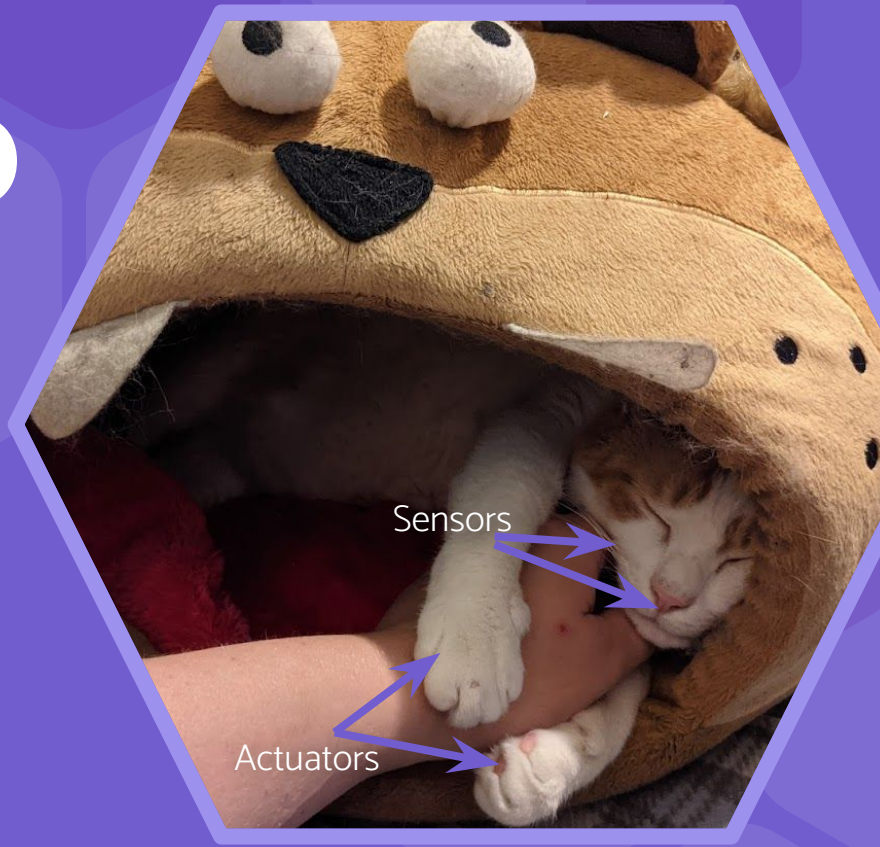
03: Sensors, Actuators, and I/O

Reminders:

- **Labs start today/tomorrow! Please install the Arduino IDE ahead of time and bring supplies/micro USB cable if you have them**
- **No late prelabs**



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

Community guidelines

- Do not assume what people do/do not know
- Treat everyone with respect
  - Trust intent, acknowledge impact
- Give space to ask/answer questions
- Active listening
- Teamwork over competition

Review

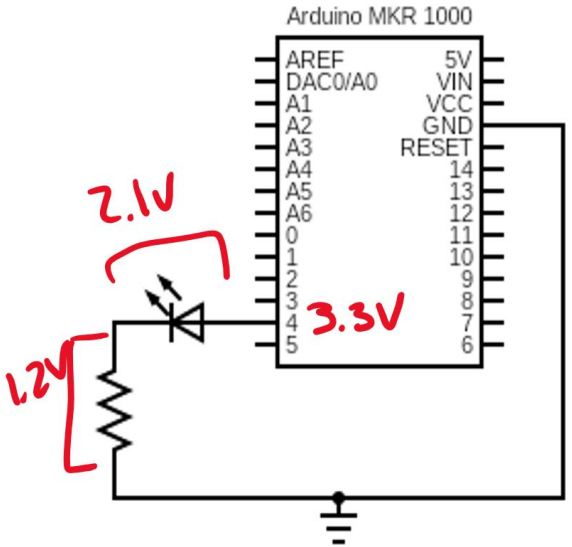
- Circuits are loops through which electricity flows (have a power source and some conductors)
- We learned computations for voltage, current, and power

Interpreting device data sheets

- Often, we assume:
  - Wires are perfect conductors
  - Constant resistance
  - Constant forward voltage
  - Discrete (on/off) or at least linear behavior
- In reality: interference; variations with supply voltage, temperature, etc

Yellow LED data sheet

What is the actual minimum resistance?



$\leq 7\,mA$

$V = IR$

$1.2V = (7mA) \cdot R$

$R \geq \frac{1.2V}{7mA}$

So are we stuck deciphering datasheets all day?

No: make reasonable assumptions to get a tolerance in safe values

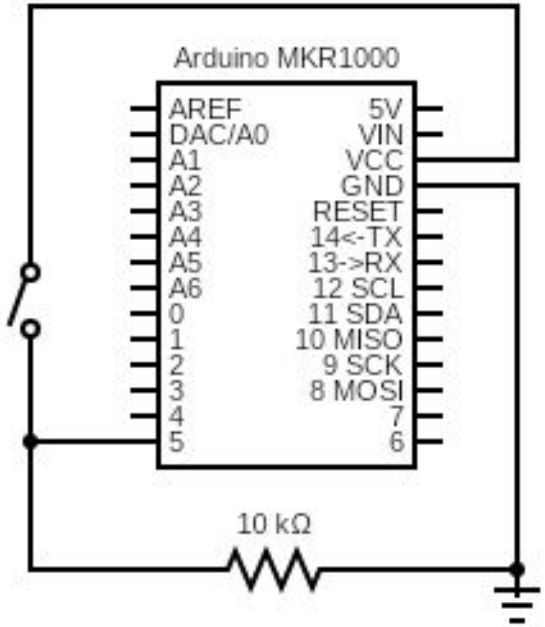
Digital devices

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

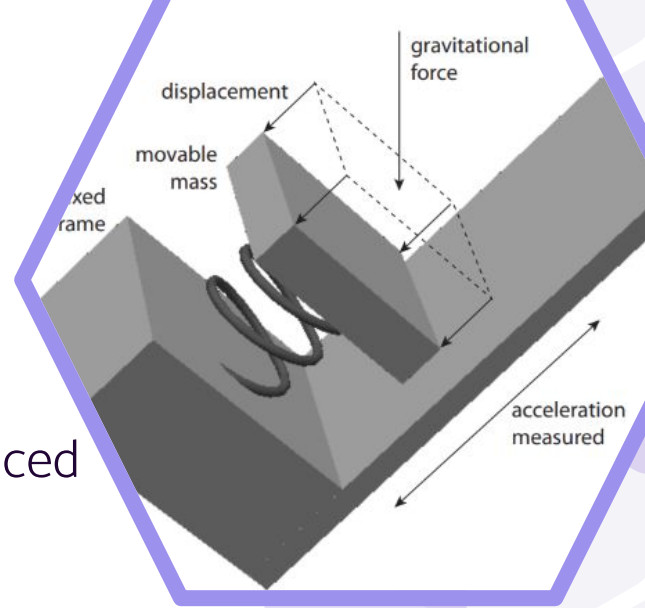
Circuit principle: must be closed for electricity to flow



Input components

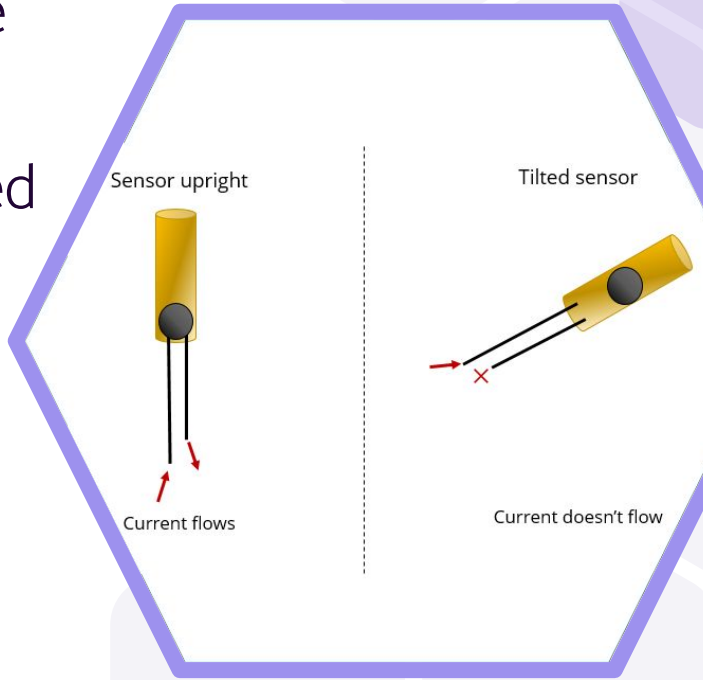
Your book talks about:

- 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

- Thermistor/Photoresistor - resistance changes based on temperature/light
- Potentiometer - divides voltage* based on rotation of the dial
- Tilt sensor - Metal bearing completes circuit



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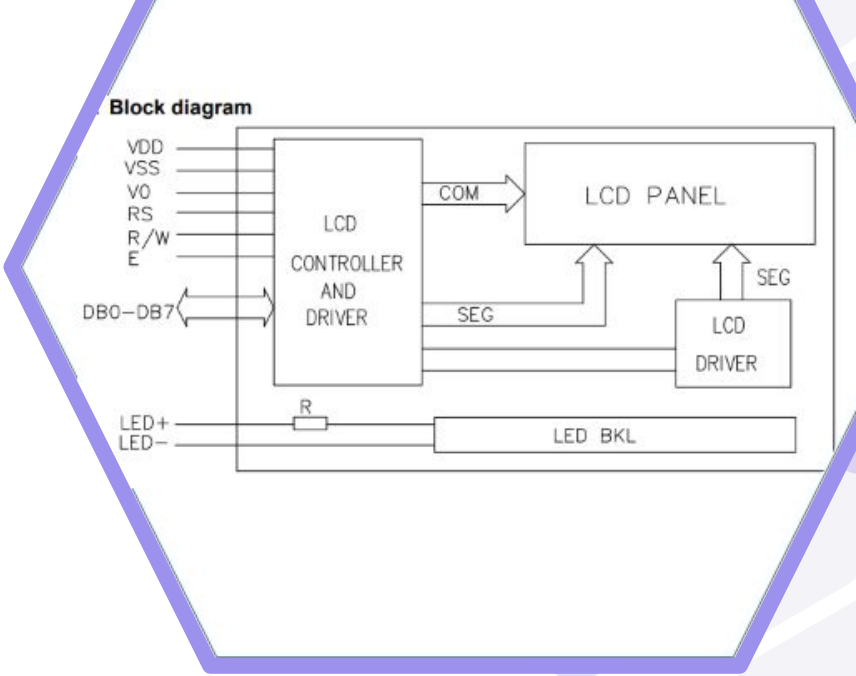
Output components

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)



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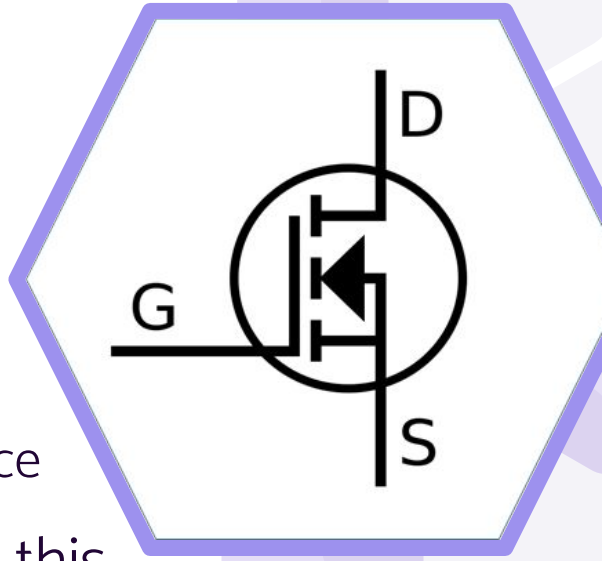
How do you control a device that has higher power/voltage/current requirements than your Arduino can provide?

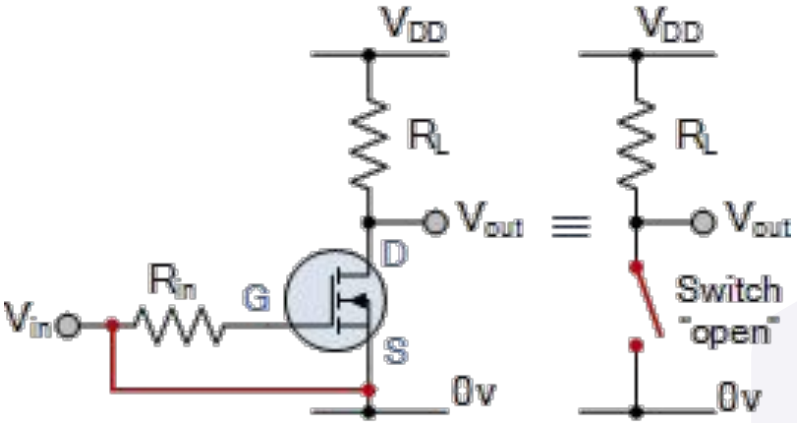
Transistors



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)



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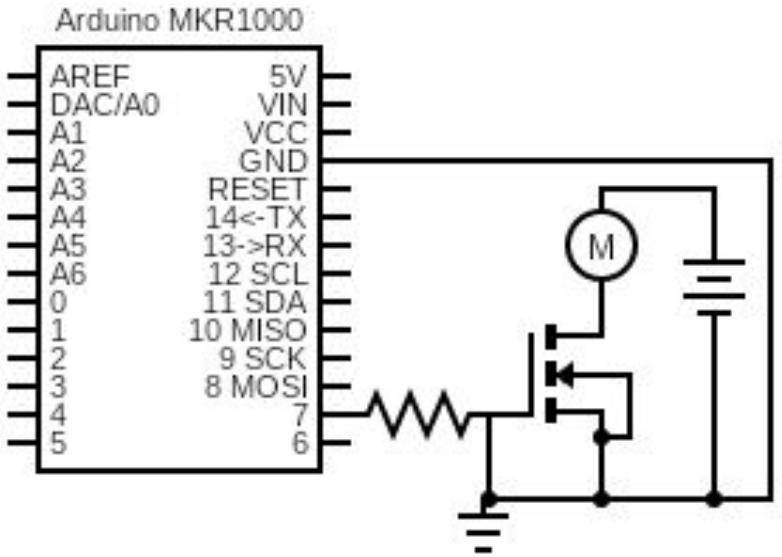
Be careful when using transistors!

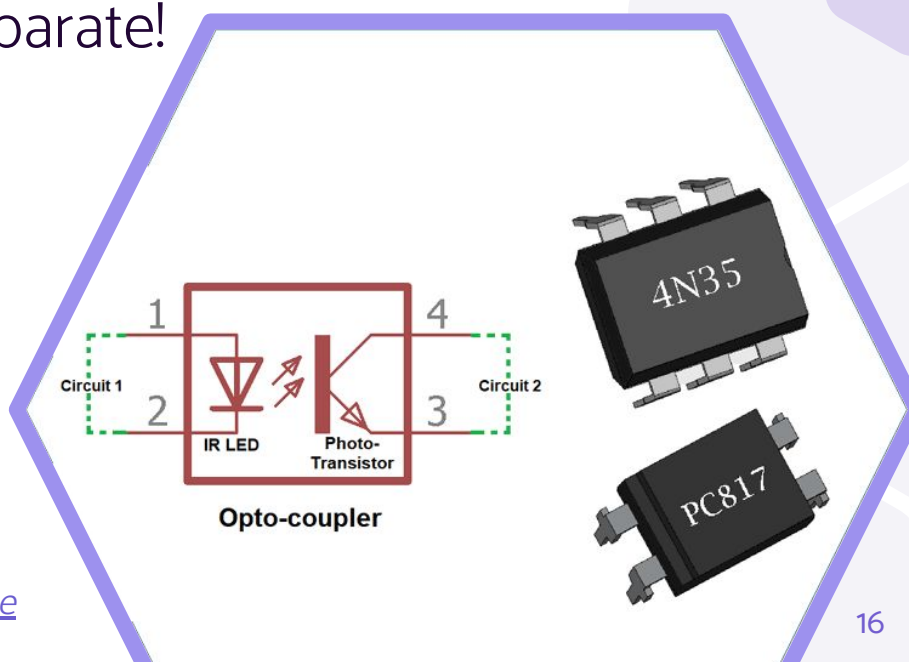
Problems with this circuit:

- Issues with FET in kit:
  - Gate voltage
  - Current
- No isolation between Arduino and higher-voltage circuit



Optocouplers

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



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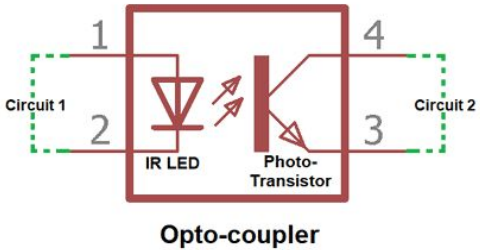
A better circuit

Still need to double-check datasheets!



Opto-coupler