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Crystallographic data on some sodium phosphorothioates.

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Sulphur can replace oxygen in the orthophosphate anion PO_4^{3-} to form the phosphorothioate anions PSO_3^{3-}, $PS_2O_2^{3-}$, PS_3O^{3-} and PS_4^{3-}. The series of phosphorothioates can be obtained as sodium salts, the crystals of which are all hydrated and generally hygroscopic (Glatzel, 1905; Klement, 1947; Neogi & Ghosh, 1929; Wurtz, 1847).

With the exceptions of the structural investigation of cuprous phosphorotetrathioate Cu_3PS_4 (Ferrari & Cavalca, 1948) and the determination of the space group and unit cell data on potassium OO-diethyl phosphorothioate $(C_2H_5O)_2POSK$ (Rollet, 1954), published crystallographic data on phosphorothioates are lacking, and so unit-cell and space-group data have been obtained for the sodium salts shown in Table 1.

Cell dimensions were measured from rotation photographs and space-group absences were determined from zero- and first-layer Weissenberg photographs taken about the principal axes.

Goniometric measurements are recorded for trisodium phosphorothioate only (de la Provostaye, 1847); these are in agreement with the X-ray measurements when c/a (X-ray) $\equiv 4c/a$ (goniometric), taking the hexagonal unit cell as basis.

The space-group possibilities for trisodium phosphorothioate require the anion to have at least three-fold symmetry. In the remaining salts special symmetry is not imposed by space-group considerations.

X-ray powder photographs of trisodium phosphorodithioate and trisodium phosphorotrithioate confirm the isomorphism suggested by the similarities in their unit-cell constants. Mixed-crystal formation is known to occur between these two salts (Klement, 1947), and the low value observed for the density of trisodium phosphorotrithioate may thus be accounted for, but the crystals of trisodium phosphorotrithioate are poorly formed and have a powdery texture.

Crystals of form I of trisodium phosphorotetrathioate appear to be always twinned; for this reason more accurate measurements of [a] and β were not possible.

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Table 1. *Crystallographic data*

Compound	System	Space group	a (Å)	b (Å)	c (Å)		Density (g.cm.$^{-3}$) Obs.	Density (g.cm.$^{-3}$) Calc.	Z
Trisodium phosphorothioate, $Na_3PSO_3.12\,H_2O$	Rhombohedral	$R\bar{3}m$ or $R32$ or $R3m$	12·58	—	—	$\alpha = 42{\cdot}3°$	1·58	1·61	2
Trisodium phosphorodithioate, $Na_3PS_2O_2.11\,H_2O$	Orthorhombic	$Pnma$ or $Pn2_1a$	12·51	13·94	9·48	—	1·58	1·58	4
Trisodium phosphorotrithioate, $Na_3PS_3O.11\,H_2O$	Orthorhombic	$Pnma$ or $Pn2_1a$	12·60	14·02	9·33	—	1·60	1·65	4
Trisodium phosphorotetrathioate, $Na_3PS_4.8\,H_2O$ I	Monoclinic	$P2_1/c$	14·7	7·09	14·15	$\beta = 92°$	1·67	1·68	4
$Na_3PS_4.8\,H_2O$ II	Monoclinic	$P2_1/a$	13·62	12·83	8·69	$\beta = 104{\cdot}0°$	1·67	1·68	4

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Ferroelectricity in ammonium monochloroacetate.*

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Ammonium monochloroacetate is dimorphous at room temperature. Form I is orthorhombic, space group $P2_12_12_1$, with $a = 5{\cdot}71$, $b = 7{\cdot}31$, $c = 12{\cdot}08$ Å, $\varrho_o = 1{\cdot}460$ g.cm.$^{-3}$, and 4 molecules per cell. Form II is monoclinic, space group $C2/c$, with $a = 8{\cdot}42$, $b = 11{\cdot}63$, $c = 9{\cdot}82$ Å, $\beta = 110°$, $\varrho_o = 1{\cdot}558_5$ g.cm.$^{-3}$, and 8 molecules per cell. Both forms appear in the same crystallization, often, when the compound is prepared under

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