〰️🍃 VOC
Volatile Organic Compounds

Sensor Starters

Grades: 4 & Up
Time: 15 Minutes -PDQ 1 & 2

Subject: Chemistry, Environment, STEM
Topics: VOC, Indoor Air Quality, PPM

Meet the VOC/Air Quality Sensor!

The VOC/Air Quality (AQ) sensor senses CO2 and volatile organic compounds (VOCs) in the air enabling you to test for air quality. The air we breathe provides oxygen and other essential components to fuel our cells and keep us healthy. If the air we breathe contains pollutants, toxic fumes, mold spores, or dangerous items like volatile organic compounds (VOCs), it can harm our body.

Background

The VOC/AQ sensor measures the VOC levels in the air. VOCs are substances that evaporate at room temperature and can be harmful if you are exposed to high levels. Overexposure can lead to headaches, nausea, and irritation of the eyes, nose, and throat. Common sources of VOCs are cleaning solutions, paints, new carpets, and furniture.

*Exposure to low levels of VOCs over a long period of time may also be considered harmful.

The VOC/AQ sensor has a sensing element known as a 'hot-plate' that senses metal oxide. The resistance of this 'hot-plate' varies with the reaction to an oxidizing gas, Ethanol. The higher the reaction, the higher the resistance! Based on this resistance level, a VOC value is calculated and output.

The VOC/AQ sensor is a black rectangular chip with a circle on it. Look for the label "Air" near the Temp 2 port on the databot PCB. The large opening in the databot case provides air flow for the sensor to read correctly.

What You Will Need/Prep

- databot & Vizeey™
- IOS/Android Smart Device
- Use Vizeey™ to scan the QR Code for Volatile Organic Compounds.
- Airtight container - 1
- Vinegar - 1 Cup

〰️🍃 **Volatile Organic Co...**
Volatile Organic Compoun...

VOC
Volatile Organic Compounds
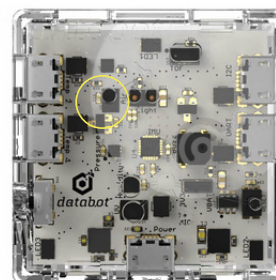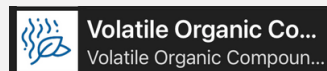
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Important Terms

Air Quality Index (AQI): Is used for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you.

Indoor Air Quality (IAC): The quality of the air inside and nearby buildings that include humidity and gas levels.

Off-Gassing: The process of VOC production; as paint thinner evaporates at room temperature, it is "off-gassing" VOCs.

Parts per million - (ppm): Usually describes the concentration of something in air, water or soil.

Volatile Organic Compounds (VOCs): Chemicals emitted by substances like cleaners, paint thinner, and paints.

How do we measure VOC's for Air Quality?

VOC levels are measured in Parts Per Billion (PPB). The term PPB expresses the VOC levels in a ratio of total parts VOC within a total of one billion parts. See the chart below for danger levels of VOCs!

Level	VOC (PPB)	Action
Low	0 - 250	No Action Required.
Moderate	250 - 2000	Sources should be identified and emissions should be reduced.
High	> 2000	Sources should be identified and require immediate ventilation of fresh air since it is very dangerous.

Exploration Preparation!

In the coming activities you will be exploring your local environment and identifying levels using databot. databot is loaded with sensors and capabilities and it helps to have a common orientation for holding it and conducting experiments. That way if you are communicating with a partner you can communicate clearly - moving left, moving right, etc.

"Home position," shown here, is holding databot flat in the palm of your hand with the power and programming port oriented to the back of your palm. In this position sensors are facing up and you can move freely in any direction.
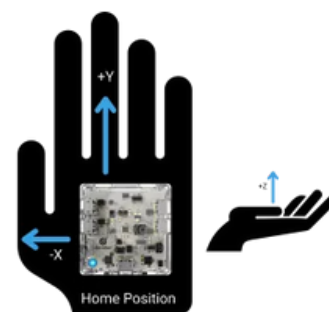
databot in "home position"

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PDQ1 :VOC Monitoring

Using the databot VOC sensor it is possible to monitor the indoor air quality by detecting VOC levels. Your mission is to monitor the production of VOC levels from a common liquid, vinegar. Do you think you will find that vinegar off-gasses VOCs?

- Open the Vizeey App on your smart device

- Turn on databot.

- Tap on "Volatile Organic Compounds*" in* Vizeey™ to load the experiment.

  Volatile Organic Co...
  Volatile Organic Compoun...

- Start your and pause your experiments using .

- Place your databot in a sealed container.
  - Place 1 cup of vinegar in a glass container beside databot in the container.
  - Seal the container to eliminate ventilation as shown.

- 1 Cup of vinegar + databot™ inside a container.

- Use the start icon to record and watch the data!
 - You can see the gradual increase in **VOC** levels.

  Predict what you think would happen to the VOC level if you were to take off the top to your container.

- When you feel the VOC level is constant, open the container to allow fresh air to circulate in it without pausing your display. Were you successful in your prediction?

- *Seal the container to avoid ventilation that may interfere with your data!*
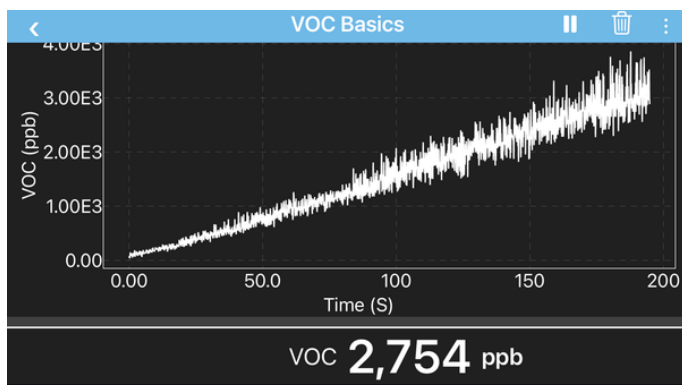
Example of emission of **VOCs** over time in Parts Per Billion

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## PDQ2 : The Hunt for Wild VOCs!

In PDQ 2 use the Volatile Organic Compounds experiment to identify five or more places that might be off-gassing VOCs. Your mission: create a data table that records VOC levels and locations. Let's check for possible indoor air quality danger!

- Open the Vizeey App on your smart device.

- Turn on databot.

- Tap on "**Volatile Organic Compounds**" *i*n Vizeey™ to load the experiment.

- Start and pause your experiments using :

- Use your data table and brainstorm at least five locations where you think **VOC** levels might be high.
  - For example, cleaning chemicals might be beneath the kitchen sink or in a chemical storage closet. New paint, furniture, or plastic toys may be off-gassing. Brainstorm a list of all the places these Wild **VOCs** may be hiding and impacting your **indoor air quality**!

- Hold databot in the palm of your hand.
  - Move to the various locations on your data table and write down all the VOC levels on your data table.

Analysis: Of the areas/objects tested which ones emit the highest level of VOCs? Are any of the levels you identified in the moderate or high areas? Develop and execute a plan to minimize VOCs as your data indicates.

PBB	Location
103	Under kitchen sink.
67	Plastic toy.
	Living room carpet.
	Garage.
	Cleaning closet.

Examples of possible VOC locations
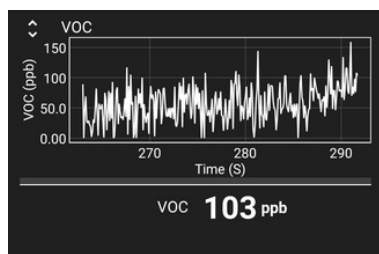
Example of **VOCs** near cleaning solution
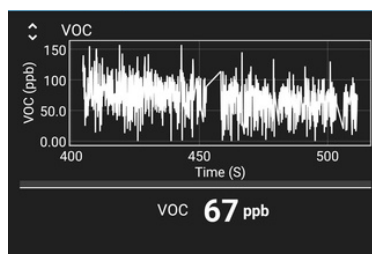
Example of **VOCs** in plastic toy

Check for Understanding

1. In your own words, explain Volatile Organic Compounds (VOCs).

2. What is an example of off-gassing?

3. What is the unit of measurement for VOCs and what level is dangerous?

Standards & Alignment

NGSS Standards

- MS-PS1/MS-PS1-2: Matter and its Interactions
- HS-ESS3-4/HS-ESS3-5 Earth and Human Activity
- HS-ETS1-3 Engineering Design/Analyzing Data

Disciplinary Core Ideas

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- ESS3.C: Human Impacts on Earth Systems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution
- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Science and Engineering Practices

- 1st Practice: Asking Questions and Defining Problems
- 3rd Practice: Planning and Carrying Out Investigations
- 4th Practice: Analyzing and Interpreting Data
- 6th Practice: Constructing Explanations and Designing Solutions
- 7th Practice: Engaging in Argument from Evidence
- 9th Practice: Digital Citizen

TEKS -Texas Essential Knowledge and Skills

Crosscutting Concepts

- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter
- Stability and Change
- Structure and Function

ISTE Standards

- 1.1 Empowered Learner (1.1.d)
- 1.3 Knowledge Constructor (1.3.a) (1.3.b)(1.3.d)
- 1.4 Innovative Designer (1.4.a) (1.4.b)
- 1.5 Computational Thinker (1.5.a) (1.5.b)
- 1.6 Creative Communicator (1.6.a) (1.6.b)

Standards & Alignment

TEKS -Texas Essential Knowledge and Skills

Elementary Process TEKS
5.2D Scientific investigation and Reasoning: Analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence.
Elementary Level Content TEKS
5.9C Organisms and Environments: Predict the effects of changes in ecosystems caused by living organisms.

Middle School Process TEKS
7.2E Scientific investigation and Reasoning: Analyze data to formulate reasonable explanations
8.2 Scientific investigation and Reasoning: Plan and implement comparative and descriptive investigations.

Middle School Level Content TEKS
6.5C Matter and Energy: Identify the formation of a new substance by using the evidence of a chemical change.
8.11B Organisms and Environments: Explore how short- and long- term environmental changes affect organisms.

High School Level Process TEKS
B.2F: Scientific Investigation and Reasoning: Collect and organize qualitative and quantitative data and make measurements with accuracy and precision, using tools such as data collecting probes.