LESSON PLAN

INDOOR AIR QUALITY LESSON + DIY PORTABLE AIR CLEANER BUILD

Grade: Adaptable for Midde to High School Subjects: Environment, Health By: GASP

Lesson Focus & Goals

Many of us (especially students) spend the vast majority of our time indoors, including all the time we spend sleeping. Portable air cleaners are filtration-based devices that remove particulate matter (PM) from indoor air.

Students will gain knowledge about the air they breathe in their homes, classrooms, and other indoor spaces everyday. They will learn how to be more aware of indoor air quality, what factors influence indoor air quality, and how to build their own portable air cleaner.

Materials for Cleaner Build (per air cleaner unit; *depends on design chosen)

1 square box fan (20” × 20”)
1-5* square 20” × 20” furnace air filters (typically MERV 13 but could be other)
Packing or duct tape (it will be visible in the final build so choose accordingly)
Cardboard (can be from filter or box fan packaging)

Activity Overview

- What is the air like outside? How do we find out? Take a look at a few free, easily accessible options to find out more about outdoor air quality.
- Why would we want to know about how healthy the air is today? How might it affect our bodies? Review air pollution’s effect on the respiratory system and sensitive populations.
- On poor air quality days, it’s usually healthier to be indoors. Why is that - how do buildings filter air? Does opening your window always mean fresher air? How do indoor air filters work to clean the air? Build a filter!

Optional Lesson Extension Ideas

- **Mentoring Opportunity** - Pair older and younger students for a student-led lesson and DIY air cleaner build. Use the air filters in classrooms, have students take them home, or find somewhere to donate them.
- **Student Advocacy** - Does your school or program have a policy in place for bad air days (re: outdoor recess, school sports, use of filtration, etc)? Find out and, if not, develop a policy draft to share with school administration.
- **Evaluation** - How might you test portable air cleaners for efficiency or other values (noise, use by room size, etc)? How might the design be improved?

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Indoor air is directly affected by outdoor air quality. What's the air like outside? How do we find out? Check out a couple free, easily accessible online options to find out more about current outdoor air quality.

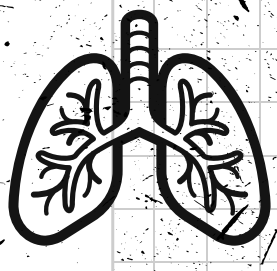
AirNow.gov
Enter your zip code to see your local air quality.

Map.PurpleAir.com
See data from privately owned monitors near you

Does outdoor air quality affect indoor air? *Yes! But buildings do a great job at keeping most pollutants outside. Closing windows on poor air quality days is the easiest way to protect indoor air quality.*

What indoor activities can affect air quality, regardless of outdoor air quality? *Smoking, cooking (especially on a stovetop), cleaning (dust, strong-smelling cleaning supplies)*

Why would we want to know about how clean the air is today? How might it affect our bodies? Review air pollution's effect on the respiratory system and sensitive populations.



Pollution in the air is usually invisible since it's too small to see with the naked eye. PM stands for particulate matter, which is the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.

PM can be so small that they can be inhaled and cause serious health problems. Some particles can get deep into your lungs and even into your bloodstream. Of these, particles less than 2.5 micrometers in diameter, also known as fine particles or PM2.5, pose the greatest risk to health.

When the air quality is especially poor outdoors, it's usually healthier to be indoors. That's because buildings usually do a good job of filtering out the worst of outdoor air pollution. Walls and windows are a protective shell, in addition to the building's HVAC system. Adding portable air cleaners in enclosed spaces is another step in improving the air.

Idea: Go check out your building's HVAC (Heating, Ventilation, and Air Conditioning) system with maintenance staff

ACRONYM & VOCAB ROUND-UP

AQI - air quality index
IAQ - indoor air quality
PM - particulate matter (often referred to by size range - PM2.5 or PM10)
MERV - minimum efficiency reporting value (rating system for filters)
HEPA - high-efficiency particulate air (used to describe type of filter)
CADR - clean air delivery rate

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Many people became more interested in indoor air filtration during the peak of the COVID pandemic and when far-traveling wildfire smoke caused spikes in poor outdoor air quality across the country. While there are many commercial options on the market, many people choose to make their own, depending on a few factors.

Why DIY?

Commercial air cleaners tend to be pretty expensive, especially when you consider the filters need to be replaced at some point. A review of academic and technical literature showed that do-it-yourself (DIY) air cleaners performed similarly to commercial portable air cleaners in terms of clean air delivery rate (CADR) and energy efficiency under controlled conditions. However, DIY devices were much more cost efficient than commercially available air cleaners. The noise they produce tends to be similar, as well.

Pick a DIY portable air cleaner design

There are many different design options, including the 1×1 (one filter, one fan), 2×1 (two filters, one fan), 4×1 (four filters, one fan), 5×1 (five filters, one fan), and 3×2 (three filters, two fans) designs. We'll focus on a couple versions.

2X1 - "WEDGE" DESIGN

This is an affordable option that's easy to put together and relatively compact.

This version is a step up from attaching one filter to a box fan, but that is also an option.

4X1 - CORSI-ROSENTHAL BOX

This is the most studied and well-established design. It also requires more materials and so it is more expensive to build and replace filters.

See building instructions for both designs on the next page.

When is a good time to run a portable indoor air cleaner?

- During cold & flu season or times when "something is going around"
- During wildfire smoke events
- During allergy season to reduce exposure to pollen indoors
- During the rest of the year to clean everyday indoor air pollution (ex: in the kitchen or a garage/workshop) and the infiltration of outdoor air pollution (especially during poor air quality days)

Where should you place the unit in a room? Should you have more than one?

Place it in a spot with good air flow. While units like the Corsi-Rosenthal box are generally more effective than designs like the Wedge with fewer filters, evidence suggests multiple DIY cleaners (even 1x1 designs) placed around a room might be just as or more effective than one multi-filter cleaner in the center of a room.

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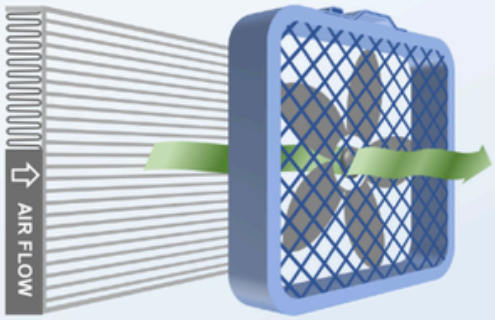
the basic version - 1 fan, 1 filter

these cleaners are functional but they can also be fun - feel free to get creative with stickers or other decorations.

Materials



20" X 20" X 1" or 4" air filter
Suggested rating: MERV 13

20" X 20" box fan
Only use certified fans with UL or ETL marking (2012 model or newer)

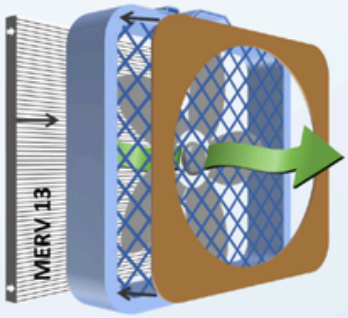
Clamps or Duct Tape or Bungee Cords

Assembly

1. Attach the air filter to the back of the box fan using either clamps, duct tape or bungee cords.
2. Check the filter for the direction of the air flow (marked on the side of the filter).
3. Replace filters when dirty.

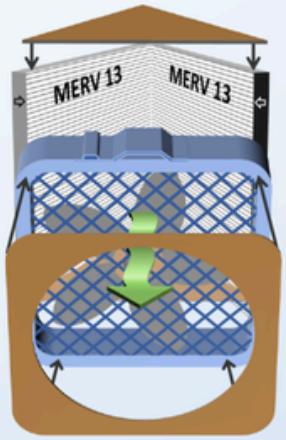
Learn about box fan safety tips:
https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors#FAQ

More options - Pick one and put it together using clamps or duct tape. Make sure the fan is facing the correct direction.



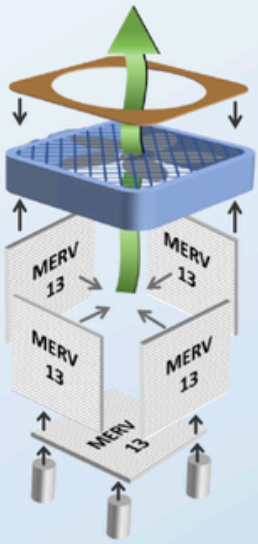
Good

Basic Supplies:
- 20" x 20" box fan
- 20" x 20" x 1" or 4" MERV 13 air filter
- 20" x 20" cardboard shroud (cutout the size of the fan blades)
- Clamps, duct tape, or bungee cords



Better

Additional Supplies:
- Two - MERV 13 air filters
- Triangle cardboard cutout for base on top



Best

Additional Supplies:
- Four or five - MERV 13 air filters
- If using five filter design, use leg supports (e.g., blocks) to allow airflow through bottom

Ways to Improve Effectiveness:

- Add a cardboard shroud (no-cost improvement)
- Use thicker filters (4" rather than 1" MERV 13 filters)
- Use multiple filters (2-5 filter designs)

Key Reminders:

- Only use certified fans with UL or ETL marking (2012 model or newer)
- Keep extra filters on hand
- Replace filters when dirty

this version is called a Corsi-Rosenthal Box. You can make it with 4 or 5 filters. To use 4, use a square of cardboard as the bottom rather than a 5th filter. In that case you don't need to use leg supports/blocks.

Sources:

"Do-It-Yourself Air Cleaners: Making Cleaner Air More Accessible, " EPA. https://www.epa.gov/sciencematters/do-it-yourself-air-cleaners-making-cleaner-air-more-accessible

"Do-it-yourself (DIY) air cleaners: Evidence on effectiveness and considerations for safe operation," National Collaborating Centre for Environmental Health (NCCEH). https://ncceh.ca/resources/evidence-reviews/do-it-yourself-diy-air-cleaners-evidence-effectiveness-and