CHEM101 Report for Laboratory Exercise #4
Spectrophotometric Determination of Salicylic acid[1]

Using Microsoft Word, students are to insert responses in all yellow highlighted areas. It is recommended that the report be completed without changing font size, column width, row width, margins, and highlights. The completed report must be uploaded to the CHEM 101 Brightspace site as a .pdf file by the due date posted on Brightspace. All answers must be the student's own work without assistance from others. Only reports which are completed using the template will be marked.

Name: Arfaz Hossain **Lab Section:** B12 **Quad:** 2 **Date:** June 13, 2024

Abstract

The % mass of salicylic acid in an acne cleanser[2] , was determined to be 2.6% by measurement of the maximum absorbance at 535 nm generated a calibration curve. This was found to be greater by 0.1% of the advertised value.

Data/Results

The observed data inserted in the tables below must be consistent with the observed data written in your laboratory notebook with the correct units.

Table 1. Experimentally measured absorbances (A) and calculated concentrations (conc) for the standard salicylic acid solutions.

	Conc (M)	
Stock salicylic solution	2.855×10^{-3} M	
	Conc (M)	Absorbance at 535 nm
Standard Solution #1	1×10^{-4} M	0.152
Standard Solution #2	6×10^{-4} M	0.737
Standard Solution #3	1.1×10^{-3} M	1.363

Table 2. Determination of the amount of salicylic acid in the acne cleanser[2].

Volume of acne cleanser used in the analysis (mL)		**0.3mL**	
Density of the acne cleanser used in the analysis (g/cm3)		**0.961**	
Advertised %mass of salicylic acid		0.5%	
	Aliquot #1	Aliquot #2	Aliquot #3
Maximum absorbance at 535 nm	**0.624**	**0.621**	**0.623**
[salicylic acid] from the curve (M)	5.04×10^{-4}	5.01×10^{-4}	5.03×10^{-4}
Moles of salicylic acid in 25.00 mL (mol)	$\mathbf{1.3 \times 10^{-5}}$	$\mathbf{1.3 \times 10^{-5}}$	$\mathbf{1.3 \times 10^{-5}}$
Mass of salicylic acid in 25.00 mL (g)	$\mathbf{1.8 \times 10^{-3}}$	$\mathbf{1.8 \times 10^{-3}}$	$\mathbf{1.8 \times 10^{-3}}$
Initial concentration of salicylic acid before dilation (M)	0.04	0.04	0.04

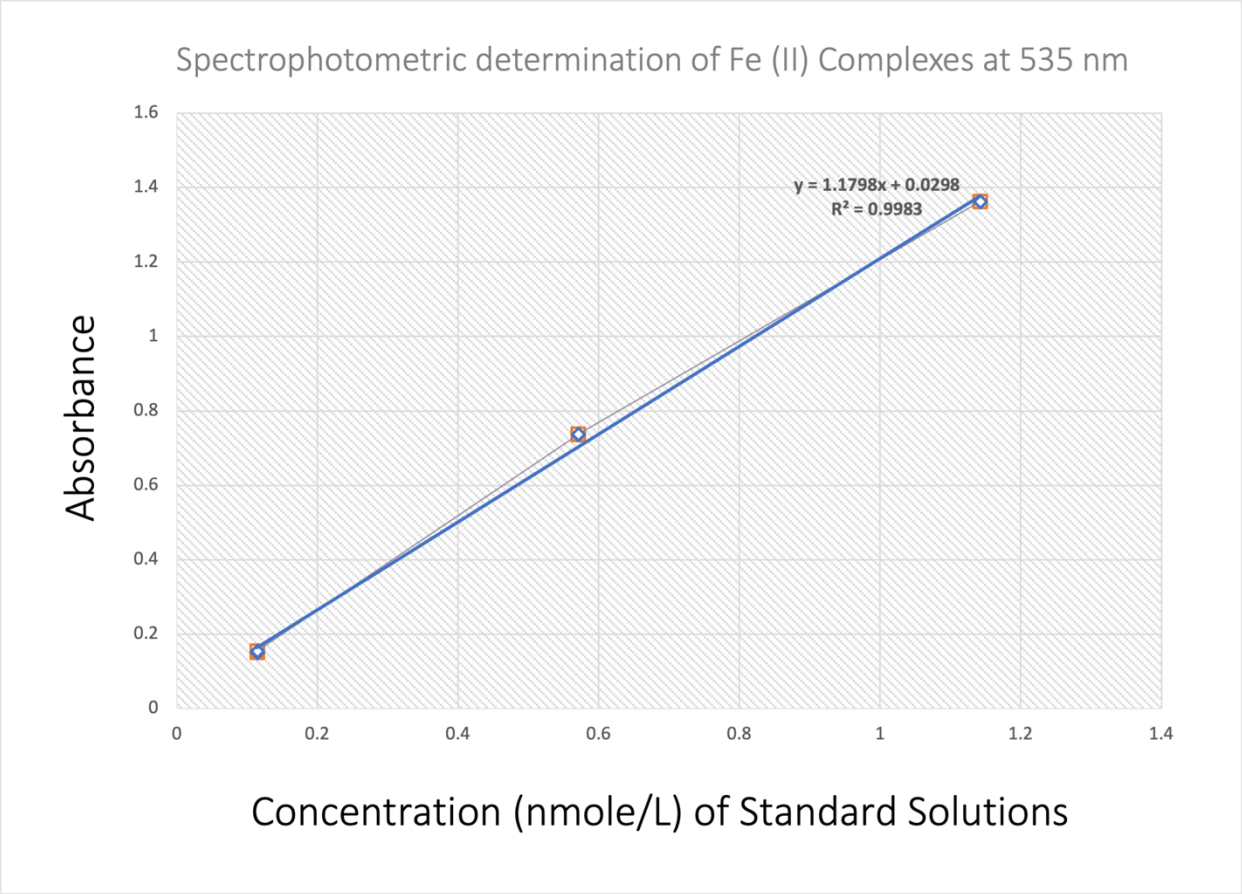
Moles of salicylic acid in 1.00 mL of acne cleanser (mole)	**4×10^{-5}**	**4×10^{-5}**	**4×10^{-5}**
Mass of salicylic acid in 1.00 mL of acne cleanser (g)	**0.006**	**0.006**	**0.006**
%mass of salicylic acid in acne cleanser	**2.6%**	**2.6%**	**2.6%**
Average % mass of salicylic acid in acne cleanser	0.6%		
Standard deviation of average % mass	0		
% RSD	0%		
% comparison to the advertised value	**+0.1%**		

Calibration curve for standard solution of salicylic acid and determination of the salicylic acid concentration in an acne cleanser by interpolation.

Table 1. Absorbance at a wavelength of 535 nm for solutions of $Fe(NO_3)_3$ at various concentrations

	1	**2**	**3**	**4**	**5**	**6**	**7**
Concentration (mM)	0.1142	0.1142	0.1142	0.571	0.571	1.142	1.142
Absorbances	0.151	0.152	0.154	0.736	0.737	1.362	1.363

Figure 1. Calibration curve for the concentration (mmole/L) of a $Fe(NO_3)_3$ solution determined by absorbance at a wavelength of 535 nm



Algebraic Equations

See page 12 of the CHEM 101 lab manual

Concentration of a standard solution

$C_iV_i = C_fV_f$,

where Ci is 0.002855 M in all 3 cases, V_i for the first standard is 1 mL or 0.001 L, second standard is 0.005 L, third standard is 0.010 L. V_f is 25 mL or 0.025 L for all cases.

Moles of salicylic acid in 25.00mL solution

$Moles_{salicylic\ acid} = C_{salicylic\ acid} \times V_{Flask}$

where,

Salicylic Acid $Moles_{salicylic\ acid}$ = Moles of salicylic acid in 25.00 mL of solution

Salicylic Acid Concentration, C_{SA} = Concentration of salicylic acid = 5.04×10^{-4} M

Volume, V_{Flask} = 25.00 mL = 0.02500 L

Mass of salicylic acid in 25.00 mL solution

$\text{Mass}_{\text{Salicylic Acid}} = \text{moles}_{\text{Salicylic Acid}} \times \text{molar mass}$

Here, the molar mass of salicylic acid is: 7×12.01 g/mol + 6×1.01 g/mol + 3×16.00 g/mol
= 7 × 12.01 + 6 × 1.01 + 3 × 16.00
= 84.07 g/mol + 6.06 g/mol + 48.00 g/mol
= 138.13 g/mol

We know $\boldsymbol{moles_{Salicylic\ Acid}}$ from the last equation. In the equation it's 1.26×10^{-5} mol. Plugging it in, we get mass $\text{Mass}_{\text{Salicylic Acid}} = 1.741\times10^{-3}$ g

Mass of salicylic acid in 1.00 mL of acne cleanser
$C_{initial} = \text{moles}_{\text{Salicylic Acid}} / \text{Volume}_{\text{Acne}}$

$\text{moles}_{\text{Salicylic Acid}}$= Moles in 25.00 mL of salicylic acid in 25.00 mL solution
$\text{Volume}_{\text{Acne}}$=Used Acne Cleanser Volume = 0.30mL × (1L / 1000mL) = 0.00030 L
$C_{initial}$ = The initial concentration of salicylic acid in the acne cleanser before dilution

Moles in 1.00 mL = Initial concentration ($C_{initial}$) × Given Volume
Moles in 1.00 mL=4.18917×10^{-2} M × 1.00mL × (1L / 1000mL) = 4.18917×10^{-5} mol
Given Volume = 1 mL = 0.001 L

%mass of salicylic acid in acne cleanser

$\text{Mass} = \text{Moles}_{\text{Salicylic Acid}} \times \text{Molar mass}$

where, Molar mass of salicylic acid=138.13g/mol and
So, Mass = 4.18917×10^{-5}mol × 138.13g/mol = 5.7884×10^{-3} g.

Discussion *Respond to the following:*

Explain how the calibration curve was generated and then used to provide a value for the concentration of the salicylic acid solution that was placed in the spectrophotometer (max 5 lines).
The calibration curve was generated by plotting absorbance and concentration values on the x and y axes, respectively. The concentration was then measured with the spectrophotometer to determine how much light was absorbed by the solution.

Explain why the iron solution was transferred to the volumetric flasks using a graduated cylinder, while the salicylic acid was transferred using volumetric pipettes (max 3 lines).
The iron solution was transferred using a graduated cylinder due to its lower required precision, while the salicylic acid was transferred using volumetric pipettes to ensure a more accurate and precise measurement, crucial for the experiment's outcome.

Was the % comparison greater than or less than 100%? Include the actual value in your answer. Give a scientific explanation as to why the value was less than or greater than 100%. Do not give personal (lost some of the solution, hard to see the calibration mark) or that the company cheated us on the quantity but rather take a close look at the experiment and determine from a chemical point of view what could have contributed to the variance (max. 5 lines).

The % comparison was greater than 100%, specifically 0.1% more. The bottle containing the acne cleanser wasn't mixed before taking the sample, which could have resulted in a higher concentration of salicylic acid in the sampled portion, leading to a higher than advertised concentration.

Conclusions

The % mass of salicylic acid in an acne cleanser was determined to be _2.6%_ with a % relative standard deviation of __0%__. This was _greater than 0.1%_ of the advertised value.

References

Note that references must be informed below in the order they are cited in text. Reference #1 is already informed, but not yet cited. Add the necessary references below and cite them in text.

1. Reimer, M. et al, *Laboratory Manual, Chemistry 101*, pp. __27-34__. (University of Victoria: Victoria, B.C.). **Summer 2024**.
2. _Clean & Clear Essentials Deep Cleaning Astringent. Johnson & Johnson Inc., Markham, Ontario, Canada, L3R 5L2, lot number 30038970, NPN 02072696_

Feedback Summary	max.
Pre-lab quiz: Are all responses correct?	4
Laboratory Notebook: Have all data, observations, and procedures been recorded?	1

Report (Results and Assessment): Are all sections completed accurately and correctly?	3
Participation: Did the student come prepared, was the time used well in the lab and was the student engaged in the experiment? Did the students request the TA to check their drawers for completeness before they left the lab and show the TA the email of successful submission?	1
Performance evaluation: Did the student follow the safe practice guidelines throughout the whole lab period?	1
Total mark	10