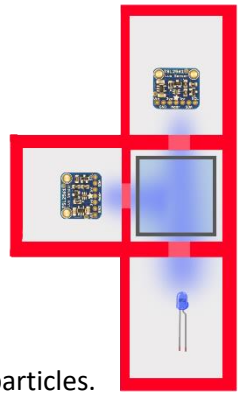
# Building a Turbidity meter



## Introduction

Turbidity gives us a measurement of how turbid, or cloudy, a liquid is. Not only the number of particles affects the turbidity, but also the color, shape and size of the particles.

There are many ways to measure turbidity. One of the easiest methods is to lower a disk on a string and measure how deep it can go before it disappears (figure 1). This method is over 150 years old and the disk used is called a Secchi disk after Angelo Secchi who is the inventor of this method.

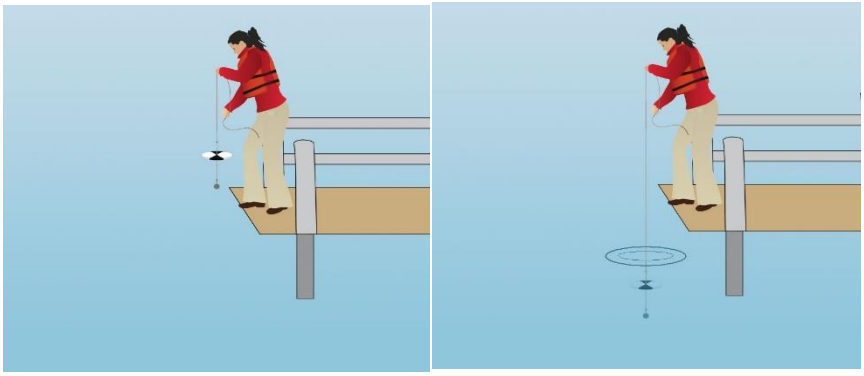


*Figure 1. A scientist is measuring visibility in a lake by lowering a Secchi disk until it is no longer visible.*

Another way to measure turbidity is to take a sample of the liquid and measure how much light that travels through the liquid, both transmitted light opposite and dispersed light perpendicular to the light source (figure 2). Turbidity is then calculated as the quotient of the two light intensity measurements.

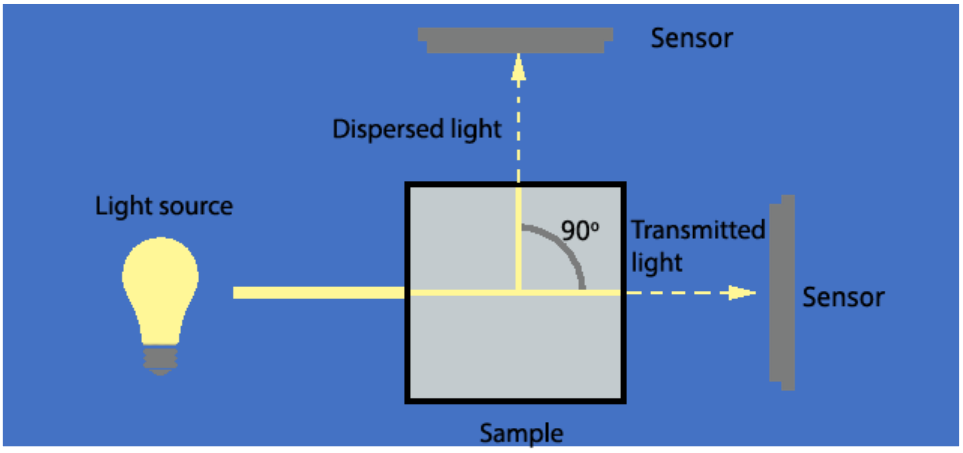



*Figure 2. The principle for the turbidity meter with a light source. Some of the light is travelling through the sample and is received by a sensor on the opposite side. The light that is dispersed perpendicular to the light source is received by another sensor.*

The reason why you calculate the quotient between the two light intensities is because a turbid liquid sample will both absorb and disperse the light. A spectrophotometer only measures the absorbed light opposite of the light source.

Different turbidity meters use different light sources and different sensors. There are several different units that you can measure turbidity in. A common unit is NTU (Nephelometric Turbidity Units) and another unit is FNU (Formazin Nephelometric Units), based on different standard solutions of formazin.

In this exercise we will study the water turbidity based on a serial dilution of a known concentration of the particle of choice. We then measure turbidity for each concentration and plot a standard curve (figure 3). The curve can then be used in the experiments.

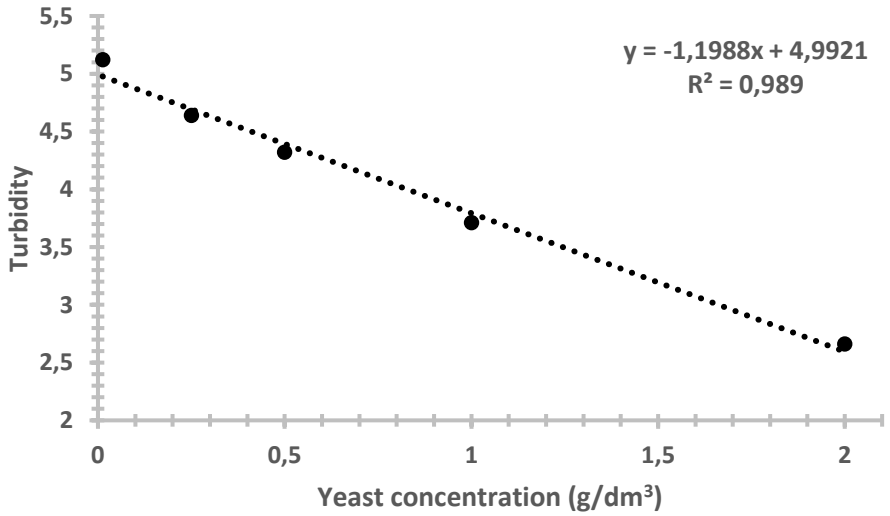
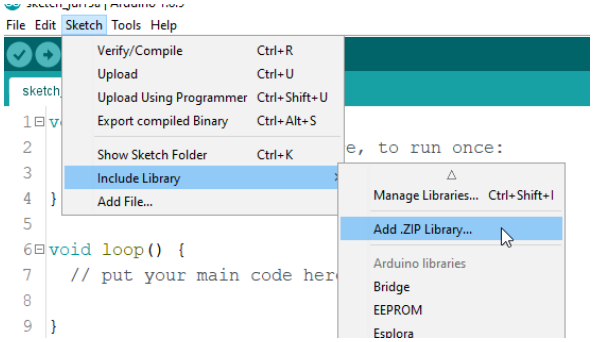



*Figure 3. With a standard curve like this you can use the turbidity measurement for an unknown sample and calculate the concentration of the particles.*

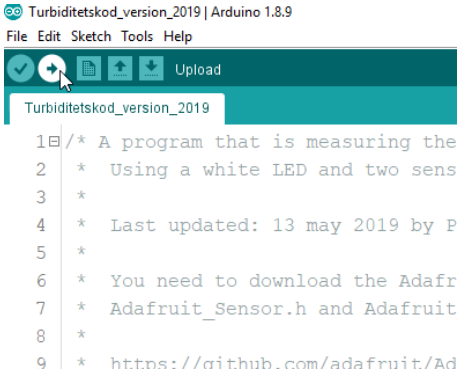
## Materials and method

- Build the enclosure by following the Lego instruction.
- Connect the Arduino to the sensors and LED according to the wire diagram. Make sure the sensors are correctly connected.
- If you don´t already have the Arduino software installed, you should do that now. Follow the instructions on https://www.arduino.cc/en/Main/Software.
- Start the Arduino program and add the sensor libraries. You must do it twice – one for each library. The files are named *Adafruit_Sensor-master.zip* and *Adafruit_TSL2561-master.zip* and you can find them on https://github.com/adafruit/Adafruit_Sensor and https://github.com/adafruit/Adafruit_TSL2561 .




- Open the program code: *Turbiditetskod_version_2018.ino* found at https://github.com/sciencemakersSE/Turbiditetsmatare.

- When the turbidity meter is connected to the computer it is time to upload the program code. Click on the arrow up to the left:




- When using the turbidity meter you need to open the serial monitor by clicking in the small box up to the right.