Bay Area Scientists in Schools Presentation Plan

Lesson Name: Water in Our Atmosphere: Make it Rain! **Grade Level**: 5
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Standards Connections

Earth Science: Water vapor makes up 1-5% of the air in our atmosphere. Water condenses onto aerosol particles. Droplets of liquid water form clouds, fog, and rain.

Investigation and Experimentation: Students will identify independent and dependent variables as well as record observations and conclusions in the "make it rain" experiment.

Next Generation Science Standards:

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Science & Engineering Practices	*Disciplinary Core Ideas*	*Crosscutting Concepts*
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. □□Develop a model using an example to describe a scientific principle. (5-ESS2-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. □□Obtain and combine information from books and/or other reliable media to explain phenomena	**ESS2.A: Earth Materials and Systems** □□Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified. (4-PS4-2) **Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (4-LS1-1), (LS1-2)

Common Core Standards:

ELA/Literacy:

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

Mathematics:

MP.2 Reason abstractly and quantitatively.
MP.5 Use appropriate tools strategically.
MP.4 Model with mathematics.

FOSS Connections:

Grade 5 Module: Water Planet

Teaser

How do clouds form? Where does rain come from? In this lesson, we will explore these questions using hands-on activities. First, we will visualize the composition of the atmosphere to see how little water is in the air. We will discuss the difference between gases and aerosols. Finally, we will observe the condensation of water onto aerosols and make rain in a jar!

Objectives

- Identify the components of air and their relative abundance.
- Understand the origin and physical state of water in the atmosphere.
- Learn what aerosols are and where they come from.
- Understand that water condenses onto aerosols to form clouds and rain.

Vocabulary

- ***composition***- the ingredients and proportions of a mixture
- ***model***- a simplified representation of a natural system used to understand that system and make predictions
- ***aerosol***- a tiny particle or droplet in the atmosphere
- ***condensation***- the process of changing from vapor to liquid
- ***evaporation***- the process of changing from liquid to vapor
- ***precipitation***- water droplets (or ice crystals) falling out of the atmosphere due to their large size
- ***independent variable***- the part of an experiment that the scientist controls
- ***dependent variable***- the part of an experiment that the scientist observes, and that (hopefully) changes when the scientist changes the independent variable.
- ***hypothesis***- the expected outcome of an experiment

Materials

We will bring all materials for the activities, as well as a worksheet for students to fill out. Students should have pencils. Full worksheet is included at the end of this document.

Classroom Set-up

Students should be divided into groups of 3 (we'll start all together and then break into groups). We will need a table where we can show students a demonstration. We will also need access to a sink.

Classroom Visit (60 minutes total)

Personal & Topic Introductions (5 minutes): We will explain that we are graduate students (18th, 19th and 20th graders!) who study atmospheric science. Each visitor will introduce her/himself and tell the students something interesting about themselves. We will introduce the main ideas of the lesson by asking the students questions: Can we see water in the atmosphere? What does it look like? What phases of water exist in the atmosphere? How does water change between these phases? Introduce the objectives of the lesson: today, we are all going to be atmospheric scientists and construct models to understand water in the atmosphere: We are going to make air, then make a cloud, then make rain.

Let's Make Air! (20 minutes): First, we will ask students to tell us what they think air is made of. We will collect all of the answers on the board. As students name gases, we will look in our

reference book to find out what fraction of air is comprised by each gas, building the recipe for air together on the board. We will organize their answers on the board into major gases (nitrogen, oxygen, argon, water), trace gases (carbon dioxide, ozone, etc.), and aerosols (smog, pollen, fog, etc.) and write down the percentages of the major gases. Then, we will pass out materials for representing the composition of air (jars, colored pompoms). Students will work in their small groups to decide which pompoms to use for which gas, and to make the appropriate mixture in their jars. We will walk around and help. Once everyone has made their jar, we will hold them up, shake them, and make observations: Notice how little water there is compared to nitrogen and oxygen. Notice that all other gases make up an even tinier fraction. Note that the amount of water in the air varies. We will explore the questions: How does water get into the air? How does it get out of the air? Why does the amount of water in air vary?

What is an aerosol? (5 minutes): We will introduce the concept of an aerosol by using a ball of beads stuck together. We'll learn that an aerosol is a liquid or a solid particle suspended in air, and will discuss where aerosol comes from and what it is made of. We'll talk briefly about different kinds of aerosols.

Let's make a cloud! (5 minutes): We will demonstrate the importance of aerosols to cloud formation by placing water into two plastic bottles, lighting a match into one of the bottles (to create aerosols), pressurizing the bottles with a bike pump, and then releasing the pressure. A much thicker cloud forms in the bottle with the aerosols because aerosols provide a surface onto which water can condense. Note that the independent variable here is the aerosol and the dependent variable is the cloud appearance. We will discuss as a group why condensation occurs when the pressure is released (air that is saturated with water vapor expands and cools) and why the cloud appears white (light is reflected by the tiny droplets of liquid water). Then we will discuss how precipitation forms (when cloud droplets grow larger than about a millimeter, they can no longer remain suspended and they fall).

Let's make it rain! experiment (20 minutes): Each group of students will have a jar, several lids (one normal and 2-3 with various sized dents hammered into them to act as the "aerosols"), and a cup of ice. We will discuss as a group how to use the materials to form rain (place the lid upside-down, put ice into lid. the hot water will evaporate into the jar and then condense onto the cold lid). Students will draw diagrams of the experiment set-up. When the students understand the experiment, we will come around and place hot water into their jars. They will try the experiment with different lids and record their observations. Presenters will walk around the room and discuss with them: if this jar were our planet, what would each part represent? What is the independent variable in this experiment? The dependent variable? What do you expect to observe for a lid with more/fewer or bigger/smaller dents?

Wrap-up and Review (5 minutes): We will ask students to share their conclusions, reiterate the major concepts, and define important vocabulary (we'll write these things on the board). We will ask a few additional questions to get the students thinking in a broader context: when you have a cold soda can and water drops collect on the outside of it, where is that water coming from? Would you expect this to happen if you were in the desert? etc.

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to perform experiment. Read worksheet directions aloud. Write vocabulary words on the board and read

words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: Have students create hypotheses and test them by performing other experiments with the materials.

Follow-up Possibilities

If you would like to continue studying the topic of rain and aerosols with your class after our visit, here are a couple of ideas:

ELA Activity:
-Have students write a lab report (introduction, hypothesis, procedure, observations, conclusions) about the Make it Rain experiment.

Reading Connections:
Can It Rain Cats and Dogs!: Questions and Answers about Weather (Scholastic Question & Answer) by Melvin Berger and Gilda Berger, Illustrated by Robert Sullivan. This book will answer children's questions about weather as it explores the basics in beautifully illustrated sections on sun, air, and wind; rain, snow, and hail; and wild weather like hurricanes and tornadoes. The questions and answers should help to appease even the most curious child's need to know why the weather keeps changing, what happens to puddles after it rains, if you can smell the rain, if lightning can grow hair, and if groundhogs really can predict the weather.

Blizzard: The Storm that Change America by Jim Murphy. About the blizzard of 1888. It makes fascinating reading either in part or in its entirety. Presents a history, based on personal accounts and newspaper articles, of the massive snow storm that hit the Northeast in 1888, focusing on the events in New York City.

Scholastic Atlas of Weather. QA International. Scholastic Reference. 80pp The ABCs of everyday weather, as well as severe conditions, will fascinate readers. Dust storms, hail, hurricanes, volcanoes, global warming, pollution, and the technology and tools meteorologists use are some of the many topics explored. Full-color illustrations, easy-to-read information, and nine weather-related experiments make this a useful classroom reference.

Mathematics Activity:
Learn about the origin and composition of aerosols and make bar graphs of real aerosol data using this activity from NASA:
http://www.crscience.org/pdf/Aerosol_activity_NASA.pdf

Other:
Learn about different types of clouds:
www.mbgnet.net/fresh/cycle/clouds.htm
http://eo.ucar.edu/webweather/cloud3.html

Make fog (clouds on the ground):
http://eo.ucar.edu/webweather/cloudact1.html

Explore other types of weather:
http://eo.ucar.edu/webweather/index.html

I Can't Take the Pressure (Integrated Teaching and Learning Program, College of Engineering, University of Colorado at Boulder) Learners develop an understanding of air pressure in two different activities. They model the magnitude of air pressure as gravitational force per unit area, and they use cookie wafers to model how air pressure changes with altitude. Instructions are also included for a demonstration to crush an aluminum can using air pressure. This activity has connections to other activities to create a larger lesson or curriculum unit. Resource contains vocabulary definitions and suggestions for assessment, extensions, and scaling for different levels of learners.
http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collection/cub_/activities/cub_air/cub_air_lesson04_activity1.xml

Make Your Own Weather Station (American Museum of Natural History) This three-part activity shows learners how to build three meteorology tools: a wind vane, a rain gauge, and a barometer. Then, they can use their tools to build their own weather station to record data about the weather, study the data to detect patterns, and use the patterns to predict the weather. This lesson also includes information about the difference between weather and climate.
http://www.amnh.org/ology/features/stufftodo_earth/weather_main.php?TB_iframe=true&height=500&width=770

NAME: _____

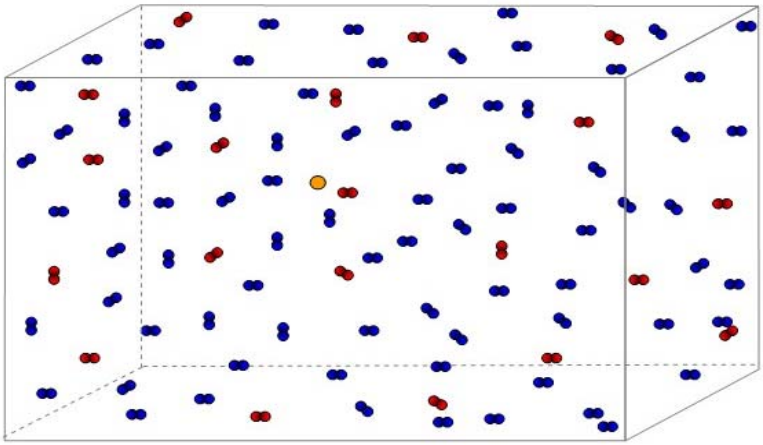
Water in Our Atmosphere Worksheet

PART I: LET'S MAKE AIR!

The recipe, or **composition**, for about 0.00000000000000002 teaspoons of air are as follows:

Name of gas	Number of molecules/atoms

Here's a **model** representing the **composition** of dry air:



Which major gas does each shape represent?

_____

Water vapor can make up between_____ % and _____% of the air around us. Draw a few water molecules in the box.

Draw an **aerosol** in your box. What is the difference between a gas and an **aerosol**?

PART II: LET'S MAKE A CLOUD!

Clouds form when water changes from a ____ to a _____. This process is called _____.

Now we are going to do a demonstration where we try to make clouds with and without **aerosols** present. Based on that experiment's results, are **aerosols** important in cloud formation? Why do you think so?

PART III: LET'S MAKE RAIN!

What causes **precipitation**?

Now we are going to do an experiment where we see how aerosols affect **precipitation** by making a **model** of the water cycle in a jar. Draw the same **model** of the experiment that is being drawn on the board. Label the important processes, including **evaporation**, **condensation**, and **precipitation**.

Your jar is a **model** representing the water cycle. What does the water in the bottom of the jar represent?

What does the lid with ice and salt represent?

There are three kinds of lids: flat lids, lids with small indents, and lids with large bumps. What do the different kinds of lids represent?

The **independent variable** is the part of an experiment that the scientist controls. In our experiment, what is the **independent variable**?

The **dependent variable** is the part of an experiment that the scientist observes and that may change when the scientist changes the independent variables. In our experiment, what is the **dependent variable**?

Make a **hypothesis** about how the lid will affect the rain in your experiment:

Circle the type of lid you have: FLAT SMALL LARGE

Record your observations here:

Now copy the results gathered from the whole class:

Lid Type	Description of lid	Did it rain?	Observations
1			
2			
3			

What conclusions and further questions do you have after this experiment?

VOCABULARY

Definitions of the words we learned today:

Composition- the ingredients and proportions of a mixture

Model- a simplified representation of a natural system used to understand that system and make predictions

Aerosol- a tiny particle or droplet in the atmosphere

Condensation- the process of changing from gas to liquid

Evaporation- the process of changing from liquid to gas

Precipitation- water droplets (or ice crystals) falling out of the atmosphere due to their large size

Independent Variable- the part of an experiment that the scientist controls

Dependent Variable- the part of an experiment that the scientist observes, and that may change when the scientist changes the independent variable.

Hypothesis- the expected outcome of an experiment