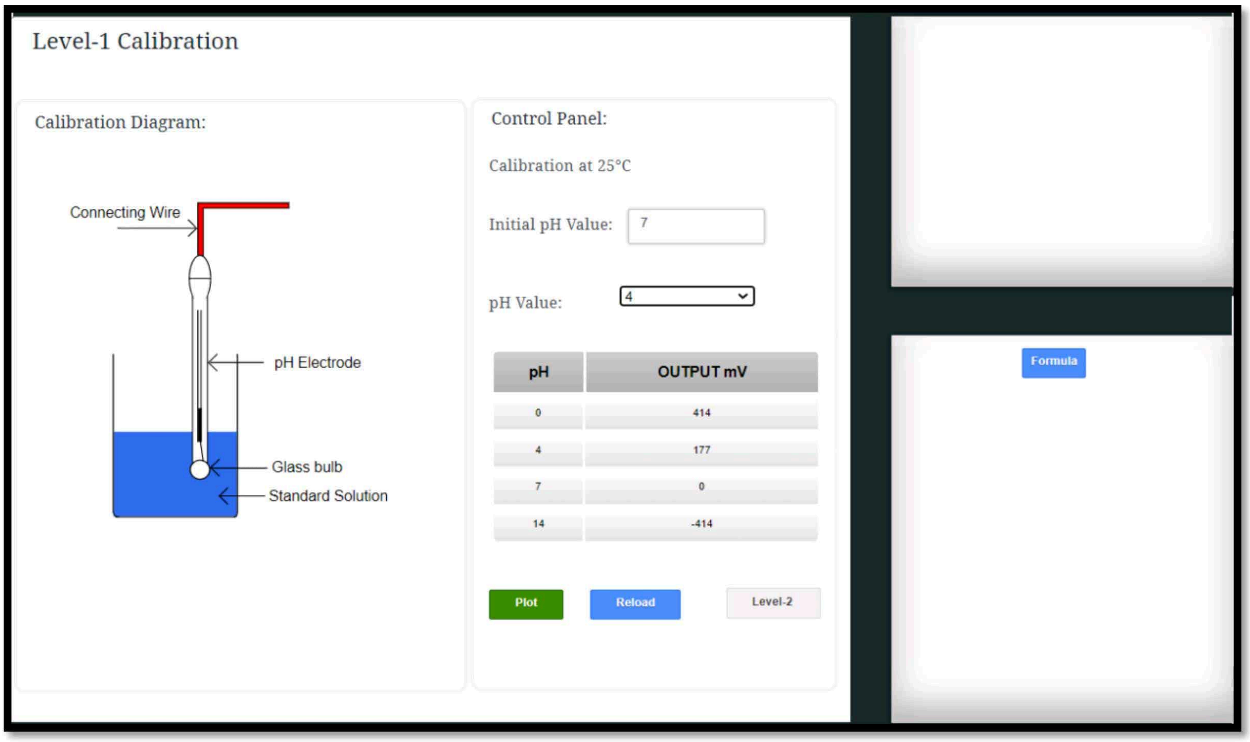
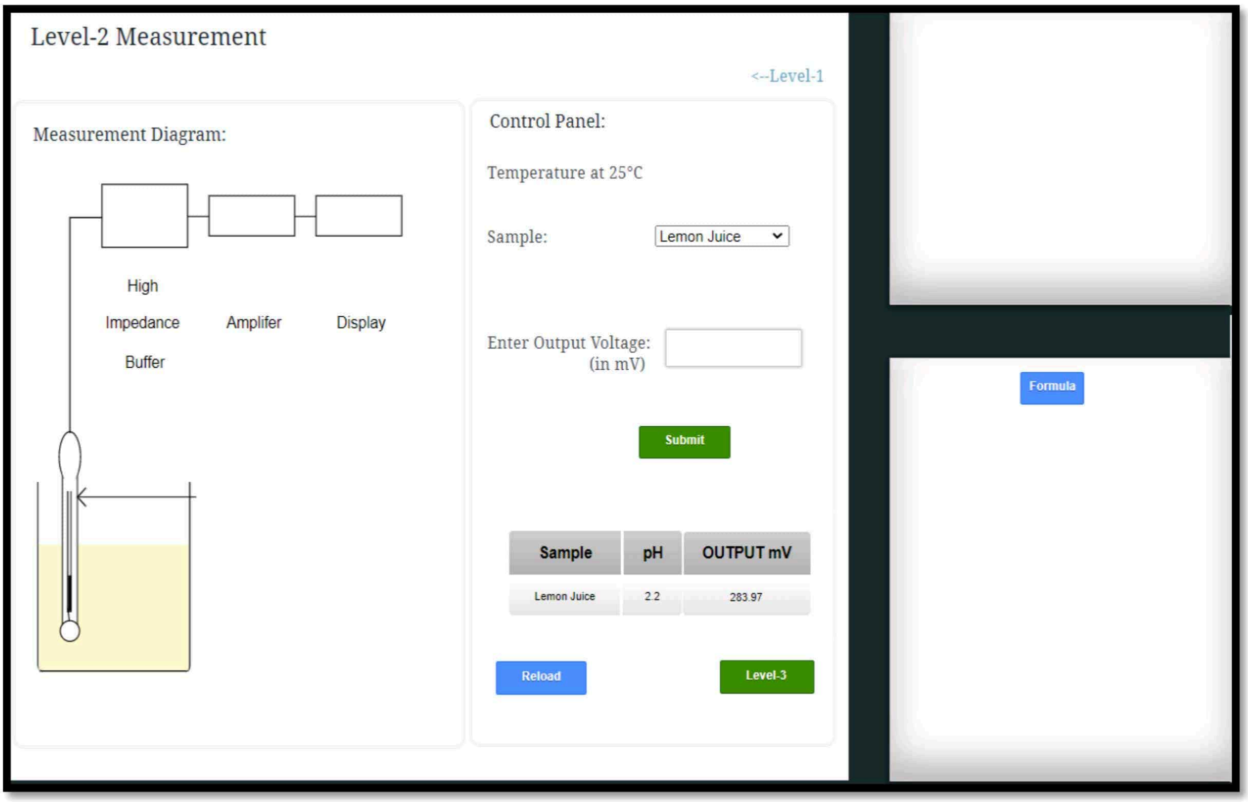
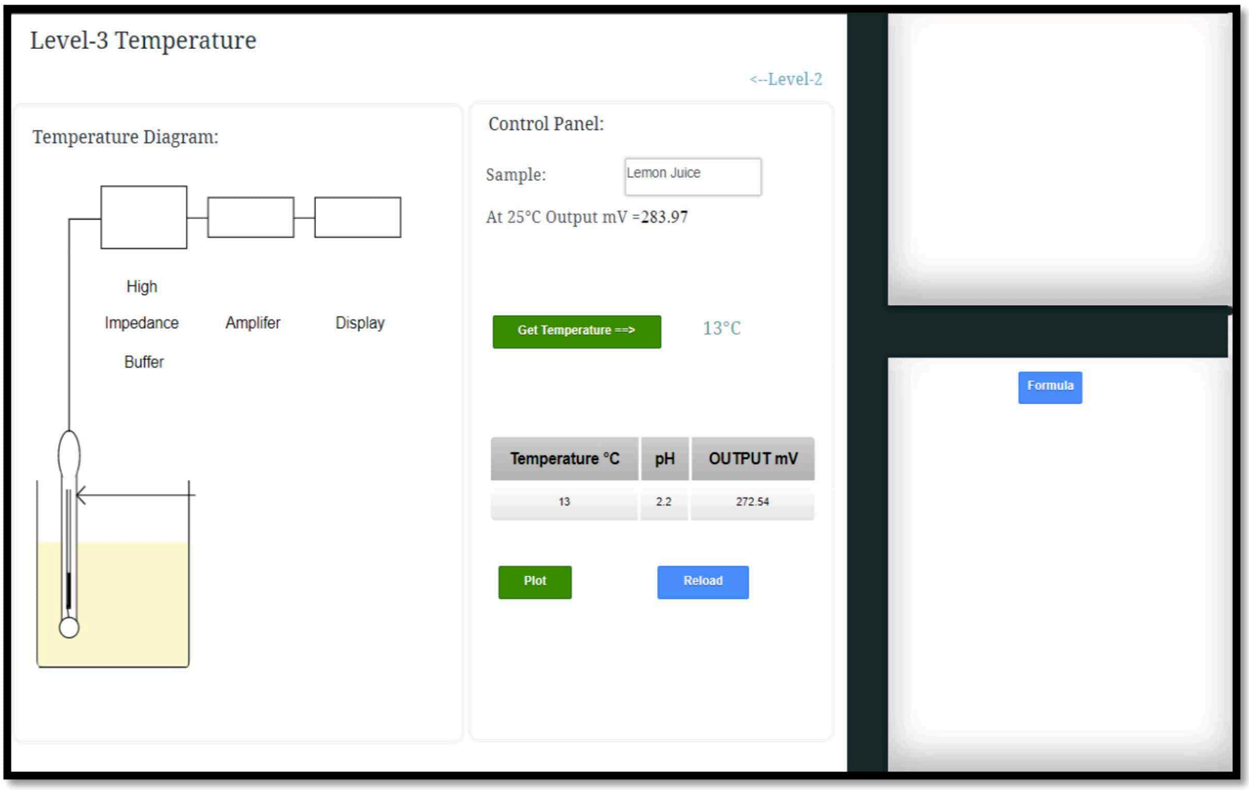
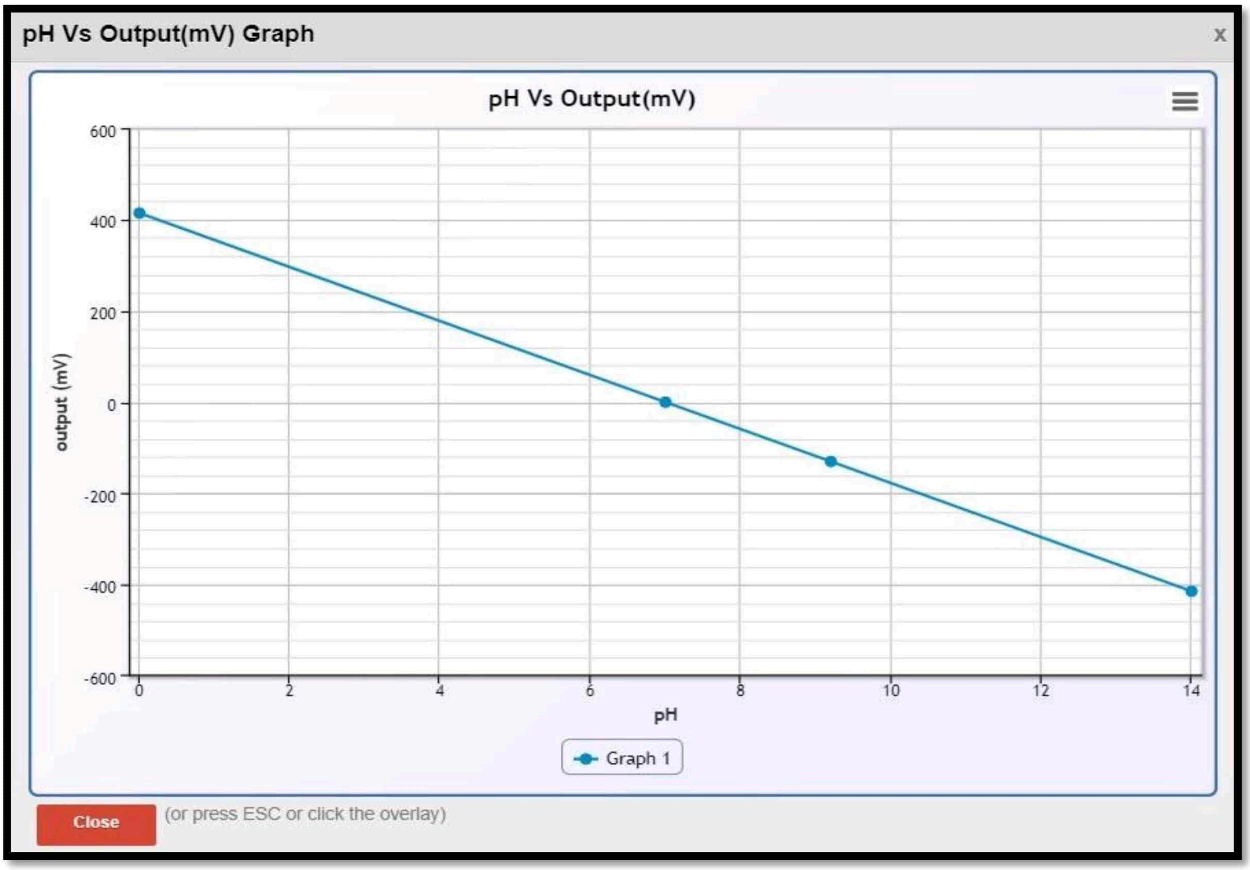
ASSIGNMENT NO: 4 : EXPERIMENT ON Ph & CONDUCTIVITY MEASUREMENT

❖ **SAMPLE: LEMON JUICE**









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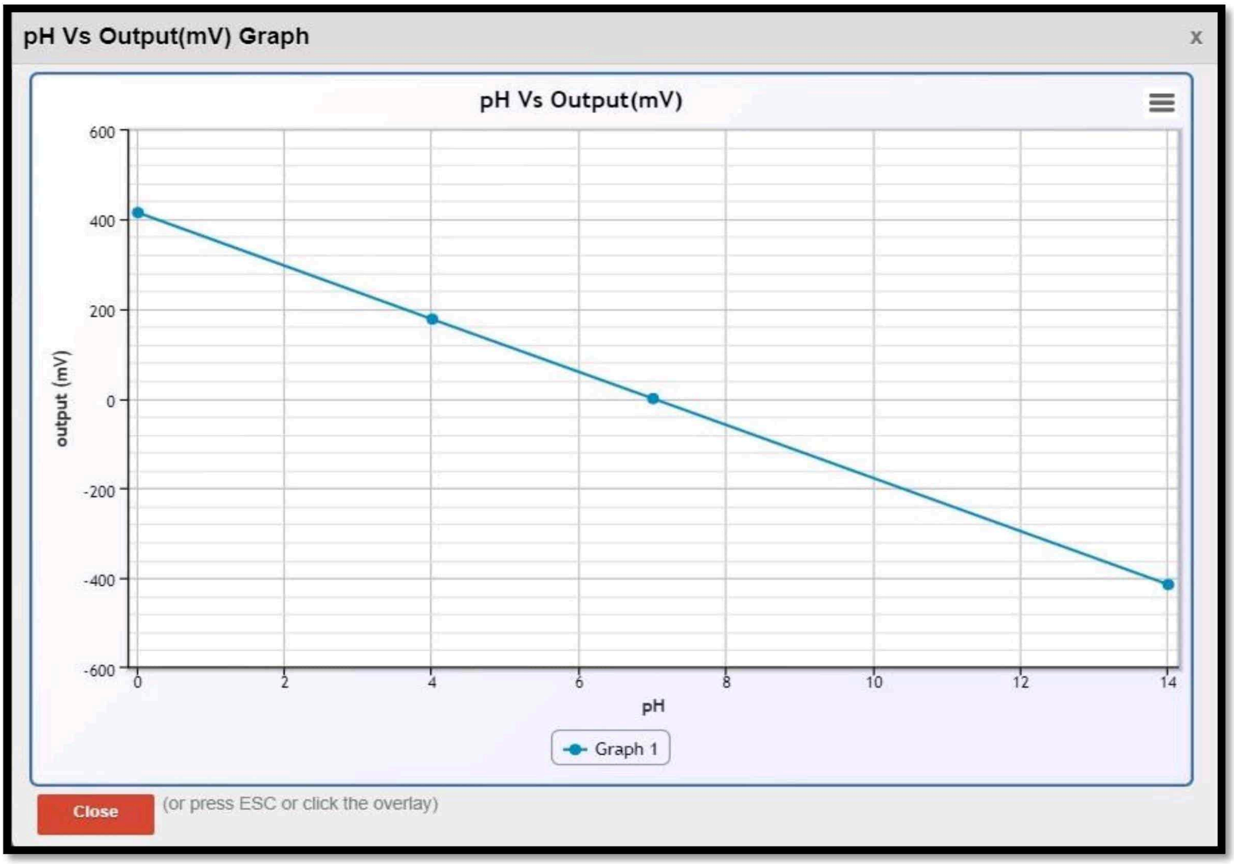
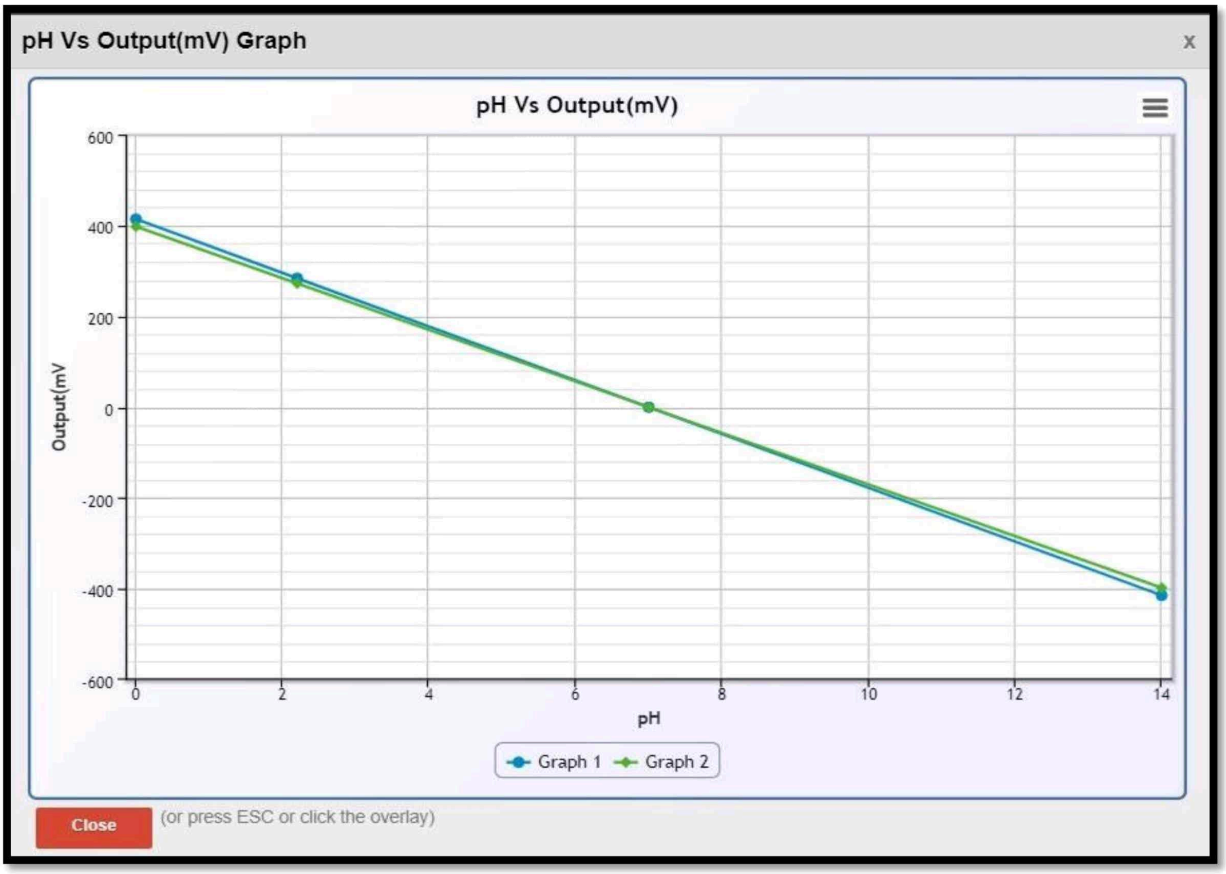
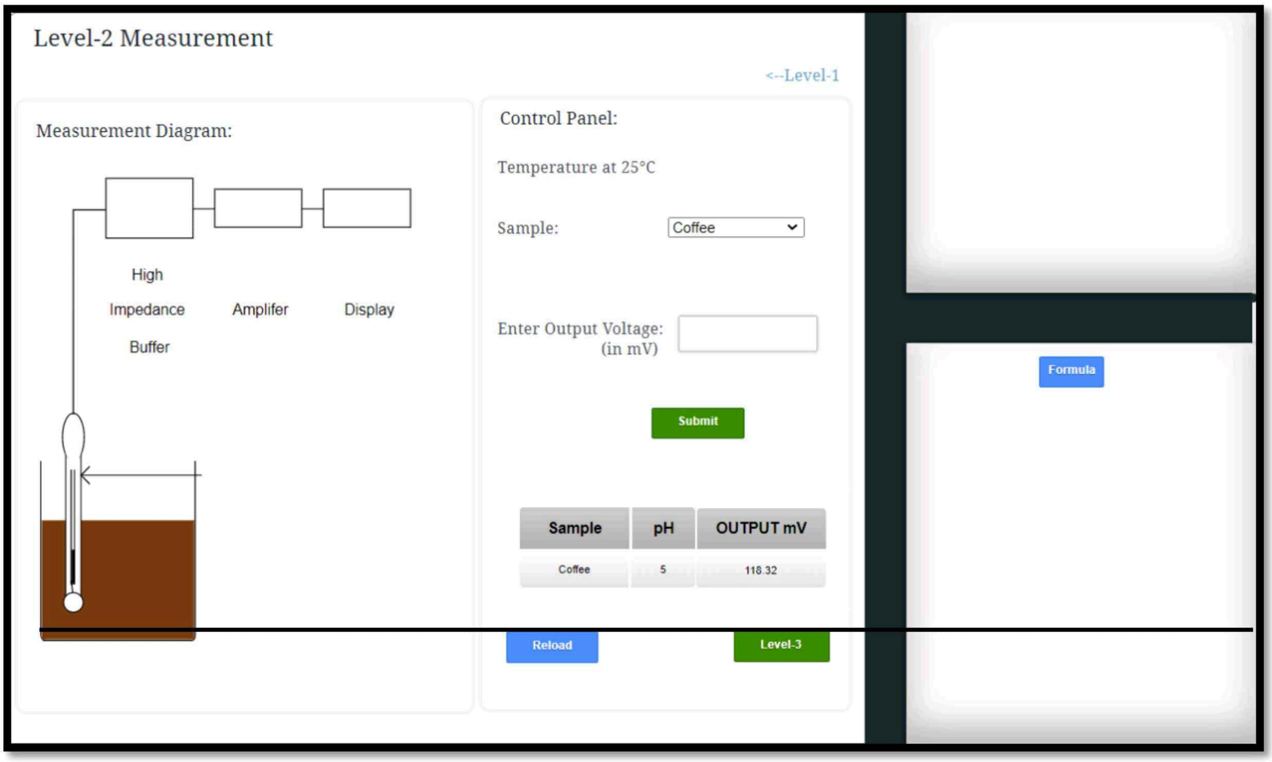
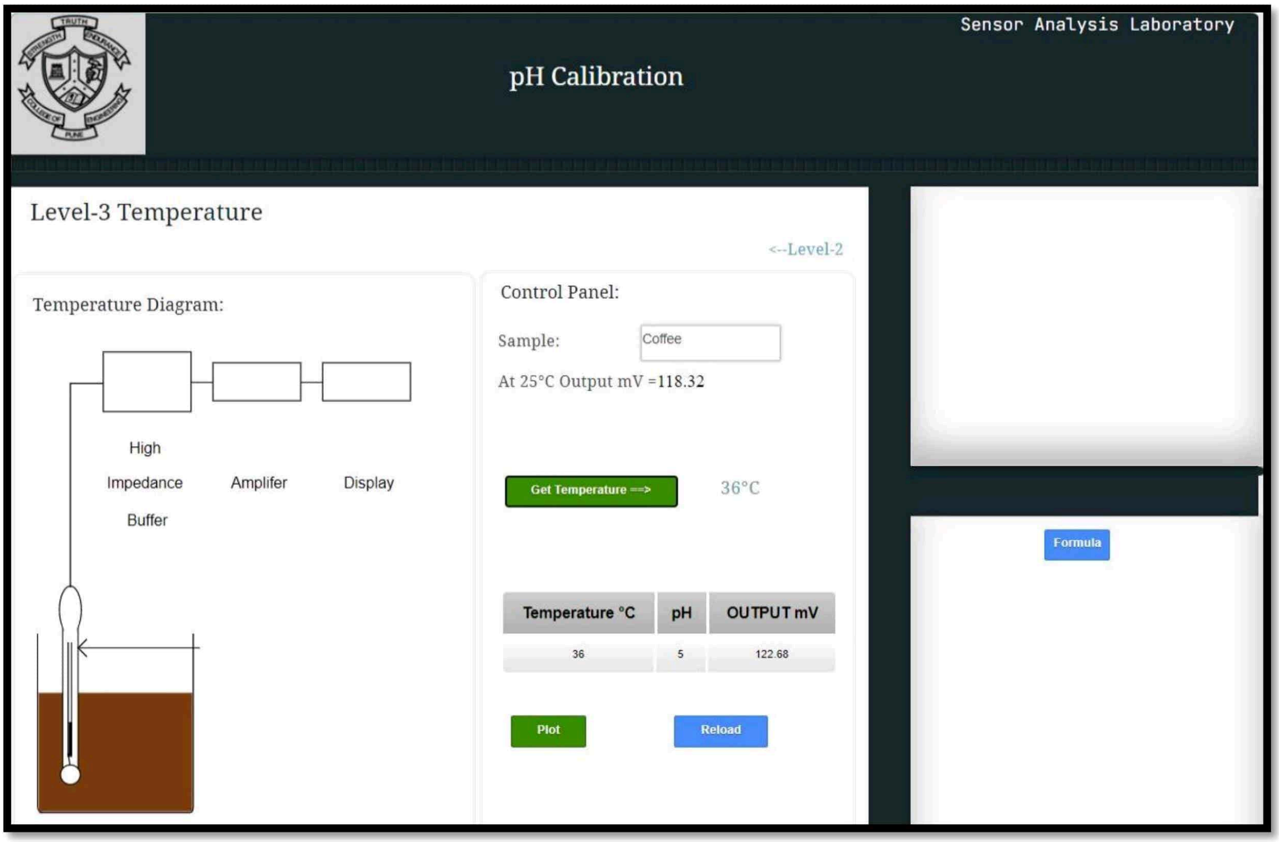
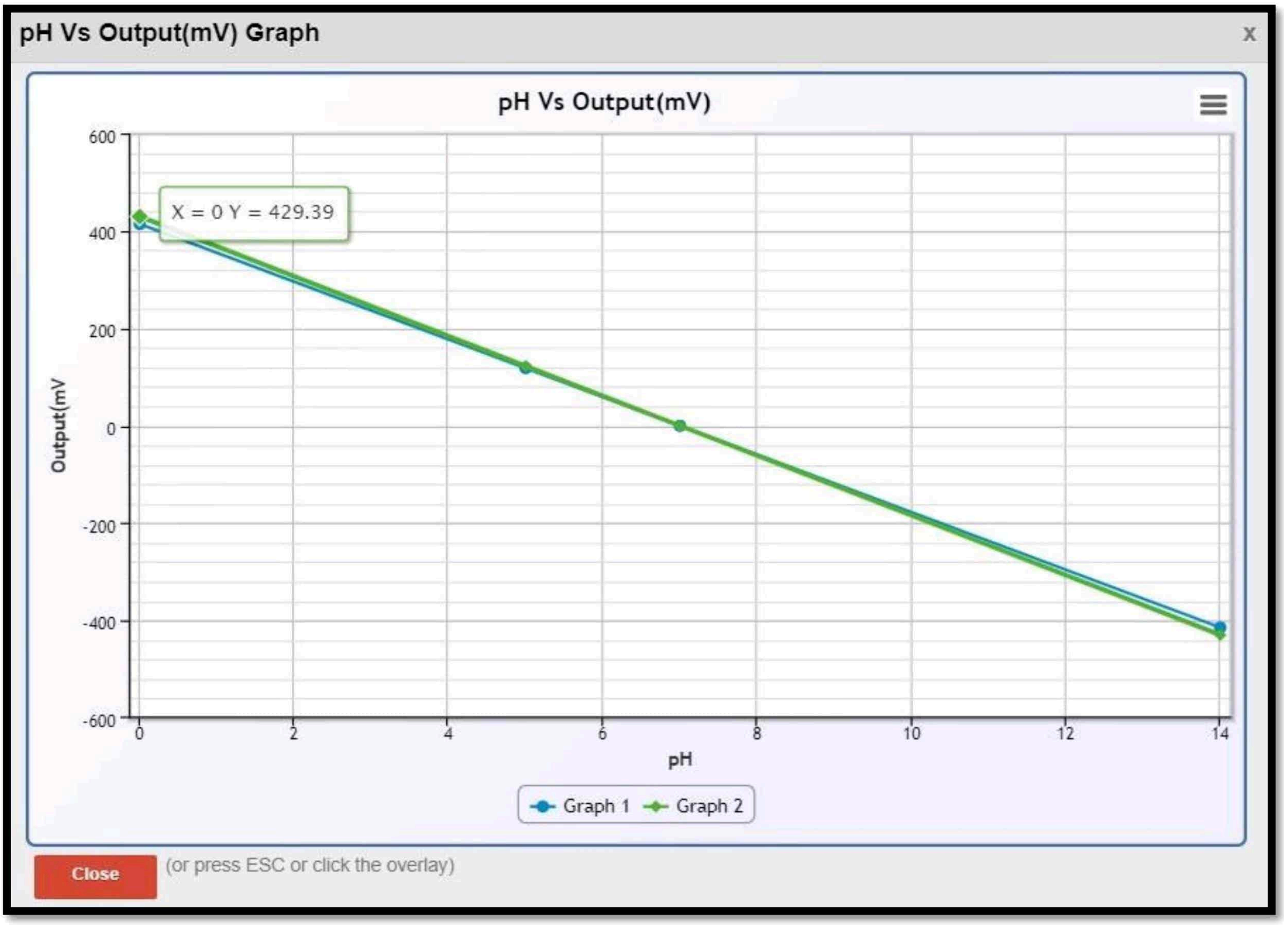

pH Vs Output(mV) Graph
x
pH Vs Output(mV)
600
400
200
0
-200
-400
-600
output (mV)
0
2
4
6
8
10
12
14
pH
Graph 1
Close
(or press ESC or click the overlay)


pH Vs Output(mV) Graph
x
pH Vs Output(mV)
600
400
200
0
-200
-400
-600
Output(mV
0
2
4
6
8
10
12
14
pH
Graph 1
Graph 2
Close
(or press ESC or click the overlay)

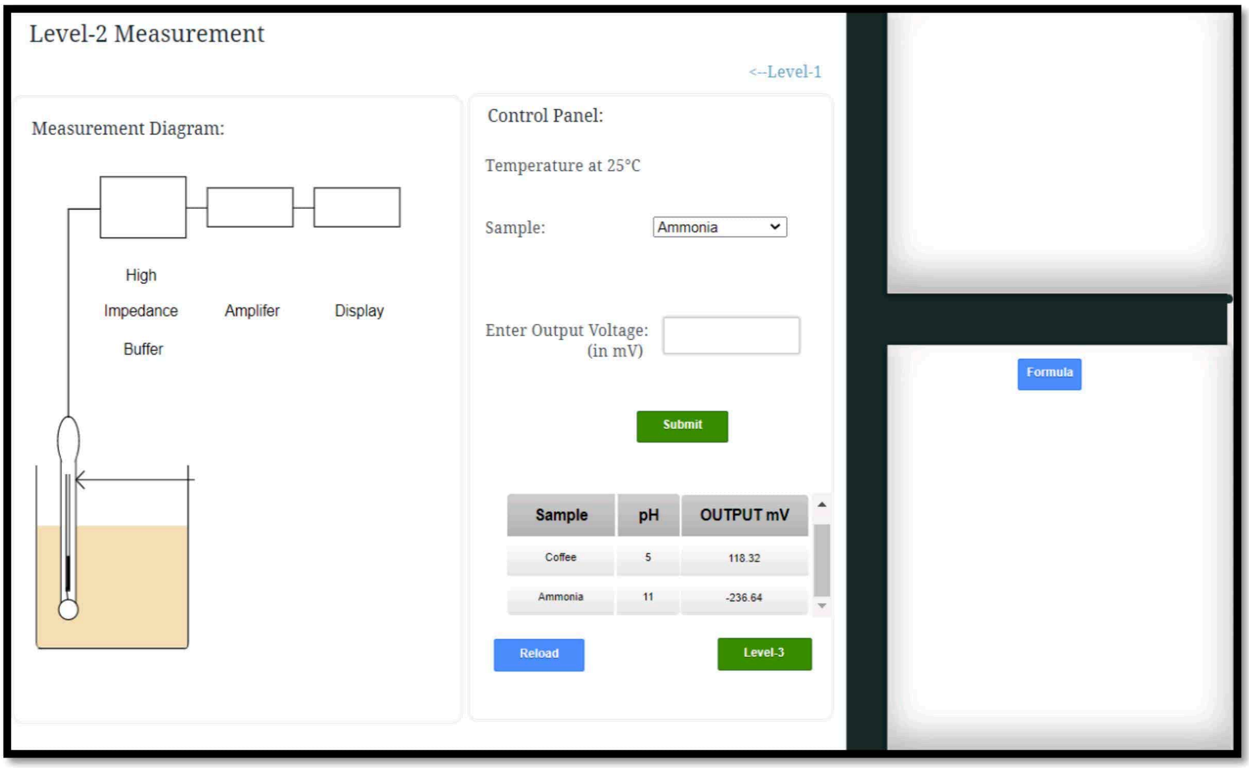
❖ SAMPLE : COFFEE

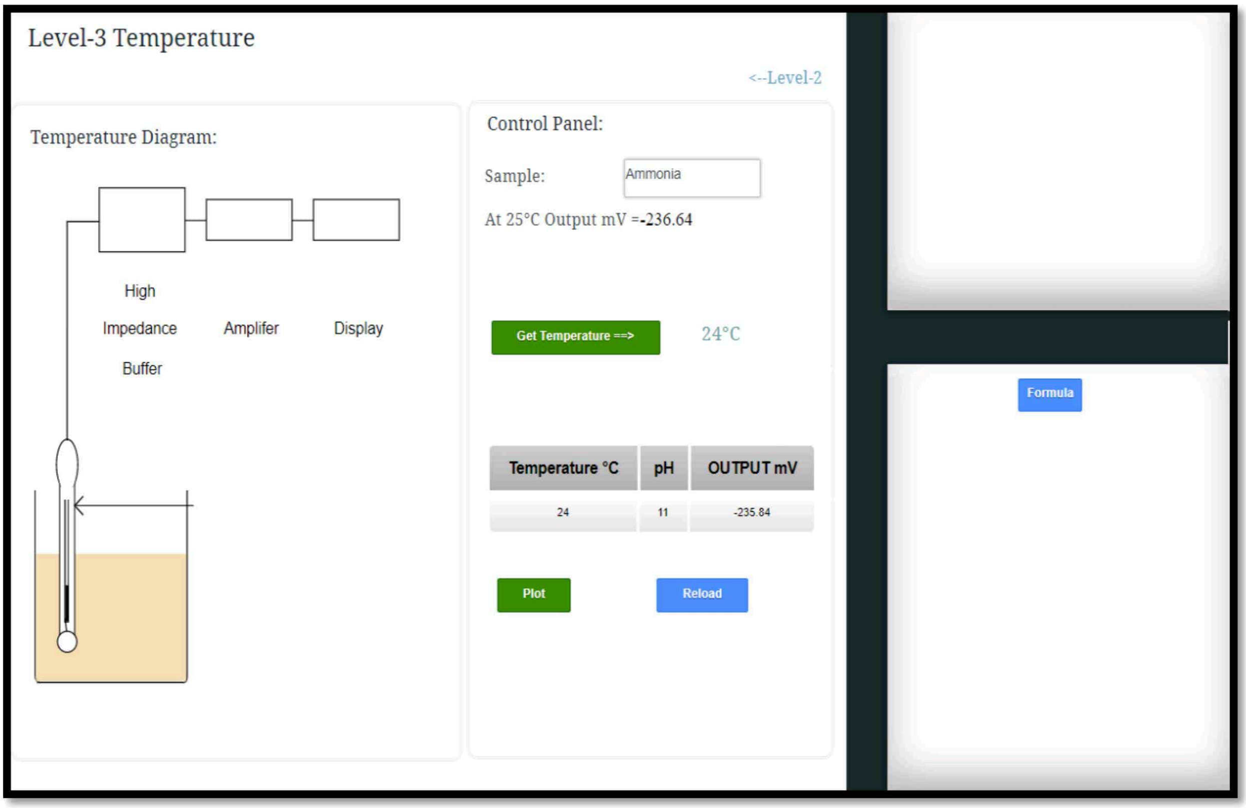


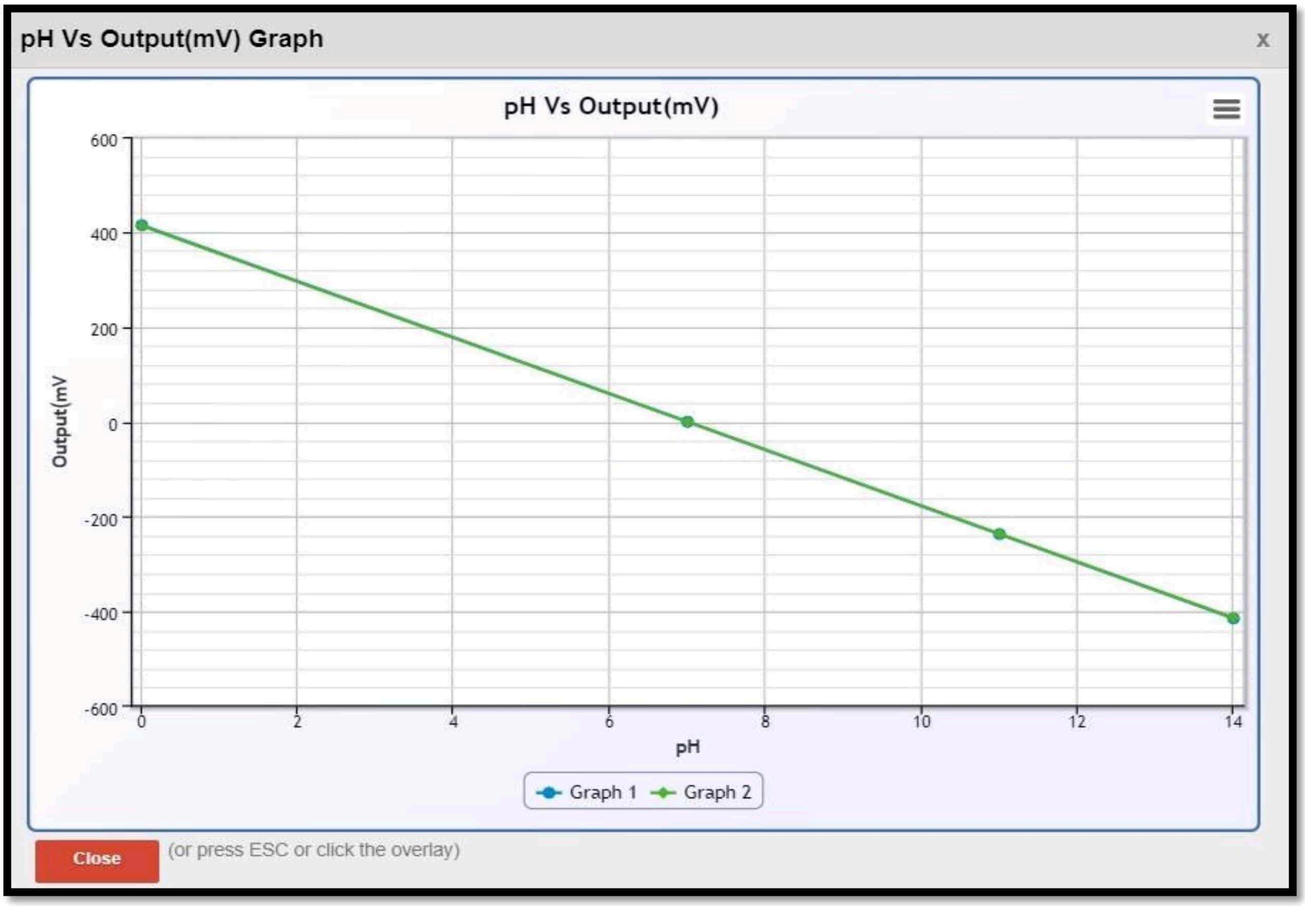



pH Vs Output(mV) Graph
x
pH Vs Output(mV)
X = 0 Y = 429.39
600
400
200
0
-200
-400
-600
Output(mV
0
2
4
6
8
10
12
14
pH
Graph 1
Graph 2
Close
(or press ESC or click the overlay)

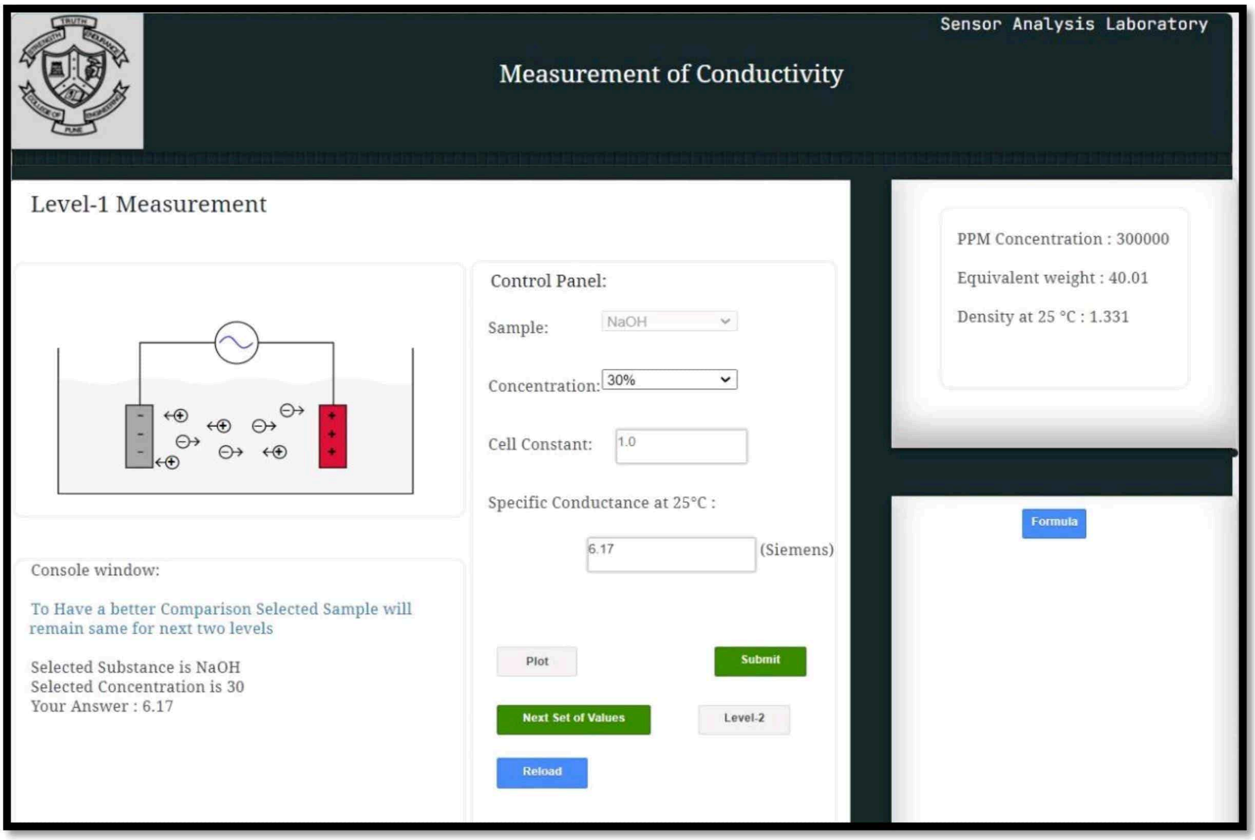
❖ SAMPLE : AMMONIA

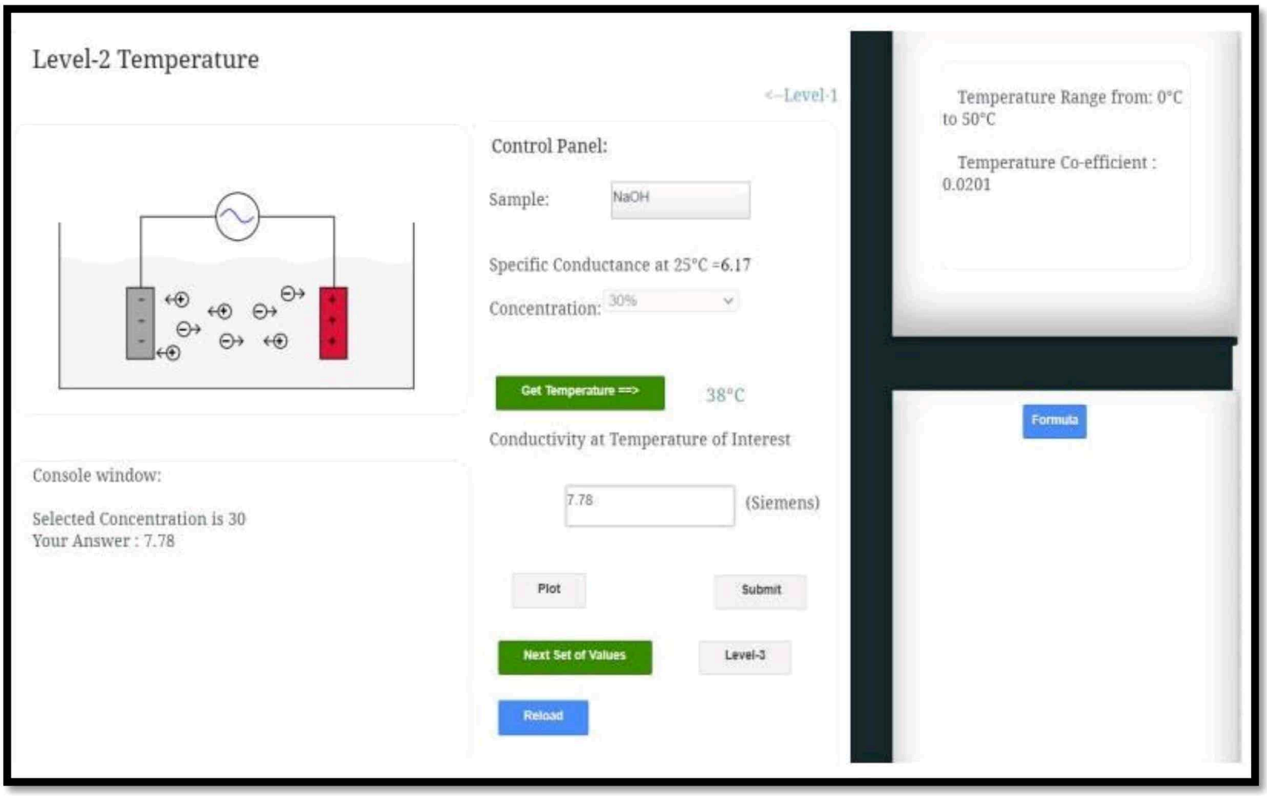


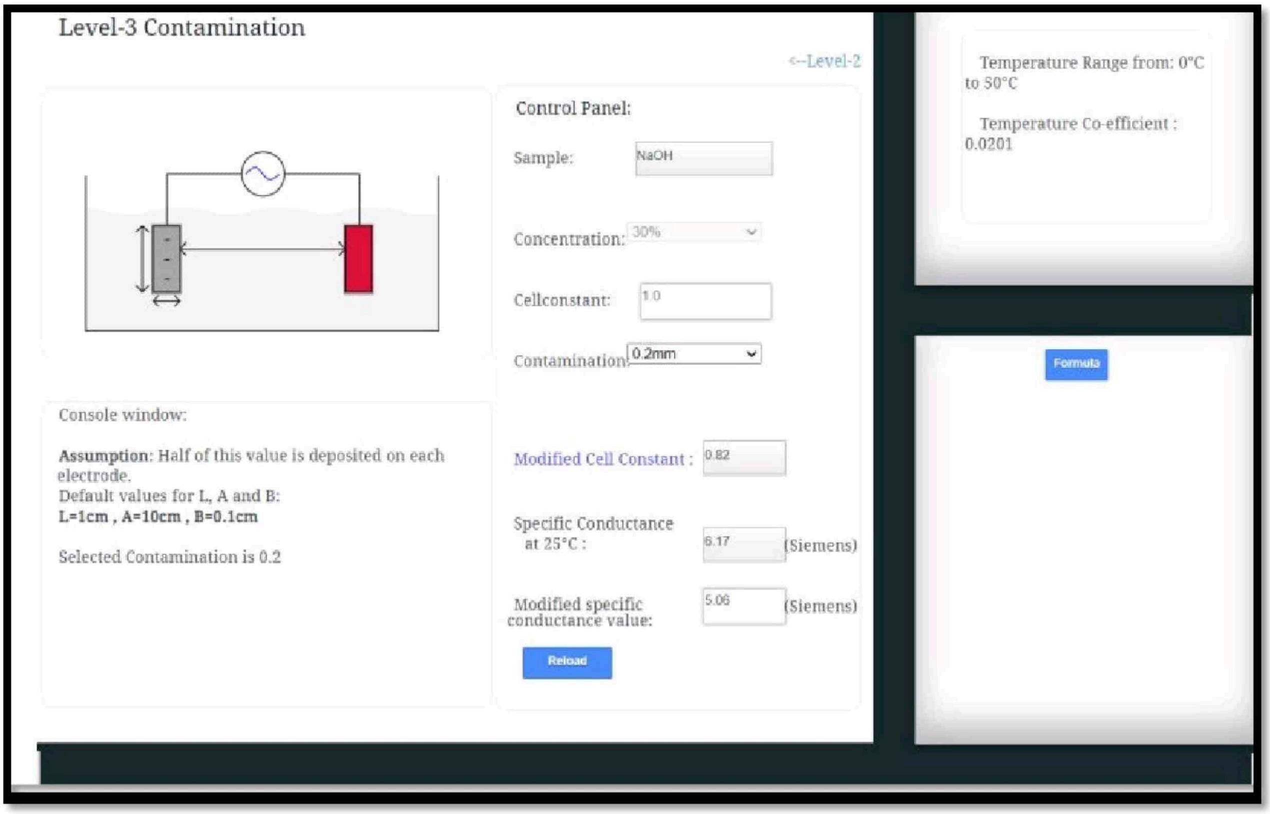



pH Vs Output(mV) Graph
x
pH Vs Output(mV)
600
400
200
0
-200
-400
-600
Output(mV
0
2
4
6
8
10
12
14
pH
Graph 1
Graph 2
Close
(or press ESC or click the overlay)

❖ SAMPLE: NaOH

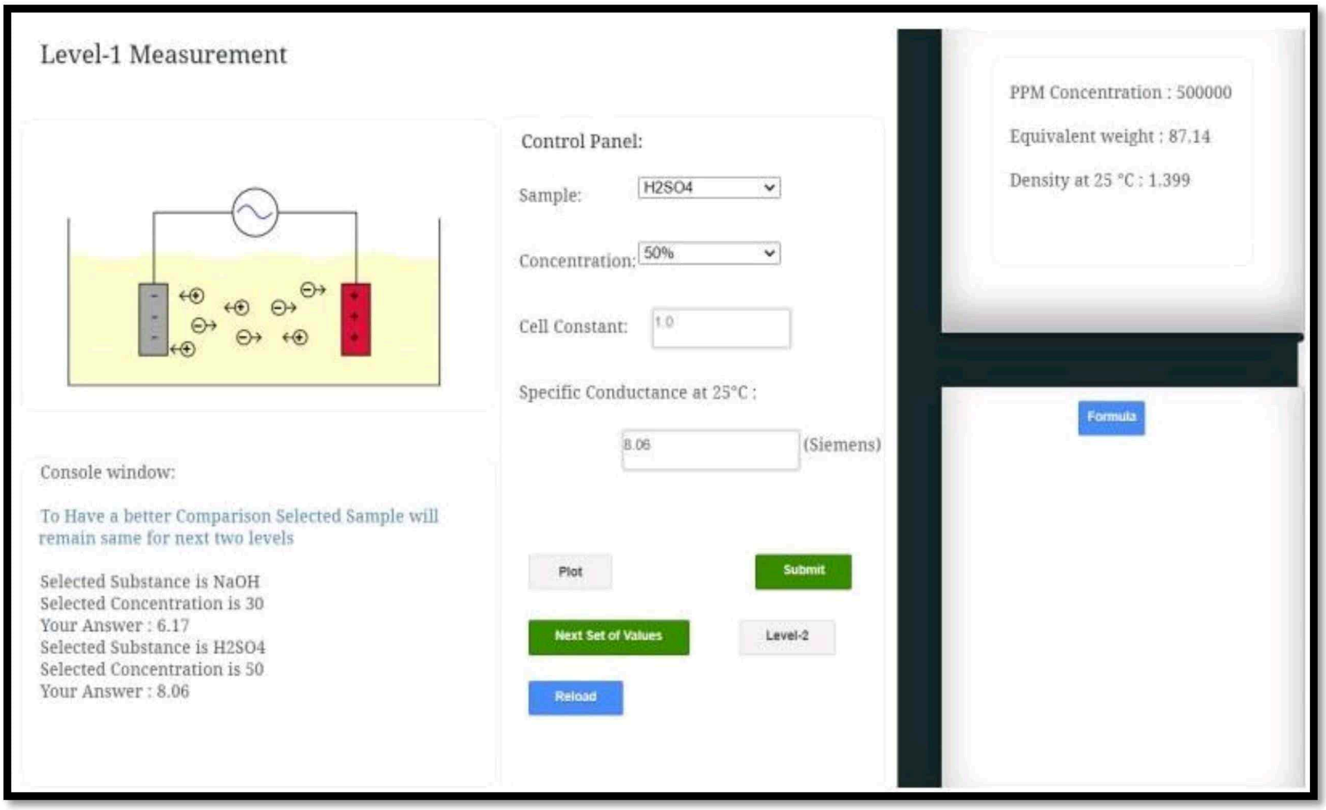

Sensor Analysis Laboratory
Measurement of Conductivity
Level-1 Measurement
Control Panel:
Sample:
NaOH
Concentration:
30%
Cell Constant:
1.0
Specific Conductance at 25°C :
6.17
(Siemens)
Plot
Submit
Next Set of Values
Level-2
Reload
Console window:
To Have a better Comparison Selected Sample will remain same for next two levels
Selected Substance is NaOH
Selected Concentration is 30
Your Answer : 6.17
PPM Concentration : 300000
Equivalent weight : 40.01
Density at 25 °C : 1.331
Formula

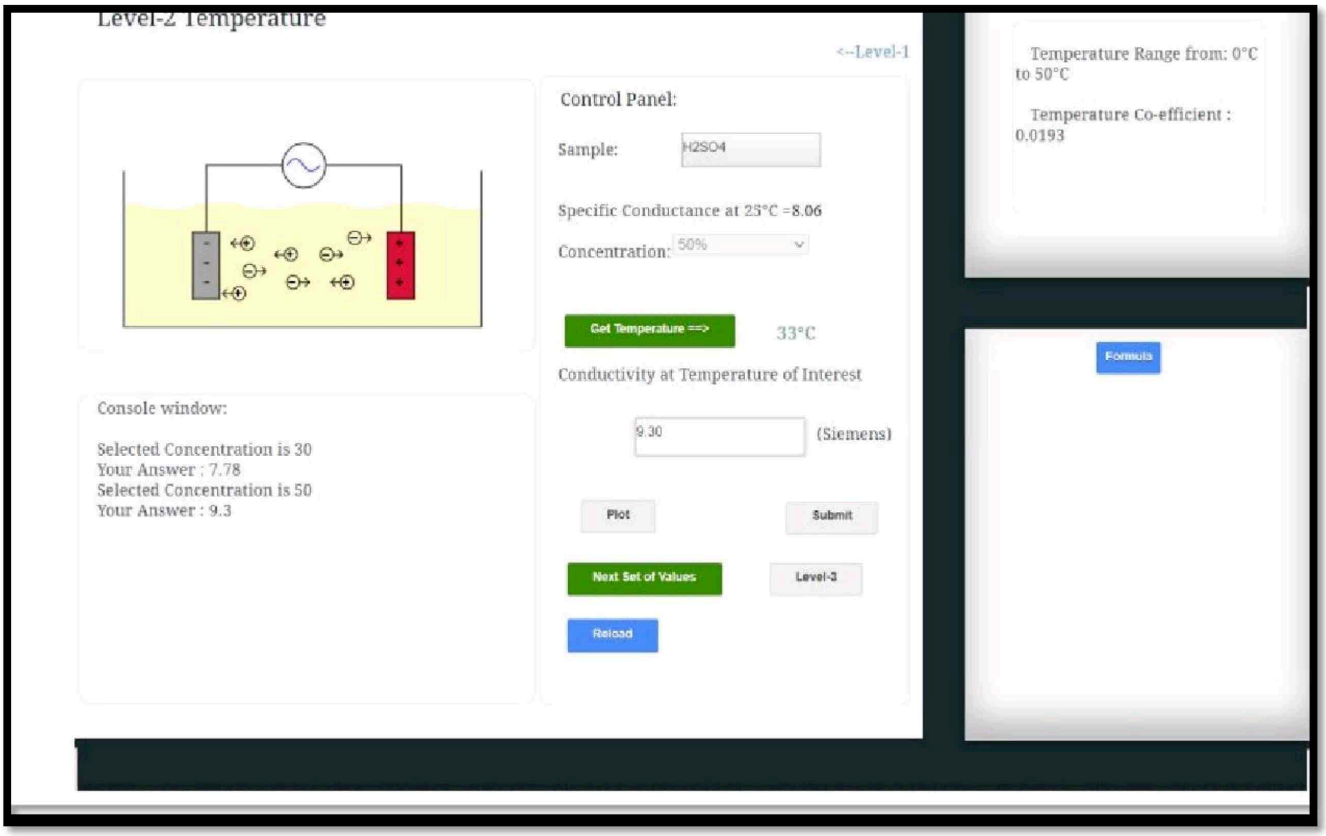

Level-2 Temperature
<--Level-1
Control Panel:
Sample:
NaOH
Specific Conductance at 25°C =6.17
Concentration:
30%
Get Temperature ==>
38°C
Conductivity at Temperature of Interest
7.78
(Siemens)
Plot
Submit
Next Set of Values
Level-3
Reload
Console window:
Selected Concentration is 30
Your Answer : 7.78
Temperature Range from: 0°C to 50°C
Temperature Co-efficient : 0.0201
Formula

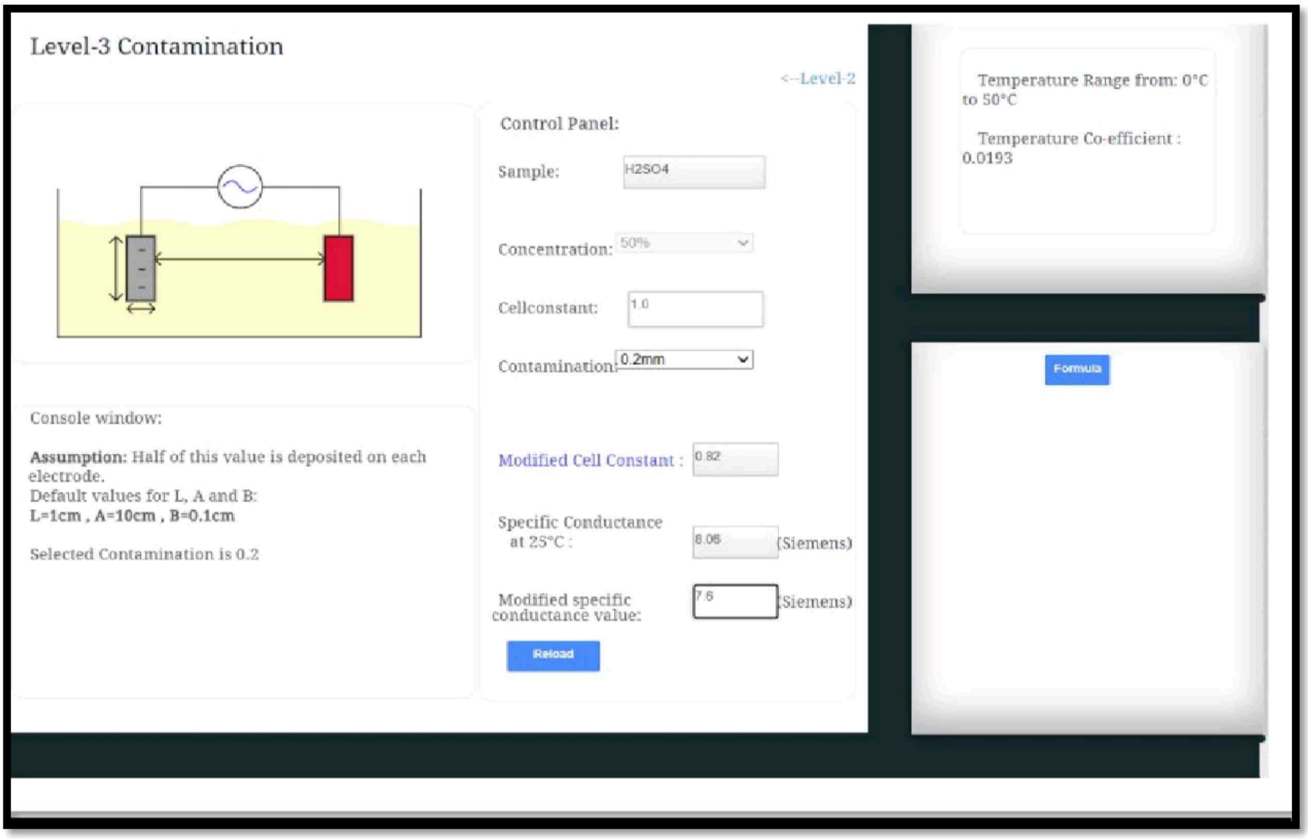


Level-3 Contamination
<--Level-2
Control Panel:
Sample:
NaOH
Concentration:
30%
Cellconstant:
1.0
Contamination:
0.2mm
Modified Cell Constant :
0.82
Specific Conductance at 25°C :
6.17
(Siemens)
Modified specific conductance value:
5.06
(Siemens)
Reload
Console window:
Assumption: Half of this value is deposited on each electrode.
Default values for L, A and B:
L=1cm , A=10cm , B=0.1cm
Selected Contamination is 0.2
Temperature Range from: 0°C to 50°C
Temperature Co-efficient : 0.0201
Formula

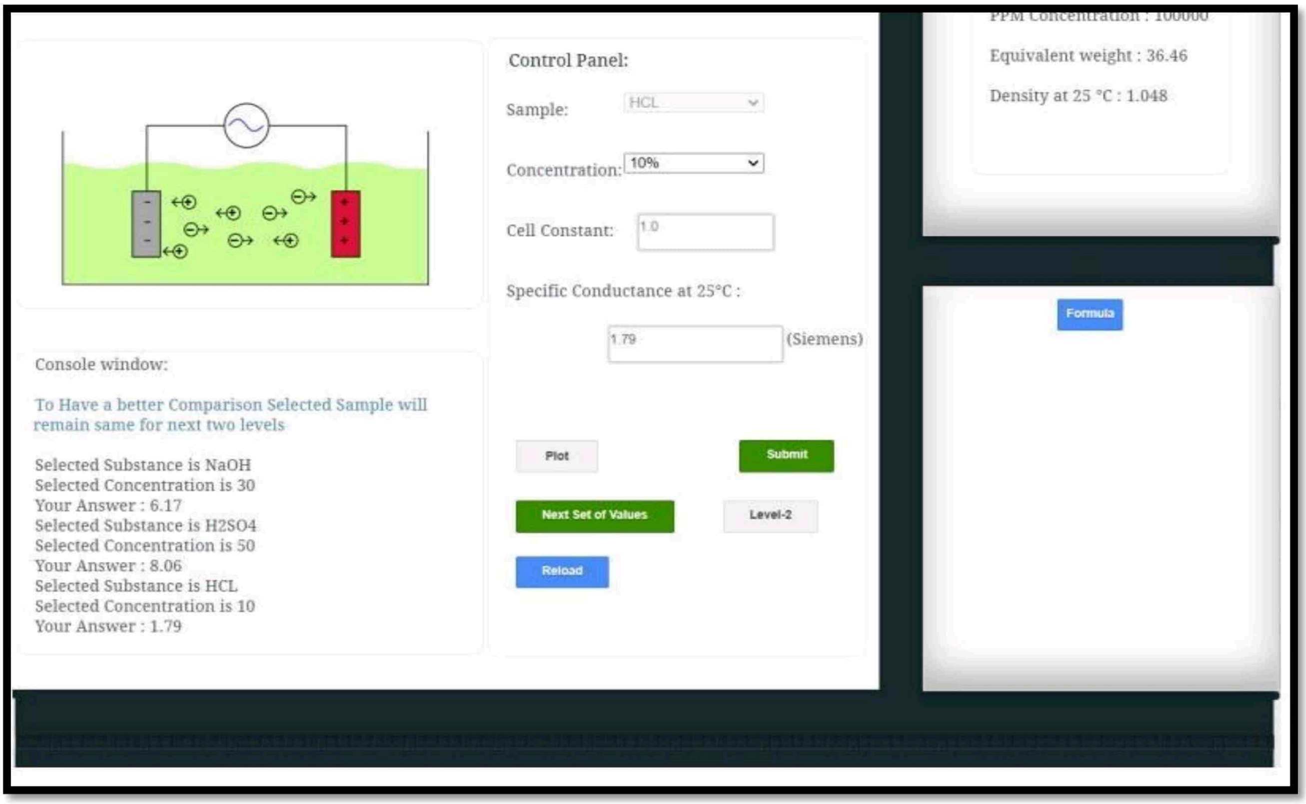
❖ **SAMPLE: H_2SO_4**

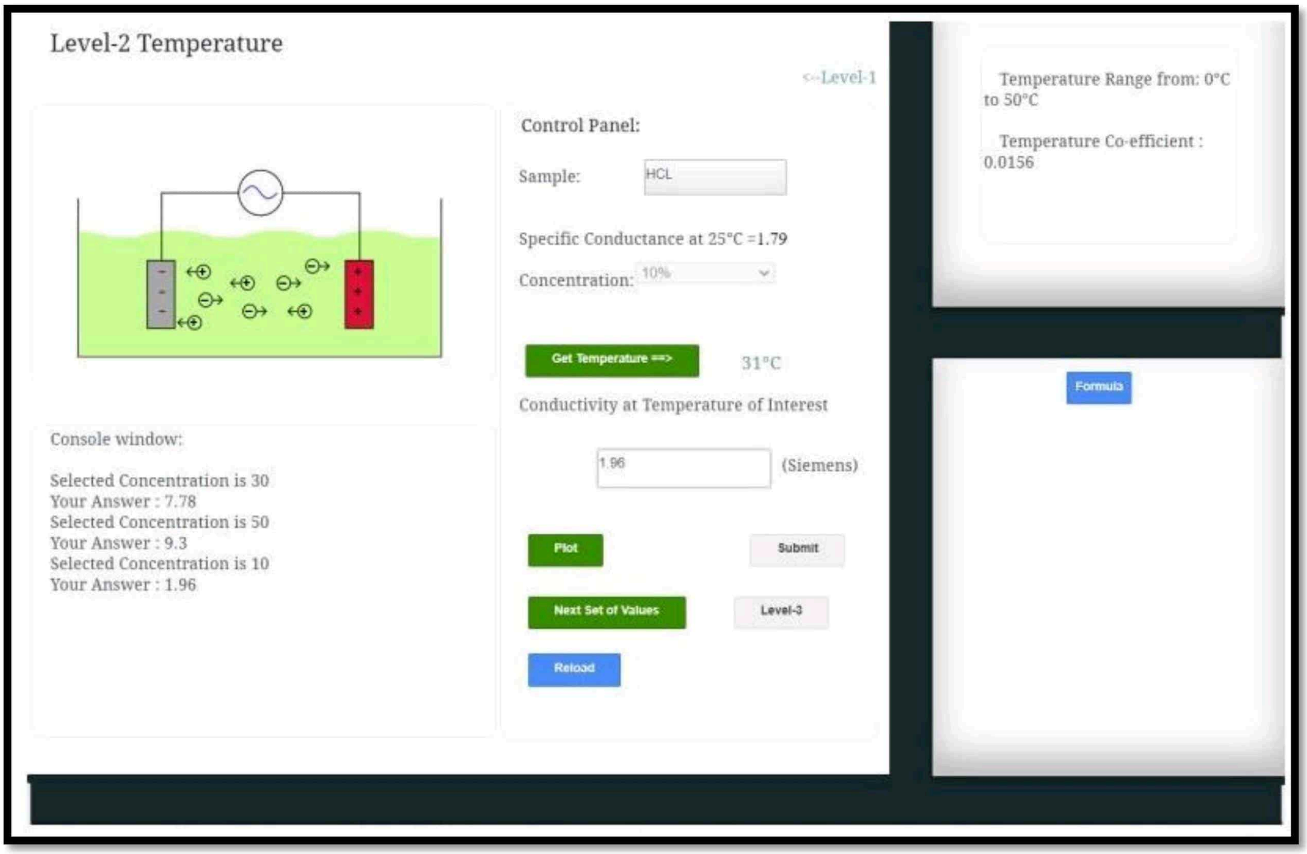


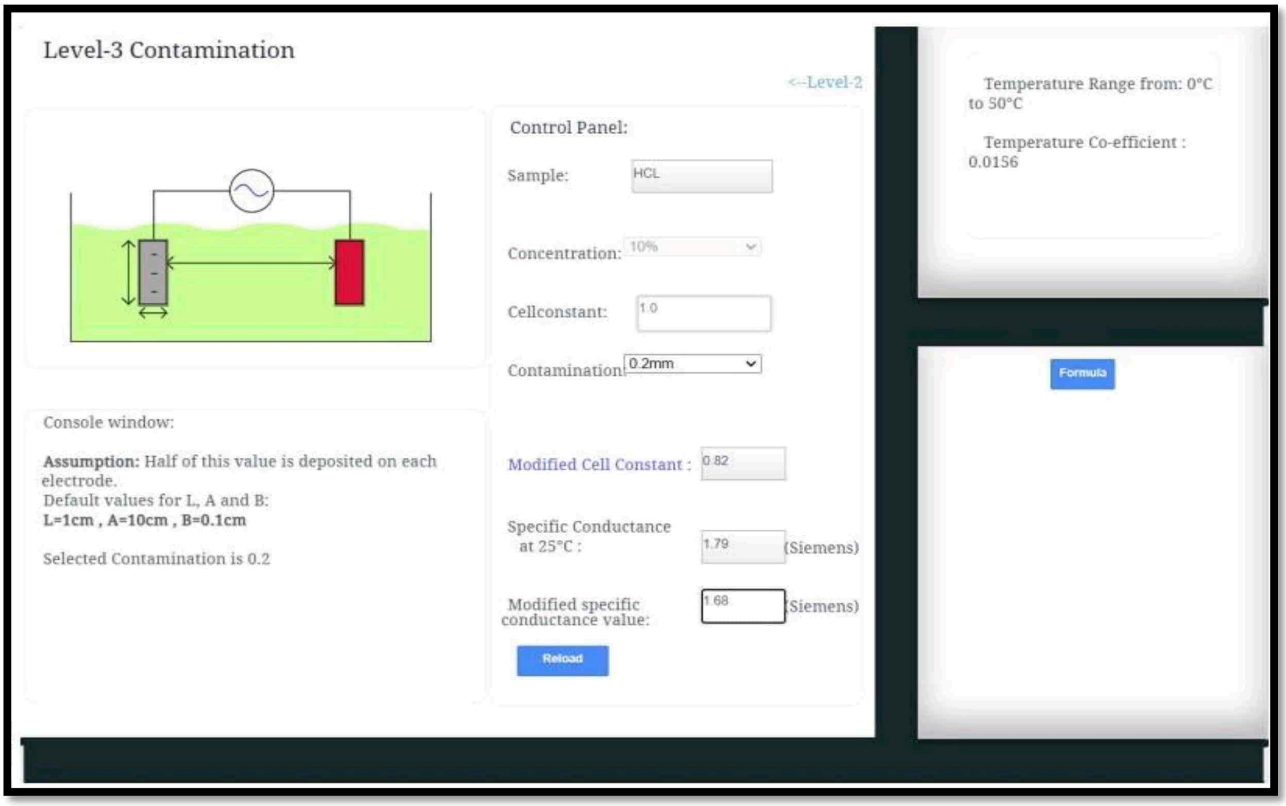



Level-3 Contamination
<--Level-2
Control Panel:
Sample:
H2SO4
Concentration:
50%
Cellconstant:
1.0
Contamination:
0.2mm
Modified Cell Constant :
0.82
Specific Conductance at 25°C :
8.06
(Siemens)
Modified specific conductance value:
7.6
(Siemens)
Reload
Console window:
Assumption: Half of this value is deposited on each electrode.
Default values for L, A and B:
L=1cm , A=10cm , B=0.1cm
Selected Contamination is 0.2
Temperature Range from: 0°C to 50°C
Temperature Co-efficient : 0.0193
Formula

❖ <u>SAMPLE: HCL</u>






Level-3 Contamination
<--Level-2
Control Panel:
Sample:
HCL
Concentration:
10%
Cellconstant:
1.0
Contamination:
0.2mm
Modified Cell Constant :
0.82
Specific Conductance at 25°C :
1.79
(Siemens)
Modified specific conductance value:
1.68
(Siemens)
Reload
Console window:
Assumption: Half of this value is deposited on each electrode.
Default values for L, A and B:
L=1cm , A=10cm , B=0.1cm
Selected Contamination is 0.2
Temperature Range from: 0°C to 50°C
Temperature Co-efficient : 0.0156
Formula

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YOUVA

Pallavi Gaikwad

142103005
S.Y. Comp

Sensors and Automation
Assignment NO: 4

Q1. What is the effect of temperature measurement of pH?

Answer When the temperature of a solution rises. The modulas vibrations in the solution rise resulting in the ionization and formation of H^+ ios. More H^+ ions lead to more acidic behaviour. During the temperature changes, the PH value of the solution changes. Thus pH decreases on increasing the temperature

Q2. Describe the construction and principle of working of a conductivity meter.

Answer **Construction:**

The meter is equipped with a probe, usually handhed for field or on-side measurement. After the probe is placed in the liquid to be measured the meter applies voltage between two electrodes inside the probe. Electrical resistance from the solution causes a drop in voltage, which is read by the meter. The meter converts this reading to milli or microsiemens per centimeter. The value indication the total dissolved solids. Total dissolved solids is the amount of solids that can pass through a glass fiber filter.

Principle of working:

Two plates are placed in the sample, a potential is applied across the plates and the current that passes through the solution is measured.

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3. Describe the calibration procedure for the pH meter.

Answer 1. The calibration must be performed for buffers with pH 4.0, 7.0 and 9.2
At least a 2-point calibration must be performed at room temperature using buffers that meet the expected pH value of the sample.
If a one point calibration is performed, measurement errors are more for the sample that is being measured.
If the temperature probe is not used at the time of calibration, default value considered is 25°C.

4. Discuss any three applications where the conductivity meter is used.

Answer. 1. Hydroponics:
The higher the reading on conductivity meter, the more nutrients that are available for your plants. But its easy to over-fertilize the indoor garden and end up with nutrient burn so the best EC levels are in the moderate range during the growing period about 1.2 to 1.6 and no longer or higher than 1.8 during flowering.

2. Purity of water:
Conductivity measures water's ability to conduct electricity due to presence of / or absence of certain ions. While pure water conducts electricity poorly, water that has certain chemicals or elements in it and at varying amounts is a better conductor of electricity.

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3. Aquaculture:

For water resources, the conductivity may indicate whether or not the water is too saline to be drinkable or usable for irrigation or industrial use.

5. What are the advantages and disadvantages of a conductivity meter?

Answer Advantages:

Conductivity offers a fast, reliable, nondestructive, inexpensive and durable means of measuring the ionic contents of a sample. Reliability and repeatability are excellent

Disadvantages:

1. It cannot distinguish between different types of ions.
2. It gives instead a reading proportional to the combined effect of all ions present.
3. It must be applied with some pre-knowledge of the solution composition or used in relatively pure solutions to be successful.

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- Calculations:
- Conductivity at temp of interest:

$T = 38^\circ C = 38 + 273 = 311K$

$CR = 6.17$, $tc = 0.02011$

$CT = CR(1 + c(T - 25))$ Siemens

$C_T = 6.17(1 + 0.0201(38 - 25))$

$\therefore C_T = 7.78$ Siemens.

- Lemon Juice

$T = 25^\circ C = 298K$

$E_0 = 0$, $F = 96485$, $R = 8.314$ Jmol/k

$pH = 2.2$; $pH = 2.2 - T = -4.8$

$E = E_0 - 2.303 \left(\left(R \times \frac{J}{F}\right) \times PH_\varepsilon\right) \times 108$

$E = 283.97$ mV.

- Coffee

$T = 25^\circ C = 298k$ $E_0 = 0$, $R = 8.34$ Jmol/k

$F = 96485$ c/mole

$pH = 5$, $pH_\varepsilon = 5 - 7 = 2$

$E = E_0 - 2.303 \left(\left(R \times \frac{T}{F}\right) \times PH_\varepsilon\right) \times 1000$

$E = 118.25$ mV

- Ammonia:

$T = 25^\circ C = 298K$; $E_0 = 0$, $R = 8.314$ Jmol/k

$F = 96485$ C/mole

$pH = 11$, $pH_\varepsilon = 11 - 7 = 4$

$E = E_0 - 2.303 \left(\left(R \times \frac{T}{R}\right) \times pH_\varepsilon\right) \times 1000$

$E = -236.63$ mV.

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- NaOH

concentration $= 30\%$

Specific condutance $= 1000 C A_0 (1 - a\sqrt{C} + bc)$

Here, $A_0 = 246.5$,

$a = 0.47$

$b = 0.3$

$T = 25°c = 298k$

Normality $= \dfrac{3 \times 10^5 \times 1.33}{10^3 \times 40.01}$

$= 9.97 \times 10^6$

$\therefore$ Specific Conductance $= 1000 \times 9.8 \times 246.5$
$(1 \cdot 0.41 \sqrt{9.91} + 5.3 \times 9.97)$

$= 24156 \times 10^6 (1 - 4.483 + 0.34997$

$CR = 6.17$ Siemens.

- H_2SO_4

Concentration $= 50\%$, $A_0 = 151.4$ $a = 1.24$ $b = 1.14$

$C(\text{Normality}) = \dfrac{\text{ppm } l}{1000 \times \text{eq. wt}} = \dfrac{5 \times 1.399 \times 10^5}{1000 \times 97.14}$

$C = 8.027$

$\therefore$ Specific conductance $= 1000 A_0 l (1 - a\sqrt{c} + bc)$ siemens

$= 1000 \times 8.027 \times 151.4 (1 - 1.24\sqrt{8027} +$
$1.14 \times 8027)$

$= 8.069$ siemens.

- Conductivity of at temperature of interst

$T = 33°C$, $Cp = 8.06$, $tc = 0.0193$

$C_T = CR(1 + tc(T - 25)]$ siemens

$C_T = 8.069 [1 + 0.0193(33 - 25)]$

$C_T = 9.3$ siemens.

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- HCL

concentration $= 10\%$

$A_0 = 420$, $a = 0.37$, $b = 0.38$

$C \text{(Normality)} = \frac{10^5 \times 1.048}{36.46 \times 10^3}$

$= 2.87$

$\therefore$ Specific conductance $= 1000 A_0 C (1 - a\sqrt{C} + bC)$

$= 1.79$ siemens

Conductivity at temperature of interest

$T = 31^\circ C$,

$CR = 1.4$, $TC = 0.0156$

$CT = CR [1 + tc (T - 25)]$ siemens

$CT = 1.791 + 0.0156 (31 - 25))$

$CR = 1.957$ siemens.