



Air Pollution CSI

Make fun, simple, cheap working models of devices that remove pollutants from the air, including a cyclone hopper, an electrostatic precipitator, and a catalytic converter. Visit www.cleanaircampaign.org or www.ealliance.org for the full lesson plan, including background and context for these model-making activities and a springboard for student action.

Georgia Performance Standards for this lesson at elementary, middle and high school levels:

3d grade (S3L2ab)
6th (S6E5j)
Biology (SB4d)
Earth Systems (SES6c)
Ecology (SEC5b)
Environmental Science (SEV4e and 5c)
all grades (Nature of Science / Model Making)

Materials

For the class:

12 [potato sacks](#) (for 1/3 of class) ~ less than \$2 ea online or free at feed store
(or substitute king pillow cases or reusable canvas grocery bags with handles)

For each student:

1 pair safety glasses or goggles (for use when handling ground spices)
1 small (3 oz.) paper cup
1 pencil
1 dab of petroleum jelly, sufficient to cover the inner sides of a 3 oz. cup
1 tsp ground cinnamon or other ground spice, for cyclone hopper model
1 tsp cinnamon or paper circles from 3-hole punch, for electrostatic precipitator model
2 coffee filters (optional) for containing the spices or paper circles until needed
1 inflated balloon (do not use helium)
1 Student Handout
1 Scoring Rubric (attached at Assessment)

Model #1 The Cyclone Hopper: One Way Factories and Power Stations Clean the Air

Ask students if they have any ideas about how pollution could be cleaned up before it leaves a factory or power station. Listen to the ideas. Tell students that they are going to make models of two inventions that clean up particle pollution inside a factory or power station, to keep these pollutants from flying up a smokestack (chimney) and dirtying the air we breathe. The first invention is called a [cyclone hopper air cleaner](#). It is a container that whirls pollution particles around and catches them, similar to the way a spinning merry-go-round slings kids off if they don't hold on tight.

- Distribute a small paper cup, a pencil, a dab of petroleum jelly, and safety glasses to each student (or smear petroleum jelly on the inside walls – but not bottoms - of cups ahead of time).
- Tell students to poke the pencil through the bottom of the cup, so that when the pencil is twirled, the cup spins.
- Then sprinkle ground cinnamon or pepper in the (ungreased) bottom of each cup to represent particle pollution.
- Remind students to keep their safety glasses on and not to eat, touch or sniff the “pollution” as they whirl it around in the cup. (Refer to these [activity directions](#) from TeachEngineering for additional details, if needed).

After allowing a few minutes for cup-whirling, ask students to tell about the results. (Particles are slung to the walls of the cup and caught in the petroleum jelly). How well did their cyclone cleaners work? Did all of the particles get caught? (Some probably remain in the bottom of the cup or flew out). Would this method of catching pollutants also work for gases instead of particles? (No). Conclude for students that factories and power stations might have to use a second way of collecting particle pollutants.

Model #2 The Electrostatic Precipitator ~ Another Way Factories & Power Stations Clean Air

The [electrostatic precipitator](#) is a device that collects pollution particles with static electricity. Ask students if they have ever gotten a shock from scuffing across the floor and then touching a metal door knob. Have they ever noticed how clothes sometimes cling together when they first come out of a dryer? Both are examples of static electricity.

- Give each student an inflated balloon (not helium filled). Emphasize that they should wear safety glasses again.
- Also, give each student ground cinnamon, ground pepper, or paper circles from a three hole punch to simulate particle pollutants, sprinkling them on a piece of paper or in a large coffee filter.
- Tell students they must first generate static electricity by rubbing the balloon on their hair or clothes.
- When the balloons have enough charge to attract hairs from students' heads, tell the class to hold their balloons over the "particle pollutants" and see how many they can collect. (Refer to these [activity directions](#) from TeachEngineering for details, if needed).

After allowing time for pollution collection, explain that real electrostatic precipitators are made of electrified metal instead of balloons. Ask students to tell about their results. (Particles were picked up by the balloon). How well did their electrostatic precipitators work? Did all of the particles get collected? (No.) Tell students that factories and power stations might have to use more than one way of collecting particle, and they still may not catch them all.

Factories and power stations are not the only air polluters. Ask students if they can think of another source of air pollution. Explain that gasoline is burned in a car to make it go, just as coal and other fuels are burned in factories and power stations, to make electricity. All of these fuels produce air pollutants when they are burned.

Model #3 The Catalytic Converter ~ How Can We Keep Cars from Polluting the Air?

Take the class outdoors to a flat, grassy area. Introduce the concept of a [catalytic converter](#), the part of a car that speeds up chemical reactions to change pollutants into harmless gases. Explain that a chemical reaction is when something changes completely into something else. For instance, when water and flour are mixed together and baked, a chemical reaction turns those ingredients into cake, a new substance that cannot be separated back into flour and water. In the same way, when dangerous pollutants go through a catalytic converter inside a car, most of them are changed quickly into safe new substances, such as water vapor.

Assign students parts to play in the catalytic converter simulation activity. One third of the class will play the catalytic converter. One third of the class will play the part of the tailpipe. And one third of the class will play pollutants that are turned into harmless emissions. Explain the following directions to the class.

- Catalytic converter: This group stands facing the same direction, in three rows of three or four students each, legs apart and toe to toe on each row. Tell each student to reach one arm forward and place it on the shoulder of a student in the row ahead, so everyone is connected in an approximation of the honeycomb structure of a catalytic converter. Students must keep their feet rooted in place and one hand touching the student ahead. With free arms only, students can touch the "pollutants" that pass by, converting them to harmless substances.
- Tailpipe: Behind the last row of the catalytic converter, and perpendicular to that row, the tailpipe players will form two lines facing each other. They will touch hands overhead in the style of a game of London Bridge or sports team gauntlet.
- Pollutants: Students portraying pollutants will start out in pairs to represent chemical compounds, each linking an arm around the other's waist, using his free hand to hold up a [potato sack](#), and hopping in unison as they try to make it through the catalytic converter to the tailpipe. If they touch or are touched by a catalyst, they must drop their sack, disconnect their arms, and run (since catalysts speed up chemical reactions). Explain that when a pair of students has been touched, they have been converted from a pollutant compound to individual harmless substances. If a pollutant compound makes it all the way through the catalytic converter without being touched, they should stay connected, continue to hop in their sacks, and exit the tailpipe together as pollutants~ because in real life some pollutants don't get cleaned up. At the end of the game, discuss whether the catalytic converter was completely effective. (Not in real life).

What Can Kids Do to Protect Our Air?

Begin a discussion by asking who is responsible for making air pollution. (Possible responses: factories, power stations, cars, people) Explain that it is tempting to blame industry, government, and power companies for making pollution- anyone but ourselves. But everyone is partly responsible. When we buy toys made in factories, some pollution was made by the machines that make the toys. When we turn on the lights in our homes and schools, power stations burn fuel (often coal) to make electricity for the lights, and air pollution is created at the same time. When riding in cars, pollution comes out the tailpipes. It is important to make as little pollution as possible and to clean up what we make.

Ask students what choices kids can make to reduce the amount of electricity or gasoline they use -and the resulting amount of pollution that is created at the same time. Note student suggestions on index cards. Divide the class into groups of two- four and pass an index card to each group. The group will silently act out the suggestion on the card and their classmates will guess what they are doing. Afterwards, the actors should tell **how** the activity reduces pollution.

- lots of students riding one school bus (instead of each riding in a separate car)
- riding a bike to school (instead of taking a bus or car)
- carpooling to sports practice (instead of taking separate cars)
- turning a car off (instead of idling) when waiting to pick someone up
- turning off lights, appliances, computers, etc. before leaving a room (or home)
- replacing incandescent light bulbs with compact fluorescents, to use less energy
- keeping the front door shut so air conditioning (or heat) does not escape
- recycling trash (instead of throwing it away)
- going in to a restaurant instead of using the drive through (to reduce idling time)
- running several errands in one car trip (instead of wasting gas on separate trips)
- driving a car powered by used french fry oil instead of gasoline
- using solar panels to generate electricity

Debriefing: The Big Ideas

Ask students to tell what they learned during this lesson. Write their key words on the board in the three categories shown below. Elaborate on student responses to make sure the following points are covered, at a minimum:

1) The importance of clean air and effects of air pollution

- **All living things need clean air** to survive.
- When we use electricity from coal to power our home, **we make air pollution**.
- When we use gasoline to power the car we ride in, **we make air pollution**.
- **Air pollution makes it hard to breathe** for plants, animals, and humans.
- **Air pollution can make people sick**.
- **Air pollution can keep plants from being able to make food** for themselves.
- **Air pollutions moves** from the place where it's made. It is blown by wind and falls from the sky on water or land.
- **Air pollution harms habitats** (homes) of plants and animals.

2) Ways to clean up air pollution

- We conserve (protect) our air when we **catch the particle pollution coming out of a smokestack** at a factory or a power station. Inventions such as the cyclonic hopper and electrostatic precipitator help to do this.
- We conserve (protect) our air when we **convert (change) pollution made by cars into safe air before it comes out the tailpipe**. That is what catalytic converters do.

3) Ways to prevent (or make less) air pollution

- We have to be careful that we **don't waste power** because the more electricity we use at home and school, and the more gasoline we use to ride in cars, the more pollution is created.
- Things we throw away are often taken in garbage trucks to a landfill where they are burned ~ making more air pollution. So, we can conserve (protect) our air by **recycling and reusing** things instead of throwing them away.
- People can **invent new ways to make electricity and to go places** without making so much pollution.

Proficiency Level ->	4 Caped Crusader	3 Earth Saver	2 Pollution Buster	1 Only Human
Activities				
Made a model of a cyclone hopper	<input type="checkbox"/> Exceeds standard model functional (trapped particles)	<input type="checkbox"/> Meets standard model complete but not functional	<input type="checkbox"/> Partially meets standard model incomplete	<input type="checkbox"/> Does not meet standard no model attempted
Made a model of an electrostatic precipitator	<input type="checkbox"/> model functional (trapped particles)	<input type="checkbox"/> model complete but not functional	<input type="checkbox"/> model incomplete	<input type="checkbox"/> no model attempted
Made a human model of a catalytic converter	<input type="checkbox"/> participated			<input type="checkbox"/> did not participate
Performed a skit about preventing air pollution	<input type="checkbox"/> participated			<input type="checkbox"/> did not participate
Drew a picture and wrote sentence(s) about what causes air pollution and how to reduce air pollution	<input type="checkbox"/> completed picture and sentence(s) demonstrated understanding of causes of air pollution demonstrated understanding of a way to reduce air pollution	<input type="checkbox"/> attempted both picture and sentence(s) some understanding of air pollution causes and/or solutions	<input type="checkbox"/> attempted either picture or sentence(s) off-topic	<input type="checkbox"/> no attempt