Operating Instructions: Hanna Instruments Conductivity Meter
Inorganic Chemistry Laboratory CHM3610L
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The use of a Hanna Instruments conductivity meter enables the measurement of the conductivity of solutions. Two electrodes are immersed in a solution and a potential is applied between them, resulting in a current produced in the external circuit that connects the two electrodes. The electrical communication between the two electrodes in solution involves the movement of ions in the solution. Assuming no appreciable solution electrolysis occurs, the magnitude of the current observed generally obeys Ohm's Law: $V = iR$, where V is the applied potential, i is the measured current, and R is the of the solution.   Electrical conductivity, the reciprocal of electrical resistivity, is a measure of a material's ability to transfer, or conduct, and electric current. The higher the concentration of ions present in the solution, the lower the resistance, ρ. More generally, resistance may be defined as:

$$R = \rho \frac{l}{A} \text{ in ohms}$$

where ρ is the specific resistance in Ω cm, l is the length in cm, and A is the cross section area in cm^2. The specific resistance is defined as the resistance in Ω (ohms) of a solution in an ideal cell that has 1 cm^2 electrodes separated by a distance of 1 cm.   The reciprocal of the specific resistance, ρ, is the specific conductance, L, thus $L = 1/\rho$. The specific conductance depends on the concentration of the electrolyte in the solution. Typically, the conductivity will double if the concentration is doubled.

$$L = \frac{l}{A \times R} \text{ in ohms}^{-1} \times cm^{-1} \text{ (or S/cm)}$$

The resistance, R, of the solution in a cell with nonstandard dimensions is obtained by multiplying ρ by a cell geometry correction factor k. Experimentally, k may be evaluated by measuring R for a given solution whose ρ has been measured in a standard cell and then calculating k from the equation $R = k\rho$. For the purposes of these experiments, use a cell constant of 1.

The molar conductance, Λ_M, is defined as the conductance of 1 cm^3 cube of solution that contains one mole (one formula weight) of solute. The specific conductance, L, is the conductance of a 1 cm^3 cube of solution and the conductance per mole of solute may be calculated by dividing L by the number of moles present in 1 cm^3 solution. Molarity is defined as moles/L and noting 1 mL is approximately 1 cm^3, the molar conductance can be expressed by:

$$\Lambda_M = \frac{1000L}{M} \text{ in S } cm^2/mol$$

Typical molar conductivity are as follows for strong electrolytes:

Number of ions	molar conductivity, Ω^{-1} cm^2 mol^{-1}
2 (1:1)	96-150
3 (1:2)	225-273
4 (1:3)	380-435
5 (1:4)	540-560

Ensure the glassware and probes are clean and rinsed with DI H_2O. Measure the conductivity of a solution by immersing the probe in a solution, ensuring the active portions of the probe are covered. The accuracy of the conductivity probe may be checked by weighing 0.746 g of dry KCl and dissolving in 1 L volumetric flask. The measured specific conductance should be near the standard values listed in the following table.

Table 1: Specific conductance of a 0.01 M KCl solution.

Temperature (°C)	Specific conductance, S/cm
15	0.001147
16	0.001173
17	0.001199
18	0.001225
19	0.001251
20	0.001278
21	0.001305
22	0.001332
23	0.001359
24	0.001386
25	0.001413
26	0.001441
27	0.001468
28	0.001496

If the values are substantially different, rinse the conductivity meter with DI water and measure again.

Make sure the equipment is _clean_ and free of chemicals before returning!