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in chemistry suggested that teachers can improve their teaching by being critical of their professors and adopt the good points while avoiding the bad points where ever possible. He recognizes the situation that teachers tend to teach the same way that they have been taught and that they are not anxious to teach using material that they have not encountered as a part of their own training. The problems associated with the training of science teachers are numerous. Further studies in progress at the State University of Iowa include the following: 1.) the subject matter of new courses, 2.) the overall curriculum required of teachers of science (chemistry), 3.) available courses which will give the student teacher a sufficient background at the undergraduate level, 4.) the development of new content courses designed for training of teachers other than method courses, 5.) the advantages of an additional year of training, 6.) the advantages of requiring a master's degree, and 7.) the success of teachers after five to ten years with varying background and experience. It is hoped that the results and the continuation of this study will identify some of the primary problems which exist in the training of teachers. Apparently improved college courses and college curricula for teachers are needed to secure an adequately trained chemistry teacher after completion of the four years required for a Bachelor's degree.

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The Dipole Moment of Styrene[1]

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Abstract. The dipole moment of styrene, calculated from eighteen solutions ranging in weight fraction from 0 - 100%, was found to be 0.181 D. The method and results of the measurement were compared to the method and results of Petro and Smyth for the same compound. It was concluded that the atomic polarization in styrene in small, and thus is taken into account by the measurement of the molar refraction at the sodium D line. It was further proposed that the relatively large dipole moments of *trans-p,β*dinitrostyrene and *trans-p,β*-dicyanostyrene may be due, at least in part, to abnormally large atomic polarizations.

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In the past there has been some doubt as to the magnitude and direction of the permanent dipole moment of the styrene molecule. Two values which have been reported are: 0.13 D by Petro and Smyth (1), and 0.37 D by Otto and Wenzke (2). It is important that we have an accurate value for this dipole moment measured on our own apparatus, in order to facilitate our study of the electronic structures and interactions of certain *para-beta*-disubstituted styrenes.

In order to obtain an accurate value for this dipole moment we have measured it four separate times, using weight fractions ranging from 0 - 100%. The average value obtained from the four sets of measurements was 0.181 D. The dipole moment was also calculated from the combined data of all eighteen solutions. Again a value of 0.181 D was obtained.

One of the most recently reported values for the dipole

Table 1
Weight Fractions and Corresponding Dielectric Constant, Density, and Refractive Index Data

Solution	ω	ε	d	n
1	0.00734	2.2742	.....	.....
2	0.00758	2.2733	0.8729	1.4978
3	0.01875	2.2760	.....	.....
4	0.02334	2.2777	0.8738	1.4981
5	0.03277	2.2780	.....	.....
6	0.03649	2.2771	0.8735	1.4990
7	0.04770	2.2800	0.8744	1.4997
8.	0.05023	2.2804	.....	.....
9.	0.05329	2.2797	.....	1.5000
10	0.06262	2.2819	0.8742	1.5001
11.	0.07457	.....	0.8750	1.5005
12	0.09002	2.2844	.....	1.5026
13	0.15404	2.2946	.....	1.5061
14	0.20473	2.3007	.....	1.5072
15	0.25796	2.3074	.....	1.5093
16	0.49852	2.3436	.....	1.5207
17	0.75374	2.3861	.....	1.5324
18	1.00000	2.4174	.....	1.5440

Table 2
Slopes and Intercepts for Dielectric Constant, Density and Refractive Index Equations

Solutions	α_0	β_0	γ_0	ε_1	d_1	n_1
1, 4, 5, 7, 11	0.13830	0.02340	0.04655	2.2736	0.8733	1.4972
2, 3, 6, 8, 10	0.15127	0.02357	0.04178	2.2724	0.8727	1.4975
9, 12, 13, 14	0.14165	......	0.04807	2.2721	.....	1.4979
15, 16, 17, 18	0.15015	......	0.04667	2.2694	.....	1.4973
All Solutions	0.14595	0.02350	0.04646	2.2724	0.8730	1.4976

Table 3
Molar Polarizations, Molar Refractions, Orientation Polarizations and Dipole Moments

Solutions	M.P.	M.R.	P_0	μ
1, 4, 5, 7, 11	37.30	36.74	0.56	0.165
2, 3, 6, 8, 10	37.55	36.49	1.06	0.228
9, 12, 13, 14	37.34	36.89	0.45	0.148
15, 16, 17,. 18	37.45	36.76	0.69	0.184
All Solutions	37.44	36.77	0.67	0.181

moment of styrene was 0.13 D as obtained by Petro and Smyth (1). However, the method used to obtain this value differed from our method. It will be of interest to compare the method and results of these authors to our method and results. We obtained the total polarization from dielectric constant and density measurements, and the molar refraction from refractive index and density measurements, according to the Kumler-Halverstadt and Palat equations. Then the dipole moment was calculated according to the Debye equation from the orientation polarization (which equals the total polarization minus the atomic and electronic polarizations). In this method the molar refraction, which equals the electronic polarization at a finite wave length such as the sodium D line, is assumed to a good approximation to be equal to the sum of the atomic and electronic polarizations at infinite wave length. The compensating factor in this approximation is that the electronic polarization, when extrapolated to infinite wave length, has a slightly smaller value than at the sodium D line. Thus the larger value of the electronic polarization obtained at the sodium D line compensates for the atomic polarization. This proposal has previously been made by Everard, Kumar and Sutton (3).

Petro and Smyth calculated the total polarization from dielectric constant and density measurements by the Clausius-Mosotti equation. The electronic polarization was determined by extrapolating the molar refraction, as calculated from refractive index and density data by the Lorentz-Lorenz equation, to infinite wave length according to the Cauchy dispersion formula. Then the Debye equation was arranged as follows:

$$P_t - P_e = P_a + \frac{4\pi N}{9kT}\mu^2$$

Thus a plot of (P_t - P_e) against the reciprocal of the absolute temperature enables the dipole moment to be calculated from the slope of the line and the atomic polarization from the intercept.

Petro and Smyth found the atomic polarization to be 2.20 ml./mole, and the electronic polarization was 34.5, both values having been obtained at infinite wave length. Thus the sum of these two values, 36.7, agrees well with the value we obtained for the electronic polarization at the sodium D line, which was 36.77. This close agreement justifies the assumptions we made in order to calculate the dipole moment of styrene.

It has been pointed out in recent literature that the atomic polarization is abnormally large in certain compounds, such that the measurement of the molar refraction at the sodium D line does not adequately compensate for the atomic polarization in these cases. DiCarlo and Smyth made a study of several symmetrical molecules which appeared to have appreciable dipole moments (4). For example, 4,4'-dinitrobiphenyl was reported to have a dipole moment of 0.7 to 1.0 debyes (5). From dielectric loss measurements DiCarlo and Smyth illustrated that this compound, if polar, could not have a permanent dipole moment greater than 0.20 D, and thus they concluded that a large atomic polarization exists in the molecule. We have encountered similar cases in our work with *para-beta*-disubstituted styrenes. Consider a molecule in which the same group is substituted in both the *para* and *beta* positions of styrene. If the groups are *trans* to each other the molecule would be expected to have a dipole moment equal approximately to that of styrene, since the groups will act equally but in opposite directions. We have found *trans-p*, β-dinitrostyrene to have a dipole moment of 0.83 D, and *trans-p*, β-dicyanostyrene a dipole moment of 1.01 D. Each of these is much greater than the value which we have presented for styrene in this article. It is possible that these relatively large values are due, at least in part, to abnormally large atomic polarizations.

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The Effect of Ferric Chloride on the Cadmium Reaction

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Abstract. The reaction of di-*n*-butylcadmium with either capryl chloride or benzoyl chloride at -10° in the presence of ferric chloride yields 50% of the expected ketone. The reactions of the same acid chlorides with diphenylcadmium are hampered by coupling of the aromatic cadmium reagent in the presence of the ferric chloride. A yield of 20-30% of ketone can be obtained, however, if the ferric chloride is added to the precooled acid chloride followed by the addition of the diphenylcadmium.

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