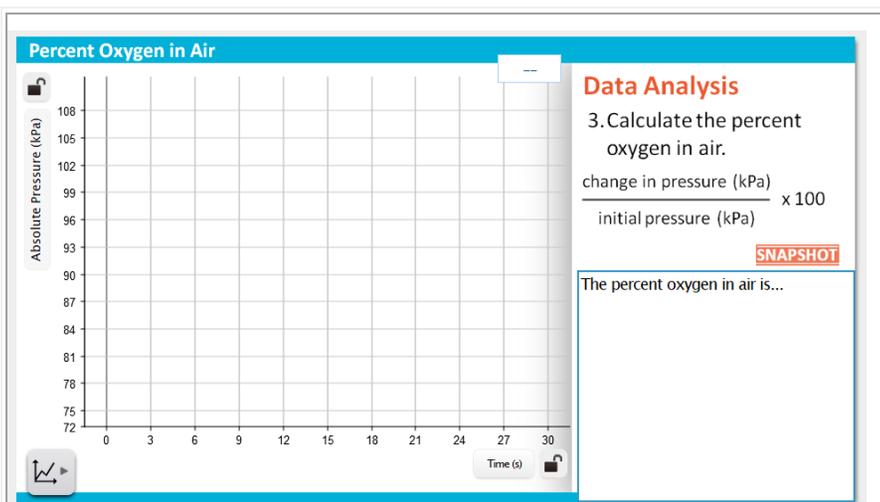


13 - Prediction

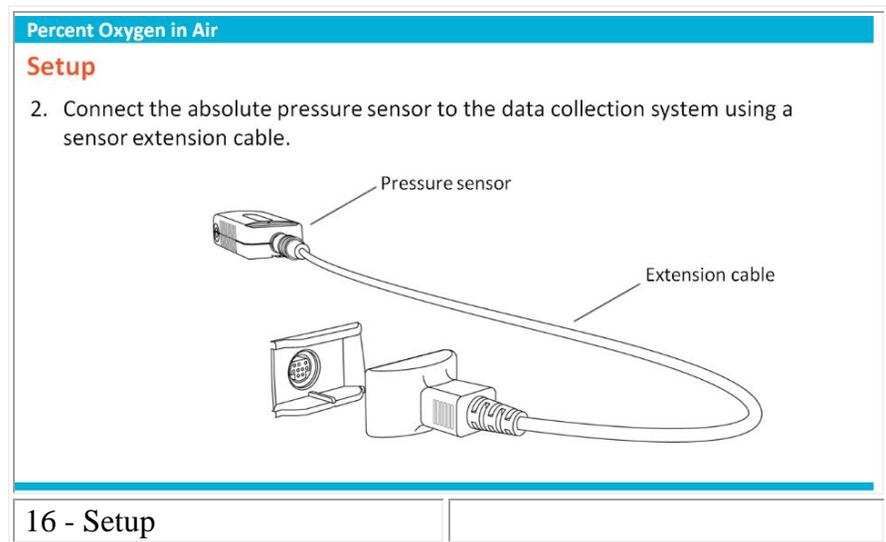


15 - Setup

14 - Since we can't count individual oxygen molecules, we can use what we know about Dalton's Law of Partial Pressure and the change in the pressure in the tube after the reaction to calculate the percent oxygen in the air. Write Dalton's Law of Partial Pressure.



14 - Percent Oxygen



16 - Setup

### Percent Oxygen in Air

#### Setup

3. Insert the quick-release connector into the port of the absolute pressure sensor and then turn the connector clockwise until the fitting "clicks" (about one-eighth of a turn).



17 - Setup

### Percent Oxygen in Air

#### Setup

7. Remove the steel wool from the beaker of vinegar and wring it out, draining the vinegar into the beaker.
8. Stretch apart the steel wool and thoroughly dry it with paper towels.



Q2: Why is it necessary to rinse the steel wool in vinegar?



19 - Setup

### Percent Oxygen in Air

#### Setup

4. Obtain enough fine mesh steel wool to fill a large test tube about 2/3 full (about 1.0 g).
5. Stretch the steel wool apart so that a large amount of surface area is exposed.
6. Clean the steel wool by soaking it in a 150-mL beaker containing approximately 50 mL of vinegar for about one minute. Use a stir rod to fully rinse the steel wool in the vinegar.



Steel wool stretched out.



Steel wool soaking in vinegar.

18 - Setup

### Percent Oxygen in Air

#### Setup

9. Stretch the steel wool apart and shake it in the air to make sure it is dry.
10. Put the steel wool in a large test tube making sure that a large surface area is still exposed. Do not pack the steel wool into the bottom of the test tube.

**Note:** You may have to gently tap the test tube to get the steel wool to slide down into the test tube.



Steel wool in a large test tube.

20 - Setup

Now you are ready! Open Sparkvue on a school laptop and...

- Click on Experiments, Chemistry, and scroll down to *Percent Oxygen in Air*

## LAB OBSERVATIONS

1. Record the initial pressure. Include this in a Data Table.
2. What is the independent variable in the experiment? What unit is it measured in?
3. What is the dependent variable in the experiment? What unit is it measured in?
4. According to Dalton's Law of Partial Pressure, what molecules are contributing to the pressure you are recording? Be specific.
5. Write a sentence for the reaction occurring in the test tube – include where each substance comes from and its physical state.
6. Write a balanced equation for the production of rust occurring in the test tube. Hint: Iron (III)
7. What is happening to the pressure as the reaction occurs? Why?
8. List three changes you observe taking place in the test tube.
9. Record the final pressure and the change in pressure in a Data Table.

## POST LAB QUESTIONS – CALCULATIONS & ANALYSIS

1. Calculate the percent oxygen in the air. Show your calculations below the Data Table and include your answer in your Data Table.
2. The actual percentage of oxygen in the air is 20.95%. Calculate your percent error. Include both of these values in your Data Table.
3. Why did the pressure graph flatten out after a while? (Hint: think about what is happening to the amount of oxygen in the test tube.)
4. Why was the pressure in the test tube not reduced to zero?
5. What was the limiting reactant in the reaction? Why?