Diffusion of a Liquid Apparatus
Instruction Manual

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Engineering Teaching and Research Equipment

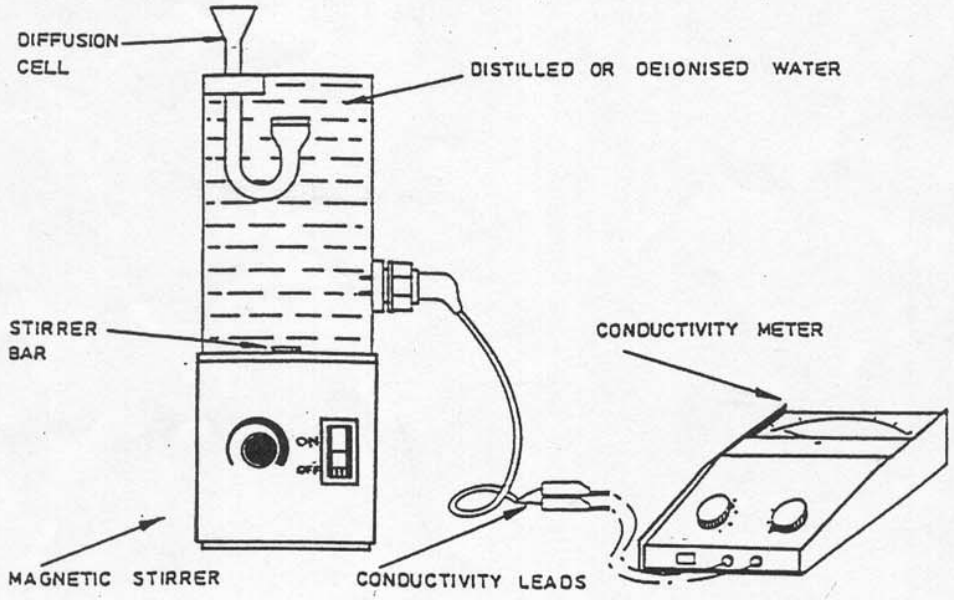
EXPERIMENT A

OBJECT OF EXPERIMENT:

To determine the diffusion coefficient of 2M NaCl solution in distilled water.

EQUIPMENT SET-UP:

Note: Volumetric glassware and balance for making up solutions of known concentrations will be required (Not Supplied).



SUMMARY OF THEORY:

The rate of diffusion is expressed by the equation:

$$J = -D \frac{\partial C}{\partial x}$$

where J is the diffusion flux across unit area at right angles to the x - direction.

D is the diffusion constant.

and $\frac{\partial C}{\partial x}$ is the concentration gradient in the x - direction.

The negative sign indicates that flow is from high to low concentrations.

If J is in mole/cm^2 sec.

C is in mole/cm^3.

x is in cm.

and t is in seconds.

then D will be in $cm^2 sec^{-1}$.

The present apparatus uses vertical capillaries 5mm long and 1mm bore to restrict diffusion to one dimension. The concentration at the lower ends chosen and taken to be constant. The concentration at the top ends is effectively zero during the experiment.

Thus $$\frac{V}{C_M} \cdot \frac{dk}{dt} = -D \frac{\pi d^2}{4} \cdot N \cdot \frac{M}{x}$$

$\therefore$ $$D = -\frac{4Vx}{\pi d^2 N M C_M} \cdot \frac{dk}{dt}$$

where

	Nominal Dimensions
V = Volume of water in outer vessel in litres.	1 litre
x = Length of capillaries in cm.	0.5 cm
d = Diameter of capillaries in cm.	0.1 cm
N = Number of capillaries.	121
M = Molarity of the salt solution.	
C_M = Electrical conductivity change for unit molarity change (Dilute solutions) $\Omega^{-1} M^{-1}$	
$\frac{dk}{dt}$ = Rate of change of conductivity with time $\Omega^{-1} sec^{-1}$.	

Thus by plotting conductivity as a function of time the diffusion coefficient can be calculated from the slope of the graph.

READINGS TO BE TAKEN:

The cell is filled with 2M NaCl solution made up from 117g salt/litre. Completely fill the cell and wipe off any excess solution from the outside of the cell and the top of the capillaries using filter paper; the cell is then clamped in position so that the tops of the capillaries lie parallel with the graduation mark on the vessel and 5mm below it. The vessel is then filled with 1 litre of distilled or deionised water to the graduation mark i.e. 5mm above the surface of the capillary tops. The conductivity meter is connected to the electrodes in the cell by the leads provided and a reading of $10^{-4}\ \Omega^{-1}$ or less should be obtained. The stirrer is switched on to provide a gentle agitation at the filter surface and readings of conductivity are taken at 200 second intervals.

RESULTS:

Time (s)	0	200	400	600	800	1000	1200	1400	1600	2000
Conduct-ivity										

Conductivity is plotted as a function of time and the slope of the graph determined. This is put into the equation derived to give the Diffusion Coefficient using $C_M = 0.41$. If another salt solution is used then C_M must be determined by calibrating the apparatus for low concentrations (0.001M to 0.002M).

Values of Diffusion Coefficient can be compared with those given in reference books.