How to do physics with Arduino?

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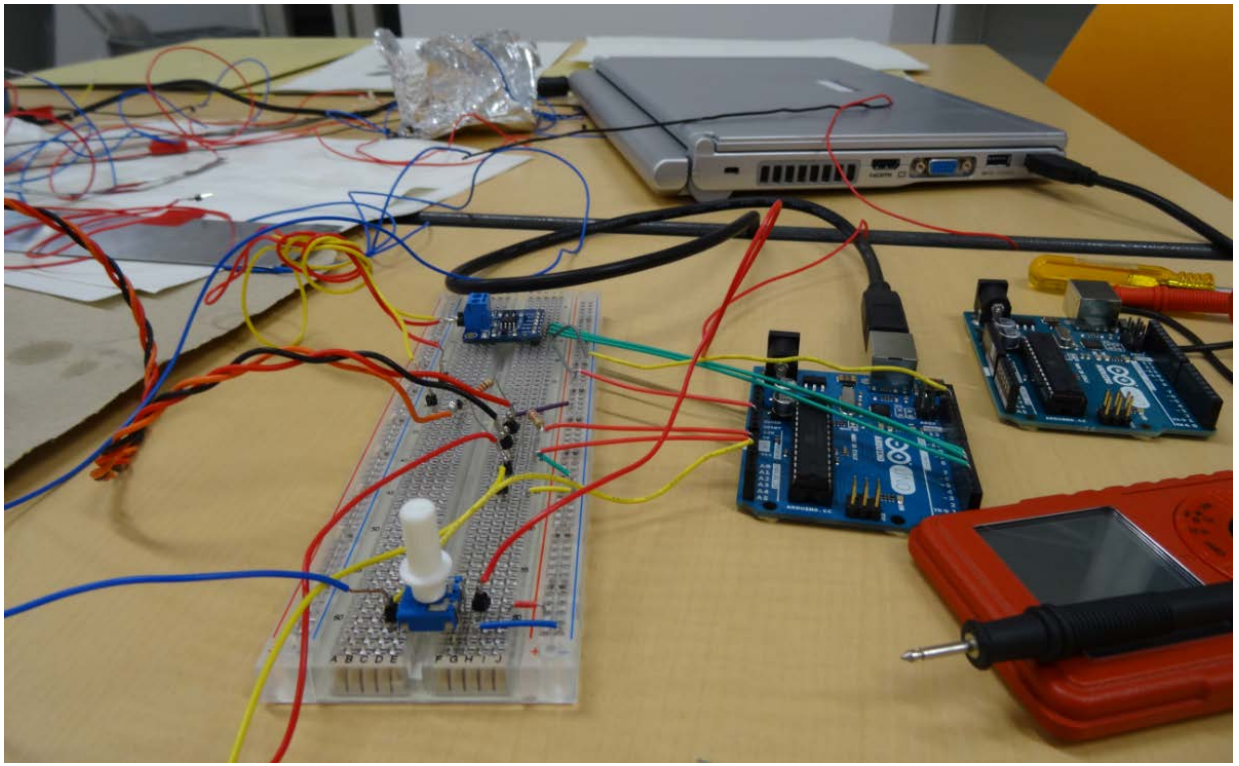
www.vulgarisation.fr



How to do physics with Arduino?

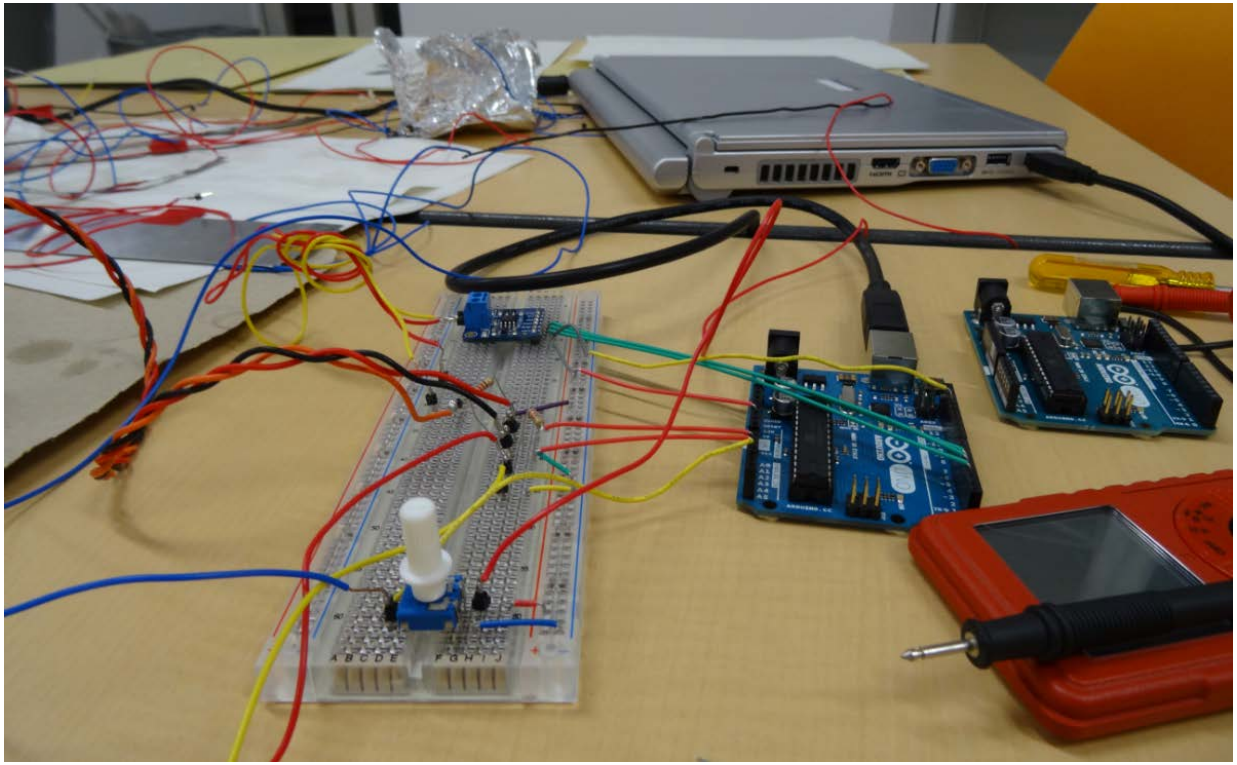
- Not exhaustive
- community, articles…

How to do physics with Arduino?

- How to communicate
- How to do a measure
- A word on sensors
- How to use it at school?

How to communicate?

Serial port!



How to communicate?

Serial port!

```
void setup() {
  // initialize serial communications at 9600 bps:
  Serial.begin(9600);
}

void loop() {
  // read the analog in value:
  sensorValue = analogRead(analogInPin);

  // print the results to the serial monitor:
  Serial.print("sensor = " );
  Serial.println(sensorValue);
  delay(100);
}
```

How to communicate?

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```

Tool/Serial Monitor

(see File/Example/Analog/AnalogInOutSerial)

How to communicate?

Serial port!

SD, Wifi are possible…

How to do a measure?

AI, (DI)

0 – 1023 on 5V

(Ref can be changed)

How to do a measure?

AI,

```
const int analogInPin = A0;  // Analog input pin
int sensorValue = 0;         // value read

void setup() {
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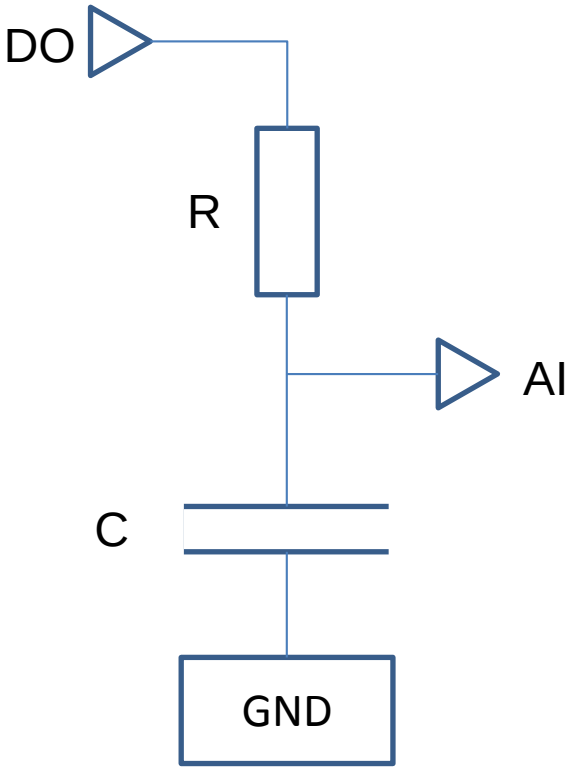
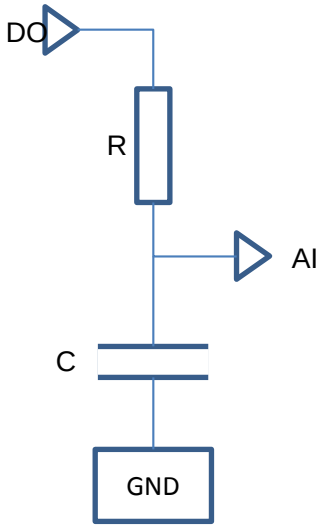
  delay(100);
}
```

Example



Example




```
const int analogInPin = A0;       // Analog input pin
const int driveDigitalPin = 13 ; // Digital pin
int Value = 0;                    // value read

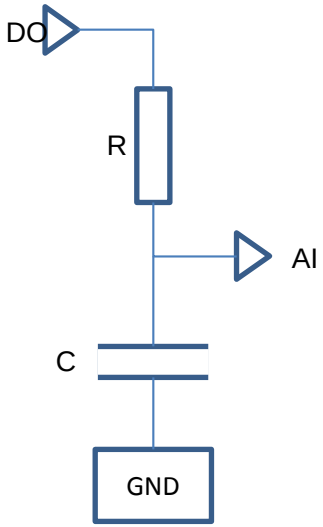

void setup() {
    // initialize serial communications at 9600 bps:
  Serial.begin(9600);
    // initialize digital pin 13 as an output.
  pinMode(driveDigitalPin, OUTPUT);
  digitalWrite(driveDigitalPin, LOW);    // turn off the voltage (LOW = 0 V)
  delay(10000);                          // wait for 10s
  digitalWrite(driveDigitalPin, HIGH);   // turn on the voltage (HIGH = 5 V)
}

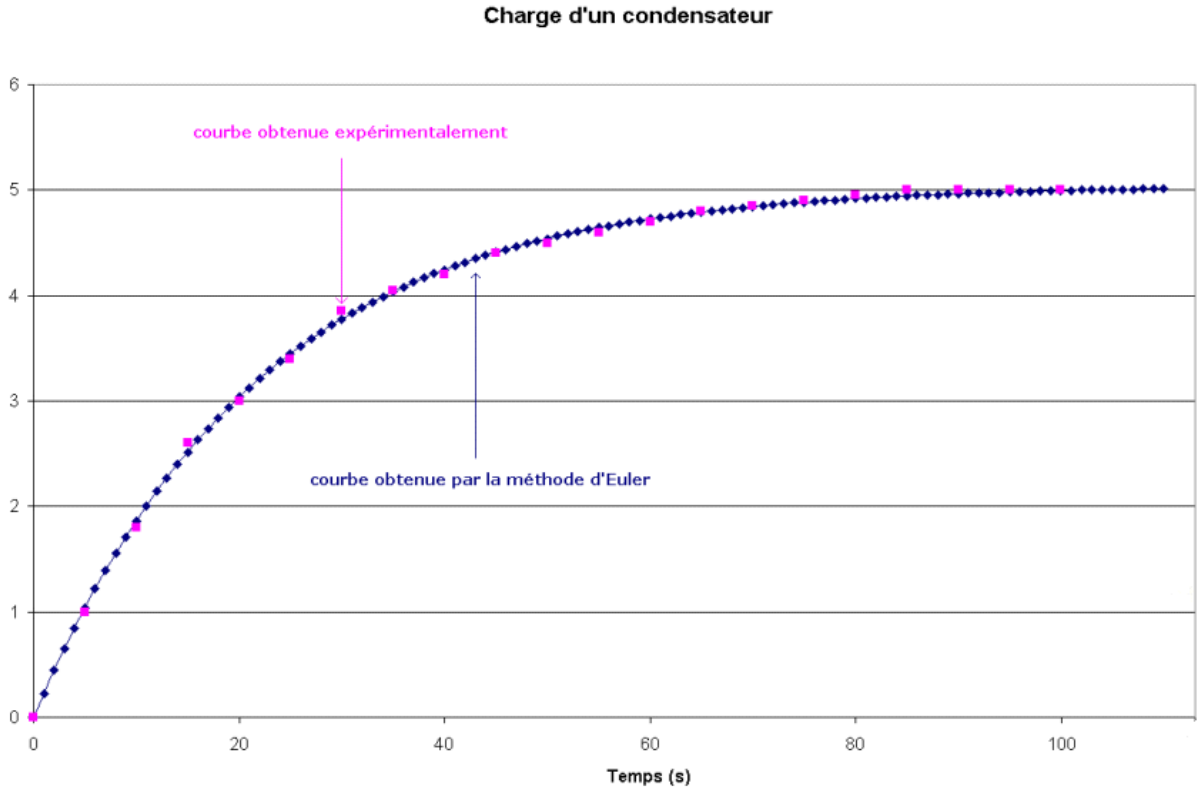
void loop() {
  // read the analog in value:
  Value = analogRead(analogInPin);

  // print the results to the serial monitor:
  Serial.print(millis());
  Serial.print("\t" );
  Serial.println(Value);

  delay(100);
}
```

Example


DO
R
AI
C
GND


Charge d'un condensateur
courbe obtenue expérimentalement
courbe obtenue par la méthode d'Euler
0
1
2
3
4
5
6
0
20
40
60
80
100
Temps (s)

Bandwidth?

Serial!

```
void loop()  {
  Serial.println(analogRead(analogInPin));
}
```

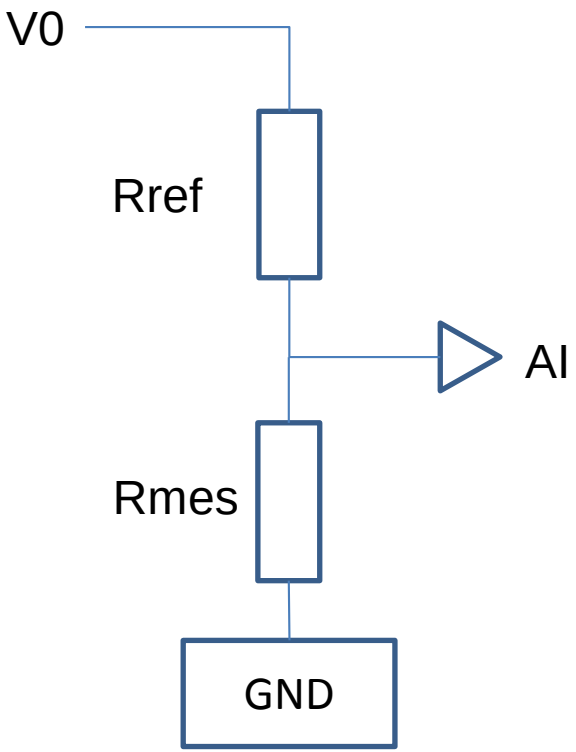
8 kHz at max serial speed

Sensitivity?

~ 5 mV by default

- averaging
- amplifying
- Lock In techniques

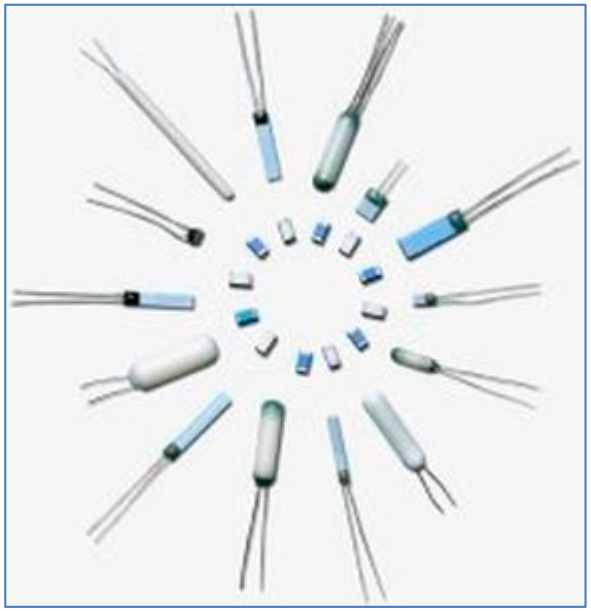
Measuring a resistor



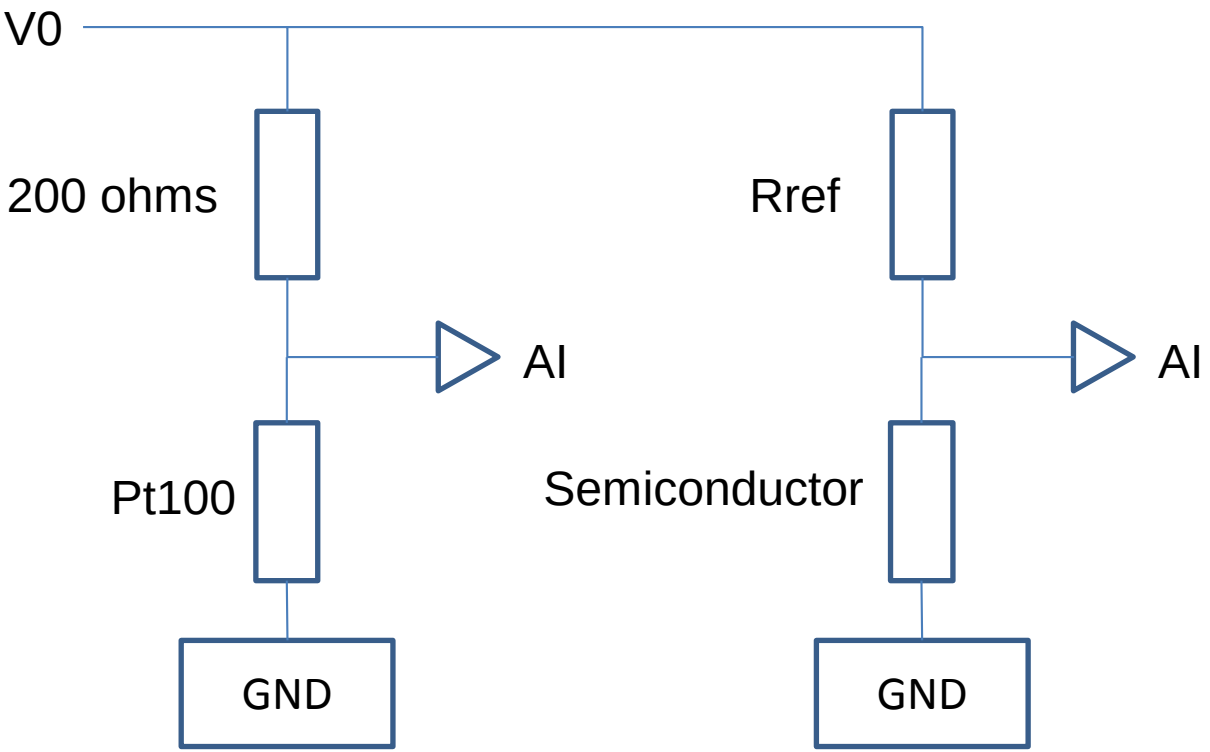
- Temperature
- Light
- Force

Measuring temperature

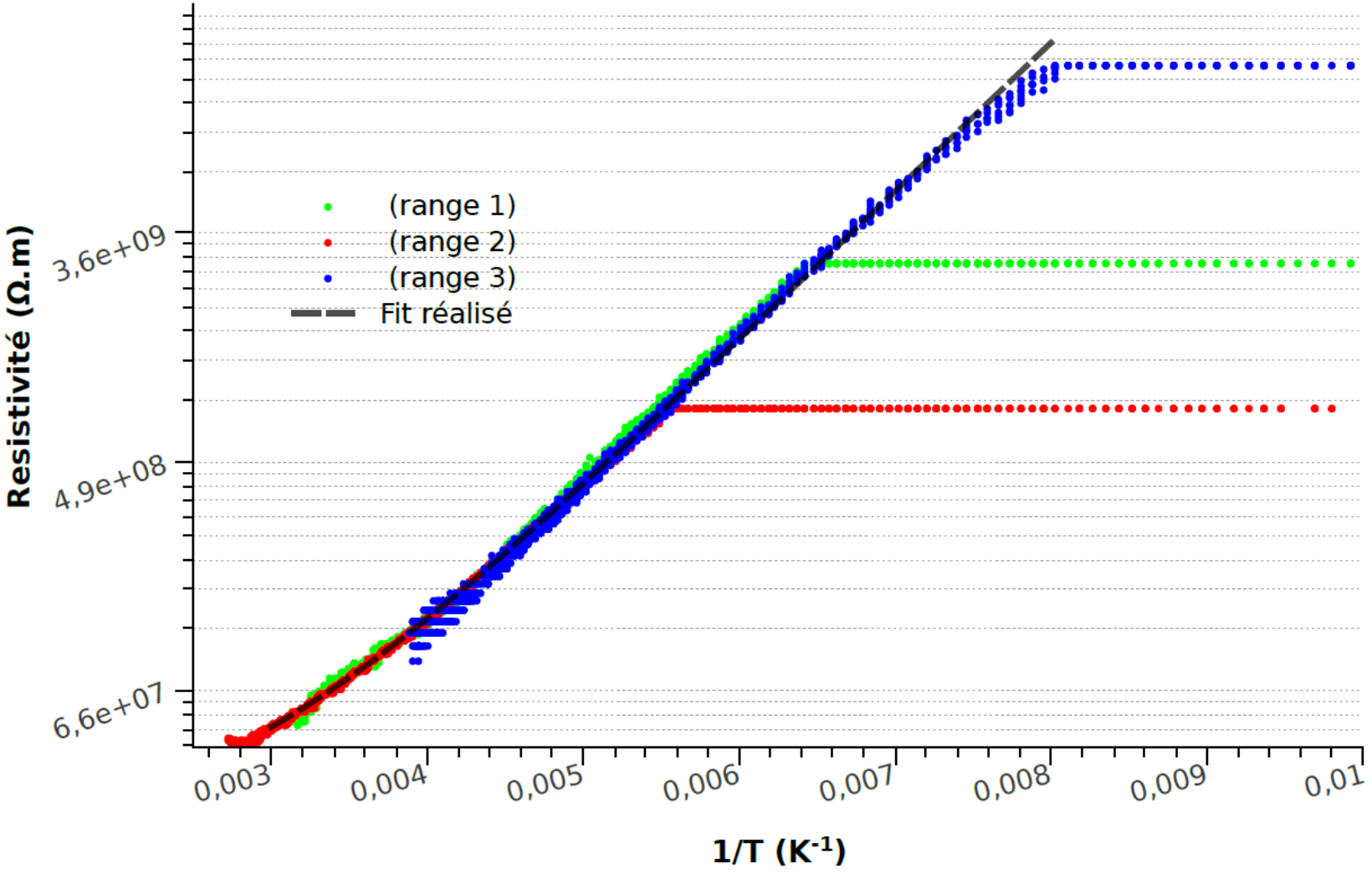
Pt100



Example



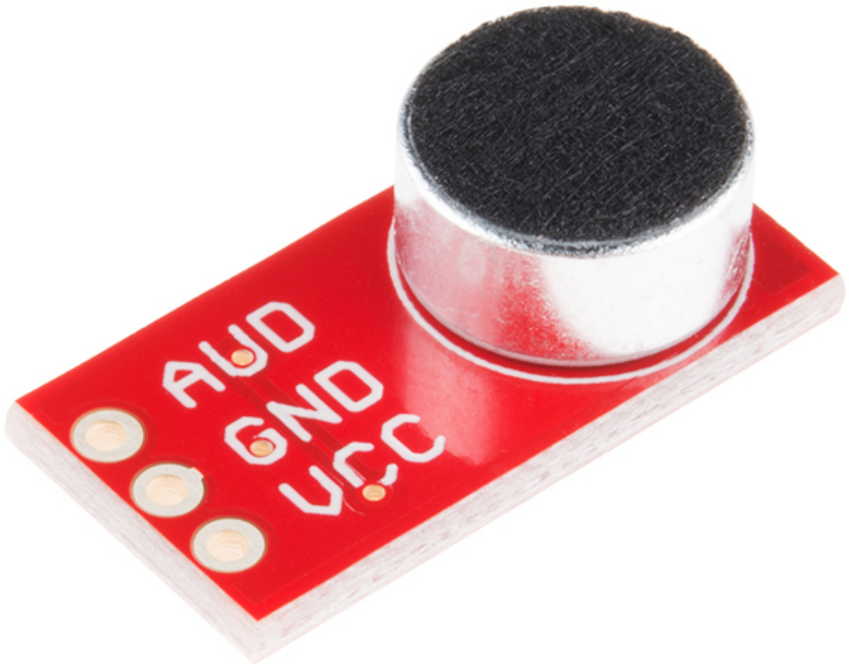
Example


(range 1)
(range 2)
(range 3)
Fit réalisé
Resistivité (Ω.m)
3,6e+09
4,9e+08
6,6e+07
0,003
0,004
0,005
0,006
0,007
0,008
0,009
0,01
1/T (K-1)

Sensors

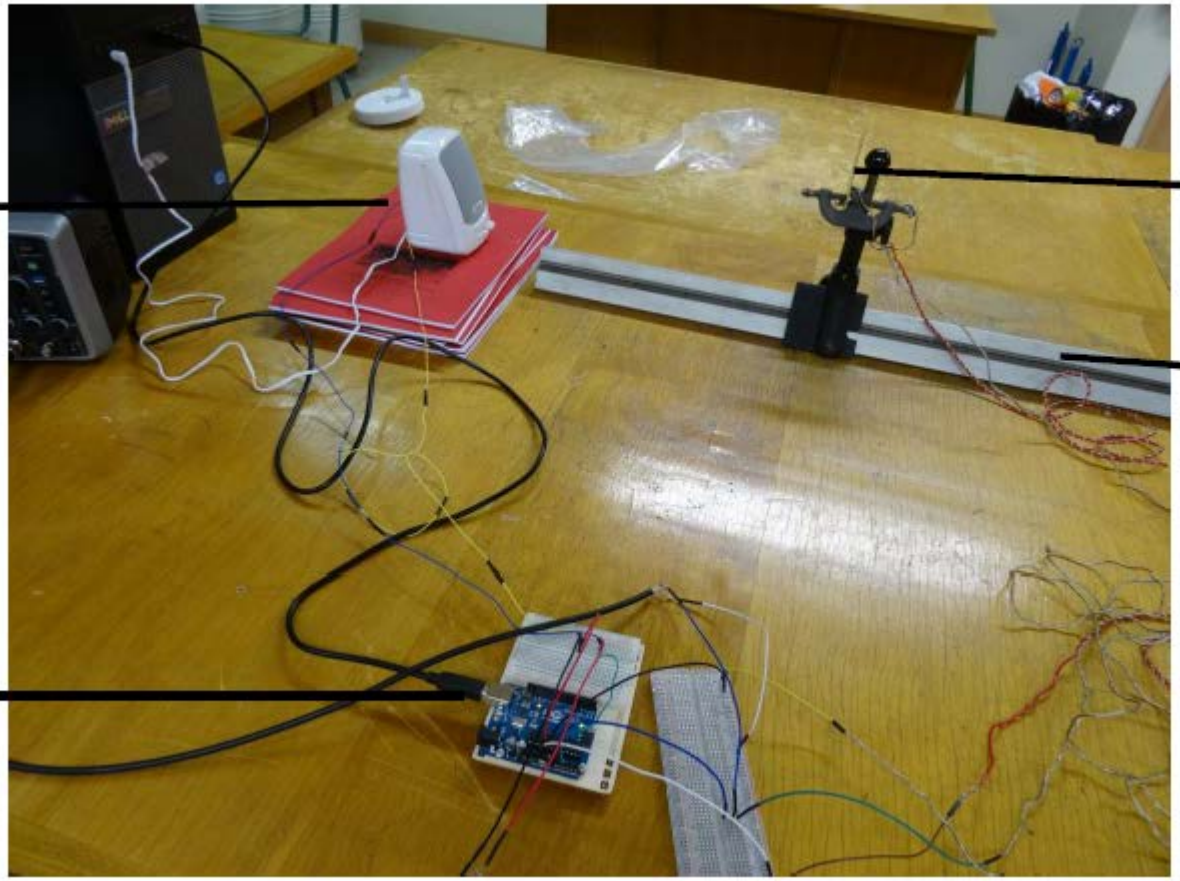
- Analog Sensors
- Digital Sensors

Analog Sensors



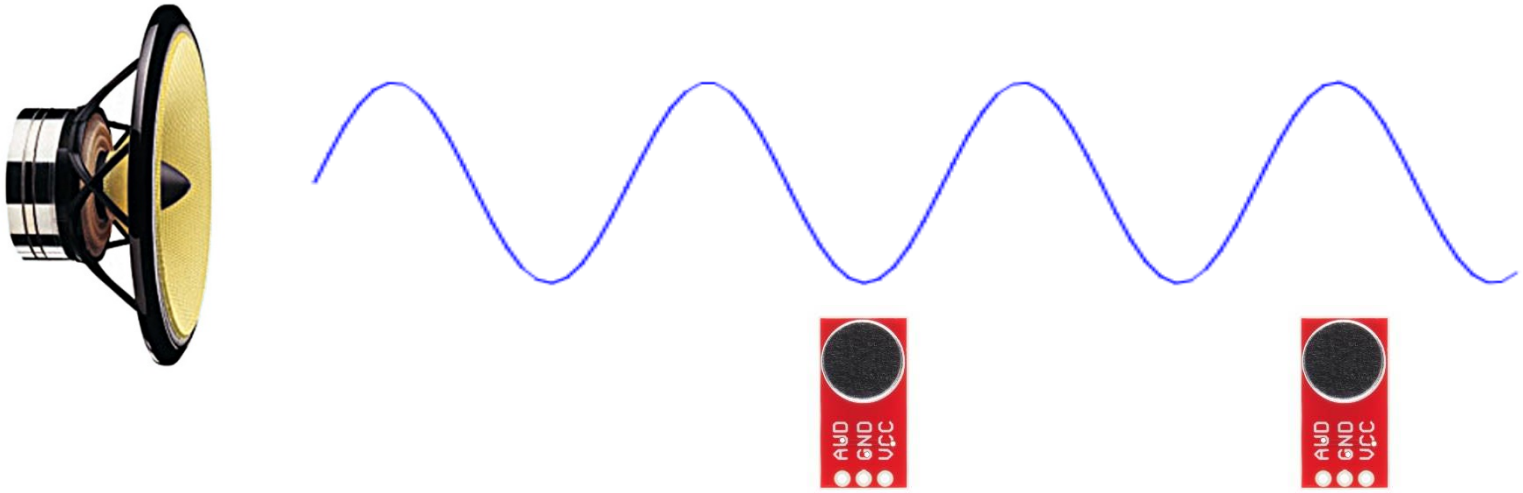
- microphone
- Hall sensors
- Light sensors
- Accelerometers

Example

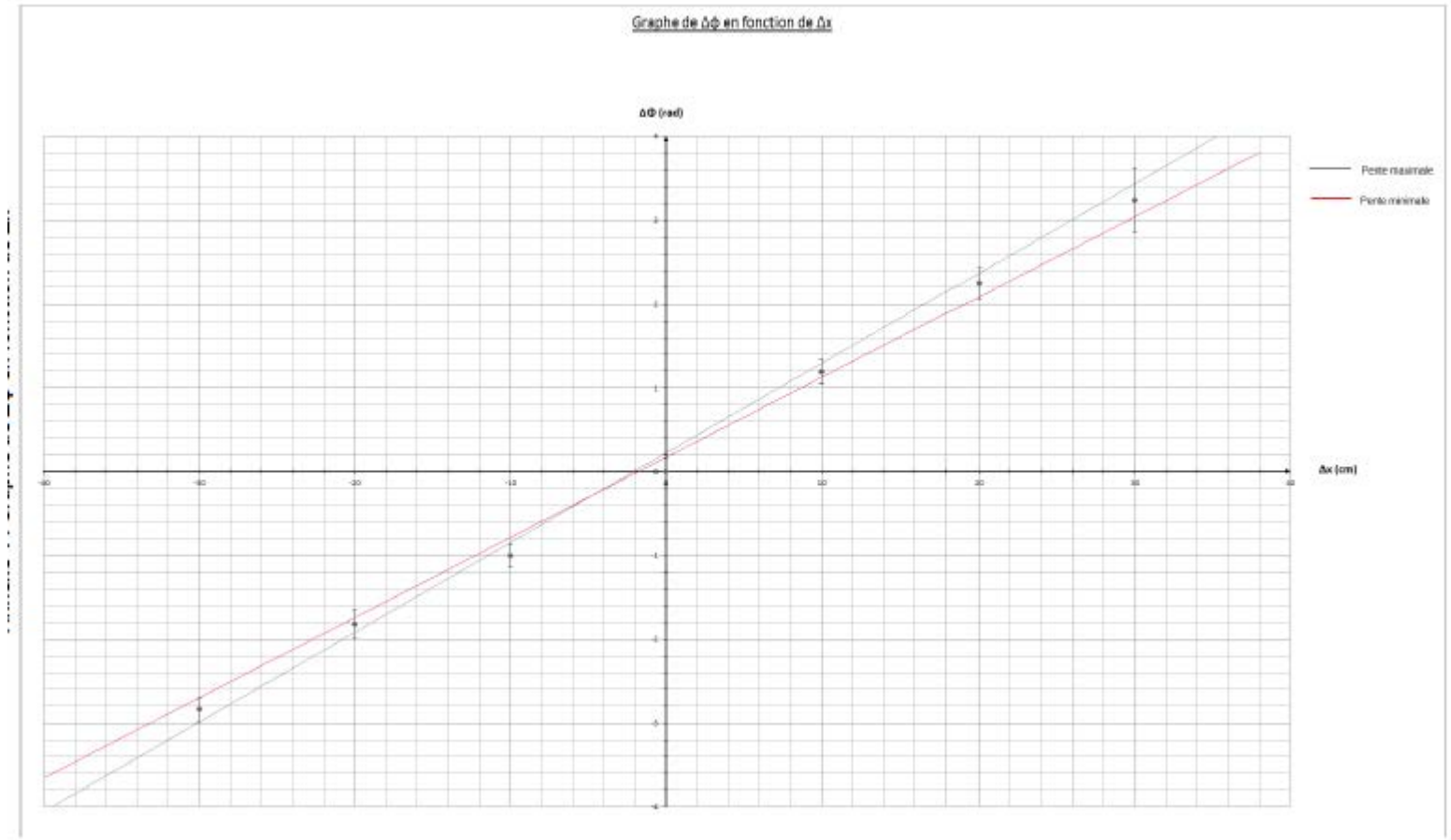


Example

```
void loop()  {
   Serial.print(analogRead(A0));
   Serial.print(analogRead("\t"));
   Serial.println(analogRead(A1));
}
```



Example


Graphe de Δφ en fonction de Δx
Δx (cm)
Pente maximale
Pente minimale

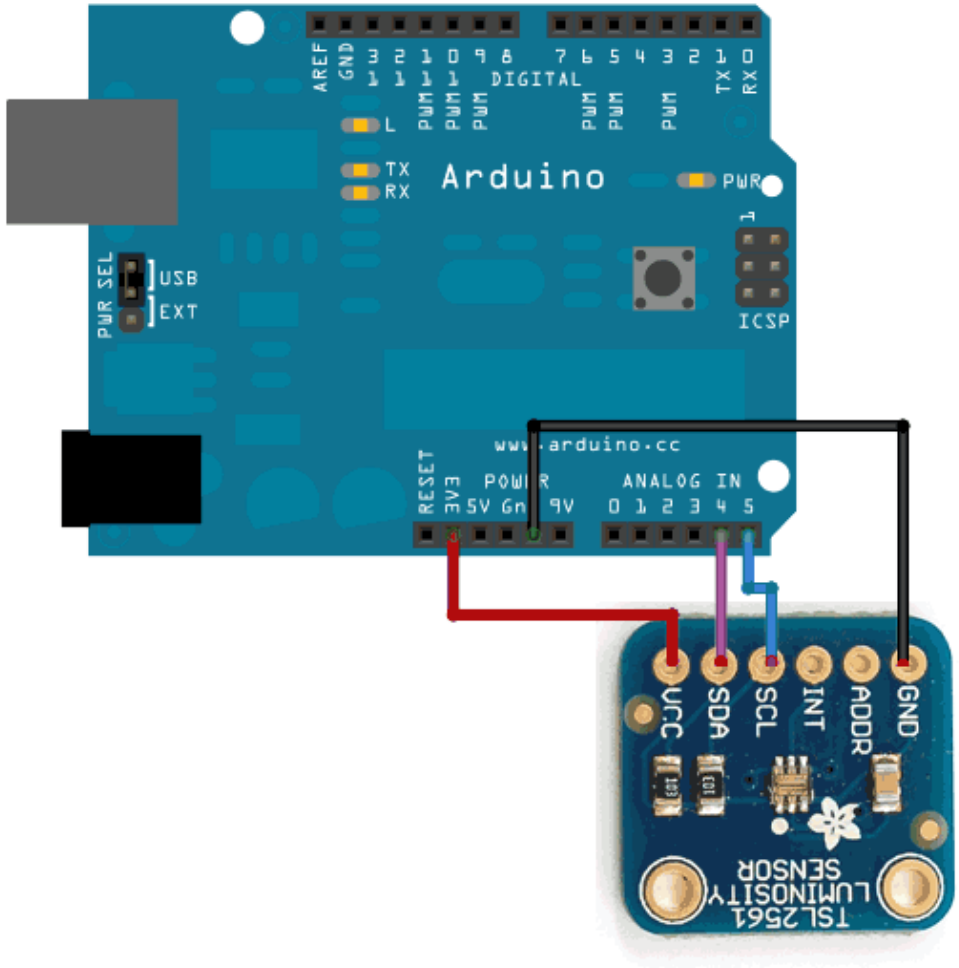
Digital Sensors

Library

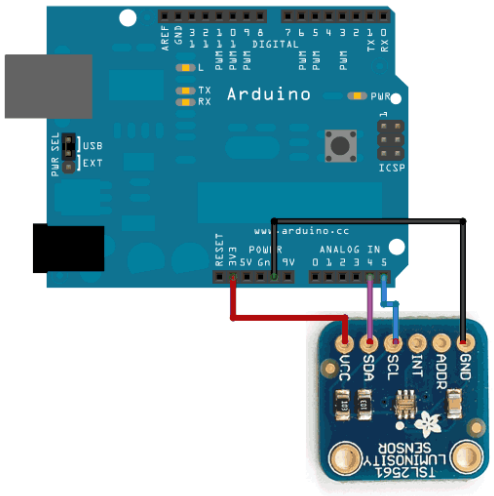
```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_TSL2561_U.h>
```

- 3 axis magnetometer
- 3 axis accelerometer and gyroscope
- Light sensors
- thermocouple amplifier

Example


AREF
GND
DIGITAL
PWM
L
TX
RX
Arduino
PWR
PWR SEL
USB
EXT
ICSP
RESET
3V3
5V
Gn
9V
ANALOG IN
0 1 2 3 4 5
VCC
SDA
SCL
INT
ADDR
GND
TSL2561
LUMINOSITY
SENSOR

Example

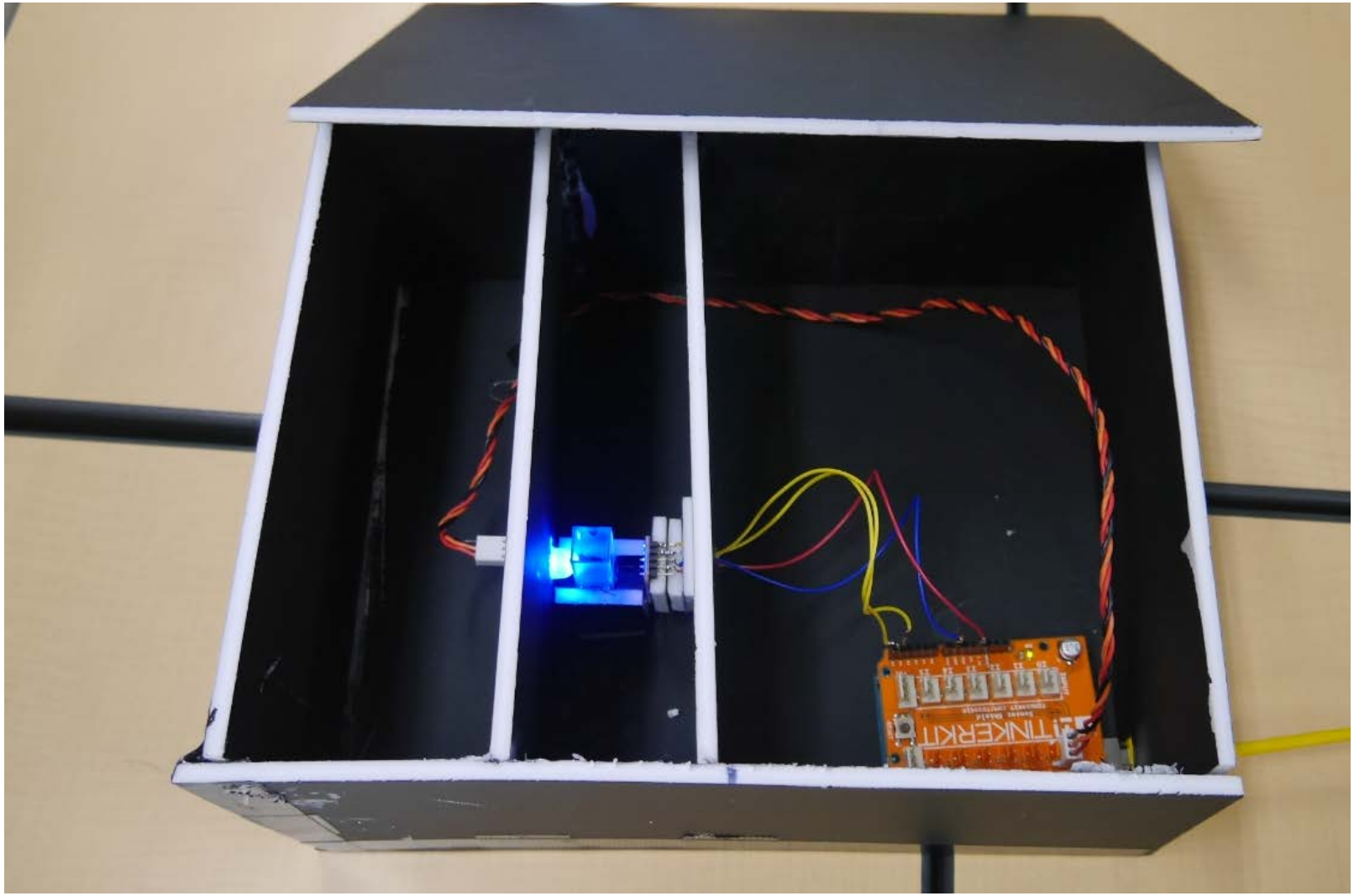



```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_TSL2561_U.h>
```

```
void loop()
{
  /* Get a new sensor event */
  sensors_event_t event;
  tsl.getEvent(&event);

  /* Display the results (light is measured in lux) */
  if (event.light)
  {
    Serial.print(event.light); Serial.println(" lux");
  }
  else
  {
    /* If event.light = 0 lux the sensor is probably saturated
       and no reliable data could be generated! */
    Serial.println("Sensor overload");
  }
  delay(250);
}
```

Example



Example

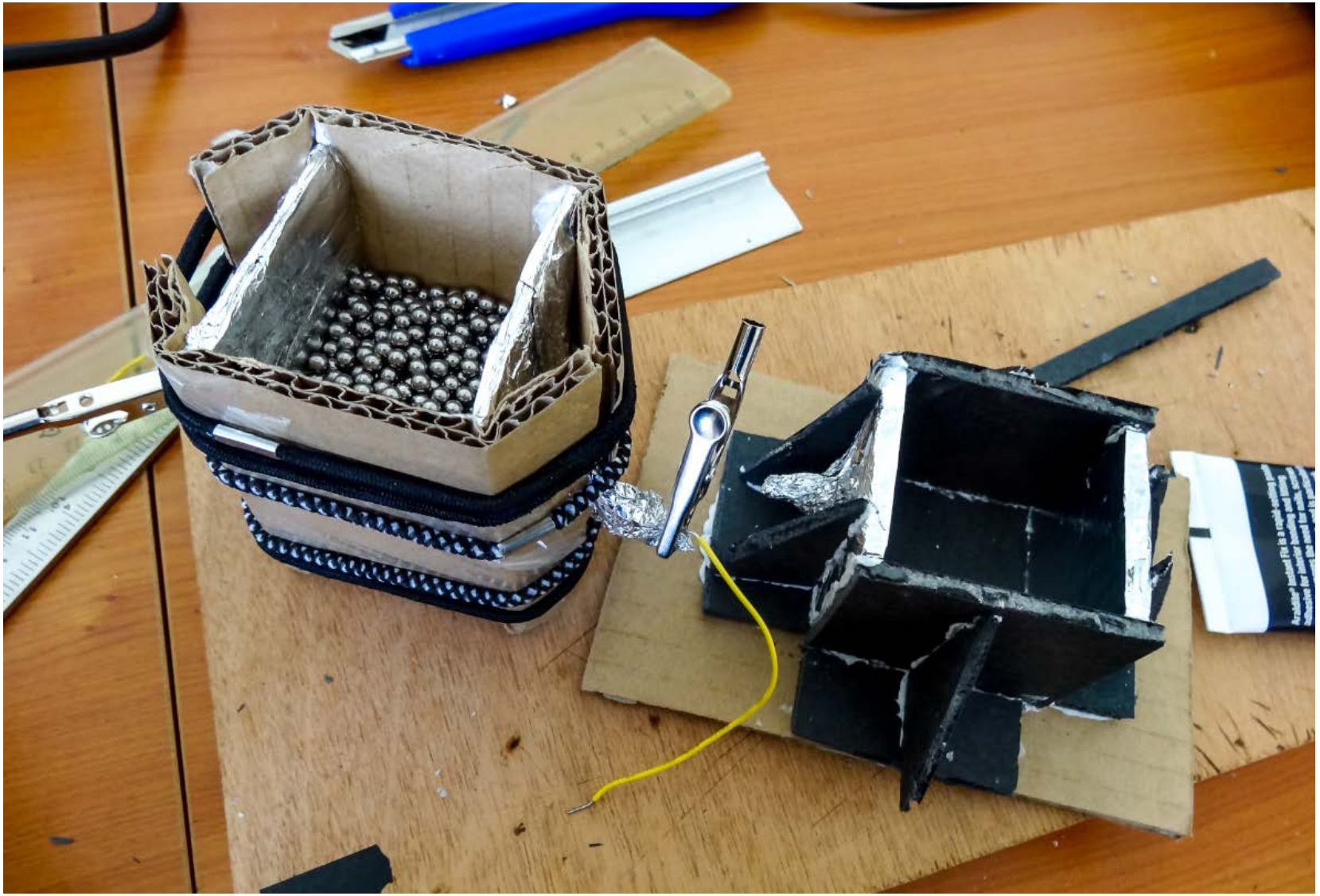
Shields

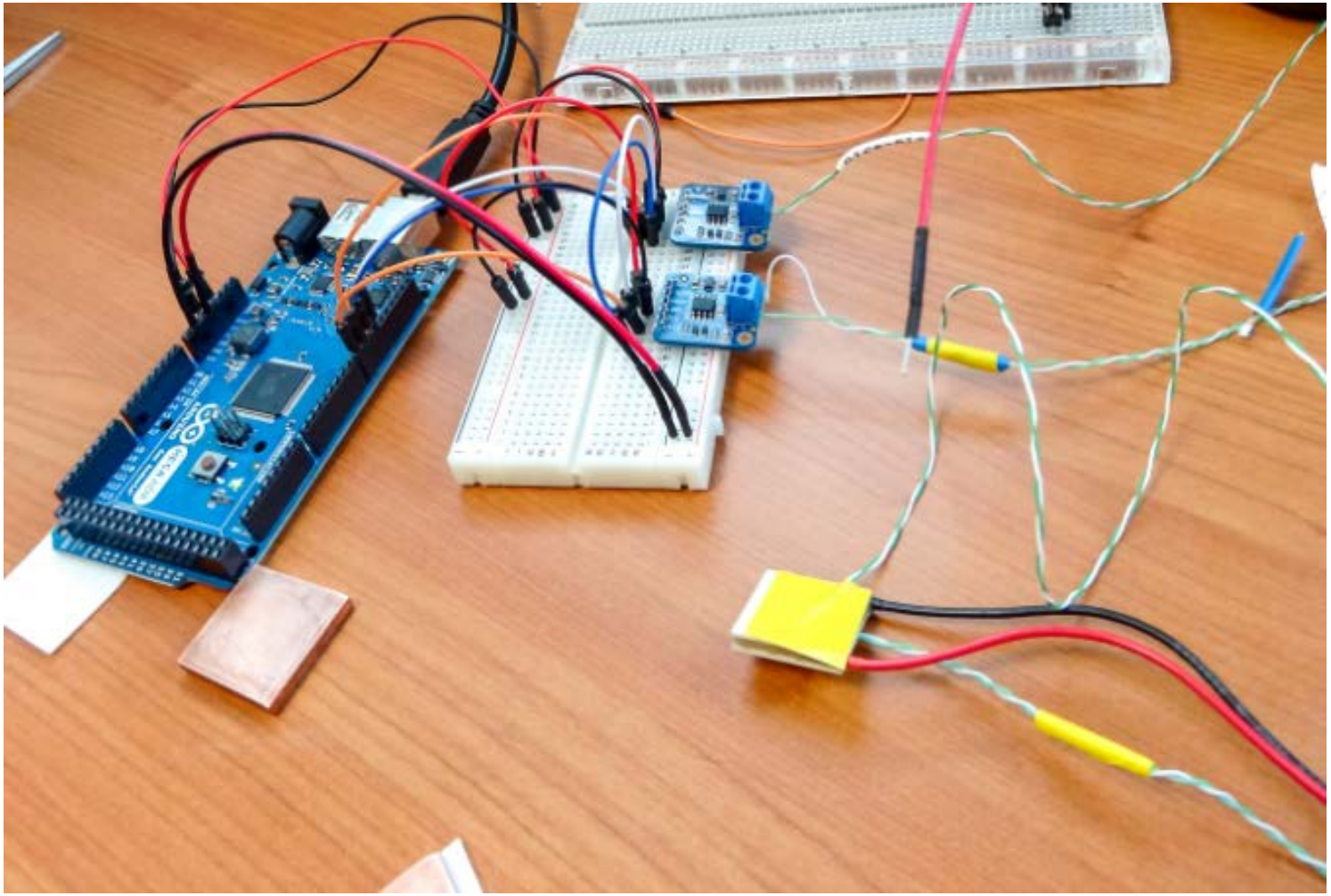
Extension of Arduino

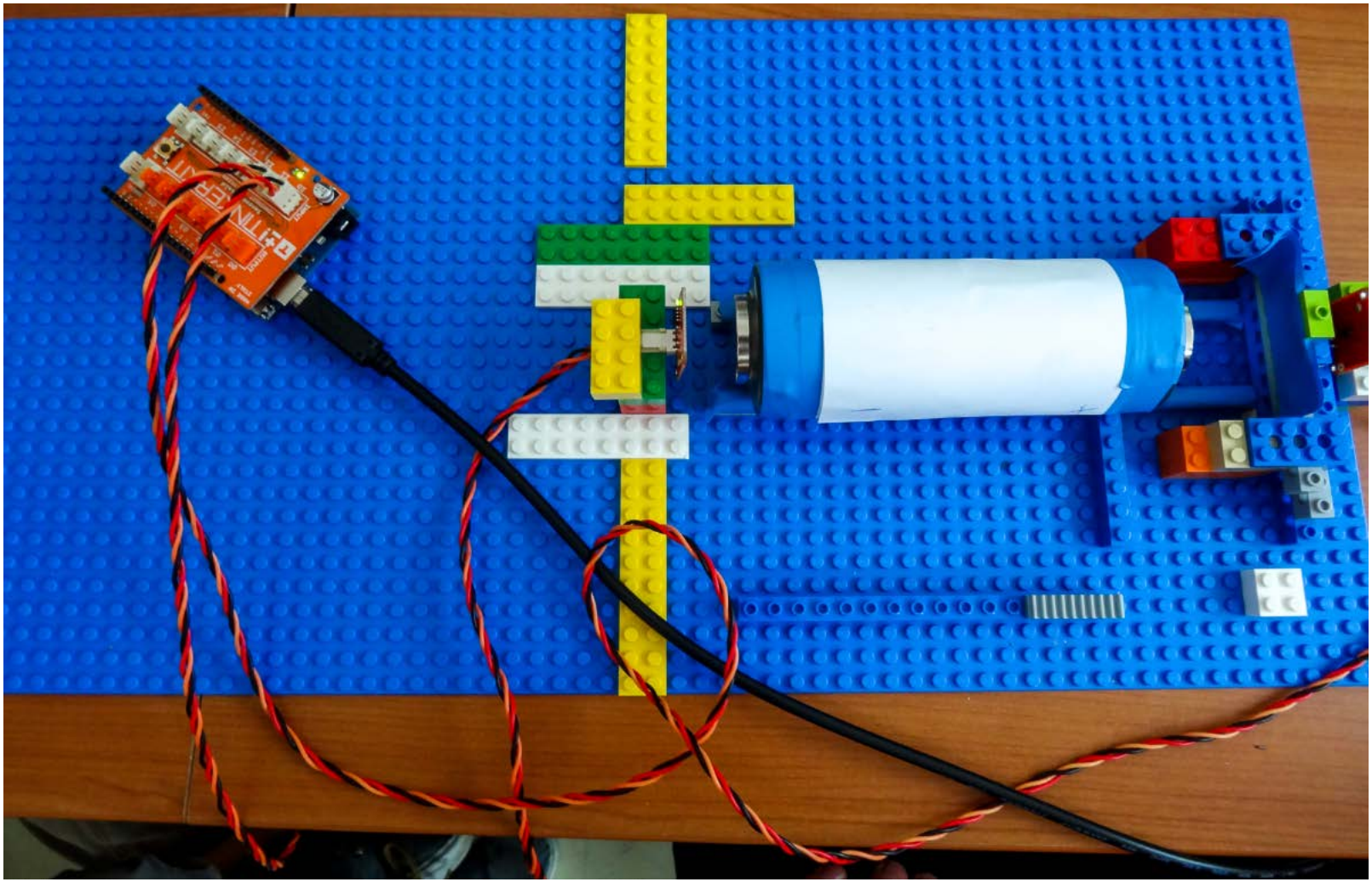
- SD capacity
- Wifi, Ethernet, …
- Motor control
- Audio

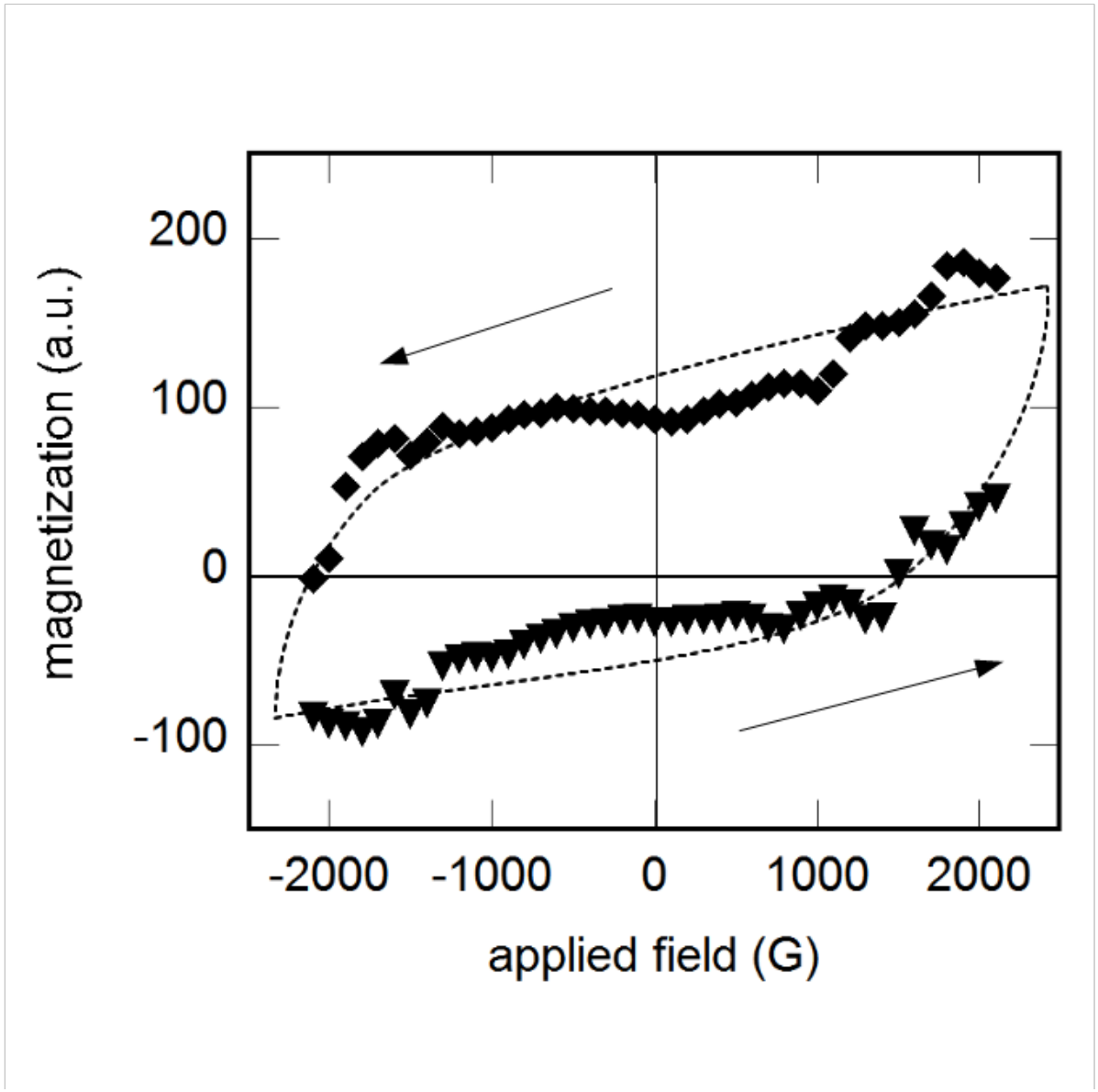
How to use Arduino in a classroom

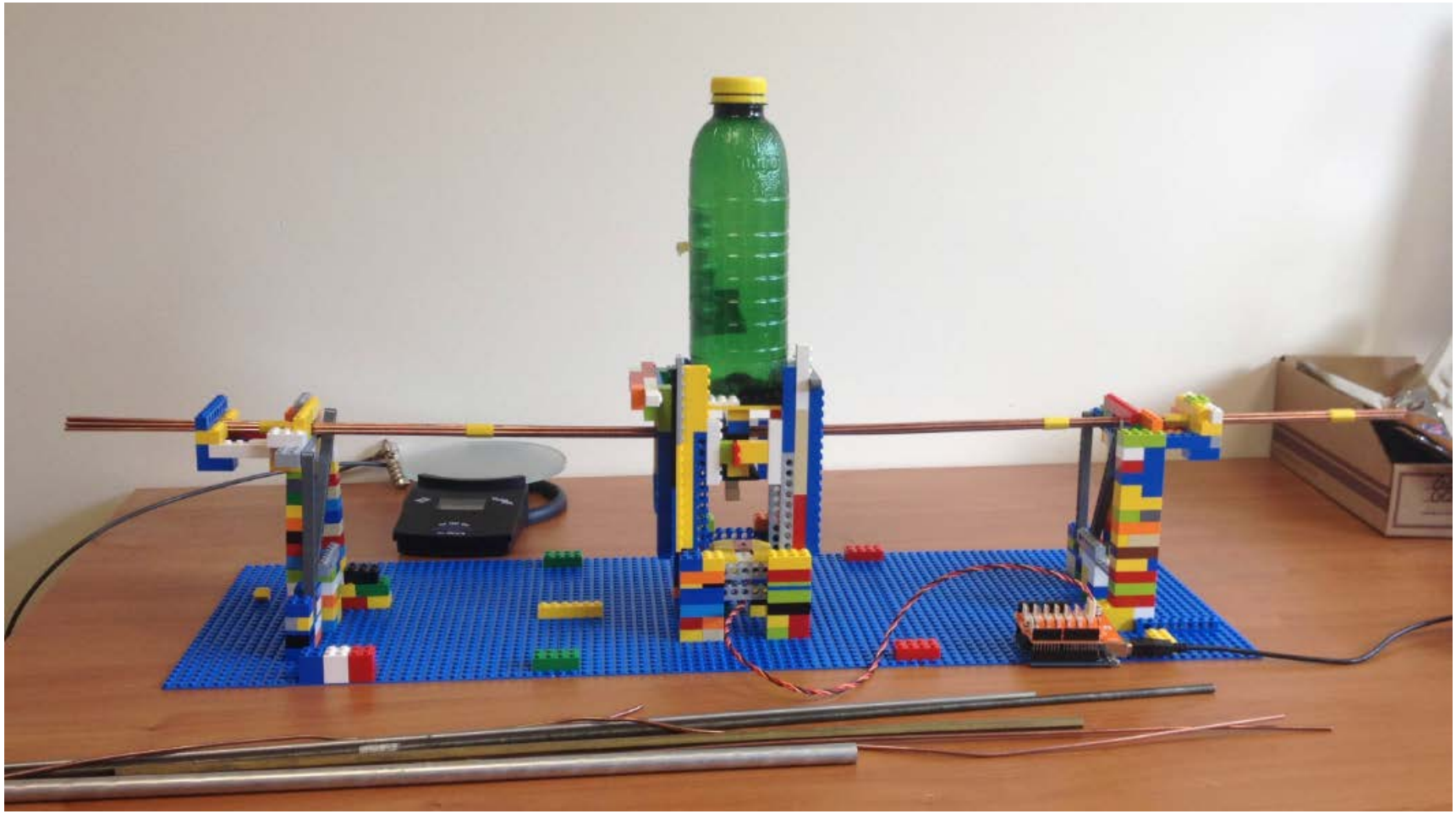
- Low cost students’ labs
- Students’ labs outside of the classroom
- PBL

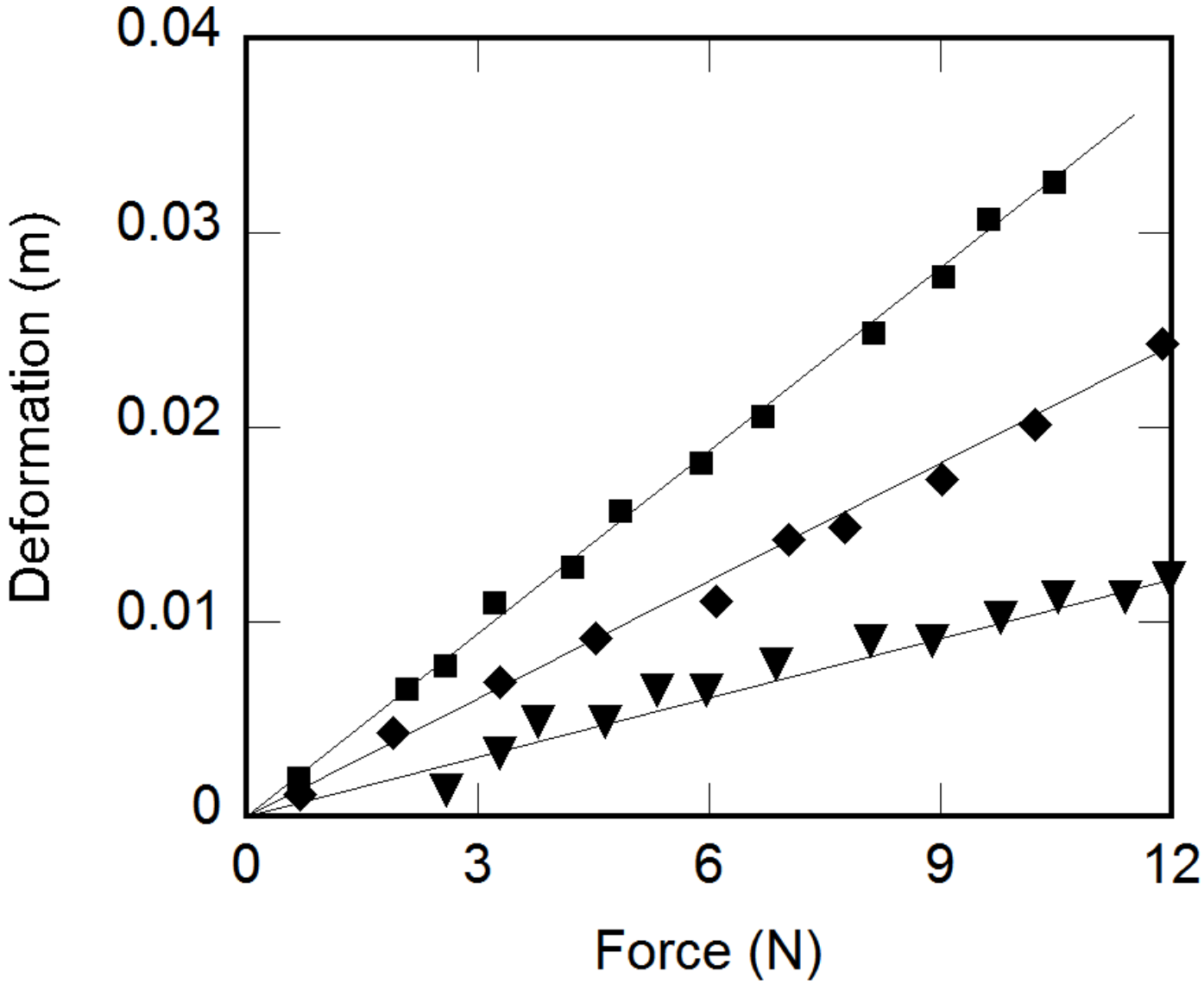







magnetization (a.u.)
200
100
0
-100
-2000
-1000
0
1000
2000
applied field (G)




0.04
0.03
0.02
0.01
0
Deformation (m)
0
3
6
9
12
Force (N)