From the Lab manual Introduction:

The discussion section is one of the most crucial sections of your report, as it highlights the findings from the results section and then analyzes all aspects of the experiment. This is a crucial place to convey your findings clearly and show your understanding of the experiment overall. Remember, length does not necessarily equal quality—Discussion sections should normally be less than two pages long.

Generally, a Discussion addresses:

What reaction(s) was/were studied?
What were you trying to determine (and why)?
What general technique was used to study this reaction?
What (overall) results were obtained?
Where the results reliable?
What do the results mean? What is going on at the molecular level?
If possible, how do these results compare with literature values? Are they significantly different from literature values, and if so, how can you account for this?

Specifically, a Discussion addresses:

What was done?

Before you can discuss the results you obtained and provide some meaningful context for these results, you need to remind your reader what was done and why. This will be a *brief* recap of the ideas from the introduction (i.e. the reaction that was studied, why it was studied, how it was studied).

What value(s) did you determine (overall) for the reaction you studied? Do the results obtained deviate from expected results? How could these deviations be explained? Were there any errors made when obtaining the results?

Quote the actual number(s), with appropriate units. To establish the validity of your results, consider the accuracy and precision of the value(s) obtained. If possible, compare your value (and its standard deviation) to a value reported in the literature. This will give you a gauge of how reasonable your values are. If your values seem reasonable, you have now shown evidence (by comparison to literature values) that support them. If there are large discrepancies between your value and the literature value, comment on any factors (e.g. temperature) that may have affected the chemistry of the reaction, and consider any possible side reactions that may have occurred. How could this explain deviations from expected values? Experimental error is also a possibility that should be taken into account when faced with unexpected results. Whenever possible, use experimental observations to support your points, this will strengthen your Discussion.

What were the errors made in obtaining the results? How do these errors affect the results? How do these errors impact your ability to achieve the objectives of the experiment?

If you believe there were no errors, be sure to provide evidence to justify the absence of errors and then discuss how the results relate to the objectives.

If you believe there were errors, strive to propose errors that are reasonable. If you are not sure what is reasonable, think as logically as you can about the results you saw and the errors you have proposed. Do the discrepancies in your results match the error(s) you propose in both magnitude and direction of error?

For example, let's say you performed a synthetic experiment where you obtained 5.23 g of your product with a percent yield of 22%. To explain your low yield, you then say that everything went as expected and the loss of product could only be attributed to the powder that you could not scrape off the filter paper and the two drops you spilled when mixing your solutions. This explanation is **not reasonable** because the small amount of product lost on the filter paper and bench-top would not account for the 78% of product that was not obtained.

If you are unsure about what is reasonable for a discussion of errors and how they affected your results, talk with your TA or instructor. Communicating well about the errors in an experiment can be difficult, but it is crucial for showing you have a clear overall understanding of the experiment.

How could the errors you identified be addressed in future experiments?

You can briefly suggest what might be useful to change, or how you would do the experiment differently, upon making a second attempt. Try to continually relate these ideas to how this would better achieve the objectives of the experiment.

Experiment #1 Sample Discussion

In this experiment the total, permanent and temporary hardness of water was determined through a series of complexeometric titrations. It was found that the total hardness of Calgary tap water is 167.0 ppm $CaCO_3$. The permanent hardness was 102.6 ppm $CaCO_3$ and the temporary hardness was 64.4 ppm $CaCO_3$. From the information given regarding the degree of total hardness of water, these results fall in the range for a 'hard' rating. The range for hard is 150 – 300 ppm $CaCO_3$ and the experimental result was 167 ppm $CaCO_3$. This implies that the water sample is safe to drink; however, some scale build-up may occur. As the water sample is in the hard range there are several adverse effects that could occur in industry if this water was used. The build-up of scale could lead to clogged pipes which would then restrict the flow of water. The scale build-up could also negatively impact the flow of heat into the water. Hard water also leads to water turbidity and the possibility of galvanic corrosion of pipes.

The data from the city of Calgary states that in September the value for water hardness for the north half of the city, where the water sample was taken from is 160 ppm $CaCO_3$. It gives the yearly average at 168.25 ppm $CaCO_3$. The experimental water hardness value was 167.0 ppm $CaCO_3$, which is 7.0 ppm higher than the city value for north Calgary. This gave a % error of 4% indicating that the experimental results were accurate as the % error was small.

The calculated standard deviation was ±0.06 mL and no values were excluded from the average volume after the Grubbs test was performed. This indicates that the precision of the experiment was high as the values for titres were all close to each other as indicated by the small standard deviation and the acceptance of all values after the Grubbs Test.

The sources of error for the experiment are potential pipetting and measurement errors. Another source of error could be that although the water sample was taken from the north half of the city and should generally be water from the Bearspaw Treatment Plant, the City of Calgary website states that

both halves of the city can receive a mixture of water from both the Bearspaw and Glenmore treatment plants. Since the water hardness level is higher at Glenmore this could account for the discrepancy between the city value and the experimental value. Another source of error could be from determining the endpoint of the titration. It was hard to determine when the colour went from dark purple to blue. Also everyone perceives colour differently. It was also assumed that all of the minerals attributed to the temporary hardness were removed during the boiling and filtering process and that all of the water hardness was due to $CaCO_3$.