Contents

10-26-21 - Khaley-Shai Wyndham

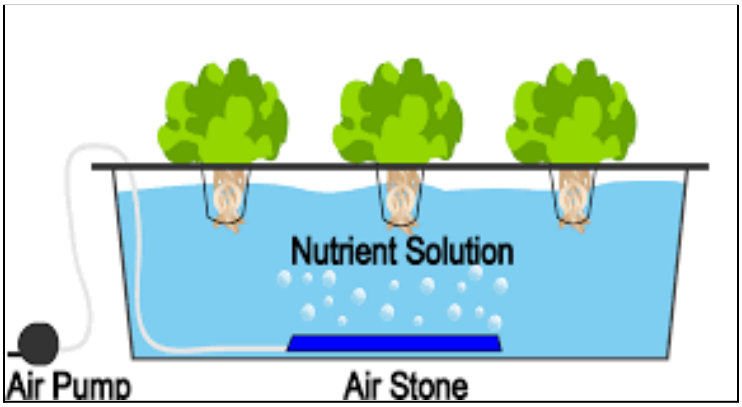
Background Research

Determining pH levels and nutrients in Deep Water Culture hydroponic systems:

←(This is what a deep water culture system looks like)
Today we did extensive research on hydroponic systems and how they operate. Learned that hydroponics is a technique for growing plants without soil which uses mineral nutrients to grow plants like peas, artichokes, cucumber, onions, radishes, leeks, etc. Using hydroponics helps to increase crop production even in areas where the soil is sterile. Although one of the main disadvantages of hydroponics is the fact that it takes so much monitoring and you have to add the correct amount of nutrients and pH for it to stay alive. Therefore our project is to build a robotic device that detects pH levels and nutrients in our hydroponic system. This device will then add nutrients to the water culture system according to the plant's growing stage and state as well as increasing and decreasing pH levels.

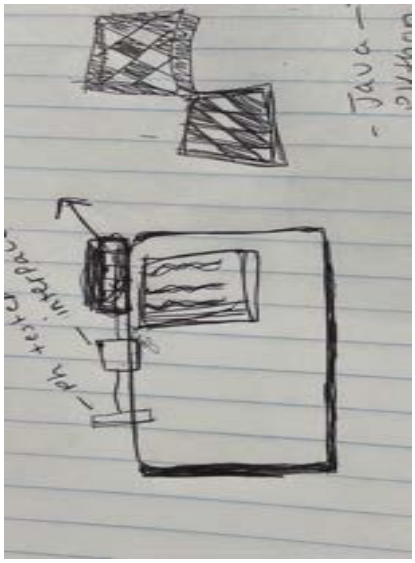
(IF WE NEED TO MAKE OUR OWN)
Hydroponic :

- Chemistry and planting process (actual hydro planting system)
- All you need is a 3 ½ gallon (13 l.) bucket 10-inch (25 cm.) net pot
- air pump, air tubing
- airstone - cost 10 - 25 dollars
- Rockwool - 0.62 cents per square
- expanding clay growing medium or the growing media of choice. (optional)



10-30-21 - Zahrion Watson

In class, we started to decide what we needed for our project. The things that we said needed would be an interface to be able to connect our dispensing device to our pH probe. Then planned to talk to our scientist advisor, Mrs. Kelly, about pH probes and asked her if she has anything that we can use for our project, was given a Vernier pH probe and discussed different alkaline and acidic solutions that could fluctuate pH. They ran into some problems because we didn't know if the fish feeder was going to work for the interface. Not only this but, we need to create another capsule within the fish feeder for both dispenses of pH (Alkaline)up and pH (acidic) down.
The crop that we decided to grow is grand leaf lettuce because the science fair -deadline- is near. Grand leaf lettuce is something that can grow in the time-space. Khaley is getting more information on the Grand Leaf lettuce this class alwell.



←[We started to sketch out our project to see how we would set it up]

In the picture there is the bin that we will use to carry the water and then we have the robotics part at the top of it and what we were researching today is what plant we should grow and we found lettuce seeds and we found it to be7 to 10 days.
When to Plant Lettuce:
We realized in the time-space we had we need to start growing really soon and we also researched how much water we will need to hold in the bin of water because there is a certain amount of water that we will need because we also don't want it to affect our growth so we found out "As a rule, there should be the following: Small plants: 1/2 gallon of water per plant. Medium-sized plants: 1 – 1/12 gallons of water per plant. Large plants: 2 1/2 gallons of water as a bare minimum." and we got this from

10-31-21 - Vanessa Weir

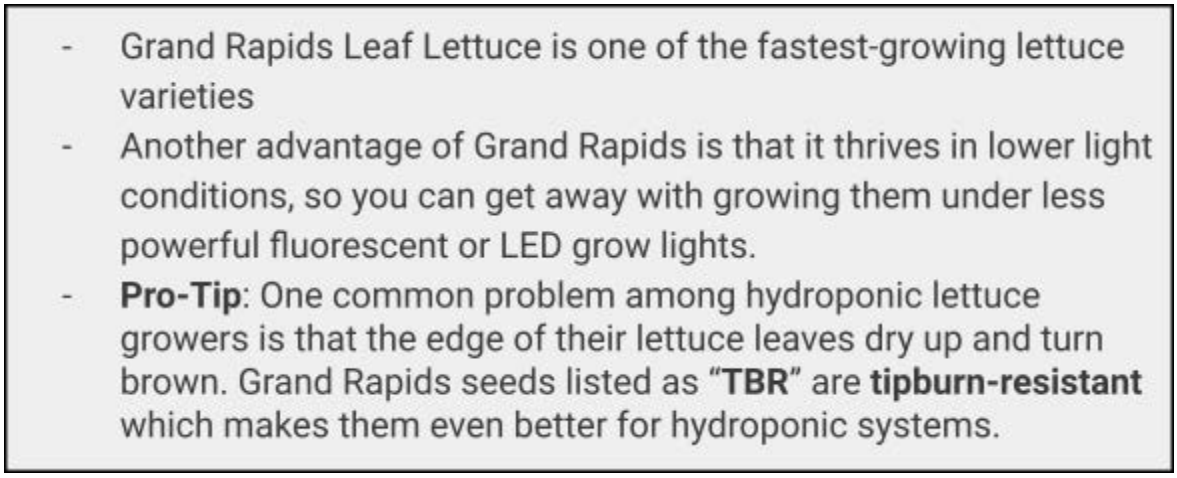
Background Research

Programming

- We need something that detects the pH in water. Once it detects pH we need the program to determine if it needs pH up or pH down based on the plant's growth stage selected.
- The standard range that most plants prefer (pH 5.5-6.5) is fine, however we will want to customize and monitor this based on what stage of growth your plants are in.

Growth stages of Grand Rapids Leaf Lettuce

What to know:

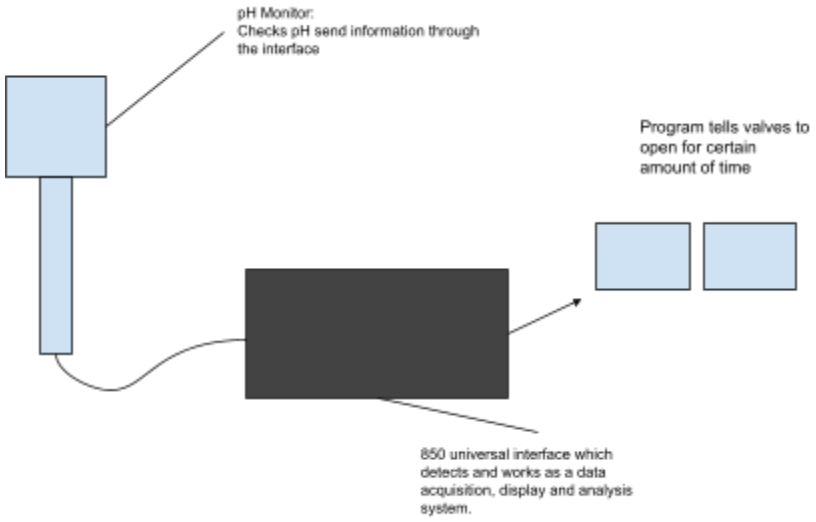


Hydroponic lettuce should be grown with a narrower pH range of 5.5 to 6.0, with an optimal target value of 5.8. During germination, hydroponic lettuce should be fertilized with **100 to 150 ppm N**, maintaining a solution EC around 1.2 mS/cm.

12-1-21 - Vanessa Weir

Programing/ Robotics Brainstorming

- 850 universal interface in order to track data
- pH monitor that can connect to the universal interface



- We might also need to use the EC electrical conductivity monitor from vernier depending if we do a recirculating DWC system because it can determine how much nutrients is in our system. Although it's not vile for the system to have
- The EC conductivity would have a very similar program to the pH one and would be great to add for future research.
  (may be changed in future)

12-4-21 - Zahrion Watson / Khaley -Shai Wyndham

Plan of Action #1

So today I had to focus on my part of building the robotic systems because in the beginning we didn't know because the fish feeder was a part that we were unsure of.

The 850 Universal Interface features the ports, fast sampling rates, and good functionality. It can be used in place of several pieces of lab instrumentation, including oscilloscopes, power supplies, timers, and function generators. Has a USB connection and is compatible with Capstone software. So we were searching up the 850 interface and we found out that this is something that we can use to help send the connection to see what needs to happen to balance out our pH. We also wanted to know how this will work with our project so we did some further research and now we know that if we connect our project to this it will help us connect the data and everything to it can give the pH balance.

Khaley - Also focusing on how to build the hydroponic model before we begin on the programming and robotic part of the projects. Next we need to run a lab to understand how the pH up and pH down works and collect data from it to ensure we use the correct amount when we stand to begin to grow the plants.

Primary focus

- Germinate seeds
- Run lab on the pH up and pH down
- Finish building hydroponic system

12-6-21 - Khaley-Shai Wyndham

Ordering Supplies

An update: so me and my group started to wrap up the final needs for our projects, we know what kind of hydroponic system were going to be using, were going to build the hydroponic system scratch were going to need thing like a bin,rockwool,fertilizer, nutrients, temp control, air filtration/ air pumps, rocks and seeds. mrs, Kincaids is going to help us build our model and we're going to get most of our product off of amazon or going to home depop to get it . We even know what kind of plant we are growing which is lettuces because it is an easy thing to grow. The other part of the project which is programming were still deciding what programming system were we going to be using but it's mostly leaning toward using Java and were going to program the ph montorior which we got from Mrs. Kelly.We knew nothing , we even went to Mrs lemke during class and she didn't help much but she did tell us to keep in mind that we would need to store the liquid in something where the liquid wouldnt dry in.

While also working on the shark tank presentation we really needed to find out about that last part of the projects.

List of things to buy :)

Grand Rapids TBR Lettuce Seeds
50 Pack 2 inch Net Pots
AtlasSchince Environmental aRobotics pH up Ph Down
27 Gallon Storage Tote
AQUANEAT Aquarium Air Pump
CNZ Fish Tank Air bubble 2-Piece
uxcell Fish Tank Aquarium Red Clear Plastic Air Pump Check Valves
Clear and Flexible Resists Kinking, 8 Feet Standard
GROW!T GMC10L 4mm-16mm Clay Pebbles,Brown
General Hydroponics GH Flora Series 32oz Quarts Trio FloraMicro FloraGrow FloraBloom

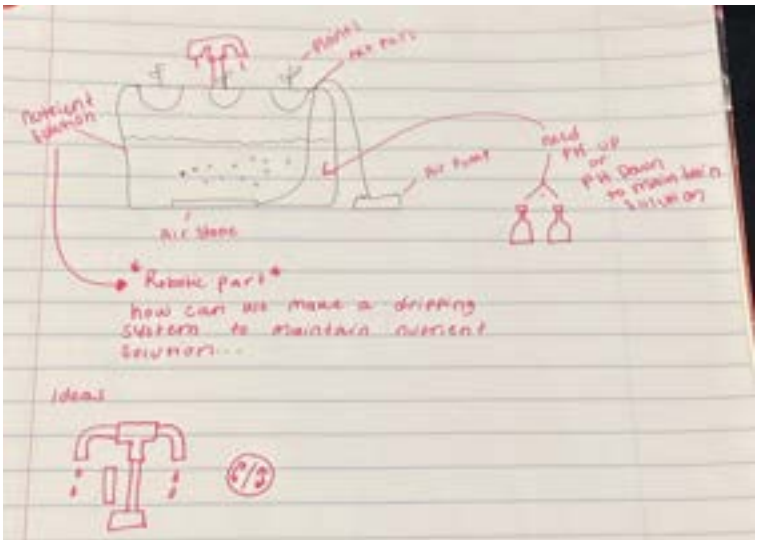
12-7-2021 - Zahrion Watson
Setting Up

Started to set up our hydroponics system to see how it would work -- went to Mr. Wright (woodshop teacher) to help us drill holes in our bind.

This is what our bin looks like with the holes drilled and the net pods placed on the top, once we have our robotic system which will drill out a section for the probe to access the water. As you can see the tube coming from the left side of the bin; this is the water pump hooked up to our airstone which bubbles oxygen into our water and will allow our plants to proper.

Worried our pump was too small for our system, we started running it in the bin with water to see if it would accumulate enough power in such deep water.
Tested the water limit so we started off with a small amount of water to see if the filter would work, continued to add more water with it and every time the pump still worked.

12-8-21 Vanessa
(supply is ordered and some is in)
Plan of Action
Model:



Bin has been set up. The next step is to figure out robotics and programming.
Vanessa is working figuring out what the brain of our system is going to be and I am working on what we could use to dispense and connect the pH up and down solution to our bin and software.

Right now we are working to order two peristaltic pumps because they can distribute liquids on time intervals with a program and software device.
To the left we got two of these pumps. And realized we will eventually have to suture wires to the pumps in order to connect it to the software.

1-24-22 - Vanessa Weir

Troubleshooting

Today, we are thinking of getting an arduino for the programming / robotics “brain of the project”
Needed in order to maintain pH level of nutrient solution
This will be better than using the 850 universal because it's more compact and can be used with more variety of different probes. It also has an Arduino IDE which will allow me to start the programming right away.

Using an arduino we are able to connect it to a pH meter as well as a peristaltic pump.
Assembling Hardware is the first step so we will need to set the pH circuit and pumps to 12C where each device is assigned a unique 12C address.
; pH sensor address 99, pump for pH up can be 103, pump for pH down can be 104

Step two will be to assemble that hardware; the peristaltic pump has two power lines → arduino 5V pin.
and step three will have to be loading the program (arduino IDE)

1-26-22 - Vanessa Weir

Troubleshooting

While getting arduino system running we need to start running pH up and pH down test to see how much solution it takes to change the nutrient solution pH
Making a google spreadsheet currently.
Look up “how much pH to use” in order to roughly estimate how much we will need in order to run our test; When adjusting pH, start out with one ml per gallon. Wait 15-30 minutes, and test your water again. Frequently you will only need 1-2 ml per gallon of water. You may need to use more if you have hard water.

(will be placed below when fully filled out)

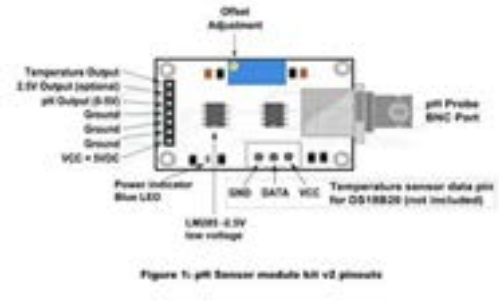
As said earlier we will no longer be using the 850 universal interface because it is too big and does not have the information we really need.
Therefore the arduino will come into play as being the brain of our robotics system
This will connect to our peristaltic pumps and to our pH monitor.

Dilemma: I will not be able to finish programming until we have the robotics put together because I need to be aware of the inputs and outputs in order for it to run correctly.

GAOHOU PH0-14 Value Detect Sensor Module + PH Electrode Probe BNC For Arduino

We found a better pH probe that will connect to our arduino with a BNC probe instead of us having to wire
Wiring the old probe is way less efficient and limits our options when wiring the peristaltic pumps

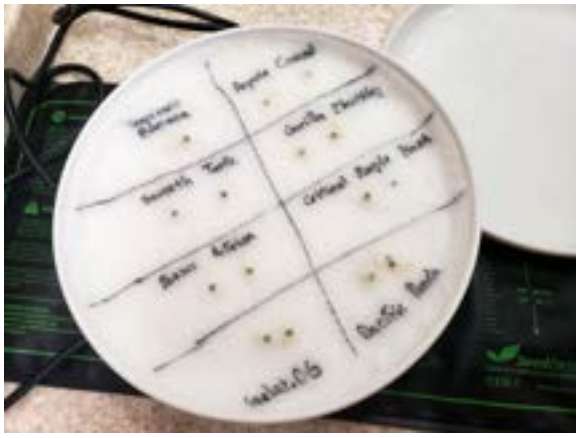
This came to about $37 ⅘ star review



This is the sensor analog that we will wire to our arduino in order to get the pH value

1-31-22 - Khaley - Shai Wyndham

Growing Seeds and pH data



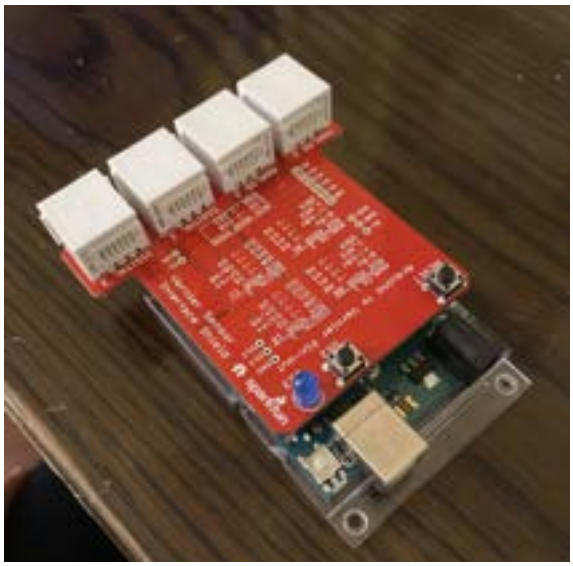
Cutting the lettuce from the white part and storing the hite part in water is a way to make the lettuce grow back, since are project revolves around growing the plant and making sure the plant is grow properly we need to have a plant to grow with, we already decided on using rapid leaf lettuce but a plant that already has root that we can use would be very convenient, another method to solve this problem is to germinate the seeds. To germain the seed you need to wet a paper towel, put it in a container, put the seeds on it, then wet it some more , then cover/close the container, and put it in a warm area. While germinating the seeds we could put it over a led light or a plant growth light to help the plant grow faster. Lettuce seeds can take 7-10 day or even weeks to start to properly sprout while germination, so when germaites and it starts to grow roots we can take those roots and import them into the hydroponic system.

For the pH up the data states that you're going to need to start out with one ml per gallon, then wait 15-20 min to test your water again to see the changes. It is also the same for the pH down you need around 1 Ml per gallon and have to wait a little longer with 15 -30 min to test the water again to see changes, normally you would need 1 to 2 Ml of pH down/up to see changes. < ---- the type of pH up/down were using (Atlas scientific)
(In hydroponic system it is noted that you need to drain the water every 7-14 days and rinse it out)

The buck we're using is 55 liters which is equivalent to around 14 gallons, something also to note is that small plants require at least ½ gallon per plant, medium plants need 1 ½ gallon, and large plants need around 2 ½ gallons. The plant while being used is a medium - large plant, the rapid leaf lettuce. So what is leaf is to figure out how much hydroponic solution is needed for the system.

2-7-22 - Vanessa
Robotics

Connecting the Proto-board analog to the arduino is becoming very difficult because there is a lot of wiring and we also need to wire the peristaltic pumps to the arduino. For example both need 5V connections in order to work and we only have one volt plug on our arduino.
Because the pH probe we have is outdated and is becoming difficult to connect we will find another way to connect this without the bread board.



We have the vernier interface shield and the red board and although connecting sensors is way easier the shield although we run into another problem where the Vernier interface shield does not allow us access to the SDA and SCL ports on the arduino which we need for the motors.

Going to talk to a vernier support tech to figure out a solution to this issue…

After talking to Vernier support they said that these were the only two options they had in order to connect the board. We have no other choice but to get a different pH probe and connect it to our arduino.

2-8-22 - Vanessa Weir

Growing

Germinating seeds for hydroponics is very important to do before putting them into the hydroponic system. We got rock wool which has a great moisture retention and a trey in substitute for a “hydroponic hood”

1) submerge rockwool cubes in water (7.2 pH*we used Poland spring water*
2) After submerging for five minute carefully placed 2-3 seeds in the rockwool
3) Stand the rockwool in the tray and place lid over it
4) Place tray in a room with warm temperature (70-80)

This is one of the techniques we are using for germinating the seeds. Each of us is going to germinate a batch so that we have a higher chance of getting some sprouts.
After a few days we should see condensation and stems sprouting…once this happens we will move the tray into sunlight.

2-10-22 - Zahrion Watson

To germinate the seed we're going to use the rockwool method, first we're going to take the rock wool and sock it in water. We used a Poland spring water bottle because it had the pH level we need, which is over 7.2. After we drenched the rock wool we took the rapids leaf lettuce seed and put around 2-3 seeds in each of the rockwool and put a led over it and went to store it in a hot room. Germinating seed is important for the project because when germinating the seed the plant starts to sprout so when it starts to sprout we can take the plant and put it in our hydroponic system.

I put the rockwool in each corner because they kept falling, and didn't want to risk the seeds falling out or them not sprouting.

2-10-22 - Khaley Wyndham

We also plan on using a smaller container with the measurement of 14 L x 11 W x 6 1/4 that holds around 2 ½ gallons. The contier we were going to use is around 55 meter and holds around 14 gallon (Red). We transfer the hydroponic system from the smaller continater to the bigger container when we finish growing and finish with the other part.
We decided to downsize because it less space, less water so it won't become to heavy, and it also will require us to use less of of product like hydroponic nutrients solution

This is our original bin. It already has the correct measurement holes for the plants as well as the pumping system for putting oxygen in the water…

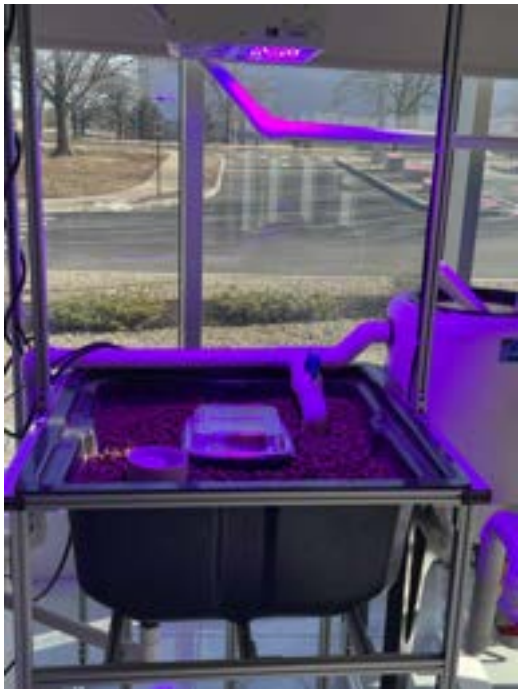
This is a 14” L * 11” W * 6 ¼ “ H bin

This is a lot smaller that our red bin we are using but eventually will need both

We decided to have a downsized bin for the beginning of our growing process because it will allow us to not only use less water but less pH and nutrient solution.
It would make no sense to start the seeds in a huge hydroponic system.

2-11-22 - Khaley - Shai Wyndham

Today I went to a mentor for the hydroponic system. We talked about germination of seed and what are some methods to germinate seeds, and if the method we choose is a good one and would work. So we used the method of putting the seed in the rockwool and soaking it to germinate. The mentor confimfer that it would work. She also recommended that I put water in the container to make sure the rockwool stays wet so the seed will germinate properly. She also recommended using another method of gemination with the other batch of seed germinated under her light, the method she suggested was using the paper towel method, which was putting seed on a wet paper towel and putting another one over it folding it and putting it in a zip lock bag to sit for a few days.



I also showed he the container were using and she also showed the spot where our hydroponic system could go which is the same spot in which the germinated seeds are, and were going to put the LED lights on because the LED lights is important for the hydroponic system because it helps give it energy, help strengthen the plant , and make the plant lifespan last longer.

2-13-21 - Vanessa Weir

These are the seeds after germinating for almost a week. Now I am going to bring the seeds into sunlight and continue to add water to the rockwool. Spoon they will be brought into our system to grow even more.

2-20-2022 - Vanessa Weir

Programming pH Sensor Calibration

Me and Zahrian put together in class in order to program. Couldn't test the code I had last week because the Arduino IDE was blocked on the school laptop and it was a 4 day weekend. Once IT got a hold of the laptop on monday it took an extra day for him to download it because it was having some problems.

Code #1:

This code is in order to calibrate the Ph sensor; what it's supposed to do is read the analog output circuit and display the voltage. In order to calibrate I twisted the trimmer to adjust the value to 2.50 because 2.50 volts is = to the pH of 7

```
int pH_Value;
float Voltage;

void setup()
{
  Serial.begin(9600);
  pinMode(pH_Value, INPUT);
}

void loop()
{
  pH_Value = analogRead(A0);
  Voltage = pH_Value * (5.0 / 1023.0);
  Serial.println(Voltage);
  delay(500);
}
```

Something new I learned/ was refreshed on was **float** which is a data type composed of a number that is not an integer, because it includes a fraction represented in decimal format.

This is initially what the calibration looked like. I didn't use the pH monitor because I wanted to get the correct voltage.

This part was rather easy and didnt have a problem with anything…

2-20-22 - Vanessa

Programming pH probe with Arduino

Connected the Ph probe to the calibrated code and now moved onto the next code which is to test different solutions and display the pH of those liquids.
There were many troubleshoots with this and it took forever!!!

Parts of the Complex code:

```
#include <Wire.h>
#include <Adafruit_GFX.h>#include <Adafruit_SSD1306.h>
#include <SimpleTimer.h>
```

These are the libraries that hold separate code within them I got these off of GitHub and they are commonly used within Arduino IDEs

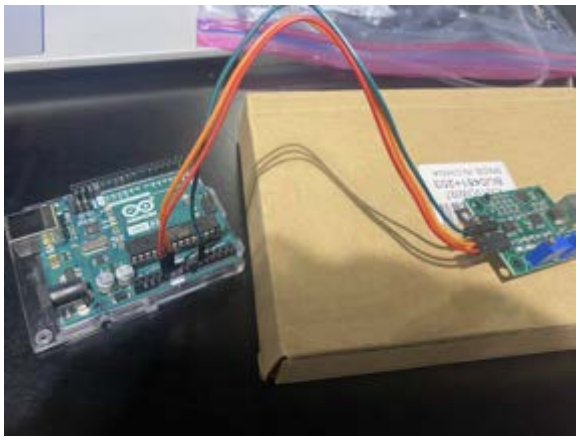
```
SimpleTimer timer;

float calibration_value = 21.34 - 0.7;
int phval = 0;
unsigned long int avgval;
int buffer_arr[10],temp;

float ph_act;

#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64
```

This is for an OLED Display screen that shows the pH although I added this code because i thought we would be able to get one later down the line and because it wouldn't affect the reading of the pH in the first place

```
takes samples, arranges values and takes the average.
 for(int i=0;i<10;i++)
 {
 buffer_arr[i]=analogRead(A0);
 delay(30);
 avgval=0;
 for(int i=2;i<8;i++)
 avgval+=buffer_arr[i];
 float volt=(float)avgval*5.0/1024/6;
  ph_act = -5.70 * volt + calibration_value;

 Serial.println("pH Val: ");
 Serial.print(ph_act);
 delay(1000);
}

void display_pHValue()
```

```
{

 display.clearDisplay();
 display.setTextSize(2);
 display.setCursor(0,0);
 display.print("pH:");

 display.setTextSize(2);
 display.setCursor(55, 0);
 display.print(ph_act);

 display.display();
}
```

This function is the part we won't really be utilizing for the science fair due to time although it is what will display the pH on the OLed display screen, which is really cool.



This is what the pH probe looks like connected to the arduino. We connect the arduino to the laptop in order to compile the code onto it.

2-21-22 - Vanessa

Errors with Arduino

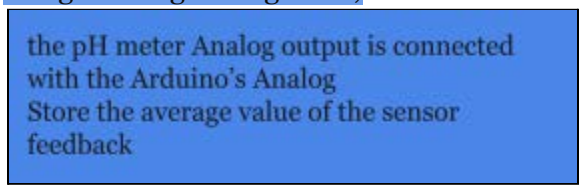
After compiling the program there were some issues with the **<SimpleTimer.h>**library, I installed the other two to my IDE so I wasn't sure why that one was not working. Figured out that the other libraries where already in the arduino IDE system so they were extracted already…I did some research on it and said I needed to extract the ZIP file for **<SimpleTimer.h>**... because it was a school laptop I didn't have administrative access to do so. Therefore I tried downloading the files separately and then adding them to my arduino library.

Eventually got the libraries working although it took a lot of time and I ran into even more problems compiling the program.

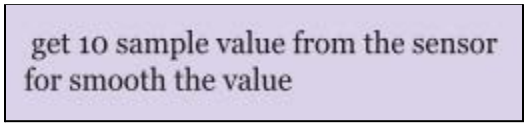
Confused and extremely frustrated because I made sure everything was right. Did even more research and ended up emailing a computer engineer…Found out the problem was not the code but it was the Arduino IDE version I was using, which was having trouble compiling the libraries. My Arduino 1.8.19 wasn't stable with the code but it should be stable on the 1.6.12 IDE which again I cannot download due to it being a school laptop.

Overall the libraries are the main issue right now so in the meantime im looking for a simpler code to refer to although it still wont read the correct pH because the libraries are all wonky… These are some parts of the code(not the whole thing just vile parts)

```
#define SensorPin 0
unsigned long int avgValue;
```




```
float b;
int buf[10],temp;

void setup()
{
  pinMode(13,OUTPUT);
  Serial.begin(9600);
  Serial.println("Ready");
}
void loop()
{
  for(int i=0;i<10;i++)
```




```
 {
   buf[i]=analogRead(SensorPin);
```

```
  avgValue=0;
 for(int i=2;i<8;i++)
```

take the average value of 6 center sample

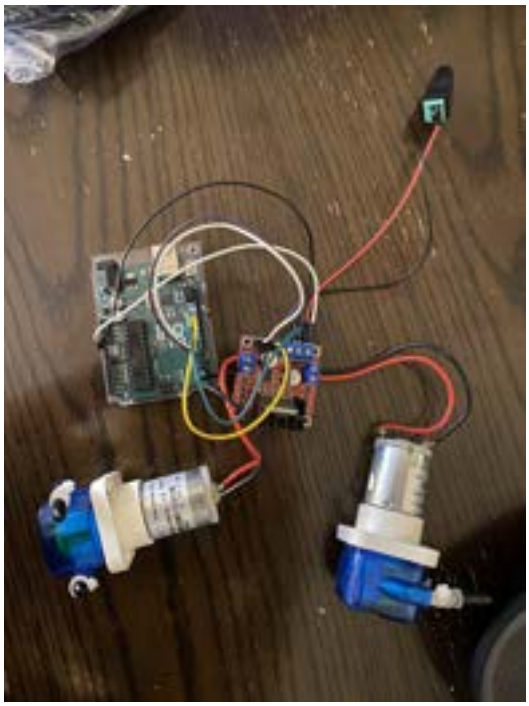
```
  avgValue+=but[i];
 float phValue=(float)avgValue*5.0/1024/6;
convert the analog into millivolt**
  phValue=3.5*phValue;
convert the millivolt into pH value**
  Serial.print("    pH:");
  Serial.print(phValue,2);
  Serial.println(" ");
  digitalWrite(13, HIGH);
  delay(800);
  digitalWrite(13, LOW);

}
```

The pH is still off. I Tried recalibrating it multiple times and editing the code. I'm going to try recalibrating it again tomorrow when I work on the peristaltic pump code.

If the pH code does not come through but I can still connect its data to the peristaltic pump our idea will still be there although just afraid it won't work as accurately/properly.

2-22-2022 - Vanessa Weir

Troubleshooting
What I have realized after working with the code is that the problem branches from the probe itself although we will not be able to order a new probe in time for the fair therefore today I just continued to work on the programming for our motors.



This is our setup for the motors connected to the Arduino. In the middle you see our DC motor controller and it is what connects our pumps to our arduino. It is a L298N motor controller. Yesterday I sutured the motors to the motor controller using a suturer.

2-22-2022 -Vanessa Weir

Motors_1 §

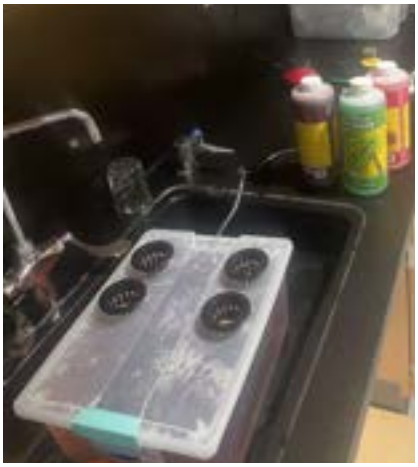
```
int motor1pin1 = 2;
int motor1pin2 = 3;

int motor2pin1 = 4;
int motor2pin2 = 5;

void setup() {

  pinMode(motor1pin1, OUTPUT);
  pinMode(motor1pin2, OUTPUT);
  pinMode(motor2pin1, OUTPUT);
  pinMode(motor2pin2, OUTPUT);

  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
}

void loop() {


  //= speed (0 = off and 255 = max speed):
  analogWrite(9, 100); //ENA pin
  analogWrite(10, 200); //ENB pin

  //Controlling spin direction
  digitalWrite(motor1pin1, HIGH);
  digitalWrite(motor1pin2, LOW);

  digitalWrite(motor2pin1, HIGH);
  digitalWrite(motor2pin2, LOW);
  delay(1000);

  digitalWrite(motor1pin1, LOW);
  digitalWrite(motor1pin2, HIGH);

  digitalWrite(motor2pin1, LOW);
  digitalWrite(motor2pin2, HIGH);
  delay(1000);
}
```

This is to test our motor controllers and make sure everything is running correctly. What this program does is reads where the motors are through the motor control pins on the arduino and tells the motors to turn on in different intervals and directions.

Today while working on the final code for the system my laptop crashed and I no longer have access to the Arduino IDE or any way to actually compile or run the code. Due to the long weekend and not being able to get a new battery till wednesday we won't be able to put everything together and collect the correct data needed.
I was planning to troubleshoot the motor code again because one of the motors was not working, more specifically the left motor. I ended up getting another motor controller to see if the problem was from the software itself but it was not.
After getting the pumps working I was then going to put the pH monitor code within the motor controller code so that it all works together.

2-23-22 - Khaley-Shai Wyndham

As our group project started to wrap up with the hydroponic system having all the materials it needed and the robotic part of the project almost done, I decided to run a lab on the hydroponic system. So the only thing left for the hydroponic system is the seeds, but the seeds are still germating and almost ready to be placed in the hydroponic system, so while the seeds are continuing to germinate, i decided to start putting together the DWC hydroponic system, so i took the rock wool and place it inside the netpod and fill the container up with water to make sure that ¼ of the net pods was covered in water, after that i took the water pump and put it inside the container. The next step was to make sure i put the right nutrients solution, putting the right nutrients solution is very important for the project because it make sure that the pH is balances is stable and the plant (which were going to add soon) has proper nutrients since there no soil in hydroponic system and the water with the nutrients solution acts as a substitute for it. Getting the right measurement for the nutrients solution was my main target due to it being important for the hydroponic system health,i used the Flora series hydroponic solution, on the back it read that you need ¼ a cup each gallon of water ,which also equal to 30/33 ML (measurement vaires for growth periods) , so I took the measurement in mL tool and since the container hold around 2 gallon i pour 60mL in the hydroponic system for each liquid of the flora series. The flora series come in 3 for the hydroponic system. I also read more about flora series and figured which one goes in first and that I need to shake the bottles before pouring it in. The floramicro goes first ,then florabloom, and last floragro, and it turns the water into a more purple color.



2-25-22 Khaley-shai Wyndham

Reflection

Today I worked on the abstracted for scientist fair, but we only really focus on explain the back rounded information , the purpose of the projects, and how are project worked, this was because we're still waiting on data for are projects because the programing part of the project is still in the works, but the hydroponic part is of the project is done, we have all the part we need and the seed have also finish germinated.

What stunted the process of the hydroponic system was the fact the computer couldnt downloaded the system before the long weekend. Once we got it downloaded by our IT advisor, Vanessa immediately started working on it. ---> The pH reader is not properly picking up the pH levels but now that the new programming system we downloaded can now correct that solution→ more technical difficulties as laptop with arduino ide and programming crashed and had to replace battery. So currently we are continuing to study the fluctuation of our nutrient system and help to incorporate the program as well as program peristaltic pumps.