



Armstrong

School Program 2023-2024

Lesson 4



Armstrong

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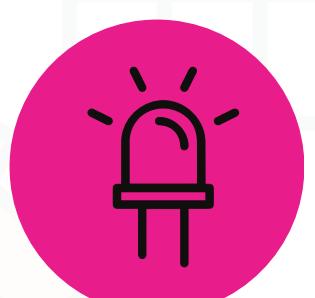
<https://armstrongedu.com/>



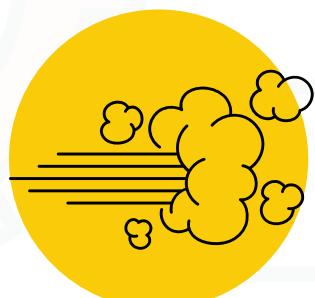
Lesson Content



Revising motor movement



PWM



Control speed



Remember

How to move wheel forward and backwards?

Pins:

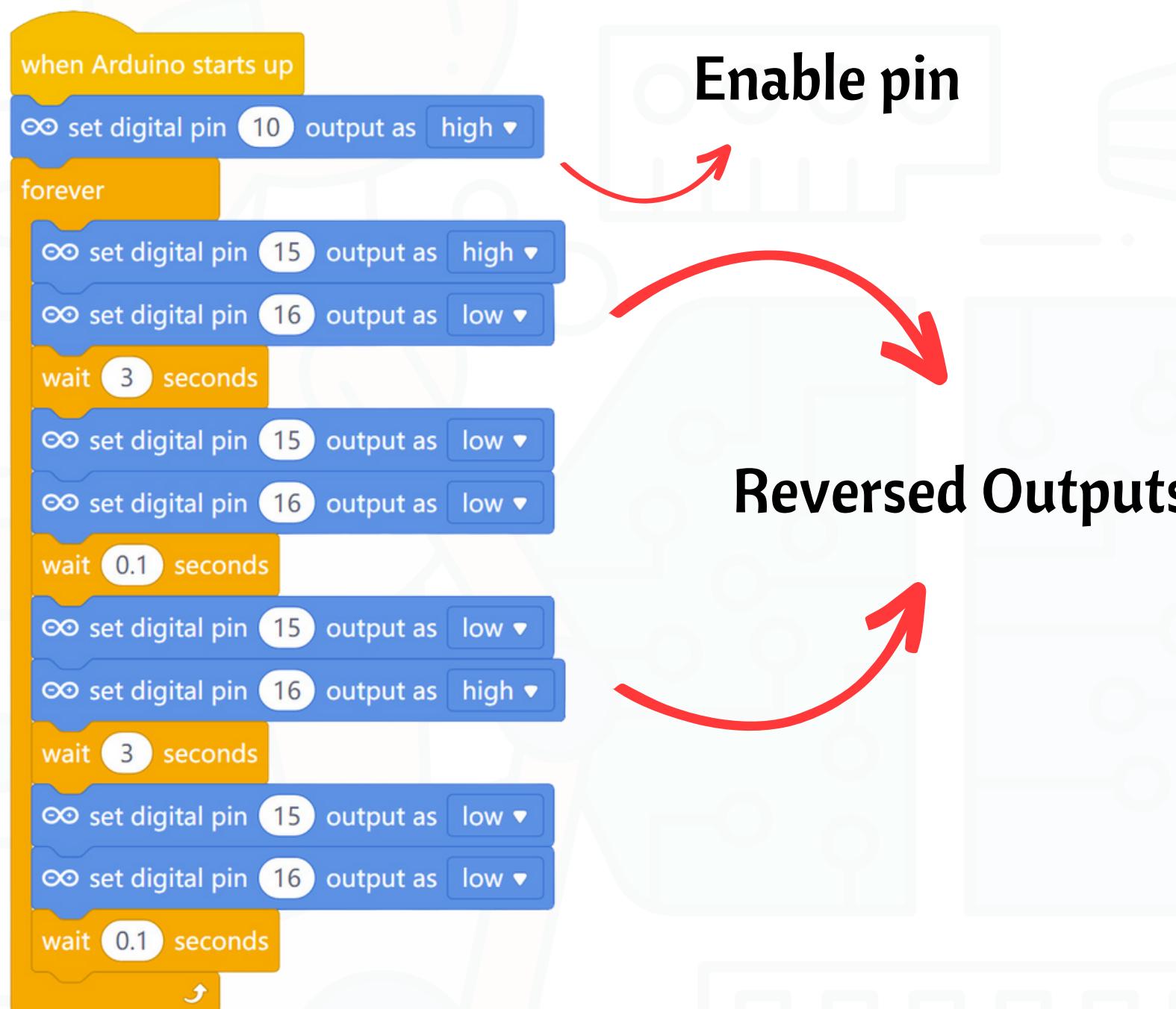
- Enable -> D10
- Input 1 -> A1 (15)
- Input2 -> A2 (16)





Remember

How to move wheel forward and backwards?

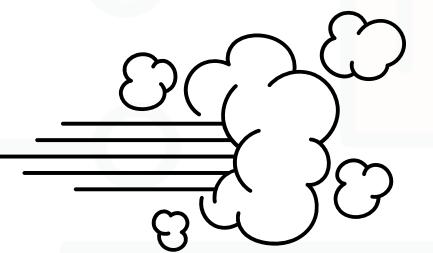


Enable pin

Reversed Outputs

Think

How can we control robot's speed?

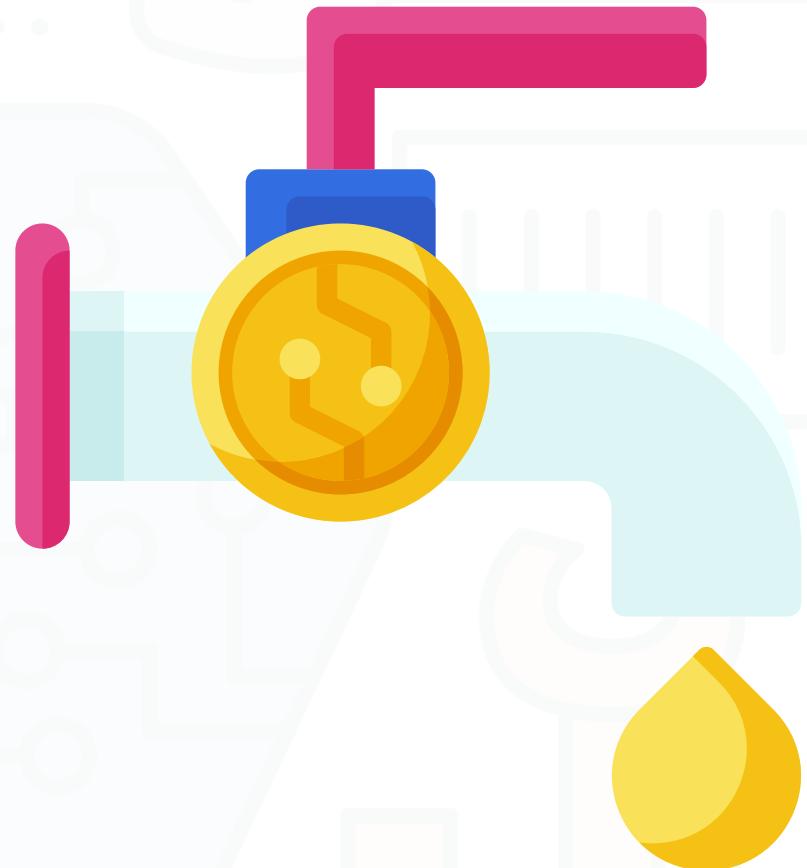


Analogy ≡

Imagine you have a faucet that can only be fully open or fully closed.

How can you control how much water comes out?

By turning the faucet on and off very quickly.



Analogy ≡

If you have to fill a bucket by turning the faucet on and off:

How can you get a small amount of water?

if you turn it on for a short time and then off for a long time.

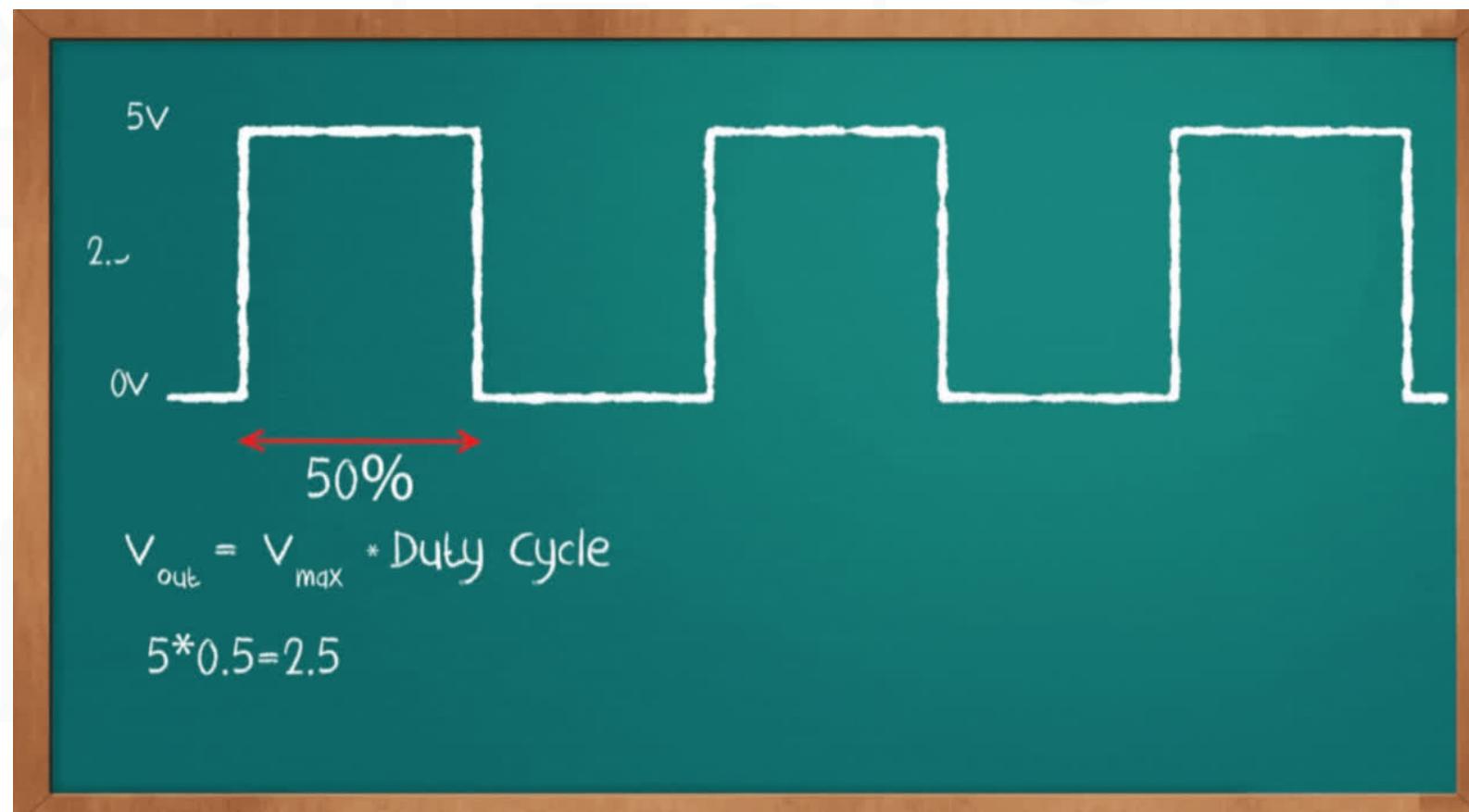


How can you get a bigger amount?

If you turn the faucet on for a long time and then off for a short time, you will get more water.

Analogy ≡

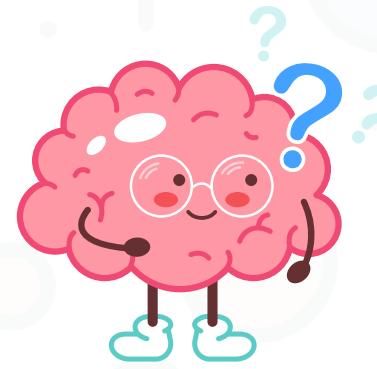
The amount of water that comes out depends on how long the faucet is on compared to how long it is off. This is called the **duty cycle**.



Duty cycle

The duty cycle is like the brightness of an LED. If the LED is on for a long time and then off for a short time, it will be brighter than if it is on for a short time and then off for a long time.

Think



If the switch is on for a long time and then off for a short time, the light bulb will be bright. If the switch is on for a short time and then off for a long time, the light bulb will be dim.

Can you see the flickering of the light?

Think



If the switch is on for a long time and then off for a short time, the light bulb will be bright. If the switch is on for a short time and then off for a long time, the light bulb will be dim.

Can you see the flickering of the light?

The human eye cannot see the flickering of the light, but it can perceive the average brightness.

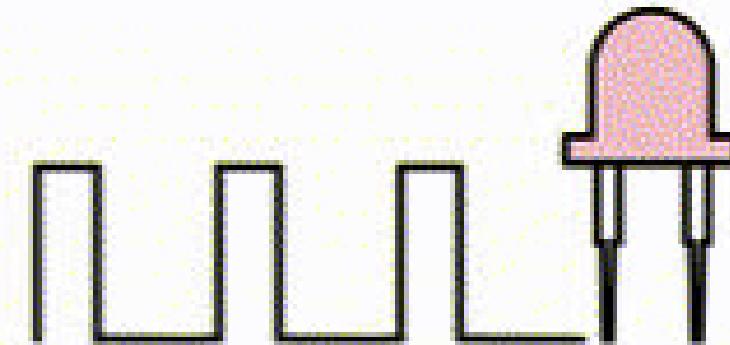
PWM

What does PWM stands for?

Pulse width modulation.

What is PWM?

PWM is a way to control the amount of electricity that goes to a device by turning it on and off very quickly, like a water faucet.

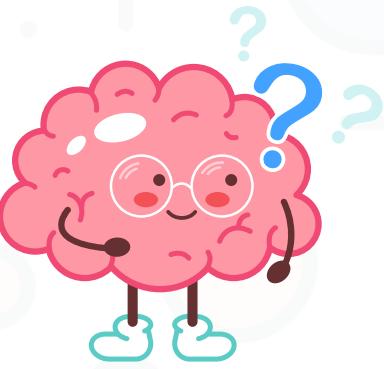


Think

Applications of PWM?

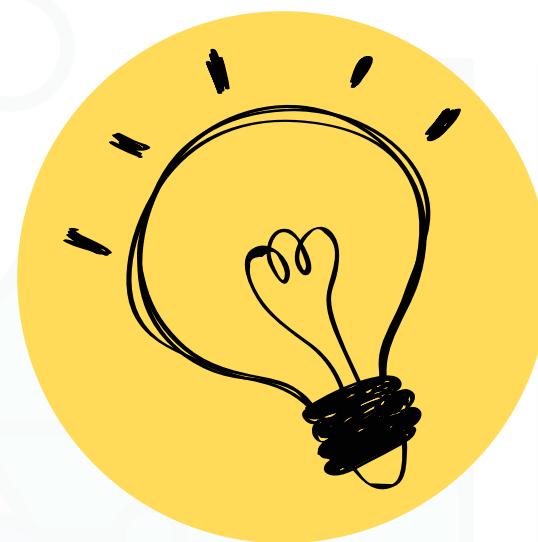
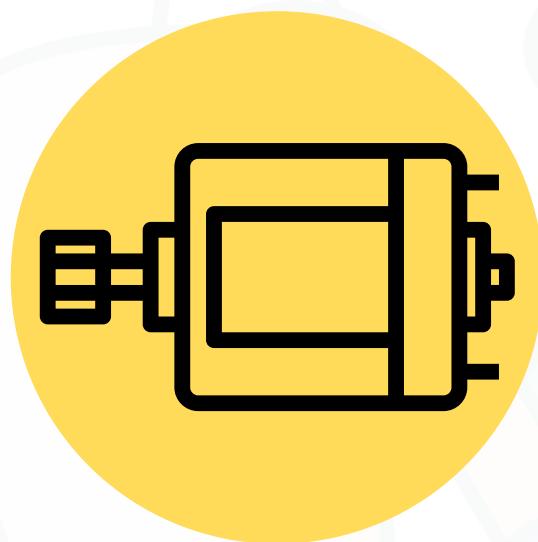


Think

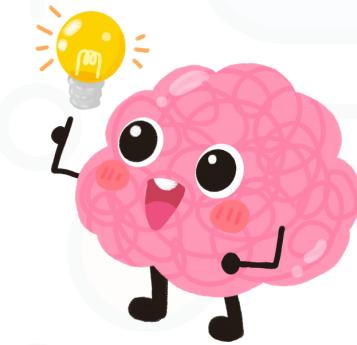


Applications of PWM

PWM can be used for various purposes, such as dimming an LED, producing audio signals, or controlling motor's speed.



Conclusion



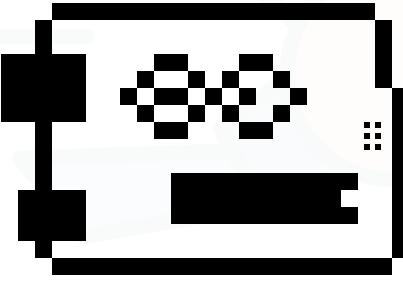
What do we conclude?

We can use the enable pin PWM to control wheel's speed in a certain way.



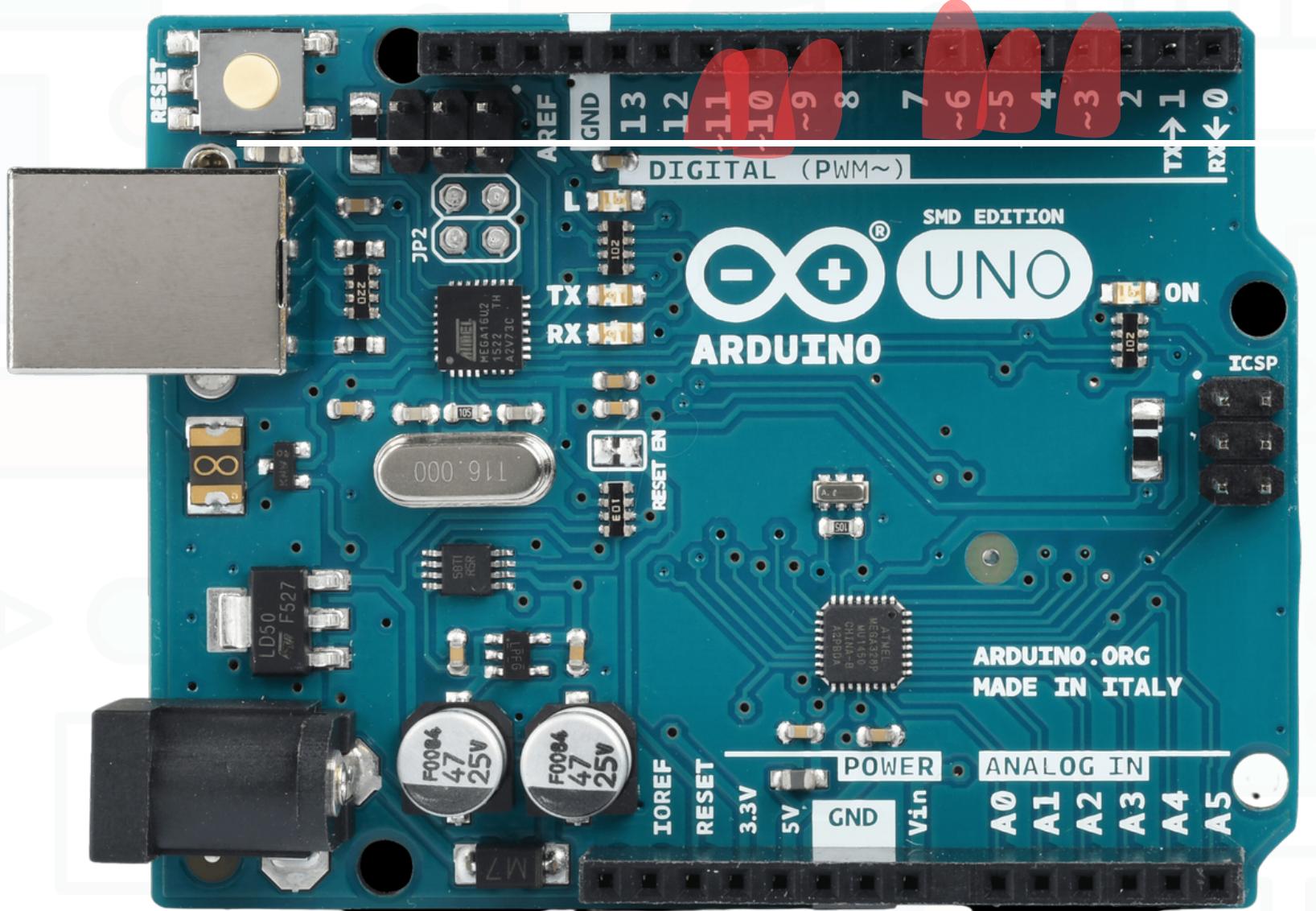
```
when Arduino starts up
  set digital pin [10 v] to [high v]
forever
  set digital pin [15 v] to [high v]
  set digital pin [16 v] to [low v]
  wait [3] seconds
  set digital pin [15 v] to [low v]
  set digital pin [16 v] to [low v]
  wait [0.1] seconds
  set digital pin [15 v] to [low v]
  set digital pin [16 v] to [high v]
  wait [3] seconds
  set digital pin [15 v] to [low v]
  set digital pin [16 v] to [low v]
  wait [0.1] seconds
```

PWM on Arduino



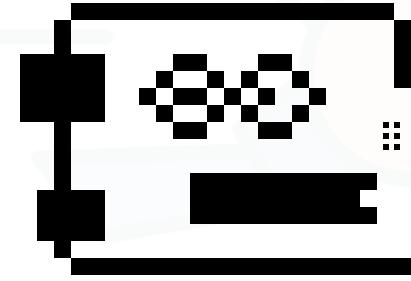
PWM pins

The PWM pins on Arduino are labeled with a ~ sign.



PWM pins are 3, 5, 6, 9, 10, 11.

PWM on Arduino



How to use it on mBlock

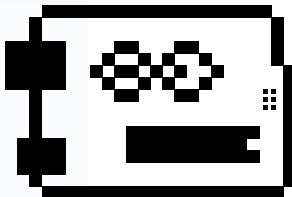


PWM pins 3, 5, 6, 9, 10, 11.

number between 0 and 255

Note

MOTOR	WHEEL	DIRECTION	SPEED
MOTOR 1	Back left wheel	D7, D8	D5
MOTOR 2	Front left wheel	D11, D12	D6
MOTOR 3	Back right wheel	D13, A0(14)	D9
MOTOR 4	Front right wheel	A1(15), A2(16)	D10

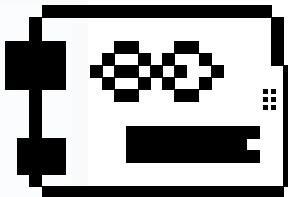
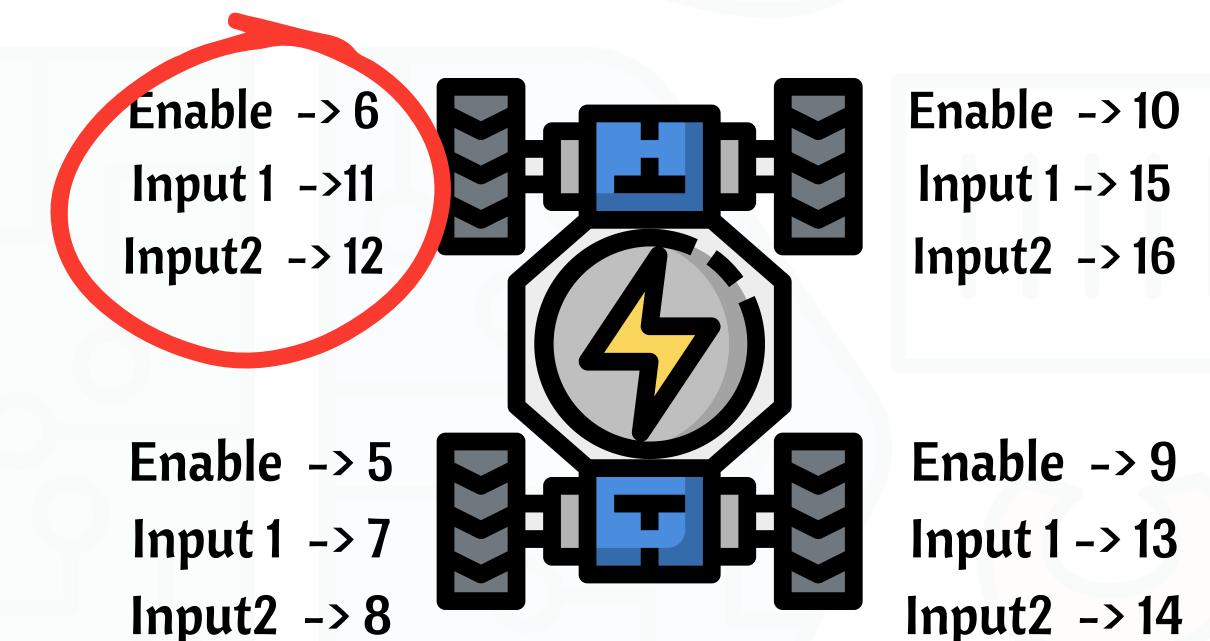


Let's try it on mBlock



Step 1: Write code to move first wheel forward with speed

Try it by yourself



Let's try it on mBlock



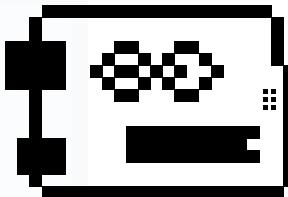
Step 1: Write code to move first wheel forward with speed

```
when Arduino starts up
  set PWM 6 output as 70
forever
  set digital pin 11 output as high
  set digital pin 12 output as low
```



Enable -> 10
Input 1 -> 15
Input2 -> 16

Enable -> 9
Input 1 -> 13
Input2 -> 14



Let's try it on mBlock



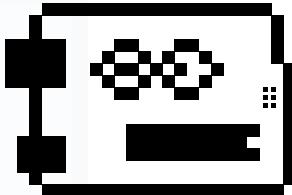
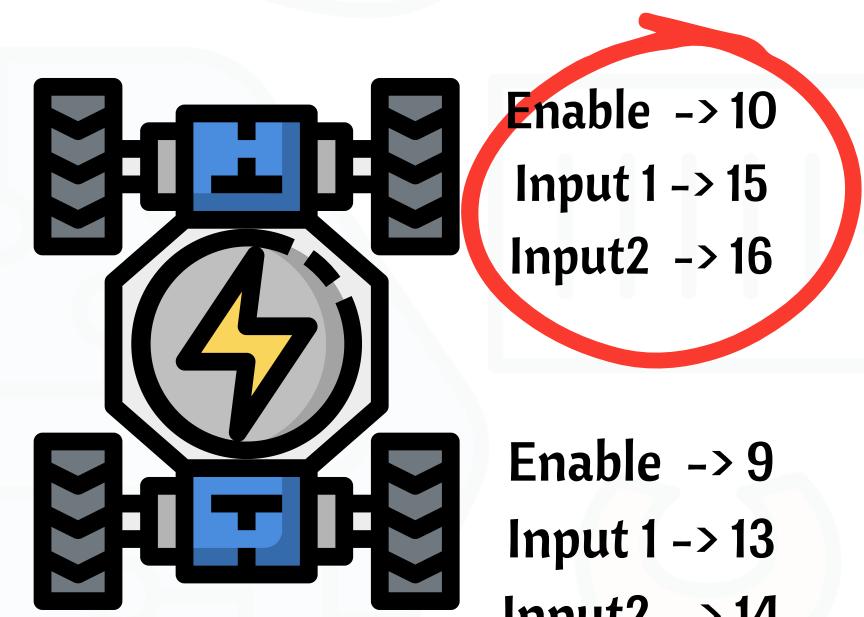
Step 2: Write code to move second wheel forward with speed

Try it by yourself



Enable -> 6
Input 1 -> 11
Input2 -> 12

Enable -> 5
Input 1 -> 7
Input2 -> 8



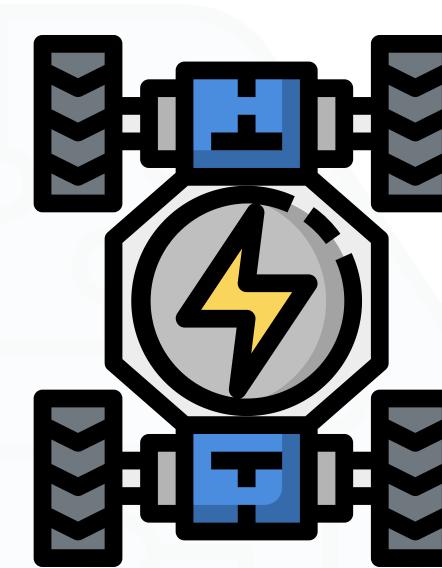
Let's try it on mBlock



Step 2: Write code to move second wheel forward with speed

```
when Arduino starts up
  ⌂ set PWM 6 output as 70
  ⌂ set PWM 10 output as 70
forever
  ⌂ set digital pin 11 output as high ▾
  ⌂ set digital pin 12 output as low ▾
  ⌂ set digital pin 15 output as high ▾
  ⌂ set digital pin 16 output as low ▾
end
```

Enable → 6
Input 1 → 11
Input2 → 12

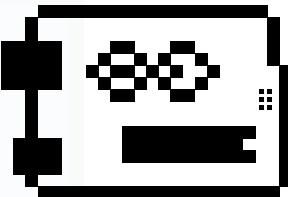


Enable → 10
Input 1 → 15
Input2 → 16

Enable → 5
Input 1 → 7
Input2 → 8



Enable → 9
Input 1 → 13
Input2 → 14



Let's try it on mBlock



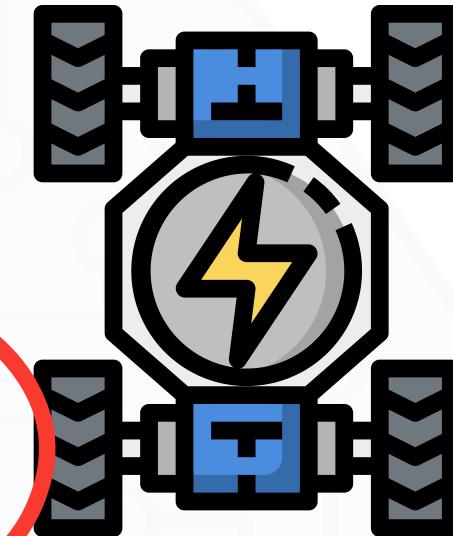
Step 3: Write code to move third wheel forward with speed

Try it by yourself



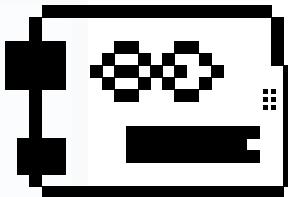
Enable -> 6
Input 1 -> 11
Input2 -> 12

Enable -> 5
Input 1 -> 7
Input2 -> 8



Enable -> 10
Input 1 -> 15
Input2 -> 16

Enable -> 9
Input 1 -> 13
Input2 -> 14

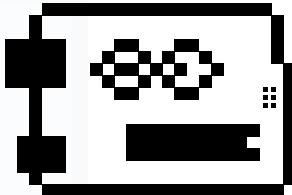
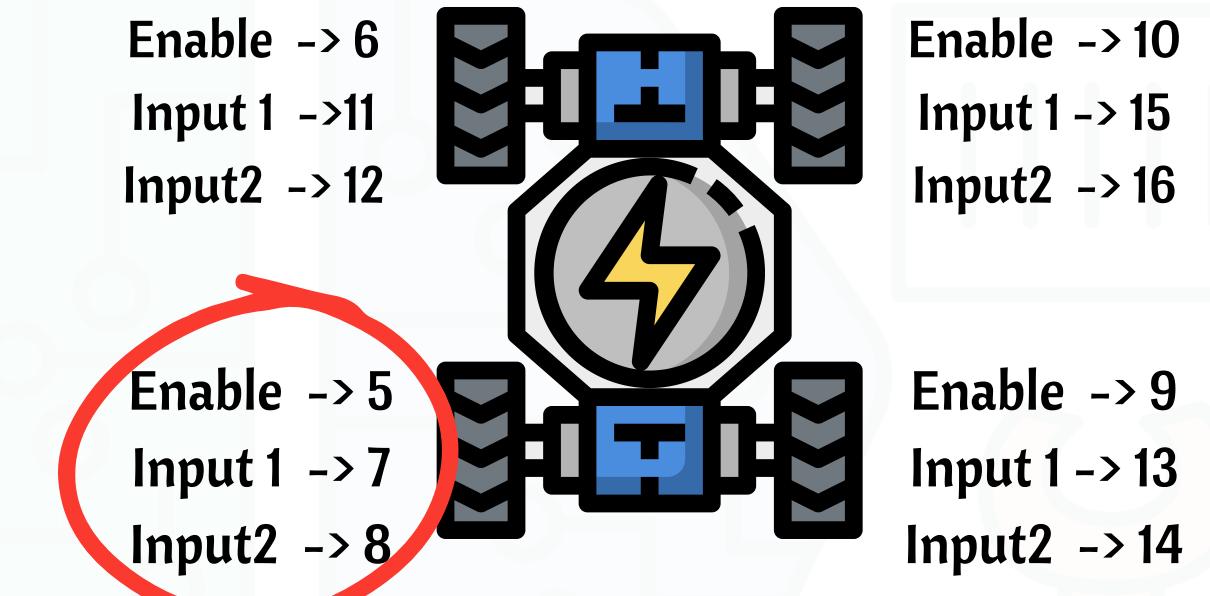


Let's try it on mBlock



Step 3: Write code to move third wheel forward with speed

```
when Arduino starts up
  ⚡ set PWM 6 output as 70
  ⚡ set PWM 10 output as 70
  ⚡ set PWM 5 output as 70
forever
  ⚡ set digital pin 11 output as high ▾
  ⚡ set digital pin 12 output as low ▾
  ⚡ set digital pin 15 output as high ▾
  ⚡ set digital pin 16 output as low ▾
  ⚡ set digital pin 7 output as high ▾
  ⚡ set digital pin 8 output as low ▾
end
```



Let's try it on mBlock



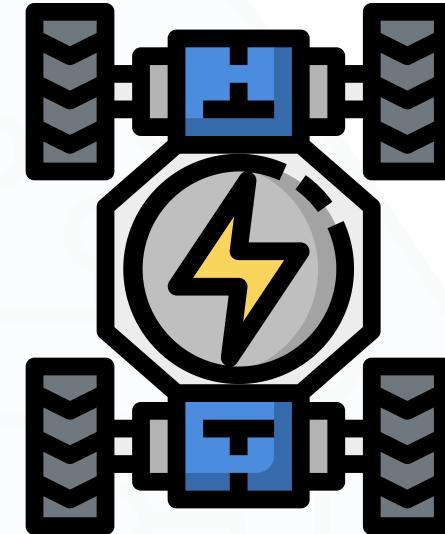
Step 4: Write code to move forth wheel forward with speed

Try it by yourself



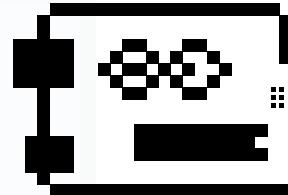
Enable -> 6
Input 1 -> 11
Input2 -> 12

Enable -> 5
Input 1 -> 7
Input2 -> 8



Enable -> 10
Input 1 -> 15
Input2 -> 16

Enable -> 9
Input 1 -> 13
Input2 -> 14



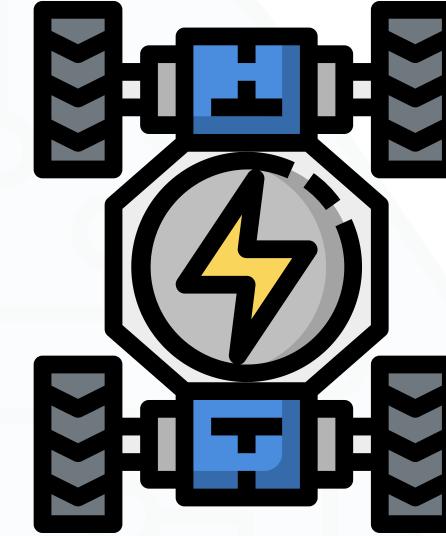
Let's try it on mBlock



Step 4: Write code to move forth wheel forward with speed

```
when Arduino starts up
  set PWM 6 output as 70
  set PWM 10 output as 70
  set PWM 5 output as 70
  set PWM 9 output as 70
forever
  set digital pin 11 output as high ▾
  set digital pin 12 output as low ▾
  set digital pin 15 output as high ▾
  set digital pin 16 output as low ▾
  set digital pin 7 output as high ▾
  set digital pin 8 output as low ▾
  set digital pin 13 output as high ▾
  set digital pin 14 output as low ▾
```

Enable -> 6
Input 1 -> 11
Input2 -> 12

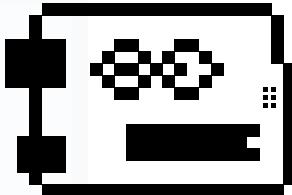


Enable -> 10
Input 1 -> 15
Input2 -> 16

Enable -> 5
Input 1 -> 7
Input2 -> 8



Enable -> 9
Input 1 -> 13
Input2 -> 14



Let's try it on mBlock



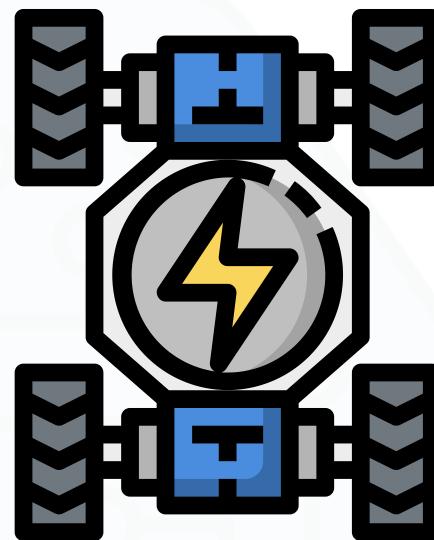
Step 5: Write code to move robot backwards with speed

Try it by yourself



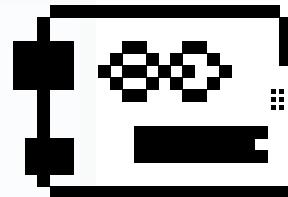
Enable -> 6
Input 1 -> 11
Input2 -> 12

Enable -> 5
Input 1 -> 7
Input2 -> 8



Enable -> 10
Input 1 -> 15
Input2 -> 16

Enable -> 9
Input 1 -> 13
Input2 -> 14

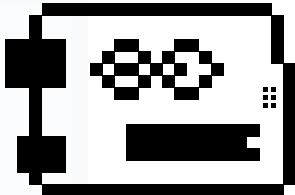


Let's try it on mBlock

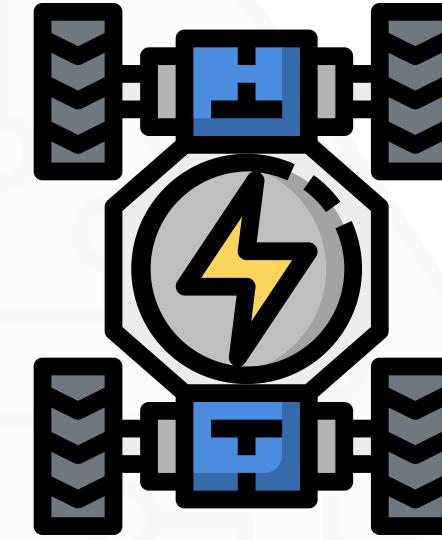


Step 5: Write code to move robot backwards with speed

```
when Arduino starts up
  ⚡ set PWM 6 output as 70
  ⚡ set PWM 10 output as 70
  ⚡ set PWM 5 output as 70
  ⚡ set PWM 9 output as 70
forever
  ⚡ set digital pin 11 output as low ▾
  ⚡ set digital pin 12 output as high ▾
  ⚡ set digital pin 15 output as low ▾
  ⚡ set digital pin 16 output as high ▾
  ⚡ set digital pin 7 output as low ▾
  ⚡ set digital pin 8 output as high ▾
  ⚡ set digital pin 13 output as low ▾
  ⚡ set digital pin 14 output as high ▾
```



- | | |
|---------------|---------------|
| Enable -> 6 | Enable -> 10 |
| Input 1 -> 11 | Input 1 -> 15 |
| Input2 -> 12 | Input2 -> 16 |
-
- | | |
|--------------|---------------|
| Enable -> 5 | Enable -> 9 |
| Input 1 -> 7 | Input 1 -> 13 |
| Input2 -> 8 | Input2 -> 14 |





Remember



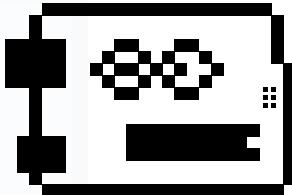
number between 0 and 255

Let's try it on mBlock



Step 6: Experiment with different speeds

Try it by yourself



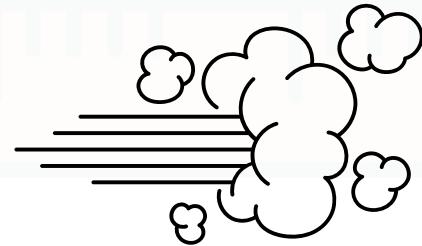
Observe

What did you notice?



Think

What if we tried different speeds for each wheel?



Let's try it on mBlock



Try different speeds for each wheel

Try it by yourself

