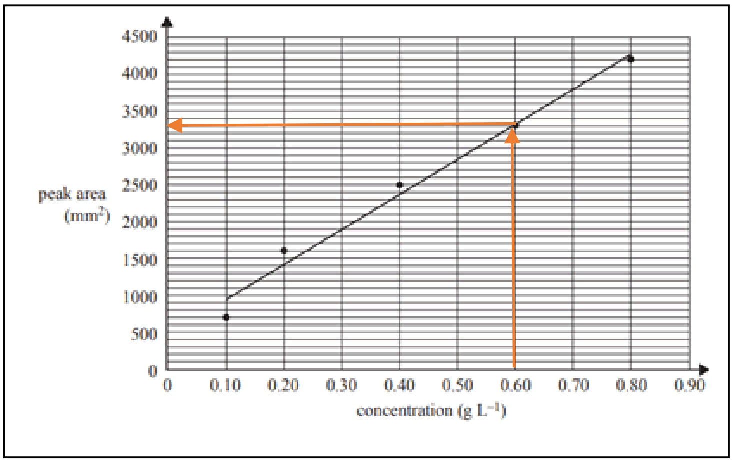
1)High-performance liquid chromatography (HPLC) was used to determine the salt (NaCl) concentration in a sample taken from a can of sports drink. Standard solutions were made up using pure salt and deionised water. A 1 mL sample of each standard solution was injected into the HPLC column and its peak area was recorded and used to construct a calibration line of the concentration of salt against peak area as shown in the graph below.




A 10.0 mL sample of the sports drink was diluted to 100 mL in a 100mL measuring cylinder. A 10.0 mL measuring cylinder was used to transfer a 10.0 mL volume of this into a 500 mL measuring cylinder and filled up to the 250 mL mark using deionised water. A small sample of this solution, around 1mL, was then taken using a 5mL syringe filled to the 1mL mark, and injected into the HPLC column. The peak area of the sample solution at the same retention time and under the same conditions as those used to determine the calibration line was found to be 3300 mm$^2$.

i. Determine the sucrose content of the sample tested in the HPLC, in grams per litre

*0.60g/L +/- 0.01*

ii. Calculate the percentage mass/volume (% m/v) of sucrose in the 10.0 mL sample of sports drink

*Diluted to* *Sample taken* *Diluted to* *Sample taken*

*10.0mL* *100mL* *10mL* *250mL* *1mL tested = 0.60g/L*

*= (1.5g/10mL) X 100*
*= 15%m/v*

*= 15g/L X 0.100 L*
*= 1.5g (amount of salt in the 100mL diluted sample.*

*= 25 X 0.60g/L*
*= 15g/L*
*(concentration in 10mL sample*

iii. The can used to obtain the sample contained 330 mL of sport drink. Assuming that the only salt in the soft drink is NaCl, calculate the mass of salt in the can of sport drink.

*=> (15g/100mL ) X 330 = 50g (2 sig fig)*

iv. Based on the results obtained, is the experimental method valid? Give your reasoning.

*No. Although the calibration curve was conducted using standard solutions and the sample was analysed under the exact same conditions as the standard solutions the accuracy of the dilutions is very poor. Measuring cylinders and syringes are not proper volumetric equipment with which to measure volume.*

v. Identify a strength of the method and a weakness. Give a reason for each.

Strength – *a valid and accurate calibration curve was obtained using standard solutions. Since the sample was analysed under the exact same conditions as the standard solutions the area under the peak of 3300 would be translated, with a high degree of accuracy, into concentration.*

Weakness – *measuring cylinders or syringes are a very inaccurate way of diluting samples or measuring volumes of samples. Volumetric flasks should be used for dilution and pipettes used to deliver accurate volumes of samples.*

2) The concentration of vitamin C in a filtered sample of grapefruit juice was determined by titrating the juice with $9.367 \times 10^{-4}$ M iodine, $I_2$, solution using starch solution as an indicator. The molar mass of vitamin C is 176.0 g $mol^{-1}$. The reaction can be represented by the following equation.

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

The following method was used:
1. Weigh a clean 250 mL conical flask.
2. Use a 10 mL measuring cylinder to measure 5 mL of grapefruit juice into the conical flask and reweigh it.
3. Add 20 mL of deionised water to the conical flask.
4. Add a drop of starch solution to the conical flask.
5. Titrate the diluted grapefruit juice against the $I_2$ solution

a) What impact would each of the following have on the calculation of the concentration of vitamin C in grapefruit juice?
A. 10 mL of deionised water was added to the conical flask.
*No impact*
B. The concentration of the $I_2$ solution was actually $8.972 \times 10^{-4}$ M.
*Overestimation of the concentration*
C. The initial volume of the $I_2$ solution in the burette was 1.50 mL, but it was read as 2.50 mL.
*Underestimation*
D. The balance was faulty and the measured mass of grapefruit juice was lower than the actual mass.
*An overestimation*
E. The burette was washed with distilled water but not dried before use.
*An overestimation*

b) If the measured mass of grapefruit juice was 4.85 g and the titre was 21.50 mL, what was the measured percentage mass/mass (% m/m) concentration of vitamin C in the grapefruit juice, to the right number of significant figures?

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

*Step 1 Calculate the mol of $I_1$ delivered in the titre.*
*=> $n = C \times V = 9.367 \times 10^{-4}$ M X 0.02150 = $2.014 \times 10^{-5}$mol.*
*Step 2 Mol of vit $_c$ = $2.014 \times 10^{-5}$mol*
*Step 3 Mass of Vit$_c$ = $2.014 \times 10^{-5}$mol X 176.0 g $mol^{-1}$ = $3.544 \times 10^{-3}$g.*
*Step 4 Calculate %m/m = ($3.544 \times 10^{-3}$g/4.85g) X 100 = 0.0731%m/m*

c) Give one assumption made in this titration.

*The only substance that $I_2$ can react with in the grapefruit juice is $Vit_C$*

d) What difference would it make if the 5 mL of grapefruit juice was delivered with a 5 mL pipette as opposed to a 10 mL measuring cylinder.

*None as it's the mass of the sample not the volume that the %m/m is calculated on.*

e) $$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

Give the balanced oxidation half equation

$C_6H_8O_6(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2e$

Give the balanced reduction half equation

$I_2(aq) + 2e \rightarrow 2I^-(aq)$