

Setup Instructions for Using the Understanding Air Curriculum at Public STEM Events

with the MIT Edgerton Center Molecule Set



INTRODUCTION:

The Understanding Air curriculum is excellent for teaching at public STEM events, festivals, or fairs. This guide has a list of materials and instructions to create tables with activity stations for public events.

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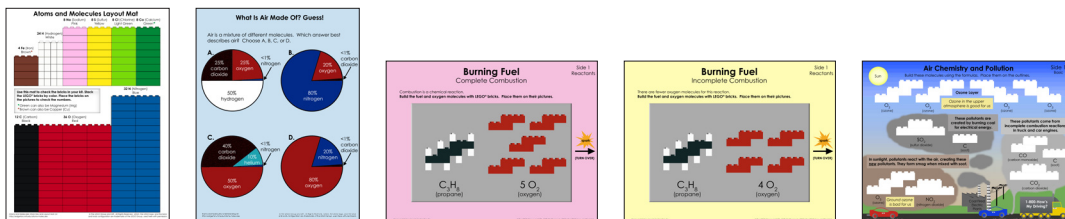


PREPARATION BEFORE THE EVENT:

1. Please download and print the following documents from:
<https://edgerton.mit.edu/molecule-sets/molecule-sets-public-events>

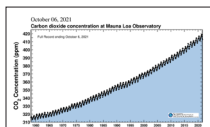


All the mats are 8.5"x11" and have 2 sides (only 1 side shown below) - print in color, double-sided, on regular paper or card stock.



- Atom Key/Layout Mat (4 copies)
- What Is Air Made of Mat (3 copies)
- Burning Fuel: Complete Combustion Mat (4 copies)
- Burning Fuel: Incomplete Combustion Mat (4 copies)
- Air Chemistry and Pollution Mat (3 copies)

The CO₂ Graph is 8.5"x11" and single-sided - print in color or black/white, on regular paper.



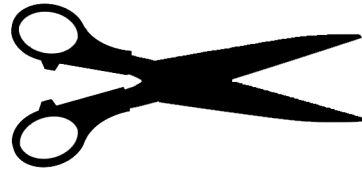
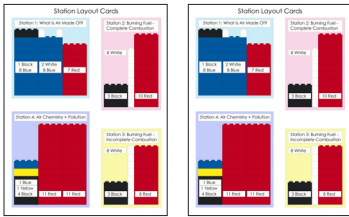
- CO₂ Graph (1 copy)

2. Purchase 8 plastic stands for 8.5" x 11" pages. Place the following mats and graph in the plastic stands.

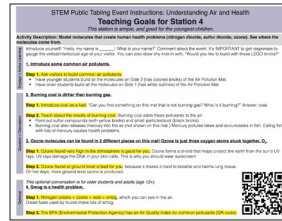
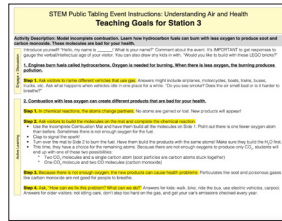
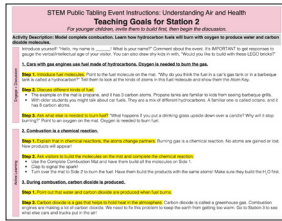
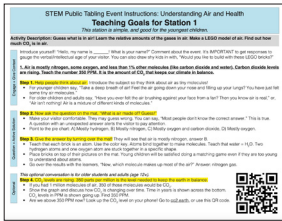
- Atom Key/Layout Mat
- What Is Air Made of Mat
- Burning Fuel: Complete Combustion Mat (2 stands)
- Burning Fuel: Incomplete Combustion Mat (2 stands)
- Air Chemistry and Pollution Mat
- CO₂ Graph



3. Print 2 copies of the Station Layout Cards on page 4. Cut out each layout card and tape to the inside bottom of a small box (plastic takeout boxes work well). Fill each box with the bricks on the Layout Card. You should have 8 boxes, 2 for each station.



4. Print copies of the STEM Tabling Event Instructions on pages 5-8. Print one for each volunteer at each station.



5. Use the station photos and directions on pages 9-12 to gather the materials for each station.

6. Meet with the volunteers in advance to go over the STEM Tabling Event Instructions and have them practice using the bricks before the event.

SETUP AT THE EVENT:

1. Use the station photos and directions on pages 9-12 to set up each station.
2. Make sure each volunteer has their STEM Tabling Event Instructions sheet for reference.
3. Place 2 participant chairs for each station. This table set up can only handle 2 participants at each station at a time – the chairs show whether there is an open place.
4. Have fun!

Station Layout Cards

Station 1: What is Air Made Of?

1 Black	2 White
8 Blue	8 Blue
	7 Red

Station 2: Burning Fuel - Complete Combustion

3 Black	8 White	10 Red
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Station 4: Air Chemistry + Pollution

1 Blue	11 Red
1 Yellow	11 Red
4 Black	11 Red

Station 3: Burning Fuel - Incomplete Combustion

3 Black	8 White	8 Red
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STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 1

This station is simple, and good for the youngest children.

Activity Description: Guess what is in air! Learn the relative amounts of the gases in air. Make a model of air with the bricks. Find out how much CO₂ is in air.

Engage + Give Context

Introduce yourself! “Hello, my name is _____! What is your name?” Comment about the event. It’s IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, “Would you like to build with these bricks?”

1. Air is mostly nitrogen, some oxygen, and less than 1% other molecules (like carbon dioxide and water). Carbon dioxide levels are rising. Teach the number 350 PPM. It is the amount of CO₂ that keeps our climate in balance.

Step 1. Help people think about air. Introduce the subject so they think about air as tiny molecules!

- For younger children say, “Take a deep breath of air! Feel the air going down your nose and filling up your lungs? You have just felt some tiny air molecules.”
- For older children and adults say, “Have you ever felt the air brushing against your face from a fan? Then you know air is real,” or, “Air isn’t nothing! Air is a mixture of different kinds of molecules.”

Question + Active Solution

Step 2. Now ask the question on the mat, “What is air made of? Guess!”

- Make your visitor comfortable. They may guess wrong. You can say, “Most people don’t know the correct answer.” This is true. A question with an unexpected answer alerts the visitor to pay attention.
- Point to the pie chart: A) Mostly hydrogen, B) Mostly nitrogen, C) Mostly oxygen and carbon dioxide, D) Mostly oxygen.

Step 3. Give the answer by turning over the mat! They will see that air is mostly nitrogen, answer B.

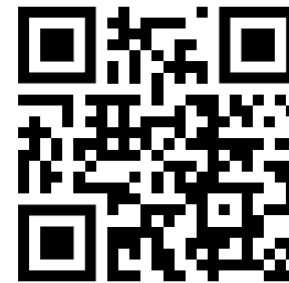
- Teach that each brick is an atom. Use the color key. Atoms bind together to make molecules. Teach that water = H₂O. Two hydrogen atoms and one oxygen atom are stuck together in a specific shape.
- Place bricks on top of their pictures on the mat. Young children will be satisfied doing a matching game even if they are too young to understand about atoms.
- Go over the results with the learners, “Now, which molecule makes up most of the air?” Answer: nitrogen gas.

Optional

This optional conversation is for older students and adults (age 12+).

Step 4. CO₂ levels are rising. 350 parts per million is the level needed to keep the earth in balance.

- If you had 1 million molecules of air, 350 of those molecules would be CO₂.
- Show the graph and discuss how CO₂ is changing over time. Time in years is shown across the bottom. CO₂ levels in PPM is shown going up. Find 350 PPM.
- Are we above 350 PPM now? Look up the CO₂ level on your phone! Go to co2.earth, or use this QR code.



STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 2

For younger children, invite them to build first, then begin the discussion.

Activity Description: Model complete combustion. Learn how hydrocarbon fuels will burn with oxygen to produce water and carbon dioxide molecules.

Engage + Discussion

Introduce yourself! “Hello, my name is _____! What is your name?” Comment about the event. It’s IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, “Would you like to build with these bricks?”

1. Cars with gas engines use fuel made of hydrocarbons. Oxygen is needed to burn the gas.

Step 1. Introduce fuel molecules. Point to the fuel molecule on the mat. “Why do you think the fuel in a car’s gas tank or in a barbeque tank is called a hydrocarbon?” Tell them to look at the kinds of atoms in this fuel molecule and show them the Atom Key.

Step 2. Discuss different kinds of fuel.

- The example on the mat is propane, and it has 3 carbon atoms. Propane tanks are familiar to kids from seeing barbeque grills.
- With older students you might talk about car fuels. They are a mix of different hydrocarbons. A familiar one is called octane, and it has 8 carbon atoms.

Step 3. Ask what else is needed to burn fuel? “What happens if you put a drinking glass upside down over a candle? Why will it stop burning?” Point to an oxygen on the mat. Oxygen is needed to burn fuel.

Active Learning

2. Combustion is a chemical reaction.

Step 1. Explain that in chemical reactions, the atoms change partners. Burning gas is a chemical reaction. No atoms are gained or lost. New products will appear!

Step 2. Ask visitors to build the molecules on the mat and complete the chemical reaction.

- Use the Complete Combustion Mat and have them build all the molecules on Side 1.
- Clap to signal the spark!
- Turn over the mat to Side 2 to burn the fuel. Have them build the products with the same atoms! Make sure they build the H₂O first.

3. During combustion, carbon dioxide is produced.

Step 1. Point out that water and carbon dioxide are produced when fuel burns.

Step 2. Carbon dioxide is a gas that helps to hold heat in the atmosphere. Carbon dioxide is called a greenhouse gas. Combustion engines are making a lot of carbon dioxide. We need to fix this problem to keep the earth from getting too warm. Go to Station 3 to see what else cars and trucks put in the air!

STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 3

Activity Description: Model incomplete combustion. Learn how hydrocarbon fuels can burn with less oxygen to produce soot and carbon monoxide. These molecules are bad for your health.

Engage + Discussion

Introduce yourself! “Hello, my name is _____! What is your name?” Comment about the event. It’s IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, “Would you like to build with these bricks?”

1. Engines burn fuels called hydrocarbons. Oxygen is needed for burning. When there is less oxygen, the burning produces pollution.

Step 1. Ask visitors to name different vehicles that use gas. Answers might include airplanes, motorcycles, boats, trains, buses, trucks, etc. Ask what happens when vehicles idle in one place for a while. “Do you see smoke? Does the air smell bad or is it harder to breathe?”

2. Combustion with less oxygen can create different products that are bad for your health.

Step 1. In chemical reactions, the atoms change partners. No atoms are gained or lost. New products will appear!

Step 2. Ask visitors to build the molecules on the mat and complete the chemical reaction.

- Use the Incomplete Combustion Mat and have them build all the molecules on Side 1. Point out there is one fewer oxygen atom than before. Sometimes there is not enough oxygen for the fuel.
- Clap to signal the spark!
- Turn over the mat to Side 2 to burn the fuel. Have them build the products with the same atoms! Make sure they build the H₂O first.
- This time, they have a choice for the remaining atoms. Because there are not enough oxygens to produce only CO₂, students will end up with one of these two possibilities:
 - Two CO₂ molecules and a single carbon atom (soot particles are carbon atoms stuck together)
 - One CO₂ molecule and two CO molecules (carbon monoxide)

Step 3. Because there is not enough oxygen, the new products can cause health problems. Particulates like soot and poisonous gases like carbon monoxide are not good for people to breathe.

Step 4. Ask, “How can we fix this problem? What can we do?” Answers for kids: walk, bike, ride the bus, use electric vehicles, carpool. Answers for older visitors: not idling cars, don’t step too hard on the gas, and get your car’s emissions checked every year.

Active Learning

STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 4

This station is simple, and good for the youngest children.

Activity Description: Model molecules that create human health problems (nitrogen dioxide, sulfur dioxide, ozone). See where the molecules come from.

Engage + Active Learning

Introduce yourself! “Hello, my name is _____! What is your name?” Comment about the event. It’s IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, “Would you like to build with these bricks?”

1. Introduce some common air pollutants.

Step 1. Ask visitors to build common air pollutants.

- Have younger students build all the molecules on Side 2 (has colored bricks) of the Air Pollution Mat.
- Have older students build all the molecules on Side 1 (has white outlines) of the Air Pollution Mat.

2. Burning coal is dirtier than burning gas.

Step 1. Introduce coal as a fuel. “Can you find something on this mat that is not burning gas? What is it burning?” Answer: coal.

Step 2. Teach about the results of burning coal. Burning coal adds these pollutants to the air:

- Point out sulfur compounds (with yellow bricks) and small particles/soot (black bricks).
- Burning coal also releases mercury into the air (not shown on this mat.) Mercury pollutes lakes and accumulates in fish. Eating fish with lots of mercury causes health problems.

3. Ozone molecules can be found in 2 different places on this mat! Ozone is just three oxygen atoms stuck together, O₃.

Step 1. Ozone found very high in the atmosphere is good for you. Ozone forms a shield that helps protect the earth from the sun’s UV rays. UV rays damage the DNA in your skin cells. This is why you should wear sunscreen!

Step 2. Ozone found at ground level is bad for you, because it makes it hard to breathe and harms lung tissue. On hot days, more ground level ozone is produced.

Question + Discussion

This optional conversation is for older students and adults (age 12+).

4. Smog is a health problem.

Step 1. Nitrogen oxides + ozone + soot = smog, which you can see in the air. Diesel fuels used by trucks make lots of smog.

Step 2. The EPA (Environmental Protection Agency) has an Air Quality Index for common pollutants (QR code).

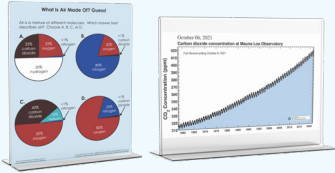
Optional



Station 1

Learn About Air

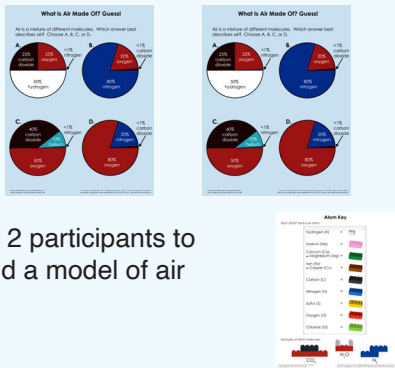
2 Stands



Keep the CO₂ graph available behind the other stand.
Use with older youth and adults.

Discuss climate change with the CO₂ graph (350 PPM = safe level)
What is the number now?

2 Mats + Atom Key



For 2 participants to build a model of air

2 Brick Boxes



Fill with enough bricks for 2 participants - use Station Mat 1 to determine number and color.



STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 1

This station is simple, and good for the youngest children.

Activity Description: Guess what is in air! Learn the relative amounts of the gases in air. Make a LEGO model of air. Find out how much CO₂ is in air.

Engage + Give Context
Introduce yourself! "Hello, my name is _____! What is your name?" Comment about the event. It's IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, "Would you like to build with these LEGO bricks?"

1. Air is mostly nitrogen, some oxygen, and less than 1% other molecules (like carbon dioxide and water). Carbon dioxide levels are rising. Teach the number 350 PPM. It is the amount of CO₂ that keeps our climate in balance.

Step 1. Help people think about air. Introduce the subject so they think about air as tiny molecules!

- For younger children say, "Take a deep breath of air! Feel the air going down your nose and filling up your lungs? You have just felt some tiny air molecules."
- For older children and adults say, "Have you ever felt the air brushing against your face from a fan? Then you know air is real," or, "Air isn't nothing! Air is a mixture of different kinds of molecules."

Step 2. Now ask the question on the mat, "What is air made of? Guess!"

- Make your visitor comfortable. They may guess wrong. You can say, "Most people don't know the correct answer." This is true. A question with an unexpected answer alerts the visitor to pay attention.
- Point to the pie chart: A) Mostly hydrogen, B) Mostly nitrogen, C) Mostly oxygen and carbon dioxide, D) Mostly oxygen.

Step 3. Give the answer by turning over the mat! They will see that air is mostly nitrogen, answer B.

- Teach that each brick is an atom. Use the color key. Atoms bind together to make molecules. Teach that water = H₂O. Two hydrogen atoms and one oxygen atom are stuck together in a specific shape.
- Place bricks on top of their pictures on the mat. Young children will be satisfied doing a matching game even if they are too young to understand about atoms.
- Go over the results with the learners, "Now, which molecule makes up most of the air?" Answer: nitrogen gas.

This optional conversation is for older students and adults (age 12+).

Step 4. CO₂ levels are rising. 350 parts per million is the level needed to keep the earth in balance.

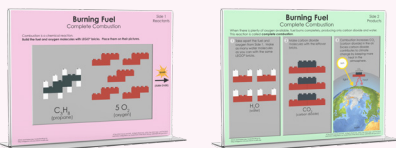
- If you had 1 million molecules of air, 350 of those molecules would be CO₂.
- Show the graph and discuss how CO₂ is changing over time. Time in years is shown across the bottom. CO₂ levels in PPM is shown going up. Find 350 PPM.
- Are we above 350 PPM now? Look up the CO₂ level on your phone! Go to co2.earth, or use this QR code.



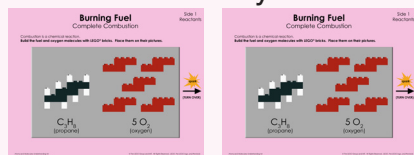
Station 2

Burning Fuel Produces CO₂

2 Stands



2 Mats + Atom Key



For 2 participants to model what burning fuel produces: water and CO₂!

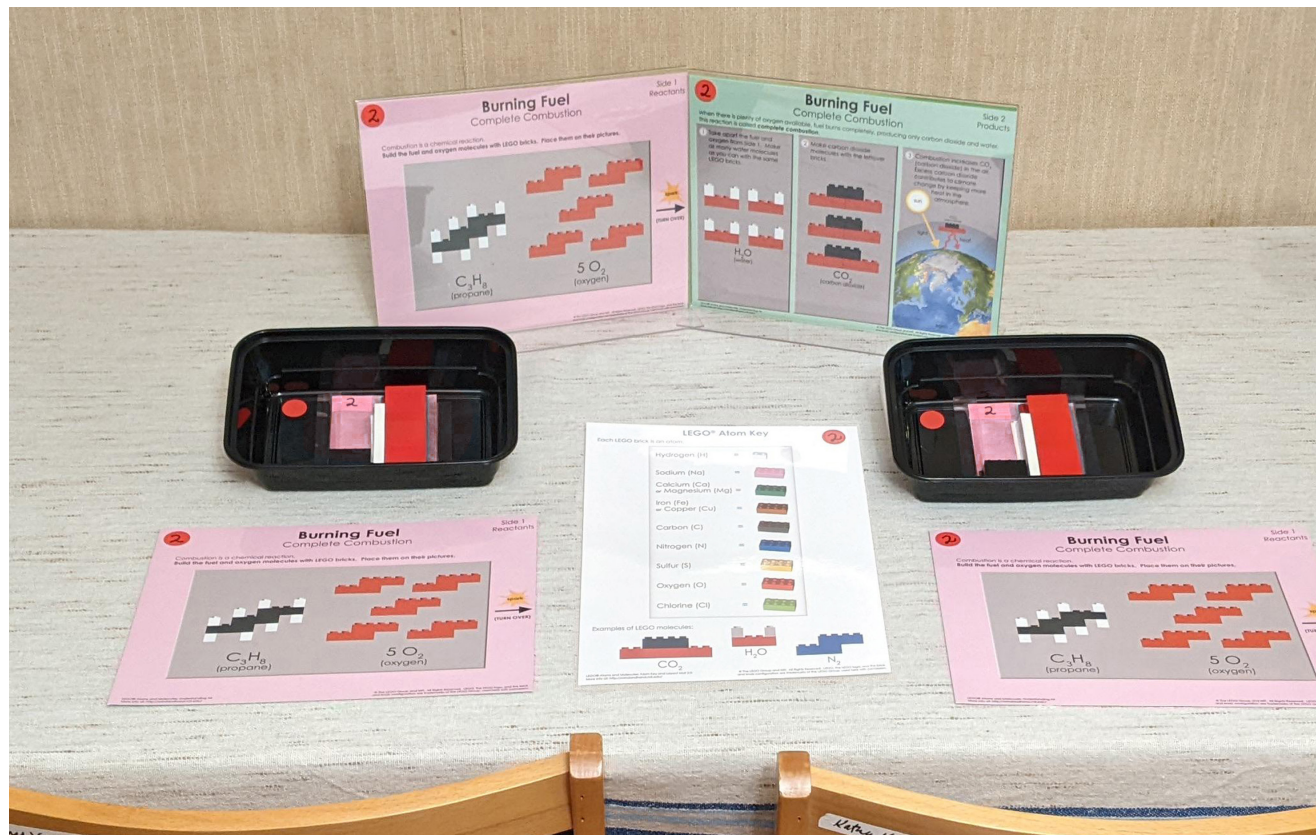


Have participants turn over the mat and rearrange the same atoms into the products.

2 Brick Boxes



Fill with enough bricks for 2 participants - use Station Mat 2 to determine number and color.



STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 2

For younger children, invite them to build first, then begin the discussion.

Activity Description: Model complete combustion. Learn how hydrocarbon fuels will burn with oxygen to produce water and carbon dioxide molecules.

Introduce yourself! "Hello, my name is _____! What is your name?" Comment about the event. It's IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, "Would you like to build with these LEGO bricks?"

1. Cars with gas engines use fuel made of hydrocarbons. Oxygen is needed to burn the gas.

Step 1. Introduce fuel molecules. Point to the fuel molecule on the mat. "Why do you think the fuel in a car's gas tank or in a barbeque tank is called a hydrocarbon?" Tell them to look at the kinds of atoms in this fuel molecule and show them the Atom Key.

Step 2. Discuss different kinds of fuel.

- The example on the mat is propane, and it has 3 carbon atoms. Propane tanks are familiar to kids from seeing barbeque grills.
- With older students you might talk about car fuels. They are a mix of different hydrocarbons. A familiar one is called octane, and it has 8 carbon atoms.

Step 3. Ask what else is needed to burn fuel? "What happens if you put a drinking glass upside down over a candle? Why will it stop burning?" Point to an oxygen on the mat. Oxygen is needed to burn fuel.

2. Combustion is a chemical reaction.

Step 1. Explain that in chemical reactions, the atoms change partners. Burning gas is a chemical reaction. No atoms are gained or lost. New products will appear!

Step 2. Ask visitors to build the molecules on the mat and complete the chemical reaction.

- Use the Complete Combustion Mat and have them build all the molecules on Side 1.
- Clap to signal the spark!
- Turn over the mat to Side 2 to burn the fuel. Have them build the products with the same atoms! Make sure they build the H₂O first.

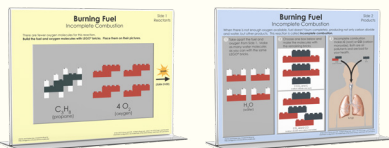
3. During combustion, carbon dioxide is produced.

Step 1. Point out that water and carbon dioxide are produced when fuel burns.

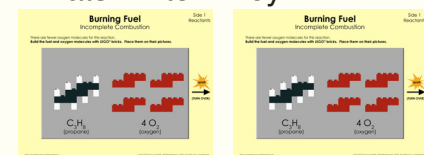
Step 2. Carbon dioxide is a gas that helps to hold heat in the atmosphere. Carbon dioxide is called a greenhouse gas. Combustion engines are making a lot of carbon dioxide. We need to fix this problem to keep the earth from getting too warm. Go to Station 3 to see what else cars and trucks put in the air!

Station 3 Burning Fuel Harms Health

2 Stands



2 Mats + Atom Key



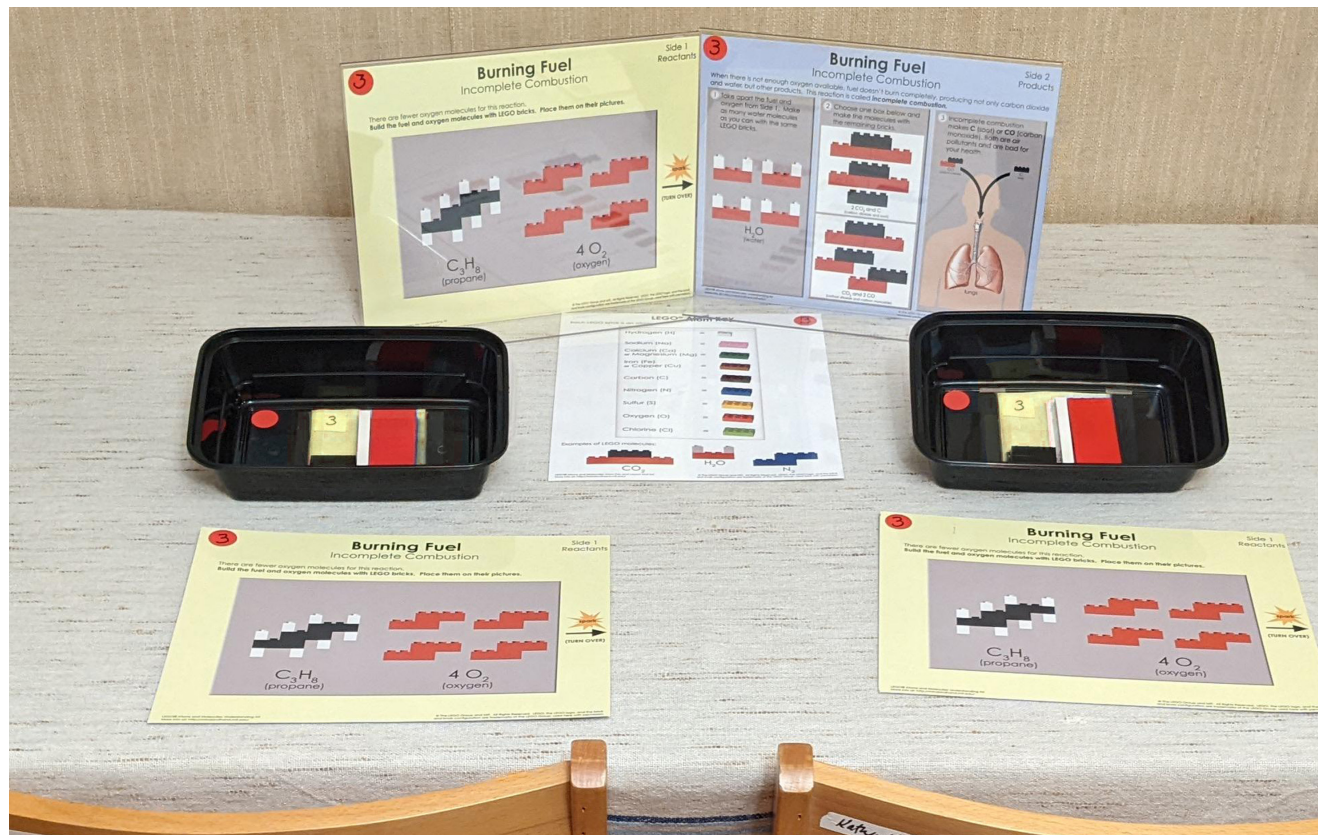
For 2 participants to model what pollutants are produced when fuel burns with less oxygen: carbon monoxide and soot. Both cause health problems.

Atom	Color
Hydrogen (H)	White
Carbon (C)	Black
Oxygen (O)	Red
Sulfur (S)	Yellow
Nitrogen (N)	Blue
Chlorine (Cl)	Green
Fluorine (F)	Purple
Iodine (I)	Brown
Bromine (Br)	Orange
Phosphorus (P)	Light Green
Selenium (Se)	Light Purple
Zinc (Zn)	Light Blue
Cadmium (Cd)	Light Orange
Mercury (Hg)	Light Yellow
Strontium (Sr)	Light Red
Barium (Ba)	Light Purple
Calcium (Ca)	Light Blue
Magnesium (Mg)	Light Green
Beryllium (Be)	Light Yellow
Lithium (Li)	Light Orange
Sodium (Na)	Light Red
Potassium (K)	Light Purple
Rubidium (Rb)	Light Blue
Cesium (Cs)	Light Green
Francium (Fr)	Light Yellow
Helium (He)	Light Orange
Neon (Ne)	Light Red
Argon (Ar)	Light Purple
Krypton (Kr)	Light Blue
Xenon (Xe)	Light Green
Radon (Rn)	Light Yellow

2 Brick Boxes



Fill with enough bricks for 2 participants - use Station Mat 3 to determine number and color.



STEM Public Tabling Event Instructions: Understanding Air and Health Teaching Goals for Station 3

Activity Description: Model incomplete combustion. Learn how hydrocarbon fuels can burn with less oxygen to produce soot and carbon monoxide. These molecules are bad for your health.

Introduce yourself! "Hello, my name is ____! What is your name?" Comment about the event. It's IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, "Would you like to build with these LEGO bricks?"

1. Engines burn fuels called hydrocarbons. Oxygen is needed for burning. When there is less oxygen, the burning produces pollution.

Step 1. Ask visitors to name different vehicles that use gas. Answers might include airplanes, motorcycles, boats, trains, buses, trucks, etc. Ask what happens when vehicles idle in one place for a while. "Do you see smoke? Does the air smell bad or is it harder to breathe?"

2. Combustion with less oxygen can create different products that are bad for your health.

Step 1. In chemical reactions, the atoms change partners. No atoms are gained or lost. New products will appear!

Step 2. Ask visitors to build the molecules on the mat and complete the chemical reaction.

- Use the Incomplete Combustion Mat and have them build all the molecules on Side 1. Point out there is one fewer oxygen atom than before. Sometimes there is not enough oxygen for the fuel.
- Clap to signal the spark!
- Turn over the mat to Side 2 to burn the fuel. Have them build the products with the same atoms! Make sure they build the H₂O first. This time, they have a choice for the remaining atoms. Because there are not enough oxygens to produce only CO₂, students will end up with one of these two possibilities:
 - Two CO₂ molecules and a single carbon atom (soot particles are carbon atoms stuck together)
 - One CO₂ molecule and two CO molecules (carbon monoxide)

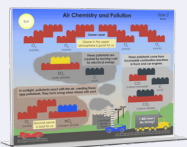
Step 3. Because there is not enough oxygen, the new products can cause health problems. Particulates like soot and poisonous gases like carbon monoxide are not good for people to breathe.

Step 4. Ask, "How can we fix this problem? What can we do?" Answers for kids: walk, bike, ride the bus, use electric vehicles, carpool. Answers for older visitors: not idling cars, don't step too hard on the gas, and get your car's emissions checked every year.

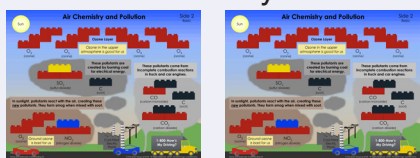
Station 4

Learn About Air Pollutants

1 Stand



2 Mats + Atom Key



Atom Key	
Hydrogen (H)	White
Sodium (Na)	Yellow
Calcium (Ca) or Magnesium (Mg)	Red
Iron (Fe) or Copper (Cu)	Blue
Carbon (C)	Black
Nitrogen (N)	Green
Sulfur (S)	Orange
Oxygen (O)	Light Blue
Chlorine (Cl)	Dark Green

For 2 participants to build pollutants. Use the side with colors for younger children. Use the side with white blanks for older children.

Explain good and bad ozone and other molecules.

2 Brick Boxes



Fill with enough bricks for 2 participants - use Station Mat 4 to determine number and color.



STEM Public Tabling Event Instructions: Understanding Air and Health

Teaching Goals for Station 4

This station is simple, and good for the youngest children.

Activity Description: Model molecules that create human health problems (nitrogen dioxide, sulfur dioxide, ozone). See where the molecules come from.

Engage + Active Learning
Introduce yourself! "Hello, my name is ____! What is your name?" Comment about the event. It's IMPORTANT to get responses to gauge the verbal/intellectual age of your visitor. You can also draw shy kids in with, "Would you like to build with these LEGO bricks?"

1. Introduce some common air pollutants.

Step 1. Ask visitors to build common air pollutants.

- Have younger students build all the molecules on Side 2 (has colored bricks) of the Air Pollution Mat.
- Have older students build all the molecules on Side 1 (has white outlines) of the Air Pollution Mat.

2. Burning coal is dirtier than burning gas.

Step 1. Introduce coal as a fuel. "Can you find something on this mat that is not burning gas? What is it burning?" Answer: coal.

Step 2. Teach about the results of burning coal. Burning coal adds these pollutants to the air:

- Point out sulfur compounds (with yellow bricks) and small particles/soot (black bricks).
- Burning coal also releases mercury into the air (not shown on this mat.) Mercury pollutes lakes and accumulates in fish. Eating fish with lots of mercury causes health problems.

3. Ozone molecules can be found in 2 different places on this mat! Ozone is just three oxygen atoms stuck together, O₃.

Step 1. Ozone found very high in the atmosphere is good for you. Ozone forms a shield that helps protect the earth from the sun's UV rays. UV rays damage the DNA in your skin cells. This is why you should wear sunscreen!

Step 2. Ozone found at ground level is bad for you, because it makes it hard to breathe and harms lung tissue. On hot days, more ground level ozone is produced.

This optional conversation is for older students and adults (age 12+).

4. Smog is a health problem.

Step 1. Nitrogen oxides + ozone + soot = smog, which you can see in the air. Diesel fuels used by trucks make lots of smog.

Step 2. The EPA (Environmental Protection Agency) has an Air Quality Index for common pollutants (AQI code).

