

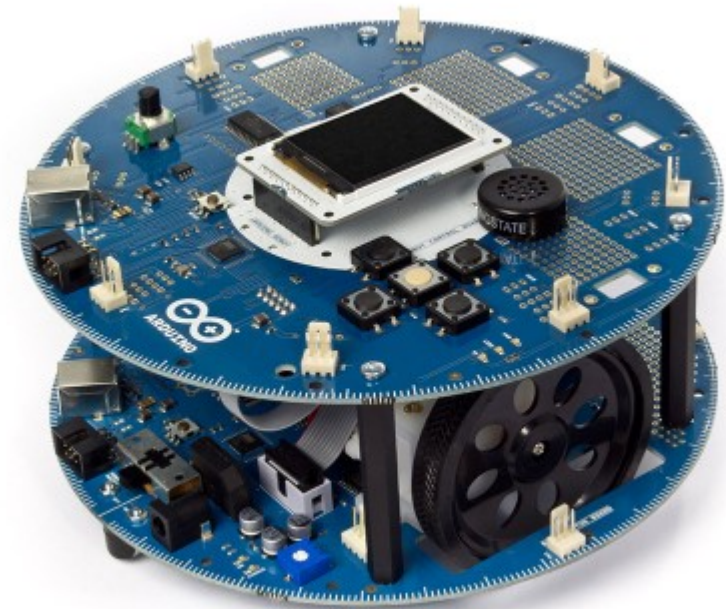
Basic circuits

- Electrical circuits
- Electrical properties
- Ohm's law
- Electrical components
- Diodes
- Switches and potentiometers
- Wiring

Electrical circuits

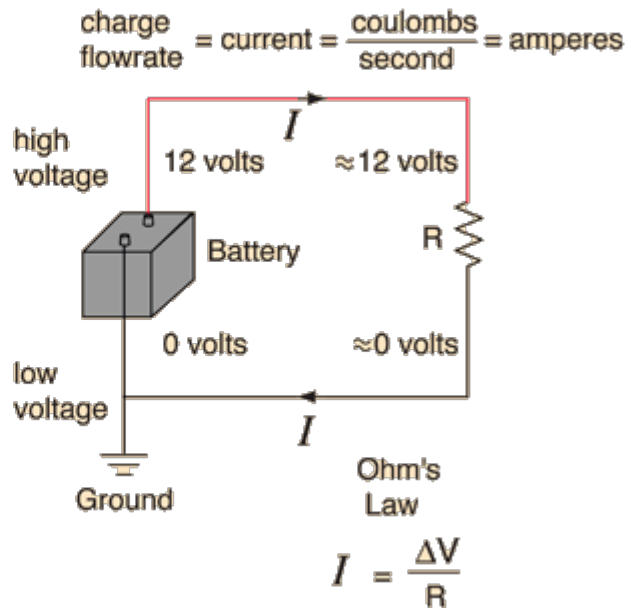
Hardware and software

- Electronic devices combine hardware and software
- Hardware interacts with the world
- Software is the intelligence

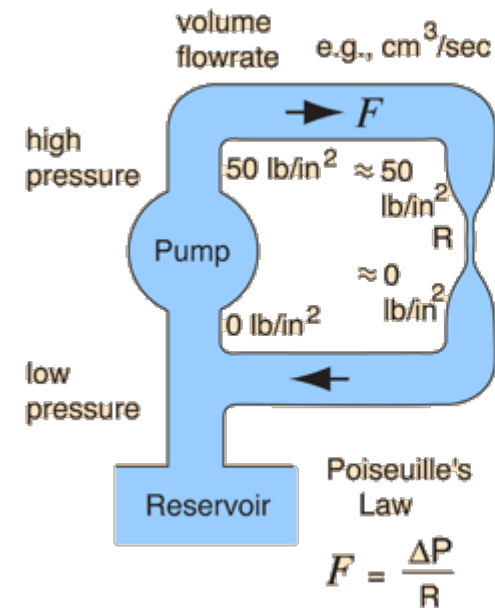


Electrical circuits

- Electrical current flowing through wires
- Battery/power supply moves current



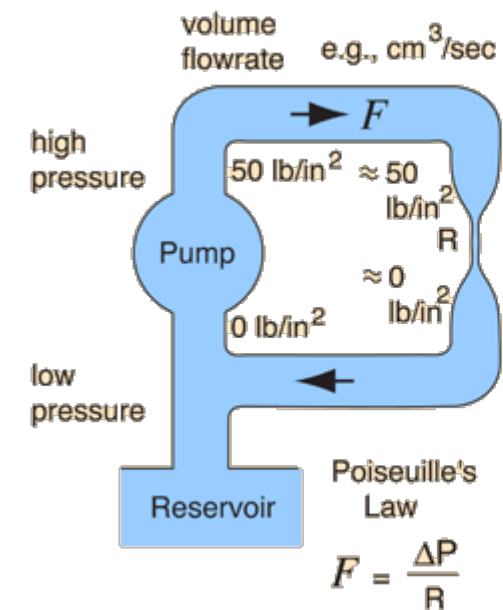
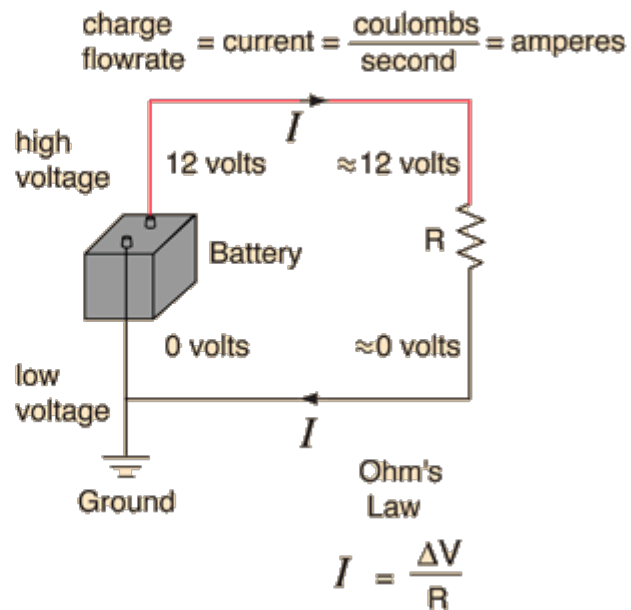
- Water flowing through pipes
- Pump moves water



Electrical properties

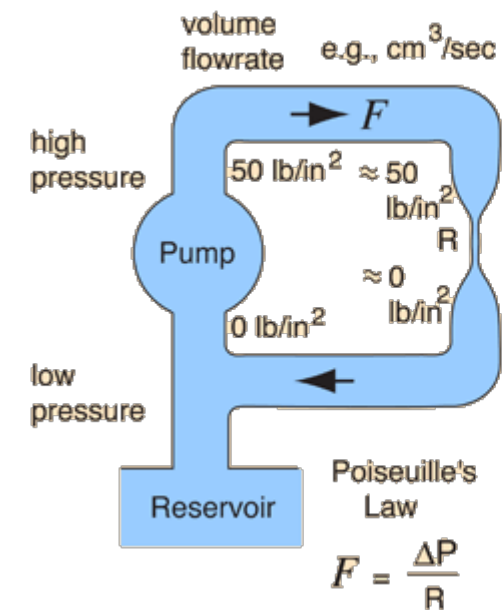
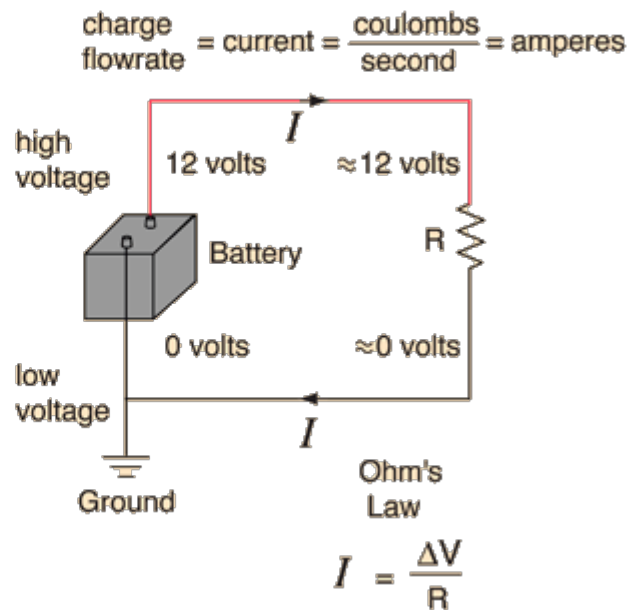
Voltage

- Voltage (V): potential difference between two points in the circuit
- Like pressure in a water system
- Measured in volts



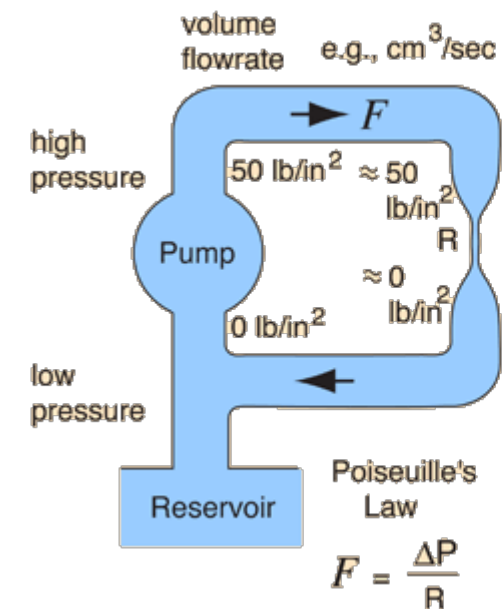
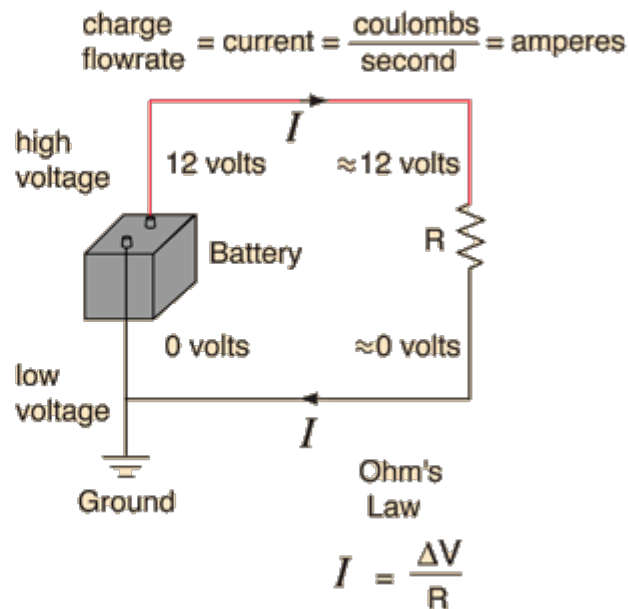
Current

- Current (I): rate of carrier flow
- Flows from positive to negative
- Electrons flow from negative to positive
- Measured in amperes



Resistance

- Resistance (R): any obstacle to current flow
- For water, might be a rock or narrow pipe
- For circuits, might be a bad conductor or narrow conductor
- Measured in ohms



Ohm's law

Ohm's law

- $V = I * R$
- Expresses the relationship between V, I, and R
- Used to compute one value given the other two
- Some common uses:
 - What resistor do I need to limit current flow, so that my device is safe?
 - What voltage can I expect for a given resistance?

Electrical components

Resistors

- Provides resistance to current flow
- Two terminals; no difference between them
- Band colors indicate resistance
 - Each color is a digit; scientific notation is used



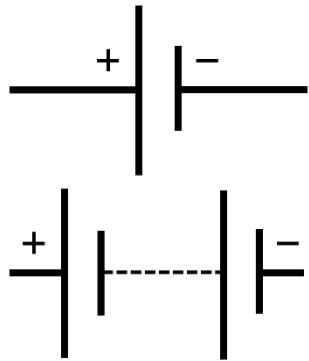
Resistor

구분		첫 번째 색	두 번째 색	세 번째 색	네 번째 색	다섯 번째 색
색	4색	첫째 수	둘째 수	배수	오차	-
	5색	첫째 수	둘째 수	셋째 수	배수	오차
검 갈 빨 주 노 초 파 보 회 흰 금 은		0	0	$10^0 / 0$	$- / 10^0$	-
		1	1	$10^1 / 1$	$\pm 1\% / 10^1$	$\pm 1\%$
		2	2	$10^2 / 2$	$\pm\% / 10^2$	$\pm\%$
		3	3	$10^3 / 3$	$- / 10^3$	-
		4	4	$10^4 / 4$	$- / 10^4$	-
		5	5	$10^5 / 5$	$\pm 0.5\% / 10^5$	$\pm 0.5\%$
		6	6	$10^6 / 6$	$\pm 0.25\% / 10^6$	$\pm 0.25\%$
		7	7	$10^7 / 7$	$\pm 0.1\% / 10^7$	$\pm 0.1\%$
		8	8	$10^8 / 8$	$\pm 0.05\% / 10^8$	$\pm 0.05\%$
		9	9	$10^9 / 9$	$\pm 1\% / 10^9$	$\pm 1\%$
은		-	-	$10^{-1} / -$	$\pm 1\% / 10^{-1}$	$\pm 1\%$
		-	-	$10^{-2} / -$	$\pm 1\% / 10^{-2}$	$\pm 1\%$

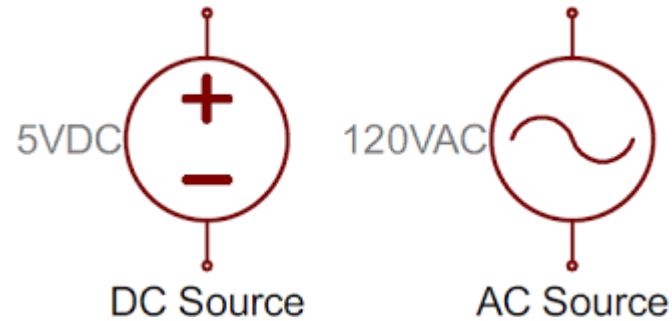
※ 두 개의 숫자가 한 칸에 나타난 것은 앞쪽이 4색 뒤쪽이 5색 저항의 정보를 나타냄.

Battery / DC power

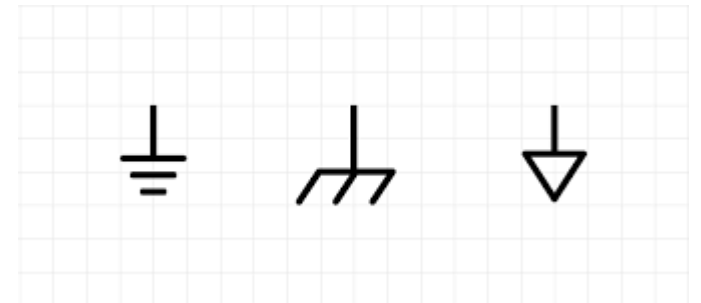
- Provides voltage via power and ground
- Do not create a short circuit



Batteries



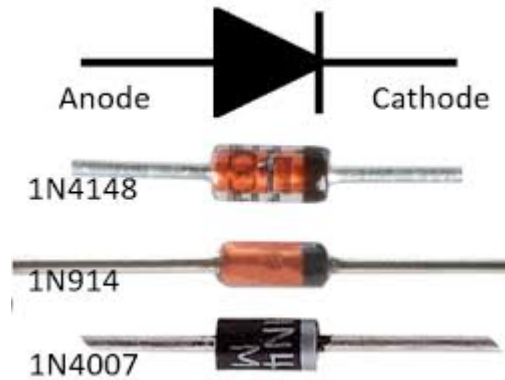
Power sources



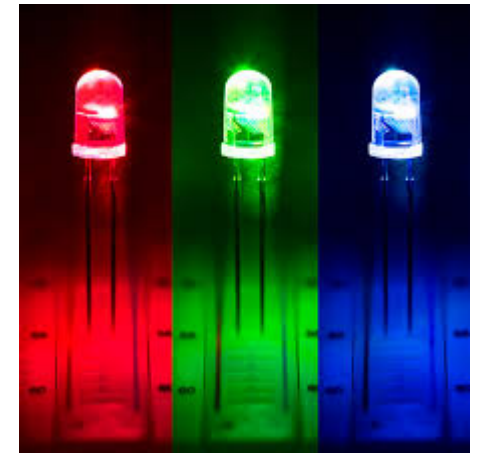
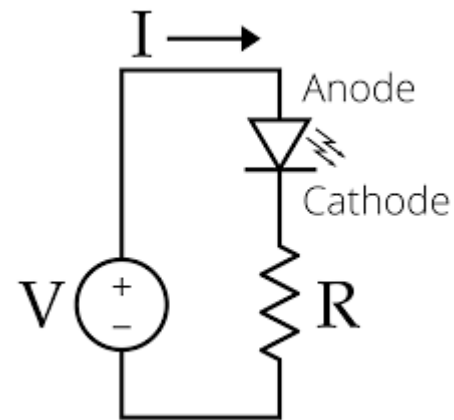
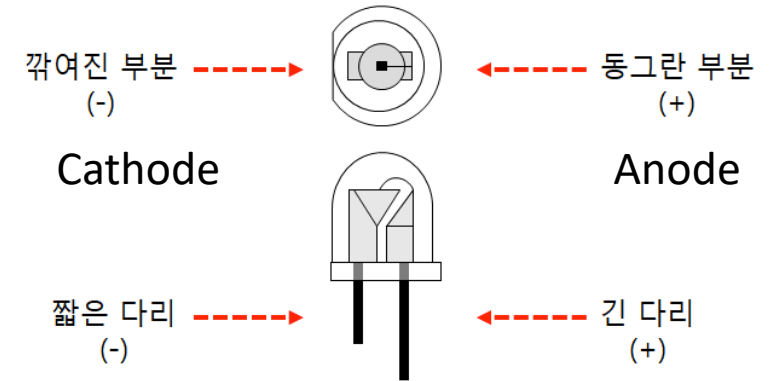
Ground

Diodes and LEDs

- Two terminals: anode (+) and cathode (-)
- Current only flows in one direction, anode to cathode
 - One-way valve
- LEDs light when current flows



Diodes



LEDs

Diode threshold voltage

- Anode-cathode voltage must be above threshold
 - Different thresholds for different diodes
- Reverse-biased: when anode is negative with respect to cathode

Diode current limit


- Diodes have a maximum current limit
 - Around 20mA
- Do not connect an LED directly across a 5V supply
 - If without an appropriate resistor, too much current will flow which will probably burn your diode.


Switches and potentiometers

Switches / pushbuttons


- Closing the switch completes the circuit
- Voltage on both terminals is identical when the switch is closed




SPST toggle
normally open


SPST toggle
normally closed

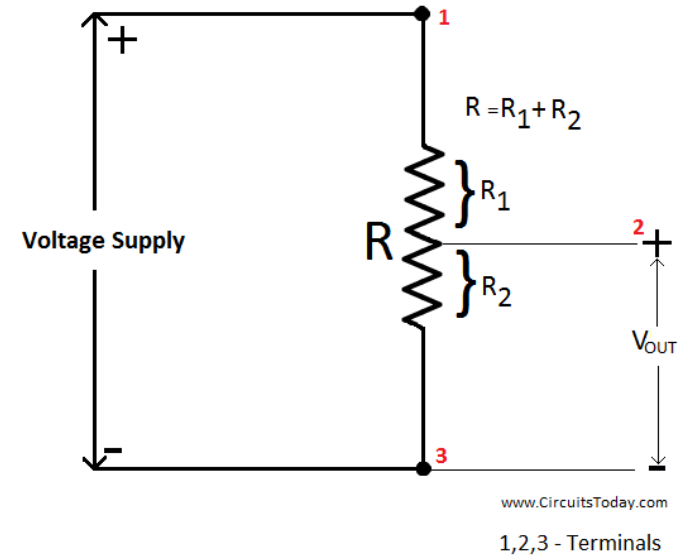
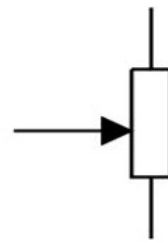
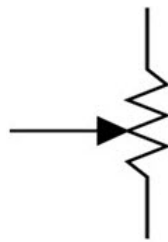



Pushbutton
normally open


Pushbutton
normally closed

Potentiometers

- Three terminals: top, bottom, middle
- Resistance between top and bottom terminals is constant
- Ratio of resistances changes



Wiring

Interpreting a schematic

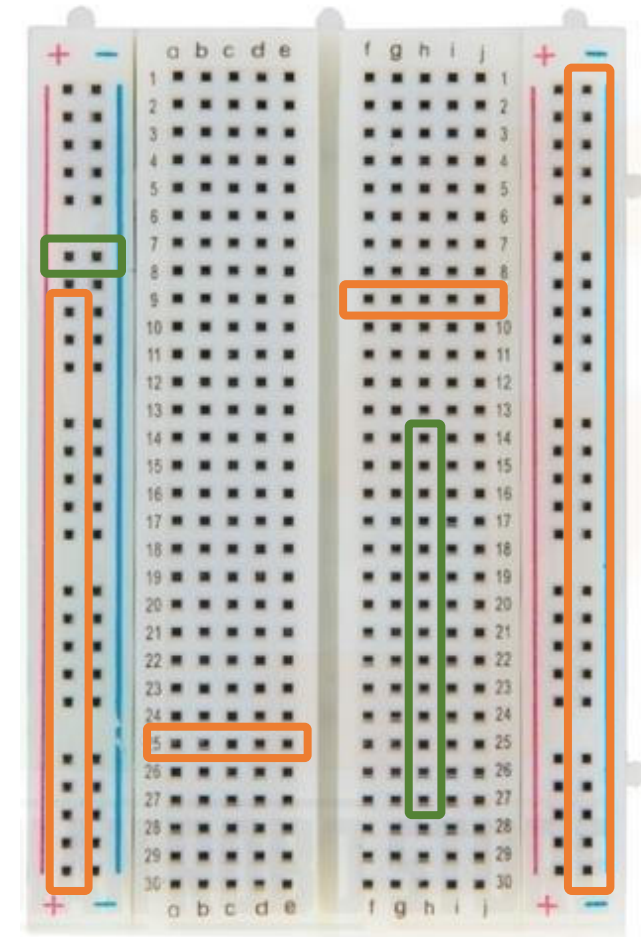
- Shows how components are connected in a real circuit
- You need to be able to build a real circuit from a schematic
- You need to be able to draw a schematic to represent your design

Solderless breadboard

- Allows components to be easily connected in a non-permanent way
- Great for prototyping
- Holes fit 24 AWG solid wires
- Connected in rows of 5 holes and columns along the sides

Connected

Disconnected



Wiring process

1. Select a hardware component
2. Select one terminal on the hardware component
3. Connect the terminal to a row of the breadboard
 - If the terminal needs to be connected to another terminal already in the breadboard, share the row
 - Otherwise, use a free row
4. Go back to step 2 until all terminals are done
5. Go back to step 1 until all components are done

중간고사 공지

- 5월 1일 금요일까지
- 5페이지 파워포인트(표지 제외)
 - 아두이노 프로젝트 목표, 내용(어떤 센서, 어떤 구조, 어떤 모터, 어떤 기능) 등 설명

Lab

Simple LED lights (I)

- Get your Arduino ready with three LEDs (R/G/B) with appropriate resistors, a push button, and a breadboard.
- Have your Arduino do the following.
 - Before you begin, you will need to select appropriate resistors.
 - LEDs should be turned off when your Arduino is powered up.
 - Turns the three LEDs on simultaneously when the push button is pressed.
 - Turns the three LEDs off simultaneously when the push button is released.

Simple LED lights (II)

- Get ready with the same hardware setting (three LEDs (R/G/B) with appropriate resistors, a push button, and a breadboard).
- Now the push button should act as a toggle switch.
 - Whenever the button's state changes from "RELEASED" to "PRESSED", all three LEDs' states should be inverted.