Student 1: Low Excellence

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Purpose:

To investigate by quantitative analysis, the variation in the concentration of Vitamin C (in gL^{-1}) of "Just Juice Orange and Mango" juice when heated to 20, 40, 60, 70 and 80 degrees Celsius for 10 minutes.

Calculations:

These are sample calculations, all calculations done are in log book.

Actual concentration of $S_2O_3^{2-}$

Using: $IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$

$n(IO_3^-) = c \times V = 0.0100 \times (25/1000) = 2.5 \times 10^{-4}$

$n(I_2) = 2.5 \times 10^{-4} \times 3 = 7.5 \times 10^{-4}$ mol

Using: $2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$

$n(S_2O_3^{2-}) = 2 \times 7.5 \times 10^{-4} = 1.5 \times 10^{-3}$ mol

$c(S_2O_3^{2-}) = n/V = (1.5 \times 10^{-3}) / 0.0293333 = 0.051136364\ molL^{-1} = 0.0511\ molL^{-1}$ (3sf)

This concentration will be used for further calculations

Part A – calculation of blank titration:

$V(S_2O_3^{2-}) = 0.02925$

n = c/V therefore $n(S_2O_3^{2-}) = 0.0511 \times 0.02925 = 1.494675 \times 10^{-3}$

$n(I_2\ total) = ½ \times 1.494675 \times 10^{-3} = 7.47335 \times 10^{-4}$ mol

This represents the maximum number of moles of iodine formed when no vitamin C is present.

Part B – calculation of back titration:

20°C

$n(I_2) = 7.47335 \times 10^{-4}$

$n(S_2O_3^{2-}) = 0.0511 \times 0.018167$ (average at this temperature)

$n(S_2O_3^{2-}) = 9.283337 \times 10^{-4}$ mol

$n(I_2\ remaining) = ½ \times 9.283337 \times 10^{-4} = 4.6416685 \times 10^{-4}$

Vitamin C reacts with iodine at a 1:1 mole ratio. This means that calculating the number of I_2 moles that reacted with vitamin C, the number of moles of vitamin C can be calculated.

So:

$n(I_2$ reacted with vit C$) = n(I_2$ remaining$) = 7.47335 \times 10^{-4} - 4.6416685 \times 10^{-4} = 2.8317065 \times 10^{-4}$ mol = n(vitamin C)

c(vitamin C) = n/V = $2.8317065 \times 10^{-4} / 0.1 = 2.8317065 \times 10^{-3}\ molL^{-1}$

c(vitamin C in gL^{-1}) = $176 \times 2.8317065 \times 10^{-3}$ (where 176 is the molar mass of vitamin C in g mol^{-1}) = $0.498\ gL^{-1}$ 1

Final Evaluation:

From the data obtained in the experiment and from the graphs of the data we can see that there is quite a strong negative relationship between the temperature of the juice and the vitamin C content of the juice. The lowest temperature of 20°C had a vitamin C concentration of 0.498 gL^{-1}, and the highest temperature of 80°C had a concentration of 0.275 gL^{-1}.

The procedure used for this investigation was the analysis of the amount of vitamin C in juice using an iodine-thiosulfate back titration. The iodine used was produced by reacting KIO_3 with KI as it would have been too difficult to handle an iodine solution.

$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$

Using this method of indirectly producing iodine the known number of moles in the solution is more accurate.

In the original method, the concentration of sodium thiosulfate was 0.100 $molL^{-1}$. However it was determined that this concentration of thiosulfate meant that the range that the number of moles of iodine would decrease was too small to determine an accurate difference, therefore it was decided to use a concentration of approximately 0.0500 $molL^{-1}$.

Quite a few uncertainties were removed from the experiment. We did this by always using the same equipment in each titration which meant that no other solutions could contaminate the equipment. We made sure we used the same solutions for sodium thiosulfate and potassium iodate because of the risk of slightly different solutions if we made batches. We made sure to use the same bottle of juice for the first set of titrations to make sure there was no variance in the amount of vitamin C before even heating it, and then we used a different bottle of juice for the second titration to make sure the first bottle of juice was an appropriate representation of that brand of juice. One thing that could have possibly affected the results was the fact that it was very hard to hold the juice at a consistent temperature for 10 minutes; however the temperature never fluctuated more than about 2 degrees from the target temperature, therefore probably did not affect the trend of the data. We also made sure to carry out the titration as immediately after all solutions and juice were set up so that the vitamin C would not oxidise in the conical flask before titrating possibly giving us a bad result.

From research we expected that vitamin C will oxidise faster under heated conditions. This is due to it being one of the least stable vitamins in solution. As time and temperature increase the concentration of vitamin C decreases. Temperature increases the rate of oxidation. The conclusion of this report is valid as we got a constant trend in the data in the direction that we were expecting, and the concordance of all titres being very close to each other's values. The graphs show a negative relationship between the two variables, showing that as temperature increases, the concentration of vitamin C decreases.