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| **Lesson Title :** Pollution types and designing and testing their device | **Unit #:** 1 | **Lesson #:** 2 | **Activity #:** 3 |
| **Activity Title:** Air pollution and vehicle exhaust lab |

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| **Estimated Lesson Duration:** | 5 days |
| **Estimated Activity Duration:** | 1 day |

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| **Setting:** | Classroom and outside in parking lot |

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| **Activity Objectives:** |

Test and evaluate local ozone levels.

Determine the Air Quality Index (AQI).

Determine CO2 concentration levels from different solutions.

Compare CO2 concentration levels of emissions from various vehicles.

Examine various ways to cut back on the use of fossil fuels.

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| **Activity Guiding Questions:** |

How do you test and evaluate local ozone levels?

What is the Air Quality Index (AQI)?

How do we compare concentrations of CO2 from vehicle exhaust?

How can we cut back on the use of fossil fuels to lessen air pollution?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☒ Cause and effect |
| ☒ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☒ Systems and system models |
| ☐ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☒ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function. |
| ☐ Engaging in argument from evidence | ☐ Stability and change. |
| ☒ Obtaining, evaluating, and communicating information |  |

| **Ohio’s Learning Standards for Science (OLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☒ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☒ Recalling Accurate Science **(R)** |

| **Ohio’s Learning Standards for Math (OLS) and/or**  **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, OLS and/or CCSS):** |

College Board for Advanced Placement Environmental Science themes covered: 1. Science is a process, 4. Humans alter natural systems, 5. Environmental problems have a cultural and social context, 6. Human survival depends on developing practices that will achieve sustainable systems. College Board for Advanced Placement Environmental Science topics covered: VI. Pollution: A. Pollution types, 1. Air pollution; B. Impacts on the environment and human health, 1. Hazards to human health.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

See ‘Air Pollution and Vehicle Emissions for AP Environmental Science’ lab pages 4-5. See the following link for a more detailed description on ‘Air Pollution and Vehicle Emissions for AP Environmental Science’ lab: <http://www.carolina.com/ap-environmental-science-lab-kits/carolina-investigations-for-ap-environmental-science-air-pollution-and-vehicle-exhaust-8-station-kit/181083.pr?question=air+pollution+and+vehicle+exhaust>

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| **Teacher Advance Preparation:** |

Have AQI website open to show students how it monitors local air pollutant levels.

See ‘Air Pollution and Vehicle Emissions for AP Environmental Science’ teacher’s manual pages 6-8. This lab has student’s complete controls of various known CO2 concentrations and then they create their own experiment where they collect CO2 emissions from various vehicles and compare the emissions to the controls. Students can then make conclusions about various vehicles and their impacts on the environment.

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| **Activity Procedures:** |

Day 1 (Continued from Lesson 1 Activity 2)

Gave students data from ‘Wet Scrubbers and Air Pollution for AP Environmental Science’ lab and discussed what the data means about the lab. (Did not have time to complete lab due to a snow day and me being gone on the field trip). Students completed the discussion questions at the end of the lab on their own.

Give students the background information and pre-lab questions for ‘Air Pollution and Vehicle Emissions for AP Environmental Science’ lab and let them work on these together and discuss the answers before starting lab.

Start and complete all activities in ‘Air Pollution and Vehicle Emissions for AP Environmental Science’ lab.

Start and complete the added inquiry activity in ‘Air Pollution and Vehicle Emissions for AP Environmental Science’ lab.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

Air pollution and vehicle emissions for AP Environmental Science pre-lab questions, data tables and end-of-activity questions.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

Air pollution and vehicle emissions for AP Environmental Science inquiry activity and discussion questions.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners. Refer to Activity Template for details. |

I grouped students with varied learning abilities to help with differentiation. Students were given the opportunity to come up with their own experiment surrounding carbon dioxide emissions from vehicles. They designed and completed their own experiment on this topic. I made standards for testing carbon dioxide levels ahead of time instead of having the students do this so they could spend more time on creating their own experiments.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson.  This was slightly rushed so I wish we could have had more time to test more vehicles to see the carbon dioxide emissions in various vehicles. Also, we had other tools to test concentrations of other air pollutants emitted from vehicles and I wish we would have had more time to explore those. This lesson was a success because the students had a great time coming up with their own experiments and running their own tests on their cars and classmates cars. |