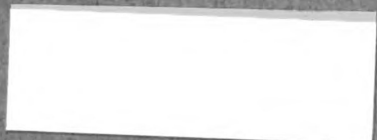




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THE CONDUCTANCE OF SOLUTIONS OF  
POTASSIUM CHLORIDE

THESIS FOR THE DEGREE OF M. S.  
Warren H. Atkinson  
1931





THE CONDUCTANCE OF SOLUTIONS  
OF  
POTASSIUM CHLORIDE

A Thesis Submitted to the Faculty  
of  
Michigan State College

In Partial Fulfillment of the  
Requirements for the Degree  
of  
Master of Science  
Department of Chemistry

By  
Warren H. Atkinson

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## INTRODUCTION

Very precise measurements have been made of the conductance of solutions of potassium chloride by several investigators, the most notable of whom are: Kohlrausch and Maltby (Kohlrausch and Maltby, *Wiss. Abh. Phys.-Tech. Reichsanst* 3, 180 -1900), Kraus and Parker (Kraus and Parker, *J. Am. Chem. Soc.* 44, 2422 - 1922), and Parker and Parker (Parker and Parker, *J. Am. Chem. Soc.* 46, 312 - 1924).

Kohlrausch and Maltby have done the most exact work, possibly, of any of the investigators. However, in the work done by them, the assumption of 74.6 for the molecular weight of potassium chloride, was made. These workers also assumed that 1000 cc. were equivalent in volume to 1 liter, which we know to be not true. The accepted value for the molecular weight of KCl is 74.553 (*International Critical Tables*, Vol. 1, Page 155), and it is also accepted that 1 liter is equivalent to 1000.027 cc. (*International Critical Tables*, Vol. 1, Page 2, Table A). The difference in the accepted values mentioned, and those used by Kohlrausch and Maltby, necessarily makes the values of conductance, obtained by them, wrong.

Kraus and Parker (Kraus and Parker, J. Am. Chem. Soc. 44, 2422 (1922)) have interpreted the results obtained by Kohlrausch and Maltby in terms of the value 1000.027 cc. equivalent to 1 liter. They have not attempted to correct these values for the accepted value for the molecular weight of KCl.

Parker and Parker (Parker and Parker, J. Am. Chem. Soc. 46 312-1924) believe that it is more convenient to use the cubic decimeter as a standard rather than the liter. As a result of this they have adopted the cubic decimeter as the standard of volume, and in place of the "Normal" system, have introduced the "demal" system. A 1.0 "Demal" solution contains an equivalent weight of substance per cubic decimeter of solution. However, the equivalent conductance of a solution is obtained by multiplying the specific conductivity by the number of cubic centimeters of the solution which contain one equivalent. In this latter respect the "Demal" system is much more convenient to work with.

The Normal system is generally accepted, whereas the "Demal" system, whatever advantages it may have, is not as generally accepted at the present time.

1. The first part of the document discusses the importance of maintaining accurate records for all transactions. It emphasizes that proper record-keeping is essential for financial transparency and accountability. This section also outlines the various methods used to collect and analyze data, ensuring that the information is reliable and up-to-date.

2. The second part of the document focuses on the implementation of these practices across different departments. It provides detailed instructions on how to integrate these procedures into existing workflows, ensuring that all staff members are aware of their responsibilities and the importance of their role in the overall process.

3. The third part of the document addresses the challenges that may arise during the implementation phase. It offers practical solutions and strategies to overcome these obstacles, such as providing additional training and support to staff members who may be struggling with the new procedures.

4. The fourth part of the document discusses the long-term benefits of these practices. It highlights how consistent record-keeping and data analysis can lead to improved decision-making, increased efficiency, and better overall performance for the organization.

5. The fifth part of the document provides a summary of the key points discussed throughout the document. It serves as a quick reference guide for all staff members, ensuring that they have a clear understanding of the expectations and requirements for their role in maintaining accurate records.

6. The sixth part of the document includes a list of resources and references that were used in the development of this document. This section is intended to provide further information and support for staff members who may need it.

7. The seventh part of the document is a conclusion that reiterates the importance of these practices and expresses confidence in the organization's ability to successfully implement them. It also expresses a commitment to ongoing improvement and learning.

8. The eighth part of the document is a list of appendices that provide additional information and data. These appendices are intended to support the main text and provide a more comprehensive view of the organization's operations.

9. The ninth part of the document is a list of references that provide further information and support for staff members who may need it. These references are intended to provide a more comprehensive view of the organization's operations.

10. The tenth part of the document is a list of references that provide further information and support for staff members who may need it. These references are intended to provide a more comprehensive view of the organization's operations.



The purpose of this investigation has been to redetermine the conductance of solutions of KCl in the Normal system. The value of 74.553 for the molecular weight of KCl has been used throughout the work, and also the fact that 1000.027 cc. are equivalent to 1 liter, has been taken into consideration and employed.

It is much more convenient to make solutions up by weight rather than by volume, and in order to determine accurately how these solutions may be so made, it was necessary to determine the densities of the various solutions under investigation.

## APPARATUS AND MATERIALS

Measuring Apparatus:- The apparatus used in measuring the conductance of the solutions, consisted of: a resistance box having a capacity range of one of ten thousand ohms, a Leeds and Northrup Microphone Hummer of 1000 cycles frequency, a Leeds and Northrup Student Type Potentiometer, and a pair of Stromberg Carlson headphones. The wiring diagram is shown in Fig. 1 . Page 10.

Conductivity Cell:- The cell used in this experiment was of the Kohlrausch and Maltby type, of about thirty milliliters volume. A sketch of the cell is shown in Fig.2, Page 11.

Thermostat:- A constant temperature bath of approximately 20 liters capacity was used, and kept at 25 (plus or minus 0.04) degrees Centigrade. The thermometer used in the bath was of the Beckman type and was previously set by means of comparison with a Bureau of Standards thermometer.

Preparation of Materials:- The salt used in making the solutions was Baker's Analyzed KCl (Special Crystal). The analysis of the salt was

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities.

2. It is essential to ensure that all data is entered correctly and consistently to avoid any discrepancies or errors.

3. Regular audits and reviews should be conducted to verify the accuracy and integrity of the information.

4. The use of standardized procedures and protocols is crucial for maintaining the reliability of the data.

5. It is also important to ensure that all personnel involved in the process are properly trained and informed.

6. The final part of the document provides a summary of the key points and recommendations.

7. The document concludes by emphasizing the need for ongoing monitoring and improvement of the data management process.

8. The overall goal is to ensure that the data is accurate, reliable, and accessible for all stakeholders.

9. The document also highlights the importance of data security and protection against unauthorized access.

10. The document is intended to serve as a guide for all personnel involved in the data management process.

given as:

Fe	0.001%	MgO	0.001%
CuO	0.001%	SO <sub>2</sub>	0.001%

The salt was allowed to dry for 48 hours in a constant temperature oven at 135 degrees Centigrade. The salt was cooled in a dessicator, so that it would remain dry.

Conductivity Water:- The conductivity water used in these measurements was prepared by re-distilling laboratory-distilled water, direct from the still, over alkaline permanganate in a block tin condenser. The first and last quarter portions were discarded, and the water used had a specific conductance of  $1.8 \times 10^{-6}$ .

Calibration of weights:- The weights used in this work were standardized as described by T. W. Richards (T. W. Richards J. Am. Chem. Soc. 22, 144 - 1900). The weight used as a standard was a 1 g. piece from a Ruprect set, which had been standardized by the U. S. Bureau of Standards.

## METHOD OF PROCEDURE

Making up Solutions:- A liter of 1.0 Normal KCl contains 74.553 g. KCl (weights in vacuum) per liter of solution. The factor for reducing weights in vacuum to weights in air, is given (Landolt-Bornstein "Physikalisch-Chemische Tabellen" Springer, Berlin Page 15 (1912) as 1.00106. Dividing by this factor we obtain 74.4740 g. (brass weights in air) KCl per liter of solution.

The graduated flasks used (Nos. 1580 & 101826) bore Bureau of Standards certificates of 1927. These had been calibrated at 20 degrees C. To change the values given at 20 degrees to the corresponding values at 25 degrees, 0.12 ml./ 1000 ml. must be added (Circular of Bureau of Standards No. 19, Table 31, Page 48). It then becomes necessary to increase the amount of KCl to terms of KCl per 1000.12 ml. solution. Setting up a simple proportion and solving we find that it requires 74.4829 g. KCl (brass weights in air) per 1000.12 ml. solution. The various concentrations were made up after calculating, in the same manner, the proportional amount of KCl necessary per 1000.12 ml. solution.

1. **Introduction**  
 The purpose of this report is to analyze the impact of the COVID-19 pandemic on the global economy and to provide recommendations for recovery. The report is structured as follows:

- 2. **Methodology**
- 3. **Results**
- 4. **Discussion**
- 5. **Conclusion**

The methodology employed in this report includes a review of relevant literature, data analysis, and expert interviews. The results show a significant decline in global GDP and a shift in economic activity. The discussion highlights the challenges faced by different regions and the need for coordinated international efforts. The conclusion emphasizes the importance of fiscal and monetary policies in supporting recovery.

The following table provides a summary of the key findings:

Region	GDP Change (%)	Unemployment Rate (%)
North America	-3.5	11.2
Europe	-5.2	10.8
Asia	-1.8	6.5
South America	-8.1	13.5
Africa	-2.3	15.2

These findings indicate that the impact of the pandemic is most severe in South America and Africa, while Asia has shown the most resilience. The high unemployment rates across all regions underscore the urgent need for job creation programs and social safety nets.

In conclusion, the COVID-19 pandemic has caused a global economic crisis. To achieve a sustainable recovery, governments must implement targeted fiscal and monetary policies, and international organizations must provide coordinated support.

In each case the KCl was weighed, and by means of a clean glass funnel, transferred to the calibrated flask. The vial, as well as the funnel, was washed with conductivity water, the rinsing allowed to run into the flask. Conductivity water was then put into the flask until the meniscus was slightly below the graduation mark. The flask was then placed in the constant temperature bath, at 25 degrees, and allowed to come to equilibrium at that temperature. This required about one hour. By using a 10 ml. pipette, conductivity water was then added until nearly to the graduation mark. The last few drops of water were added by using a capillary tube as a pipette, and when finally filled, the top part of the lower meniscus was on a level with the mark.

Determination of Densities:- As soon as the solution was made up, it was taken from the constant temperature bath, and wiped dry and weighed. This weight is the weight of the flask plus 1000.12 ml. of solution at 25 degrees. The weight of the flask, being previously determined, is subtracted from the weight of the flask plus the 1000.12 ml. of solution. This is the weight of 1000.12 ml. of solution at 25 degrees. By dividing the weight of the 1000.12 ml. of solution by 1000.12, the density, in g./ml. (brass weights in air) is obtained. If this value for the density is multiplied by 1.00106, the factor for converting weights

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance against a desired state or goal.

2. Once a problem is identified, the next step is to define the problem more precisely. This involves identifying the causes of the problem and the scope of the problem.

3. The third step is to generate potential solutions. This is often done by brainstorming or using creative problem-solving techniques.

4. The fourth step is to evaluate the potential solutions. This involves comparing the solutions against the criteria that were used to define the problem.

5. The fifth step is to select a solution. This is often done by choosing the solution that is most likely to be successful and that is most consistent with the organization's values and goals.

6. The sixth step is to implement the solution. This involves putting the solution into action and monitoring its progress.

7. The seventh step is to evaluate the results. This involves comparing the actual results against the desired results and identifying any areas for improvement.

8. The eighth step is to learn from the experience. This involves reflecting on what worked well and what didn't work well, and using this information to improve future problem-solving efforts.

9. The ninth step is to communicate the results. This involves sharing the results of the problem-solving process with others who may be affected by the solution.

10. The tenth step is to document the process. This involves recording the steps that were taken and the results that were achieved, so that the process can be repeated if necessary.

11. The eleventh step is to review the process. This involves reflecting on the overall process and identifying any areas for improvement.

12. The twelfth step is to celebrate success. This involves recognizing and rewarding the individuals and teams who were instrumental in solving the problem.

13. The thirteenth step is to share the solution. This involves sharing the solution with others who may be facing a similar problem.

14. The fourteenth step is to continue to monitor the results. This involves continuing to track the performance of the solution and making adjustments as needed.



in air to weights in vacuum, the density of the solution will be obtained in terms of g. / ml. in vacuum. A table of densities, of the various solutions dealt with, is given on page 13. The densities in that table are based on the weight of 1000.12 ml. of solution.

Another method was employed in determining the densities of these solutions. This method involved the use of pycnometers. If a pycnometer, of approximately 25 ml. capacity, is cleaned well and filled with conductivity water and allowed to come to a constant temperature of 25 degrees in a bath kept at that temperature, it will contain an exact volume of the water. The time required for this equilibrium of temperature to be reached, is about one hour. The weight of the pycnometer, and contained water, is then obtained. If this same pycnometer is then cleaned and rinsed well with a certain concentration of KCl solution, filled and allowed to come to equilibrium temperature at 25 degrees, for the same length of time, the volume of the solution will be the same as obtained as in the case of the water. The weight of the pycnometer plus this volume of KCl solution is then obtained. Assuming that the weight of the pycnometer does not vary, which is the case, the weights obtained will be proportional to the densities of the water and KCl solution. By dividing the weight of the pycnometer and solution, by the weight

of the pycnometer and conductivity water, a value is obtained which is density of the solution relative to the density of water. The density of water at 25 degrees is 0.9904 g./ml. (weights in vacuum) (Bulletin of Bureau of Standards Vol. 4, No. 4, Page 600, Table No. 19). To convert this density of water to terms of g./ ml. brass weights in air, it is necessary to multiply by 1.00106. This gives a value of 0.996066 for the density of water in g. / ml. brass weights in air. By multiplying the relative value of the density of the solution by the actual density of water at 25 degrees, the density of the solution is obtained in terms of g./ml. brass weights in air. If desired to interpret this value for the density of the solution in terms of g./ml. in vacuum the density, in terms of g./ml. brass weights in air, must be multiplied by 1.00106. A table of densities so determined is given on Page 13.

Determination of the Cell Constant:- Kraus and Parker (Kraus and Parker, J. Am. Chem. Soc. 44, 2422 - 1922), give data for the conductivity of 0.1 Normal KCl, at 25 degrees. "0.1 Normal KCl solution made by dissolving 7.455 g. KCl in one liter of solution." To transpose this weight to brass weights in air, it is necessary to divide by 1.00106, which

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. This is essential for ensuring the integrity of the financial statements and for providing a clear audit trail. The document emphasizes that every transaction, no matter how small, should be properly recorded and classified.

2. The second part of the document outlines the various methods used to record transactions. These include the double-entry system, which ensures that every transaction is recorded in two accounts, and the use of journals and ledgers to organize the data. The document also discusses the importance of using standardized accounting principles to ensure consistency and comparability.

3. The third part of the document focuses on the classification of transactions. It explains how transactions should be categorized based on their nature and the accounts affected. This classification is crucial for determining the correct debit and credit entries and for ensuring that the accounting equation remains balanced.

4. The fourth part of the document discusses the importance of maintaining accurate records of all transactions. This is essential for ensuring the integrity of the financial statements and for providing a clear audit trail. The document emphasizes that every transaction, no matter how small, should be properly recorded and classified.

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gives a value of 7.4474 g. KCL per liter of solution. As has been stated, the flask used contained 1000.12 ml. at 25 degrees. By multiplying 7.4474 by 1.00012, the value 7.4483 g. is obtained. Thus in order to make up this solution it was necessary to weigh 7.4483 g. KCL (brass weights in air), in order to have a 0.1 Normal KCL solution at 25 degrees. Nine solutions were so made, and three separate determinations of conductivity were made for each of the nine solutions. Kraus and Parker give a value of 0.0129014 for the specific conductance of that solution. If the conductance of the solution is calculated, which is the reciprocal ohms resistance of the cell, and divided into the specific conductance, the cell constant is obtained. Taking the average of all determinations, the value of 0.5971 was accepted as the cell constant. Great care was taken in the handling of the cell, and it was assumed that the value 0.5971 did not change throughout the entire investigation.

Conductance Measurements:- The conductance of a solution, as is stated above, is the reciprocal ohms resistance of the solution. If a cell is inserted in a circuit, as is shown in Fig.1, Page 10, and the slide wire adjusted so that minimum sound is heard

1. **Introduction**

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- 5. **Conclusion**

2. **Methodology**

The data for this report was collected from various sources, including government reports, academic journals, and news articles. The data was analyzed using statistical methods and economic models.

3. **Results**

The results of the analysis show that the COVID-19 pandemic has had a significant negative impact on the global economy. The global GDP has declined, and unemployment rates have risen. The impact has been particularly severe in developing countries.

4. **Discussion**

The discussion of the results highlights the need for coordinated international efforts to address the economic challenges posed by the pandemic. Key areas for discussion include the impact of the pandemic on different sectors of the economy, the role of government intervention, and the potential for long-term economic recovery.

5. **Conclusion**

The conclusion of the report is that the COVID-19 pandemic has had a profound impact on the global economy. It is essential that governments and international organizations work together to implement effective recovery strategies. This includes measures such as fiscal stimulus, monetary policy, and social safety nets. The report also emphasizes the importance of addressing the underlying structural issues of the global economy to prevent future crises.

through the headphones, the unknown resistance of the cell is balanced by the outside resistance R. The cell resistance is then calculated by use of the formula;

$$X = R \times \frac{1000 - \text{Bridge Reading}}{\text{Bridge Reading}} .$$

To calculate the conductance of the solution, then

it is necessary to divide this value of X into 1.

In order to get the specific conductance of the solution, which is the conductance of 1 cc. of the solution, the value X must be multiplied by the cell Constant, K. The equivalent conductance of the solution is then determined by multiplying the specific conductance of the solution by the number of cubic centimeters which contain one equivalent. This value for 1.0 Normal KCl, is 1000.027, since there are that many ccs. in one liter. For each concentration below the 1.0x Normal, this must necessarily be taken into consideration.

In preparing the cell for conductance measurements, the cell was rinsed thoroughly, with the solution under investigation, three times. The electrodes were also rinsed with the same solution three times. The cell was then filled, and the electrodes carefully inserted. It was then placed in the constant temperature bath, kept at 25 degrees, and allowed to come to equilibrium at that temperature. This required about half an hour. After equilibrium was obtained, the measurements were taken. Measurements were taken for three five-minute



intervals, and the results tabulated. This was repeated twice, so that for each and every solution made up, there were three separate determinations of the conductivity. Calculating the specific and equivalent conductance for every reading of the bridge, and averaging them, gives the same result as averaging all the bridge readings and then calculating the specific and equivalent conductances. This latter method was the one used in determining the conductivity values found in Table 2, Page 20.



## WIRING DIAGRAM

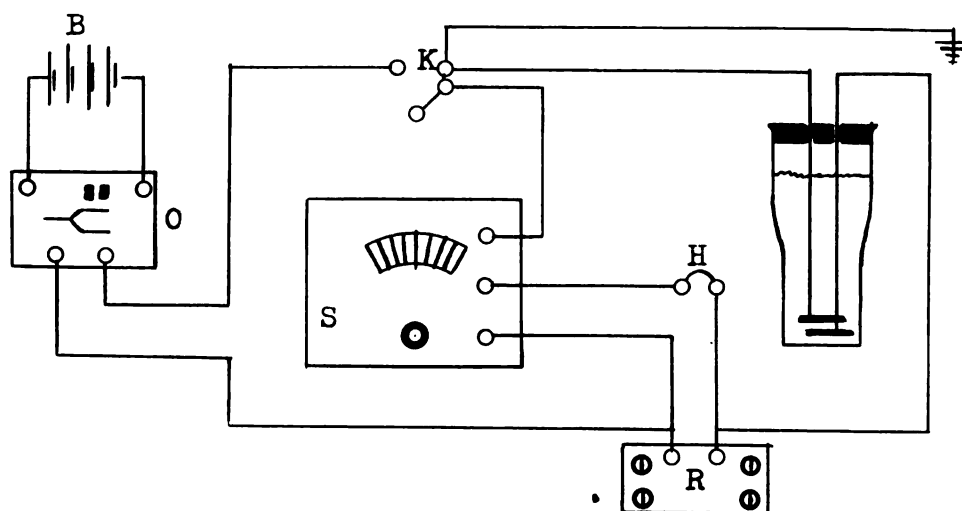


FIG. -1-

- B - Battery.
- O - Microphone hummer.
- K - Key.
- S - Slide wire, or bridge.
- H - Headphones.
- R - Outside resistance.

## CONDUCTIVITY CELL

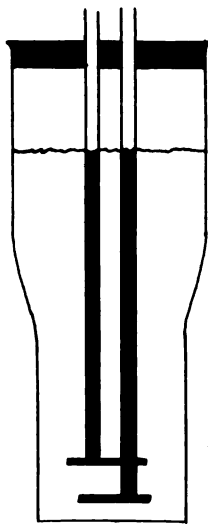


FIG. -2-

## DETERMINATION OF CELL CONSTANT

0.1 Normal KCl solution. 7.455g. (vacuum)  
per liter of solution.

Specific Conductivity - 0.0129014

Solution	R	Bridge	Ratio	X	L	-L	K
1	50	320	0.9305	46.525	0.02149	0.01290	0.6002
2	50	307	0.9257	46.285	0.02149	0.01290	0.5971
3	50	307	0.9257	46.285	0.02149	0.01290	0.5971
4	50	307	0.9257	46.285	0.02149	0.01290	0.5971
5	50	307	0.9257	46.285	0.02149	0.01290	0.5971
6	50	307	0.9257	46.285	0.02149	0.01290	0.5971
7	50	307	0.9257	46.285	0.02149	0.01290	0.5971
8	46	515	1.0061	46.281	0.02160	0.01290	0.5971
9	45	570	1.0285	46.283	0.02161	0.01290	0.5971
Average							0.5971

R Outside resistance.

X Resistance of the cell.

L Conductance of solution.

$\bar{L}$  Specific Conductance of solution.

K Cell Constant.

The values tabulated are the result of three determinations of conductance of each solution.

## DENSITY TABLE

Density of 1.0 Normal KCl Solution at 25 Degrees, C.

Table "A"- Densities as calculated from pycnometer determinations.

Table "B"- Densities as calculated from the weight of 1000.12 ml. of solution.

Soln.	-A-		-B-	
	(air)	(Vacuum)	(air)	(vacuum)
I	1.0271	1.0282		
	1.0272	1.0283		
	1.0271	1.0282		
	1.0271	1.0282		
Av.	1.0271	1.0282	1.0270	1.0281
II	1.0272	1.0283		
	1.0271	1.0282		
	1.0271	1.0282		
	1.0271	1.0282		
Av.	1.0271	1.0282	1.0270	1.0281
III	1.0272	1.0283		
	1.0271	1.0282		
	1.0271	1.0282		
	1.0271	1.0282		
Av.	1.0271	1.0282	1.0270	1.0281
Average	1.0271	1.0282	1.0270	1.0281

All values of densities are given in terms of grams per milliliter.

## DENSITY TABLE

Density of 0.5 Normal KCl Solution at 25 Degrees, C.

Table "A" - Densities as calculated from  
Pycnometer Determinations.

Table "B" - Densities as calculated from the  
weight of 1000.12 ml. solution.

Soln.	-A-		-B-	
	(air)	(vacuum)	(air)	(vacuum)
I	1.0108	1.0119		
	1.0108	1.0119		
	1.0108	1.0119		
	1.0108	1.0119		
Av.	1.0108	1.0119	1.0103	1.0114
II	1.0110	1.0121		
	1.0110	1.0121		
	1.0110	1.0121		
	1.0111	1.0122		
Av.	1.0110	1.0121	1.0111	1.0122
III	1.0111	1.0122		
	1.0110	1.0121		
	1.0109	1.0119		
	1.0111	1.0122		
Av.	1.0111	1.0122	1.0110	1.0121
Average	1.0110	1.0121	1.0110	1.0121

All values for densities given in terms of grams  
per milliliter.

## DENSITY TABLE

Density of 0.2 Normal KCl Solution at 25 Degrees, C.

Table "A" - Densities as calculated from  
pycnometer determinations.

Table "B" - Densities as calculated from the  
weight of 1000.12 ml. solution.

Solution	-A- (air)	(vacuum)	-B- (air)	(vacuum)
I	1.0024	1.0034		
	1.0024	1.0034		
	1.0024	1.0034		
	1.0024	1.0034		
Av.	1.0024	1.0034	1.0024	1.0034
II	1.0024	1.0034		
	1.0024	1.0034		
	1.0024	1.0034		
	1.0024	1.0034		
Av.	1.0024	1.0034	1.0024	1.0034
III	1.0024	1.0034		
	1.0024	1.0034		
	1.0024	1.0034		
	1.0024	1.0034		
Av.	1.0024	1.0034	1.0024	1.0034
AVERAGE	1.0024	1.0034	1.0024	1.0034

All values for densities given in terms of grams  
per milliliter.

## DENSITY TABLE

Density of 0.1 Normal KCl Solution at 25 Degrees, C.

Table "A" - Densities as calculated from  
pycnometer determinations.

Table "B" - Densities as determined from the  
weight of 1000.12 ml. solution.

Solution	-A-		-B-	
	(air)	(vacuum)	(air)	(vacuum)
I	0.9992	1.0002		
	0.9992	1.0002		
	0.9992	1.0002		
	0.9992	1.0002		
Av.	0.9992	1.0002	0.9991	1.0002
II	0.9989	1.9999		
	0.9991	1.0002		
	0.9992	1.0002		
	0.9991	1.0002		
Av.	0.9991	1.0002	0.9991	1.0002
III	0.9991	1.0002		
	0.9992	1.0002		
	0.9992	1.0002		
	0.9990	1.0000		
Av.	0.9991	1.0002	0.9991	1.0002
AVERAGE	0.9991	1.0002	0.9991	1.0002

All values for densities given in terms of grams  
per milliliter.

## DENSITY TABLE

Density of 0.02 Normal KCl Solutions at 25 Degrees, C.

Table "A" - Densities as calculated from  
pycnometer determinations.

Table "B" - Densities as calculated from the  
weight of 1000.12 ml. of solution.

Solution	-A-		-B-	
	(air)	(vacuum)	(air)	(vacuum)
1	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
Av.	0.9967	0.9977	0.9966	0.9977
11	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
Av.	0.9967	0.9977	0.9967	0.9977
111	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
Av.	0.9967	0.9977	0.9967	0.9977
AVERAGE	0.9967	0.9977	0.9967	0.9977

All values for densities are in terms of grams  
per milliliter.



## DENSITY TABLE

Density of 0.02 Normal KCl Solutions at 25 Degrees, C.

Table "A" - Densities as calculated from  
pycnometer determinations.

Table "B" - Densities as calculated from the  
weight of 1000.12 ml. of solution.

Solution	-A-		-B-	
	(air)	(vacuum)	(air)	(vacuum)
1	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
Av.	0.9967	0.9977	0.9966	0.9977
11	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
Av.	0.9967	0.9977	0.9967	0.9977
111	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
	0.9967	0.9977		
Av.	0.9967	0.9977	0.9967	0.9977
AVERAGE	0.9967	0.9977	0.9967	0.9977

All values for densities are in terms of grams  
per milliliter.



## DENSITY TABLE

0.01 Normal KCl Solution - 25 Degrees, C.

Table "A" - Densities calculated from pycnometer  
determinations.

Table "B" - Densities calculated from the weight of  
1000.12 ml. of solution.

Solution	-A-		-B-	
	(air)	(vacuum)	(air)	(vacuum)
I	0.9963	0.9974		
	0.9962	0.9973		
	0.9962	0.9973		
	0.9963	0.9974		
Av.	0.99625	0.99735	0.9964	0.9975
II	0.9962	0.9973		
	0.9962	0.9973		
	0.9963	0.9974		
	0.9963	0.9974		
Av.	0.99625	0.99735	0.9963	0.9974
III	0.9963	0.9974		
	0.9963	0.9974		
	0.9963	0.9974		
	0.9962	0.9973		
Av.	0.9963	0.9974	0.9963	0.9974
AVERAGE	0.9963	0.9974	0.9963	0.9974

All densities given in terms of grams per milliliter.

## CONDUCTANCE TABLE

1.0 Normal KCl Solution - 25 Degrees, C.

74.4829 g. KCl/ liter of solution.(air wgts)

78.1932 g. KCl/ 1000g. water. (air weights.)

R - Outside Resistance.

Ratio - Bridge ratio.

X - Resistance of solution.

$\bar{L}$  - Conductance of solution.

$\bar{L}$  - Specific Conductance of solution.

$\Lambda$  - Equivalent Conductance of solution.

Soln.	R	Bridge Ratio	X	L	$\bar{L}$	$\Lambda$	
I	5	742	1.1017	5.5085	0.1815	0.1084	108.4
II	5	740	1.1008	5.504	0.1817	0.1085	108.5
III	5	741	1.1013	5.5065	0.1816	0.1084	108.4
Average						0.1084	108.4
IV	5	738	1.0999	5.4995	0.1818	0.1086	108.6
V	5	739	1.1004	5.502	0.1817	0.1085	108.5
Average						0.1085	108.5

Solutions, I, II, III, were made up volumetrically at 25 Degrees, C.

Solutions IV, and V, were made up by weight, after determining weight of KCl per 1000 g. water.

The tabulated results are the averages of three determinations.

The first part of the document discusses the importance of maintaining accurate records of all transactions. This includes not only sales and purchases but also the flow of goods and services between different departments and locations. By keeping detailed records, management can identify trends, track inventory levels, and ensure that all financial activities are properly documented.

In addition, the document emphasizes the need for regular audits and reconciliations. These processes help to detect any discrepancies or errors in the accounting system and ensure that the financial statements are accurate and reliable. It is also important to maintain up-to-date records of all assets and liabilities, as well as any changes in ownership or control of the company.

Finally, the document highlights the importance of transparency and communication in financial reporting. Management should provide clear and concise information to all stakeholders, including investors, creditors, and regulatory authorities. This helps to build trust and confidence in the company's financial performance and ensures that all parties are kept informed of any potential risks or opportunities.

The second part of the document focuses on the implementation of internal controls and risk management strategies. These measures are essential for protecting the company's assets, ensuring the integrity of its financial reporting, and minimizing the risk of fraud or other financial misstatements.

Key elements of an effective internal control system include the establishment of clear policies and procedures, the assignment of responsibilities, and the implementation of segregation of duties. Regular monitoring and evaluation of these controls are also necessary to ensure they remain effective and relevant over time.

Risk management involves identifying, assessing, and mitigating the various risks that the company faces, both internally and externally. This includes risks related to market conditions, operational processes, and the company's financial health. By proactively managing these risks, the company can better position itself to achieve its long-term goals and maintain a strong competitive advantage.

In conclusion, the document provides a comprehensive overview of the financial and operational aspects of a company. It emphasizes the importance of accurate record-keeping, regular audits, and transparent reporting, as well as the need for strong internal controls and risk management strategies.

## CONDUCTANCE TABLE

0.5 Normal KCl Solution - 25 Degrees, C.

37.2415 g. KCl/ liter of solution(air wghts.)

38.2432 g. KCl/ 1000g. water(air weights.)

R - Outside Resistance.

Ratio - Bridge Ratio.

X - Resistance of Solution.

$\bar{L}$  - Conductance of solution.

$\bar{L}$  - Specific Conductance of solution.

$\Lambda$  - Equivalent Conductance of solution.

Soln.	R	Bridge Ratio	X	L	$\bar{L}$	$\Lambda$	
1	10	586	1.0351	10.351	0.0966	0.05769	115.4
11	10	591	1.0370	10.370	0.0964	0.0576	115.2
111	10	588	1.0358	10.358	0.0965	0.0577	115.3
					Average	0.0577	115.3
1V	10	588	1.0358	10.358	0.0965	0.0577	115.3
V	10	589	1.0362	10,362	0.965	0.0576	115.2
					Average	0.0576	115.3

Solutions 1, 11, and 111, were made up at 25 degrees, volumetrically.

Solutions 1V, and V, were made up by weight, after calculating weight of KCl per 1000 g. water.

The tabulated results are the averages of three determinations.

## CONDUCTANCE TABLE

0.2 Normal KCl Solution - 25 Degrees, C.

14.8966 g. KCl/ liter of solution (air wgtts.)

15.0852 g. KCl/ 1000g. water (air weights)

R - Outside Resistance.

Ratio - Bridge ratio.

X - Resistance of solution.

$\bar{L}$  - Conductance of solution.

$\bar{L}$  - Specific Conductance of solution.

$\Lambda$  - Equivalent conductance of solution.

Soln.	R	Bridge	Ratio	X	L	$\bar{L}$	$\Lambda$
1	24	531	1.0125	24.3	0.0412	0.0246	122.9
11	24	529	1.0117	24.28	0.0412	0.0246	122.9
111	24	530	1.0121	24.29	0.0412	0.0246	122.9
				Average		0.0246	122.9
1V	24	529	1.0117	24.28	0.0412	0.0246	122.9
V	24	530	1.0121	24.29	0.0412	0.0246	122.9
				Average		0.0246	122.9

Solutions 1, 11, and 111 were made up volumetrically at 25 degrees, C.

Solutions 1V, and V, were made up by weight, after determining weight of KCl per 1000g. water.

The tabulated results are the averages of three determinations.

The first part of the document discusses the importance of maintaining accurate records of all transactions. This includes not only sales and purchases but also any other financial activities that may occur. The second part of the document provides a detailed breakdown of the company's income and expenses for the year. This includes a list of all revenue sources and a list of all expenses, with a corresponding calculation of the net profit. The third part of the document discusses the company's financial position at the end of the year, including a balance sheet and a statement of equity. The final part of the document provides a summary of the company's performance and a forecast for the future.

Category	Item	Amount	
Revenue	Sales	1000000	
	Interest	50000	
	Dividends	20000	
	Other	10000	
	Net Revenue	1080000	
	Expenses	Cost of Goods Sold	600000
		Salaries	200000
		Rent	100000
		Utilities	50000
		Insurance	30000
Depreciation		20000	
Interest		10000	
Other		10000	
Net Expenses		1050000	
Net Profit		30000	

The company's financial performance for the year was generally strong, with a net profit of 30,000. This was primarily due to the high volume of sales and the relatively low cost of goods sold. However, the company did face some challenges, particularly in the area of interest expenses, which were higher than in previous years. Despite these challenges, the company's overall financial position remains solid, and it is well-positioned to continue its growth in the future.



## CONDUCTANCE TABLE

0.1 Normal KCl Solution - 25 Degrees, C.

7.4483 g. KCl/ liter of solution (air wghts.)

7.5107 g. KCl. 1000g. water (air weights).

R - Outside Resistance.

Ratio - Bridge Ratio.

X - Resistance of solution.

L - Conductance of solution.

$\bar{L}$  - Specific conductance of solution.

$\Lambda$  - Equivalent conductance of solution.

Soln.	R	Bridge Ratio	X	L	$\bar{L}$	$\Lambda$	
1	45	579	1.0321	46.44	0.0215	0.01286	128.6
11	45	582	1.0333	46.50	0.0215	0.01286	128.6
111	45	580	1.0325	46.46	0.0215	0.01285	128.5
				Average		0.01285	128.6
IV	45	580	1.0325	46.46	0.0215	0.01285	128.5
V	45	580	1.0325	46.46	0.0215	0.01285	128.5
				Average		0.01285	128.5

Solutions 1, 11, and 111, were made up volumetrically at 25 degrees, C.

Solutions IV, and V, were made up by weight, after determining weight of KCl/ 1000g. water.

The tabulated results are the averages of three determinations.

CONDUCTANCE TABLE

0.05 Normal KCL Solution - 25 Degrees C.

3.7242 g. KCL / liter of solution. (air wgtg.)

3.7470 g. KCL / 1000 g. water (air wgtg.)

R - Outside resistance.

Ratio - Bridge ratio.

X - Resistance of solution.

$\underline{L}$  - Conductance of solution.

$\bar{L}$  - Specific Conductance of Solution.

$\Lambda$  - Equivalent Conductance of solution.

Soln.	R	Bridge	Ratio	X	L	$\bar{L}$	$\Lambda$
I	87	577	1.0313	89.72	0.0111	0.00665	133.1
II	87	577	1.0313	89.72	0.0111	0.00665	133.1
III	87	577	1.0313	89.72	0.0111	0.00665	133.1
				Average		0.00665	133.1
IV	87	579	1.0321	89.79	0.0111	0.00665	133.1
V	87	578	1.0317	89.76	0.0111	0.00665	133.1
				Average		0.00665	133.1

Solution I, II, and III were made up volumetrically at 25 degrees, C.

Solutions IV, and V, were made up by weight, after determining weight of KCL per 1000 g. water.

The tabulated results are the averages of three determinations.

## CONDUCTANCE TABLE

0.02 Normal KCl Solution - 25 Degrees, C.

1.4897 g. KCl/ liter of solution (air wghts.)

1.4969 g. KCl/ 1000g. water (air weights)

R - Outside resistance.

Ratio - Bridge ratio.

X - Resistance of solution.

$\bar{L}$  - Conductance of solution.

$\bar{L}$  - Specific Conductance of solution.

$\Lambda$  † Equivalent conductance of solution.

Soln.	R	Bridge	Ratio	X	L	$\bar{L}$	$\Lambda$
1	214	518	1.0073	215.6	0.0046	0.00277	138.5
11	214	519	1.0077	215.6	0.0046	0.00277	138.5
111	214	518	1.0073	215.6	0.0036	0.00277	138.5
					Average	0.00277	138.5
1V	214	516	1.0065	215.4	0.0046	0.00277	138.5
V	214	518	1.0073	215.6	0.0046	0.00277	138.5
					Average	0.00277	138.5

Solutions 1, 11, and 111 were made up volumetrically at 25 degrees, C.

Solutions 1V, and V, were made up by weight, after determining weight of KCl per 1000 g. water.

The tabulated results are the averages of three determinations.

## CONDUCTANCE TABLE

0.01 Normal KCl Solution - 25 Degrees, C.

0.7448 g. KCl/liter of solution (air weights).

0.7522 g. KCl/1000 g. water (air weights).

R - Outside resistance.

Ratio - Bridge Ratio.

X - Resistance of solution.

L - Conductance of solution.

$\bar{L}$  - Specific conductance of solution.

$\Lambda$  - Equivalent conductance of solution.

Soln.	R	Bridge Ratio	X	L	$\bar{L}$	$\Lambda$	
I	410	573	1.0293	422.013	0.0024	0.0014	141.5
II	410	571	1.0289	421.849	0.0024	0.0014	141.5
III	410	570	1.0285	421.685	0.0024	0.0014	141.5
					Average	1.0014	141.5
IV	410	571	1.0289	421.849	0.0024	0.0014	141.5
V	410	571	1.0289	421.849	0.0024	0.0014	141.5
					Average	0.0014	141.5

Solutions I, II and III were made up at 25 degrees, C., volumetrically.

Solutions IV and V were made up by weight, after determining the density of the solution.

All tabulated results are the averages of three determinations.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In the second section, the author outlines the various methods used to collect and analyze the data. This includes both primary and secondary data collection techniques. The primary data was gathered through direct observation and interviews, while secondary data was obtained from existing reports and databases.

The third section provides a detailed description of the data analysis process. This involves identifying patterns, trends, and correlations within the data set. Statistical tools and software were used to facilitate this process, ensuring that the results are both accurate and reliable.

The fourth section presents the findings of the study. It highlights the key insights gained from the data, such as the impact of certain variables on the overall outcomes. These findings are supported by clear evidence and are presented in a logical and coherent manner.

Finally, the document concludes with a summary of the research and its implications. It discusses the limitations of the study and offers suggestions for future research. The author expresses confidence in the validity of the findings and hopes that the research will contribute to a better understanding of the subject matter.

Conc. (1)	Density - 25 deg.C.		g. KCl1000g. water(air wts.)	Conc.(2)	L	A
	g./ml.(air)	g./ml.(vac.)				
1.0 (n)	1.0271	1.0282	78.1927	1.0499(f)	0.1084	108.4
0.5	1.0110	1.0121	38.2432	0.5135	0.0577	115.3
0.2	1.0023	1.0034	15.0852	0.2026	0.0246	122.9
0.1	0.9991	1.0002	7.5107	0.1008	0.0129	128.6
0.05	0.9976	0.9987	3.7470	0.0503	0.0067	133.1
0.02	0.9966	0.9977	1.4969	0.0210	0.0028	138.5
0.01	0.9963	0.9974	0.7522	0.0101	0.0014	141.5

(1) Concentration of solution, expressed in Normality.

(2) Concentration of solution, expressed in Formality.

L Specific Conductance of solution.

A Equivalent Conductance of solution.

## DISCUSSION

The densities of the various solutions, of KCl in the Normal system, were determined accurately by two methods. It was found that the densities so determined checked very well.

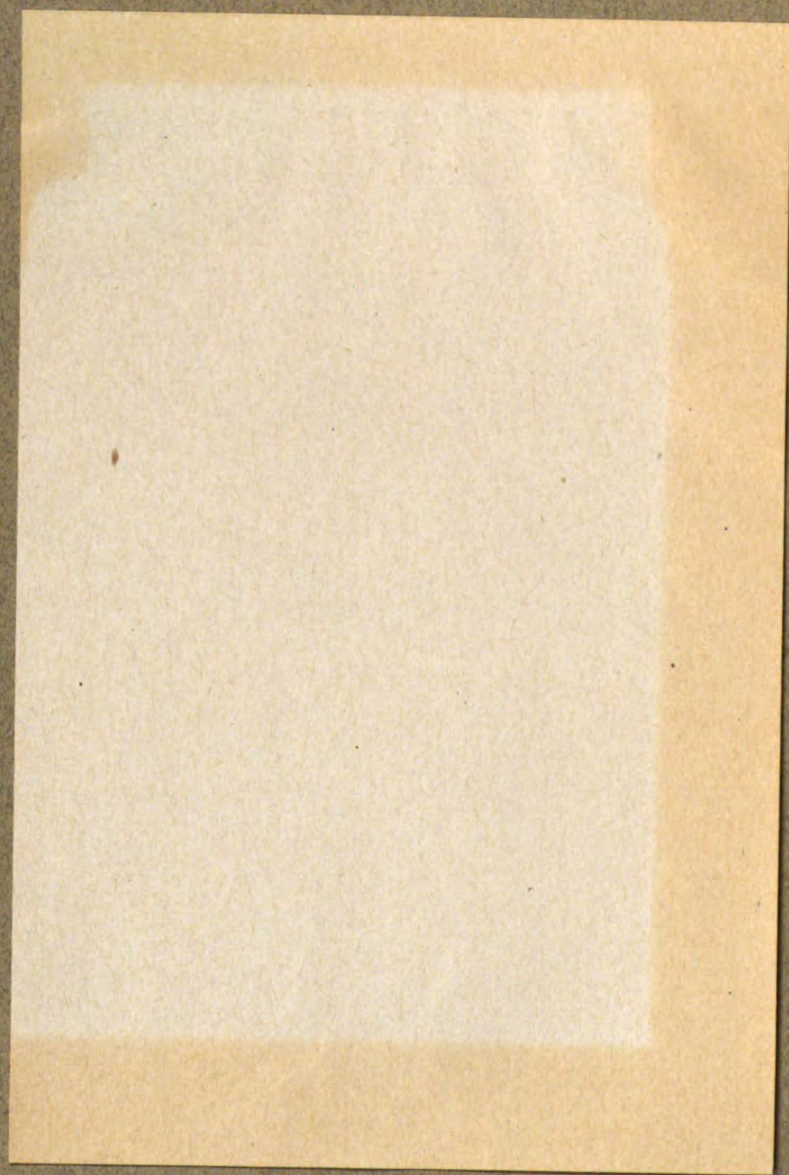
It was found that 1 drop of water weighed 0.1206 g. By using a length of capillary tubing, the amount of water admitted to the vessel, was diminished. The average amount of water admitted, by means of the capillary, was found to be 0.0418 g. This is approximately the weight of a quarter of a drop. In making up a solution which will contain 500 g. of water, the error introduced by weighing is of the order of 0.008%, which is less than the error commonly made in making solutions up volumetrically.

Conductivity measurements served as a check on the density determinations. It may be seen, from the Conductance Tables, that these values checked.

## SUMMARY

1. - The conductivity of solutions of KCl, in the normal system, has been measured.
2. - The densities of these same solutions have been determined.
3. - The weight of materials (brass weights in air), necessary to make these solutions, has been calculated.
4. - Solutions in the normal system have been made by weight, and the conductivity of them has been measured.





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