Student 2: High Merit

NZQA Intended for teacher use only

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

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}) = $0.498380344\ gL^{-1}$ 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 0.498380344 gL^{-1}, and the highest temperature of 80°C had a concentration of 0.27456 gL^{-1}. 2

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. 3

In the original method, the concentration of sodium thiosulfate was 0.1 $molL^{-1}$. 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 0.05 $molL^{-1}$.

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.