

Candidate 5 evidence

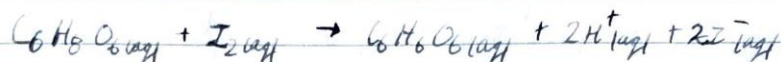
Title: Mass of Vitamin C

Aim

To determine which, out of 3 different vitamin C tablets has the greatest mass of vitamin C present in it.

Underlying chemistry

(Vitamin C (also known as ascorbic acid) reacts with iodine solution in the following redox reaction.



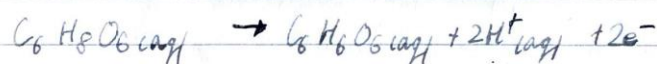
A redox reaction is a reaction where oxidation (loss of electrons) and reduction (gain of electrons) occur at the same time. The ion-electron equations for the above reaction are as follows.

Reduction

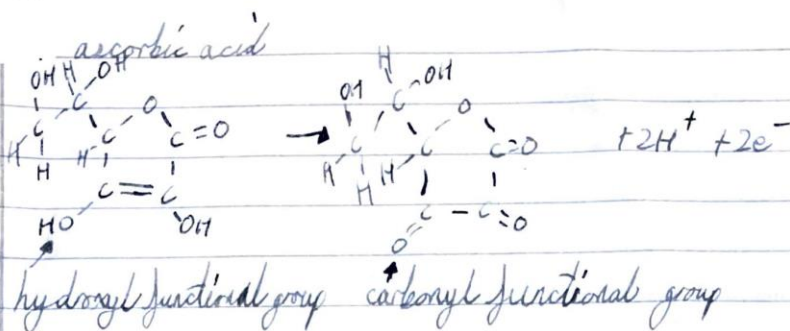


Here the iodine is acting as an oxidising agent. An oxidising agent is a substance which causes oxidation to occur. Thus it undergoes reduction. Reducing agents opposite.

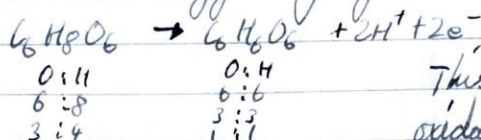
Oxidation



Or using full structural formulae-



It is clear from this format that when vitamin C undergoes oxidation as well as electrons being lost hydrogen is lost. This can be expressed in an oxygen-hydrogen ratio.



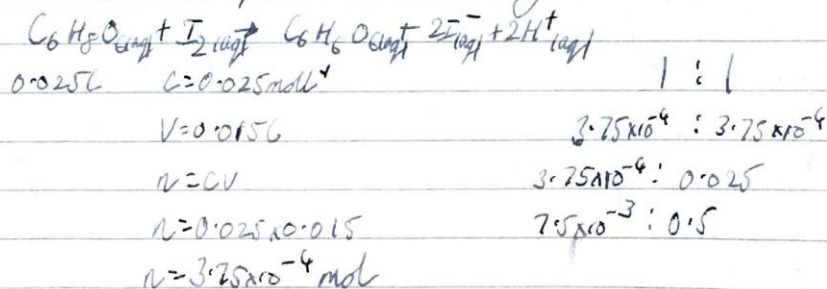
This also indicates oxidation.

Vitamin C can be described as an antioxidant. An antioxidant is a substance which is oxidised in preference to other substances. Hence why vitamin C is commonly found in foodstuffs.

By having a known volume and concentration of iodine solution it is possible to calculate the mass of vitamin C that was dissolved in the standard solution (i.e. the mass in the tablet).

Example calculation

An unknown mass of vitamin C was dissolved in water, transferred to a 500cm^3 standard flask and made up to the mark. If 15cm^3 of 0.025mol l^{-1} of iodine solution was needed when titrated against 25cm^3 of vitamin C solution, what is the mass of vitamin C?



$$n = 7.5 \times 10^{-3} \text{ mol}$$

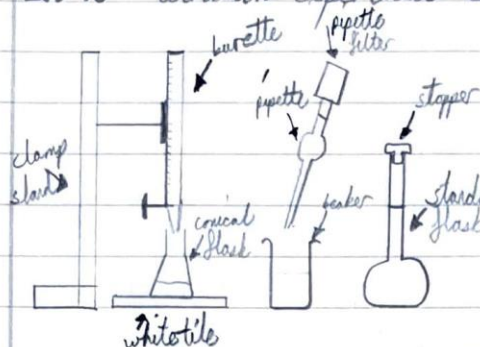
$$\text{MFM} = 176 \text{ g}$$

$$m = n \times \text{MFM}$$

$$m = 7.5 \times 10^{-3} \times 176$$

$$m = 1.32 \text{ g}$$

In a titration experiment the following apparatus is used.



Initially, all apparatus is rinsed with the chemical that will use that piece of equipment.

In a titration, some of the standard solution (eg vitamin C solution) is poured into a beaker and pipetted into a conical flask.

The indicator (eg starch) is added to this. The other reactant (eg iodine solution) is put in the burette and allowed to run through to the bottom. The initial volume of reactant in the burette is recorded. The reactant is slowly added from the burette into a swirling conical flask. When the colour change occurs (eg colourless to blue-black) the reaction has finished and the volume of reactant now in the burette is recorded.

Method

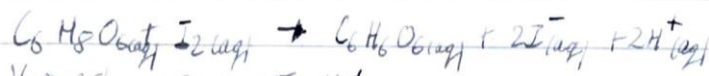
Make a standard solution for each of the 3 vitamin C tablets. Titrate this against iodine solution with a starch indicator. Record results in a table and calculate mass of vitamin C.

We wore gloves to avoid contact of iodine solution as it is harmful and can stain skin.

Raw Data				
Energy				
Try	Initial Volume (cm ³)	Final Volume (cm ³)	Volume Used (cm ³)	
				Concordant results of
Rough 1	2.2	10.0	7.8	6.6 cm ³ and 6.5 cm ³
2	10.0	19.3	9.3	Average 6.55 cm ³
3	19.3	25.5	6.2	= 0.00655 L
4	25.5	32.1	6.6	
5	32.1	40.0	7.9	
	40.0	46.5	6.5	
Men's Health				
Try	Initial Volume (cm ³)	Final Volume (cm ³)	Volume Used (cm ³)	
				Concordant results of
Rough 1	0.0	2.4	2.4	2.7 cm ³ and 2.6 cm ³
2	2.4	5.9	3.5	Average 2.65 cm ³
3	5.9	8.6	2.7	= 0.00265 L
	8.6	11.2	2.6	
Immune Support				
Try	Initial Volume (cm ³)	Final Volume (cm ³)	Volume Used (cm ³)	Concordant results of
Rough 1	11.2	24.1	12.9	13.0 cm ³ and 13.0 cm ³
2	24.1	37.1	13.0	Average 13.0 cm ³
	27.2	40.2	13.0	= 0.013 L

Calculations

Energy



$$V = 0.025\text{L} \quad C = 0.025\text{molL}^{-1}$$

$$V = 0.00655\text{L}$$

$$n = CV$$

$$n = 0.025 \times 0.00655$$

$$n = 1.6375 \times 10^{-4}\text{mol}$$

1:1

$$1.6375 \times 10^{-4} : 1.6375 \times 10^{-4}$$

$$n = 3.275 \times 10^{-3}\text{mol} \quad \text{GFM} = 176\text{g}$$

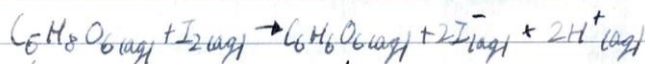
$$1.6375 \times 10^{-4} : 0.025\text{L}$$

$$m = n \times \text{GFM} \quad m = 3.275 \times 10^{-3} \times 176$$

$$3.275 \times 10^{-3} : 0.5\text{L}$$

$$m = 0.5764\text{g} = \underline{576.4\text{mg}}$$

Men's Health



$$V = 0.025\text{L} \quad C = 0.025\text{molL}^{-1}$$

$$V = 0.00265\text{L}$$

$$6.625 \times 10^{-5} : 0.025$$

$$n = CV$$

$$1.325 \times 10^{-3} : 0.5$$

$$n = 6.625 \times 10^{-5}\text{mol}$$

$$n = 1.325 \times 10^{-3}\text{mol} \quad \text{GFM} = 176\text{g}$$

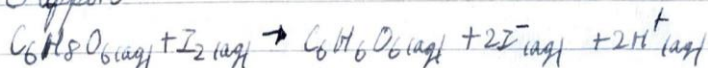
1:1

$$m = n \times \text{GFM}$$

$$6.625 \times 10^{-5} : 6.625 \times 10^{-5}$$

$$m = 0.2332\text{g} = \underline{233.2\text{mg}}$$

Immune Support



$$V = 0.025\text{L} \quad C = 0.025\text{molL}^{-1}$$

$$V = 0.013\text{L}$$

$$3.25 \times 10^{-4} : 0.025\text{L}$$

$$n = CV$$

$$6.5 \times 10^{-3} : 0.5$$

$$n = 3.25 \times 10^{-4}\text{mol}$$

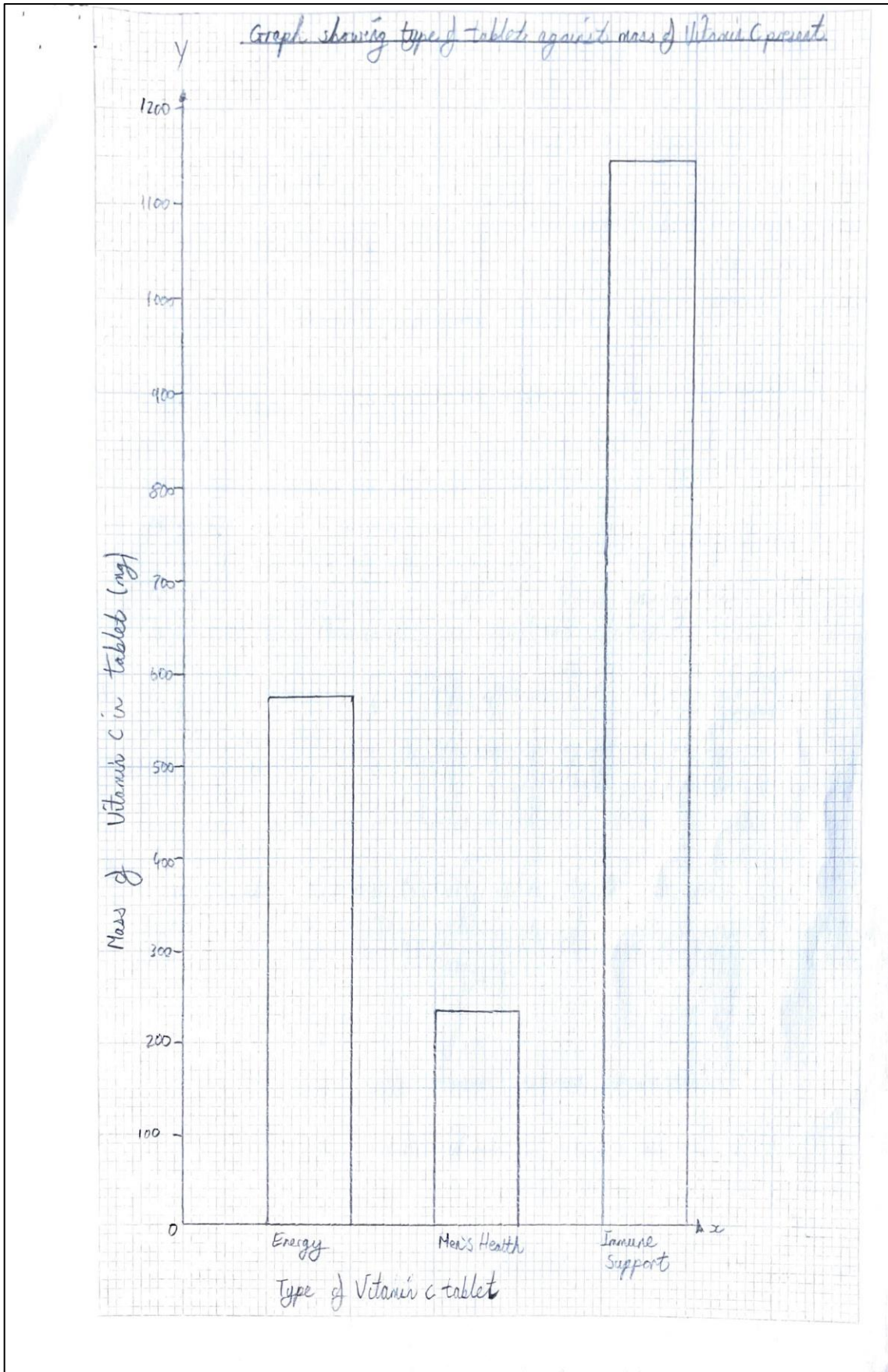
1:1

$$n = 6.5 \times 10^{-3}\text{mol} \quad \text{GFM} = 176\text{g}$$

$$3.25 \times 10^{-4} : 3.25 \times 10^{-4}$$

$$m = n \times \text{GFM}$$

$$m = 1.144\text{g} = \underline{1144.0\text{mg}}$$



Graph - On graph paper

Internet Source

Energy¹ Vitamin C mass - 476.0mg

Mei's Health² Vitamin C mass - 200.0mg

Immune Support³ Vitamin c mass - 1000.0mg

Analysis

Tablet Type	My Data (mg)	Internet Source (mg)	On comparing my results to the internet source it is clear that my results are higher.
Energy	576.4	476.0	$576.4\text{mg} > 476.0\text{mg}$ percentage decrease 17.4%
Mei's Health	233.2	200.0	$233.2\text{mg} > 200.0\text{mg}$ percentage decrease 14.2%
Immune Support	1144.0	1000.0	$1144.0\text{mg} > 1000.0\text{mg}$ percentage decrease 12.6%

However, all of the results clearly show that the immune support vitamin C tablet has the greatest mass of vitamin C present with 1144.0mg (internet source 1000.0mg).

Conclusion

In conclusion the mass of vitamin C present in each of the three tablets is:- Energy, 576.4mg; Mei's Health, 233.2mg; and Immune Support, 1144.0mg. Thus the tablet with the greatest mass of vitamin C present is the Immune Support with 1144.0mg. These results are in accordance with the internet source, the Tesco

website, which cites Immune support as having the greatest mass of vitamin C present (1000.0mg).

Evaluation

My internet source should be reliable as it came from a supermarket website. Therefore it must comply with all food standard regulations and the information must have been verified by food scientists.

Starch was a good indicator to use as it gave a sharp endpoint to the reaction. Therefore the volume of iodine solution used could be more accurately measured. This would make the calculation of the mass of vitamin C more accurate.

On comparing my results to the internet source it is clear that my results are significantly higher (576.4 > 476.0, 233.2 > 200.0, 144.0 > 1000.0). This could have been because the vitamin C tablets were not pure and contained other compounds which could have reacted with the iodine solution. Within the limits of my experiments there was little I could do about this. To combat this a different chemical could have been used instead of iodine solution. This could have resulted in only the vitamin C being oxidised and not any other compounds. This would have made the volume of iodine used more accurate therefore the mass of vitamin C present could more accurately be calculated. This could have made my data closer to the internet source data.

Some of the volumes of iodine used were very small. This could have affected how precise some of the volumes of

iodine solution used were. To combat this a 50cm^3 pipette could have been used instead of a 25cm^3 pipette. This would have made the volume of iodine solution used twice as large. This could have made my results more precise thus giving a better indication of the mass of vitamin C present in the tablet (particularly for the 2.65cm^3 volume).

References

1 https://www.tesco.com/groceries/en-GB/products/257803002?sc_cmp=ppc*GHS+-+Grocery+-+New*PX+%7C+Shopping+GSC+%7C+Top+Offers+%2B+Tesco+Brand*New:+Non-Food:+Health+%26+Beauty:+Health+%26+Beauty+-+Top+Offers*PRODUCT_GROUP257803002*&ds_rl=1116019&ds_rl=1116016&ds_rl=1116019&gclid=EAlaIqobChMI6JTIn-KF5wIVSrDtCh2CYASREAQYASABEgKNpFD_BwE&gclidsrc=aw.ds

Accessed on 15/1/20

2 https://www.tesco.com/groceries/en-GB/products/250195268?sc_cmp=ppc*GHS+-+Grocery+-+New*PX+%7C+Shopping+GSC+%7C+Top+Offers+%2B+Tesco+Brand*New:+Non-Food:+Health+%26+Beauty:+Health+%26+Beauty+-+Top+Offers*PRODUCT_GROUP250195268*&ds_rl=1116019&ds_rl=1116016&ds_rl=1116019&gclid=EAlaIqobChMI7fkj7-SF5wIVSrDtCh2CYASREAQYBCABEgKraPD_BwE&gclidsrc=aw.ds

Accessed on 15/1/20

3 https://www.tesco.com/groceries/en-GB/products/252479807?sc_cmp=ppc*GHS+-+Grocery+-+New*PX+%7C+Shopping+GSC+%7C+Top+Offers+%2B+Tesco+Brand*New:+Non-Food:+Health+%26+Beauty:+Health+%26+Beauty+-+Top+Offers*PRODUCT_GROUP252479807*&ds_rl=1116019&ds_rl=1116016&ds_rl=1116019&gclid=EAlaIqobChMI18-58uOF5wIVrTtCh2Thw9UEAQYASABEgJzbfD_BwE&gclidsrc=aw.ds

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