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| **Lesson Title :** The causes of air pollutants and methods used to control air pollutants | **Unit #:** 1 | **Lesson #:** 1 | **Activity #:** 2 |
| **Activity Title:** Air pollution control methods concept map; Wet scrubbers and air pollution lab |

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| **Estimated Lesson Duration:** | 5 days |
| **Estimated Activity Duration:** | 3 days |

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| **Setting:** | Classroom |

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| **Activity Objectives:** |

(Concept Map)

Explain strategies and techniques for controlling sulfur dioxide, nitrogen oxides, and particulate matter.

Describe innovative pollution control measures.

(Carolina Wet Scrubbers and Air Pollution)

Construct a wet scrubber model.

Observe how the wet scrubber model works.

Extract solid pollutants from the wet scrubber model.

Observe the change in pH of the wet scrubber solution before and after use.

Evaluate how effective the wet scrubber model is.

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| **Activity Guiding Questions:** |

What are some strategies or techniques used for controlling the emissions of air pollutants?

What are some innovative pollution control measures?

How does a wet scrubber work? What are the parts of a wet scrubber?

How are solid pollutants extracted from the wet scrubber?

Is there a pH change in the wet scrubber solution before and after use?

How do we know wet scrubbers are effective in controlling air pollution emissions?

| **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) |

Air pollution control methods concept map, see ‘Wet Scrubbers and Air Pollution for AP Environmental Science’ lab teacher’s manual page 4. See the following link for details on the ‘Wet Scrubbers and Air Pollution for AP Environmental Science’ lab: <http://www.carolina.com/ap-environmental-science-lab-kits/carolina-investigations-for-ap-environmental-science-wet-scrubbers-and-air-pollution-8-station-kit/181076.pr?question=wet+scrubbers> . ‘Indoor Air Pollutants Chart/Notes’ worksheet,

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| **Teacher Advance Preparation:** |

Complete concept map to make sure you know exactly what you want your students to know about methods to control air pollutants.

See ‘Wet Scrubbers and Air Pollution for AP Environmental Science’ teacher’s manual pages 7-8. This lab gives students instructions on how to create and test their own wet scrubber models. Once they are finished creating and testing they can then answer questions on the effectiveness of wet scrubbers in lowering emissions of air pollutants.

Have textbooks and laptops available for student research.

Complete ‘Indoor Air Pollutants’ notes ahead of time to know exactly what you want your students to know about indoor air pollutants

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| **Activity Procedures:** |

Day 1 (Continued from Lesson 1 Activity 1)

Gave pre-lab quiz to make sure students read through the lab and answered the pre-lab questions.

Started and completed some activities in the ‘Carolina Ecokits: Air Quality Survey’ lab.

Introduced the topic ‘control methods for air pollutants.’

Completed ‘Air Pollution Control Methods Notes’ with students. (Lesson 2 Activity 2)

Introduced the challenge🡪 KWL Section of ‘Big Idea’ worksheet.

Completed ‘EDP Worksheet’ Identify and Define; Gathering Information sections.

Handed out ‘Wet Scrubbers and Air Pollution for AP Environmental Science’ lab and had the students read through the background information and answer the pre-lab questions together.

Day 2 (I was on a field trip with my other class so I left this work behind with the substitute)

Finish up ‘Air Quality Survey’ lab activities and questions.

Started ‘Indoor Air Pollutants’ worksheet in groups with textbooks and laptops to complete. (Lesson 2 Activity 3).

Day 3

Gave students data from ‘Wet Scrubbers and Air Pollution for AP Environmental Science’ lab and discussed what the data meant about the lab. (Did not have time to complete lab due to a snow day and me being gone on the field trip).

(Started Lesson 2 Activity 3) Gave 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 discussed the answers before starting lab.

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

Started and completed 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.

‘Wet Scrubbers and Air Pollution 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.

‘Wet Scrubbers and Air Pollution for AP Environmental Science’ 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. In addition, animations and graphics were used on Power Point presentations to give students’ notes.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson.  We had a snow day when we were supposed to complete the ‘Wet Scrubbers’ lab and then the day we returned from the snow day I was out with my other classes on a field trip, so this really messed up my original plan for the sequencing of the lessons. Because of this, we did not have time to complete the ‘Wet Scrubbers’ lab so I gave the students data to draw conclusions from to answer the questions. We discussed the data and what the data meant in relation to the experiment which was helpful but I think they would have benefitted more from actually performing the experiment I just did not have the time I needed to add it back in. |