Answer on Question #71399 - Chemistry - General Chemistry

Question:

When chlorine is bubbled through an ethanol solution of [NEt4]I a bright yellow precipitate results. Elemental analysis of the product reveals that it contains 3.51% nitrogen. Use this information to elucidate the product of this reaction. Write a balanced equation for the reaction and use VSEPR theory to predict the structure of the solid. What is the oxidation state of iodine at the end of the reaction?

Solution:

$[NEt_4]I + 2Cl_2 = [NEt_4]ICl_4;$
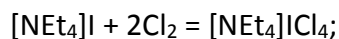
The product of this reaction is $[NEt_4]ICl_4$ (tetraethylammonium tetrachloride monoiodide)

$M([NEt_4]ICl_4) = 399$ g/mol;

$\omega(N) = M(N) / M([NEt_4]ICl_2) = 14/399 = 0.0351 = 3.51\%;$

VSEPR theory: The central atom, iodine, contributes seven electrons. Each chlorine contributes seven, and there is a single negative charge. There are six electron groups around the central atom, four bonding pairs and two lone pairs. the ICl_4^- ion forms a molecular structure that is square planar, an octahedron with two opposite vertices missing.

Oxidation state of iodine at the end of the reaction is +3:

$[Net_4]ICl_4 = [Net_4]^+ + I^{+3} + 4Cl^-.$