

THE MAGIC SCHOOL BUS



3-5 Curriculum & Activity Guide **Air Quality Education** Lesson, Activities and Videos



The Magic School Bus

MISSION

NC Division of Air Quality

The Division of Air Quality (DAQ) works with the state's citizens to protect and improve outdoor, or ambient, air quality in North Carolina for the health, benefit and economic well-being of all. To carry out this mission, the DAQ operates a statewide air quality monitoring network to measure the level of pollutants in the outdoor air, develops and implements plans to meet future air quality initiatives, assures compliance with air quality rules, and educates, informs and assists the public with regard to air quality issues.

NC Air Awareness

NC Air Awareness is a DAQ public outreach and education program which reaches thousands of citizens annually, since 1997. Local Air Awareness Coordinators strategically located in six large metropolitan areas provide outreach and education to students and the general public and work with businesses and organizations to teach them about ways to reduce their contribution to air pollution and to protect their health.





Grades 3-5 The Magic School Bus



SUMMARY

In North Carolina, much of our air pollution comes from motor vehicles (cars, trucks and buses). In this lesson students will read *The Magic School Bus Gets Cleaned Up* to learn about air pollution from motor vehicles, including school buses. Students will explore the definition of carpooling and will be able to explain why vehicles are a source of air pollution and the steps that can be taken to reduce air pollution in school areas during carpool times. In this activity, students also will evaluate different ways of traveling between school and home and will learn how personal or family transportation choices have an impact on their health and the environment.

Time Needed

Activity 1: 45 minutes – 1 class period

Activities 1 and 2 (STEM):
approximately 2 class periods

ESSENTIAL QUESTIONS

1. Does air pollution come from cars, trucks and buses?
2. Why is air pollution from motor vehicles a health concern?
3. What choices can students, school personnel and parents make to improve air quality?

NC Standards

A list of NC Standards and clarifying objectives, related to this lesson plan, are located at end of this document.



MAKING CONNECTIONS



Most environmental issues can be addressed from multiple angles: with laws or by changing behavior and choices. With respect to vehicles, the Environmental Protection Agency (EPA) regulations have resulted in much cleaner vehicles, but that doesn't mean that personal choices aren't important. Reducing idling, carpooling, riding the school bus and making other personal choices can have a large and lasting impact on the air we breathe. In North Carolina, motor vehicles are among the largest source of man-made air pollution. At schools, students are affected daily by pollution coming from vehicles idling at carpool areas. Parents should be encouraged to take a closer look at their daily habits and find ways to improve air quality.



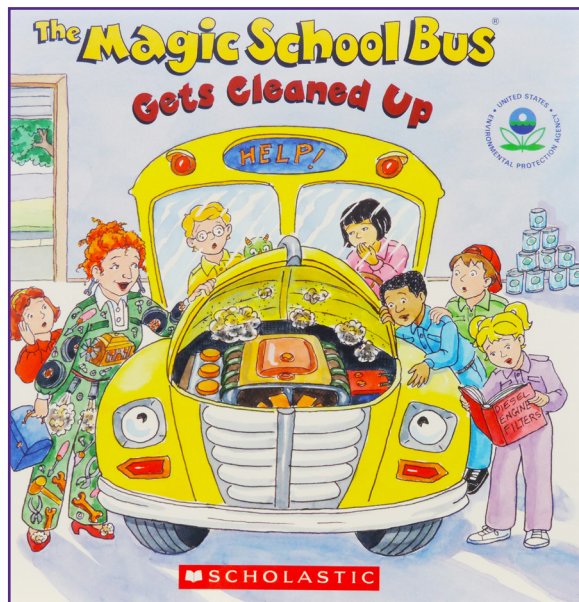


BACKGROUND

If you or the students were in charge, how would everyone get to school?

This discussion will start with reading *The Magic School Bus Gets Cleaned Up* so that students learn about air pollution, health effects from air pollution, diesel engines and fuel, exhaust, particulate matter (e.g. soot), and what has been done to reduce air pollution from diesel school buses. From that point, they will learn about school bus particulate filters and other things that can be done to reduce vehicle emissions. They will also discuss gasoline car and truck air pollution and how it may be reduced.

In this lesson, students will begin to explore how best to get to and from school each day. They will compare school bus emissions to car emissions, and study idling emissions at their school. They will be provided with ways to walk or bike to school. With all this information, students will develop a plan to get all the students back and forth to school safely, efficiently, and with a minimum impact to air quality.



Why should we be concerned about Air Pollution?

Studies conducted during school dismissal hours at carpool areas, where cars idle, showed high levels of air pollutants. Children are more sensitive to air pollution because their lungs are still developing. They also have a higher risk of developing asthma, respiratory problems and other adverse health effects because they are more active outdoors and they use more air per pound of body weight than adults.

What air pollutants are emitted by vehicles tailpipe?

Gasoline and diesel vehicles produce different types of air pollution. Diesel vehicles emit particulate matter, which can also be called soot, particle pollution or PM. Soot is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids, organic chemicals, metals, and soil or dust particles.

For all motor vehicles, the major pollutant is nitrogen oxides (NO_x), a precursor of ground-level ozone. When NO_x combine with volatile organic compounds (VOCs) in the presence of sunlight and heat to form ground-level ozone. Ground-level ozone is the air pollutant of greatest concern in NC. While vehicles produce air pollution when they are running, idling vehicles, and vehicles that have just been started produce more air pollution than those vehicles running at 60 mph on the highway.



What are the health effects of motor vehicle exhaust or tailpipe emissions?

Exposure to tailpipe emissions (i.e. exhaust) from motor vehicles can harm our health. Exposure to small particles, like PM_{2.5}, is associated with an increased frequency of childhood illnesses and the reduction of lung function. Children have a high physiological vulnerability to air pollution because they have narrow airways and their lungs are still developing. Irritation caused by air pollutants that would produce only a slight response in a healthy adult can result in potential obstruction in the airway of a young child. When particles are inhaled, they pass multiple filters (nose hairs, etc.), before reaching the lungs. Large particles are expelled from the system through coughing, sneezing and swallowing. The mucus lining in the lungs filters and traps particles, but small particles (PM_{2.5}) reach much deeper and are deposited in billions of tiny air-filled sacs, called alveoli. The sacs are lined with capillaries and allow for the blood-gas exchange. The alveoli don't have the capacity to expel these microscopic particles out of the lungs. The size of particles is directly linked to their potential for causing health problems. The smaller the particle the greater the danger. PM is a pollutant of concern in NC and is emitted from older diesel vehicles. It is for this reason that there has been an emphasis on "cleaning up" diesel emissions using particulate filters, as described in *The Magic School Bus Gets Cleaned Up*.

Another pollutant of concern is ground-level ozone. Ozone, at high concentrations, can cause lung irritation. High concentrations generally occur on hot, sunny summer days with no breeze. Children and adults with respiratory conditions are especially sensitive to high concentrations of ozone. To protect your health, and the health of your family, you can check the ozone levels in your area by consulting the air quality forecast at: <https://xapps.ncdenr.org/aq/ForecastCenter>

Ground-Level Ozone Formation

Sunlight

Nitrogen Oxides

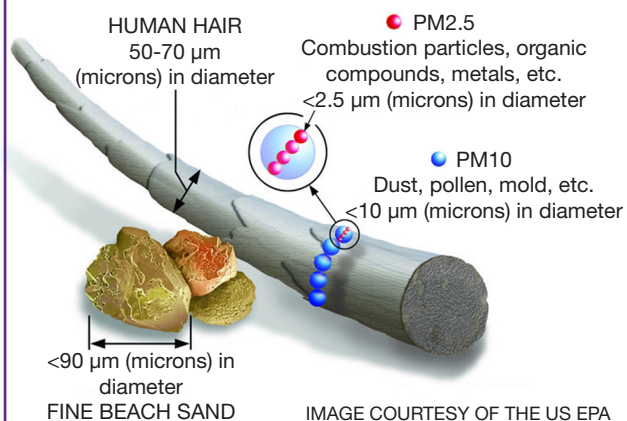
Volatile Organic Compounds

Ozone

Pollutants "bake" together in direct sunlight forming ozone.

How Ozone is formed <http://www.epa.gov/airnow/airnow/ozone/o3.html>

Diagram comparing the size of Particulate Matter to a human hair ¹



Lung Attack video: <http://web1.pima.gov/deq/lungattack/lungplay.htm>

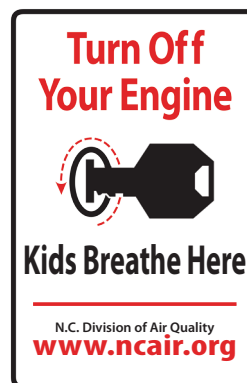


How to reduce motor vehicle tailpipe emissions or exhaust?

During the last 18 years, through the program “[Clean School Bus NC: Children Breathe here](#)”² the North Carolina Department of Environmental Quality – Division of Air Quality (DAQ) and Department of Public Instruction (DPI) have joined forces to reduce air pollution from school buses. Over the same period, the Environmental Protection Agency has established new regulations for vehicles. The North Carolina school districts also have implemented policies to reduce idling on school grounds and installed particulate filters on the exhaust systems of school buses. As well, the NC Department of Health and Human Services has been orienting parents and kids to reduce vehicle idling as an easy, low cost way to drastically reduce air pollution and prevent exposures. Reducing air pollution is not only the responsibility of federal or state agencies however; the general public is also responsible for protecting their own health. Simple and practical changes in our daily routine can make a difference. Below is a list of practical tips to reduce tailpipe emissions that everyone can use!

Practical tips to reduce tailpipe emissions

- Take the bus. This will reduce the number of vehicles on the road, reduce air pollution and save money.
- Carpool. Share a ride with friends and neighbors. It reduces traffic, saves fuel, and reduces air pollution.
- [Walk or bike to the school](#)³. Walk and bike with friends for fun, and exercise.
- [Turn off your engine](#)⁴.
- Warm up your engine by driving it, not by idling.
- Protect your car engine by idling less. Idling may increase overall engine wear by causing the car to operate for longer than necessary.



Simple! Save money and fuel and help the environment, by turning off the engine.



MATERIALS

- Book: *The Magic School Bus Gets Cleaned Up*
- Videos
 - EPA: [How Ozone is formed](#)⁵
 - DEQ, Pima County, AZ: [Lung Attack](#)⁶
 - NCDQAQ: [Meet Otto Parts](#)⁷

Air Info Now presents **Lung Attack!**
Learn about how your lungs work and how pollution affects them

Normal breathing (gas exchange)

Choose a kind of pollution and see what happens to the LUNGS

Ozone

BIG particles (PM₁₀)

small particles (PM_{2.5})

DEQ, Pima County, AZ: [Lung Attack](#)



- UNIVISION: [How kids in Titicaca Lake community, Bolivia get to the school](#)⁸ (This video is in Spanish but is still informative for English speakers)
 - EPA lung diagram, Effects of Common Air Pollutants⁹
 - Student Activity Sheet – (pdf)
 - Extension: Activity Book-[The Lone Rider](#) (pdf)

TEACHER TIPS

- Use the *Lung Attack* video and lung diagram to show and explain how pollutants (ozone, and PM) reach the lungs.
- Use *How Ozone is Formed* video to show the formation of ozone.
- Use the *How Kids in Titicaca Lake Community, Bolivia get to school* video to show unusual transportation methods.
- Use the *Meet Otto Parts* videos to study the way a catalytic converter collects the products of incomplete combustion from gasoline engine vehicles.



WARM UP

Walking, biking, and riding in vehicles and on buses are all ways students can get to school. Each mode has its own set of advantages, disadvantages, and costs in time, money and health. In the following activities, students will look at how people get to and from school, and they will also begin to better understand the effects of their choices.

Start the activity by asking students to define carpooling and idling. Introduce and discuss the definitions of carpooling, idling, and tailpipe emissions. Using the background information, explain briefly or show a video about how the respiratory system works and how air pollution affects the lungs. You can also use the recommended videos in this lesson.

- Activity 1, students will do an imaginary travel through the school bus engine. During this experience students will learn the definition of idling, health risks related to tailpipe emissions, and how technology when installed on school buses helps reduce air pollution.
- Activity 2: (STEM), consists of two parts: After learning the concepts in activity 1, students will look at the air quality impacts of vehicle tailpipe emissions, carpooling, the school bus, walking and biking. In addition, students will learn about idling and air pollution.

ACTIVITIES

1. How the Magic Bus helps to keep the air clean?

Students will read the book, *The Magic School Bus Gets Cleaned Up* (to increase students engagement it is recommended to read it aloud) and they will answer questions in a class discussion or in a written format.

The goal for this activity is:

- Learn what air pollutants are emitted by buses and how the diesel particulate filter works to reduce and control air pollution.

After reading *The Magic School Bus Gets Cleaned Up*, answer the questions below. Use Glossary section to help you with terms.

1. Provide a brief summary of the story.
2. Who were the main characters?
3. Why did the Magic School Bus need to be cleaned up?
4. Why do you think the Magic School Bus became as small as a particle?
5. What special device was installed on the Magic School Bus to clean it up?
6. What did this device do?
7. What was the first place that the bus went and how did it get there?
8. What is one air pollutant that comes from vehicles?
9. What are the two reasons why children are at greater risk from air pollution?
10. What types of motor vehicles use diesel fuel? What types use gasoline?



2. STEM Project: Getting to school and how your transportation choices can affect air quality.

Students need to get to school quickly and efficiently. Most ride buses or are dropped off in carpool areas. When parents come to drop off and pick up their children, they don't see the consequences of idling their vehicle. Almost all US schools are looking for ways reduce air pollution created by motor vehicles on school grounds in order to keep the air surrounding the school clean for the students to breathe. In North Carolina, school bus drivers are trained about idling and they are required to turn off the bus while they are waiting.

In *The Magic School Bus Gets Clean Up*, we learned about the main pollutants produced by diesel engines, a pollution control device for diesel particulate, and the health implications of air pollution. (For a better understanding of this lesson, it is recommended you read, *The Magic School Bus Gets Cleaned Up*, and answer the following questions).

The main goals for this activity are:

- Practice data collection and graphing while studying the ways students get to school and back. (Part A and B)
- Learn about the air pollution health risks caused by bus and vehicle emissions. (Part A and B)
- Discover the reduction in air pollution when you ride the bus instead of being dropped off by your parents. (Part B)
- Compare air pollution emitted by idling from three different vehicles that typically travel to school and determine which vehicle is the most air-friendly per student. (Part B)

A. Survey: Identify how you and your classmates get to the school (walking, biking, parent's vehicles or school bus).

In many communities, traveling to school can have a really big impact on local traffic, particularly in the morning when everyone is in a hurry to drop-off their children at school. Each school has its own name for the area where students are dropped off and picked up. Some schools call it a *carpool area*, others a *carpool line*, or even a *drop-off or pick-up area*, but for purposes of this activity we will call it carpool area.

Students will evaluate the current carpool area of the school for school buses and parents' vehicles, and they will suggest effective ways to decrease the emissions in those areas. Using a survey, students will identify the main transportation methods used by the class to get to the school. They also will have a better understanding of the benefits of carpooling. Then, students will present suggestions about how to minimize the traffic at the school carpool area. Students will practice tabulation and graphing skills by using a pictograph.

1. Define and discuss the terms: transportation method(s), passenger(s), carpool, pictograph, and percent (Glossary section can help you with terms).
 - a. Brainstorm the methods of transportation that students use to travel to school.
 - b. List the practical and common methods of transportation used to get to the school. (This can vary greatly depending on the area where students live).



- c. Ask students to name unusual forms of transport used by students to get to school in other areas of the world. For example, sledding or snowmobiling in Alaska or canoeing in Titicaca Lake.



See: [How kids in Titicaca Lake community, Bolivia get to the school](https://www.youtube.com/watch?v=IEsBctJq96E)
<https://www.youtube.com/watch?v=IEsBctJq96E>

2. Create symbols/images for the pictographs



- a. Help students select the symbols that will represent the methods of transportation used to get to school. *For example, a pair of shoes can represent walking to school, and sticks or lines can represent the number.*
- b. Help the students recognize the value of each symbol/picture. *For example, 1 shoe/foot= 1 person walked to the school. Remember to use different symbols to identify each type of vehicle.*



3. Collect student data

- a. Develop a list of the transportation methods mentioned by the students.
- b. Write the number of students next to each category.



4. Develop a pictograph with collected data

















- a. Let the students learn how to develop a pictograph and label the columns with the method of transportation, using their own symbols/pictures.
- b. Ask students, how many passengers represents each symbol.
- c. Show them how to calculate the total number of students by transportation type using the symbols/pictures and help them to calculate the percentage of the class that use each method of transportation.



Pictograph example

Total students per classroom: 27

(Example: 10 students ride the bus, 10 ride in cars, 4 take a van, one rides a bike and 2 walk.)

Types of Transportation	How do we get to school?					Total kids/day	Percent(%)
Bus (1 = 5 student) 							10/27 = 0.37
Car (1 = 1 student) 							10/27 = 0.37
After school Program Vans (1 = 2 students) 							4/27 = 0.14
Bike (1 = 1 student) 							1/27 = 0.03
Walk (1 = 1 student) 							2/27 = 0.07
Train 						0	0
	Monday	Tuesday	Wednesday	Thursday	Friday	27	

1. Discussion of results

a. Key questions

1. How do most of my classmates get to the school? Car
2. How many students usually travel in one car? 1
3. How many students get to school by walking, or biking? 3
4. What percent of the classroom gets to the school in a car? 37%
5. What percent of the classroom gets to school in a bus? 37%

I think most of my classmates get to the school by Bus and cars.

With regards to air pollution, what do you think is the best way for students to travel to school?
How could we encourage the use of school buses or how we can maximize the use of carpools?

b. Air quality impact

1. How do tailpipe emissions or exhaust affect our health?
2. What can we do to reduce vehicle emissions and to improve air quality?



B. Compare the air quality impact of school buses, vans and vehicles by calculating how many vehicles can be replaced by a school bus.

There are different factors that affect the rate at which any vehicle emits air pollutants: the type and size of vehicle, vehicle age and accumulated mileage, amount and type of fuel, vehicle maintenance, and local weather conditions (hot, cold days).

Students use different transportation methods to get to school, but vehicles and school buses are the most common. School buses are one of the safest means of transporting children to and from school. In North Carolina, many school districts have installed diesel particulate filters or have replaced old buses with new ones that come with the diesel particulate filters already installed in order to reduce PM pollution.

- In this activity students will learn to identify the main air pollutants emitted by vehicle exhaust and the effects they may have on the respiratory system. They will also make a comparison of the air pollution emitted by idling from three different vehicles that typically travel to school and determine which vehicle is the most air-friendly per student.

Table 1 presents the average pollution emitted by vehicles idling in the carpool area.

Table 1. Average Idle Emission Rates by Pollutant and Vehicle Type¹⁰

Pollutants	Emissions (grams/min)		
	Cars (4 passengers)	SUV, Mini-Van, Pick-up (5 passengers)	School Bus (27 passengers) ¹¹
NO _x *	0.059	0.068	0.725
PM _{2.5}	N/A	N/A	0.023
PM ₁₀	N/A	N/A	0.025

*Note: For this activity, NO_x emissions, a precursor of ozone, were selected because ozone is one of the main pollutants of concern in North Carolina.

1. To start the discussion, review the terms: carpool, air pollutants, particulate matter, respiratory system and tailpipe emissions. Introduce a new term: nitrogen oxide (NO_x).
 - a. View Lung Attack video: <http://web1.pima.gov/deq/lungattack/lungplay.htm>
Discuss how air pollution affect the lungs.
 - b. Discuss which areas around the school may have more air pollution from vehicles.



2. Present the problem: How many vehicles can be replaced by a school bus to help reduce the NO_x air pollution a precursor of ozone?
 - a. If each car has 1 student-passenger, how many cars can fit into a bus with a capacity of 27 students?

Answer: if we have 1 student per car, 1 bus = 27 cars

- b. Using information in Table 2, ask students to calculate the NO_x emitted by 27 cars at different times, 3, 5 and 10 minutes.

Table 2. Average NO_x emissions per minute by transportation type


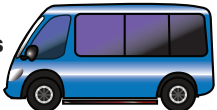



Types of School Transportation	Average NO_x Emissions (g/min) produced by idling in carpool line per minutes		
	3	5	10
Bus 	2.17		
After school Program-Vans 	0.2	0.34	0.68
Car 	0.17	0.29	0.59
Bike 	0	0	0
Walk 	0	0	0



Table 3. Result of NO_x emissions calculation of 27 cars idling at different times

NO _x Emissions (g/min)		
Minutes	Emissions 1 car	27 cars w/1 student-passenger = emissions of 1 car X 27
3	Answer: 0.17	Answer: 4.59
5	Answer: 0.29	Answer: 7.83
10	Answer: 10.59	Answer: 15.93

- c. Compare the idling emissions of one bus to 27 cars. What will be the reduction of emissions in the school grounds if 27 students decide to take the bus instead of riding in with their parents? **Note: In North Carolina school buses are encouraged to idle no longer than 3 minutes.**

Table 4. Result of comparison of NO_x emissions produced by 27 cars idling vs. 1 school bus at different times

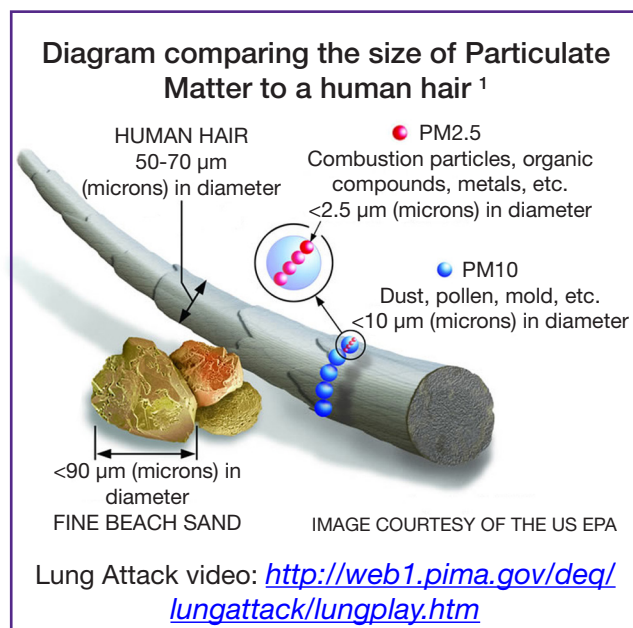
NO _x Emissions (g/min)			Emissions reductions = 27 cars - bus
Minutes	School Bus Emissions	27 Cars Emissions	
3	2.17	4.59 (0.17 x 27)	4.59 - 2.17 = 2.42
5	2.17	7.83 (0.29 x 27)	7.83 - 2.17 = 5.66
10	2.17	15.93 (0.59 x 27)	15.93 - 2.17 = 13.76

- d. Extension: Let's complicate the situation.
- Compare the reduction in emissions between multiple cars with different idling time periods against a school bus's emissions (Example: Total = 5 cars in the carpool line: 2 with 10 minute idle times, 2 with 5 minute idle times and 1 with 3 minute idle times).
 - Calculate 27 cars idling in the carpool area at different times: ones idling at 3 minutes, others at 5 and 10 minutes.
 - What are the emission reductions if 27 students decide to take the bus instead of riding in with their parents?
- e. Analyze results
- Brainstorm solutions to reduce the waiting time in the carpool area and how to ask parents to turn off their car's engine when they are waiting in the carpool area.
 - Students could develop a letter, a flyer, or a cardboard signs to display the messages.



GLOSSARY

- **Ozone** - is a colorless gas, which is composed of three oxygen atoms (O_3). When found in the stratosphere, the upper atmosphere, it is a natural barrier to the harmful rays of the sun. When ozone is found at ground level, which is within the troposphere, it can be hazardous to the human's health, animals and plants. Ozone is formed when volatile organic compounds (VOCs) and nitrogen oxides (NO_x) react during a sunny, hot day. Industry, gasoline fumes, vehicle exhaust, chemical solvents, and natural sources release VOCs and NO_x . Ozone can affect one's health by damaging lung tissue and increasing the susceptibility to infections. Ozone is also known to aggravate already existing health problems, such as asthma, heart disease and emphysema. It can inhibit the growth of plants, and cause damage to crops. On days that ozone levels are high (hot, summer days, with no wind), residents should try to reduce the amount of time spent outdoors later in the day and should avoid most outdoor exercise later in the day; people with asthma or other respiratory problems should be especially careful. Information on ozone levels for particular days can be obtained from <http://airnow.gov>.
- **Nitrogen Oxides (NO_x)** - NO_x is a generic term for mono-nitrogen oxides NO and NO_2 (nitric oxide and nitrogen dioxide). They are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. In atmospheric chemistry, the term NO_x means the total concentration of NO and NO_2 . During daylight, these concentrations are in equilibrium; the ratio NO/ NO_2 is determined by the intensity of sunshine (which converts NO_2 to NO) and the concentration of ozone (which reacts with NO to again form NO_2). NO_x is one of the precursors of ozone formation when it reacts with Volatile Organic Compounds on sunny days. The largest sources of NO_x include cars and other vehicles with internal combustion engines, power plants, and industry.
- **Particulate Matter (PM)** - also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Particulate matter is formed from gasoline and diesel engines from incomplete fuel and oil combustion.

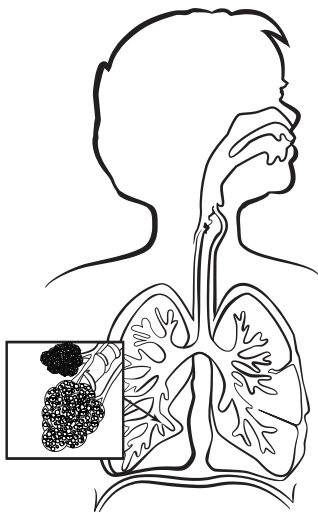




- Carpool- when 2 or more people share a vehicle to travel to the same or nearby locations.
- Idling- an idling vehicle is one whose engine is running when it is parked or not in motion, like at a drop-off area at a school.
- Transportation method(s) - Different ways in which people move from one point to another.
- Passenger(s) – person who travels in a conveyance, such as a car or truck, without participating in its operation.

- Pictograph- a pictorial representation of numerical data or relationships, especially a graph, but having each value represented by a proportional number of pictures. Also called a pictogram.
- Percent – one part in a hundred.
- Air pollution- mixture of solid particles and gases, man-made and natural, suspended in air. Air pollution can cause human health problems and environmental damage.

Types of School Transportation	
Bus	
After school Program-Vans	
Car	
Bike	
Walk	



- Respiratory system – the system of organs and structures, such as lungs in mammals and gills in fish, involved in the exchange of oxygen and carbon dioxide between an organism and its environment.
- Tailpipe emissions – air pollution coming from a vehicle's exhaust.



NC STANDARDS

NC Essential Standards

Grade 3:

Social Studies- Geography and Environmental Literacy

3.G.1.3 Exemplify how people adapt to, change and protect the environment to meet their needs.

Civics and Government

3.C&G.2.2: Exemplify how citizens contribute to the well-being of the community's natural environment.

Science

3.P.2.1 Recognize that air is a substance that surrounds us, takes up space and has mass.

Technology as Tool

3.TT.1.2 Use a variety of technology tools to organize data and information (e.g., word processor, graphic organizer, audio and visual recording, online collaboration tools, etc.).

Grade 4:

Science

4.PCH.2.1 Identify the basic components and functions of the respiratory system.

Social Studies-Geography and Environmental Literacy

4.G.1.2: Explain the impact that human activity has on the availability of natural resources in North Carolina.

4.L.1 / 4.L.1.3 Understand the effects of environmental change ... + Explain how humans can adapt their behavior to live in changing habitats.

Technology as Tool

4.TT.1.2 Use a variety of technology tools to organize data and information (e.g., word processor, graphic organizer, audio and visual recording, online collaboration tools, etc.).

Grade 5:

Science

5.L.1 Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.

Technology as Tool

5.TT.1.2 Use a variety of technology tools to organize data and information (e.g., word processor, graphic organizer, audio and visual recording, online collaboration tools, etc.).



Common Core

3.OA.5 Apply properties of operations as strategies to multiply and divide. (Note: Students need not use formal terms for these properties.)

3.MD.3 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs.

4.OA.2 Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.

4.OA.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

5. NBT.5 Fluently multiply multi-digit whole numbers using the standard algorithm.

5. NBT.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

5. NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

5. NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.



RESOURCES

1. Attention drivers! Turn off your idling engines. Environmental Defense Fund. <http://www.edf.org/transportation/reports/idling>
2. Biodiesel. Paratherm Heat Transfer Fluids. <http://www.biodiesel.org/using-biodiesel/market-segments/school-buses>
3. Clean School Bus's National Idle Reduction Campaign. EPA. <http://www.epa.gov/cleandiesel/sector-programs/antiidling.htm>
4. Idling, Myths, Facts and Information. Triad Air Awareness, http://www.forsyth.cc/eap/air_awareness.aspx
5. Idle Reduction. North Carolina Division of Air Quality. <http://deq.nc.gov/about/divisions/air-quality/motor-vehicles-air-quality/idle-reduction>
Inspection / Maintenance (I/M) Program.
6. North Carolina Division of Air Quality. <http://deq.nc.gov/about/divisions/air-quality/motor-vehicles-air-quality/inspection-maintenance-program>
7. Idle Free Schools. <http://www2.epa.gov/region8/idle-free-schools> Youtube videos:
8. Diesel Pollution, School Buses and Children's Health. <https://www.youtube.com/watch?v=VKAKRUKCLMk>How can we reduce air pollution?
<https://www.youtube.com/watch?v=ukZtWnUetq0>
9. Idle off. <http://www.greeneducationfoundation.org/institute/lesson-clearinghouse/508-Idle-Off.html>
10. Emissions and the EPA. <http://www.greeneducationfoundation.org/institute/lesson-clearinghouse/520-Emissions-and-the-EPA.html>
11. Air Quality and transportation. <http://www.aacog.com/documentcenter/view/247>
12. Cool School Challenge. http://www.hfcsd.org/webpages/tnassivera/files/cool-school-challenge-classroomtoolkit_v3.pdf
13. National Safe Walk to school (Chapel Hill, NC). <http://www.walkbiketoschool.org/keep-going>
14. Walking School bus. <http://www.walkingschoolbus.org/resources.html>
15. Census – How do we travel to the school? http://www.census.gov/schools/pdf/travel_to_school_3-5.pdf
16. EPA- Consumer information with emissions estimated factors-<http://www.epa.gov/oms/consumer.htm#kids>
17. Clean Bus –EPA webpage- <http://www.epa.gov/cleanschoolbus/csb-whatyoucando.htm>



ACKNOWLEDGEMENTS

NC Air Awareness Curriculum Developers

Keith Bamberger

Teresa D. Colón

Anne Galamb

Jonathan Navarro

NC Air Awareness Editors

Robin Barrows

Tom Mather

STEM Evaluator

Barbara Fair, STEM Coordinator, Kingswood Elementary School, Wake County

Videos and Informative Materials

Univisión, Primer Impacto

DEQ, Prima County, AZ

Lorelei Elkins, NC Triad Air Awareness

Roberta M. Burns, Kentucky Division for Air Quality

Spanish Translations & Outreach

Teresa Colón

Spanish Language Editors

Aida T. Fuentes, Puerto Rico Environmental Quality Board

Jorge Montezuma, NC Division of Environmental Assistance & Customer Service

Lourdes Morales, US Environmental Protection Agency

Ramón Tristani, NAVY Retired Engineer

Graphic Design

Jerome Moore



FOOT NOTES

- ¹ What is PM?. <http://www.epa.gov/region1/airquality/pm-what-is.html>
- ² http://www.ncair.org/news/pr/2014/clean_air_04082014.shtml
- ³ Walk Bike to School. <http://www.walkbiketoschool.org/keep-going/pedestrian-safety>
- ⁴ Idle Reduction. <http://deq.nc.gov/about/divisions/air-quality/motor-vehicles-air-quality/idle-reduction>
- ⁵ How Ozone is Formed. <http://www.epa.gov/airnow/airnow/ozone/o3.html>
- ⁶ Lung Attack. <http://web1.pima.gov/deq/lungattack/lungplay.htm>
- ⁷ Meet Otto Parts. <http://deq.nc.gov/about/divisions/air-quality/motor-vehicles-air-quality/inspection-maintenance-program>
- ⁸ Titicaca Lake, Bolivia. <https://www.youtube.com/watch?v=IEsBctJq96E>
- ⁹ Effects of Common Air Pollutants, EPA. <http://epa.gov>
- ¹⁰ Average In-Use Emissions from Urban Buses and School Buses. EPA Office of Transportation and Air Quality. <http://www.epa.gov/otaq/>
- ¹¹ Average of students-passengers that ride in a school bus. <http://www.ncbussafety.org/index.html>

Publication Number: **EPA420-K-07-001**
To order: Phone: 800-490-9198 · Email: nscep@lmsolas.com · Fax: 301-604-3408