Example question: Nucleophilic reactions

Following concentrations for anionic constituents are determined for a water sample with a pH value of 7.0 at 25℃.

Constituents	Ionic weight	Concentration (mg/L)
NO_3^-	62.0	27.2
SO_4^{2-}	96.1	76.5
Cl^-	35.5	204.7
OH^-	17.0	can be derived from pH

The n_{Nu,CH_3Br} values for the anions are shown below:

Anionic nucleophiles	n_{Nu,CH_3Br}
NO_3^-	1.0
SO_4^{2-}	2.5
Cl^-	3.0
OH^-	4.2

i) Determine the $[Nu]_{50\%}$ values for the anionic nucleophiles assuming s=1. Considering the $[Nu]_{50\%}$ values and the nucleophile concentrations, list nucleophiles that are significant for reaction with CH_3Br in the water. If the reaction rate for a nucleophile is more than 5% of the hydrolysis rate, determine the nucleophile as significant.

ii) If 10^{-5} M of CH_3Br is added to the water sample, what will be the concentration of the products of nucleophilic substitution (including hydrolysis) after all the reactions occur completely? Consider only significant nucleophiles.