

# The weather station project (Level 2)

Worksheet for students

Team:.....

**Aim: Measure the temperature, pressure, humidity and dust concentration**

What is the smog? What kind of chemical compounds make up the smog? Search for information online and write your answers below.

Air quality is described by PM2.5 and PM10 indicators. What does PM2.5 and PM10 mean? Search for information online and write your answers below.

Review several scenarios, how weather station can be build, and choose one to demonstrate. Sketch your weather station and list the crafting materials that you may need.

*Area for sketches*

*Bill of materials*

## Time for circuit making!

During this project, the sensors with Grove standard will be used. This standard allows to connect elements easily. This is really important when sensors are sensitive to damage.

The circuit from level 1 will be extended by adding optical dust sensor as is shown in Fig. 1.

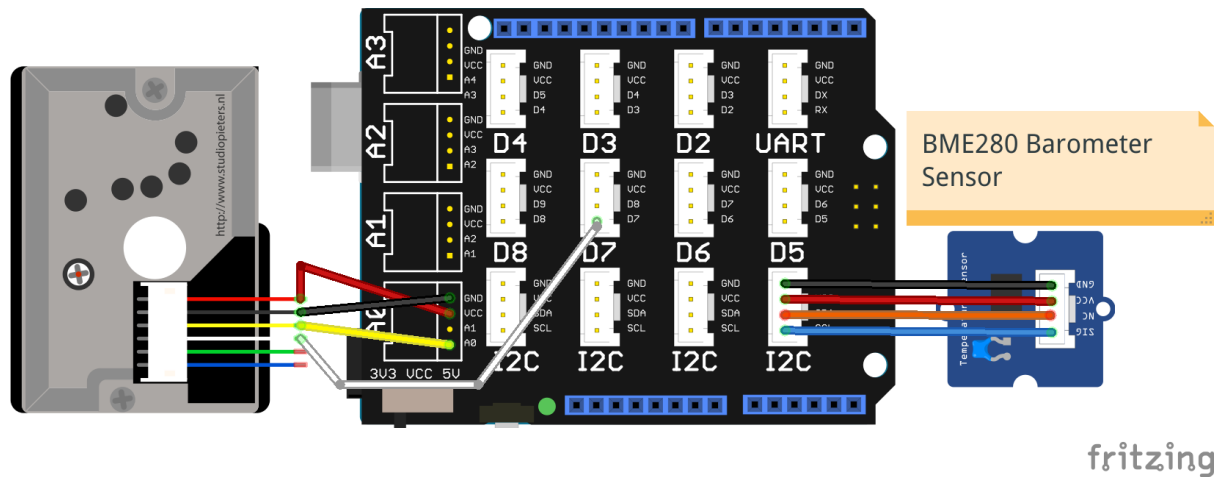


Figure 1: The dust sensor connected to the Grove shield. Red wire should be connected to 5 V (VCC). Black wire should be connected to ground (GND). LED input should be connected to PWM pin. The analog output (AOUT) should be connected to analog pin.

## Time for hands-on practice!

Let's create the circuit using your Arduino board and the corresponding electrical components.

## Time for programming!

Connect your Arduino to USB and open Arduino IDE software.

The optical dust sensor has an IR LED inside, which emits light invisible for our eyes (infra-red range). If dust is present, the light bounces off it and the light is registered by photodiode. If intensity of reflected light is higher, the analog signal returned by sensor has proportionally higher voltage. The schematic idea of how dust sensor works is shown in Fig. 2.

The returned value from the dust sensor is proportional to the dust concentration in the air. The measurement of the dust concentration consists of the following steps:

1. turn on the LED diode,

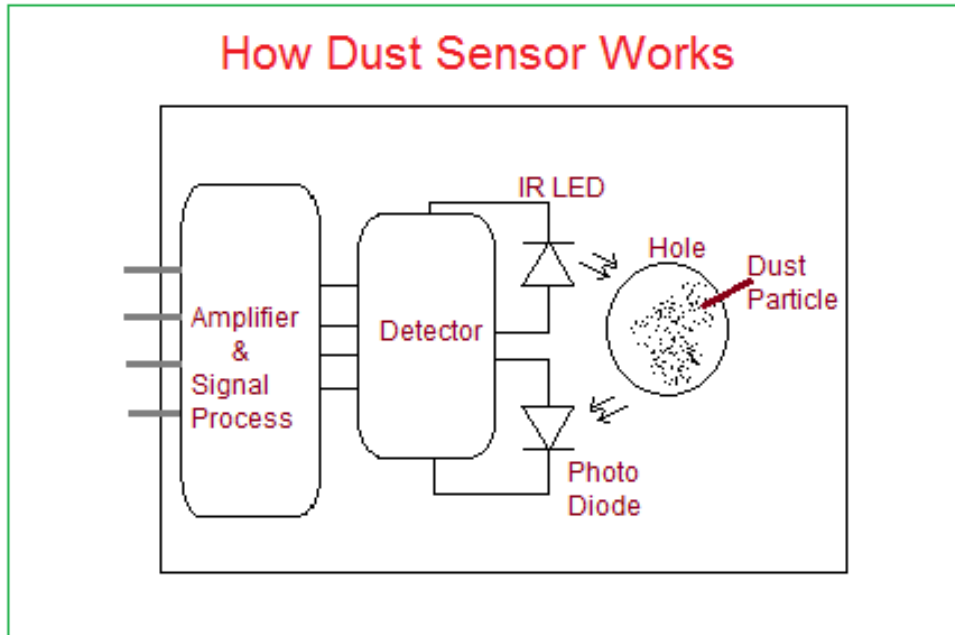


Figure 2: The schematic idea of how dust sensor works. Source: <http://www.theorycircuit.com/dust-sensor-arduino-interface/> .

2. wait 280  $\mu s$ ,
3. read value from the sensor,
4. turn off the LED diode.

Modify your code from level 1 by adding the measurement of the dust concentration:

1. Create three variables, which will store:
  - returned value from A0 input,
  - calculated voltage based on value from A0 input,
  - dust concentration value.
2. At the beginning, the LED diode should be configured as *OUTPUT* and turned off.
3. The returned analog signal from the dust sensor has small voltage. Therefore, standard range of voltage (0-5V) is too high and cause large inaccuracy. The reference voltage can be changed from 5V to 1.1V by *analogReference(option)* function inside *setup* function. This option is *INTERNAL* in case of Arduino UNO board or *INTERNAL1V1* in case of Arduino Mega 2560 board.
4. Add the part of code, which will measure the dust concentration inside the *loop* function.

5. Calculate the dust concentration based on value returned from A0 pin. The analog value, read from sensor, should be transferred to voltage. The Arduino board returns analog value in range (0;1023) - 1024 possible values. The maximum voltage value is 1.1 V (1100 mV) therefore voltage can be calculated as:

$$U_{dust} = \frac{1100}{1024}A \quad (1)$$

where:  $A$  is analog value returned by Arduino board.

According to dust sensor documentation, the divider was used. Therefore, the final value should be multiplied by 11:

$$U_{dust} = 11 \cdot \frac{1100}{1024}A \quad (2)$$

6. Print the dust concentration value in the serial monitor.

#### Useful functions:

- `int name_of_variable` - creation of integer value,
- `float name_of_variable` - creation of floating point number,
- `pinMode(pin number, INPUT or OUTPUT)` - define, which pin should be configured as input or output,
- `digitalWrite(pin number, LOW or HIGH)` - set the *LOW* (0 V) or *HIGH* (5 V) voltage level to chosen pin,
- `delayMicroseconds(time in  $\mu s$ )` - stop execution of script for chosen period of time specified in microseconds,
- `analogRead(pin number)` - reading value from analog pin. The returned value is in range of (0;1023),

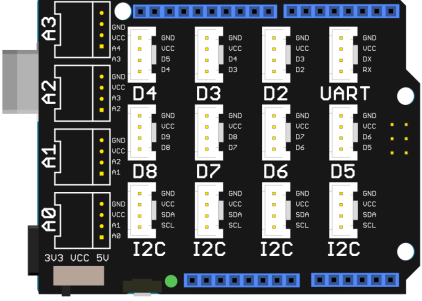
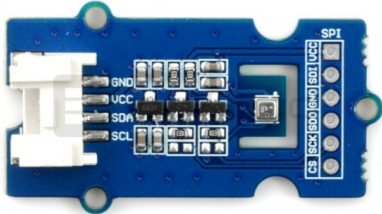

#### Time to revise your model!

Start improving the design of the weather station using the available crafting materials. Integrate the electrical circuit and the script to add the needed level of interactivity.

**Remember that the hole in the dust sensor should not be covered!**

## Electrical components

The following table is an index containing all the components that need to be implemented for accomplishing the present activity.

 <p>The diagram shows a black PCB layout for a Grove Base Shield. It features a 5-pin header on the left labeled A0, A1, A2, A3, and a 4-pin header on the right labeled D4, D3, D2, D1. There are four I2C modules labeled I2C1, I2C2, I2C3, and I2C4. A UART module is also present. The board has a 3.3V, 5V, and GND header at the bottom. The 'fritzing' logo is visible at the bottom right of the diagram.</p>	<p>Grove Base Shield (for Arduino UNO) or Grove Mega Shield (for Arduino Mega 2560)</p>
 <p>The image shows a blue PCB for a Grove Barometer Sensor (BME280). It has a 5-pin header on the left and a 4-pin header on the right labeled CS, SCK, SDA, and SCL. The BME280 sensor chip is mounted on the board.</p>	<p>Grove Barometer Sensor (BME280)</p>
 <p>The image shows an optical dust sensor (GP2Y1010AU0F) with a blue PCB. It has a 5-pin header on the left and a 4-pin header on the right. The sensor is housed in a metal enclosure. Cables are connected to the headers.</p>	<p>Optical dust sensor (GP2Y1010AU0F)</p>

## **ROBOSCIENTISTS PROJECT**

Motivating secondary school students towards STEM careers through robotic artefact making

**Erasmus+ KA2 2018-1PL01-KA201-051129**

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### **Declaration**

This report has been prepared in the context of the ROBOSCIENTISTS project. Where other published and unpublished source materials have been used, these have been acknowledged.

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