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Embedded Systems Course

Project 1: Automatic Water Level Controller

In your neighbourhood, you have noticed the water tanks on the roof of the houses overflow frequently. You have also noticed that many times, the existing water in the tank is not fully consumed before the tank starts filling again. You are a responsible citizen and conscious of the fact that water is one of the most important natural resources on earth for sustaining human life and hence shouldn't be wasted. You want the residents of your neighbourhood to responsibly save and consume water.

To help the residents you have decided to build an automatic water level controller that will monitor the water consumption and accordingly fill the tank when the tank is almost empty. You will also ensure that your solution ensures that water is not overflowing from the tank.

In this project, you will learn to build an automatic water level controller.

Let's get started!

Prerequisite:

Ensure that you have gone through all the videos of the course Embedded Systems on Planetcode.in portal. These videos will help you to learn about the important terms and concepts as well as the equip you with the tools needed for this project. If you have already completed watching all the videos, well done! You are also set to begin the project.

If you have not completed the videos, please go to the platform https://planetcode.in/ to complete them before you proceed.

1. Platforms / Tools Needed

Tinkercad: https://www.tinkercad.com/

2. Major Steps to be performed in the Project

a) Make the Arduino and the breadboard Connections.

b) Connect the circuit for the water-level indicator.

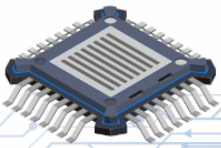
c) Connect the ultrasonic sensor that will gauge the water level.

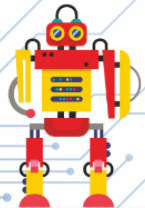
d) Link the LCD to display the state of the water level.

e) Connect l239d IC, DC motor and battery in the circuit.



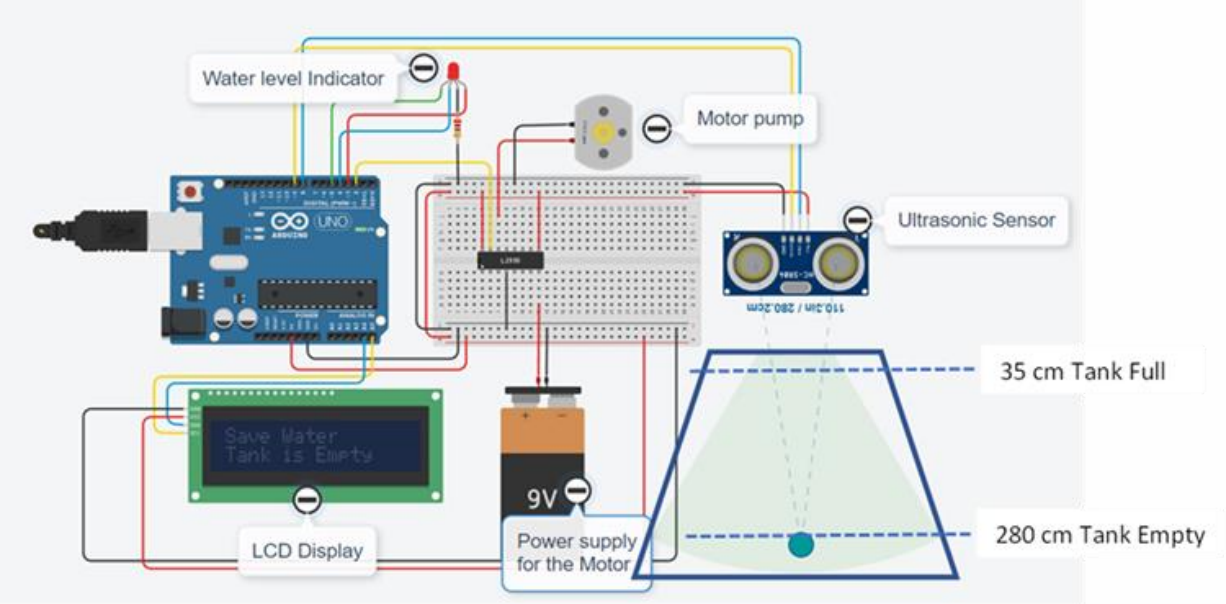






f) Program the circuit using Tinkercad's code editor.

g) Test the simulation and note your observations.



Components Used:

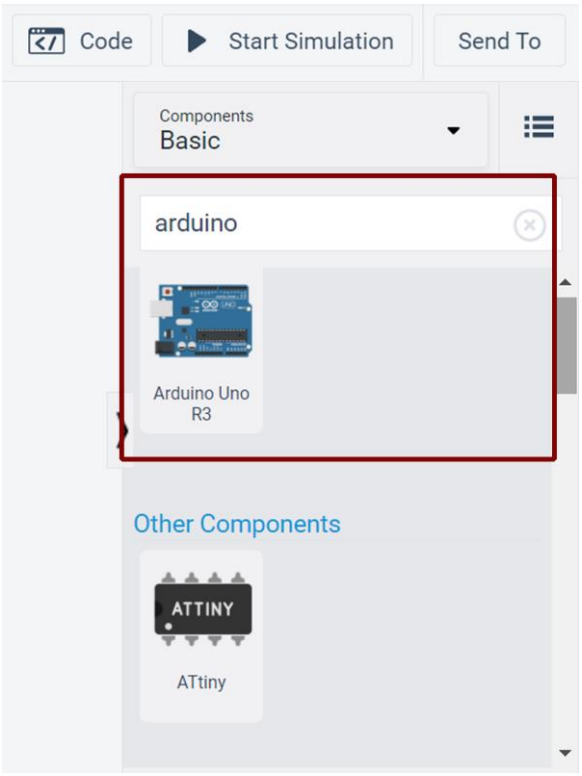
STEP by STEP Instructions

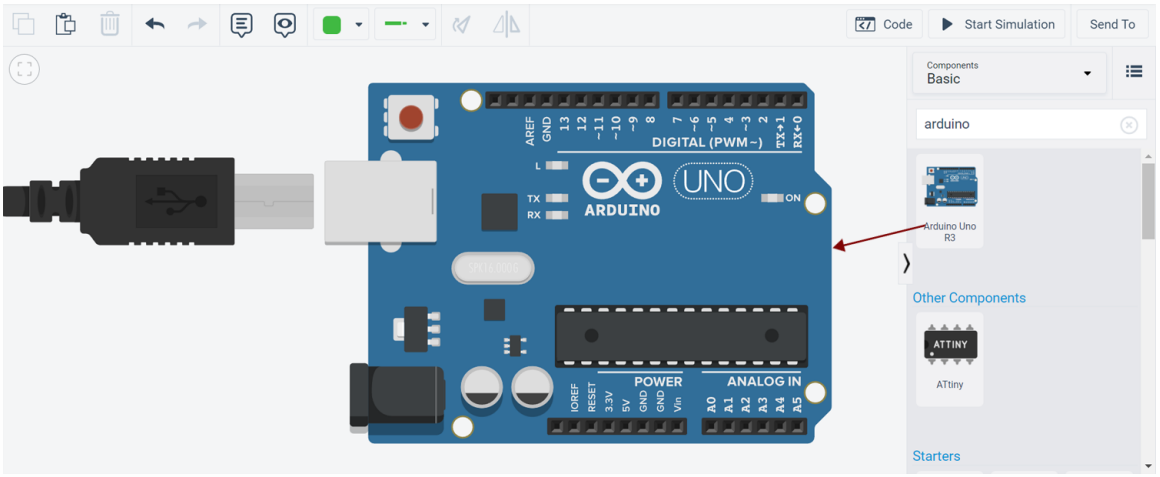
Part 1: First, you will setup the Arduino uno board (Controller) and the breadboard

Step 1

Search for 'Arduino'.

Drag and drop it in the circuit area.



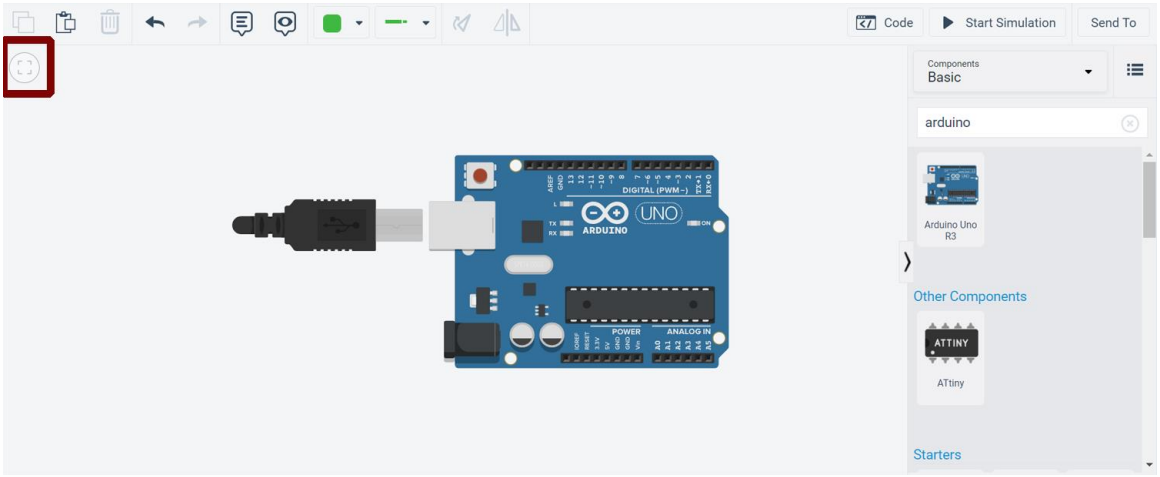


Step 2

Press the keys '**ctrl**' and '**-**' simultaneously, to zoom out the components in the circuit area.

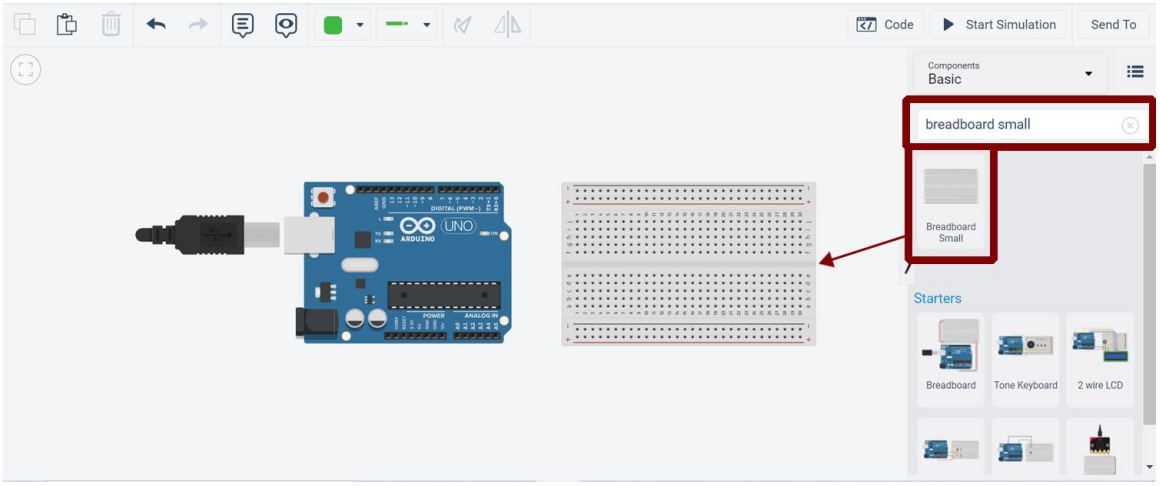
Press '**ctrl**' and '**+**' together to zoom in, when required.

You can also use the 'zoom to fit' option as shown in the image below.



Step 3

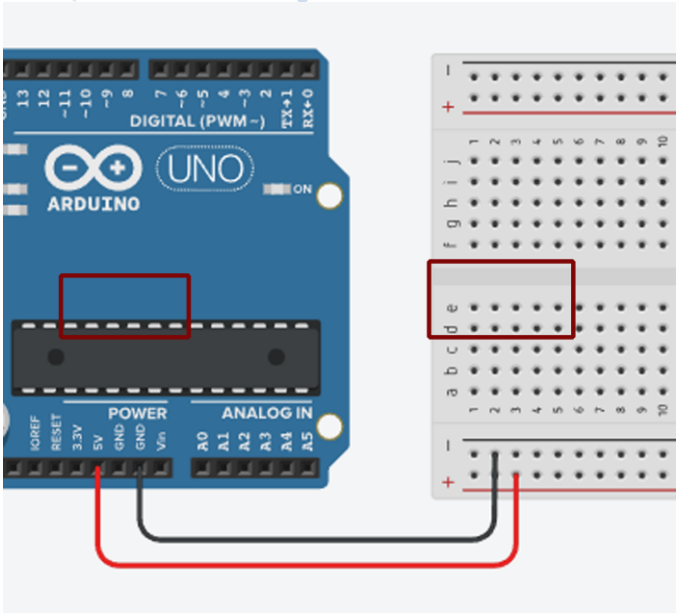
Search and place the '**Breadboard small**'.



Step 4

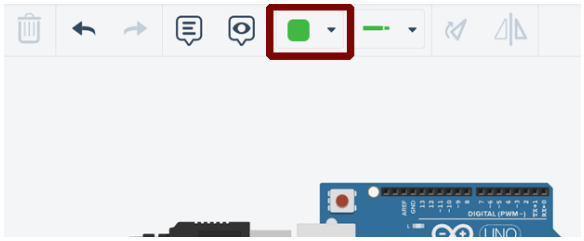
Find +5v in the Arduino and connect it to the '**+ve**' row of the breadboard's power rail as shown in the image.

Find GND (Ground) in the Arduino and connect it to the '**–ve**' row of the breadboard's power rail as shown in the image.



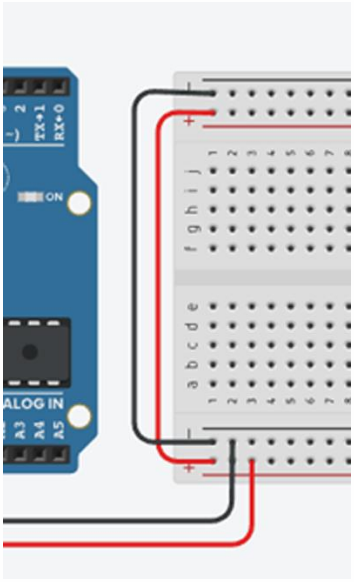
Step 5

You can change the wire colour, by using the drop-down list as shown.



STEP 6

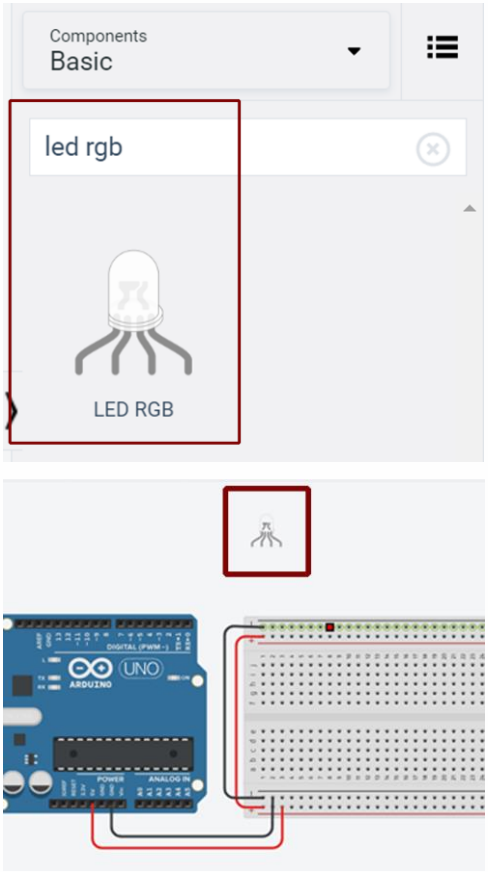
Connect the lower to the upper power rail of the breadboard.



Part 2: You will now make the circuit connections for the water-level indicator.

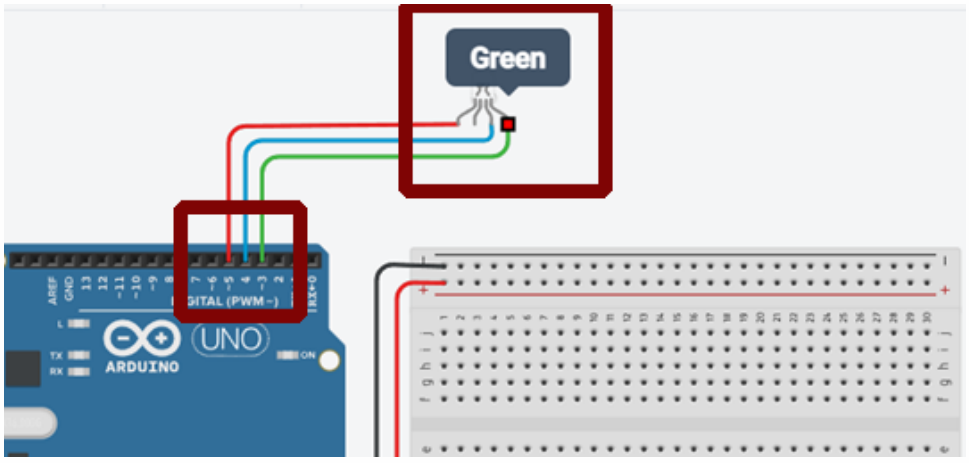
Step 7:

Search for '**RGB LED**' and place it as shown.



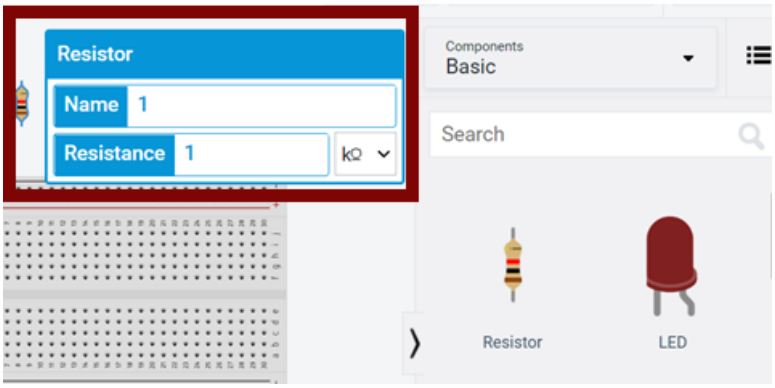
Step 13

Connect Arduino pins 3, 4, and 5 to RGB LED's green, blue, and red legs accordingly.



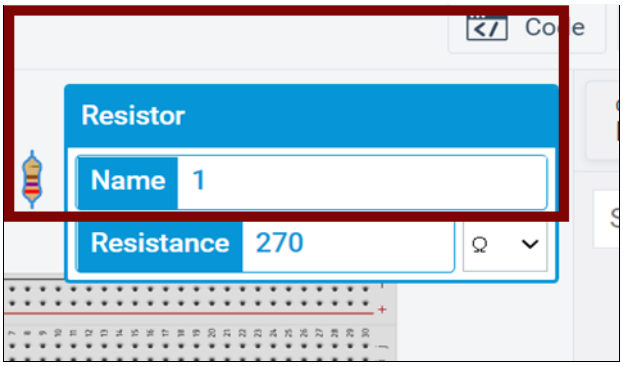
Step 9

Search and place a Resistor.



Step 10

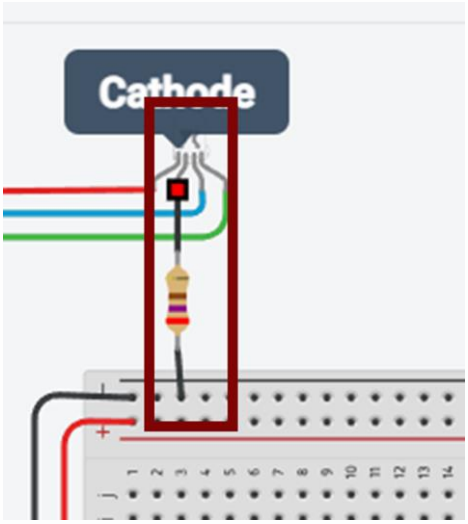
Change the Resistor value to 270ohms.



Step 11

Connect one end of the resistor to the RGB LED's cathode leg.

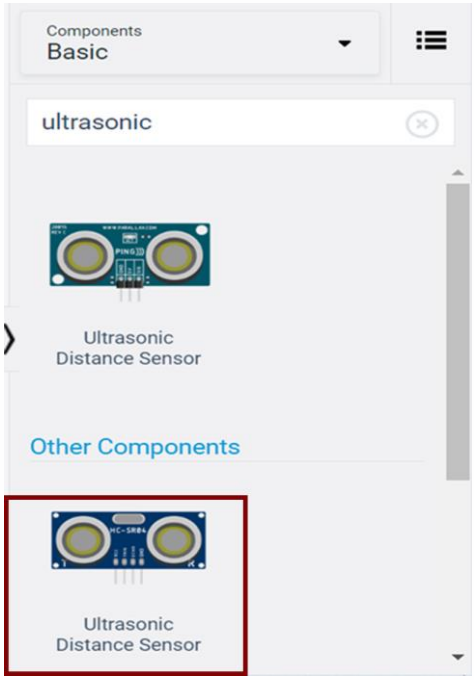
Connect the other end of the resistor to the -ve row of the upper rail of the breadboard.



PART 3: Connect the ultrasonic sensor that will gauge the water level.

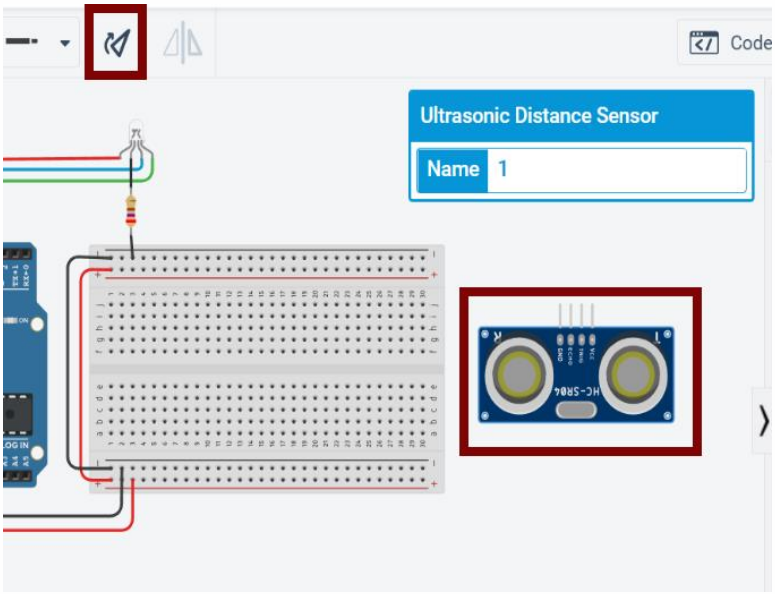
Step 12

Search and place the Ultrasonic sensor HC-SR04.



Step 13

Rotate the ultrasonic sensor using the rotate button, as shown.

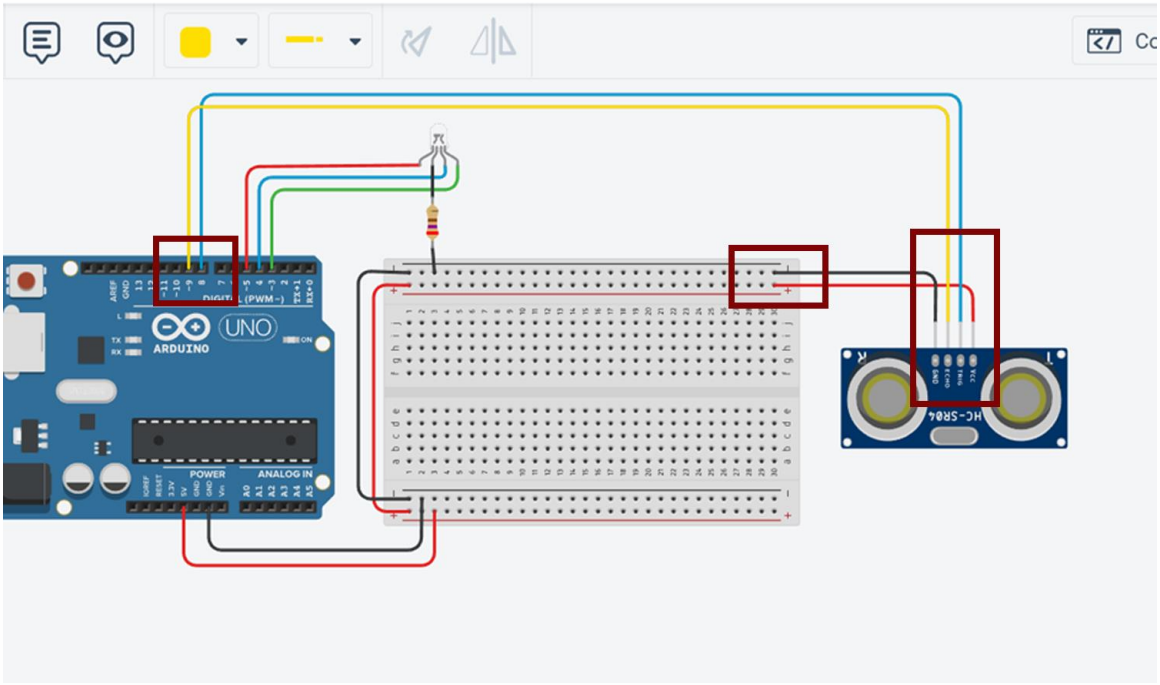


Step 14

Connect the Power (Vcc) pin of the ultrasonic sensor to the +row of the Breadboard power rail.

Connect the Ground (GND) pin of the ultrasonic sensor to the Breadboard power rail -row respectively.

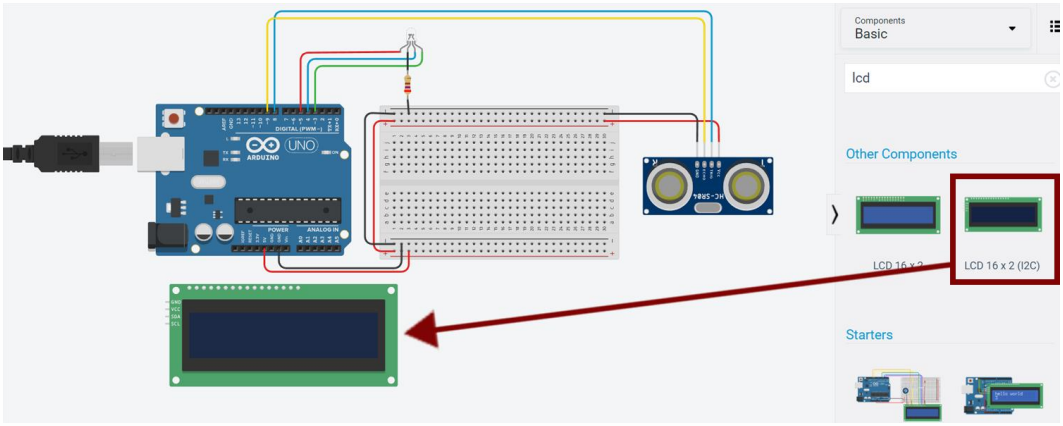
Connect trig, and echo pins of the Ultrasonic Sensor to the Arduino digital pins D8, and D9 respectively.



Part 4: You will now connect the LCD to the Arduino that will display the state of the water level.

Step 15

Search and place the LCD 16 X 2 (I2C) component as shown.



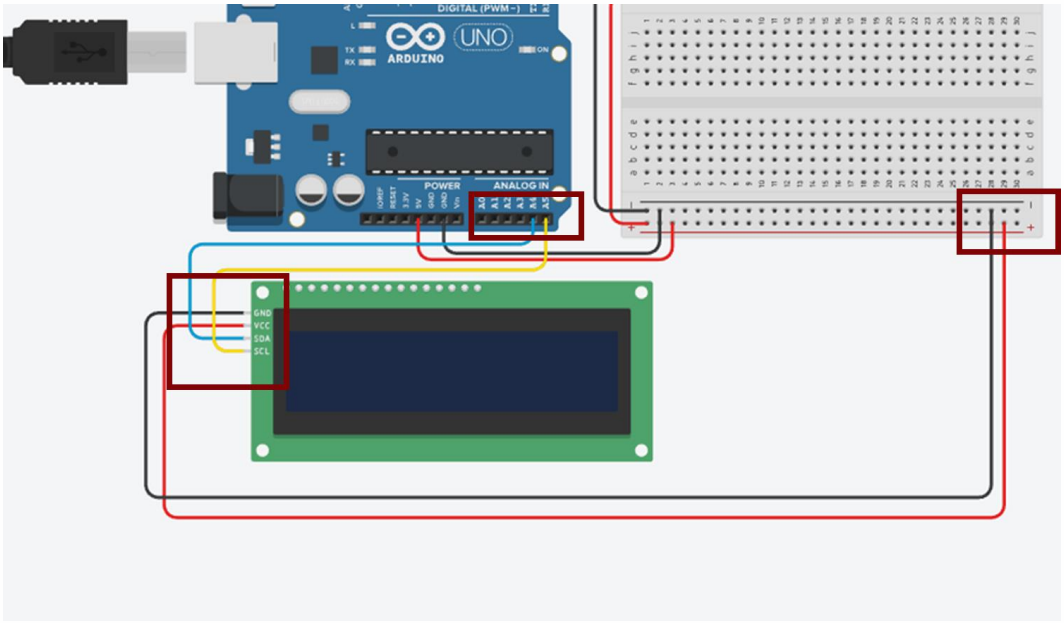
Step 16

Connect power (Vcc) of the LCD to the power rail +ve of the breadboard.

Connect the Ground (GND) of the LCD to power rails -ve of the breadboard.

Connect SDA pin of the LCD to the A4 Arduino pin.

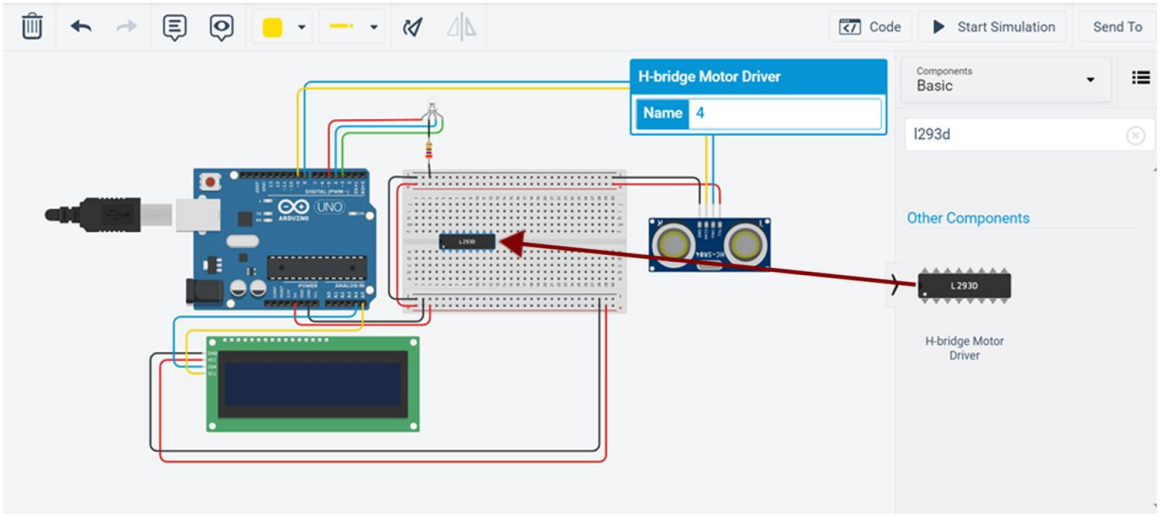
Connect the SCL pin of the LCD to the A5 Arduino pin.



Part 5: You will now set up the circuit connections for L293D IC, DC motor and battery in the circuit.

Step 17

Search and place L293D IC on the breadboard as shown.

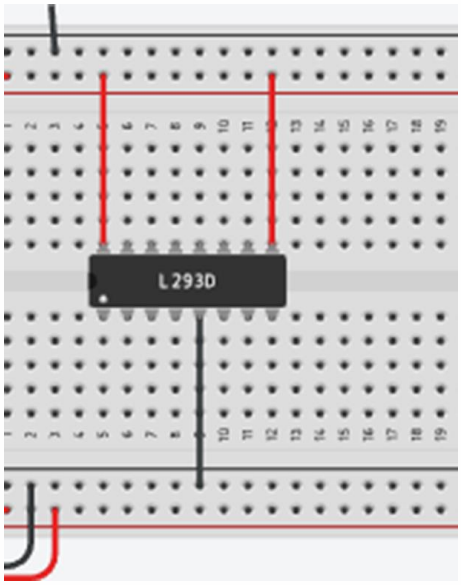


Step 18

Connect power1 pin of the L293D IC to +ve power rail of the breadboard.

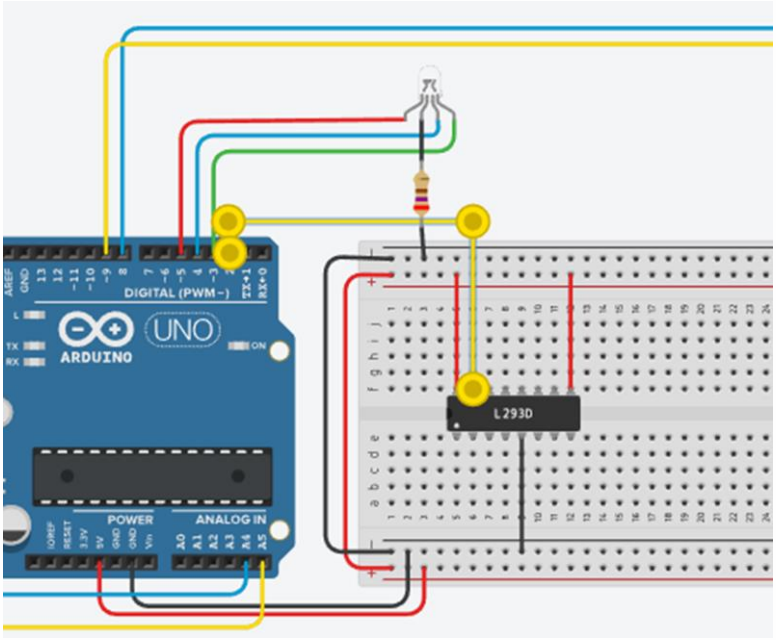
Connect the Ground pin of the L293D IC to the -ve power rail of the breadboard.

Connect Enable 3&4 pin of L293D IC to the +ve power rail on the breadboard.



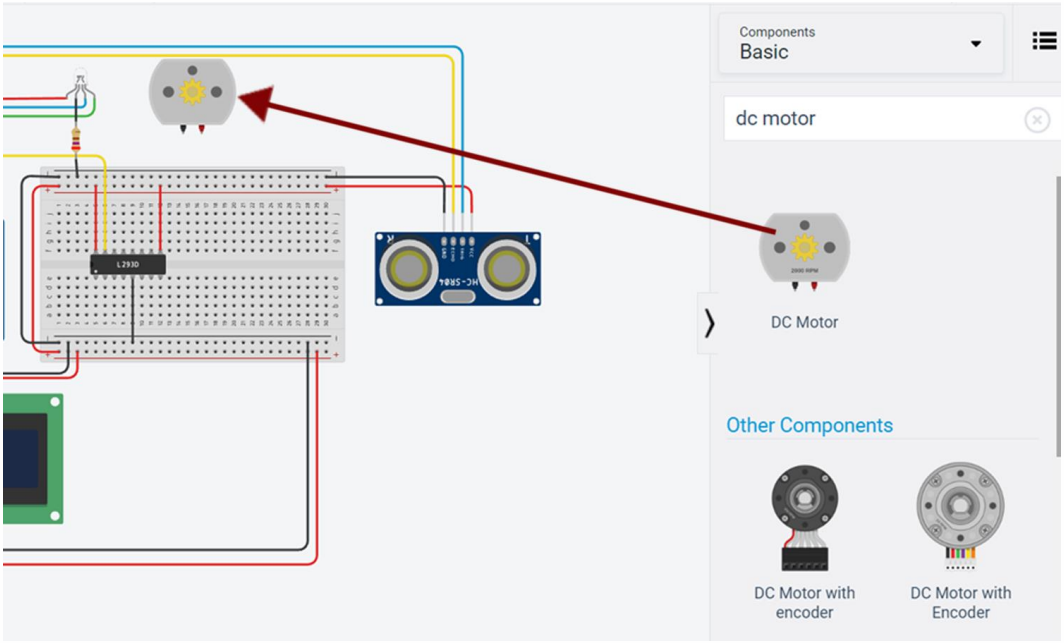
Step 19

Connect input 4 pin of the L293D IC to Arduino pin D2.



Step 20

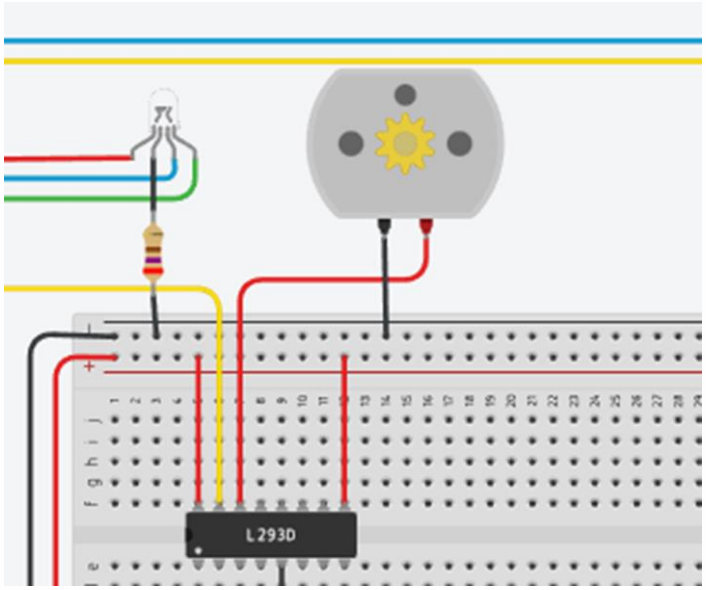
Search and place the DC Motor as shown.



Step 21

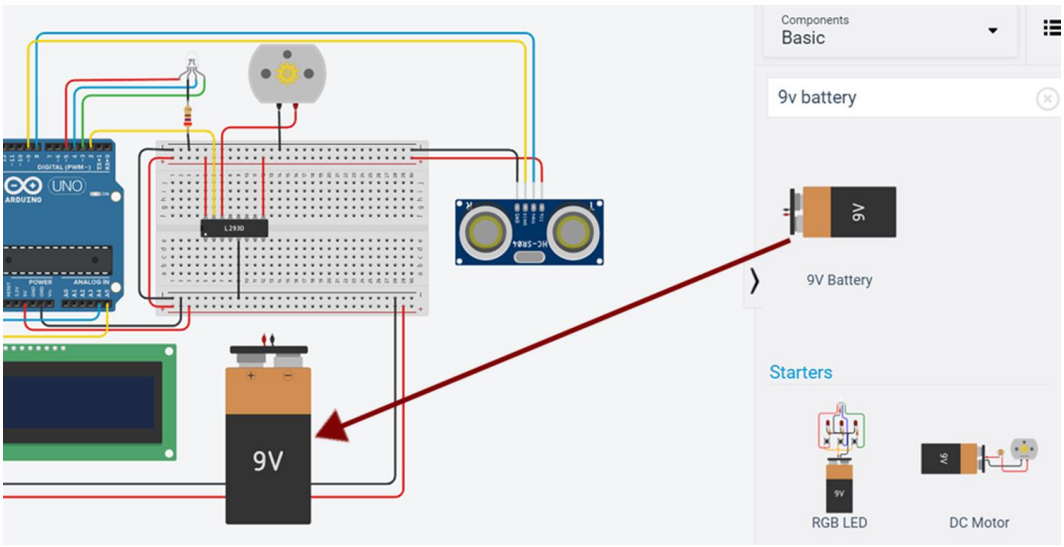
Connect output 4 pin of the L293D IC to the DC motor's terminal2(+ve)

Connect Dc motor's terminal1(-ve) to the breadboard -ve(gnd) power rail.



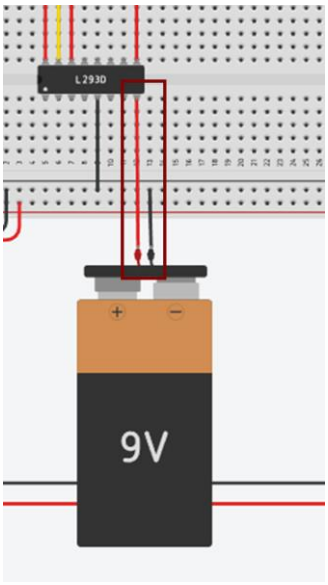
Step 22

Search and place the 9v battery.



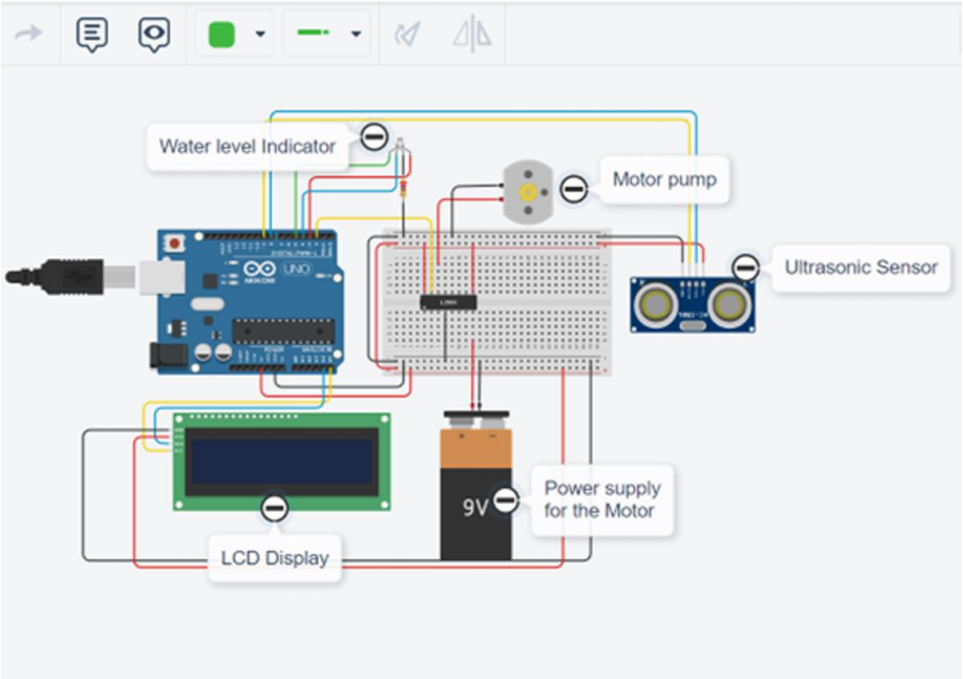
Connect the positive terminal of the 9v battery to L293D IC's power 2 pin.

Connect the negative terminal of the 9v battery to the breadboard's -ve row power rail.



Step 24

Name the components using the Notes tool as shown in the image below.

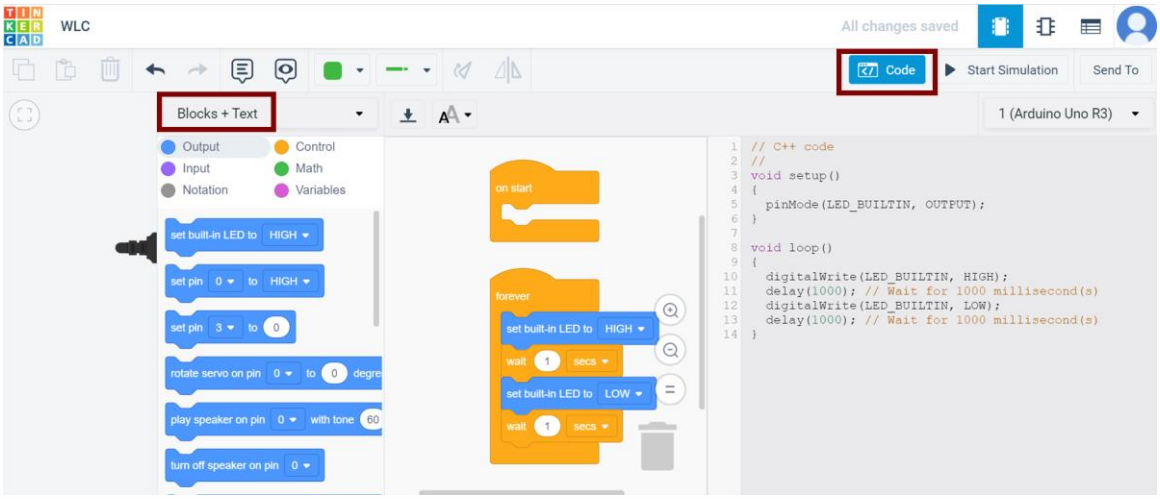


Part 6: You have set up the components and connected the circuit.

You will now program the Arduino using Tinkercad's code editor.

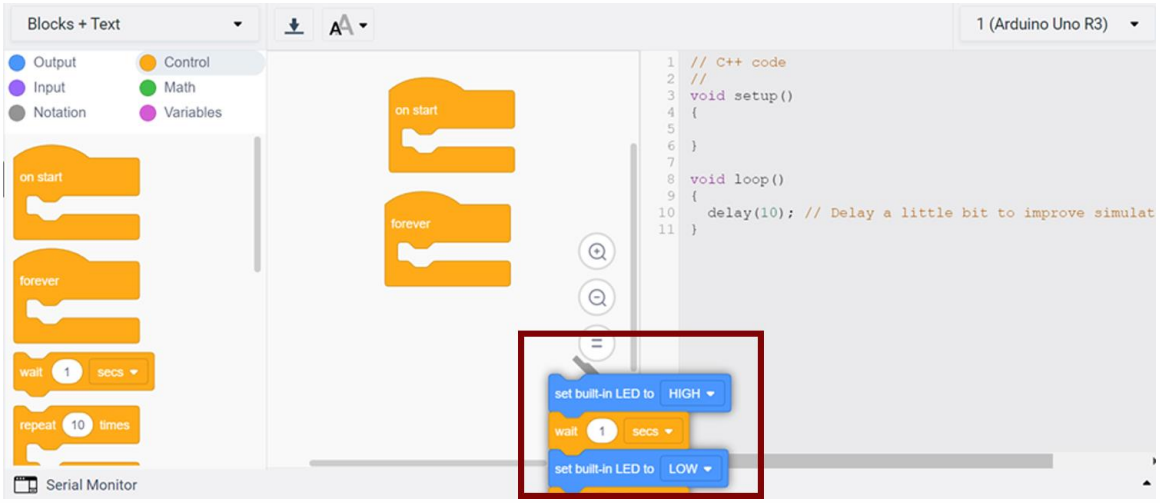
Step 25

Click '**code**' button to open the code editor. And change from the '**Edit**' mode to '**Blocks+Text**'.



Step 26

Delete the default blocks inside the forever loop.

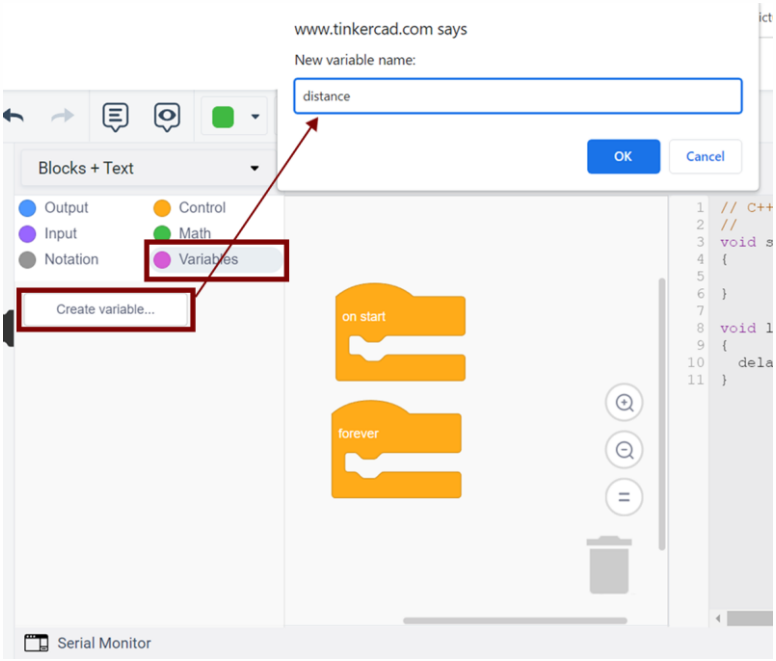


Read the ultrasonic sensor value and store it in a variable.

Step 27

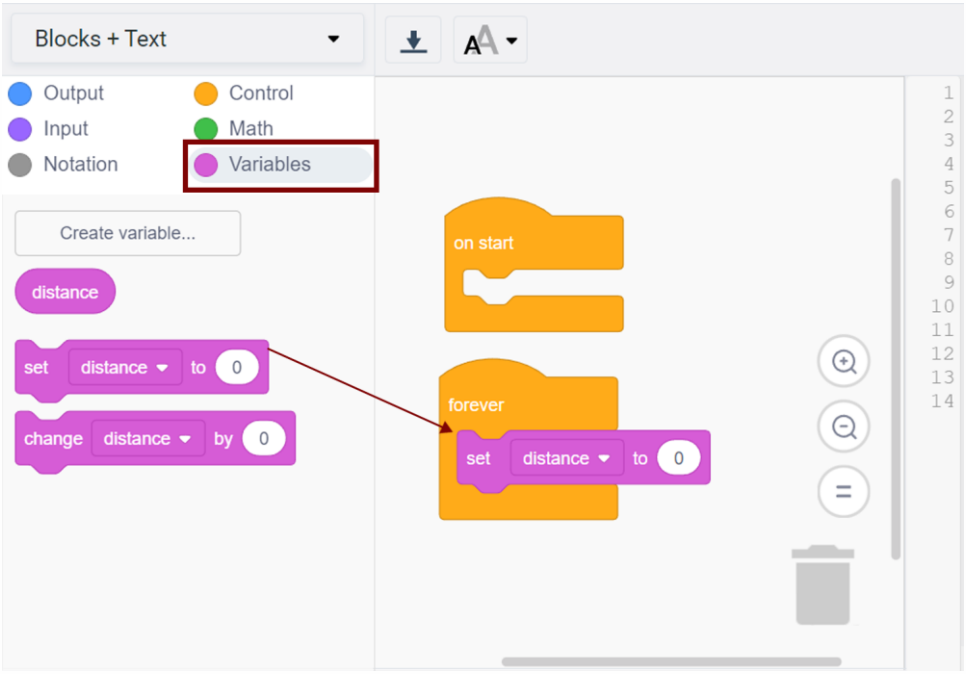
Create a new variable '**distance**'.

From Variables block menu, click '**Create variable**' and type the new variable name as '**distance**' and click ok.



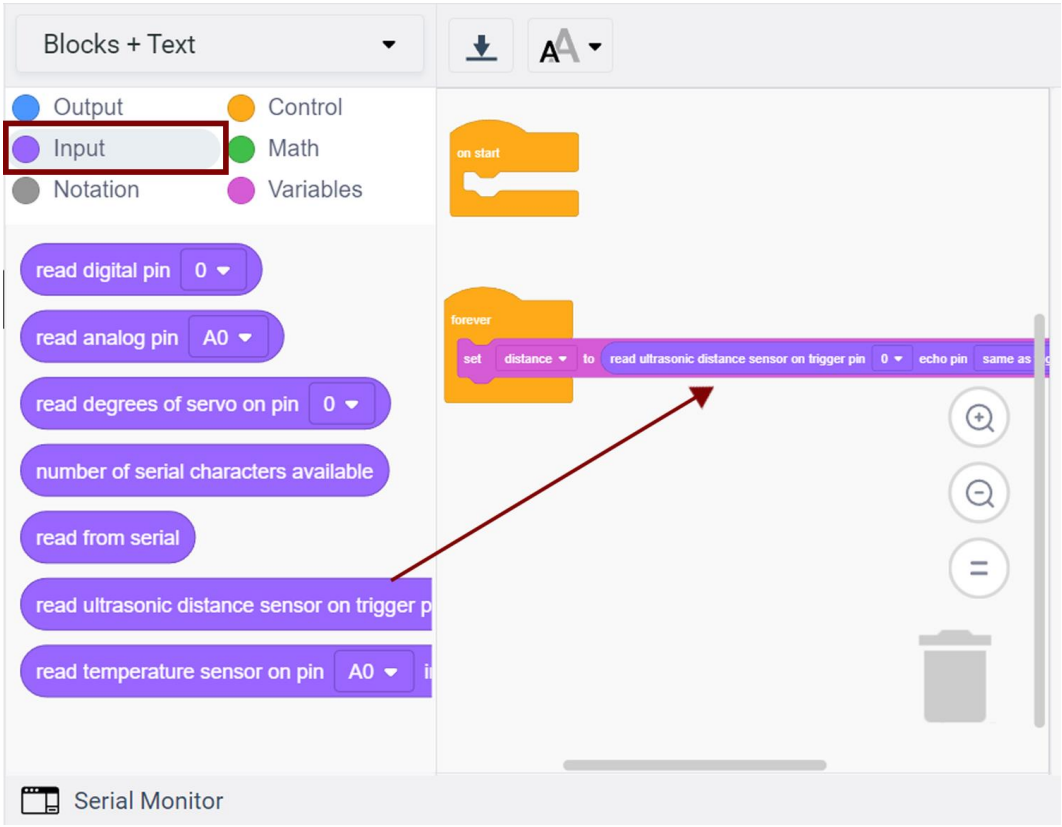
Step 28

Drag and place the '**set distance to 0**' block inside the forever block as shown.



Step 29

In the Input menu, find '**read ultrasonic distance sensor**' block, drag and place it in the '**set distance to**' block.

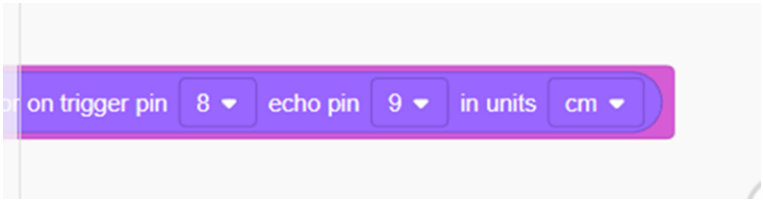


Step 30

In the read ultrasonic distance sensor block,

Set trigger pin to 8.

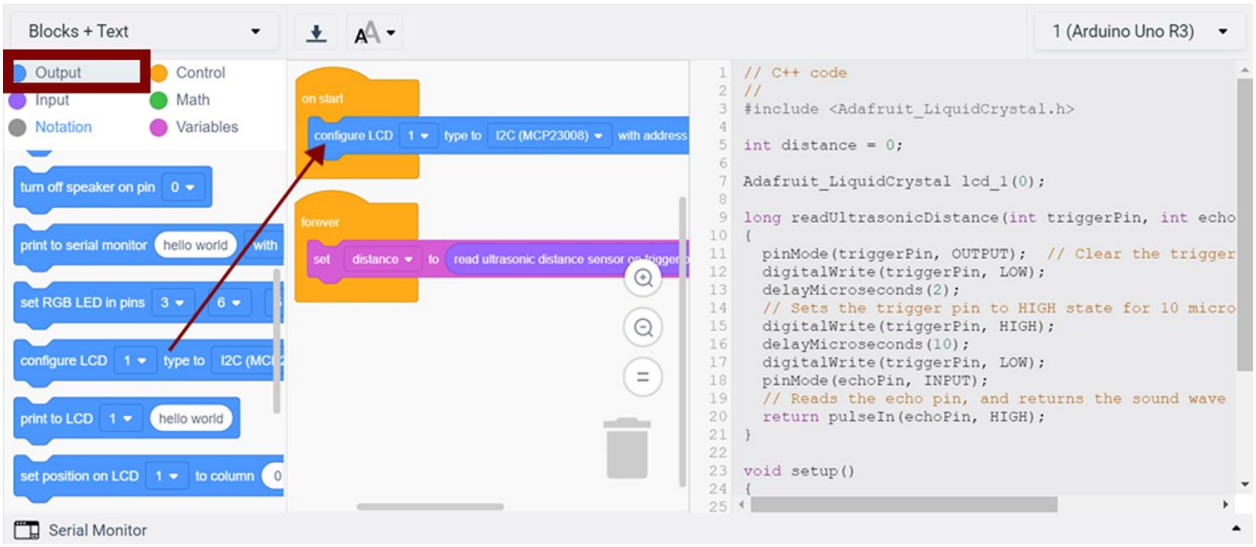
Set echo pin to 9.



Now you will set up an LCD Display that informs us, regarding the water level in the tank, in the form of text.

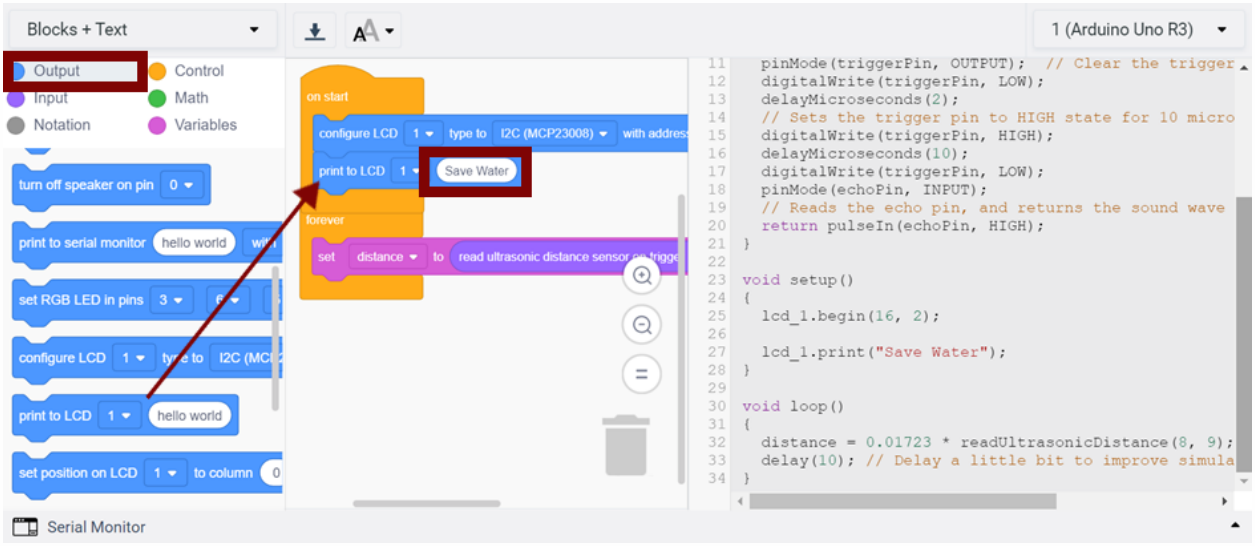
Step 31

In the output menu, select the '**configure LCD**' block, and place it inside the start block.



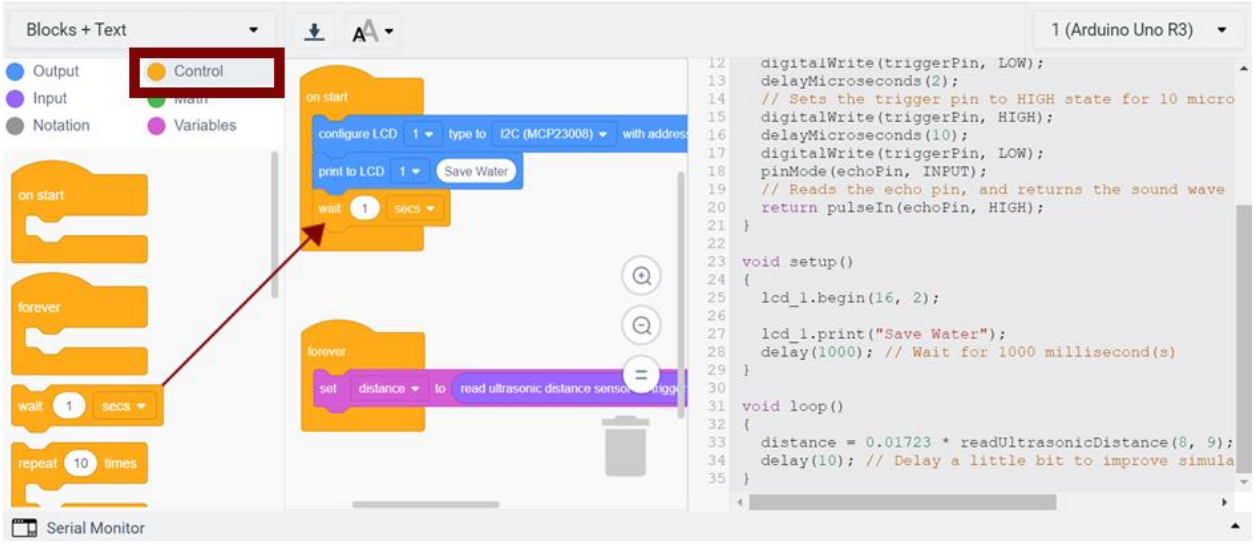
Step 32

Place the '**print to LCD**' block inside the start block. Change the text to '**Save Water**', as shown.



Step 33

From the control menu select the '**wait**' block and place it inside the '**on start**' block.



You will now add the code blocks to check for the 3 states based on the **value of the variable 'distance'**.

State 1: If the **value is <= 35** then; the water in the **tank is full**.

Action to be taken:

The **motor** needs to be **turned off**.

The **LED** should be in **red** colour.

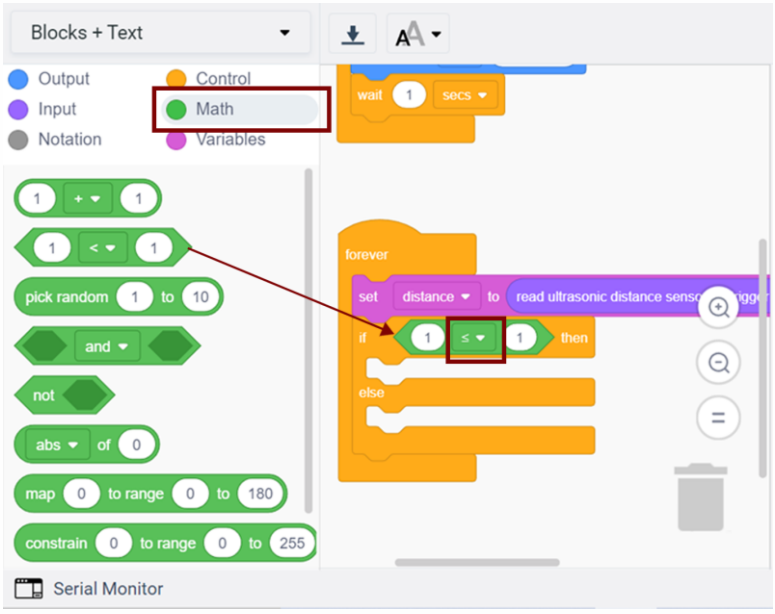
The **LCD** should display the text, "**Tank is full**".

Step 34

In the Control menu, select the '**if else**' block and place it inside the forever block.

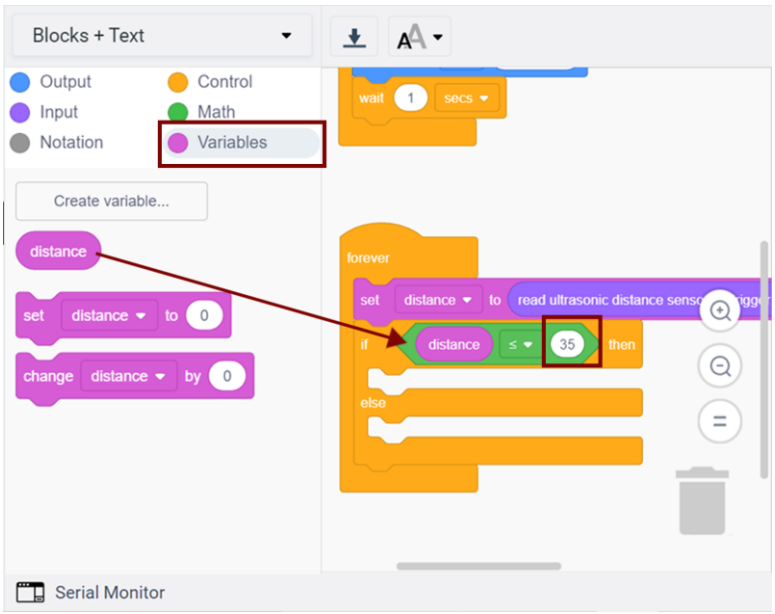
Step 35

To check the states, in the math menu select the comparison block and place it inside the if-else condition block and change the comparison to '<=' from the down list.



Step 36

From Variables menu select the distance variable and place it inside the comparison block and change the text value to 35.



We have checked for the State 1 condition. Now you will design the code blocks that will take the actions as needed.

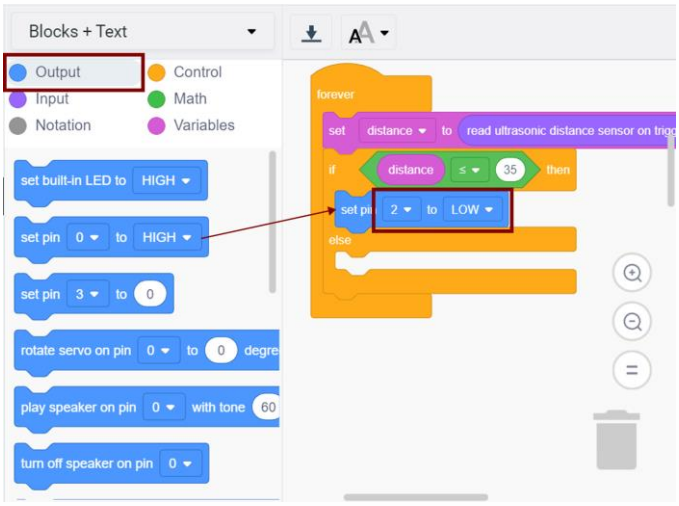
Step 37

From the Output menu, select and place the set pin block in the if block.

Motor is connected to pin number 2.

To turn off the motor, set the pin 2 to low.

Select the pin 2 from dropdown and also select LOW from the dropdown of the set pin block.

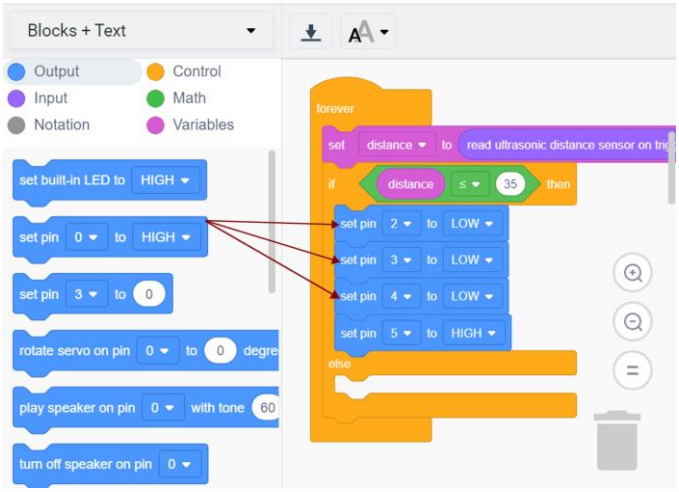


Step 38

LED indicator to glow red in colour.

Set pin 5 to HIGH.

Set pin 3 and pin 4 to LOW.

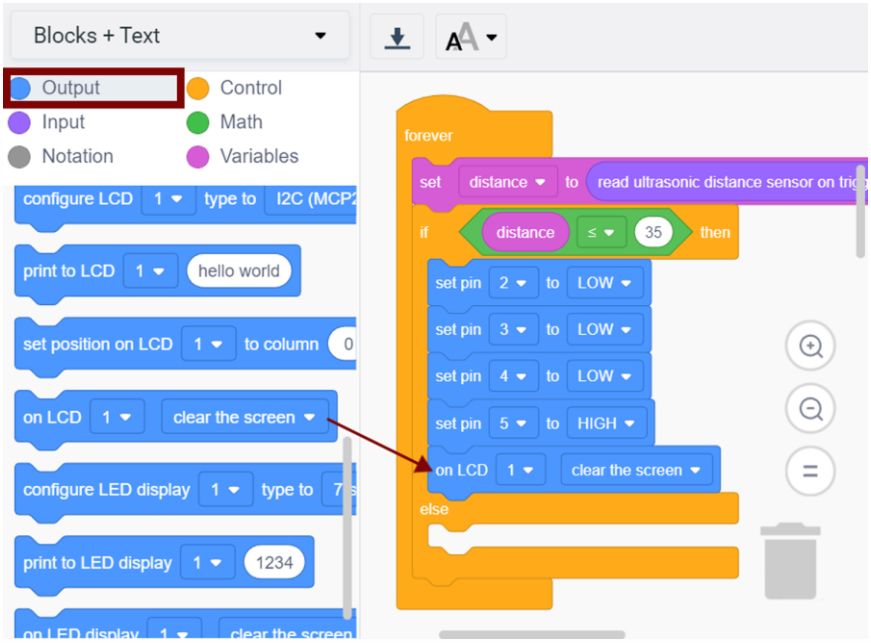


Display ‘save water’ in the first row of the LCD and ‘tank is full’ in the second row of the LCD.

Step 39

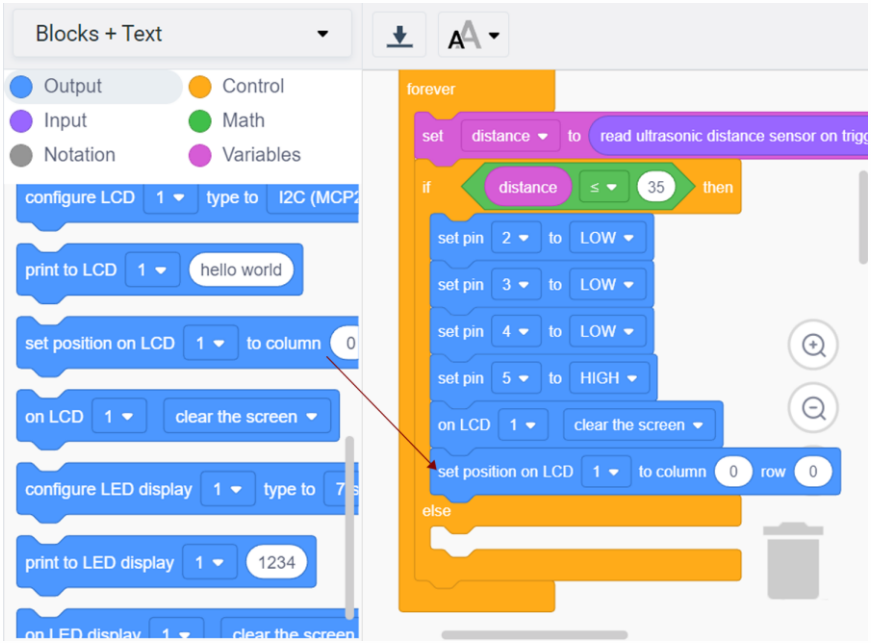
Clear the previous text to display the new text in the LCD.

From output menu, select ‘on LCD 1 clear the screen’ block, place it inside the if block as shown.



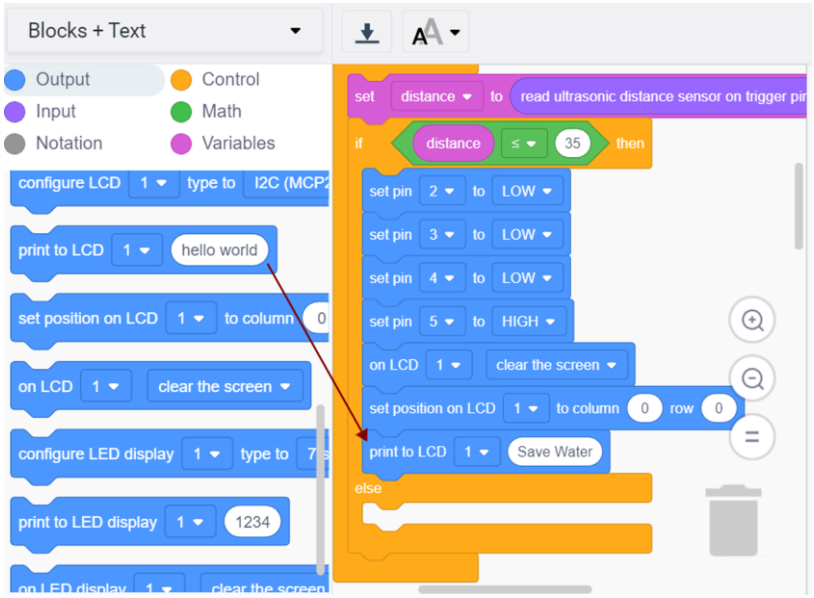
Step 40

In the output menu, select ‘set position on LCD 1 to column 0 row 0’ block and place it inside the if block. To select the first row, enter row value 0.



Step 41

Select '**print to LCD 1 hello world**' block and place it inside the if block and edit the text to '**Save Water**'.



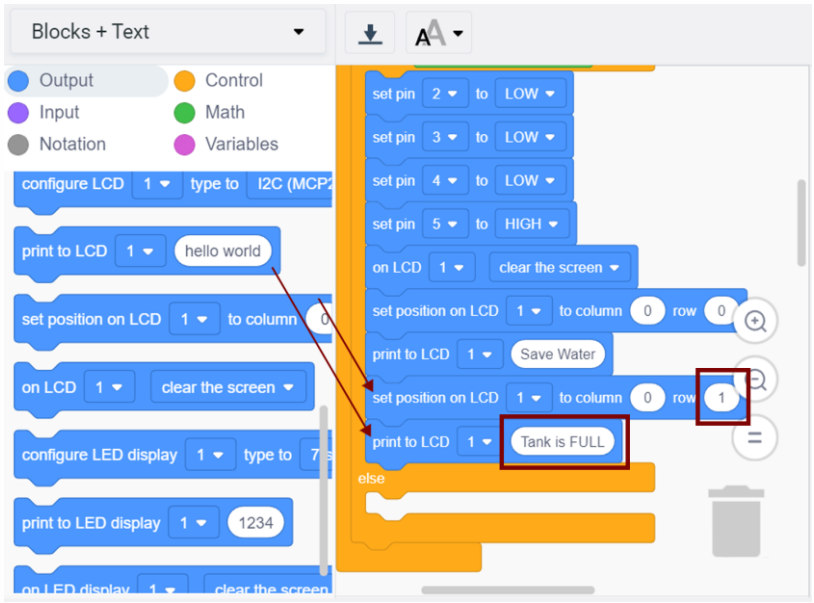
Step 42

Now you have to set the position on LCD to select the second row to display the second the line.

Select '**set position on LCD 1 to column 0 row 0**' block, place it inside the if block.

Change the row text as 1 (to set the second row).

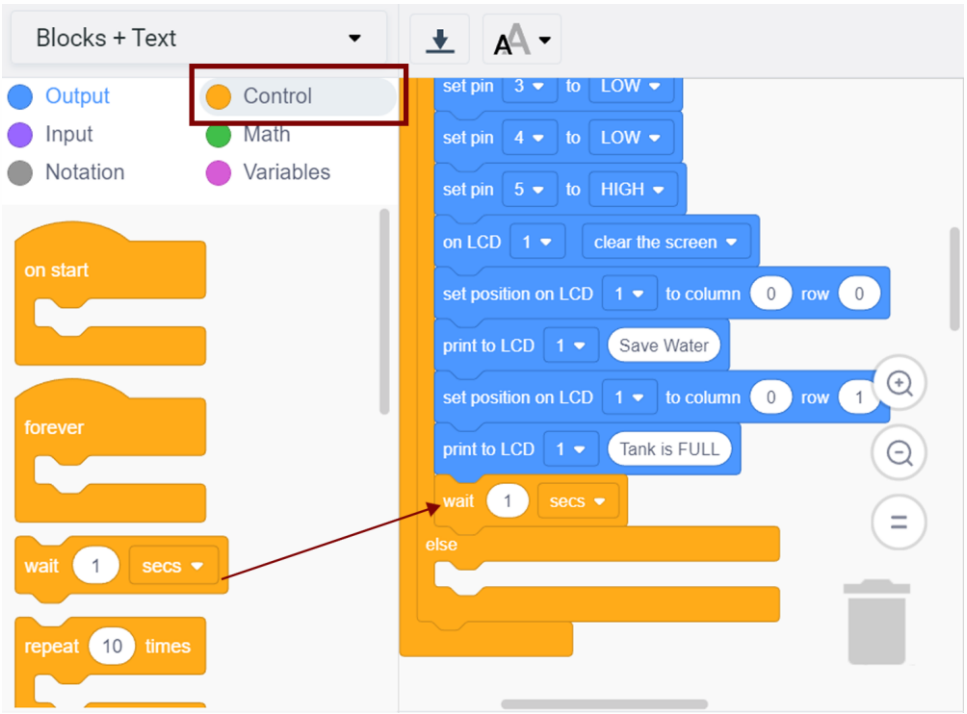
Now place '**print to LCD 1 hello world**' block and change the text to '**Tank is full**'.



Step 43

Add delay of 1 second.

From Control menu, select 'wait 1 secs' block, and place it inside the if block as shown.



State 2: If the **value is between 50 and 250 cm**; the **tank is half full**.

Action to be taken:

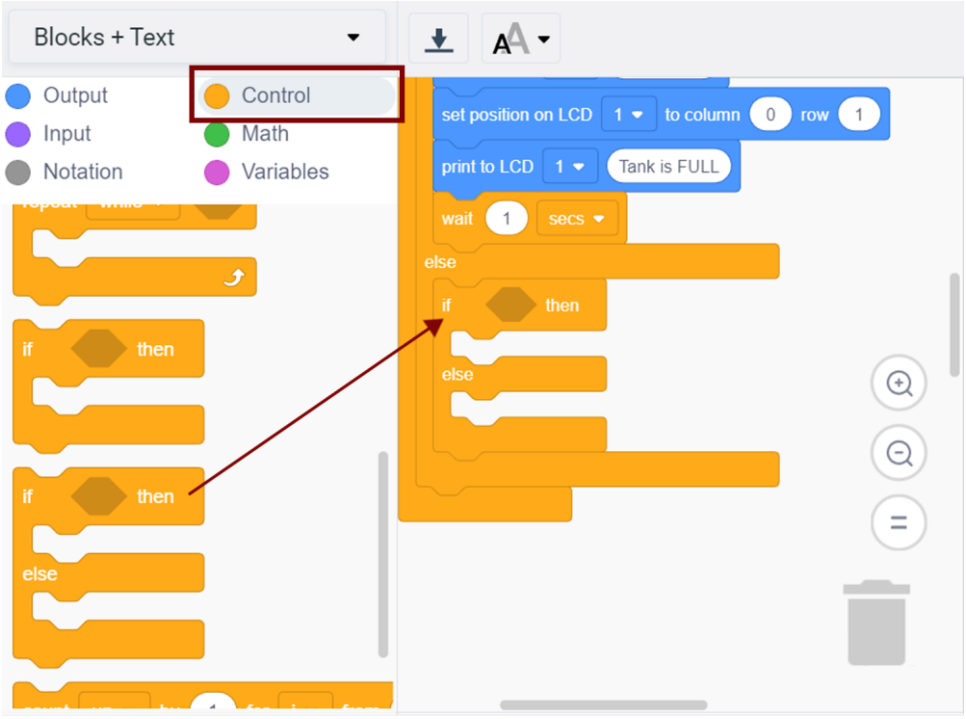
The **LED** should glow in **blue** colour.

The **LCD** should display the text "**Half Full**".

To check this condition, follow the steps below.

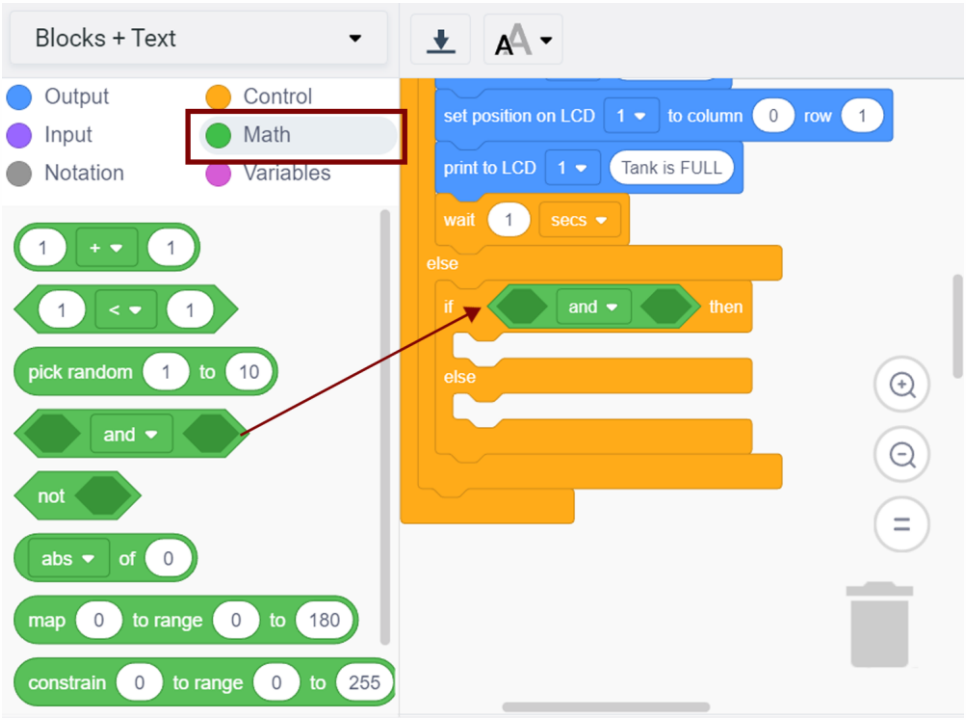
Step 44

From control menu, select 'if else' block place it inside the else part



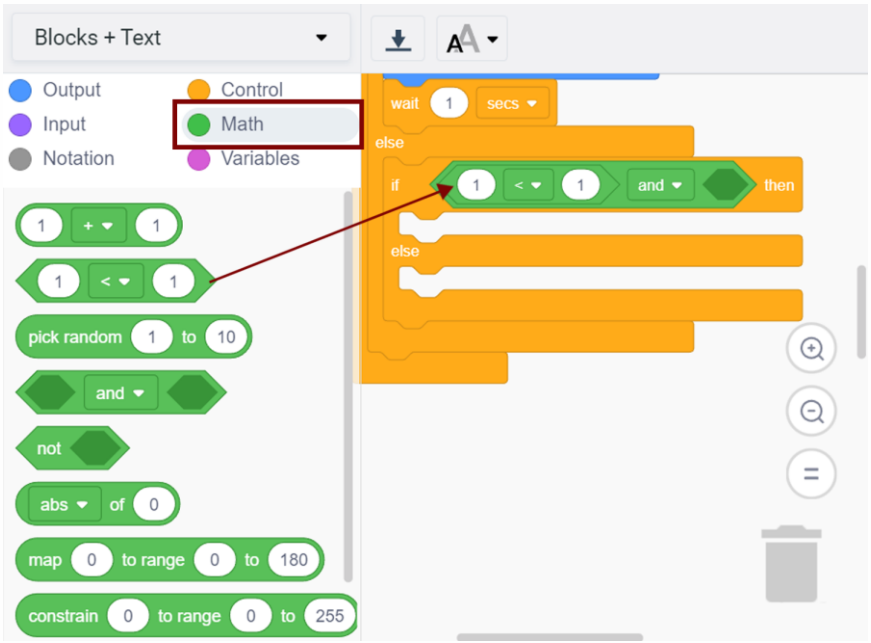
Step 45

From math menu, select '**and**' block and place it in the if block as shown.



Step 46

Select comparison block place it in the '**and**' block as shown.

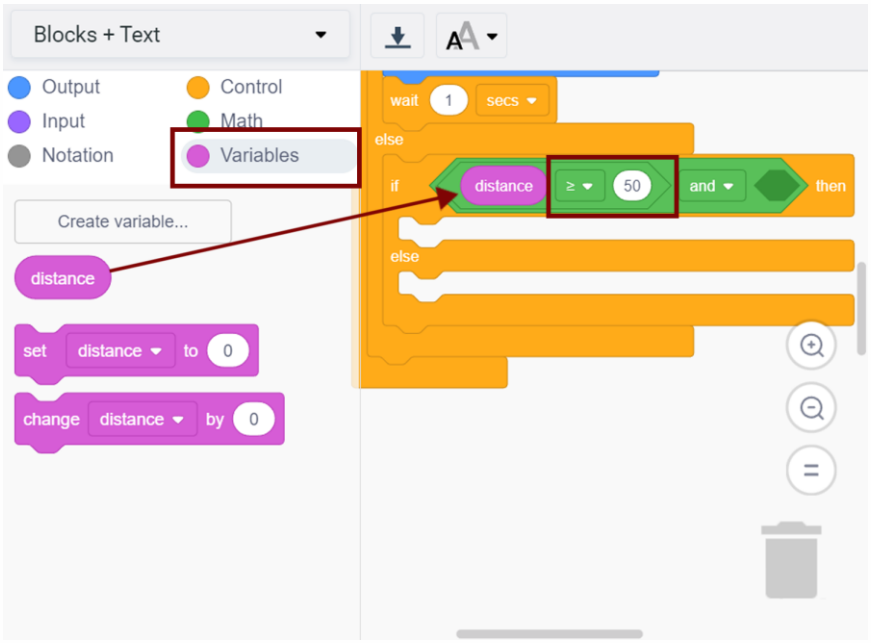


Step 47

From variables menu, select '**distance**' variable block and place it in the comparison block.

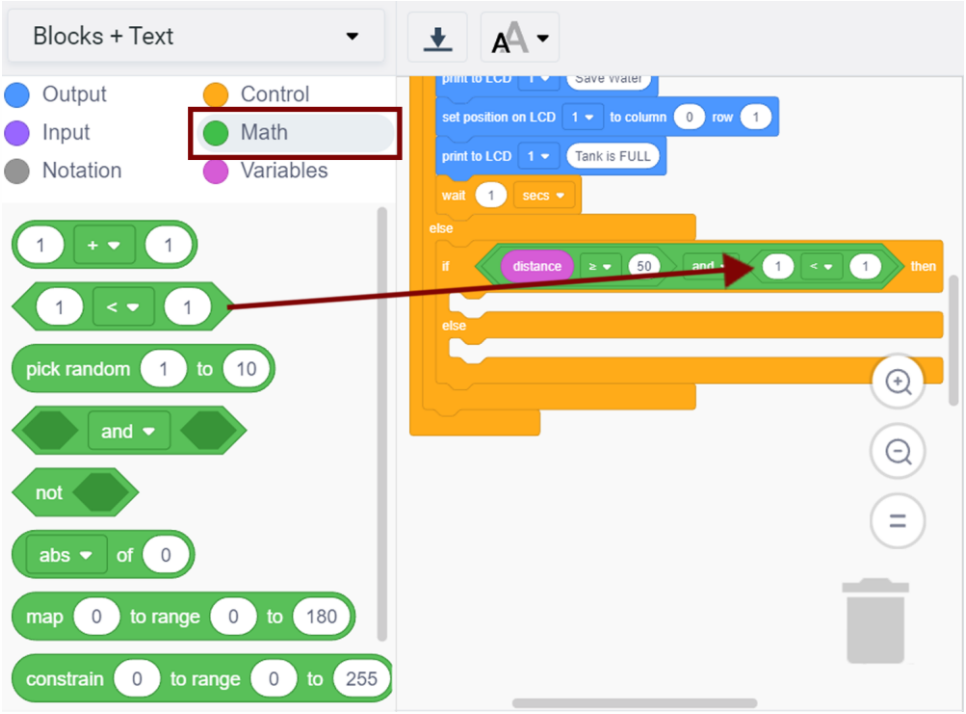
Change '>'= option from the dropdown list of comparison block.

Change the value to 50 as shown.



Step 48

From maths menu, select comparison block, place it inside the '**and**' block.

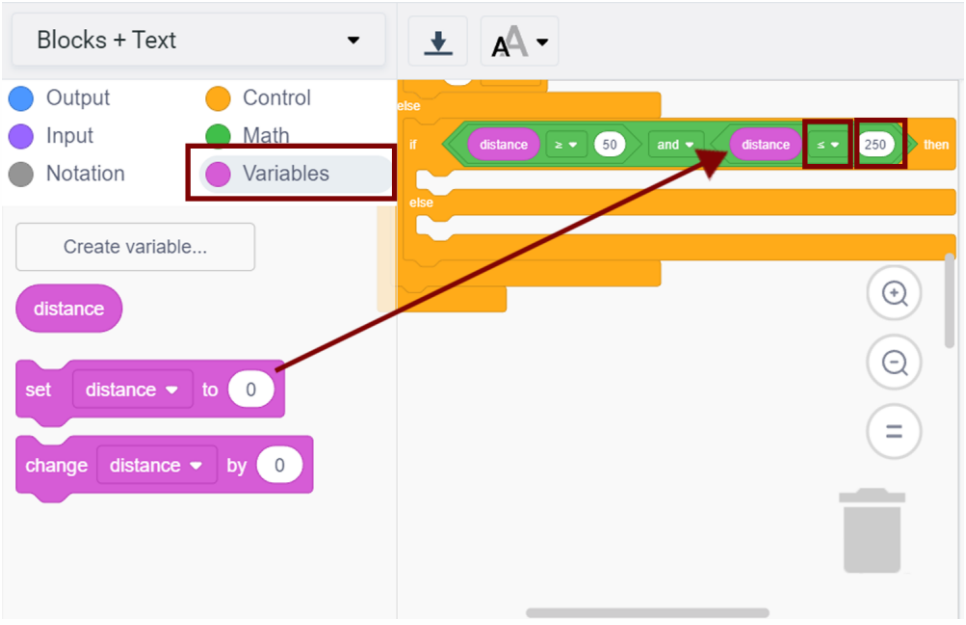


Step 49

From variables menu, select '**distance**' block, place it inside the comparison block.

Change '<=' comparison symbol from the dropdown list

Enter the value 250 in the second comparison block.



Step 50

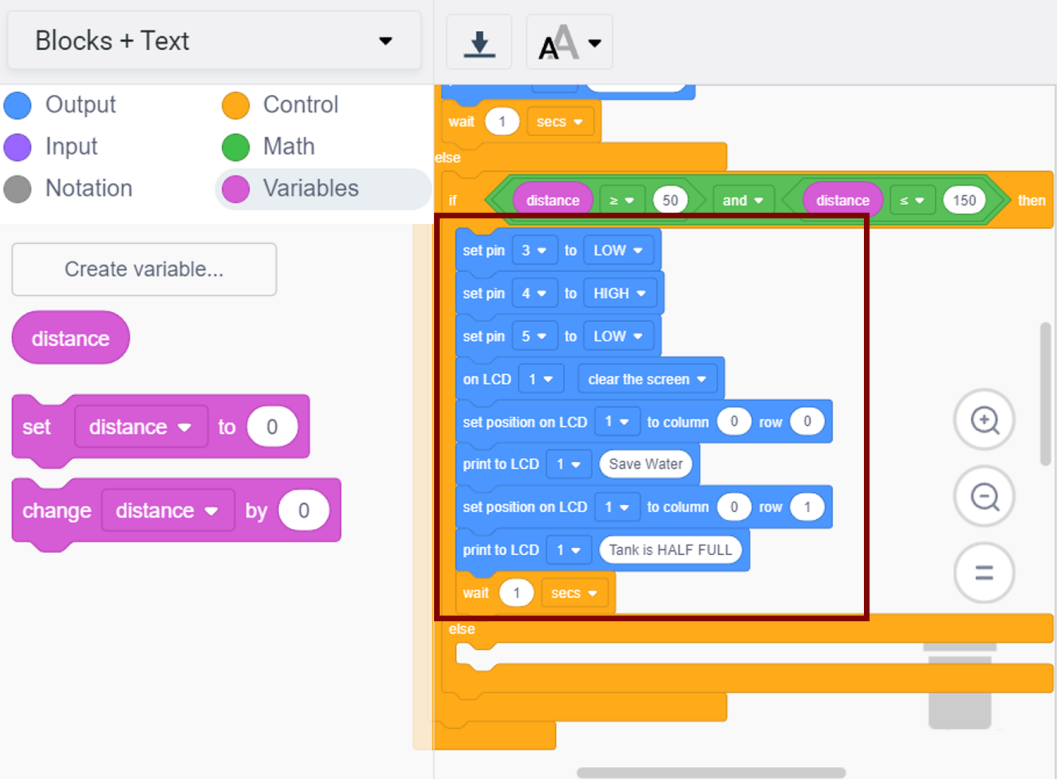
Set pin 3 to LOW.

Set pin 4 to HIGH.

Set pin 5 to LOW.

Blocks for LCD to print '**Save water**' in first row, '**Tank is HALF FULL**' in the second row of the LCD.

And wait for 1 second.



State 3: If the **value is > 280 cm**, then the **tank is empty**.

Action to be taken:

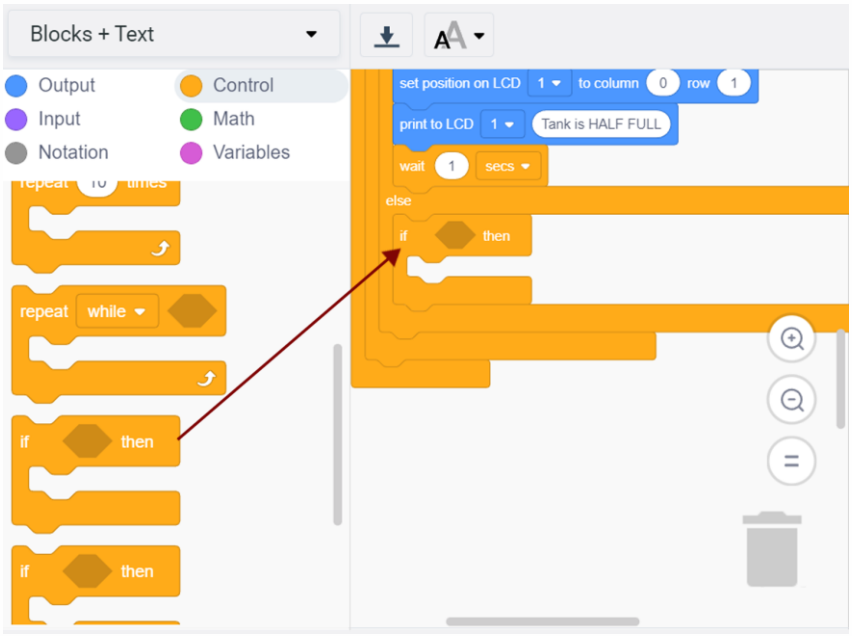
The **motor** needs to be **turned on**.

The **LED** colour should turn **green**.

The **LCD** should display the text, "**Tank is Empty**".

Step 51

From control menu, select if block, place it inside the previous else block



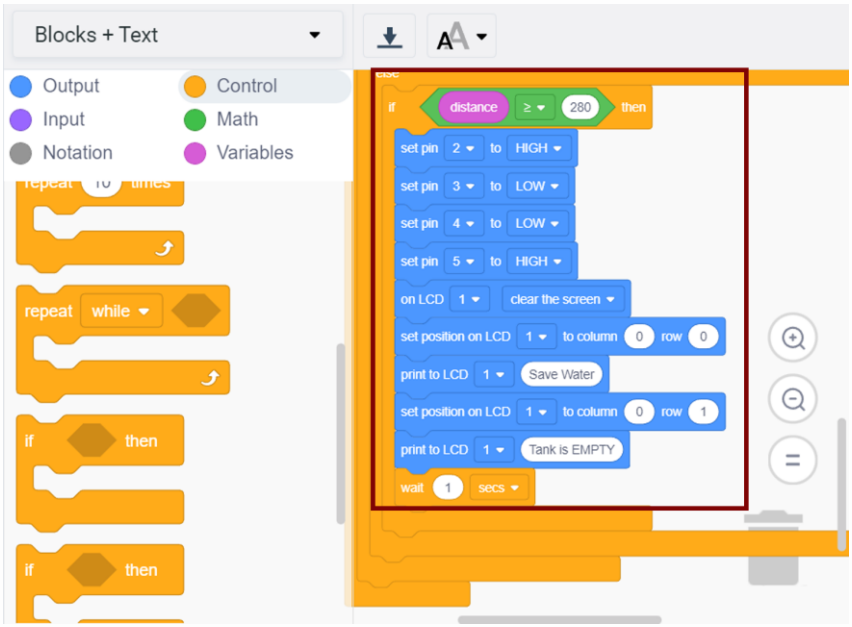
Step 52

Set the motor pin to HIGH.

Set the blocks for **LED** indicator to glow in green colour.

Set **LCD** blocks to display '**save water**', '**Tank is EMPTY**'.

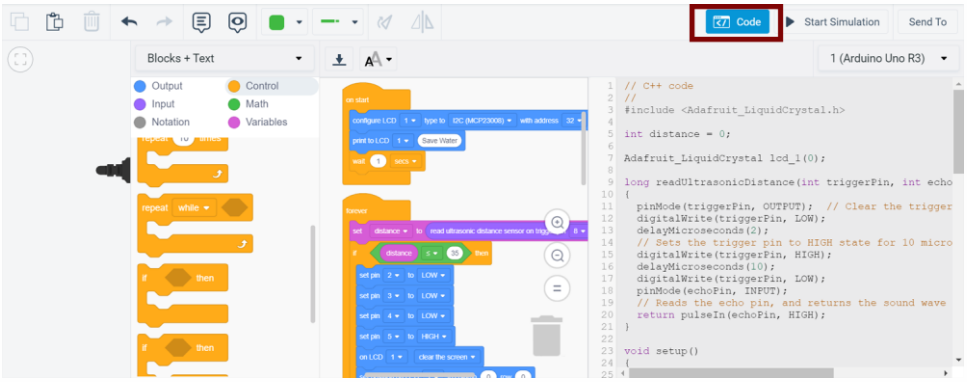
And add block for wait for 1 second.



Part 7: Simulation

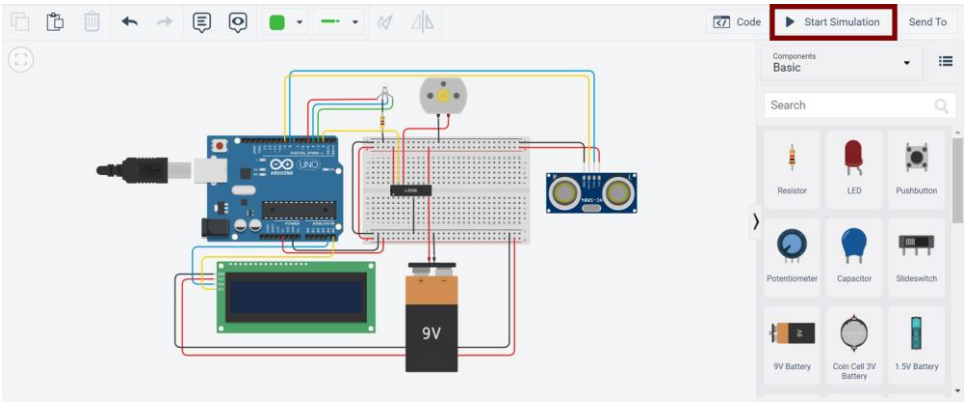
Step 53

Click '**Code**' button to enter into the circuit screen.



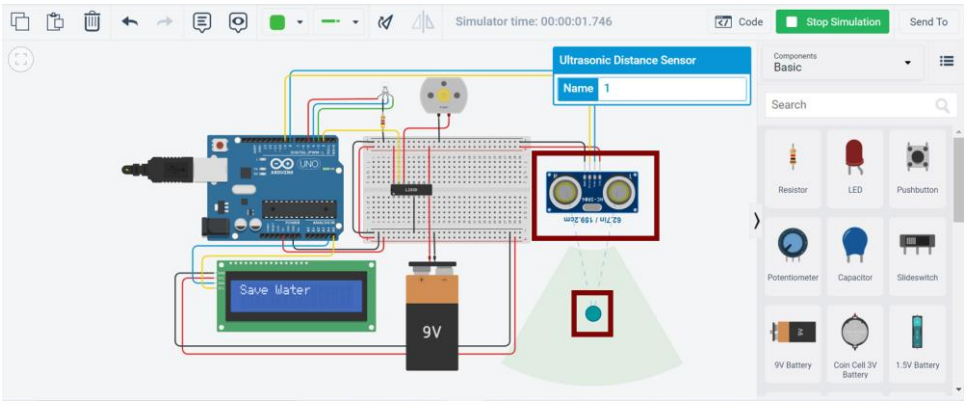
Step 54

Now click the '**Start Simulation**' button to start the simulation.



Step 55

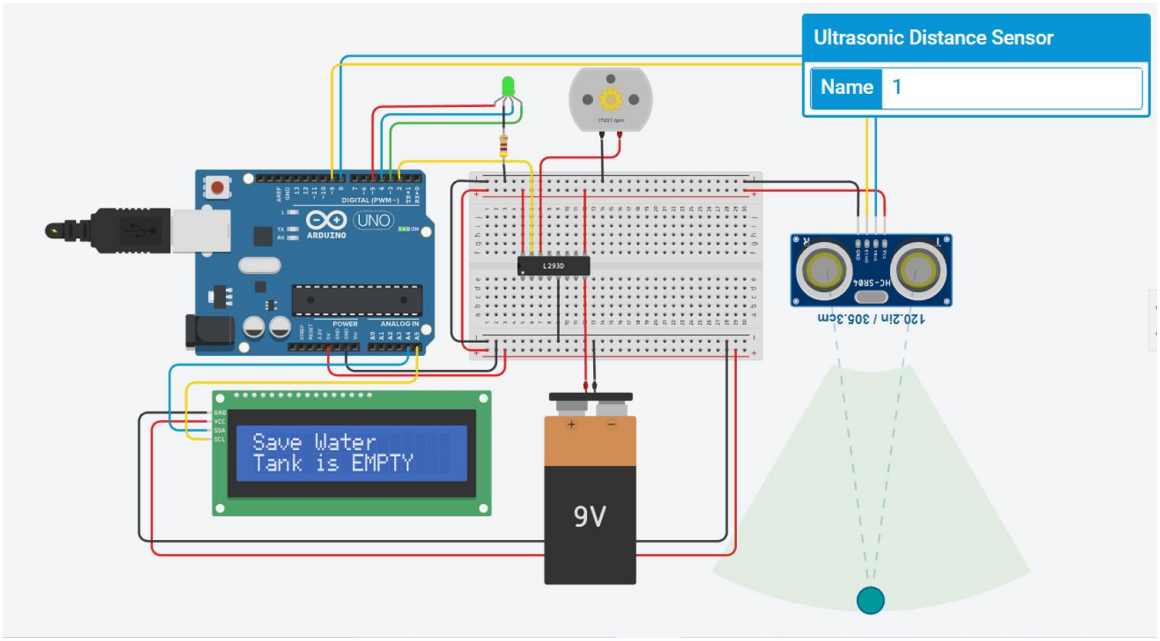
Click the ultrasonic sensor and you will see a blue circle that will enable you to vary the distance.



Step 56

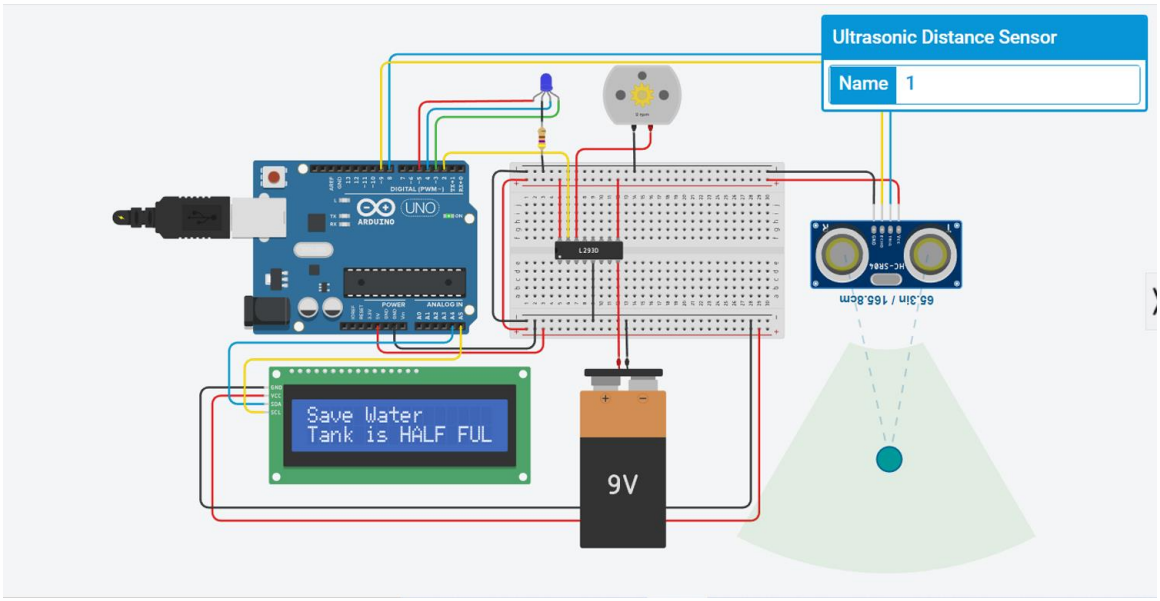
Drag the blue circle upwards/downwards and check the LED indicator, LCD display and the DC motor to note the results. Refer to the images below for the different states.

State 1: Tank is EMPTY.



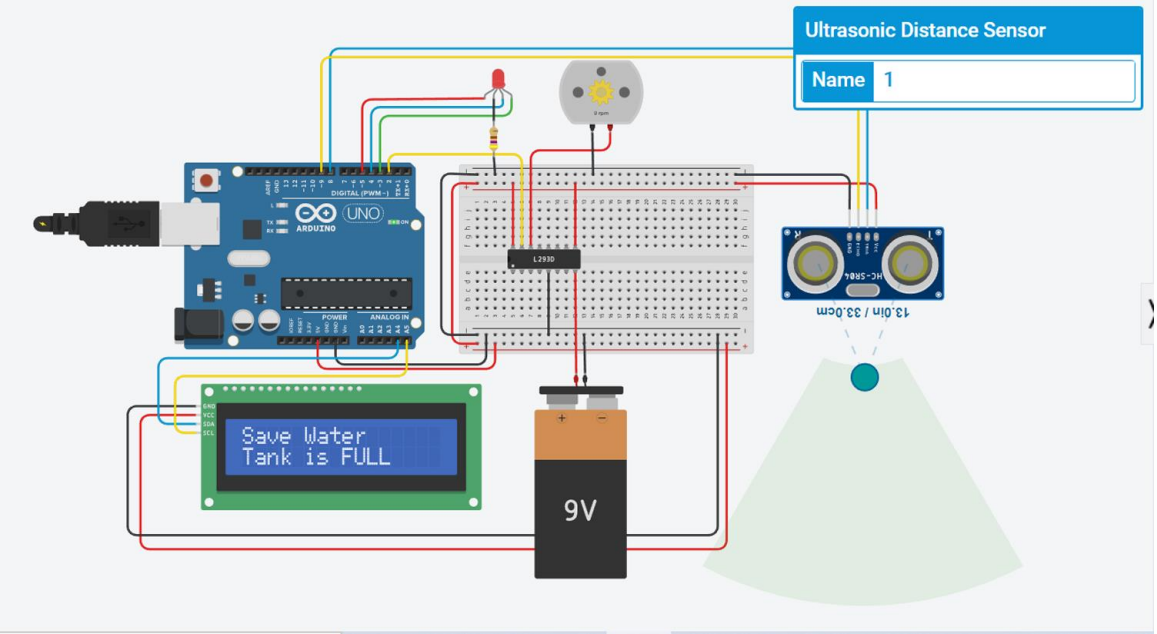
Step 57

State 2: Tank is HALF FULL.



Step 58

State 3: The tank is FULL.



Congratulations! Your simulation model for automatic water level controller is working perfectly well.

You can now gather the same physical components and set up an automatic water level controller in real time in your neighbourhood and enable the residents to responsibly consume water, one of the most essential natural resources for human beings.