


**Question 39****(13 marks)**

Herbicides are chemicals that kill plants, including weeds. The label of a commercially-available herbicide concentrate is shown below.

<h2 style="text-align: center;">Generic Weed Killer</h2> <p style="text-align: center;">Fast, effective, easy to apply. Recommended by professional gardeners.</p>		<p style="text-align: center;"><b>SUPER CONCENTRATE</b></p> 
<p><b>Ingredients:</b></p>	<p>155 g/L <math>\pm</math> 5.00% sodium chloride 295 g/L <math>\pm</math> 5.00% acetic (ethanoic) acid</p>	

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A chemist was given the task of verifying the concentrations of sodium chloride and acetic (ethanoic) acid stated for this herbicide.

The sodium chloride content of the herbicide was analysed. It was found to be consistent within the tolerance of  $\pm 5.00\%$  of the stated concentration. The chemist then performed a series of titrations with sodium hydroxide to measure the acetic (ethanoic) acid concentration.

The herbicide solution used in the titrations was prepared by pipetting 5.00 mL of the concentrate into a 250.0 mL volumetric flask. The solution in the flask was then made up to the mark with distilled water.

A 20.00 mL sample of the diluted herbicide was pipetted into a conical flask and a few drops of a suitable indicator were added. This solution was then titrated with standardised 0.0947 mol L<sup>-1</sup> NaOH solution.

After an initial 'rough titration', a further four titrations were performed. The results are shown in the following table.

(a) Complete the table and determine the average titre.

(2 marks)

Titration number	Burette readings (mL)		
	Initial	Final	Titre
1	1.28	20.75	
2	20.75	40.19	
3	1.48	21.82	
4	21.82	41.21	
Average titre			

- (b) Identify with what solution each of these pieces of glassware should be rinsed prior to their use in these titrations. (3 marks)

Glassware item	Rinse solution
5.00 mL pipette	
20.00 mL pipette	
250.0 mL volumetric flask	

- (c) Demonstrate whether or not the experimentally-determined value of the acetic (ethanoic) acid concentration matches the value given on the herbicide label, bearing in mind that a difference of  $\pm 5.00\%$  is considered acceptable. Show **all** workings and reasoning. (8 marks)

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