Candidate 1: Identification of an Unknown

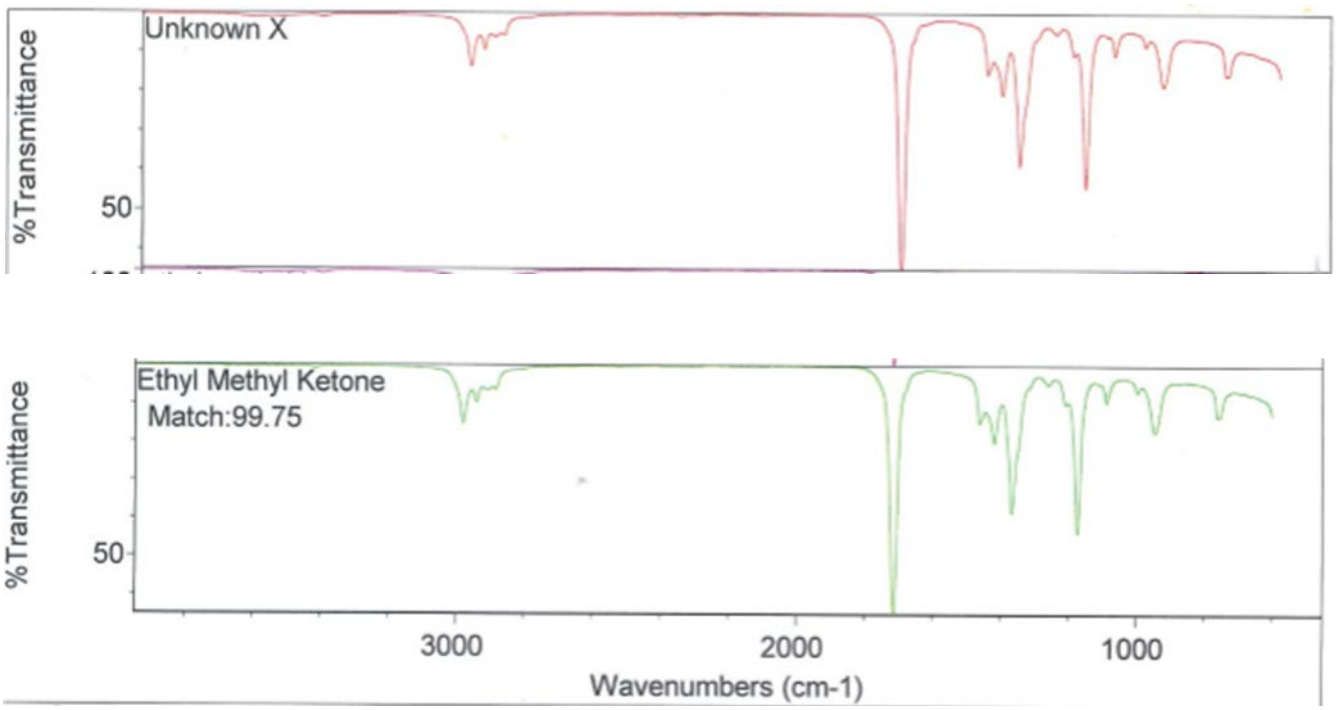
Results

		Repeats	Replicate 1	Replicate 2	Control using butanone
Physical properties	Colour		clear, colourless	clear, colourless	clear, colourless
	State at 25 °C		liquid	liquid	liquid
	Smell		solvent smell	solvent smell	solvent smell
	pH		7	7	7
	Saturation		Saturated	Saturated	Saturated
	Polarity		Immiscible in water	Immiscible in water	Immiscible in water
	Flammability		burns with clear flame, vapour flammable	burns with clear flame, vapour flammable	burns with clear flame, vapour flammable
	Density:				
	Mass of beaker (g)	1	55.3662	52.3475	52.2249
		2	55.3623	52.3212	52.2753
		3	55.3765	52.3560	52.2249
	Mass of beaker and 50ml of organic compound (g)	1	95.4832	92.4396	92.2318
		2	95.5323	92.3129	92.3249
		3	95.4832	92.4612	92.2138
	Difference in mass (g)	1	40.1170	40.0921	40.0069
		2	40.1700	39.9917	40.0496
		3	40.1067	40.1052	39.9889
	Density (mass/volume (0.05l)) (kg/m^3)	1	802.3	801.8	800.1
		2	803.4	799.8	801.0
		3	802.1	802.1	799.8
		Average	802.6	801.3	800.3
Chemical tests	Reaction with sodium metal		no reaction	no reaction	no reaction
	Reaction with Tollens' solution		Silver mirror forms	Silver mirror forms	Silver mirror forms
	Melting point of crude derivative (°C)		115	114	114
		1	116	115	117
		2	116	117	116

	Melting point of purified derivative (°C)	3	115	117	115
		Average	115.7	116.3	116.0

Density Calculations:
The mass of the compound was found using weighing by difference. The mass of the empty beaker was taken away from the mass of the beaker containing the compound to find the mass of the compound. Then the density was calculated by dividing the mass by the volume of the compound. Example calculation using data from the 1st repeat of 1st replicate:
Mass of beaker and compound – Mass of beaker = Mass of compound
95.4832 g - 55.3662 g = 40.1170g
Mass of compound ÷ Volume of compound = Density
40.1170 g ÷ 0.05000 m^3 = 802.3 kg/m^3

IR Spectra



Identified groups: [6]
Peak around 2950 cm^{-1} = C-H stretch
Peak around 1700 cm^{-1} = C=O stretch
Peak around 1390 cm^{-1} = C-H bend
The top spectra shown is for the unknown organic compound. Using the software package on the PC, the school's IR library was searched. This provided a 99.75% match with the spectra for "ethyl methyl ketone" or butanone (shown below)

Candidate 2: Iron tablets

Experimental Procedure

Kit List

- 4 different types of ferrous sulphate tablets
- 1.5 $moll^{-1}$ sulfuric acid
- 0.01 $moll^{-1}$ potassium manganate (VII)
- Deionised water
- Pestle and mortar
- Weighing boat
- Electronic balance
- 250 cm^3 beaker
- Filter funnel and paper
- 250cm^3 volumetric flask
- 25cm^3 pipette
- 50cm^3 burette
- 250cm^3 conical flask
- A white tile
- Wash bottle
- 100cm^3 conical flask and stopper
- 100cm^3 measuring cylinder

Stage 1- Preparation of Iron Tablet Solutions

5 iron tablets of one brand were weighed using an electronic balance. These tablets were then transferred into a mortar and were crushed carefully making sure not to lose any of the crushed tablets. Once the tablets were crushed into a fine powder they were transferred into a 100cm^3 conical flask along with 50cm^3 sulfuric acid. Some of the sulfuric acid was used to rinse the mortar and pestle. These rinsings were also transferred into the conical flask. The flask was stoppered and inverted multiple times before being put aside for 24 hrs to allow the tablets to dissolve fully. The following day the solution was filtered into a 250cm^3 volumetric flask using filter paper and filter funnel. Deionised water was used to rinse the original conical flask and these rinsings were also filtered. Deionised water was used to make the solution up to the mark on the 250cm^3 volumetric flask. The flask was inverted several times to ensure the solution was mixed well. This whole process was repeated for each brand of tablet.

Stage 2- Redox Titration

The pipette, burette and conical flask were all washed with deionised water. Then the burette was rinsed with potassium manganate (VII) and the pipette was rinsed with the iron tablet solution. Using the pipette filler, the pipette was filled with iron tablet solution and this was transferred to a 250cm^3 conical flask. The solution was acidified by adding about 25cm^3 sulfuric acid to the conical flask. The burette was then filled with potassium manganate (VII) solution and allowed to slowly run into the burette. While the potassium manganate (VII) ran into the conical flask the contents of the flask was swirled. The titration was carried out until the colour changed from pink/purple to colourless. The potassium manganate (VII) is so intense that the top of the meniscus was used to measure the volumes. For each brand of tablet a rough titration was carried out and then further titrations were done until 2 concordant results were achieved.

Results

Type 1 – Actavis

First Titration:

	Titre (cm^3)			
	Rough	First	Second	Third
Initial burette reading (cm^3)	0.6	12.4	24.0	36.1
Final burette reading(cm^3)	12.4	24.0	36.1	48.0
Volume of $KMnO_4$ (cm^3)	11.8	11.6	12.1	11.9
Average volume of concordant results (cm^3)	12.0			

Replicate:

	Titre (cm^3)		
	Rough	First	Second
Initial burette reading (cm^3)	0.2	12.2	24.4
Final burette reading(cm^3)	12.2	24.4	36.5
Volume of $KMnO_4$ (cm^3)	12.0	12.2	12.1
Average volume of concordant results (cm^3)	12.2		

Type 2- Actavis

First Titration:

	Titre (cm^3)		
	Rough	First	Second
Initial burette reading (cm^3)	27.7	11.8	24.0
Final burette reading(cm^3)	39.7	24.0	36.0
Volume of $KMnO_4$ (cm^3)	12.0	12.2	12.0
Average volume of concordant results (cm^3)	12.1		

Replicate:

	Titre (cm^3)		
	Rough	First	Second
Initial burette reading (cm^3)	13.7	25.8	23.0
Final burette reading(cm^3)	25.8	38.3	35.3
Volume of $KMnO_4$ (cm^3)	12.1	12.5	12.3
Average volume of concordant results (cm^3)	12.4		

Type 3- Actavis

First Titration:

	Titre (cm^3)		
	Rough	First	Second
Initial burette reading (cm^3)	0.2	12.0	23.8
Final burette reading(cm^3)	12.0	23.8	35.7
Volume of $KMnO_4$ (cm^3)	11.8	11.8	11.9
Average volume of concordant results (cm^3)	11.9		

Replicate:

	Titre (cm^3)		
	Rough	First	Second
Initial burette reading (cm^3)	12.9	25.2	1.2
Final burette reading(cm^3)	25.2	37.7	13.7
Volume of $KMnO_4$ (cm^3)	12.3	12.5	12.5
Average volume of concordant results (cm^3)	12.5		

Type 4- Wockhardt

First Titration:

	Titre (cm^3)		
	Rough	First	Second
Initial burette reading (cm^3)	0.3	12.4	29.2
Final burette reading(cm^3)	12.4	24.1	40.8
Volume of $KMnO_4$ (cm^3)	12.1	11.7	11.8
Average volume of concordant results (cm^3)	11.8		

Replicate:

	Titre (cm^3)			
	Rough	First	Second	Third
Initial burette reading (cm^3)	2.2	14.3	25.9	1.0
Final burette reading(cm^3)	14.3	25.9	38.0	12.9
Volume of $KMnO_4$ (cm^3)	12.1	11.6	12.1	11.9
Average volume of concordant results (cm^3)	12.0			

Calculations

Example Calculation for Type 1 – Actavis

Average volume $KMnO_4$ = 12.0 cm^3

Concentration $KMnO_4$ = 0.01 $moll^{-1}$

Volume Fe^{2+} solution = 25 cm^3

Moles MnO_4 = C x V

= 0.01 x 0.012

= $1.2x10^{-4}$ moles

5 moles Fe^{2+} : 1 mole MnO_4^-

So,

Moles Fe^{2+} (in 25cm^3) = 5 x 1.2 $x10^{-4}$ = $6x10^{-4}$ moles

Moles Fe^{2+} (in 250cm^3) = 10 x $6x10^{-4}$ = $6x10^{-3}$ moles

Atomic mass Fe = 55.8

Mass of iron (in 5 tablets) = n x gfm

= $6x10^{-3}$ x 55.8

= 0.3348 g

Mass of iron (in one tablet) = 0.3348 /5 = 66.96 mg

Replicate –

Mass of iron (in one tablet) = 67.80 mg

Average mass of iron = (66.96 + 67.80) / 2 = **67.38 mg**

Type 2- Actavis

Mass of iron (in one tablet) = 67.52 mg

Replicate –

Mass of iron (in one tablet) = 69.19mg

Average mass of iron = (67.52 + 69.19) / 2 = **68.36 mg**

Type 3- Actavis

Mass of iron (in one tablet) = 66.12 mg

Replicate –

Mass of iron (in one tablet) = 69.75 mg

Average mass of iron = (66.12 + 69.75) / 2 = **67.94 mg**

Type 4- Wockhardt

Mass of iron (in one tablet) = 65.57 mg

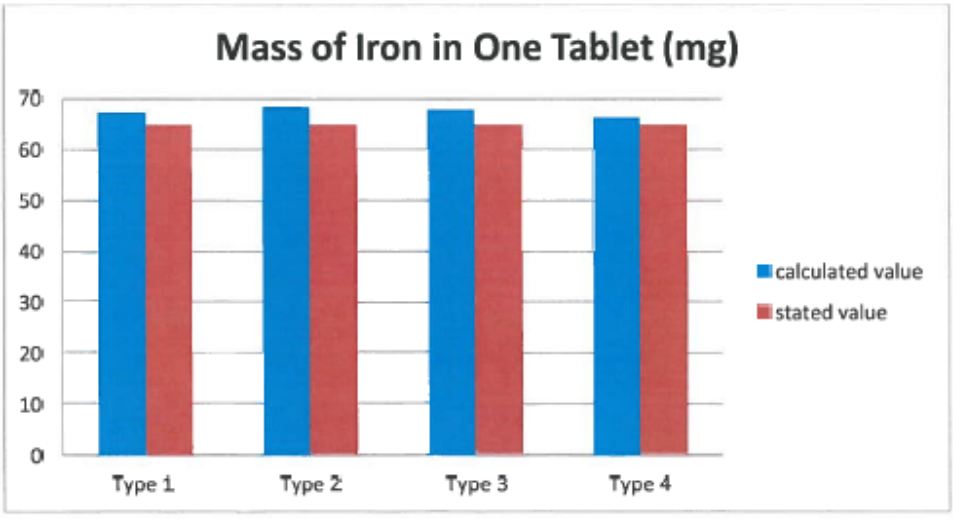
Replicate –

Mass of iron (in one tablet) = 66.96 mg

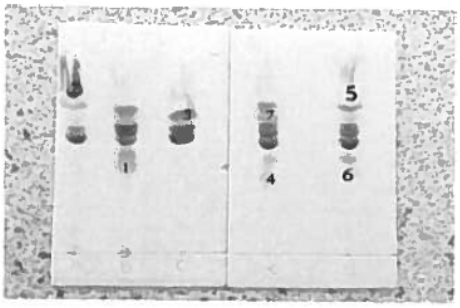
Average mass of iron = (65.57 + 66.96) / 2 = **66.27 mg**

Summary of Results :

Tablet Type	Average mass of iron (mg)
1	67.38
2	68.36
3	67.94
4	66.27



Candidate 3: Ink analysis



Replicate 1:

Fig.6 Replicate 1 Thin Layer Chromatography Plates

Distance travelled by solvent in control plate (spots 1-3)= 60mm
Distance travelled by solvent in unknown plate (spots 4-7)= 62mm

Rf Calculation:

Spot 1:distance traveled by substance= 26mm
Rf= 26/60
Rf=0.43

Number corresponding to spot	Distance travelled by substance (mm)	Retardation factor (Rf) Value
1	26	0.43
2	48	0.80
3	41	0.68
4	23	0.37
5	47	0.76
6	24	0.39
7	43	0.69

Replicate 2:

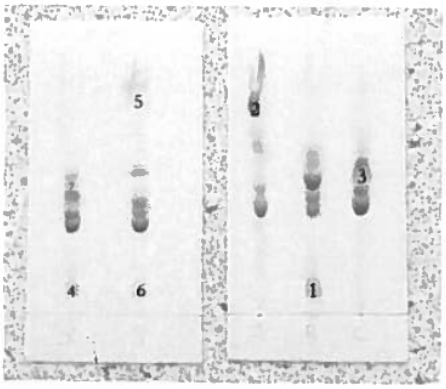


Fig.7 Replicate 2 Thin Layer Chromatography plates

Distance travelled by solvent in control plate (spots 1-3) = 65
Distance travelled by solvent in unknown plate (spots 4-7) = 64

Number corresponding to spot	Distance travelled by substance (mm)	Retardation factor (Rf) Value	Average Rf (Rep.1+2)
1	6	0.09	0.26
2	47	0.72	0.76
3	32	0.49	0.59
4	6	0.09	0.23
5	52	0.81	0.79
6	5	0.08	0.24
7	29	0.45	0.57

Spots 1, 4 and 6 are all the same peach colour and similar average Retardation factor values ranging from 0.23 to 0.26. This suggests that control B is in both samples X and Y. Spots 2 and 5 could be argued to be the same since its is previously suggested that control B is in sample Y therefore spot 5 is a mixture of spot 2 and the pale pink colour at the similar point. Spots 2 and 5 also have similar averageRf values with a difference of 0.03. Spots 3 and 7 are the same dark yellow colour and have similar average Retardation factor values with the difference of 0.02 so could be considered the same substance.

Candidate 4: Calcium in milk

5. Results:

Raw Data:

Skimmed Milk

Trial 1

	Initial Reading	Final Reading	Titre Volume
Rough	1.1	11.2	10.1
1	13.9	24.0	10.1
2	24.0	34.1	10.1
3	34.1	44.3	10.2

Trial 2

	Initial Reading	Final Reading	Titre Volume
Rough	2.2	13.1	10.9
1	21.3	32.6	11.3
2	32.6	43.9	11.3
3	8.5	19.9	11.4

Semi skimmed Milk

Trial 1

	Initial Reading	Final Reading	Titre Volume
Rough	2.5	9.1	6.6
1	10.5	20.0	9.5
2	20.0	29.5	9.5
3	29.5	39.0	9.5

Trial 2

	Initial Reading	Final Reading	Titre Volume
Rough	3.5	13.5	10.0
1	15.2	25.9	10.7
2	26.4	37.1	10.7
3	13.2	23.9	10.7

Whole Milk:

Trial 1

	Initial Reading	Final Reading	Titre Volume
Rough	5.7	15.0	9.3
1	15.0	24.4	9.4
2	24.4	33.8	9.4
3	33.8	43.2	9.4

Trial 2

	Initial Reading	Final Reading	Titre Volume
Rough	6.3	15.8	9.5
1	15.8	25.0	9.2
2	25.0	34.2	9.2
3	34.2	43.5	9.3

Calcium Chloride Control:

Trial 1

	Initial Reading	Final Reading	Titre Volume
Rough	1.0	12.5	11.5
1	12.5	24.0	11.5
2	24.0	35.5	11.5
3	35.5	47.0	11.5

Trial 2

	Initial Reading	Final Reading	Titre Volume
Rough	2.4	14.2	11.8
1	14.2	25.6	11.4
2	25.6	36.9	11.3
3	7.2	18.6	11.4

Calculations:

Example calculation for Skimmed Milk:

Reaction: $Ca^{2+} + H_2EDTA^{2-} \rightarrow CaEDTA^{2-} + 2H^+$

Average Titre Volume = $\frac{(\text{titre volume 1} + \text{titre volume 2} + \text{titre volume 3})}{\text{Number of concordant titre volumes}}$

From the average titre volume, the calcium ion concentration can be calculated using the equation:

$$Moles = concentration \times volume$$
$$(n = cv)$$

Trial 1:

Average titre volume = $\frac{(10.10+10.10+10.20)}{3}$ = 10.13cm^3 / 0.01013l

EDTA
$c = 0.1 mol l^{-1}$
$v = 0.01013l$
↓
$n = cv$
$n = 0.1 \times 0.01013$
$n = 0.001013mol$
– due to the 1:1 ratio, Number of moles of EDTA = Number of moles of Calcium.

Ratio
EDTA : Calcium
1 : 1

Milk
$v = 0.025l$
$n = 0.001013mol$
↓
$n = cv$
$c = \frac{n}{v}$
$c = \frac{0.001013}{0.025}$
$c = 0.0405 mol l^{-1}$

Trial 2:

Average Titre Volume = $\frac{(11.30+11.30+11.40)}{3}$ = 11.33cm^3 = 0.01133L

EDTA
$c = 0.1 mol l^{-1}$
$v = 0.01133l$
↓
$n = cv$
$n = 0.1 \times 0.01133$
$n = 0.001133mol$
– Due to 1:1 ratio, number of moles of EDTA = Number of moles of Calcium.

Ratio
EDTA : Calcium
1 : 1

Milk
$v = 0.025l$
$n = 0.001133mol$
↓
$n = cv$
$c = \frac{n}{v}$
$c = \frac{0.001133}{0.025}$
$c = 0.0453 mol l^{-1}$

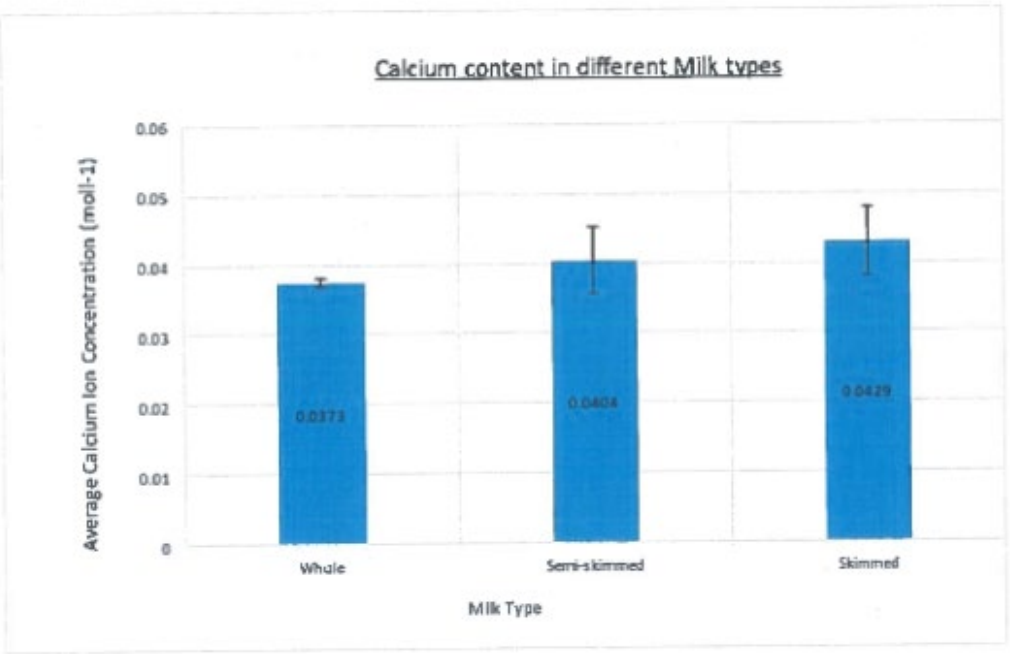
Average Concentration = $\frac{Trial\ 1\ Avg.Concentration + Trial\ 2\ Avg.concentration}{2}$

Average Concentration = $\frac{0.0405+0.0453}{2}$ = **$0.0429 mol l^{-1}$**

Processing Results:

Table shows the Calcium Ion Concentration in different Milk and Calcium Chloride control:

Milk Type	Trial 1 Calcium ion concentration ($moll^{-1}$)	Trial 2 Calcium ion concentration ($moll^{-1}$)	Average Calcium ion concentration ($moll^{-1}$)
Whole	0.0376	0.0369	0.0373
Semi skimmed	0.0380	0.0428	0.0404
Skimmed	0.0405	0.0453	0.0429
Control	0.0460	0.0454	0.0457



Graph 1 – The average calcium ion concentration in different milk samples

Candidate 5: Piperine in pepper

Results:

Raw Results:

Experiment	Mass of Weighing Boat (g)	Mass of Weighing Boat + Pepper (g)	Initial Mass of Pepper (g)	Mass of Weighing Boat (g)	Mass of Weighing Boat + Mass of Piperine (g)	Final Mass of Piperine (g)	Melting Point (°C)
1	1.6118	11.6158	10.0040	1.6118	2.1357	0.5239	120-123
2	1.6132	11.5992	9.9860	1.6132	2.5247	0.9115	122-125

Percentage Mass Calculations:

Experiment 1:

$$\%\ Mass = \frac{Mass\ of\ Piperine}{Mass\ of\ Pepper}\ x\ 100$$

$$= \frac{0.5239}{10.004} x100$$

$$= 5.24\%$$

Experiment 2:

$$\%\ Mass = \frac{Mass\ of\ Piperine}{Mass\ of\ Pepper}\ x\ 100$$

$$= \frac{0.9115}{9.9860} x100$$

$$= 9.13\%$$

Final Results:

Experiment	Percentage Mass of Piperine in Black Pepper (%)	Percentage Uncertainty (± %)	Melting Point (□C)
1	5.24	0.002	120-123
2	9.13	0.001	122-125

Candidate 6: Aspirin

2.2 Results

Table 1 – Values from titration of Flask #1

	1st Titre	2nd titre	3rd titre
Start volume of sulphuric acid (cm^3)	0.1	9.3	17.6
End volume of sulphuric acid (cm^3)	9.3	17.6	25.9
Volume of sulphuric acid added (cm^3)	9.2	8.3	8.3

Mass of aspirin in the 3 tablets = 1.503g

Total mass of the 3 tablets = 1.7531g

Mean titre volume = $8.3cm^3$

Percentage of aspirin in the aspirin tablets = 85.7%

Table 2 – Values from titration of Flask #2

	1st Titre	2nd titre
Start point (cm^3)	0.3	8.7
End point (cm^3)	8.7	17.0
Volume (cm^3)	8.4	8.3

Mass of aspirin in 3 tablets = 1.4985g

Total mass of the 3 tablets =1.8192g

Mean titre volume = $8.35cm^3$

Percentage of aspirin in the aspirin tablets =82.4%

Example calculations

- Flask #1 titration calculations

$$n\ of\ sulfuric\ acid = cv = 0.0083 \times 0.050 = 0.000415\ mol$$

$$n\ of\ NaOH\ (left\ in\ 25ml\ of\ the\ hydrolysed\ solution) = 2 \times 0.000415 = 0.00083\ mol$$

(1 mole of sulfuric acid reacts with 2 moles of NaOH)

$$n\ of\ NaOH\ in\ 250ml = 10 \times 0.00083 = 0.0083\ mol$$

$$n\ of\ NaOH\ added\ to\ the\ aspirin\ tablets\ originally = 0.025 \times 1 = 0.025\ mol$$

$$n\ of\ NaOH\ that\ reacted\ with\ the\ aspirin\ tablets = 0.025 - 0.0083 = 0.0167\ mol$$

(2 moles of NaOH react with 1 mole of aspirin)

$$n\ of\ aspirin\ in\ sample = \frac{0.0167}{2} = 0.00835\ mol$$

$$m\ of\ aspirin\ in\ sample = 0.00835 \times 180 = 1.503g$$

$$\%\ by\ mass\ of\ aspirin\ in\ the\ tablets = \frac{1.503}{1.7531} \times 100 = 85.7\%$$