



Grade 8 Unit Plan

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Unit Title: Corsi-Rosenthal Box Learning Modules

Science Area Focus: Physical Science, Life Science - Biology

Note: These instructional materials were co-developed by two graduate students and a professor/researcher in science education and in the Neag School of Education

Corsi-Rosenthal Box Learning Module:

How can we make clean air accessible for schools?

Unit Author(s):	Aaron Richardson, Jannatul Anika, David Todd Campbell
Unit Title:	Engineering for Air Quality
Science Area Focus:	Physical Sciences, Life Sciences–Biology

STAGE 1: PLANNING FOR ENGAGEMENT WITH IMPORTANT SCIENCE IDEAS

PART A: Unpack the Standards. *This is completed by reviewing the Framework for K-12 Science Education to identify the Disciplinary Core Ideas (DCI), DCI Progressions, and Performance Expectations that will make up the student learning targets of the unit.*

STEP 1. Based on the science area focus above, identify the appropriate **disciplinary core idea(s)** (DCI) [include both DCI (e.g., MS-LS2) and applicable **sub-DCIs** (e.g., MS-LS2A)]

LS1.A: Structure and Function: In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

LS2.A: Interdependent Relationships in Ecosystems: Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

ETS1.A: Defining and Delimiting an Engineering Problem: The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (MS-ETS1-1) (secondary to MS-PS3-3)

STEP 2. Identify the relevant **performance expectations** that you are working toward.

Life Sciences:

- **LS2.A:** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [MS-LS2-1](#)

Physical Sciences:

- **PS2.A:** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [MS-PS2-2](#)

Engineering Design: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. [MS-ETS1-1](#)

PART B: Identify a Scientifically Rich, Complex Anchoring Phenomenon. *The anchoring phenomenon will serve as the real-world event that students work to explain as the purpose for engaging in the unit.*

STEP 1. Describe a **scientifically rich, complex environmental phenomena** that will require students to use multiple science ideas that are central to the DCI(s) to explain.

<https://ctmirror.org/2022/08/09/ct-connecticut-schools-clean-air-hvac-human-right-mold/>

Teachers in Fair Haven School spent their last month of summer vacation scraping mold off of the desks, tables, and various other pieces of furniture in their classrooms. This process is necessary to reduce the risk of health problems to students and the teachers themselves, because the school's heating, ventilation, and air conditioning (HVAC) system is too old and faulty to maintain proper air flow and temperature within the building. Mold infestations on furniture, as well as black mold infestations in the ceiling above the classrooms, have been reported due to the increased humidity and temperature, particularly as the state begins to experience its summer weather. This is not an isolated case. A teacher in another district two years prior had to take a leave of absence from the school premises. This was after receiving a stay-at-home order from her doctor due to the level of mold within the building. Much of the country's HVAC systems have not been maintained to allow their continued use, and so many have begun to fail to clean the air within school buildings, leading to epidemics like what Fair Haven faces today.



Temperatures within school buildings can easily climb to above 90 Fahrenheit without air conditioning during the summer and early fall months, leading some districts to have to close the building, or dismiss students early, until temperatures are back out of the health risk range. These early dismissals and school closings, along with the present mold and mildew problem within classrooms, lead to many possible disruptions to student learning.

A third of schools do not have the appropriate funding to replace or maintain their HVAC systems, and 39% of Connecticut districts have not approved any such funding. Many HVAC systems, like the one in Fair Haven School, are too old to continue to operate efficiently, and with systems as old as these, their continued maintenance and use cost more than would a replacement. However, this requires the approval of funding to replace HVAC systems with more up-to-date, efficient models. Schools and their faculty must find ways to reduce the harm done by these faulty or broken systems in the meantime.

STEP 2. List **resources** (websites, articles, books, etc.) that help you (i.e., the teacher) better understand the anchoring phenomenon:

1. POSSIBLE SIMULATION ACTIVITY:

<http://labs.minutelabs.io/Brownian-Motion/>

- **Accompanying video:**

<https://www.youtube.com/watch?v=nrUBPO6zZ4o&list=PLED25F943F8D6o81C>

http://physics.bu.edu/~duffy/HTML5/brownian_motion.html#:~:text=Brownian%20motion%20is%20the%20apparently,the%20path%20of%20the%20particle.

2. AIR MOVEMENT AND FILTERS:

a. <https://www.youtube.com/watch?v=WhiTkZlw14>

3. AIR PARTICLES:

a. <https://nceeh.ca/documents/evidence-review/do-it-yourself-diy-air-cleaners-evidence-effectiveness-and-considerations>

b. Particle sources: https://www.cdc.gov/air/particulate_matter.html

c. Particle pollution: <https://www.epa.gov/pmcourse/what-particle-pollution> and <https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution#:~:text=Fine%20particles%20>

d. EPA Air Quality Guide:

<https://www3.epa.gov/region1/airquality/pdfs/airqualityguideparticles.pdf>

e. Static Pressure:

<https://blog.orientalmotor.com/fan-basics-air-flow-static-pressure-impedance>

4. HOW A BOX FAN WORKS: <https://www.youtube.com/watch?v=qF7WHQRSHGU>

5. WORLD IMPACT:

a. <https://www.whitehouse.gov/cleanindoorair/>

i. <https://www.epa.gov/indoor-air-quality-iaq/clean-air-buildings-challenge>

ii. https://www.epa.gov/system/files/documents/2022-03/508-cleanairbuildings_factsheet_v5_508.pdf

b. <https://www.epa.gov/iaq-schools>

c. <https://www.energy.gov/eere/buildings/efficient-and-healthy-schools>

6. Printout of the CR Box Construction Guide– <https://blink.ucsd.edu/files/safety-tab/COVID-filter-system-poster.pdf>

7. HUMAN HEALTH:

a. <https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm>

8. JUSTICE RESOURCES:

a. <https://www.epi.org/publication/toxic-stress-and-childrens-outcomes-african-american-children-growing-up-poor-are-at-greater-risk-of-disrupted-physiological-functioning-and-depressed-academic-achievement/> (it should be noted that this resource refers to the ‘achievement gap’, which is a concept that is outdated and rooted in a deficit approach to students, instead of regarding students as having unique sets of knowledge that they bring into the classroom with them)

b. <https://www.aaihs.org/why-the-academic-achievement-gap-is-a-racist-idea/>

9. OTHER RESOURCES:

a. To give students an idea of the scale on which viruses such as the coronavirus exist:

<https://learn.genetics.utah.edu/content/cells/scale/>

i. Based on article: <https://www.news-medical.net/health/The-Size-of-SARS-CoV-2-Compared-to-Other-Things.aspx#:~:text=How%20does%20it%20compare%20to,as%20large%20as%20500%20nm.>

b. <https://cleanaircrew.org/box-fan-filters/>

10. ARTICLES AND RESEARCH:

a. Study on DIY Filters:

- <https://www.sciencedirect.com/science/article/pii/S0360132322011507>
- b. About Covid-19: <https://www.cdc.gov/coronavirus/2019-ncov/your-health/about-covid-19/basics-covid-19.html#:~:text=COVID%2D19%20most%20often%20causes,some%20people%20become%20severely%20ill.>
 - c. Latest Brown article on subject: <https://www.brown.edu/news/2022-12-23/corsi-cubes-study>
 - d. Rosenthal's article on the MERV 13 filter and Covid Box: <https://www.texairfilters.com/how-a-merv-13-air-filter-and-a-box-fan-can-help-fight-covid-19/>
 - e. <https://ewa.org/data-research-tips/how-indoor-air-quality-in-schools-affects-student-learning-and-health#:~:text=Breathing%20polluted%20air%20harms%20students,air%20quality%20reduces%20cognitive%20ability.>
Sources in above article:
 - i. <https://files.eric.ed.gov/fulltext/ED609665.pdf>
 - ii. <https://iaqscience.lbl.gov/publications/ventilation-problem-schools>
 - iii. <https://pubmed.ncbi.nlm.nih.gov/33091637/>
 - iv. <https://jamanetwork.com/journals/jamapediatrics/article-abstract/2587681>
 - v. <https://www.sciencedirect.com/science/article/pii/S0160412018324140>
 - vi. <https://pubmed.ncbi.nlm.nih.gov/31310034/>
 - vii. <https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001792>
 - viii. <https://www.nber.org/papers/w30061>

STEP 3. Identify **technologies** (CS, AI, machine learning, etc.) related to the phenomenon and describe how the technologies listed above are used in solving the environmental problem:

COMPUTER TECHNOLOGIES:

- a. **Brownian motion simulation:**
<http://labs.minutelabs.io/Brownian-Motion/> –this simulation strongly recommended due to the ability to change mass and size ratio, and energy level.

http://physics.bu.edu/~duffy/HTML5/brownian_motion.html#:~:text=Brownian%20motion%20is%20the%20apparently,the%20path%20of%20the%20particle

MATERIAL TECHNOLOGIES:

- a. **For C-R Box:**
 - 20-in. portable box fan–Corsi recommends keeping the cardboard from packaging; this will be used to block holes that can cause air leaks
 - 4 MERV 13 2-in. air filters
 - Duct tape
 - Scissors
 - User guide: https://aghealth.ucdavis.edu/sites/g/files/dgvnsk261/files/inline-files/DIY%20Air%20Purifier%20Directions_English.Spanish_o.pdf

STEP 4. Develop a **driving question** to frame the anchoring phenomenon for the students. State your driving question below. ([See Example Here](#))

How can we make clean air accessible for schools?

PART C: Provide a Target Written Explanation. *The target written explanation serves as a resource for identifying which science ideas are important for explaining the phenomenon. After identifying the important science ideas, you can consider when and how these ideas are introduced and explored across the unit.*

Provide a **target written explanation** of the phenomenon. This should be written at the appropriate grade level. (Note: the explanation should identify how science ideas are coordinated to explain the occurrence or event that happened in the world).

In the United States today, nearly 41% of school districts need their HVAC systems replaced, repaired, or otherwise updated in at least half of the buildings within their district. Additionally, 28% of schools need roof replacements and repairs to keep moisture from creating mold and mildew infestations that can harm students and faculty. The spores of mold and mildew are among many potentially airborne particles—along with trace metals from nearby traffic, volatile organic compounds from construction materials and furnishings, bacteria, viruses, and particulate matter—that can pose a threat to student and faculty health.

Even before air pollutants—such as the mold found in Fair Haven School is taken into account—students of color have already been documented as having to overcome more obstacles to their education than their white peers. Because of historical practices (e.g., redlining) and unequal school funding models, they are disproportionately more likely to come from a family of low socioeconomic status, which exposes them to more stress such as food insecurity, homelessness, etc. This can leave many students without access to resources that would help them succeed in the classroom. When a high concentration of air pollutants, such as can be found in highly populated areas, is present, students and faculty in these areas are more likely to feel the effects of these pollutants on their health.

Health problems caused by air pollutants such as mold can range from asthma to [cognitive abilities and emotional regulation](#) due to brain inflammation in the presence of pollutants such as mold, can increase truancy, absenteeism, and academic ability. Higher air quality has been linked to better learning retention because of an increase in alertness, a drop in chronic absenteeism, and a drop in suspension rate. As many districts, as shown in the case of Fair Haven School in New Haven, CT, and Westhill High School in Stamford, CT, lack funding or the legislative support needed to acquire funding to restore their HVAC systems, Corsi-Rosenthal boxes can be a useful tool in bridging the gap in access to high quality air. The use of air filtering devices have been proposed as useful tools in offsetting the effects of faulty HVAC systems.

Understanding the properties of air is necessary to understanding how air particles and pollutants, such as mold and mildew, are able to impact human health. Firstly, Brownian motion is the random movement of particles in the air that is caused by collision with smaller, gaseous molecules. These collisions vary in degree of impact as well as frequency and direction, and can even be impacted by temperature and concentration gradients as molecules will tend to move from areas of high to low concentration—in this case gas dispersing into a room of a certain volume from a given point.

Specifically related to the Corsi-Rosenthal box, air pressure is the second property used by fans and air filtration devices to clean the air. The fan within the filter works by first creating low pressure inside of the filter, causing air within the air filter box or box fan to move outside. This change in air pressure causes air from outside of the filter box or box fan to move inside, to the area of lowest concentration. As this exchange continues while the fan runs, the air pressure equalizes in both the outside and inside areas, air from outside of the filter moves to the inside of the filter box or box fan and vice versa. Because areas of high pressure have more air particle collisions than areas of low pressure, more collisions between particles are possible in the space leading into the box due to the interaction between this air pressure difference and the Brownian motion of particles in the air.

Air purifiers use these mechanisms—Brownian motion of air particles and the pressure difference created by a filter’s fans—to capture particles out of the air using a maze of walls that air moves through. While the fan continues to run, creating areas of low and high pressure for air molecules to

move between, the Brownian motion of the particles causes them to collide with air molecules as well as the maze of the filter pad so that eventually the particles can no longer avoid collision with the maze and are captured by the filter pad. The bigger the particle, the easier it is captured, which means that higher the quality of the air filter cartridge, the smaller the particle that can be captured by the air purifier.

PART D: Identify Science Ideas. (REVISIT AND FINALIZE PART A: UNPACK THE STANDARDS).
Using the target explanation above, identify the science ideas that are essential for explaining the phenomenon. After identifying the science ideas, identify at least one science task for each science idea as a resource that can be used during Stage #3.

STEP 1. **Identify the science ideas** within the explanation that are central to students explaining the phenomenon.

Science Idea 1: Properties of air particles
Science Idea 2: Air filters and how they work
Science Idea 3: Engineering for human health

STEP 2. For each science idea identified above, **choose one task, reading, video, simulation, or investigation that will help students understand this important idea and begin to see its usefulness in explaining the anchoring phenomenon.** Do this for each science idea below.

Science Idea 1: Brownian motion and air pressure—ask students to watch <https://www.youtube.com/watch?v=PzssJDZnqxI> and come up with a simple model of how they believe these particles, when in the air, are able to seemingly move *and* stay suspended in the air
Science Idea 2: Impacts of air quality on human health—Day 2 class investigation and mini model
Science Idea 3: Air filters and how they work—building the Corsi-Rosenthal box

STEP 3. **PART E: Identify Social Justice and Equity Ideas.** Identify the [social justice ideas](#) that are either central to supporting student engagement and connection to science (i.e., identity, diversity) you want to focus on during the unit or essential for explaining and taking action to resolve social injustices related to the phenomenon. After identifying the social justice ideas, identify at least one instructional strategy or task that will help you realize each social justice idea as a resource that can be used during Stage #3.

STEP 1. **Identify the social justice ideas** that are central to supporting student engagement and connection to science (i.e., identity, diversity) or essential for explaining and/or taking action to resolving social injustices related to the phenomenon.

Justice 14—JU.6-8.14: I know that all people (including myself) have certain advantages and disadvantages in society based on who they are and where they were born.
Action 20—AC.6-8.20: I will work with friends, family and community members to make our world fairer for everyone, and we will plan and coordinate our actions in order to achieve our goals.

STEP 2. For each social justice idea identified above, **choose one instructional strategy, task, reading, video, simulation, or investigation that will help students understand**

this important idea and begin to see its importance in supporting their connection with science (i.e., identity, diversity) or for explaining and taking action to resolve social injustices related to the phenomenon. Do this for each social justice idea below.

Justice 14–JU.6-8.14: I know that all people (including myself) have certain advantages and disadvantages in society based on who they are and where they were born.

- **Task**—Students will read an article to investigate how schools in Connecticut are facing issues with poor indoor air quality that leads to an unsafe learning environment. In the [article](#), they will learn how infrastructure is an integral aspect of supporting “the delivery of education” as well as how funding plays a role in this issue.

Action 20–AC.6-8.20: I will work with friends, family and community members to make our world fairer for everyone, and we will plan and coordinate our actions in order to achieve our goals.

- **Task**—Students will be learning how to design and construct a filtering device that can create clean air. In addition, they will understand the way in which their design or construction can be made as an affordable solution for communities to use and why this need for affordable devices is vital.

STAGE 2: NEGOTIATING IDEAS AND EVIDENCE THROUGH TASKS

The goal of the second stage is to support ongoing changes in students' thinking by providing learning experiences that help coordinate their own ideas with powerful ideas in science to build a scientific explanation of the anchoring phenomenon. This involves designing or adapting a number of purposeful tasks, coordinated with the important science ideas identified earlier, and the construction and use of public records such as a Summary Table to help keep track of ideas over time. Important in this stage is the revision and testing of the students' models. This stage makes up the majority of the unit as the class works to develop their explanations of the phenomenon through engagement in the practices of science.

PART A: Develop Unit Task Outline. *Provide the outline of each purposeful task that includes the introduction or highlighting of science ideas to reason with, the task launch, the procedures for the main task, and how the summary table will be updated. Each task may take one or more days. For each task, identify target Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs) that will guide student sensemaking in that task. Also include an outside of how you will facilitate the mid-unit model revision.*

Purposeful Task	Outline*
<p>Task #1:</p> <p>Problems and Constraints</p> <p>Day 1</p> <p>DCI:</p> <p>ETS1.A: Defining and Delimiting an Engineering Problem</p> <p>SEP:</p> <p>Asking Questions and Defining Problems</p> <p>CCC:</p> <p>Stability and Change</p>	<p>Introduction or highlighting of science idea to reason with:</p> <p>Introducing the phenomenon:</p> <ul style="list-style-type: none"> - https://ctmirror.org/2022/08/09/ct-connecticut-schools-clean-air-hvac-human-right-mold/ - Students will read and discuss this article: <ul style="list-style-type: none"> - Discuss HVAC systems - Discuss effects of mold and mildew on health - Discuss how, without the ability to repair or replace HVACs, air quality in classrooms can be improved <p>Main task (include backpocket questions):</p> <p>Main task to be completed:</p> <ol style="list-style-type: none"> 1. Students will read and discuss article centering phenomenon (link above) and will cover Justice 14 task. <p>(It may be suggested that students are made aware that this article was written by high school seniors, as a way to empower students about their ability to affect change)</p> <ul style="list-style-type: none"> - Students will complete Guided Notes handout - Guiding questions: <ul style="list-style-type: none"> - <i>What message did you take away from this article?</i> (Identify problems) - <i>What stood out to you in the article?</i> (Identify problems and constraints) <ul style="list-style-type: none"> - <i>Based on your observations, what factors seem to be at play?</i> - <i>Where do you think the biggest/highest priority changes need to happen?</i> - <i>Do you know what an HVAC system is?</i> <ul style="list-style-type: none"> - <i>What do you know about HVAC systems?</i> - <i>How does an HVAC system prevent mold and mildew from collecting on furniture?</i> - <i>Why does a faulty, failing, or absent HVAC system cause mold and mildew to form?</i> - <i>Based on the article, what can you tell me about why HVAC systems in Connecticut schools are no longer working, or not working well?</i> <ul style="list-style-type: none"> - <i>Why do you think these systems have gotten to this point?</i> - <i>What do you know about how mold and mildew affect human health?</i> - <i>While there are these obstacles preventing these HVAC repairs, what is something we might be able to do to improve air quality in the meantime?</i> - What does accessibility mean to you? - Relevance to students' lives: <ul style="list-style-type: none"> - <i>How does this article make you think of your own experience here at school?</i> - <i>How do you think the air inside the classroom might affect you?</i> - <i>Have you ever experienced trouble breathing?</i> <ul style="list-style-type: none"> - <i>What brought on this trouble breathing? Was it something in the air?</i> (could lead to discussions about forest fires, humidity, air quality alerts, etc)

- Wrap-up question:
Without the ability to fix an HVAC system, what could schools do to help increase their air quality? (Brainstorming solutions)
2. (Optional) Could demonstrate the school's own HVAC system if teacher has access to thermostat
 - Potential questions to ask students:
 - *What do you envision is happening now as the system is running?*
 - *How do you think this helps you and I work in the classroom?*
 - *Why do you think air quality is so important to us?*
 - *Do you have some form of HVAC system in your home?*
 - *How do you heat and cool your home?*
 3. (Optional—encompasses more than just mold as air pollutants) Students will investigate the impacts to human health that air pollutants (capable of being captured by the CR box) have and discuss.
 - Using <https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm>
 - [Handout](#) to guide students' investigation of webpage (optional resource as it expands to talk about other air pollutants)

Adding to the summary table (see example Summary Table below in Part B):

What we learned: HVAC systems in public schools aid in proper air flow and prevents the build up of mold and mildew that can impact the health of students and faculty negatively. Health impacts of mold exposure can include respiratory illness as well as trouble learning and trouble regulating emotions.

How it helps answer the phenomenon: Because HVAC systems are out of date, and many school districts do not have the funding to update, different solutions must be made to reduce mold and other air pollutants, and to make sure students and faculty have clean air to breathe. Having clean air to breathe is necessary to keep building occupants healthy.

<p>Task #2:</p> <p>Filtration Devices</p> <p>Day 2</p> <p>DCI:</p> <p>PS2.A: Forces and Motion</p> <p>SEP:</p> <p>Developing and Using Models</p> <p>CCC:</p> <p>Systems and System Models</p>	<p>Introduction or highlighting of science idea to reason with:</p> <p>Introduction: Students will view https://www.youtube.com/watch?v=PzssJDZn9xI</p> <p>Day will include:</p> <ol style="list-style-type: none"> 1. Air particles <ol style="list-style-type: none"> a. Familiarize students with the size of air particles relevant to air filtering devices b. Familiarize students with particle properties relevant to air filtering devices 2. Fans and air pressure <ol style="list-style-type: none"> a. Familiarize students with how fans create a difference in air pressure to move air 3. Filters <ol style="list-style-type: none"> a. Familiarize students with how filters can remove air particulate matter from the air inside of the classroom <p>Main task (include backpack questions):</p> <p>Introduction:</p> <ul style="list-style-type: none"> - Introduce video https://www.youtube.com/watch?v=PzssJDZn9xI - Notes and observations log - Questions: <ul style="list-style-type: none"> - <i>What seems to be happening here?</i> - <i>What are your observations or interpretations?</i> - <i>How are these particles moving around?</i> <ul style="list-style-type: none"> - <i>How can something that isn't alive move?</i> - <i>What is the air composed of? What do you typically think of as being part of the air?</i> <p>Partner Work–Air particles:</p> <ul style="list-style-type: none"> - Students will construct a mini model with a partner for how particles stay suspended, as well as move, through air as seen in the video. <ul style="list-style-type: none"> - This model should include: <ul style="list-style-type: none"> - What causes particles to stay suspended - What causes particles to “move” throughout the air space - What interactions are happening - Guiding questions: <ul style="list-style-type: none"> - <i>How can these particles be moving?</i> - <i>What is the air made of?</i> - <i>What are these particles suspended in?</i> - <i>Do you think all or only some particles stay in the air?</i> - <i>How do you think these particles can be taken out of the air?</i> <p>Small Groups–Air pressure</p> <ul style="list-style-type: none"> - Students will use their mini model to answer the question of <i>“How can air properties be used to clean the air?”</i>
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- Turn-and-talk to come up with an answer
 - Teacher will check answer before allowing students to move on and formalize their answer
- Could take a variety of forms depending on what skills a teacher wants their class to work on:
 - An expanded model that incorporates this new information into the existing model
 - A short essay that uses their knowledge of air particles and how fans use air pressure to move air
 - Can collect student group responses verbally and look for:
 - Commonalities/Differences
 - What students understand
 - What students feel they need more information on
 - Predictions/hypotheses
- Guiding questions:
 - *Remember when we discussed whether you and the other people in your household prefer to keep your home warm or cool?*
 - *How do you think an HVAC system works to cool the air? Warm the air?*
 - *What do you think is happening to the air when an HVAC system is running?*
 - *Why does the way an HVAC system runs warm or cool the air?*

Transition Question:

How do we remove these particles from the air?

(Turn-and-talk with a partner using what they have learned above)

Class Discussion–Fans

- Discuss what students talked about with their partner in the “Transition Question”.
- Introduce this video:
<https://www.youtube.com/watch?v=WhiTkZlw14> (watch from 0:00 to 1:49)
 - Guiding questions:
 - *Do you know what is meant by a sieve?*
 - *What is inertia?*
 - *How can we use these filter properties to clean the air?*
 - *Should we add something?*
 - *How should we use this in the classroom?*
 - *How can we make this as efficient as possible?*

Class Discussion/Building Consensus–Air filters

- As students have now discussed the properties of air and air particles, students have had the opportunity to discuss with a partner, and been introduced to how an air filter works, pose the transition question to the whole class:
 - *How do we remove these particles from the air?*

	<ul style="list-style-type: none"> - Prepare students for learning to build and understand an air filtering device the following class <p>Simulation (optional): http://labs.minutelabs.io/Brownian-Motion/ Instructors will direct students to explore “nature of particulate matter” simulator linked in the introduction sections above, potentially with an accompanying worksheet.</p> <ul style="list-style-type: none"> - This worksheet can be used as a guide for students to explore the various variables to manipulate: <ul style="list-style-type: none"> - Mass ratio - Size ratio—one note here: because of how much the air molecules outnumber the particles, it may appear that it is the molecules growing in size, so some students might need direction in order to think about the size of the <i>particle</i> versus the size of the <i>air molecules</i> - Energy - Guiding questions: <ul style="list-style-type: none"> - <i>How was the particle’s movement affected by its size or mass compared to that of the air molecules around it?</i> - <i>What did you observe when the air molecules has more energy?</i> - <i>What could higher energy correspond with in nature? (That is to say, what could cause molecules to have higher energy—temperature is one example)</i> <p>Adding to the summary table (see example Summary Table below in Part B):</p> <p>What we learned: The nature of particulate matter causes these air particles to collide at random with air molecules. Particles move from areas of high pressure to low pressure until the occupied space is of even pressure. While particles are in high pressure spaces, caused by the volume of air molecules, there are more collisions. This continues to happen until particulate matter is bombarded randomly into a lower pressure space where fewer collisions can move the particle around.</p> <p>How this helps answer the phenomenon: Air purifiers use these properties to clean the air. First, fans create an area of high air pressure and an area of low air pressure around the outside and inside of the fan, respectively. Second, as air moves from the high to low pressure, it proceeds through a filter that uses a complex series of mazes. Third, as these particles move, they are bombarded by air molecules around them, causing these particles to eventually become caught in the maze of the air filter, and be taken from the newly circulated air.</p>
<p>Task #3:</p> <p>Engineering Construction</p> <p>Day 3</p> <p>SEP:</p> <p>Constructing Explanations and</p>	<p>Introduction or highlighting of science idea to reason with:</p> <p>Introduction: Students will review their models from the previous class and find common themes or designs</p> <p>Warm-up: Solidify student understanding of how air purifiers work by introducing them to this video</p> <p>Main task (include backpocket questions):</p>

Designing Solutions

Printout of the CR Box Construction Guide:

<https://blink.ucsd.edu/files/safety-tab/COVID-filter-system-poster.pdf>

Class Activity:

- Construct CR Box as a class
- Class discussion on:
 - Limitations
 - Potential improvements (such as increasing filter thickness, as discussed in the study on DIY filter efficacy in **Articles and Research** item 'a', or using multiple filters per classroom and higher air flow rate, as also discussed in the aforementioned study)
 - Students can also be guided in discussing how to supplement the CR box, such as with masks, or occupancy limits such as what was standard during the height of the Covid-19 pandemic
 - Discussion of how to test the efficacy of the CR Box
 - *The **Articles and Research** item 'a' says that normally there are not well-studied ways for a person to test the efficacy of the filter, other than with a monitor such as a PM2.5 monitor, which would be expensive for a district to purchase. Still, discussion can potentially add to students' understanding of how to test their creations.*

Build consensus:

- Students will discuss what they have learned about this technology and the phenomenon this technology was designed to solve.
- Students will investigate available air purifiers on the market and come to conclusions around accessibility of the C-R box
 - Students will choose one of the listed suppliers and complete the [handout](#)
- Guiding questions:
 - *Based on what we know now, are there any ways in which you would improve this CR box?*
 - *Based on observations we've made about the CR box, what are important things to consider when deciding whether to use one in the classroom?*
 - This could lead to a discussion about how there are tradeoffs that need to be considered such as:
 - Noise level
 - Effective air flow rate (low versus high settings on the box fan)
 - Energy consumption cost
 - Availability of materials
 - *How can this technology impact communities in need? –Action 20* task along with the above [handout](#)

Construct the explanation/analysis and propose suggestions:

- Facilitate the writing of the evidence-based explanations based

around the driving question: **How can we make clean air accessible in schools?**

- Provided an example of an explanation of another topic as an example. One such example, from this unit– <https://drive.google.com/file/d/18c2qZebQIDoGo6Sj81LWOFxNUIOUN-S6/view> centering the driving question: **In the cold water near the north and south poles, the formation of brinicles, or “underwater icicles of death”, has been observed and recorded by scientists. How do the brinicles form, and why do they grow downward through the water?**

Target explanation of phenomena:

When seawater at the poles cools and freezes into ice that covers the surface, the salt from the water precipitates out so that the ice crystals can form. This means that the water around the forming ice has a higher salinity than the ice or the original seawater. This water gets trapped in the forming ice, but the high salt concentration depresses the freezing point so that the water is below normal freezing temperature but is still liquid.

As the ice moves/breaks, this super cold water escapes and sinks through the normal ocean water below the ice. It sinks because its high salt concentration and super cold temperature make it more dense than the surrounding water (and denser substances sink). As it sinks, the water around it freezes as it comes into contact with the super cold solution, creating a hollow tube of ice around the cold, high-salt solution. The brinicle will continue to form if the solution keeps flowing, meaning that they are sometimes small and sometimes very large and can take several hours to form. The growth flows downward from the surface because it follows the sinking solution.

- Students will be given sentence stems to help guide their thinking and to make sure they are using evidence if needed.
 - For example: “I learned _____ because in class we did _____ which showed that _____”.
 - Another example (also fulfilling **Action 20** task): “This technology _____ can solve _____ because as we learned in class, it _____”.
- Students may need time outside of the classroom to finish their evidence-based explanation.
 - This could also offer an opportunity for students to peer review and then correct their work into a more complete draft in the day following the assignment, should time or curriculum allow.

Adding to the summary table (see example Summary Table below in Part B):

What we learned: While many different air purifiers exist on the market, and many have similar efficacy to the CR box, with the understanding of how fans use a change in air pressure to cause collisions of air particulate matter into the filter material, air particulates that can be successfully removed from the air using homemade air purifiers.

How this helps answer the phenomenon: When compared to the air purifiers available on the market, this DIY air purifier is more cost effective and accessible for schools, making it easy to acquire supplies to make these even on a limited budget. Air purifiers have been shown to reduce the concentration of pathogens and air pollutants in the air, helping building inhabitants stay healthy. Particularly in school districts whose HVAC systems may be out of date or failing, the CR box provides a way to prevent molds and mildews from taking root in classrooms and on furniture or the ceilings of said classrooms.

PART B: Draft Summary Table. Construct a draft Summary Table that includes each task, the intended understandings from the task, and how the task helps develop an explanation for the anchoring phenomenon. We suggest that responses are written as full sentences and no more than two sentences are included in each box. Adapt the table based on the number of tasks in the unit. While the goal is for students to come to consensus statements to be included on the table, having already thought through possible responses will make facilitating the discussion easier.

Task	What we learned about the science ideas	How it helps us answer the phenomenon
Problems and Constraints	HVAC systems in public schools aid in proper air flow and prevent the build up of mold and mildew that can impact the health of students and faculty negatively. Health impacts of mold exposure can include respiratory illness as well as trouble learning and trouble regulating emotions.	Because HVAC systems are out of date, and many school districts do not have the funding to update, different solutions must be made to reduce mold and other air pollutants, and to make sure students and faculty have clean air to breathe. Having clean air to breathe is necessary to keep building occupants healthy so that learning can take place.
Filtration Devices	The nature of particulate matter causes these air particles to collide at random with air molecules. Particles move from areas of high pressure to low pressure until the occupied space is of even pressure. While particles are in high pressure spaces, caused by the volume of air molecules, there are more collisions. This continues to happen until particulate matter is bombarded randomly into a lower pressure space where fewer collisions can move the particle around.	Air purifiers use these properties to clean the air. First, fans create an area of high air pressure and an area of low air pressure around the outside and inside of the fan, respectively. Second, as air moves from the high to low pressure, it proceeds through a filter that uses a complex series of mazes. Third, as these particles move, they are bombarded by air molecules around them, causing these particles to eventually become caught in the maze of the air filter, and be taken from the newly circulated air.
Engineering Construction	While many different air purifiers exist on the market, and many have similar efficacy to the CR Box, with the understanding of how fans use a change in air pressure to cause collisions of air particulate matter into the filter material, air particulates that can be successfully removed from the air.	When compared to the air purifiers available on the market, this DIY air purifier is more cost effective and accessible for schools, making it easy to acquire supplies to make these even on a limited budget. Air purifiers have been shown to reduce the concentration of pathogens and air pollutants in the air, helping building inhabitants stay healthy. Particularly in school districts whose HVAC systems may be out of date or failing, the CR box provides a way to prevent molds and mildews from taking root in classrooms and on furniture or the ceilings of said classrooms.