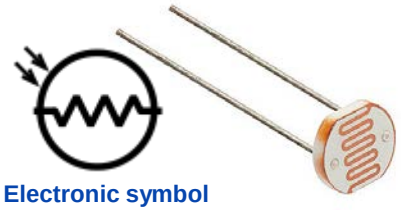
Engineering Technology (ENGR 101)

Arduino, and light sensors, Ultrasonic Distance Sensors

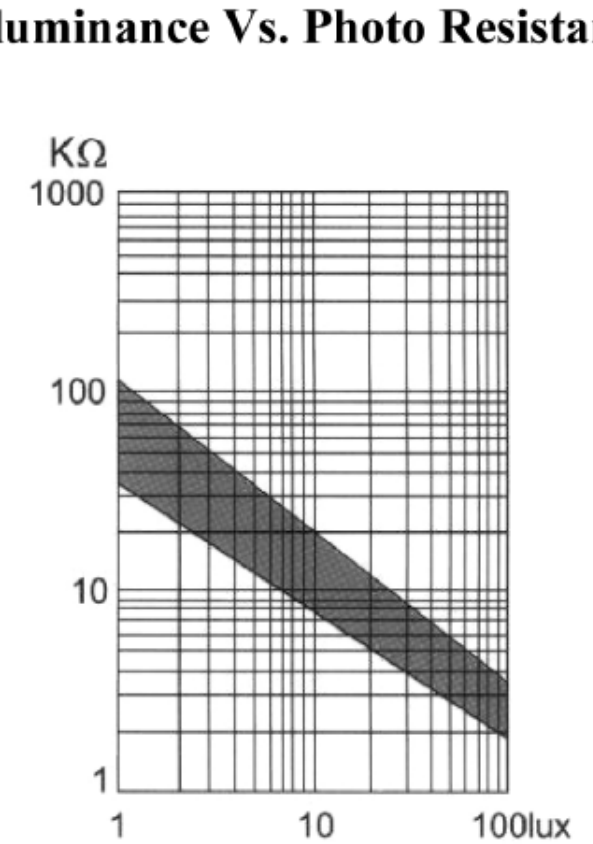
Introduction Why Sensors

- Human body has the five sensory organs :
  - eye,
  - ear,
  - tongue,
  - nose,
  - skin.
- Human take the information about the environment and react.
- An automatic system is very much like the human body.
  - It receives information and command inputs
  - It sends this information as input signals to Arduino.
  - Arduino can make decisions and respond by sending output signals to actuators and indicators.
- Sensors in this course:
  - Light Sensor
  - Ultrasonic Distance Sensor

Light Sensor


Electronic symbol

- Photoresistor or photocell is one type of light sensors
  - The resistance of a photoresistor decreases with increase in incident light intensity (luminosity)
    - lux is the unit of illuminance, measuring luminous flux per unit area.
    - Luminous flux or luminous power is the measure of the perceived power of light.



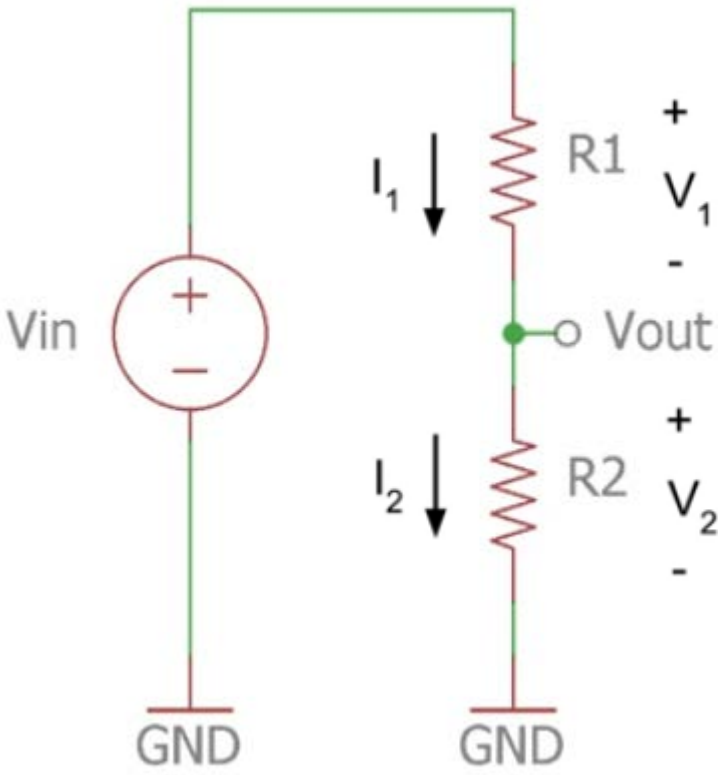
Voltage divider

- When a voltage is applied to a series combination of resistances, a fraction of voltage appears across each of the resistance.

- A series circuit acts as a voltage divider. The voltage divider is an important application of series circuits.

- A circuit consisting of a series string of resistors connected to a voltage source act as voltage divider.

How to calculate voltage in voltage divider?



$$V_{out} = V_2$$

$$V_{out} = I_2 \times R_2$$

$$I_2 = I_1 = I$$

$$V_{out} = I \times R_2$$

$$I = \frac{V_{out}}{R_2}$$

$$V_{in} = I \times R$$

$$R = R_1 + R_2$$

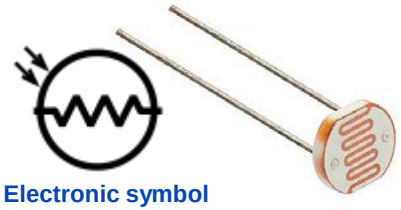
$$V_i = I \times (R_1 + R_2)$$

$$I = \frac{V_{in}}{(R_1 + R_2)}$$

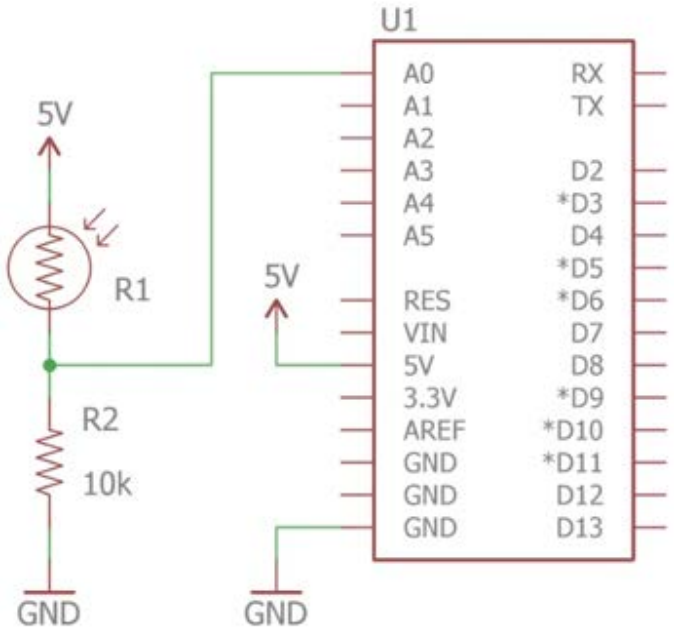
$$\frac{V_{out}}{R_2} = \frac{V_{in}}{(R_1 + R_2)}$$

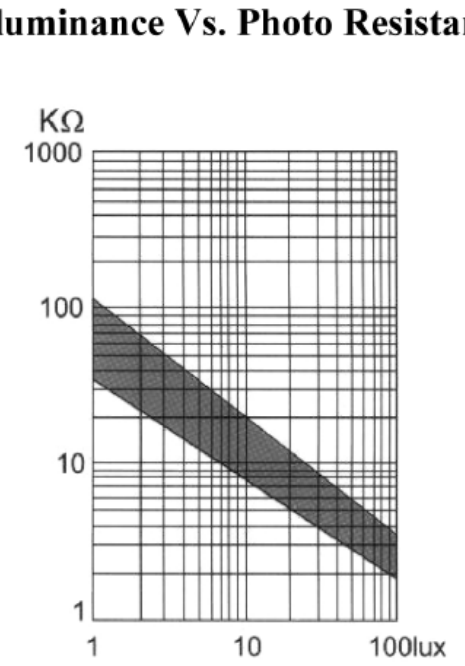
$$V_{out} = V_2 \times \frac{R_2}{R_1 + R_2}$$

Photoresistor


Electronic symbol

- Arduino cannot measure the change in resistor
  - To measure the change in resistance, we use another resistor to create voltage divider.
  - As the resistance of photocell changes, it will cause a change in voltage divider, which Arduino can measure.





$$V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}$$

$$V_{out,dark} = 5V \times \frac{10\ k}{100k + 10k} = 0.45\ V$$

$$V_{out,light} = 5V \times \frac{10\ k}{2k + 10k} = 4.17\ V$$

Analogue Input

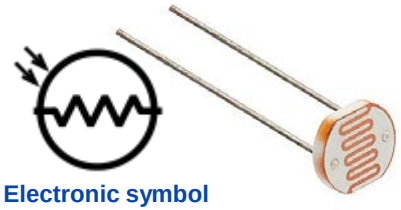
int analogRead(pin)

- Returns the state of an analogue input pin
- Returns an integer from 0 to 1023
- 0 for 0 volts, 1023 for 5 volts

- Example:
  - `int pin_val;`
  - `pin_val = analogRead(A3);`

- pin must be an analogue pin
  - (A0, A1, A2, A3, A4, or A5)

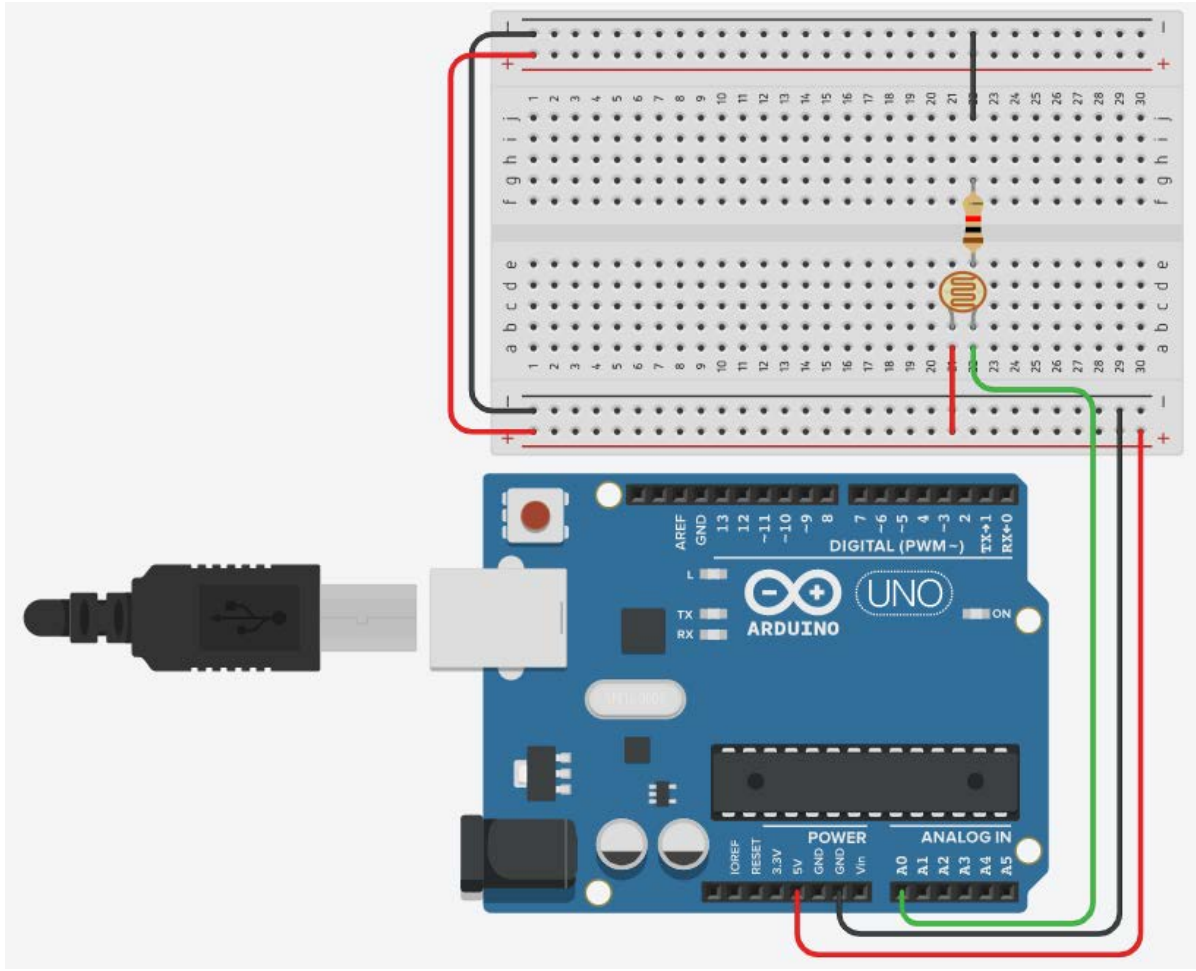
Photoresistor



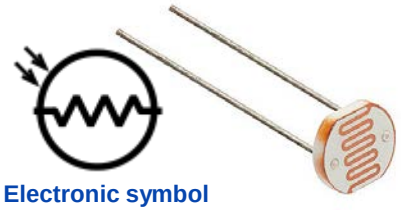

```
const int light_pin = A0;
void setup() {
    Serial.begin(9600);
    pinMode(light_pin, INPUT);
}

void loop() {
    int light_val;
    light_val = analogRead(light_pin);
    Serial.println(light_val);
    delay(1000);
}
```

returns int between 0-1023 (0V – 5V)



Photoresistor

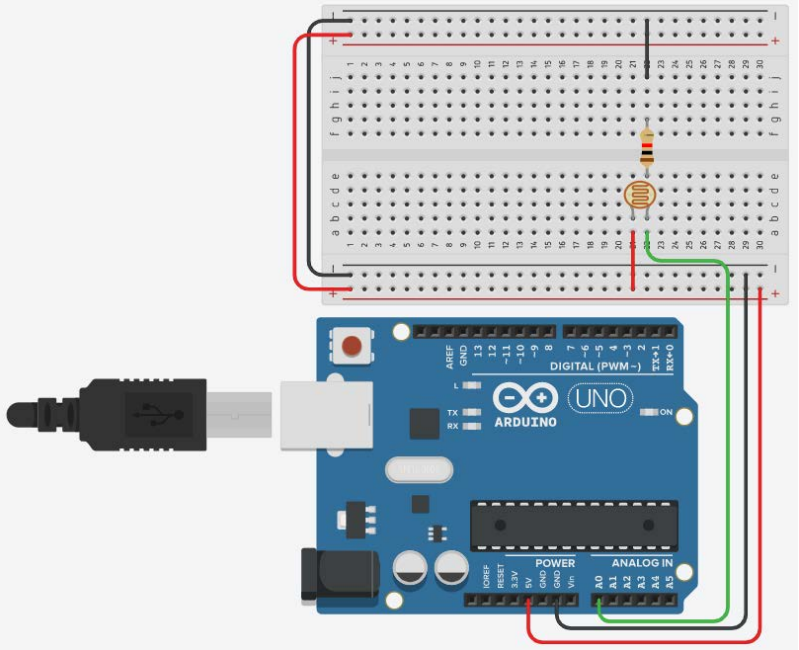


Electronic symbol

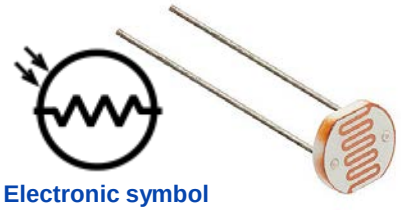
```
void loop() {
    int light_val;
    light_val = analogRead(light_pin);
    Serial.print(light_val);

    // We'll have a few threshholds, qualitatively determined
    if (light_val < 10) {
        Serial.println(" - Dark");
    } else if (light_val < 200) {
        Serial.println(" - Dim");
    } else if (light_val < 500) {
        Serial.println(" - Light");
    } else if (light_val < 800) {
        Serial.println(" - Bright");
    } else {
        Serial.println(" - Very bright");
    }

    delay(1000);
}
```



Photoresistor connected to LED




```
const int light_pin = A0;
const int led_pin = 4;
// Set darkness threshold
const int threshold = 500;
void setup() {
    Serial.begin(9600);
    pinMode(light_pin, INPUT);
    pinMode(led_pin, OUTPUT);
}
void loop() {
    int light_val;
    light_val = analogRead(light_pin);

    if (light_val < threshold) {
        digitalWrite(led_pin, HIGH);
    }
    else {
        digitalWrite(led_pin, LOW);
    }
    delay(1000);
}
```