

Lesson 4 (High Power)

Controlling Motors, Pumps, Deathrays, and other high power devices

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Current Limits

- Arduino UNO max current
 - 40 mA per I/O pin
 - 200 mA total
 - 5V pin can supply 500mA (cannot control in program)



20mA



150mA



300mA



1.8A
(each motor)

Current Limits

- 40mA is only enough for...
 - Small LEDs
 - Small speakers
 - Sensors (...most requires very little current)



Transistor

- Works like a switch
 - Can control much higher current than an Arduino
 - Receives electrical signal from the Arduino to turn on or off



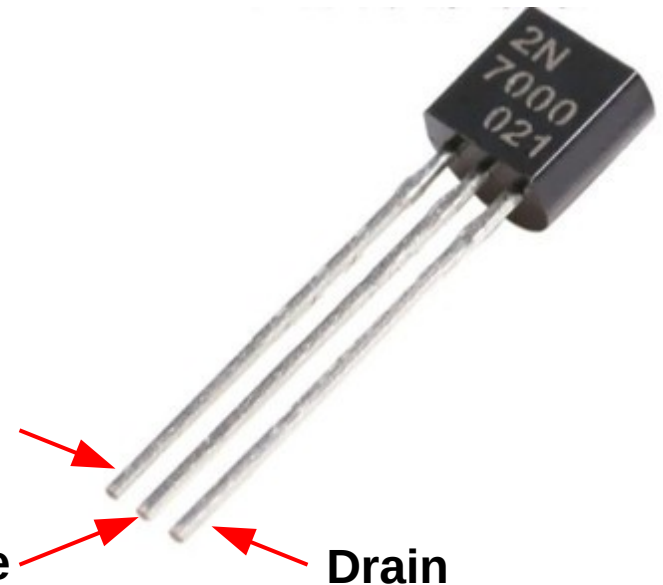
Works the same, but
without the finger



Source

Gate

Drain



Transistor

Positive Voltage

Connect to Arduino Vin pin.

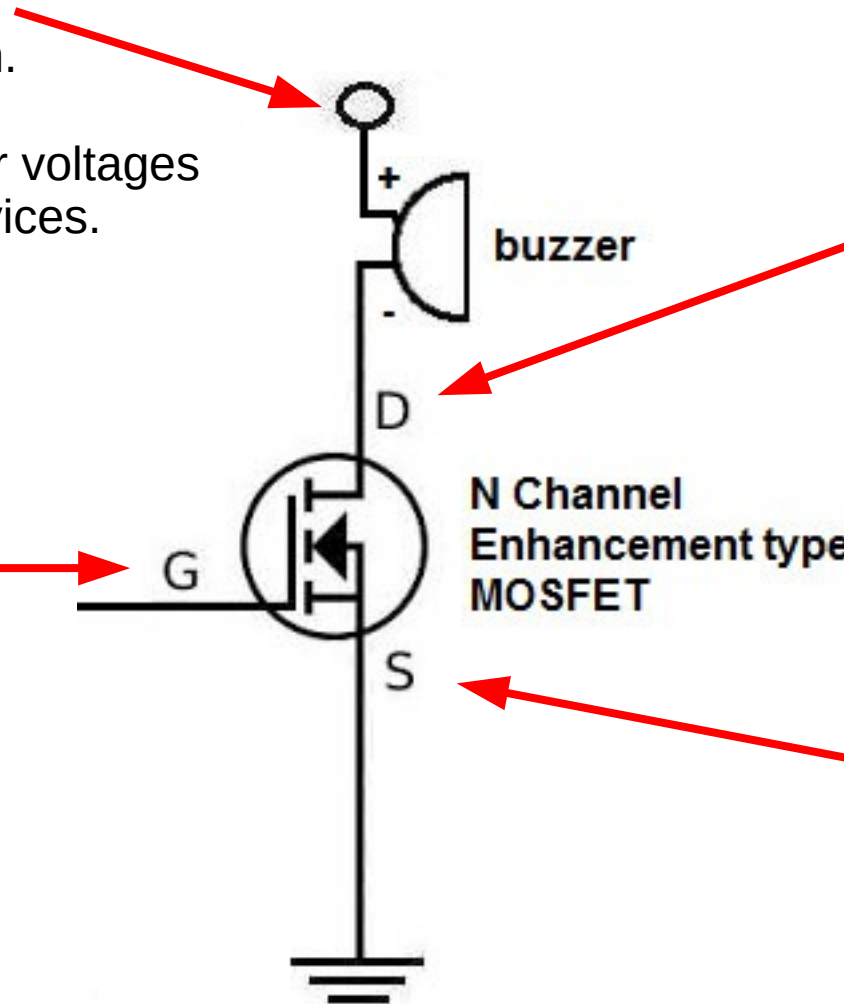
Can also connect to higher voltages to drive more powerful devices.

Gate

Connect to Arduino I/O pin (eg. pin 11).

Transistor turns on when pin 11 is **High (5V)**.

Transistor turns off when pin 11 is **Low (0V)**.



Drain

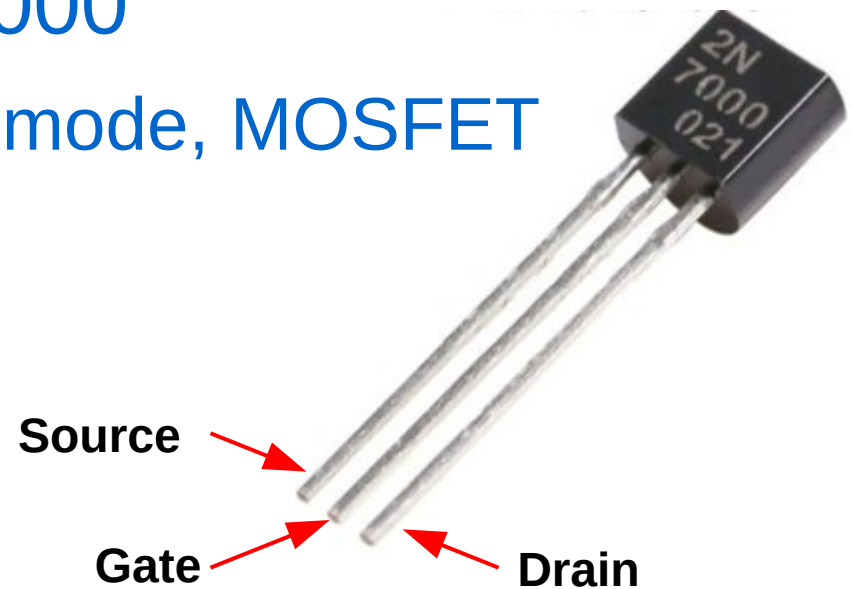
Connect to the load.
Load can be a buzzer, LED, motor, etc...

Source

Connect to Gnd

Transistor

- Many types of transistors...
 - BJT, Darlington, MOSFET, JFET, PNP, NPN, etc...
- Model we are using: 2N7000
 - N-channel, Enhancement-mode, MOSFET
 - Max voltage 60V
 - Max current 200mA



2N7000

- N-Channel
 - Connect transistor between Load and Ground
- Enhancement-mode
 - Supply voltage to turn on
- MOSFET
 - Gate draws very little current (...treated as zero)

Exercise 4

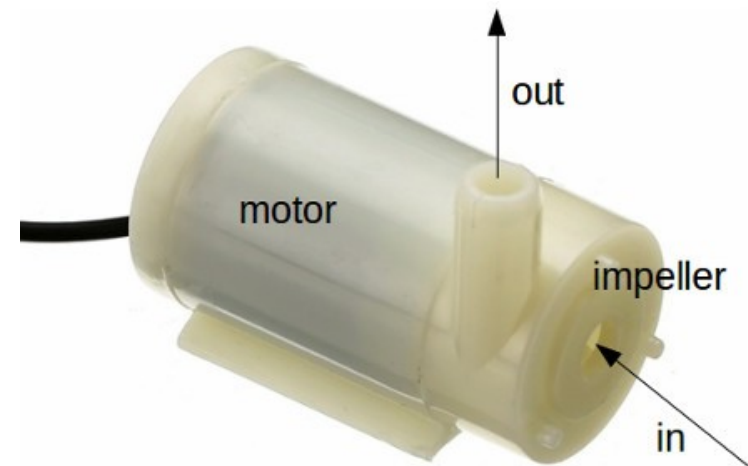
Connecting Pumps

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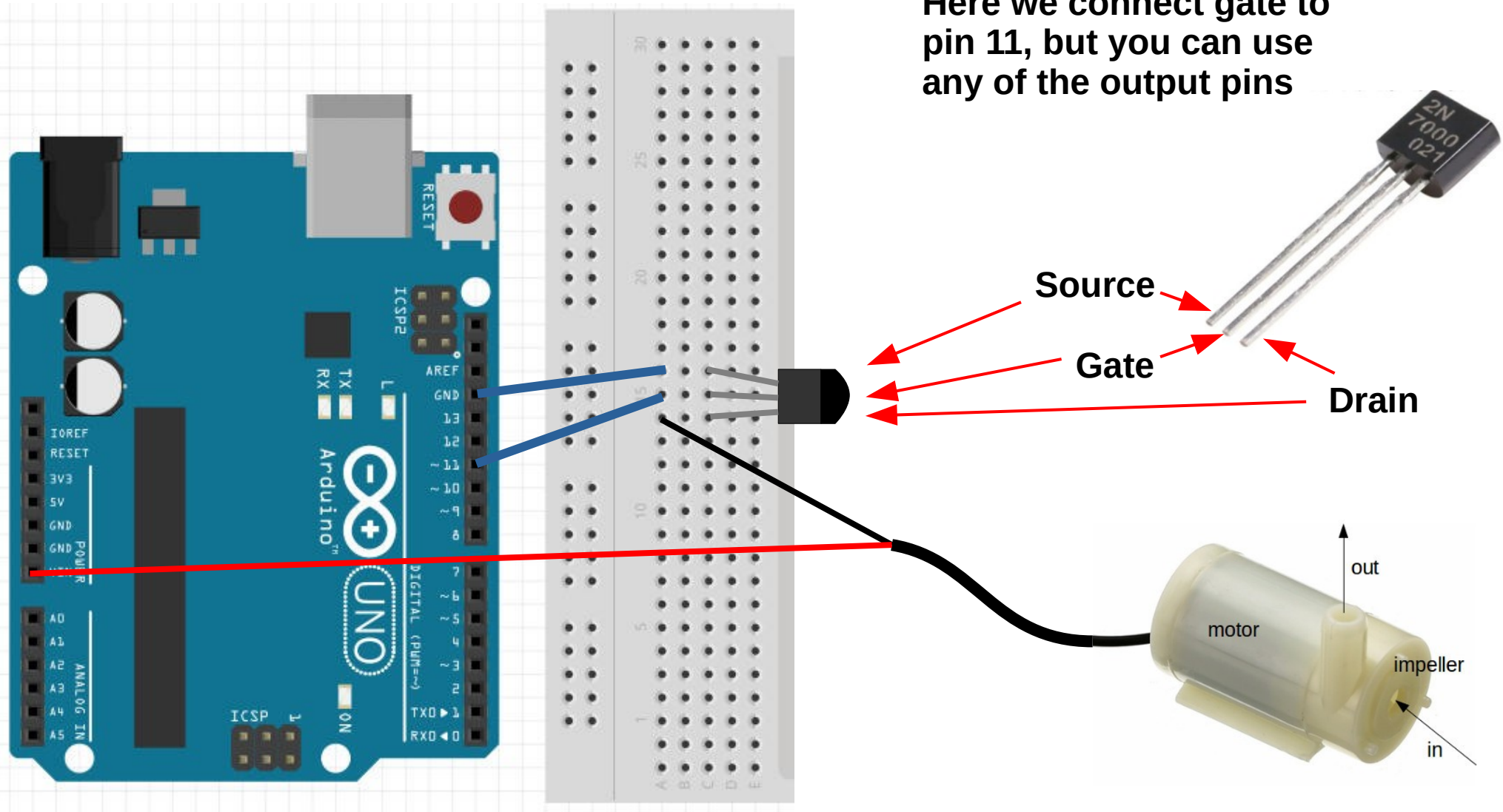
Pump

- Mini-Submersible Pump

- Red wire (positive): Connect to Vin
- Black wire (ground): Connect to Transistor
- Can be submerged in water
- Cannot be reversed
- Centrifugal type pump

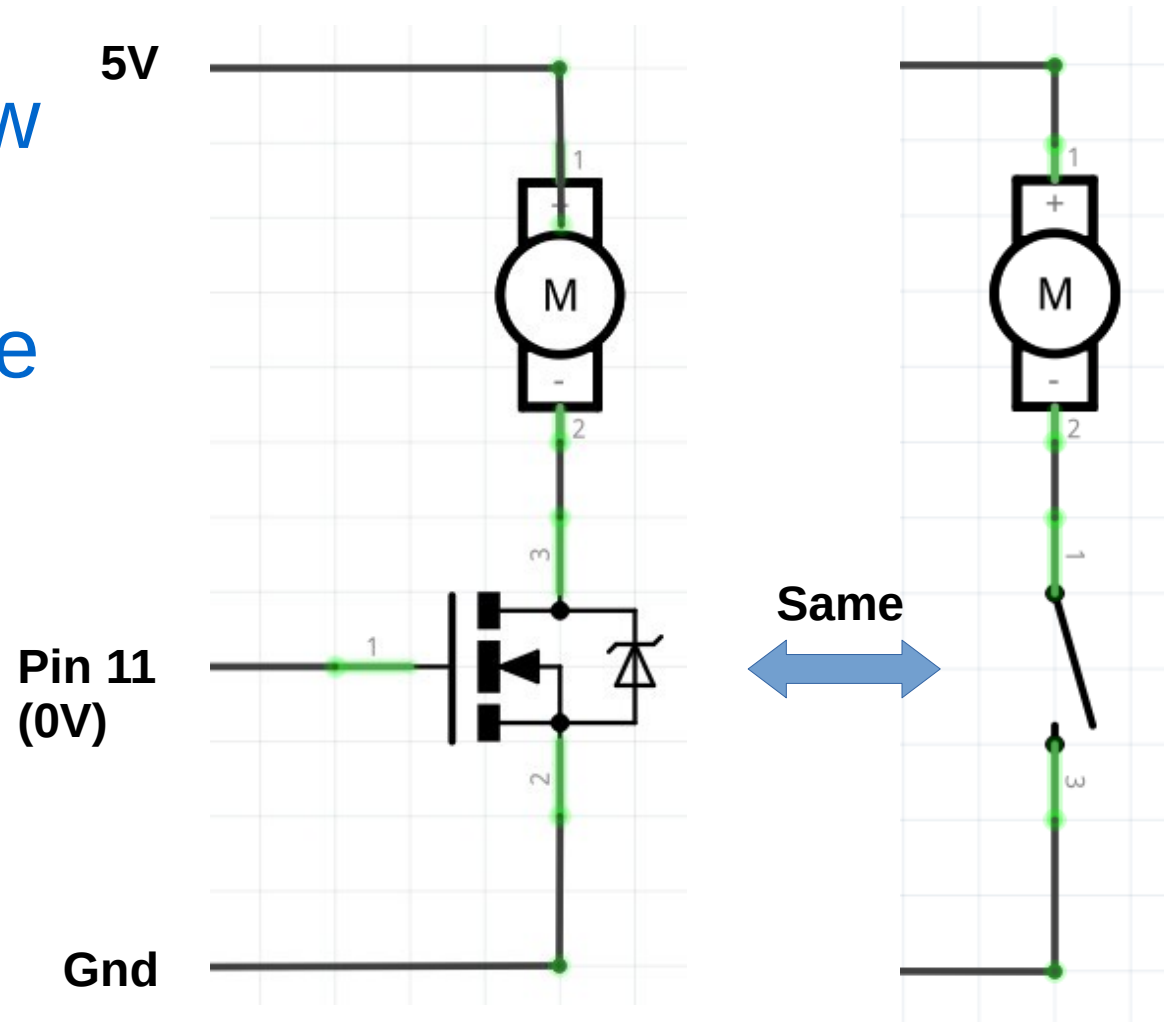


Transistor + Pump



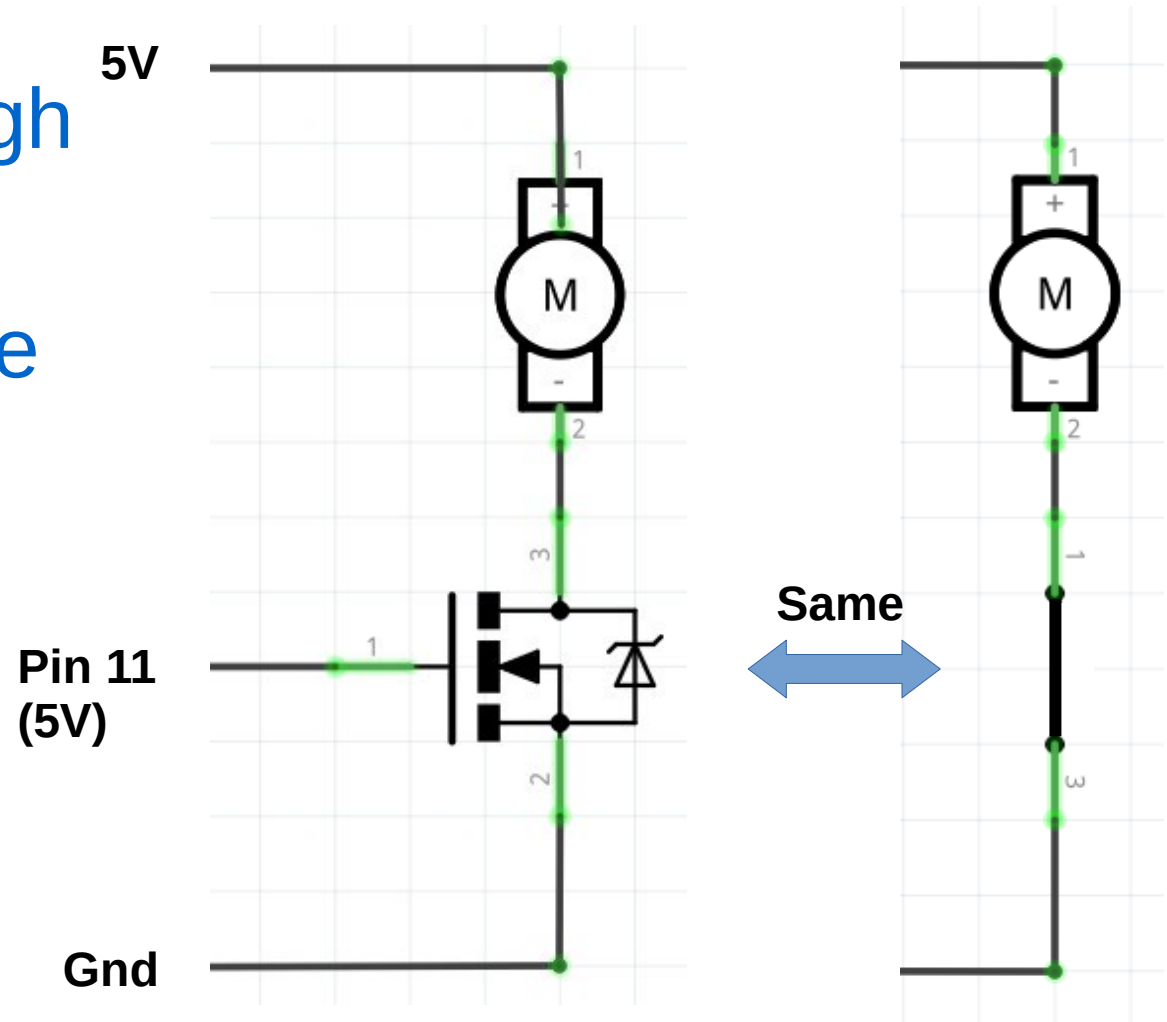
Transistor + Pump

- When pin 11 is low (0 V)
- Transistor acts like an opened switch



Transistor + Pump

- When pin 11 is high (5 V)
- Transistor acts like an closed switch



Try Out

- Like an LED, we can adjust the power of the pump using PWM.
- Unlike an LED, the pump may not turn at all if the PWM power is too low

What's the lowest power you can set and still have the pump turn?

Minimum Power

- Unlike an LED, a pump motor has inductance. This means that it takes a while for the current to flow.
- The pump will also need to overcome friction to start turning.
- If the PWM power is too low, it's not enough to overcome friction.

Adjustable Power Program

- Create a program that allows the user to set the pump power



Add this script to the sprite

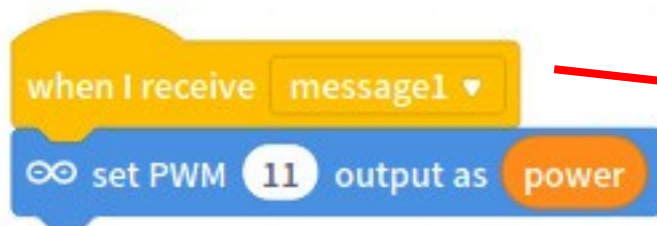


Draw this sprite
or use one of the
built-in sprite

Adjustable Power Program



Add this second script to the sprite



Add this script to the Arduino device



Challenges

1) Add in a script for reducing power when the down key is pressed

2) Part of the code for the “Set Power”, “Up key”, and “Down Key” are the same. Convert them into a My Block.

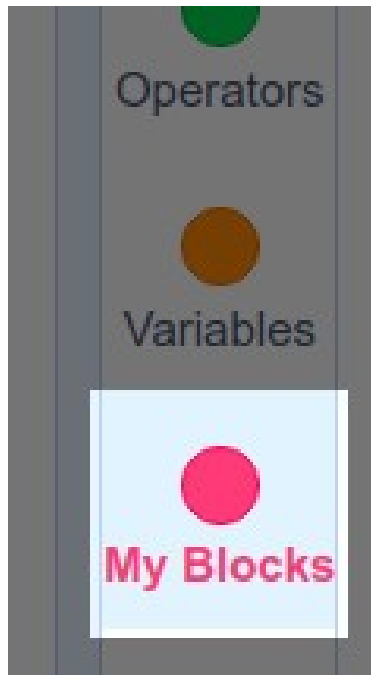
* Using My Blocks make your code neater and easier to change.

My Blocks

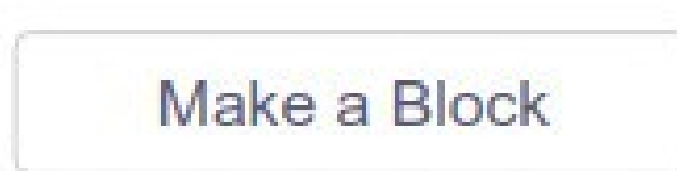
- My Blocks (...aka Functions, Subroutines)
 - Helps breaks a complicated program into smaller parts
 - Eliminate repetition
 - When making changes, only need to change one place

My Blocks

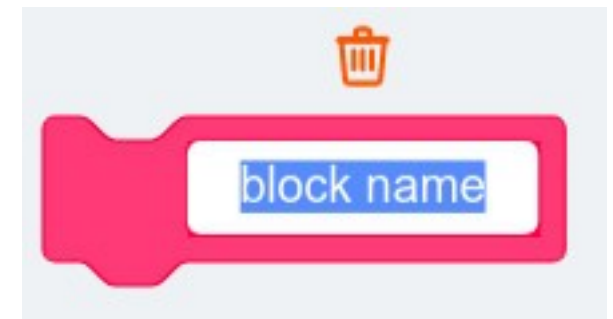
1) Go to “My Blocks”



2) Click “Make a Block”



3) Give it a name



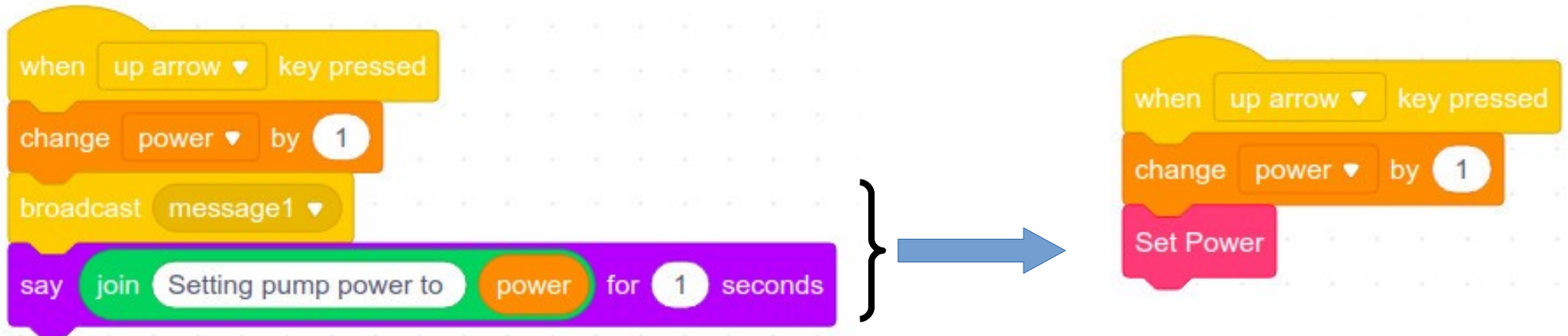
My Blocks

4) Fill in the “define”



My Blocks

5) Use the block!



Challenges

- Create a program that allows you to set...
 - How often to turn on the pump (eg. once every 60 seconds)
 - How long to turn on the pump each time (eg. on for 4 seconds)
 - The settings should be changeable using keyboard or mouse, but without changing the program code.

Bonus Challenges

- Add a potentiometer and use it to control the pump power
- Add a push button and program it to be an on-off toggle

Summary

- Use transistors to control high power devices
- Motors require a minimum power to start turning
- Use My Blocks to...
 - Replace repeated code
 - Break down complicated programs into smaller parts

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