Irrigation water-sulphate ion analysis by conductometry

Expt No. 1 **Date:** 14|12|2017

Principle

Electrolyte solutions conduct electricity due to the presence of ions in solution. In case of precipitation titration between $BaCl_2$ and Na_2SO_4, the conductance decreases slowly due to the replacement of Na^+ ion by SO_4^{2-} upto the equivalence point. After the equivalence point the conductance increases rapidly due to the excess addition of $BaCl_2$ which remains in solution as Ba^{2+} and Cl^-. This makes detection of neutralization point easy from the conductance trend plotted as a graph. This principle is used in the estimation of SO_4^{2-} from an effluent sample.

Apparatus required

TDS-Conductivity bridge, conductivity cell, burette, pipette, volumetric flasks, glass rod and 100 mL beaker.

Chemicals required

$BaCl_2$, Na_2SO_4, unknown sulphate solution and distilled water.

Procedure

Calibration of TDS-Conductivity meter:

Place a freshly prepared 0.01 N KCl solution (given in bottle) in a 100 mL beaker and dip the conductivity cell in this solution and connect to the TDS-Conductivity meter. Press "CAL" button and complete the internal calibration of the instrument

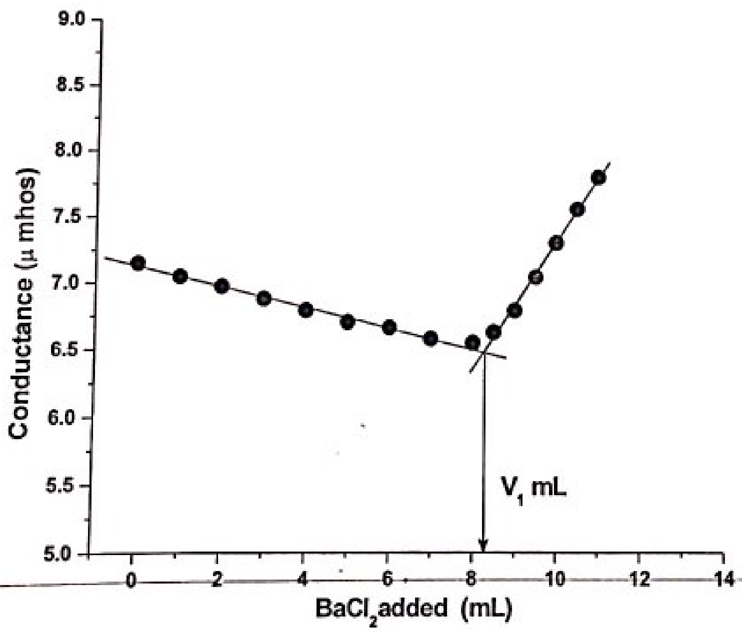
Standardization of $BaCl_2$:

Standard flask A contains Na_2SO_4 which after making up to 50 mL will result in a solution containing 0.96 mg/mL of sulphate ions. Pipette out 20 mL of this solution and add 20 mL of distilled water to it in a 100 mL beaker. The conductivity cell is dipped into the beaker and connected to TDS conductivity meter. Fill the burette with $BaCl_2$ solution (Solution B). Record the conductivity of the sulphate solution as 0th reading. Add 0.5 mL portion of known concentration of $BaCl_2$ into the beaker, stir with glass rod and note down the conductance. Continue the addition of $BaCl_2$ (0.5 mL each time) and note the conductance after each addition. Continue the titration beyond the equivalence point for about 3mL. The conductance will decrease till complete precipitation of $BaSO_4$ and then starts increasing on continuing the addition of $BaCl_2$. A graph is now drawn by plotting conductance Vs volume of $BaCl_2$ added and the intersection point from the graph gives the volume of $BaCl_2$ required for precipitating the sulphate from the known sample.

Table. 1. Standardization of $BaCl_2$

Volume of $BaCl_2$ added (mL)	Conductance (μ mhos)	Volume of $BaCl_2$ added (mL)	Conductance (μ mhos)
0.0	4.8	~~5.5~~ 11.0	3.8
~~0.5~~ 1.0	4.7	~~6.0~~ 12.0	4.1
~~1.0~~ 2.0	4.6	~~6.5~~ 13.0	4.2
~~1.5~~ 3.0	4.4	~~7.0~~ 14.0	4.4
~~2.0~~ 4.0	4.3	~~7.5~~ 15.0	4.6
~~2.5~~ 5.0	4.2	~~8.0~~ 16.0	4.7
~~3.0~~ 6.0	4.1	~~8.5~~ 17.0	4.9
~~3.5~~ 7.0	4.0	~~9.0~~ 18.0	5.0
~~4.0~~ 8.0	3.9	~~9.5~~ 19.0	
~~4.5~~ 9.0	3.8	~~10~~	
~~5.0~~ 10.0	3.7	~~10.5~~	

Fig. Model graph-1 for TDS-Conductometric estimation of known sulphate sample solution



Estimation of unknown sulphate in the given solution:

Make up the unknown sulphate solution given in standard flask B up the 50 mL mark. Pipette out 20 mL of this solution into a 100 mL beaker and add 20 mL distilled water to it. Dip the conductivity cell and repeat the above procedure with the unknown sulphate solution and determine the amount of $BaCl_2$ required for precipitating the unknown sulphate in the sample.

From the two titrations carried out, calculate the amount of sulphate present in the effluent sample.

Table. 2 Estimation of unknown sulphate solution

Volume of $BaCl_2$	Conductance	Volume of $BaCl_2$	Conductance
0.0	4.7	~~5.5~~ 11.0	3.8
~~0.5~~ 1.0	4.6	~~6.0~~ 12.0	3.9
~~1.0~~ 2.0	4.5	~~6.5~~ 13.0	4.1
~~1.5~~ 3.0	4.3	~~7.0~~ 14.0	4.3
~~2.0~~ 4.0	4.2	~~7.5~~ 15.0	4.4
~~2.5~~ 5.0	4.1	~~8.0~~ 16.0	4.6
~~3.0~~ 6.0	4.0	~~8.5~~ 17.0	4.7
~~3.5~~ 7.0	3.9	~~9.0~~ 18.0	4.9
~~4.0~~ 8.0	3.8	~~9.5~~	
~~4.5~~ 9.0	3.7	~~10~~	
~~5.0~~ 10.0	3.7	~~10.5~~	

Scanned by CamScanner

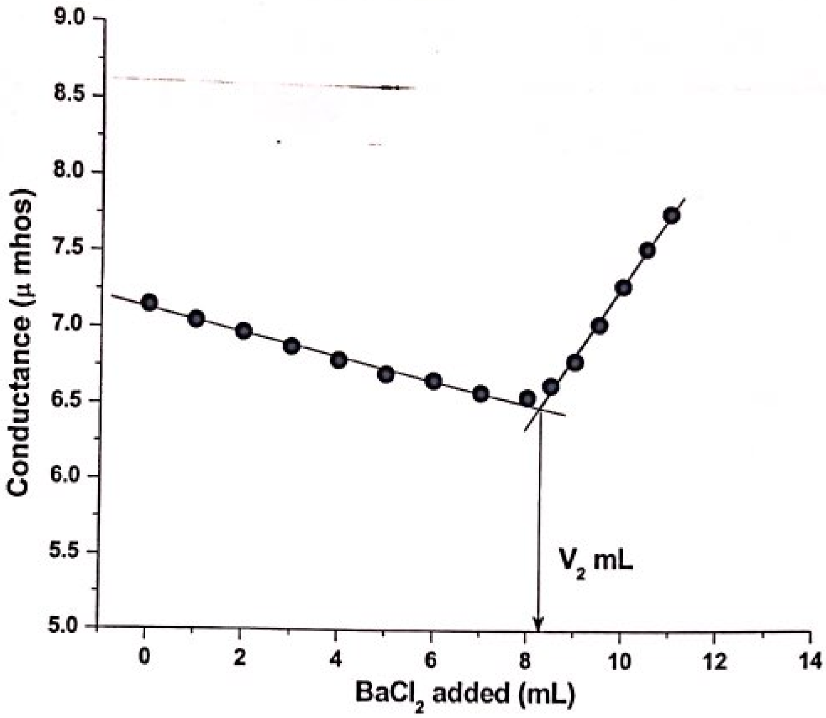


Fig. Model graph-2 for TDS-Conductometric estimation of unknown sulphate sample solution

Calculations:

A) Standardization of $BaCl_2$:

From the first plot,

20 mL of known sulphate solution required V_1 mL of $BaCl_2$ for complete precipitation of sulphate.

142 g of Na_2SO_4 contains 96 g of SO_4^{2-}

Therefore, 0.02N of 1 L Na_2SO_4 contains 0.96 g of SO_4^{2-} ions

20 mL of 0.02N of Na_2SO_4 contains 0.024 g = **24 mg** of SO_4^{2-} ions

Therefore, 1 mL of $BaCl_2$ will precipitate $24/V_1$ = ..2.4...mg of sulphate (Y)

B) Estimation of unknown sulphate:

From the second plot,

20 mL of unknown sulphate consumed V_2 mL of $BaCl_2$ for complete precipitation of sulphate.

Sulphate present in 20 mL of the unknown solution = V_2 x Y = 23.04 mg (Z)

Sulphate present in 1 L of unknown solution = $\frac{Z \times 1000}{20}$ ppm

Result

ipd

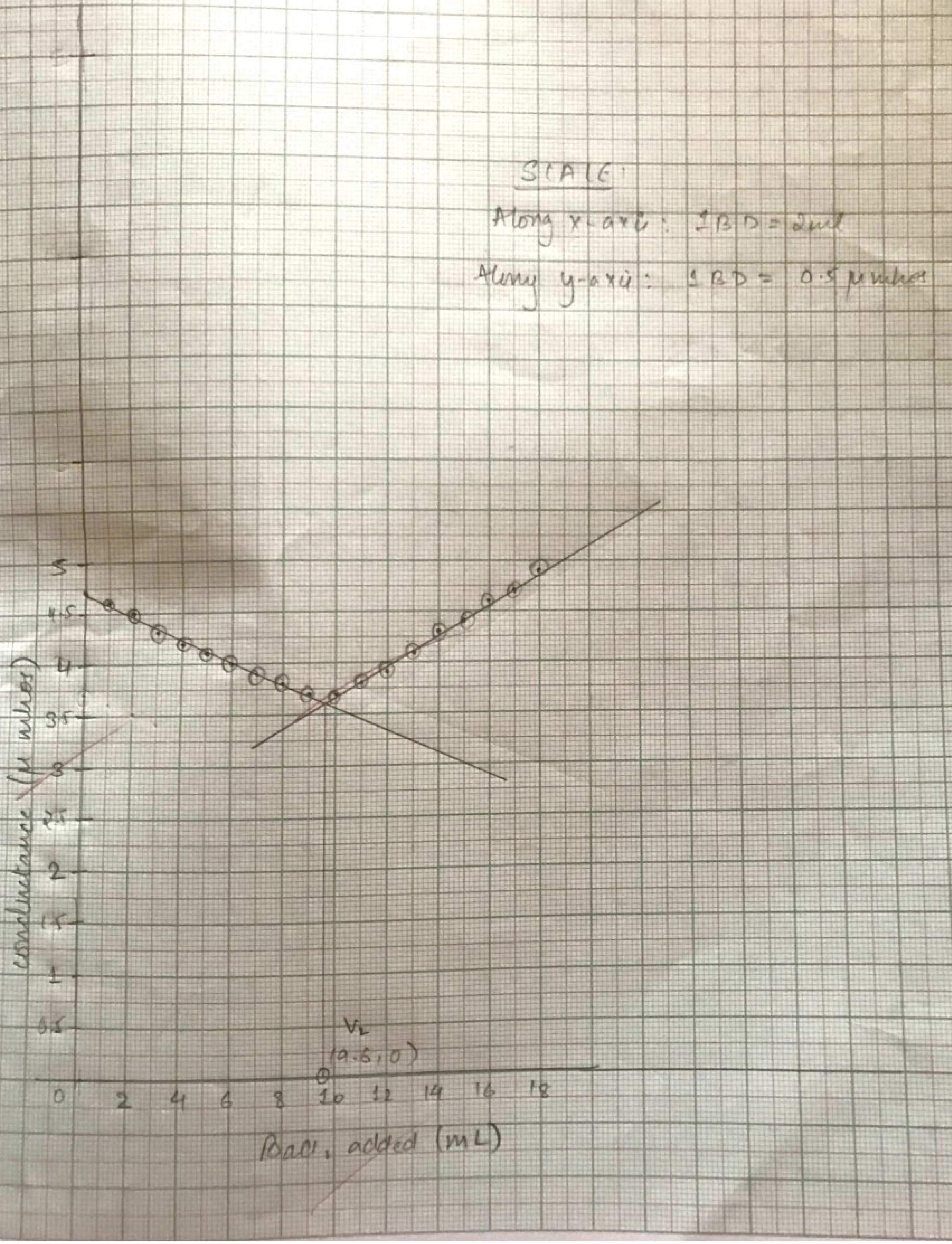
Amount of sulphate present in the given sample = ...1152.......ppm. (1052)ppm/

Evaluation of result

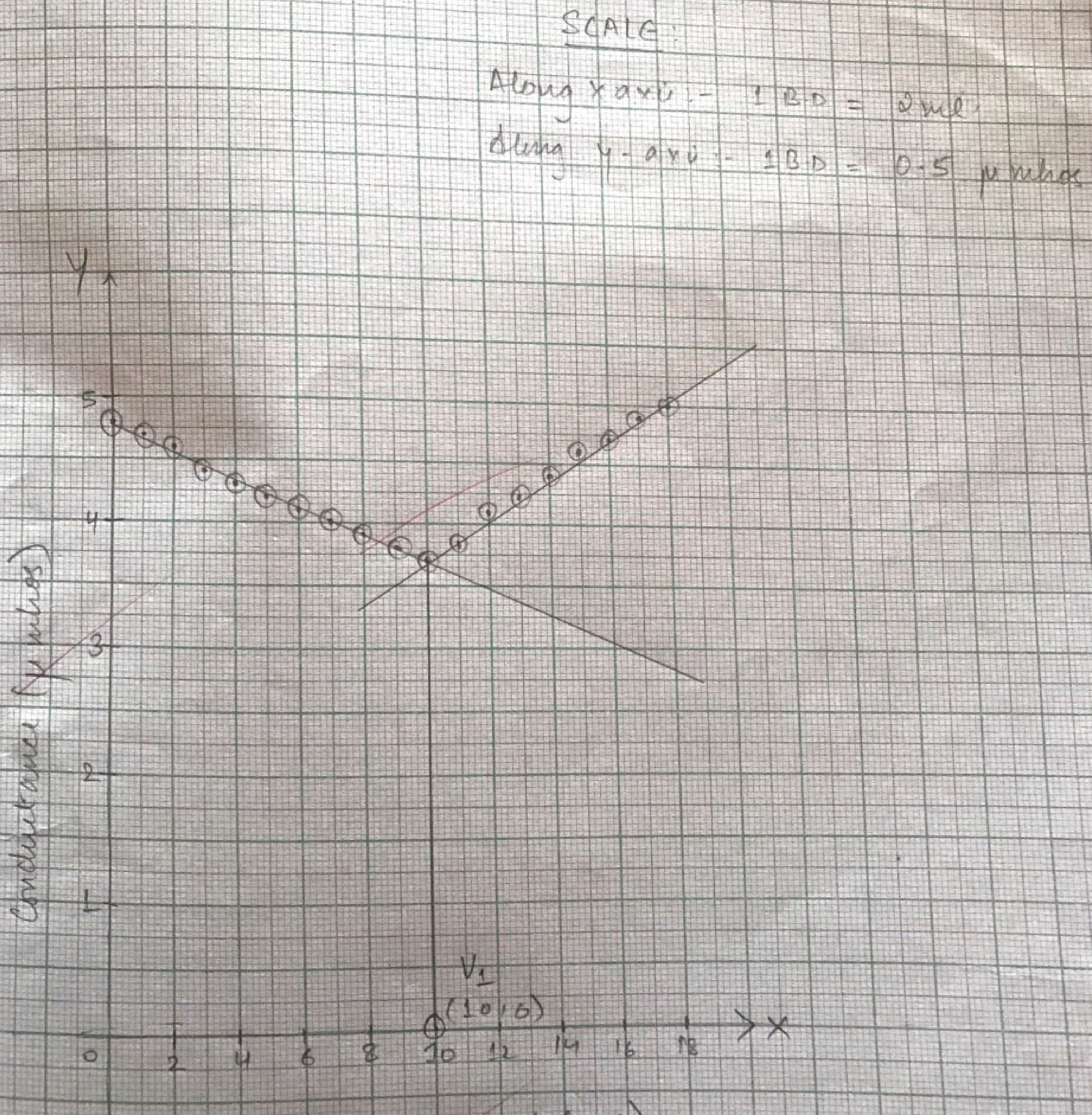
2 %, err

$\frac{100}{1052} \times 100 = 9.5$

Sample number	Experimental value	Actual Value	Percentage of error	**Marks awarded**
	1152	1100	2.1	8/8 29/12/17



SCALE:
Along x-axis : 1 BD = 2 ml
Along y-axis : 1 BD = 0.5 μ mhos
conductance (μ mhos)
BaCl₂ added (mL)
V₂
(9.6, 0)
0
2
4
6
8
10
12
14
16
18
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


SCALE:
Along x axis :- 1 BD = 2 ml
Along y - axis :- 1 BD = 0.5 μ mhos
Y
X
5
4
3
2
1
0
2
4
6
8
10
12
14
16
18
V1
(10, 0)
Conductance (μ mhos)
BaCl2 added (ml)