

The corresponding methiodide was prepared by adding 2 g. of methyl iodide to 1 g. of the amine ether, and allowing the mixture to stand for forty-eight hours. The benzyl chloride and the benzyl bromide were obtained by heating 1 g. of the amine ether with 2 g. of the benzyl halide for eight hours. The salts were recrystallized from ethyl acetate.

TABLE I
4- $[\beta$ -OXY-ETHYL]-MORPHOLINE

Compound	Formula	M. P., °C. (uncor.)	Analyses, % N	
			Calcd.	Found
O-Dodecyl-				
Hydrochloride	C ₁₈ H ₂₈ O ₂ NCl	97	4.17	3.99
Hydrobromide	C ₁₈ H ₂₈ O ₂ NBr	105	3.69	3.53
Oxalate	C ₂₀ H ₂₈ O ₄ N	108	3.29	3.39
Picrate	C ₂₄ H ₄₀ O ₆ N ₄	62	10.60	10.53
Methiodide	C ₁₉ H ₄₀ O ₂ NI	56	3.17	3.10
Benzyl chloride	C ₂₀ H ₂₄ O ₂ NCl	96	3.29	3.51
Benzyl bromide	C ₂₀ H ₂₄ O ₂ NBr	105	2.98	2.98
O-Tetradecyl-				
Hydrochloride	C ₂₀ H ₃₂ O ₂ NCl	112	3.85	3.85
Hydrobromide	C ₂₀ H ₃₂ O ₂ NBr	115	3.43	3.55
Oxalate	C ₂₂ H ₃₂ O ₄ N	109	3.35	3.52
Picrate	C ₂₆ H ₄₄ O ₆ N ₄	80	10.07	9.96
Methiodide	C ₂₁ H ₄₄ O ₂ NI	73	2.98	3.20
O-Hexadecyl-				
Hydrochloride	C ₂₂ H ₃₆ O ₂ NCl	105	3.59	3.37
Hydrobromide	C ₂₂ H ₃₆ O ₂ NBr	112	3.22	3.17
Oxalate	C ₂₄ H ₄₀ O ₄ N	112	3.16	3.21
Picrate	C ₂₈ H ₄₈ O ₆ N ₄	78	9.62	9.48
Methiodide	C ₂₃ H ₄₈ O ₂ NI	80	2.83	2.83

DEPARTMENT OF CHEMISTRY
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The Aqueous Solubility of Hydrated Chromic Nitrate at 25°

BY NORMAN O. SMITH

In connection with the recrystallization of chromic nitrate the author was surprised to discover that there is no information in the literature as to the solubility of this common salt. The following solubility determination was therefore carried out.

Samples of J. T. Baker Analyzed chromic nitrate nonahydrate were rocked in a 15-ml. glass-stoppered tube in a thermostat at 25 ± 0.03° for several days. Equilibrium was approached from both under- and over-saturation and concentrations were measured by means of chromium analyses. Chromium was determined by oxidation to chromate with sodium peroxide followed by the iodometric determination of the chromate. The resulting values of the solubility were

	Wt., % Cr(NO ₃) ₃
From undersaturation	44.95
From oversaturation	44.71
Av.	44.83

The solid phase was removed by filtration, centrifuged, air-dried for ten minutes and then analyzed. It was found to contain 59.33% Cr(NO₃)₃. Calculated for

Cr(NO₃)₃·9H₂O: 59.48% Cr(NO₃)₃. The solid phase is therefore the nonahydrate.

Apparently hydrolysis is not sufficient to produce any solid basic compound. Furthermore, the ready attainment of equilibrium distinguishes the behavior of the nitrate from that of several other chromic compounds.^{1,2,3}

(1) Olie, *Z. anorg. Chem.*, **51**, 29 (1906).

(2) Montemartini and Vernazza, *L'Industria chimica*, **8**, 445 (1933).

(3) Hill, Smith and Ricci, *THIS JOURNAL*, **62**, 858 (1940).

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On Phosphorescence Vibration Spectra of Polyatomic Molecules

BY O. REDLICH AND E. K. HOLT

A few more details can be read from the phosphorescence vibration spectra recently published and interpreted by Lewis and Kasha¹ on the basis of the principle of Franck and Condon.

(1) For a complete interpretation, the analysis of the vibration spectra and the knowledge of the parameters of the phosphorescent state is required. If x denotes a $(3n - 6)$ -dimensional vector representing the elongations in internal geometric coordinates, and $q = Ax$ is the vector of the normal coordinates, then the vector $p = Bx$ representing the distortion of the phosphorescent molecule determines, according to the Franck-Condon principle, the amplitudes $q_v = AB^{-1}p$ of the vibrations excited in the transition to the ground state. The quantum number v of the k^{th} vibration is given by $2v + 1 = 3(q_v^k/q_1^k)^2$ where q_1^k denotes the amplitude of the first quantum state. This somewhat crude application of the Franck-Condon principle should furnish a fair approximation if, as in the measurements of Lewis and Kasha, only the zero-point vibration of the phosphorescent molecule is excited.

The distortion p can be represented as a vector in the space spanned by the amplitudes q_1^k . If p has a lower symmetry than q_1 , the vector p lies in the subspace spanned by those amplitudes which are symmetric with respect to the phosphorescent molecule. Only the corresponding vibrations are excited. Provided the symmetry of p is not higher than that of q_1 , the totally symmetric vibrations are always permitted. If p has no symmetry element, all vibrations are permitted. The interpretation of the phosphorescent molecule as a biradical suggests the assumption that a center of symmetry, if present in the ground state, is maintained in the phosphorescent state.

(2) For a crude analysis of the spectrum of benzene, approximate normal coordinates are derived from the assumptions that the vibrations are carried out either by the rigid CH groups or by the hydrogens against the carbons, and that they are either stretching or bending vibrations. The

(1) G. N. Lewis and M. Kasha, *THIS JOURNAL*, **66**, 2100 (1944).