# Exploring Water Turbidity Using A Smartphone

sead : stem

**Subjects**

Biology    Chemistry    Physics

**Topics**

Water Turbidity    Light    Clean Water

**Key Words**

Drinking Water    Level of Turbidity    Cleanliness of Water

**Connection to SDG**

3 GOOD HEALTH AND WELL-BEING

6 CLEAN WATER AND SANITATION

**STEM Chart**

| S | T | E | M |
|---|---|---|---|
| 60% | 10% | 0% | 10% |
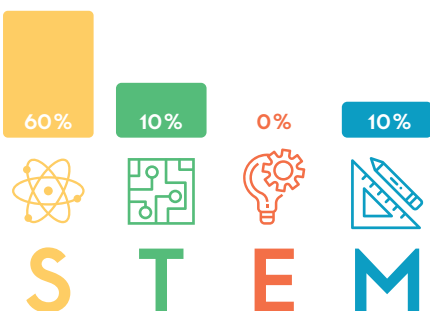
**Time for Activity**

## 3 Hours

## Introduction

Water is a natural resource that is very important for the survival of humans and various creations on earth. Water is needed for drinking, washing, bathing and is an important habitat for many living beings and plants. Therefore, water needs to be kept clean and safe.

In some places, water is not well maintained so that it appears cloudy, smelly and even toxic. This is because water is often overlooked, and humans often dispose of waste in the water. Water that is too turbid is not safe for consumption or even washing. Besides, in cloudy water, the aquatic life may not be able to survive because of the lack of light. Particles floating in the water may to some extend also impede UV light sterilization processes, as viruses can avoid UV radiation by hiding behind the particles.

This activity will focus on simple ways to measure the turbidity of water. This knowledge will be used to explore water turbidity around the school or the students' homes. The measuring instrument that will be used is a smartphone, a communication tool that is nowadays available to almost all teachers and students.

## Key Objectives

1. Differentiating particles that are soluble and insoluble in water.

2. Understanding that particles that do not dissolve in water can be detected by observing the effects of scattering or reflected light.

3. Designing a simple water turbidity measuring device using the concept of scattering and reflection or light transmission.

4. Collecting data, analyzing results and interpreting data.

## Materials

1. Transparent glass

2. Smartphone with lux meter application installed

3. Flash light (or flash from another smartphone)

4. 10 ml of milk

5. Salt, sugar, tea

6. Water from various sources near the school or students' homes

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## Safety

1  Be careful to not spill liquid directly on the smartphones.

2  The liquids used are not safe for drinking.

## General Information

### About Scattering, Absorption and Reflection of Light

Light scattering occurs because a beam of light that falls on small particles dissolved in water is absorbed and then re-emitted in all directions. Generally speaking, the size of the particles that scatter light is almost the same as the wave-length of light itself. Visible light has a wavelength of 400–700 nm. The scattered light has properties that are slightly different from the incoming light, for example color shift. In addition to scattering, particles in the water can also reflect light. This reflection will become prominent if the particle size is much greater than the wavelength of incoming light. The more particles in the water, the more light can be scattered or reflected. In addition to light scattering and reflection, light can also be absorbed by particles. Absorption causes the transmitted intensity of light to gradually decrease throughout the journey or disappear if the solution is too thick or cloudy. There is a correlation between the number of particles in water and the amount of light scattered, reflected or absorbed. In this experiment, students will be guided to design a simple tool to measure the level of water turbidity and use it to evaluate water that is available in proximity of the school or near students' homes.

## Guiding Questions

1  How does the light transmission of water change when different substances are added?

2  What is the difference between water-soluble and water-insoluble substances in the turbidity of water?

3  What influence does the quantity of a substance used have on water turbidity?

4  What does the degree of turbidity say about the cleanliness of water?

## Task

### Setup

1  This activity can be done in groups of 2 or 3 students.

2  This experiment to measure turbidity of water is very simple. You need to download the free light meter application on the App store for iPhone or Google Play for Android.

3  With the naked eye it is sometimes difficult to quantify the amount of light scattered and reflected. We can use a smartphone's camera along with a lux meter application for that (for example, LightMeter for iPhone and android which can be downloaded for free). The application will give different values depending on the amount of light captured by the camera.

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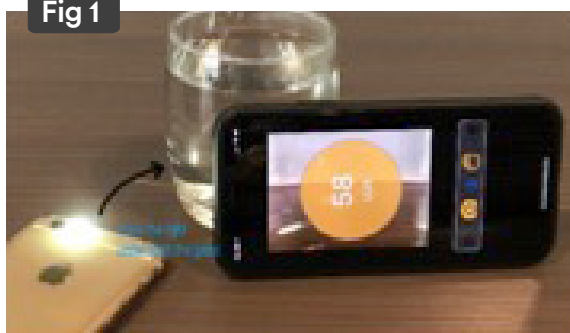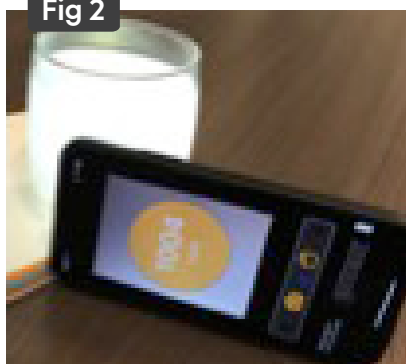
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**4** Use a transparent glass as a water container. If you have two smartphones, one of them can be used to run the LightMeter application while the other one can be used as a flash light. Alternatively, you use your own self-made LED circuit as a light source.

**5** Place the flashlight under the glass so that the flashlight illuminates the water from below. Another smartphone camera is used as a light sensor to capture the scattered or reflected light from particles in the water. The smartphone camera running the LightMeter application can be placed next to the glass.

**6** Observe the change in numbers displayed on the smartphone screen every time you change the turbidity of the water, for example by adding milk little by little. Make sure that every time you add a drop of milk, wait for a while it dilutes evenly.

**7** Information Often materials dissolved in water cannot be detected this way. In that case, we need to apply different techniques, for example using a simple Total Dissolved Solid (TDS) measurement solution.

## Task A

### Basic Experiments

**1** What happens if you continuously add drops of milk? Will the scattered and reflected light captured by the camera continuously increase? Try it!

**2** Can you quantify light captured by the smartphone every time you change water turbidity using different amounts of milk? Evaluate the trend by using a graph of lux versus the number of milk drop.

**3** Discuss the results with students.

**4** Use other liquids and substances besides milk. Will you get the same results as with milk? Try to evaluate quickly, using a flash light, whether salt, sugar, milk or tea dissolved in clear water can scatter and reflect light. For milk and tea, pour one drop in a cup of water. When it looks cloudy, then the material reflects and scatters light.


Fig 1


Fig 2

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## Task B

### Experiments with Water from Different Sources

Now compare the level of turbidity of water that you collect from the surrounding environment in a similar way. Sort the water samples according to their turbidity from most turbid to least turbid, then discuss the results in the class or in groups. Ask the students to create a report in the form of a poster.

5   Can you make turbid water clear again? Often, we need to purify turbid water before use, for example by applying simple filtering techniques.  Use a paper filter to filter one of the water samples. Measure the transparency before and after the filtration and compare.

6   By measuring the turbidity of the water, is it possible to determine whether the water tested is safe to drink?

## Questions about the experiment

1   Explain why every time new particles are added, the light reflection increases.

2   Describe the results that you obtain in task No. 2 above. Can you explain why the reflection finally decrease when turbidity becomes too much? What kind of modification of the experimental technique do you suggest?

## Assessment

| Score | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| | Both answers are complete and correct | Answer 2 is complete and correct | Both answers are correct in general, but incomplete | The answers are incomplete and incorrect |