	Page 3/3	Marks
c)	A lab-technician checked the label on a commercial bottle of bleach: 14° Chl (14 chlorometric degrees). The chlorometric degree represents the volume (in dm^3) of chlorine, $Cl_2(g)$, that is released under **standard conditions** by 1.00 dm^3 of bleach in a reaction with an acid, according to the equation: $$ClO^-(aq) + Cl^-(aq) + 2H^+(aq) \rightarrow Cl_2(g) + H_2O(l)$$ He used the following method to determine the concentration of the hypochlorite ions, $ClO^-(aq)$, in the bleach: • He made a tenfold dilution (1:10) of the concentrated commercial bleach solution. • He took a sample of 10.0 cm^3 of the diluted bleach solution and added an excess of acidified potassium iodide solution, KI(aq). • After stirring, he titrated the iodine produced, $I_2(aq)$, with a 1.00×10^{-1} mol dm^{-3} sodium thiosulfate solution, $Na_2S_2O_3(aq)$. Shortly before the end of titration he added some starch solution. The end-point of the titration occurred when 10.6 cm^3 of the sodium thiosulfate solution had been added to the sample.	
i.	Using the relevant couples given below, write the equation for the reaction between the hypochlorite ion, $ClO^-(aq)$, and the iodide ion, $I^-(aq)$, under acidic conditions.	2 marks
ii.	Using the relevant couples given below, write the equation for the reaction between the thiosulfate ion, $S_2O_3^{2-}(aq)$, and iodine, $I_2(aq)$.	2 marks
iii.	Describe how the end-point is observed experimentally in the titration with thiosulfate ion, $S_2O_3^{2-}(aq)$.	1 mark
iv.	Determine the concentration of the hypochlorite ions, $ClO^-(aq)$, in the diluted bleach solution.	3 marks
v.	Deduce the chlorometric degree of the concentrated commercial bleach solution.	2 marks

Given: Standard redox potentials:

Redox couple	$E^\ominus$ / V
$Cl_2(g) / Cl^-(aq)$	+1.36
$O_2(g) / H_2O(l)$	+1.23
$H_2O(l) / H_2(g)$	-0.83
$Na^+(aq) / Na(s)$	-2.71

Molar volume of chlorine gas:

V_m = 24.5 dm^3 mol^{-1} under the experimental conditions.

1 Faraday = 9.65×10^4 C mol^{-1}