Technology understanding

MODULE 1

Agenda (4h25min workshop)

- 9.00 - 9.15 Welcome
- 9.15 - 11.30 Workshop
- 11.30 - 12.20 Lunch
- 12.20 - 12.30 Presentation of EUC Syd
- 12.30 - 14.00 Workshop
- 14.00 - 14.30 Coffee and refreshments
- 14.30 - 15.50 Workshop
- 15.50 - 16.00 Have a nice evening and see you tomorrow

Link to the materials

http://www.teknologiskolen.dk/technology-understanding-workshop/

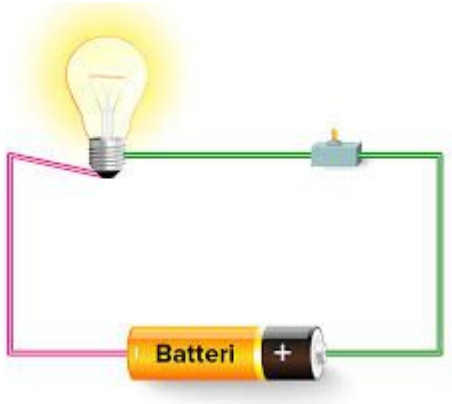
Basic Circuit Understanding

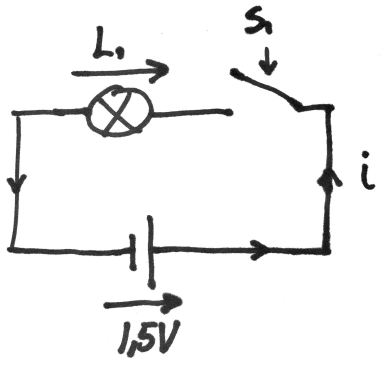
Where do we normally start

How do we connect?

What is + and - and Ground/GND

How does the current flow





Names and Units

Voltage (U) - Volt

Current (I) - Ampere

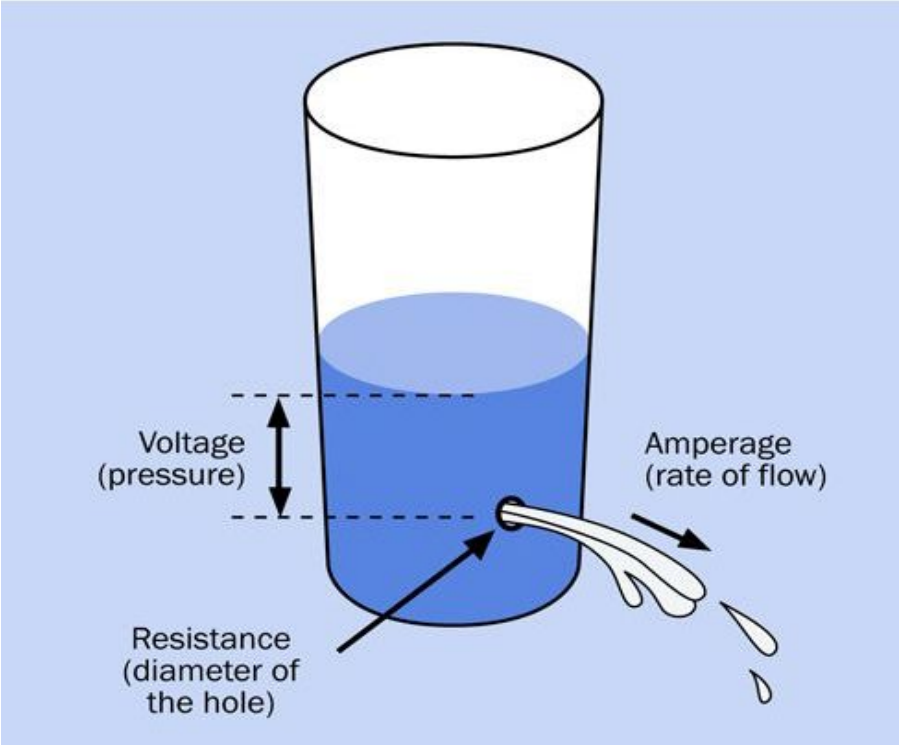
Resistance (R) - Ohm

Supply (Vcc)

Ground (GND)

Assumption: The current flows from the highest potential + 5V to the lowest GND

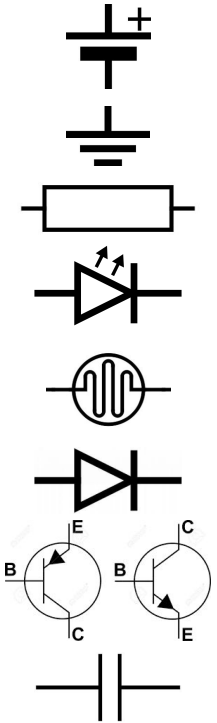
Water analogy

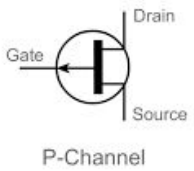


from Make:Electronics

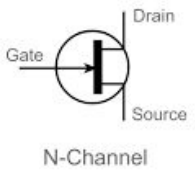
The main components and symbols

- Power supply / Battery
- GND
- Resistor
- Light Emitting Diode (LED)
- Light-dependent resistor
- Diode
- Transistor (BJT + FET)
- Capacitor



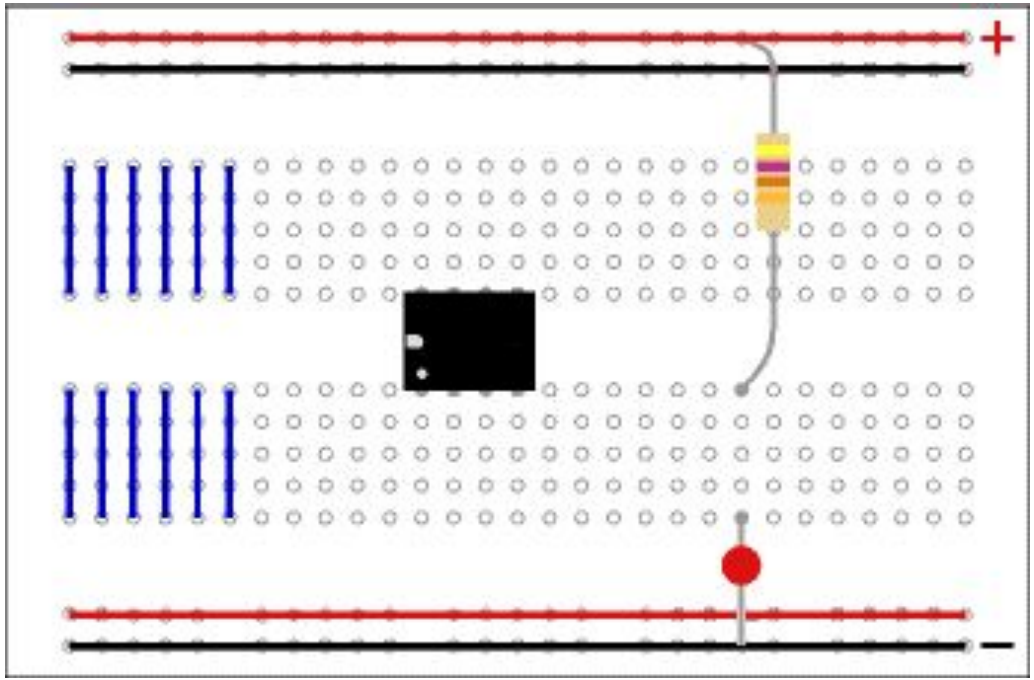


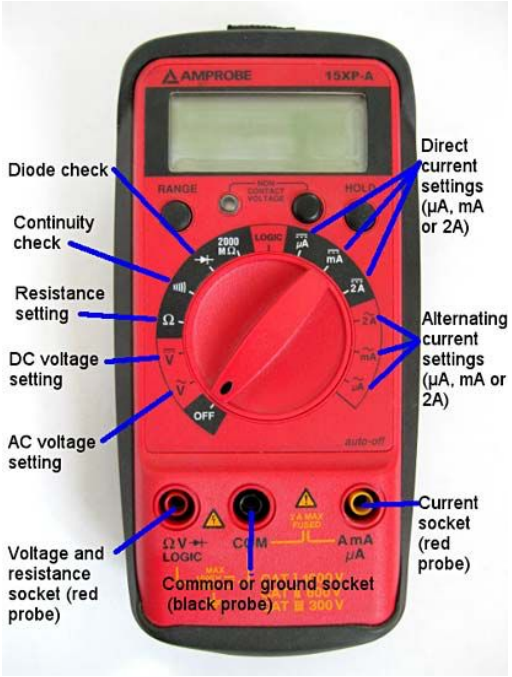
P-Channel



N-Channel

Indispensable tools





And the digital ones

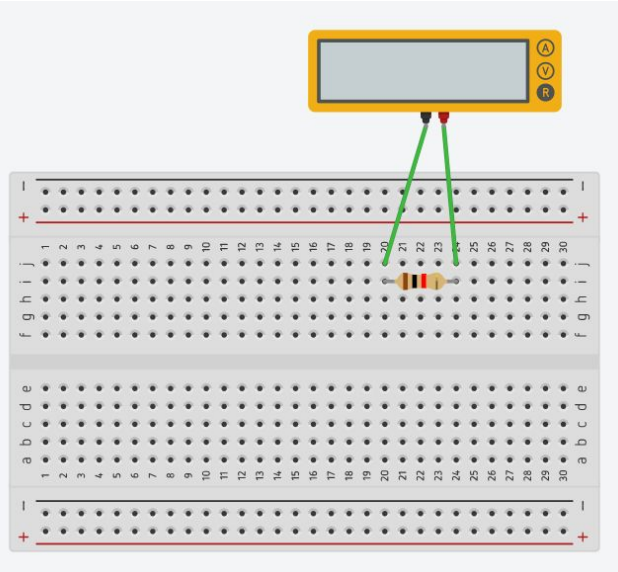
- Autodesk Education
  - https://www.autodesk.com/education/free-software/featured
- Autodesk **TinkerCAD**
  - https://www.tinkercad.com

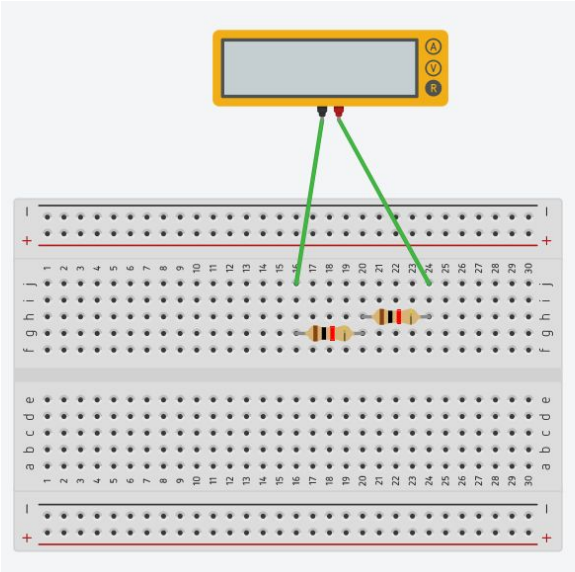
A great tool to try some things out when the equipment / components are not available.

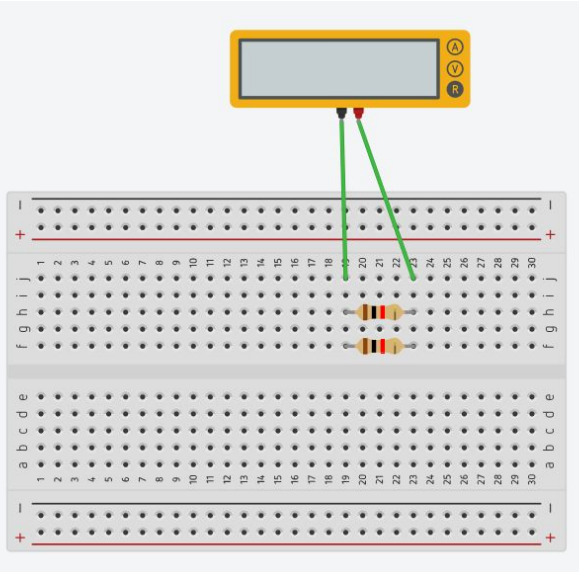
Task 1

Build these 3 circuits in TinkerCAD and measure the resistance with the “multimeter”.

Then build the circuits in “real life” and check with a real multimeter.







Basic rules for current and voltage

Applies to circuits that do not accumulate charge, e.g. without capacitors

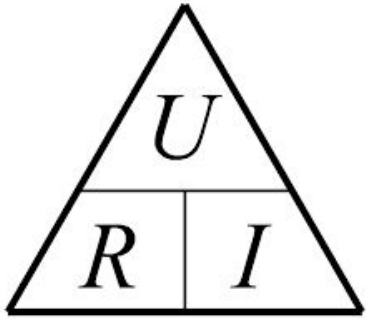
Wikipedia: https://da.wikipedia.org/wiki/Kirchhoffs_love_(elektriske_kredsløb)

- The sum of currents flowing into a node is equal to the sum of currents flowing out of that node
- The directed sum of the potential differences (voltages) around any closed loop is zero.

Ohms Law

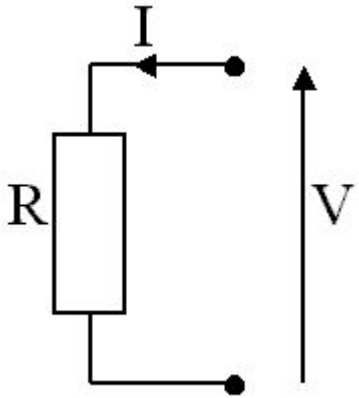
- U = I * R

  Voltage = Current * Resistance



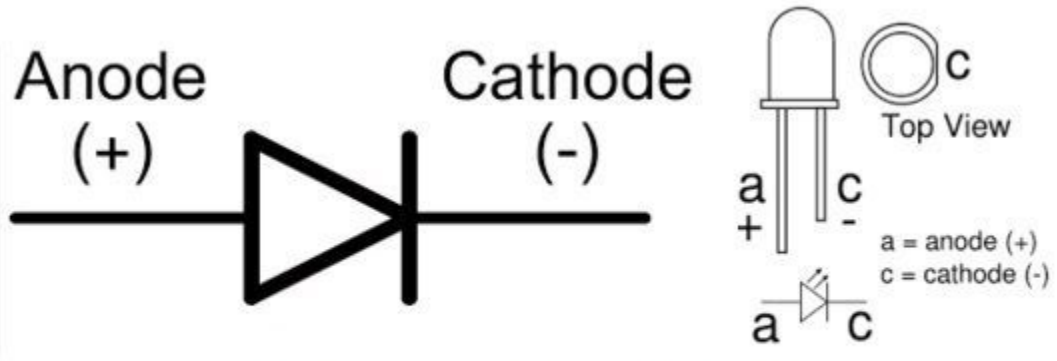
- Electrical Power:

  P = U * I



LED

Rectifier - Does not light if oriented incorrectly

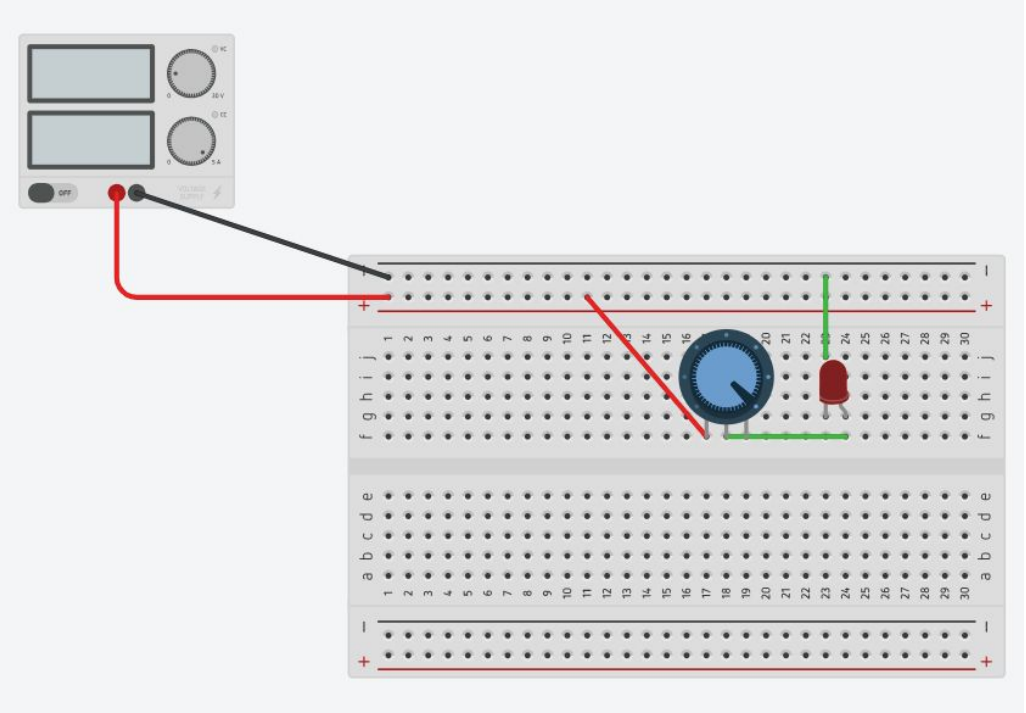


Build in TinkerCAD

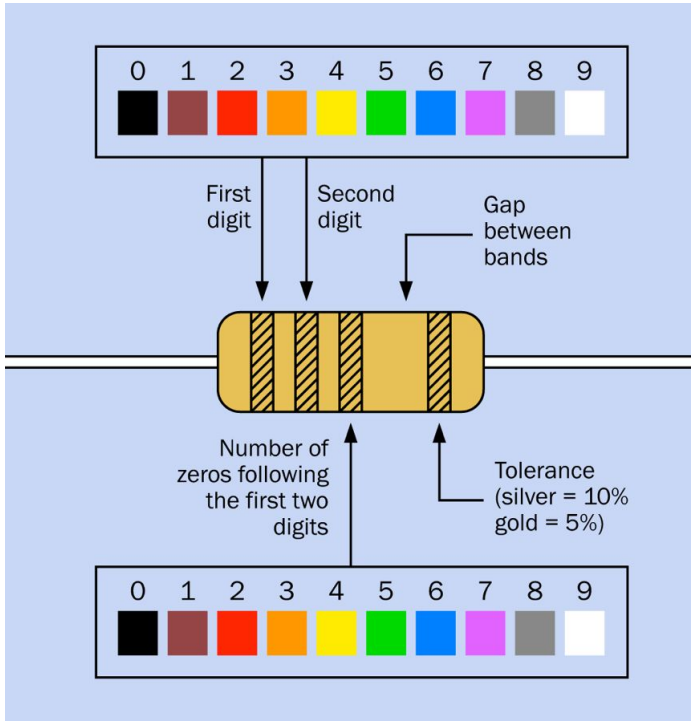
Set power supply to 5V

Set the Potentiometer to 5KOhm

Try to start the simulation and gently turn to the left on the potentiometer.



Color codes for resistors

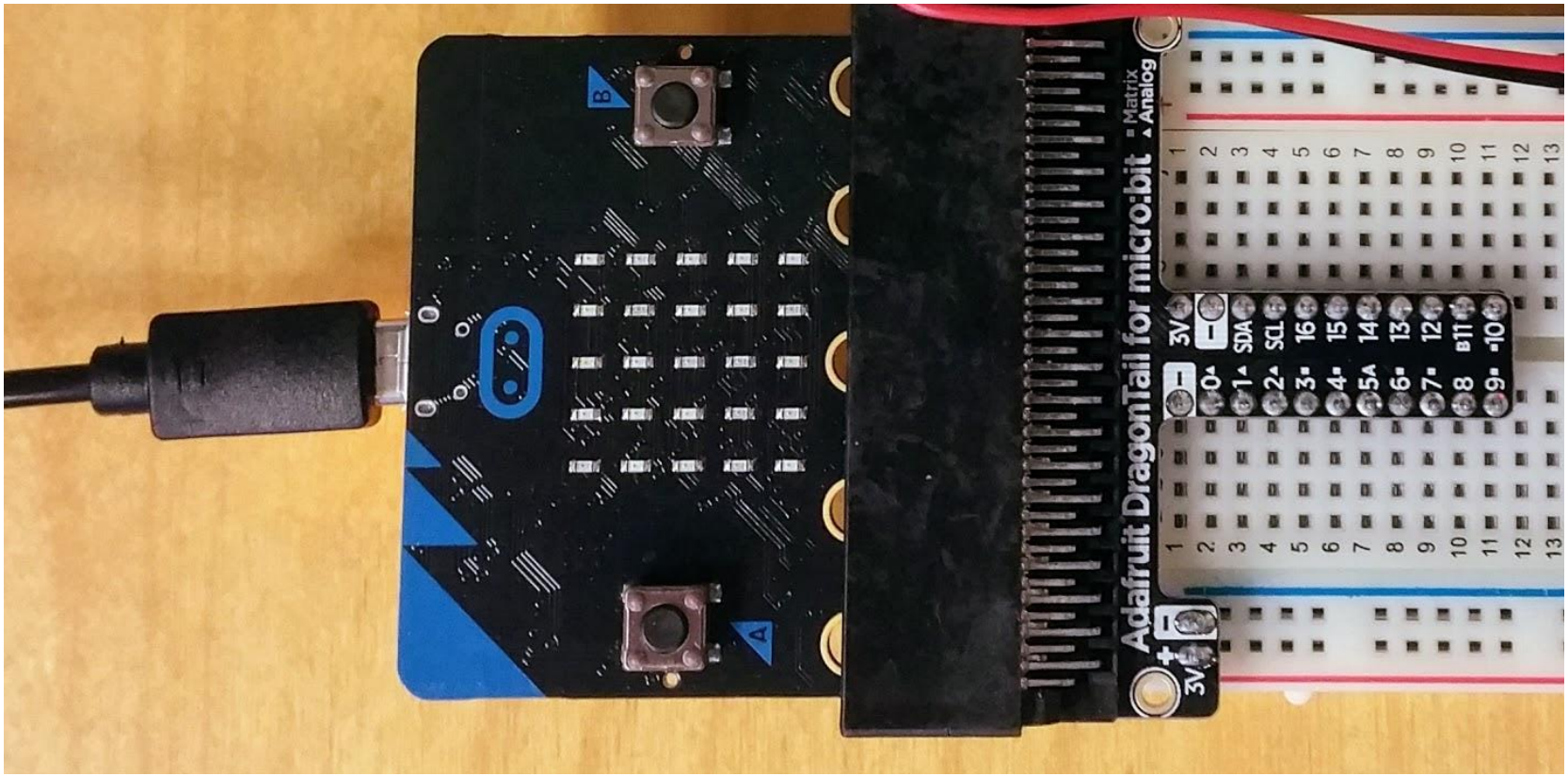


Task 2: Current limiting resistor for an LED

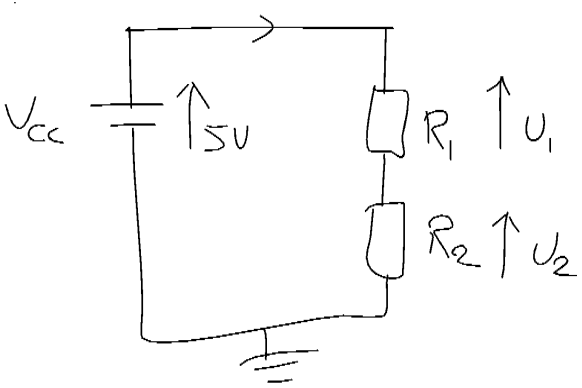
We have a 3.3V power supply available and need an LED to illuminate our home-built robot car. Most LEDs cannot withstand 3.3V, so we have to put in a resistor that shares the supply voltage with our LED.

a) Draw a circuit diagram with an LED + a current limiting resistor at 3.3V supply voltage. Draw current and voltage arrows.
b) A standard LED typically uses 20mA at approx. 2V - View data sheet: http://www.us.kingbright.com/images/catalog/SPEC/WP7113SRD-D.pdf. Use Ohm's law to calculate the size of the resistor, in order to comply with this.
c) Build the circuit and check that voltage and current match what you calculated. Use the MicroBit as supply for your circuit.

micro:bit and breadboard



Serieforbindelse



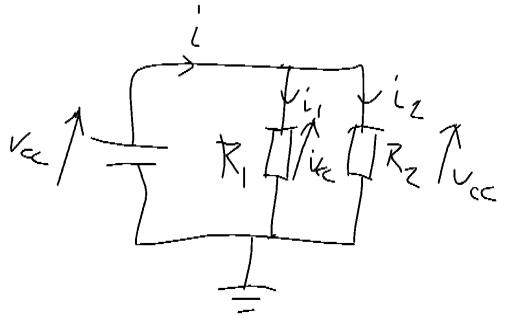
$$U_1 + U_2 = V_{cc}$$

Spændingsdeling:

$$U_1 = V_{cc} \cdot \frac{R_1}{R_1 + R_2}$$

$$U_2 = V_{cc} \cdot \frac{R_2}{R_1 + R_2}$$

Parallelforbindelse



$$R_{TOT} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

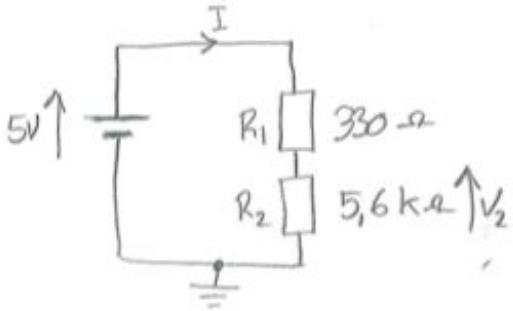
$$I_1 = \frac{V_{cc}}{R_1} \qquad I_2 = \frac{V_{cc}}{R_2}$$

$$I = I_1 + I_2$$

$$I = \frac{V_{cc}}{R_{TOT}}$$

Opgave 3:
Modstande i serie

a)

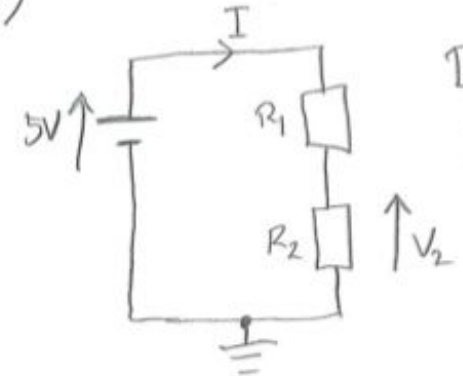


Beregn den samlede modstand

Beregn strømmen, I

Beregn spændingen, V_2

b)

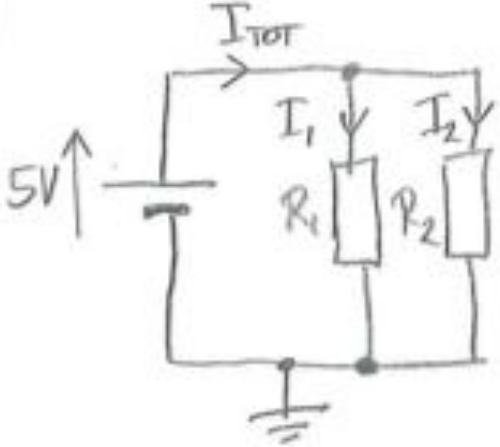


Beregn R_1 og R_2, således at

$I = 20\,mA$ og $V_2 = 3{,}3V$

Opgave 4: Modstande i parallel

c)



Hvad er den samlede modstand, når:

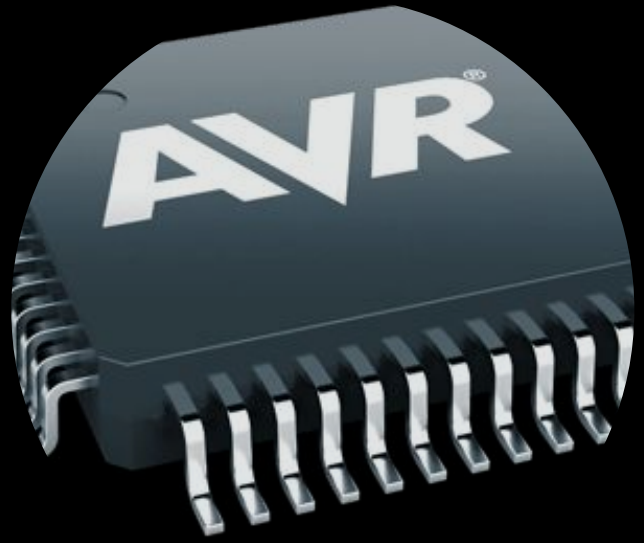
1: $R_1 = R_2 = 3{,}9\,k\Omega$?

2: $R_1 = 3{,}9\,k\Omega$, $R_2 = 1{,}8\,k\Omega$

3: $R_1 = 1\,M\Omega$, $R_2 = 100\,\Omega$

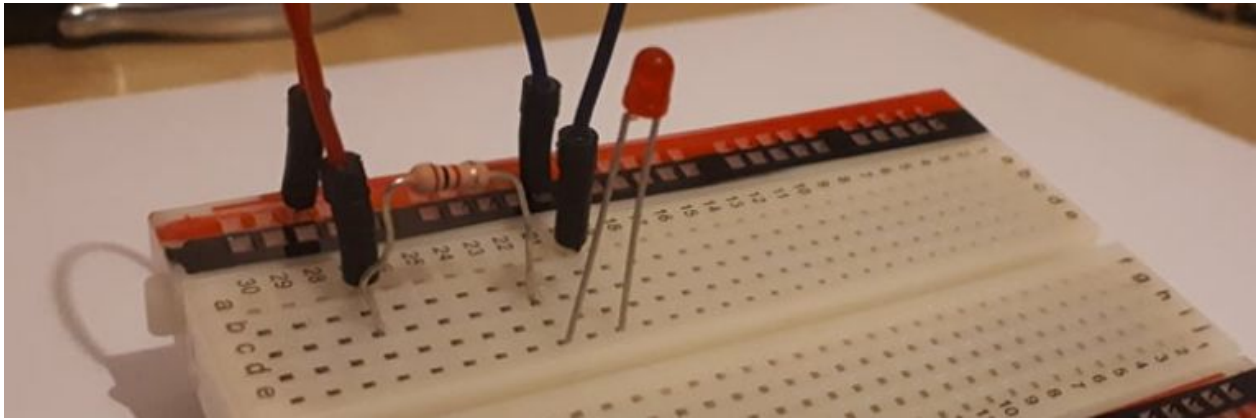
Beregn I_1 og I_2 i alle 3 ovenstående tilfælde.

Breadboard (extended)

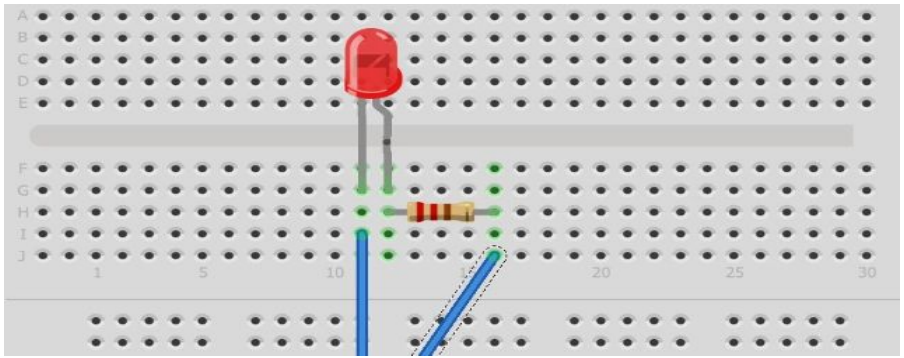


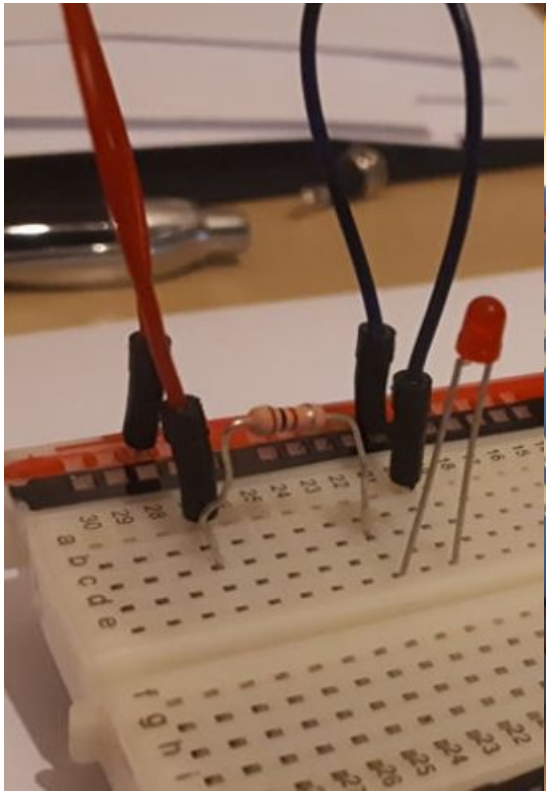
- Traditional and Fritzing
- New breadboard cover-plate
- New intermediate diagrams

Traditional diagram

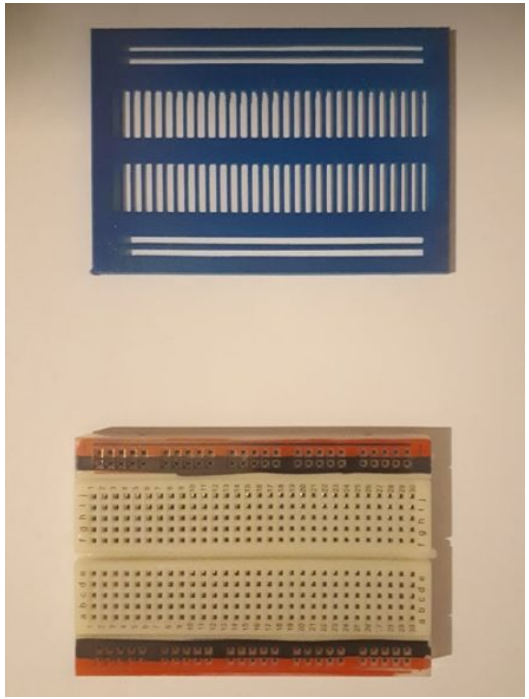


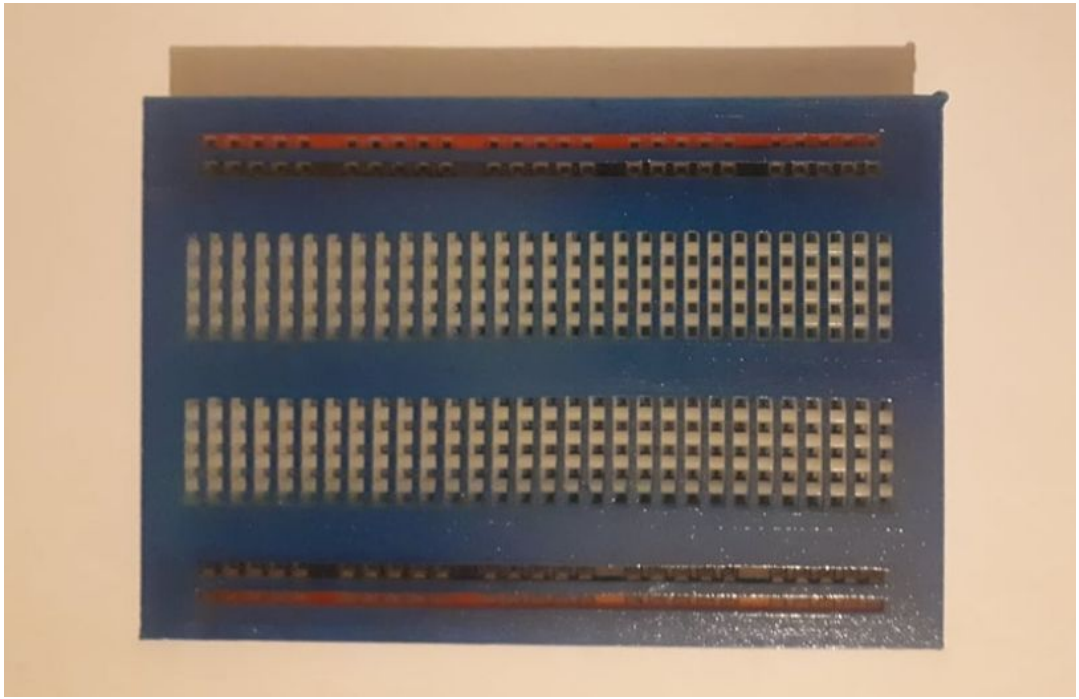
Fritzing diagram



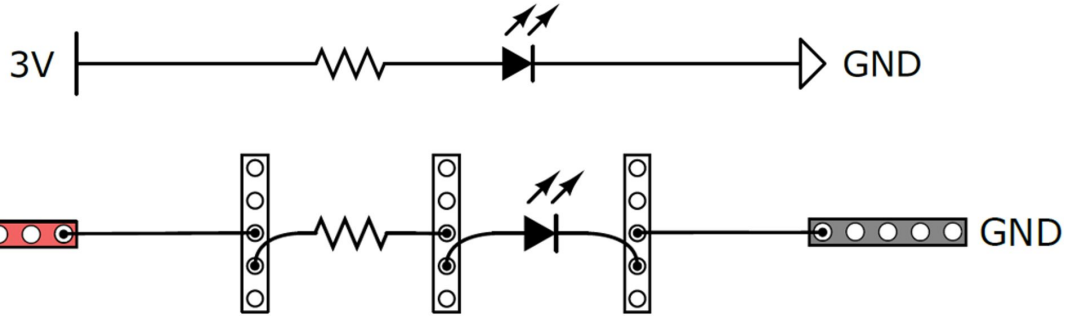


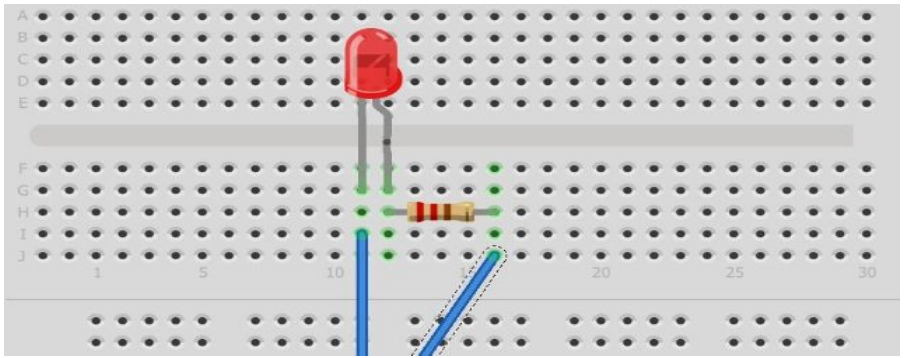
Breadboard cover-plate

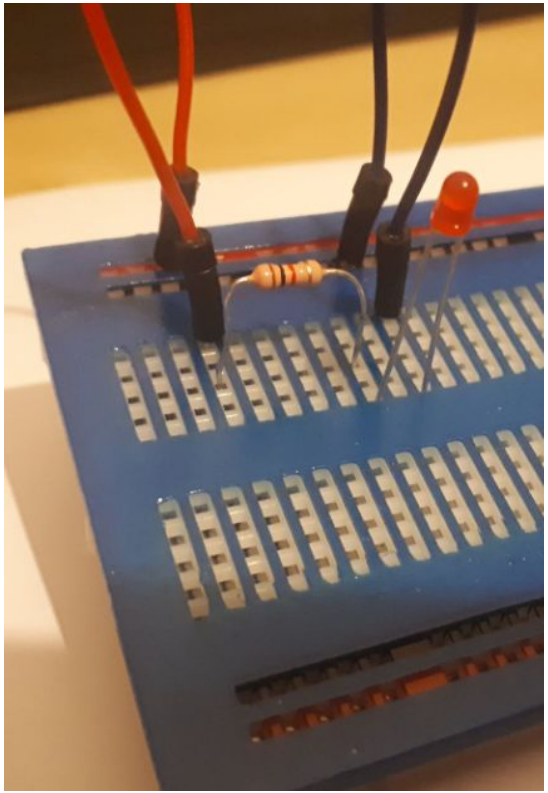




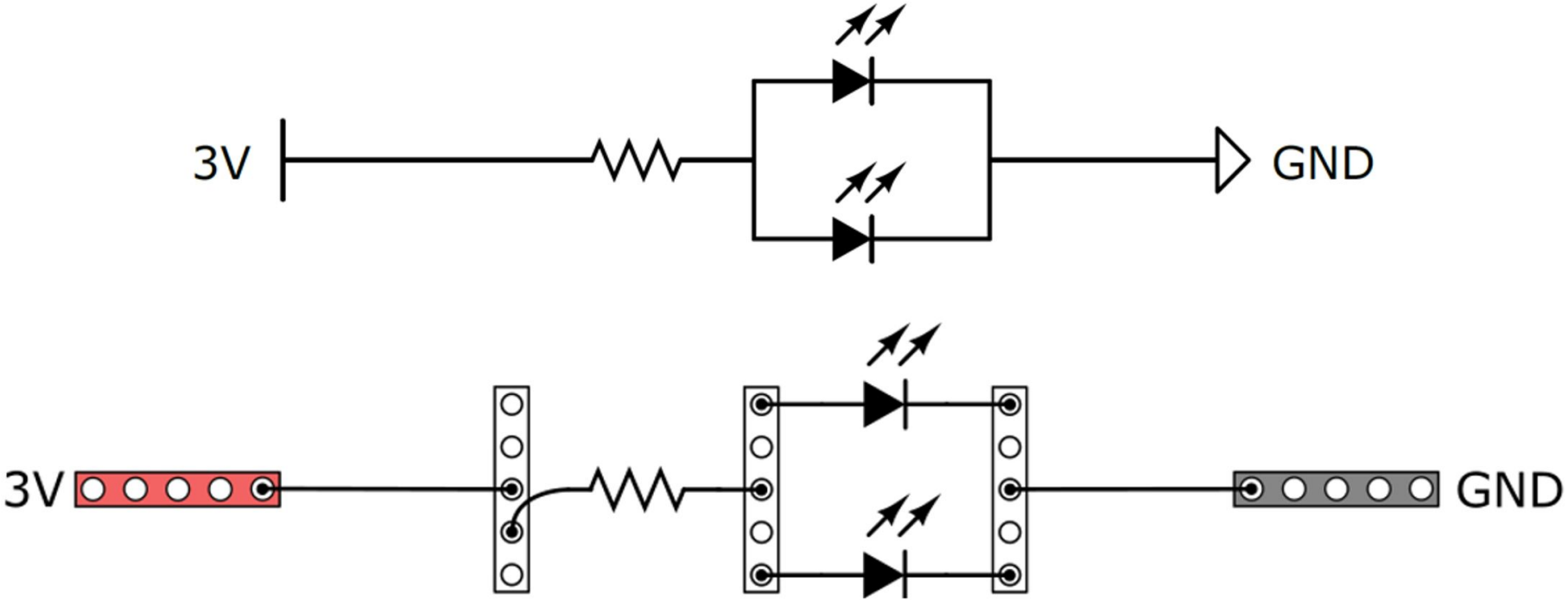
Intermediate diagram



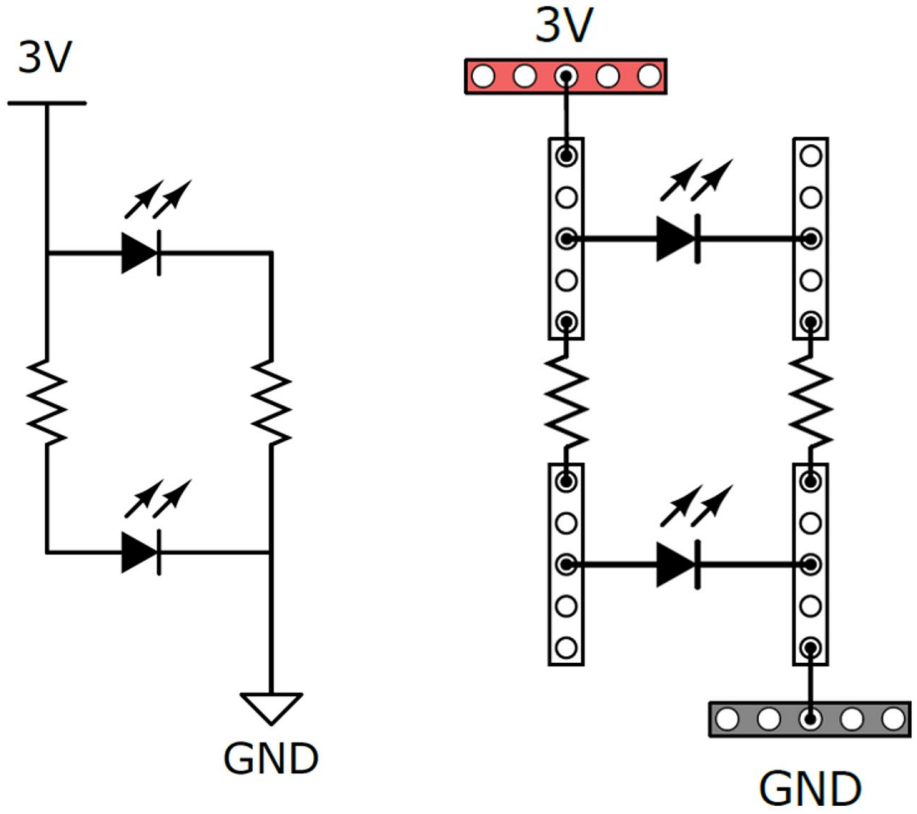




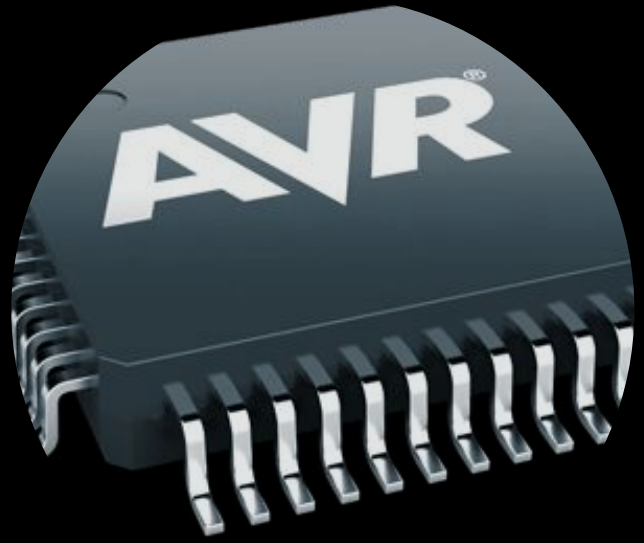
Intermediate diagram



Intermediate diagram

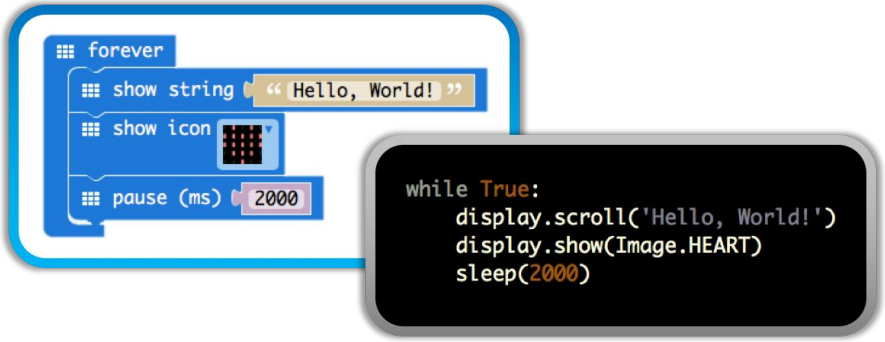


The Microcontroller



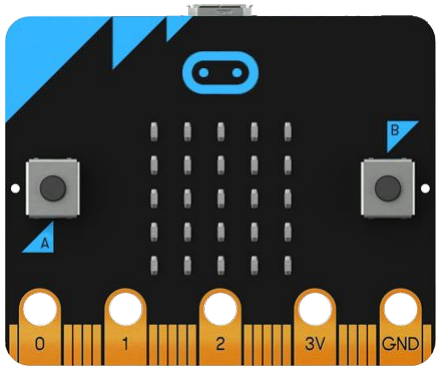
Intro to the micro:bit

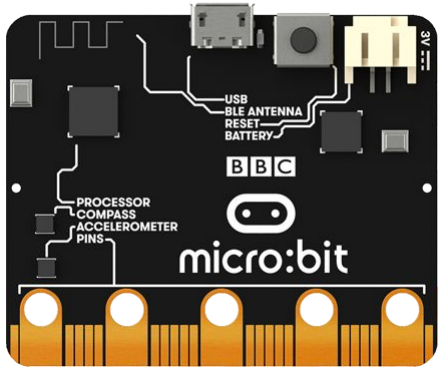
Micro: bit is a microcontroller platform that can be programmed with Microsoft Makecode, Javascript, Python, Scratch, Arduino, etc.

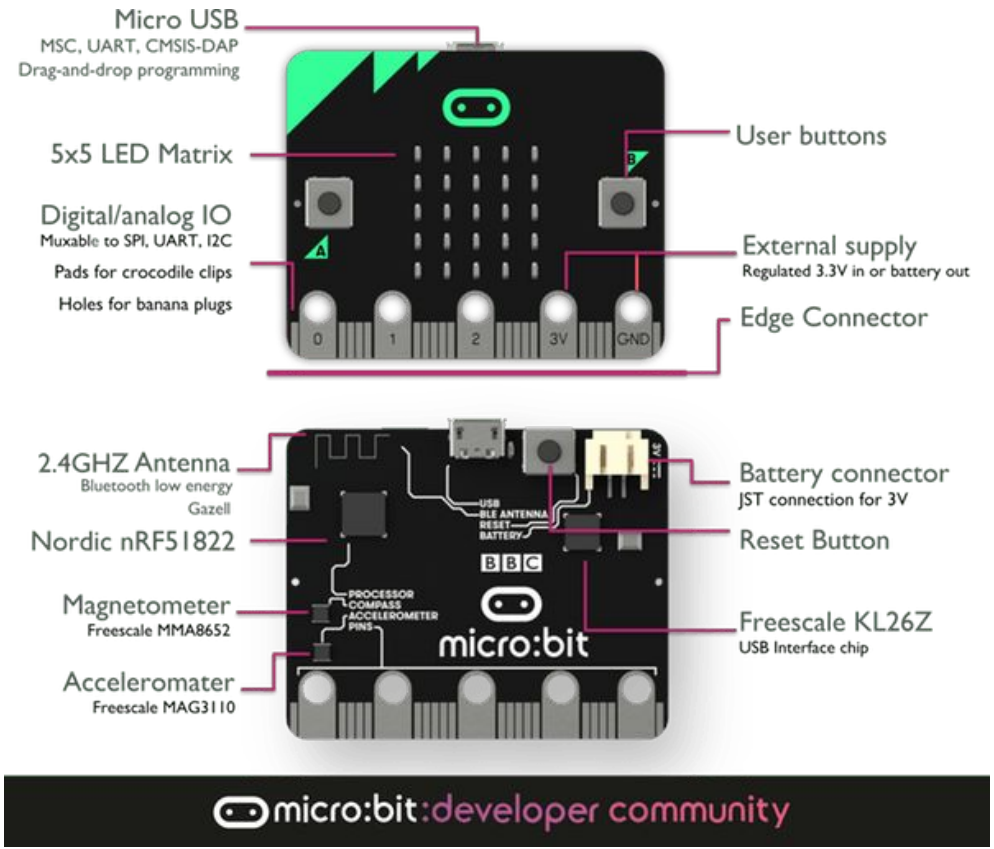


It includes both sensors and actuators

- Compass, Accelerometer, "Temperature", "Light", Buttons
- LED Matrix
- Bluetooth and USB






Micro USB
MSC, UART, CMSIS-DAP
Drag-and-drop programming
5x5 LED Matrix
Digital/analog IO
Muxable to SPI, UART, I2C
Pads for crocodile clips
Holes for banana plugs
User buttons
External supply
Regulated 3.3V in or battery out
Edge Connector
0
1
2
3V
GND
2.4GHZ Antenna
Bluetooth low energy
Gazell
Nordic nRF51822
Magnetometer
Freescale MMA8652
Acceleromater
Freescale MAG3110
Battery connector
JST connection for 3V
Reset Button
Freescale KL26Z
USB Interface chip
USB
BLE ANTENNA
RESET
BATTERY
BBC
PROCESSOR
COMPASS
ACCELEROMETER
PINS
micro:bit

Intro to the micro:bit

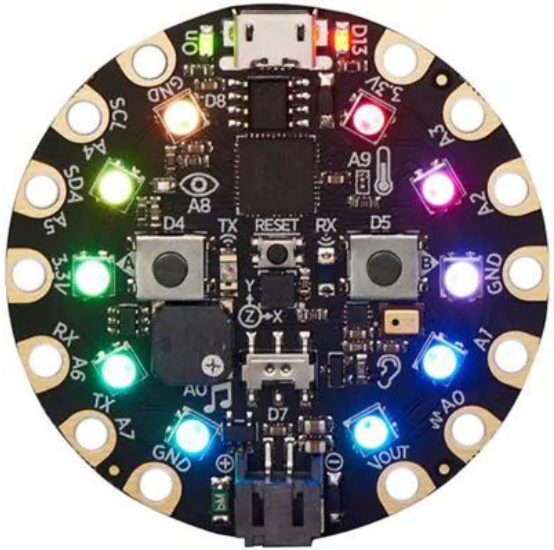
Good for Computational Thinking:

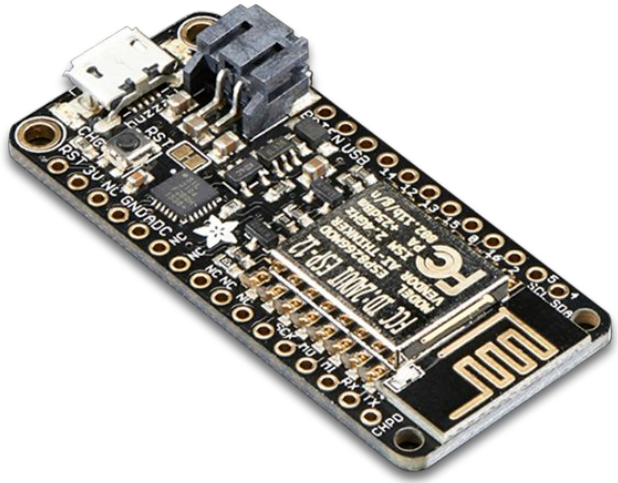
“The thought process involved in formulating a problem and expressing its solution(s) in such a way that a computer—human or machine—can effectively carry it out”

Not that good for Engineering -

Unless you add something**:**

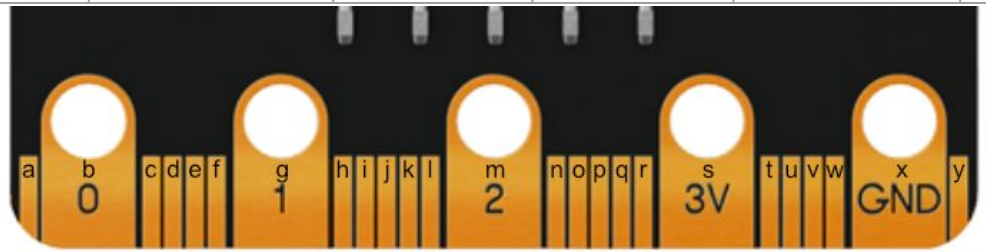
Differences / similarities



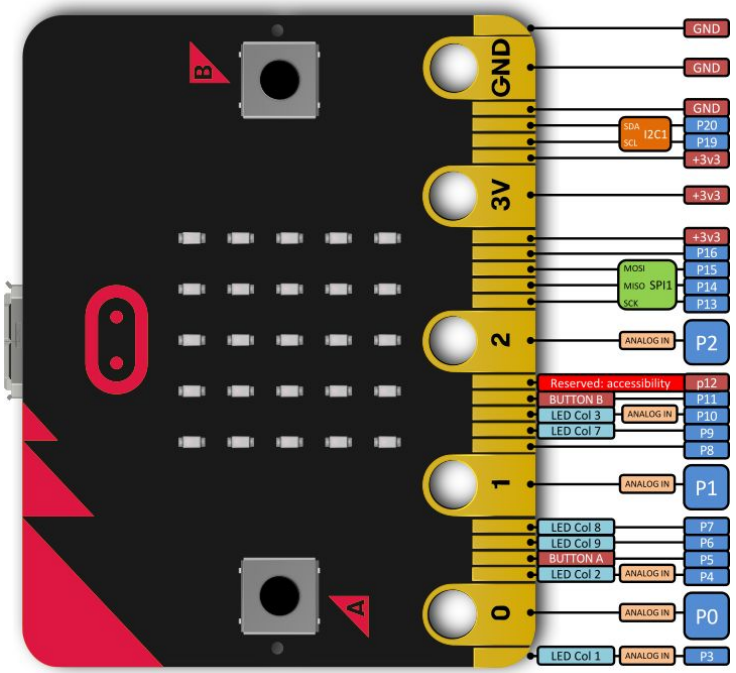


Comparison

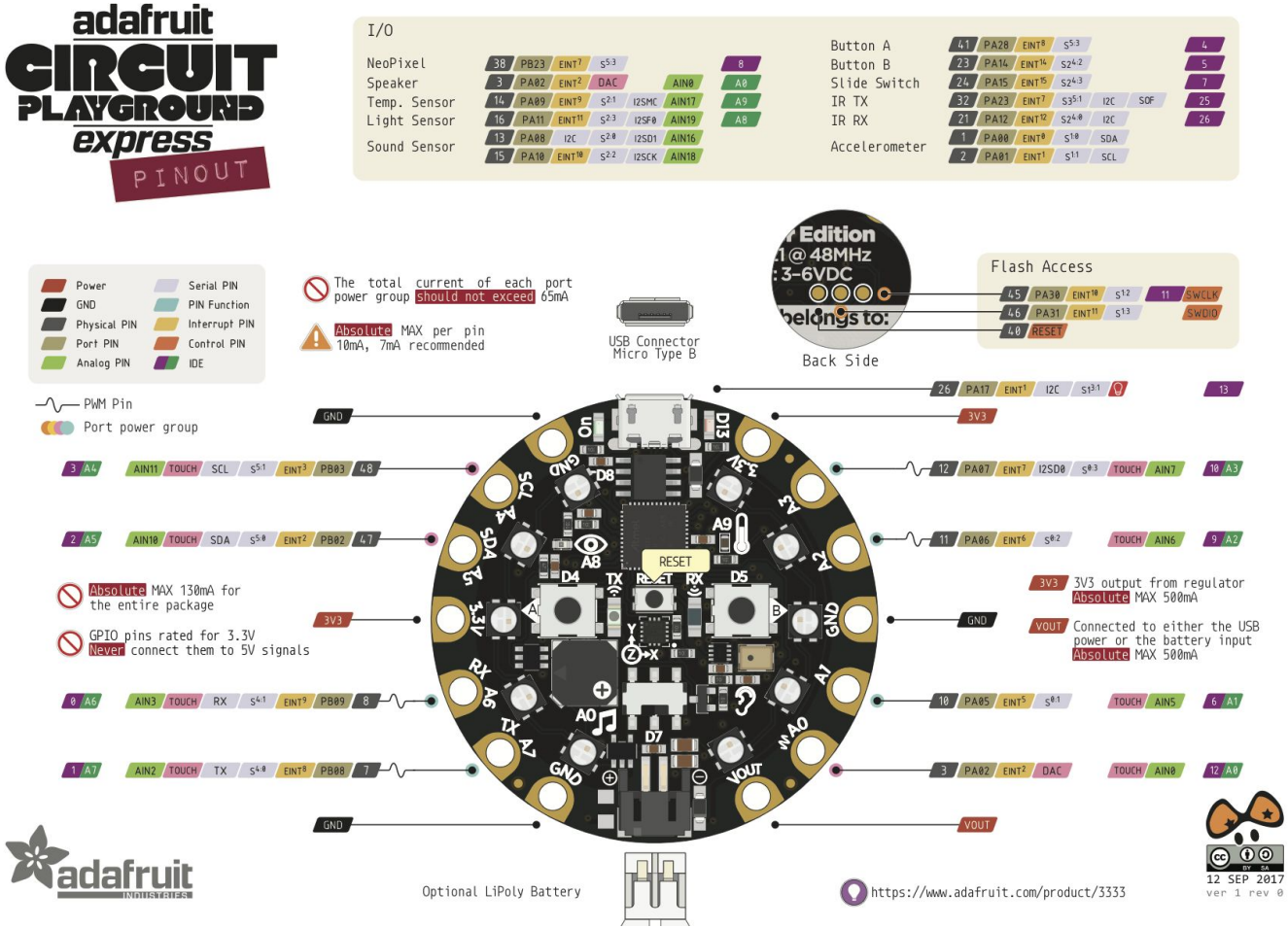
Platform	Digital Ports	Analog Ports	Serial UART	I2C	SPI
Arduino Uno	0 - 13	A0 - A5	0 - RX 1 - TX	SCL SDA	17 - MOSI 18 - MISO 19 - SCK
Microbit (a - y)	P0 - P20 (- P12, P17 og P18) a - k, m - q, u, v	a - c, g, j, m	Soft Serial kan opsættes på P-porte	u - SCL v - SDA	n - SCK o - MISO p - MOSI
Circuit Playground Express	A0 - D12, A1 - D6, A2 - D9, A3 - D10, A4 - D3, A5 - D2, A6 - D0, A7 - D1	A0 - A7	A6 - RX A7 - TX	A4 - SCL A5 - SDA	Used internally.



Microbit

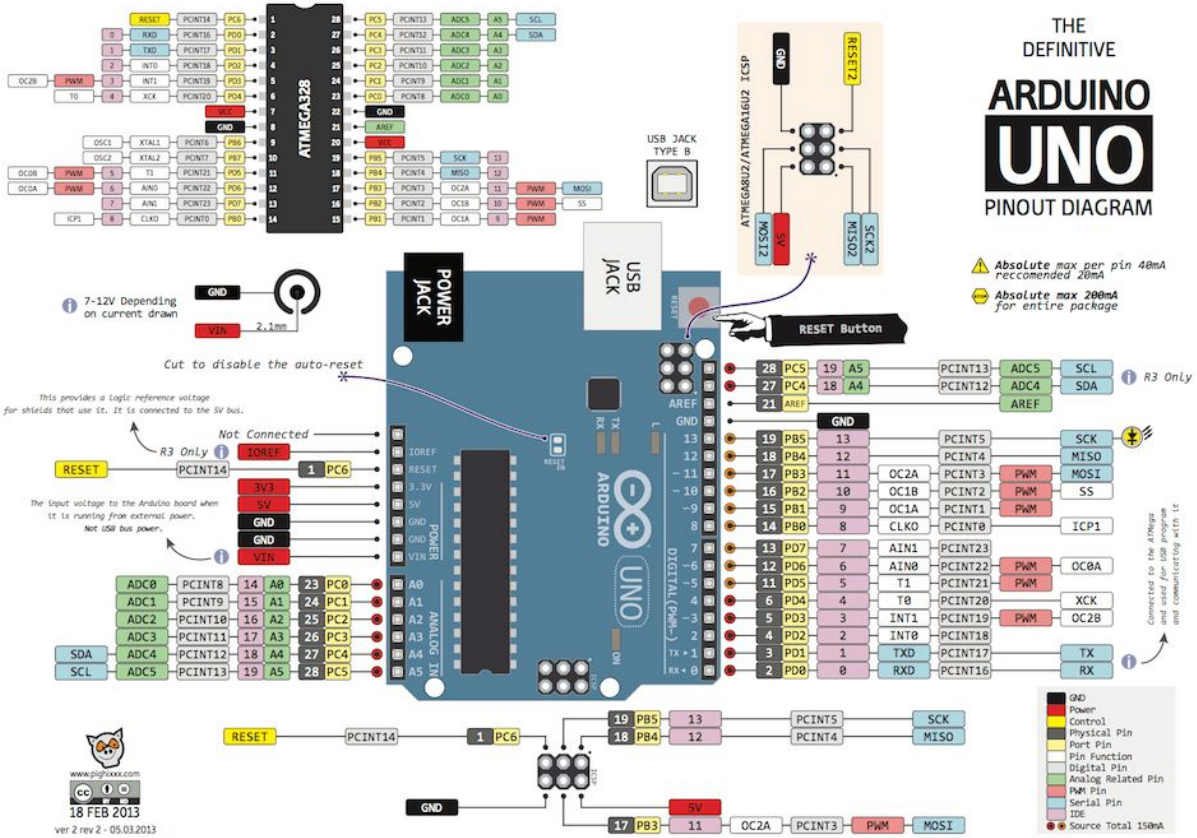


https://microbit.org/guide/hardware/pins

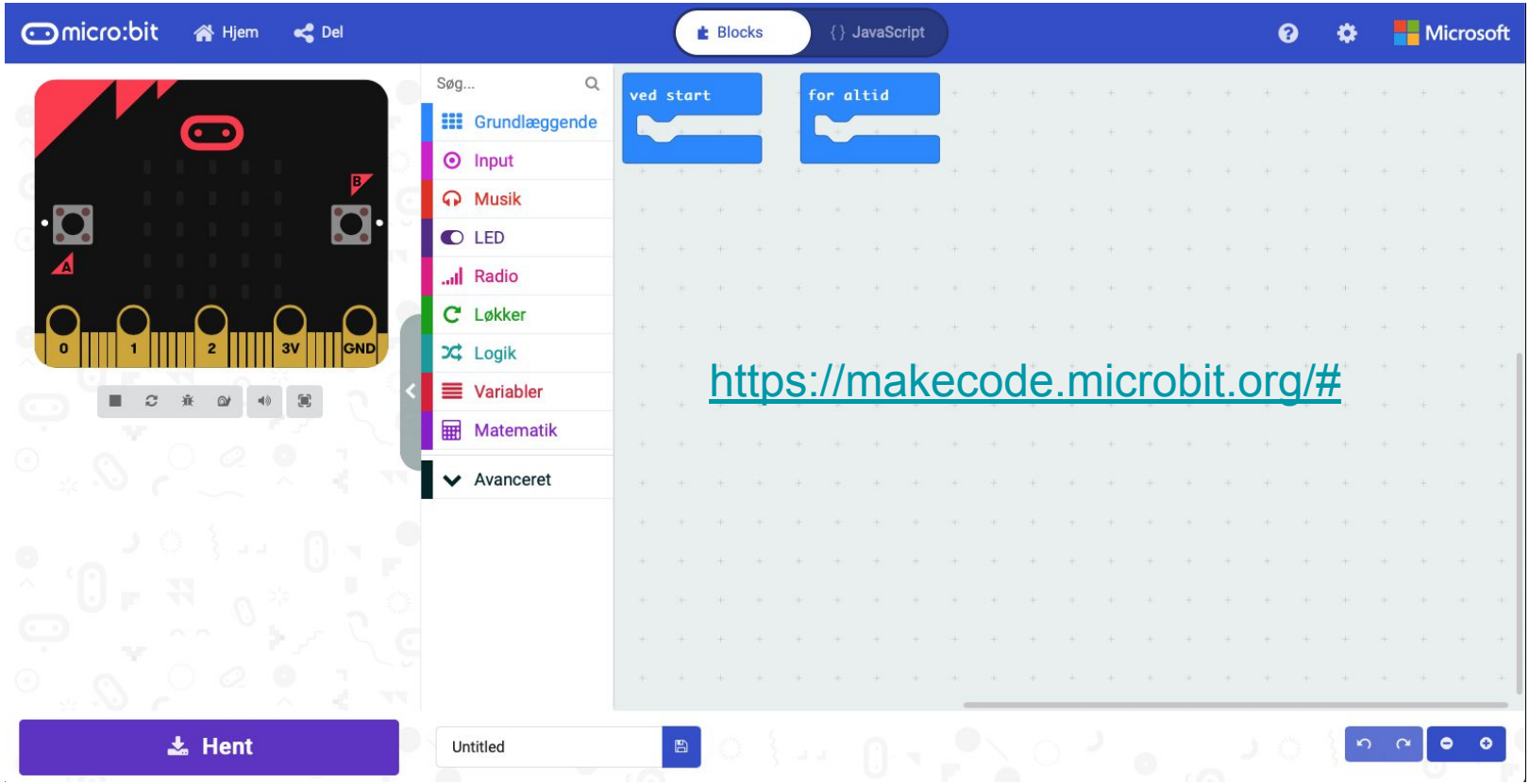


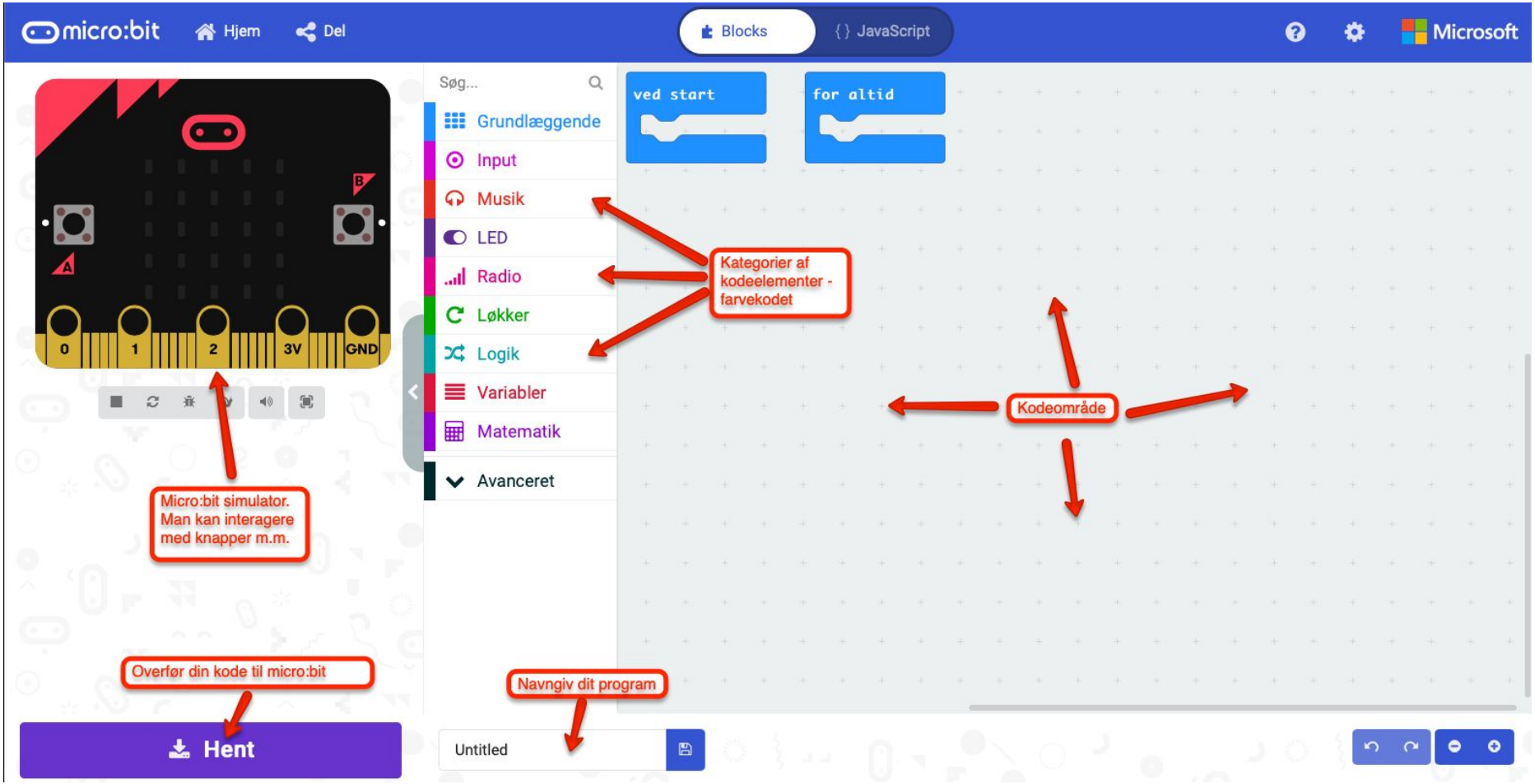
https://learn.adafruit.com/adafruit-circuit-playground-express/pinouts

Arduino UNO


THE
DEFINITIVE
ARDUINO
UNO
PINOUT DIAGRAM
ATMEGA328
ATMEGA8U2/ATMEGA16U2 ICSP
USB JACK TYPE B
POWER JACK
USB JACK
RESET Button
7-12V Depending on current drawn
Cut to disable the auto-reset
Not Connected
R3 Only
The Input voltage to the Arduino board when it is running from external power.
Not USB bus power.
Absolute max per pin 40mA reccomended 20mA
Absolute max 200mA for entire package
Connected to the ATMega and used for USB program and communicating with it
GND
Power
Control
Physical Pin
Port Pin
Pin Function
Digital Pin
Analog Related Pin
PWM Pin
Serial Pin
IDE
Source Total 150mA
18 FEB 2013
ver 2 rev 2 - 05.03.2013

Intro til Makecode

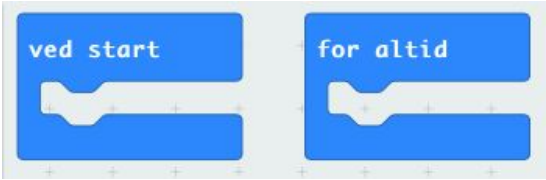



micro:bit
Hjem
Del
Blocks
{ } JavaScript
Microsoft
Søg...
Grundlæggende
Input
Musik
LED
Radio
Løkker
Logik
Variabler
Matematik
Avanceret
ved start
for altid
Kategorier af kodeelementer - farvekodet
Kodeområde
Micro:bit simulator. Man kan interagere med knapper m.m.
Overfør din kode til micro:bit
Navngiv dit program
Hent
Untitled

The beginning

“on start”: Code that runs only one time when the program starts.

“forever”: Code that runs all the time in a loop.



Example:

Input

Buttons

Input

Movement

HelloWorld

TASK: Create a program that writes “hello” on the LED-matrix display.

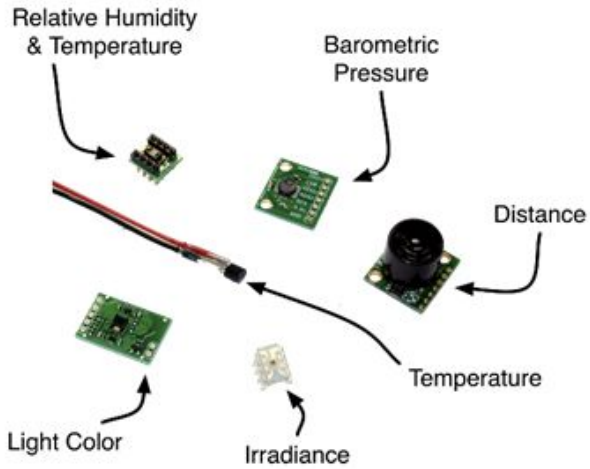
Make suggestions for extensions.

- Buttons?
- Other sensors?

Electronic components

Sensors

- Sense the world
- Measures its physicals surroundings
  - Light
  - Sound
  - Pressure
  - Moisture
  - Movement, etc.
- And translates it to an electrical signal we can read



Essentials regarding sensors

- What is it actually measuring?
- Electric - Voltage / Current / Resistance etc.?
- Resolution?
- Velocity?
- Working boundaries?
- Linearity?
- Sensitivity to noise
- Temperature etc.
- Environment
- Under what physical conditions can one rely on its results?
- Lifetime
- Data sheets !!!

Activity (5min)

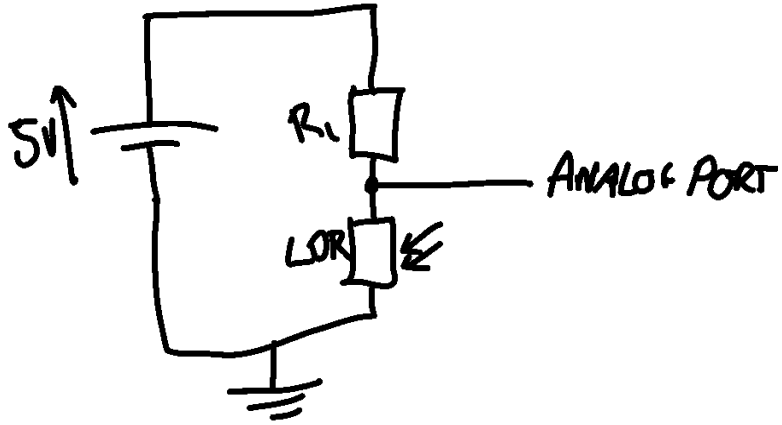
- Locate the data sheet on an LDR (Light-dependent resistor) sensor
  - Try to find answers to as many of the questions from the previous slide as possible.

Various interfaces for the Microcontroller

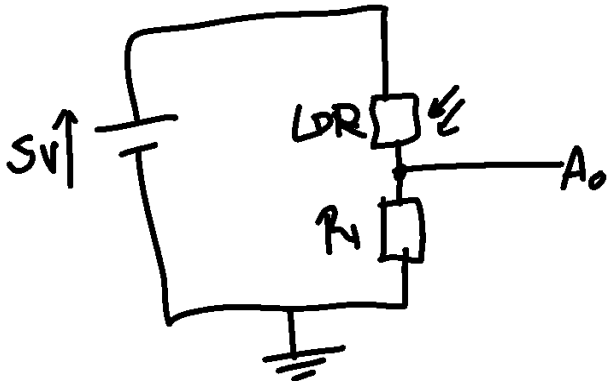
- Digital on/off – digitalRead()
  - Buttons, tilt – others?
- Analog – analogRead()
  - LDR, temperature, movement, force, sound, vibrations etc.
- Pulse Width (PW) – pulseIn()
  - Distance etc.
- Serial
  - RFID, GPS
- Synchrone protocols, I2C og SPI
  - Compas, accelerometer m.m.

Analog – analogRead()

- How do the 2 circuits work?
- LDR-resistor: NSL-19M51 - Find Datasheet!
- Which size should R1 have in the upper and lower case, respectively?



ELLER



Actuators

DC motor

Brushless DC (BLDC)

Speaker

LED

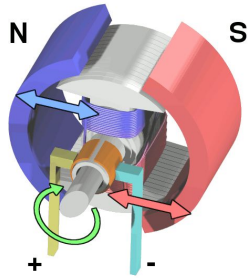
Servomotor

Linear actuator

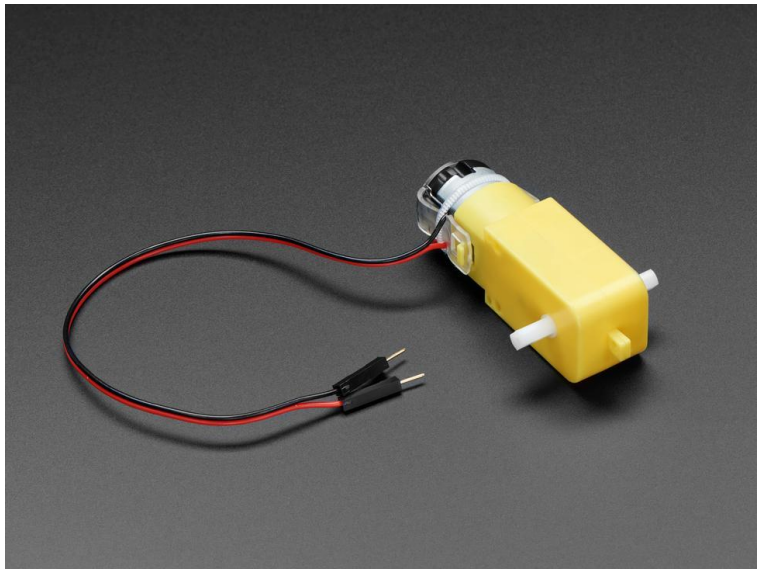
PWM

Most commonly used motors

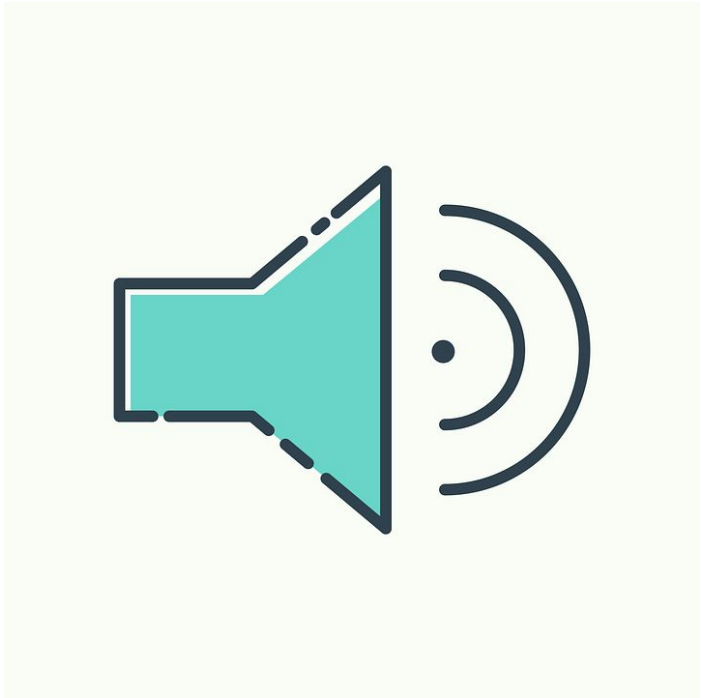
DC motor



- **Most useful when geared down**
- **Slower rotation**
- **Higher torque**

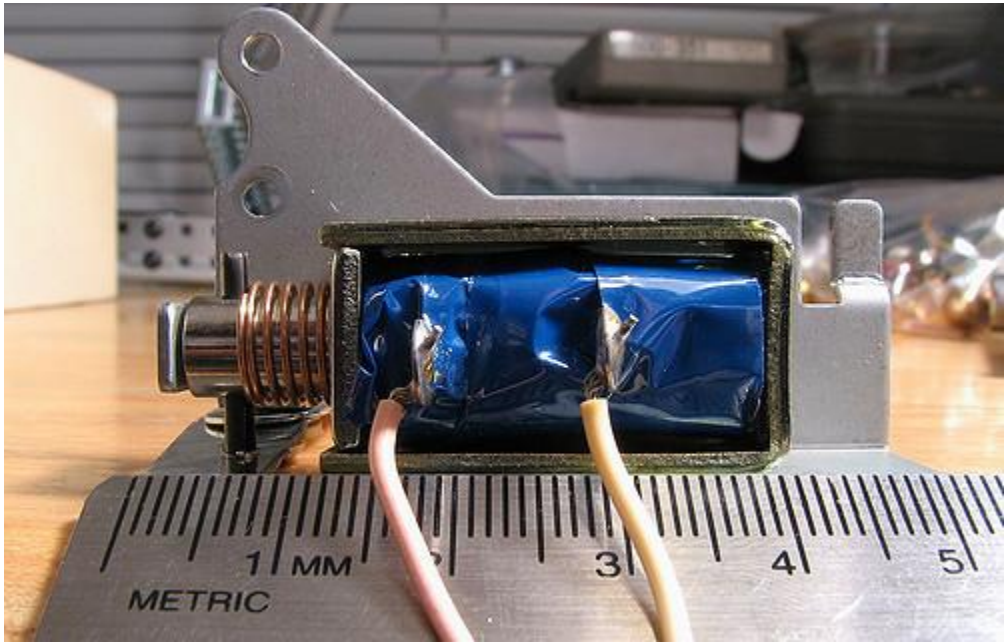


Speaker



Servomotor

Linear Actuator



PWM (Pulse Width Modulation)