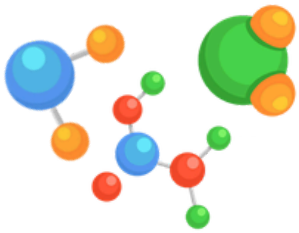
Light Temp Probe VOC



# Structure of Matter 2

## Overview

This exciting lesson dives into the fascinating world of matter and its unique properties! You'll investigate how temperature changes, light reflectivity, and the release of volatile organic compounds (VOCs) reveal the differences between various substances. Let's uncover the secrets of matter and learn how these properties can help us identify and understand the materials around us.

## Background

Materials are all around us, and each has unique properties that make it suitable for specific purposes. These properties are broadly classified into two categories: physical properties and chemical properties. Understanding these properties helps scientists and engineers identify, classify, and use materials effectively.

Physical properties can be observed or measured without altering the substance itself. Examples include color, density, light reflectivity, and how a material responds to heat. For instance, when light strikes a material, some of it reflects off the surface while the rest may be absorbed or transmitted. The amount of light reflected can reveal important information about the material's texture, surface composition, and color. Similarly, when a material is heated, its temperature changes at a rate determined by its ability to absorb and conduct heat.

In contrast, chemical properties describe how a material reacts and transforms into a new substance. For example, when wood is exposed to fire, it undergoes combustion, releasing heat, smoke, and gases, some of which are volatile organic compounds (VOCs). These emissions are evidence of chemical change, as new substances are produced during the process.

**Grades**: Middle School
**Time**: 45 Minutes
**Subject**: Physical Science
**Topics**: Physical and Chemical Properties, Temperature Response, Light Reflectivity, VOCs

## What You Will Need/Prep

- databot with Temperature, Light, and VOC Sensors
- IOS/Android Smart Device
- Heat source (e.g., warm water or heating pad)
- Flashlight or other light source
- Various materials (plastic, wood)
- Install Vizeey™ on your Smart device.
- Scan the QR code to load the experiment.
- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot™'s listed, the one closest to your device will be highlighted.
- Study the background information and terms and prepare to explore!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In this lab, you will investigate the properties of matter by using databot sensors to observe temperature response, light reflection, and VOC emissions. By measuring these properties, you will understand how they help us classify and describe different types of matter.

## Learning Objectives

In this investigation you will master the following knowledge and skills:

- Use databot's sensors to collect, measure, and record data accurately.
- Learn how to identify and distinguish between physical and chemical properties of materials.
- Explore how materials interact with light by measuring their light reflectivity.
- Investigate how materials respond to heat by observing and recording temperature changes.
- Analyze the emission of volatile organic compounds (VOCs) as evidence of chemical change.
- Interpret experimental data to draw conclusions about the physical and chemical properties of matter.

## Important Terms

**Physical Properties:** Characteristics of a material that can be observed or measured without changing its composition, such as color, density, reflectivity, and thermal conductivity.

**Chemical Properties:** Characteristics that describe a material's ability to undergo a chemical change, resulting in the formation of new substances.

**Light Reflectivity:** The ability of a material to reflect light from its surface.

**Thermal Conductivity:** The rate at which a material transfers heat.

**Volatile Organic Compounds (VOCs):** Organic chemicals that can easily become gases and are often released during chemical reactions, such as combustion. The concentration of VOCs is measured in ppb.

**Parts Per Billion (PPB)**: Usually describes the concentration of something in air, water or soil.

**Combustion:** A chemical process in which a substance reacts with oxygen, releasing energy in the form of heat and light, often accompanied by gas production.

**Temperature Response:** The change in temperature of a material when it absorbs or releases heat.

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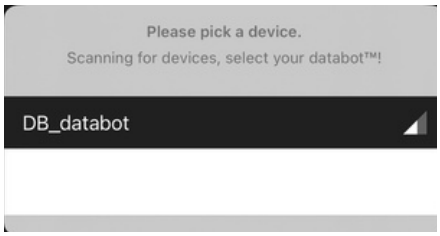
## Using Vizeey

In order to work with the experiment you need to launch the Vizeey application and click on + in the upper right corner.

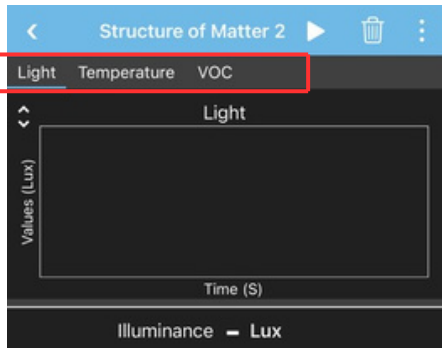
Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.




When you start the experiment you will be immediately offered to connect to your databot. Make sure that databot is enabled.

## Once in the Experiment

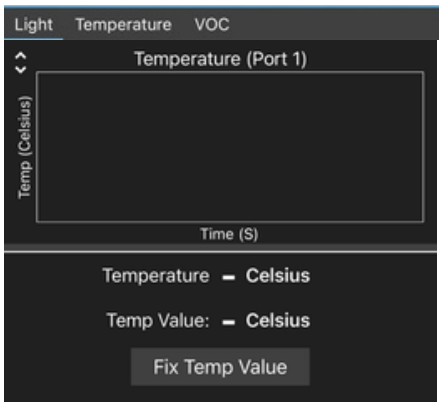
This lab consists of 3 experiments.
There is a separate tab for each experiment.




During the experiment, you need to record the temperature and VOC values

Press the "Fix Temp Value" button to capture the next values for your data table.

Once you have captured the values, write them down in the table to avoid losing any information and prepare to capture the values. Be fast and accurate!

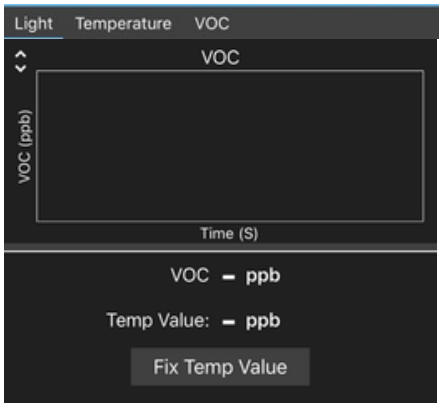


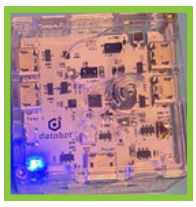

The Databot has two operating modes:

- **Vizeey Mode** (for use with the Vizeey app).
- **Web Server Mode**

To activate Vizeey Mode:

- Position the Databot with its sensors facing upward and turn it on.
- If the Databot’s LED glows green, it’s in Web Server Mode. If this happens, turn it off, adjust the orientation, and try again.



Good

Bad

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## Part 1: Initial Observations and Questions

Does the size or type of wood affect its physical and chemical properties?

What are some characteristics that you notice make materials different from one another?

How do you think temperature response, light reflection, and VOC emissions might help us identify different types of materials?

## Part 2: Hypothesis

Consider the following guiding questions to help you think critically about the experiments you will conduct:

Temperature Response:

How do you think different materials will respond to heat?

Light Reflection:

Predict which materials will reflect the most or least light.

VOC Emissions:

Predict which materials might emit VOCs and explain why.

## Part 3: Experiment Procedure and Data Analysis

In this lab, you will conduct a series of experiments to explore the properties of materials, focusing on wood, plastic, and paper. By comparing these three materials, you aim to uncover how their unique characteristics influence their interaction with light, heat, and fire.

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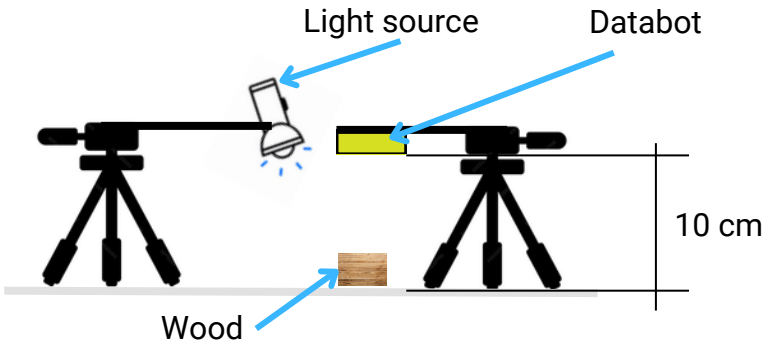
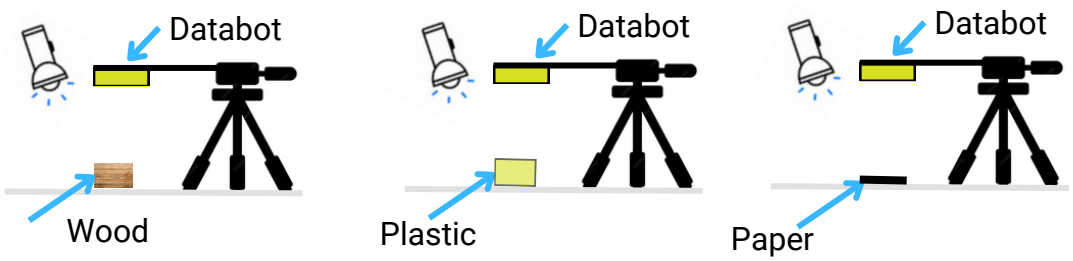
Experiment 1. Light Reflectivity.

- Choose a dark location for the experiment to minimize external light.
- Ensure the working surface is flat and clean.
- Activate Vizeey mode in databot:
  (Position databot with its sensors facing upward and turn it on.)
- Mount databot on a tripod, ensuring the sensors face downward at a distance of approximately 10 cm from the table surface.
- Place a light source near databot, also 10 cm from the surface, and direct it downward.




- Tap on **"Structure of Matter 2"** in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.
- Place the wooden cube under databot sensors. Record the observed values in a table below.
- Replace the wood with a plastic cube and record the new values.
- Repeat the process with paper, noting all measurements.



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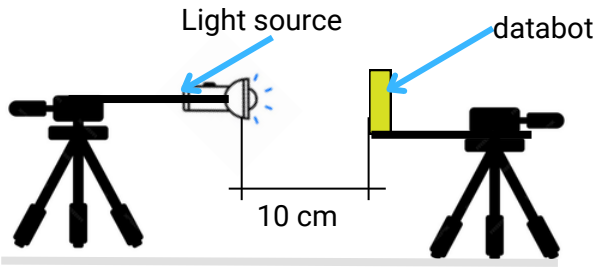
## Experiment 1. Light Reflectivity.

| Material | Measured Illuminance (Lux) |
|---|---|
| | |
| | |
| | |
| | |

Write down your observations.

Determine Reflected Light:

Direct the light source towards databot sensors from the same 10 cm distance and record the maximum light intensity.




## Data Analysis. Experiment 1.

Use the recorded values to create a bar graph comparing the results for wood, plastic, and paper.

Calculate the percentage of light reflected by each material using the proportion:

$$\text{Reflected Light Percentage} = \frac{\text{Measured Value of Material}}{\text{Maximum Light Source Value}} \times 100\%$$

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Experiment 2: Measuring Heat Absorption

In this experiment, you will investigate how different materials absorb heat using temperature sensors and three databots.

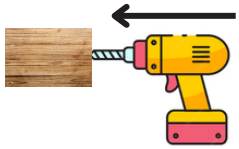
Materials Required:

- 3 Databots
- 3 Temperature probes
- Wooden Cube (with a 6 mm diameter hole for the sensor)
- Plastic Cube (available for download and 3D printing )
- Paper
- Heat Source (e.g., warm water)

Experiment Steps:

**Wooden Cube (Databot 1):**

- Drill a 6 mm diameter hole into the wooden cube to fit the temperature sensor.



- Insert the temperature sensor to its full length into the hole and secure it firmly.

**Plastic Cube (Databot 2):**

- Follow the same steps as for the wooden cube. If you don't have a suitable plastic cube, download the 3D model and print it.

**Paper (Databot 3):**

- Wrap the temperature sensor in a small piece of paper, ensuring full coverage, and secure it gently with tape.

**Procedure:**

- Connect each databot to the Vizeey app for real-time temperature monitoring.
- Tap on **"Structure of Matter 2"** in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.

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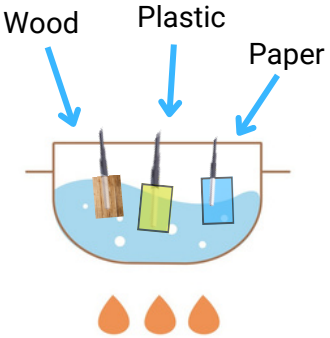
- Record the initial temperature of each material using the sensors.
- Place all 3 materials near the heat source, ensuring uniform heat exposure. (You can heat the water and put the 3 materials in at the same time)
- Observe and log temperature readings at 30-second intervals for 5 minutes.




Material _____

| Time (s) | Temperature (°C) |
|---|---|
| 0 | |
| 30 | |
| 60 | |
| 90 | |
| 120 | |
| 150 | |
| 180 | |
| 210 | |
| 240 | |

Material _____

| Time (s) | Temperature (°C) |
|---|---|
| 0 | |
| 30 | |
| 60 | |
| 90 | |
| 120 | |
| 150 | |
| 180 | |
| 210 | |
| 240 | |

Material _____

| Time (s) | Temperature (°C) |
|---|---|
| 0 | |
| 30 | |
| 60 | |
| 90 | |
| 120 | |
| 150 | |
| 180 | |
| 210 | |
| 240 | |

Compare how quickly each material absorbs heat by plotting the recorded temperatures over time on a line graph.

Analyze the heat absorption rates and identify which material absorbs heat the fastest and the slowest.

Light Temp Probe VOC

## Experiment 3: VOCs emission

**This experiment is for demonstration purposes only.**

In this experiment, we will observe the volatile organic compounds (VOC) emitted by different materials (wood, plastic, and paper) when exposed to fire.

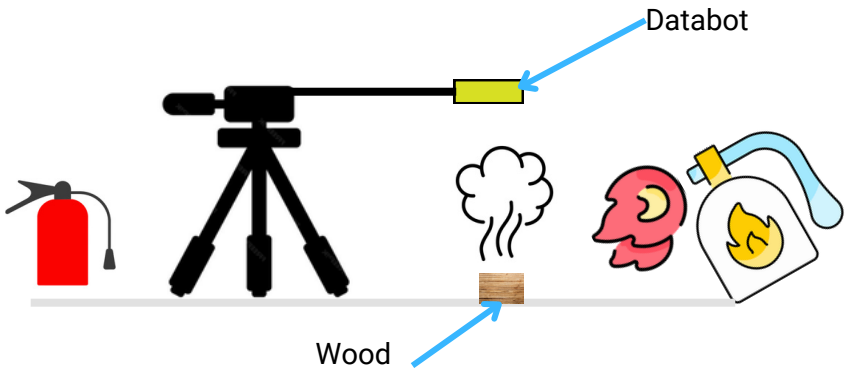
**Safety Precautions:**

- Conduct this experiment in a controlled environment under an exhaust hood or in a well-ventilated area.
- Wear heat-resistant gloves to handle materials.
- Keep a fire extinguisher nearby in case of emergencies.

- Place databot directly above the area where the smoke from the burning material will rise.
- Ensure the databot's VOC sensor is clean and functioning.
- Position the heat source at a fixed distance from the materials to maintain consistent heating.
- Tap on "**Structure of Matter 2**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.

Testing Wood:

- Place the wooden cube on the fireproof surface.
- Using tongs, expose the wood to the flame for a few seconds until it begins to emit smoke.
- Observe and record the VOC readings displayed by databot.



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Testing Plastic:

- Replace the wood with the plastic cube.
- Follow the same process, ensuring the plastic is heated from the same distance and for the same duration.
- Record the VOC readings.

Testing Paper:

- Replace the plastic with a sheet of paper.
- Repeat the process, ensuring identical heating conditions.
- Record the VOC readings.

Material _____

| Time (s) | VOC (ppb) |
|---|---|
| 0 | |
| 5 | |
| 10 | |
| 15 | |
| 20 | |
| 25 | |
| 30 | |

Material _____

| Time (s) | VOC (ppb) |
|---|---|
| 0 | |
| 5 | |
| 10 | |
| 15 | |
| 20 | |
| 25 | |
| 30 | |

Material _____

| Time (s) | VOC (ppb) |
|---|---|
| 0 | |
| 5 | |
| 10 | |
| 15 | |
| 20 | |
| 25 | |
| 30 | |

Experiment 3: Data Analysis

Compare the VOC readings for wood, plastic, and paper.
Identify which material emits the highest concentration of VOCs during combustion.
Create a histogram from the obtained values

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## Part 5: Concept Questions

Data Interpretation:

1. Which material had the greatest change in temperature, and what might this tell you about its properties?

2. Which material reflected the most light, and what does this indicate about its surface?

3. Did any materials emit VOCs, and what could this suggest about their chemical composition?

## Part 6: Reflection

1. If you were to repeat this experiment, what changes or improvements would you make to your setup or process?

2. What did you learn about how different materials respond to temperature, light, and VOC sensors?

3. Why is it important to understand the physical and chemical properties of matter?