

If you have not used this set before, introduce the concepts of elements, compound, mixtures with p. 5, 6, & 7. (one class period) Pages here follow lesson plan "Part 1 Understanding Air" found online: http://www.teachersdomain.org/resource/envh10.health.lp58a/
Note: Teachers Domain is moving to PBS LearningMedia on Oct 15, 2013

Instructional Key
Red = instructional notes
Blue = student answers

Atoms and Molecules: Understanding Air

To learn student misconceptions and to pique their interest-- Climate Change

Hand out the mat "What is Air Made of? Guess!" Careful--answer is on the back side. Tell them not to turn it over.

Have students vote by secret ballot or by putting heads down, eyes closed, raising a hand. Record the class' results on the board for A, B, C, and D.

Part 1: What is Air?

Explain the answer is B. Have students circle the answer on this paper. Tell them to help remember what's in air we are going to build a model of air!

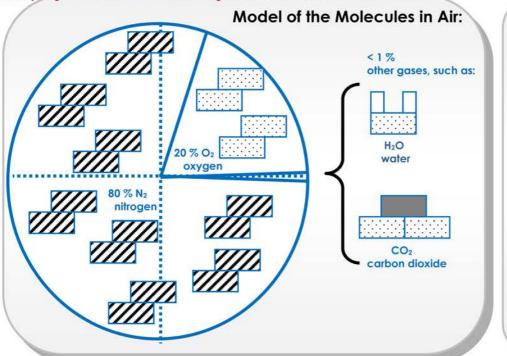
Activity 1 What is air made of? Guess! A B C D (Circle the letter.)

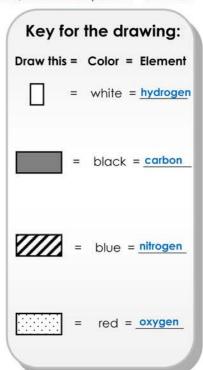
Turn mat over and build, "Model the Molecules in Air". Tell students to place the bricks on top of their images. Helps students self correct.

Activity 2 Build with LEGO! Next, draw the model below. (Copy the whole LEGO mat.)

Use the key provided for the brick colors. Label the molecules and add the percents.

Ask students close the lid on the kits, after they finish. This is to prevent off-task building! Use this technique at other times, as necessary. Next, have the students copy their model of air on paper. This is a good repetition. USE the correct COLORS if you have them, instead of the patterns. Colors are simpler for younger students and useful for learning elements' colors for older students.





Explain that <u>CO₂ levels are less than 1%.</u> Therefore we need to measure in PPM to track the changes in CO₂. (The number 390 PPM was the CO₂ concentration when this lesson was created.)

 CO_2 level written on the LEGO mat = 390 PPM Safe upper limit for CO_2 level = 350 PPM PPM = <u>Parts Per Million</u> (parts per 1,000,000)

You will need to tell them the ideal or "safe" number is "350 PPM" and then explain it. This famous number "350" was determined by an international panel of experts to be the ideal or "safe" level of carbon dioxide. We are above this level. Climate change is happening, when the level is above "350" However people can do something about climate change!

Activity 3 Practice figuring out PPM:

Calculate the PPM of 80% nitrogen in air Calculate the PPM of 20% oxygen in air

 $N_2 = 800,000$ PPM $O_2 = 200,000$ PPM

Explain that CO_2 concentrations are very low compared with other gases like nitrogen and oxygen. However CO_2 can have a big effect!

Show your work (hint: use fractions) This is equivalent fractions work, for example:

75% = 75/100 = 3/4

80% nitrogen

<u>80</u> ? <u>800,000</u> 100 = 1,000,000 = 1,000,000

20% oxygen

 $\frac{20}{100} = \frac{?}{1,000,000} = \frac{200,000}{1,000,000}$

Let's look at the records of CO₂ concentration over time.

Mauna Loa Observatory, Hawai'i Monthly Average Carbon Dioxide Concentration



The Mauna Loa atmospheric CO2 measurements constitute the longest continuous record of atmospheric CO2 concentrations available in the world. The Mauna Loa site is considered one of the most favorable locations for measuring undisturbed air because possible local influences of vegetation or human activities on atmospheric CO2 concentrations are minimal and any influences from volcanic vents may be excluded from the records. The methods and equipment used to obtain these measurements have remained essentially unchanged during the 46-year monitoring program. Because of the favorable site location, continuous monitoring, and careful selection and scrutiny of the data, the Mauna Loa record is considered to be a precise record and a reliable indicator of the regional trend in the concentrations of atmospheric CO2 in the middle layers of the troposphere.

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1998 365.32 366.15 367.31 368.61 369.29 368.87 367.64 365.77 363.90 364.23 365.46 366.97 366.63	366.58
1999 368.15 368.87 369.59 371.14 371.00 370.35 369.27 366.94 364.63 365.12 366.67 368.01 368.31	368.30
2000 369.14 369.46 370.52 371.66 371.82 371.70 370.12 368.12 366.62 366.73 368.29 369.53 369.48	369.47
2001 370.28 371.50 372.12 372.87 374.02 373.30 371.62 369.55 367.96 368.09 369.68 371.24 371.02	371.03
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2003 374.68 375.63 376.11 377.65 378.35 378.13 376.62 374.50 372.99 373.00 374.35 375.70 375.64	375.61

Monthly values are expressed in parts per million (ppm) and reported in the 2003A SIO manometric mole fraction scale. The monthly values have been adjusted to the 15th of each month. Missing values are denoted by -99.99. The "annual" average is the arithmetic mean of the twelve monthly values. In years with one or two missing monthly values, annual values were calculated by substituting a fit value (4-harmonics with gain factor and spline) for that month and then averaging the twelve monthly values.

Source: Carbon Dioxide Information Analysis Center. Oak Ridge National Laboratory. U.S. Department of Energy

Part II: Burning Fuel: Complete Combustion

Have students build reactants on LEGO mat. (Close kit lid.) Wait. Then clap to signal the spark! Turn over mat. Convert reactants into the products.

Activity 1 Complete combustion is a chemical reaction in which all the fuel is burned. Record the complete combustion reaction from the LEGO mat. Use chemical symbols.

Reactants (What we burn) C₃H₈ + 5 O₂ Propane oxygen Products (What we find in the exhaust) 4 H₂O + 3 CO₂ Water carbon dioxide

Ask students to name different kinds of fossil fuels/ hydrocarbons: (Coal, oil, gasoline, diesel fuel, natural gas) natural gas= methane Octane in gasoline has 8 carbons and its formula is C8H18. You can build this like propane. For methane put 4H bricks on all 4 edges of the carbon brick. Briefly discuss how CO₂ in the atmosphere traps the heat from the earth that is radiated back into the atmosphere using the figure on the mat.

Part III "Global Warming and the Greenhouse Effect" Videos

Activity 1 Listen to the video "Global Warming and the Greenhouse Effect"

- Name 2 weather-caused disasters: forest fires, hurricanes, floods, record high temperatures, and drought.
- Name 3 contributors/offenders: 1) carbon dioxide, 2) CFCs, 3) methane
- Explain how a greenhouse gas works: Light from the sun heats the earth, which radiates heat back into the atmosphere. Some gases like carbon dioxide can hold the heat, much like a car window or greenhouse can.

Activity 2 Examine the Data Table: "Monthly Average Carbon Dioxide Concentration" on page 2. Record the measurements for 1990 and 2000 here. Round off to whole numbers

Year	Annual CO ₂ PPM
1990	354
2000	369

Work space
In 2000 = 369 PPM
In 2010 = 384 PPM
In 2020 = 399 PPM

What was the increase in CO₂ PPM between 1990 and 2000?

1) The CO₂ increased <u>15</u> PPM in 10 years.

Assume that the increase will be the same every 10 years:

2) Predict the CO₂ PPM in 2010: 384 PPM

3) Predict the CO₂ PPM in 2020: __399_PPM

Find out* the CO₂ PPM now:

4) Measured CO₂ PPM in _____: ____ PPM Answers will vary ______:

Think about it! CO₂ levels are rising... <u>faster or slower</u> than predicted.

Activity 3 Listen to the video "Global Warming: the Physics of the Greenhouse Effect" 2 min

Why is the greenhouse effect usually a good thing?

You may want to teach the greenhouse gases (methane, carbon dioxide, nitrous oxide, ozone and water vapor.) These are mentioned here.

The greenhouse effect keeps the earth warm. Without the green house gases the average temperature on earth would be much colder, 0 degrees Fahrenheit, and the oceans would freeze. The greenhouse gases absorb the sun's infrared heat and re-emit the heat back into the atmosphere so that the average earth surface temperature is 79 degrees Fahrenheit.

Where is the carbon dioxide coming from?

The carbon dioxide is coming from fossil fuels (coal, oil and natural gas.) which release CO2 when burned.

Ask: Does using electricity put carbon dioxide into the air? Yes, when we use electricity produced from burning coal we are adding more carbon dioxide to the air. Ask: Can we produce electricity in a way that doesn't add carbon dioxide to the air? Hydroelectric production and solar cells

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^{*} website: http://co2now.org/

Part IV: Human Health

	ve "Climate Change and Human Health." Select Developmental Disorders	a topic:
Group work time if you have Vectorborne computers for students.	Diseases	
 Describe the issue and one or 	two examples of what could go wrong.	
Have teams of students each pick a topic and complete this paper. Pick teams to report back to the class as you show the Asthmoslides to the class. OR Just pick 1 or 2 topics to complete as a class group. Note: Airways; Vectorborne, and Waterborne Diseases are best topics for middle school students.	Diseases could increase is an example of an airway disease. Increasing temperature 1) plants to make more pollen 2) droughts to occur and make more dust, 3) wildfires to occur and make more smoke and particulates.	could cause:

Describe one or two things we can do.

Things to do for managing Airway Diseases include

- 1) Plant more trees in urban spaces to reduce ozone and other pollutants. Plants also create shade
- 2) Walk, bike ride and use public transportation
- 3) Reduce energy use overall

Part V: Proposed Solutions

Activity 1 Discussion of what we can do.

Describe some general approaches

- 1) What citizens can do: switch to different and, preferably, renewable fuels, and reduce driving
- 2) What scientists and engineers can do: develop technologies that can capture the CO₂ and store it in places underground like mines, or in plants or under oceans.

 See interactive "Capturing Carbon" below.
- 3) What governments can do: increase fuel efficiency standards, limit the amount of carbon that polluters are allowed to make, invest in cleaner fuels, promote more efficient energy technologies and industries

(Optional) Activity 2 View interactive: "Capturing Carbon Where do we put it?" Click on the options to get explanations and to learn the advantages and disadvantages of each

Carbon dioxide storage is becoming an important science and engineering research topic.

Alkaline minerals (above and underground), silviculture (forests), aquaculture, unmineable coal seams, deep saline aquifers, oil and gas fields, oceans (surface), and oceans (deep sea and seabed.)

(Optional) Activity 3 View the slide: "The Carbon Cycle"

Notice where the carbon is moving. One industry produces a lot of carbon dioxide.

Point out the main idea here: Carbon atoms move around on our planet. We call this the carbon cycle. Carbon atoms can be found in water, air and soil. Surprise! Carbon dioxide production from world-wide cement production is significant: 5 to 10 percent of the world's CO_2 emission.

Final Check for Understanding:

What other activities besides driving cars do millions of people do that emit tons of carbon dioxide into the atmosphere?

Answers might include breathing, heating our homes by burning wood or coal, cutting down trees, flying on jets, and manufacturing cement.

Page 4. Atoms and Molecules: Understanding Air, Climate Student Worksheet Version: Feb 2014

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The Molecule Reference Sheet

A) Chemical Vocabulary.

First introduce LEGO kits, showing how to line bricks up on the Layout Mat for easy counting and cleanup. Then close kits, only opening as needed for vocabulary.

Is air matter? (Y) N Answers will vary.... There are 3 major types of matter: elements, compounds, and mixtures. Matter is anything that has mass and takes up space. bencil Examples of matter are:

a hat

Compound - a pure substance kinds of atoms bonded together. made up of 2 or more different New properties appear that has only one kind of atom in 1) Element - a pure substance

Examples of compounds:

Examples of elements:

salt NaCl water

Cl

chlorine

Fe

505

oxygen

carbon dioxide

LEGO compounds are represented by bricks bonded (clicked)

Make the compound carbon dioxide. together.

These bricks are black. What element do

carbon

they represent?

Atom - the smallest unit of an element

Different colored LEGO bricks represent

different elements

might it look like?Students may connect 2 water molecules together and incorrectly call it ice. Now make a water molecule. What The chemical formula is CO_2

bonded together. It comes from a Latin Molecule – a combination of atoms word meaning "little lump.

combination with either alone or in Atoms can exist

other atoms.

Correct student molecules so that they all look alike.



Mixture - a combination of two methods. The substances keep (elements or compounds) that can be separated by physical or more pure substances their original properties.

Examples of mixtures:

salt water, brass(copper and zinc) dry calcíum chloríde and iron filings and sand,

Different LEGO compounds (and/or free bricks) are near each other, but not "clicked" together.



is a mixture of CO₂ and H_2O . Could you Make some carbonated water (soda). still separate the molecules? How?

Yes. Open bottle and let the CO escape! The soda will "go flat".

Page 5. Atoms and Molecules: Understanding Air, Climate Student Worksheet Version: Feb 2014 © The LEGO Group and MIT. All Rights Reserved.

Matter can change in appearance. Is it a physical change or a chemical change? Here's how to decide: Answers may vary:

4) Physical change - <u>molecules are</u> <u>the same</u> before and after the change, although the matter may look different. LEGO compounds and

atoms are near each other, but do not bond

Examples: (click) together.

dissolving,

cutting paper, breaking pencil freezing, mixing

Hints:

- Physical changes include making mixtures, dissolving one thing in another, and cutting or breaking something.
- 2) All **changes of state** are physical changes. A water molecule is the same water molecule when it is ice, when it is liquid water, and when it is water vapor in the air.

5) Chemical change - <u>new and</u> different molecules are formed.

LEGO compounds break apart, and the atoms recombine, or "re-click".

Examples:

today's reaction

rusting

digesting food

Hints:

- 1) All **chemical reactions** are chemical changes.
- 2) New properties appear.
- 3) The bonds between the atoms are broken and the atoms recombine in new ways.

Demonstrate water changing state by moving a few LEGO molecules around:

- Ice: very slowly and close together,
- Water: faster and further apart
- Boiling water and water vapor: even faster and further apart. Students love it if you allow the molecules to fly into the air as vapor.

The carbon dioxide gas was produced through the chemical reaction in the bag. Be sure students don't misinterpret it as a change of state.

B) Practice Writing Chemical Formulas.

A chemical formula is an easy way to tell what atoms are present in a compound.

Use the "Atom Key" to find the **chemical symbol** for each element.

It is important to write your formula using the correct uppercase or lowercase letters. The subscript number refers to the atom before it. Remember that " H_2O " means there are 2 hydrogen atoms and 1 oxygen atom. We write the subscript 2 for the hydrogen but it is unnecessary to write the 1 after the oxygen.

Chemists have a complicated set of rules about the order of atoms in their formulas. For this activity, we'll keep it simple, and list the atoms in order starting from the top of the Atom Key.

Directions.

- 1) Watch your teacher demonstrate how to write a formula.

 Make something simple in a funny shape
- 2) Build a compound with less than 10 LEGO bricks. (Don't worry about whether it would be a real compound. Build any shape/color you like!)
- 3) Write out the formula for YOUR compound here (write the symbols in the order of the Atom Key, from top to bottom):

Answers will vary but will look something like: H, Na, C, NO,

4) Trade your compound with your teammate and write out the formula for your TEAMMATE's compound here:

Another sample: Na₅Ca₂C

Compare answers with your teammate. Do you agree? (Y)N

5)	Build a second molecule and name it.	
	My formula	My Teammate's formula

Look! These formulas follow more complicated rules but are still neat to see!							
CH3COOH is the formula for vinegar!	C ₁₉ H ₁₄ O ₅ S is the formula for phenolsulfonphthalein or phenol red!	CH4 is the formula for methane gas!	C ₆ H ₁₂ O ₆ is the formula for glucose!	NaOCI is the formula for bleach!			