LESSON 4

Do Gases Have Density?

SCIENCE VU/VISUALS UNLIMITED

A destructive tornado like this one is evidence that air is matter.

INTRODUCTION

Have you ever thought about air? Air is strange stuff. It's invisible, yet we know it exists. We can feel our own breath or see the effect of the wind. But is air matter? If it is, then it must have both mass and volume. In this lesson, you will find out whether air has mass and volume.

OBJECTIVES FOR THIS LESSON

Find out whether air has volume.

Design an experiment that can be used to find out the mass of a sample of air.

Try to measure the mass of a sample of air.

Discuss the accuracy of the procedure.

Getting Started

1. Your teacher will show you two pieces of apparatus. In the first one, the funnel goes into the test tube but is held firmly in place by a rubber stopper. The second test tube also holds a funnel but is not sealed around the edge of the tube.

2. In your science notebook, describe what happens when colored water is poured into each funnel (see Figure 4.1). Try to explain why water behaves differently in each funnel.

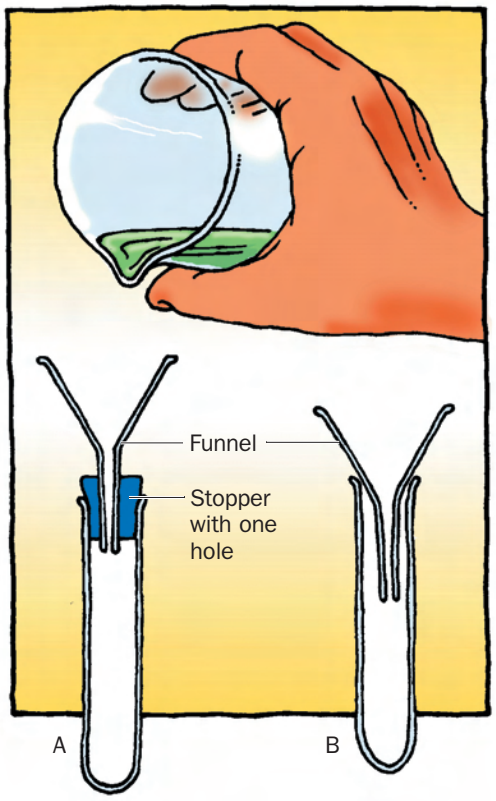


Figure 4.1 *In this experiment, colored water is poured into both funnels.*

MATERIALS FOR LESSON 4

For you

1 copy of Student Sheet 4.1: Finding the Density of Air

For your group

1 thick-walled plastic bottle
1 rubber washer
1 vacuum pump with vacuum stopper (rubber valve)
1 100-mL graduated cylinder
Access to water
Access to an electronic balance

3. Your teacher will pass around the second piece of apparatus, which consists of two syringes connected by a tube.

4. Try to explain what you observe when one syringe is pushed in. In your notebook, draw what happens when the syringe is pushed in (see Figure 4.2).

5. What do these two experiments tell you about air? Write your answer in your notebook.

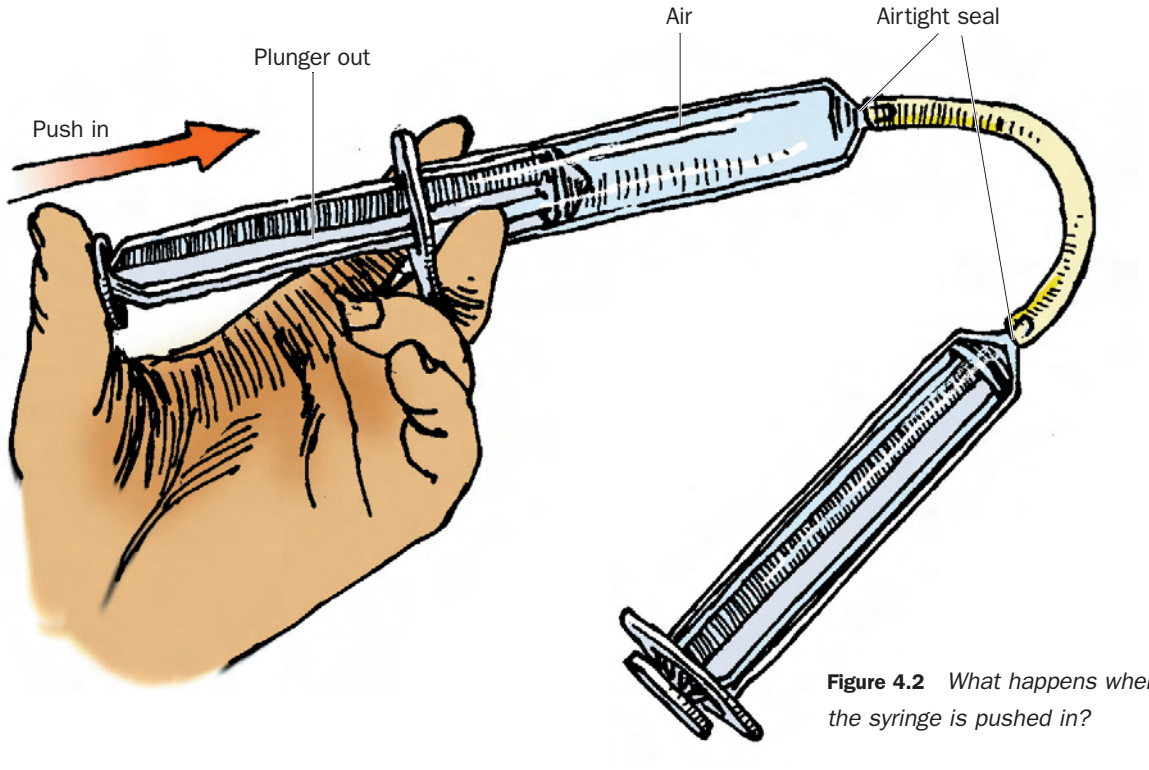


Figure 4.2 *What happens when the syringe is pushed in?*

Inquiry 4.1
Finding the Density of Air

PROCEDURE

1. What will you need to measure in order to calculate the density of air? Examine the contents of your plastic box and try to think how you could use the apparatus and an electronic balance to find the density of some air (see Figure 4.3). Discuss your ideas with the rest of your group. Try to agree on a procedure that you think will work. Write down your ideas in a short paragraph in your notebook. Be prepared to present your group's ideas to the rest of the class.

2. After all the groups have shared their ideas, your teacher will use them to devise a standard procedure. Record the procedure on Student Sheet 4.1.

3. Use the procedure to find the mass and volume of an air sample. Under Steps 2 and 3 on the student sheet, record your results and use them to calculate the density of air.

4. Return the apparatus to your plastic box.

REFLECTING ON WHAT YOU'VE DONE

1. Your teacher will write down the different group results for this experiment. Look carefully at the results. Answer the following question on the student sheet: How does the density of air compare with the density of solids and liquids?

2. Are the results all the same? Do you think the procedure you used is very precise? Answer the following question on the student sheet: Why do the class results vary so much?

3. You have discovered that air does have density. Use this information to answer the following question on the student sheet: Why do some things float in air?

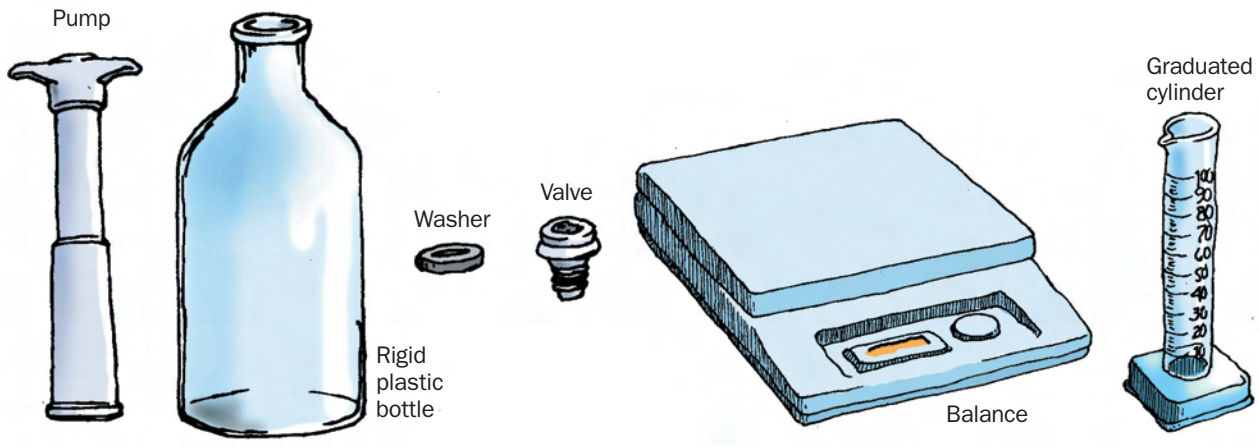


Figure 4.3 *How can you use this apparatus to determine the density of air?*

DEADLY DENSITY

Chlorine is used to kill the microorganisms in swimming pools.

Have you heard about a substance called chlorine? If you have, you probably know that it is sometimes added to water. Chlorine is added to drinking water to kill harmful microorganisms. When you go swimming, you can smell the chlorine at the pool. That's because chemicals that release chlorine are added to the water to keep it safe for swimming.

You may be surprised to learn that chlorine is a greenish yellow gas. It is also a very poisonous substance. This property is exploited when chlorine is used as a disinfectant to kill microorganisms. In small amounts, chlorine kills microbes but not larger organisms. However, chlorine has also been used to kill people.

In World War I (1914–1918), chlorine was used as a weapon. Most of the battles in this war were fought between lines of trenches that provided the soldiers with some protection against gunfire. On April 22, 1915, at the battle of Ypres, in France, the Germans used a new secret weapon. That weapon was chlorine. They released chlorine gas from their side of the lines. The chlorine was carried by the wind to the enemy trenches. Because chlorine is much denser than air, it stayed near the ground and poured into the trenches. Choked and blinded, the defenders were then overrun by German troops wearing gas masks. After this gas attack, soldiers on both sides were issued gas masks. □

QUESTION

What are other properties and uses of chlorine? Use the library and Internet resources to find out more about chlorine.

To protect themselves against poisonous gases in World War I, these U.S. troops and their mules wore gas masks.

AIR HEADS

What do a scuba diver and an astronaut have in common? They both have air on their minds. Air is something most of us take for granted. We might think about it when we are swimming or exercising, but otherwise we know there is plenty of it around. The air that surrounds our entire planet is called the atmosphere. To an astronaut and a diver, air is something to think about. They have to carry an atmosphere with them: their own supply of air compressed into a small tank. If it runs out, they are in big trouble!

Why do we need air? Sometimes people say, "We need air to breathe." This is the opposite of the truth. In fact, we breathe because we need air—even then, we only need part of it. Air is a mixture of gases. The part we use is called oxygen, and it makes up about one-fifth of normal atmospheric air.

Why is oxygen so important? Our bodies use oxygen to combine with food substances in a process called respiration. Respiration releases energy that we can then use for our body processes (another gas, carbon dioxide, also found in air, is made in this process). If you were deprived of oxygen for more than a few minutes, these life processes would stop. You would suffocate to death!

Oxygen is also needed for things to burn. Think back to what happened in Lesson 1 when you placed a beaker over a burning candle. The candle went out because it had used up most of the oxygen in the air. Things burn very quickly in pure oxygen. In fact, burning things in pure oxygen can be explosive. It's a good thing that air consists mainly of another gas called nitrogen.

From our point of view, nitrogen gas doesn't do very

NASA

What do these two explorers have on their minds?

A layer of air called the atmosphere surrounds Earth.

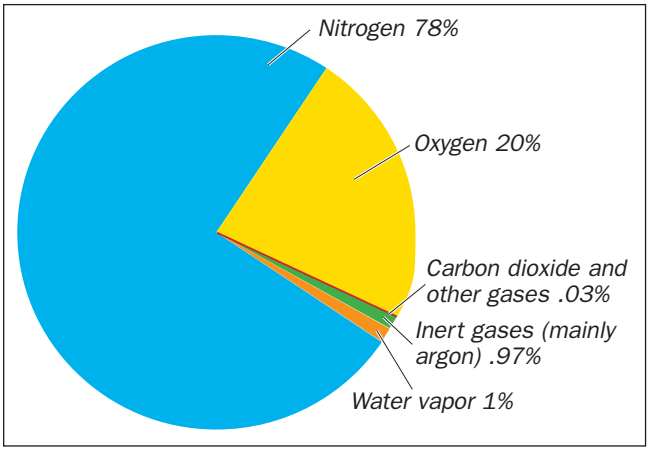
This fierce forest fire would burn explosively if the atmosphere were pure oxygen. Luckily, air consists mainly of less reactive nitrogen.

much. Our bodies don't use it, very few substances react with it, and it's colorless and odorless. Many of the other gases found in air don't do much either. Some of these gases, including argon, neon, and helium, are so renowned for doing nothing that they are called inert gases.

Other gases are more important to living things. Without the 0.03 percent of carbon dioxide in the air, there would be no green plants. Plants use carbon dioxide to make food. They use the energy from sunlight to combine water with carbon dioxide to make carbohydrates. They turn parts of the air into living matter! Most plants absorb water through their roots, but water is also found in the air (it's called water vapor). The amount of water in the form of water vapor varies. On hot, sticky days, you can easily feel that there's a lot of water in the air.

There are other gases in air. Some of these occur naturally;

This leaf is a factory that uses carbon dioxide from the air as a raw material.



Air is composed of several different gases. This chart provides a simplified summary of the composition of air.

others are the result of pollution. In fact, air has a chemistry all its own. You will have the opportunity to investigate some aspects of the chemistry of air later in the module. □

QUESTIONS

Use library or Internet resources to answer one of the following questions:

1. Where did Earth's atmosphere come from?
2. Has the atmosphere always had the same composition?
3. Is the composition of the atmosphere changing? If so, what are the causes of this change? Write your answer as a paragraph with four to seven sentences.