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Experiment 4

Aim :-

To understand the working principle of chemical sensors

Objectives :-

1. Study the working principle of pH and conductivity sensors
2. Calibrate the pH sensor
3. Study the effect of temperature on pH measurement
4. Study effect of temperature and effect of contamination on conductivity measurement

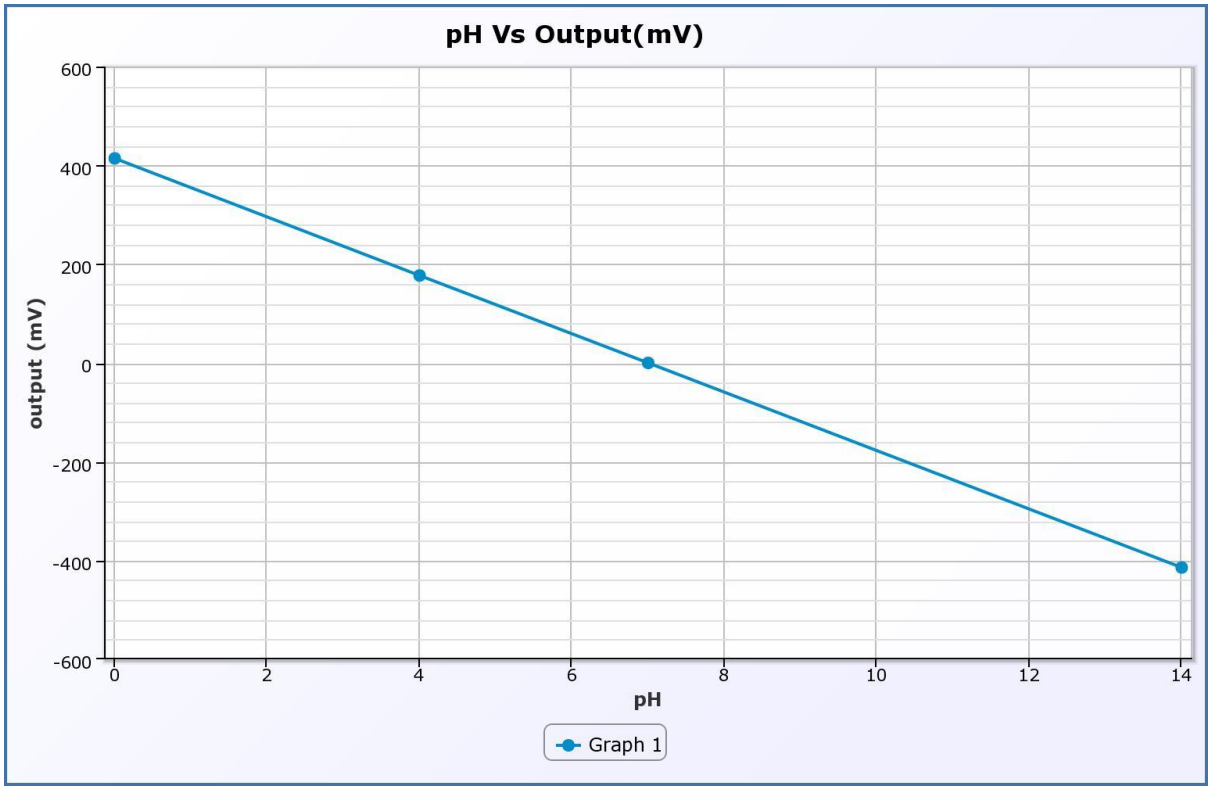
Level 1: pH probe Calculations

Aim : Study Calibration of pH probe.

Calibrations at 25 C

pH Value : 4

PH	Output voltage (mV)
0	414
4	177
7	0
14	-414



Conclusion:

1. A pH calibration is the process of adjusting pH meter by measuring solutions of a known pH value, 2. Calibration should be done regularly to maintain accuracy.

3. The Characteristics of electrode change over time and need to be compensated.

4. A calibration does this by matching pH meter to the current characteristics of pH sensor.

Level 2:- Measurement of pH

Aim :-

Study of Measurement of pH

Sample	PH	Output voltage (mV)
Boric acid	5	118.32
Milk	6.6	23.66
Distilled Water	7	0
Baking Soda	9	-118.32

Equation of graph :-

Line equation : $y=-59.16250000000001x+414.13250000000005$

Formula
Calculation of Output Voltage:
E (millivolts) =(E0 - 2.3026(R * T/F)* pHc)*1000

Where,
E0=standard potential = 0 mV
R=Universal gas constant = 8.3144 J/K
T=Absolute temperature (kelvin)
25 degree Celsius = 298.15 kelvin
F=Faraday's constant = 96485 C/mole
For Effect of Temprature :
kelvin = degree celsius + 273.15 pHc = pH value deviation from 7 in the Formula

Conclusion:-

1.Relation between potential and voltage is
V=−59.16250000000001(pH)+414.13250000000005

2.At a pH of 7 , the electrodes will produce 0 volts between them. Just like that of Distilled Water.

3. At a low pH (acid) a voltage will be developed of one polarity, and at a high pH (caustic) a voltage will be developed of the opposite polarity.

4. For pH > 7 ,i.e basic the output voltage will be negative ,it is positive for acidic solutions.

Level 3: Effect Of Temperature

Aim :-

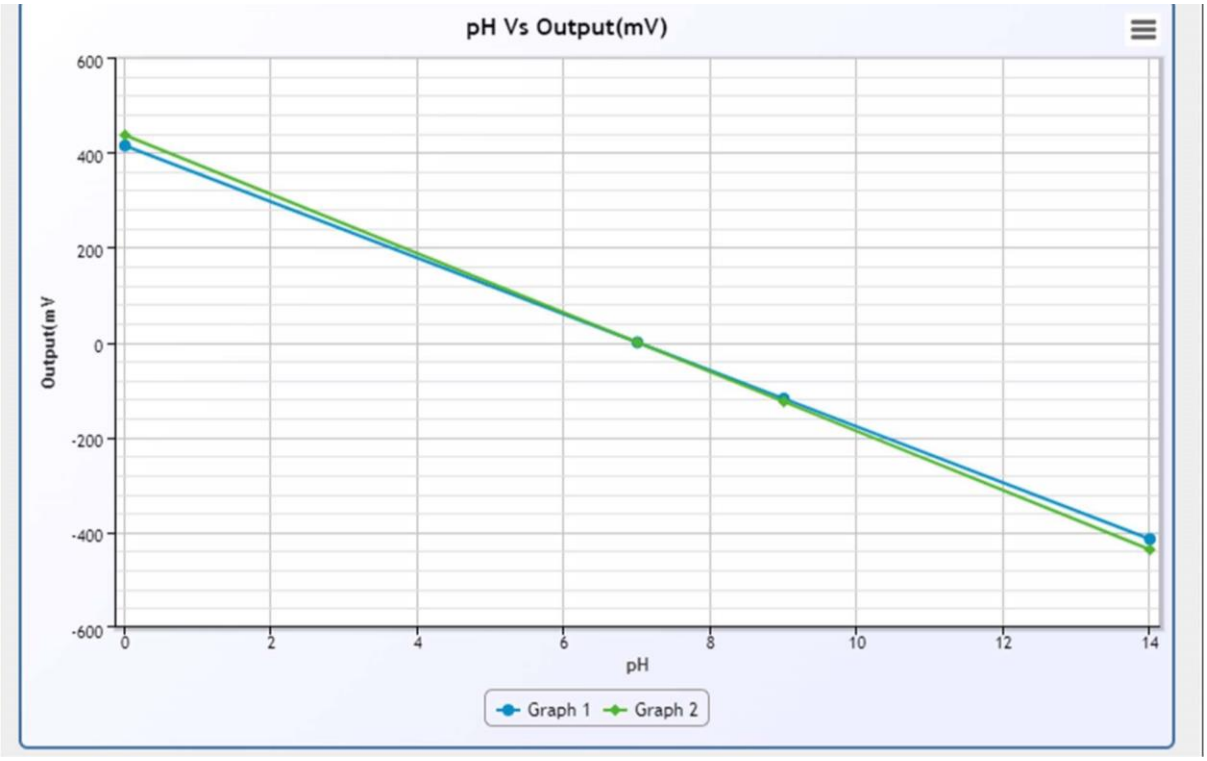
Study the effect of temperature change on measurement of pH.

Sample : Baking Soda.

At 25^0 C Output mV = -118.32.

V=−59.16250000000001(pH)+414.13250000000005

Temperature	pH	Output
35	9.09	-122.29
20	8.96	-116.33
41	9.107	-124.67



Conclusion:-

1. The output voltage depends upon the temperature.
2. As the temperature rises, molecular vibrations increase which results in the ability of water to ionise and form more hydrogen ions. As a result, the pH drops.
3. In case of Baking Soda OH ion increases thus pOH drops and pH increases as observed in above data.

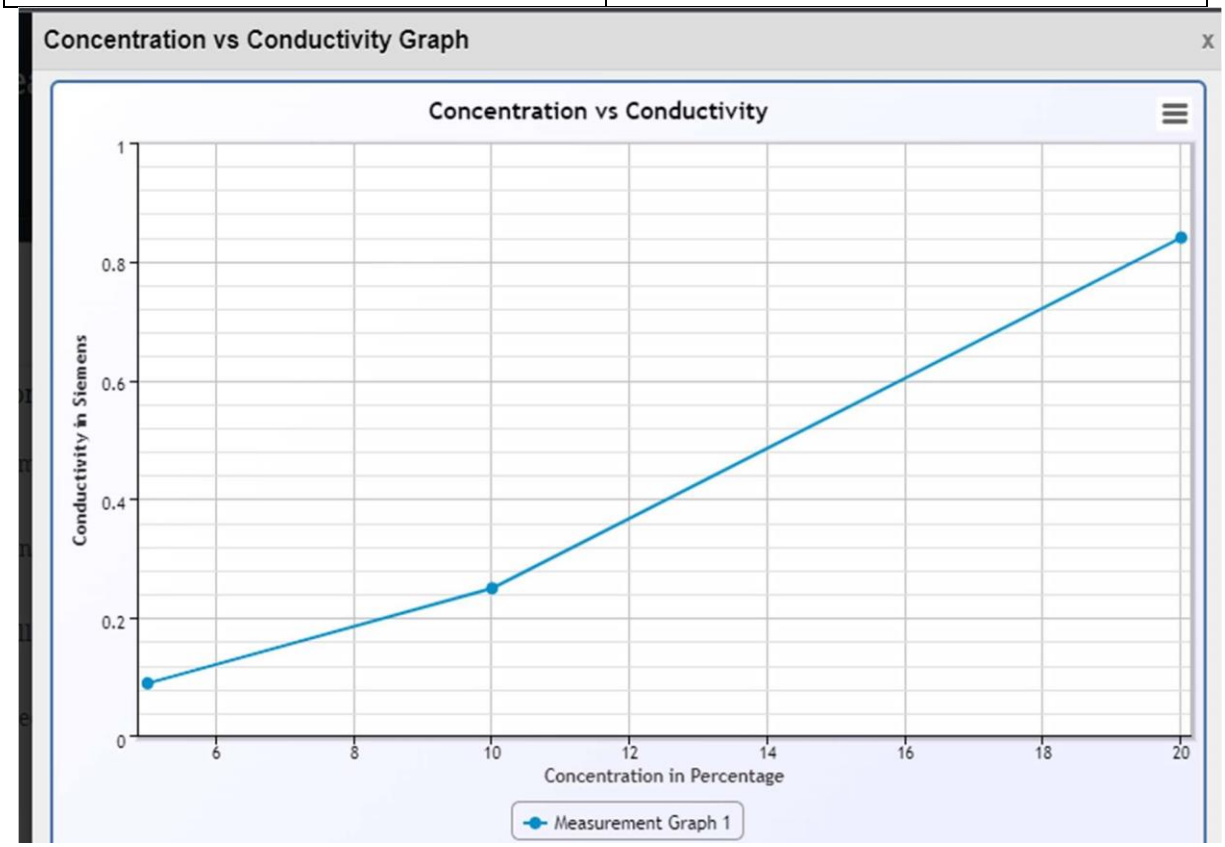
Part II

Measurement Of Conductivity

Level 1 : Measurement

Sample : KCL

Concentration	Specific Conductance
5	0.09
10	0.25
20	0.84



Conclusion :-

1.Specific Conductance of substance depends on concentration of a substance. And relation is given by

Formula,

Specific Conductance at 25^0C = 1000 C $A_0(1-a\sqrt{C}+bC)$(Siemems)

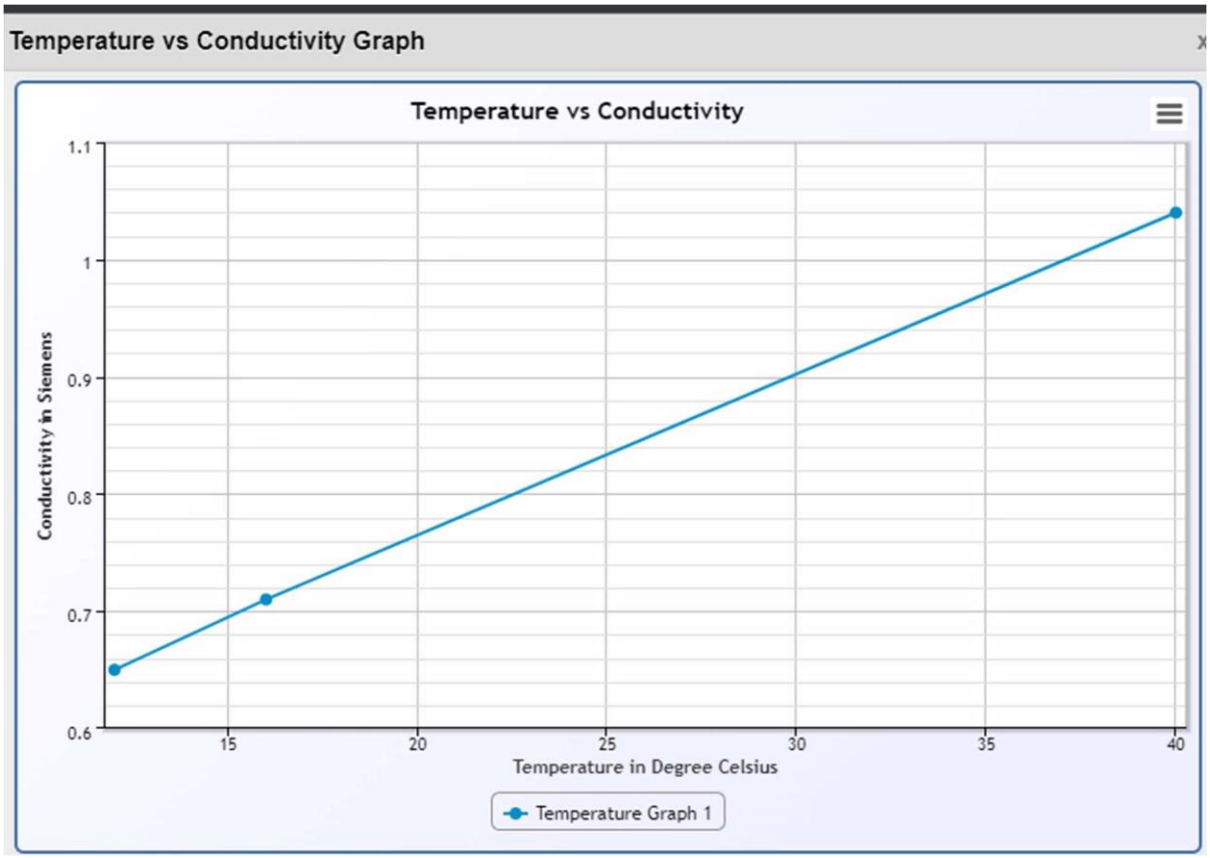
A_0, a and b are constants for details refer to theory tab.
C= Normality = Parts per million concentration * Density / (1000 * Equivalent weight)

2. Specific Conductivity decreases with a decrease in concentration. Since the number of ions per unit volume that carry current in a solution decrease on dilution.

Level 2: -

Variation of conductivity of temperature:

Temperature	Conductivity
40	1.04
12	0.65
16	0.71



Conclusion :-

1. An increase in temperature will result in an increase in the number of ions in solution due to dissociation of molecules.
2. An increase in the solution's temperature will lead to an increase in its conductivity.
3. A decrease in temperature will also result in decrease of dissociation of molecules, leading to low conductance.

Level 3 : -

Contamination	Specific Conductance	Modified specific conductance value
0.1	0.84	0.76
0.2	0.84	0.69
0.3	0.84	

Aim:-

Study the effect of contamination on measurement of pH.

Sample :KCL

Concentration : 20%

Conclusion :-

1. Specific Conductance value decreases due to additional layer on electrode.
2. As contamination increases specific conductance decrease because ion concentration decreases.