Question 30 **(7 marks)**

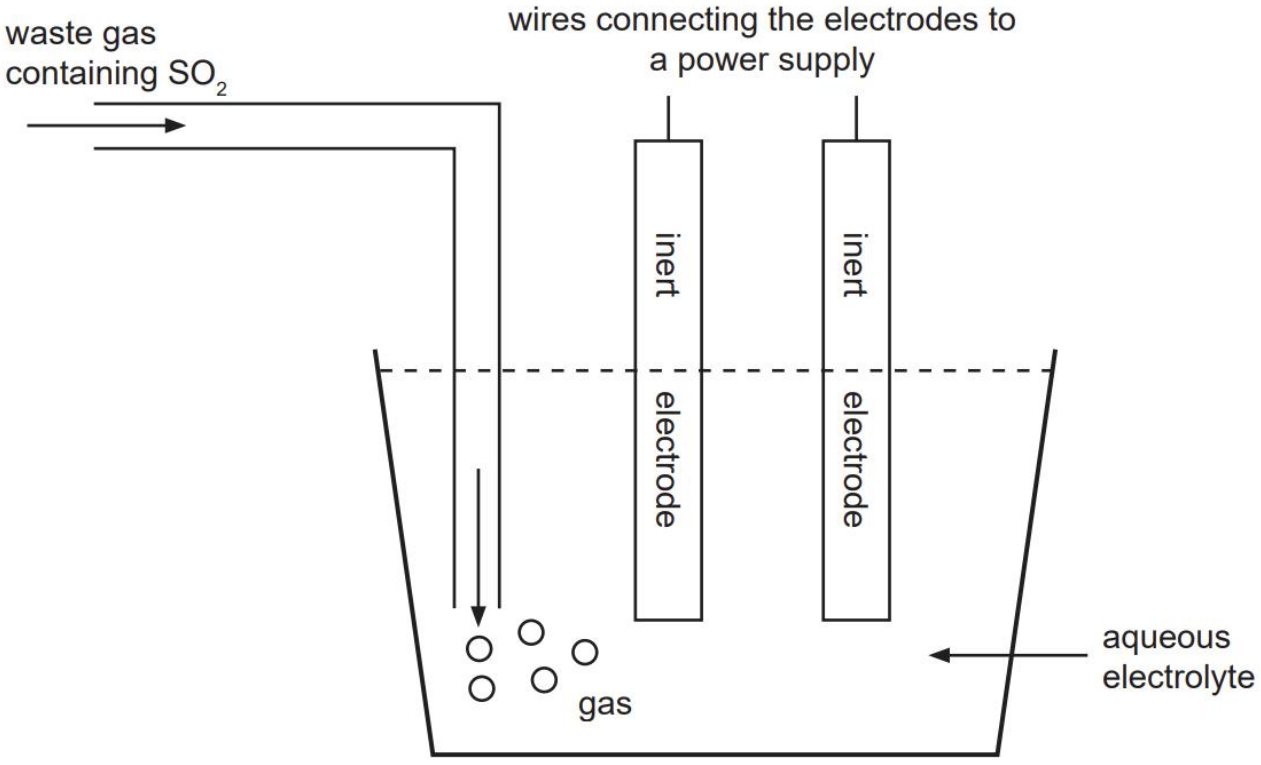
Sulfur dioxide must be removed from waste industrial gases before they are released into the atmosphere. One method of doing this is the electrolytic conversion of sulfur dioxide into dithionate ($S_2O_6^{2-}$):

$$2\ SO_2(g) + 2\ H_2O(\ell) \rightarrow S_2O_6^{2-}(aq) + 2\ H^+(aq) + H_2(g)$$

(a) Identify the atom that is oxidised and the atom that is reduced in this reaction. (2 marks)

Atom that is oxidised	
Atom that is reduced	

An electrolytic cell, similar to the simplified one shown below, can be used for the above process.



A chemist, who was investigating this process, used 1.00 mol L^{-1} sodium perchlorate ($NaClO_4$) solution as the electrolyte. The chemist found that the pH of this electrolyte steadily decreased as more SO_2-containing waste gas was treated. The final pH was 2.42.

The observed pH change prompted the chemist to change the electrolyte to a mixture of potassium hydrogen phosphate (K_2HPO_4) and potassium dihydrogenphosphate (KH_2PO_4), in which the following equilibrium occurred:

$$HPO_4^{2-}(aq) + H_3O^+(aq) \rightleftharpoons H_2PO_4^-(aq) + H_2O(\ell)$$

No significant pH changes occurred when this new electrolyte was used.

(b) Explain how the $HPO_4^{2-}/H_2PO_4^-$ prevented any significant pH change when the SO_2 was bubbled into the solution. (5 marks)