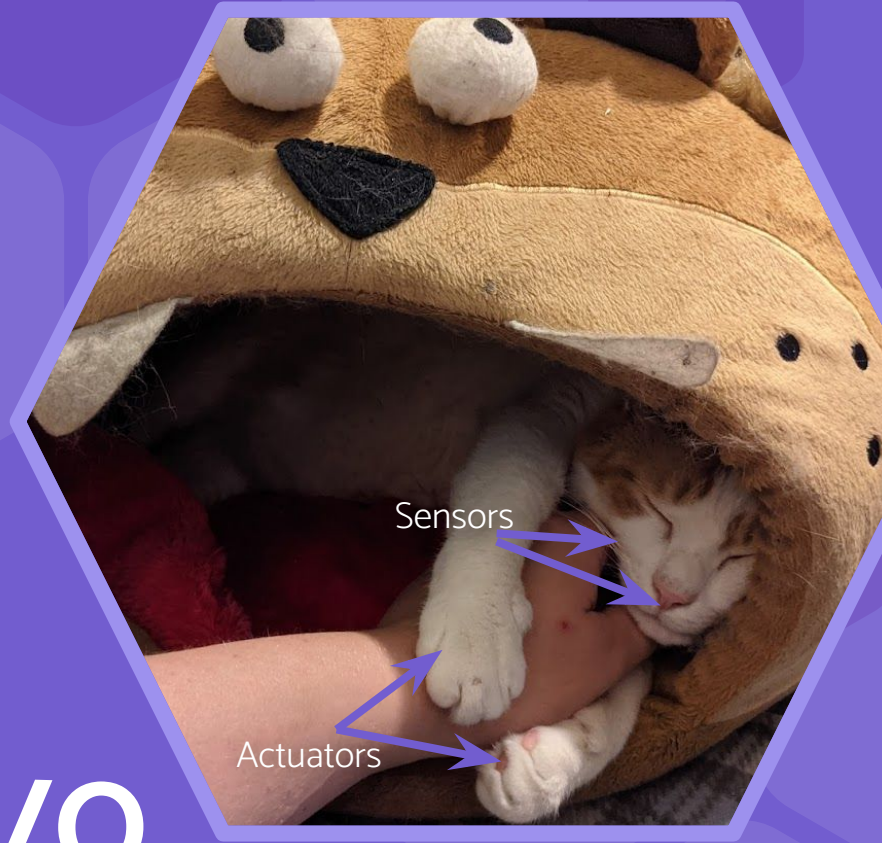# O3: Sensors, Actuators, and I/O

Labs start this week!

- Today (Monday) or tomorrow
- *Please* bring your kit if you have it already
- If you want, install the Arduino IDE on your computer (and the SAMD drivers – step 1 of lab)

Homeworks

- Due before class Wednesday and Friday
- First one is out at the end of class
- Smaller, theoretical assignments
  - Typically a short reading and 1-3 questions
- Graded on **good-effort completion**
  - A preview of material taught in lecture
  - You're not expected to know it perfectly
  - If you get stuck, write down why you're stuck and move on
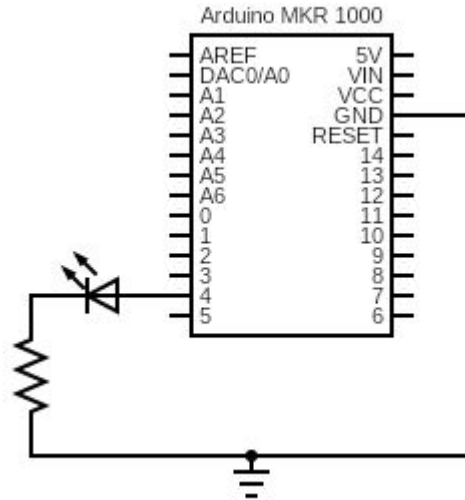
Review

- Circuits are loops through which electricity flows (have a power source and some conductors)
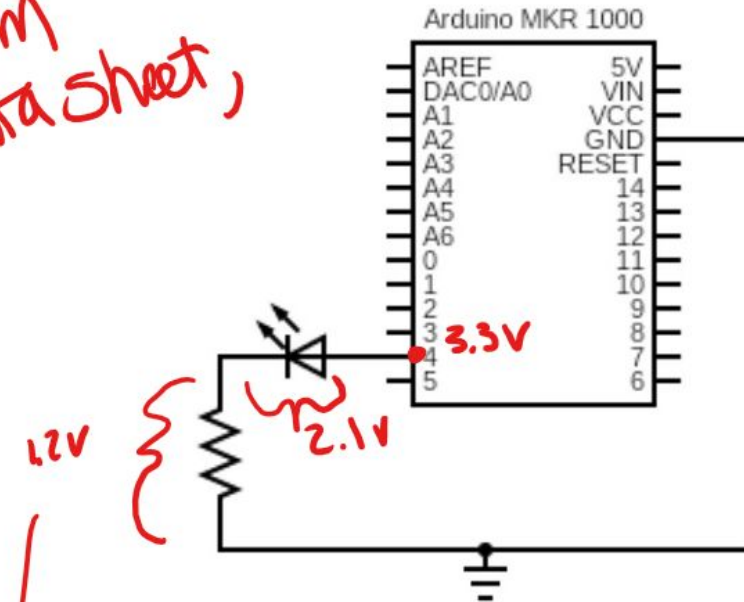- We learned computations for voltage, current, and power

Interpreting device data sheets

Yellow LED data sheet

What is the actual minimum resistance?

from
data sheet,

Arduino MKR 1000

AREF	5V
DAC0/A0	VIN
A1	VCC
A2	GND
A3	RESET
A4	14
A5	13
A6	12
0	11
1	10
2	9
3	8
4	7
5	6

3.3V

2.1v

12V

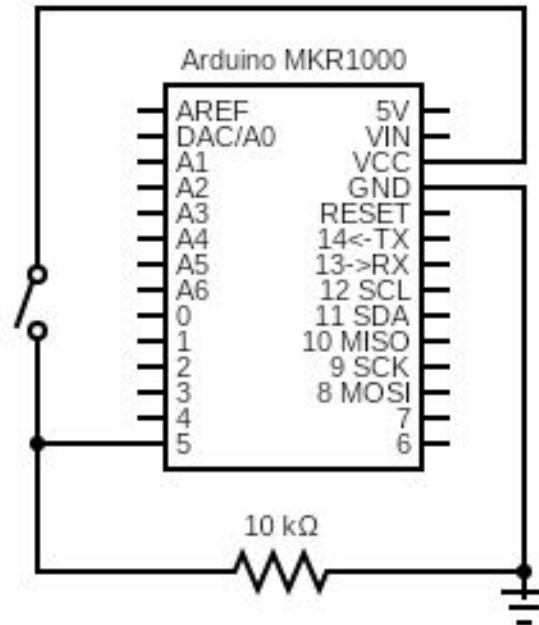→ Use this voltage to compute R.

Digital devices

Leds are digital **output** devices

Things like push buttons are digital **input** devices

(**When connected correctly**) are driven by or produce a high/low signal
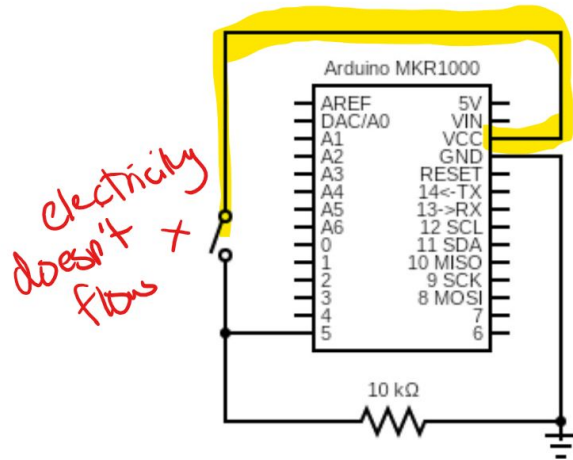
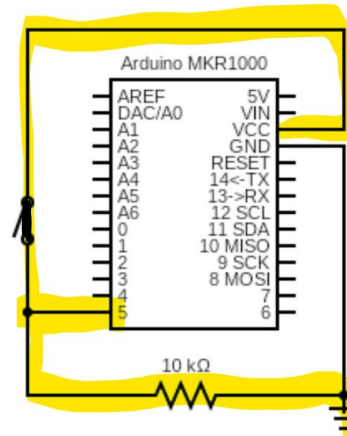# Circuit principle: must be closed for electricity to flow

Pin 5 is configured as an input pin (receives electrical signal)
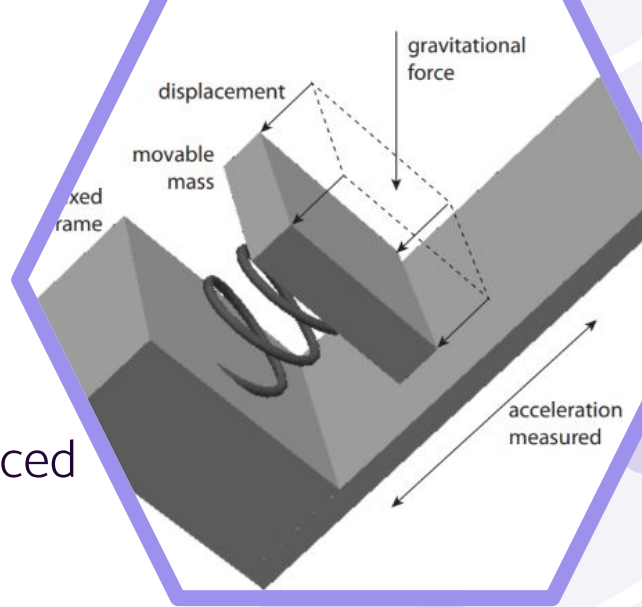
## Button not pressed

Button pressed

Input components

Your book talks about:

- Accelerometers (measure acceleration of displaced mass)
- Anemometers (air flow for velocity)
- GPS (satellite for position)
- Gyroscopes (gimbals and modern)
- Microphones
- Engine controllers, thermometers, cameras, chemical sensors, etc

Other input components in your kits

- Photoresistor - resistance changes based on light
- Potentiometer - produces voltage based on rotation of the dial
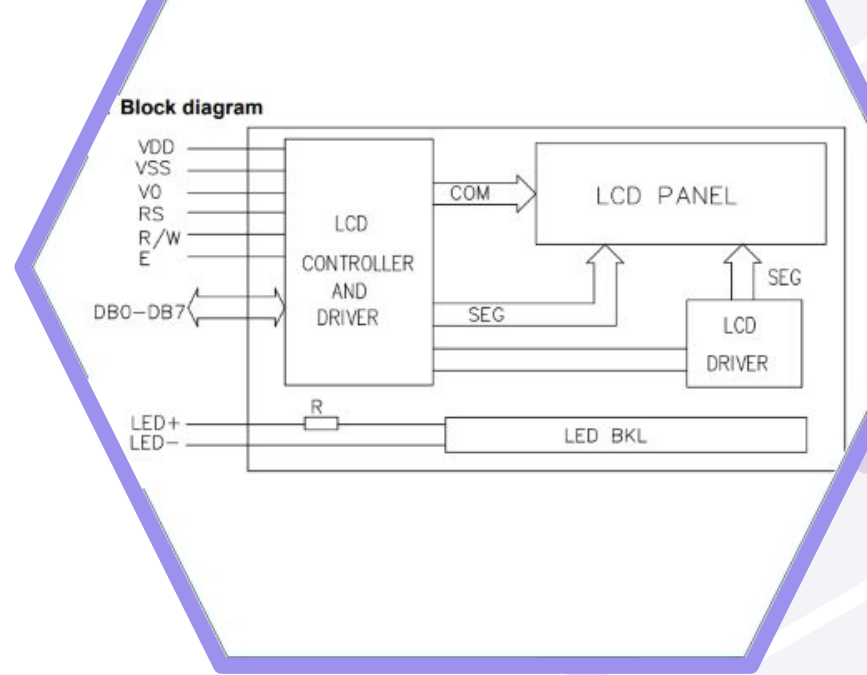- Tilt sensor - Metal bearing completes circuit

Sensor upright

Tilted sensor

Current flows

Current doesn't flow

Image source

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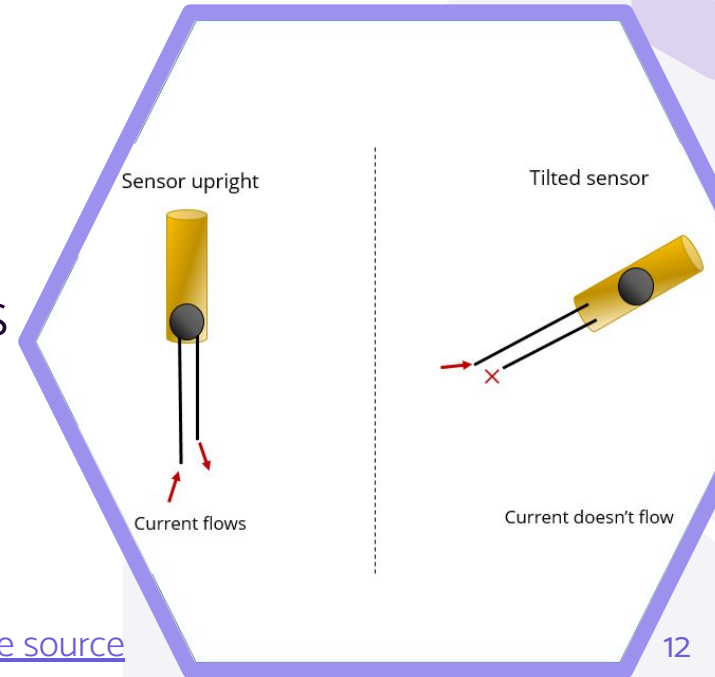
Output components

Your book talks about:

- LEDs
- Motors (DC)

Your kits have:

- LCD screen (controlled digitally)
- Servo motor (controlled by lengths of high/low pulses)
- Piezo speaker (electricity displaces film to make sound)

Image source

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"

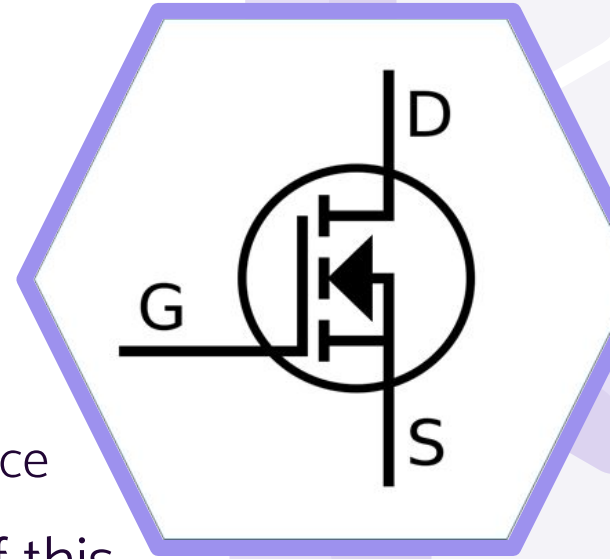*How do you control a DC motor that requires an external power source?*

Transistors

Basically an electric switch

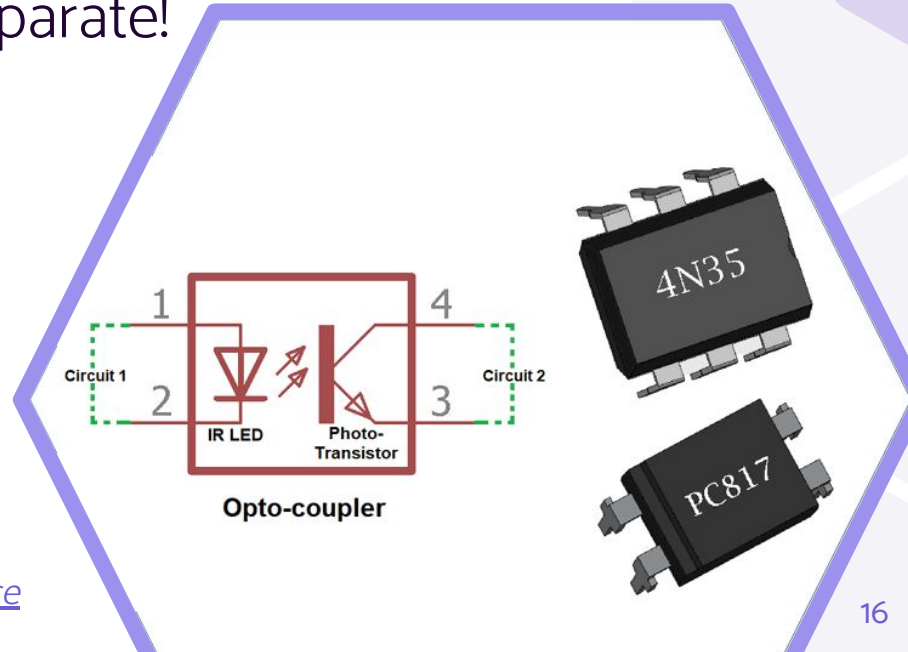   Voltage applied to **G**ate connects **D**rain and **S**ource

Come in different types (beyond the scope of this course)

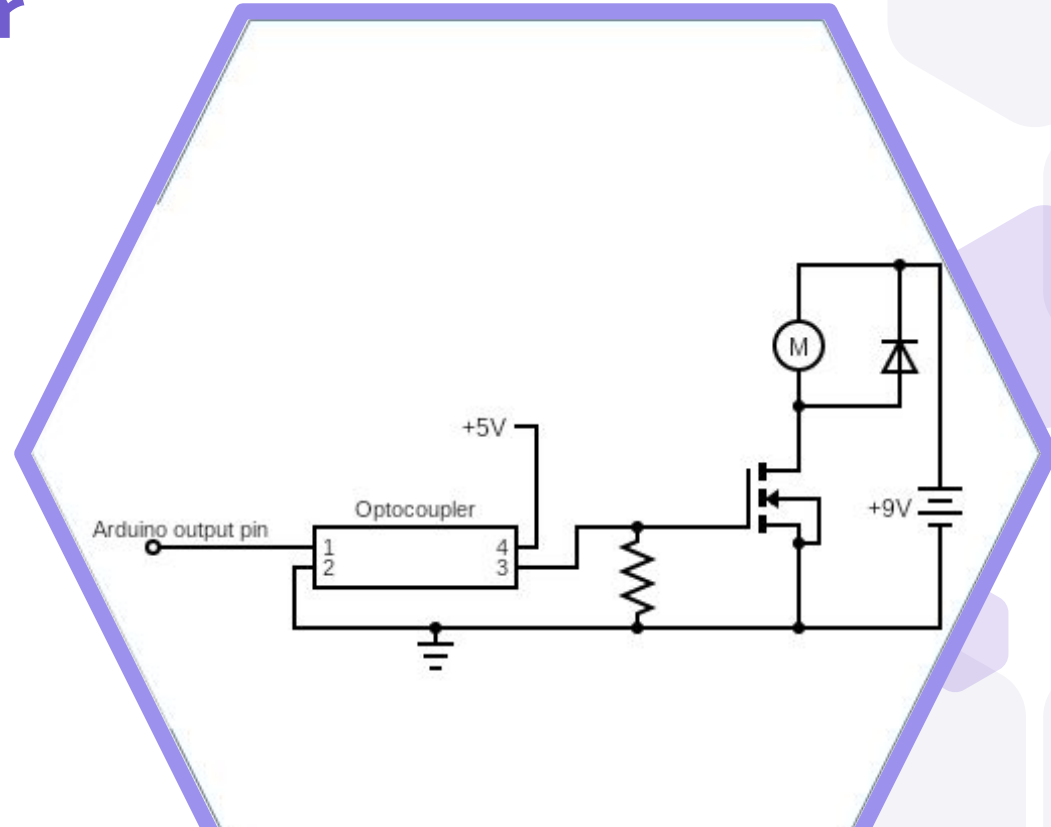The MOSFET transistor in your kits has a minimum gate voltage of 4.2V… what do we do?

Optocouplers

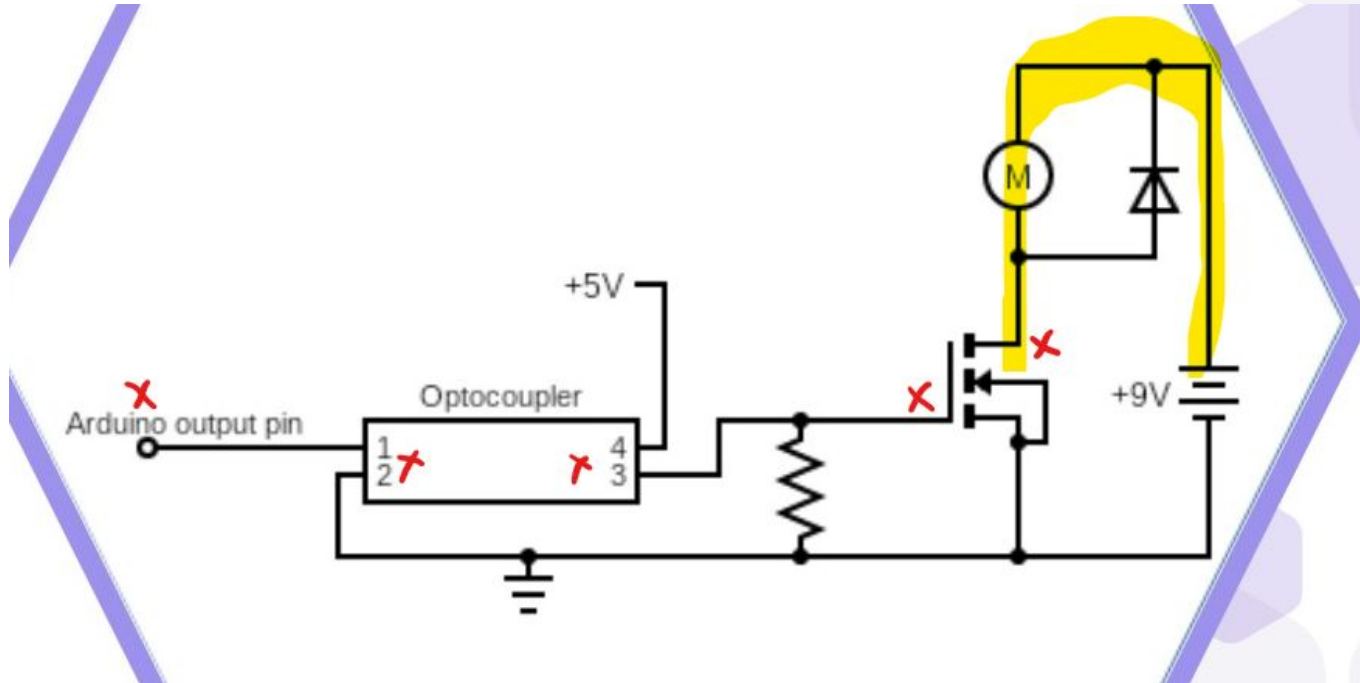- Control one circuit using another, but they are completely electrically separate!

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Motor driven using mosfet and optocoupler

No voltage from Arduino output pin

3.3V from Arduino output pin