Student 1: Low Excellence

Intended for teacher use only

Results from your trial:

I added 1mL of undiluted vinegar and 1 drop of phenolphthalein indicator to my small beaker. I then pipetted NaOH into the beaker until I observed the solution changing from clear to pink. My results were: 6.2mL, 6.25mL, 6.2mL. This shows that I need about 6.2mL of NaOH for every 1mL of undiluted vinegar. I will use 20mL of my vinegar solution in the experiment, so I would need about 124mL (20x6.2) of NaOH in order to observe a colour change in the actual titration.

Proposed procedure:

The original solution of vinegar needs to be diluted 10 x times to make a 1 in 10 dilution. A 20 mL sample of the diluted solution will be used in the titration.

The required dilution can be made by pipetting 25 mL of the original vinegar solution and adding distilled water to make it up to the mark on a 250 mL volumetric flask.

In the actual titration with the sodium hydroxide I will use a 20 mL pipette to add the diluted vinegar solution to the conical flask, add a few drops of phenolphthalein indicator and titrate with the standardised NaOH until a colour change from colourless to pink occurs.

Using this procedure, I would predict an average titre volume of approximately 12.4mL.

If I did not dilute the vinegar, I would need to use about 124mL of NaOH in order to observe a colour change from colourless to pink. This is not only a waste of resources and time, but would also reduce the accuracy of my experiment. This is because I would have to refill the burette two times after beginning my titration to get the full amount, which means there is a higher chance of making errors. These could include contaminating the solution, measuring incorrectly, forgetting how many times I had refilled the burette, leaving the funnel in etc. Alternatively, a lower dilution (eg. 1 in 20) would also not be ideal, as this would make the titre value small (about 6.2mL for 1 in 20 dilution). This would increase the likelihood of making significant errors. This is because proportionally, a 0.2mL difference in titres is a lot more significant to a 6.2mL titre than to a 15mL titre. My predicted titre of 12.4mL is good, as it is large enough that minor errors/differences are not too significant, but small enough that I will not have to refill to burette many times. This means that I am better able to control other variables, and my results are more likely to be accurate which enables me to draw a valid conclusion. I will try to obtain this predicted titre of 12.4mL using a 1 in 10 dilution of vinegar (CH_3COOH). 2

Discussion:

In order for my experiment to be valid and provide accurate results, I had to control (keep the same) any variables that could alter my results. These Included:

Taking all measurements from the bottom of the meniscus, which meant that my measurements were consistent and accurate. If I had measures from a different/varying part of the meniscus (or somewhere else), my measurements would be incorrect and inconsistent, and I probably wouldn't have been able to get concordant titres. This would have made my experiment invalid/unreliable, and my calculations incorrect. This would have meant that I would not be able to draw a valid conclusion.

Measurements were taken from eye level, so that they were all accurate and consistent. If I did not do this, my measurements (and therefore calculations) would be wrong. This is because the values indicated on the measuring cylinders, burettes, pipettes etc. appear different from below/above. Controlling this made my investigation more valid as my calculations and measurements were more likely to be accurate.

I improved the quality of my experiment by trialling the titre of the undiluted vinegar three times. This was to ensure that my results were not anomalies/outliers. This helped me to know that the amount was accurate and true, so that I was able to make the most sensible decision of what my dilution should be.

Before using the equipment, I rinsed it with the solution that was going in it to get rid of any other particles that would contaminate my solutions and make my results unreliable. For example, if there was water in the burette and I did not rinse it with NaOH, they would mix and the concentration of the NaOH would decrease, by an unknown amount, which would make my calculations wrong. This would make my investigation unreliable and my conclusion would not be valid. 5

When pouring solutions into flasks, measuring cylinders etc., I put the pipette near the bottom of the container, and did not touch the sides so that all of the solution got in, and none was lost on the sides or splashed out. This meant that I knew exactly how much of each solution was in the flask and none was lost, which would also make it unreliable. This would have made my calculations incorrect, thus making my conclusion inaccurate and invalid.

During my titrations, I accidentally put two drops of indicator into one flask instead of one like I did in the rest of my titrations. I tipped this into the waste beaker and started again (remeasured CH_3COOH and redid indicator) so that all of my trials had the same amount of phenolphthalein indicator (one drop). I did this because having more indicator may have made the colour change brighter at an earlier stage, so my measurement for when I observed this would have likely been wrong. This would have made my experiment inaccurate and my conclusion unreliable. 3

I always stopped titrating and took the measurement at the same colour (as soon as I saw pink colouring that remained in the flask). This meant that I was always measuring the same thing. If I had not done this, I would have been unable to get concordant titres, and my results would therefore be unreliable.

Evaluation: 1

I found that the concentration of CH_3COOH in the vinegar to be $39.7gL^{-1}$, which is $10.3gL^{-1}$ lower than the manufacturers claim of $50gL^{-1}$. There are several potential reasons for this, including:

The vinegar bottle has been open for a long time, and is past its use by date. If this were the case, air would have gotten into the product being opened. The vinegar would react with the air, which would alter the concentration of the vinegar.

The vinegar may have been made incorrectly. It is possible that the wrong amounts of ingredients were added, which would mean that the concentration of CH_3COOH would be incorrect. In addition to this, it is possible that the quality control of the vinegar production was poor, so mistakes in the concentration may have gone unnoticed. 4

The vinegar may contain $50gL^{-1}$ like the manufacturer claims, but it is not evenly distributed throughout the bottle. This may open if the vinegar had not been used in a while, and the CH_3COOH particles had begun to settle on the bottom of the bottle, reducing the concentration of the top part of the vinegar, even though the overall concentration would still be $50g^{-1}$.

There are many possible reasons for why the concentration I found ($39.7gL^{-1}$) is different to the $50gL^{-1}$ claimed by the manufacturer; either in human error, reaction to the air, improper equipment, etc.