CALCULATION **[10 Marks]**

1. Spirits of salts is used in the building industry to clean excess mortar from new brickwork. The active ingredient is hydrochloric acid with a concentration of around 13 mol L^{-1}. In order to precisely determine the concentration of hydrochloric acid in some spirits of salts, a chemist takes a 20.00 mL aliquot and makes this up to 500.0 mL in a volumetric flask. The diluted spirits of salts is analysed by taking 20.00 mL samples of the diluted solution and titrating this with 0.4590 mol L^{-1} sodium hydroxide solution. An average titre of 21.25 mL of base was obtained for the end point. Use this information to determine the following:

   a) The moles of sodium hydroxide used in the titration.

   [2 marks]

   b) The concentration of hydrochloric acid in the diluted solution.

   [3 marks]

   c) The concentration of the hydrochloric acid in the original spirits of salts.

   [2 marks]

   d) The percentage of hydrochloric acid by mass in the original undiluted spirits of salts. Assume the original solution has a density of 1.18 g mL^{-1}.

   [3 marks]