Activity #2
It's All About the Atmosphere *[Cadette]*

Adapted from: *NOVA's How to Get an Atmosphere:* http://tinyurl.com/oc7yltg and *Introduction to the Atmosphere — The Goldilocks Principle: A Model of Atmospheric Gases.* Unless otherwise noted, all images are courtesy of SETI Institute.

1. Introduction

In this activity you will explore atmospheric density. You will also "Think like a scientist!"

2. Science Objectives

Examine the atmospheric density of Venus, Earth, and Mars using a model.

Scientists use models to test ideas about objects or processes that cannot be directly studied. A model is not the real thing, but a substitute that can be tested and used to make predictions.

3. Materials

For each group of 3–4 Cadettes.

- [1] set of 3 Atmosphere Models: Venus, Earth, and Mars

4. Get Ready

4.1. Read *Background Inner Planets Table of Information* (page 4).

4.2. How are atmospheres described?

Atmospheres are described in terms of the **amounts and kinds of different gases** and **how much those gases push on a surface area.**

If there are **more closely packed (dense)** gas molecules, they push down more ↓ on the same-sized surface, and the atmosphere has **more** pressure.

If there are **fewer closely packed (less dense)** gas molecules, there are fewer molecules to push down on the surface and the atmosphere has **less** ↓ pressure.

4.3. How does a planet "get" an atmosphere?

Of the four inner Solar System planets only three — Venus, our Earth, and Mars — wear some sort of blanket of gas called an atmosphere. Why just these three? Why does Mercury have an almost negligible atmosphere?

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It turns out that "**getting**" an atmosphere and "**holding**" onto it come down to *mostly* a combination of **how large the planet is** and **how close it is to the Sun**. If you are a planetary geologist, the story is a lot more complicated than size and location. For now, if we look at only these two variables, we can go far in understanding why Earth ended up such a nice cozy place while Mars turned into an icebox. Later on we will explore other factors that contribute to whether an atmosphere hangs around or not.

In the beginning of our Solar System…when the planets were forming, all the four inner planets started out with the same kind of air: mostly hydrogen and helium. During this period, the Sun was not very bright or hot. Hydrogen and helium are lightweight molecules and our inner four had enough gravity to hang onto this early atmosphere briefly.

Over a very long period of time, the Sun grew hotter and brighter, and heated up the small lightweight molecules of hydrogen and helium. Over a few hundred million years, almost all of the hydrogen and helium escaped, leaving Earth and the other three inner planets little more than balls of rock.

We know that Earth and Mars are very different now, so something must have changed! Later we will explore how a planet can lose an atmosphere over time.

Some sources of heavier molecules like nitrogen, carbon dioxide, and water vapor were:

- **Comets** that regularly slammed into the planets; and
- A molten planetary core that kept the mantle extremely hot — enough to form magma and produce **volcanoes** which spewed gases out of the interior beginning as long as 4.4 billion years ago.

5. Explore

5.1. Compare the three labeled models representing the atmospheres of Venus, Earth, and Mars by holding each in the palm of your hand. The grains of sand represent gas molecules in the atmosphere of each of the planets. Each model has about the same volume, but not the same number of sand grains. This means the density is different.

5.2. Shake the models to see the grains of sand moving around.

5.2.1. Which model has sand grains that are closest together?

5.2.2. Which model has sand grains that are the farthest apart?

5.2.3. Which atmosphere would be the heaviest and warmest around a planet?

5.2.4. Which atmosphere would be the lightest and and coldest around a planet?

5.3. Show the video *Olympus Mons on Mars* (BBC): http://www.seti.org/ggtm

5.3.1. For Mercury, Venus, Earth, and Mars: Reflect on the video, what you learned about size and the distance these planets are from the Sun (Activity #1), and the atmospheric pressure:

5.3.1.1 Which planet is smallest, closest to the Sun, and has no atmosphere?

5.3.1.2 Which planet is large, closer to the Sun than the Earth is, and has a lot of atmosphere?

5.3.1.3 Which planet is smaller, far away from the Sun, with little atmosphere?

5.3.2. Look at the Inner Planets Table of Information on page 4. Compare the data for Mercury and Venus. Explain the temperature of Venus relative to Mercury.

5.4. It's All Up in the Air…clearly atmospheres can change drastically over time. What can cause atmospheres to change? What happens when atmospheres change? We will explore what can happen to an atmosphere in other activities.

6. Connection to the Leadership Journey *Breathe. It's Your Planet — Love It!*

Start your Air Log today, refer to page 103 in *Breathe. It's Your Planet — Love It!*

Activity #2: BACKGROUND *Inner Planets Table of Information*

Currently, scientists interpret data from spacecraft to determine:

Inner Planets	What Happened to the Water?	Planet Diameter Relative to Earth	Average Surface Temperature	Distance from Sun (km)	Energy from the Sun (Watts per Sq Meter)
Mercury	None	4,878 km 38% of Earth	Very cold (–183°C) to very hot (427°C) [–297 to 800°F]	58,000,000	9,116
Venus	All **water vapor burned off** long ago. Could not form oceans to absorb carbon dioxide.	12,100 km 95% of Earth	Extremely hot! +465°C (869°F)	108,000,000	2,611
Earth	All water vapor that belched out of volcanoes cooled and turned into **liquid water**. Over many eons, liquid water formed oceans.	12,742 km	Average surface temperature is a comfortable 15°C (59°F); varies from –89 to 58°C (–128 to 136°F)	150,000,000	1,366
Mars	May have had oceans 3.8 million years ago. Volcanoes ceased. **Water vapor froze** out of atmosphere; trapped under surface in form of ice.	67,94 km 53% of Earth	Brrrrr! –125° to 20°C (–193 to 68°F)	228,000,000	589