Flatustop investigation

We are working for a pharmaceuticals company, and they have developed a new drug called Flatustop that helps stop public “embarrassments”. Our task is to discover what is the best way of dissolving the drug for administration.

Preliminary work.

For our preliminary investigation we investigated how surface area affects the rate of dissolving.

For this experiment we need:

- Stirring rods.
- 100ml glass beakers.
- 1 stopwatch.
- Cube granulated and powdered flatusop.
- Pipettes to measure out the 50ml exactly.

Diagram

Method

- Firstly we will weigh the cubed Flatustop. The weight of this was recorded and the granulated and powdered Flatustop was weighed to equal the weight of the cube.
- We will then fill three beakers up with 50ml of water (the solvent). We will measure this accurately as possible by using pipettes to get the level of the water exactly on 50ml

- We will then put the cubed Flatustop, the granulated Flatustop and the powdered Flatustop in the three beakers (Cubed in one beaker, Granulated in another beaker and powdered in anoth Read off from the bottom of the meniscus. at the same time for it to be a fair tes
- Once the Flatustop is in we will give each beaker one sir of one revolution every 5 seconds. Until the Flatustop is completely dissolved.
- As soon as the Flatustop is dissolved we will read off the stopwatch how long it took for the Flatustop to dissolve.
- Once we have got all the measurements we will repeat the experiment 3 times, until we have 3 sets of times for dissolving each type of Flatustop.

Prediction

I predict that the powdered Flatustop will be the fastest to dissolve then the granulated and then the cube.
This is because of surface area. The cube has a relatively small surface area when compared to its mass, but the granulated Flatustop and the powdered Flatustop have lots more surface area. So the water (solvent) has more surface area to work on for the granulated and even more surface area on the powdered that the cubed Flatustop.

A	B	C

A = Cubed Flatustop
B = Granulated Flatustop
C = Powdered Flatustop

A- In 'A', the cube. The water only has a small surface area compared to its mass. So the water (Solvent) doesn't have much contact with the sugar, so consequently the Flatustop takes longer to dissolve.
B- In 'B', the granulated Flatustop there is more surface area due to the Flatustop being in smaller pieces, so the water (Solvent) has more area to work on, so the granulated Flatustop should dissolve quicker.
C- In 'C', the powdered Flatustop the water has a larger surface area to work on. So the Powder should dissolve the fastest.

Results

Weight of Flatustop (grams)	Powder dissolving time (minutes-seconds)	Granulated dissolving time (minutes-seconds)	Cubes dissolving time (minutes-seconds)
3.33	3.30	8.45	10.00
3.42	4.00	8.40	*10.45*
3.32	4.00	8.50	10.00
Average dissolving time (minutes-seconds	3.30+4.00+4.00 3 =3.50 Minutes	8.45+8.40+8.50 3 =8.45 Minutes	10.00+10.00 2 =10.00 Minutes

Italics = Anomalous result

Analysis

In this experiment I found that Powdered Flatustop dissolved first, then granulated and then cubed dissolved last. This is what I put in my prediction. I stated, that due to the surface different surface areas of the Flatustop, Powdered, then Granulated and then Cubed Flatustop would dissolve in that order, and that is what happened. But when I look at my graph, it shows a curve on cubed Flatustop, this means that cubed Flatustop dissolved quicker than expected, but was still last to dissolve. My prediction was based on the fact that the cube had the biggest surface area, and so the solvent had less area to work on to dissolve, as the powdered Flatustop had the largest surface area per mass, I expected it dissolve much quicker than the rest, which it did. But in practice, when the cube was submerged into the solvent, the cube immediately begins to fall apart into smaller pieces, roughly the same size as the powder. So the cube took a shorter time to dissolve than we expected, but still took longer as some of the cube still stayed together.

Evaluation

I think my results were accurate due to the consistency of them. I only had one anomalous result, which was 10.45, this could have been due to the fact that there were a few of us doing the stirring, and due to the fact that someone didn't stir fast enough and we all have different styles, I have discounted it from my average, so it will not alter the results. For my main experiment I can try to improve accuracy by discussing with other members of the group how to stir and we could come up with a fixed style of stirring.
Another thing the preliminary experiment has given our group are the variables we are going to use in our other two investigations, we now know, that the minimum amount of water (solvent) we can use to dissolve 3 grams in a reasonable amount of time, is 50ml. And that any amount of Flatustop greater than 3 grams would mean a longer time to dissolve which in turn would mean that our experiment would take longer to carry out.
To extend my experiment further, I am going to introduce two new variables, Heat and amount of water (solvent).

<u>I will now investigate heat to see what effect it has on dissolving times.</u>

- Rather than investigate each type of Flatustop, Powdered Granulated and Cubed. I will just choose one. I will still be able to see if the temperature affects the rate of dissolving, but by using Powdered Flatustop, that I know dissolves fastest I can save time.

Method

For Our second experiment, we will see what effect the temperature has on the rate of dissolving

For this experiment we need:

- Stirring rods.
- 100ml glass beakers.
- 1 stopwatch.
- Powdered Flatustop.
- Heat proof mat
- Tripod
- Gorse
- Bunsen Burner
- Paper towels
- 200 ml glass beakers
- Pipettes to measure out the 50ml exactly.

- Goggles

Diagram

Method

- Firstly we will weigh out the Flatustop, 3 grams of powdered Flatustop, In the preliminary experiment, we discovered that 3 grams of Flatustop was the best for dissolving in 50 ml of water (solvent)
- We will then fill three beakers up with 50ml of water (the solvent). We will measure this accurately as possible by using pipettes to get the level of the water exactly on 50ml
- We will then heat the Solvent up to its required temperature. If the temperature gets too high, we will take the Flatustop off the heat and insert it into a water bath made from the 200-ml beakers filled with water.
- Once the desired temperature has been reached, the 3 grams of Flatustop will be put in and given one stir every 5 seconds
- As soon as the Flatustop is dissolved we will read off the stopwatch how long it took for the Flatustop to dissolve.
- Once we have got all the measurements we will repeat the experiment 3 times, until we have 3 sets of times for Temperature we decided to use.

Although this experiment is not too dangerous, great care must be taken when using the Bunsen's, when heating the water. As, if the water gets too hot it may begin to spit oiling water out, so goggles must be worn to protect your eyes, and girls with long hair and students wearing ties must tie their hair/ties back to prevent them catching fire.

The variables for temperature that we have thought of are:

- 20ºC
- 30ºC
- 40ºC
- 50ºC
- 60ºC
- 70ºC

We chose them, as the lowest temperature we could have is room temperature, which is around 20ºC (If room temperature is above 20ºC we can cool the Flatustop to 20ºC by inserting it into a water bath.) Also, the highest temperature we could have, before the water starts to dissolve is, 70ºC

Prediction

I predict that as the temperature of the solvent rises, the Flatustop will dissolve faster. This is all to do with the spaces between the molecules.

A

Room temperature

B

70ºC

Take the two above diagrams for example. Both beakers are the same size, and each beaker contains the same volume of water. The only difference between the two beakers is that one has been filled with tap water at room temperature, about 27ºC, and the other beaker has been filled with tap water that has been heated to 70ºC. When looked at through the naked eye, there seems to be very little difference. And the only sign that there is any heat in the beaker that contains tap water 70ºC is the steam rising up off it. But when the water is looked at more closely (through a powerful microscope) the difference now is the space there is between the molecules. This is caused by the energy that each molecule has. In container 'A' the temperature of the water is not very high, only about 27ºC, so the water molecules do not have much energy to move about and spread themselves out. Whereas in 'B' the temperature is much higher, 70ºC. So the water molecules have more energy to move about and spread apart. In container 'B' the molecules have more energy to move about and move away from each other. So there are more spaces in between the molecules for Flatustop molecules to dissolve into, and as there are more spaces. The Flatustop can 'Find' these spaces more quickly and so the Flatustop will dissolve more quickly than the Flatustop that is dissolved in water that is cooler that 70ºC where there are not as many spaces for the Flatustop to dissolve.

Results

The results for how temperature affects rate of dissolving are as follows:

Temp of solvent	20ºC dissolving time (minutes-seconds)	30ºC dissolving time (minutes-seconds	40ºC dissolving time (minutes-seconds	50ºC dissolving time (minutes-seconds	60ºC dissolving time (minutes-seconds	70ºC dissolving time (minutes-seconds
	5.00	4.30	3.45	1.58	1.59	1.20
	5.10	4.38	3.20	*2.26*	1.47	1.32
	4.58	4.28	3.36	1.50	1.56	1.28
Average	**5.03**	**4.32**	**3.34**	**1.54**	**1.42**	**1.27**

Italics = Anomalous result

Analysis

In this experiment I found out that as the temperature of the solvent increases, the time taken for the Flatustop to dissolve decreases, this means my prediction that stated, 'as the temperature of the solvent rises, the Flatustop will dissolve faster.' Was correct.

This is because of the amount of energy the solvent has at each temperature. When the temperature is low, 20ºC, the solvent does not have as much energy to move about, so there are not as many spaces between the molecules for the Flatustop to dissolve into making the time that the Flatustop takes to dissolve longer. But when the temperature is high 60ºC the solvent has more energy to move about, so the gaps between the Molecules of the solvent are greater, so the Flatustop has more places to dissolve and so it dissolves quicker.

I can tell the Flatustop is affected by temperature by looking at my graph, the graph shows a definite downward trend as the temperature increases, the time taken to dissolve decreases. The graph also shows me that at the start. The decrease in time taken to dissolve was very sudden, from 20ºC to 40ºC 1 minute 29 seconds was taken off the time taken to dissolve. Whereas over the same range from 50ºC to 70ºC the decrease in time taken to dissolve was only 27 seconds, this shows me that the solvent gains energy very quickly at the start. But at the end, the energy held was still more, but not as big an increase as before. This shows that water is not very good at storing heat, and at one point there will be a Plato, that is, a point where the time taken for the Flatustop to dissolve does not either increase or decrease. But with water, it is doubtful whether this Plato could be reached before the water starts to evaporate off and affect the results.

Evaluation

I thought the experiment I carried out was very successful. I only had one anomalous result which was at 50ºC on the second time the experiment was carried out, this reading was 2.26 minutes which was obviously way out of the other two results which were reasonably close together, they were 1.58 and 1.50 minutes. The reading of 2.26 minutes was not included in the average, as it would make the average and consequently the graph higher than it should be. This anomalous result was probably due to the fact that one of us was stirring slower than the rest of us. Although I was very pleased with the method (as we only got one anomalous) I think I could improve it. When we were heating the water, and got close to the temperature we wanted we took the beaker containing the water off the heat and put it on a heatproof mat. But the temperature of the water continued to rise, so we had to put the water in a water bath to decrease the temperature. If I did this experiment again I would heat the water more gradually to make temperature changes not as dramatic.

I will now investigate how the amount of solvent effects the rate of dissolving

Method

For Our Third and final experiment, we will see what effect the temperature has on the rate of dissolving

For this experiment we need:

- Stirring rods.
- 100ml glass beakers.
- 1 stopwatch.
- Powdered Flatustop.
- Bunsen Burner
- Pipettes to measure out the amount of solvent exactly.

Diagram

Method

- Firstly we will weigh out the Flatustop, 3 grams of powdered Flatustop, In the preliminary experiment, we discovered that 3 grams of Flatustop was the best for dissolving in 50 ml of water (solvent)
- We will then fill three beakers up with the desired amount of water (the solvent). We will measure this accurately as possible by using pipettes to get the level of the water exactly on the chosen amount of ml.
- Then 3 grams of Flatustop will be put in and given one stir every 5 seconds
- As soon as the Flatustop is dissolved we will read off the stopwatch how long it took for the Flatustop to dissolve.
- Once we have got all the measurements we will repeat the experiment 3 times, until we have 3 sets of times for Temperature we decided to use.

Although this experiment is not too dangerous, care must be taken when using the glass Stirring rods, as if they are held too tightly or dropped on the floor they could smash

The variables for amount of solvent that we have thought of are:

- 50ml
- 60ml
- 70ml
- 80ml
- 90ml
- 100ml

We chose these amounts, because there are six readings, the minimum amount of readings we could have would be five readings. And we found in our preliminary work, any amount of water that has less volume than 50ml takes too long to dissolve, and if we were to go any higher than 100ml, the water would overflow.

Prediction

I predict that as the amount of solvent in the beaker rises, the time taken for the Flatustop to dissolve completely into the solvent will decrease. This is all to do with the amount of spaces there are in the Solvent.

A

B

10ml of water

100ml of water

Take the above two beakers for example, the beaker size is the same, the temperature of the solvent is the same, the only difference is the amount of water contained in each beaker. Container A has more water in than container B. This may not seem too important until you think of the amount of molecules contained in each beaker. In beaker A, there are fewer molecules than in beaker B. And so there are fewer spaces for the Flatustop molecules to dissolve, and as there are less spaces for the Flatustop to dissolve, the time taken for the Flatustop molecules to 'find' these spaces increases and consequently the Flatustop molecules take longer to dissolve.

Results

Volume of solvent	50ml dissolving time (minutes-seconds)	60ml dissolving time (minutes-seconds	70ml dissolving time (minutes-seconds	80ml dissolving time (minutes-seconds	90ml dissolving time (minutes-seconds	100ml dissolving time (minutes-seconds
	3.50	3.00	2.40	2.20	2.05	1.50
	3.42	3.09	2.38	2.22	2.07	2.00
	3.59	2.50	2.47	2.18	2.09	1.57
Average	**3.50**	**3.00**	**2.42**	**2.32**	**2.07**	**1.56**

Italics = Anomalous result

Analysis

In this experiment I found out that as the amount of solvent increases, the time taken for the Flatustop to dissolve, decreases. This means my prediction that stated, 'as the amount of solvent in the beaker rises, the time taken for the Flatustop to dissolve completely into the solvent will decrease' was correct.

This is because of the amount of spaces there are in the Solvent, which is in this case water. When there is a small volume of water, e.g. 10ml, there are less spaces for the Flatustop to dissolve into and because there are less spaces, the Flatustop takes longer to dissolve. Whereas in a Beaker with 100ml of solvent, there are more spaces for the Flatustop to dissolve into and consequently, the Flatustop is quicker to 'find' these spaces and therefore takes less time to completely dissolve

I can tell Flatustop is affected by the amount of solvent it is dissolved into by looking at my graph. The graph shows a curve that curves to produce a semi 'U' shape, with the biggest value at the left, so as the amount of solvent increases, the time taken for the Flatustop to dissolve decreases. Contrary to what the temperature graph was like, on this graph the decrease in time is not as sudden as a shallower curve is shown. This curve is to do with the number of spaces between the molecules, and that the Flatustop dissolves in these spaces if there are more spaces between the molecules, then the Flatustop will 'find' these spaces more quickly and the time taken to dissolve decreases. As with the other graph, there will be a point where there is no more decrease in the amount of time the Flatustop takes to dissolve. This point is called the Plato, as if the time continued to decrease the Flatustop would dissolve before you put it in the water!

Evaluation

I thought the experiment I carried out was very successful. I had no anomalous results, I can tell this because all my results that we got were close together so there were no mistakes in our method. Because our results were very close together I can tell our method was accurate, as we finally perfected stirring. I was very pleased with the method, and as got good results, I would say the method wouldn't need changing.

I will now do a broad analysis for all three experiments.

Evaluation

Overall I think the entire experiment went very well over the three parts of how surface area effects rate of dissolving, how temperature affects rate of dissolving and how amount of solvent affected the rate of dissolving. I was very pleased with all of my methods as they got very good results.

If I was to repeat this entire experiment again and if I had unlimited money to carry out the experiment I would use the very latest technology to make this experiment more accurate. I would buy an electromagnetic stirring machine that stirred at a constant speed to make the affair of everyone stirring at their own speed a thing of the past, which would of course improve accuracy.

Another improvement in accuracy would be to incorporate a digital thermometer this would be accurate up to two decimal places making reading the temperature easier to read and dispelling human inaccuracy.

In the experiments, we have been using our eyes to see whether the Flatustop has dissolved or not. This has been a very hit and miss affair as we all have different thoughts about whether the Flatustop has dissolved or not. To solve this problem I would use an infa red beam that tells you exactly when the Flatustop has been dissolved.

When measuring out water, we have used measuring cylinders, these are relatively accurate, but if the person who is measuring the water out reads the number wrong, the accuracy of the experiment will suffer. To solve this problem we could use a machine that measures out the water exactly, and the water could be weighed to ensure accuracy.

The scales we used were very accurate but there are more accurate scales on the market that will measure even more accurately than 2 decimal places. These newer more accurate scales would mean the experiment was more accurate.