2. This question is about the analysis of a copper-containing complex.

In the practical exam for the 2009 International Chemistry Olympiad held in Cambridge, students were asked to analyse compound **X**, a compound containing copper(II). This compound consists of ions: the negatively charged ion is a complex ion containing copper, chlorine and oxygen. The positive counter ion in compound **X** is the tetramethylammonium ion, $(CH_3)_4N^+$. The students were asked to determine the formula of the negative ion, using two titrations.

The first titration was used to determine the proportion of copper ions in the complex. In this titration, the complex was reacted with EDTA solution. EDTA reacts with copper ions according to the equation:

$$Cu^{2+}(\text{from the complex}) + EDTA^{4-}(aq) \rightarrow [CuEDTA]^{2-}(aq)$$

The end-point of this titration was determined using an indicator called murexide, and one of the UK team found that 0.1000 g of **X** required 21.70 cm^3 of 0.02000 mol dm^{-3} EDTA solution for complete reaction.

(a) Calculate the % by mass of copper in compound **X**.

The second titration determined the proportion of chloride ions in the complex. The chloride ions from the complex were titrated against 0.1000 mol dm^{-3} silver(I) nitrate solution, and the student found that 0.2000 g of **X** required 21.70 cm^3 of silver nitrate.

(b) **i)** Give a balanced equation that shows the reaction that takes place in this titration.

ii) Calculate the % by mass of chlorine in compound **X**.

The proportions by mass of carbon, hydrogen and nitrogen in compound **X** were determined by combustion analysis. The results were found to be C 20.87%, H 5.17%, and N 5.96%.

(c) **i)** Which of the six elements in compound **X** has the greatest percentage error in the determination of its proportion? Circle the element in the answer booklet.

ii) Ignoring this element, because of this uncertainty, determine the simplest whole number ratio of the remaining five elements in **X**.

iii) Hence determine the formula of the negative ion in **X**.