



# Teacher's Guide

## For the Museum on the Go's

### “Air Power” Program

#### Table of Contents

<b>LETTER TO TEACHER OR EDUCATOR.....</b>	<b>2</b>
<b>VOCABULARY.....</b>	<b>3</b>
<b>FUN FACTS .....</b>	<b>4</b>
<b>FACT 1 Air is made up of gases. ....</b>	<b>4</b>
<b>FACT 2 Air is our atmosphere, our sky. ....</b>	<b>4</b>
<b>FACT 3 The temperature of the air affects its pressure and movement creating low and high pressure that causes change in our weather. ....</b>	<b>4</b>
<b>FACT 4 When air moves we feel it as wind. ....</b>	<b>4</b>
<b>FACT 5 Air moves odors around so we smell things “in” the air. ....</b>	<b>4</b>
<b>EXPERIMENTS .....</b>	<b>5</b>
<b>Experiment 1: Balloon Blow up .....</b>	<b>5</b>
<b>Experiment 2: Bernoulli Bags-post visit .....</b>	<b>6</b>
<b>Experiment 3: Bernoulli Principal.....</b>	<b>7</b>
<b>Experiment 4: Lamp Wind .....</b>	<b>8</b>
<b>Experiment 5: Bottle Wad Trick.....</b>	<b>9</b>
<b>Experiment 6: Go Fly a Kite .....</b>	<b>10</b>
<b>CALIFORNIA CONTENT STANDARDS FOR EXPERIMENTS.....</b>	<b>11</b>

## LETTER TO TEACHER OR EDUCATOR

The Museum on the Go is coming to your school! We will be talking about something that you cannot see or smell. You can feel it when it moves. What is it? Air!!

The Museum on the Go will be presenting the concept of air as a State of Matter. During the Museum visit, children will observe, explore and investigate the properties of air through several hands-on exhibits and a facilitated activity. We will begin each group session with three experiments demonstrated by the Museum on the Go educators. After a brief introduction to the exhibits, the students will have approximately 20 minutes of free exploration. We will end the group session with a closing demonstration.

To help get you and your students excited about the science of air and the Museum on the Go visit, we have provided you with some key vocabulary, fun facts about air and a few experiments that you can do in the classroom before and after the Museum's visit.

At the end of this document all the experiments have been correlated to California Science Content Standards for grades 2-6.

Get excited about science!

Please don't hesitate to call me if you have questions. I look forward to seeing you and your students soon.

Theresa Giacomino,

Director of Education and Programs

[theresa@cmosc.org](mailto:theresa@cmosc.org)

707-338-3412

# VOCABULARY

## Some words relating to air with Spanish translations:

Gas-gas	Vapor-vapor
Atmosphere-atmosfera	Pressure low and high-presion alta y baja
Wind-viento	Weather-el tiempo
Oxygen-oxigeno	Argon-argon
Nitrogen-nitrogeno	Carbon Dioxide-dioxido de carbono
State of Matter	

Can you think of anymore?

## Some Vocabulary:

**Gas-gas:** a fluid (as air) that has neither independent shape nor volume but tends to expand indefinitely

**Vapor-vapor:** diffused matter (as smoke or fog) suspended floating in the air and impairing its transparency: a substance in the gaseous state as distinguished from the liquid or solid state

**Atmosphere -atmosfera :** the whole mass of air surrounding the Earth.

**Pressure low and high-presion alta y baja:** the pressure exerted in every direction by the weight of the atmosphere.

**Wind-viento:** a natural movement of air of any velocity; *especially:* the earth's air or the gas surrounding a planet in natural motion horizontally or an artificially produced movement of air.

**Weather-el tiempo:** the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness.

**Oxygen-oxigeno:** a colorless, odorless, tasteless, gaseous chemical element that occurs free in the atmosphere, forming one fifth of its volume, and in combination in water, sandstone, limestone, etc.: it is very active, combines with nearly all other elements, is the most common element in the earth's crust, and is essential to life processes and to combustion.

**Argon-argon:** a colorless, odorless chemical element, one of the noble gases, constituting nearly 1% of the atmosphere: it is used in incandescent light bulbs, radio tubes, welding, etc.

**Nitrogen-nitrogeno:** a colorless tasteless odorless element that as a diatomic gas is relatively inert and constitutes 78 percent of the atmosphere and that is a constituent of organic compounds found in all living tissues.

**Carbon Dioxide-dioxido de carbono:** a heavy colorless gas CO<sub>2</sub> that does not support combustion, dissolves in water to form carbonic acid, is formed especially in animal respiration and in the decay or combustion of animal and vegetable matter, is absorbed from the air by plants in photosynthesis, and is used in the carbonation of beverages.

## FUN FACTS

### **FACT 1**     ***Air is made up of gases.***

Dry air is primarily made up of nitrogen (78.09%) and oxygen (20.95%). The remaining 1% is made up of argon (0.93%), carbon dioxide (0.03%) and other trace gases (0.003%). Water vapor (water in its gaseous state) is also present in air in varying amounts. Clouds are made up of water vapor.

**Experiment 1: Balloon Blow-Up (attached)** this experiment demonstrates the different states of matter and introduces students to CO<sub>2</sub> gas (carbon dioxide)

### **FACT 2**     ***Air is our atmosphere, our sky.***

**Experiment 2: Bernoulli Bags (attached)** borrow some air from the atmosphere to blow up a bag in one breath. **Please save the Bernoulli Bags experiment for after our visit.**

**Experiment 3: Bernoulli Principal (attached)** observe the Bernoulli principal floating a ping pong ball with a hair dryer or a leaf blower. You can have your students measure the angles that the ball reaches.

### **FACT 3**     ***The temperature of the air affects its pressure and movement creating low and high pressure that causes change in our weather.***

**Experiment 4: Lamp Wind (attached)** using a household lamp, you can demonstrate the movement of the air molecules and create some wind.

**Experiment 5: Bottle Wad Trick (attached)** blowing a wad of paper into a bottle seems easy but not so fast.....

### **FACT 4**     ***When air moves we feel it as wind.***

What can we do with wind? Can we use it? We use it to fly kites, go sailing, and even move wind turbines, which can generate electricity.

**Experiment 6: Go fly a kite (attached)** here is a great kite pattern with a couple more wind exploring ideas

### **FACT 5**     ***Air moves odors around so we smell things “in” the air.***

**Experiment 7: Scent in the air**-how long does it take to smell an odor? Being aware of scent sensitive people, allow a scent (essential oil, room freshener) into the air and see how long it takes for someone 5 feet away to smell it. 10 feet away? 15 feet away? Think about how that scent got to you.

## EXPERIMENTS

\*Experiments 1-6 have been correlated to California Science Content Standards for grades 2-6. This information is located on pages 9 thru 11.

Have fun with these experiments. Think of ways to extend the activities to compliment your current curriculum and don't hesitate to share any great ideas with us. Send your ideas to [theresa@cmosc.org](mailto:theresa@cmosc.org)

### ***Experiment 1: Balloon Blow up***

We talked a little bit about the states of matter when we used air (a gas) to trap the napkin (a solid) into a glass (also a solid) that we submerged in water (a liquid). We also chopped a solid stick in half! Wow!

Here's an activity to get the students thinking about the states of matter.

#### **Some things to wonder about before doing the experiment:**

Think about whether the items and ingredients you use are solids, liquids, or gases. How can you tell?

Explore the ingredients and use your senses to make observations about them. How do they feel? Are they hard, soft, heavy or light? What color are they? How do they smell? How do they taste? (offer this idea at your discretion. Neither the baking soda nor the vinegar are toxic and can be tasted)

What do you think will happen when you mix the ingredients together?

#### **What you need for each experiment:**

- 16 oz. (473 ml) water bottle
- 10-12" latex balloon
- 1 tsp. (5 ml) baking soda
- 2-3 Tbsp. (30ml) Vinegar
- Funnel- wipe out after use so residue doesn't react with the other Ingredient.

#### **What to do:**

1. Add 1 teaspoon (5ml) baking soda to balloon using the funnel.
2. Fill the water bottle with 2-3 Tbsp. (30ml) vinegar.
3. Fit the balloon over the bottle opening.
4. Start your countdown from 5\*4\*3\*2\*1
5. Lift the balloon and let baking soda fall from the balloon into the bottle!  
Keep the balloon dry so you can do it again.

#### **WOW!! What's happening?**

Baking soda is a chemical called sodium bicarbonate and it reacts with vinegar. Vinegar is called acetic acid. These two chemicals react and form something new. The baking soda and vinegar fizzed and you may have seen some bubbles. These bubbles are filled with carbon dioxide gas or CO<sub>2</sub>. The pressure of this gas is what blew up the balloon. All of these observations tell us that a chemical reaction occurred.

For a detailed explanation on a molecular level of the chemical reaction of vinegar and baking soda go to: <http://www.apple-cider-vinegar-benefits.com/baking-soda-and-vinegar.html>

## ***Experiment 2: Bernoulli Bags-post visit***

You saw us blow up a huge plastic bag in ONE BREATHE! You can do this too.

You can order the Wind Bags that we used from [www.stevespanglerscience.com](http://www.stevespanglerscience.com) or you can use Diaper Genie refills that are sold in some stores.

You can also very simply demonstrate the same concept using a produce bag you might bring your apples home in from the grocery store. Of course, please use the plastic bags in a safe manner.

### **What you need:**

- Plastic produce bag

### **What to do:**

You'll do this twice to compare the differences in methods and outcome.

#### **First time**

1. How many breaths do you think it will take to fill the bag with air? Record this info.
2. Grab the bag opening in your fist leaving a small opening to blow air through and into the bag.
3. Put your mouth against the opening and start blowing. Count how many breaths it takes you to blow up the bag.
4. Don't pop it! We still need it.

#### **Second time**

1. Now you will blow up the bag in ONE breath!
2. Hold the opposite edges of the bag wide open about 6 inches from your face.
3. Take a breath-not giant-just a regular steady breath and blow into the bag.
4. What happened!!! Did you do it?

### **Some things to wonder about:**

Where did the air come from the first time?

Where did the air come from the second time?

See Experiment 3 for a great explanation of the Bernoulli Principle and a bit about who Daniel Bernoulli, a Dutch-Swiss mathematician was.

## **Experiment 3: Bernoulli Principal**

### **What you need:**

- Hair dryer
- Empty toilet paper tube
- A ping-pong ball/ balloon/beach ball
- A roll of toilet paper
- A leaf blower (optional)

### **What to do:**

1. Set the hair dryer to cool, switch it on, and point it at the ceiling.
2. Carefully put the ping-pong ball in the stream of air. Hold the hair dryer very steady and watch as the ping-pong ball floats in the stream of air.
3. Carefully move the hair dryer from left to right and watch how the ball moves as well, staying in the stream of air.
4. Try floating other lightweight objects in the air stream at the same time! With the hair dryer on, place an inflated balloon over your levitating ping-pong ball. You might want to place a penny in the balloon before you blow it up to give it some added weight.
5. Try to float two or more balls in the same air stream. How many can you float at once? How do they behave when there is more than one?
6. Need more power? Try using a leaf blower in place of the hair dryer. Now you can float larger objects like beach balls.

**Flying Toilet Paper!** Just hold a roll of toilet paper in the stream of air and watch the paper take off! Be sure to hold the toilet paper roll on a long stick (piece of dowel) in order for it to spin fast and unroll the paper. Always conclude this demo with a thanks to Bernoulli (see below if you don't get it).

### **How does it work?**

The floating ping-pong ball is a wonderful example of Bernoulli's Principle, the same principle that allows heavier-than-air objects like airplanes to fly.

Bernoulli, an 18th century Swiss mathematician, discovered something quite unusual about moving air. He found that the faster air flows over the surface of something, the less the air pushes on that surface (and so the lower its pressure).

The air from the hair dryer flows around the outside of the ball and if you position the ball carefully, the air flows evenly around each side. Gravity pulls the ball downwards while the pressure below the ball from the moving air forces it upwards. This means that all the forces acting on the ball are balanced and the ball hovers in mid-air.

Airplanes can fly because of this principle. Air rushing over the tops of airplane wings exerts less pressure than air from under the wings. So the relatively greater air pressure beneath the wings supplies the upward force, or lift, that enables airplanes to fly.

You can make the ball follow the stream of air as you move the hair dryer because Bernoulli's principle says that the fast moving air around the sides of the ball is at a lower pressure than the surrounding stationary air. If the ball tries to leave the stream of air, the still, higher pressure air will push it back in - so the ball will float in the flow no matter how you move.

When you place the empty toilet paper tube into the air stream, the air is funneled into a smaller area, making air move even faster. The pressure in the tube becomes even lower than that of the air surrounding the ball, and the ball is pushed up into the tube

*Retrieved from [www.stevespanglerscience.com](http://www.stevespanglerscience.com)*

## **Experiment 4: Lamp Wind**

Students will be introduced to the effects that heat has on our atmosphere and be introduced to convection currents (wind). The light bulb will get hot. **Remember safety first.**

### **What you need:**

- Lamp, with lampshade taken off
- Talcum powder
- Pencil
- Piece of paper
- Scissors

### **What to do:**

#### **Part One**

1. Turn on the lamp, and let it heat up a bit.
2. Sprinkle some talcum powder just above the bulb. What happens? What might be some reasons? (The heat from the light bulb warms the air around it. As the heat rises, it takes the talcum powder with it. In real life, as the sun heats the air just above it also heat up. This hot air expands and becomes lighter; that's why it rises. Cold air moves in the now warm air's place, and this movement of air is wind.)

#### **Part Two**

1. Cut a spiral out of the piece of paper
2. Carefully balance the spiral on the point of a pencil. Don't make a hole in the spiral.

Turn on the lamp, and let it heat up a bit

Hold the pencil with the spiral just above the bulb. What happens? What are some reasons for this? (The spiral should spin because of the same reason that the talcum powder rose. The air around the bulb is heated and rises through the spiral, which causes it to spin.)

### **Some things to wonder about:**

What happens when the lamp heats up the air around it?

Where does hot air go?

Where does the cold air go?

The warm air moves up and more cold air moves in to take its place. When two **convection currents** meet, it causes the **wind** to blow.

Retrieved from: <http://www.canteach.ca/elementary/earthspace11.html>

## ***Experiment 5: Bottle Wad Trick***

You will be blowing a small wad of paper into the mouth of a soda bottle. Sound easy? Don't be so sure.

### **What you need:**

- 2-liter soda bottle
- Wad of paper the size of a pea

### **What to do:**

1. Hold the empty soda bottle on its side. You can place it on a table but hold it still.
2. Place a wad of paper the size of a pea into the mouth of the soda bottle.
3. Now blow directly at the mouth of the bottle.

### **What happened?**

The wad of paper should have jumped out rather than shot into the bottle.

Why?

What was in the bottle before you blew?

What did you do to the air around the bottle when you blew?

The air that you blew lowered the air pressure around the bottle opening letting the higher air pressure inside the bottle push the paper out. Wow!

## **Experiment 6: Go Fly a Kite**

How better to enjoy a good wind than to fly a kite.

**Idea:** If you are short on time but want the kids to run in the wind, tie strings on plastic grocery bags and catch the breeze or run madly around the playground with one trailing behind. Be careful not to leave your bags behind.

**Idea:** If you have large pieces of cardboard the kids can walk into the wind holding them. Be aware of strong winds when doing this and be safe. Safety first!

**Things to think about:** How does that kite stay up in the air? It has to do with air pressure. Airplanes can fly because of the Bernoulli Principle. Air rushing over the tops of airplane wings exerts less pressure than air from under the wings. So the relatively greater air pressure beneath the wings supplies the upward force, or lift, that enables airplanes and kites to fly. You can learn more about the Bernoulli Principle in Experiment 3. Think about the cloud we talked about and how it is able to stay up in the sky. The pressure below is greater than the weight of the cloud which can be up as much as 8 elephants.

### **Basic Sled Kite**

#### **What you need:**

- 1 Sheet of Paper 12" X 18"
- Scissors
- 2 Sticks 12" long (bamboo skewers with points cut off)
- Cellophane tape
- Hole punch
- 3 pieces of crepe paper 2" long
- 21' of thick sewing thread
- Cardboard 3" X 2"

#### **What to do:**

1. Fold the sheet of paper in half and cut off both of the corners on the open side. Don't cut the folded side. Your 2 cuts should meet at a point on the open side that is higher than the middle so you will have the lopsided diamond shape that is common in kites.
2. Take the top wing and fold it towards the folded side so the point of the triangle just meets the fold in the middle of the kite. Then turn the paper over and fold the other wing the same way.
3. Open the kite up and put cellophane tape over each wing tip. You can also use packing tape. The larger the area you cover with the tape, the sturdier the wings will be. Using a hole punch, make a hole in each wing tip approximately 2 inches in from both sides.
4. Attach a stick along the underside of each of the wings using 4 pieces of tape. Use 3-inch pieces and run them across the stick like brackets.
5. Twist the 3 pieces of crepe paper together to form a tail. Tape the pieces together at each end of the tail. Tape one end of the tail to a stick on a wing, and then loop it around. Tape the other end to the other stick.
6. Cut 3 feet of thick sewing thread and tie each end to each of the holes you punched in the wing tips. Then form a loop in the middle of the thread and tie a knot to hold it in place.
7. Tie one end of an 18-foot piece of thread to the loop that you just created. This is your line for flying your kite.

# CALIFORNIA CONTENT STANDARDS FOR EXPERIMENTS

## **\*Experiment 1-Balloon Blow up**

### **Grade 2**

#### **Physical Sciences:**

**1a.** Students know the position of an object can be described by locating it in relation to another object or to the background.

**1b.** Students know an object's motion can be described by recording the change in position of the object over time.

**1c.** Students know the way to change how something is moving is by giving it a push or pull. The size of the change is related to the strength, or amount of force, of the push or pull.

#### **Investigation & Experimentation:**

**4a.** Make predictions based on observed patterns and not random guessing.

**4b.** Measure length, weight, temperature, and liquid volume with appropriate tools and express those measurements in standard metric systems.

### **Grade 3**

#### **Physical Sciences:**

**1e.** Students know that matter has three forms: solid, liquid, and gas.

**1g.** Students know that when two or more substances are combined, a new substance may be formed with properties that are different from those of the original materials.

### **Grade 4**

#### **Investigation & Experimentation:**

**6f.** Follow a set of written instructions for a scientific investigation.

### **Grade 5**

Check link to molecular reaction on Experiment 1 page.

## **\*Experiment 2 & 3-Bernoulli Bags and Bernoulli Principal**

### **Grade 2**

#### **Investigations & Experimentation:**

**4a.** Make predictions based on observed patterns and not random guessing.

**4g.** Follow oral instructions for a scientific investigation.

### **Grade 3**

#### **Physical Sciences:**

**1e.** Students know that matter has three forms: solid, liquid and gas.

#### **Investigations & Experimentation:**

**5a.** Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in things being investigated, methods being used, or uncertainty in the investigation.

**5d.** Predict the outcome of a simple investigation and compare the result with the prediction.

### **Grade 4**

#### **Investigations & Experimentation:**

**6a.** Differentiate observation from inference (interpretation) and know scientists' explanations come from partly from what they observe and partly from how they interpret their observations.

**6c.** Formulate and justify predictions based on cause-and-effect relationships.

**6f.** Follow a set of written instructions for a scientific investigation.

## **\*Experiment 4-Lamp Wind**

### **Grade 2**

#### **Physical Sciences:**

**1b.** Students know an object's motion can be described by recording the change in position of the object over time.

**1c.** Students know the way to change how something is moving is by giving it a push or pull. The size of the change is related to the strength, or amount of force, of the push or pull.

**1d.** Students know tools and machines are used to apply pushes and pulls( forces) to make things move.

**1e.** Students know that objects fall to the ground unless something holds them up.

### **Grade 3**

#### **Physical Sciences:**

**1c.** Students know machines and living things convert stored energy to motion and heat.

**1d.** Students know how energy can be carried from one place to another by waves, such as water and sound waves, by electric current, and by moving objects.

### **Grade 5**

#### **Earth Science:**

**4.** Energy from the Sun heats Earth unevenly, causing air movements that result in changing weather patterns. As a basis for understanding this concept:

**4a.** Students know uneven heating of Earth causes air movements (convection currents)

### **Grade 6**

#### **Focus on Earth Science**

##### **Heat (Thermal Energy) (Physical Sciences):**

**3.** Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are the same temperature. As a basis for understanding this concept:

**3a.** Students know energy can be carried from one place to another by heat flow or by waves, including water, light and sound waves or by moving objects.

**3b.** Students know that when fuel is consumed, most of the energy released becomes heat energy.

##### **Energy in the Earth System:**

**4a.** Students know that the sun is the major source of energy for phenomena on Earth's surface; it powers wind, ocean currents, and the water cycle.

**4d.** Students know that convection currents distribute heat in the atmosphere and ocean.

## **\*Experiment 5-Bottle Wad Trick**

### **Grade 2**

#### **Physical Science:**

**1a.** Students know that the position of an object can be described by locating it in relation to another object or to the background.

**1b.** Students know an object's motion can be described by recording the change in position of the object over time.

**1c.** Students know the way to change how something is moving is by giving it a push or pull. The size of the change is related to the strength, or the amount of force, of the push or pull.

### **Grade 3**

#### **Investigations & Experimentation:**

**5d.** Predict the outcome of a simple investigation and compare the result with the prediction.

#### **Grade 4**

##### **Physical Science:**

**1g.** Students know electrical energy can be converted to heat, light and motion.

##### **Investigation & Experimentation:**

**6f.** Follow a set of written instructions for a scientific investigation.

#### **\*Experiment 6-Go Fly a Kite**

#### **Grade 2**

##### **Physical Sciences:**

**1a.** Students know the position of an object can be described by locating it in relation to another object or to the background.

**1b.** Students know an object's motion can be described by recording the change in position of the object over time.

**1c.** Students know the way to change how something is moving is by giving it a push or pull. The size of the change is related to the strength, or amount of force, of the push or pull.

**1d.** Students know tools and machines are used to apply pushes and pulls (forces) to make things move.

**1e.** Students know that objects fall to the ground unless something holds them up.

#### **Grade 5**

##### **Earth Science:**

**4a.** Students know that uneven heating of Earth causes air movements (convection currents)

#### **Grade 6**

##### **Earth Science:**

**3c.** Students know heat flows in solids by conduction (which involves no flow of matter) and in fluids by convection (which involves flow of matter)

**4a.** Students know that the sun is the major source of energy for phenomena on Earth's surface; it powers wind, ocean currents, and the water cycle.

**4d.** Students know that convection currents distribute heat in the atmosphere and ocean.

**4e.** Students know differences in pressure, heat, air movement, and humidity result in changes of weather.