Demo Lab Report for AP/IB Chemistry

IB Standard	Comments	Text of the Lab
Defining the problem or research question Identifies a focused problem or research question	The report includes a research question. The relevant background information could be expanded and explained in more detail	**Investigation of the Effect of Heat on Vitamin C** **Background:** Vitamin C, or ascorbic acid, is a water-soluble vitamin of molar mass 176 g/mol. It is known that cooking foods destroys the vitamin C. Ascorbic acid also reacts with free iodine in a 3 to 1 ratio. This free iodine is formed by mixing KIO_3 with acidified KI. **Research Question:** How is vitamin C affected by short and extended exposure to high temperatures?
Formulating the hypothesis or prediction Relates the hypothesis or prediction directly to the research question and explains it quantitatively where appropriate	A hypothesis is stated, however it is not clear what the student means by the last sentence The relevant independent variable and the controlled variables are implied but not explicitly stated	**Hypothesis:** Because cooking food destroys vitamin C, extended exposure to high temperatures will destroy ascorbic acid, and the longer the duration the less vitamin C that will survive. At lower temperatures, the vitamin C should be destroyed to a degree proportionate to the temperature.
Selecting variables Selects the relevant independent and controlled variables		
Selecting appropriate materials or apparatus	The procedure at the left indicates most of the equipment used.	**Procedure:** Approximately 15 cm^3 of 0.1966 M ascorbic acid was placed in a 50-cm^3 flask. Then the flask was placed on a hot plate, heated up to 50°C, and kept there for two minutes. Then about 5 cm^3 of the solution (accurately massed) was placed in a 25-cm^3 beaker. Then 15 drops of 0.10 M KI, 25 drops of 1.0 M HCl, and 10 drops of 5% soluble starch was added, and the solution was stirred. Then a dropper was filled with .01 M KIO_3 and was added to the solution until a dark blue/black color appears (starch-iodine indicating there is no more ascorbic acid to react) and remains even after stirring. Then the KIO_3 dropper was weighed again and the difference recorded. Then another 5-cm^3 of the solution was titrated in the same manner as the first. These two trials were repeated a flask heated to 75°C for two minutes, a flask at room temperature; and three flasks heated to 100°C for two minutes, five minutes, and ten minutes, respectively.
Designing a method for the control of variables	It fails to discuss the reasons for the time and temperature intervals chosen. There is no real definitive list of controls	
Designing a method for the collection of sufficient relevant data	Hence the discussion of experimental design needs to be improved	

Collecting and recording raw data

Organizing and presenting raw data

Records appropriate raw data (qualitative and/or quantitative, including units and uncertainties where necessary

Presents the raw data clearly allowing for easy interpretation

Processing raw data

Processes the raw data correctly

Presenting processed data

Presents processed data appropriately, helping interpretation and, where relevant takes into account errors and uncertainties

There is some inconsistency in the degree of precision recorded for the data. Why is the time measured only tom the nearest minute

No error propagation attempted

The raw data is calculated appropriately or so it appears

The student needs to provide more explanation.

Some attempt was made to indicate error, but that the idea of percent variance in this context needs to be explained

Indicate units and explain the percent variance

Data

Temp (^oC):	Time (m)	Solution (g)	Initial KIO_3 (g)	Final KIO_3 (g)	Total KIO_3(g)
19.5	2	4.99	7.49	4.79	2.70
19.5	2	5.02	4.07	1.36	2.71
50	2	4.93	7.31	4. 39	2.92
50	2	5.02	7.29	4.53	2.76
75	2	5.27	7.50	4.32	3.18
75	2	4.79	7.06	3.75	3.31
100	2	4.66	4.10	1.72	2.38
100	2	4.66	9.17	4.84	4.33
100	5	4.67	8.43	2.85	5.58
100	5	3.59	4.88	2.75	2.13
100	10	2.86	7.91	5.14	2.81
100	10	2.94	8.26	4.32	3.94

Calculations:

For the following table this equation is used to calculate the values in the second column, shown here with the example of the first row of data:

$$\frac{\text{Mass of Std } KIO_3 \text{ solution}}{\text{Mass of Vitamin C solution}} \times \frac{\text{Conc. of Std } KIO_3 \text{ moles } dm^{-3}}{} \times \frac{1\ dm^3}{1000\ cm^3} \times \frac{1.00\ cm^3}{1.00 \text{ Std } KIO_3 \text{ solution}} \times \frac{3 \text{ mol Vitamin C}}{1 \text{mol } KIO_3} \frac{176 \text{ g } mol^{-1} \text{ Vitamin C}}{}$$

Sample calculation

$$\frac{2.70\text{g of Std } KIO_3 \text{ solution}}{4.99\text{ g Vitamin C solution}} \times \frac{.0100 \text{ M of Std } KIO_3 \text{ moles } dm^{-3}}{} \times \frac{1\ dm^3}{1000\ cm^3} \times \frac{1.00\ cm^3}{1.00 \text{ Std } KIO_3 \text{ solution}} \times \frac{3 \text{ mol Vitamin C}}{1 \text{mol } KIO_3} \times \frac{176 \text{ g } mol^{-1} \text{ Vitamin C}}{}$$

= 0.0162 M vitamin C

Temp (^oC):	Time (m)	Molarity of Vitamin C Solution
19.5	2	.0162
19.5	2	.0162
50	2	.0178
50	2	.0165

75	2	.0181
75	2	.0207
100	2	.0153
100	2	.0178
100	5	.0279
100	5	.0295
100	10	.0358
100	10	.0402

Percent Variance:

Experiment:	% Variance	
2 min @ 19.5^{o}C	0 =	(.0162-.0162)/.0162
2 min @ 50^{o}C	7.9 =	(.0178-.0165)/.0165
2 min @ 75^{o}C	14.4 =	(.0207-.0181)/.0181
2 min @ 100^{o}C	16.3 =	(.0178-.0153)/.0153
5 min @ 100^{o}C	5.7 =	(.0295-.0279)/.0279
10 min @ 100^{o}C	12.3 =	(.0402-.0358)/.0358

Conclusion:

The length of exposure to a high temperature has a significant effect on the concentration of vitamin C. It is clear from the data that the longer the exposure to high temperatures, the greater the concentration. It appears that there is little effect on Vitamin C at temperatures below about 100 degrees Celsius. For the three lowest temperatures, all are very similar. There does appear to be a slight upward trend as the temperature increases, but this is small and is not conclusive, especially considering the relatively high % variance of the two trials when compared with the difference between concentrations. However when compared to the rest of the data, this contradicts the prevalent pattern. At 100 degrees, the data becomes more varied. There looks to be a slight to mild drop in concentration between the 75^{o} test and the 100^{o} test. However the percent of variances of these two samples are the two largest of all the experiment, and considering that his doesn't seem to match the overall pattern of the results, it is possible this is merely an anomaly, though maybe not. The conclusion that the longer the exposure to heat, the higher the concentration of vitamin C is the complete opposite of my hypothesis. This does not make any sense, however. How could vitamin C be created by high temperatures, especially when ascorbic acid is supposed to be destroyed at this point? There has to be something wrong with the procedure.

The procedural method was very solid. It was fairly simple and straightforward, with pretty good precision. There were, however a couple possible sources of error. While we tried to add the extra ingredients consistently and according to the directions, using droppers is not very

Drawing conclusions

Gives a valid conclusion based on the correct interpretation of results with an explanation of results, with an explanation and where appropriate compares results with literature values

A graph would have been helpful here to illustrate the point

An attempt was made to relate the data to the original purpose and hypothesis

Evaluating procedures and results

Evaluates procedure(s) and results including limitations, weaknesses or errors

Some attempt was made to evaluate the procedure

Does not know how to handle the aberrant data

Improving the investigation

Identifies weaknesses

Identifies a weakness but does not make an effort to suggest a way to remedy the flaw

and states realistic suggestions to improve the investigation

accurate and there being different quantities of these could affect the outcome. Also, it is difficult to find the exact point where the black becomes apparent, and is easy to add a little bit too much, undermining the accuracy of the results. However all these are fairly minor, and were carefully controlled whenever possible. So the method cannot be to blame for the unbelievable results, there must be a fundamental flaw in the titration procedure. The issue must be with the heated ascorbic acid because only the ascorbic acid and water and heated, and it's inconceivable that hot water would significantly affect such a reaction. The differences cannot be caused merely by the hotter environment of titration, because all the trials at 100 degrees should cool at the same rate, yet have very different results. So there must be something about the heated vitamin C that causes it to react more with the free iodine. A possible explanation is that the altered state of the heated vitamin C causes it to oxidize with multiple iodine molecules. Another possible cause is that denatured vitamin C hinder the formation of free iodine in some way.

This experiment had major problems. The results were completely counterintuitive. Before this experiment could be done again, the source of this problem would have to be identified and remedied, or another method of measuring vitamin C would need to be found. Unfortunately, I'm not aware of a method for either and thus cannot suggest concrete changes to the experiment.