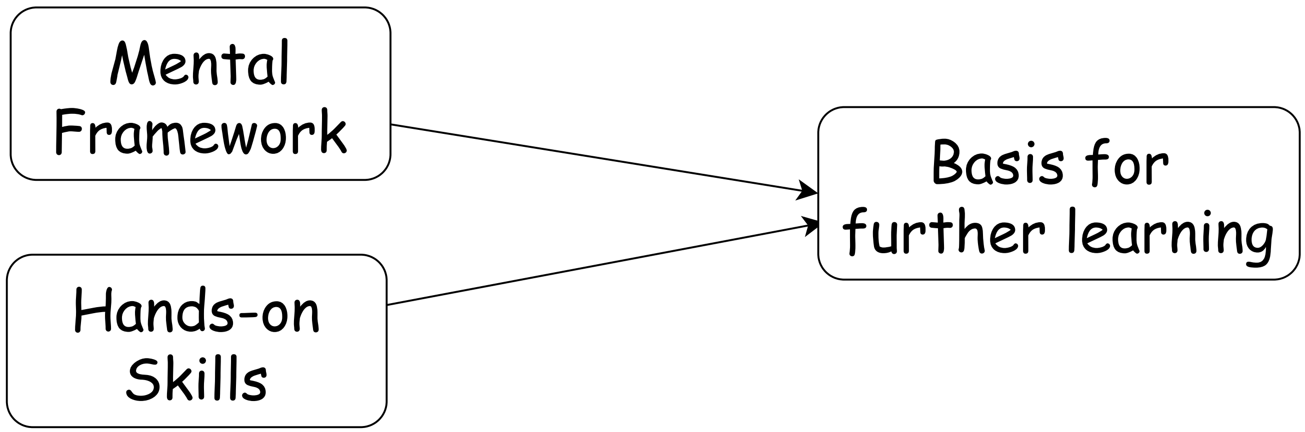
Modular Electronics



The mental framework is vocablulary + concepts.

The main concept is a circuit.

The skills are : using tools, using components and troubleshooting.

Hardware Tools

Power Supply
Digital Voltmeter (DVM)
Solderless Breadboard
Wire strippers
Test cables: banana, alligator, grabber, BNC

Soldering Iron
Oscilloscope

Components

Wire
Resistor
LED
Switch
Potentiometer

Integrated circuits:

Microcontroller (Feather RP2040)
Digital Potentiometer (DS3502)
Input/Output expander (MCP23008)

Components - the bigger picture

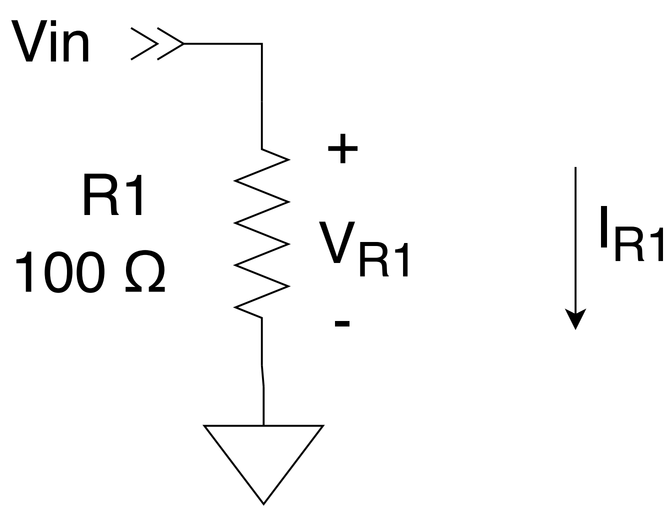
Passive	Active	Integrated circuit
Resistor	Diode	CPU
Capacitor	Light emitting diode	Microcontroller
Inductor	Transistor	Operational Amplifier
		Comparator, Flip-Flop, etc. etc.

Circuits

Open circuit
Short circuit
Single resistor
Voltage divider
LED with current limiting resistor

RP2040 with USB power and comm link
Pullup resistor
RP2040 OUTPUT pin driving external LED
RP2040 OUTPUT pin driving INPUT pin
Switch driving RP2040 INPUT pin

Resistor

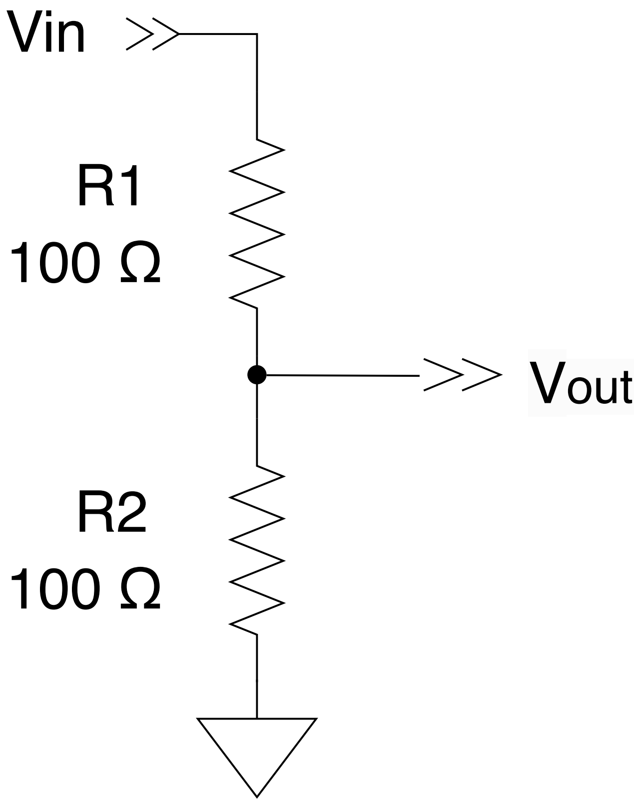


(1) $V_{R1} = I_{R1} \times R$

Draw, then build the circuit.

Discussion and demos:
wire, wire stripping,
Power Supply, cables,
solderless breadboard,
Digital Voltmeter

Resistors (voltage divider)



$$R_{equivalent} = R_{series} = R1 + R2$$

(2) $I = I_{R1} = I_{R2}$ (!!!)

$$I = V_{in} / R_{series}$$

$$V_{R1} = I \times R1$$

$$V_{R2} = I \times R2$$

(3) $V_{R1} + V_{R2} = V_{in}$ (!!!)

$$\boxed{V_{out} = V_{in} - V_{R1}}$$

Draw, build and test the circuit.

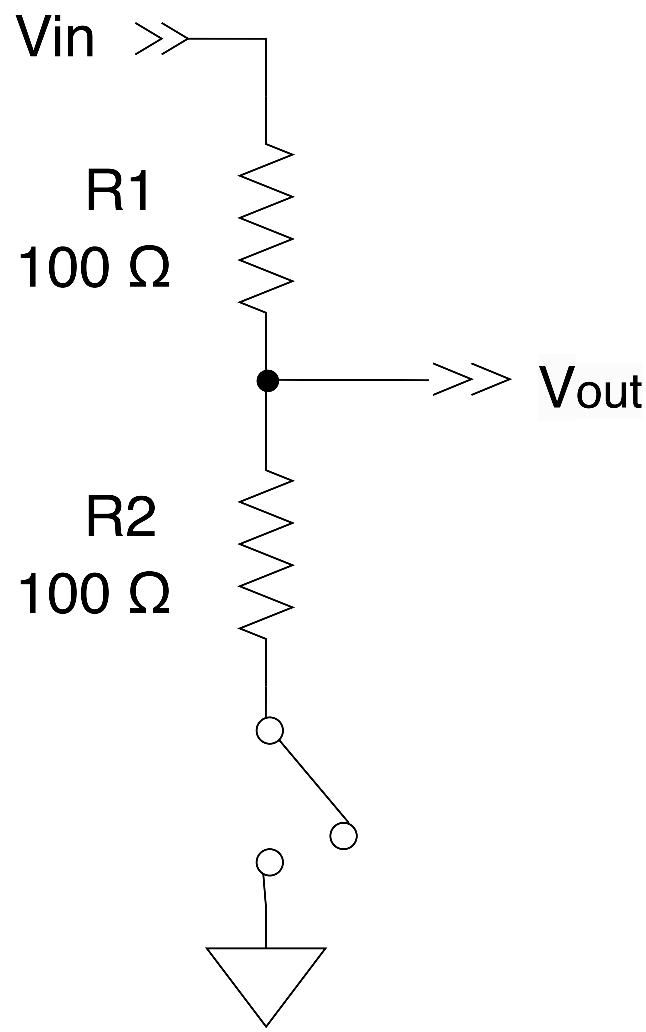
Discussion and demos:
Safety, Troubleshooting
Circuit Analysis

Resistors + switch

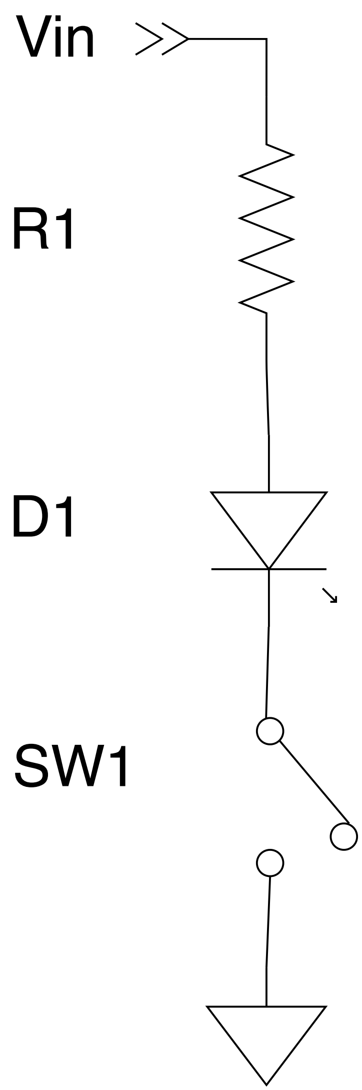
Draw, build and test the circuit,
maybe with different R values.

Discussion:

Buzzing out your switch.
How does the voltage change
when you close the switch?



Resistor + switch + diode



D1 turns on when the voltage across it is greater than ~ 2V.

R1 limits the current through D1.

Reference: Analysis Tools

1. Voltage = Current x Resistance (Ohm's Law)
2. Resistive Power Loss = Voltage x Current
3. Series equivalent resistance: Requiv = R1 + R2 + ...
4. Parallel equivalent resistance: 1/ Requiv = 1/R1 + 1/R2 + ...
5. Current is the same through components in series
6. Voltage is the same across elements in parallel
7. Voltage drops in a series path to ground add up to the voltage at the beginning of the path (Kirchoff's Voltage Law)
8. Currents in parallel paths add up to the current at their common input point (Kirchoff's Current Law)