International Baccalaureate

Extended essay cover

SAMPLE D

Diploma Programme subject in which this extended essay is registered: CHEMISTRY

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: How does the Niacin content of a vitamin B supplement compare to that of a prescription drug and do these values accurately regleet what is stated on the label

Candidate's declaration

If this declaration is not signed by the candidate the extended essay will not be assessed.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: _____ Date: Feb 25, 2009

IB Cardiff use only: A: 44433 B: √

Supervisor's report

The supervisor must complete the report below and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator. The supervisor must sign this report; otherwise the extended essay will not be assessed and may be returned to the school.

Name of supervisor (CAPITAL letters) _____

Comments

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

has worked through his extended essay with dedication and perseverance. He initially came across several barriers with the practical work and obtaining a sample of the prescription drug to use. used his initiative and researched other ideas for the lab work and how to obtain a sample through his G.P. A great deal of time was spent in the lab getting his method to work, a limited range of data could only be collected with the small sample of drug he had available - this was a disappointment to him but no more sample could be obtained. This area is new to me as a teacher so I was impressed with the work he produced.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent [3-4] hours with the candidate discussing the progress of the extended essay.

Supervisor's signature: _____ Date: FEB 25 2009

Chemistry Extended Essay

How does the niacin content of a **vitamin B supplement** compare to that of a **prescription drug** and do these values accurately reflect what is stated on the label?

Candidate number: _____

Word count: 3567

No numbering needed!!

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Abstract:

The aim of the investigation was to answer the research question; **How does the niacin content of a vitamin B supplement compare to that of a prescription drug and do these values accurately reflect what is stated on the label?** This research question was chosen to determine whether the same benefits could be achieved from taking niacin dietary supplements as from taking NIASPAN prescription drugs.

To investigate the research question, after a few research methods were considered, the method of acid catalyzed hydrolysis of the drugs followed by a titration was chosen. Then preliminary experiments were carried out to find a suitable hydrolysis reaction for each drug and then preliminary experiments determined the most suitable indicator for the titration reaction. Both niacin supplements and NIASPAN prescription drugs were hydrolysed with sulphuric acid and water, and standardised. This solution was then titrated against ~~a~~ sodium hydroxide solution. The unreacted volume in the titration was equal to the volume of sulphuric acid that reacted in the hydrolysis stage. The mass of niacin reacted could be derived through mole calculations and this showed the content of active ingredient. In 1.00g of niacin supplement tablets there was 84.3±0.388mg of active niacin and in each tablet there was 69.1±1.16mg of active niacin contrary to the label value of 500mg. In 1.00g of NIASPAN 64.6±0.28mg of active niacin was determined. The label value of the content of 1 tablet was stated as 500mg but experimentation gave a result of 45.2±0.84mg per tablet.

The conclusion was drawn from the results that niacin dietary supplements contain more active niacin than NIASPAN prescription drugs and that both contain far less than the label states. The conclusion was also made that these results were not completely reliable due to factors such as experimental error and human error.

(297 words)

- 3 -

How does the niacin content of a vitamin B supplement compare to that of a prescription drug and do these values accurately reflect what is stated on the label?

Introduction:

Niacin is well known for its benefits in the treatment of cardiovascular disease and lipid disorders. Whilst the mechanisms behind this are related more to biology, the chemical composition of the supplements and prescription drugs containing niacin can be analysed through chemical process and theory. The active ingredient, niacin itself, has the chemical formula $C_6H_5NO_2$ and the content of this in each of the medicines can determine their effectiveness. To determine the quantity of niacin in each case I planned to carry out a quantitative and qualitative analysis of the content of the active ingredient "niacin" in vitamin B supplements and prescription drugs. Each of these contains the same active ingredient so one may be drawn to ask: "why pay more for the prescription drugs?" This is a question that I asked myself and which fascinated me. The fact that drug companies could be charging large amounts of money for drugs that could be purchased in supplement form, over the counter, made this investigation worthwhile for me. I researched a prescription version of niacin called "NIASPAN" to try and understand its benefits. The following argument is from the official "NIASPAN" website:

> "NIASPAN gives you the long-established benefits of niacin, in a prescription form that is both effective and safe."[1]

This argument implies that anything other than NIASPAN would not be effective but I think it is only reasonable to argue that if the same content of active ingredient is used a supplement would be equally as effective. One argument that I found convincing for the use of prescription drugs rather than supplements was proposed by the American Heart Association (AHA). It stated that supplements:

> "may contain widely variable amounts of niacin — from none to much more than the label states."[2]

Although this sounds reliable, coming from the American Heart Association, no scientific evidence was supplied in order to back up the claim. This was one factor that made the investigation seem worthwhile to me. My investigation into the content of active ingredient in both supplements and prescription drugs would possibly double up to serve the purpose of investigating this claim as well. A reason that the American Heart Association provide for not taking dietary supplement niacin is:

> "It should not be used for cholesterol lowering because of potentially very serious side effects."[3]

Researching the side effects told me that this could be a feasible reason to not take dietary supplement form niacin. I discovered that large doses of niacin can potentially cause some side effects.[4] These side effects include something known as "niacin flush" described as:

> "a reddening of the skin along with a prickly, burning sensation"

[1] http://www.niaspan.com/About_Niaspan/Why_Prescription_Niacin.asp(September 23 2008)
[2] http://www.americanheart.org/presenter.jhtml?identifier=4704. (September 23 2008)
[3] http://www.americanheart.org/presenter.jhtml?identifier=4704. (September 23 2008)
[4] Kowalski R 2004 The New 8 Week Cholesterol Cure HarperCollins

Which occurs:

"20 to 30 minutes after taking a dose of niacin."[5]

This was the only prominent side effect stated and it appears that this is common to both the supplement and the prescription form of niacin. Upon discovering this I realised that the risks are similar for both forms of niacin and so the only thing that should be taken into consideration when differentiating between the two is content of active ingredient. This finally led me to a focused aim for my investigation: to determine, through quantitative and qualitative analysis, the content of active ingredient in niacin dietary supplements and the prescription drug "NIASPAN". An appropriate method to use to determine this would be to hydrolyse each compound and then do a titration to find out how much of each drug had reacted in the hydrolysis stage, thus determining the content of active ingredient. All of these factors led me to create the question: How does the niacin content of a **vitamin B supplement** compare to that of a **prescription drug** and do these values accurately reflect what is stated on the label?

this is a better statement of RQ hydrolyse how & titrate with what?

Sources of niacin:

To put the drug in the context of everyday life it was deemed relevant to research some naturally occurring sources of niacin.

Meat extract and marmite have particularly high niacin contents with 60 milligrams per 100 grams and 58.5 milligrams per 100 grams respectively. Other foods with a lower content of niacin include roast beef and sardines in oil which contain 5 milligrams per 100 grams each.[6]

One thing that this displays is that it is necessary for there to be a medical form of niacin as a great amount of any of these foods would have to be consumed to achieve the same benefits as the medicinal form. In addition to this eating almost a kilogram of marmite would probably have some more severe side effects than flushing.

Methods of investigation

There are a number of ways in which the task of determining the content of active ingredient for each drug can be approached. One of these includes my chosen method of hydrolysis and then titration. This determines the volume that has been reacted in the hydrolysis stage and thus the mass of active ingredient can be deduced. This method was initially decided upon due to another experiment involving the measuring of the content of salicylic acid in aspirin tablets. Although this is the method that was chosen there were initially a few other options that were being considered. These options included high pressure liquid chromatography and solid phase extraction but both of these were ruled out as it wasn't feasible to perform these experiments in a school laboratory both because of cost and availability of equipment. Hydrolysis of the drugs and a titration of the hydrolysed solution was the most appropriate method because the equipment needed was readily available and I was familiar with the principal behind it.

what

Repeats!

give equation and paper background chemistry of this.

[5] Kowalski R 2004 The New 8 Week Cholesterol Cure HarperCollins

[6] http://www.purchon.com/biology/nicotinic.htm#sources (December 30th 2008)

Preliminary Experiments:

To come up with the design for the final experiments it was necessary for me to investigate certain factors affecting the outcome of the experiment. The main factor that needed to be decided upon for the hydrolysis of the drugs was whether to use an acid or an alkali solution to hydrolyse them.

Preliminary experiment 1:

Aim: to determine whether an acid or an alkali solution is more appropriate in the hydrolysis of niacin supplements and Niaspan prescription drugs

Nicotinic Acid + Base → Weak Base Salt ???

Method:

- Approximately 1.0g of the relevant drug in powdered form was added to 10cm³ of NaOH (aq) with the same volume of water in a conical flask and simmered and stirred for ten minutes on a hotplate/magnetic stirrer. (the outer casing should be removed from the NIASPAN)
- The same experiment was carried out on both drugs but instead of NaOH (aq), H_2SO_4 (aq) was used.

what concen

concentration?

Niacin is Nicotinic acid why do you need to hydrolyse the acid?

Results:

Observations for NaOH (aq) and water:

Niacin supplement –

- It appeared that none of the solute had been dissolved or hydrolysed
- The solute formed a thick semi solid at the bottom of the conical flask

NIASPAN –

- The solute did not react, or dissolve in the solution as all of it was still evident in its original form at the bottom of the conical flask

Observations for H_2SO_4 (aq) and water:

give Symmers equation.

Niacin supplement –

- The solute was almost completely hydrolysed leaving little apparent solute in the conical flask. This made a Niacin supplement solution

how can you be sure of hydrolysis?

NIASPAN –

- The solute was completely hydrolysed and a NIASPAN solution made

Conclusions:

↓ Not clear

It is clear from the qualitative observations that an acid - H_2SO_4 (aq) - would be the most appropriate solution to use in the hydrolysis of the drugs. It is important to note also that there was a little solute remaining in the acid/niacin supplement solution. This could be due to an outer casing on the niacin supplements that had not previously been apparent.

I think Niacin can be estimated by potentiometric titration.

An easy way to get around this would be to use filter paper when standardizing the hydrolysed solution to collect any solute. The mass of this solute could then be recorded and subtracted from the original mass of niacin that would have been used for the hydrolysis.

Another reason that acid hydrolysis would be more appropriate is that hydrolysis with an alkali often yields total niacin rather than free niacin. "Alkaline hydrolysis can release niacin vitamers that are nutritionally unavailable; thus, acid extracts are sometimes referred to as biologically active niacin."[7]

Still no actual Chemistry

How will the H_2SO_4 used for hydrolysis add up to the titration with NaOH?

Preliminary experiment 2:

It was necessary for me to find out an appropriate indicator for use in the titration stage of my experiment so that firstly there would be a colour change and secondly the colour change would be obvious. These are the indicators that were chosen, for use in this experiment, are listed below along with the pH range at which they change:[8]

Indicator	**pH Range**
Thymol blue	1.2 – 2.8
Methyl orange	3.1 – 4.4
Methyl red	4.4 – 6.2
Phenol red	6.4 – 8.0
Phenolphthalein	8.0 – 10.0

Aim: to determine which indicator from a range of indicators would be most suitable for use in the titration of the standard solutions containing the niacin supplements and NIASPAN.

Method:

- Approximately 5 cm^3 of NaOH (aq) was added to a beaker with the relevant indicator from the list of indicators above.
- After this a maximum of 50 cm^3 of either the niacin supplement or the NIASPAN solutions was added. This meant that a lot of standardized solutions had to be made up.

Conen?

how?

??

[7] Nollet LML Handbook Of Food Analysis 2004 CRC press

[8] Green J Damji S 2001 Chemistry For Use With The International Baccalaureate Diploma Programme 2nd edition Ibid press

Is there any need of doing this?

Results:

Niacin supplement solution

Indicator	Initial colour in NaOH (aq)	Colour change
Thymol blue	Yellow	No
Methyl orange	Orange	No
Methyl red	Yellow	No
Phenol red	Red	No
Phenolphthalein	Purple	Yes – colourless

Other observations:

Obviously its a Strong Acid - Strong Base titration now!

- The colour change with the phenolphthalein was rapid

NIASPAN solution

Indicator	Initial colour in NaOH (aq)	Colour change
Thymol blue	Yellow	No
Methyl orange	Orange	No
Methyl red	Yellow	No
Phenol red	Red	No
Phenolphthalein	Purple	Yes – colourless

Other observations:

? what is the point of all of this?

- The colour change with the phenolphthalein was rapid as with the niacin supplement solution

Conclusion:

The results show that Phenolphthalein is the most appropriate indicator for use in the titration stage of my investigation. The colour change was also very rapid in each case with the phenolphthalein which is definitely a good characteristic to have in a back titration. Additionally it is interesting to note that the reaction must take place within the pH range of 8.0 and 10.0 for both solutions.

not surprising as NaOH is present.

Additional learning:

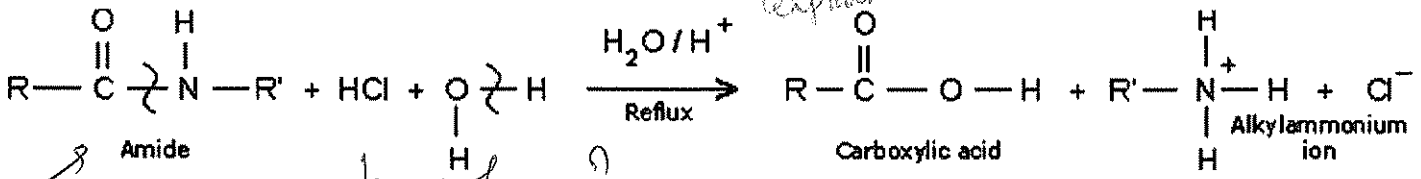
After completing just the preliminary experiments I found that I had learned much about the nature of scientific investigation. The number of mistakes that could be made in attempting a new experiment with no direct instruction was difficult to deal with and forced me to streamline my techniques. I also had trouble understanding why certain indicators wouldn't work for a reaction as this topic area hadn't been covered in school. This forced me to use my initiative and research the reasons for this. I also had to research the acid catalyzed hydrolysis of an amide to understand the reaction that was actually taking place in the hydrolysis stage of the experiments. This in turn helped me to derive an equation for the reaction which would help with the calculations in the final data analysis section.

Did the prescription & ingredients say it an amide?

Finally...!!

Design for standardisation of niacin supplements and NIASPAN

In both drugs the Niacinamide ($C_6H_6N_2O$) is what will react in the hydrolysis. An equation needs to be deduced for the calculations that will come in the data analysis stages of the investigation. The equation was made by researching the acid catalyzed hydrolysis of an amide. The reaction involved water, sulphuric acid, and Niacinamide. It was found that Niacinamide is made up of a pyridine ring and an amide functional group ($CONH_2$). The following example was found through research:[9]



leaflet

by whom?

my guess

It was assumed that the pyridine ring would take the position of R, and R' could be taken as the hydrogen in the Niacinamide functional group. Since H_2SO_4, which is diprotic, was used, instead of having Cl^- in the products $H(SO_4)^-$ was produced. Following is the balanced equation using molecular formulae:

$$C_6H_6N_2O_{(aq)} + H_2SO_{4(aq)} + H_2O_{(l)} \rightarrow C_6H_5NO_{2(aq)} + NH_{4(aq)}^{+} + H(SO_4)_{(aq)}^{-}$$

which one is a acid

Source?

The carboxylic acid produced was nicotinic acid. As Niacinamide does not provide any pharmaceutical benefits the nicotinic acid must be what provides them.[10] It is thus the content of the nicotinic acid that will be calculated.

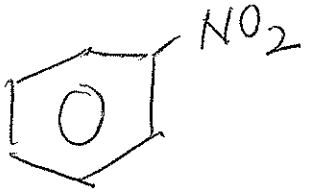
Equipment:

- Pipette (10 cm³)
- 2 Standard flasks (100 cm³)
- 2 Conical flasks (150 cm³)
- Small funnel
- Filter paper
- Mortar and pestle
- Magnetic stirrer/ hot plate + magnet

? but above you say it contains $C_6H_5N_2O$ niacinamide not nicotinic acid

Reagents:

- 1.0 mol.dm⁻³ H_2SO_4 solution
- Niacin supplements – active ingredient: $C_6H_5NO_2$
- Niaspan – active ingredient: $C_6H_5NO_2$



Nitrobenzene???

[9] http://www.avogadro.co.uk/organic/hydrolysis/hydrolysis.htm (December 30th 2008)
[10] Jaconello P October 1992 "Niacin vs. Niacinamide" page 990 Canadian Medical Association Journal

Method:

how — like what?

- It is apparent that the prescription form of niacin has an outer casing which needs to be carefully removed with sandpaper before pulvarisation.
- Firstly it is necessary to pulvarise both the niacin supplements and the Niaspan into powdered form so that hydrolysis with the sulphuric acid may occur with a greater rate of reaction.
- 1.00g of each of the drugs should be weighed accurately into a weighing boat then transferred into a clean conical flask; this is generally between 3 and 6 pills.
- A safety filler should then be used to pipette exactly 10 cm^3 of the 1.0 $mol.dm^{-3}$ H_2SO_4 solution on to the powdered pills, along with approximately the same volume of distilled water. (This volume of water doesn't matter too much because the solution will be made up to 100 cm^3 after hydrolysis).
- The mixture should then be simmered gently on the hot plate/ magnetic stirrer for ten minutes and the magnet added to the conical flask. The heat and the movement should increase the rate of the hydrolysis reaction.
- Finally the solution should be transferred with washings to a 100 cm^3 standard flask, using filter paper and a funnel, and made up to the mark with distilled water.

Source for these procedures?

Raw data:

The raw data obtained from this experiment is of no relevance by itself but will be very important in the calculations during the data analysis stage to determine the content of active ingredient in the two drugs.

Niacin

Mass of weighing boat: 1.13 ± 0.01g
Mass of weighing boat and niacin: 2.13 ± 0.01g
Mass of niacin: 1.00 ± 0.02g

Observations:

- There was a very small amount of solute left in the filter paper after the solution had been transferred with washings to standard flask. This could be due to there being an outer casing on the niacin supplements that I hadn't noticed before. It was necessary to weigh this to determine the exact mass of powdered niacin in the solution. The filter paper with the solute in it was left to dry and then the mass of the remaining solute was measured in a weighing boat. → where?

what solute?

Mass of weighing boat: 1.13 ± 0.01g
Mass of weighing boat and solute: 1.27 ± 0.01g
Mass of solute: 0.14 ± 0.02g

Mass of niacin tablets used: 1.00 ± 0.02g
Mass of remaining solute: 0.14 ± 0.02g

Very vague!!

Contains salts etc from the H_2O if was dried after filtering. Needs washing with distilled water.

Mass of niacin in solution = (Mass of niacin tablets used - Mass of remaining solute)
= 1.00 ± 0.02g - 0.14 ± 0.02g
= 0.86 ± 0.04g

NIASPAN

Mass of weighing boat: 1.13 ± 0.01g
Mass of weighing boat and NIASPAN: 2.13 ± 0.01g
Mass of NIASPAN: 1.00 ± 0.02g

Mass of NIASPAN in solution (no solute): 1.00 ± 0.02g

Observations:

- Although there was no solute present, the hydrolysis of the NIASPAN caused a gel to be formed. This will be discussed further in the conclusion and evaluation sections.

Design for the titration of NIASPAN and Niacin supplement solutions against 1.0 $mol.dm^{-3}$ NaOH solution

Equipment:

- Phenolphthalein indicator
- Small funnel
- Burette and stand
- Pipette (10 cm^3)
- 2 Conical flasks (150 cm^3)

Reagents:

- 1.0 $mol.dm^{-3}$ NaOH solution
- Unreacted H_2SO_4 in the niacin supplement solution
- Unreacted H_2SO_4 in the NIASPAN solution

Method:

- A safety filler should be used to pipette exactly 10 cm^3 of the 1.0 $mol.dm^{-3}$ NaOH solution into each conical flask
- One conical flask containing the 1.0 $mol.dm^{-3}$ NaOH solution should be titrated against the niacin supplement hydrolysed solution and the other should be titrated against the NIASPAN hydrolysed solution.
- The point of colour change should be recorded and this repeated and averaged to obtain the mean titre.

Data collection and processing:

During the data processing stage it is necessary to do a number of calculations to determine the mass of active ingredient in each of the drugs. The very first calculation that must be done involves finding out the theoretical volume of H_2SO_4 (aq) reacted for a complete reaction between NaOH (aq) and H_2SO_4 (aq). This is necessary to determine in an ideal reaction what volume of H_2SO_4 (aq) would react with NaOH (aq) and then the titre for each drug can be subtracted from this to find out the volume of H_2SO_4 (aq) that has reacted with the relevant drug. It is assumed that since the H_2SO_4 (aq) will be in standard solution, and diluted by a factor of ten, that the concentration will also decrease by a factor of ten. Consequently the acid's concentration will decrease from 1.0 $mol.dm^{-3}$ to 0.1 $mol.dm^{-3}$

$$2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow 2H_2O_{(l)} + Na_2SO_{4(aq)}$$

Concentration (NaOH) = 1.0 mol.dm^{-3} 2:1 Concentration (H_2SO_4) = 0.1 mol.dm^{-3}

Volume = 10 cm^3

$$\text{Moles} = conc. \times \frac{vol.}{1000}$$
$$= 1.0 \times \frac{10}{1000}$$
$$= 0.01 \text{ moles}$$

This is the theoretical volume from which the titre obtained from each drug will be subtracted

$$\text{Moles} = \frac{0.01}{2} = 0.005 \text{ moles}$$

$$\text{Volume} = \frac{1000 \times moles}{conc.}$$
$$= \frac{1000 \times 0.005}{0.1}$$
$$= 50 \text{ cm}^3$$

Niacin

	Run 1	Run 2
Initial volume ±0.05 cm^3	5.00	4.30
Final volume ±0.05 cm^3	48.20	47.40
Added volume ±0.10cm^3	**43.20**	**43.10**

Observations:

- During the titration a suspension was formed when the remaining H_2SO_4 in the niacin supplement solution reacted with the NaOH (aq).

$$Titre = \frac{43.2 + 43.1}{2}$$
$$Titre = 43.15 cm^3 \pm 0.46\%$$

$$\%\text{ uncertainty (run 1)} = \frac{0.1}{43.2} \times 100 = 0.23\%$$
$$\%\text{ uncertainty (run 2)} = \frac{0.1}{43.1} \times 100 = 0.23\%$$
$$\text{Total \% uncertainty} = 0.23 + 0.23 = 0.46\%$$

Volume of H_2SO_4 reacted with niacin = 50 – 43.15
= 6.85 cm^3 ±0.46%

back to niacinamide - which it is?

Now the equation of the reaction is needed:

$$C_6H_6N_2O_{(aq)} + H_2SO_{4(aq)} + H_2O_{(l)} \rightarrow C_6H_5NO_{2(aq)} + NH_{4(aq)}^{+} + H(SO_4)_{(aq)}^{-}$$

how did NO_2 become N_2O?

This is necessary so it can be seen that the ratio of moles between $C_6H_5NO_2$ and H_2SO_4 is 1:1

H_2SO_4

$Volume = 6.85 cm^3 \pm 0.46\%$

$Concentration = 0.1 mols.dm^{-3}$

$$moles = concentration \times \frac{Volume}{1000}$$
$$moles = 0.1 \times \frac{6.85}{1000}$$
$$moles = 6.85 \times 10^{-4} \pm 0.46\%$$

$C_6H_5NO_2$

$moles = 6.85 \times 10^{-4} \pm 0.46\%$

Procedure inappropriate

$Mr = (6 \times 12.01) + (5 \times 1.01) + (14.01) + (2 \times 16.00)$

$Mr = 123.12 g.mol^{-1}$

$Mass = moles \times Mr$

$Mass = (6.85 \times 10^{-4}) \times (123.12)$

$Mass = 0.0843 g$

$Mass = 84.3 mg \pm 0.46\% = 85.3 \pm 0.39 mg$

The uncertainty in the calculations on the previous page stays the same because it is assumed that there is no uncertainty in the values for both concentration and molar mass. This is the same case as with the following calculations.

NIASPAN

	Run 1	Run 2
Initial volume ±0.05 cm³	3.90	3.20
Final volume ±0.05 cm³	48.60	48.00
Added volume ±0.1 cm³	**44.7**	**44.8**

Only 2 repeats?

Only two concordant results were found for each drug because NIASPAN, being a prescription drug, was very expensive and because of all the preliminary experiments there was only enough left to find two results. There were only two concordant results found for the niacin dietary supplement to keep the number of concordant results constant.

OK - have explained why only two. fair enough

$$Titre = \frac{44.7 + 44.8}{2}$$

$$Titre = 44.75cm^3 \pm 0.44\%$$

$$\%\ \text{uncertainty (run 1)} = \frac{0.1}{44.7} \times 100 = 0.22\%$$

$$\%\ \text{uncertainty (run 2)} = \frac{0.1}{44.8} \times 100 = 0.22\%$$

$$\text{Total \% uncertainty} = 0.22 + 0.22 = 0.44$$

Volume of H_2SO_4 reacted with NIASPAN= 50 – 44.75
= 5.25 cm³ ± 0.44%

H_2SO_4

$Volume = 5.25cm^3 \pm 0.44\%$

$Concentration = 0.1mols.dm^{-3}$

$$moles = concentration \times \frac{Volume}{1000}$$

$$moles = 0.1 \times \frac{5.25}{1000}$$

$$moles = 5.25 \times 10^{-4} \pm 0.44\%$$

$C_6H_5NO_2$

$moles = 5.25 \times 10^{-4} \pm 0.44\%$

$Mr = (6 \times 12.01) + (5 \times 1.01) + (14.01) + (2 \times 16.00)$

$Mr = 123.12g.mol^{-1}$

$Mass = moles \times Mr$

$Mass = (5.25 \times 10^{-4}) \times (123.12)$

$Mass = 0.0646g$

$Mass = 64.6mg \pm 0.44\% = 64.6 \pm 0.28mg$

in how many grams of medicine

Final results: what is total wt of tablet?

Content of niacin in 1.00g of **Niacin supplements**/mg	**84.3±0.388mg**
Content of niacin in one "500mg" **Niacin supplement** tablet/mg	**69.1±1.16mg**
Content of niacin in 1.00g of **NIASPAN prescription drugs**/mg	**64.6±0.28mg**
Content of niacin in one "500mg" **NIASPAN prescription drug** tablet/mg	**45.2±0.84mg**

Conclusion and Evaluation:

From my results I can conclude that the content of the active ingredient, niacin, is greater in niacin dietary supplements than in NIASPAN prescription drugs. I can also conclude that the niacin supplement tablets each contain 69.1±1.16mg, while NIASPAN prescription drug tablets contain 45.2±0.84mg. These results cannot be accepted at face value though, for reasons that will be discussed. This achieves the aim of my investigation: to determine the content of active ingredient in niacin dietary supplements and the prescription drug "NIASPAN". I have not however determined another aim that I set myself and this was to examine the claim, made by the AHA, that dietary supplements:

> "may contain widely variable amounts of niacin — from none to much more than the label states."

My results show that the dietary supplements do have a far different content of niacin than the label states (500 mg) but they are limited in that I have only one result for the dietary supplements. In addition to this my results for the NIASPAN gave a far different content than that which the label states (also 500 mg). Both of these discrepancies bring me to the errors involved in my experiment. There were a number of errors that could have caused the difference between the actual results obtained and the values for content of active ingredient stated on the containers.

One of these problems was the uncertainties with the results themselves caused by the lab equipment. For every piece of lab equipment used there was an uncertainty value though the significance of these uncertainties varied greatly. Though most of these uncertainties individually didn't make a huge difference to the results, when they were compounded they made a difference of almost 2% for each drug. The only way to improve this uncertainty would be to use more accurate equipment but this uncertainty was not the main issue causing the difference in results. Even though this clearly had some effect on the results it cannot have been the only reason for the difference between the experimental values and the labeled values of the drugs. This means that there must have been other factors affecting the results that were not taken into account when looking at propagation of errors.

One of such factors was an assumption made in the initial calculations in the titration stage of my investigation. This was the assumption that the theoretical volume of 50 cm^3 of sulphuric acid was an accurate one to use in my calculations and also had no uncertainty value. Although this was probably quite accurate the acid may not have had a concentration of exactly 1.0 $mol.dm^{-3}$ as was assumed, allowing for uncertainties that would only have been compounded when another assumption was made. This assumption was that when the acid was made up to a standard solution by diluting it by a factor of ten the concentration would also decrease by a factor of ten exactly making the 1.0 $mol.dm^{-3}$ solution 0.1 $mol.dm^{-3}$. An extra experiment could be carried out to omit all of these assumptions and get an experimental value with uncertainties that account for errors in the experiment. This experiment would involve making a 100 cm^3standard solution with 10 cm^3 of 1.0 $mol.dm^{-3}$ H_2SO_4 solution and titrating it against 1.0 $mol.dm^{-3}$ NaOH solution using phenolphthalein indicator. This would mean that the titre obtained would be the volume that would be used in calculations. This titre would have an uncertainty accounting for most of the errors and it could also be used with the mole calculations to

determine an accurate result for the concentration of the sulphuric acid. This would mean that the assumption would not have to be made that the concentration decreases exactly by a factor of ten when the sulphuric acid is standardised. This would be an extremely effective way to reduce the errors made by assumptions and account for them using real quantifiable uncertainties.

Another problem in the earlier stages of my experiments was that after hydrolyzing and standardizing the niacin supplement solution, there was still some solute left in the filter paper. I managed to account for this by weighing the mass of solute in the filter paper but that had the negative effect of increasing the uncertainty from ± 0.02g to ± 0.04g. The best way to reduce the uncertainty would be to not have to carry out the step of weighing the solute in the filter paper in the first place. As the solute is probably comprised completely of the outer casing, which I failed to adjust to, it would be quicker and easier to remove the outer casing with sandpaper for the niacin supplements as I had done for the NIASPAN drugs. This would decrease the uncertainty attached to this result which would have less of an effect down the line in the calculation stage.

Human error has to be taken into account, due to the difference between the labeled values and the experimental values, as well. The biggest problem under the umbrella of human error in my investigation was probably parallax error. This is affected by the angle at which you read the measurement from something such as a standard flask or burette and can have massive consequences. Though I did not notice myself doing this during the investigation it could definitely have had an effect on the results. With the titration of the NIASPAN solution I discovered that once the burette had been filled twice there appeared to be more than the 100 cm^3 of standard solution for NIASPAN that had been in the standard flask. This would almost definitely be because of human error and may have affected the final results.

(3567 words)

What are the techniques normally used by the to calculate the Niacin conc?

Evaluation poor!!!

No real understanding of any underlying chemistry shown. Poor evaluation and experimental method.

Bibliography:

- http://www.niaspan.com/About_Niaspan/Why_Prescription_Niacin.asp (September 23 2008)
- http://www.americanheart.org/presenter.jhtml?identifier=4704. (September 23 2008)
- Kowalski R 2004 The New 8 Week Cholesterol Cure HarperCollins
- http://www.purchon.com/biology/nicotinic.htm#sources (December 30th 2008)

poor biography.

Assessment form (for examiner use only)

Candidate session number	0	0	

		Achievement level		
		First examiner	maximum	Second examiner
Assessment criteria	**A** research question		2	
	B introduction		2	
	C investigation		4	
	D knowledge and understanding		4	
	E reasoned argument		4	
	F analysis and evaluation		4	
	G use of subject language		4	
	H conclusion		2	
	I formal presentation		4	
	J abstract		2	
	K holistic judgment		4	
	Total out of 36			

Name of first examiner: _____ Examiner number: _____
(CAPITAL letters)

Name of second examiner: _____ Examiner number: _____
(CAPITAL letters)