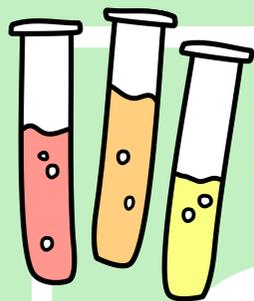


THE

GREEN⁷

F⁸ORMULA⁵⁷



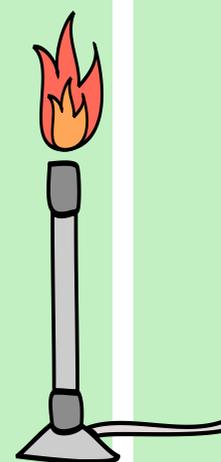


The Green Formula (2018), list of authors and contributors:

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**Green
Chemistry**
Centre of Excellence



2

Introduction



Interviewer: Good morning and welcome to the breakfast show on radio Bellfield; today we are joined by some very special guests. Our very own child geniuses and NATS entrants, a very warm welcome to all of you.

Interviewer: NATS, I don't even know what it stands for?

Morgan: Ooooh I know! NATS stands for National Awards for Technology and Science!

Johanna: Wow Morgan, I am surprised you know that.

Charlotte: To be fair, I have only just learnt what it stands for.

Johanna: I am sure Harrison knew what it stood for.

Harrison: Of course I did.

Charlotte: Anyway, each school picks a team to go to NATS where they do a presentation in front of a massive audience-

Morgan: Like a celebrity!

Charlotte: Sadly without all of the perks.

Harrison: It was worth it though, the topic they chose this year was great!

Morgan: GREEN CHEMISTRY

Charlotte: No need to shout...

Johanna: I don't blame him for getting excited, it is a really important topic.

Interviewer: Yeah it is very important, I always make sure that I do my recycling! It all sounds very exciting, is this the first competition you have all entered?

Morgan: I have been in a couple of gaming competitions...not won any yet. I've never done anything like NATS before.

Charlotte: Morgan, technically they aren't gaming competitions, it's just you and your friends playing on your games console in your bedroom.

Morgan: It is not just a games console, it is a Redemption!

Johanna: Well, I have won real competitions. You name it, I have won it! Football, tennis, debating, hockey, dance-

Charlotte: Ok Johanna, we all know you are really talented, I have won some of those too.

Morgan: You certainly are competitive when it comes to the amount of makeup you wear.

Charlotte: It is a good job I know you are only joking, what about you Harrison?

Harrison: I have never really done many sports competitions but secretly I am a table tennis champion.

Johanna: Oh, I never knew that, maybe you should play against me some day. I am quite impressed, but just to warn you I am known as 'Johanna - the destroyer'.

Harrison: Game on! I have also entered chess competitions, and have done a couple of science ones in the past, so I reckon I have the most experience.

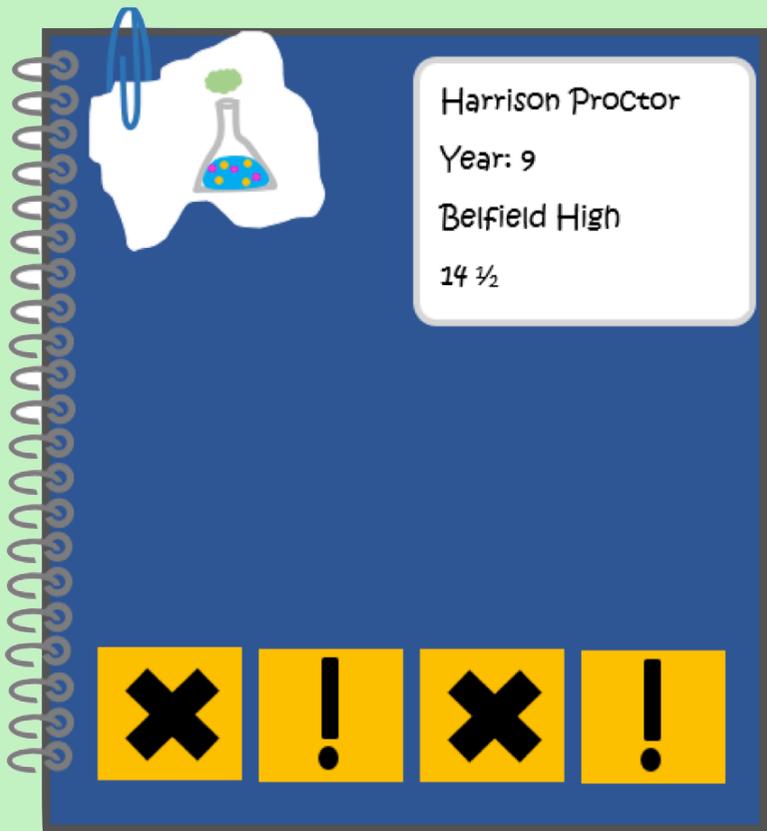
Morgan: Everyone always says you are the real scientist anyway!

Interviewer: I am sure our listeners are dying to hear all about how you got on, why don't you tell us what happened?

2 months earlier...

3

Week 1: Harrison



Monday 15/01/2018 4:34pm

Due to the fact that I am now a year 9 student, I thought it was about time I started writing about my day to day life.

You see, in the future when I am a famous scientist, when I am discovering new elements and solving all of the world's problems, I am sure people will want to read all about how I grew up.

This could be my time to shine! This morning they announced that they are holding a science competition for all year 9 students!! I can't wait to get started!

My first lesson was maths, this year we have Mrs Norbert. I don't think you can even begin to guess how old she is...



Charlotte Smith is sat in front of me, it looks like she may have had a haircut over summer actually...

Grandma just shouted - my tea is ready. I am not going to be late, she has made my fave!

Monday 15/01/2018 5:56pm

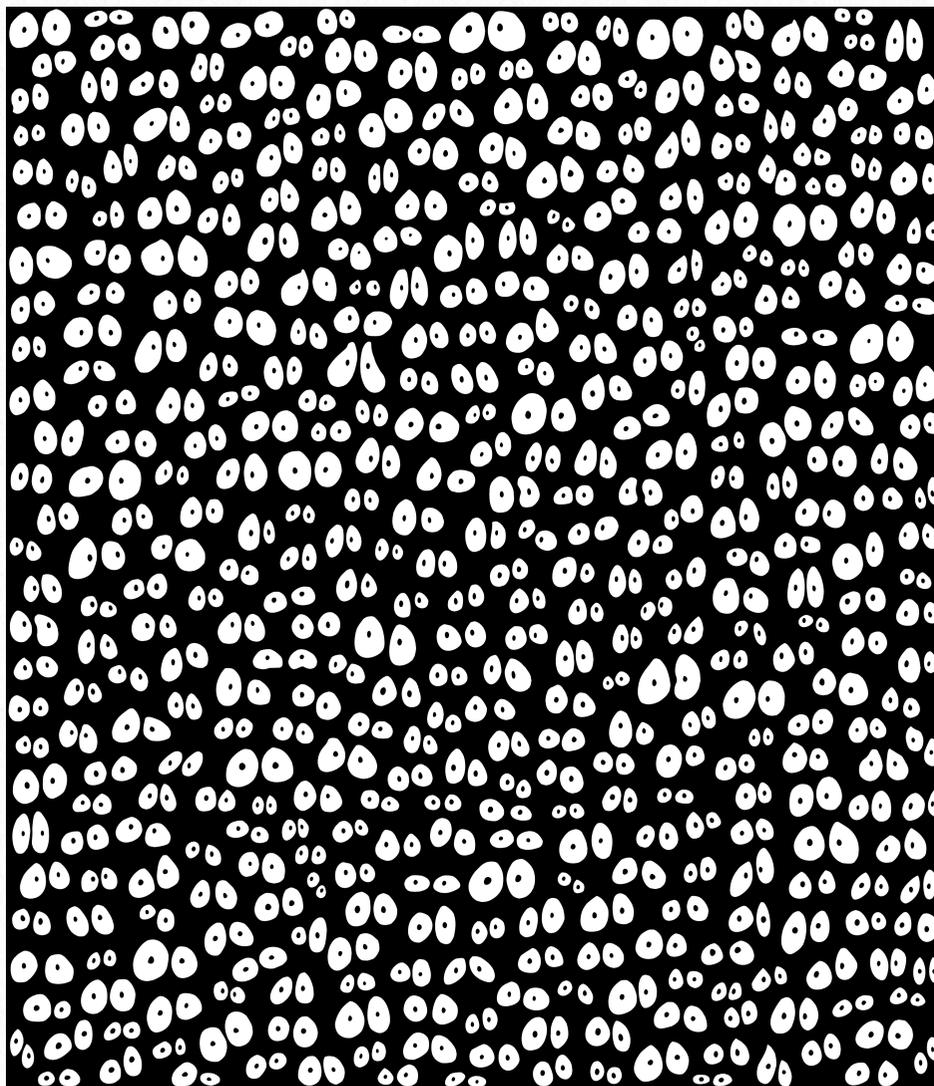
Well then, that was interesting.

As soon as I mentioned the science competition to Grandma, she was so eager for me to enter it.

I wasn't so sure.

What if I have to accept the prize in front of the whole school?

I tried explaining to her how scary it would be having 800 people looking at me. 800 people, that is 1600 eyeballs all ogling at me!!!



Well I suppose that's it for today, I am going to start doing a little bit of research in preparation for the sign up tomorrow.

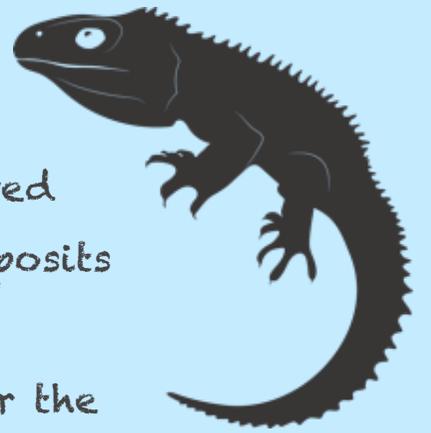
Grandma has managed to dig me out a notebook for me to write down all my research in...

Fossil fuels are running out!

Fossil fuels are formed from the remains of organisms that lived millions of years ago, and are buried deep underground as deposits beneath many layers of rock.

They include coal, oil, and natural gas, and have been used for the past 100 years. Since it takes millions of years to make fossil fuels, they will one day (very soon) run out.

Luckily we have found alternative sources of energy through renewable methods, such as solar and wind power.



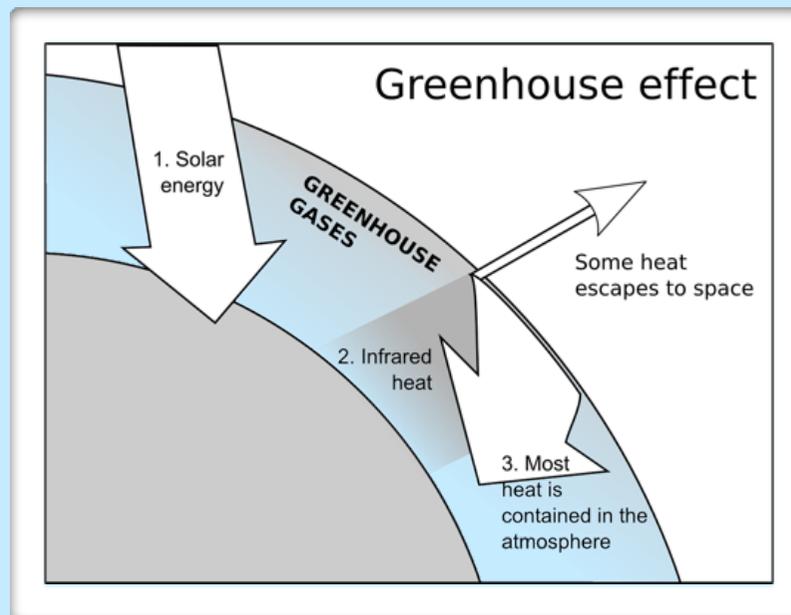
The greenhouse effect

The sun is a big ball of energy that emits radiation, which travels towards earth. Some of this radiation is dangerous, but our atmosphere protects us by either absorbing it, or reflecting it back out into space. The remaining radiation is absorbed by the earth's surface, heating it and some of this is then reflected back out into space as heat.

Gases that absorb the radiation are called greenhouse gases, because they trap heat in the atmosphere in the same way that a greenhouse is warmed up by the sun (this is called the greenhouse effect). Greenhouse gases are a natural part of the earth's atmosphere and have been around since its formation.

Global warming

If the earth didn't have an atmosphere, and no heat energy was absorbed, then it would be far too cool to support life. Recently however, there has been an unnatural increase in the amount of greenhouse gases in the atmosphere due to human (anthropogenic) activity. This means that the earth is heating up at an unnatural rate which is having a catastrophic impact on the environment. This is called 'global warming'.



Examples of greenhouse gases are:

CO₂ (carbon dioxide) emitted by respiration and burning of fossil fuels.

CH₄ (methane) emitted by coal mining, production of natural gas and cattle farming

NO_x (nitrogen oxides) emitted from cars.

Consequences of climate change include: ice melting in the Arctic and Antarctic, ocean warming and changes to the habitats of certain species. There could also be a lack of food as it may cause problems with agriculture (farming), more intense storms and sea levels rising.



The carbon cycle

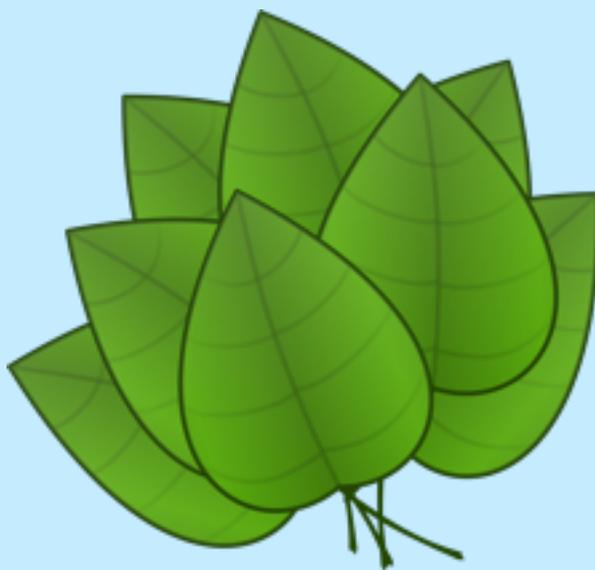
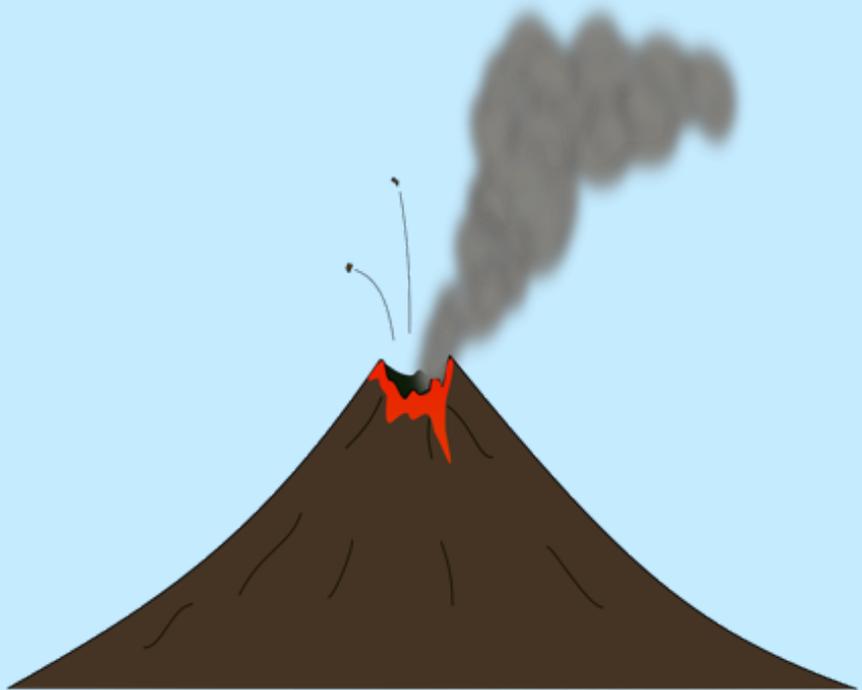
Carbon is an important element present in lots of different molecules. Since the amount of carbon on earth is fixed, it has to be recycled so that it can be used again. For example, when an animal dies, its body breaks down and returns to the soil where the carbon is deposited.

Sources of CO_2 are:

- Burning fossil fuels
- Industrial processes
- Volcanic eruptions
- Plant and animal respiration

Removal of CO_2

CO_2 is taken out of the atmosphere by plants in a process called photosynthesis. The plants use the carbon in CO_2 to make food, and a by-product of this is oxygen (which is released into the environment and used by us to breathe!)



Tuesday 16/01/2018 5:18pm

To get to the sign-up sheet I had to push my way through a crowd!

And guess whose name was pristinely written right at the top of the sheet?

Johanna's.

She has a bit of a reputation at school for being ultra competitive. I don't know if it is something to do with the fact that her mum is the headteacher.

One thing for sure - she struggles to make friends.

You know what would be even better though! Maybe her not getting an A*** in every single test! It would at least make her less arrogant!

Even though I will be competing against Johanna - I have decided to stick with doing the competition.

Hey, perhaps I could invent a new compound. One that turns her skin green and covers her in boils every time that she bosses someone around!

On the way home from school today I made a quick stop off at the library; me and Jonny walked there after chess club.

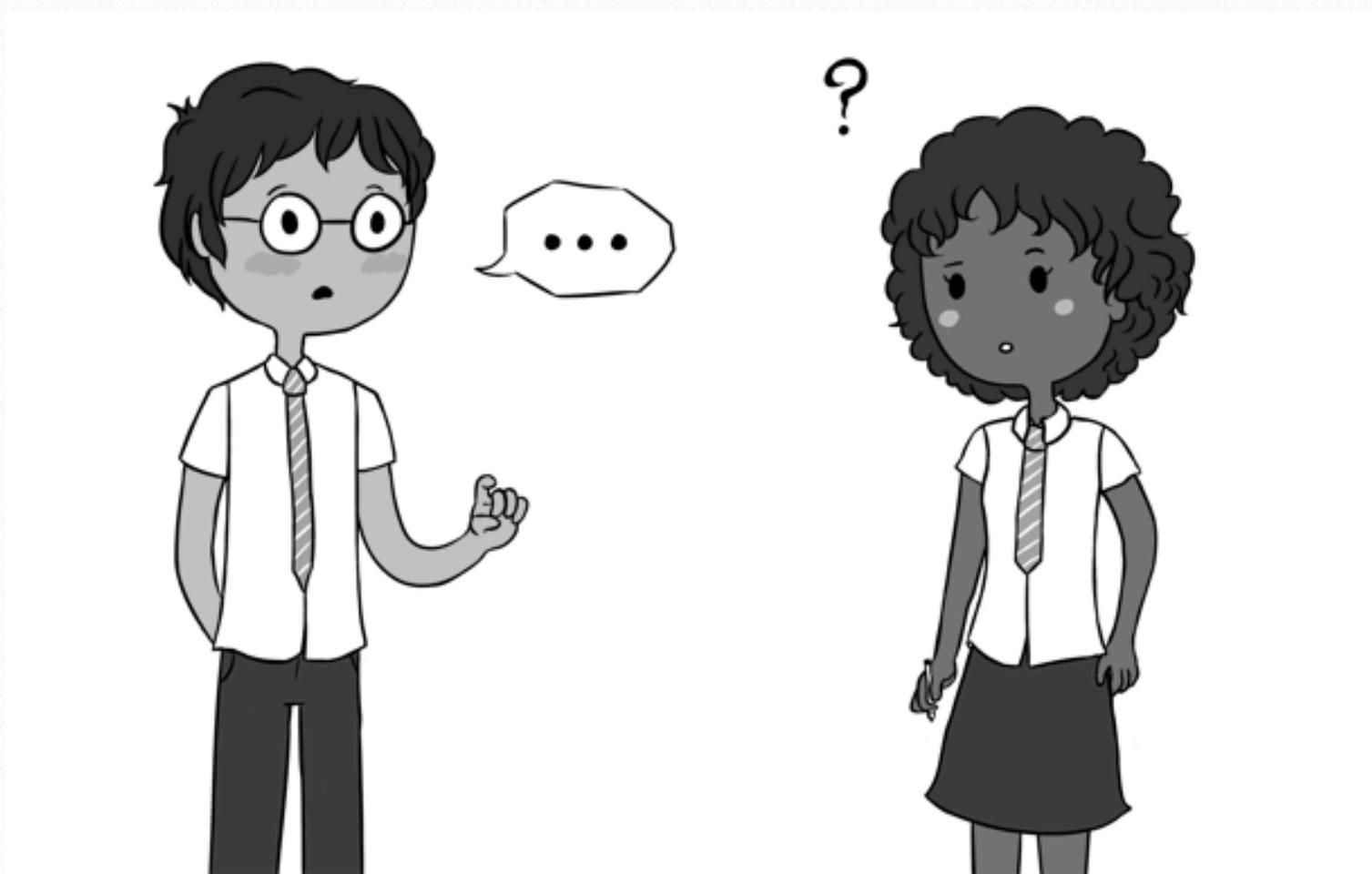
After searching for a good 20 minutes, we found a whole shelf in the library dedicated to green chemistry! I grabbed the two biggest books I could find and rushed home to make a start on them.

Wednesday 17/01/2018 4:15pm

Today has just been one of those days.

It all started this morning as I was walking to class. I thought it was be a good idea to wander over to the sign-up sheet and have a look to see who else had signed up.

I spun round to head towards the sheet and came face to face with Charlotte.



Panic.

She told me she was entering and asked if I was signing up too (even though my name was already up there).

And you know what my response was?

I panicked and ran off to class leaving Charlotte wondering what on earth I was doing. Played it really cool there.

Well done Harrison, at least I can take my mind off today with some research, after all it's only 2 more days until the poster is due in.

Thursday 18/01/2018 4:29pm

I can't believe the deadline for the poster is tomorrow!

I haven't even started it yet!

I think Morgan was actually the last one to sign up for the competition so I have no idea how he is going to have his poster ready.

After I spent all last night researching, I have decided to include recycling in my research project along with all the bits about fossil fuels and the environment.

Last night I found this great website about, how much rubbish the human race produces. It's absurd. But do you know what the crazy thing is?

There are loads of ways for us to turn our waste into something useful!

I decided it is about time recycling came to school. I thought if I could get the school started on recycling then it would soon catch on and before you know it the WHOLE of Bellfield will be doing it!

After getting a few funny looks in registration for carrying around two old, smelly boxes I went to English. Mr Thomsins sat us all down and did his usual disappearing act for 5 minutes.

Rumour has it that he goes to make a cup of tea at the same time every morning just so that he gets to say hello to Miss Flowerby.

As soon as that classroom door shut, I rushed to the bin and started to sort the rubbish into my two boxes.

I must have been concentrating too hard on sorting the rubbish as the next thing I felt was a dark presence looming over me.

Needless to say, Mr Thomsins was baffled as to why one of his year 9 students had decided to root through his classroom bin and take all his rubbish. In the excitement I may have failed to notice all the rubbish that had missed my boxes.

Mr Thomsins wasn't best pleased.

An old, mouldy yoghurt pot had managed to hit his desk and explode all over our classes work.

I tried to explain my idea, and that the yoghurt pot was actually meant to land in the cardboard box. He didn't seem convinced.



Mrs Evans was extremely understanding about the whole thing, she understood what I was trying to do and thought it was a brilliant idea!

I just maybe went about it the wrong way.

I told her all about my project and explained my new found love for recycling. She thought that controlling fossil fuel use, the greenhouse effect and recycling were all really important issues; she even went on to say a project based on them is a 'Fabulous' idea!

Right, I best start my poster before it gets too late. I've got a perfect picture in my head of what I want it to look like, let's just hope that I can recreate it on paper!

Friday 19/01/2018 17:05pm

Well I've just about managed to survive the first week of year 9 - on the whole it has been a really good week. The start of the science competition may have been intense, but I cannot wait to hear if I manage to get through to the next stage. Let's not forget Mrs Evans said my idea was a Fabulous one!

I think Jonny is coming over tonight, we are going to try out his new chess software and see if we can both become undefeated school champions! We just have to make sure we never play each other...

Thinking about it now, I have been so busy with the science project I don't think I have actually seen him at school this week.

Friday 19/01/2018 9:05pm

Jonny still hasn't come round. I don't think he will be coming now it seems a bit too late.

I'm sure that he will have a good explanation.

I printed an extra copy of my poster and am going to stick it into my notebook. A scientist's notes should always be complete!

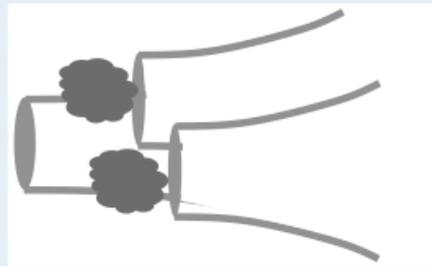
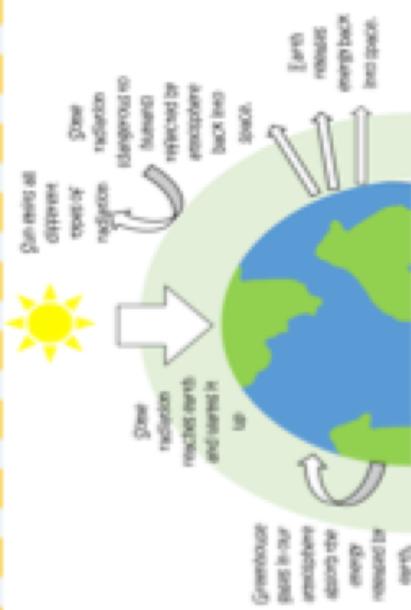
Fossil fuels & The Future

TRISON

Fossil fuels need many years to form. A lot of the fossil fuels on earth have already been used up, to

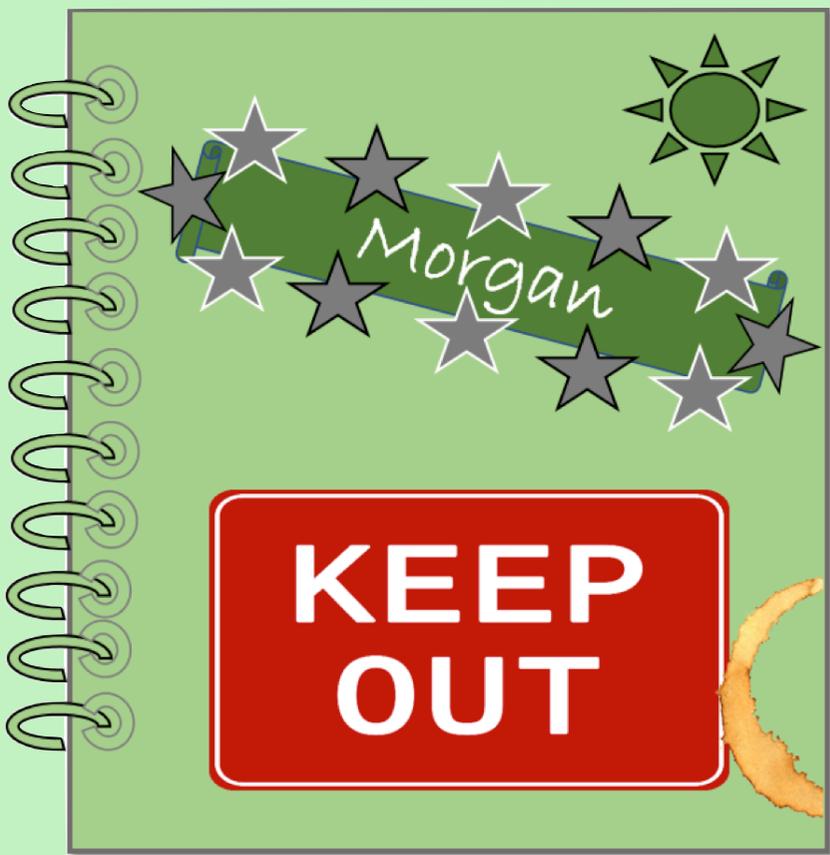
Fossil fuel - crude oil, natural gas and coal are all examples of fossil fuels, they form over millions of years. They are made of hydrogen and carbon and therefore are called hydrocarbons.

Greenhouse effect:



4

Week 1: Morgan



Day 1:

I really need to start writing in this more. Maybe if I had more exciting days, I would have more exciting stuff to write about? Although, surely, this would leave me too busy doing the exciting things to actually keep a successful diary.

If you think about it, I can't really win.

Today is going to be so so so exciting!

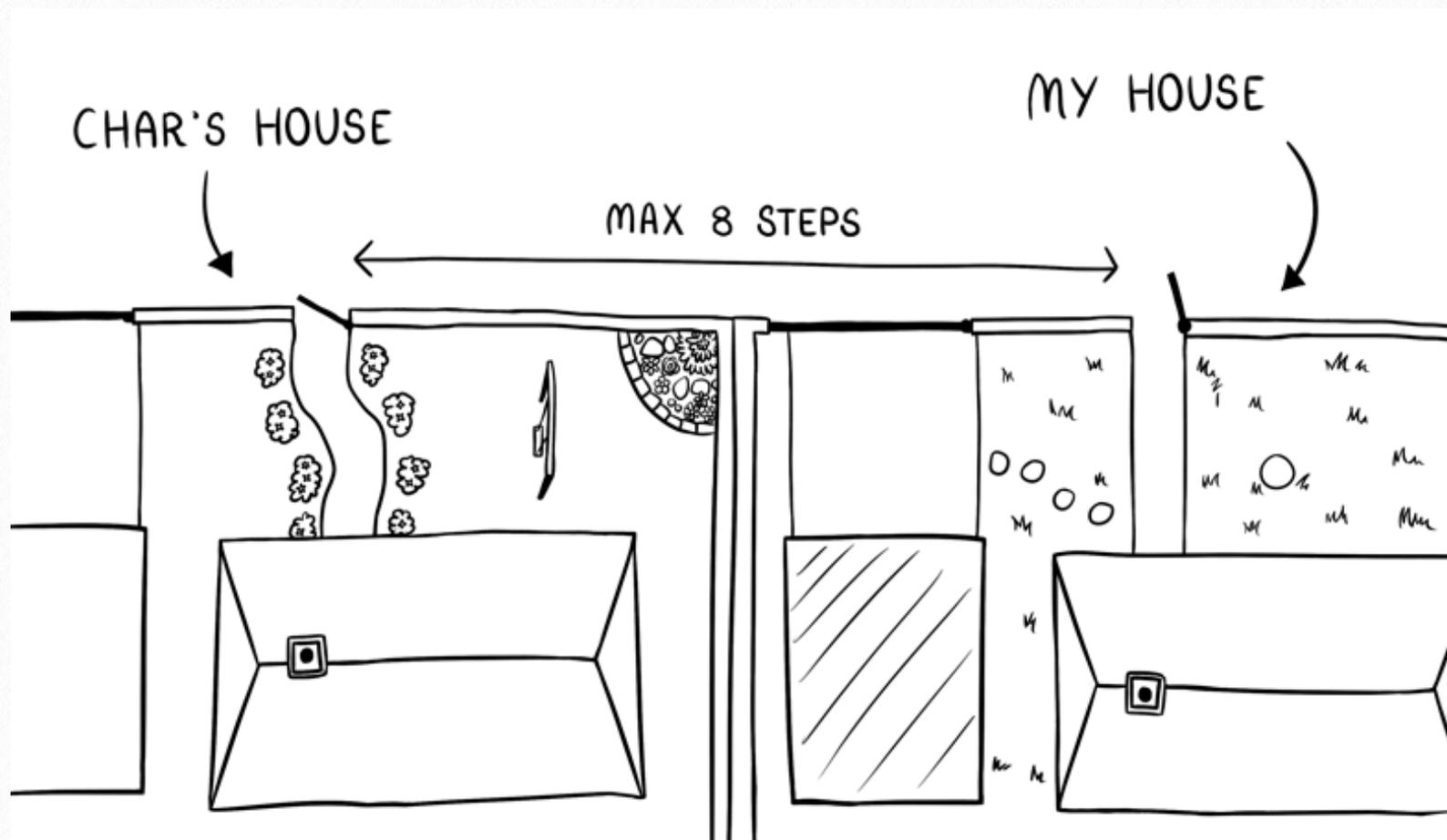
The new Warfield game is out!! It's gonna be AMAZING!!!

I have heard that you can have up to 100 people in the same online game at any given time - it's amazing how they do that. However there is some bad news, I still don't have enough money to buy it. So technically, it's not exciting news. Not until I manage to convince Dad anyway.

Anyway, I'm rambling.

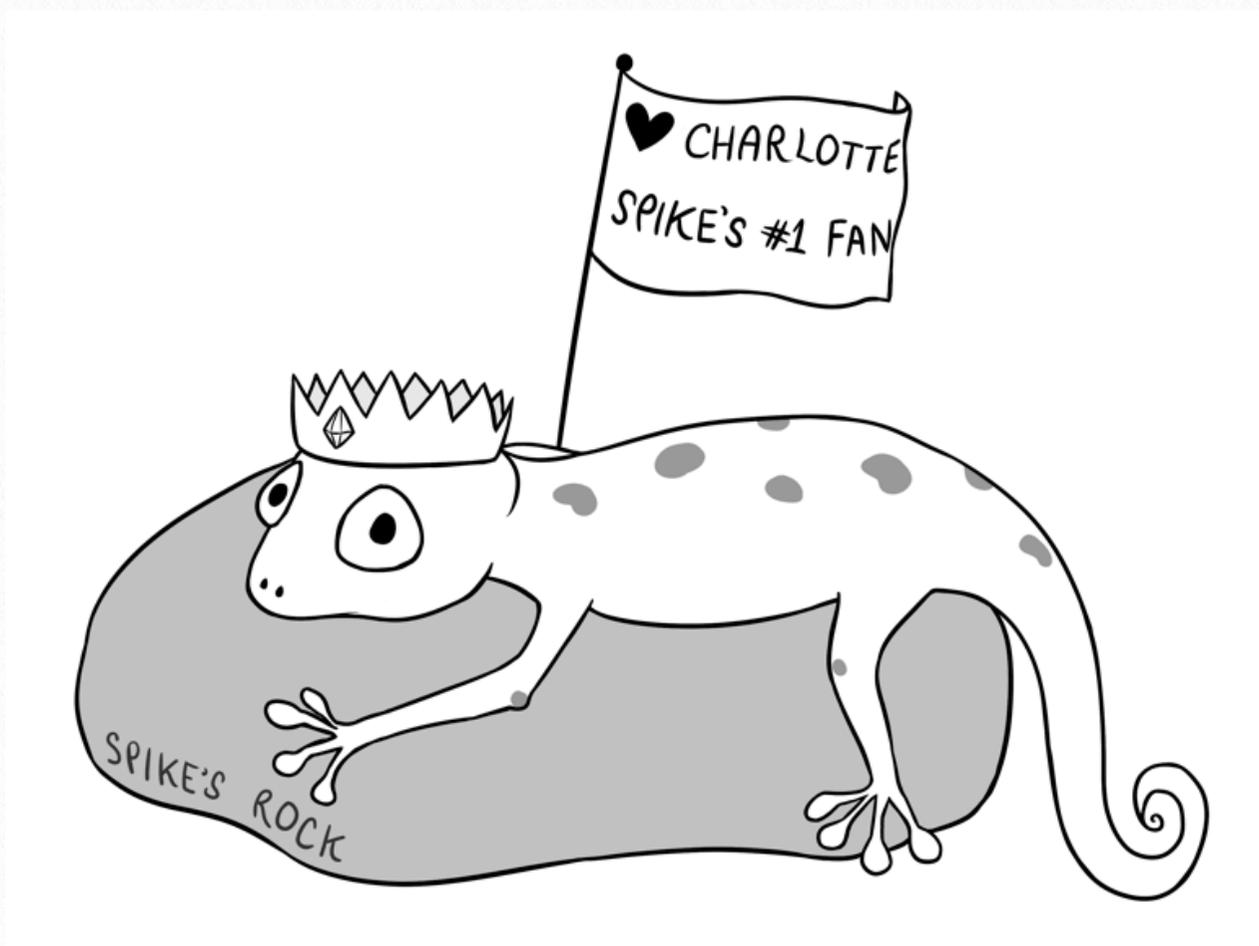
If this is a diary, surely I need to write about my day? Rather than just splurge my thoughts from pen to paper. Alright, here we go:

As usual, I walked home with Char (her real name is Charlotte but she hates Char - so that's obviously what I call her).



I still feel pretty lucky to have her as a neighbour. Everyone says I'm so lucky to be so close to her. She's pretty I guess... but she's just Char to me. Oh and she has grown to absolutely love Spike. I mean, who doesn't. Saying that, she ran for the hills when she first met him. I had never heard anyone scream so loud!

Now I can't separate the two!



Spike doesn't exactly have it rough.

She followed me in to hang out for a bit (and obviously, to see the one and only lizard king himself). She mentioned this science competition thing and even started looking stuff up for it. I had a quick look but it all looked quite complicated.

Char is always trying to get me involved in this kind of stuff, I could always sign up with her I suppose? I am sure I would be able to find something exciting to write about? I was originally thinking more bungee jumping than a science project, but hey-ho, all good adventures have to start somewhere.

Day 2, entry 1:

Today in a nutshell:

Good News:	Bad News:
I've managed to write in my diary 2 days straight	FORGOT to meet Char this morning
Got to be lab partners with Connie Erikson and made her laugh, twice	FORGOT to sign up for the science project
	FORGOT my maths homework and had to stay behind after school

So, overall I'm on -1 for the day (2x good – 3x Bad).

Day 2 entry 2:

Surprise surprise! Char was over for dinner! Seen so much of her the last few days, this means:

- a) I could apologise for forgetting to meet her this morning
- b) I can erase it from the bad column in the table
- c) This brings my overall score for the day back to 0 (2x Good & 2x Bad)

Mum made meatballs and it was the best thing ever. I really should have invested in a bib; I ate it in record time, with record spillage. Char didn't look very impressed.

I could tell she had forgiven me because she helped me try to fix the redemption. She hates all that kind of stuff.

Sadly, it didn't exactly go to plan.

Char did the research and found out that I need some expensive metal thing. I said maybe she could do her project on those metals so I could be in with a chance of getting my redemption fixed!

The strange thing was, she seemed genuinely interested in the console, I couldn't even tell if she was just trying to be polite or what.

Day 4:

I didn't get chance to write yesterday, BUT, hear me out. I wrote twice on Tuesday, so that's fine. Right?

Oh and I signed up! I signed up for the science project! Turns out it's for green chemistry, so essentially I'm writing about how to save the world. Sounds kind of like a task for a super hero, let the exciting stories begin!

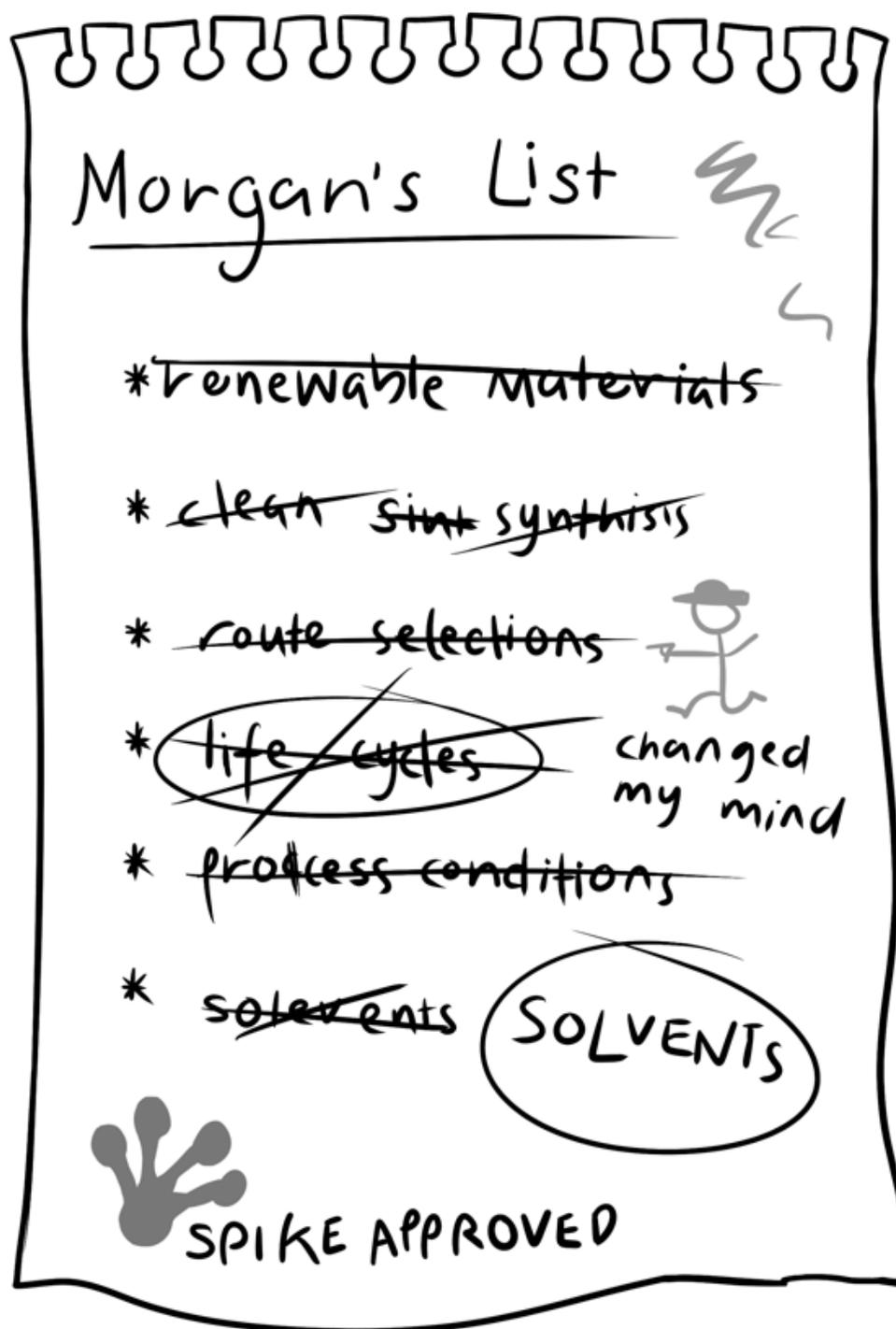
I'll admit, I didn't start the day very super, actually slightly villainous to be honest. When I was running to sign up (shocker, I was late), I may have accidentally knocked Johanna. All I had time for was a quick sorry, it shouldn't be a huge issue.

It was only a little bump...



I hope she doesn't mention it to her mum. I really can't be dealing with another after school detention, especially for something as boring as running in the corridor.

Anyway, now it's time to talk about my project! So many choices!



Solvents it is then! Apparently they can be quite dangerous so it should be exciting. Let's see if I can get some research done for my poster...

Introduction to Solvents

A solvent is a liquid used to dissolve another substance. We can think about sea water to understand this and some other key terms:

A solvent is the liquid in which a solute dissolves e.g. the water in sea water

A solute is a substance being dissolved in a solvent e.g. salt in water

A solution is a mixture formed when a solute is dissolved in a solvent e.g. sea water

If a substance is soluble then it will dissolve in a given solvent e.g. salt dissolving in water

If a substance is insoluble then it will not dissolve in a given solvent e.g. sand does not dissolve in water



Why do some substances dissolve and others don't?

To understand why some things dissolve and others don't, let's have a look at dry cleaning as an example. This is a process where stains are removed from clothes using an organic solvent rather than water.

Intermolecular forces are the forces acting between molecules, and they are responsible for 'sticking' them together. As the molecules that make up the stain are similar, they exert similar forces and so are attracted to each other. This means that it is difficult to break up and remove the stain from clothing.



In dry cleaning, solvents are used that have similar molecules to those in the stain. Therefore the intermolecular forces between the stain and the solvent are similar to those between the stain molecules themselves and hence the stain molecules are able to be separated from each other and dissolve in the solvent, removing them from the clothing.

Solvents must be chosen appropriately so that they are effective. If the wrong solvent is chosen for dry cleaning, clothes could become damaged, remain dirty, or even become contaminated.

Day 5:

This morning was crazy! I had the most surreal dream. I woke up. Nice and normal. Looked over at the alarm clock. 11:30am!

I just felt my heart sink, I had this really horrible wobbly feeling in my stomach. After panicking, I grabbed my poster and legged it to school.

I missed the hand in for the poster. I couldn't believe it!

The sinking feeling just got worse.

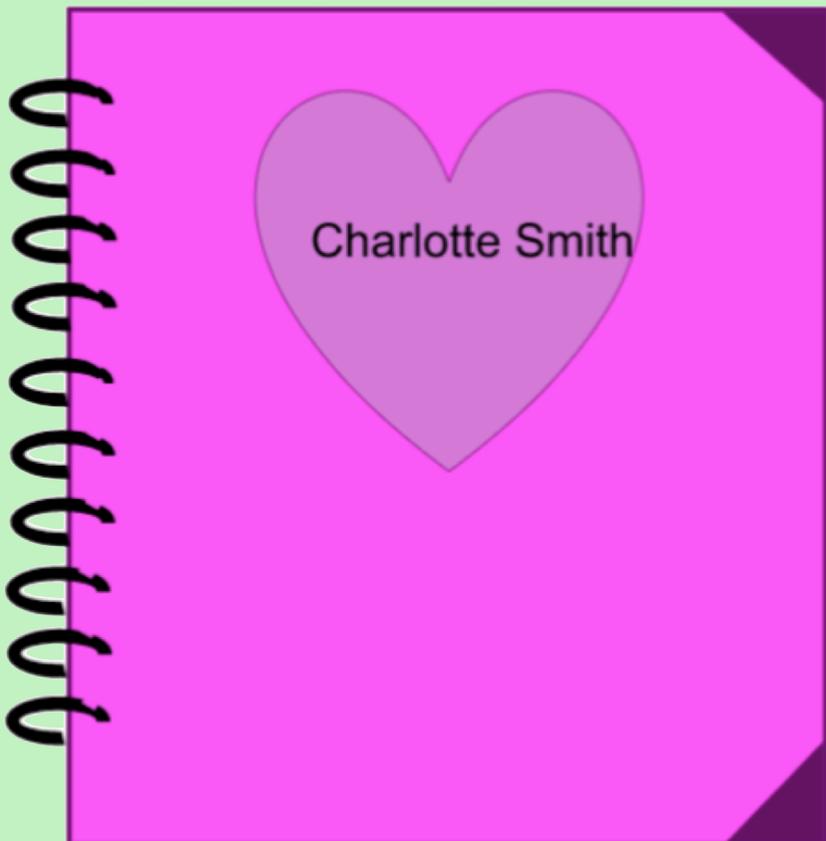
I woke up sat bolt upright in my bed. In reality It was 6:20am, I had hours until the hand in deadline. Phew!

Just the thought of that horrible feeling of being late pushed me to get out of bed and hand this thing in as soon as humanly possible! I couldn't risk it! I said goodbye to spike and set off for school about an hour earlier than usual.

When I approached the hand in letterbox, there was no-one to be seen, I think I might have actually been the first one! Genuinely felt good to be on top of things for once, I even had time to go to the computer rooms and play a few games...maybe I should start doing this more often.

5

Week 1: Charlotte



Monday

5:13 pm

I can't believe the summer holidays are over already!

To make it worse, we had a school assembly first thing this morning. What a bore. I guess it wasn't so bad though; it was only information about some science competition. I wouldn't usually enter it but if you win you get to go to this big nationwide competition, which sounds like it could be cool.

Another bonus is you get to miss a day of school. I spoke to Morgan about it on the walk home; he didn't have a clue what I was talking about.

Clearly someone wasn't listening on his first day back.

8:48 pm

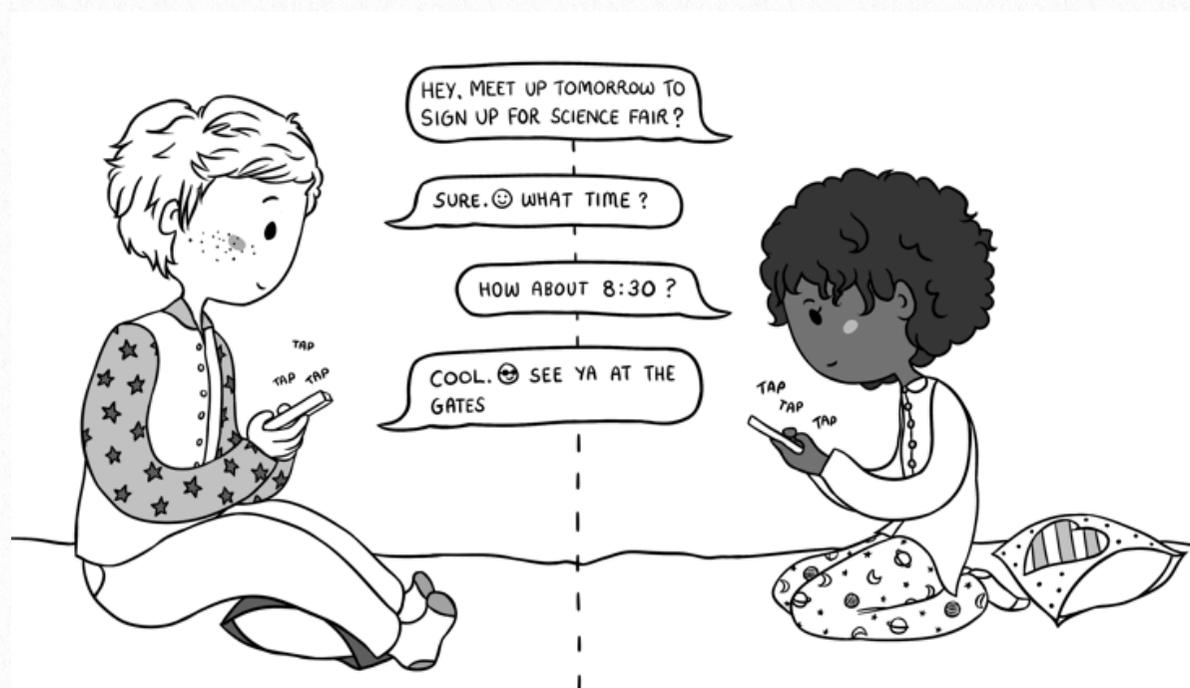
I went next door after dinner so Morgan and I could do some research together.

When I say together I mean that I did some research and he just played with his lizard, Spike.

Although, I think I might have convinced him to sign up with me. I did catch him reading over my shoulder at one point, so he must be interested.

When I got home there was a package on my bed, it was my new hair straighteners! I can't wait to try them out in the morning. Maybe I'll see if Sarah wants to come over tomorrow so I can do her hair.

They'll definitely be loads better than the ones she has.



Tuesday

9:14 am

Guess what?

I waited 20 minutes at the school gates for Morgan this morning and he never turned up! He's not even apologised! It's so typical of him; I know that he's unorganised but he can be so RUDE sometimes.

He'll have to go by himself now - I've already signed up.

12:37 pm



I saw an advert for some great new eco-friendly makeup. I don't want to spend all my allowance on it so I think I'll ask Mum to buy me some. Maybe I could even say it's research for my science project to help convince her.

After school I really want to go home and start researching for my project - the eco-friendly makeup is definitely a winning idea. The only problem is Mum is working late today so I have to go over to Morgan's house for dinner. I still haven't forgiven him for this morning!

Hopefully he'll just sit on his games console and I won't even have to talk to him.

9:18 pm

Morgan finally apologised and his Mum made my favourite pasta dish for dinner so I guess it wasn't such a bad evening overall. I text Sarah about my eco-friendly makeup idea and she thought it was really good, might even win - she better not try and steal it!

After dinner I tried to talk to Morgan about his project but he was too busy playing on his games console, as per usual. I don't think he would have spoken to me at all if the stupid thing hadn't broken. I guess it serves him right!

We had a look online to see if we would be able to fix it but it would be way too complicated, you need all these really expensive parts made from rare elements. It even said that if some elements run out we might not even have smartphones any more, imagine that!

What a N I G H T M A R E.

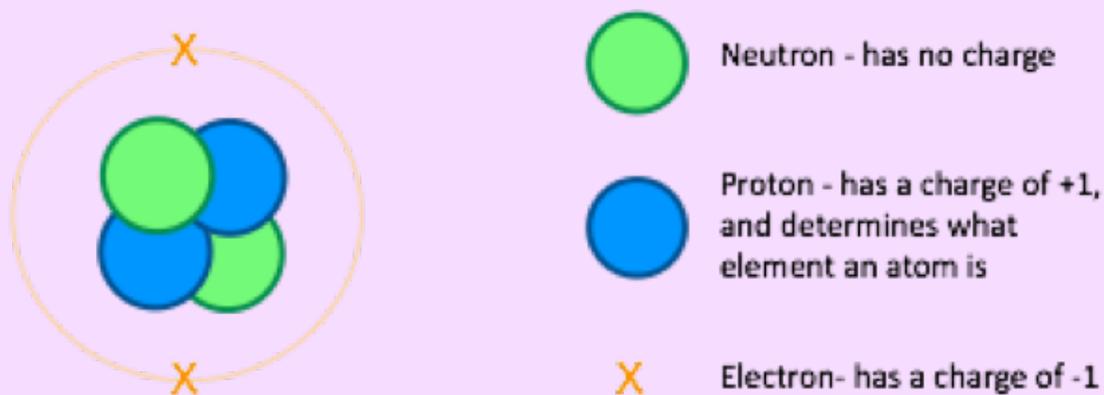
Morgan suggested I could do my project on elemental sustainability, I'm not sure if he was actually being serious but I think it's a really good idea.

Sarah's welcome to the environmentally friendly makeup idea after all.

The Periodic Table

Everything is made of atoms, and the different types of atoms are called elements. They are organised in the periodic table, which was produced by Dmitri Mendeleev in the 19th century.

Atoms are made three subatomic particles; protons, neutrons, and electrons. The number of protons an atom has determines what element it is; for example, hydrogen has 1 proton and helium has 2 protons. Elements in the period table are arranged in order of increasing number of protons (their atomic number).



Elements close to each other in the periodic table have similar chemical properties. For example, the non-metals are on the left, and the non-metals are on the right.

The rows are called periods, and the columns are called groups. Each element has its own box in the periodic table, which gives information about the atom.

The atomic weight is found by adding the number of protons and neutrons. In helium, it is (approximately) 4, since there are 2 protons, and 2 neutrons.

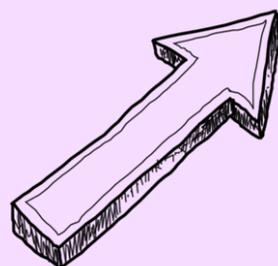
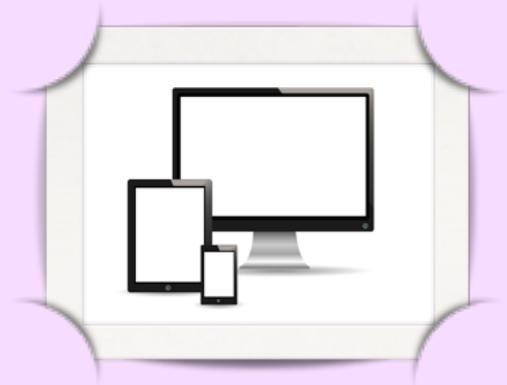
Elemental Sustainability

Elemental sustainability is where the sustainability of each element in the periodic table is guaranteed. This means that the current use of an element should not stop future generations from using it. There is only a certain amount of each element available on the Earth, and this is larger for some elements than others. There is varying demand for each element, so different amounts of each are needed.

Critical elements are those that have major supply risk issues and will have a large impact if that supply is restricted. This can vary for different countries and industries.

Some factors that affect elemental sustainability:

- ♦ *Some elements are only found on Earth in very small amounts;*
- ♦ *As the population increases there is a greater demand for products and more of the elements available will be used up;*
- ♦ *Electronic goods such as televisions and mobile phones require some elements that are in short supply. New technology is using a greater amount of these rare elements;*
- ♦ *Many electronic goods are unnecessarily discarded when newer models are available, so the valuable elements are thrown away too;*
- ♦ *Different countries and industries require different amounts of each element; Production and costs of elements are increasing.*



Wednesday

6:36 pm

Today I saw Harrison by the project sign up sheet. I said hello but he ignored me which I thought was strange - he seems really nice.

I wonder if he's okay?

I bet his poster will be really good, he seems to be the complete opposite of Morgan; organised and always on time.

It was gymnastics after school today. I really like it, but it's just not quite the same as dance. I suppose the one positive is that Johanna's not at gymnastics.

When I got home, I decided to do some work on my project. It was a perfect excuse to use my new laptop. Mum couldn't tell me that I wasn't allowed to use it all evening because I was doing schoolwork (and looking at clothes online, but she doesn't need to know that...).

I'm so pleased with this topic; I think my project's going to be great.

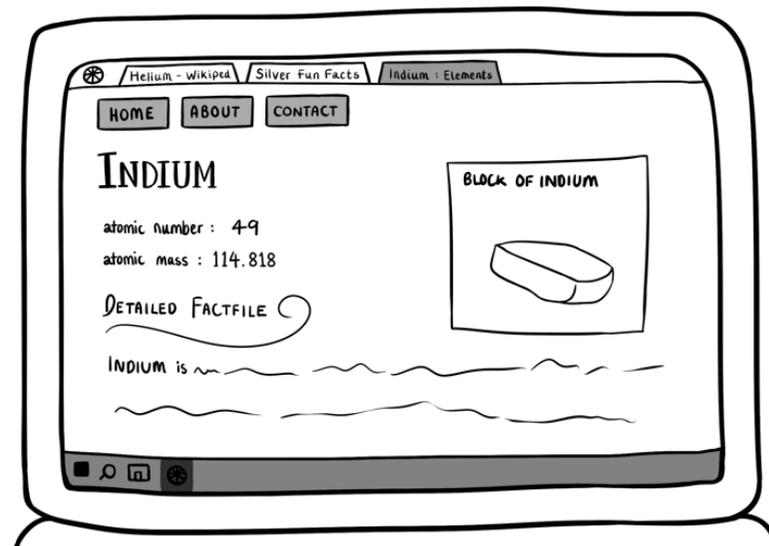
8:41 pm

I had no idea so many elements were running out! In the next 100 years we might run out of helium, silver and indium.

That could mean no more TVs, laptops AND PHONES!

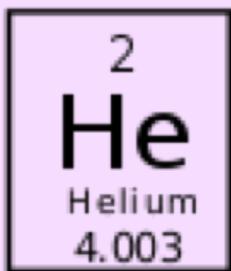
I can't believe we might not be able to make phones in the future. Maybe I should take better care of my phone now in case they can't make them anymore. I think I'll order a new case tomorrow.

I've just done the finishing touches on my poster, it looks so pretty. Even if I don't win at least mine will be the best looking



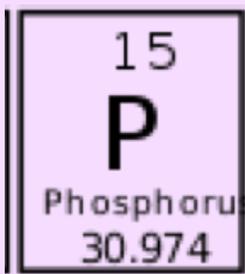
Critical Elements

Here are some examples of elements that are classed as being critical and their uses:



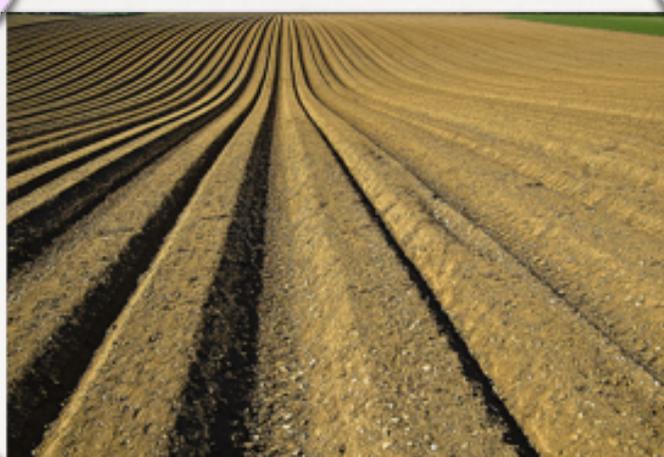
Helium:

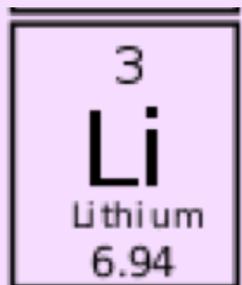
Helium is the second most abundant element in the universe, yet it is rare on earth and we have already used up a lot of its reserves. Aside from inflating balloons, it also has important uses in science. For example, MRI scanners are used to view internal images of the body to find out what is making a patient ill and helium is used to keep the magnets inside the MRI scanner cool.



Phosphorus:

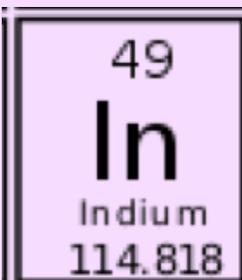
The largest use of phosphorus is for making fertilisers, which helps crops grow, allowing farmers to meet the food demands of an increasing population.





Lithium:

Lithium is most commonly used in rechargeable batteries for mobile phones, laptops and electric vehicles. It is also used in the pharmaceutical industry for making medicines.

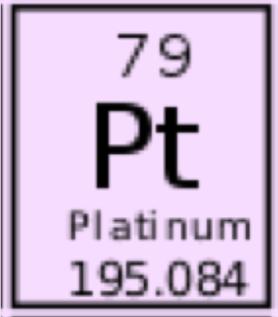


Indium:

Indium is used mostly by the technology industry to make products such as smartphones, flat panel display screens and solar panels. If we continue to use indium at the rate that we are now, it may run out within the next 20 years.

We can recycle indium from existing products, although this is not a straightforward process

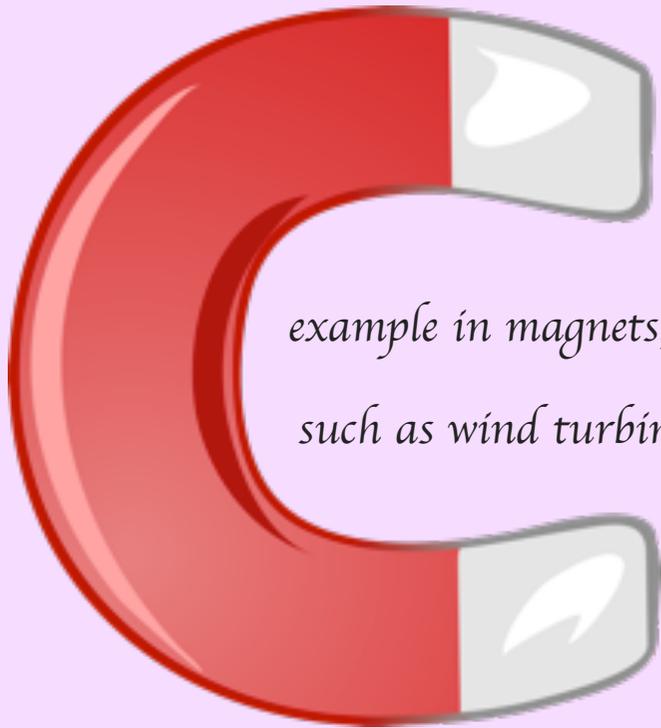




Platinum:

Platinum is a key component of low-temperature fuel cells. These convert fuel into electricity without using combustion, and so are more environmentally friendly. Platinum is widely used in catalytic converters in car engines, as it can convert pollutants in the exhaust gas to less harmful products.

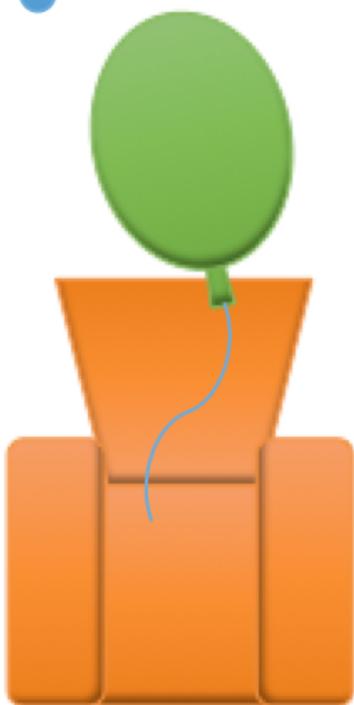
Rare earth elements



The rare earth elements are a group of 17 elements found in the earth's crust. They are being used up rapidly because of their important role in modern technology; for example in magnets, smartphones, and military gadgets. Green technologies such as wind turbines and hybrid cars also use rare earth elements. Due to their similar chemical properties, rare earth metals are usually found in clumps which makes them difficult and expensive to separate.

Retirement Home for Elements

Where unsustainable elements come to retire when they have almost ran out



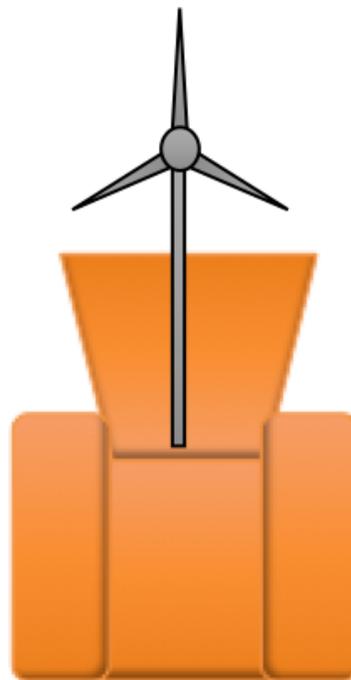
Helium

Second most abundant element in the Universe but rare on Earth. Most commonly used to inflate balloons.



Lithium

Important uses in batteries and pharmaceuticals. May run out in the next 45 years



Rare Earth Elements

Used frequently in modern technology. Also has applications in green technology, such as wind turbines



Indium

Commonly used in smartphones. May run out within 20 years, but can be recycled from waste electronic equipment

6

Week 1: Johanna



Monday Morning

Mum is taking me into school early - she says we are having an important assembly. That is just great. An hour of listening to how “we are responsible for the school blah blah blah”. Like I don’t already get that enough at home.

In case you haven’t guessed: my mum is the head teacher.

To top it off, I either have to sit with the boys or on my own. The girls all sit as a pack and they make it clear there is never any room for me - even on the end.

Monday Afternoon

This year the school are launching a science fair. For once, the assembly didn’t turn out to be so bad.

Although, the boy sat next to me did get chewing gum stuck on my skirt! I’ve put it in the fridge to get it off; I just hope mum doesn’t find it.

I was the first to sign up, probably only one in the whole school who will. But the project is the perfect get-out clause with mum for not making the stupid girly dance teams again this year.

Not that I was even trying.

The theme is “green chemistry”. It could be worse - but I need to scoot to decide on a topic.

Tuesday Lunch

It’s been a day since the project started and I’m already struggling. I snuck into the IT room at break and lunch, I would have sat in art with Mona but she is ill - some best friend.

I’m escaping the rabble of the dinner hall - honestly the lot of them are like animals. Seriously though, I need to choose an area!

I tried to go and talk to Mr Brady about it but he wasn’t in.

I went back round to check the signup sheet...

Science COMPETITION SIGN-UP

- | | |
|----------------------|-----|
| 1. Harrison Proctor | 21. |
| 2. Angelina Ryley | 22. |
| 3. Filiks Kedzierski | 23. |
| 4. Charlotte Smith ♥ | 24. |
| 5. Larry Shi | 25. |
| 6. Ben Prescott | 26. |
| 7. RAJYA KARIMI | 27. |
| 8. Lina Parkin | 28. |

...Harrison Proctor!

This means I can't just pick anything, the stuff we learnt in class won't cut it. If I want to win I need to think big. This project topic is just so broad; I knew it was too good to be true.

Tea time

Well, my day got loads better:

1. I beat Harrison in a maths test (Yes!), that just never happens.
2. I finally decided on a topic to do for the project

Drum roll please... Catalysis.

After school I was reading up on green chemistry websites that discuss catalysts - I can't believe how useful they are. To think I had never heard of them, considering: they speed up reactions, allow more green starting materials to be used and can allow lower temperatures to be used...

Anyway this is perfect - NO ONE WILL EVER THINK TO DO THAT. At this rate the project folder will soon be full.

Catalysis

A catalyst speeds up a chemical reaction but is itself not used up and remains unchanged at the end of the reaction. Imagine making a cup of tea; the teaspoon acts as a catalyst to speed up how fast everything dissolves by stirring the tea, milk and sugar, but stays the same after stirring.

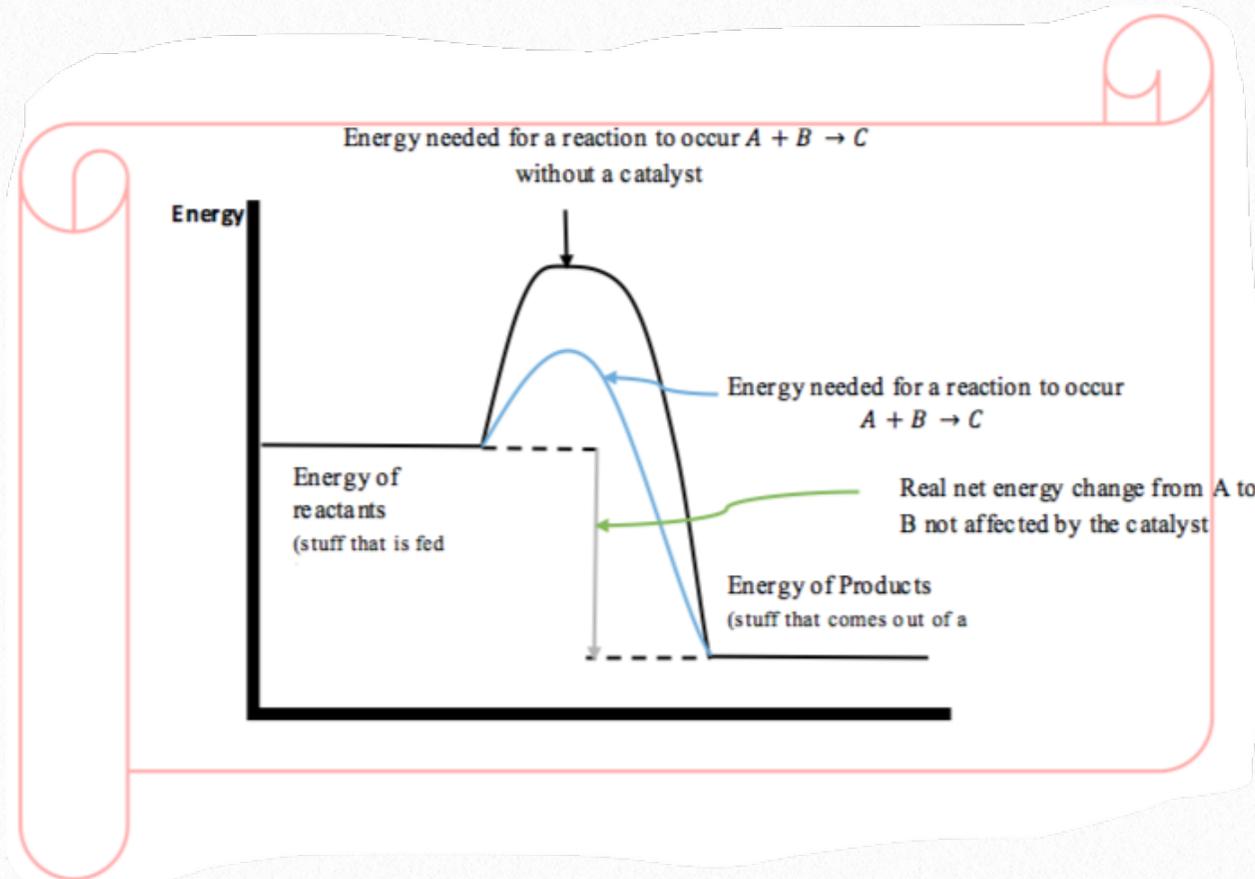


Reactions happen faster with catalysts because the energy needed to start a reaction (the activation energy, E_a) is reduced. However catalysts do not change the overall energy change of the reaction.

Without a catalyst, reactions can be slow and inefficient. Catalysts are used in industry to make reactions greener. For example, if a catalyst is used then the reaction might not need a high temperature to work, and so this is better for the environment as it uses less energy.



If a catalyst can be recovered from a reaction, it can be used again and again since it remains unchanged.



Wednesday evening

There's only 2 days left till the poster's due; I've only just started making it. I came up with a great idea for the design, so I asked Mona to get me loads of art stuff from Ms Jones. Mona and her are besties because she is amazing at art (I am too!).

Anyway I found all this research out last night so at least that's done.

I was thinking of going to the library after school to get a little bit more; Mr Brady told me there was loads of info on catalysis there.

That leaves me free, so tonight, I can finally tell mum about my project and maths test success.

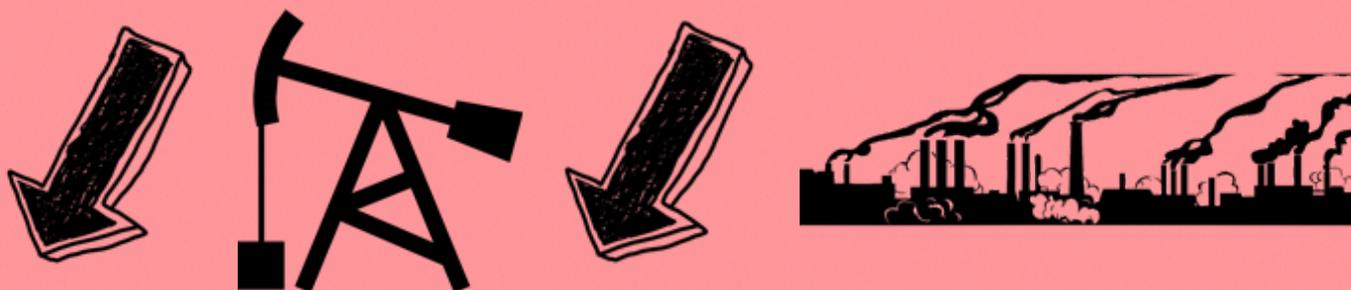
Thursday Morning

Didn't have time to write last night; got back so late from the library.

At least my project is finally coming together.

I have all my research ready, who knew catalysis could be so interesting! I found out about the different types of catalysis, the good and bad points of them all, look:

Why are catalysts green?



Catalysts reduce the energy needed for a reaction. This is good for the environment because less fossil fuels are burned, and therefore less carbon dioxide is released into the environment.

Chemical reactions can often result in a number of different products (by-products) being made, as well as the one you want (desired product). Catalysts can be used to selectively make only (or mainly) the desired product of the reaction, which therefore reduces waste.

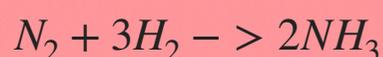
Only a very small amount of catalyst is needed in a reaction and it can be used repeatedly, reducing the amount of waste produced.

However there can still be some issues with catalysts as they may contain scarce or toxic metals, and can also be very expensive.



What are catalysts used for?

As many as 90% of industrial reactions use catalysts because of their ability to speed up reactions. One such example is the Haber process, which reacts nitrogen and hydrogen together at high temperature and pressure with an iron (Fe) catalyst to make ammonia.



The ammonia made by this reaction can be used to make nitric acid, which is a component of plant fertiliser. Ammonia was originally made using KNO_3 (potassium nitrate) crystals that were dug up from the earth. Since then other methods have been used to produce ammonia but the Haber process is the most efficient.

Some advantages of using the Haber process and an Iron catalyst are:

- ◆ Ammonia is easily separated.
- ◆ Catalyst allows the reaction to run at relatively low temperatures.
- ◆ No by-products are made so any remaining starting materials can be recycled and used again.
- ◆ No damage to the environment from mining.

Iron was selected over alternatives e.g. uranium, which is radioactive and unsafe to handle.



Types of Catalysis

There are many different types of reaction, and so different catalysts are needed to fit these reactions. Catalysts fall into two categories- heterogeneous, and homogeneous.

1. Homogeneous catalysts are in the same phase as the reactants. For example, if they were both a liquid.
2. Heterogeneous catalysts are in a different phase to the reactants. For example, the reactants are liquid and the catalyst is a solid (which does not dissolve).

The advantage of a heterogeneous catalyst is that it is very easy to remove and reuse, as it can just be filtered away from the products.

There are other types of catalysts like photocatalysts and biocatalysts:

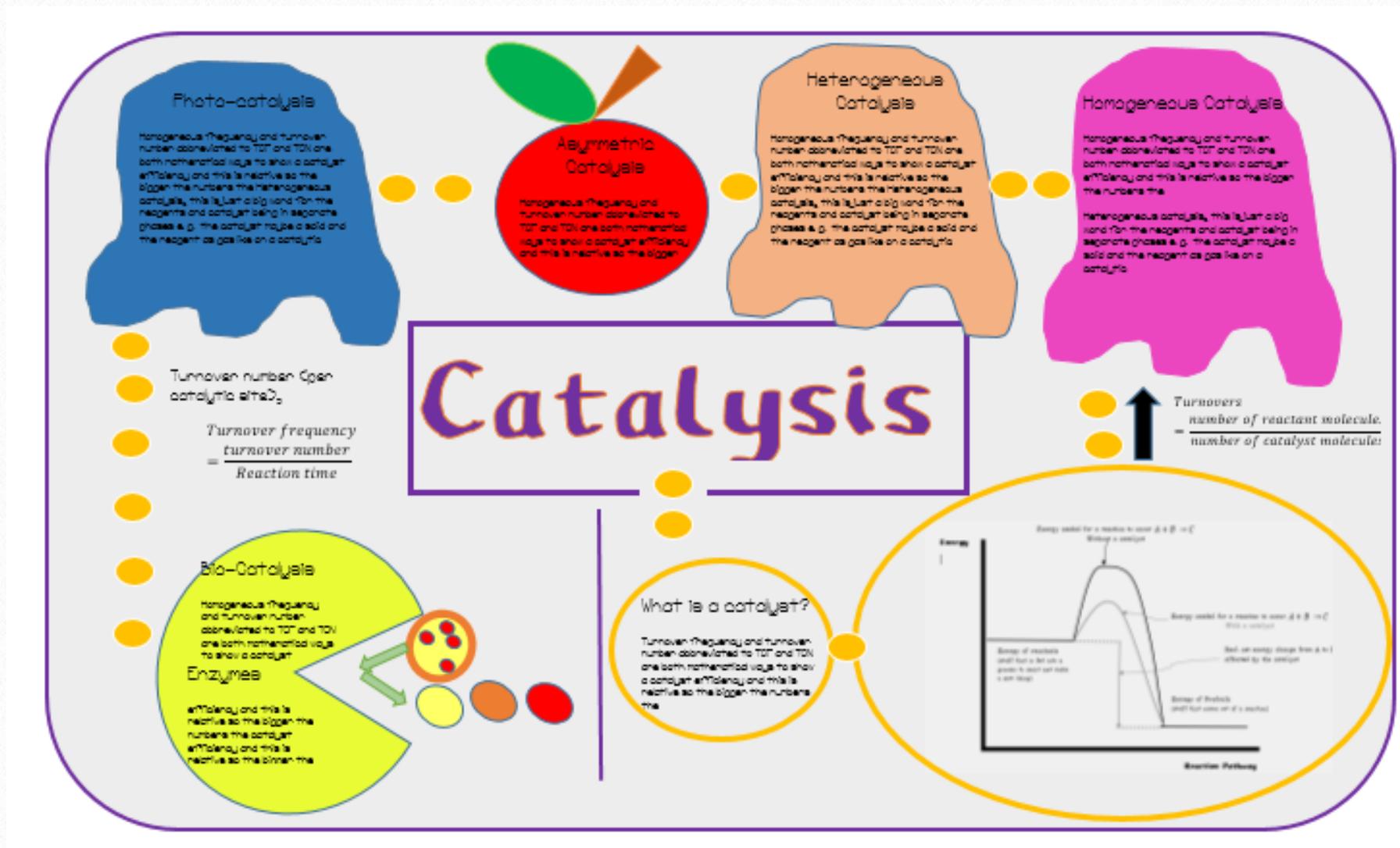
- ◆ **Photocatalysis:** This is where light energy is used to catalyse reactions. This is a green process since usually the light energy is harvested from the sun.
- ◆ **Biocatalysis:** Enzymes are biological catalysts that are found in all living things.



Mum didn't have much time to listen last night, she was "swamped in paperwork".

That did mean that when I eventually got back, I snuck my tea upstairs (it's fine nothing spilled) and I stayed up so late to finish the poster.

How can Ms Jones say I'm no good at art now?



Thursday Lunch

I handed in my poster!

I was first there, some people were only just signing up. Morgan was in such a rush he knocked me over and made me drop my English essay all over the floor. Luckily the poster was already safely in the box, otherwise he would have got a mouthful.

Thursday Afternoon

Mum was working late and Dad couldn't pick me up from school, so I had no choice but to go to stupid dance. Hockey was so much better, I was the school's star player last year but mum says I can't play anymore. All the girly girls do dance.

It's no coincidence the school football team practice at the same time and you can see them through the window.

So, I know this sounds bad, but I was sat in mum's office... waiting for her to finish a meeting... and there was a piece of paper hanging out of her bag.

There is only so long you can entertain yourself with a spinny chair...



Basically, I'm one step ahead!

I could have been getting on with it all this time (and missed dance). The annoying thing was I couldn't even do it when I got home either because mum took me out for tea. I think she felt bad for not listening to me all week so she finally got to hear about my achievements. She was so impressed, less about the maths test ("I should be more courteous to others when I do well") but the project was a big success.

So tomorrow and next week is building a model on the poster I made, looks like another trip to the library for me and another mission to the art department for Mona. She won't mind, I will just let her copy some answers off my maths test.

Not all of them though.

Friday Morning

I have to get the bus this morning - I hope it isn't late. I need to check out the competition, mum had to go in early for a random staff meeting.

I hate the bus - there is always some big mouth year elevens shouting at you as you get on and you have to dodge all the flying weapons going across one side to the other.

It's literally a war zone.

Friday Afternoon

I feel such a fool.

As if the project was going to be as easy as make a model of your poster, I'm so stupid. Mona can never find out; she may disown me if she has to go crawling back to Art again to restock my supplies.

The actual task is to make a model for the science fair, to represent your chosen topic. But it's ok, I've come up with a great idea to use practical chemistry.

I can't tell you yet just in case this gets out.

7

Week 1: End



Interviewer: Green chemistry covers such a huge range of topics, how did you all know where to begin?

Morgan: I was struggling to start with, it really doesn't take a lot to distract me.

Johanna: Well I thought it was all plain sailing to be honest. I got it done when I wanted, everything was finished by Wednesday.

Morgan: That's actually when I started!

Harrison: I did take all week to make mine, but I did spend a lot of time on it each night.

Morgan: I tried that, didn't last long. Kept getting distracted by Spike.

Charlotte: I'm not surprised, you spend so much time with that lizard.

Harrison: I would love to actually meet Spike one day.

Charlotte: That could be hard, Morgan is quite protective over him!

Johanna: What? Over a lizard?!

Morgan: You honestly have no idea; he is not just any lizard.

Charlotte: I still remember the time he thought he was a fish and we found him swimming in the fish tank.

Harrison: I definitely want to see him now! He doesn't sound like any other lizard.

Johanna: To be fair, seeing Spike might be kind of cool.

Interviewer: He sounds like a legend of a lizard, I wouldn't mind meeting him myself! I am not surprised you haven't had time to meet him yet, that model must have kept you super busy?

Morgan: Yeah, we were all absolutely working flat-out, plus I had absolutely no idea where to start. I wouldn't exactly call myself creative.

Harrison: Me too, I would say I am more of a scientist than an artist.

Charlotte: I was really pleased, it was a good excuse to buy new pens.

Morgan: You do have an unbelievable amount of stationary.

Harrison: I think a notebook and a decent biro is all you need in life.

(tumbleweed – awkward silence then burst out laughing)

Harrison: Johanna, you seemed to go through loads of art materials that week!

Johanna: Erm.....I will admit I do have a confession.

Morgan: Do tell...

Johanna: Well I was in my mum's office and saw her folder, it might have blown open in the wind, and I might have tripped into her chair and happened to see that we had to build a model.

Charlotte: We all suspected you knew something we didn't.

Johanna: It backfired on me anyway I made the wrong model.

Interviewer: **DISASTER! Did you even dare to consider what the national competition would be like at this point?**

Harrison: I thought it would be like my dream come true, presented with an award but stood in front of loads of people.

Morgan: Absolutely massive. I expected a huge crowd, lots of lights, I half expected it to be on TV.

Charlotte: Do you live in the virtual world?

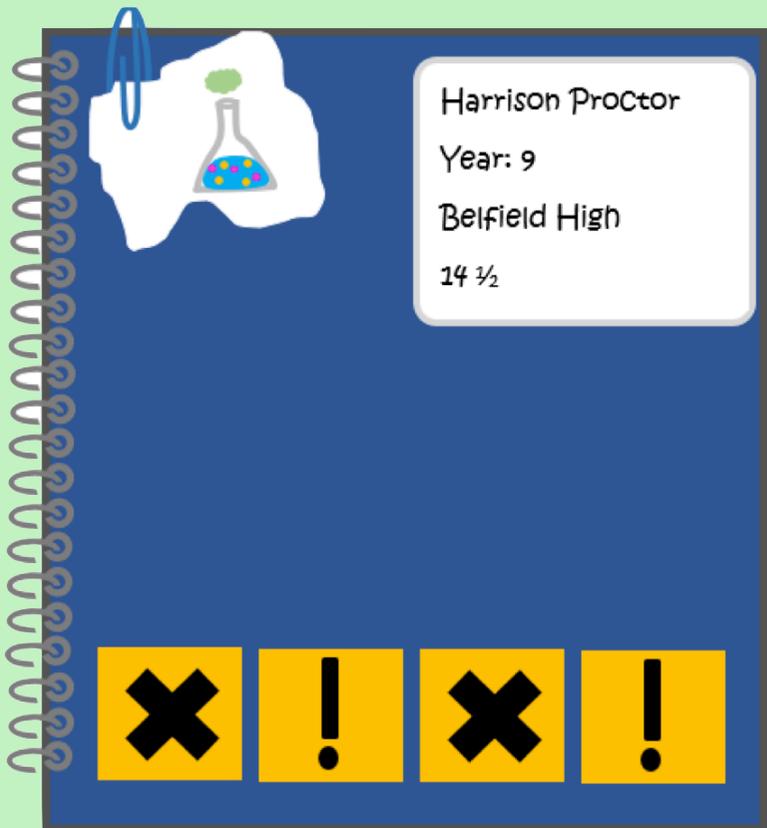
Morgan: Yes, I wish I did....

Johanna: Anyway, back to reality, I thought it would be really hard work, but at least I could show off in front of an audience.

Morgan: No surprises there.

8

Week 2: Harrison



Monday 22/01/2018 4:06pm

I received some bad news today.

Jonny hadn't been in school all last week, I really started to wonder where he was I thought he might have just been ill, so at the end of registration I asked Miss Noble if she had any idea where he was. She broke the news to me...

His dad has a new job.

Jonny had to move away.

The worse thing is that nobody seems to know where they have moved to! How am I supposed to keep in contact with him? I don't even have a phone number or anything! I thought that we were going to stay school chess champions for the whole of year 9.

Maybe even year 10 and 11 too...

This has been such a terrible day, I need to keep my mind busy. I'm going to make sure I have a productive evening working on my project.

I have decided to focus on fossil fuels and minimising chemical waste, so the plan for tonight:

- i) Get some research done
- ii) Start thinking about possible ideas for my model

The school is running their first model building session tomorrow at lunch; I need to have all of my research ready by then so that I can finally start my model.

Environmental Impacts of Pollution

Humans release many pollutants into the environment from burning fossil fuels. Not only have these pollutants led to global warming, they are also having additional environmental impacts.



Photochemical smog can also form in big cities, especially in the summer. This occurs when NO_x from motor vehicle emissions reacts with other pollutants within the atmosphere in sunlight to produce a molecule called ozone. Although, we need ozone higher up in the atmosphere to protect us from dangerous radiation, ground-level ozone causes problems when inhaled by humans.

Other man-made pollutants at ground level such as NO_x and SO_2 (this comes from burning fuel that contains sulfur) also cause lung problems.

SO_2 can also lead to acid rain, which can negatively affect species living in ponds and rivers. Acid rain can also destroy forests by dissolving the nutrients in the soil, which the trees need to be healthy.



Where do synthetic chemicals come from?

The chemical industry is the name given to all the companies that produce synthetic chemicals. These chemicals are used to make medicines and materials such as plastics, as well as a huge range of other things used in our homes.

These chemicals are made from crude oil, yet this is non-renewable. Crude oil is found trapped in rocks, and is the remains of tiny animals and microscopic plankton that lived millions of years ago. Since it takes so long for crude oil to form, there will be none left when we have used up the reserves. Therefore we need to find more sustainable ways to make chemicals i.e. from renewable resources.



Using waste to make chemicals

Renewable resources such as agricultural crops can be used to make chemicals, for example sugarcane can be used to produce a polymer called polyethylene. However there is growing concern that crops used to make food for humans are going to be used for making chemicals instead; this has led to a 'food vs fuel' debate, and hence we need to find ways of producing chemicals without affecting food production.

One way of doing this is to make chemicals from waste! At the moment, research is being done into how we can use waste to make useful chemicals and materials rather than sending it to landfill. If done properly, this will reduce strain on non-renewable resources such as fossil fuels and avoid issues over using food crops.

Organic waste includes any waste that comes from humans, animals, or food. We are able to convert this waste into fuel and chemicals using renewable methods, which reduces the amount of fossil fuels being used.

Recycling

Another way of preserving our limited supply of crude oil is through recycling. This is a very green process because it means that less of the earth's resources are wasted, and reduces the amount of landfill. Some examples of recycling are:

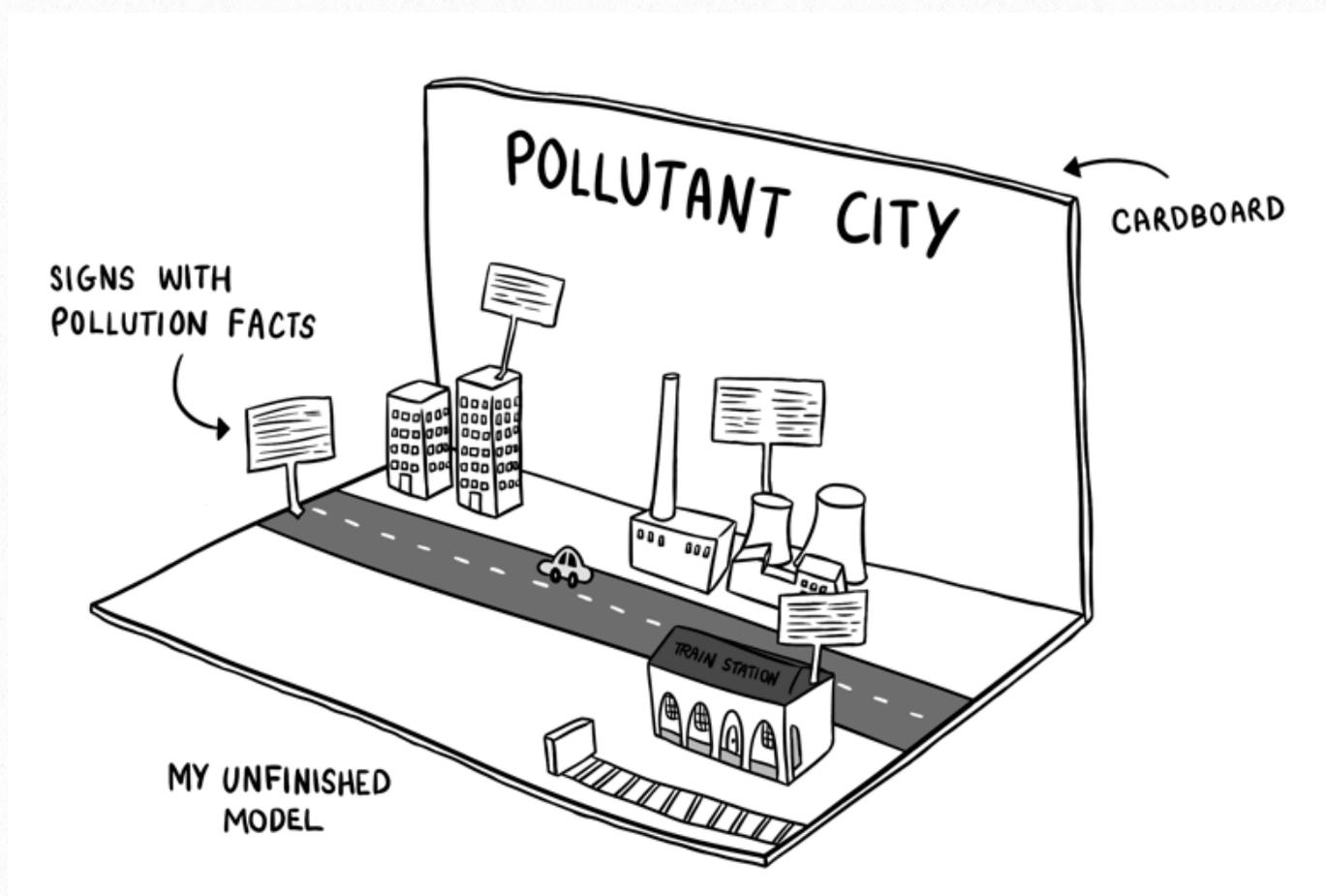
- 1) Glass and metals can be melted down and moulded into new materials such as glass bottles or cans. It takes less energy to recycle them rather than to make them from raw materials
- 2) Paper can be broken down into small pieces and used to make brand new paper. This reduces deforestation.
- 3) Most plastics can be recycled- some are now even being used to make clothes. By recycling plastic, crude oil reserves are being saved.



Tuesday 23/01/2018 4:23pm

Mr Brady is in charge of running the model building sessions this week, he has even managed to get hold of loads of art supplies. Jackpot. Amongst them I found this big cardboard box -it would be perfect to use as the base of my model! I rushed to claim it and quickly scribbled my name on the bottom. I didn't want anybody (cough...Johanna....cough) to steal it.

I have decided to do a birds-eye view map of "Pollutant City". It's going to show where the main sources of pollution are within a city.



After such a busy lunchtime session, I'm just too exhausted to do any more work on my project. It'll have to wait until tomorrow.

After school I was meant to have Chess club, but it's just not the same without Jonny. I think this weekend I am going to try see if I can find out where he has moved to, or at least see if anyone else in class has his telephone number.

It's been really quiet without him.

Wednesday 24/01/2018 6:42pm

I have only just got back from school, I can't believe it! Today was the last afterschool model-building session and I managed to get mine completed. I'd already written out the little information cards at lunch, so by the time the session came around I had done the majority of my model. The only thing I actually did in the session was make little flags to stick onto the map (using cocktail sticks and little bits of coloured paper).

Not really being the creative type, I think I have outdone myself with this model I reckon I have done a good job at getting the science across to everyone- Just hope I've made it interesting enough!

Ben's model was amazing. He was sat next to me and told me all about his medicinal chemistry topic. It was so advanced; I was surprised to hear that Ben could handle it (with him being the class clown). It might have something to do with the fact that his older sister does chemistry in sixth form.

I wouldn't put it past Ben to have a bit of inside help.

I asked him about how Morgan was getting on, Ben said he was actually working on his project at home and was really enjoying it! You never know with Morgan.

I am not actually that nervous for the model judging tomorrow. If anything I would say that I am really looking forward to it!

Thursday 25/01/2018 5:48 pm

Today has quite possibly been one of the most exciting days of my life; I feel like I am one step closer to fulfilling my dream of becoming a famous scientist. As the science fair was on, all of year 9 were excused from normal lessons. Absolutely everyone got to see my model, I've never been so proud!

When I got to school this morning I moved my model from Mr Brady's classroom into the assembly hall, along with all the other contestants'. We were all given our own table to place our models on; the judging panel announced that everyone had a maximum of two hours to set up their projects before judging started.

I managed to have my project ready in the first 20 minutes, so I decided to colour in a big title to hang over the front of my table.

Whilst making the title I noticed that Charlotte was trying to set up her project on the table next to me.

She was panicking that she wasn't going to be ready in time for the judges; I kept offering to help her. After three attempts - she accepted.

I chatted with her in an effort to cheer her up, and after a while it seemed to work. At least she was smiling again anyway. The important thing is we managed to get her project all set up before judging time and she was really grateful.

Charlotte was impressed with my model, and the judges seemed to be extremely interested too. They spent longer looking at mine compared to the other contestants. They asked so many questions, hopefully that is a good sign!

Charlotte was judged after me and I think she did extremely well! She had completely cheered up by then and so was back to her usual happy self!

Friday 26/01/2018 5:37 pm

I have been picked to go to the NATS awards! I am over the moon!

As soon as school opened the main entrance doors, everybody made a beeline for the winners sheet. I had to really push my way close enough to the front to see - I was so pleased to see my name written on there!

Ben, Charlotte and Morgan also got through, but that is not surprising as all of their models were amazing. I also kind of know them all, which is nice.

I was so pleased. People were even coming up to congratulate me, even Johanna! I feel quite sorry for her really, her project was really good and I think she should have made the team. Johanna seems to be acting really weird recently; she is being really nice...I hope she doesn't fancy me!

This afternoon, Mr Brady took me, Morgan and Charlotte out of our classes and sat us all down in his office. He explained that Ben had to pull out of the competition because it clashed with some sports tournament that he wanted to take part in.

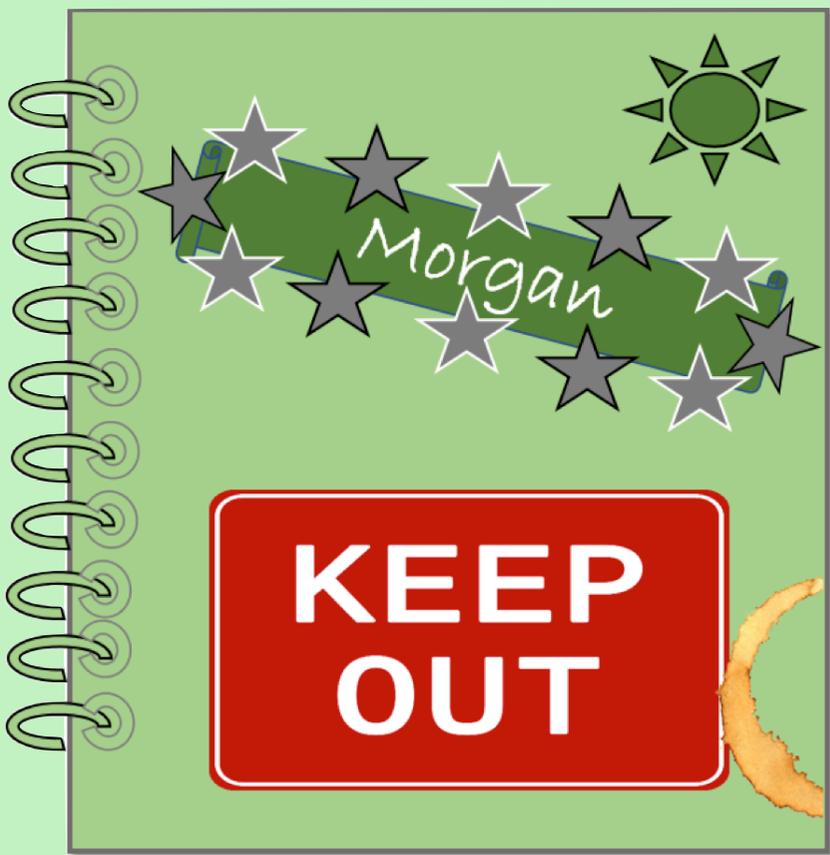
I have to say I was a bit gutted. Ben's topic was really interesting and it seemed as though he had really researched it in detail. We were told that as a group we had to go and look at everyone's model to choose who we want to replace Ben.

Me, Charlotte and Morgan had a long look around all the models.

I have a favourite one but I haven't told them who yet.

9

Week 2: Morgan



Monday afternoon

This weekend was so much fun! I still haven't got the redemption fixed so I was roped into playing football with Ben and some of the other boys. I hate to say it but I really enjoyed myself. I'll admit I wasn't the best but that didn't seem to matter to them.

That all being said, I have a busy week ahead! I found out that I have got through to the next round of the green chemistry competition! Apparently I have to make some kind of model.

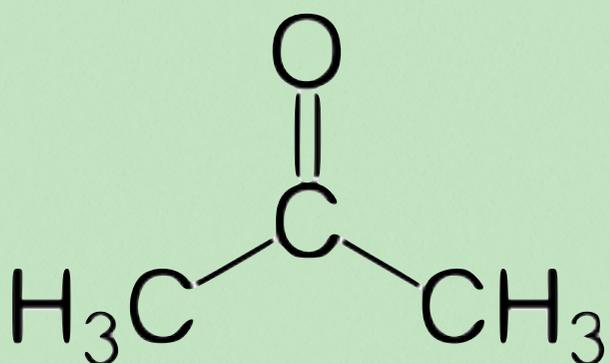
This is kind of good news as I had so much more to write, I could hardly get it all on the poster. I just really have to think about what to make - it really could be my time to shine. I can't mess this one up.

Green chemistry is what is key here right? So that means, what? I've already looked a bit into solvents, how does it all fit into green chemistry?

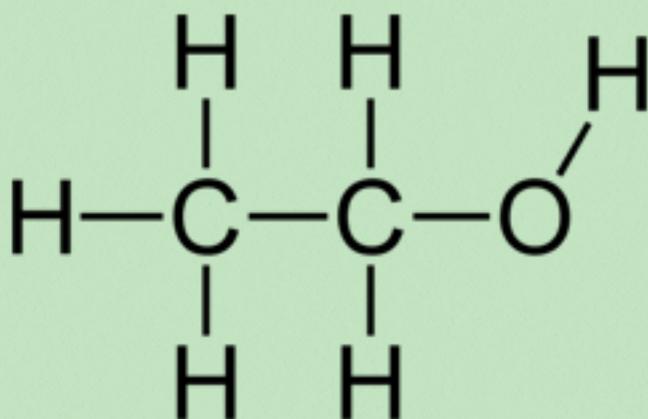
Anyway, I have to go for dinner; Mum is calling me, peace out.

Common Solvents

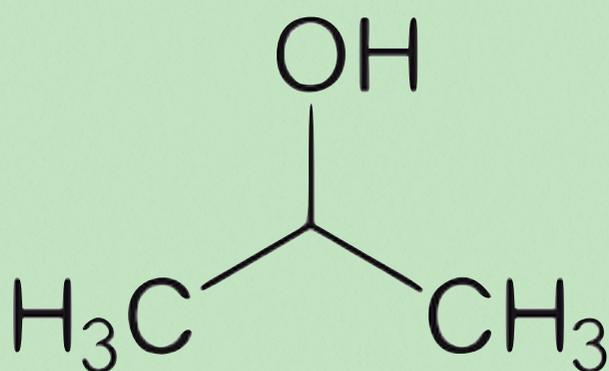
Acetone is the main ingredient in nail polish removers. This solvent dissolves nail polish and allows it to be removed from the nail.



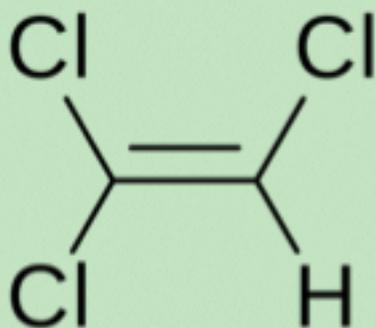
Ethanol is used in perfumes because it is volatile (evaporates easily) and has a weak scent (this is important as an overpowering smell may ruin a perfume)



Isopropyl alcohol is used as a de-icer for car windscreens. As it remains a liquid well below zero degrees, it can remove ice without becoming frozen itself.



Perchloroethylene (PCE) is commonly used to remove stains in dry cleaning. It evaporates from the clothes quickly, leaving a strong sweet odour. There is some concern over a possible link between the use of PCE and a risk of cancer developing in dry cleaning workers. This increased risk has led to a need for 'greener' solvents to be used that aren't harmful to workers. PCE is slowly being replaced with liquid carbon dioxide or silicone solvents, which are much safer.



Environmental Impact of Solvents

Solvents are often the biggest input (by mass) into a chemical reaction. Therefore, carefully choosing a solvent that causes the least harm to the environment and is non-toxic can have a big impact in terms of the overall greenness of a reaction.

For example certain chlorinated solvents are toxic and some contribute to global warming therefore their use should be avoided. New, greener solvents are being phased in to gradually replace harmful solvents. By reducing, reusing, and recycling solvents, we can reduce the damage they have on the environment while continuing to use them.



Monday evening

After 4 hours of researching (well, 1 hour of researching, 2 hours of playing on my phone and one hour devoted to Spike), I came across this eco friendly science website. I hate to admit it, but some of it was quite cool. Turns out there are 12 principles of green chemistry!

After some more research I decided to focus on safer solvents, waste prevention and designing a safer synthesis seem the most relevant to me.

Bearing this in mind, I've had a bit of a think and have a really good idea for the project. It sounds very strange but just you wait, I may be able pull it out the bag this time.

Tuesday

Char is making a model of a games console. I can't believe she is actually doing it! I was joking but here we are. I went round earlier to help her design it and it's already starting to look good.

Knowing Char, I'm sure she will ruin it with glitter, make it fluorescent pink or something stupid.

She seemed a big fan of my project idea. I don't think she has ever seen me this organised. I hope it turns out as well as it looks in my head. Just got to be strict with myself and keep up the hard work.

Wednesday

Ok, I know I'm always trying to justify things... I am also aware that whenever I'm trying to justify something I've done that I start my sentence with "ok".

Noted: BE LESS PREDICTABLE.

I skipped the after-school session to work on the project, which I'll admit doesn't look good on paper, BUT I do have a good reason for it.

Even when I try to sit on a different table to everyone I still get way too easily distracted. I don't quite trust myself and I don't want anyone to think I'm ignoring them!

So close to finishing now. I've done the entire fact file, I just need to scribble a few drawings down and hey presto! Model done!

Starting to get nervous for the big reveal tomorrow, which is weird, this never happens to me!



Thursday morning

Just woken up.

I'm actually getting quite excited about it all now. My nerves are still there, but once I get talking to people I know I will be fine. Talking to people has always been my saving grace, although knowing when a conversation turns into a rant is something I am yet to perfect.

Thursday afternoon

Wow. Ok. It went well...

I think. I can never tell with these things.

The judges referred to it as "very creative and original", I couldn't tell if they were being honest or just polite. I never usually stress like this - I've never done anything like this before.

Guess I'll have to wait and see if I get through.

Anyway, I'll get a bit more specific. Juicy details are what make these big events exciting right?

Since it was in the assembly hall, it felt very official to say the least. We had so long to set up, I did mine in about 20 minutes and had to wait for like an hour and a half! Char was nowhere to be seen, which is very odd behaviour on her part. She eventually came flying in, looking almost as flustered as the first time she met Spike.

Char and Harrison had their stalls side by side, which I'm sure Harrison wasn't complaining about. I went over to chat to them before the judges came to my stall. I thought it would be nice to see their finished projects too.

On the walk over I turned and scanned the hall.



Was Johanna glaring at me? Was I just being paranoid? I just couldn't figure it out.

Char's looked quite different to when I last saw it, but I kind of didn't want to ask. She seemed a bit agitated after her last minute entry to the hall. The executive decision to go to Harrison's stall was made. His looked absolutely incredible, I mean, I knew it would be, but wow. It looked like a professional had made it. He could tell by the look on my face but I told him how great it was regardless. He really will be a proper scientist when he grows up, I don't doubt it in the slightest.

As I got back to my stall, the judges were waiting for me. I was still a bit nervous but a rush of excitement just washed over me. I wanted to show them what I'd actually achieved.

In hindsight, my project was good.

Once we started packing up, I glanced over at Johanna and she was still glaring at me.

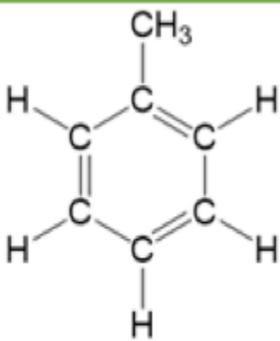
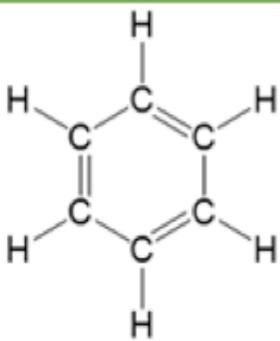
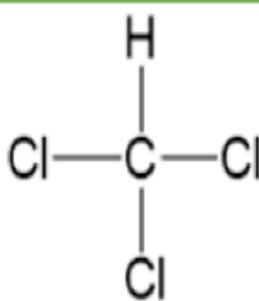


It hit me, I still had not apologised to her properly from when I knocked her over last week! No wonder she wouldn't stop staring at me.

I couldn't exactly leave it like this, I wandered over to her and apologised straight away. I tried to explain but I think I just ended up babbling more than anything. She seemed to accept it, and I even got a little smile from her as I left.

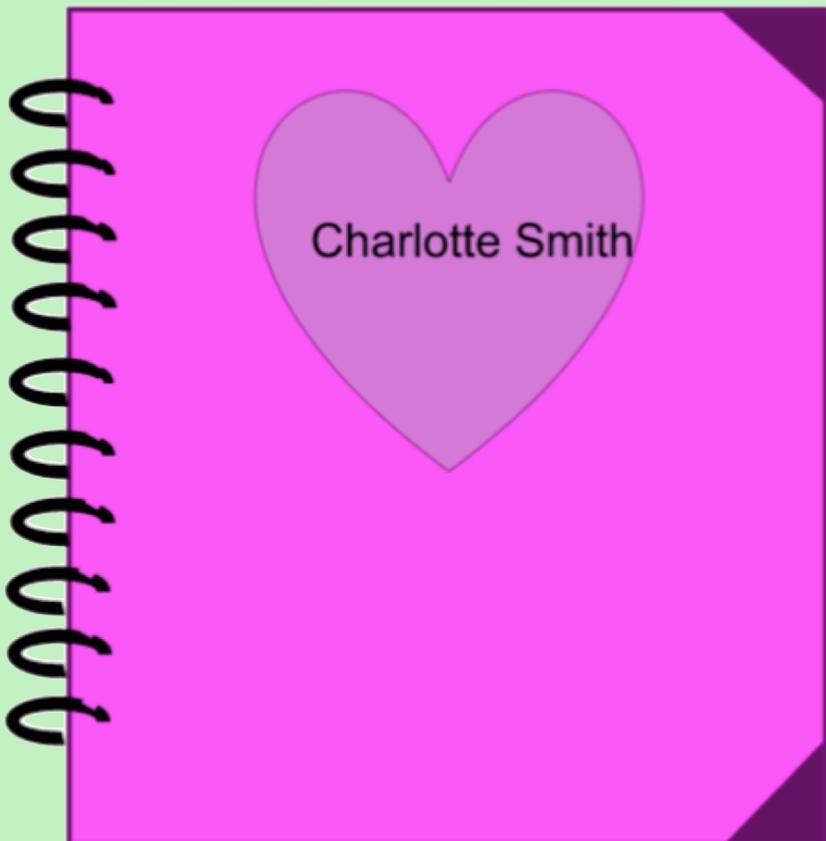
So proud of my project, it took me so so long. Have a look for yourself! :

Sinister Solvents

Molecule Name	Toluene	Benzene	Chloroform
Molecule Structure			
Volatile?	✓	✓	✓
Carcinogenic?	✓	✓	✓
Flammable?	✓	✓	X
Uses	<ul style="list-style-type: none"> - The manufacture of nylon, plastic bottles - As a solvent for pharmaceuticals 	<ul style="list-style-type: none"> - Synthesis of drugs - Manufacture of plastics and pesticides 	<ul style="list-style-type: none"> - Used in chemical analysis machines - The manufacture of fridge coolants, non-stick frying pans and paper
Why is it Dangerous?	<ul style="list-style-type: none"> - Causes serious harm if breathed in - Can cause dizziness, headaches, fatigue, depression and permanent brain damage 	<ul style="list-style-type: none"> - Creates smog - If long, intense exposure, can cause unconsciousness and even death - Has detrimental effect on aquatic life 	<ul style="list-style-type: none"> - Indirectly contributes to climate change as coolants produced from chloroform can damage the ozone layer (which protects the earth from harmful sun rays)
How Does it Enter the Environment?	<ul style="list-style-type: none"> - Through use in vehicle and aircraft fuels - Evaporation of when used a solvent 	<ul style="list-style-type: none"> - It comes from industrial waste, motor vehicle exhaust - Tobacco smoke 	<ul style="list-style-type: none"> - Waste from chemical companies and paper mills

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Week 2: Charlotte



Monday

5:49 pm

I have had such a busy weekend! Sarah and I went to the county gymnastics championships; it went really well but unfortunately we didn't win.

Not surprisingly Jessica Smith got 1st place yet again – it's the same every year.

I don't know how she does it; she's not even that good.

I've been so busy that I haven't even started my model yet. If I want to be in the top 4 and go to the national competition I better get a move on - I bet Johanna's already finished hers. I have decided on a topic though, so technically I have done something!

I'm going to do it on alternative sources of critical elements.

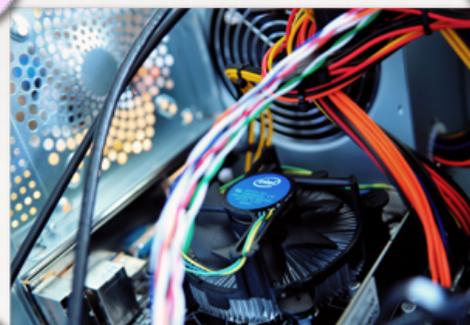
Mum's really impressed that I'm getting involved with the competition; she even went out this weekend and bought me loads of craft materials to make my model with.

Maybe this is a subtle hint I should be more interested in schoolwork...

Alternative Sources of Elements

Waste electrical equipment:

Currently, around 50 million tonnes of electronic equipment is wasted worldwide annually. Up to 60% of the elements in the periodic table may be present in this waste, and so there is potential for scarce metals to be recycled from it. However, only a small proportion is treated because of the risk of toxic and hazardous materials also being present in this waste.



Mining waste:

Mining is a wasteful process. By extracting metals from the waste produced, they can be recycled and used again.



Landfill mining:

Water passing through landfill sites is able to pick up soluble components such as metals. If this water is collected, the valuable metals can be extracted. Over 40 different metals including zinc, iron, and copper, have been extracted from this process.

Roadside Dust:

Cars contain catalytic converters, which reduce harmful pollutant emissions in the exhaust gases. Platinum is often used as the catalyst, and is released into the environment in small amounts over the lifetime of the catalytic converter. The platinum is deposited in the roadside dust, which can be collected using road sweepers so that the platinum can be recovered



Tuesday

6:13 pm

Morgan and I walked home from school together today. I told him about my model idea - he thought it was great. I'm not sure if he actually meant it or was just interested because it's about a games console. He even came over to give me a hand with constructing it as he's such an expert.

After Morgan left I did a bit more on my model before Mum took me for my piano lesson.

8:47 pm

I AM SO ANGRY!!!!

What a STUPID idea!!!

So now my model has become a casualty of the kitchen football game and all my hard work is ruined. I'm not starting again; I don't care about the competition anymore!



Tom's going to pay for this...

Wednesday

7:32 am

I didn't want to go into school today.

Hearing everyone talking about how good their models are would just make my bad mood even worse. I even tried to convince Mum I wasn't feeling well so I could stay at home. She saw straight through my phoney illness though and sent me off to school anyway.

Maybe if I can just get out of going to the after school model building session, today won't be so bad.

12:31 pm

The thought of going to gymnastics tonight hasn't even cheered me up. To make it worse, Sarah noticed I was really upset about something so kept asking me what was wrong.

Eventually I had to tell her - I felt so embarrassed getting so annoyed over something so stupid.

She really liked my model idea though and thinks I should go to the model building session anyway - even though I'd have to start my model again. She even offered to come with me and lend a hand before gymnastics club.

Perhaps if I tell Mrs Evans what happened she might give me some extra time to finish it?

7:29 pm

I gave in and we went to the model building session. It was pretty quiet, the science fair is tomorrow so most people must have finished their models by now.

Guess who was there though?



She even came over to our table and accused me of cheating because Sarah was helping me!

What is her problem!?

After gymnastics, I came home and carried on working on my model. It's going to be tight to get it finished before tomorrow morning...

Thursday

7:12 am

I DID IT!

The model is finished! I'm not sure it's as good as it could have been, but at least I have something to show at the fair.

Now I just need to get to school on time, I'm already running late!

11:24 am

Dad gave me a lift into school as I was so panicked. I managed to just make it through the door at 8:59, 1 minute before the bell went; phew!

When I got to the hall everyone had almost finished setting up their models; they all looked really good. I don't think I stand a chance of getting through to the national competition.

I found my bench; it was next to Harrison. Oh great, his model is bound to be amazing. It's going to make mine look even worse – just my luck. I think he saw that I was struggling to get set up in time so he offered to help me.

Talking to Harrison It made me feel a lot better; I've never really had a proper conversation with him but he's really nice and funny! He told me about his model, which is on pollution. It's really impressive; I definitely think he'll get a place in the top 4. He said mine was really good too.

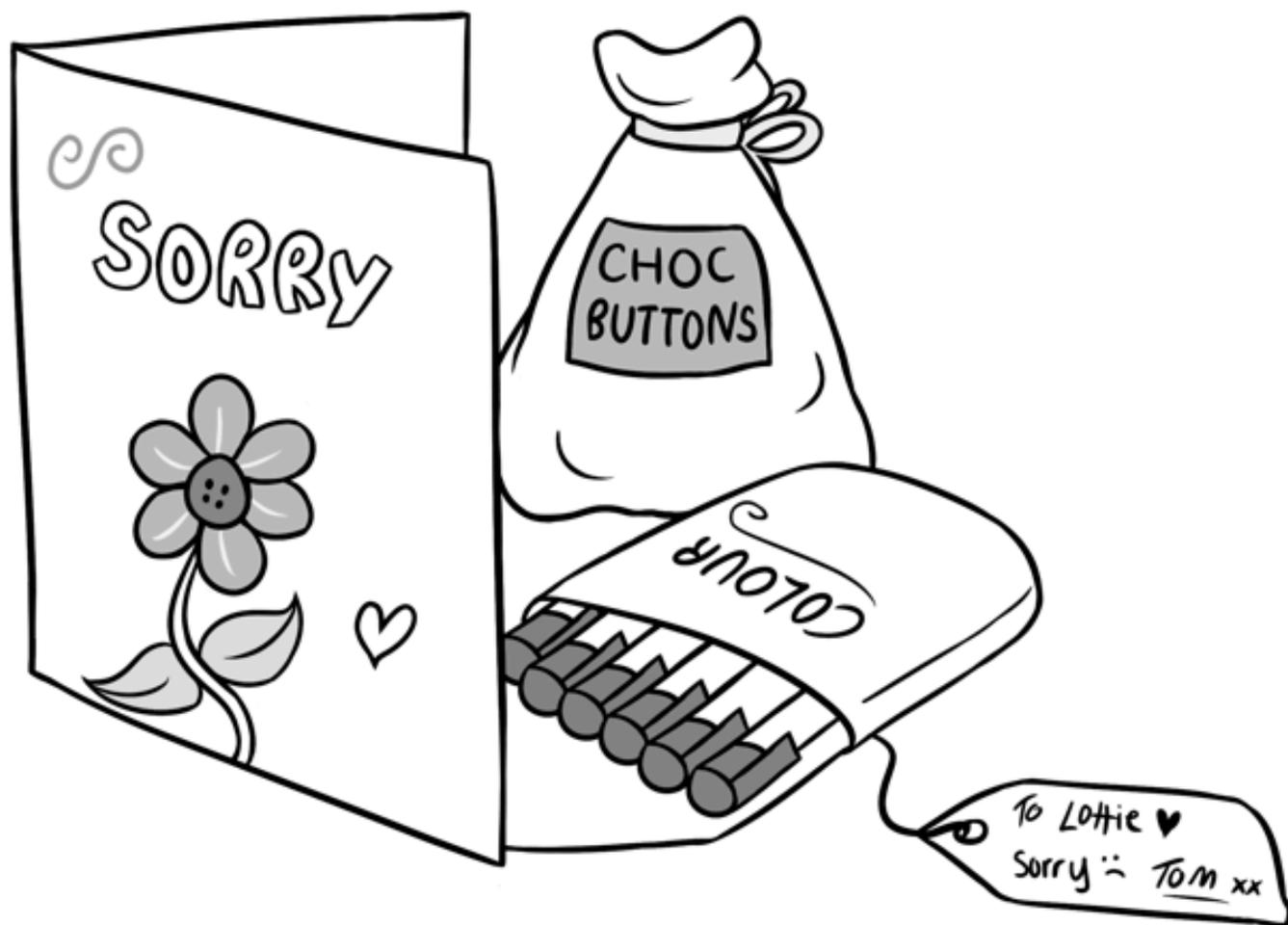
I think he was just being nice.

2:05 pm

The judges came round to look at our models. I couldn't really tell what they thought about mine - they seemed really excited about Harrison's though. They spent a lot longer looking at his than mine. I'm not sure whether that's a good sign.

I guess we'll just have to wait and see.

5:58 pm



He must have actually felt really bad, he never usually apologises to me. He's still very annoying but I guess he's forgiven this time.

Friday

7:41 am

I'm so nervous to find out whether I got through to the national competition! I really want to go - I'm just not sure if my model was good enough.

I walked to school with Morgan this morning to try and distract myself from thinking about it.

He seemed a bit quiet though; maybe he's nervous too.

9:22 am

When we got to school we went straight to the notice board. The judges had already picked the winners.

And guess what?

I GOT IN!

I'm so excited!

To make it even better Morgan got a place too, and Harrison! Although I'm really surprised that Johanna didn't get in - she definitely won't be happy about that. I can't say I mind that much though, I'm glad I don't have to work with her. Morgan's friend Ben got the last place, he worked so hard on his project so I'm really pleased for him.

11:45 am

DISASTER!

Ben has had to drop out of the national competition. He has a big hockey tournament on the same day that he can't miss.

Mr Brady told me, Harrison and Morgan that we need to choose someone to replace him. After lunch we have to go and look at the rest of the models and see which one we like the best. There were lots of really good ones; it's going to be so hard to pick. There was one that I really liked though.

I hate to say it, but Johanna's model was really good...

11

Week 2: Johanna



Monday Morning

It's been a whirlwind of a weekend; a mum triple whammy!

First, I had to go clothes shopping, on a Saturday! Then Mum invited Mona's parents around for tea on Sunday.

But then had the nerve to take everything off me until I cleaned my room - she is still in a mood about that. It might have something to do with all the glitter still left on the floor... and the desk ... and the wall.

To be fair I had been in my room a whole 12 hours since it was "cleaned" and I have a model to remake, what did she expect?

So, this morning I opted to get the bus.

Yes, it's that bad.

Monday Night

Connie Erikson was sat with Morgan again in science today, I'm sure they were talking about me. Probably because I saw her at the shopping centre on Saturday. No surprise really, the girly girls are always there.

I bet to them it's really funny to see a classmate shopping with the head teacher.

Anyway, at lunch Mona suggested I should focus on one area to cover for the project model. For once that isn't a bad idea, although I think it was so she didn't have to visit art again.

I really enjoyed reading the bio-catalysis stuff, so I guess bio-catalysis it is! Who else is going to do anything near as complicated as that...Morgan!

Like that would ever happen.

Hang on... Be right back...

That's a relief!

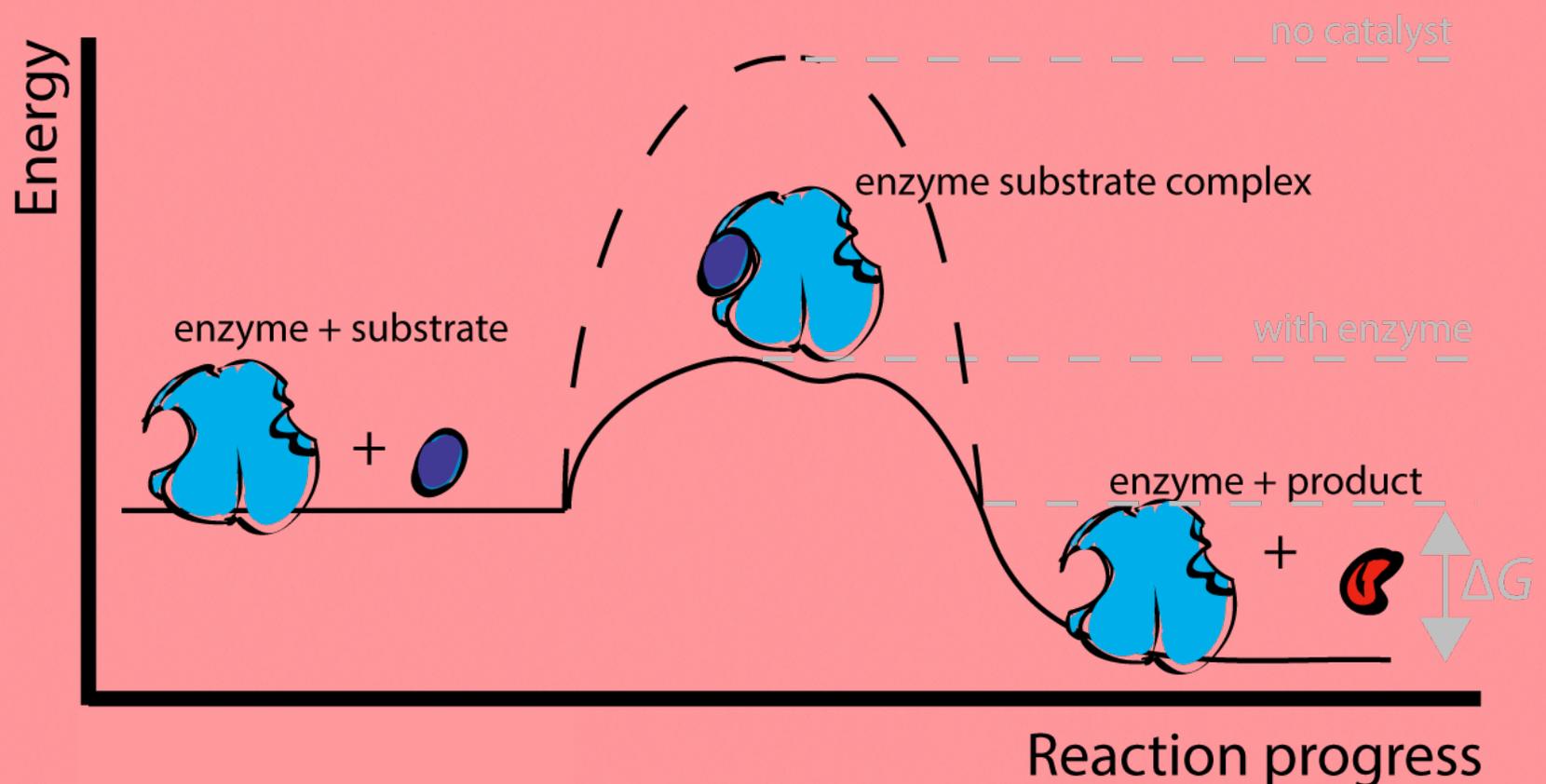
I just had a horrible feeling I might not be allowed to do a demo for the science fair, Mum says it's okay, but Mr Brady has to supervise me. Those losers will probably think I am getting extra help for the project. With any luck that might scare them into not turning up to the fair.

Anyway, need to get back to my research.

Bio-catalysis

Enzymes are biological catalysts and are green because they work under very mild reaction conditions (body temperature and pH; in water).

Enzymes are proteins found in every living organism, whether that be a plant, animal, or fungus. Just like any other catalyst, they lower the activation energy of reactions.



For example, when we eat food the enzymes in our gut digest it and break it down.

Enzymes are currently used in industry to make chemicals, although they are not as widespread as chemical catalysts. One of the reasons for this is due to the fact that they are very specific and will only work for certain reactions.

Tuesday Morning

These enzymes are everywhere! I researched enzymatic catalysis and I found a cool demo to do.

All I can say is, it's edible.

Off to see Mr Brady today; hopefully he will agree to be my mad scientist assistant.

Tuesday Lunch

Just got back from Mr Brady's office - he said yes!

Not that I'm surprised - I am his best student after all.

Harrison was sat in the study room at break he seems to have upped the effort this week. Obviously I'm not worried, but I do need to get on and actually make this model.

Second time lucky!

Tuesday Night

We have a lot of catching up to do.

I had the first preparation session after school. I managed to get on the computer and found loads of stuff on enzyme action - particularly lock and key theory,

Take a look:

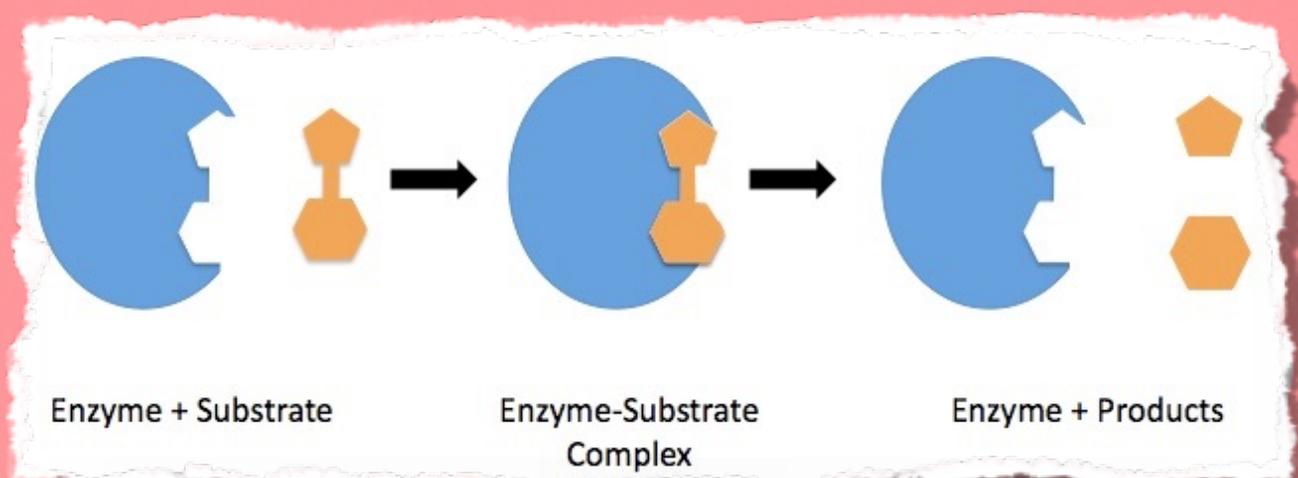
How do enzymes work?

Enzymes work by binding to a substrate (the reactant/chemical) and changing it. They are very specific, which means they will only bind to certain substrates. For example, protease enzymes only bind to proteins.

Shape is an important factor when considering how enzymes work, and the 'lock and key' theory provides an explanation as to how they are able to catalyse reactions.



Imagine the enzyme is a keyhole, and the substrate (reactant/chemical) is the key. The substrate can fit inside the keyhole (enzyme) since it is the right shape to do so. If the key does not fit the keyhole, then the door cannot be unlocked, just as the reaction cannot happen.



At least I know what I'm doing for the model - I'm still super stressed. I totally forgot I'm staying at Mona's tonight. I bet Harrison has practically finished his model by now and I've barely started.

On the plus side Mona's is the perfect place to build a model - it's like Aladdin's cave for art stuff. I'm here because Mum is on a teacher training course and there is no way I'm having a baby-sitter.

Mona's mum has been briefed though; she's being just as strict as mum! Mona isn't taking it that well, she's stormed off to have a shower.

So, I'm writing now so she doesn't read it. Mona isn't exactly famed for keeping her mouth shut.

At the minute, she doesn't know anything that those losers won't find out after-school tomorrow ...

And I want to keep it that way.

Wednesday morning

Amazingly, I got work done yesterday. Mona went to hockey but at least I had an excuse not to tag along - any excuse would have done to avoid meeting that lot face to face again.

Monas' mum let me do paper mache, I haven't done that since primary school. Believe it or not it actually looks like an enzyme - I told you Ms Jones was wrong about me. All it needs now is a coat of paint!

Wednesday Night

I'm officially grounded and it's all that stupid Charlotte's fault.

In the meeting after-school, she brought along Sarah Thompson to help her.

Who would do that?

She's the reason I can't do hockey anymore.

Okay, I did hit her in the shins with a hockey stick last year but she could have won an Oscar for her performance! It's not my fault she wasn't good enough.

Anyway, I walked over and shouted at Charlotte. Well it wasn't fair she has help - no-one else had! They just ignored me and starting giggling. It wasn't worth a fight so I left.

She won't win anyway, even with help.

Oh, of course mum had heard when I got home - probably from Sarah's mum. She clearly has it in for me. I will spare you the details but basically "I should set an example" ... "you should apologise".

Me apologise!

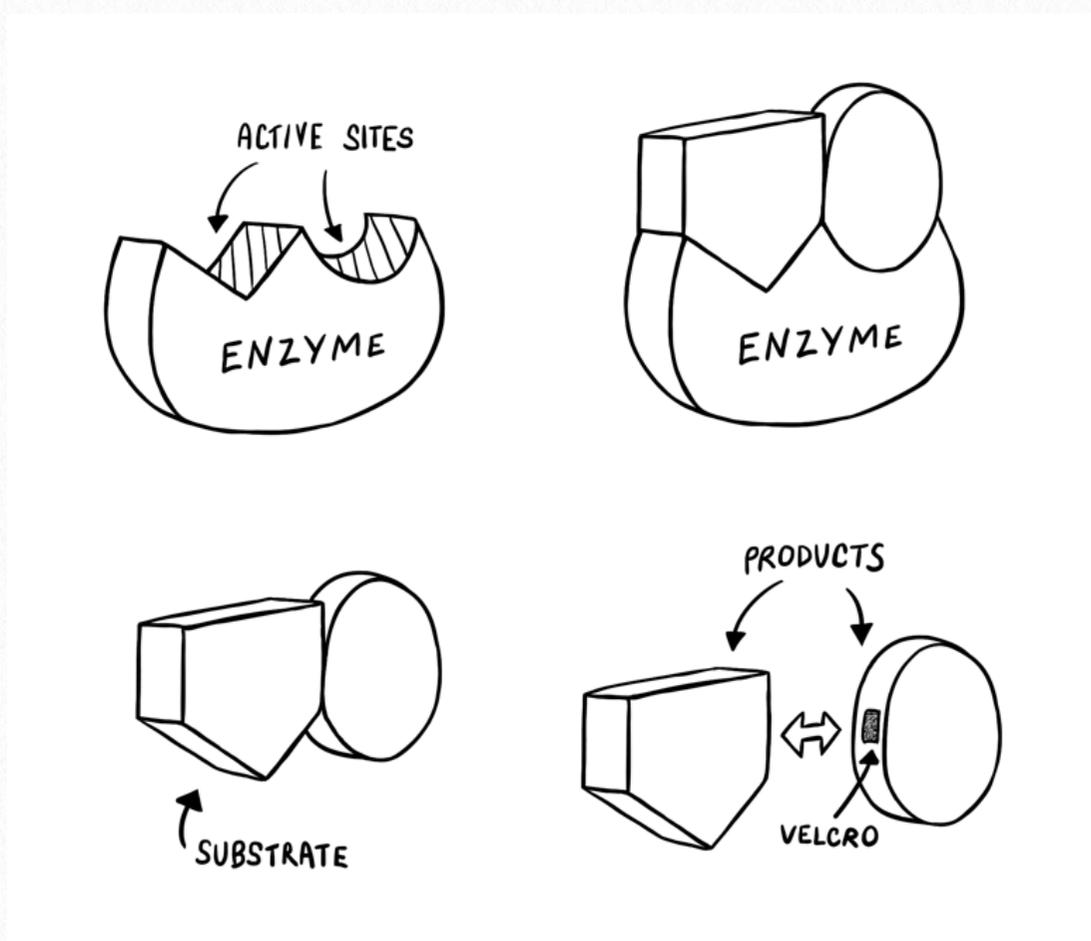
Everyone else was thinking the same thing - it's just they don't have the backbone to say anything to perfect Charlotte!

Thursday Morning

I was up all night, that meeting made me so last minute I hadn't finished painting the model. I added the enzymes in industry research to make link it back to green chemistry:

You would hope the judges are smart enough to see that, but judging the teachers in the school, I'm not sure.

At least my model looks amazing:



Those losers will be so nervous! Serves them right.

This is just a formality for me, and at least I get to miss the lessons for the day. With any luck, I will avoid mum.

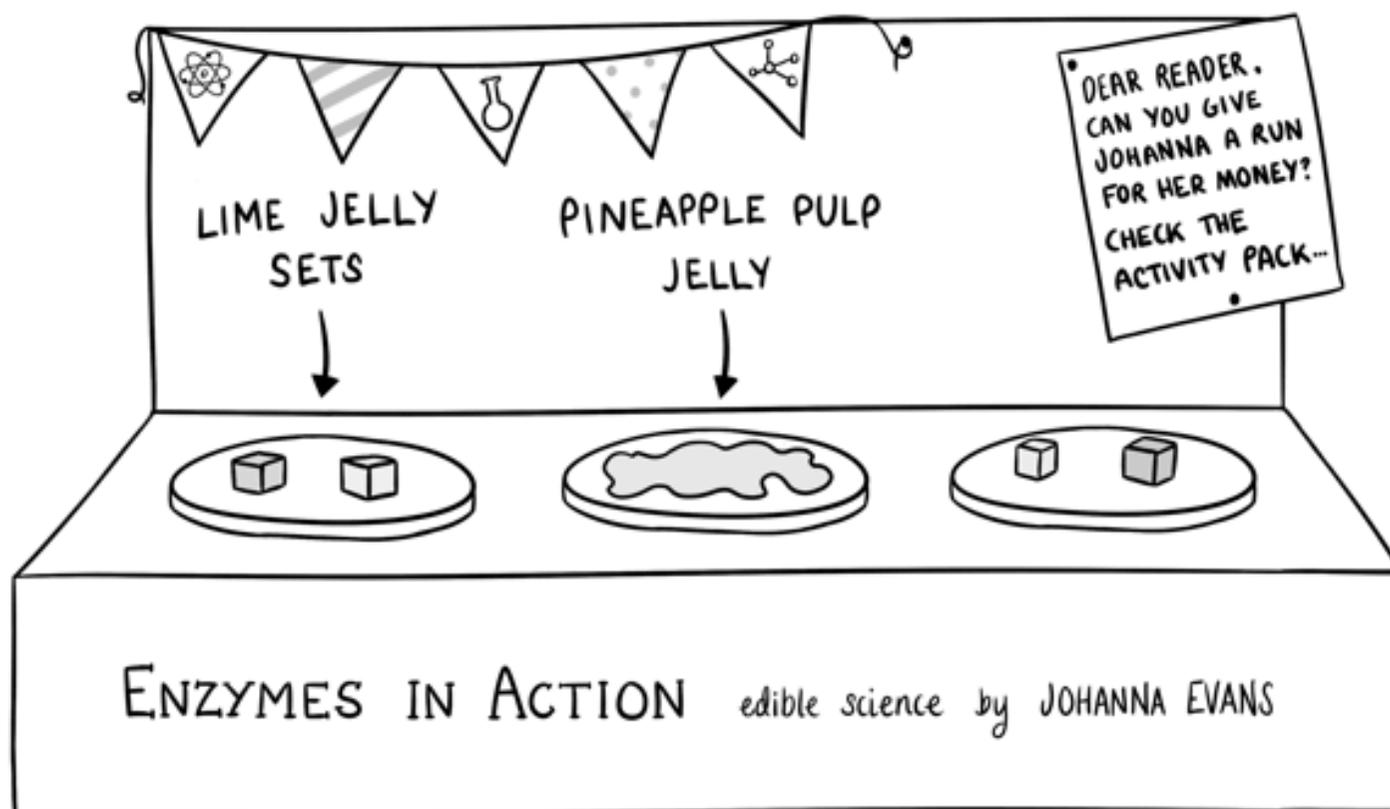
Thank goodness she isn't a judge.

Thursday Afternoon

Mum created the world's most awkward journey to school, I couldn't get there fast enough.

Mr Brady was meant to be helping me, he was running late so I started making the jellies: strawberry, lime, orange and the special pineapple flavour.

When he eventually showed, blaming traffic like all the teachers, we put the jelly into petri dishes. Amazingly the demonstration worked! It was funny trying to get the pineapple sludge into a Petri dish.



Setting up the stall took ages. At least I remembered to put my poster up unlike a certain Morgan.

After, I sat back and watched the entertainment as the others ran around like headless chickens. Charlotte was my personal favourite; she clearly hadn't finished and was in such a grump.

Serves her right.

Thursday Night

The rest of the day was relatively chilled out - although some kid from year 7 started asking stupid questions:

why have you done it like that?

Would you have done anything different?

... what type of questions are those?

So, I told him to get lost, what an idiot.

The cool thing was Mona's class went around at lunch, me and her had such a laugh. She spied on all the stalls and gave me an update; nobody else has done any demos. We were so busy I nearly missed the judging.

It all turned out ok, my demo was a big hit. You see, the pineapple jelly doesn't set. The enzymes in the pineapple pulp destroys the gelatine (mixture of proteins). I may have got a little carried away and poured some pineapple pulp on the other jellies which destroyed them. I ended up with a huge pile of goo, but I think the judges were impressed and any questions they had were really easy.

It couldn't have gone any better.

When we were packing up, Morgan came up to me...

I don't think we have ever spoken before. Anyway, he apologised for knocking into me last Friday, to be honest I'd forgotten but I thought that was kind of nice; he really didn't need to.

How bizarre!.

Friday Morning

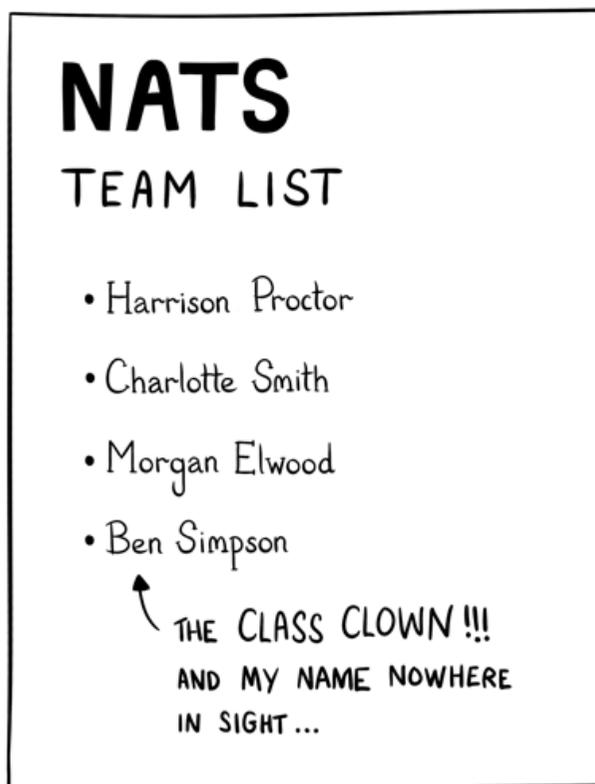
Best morning ever,

Me and mum are friends again, obviously due to my amazing project success. I didn't have to go to dance because of the science fair AND I'm just so super excited because nationals it's a dead cert.

This project is amazing.

Friday Lunch

I can't believe it ... there in huge writing, I haven't made it to nationals. What a nightmare!



EVEN THE CLASS CLOWN BEN MADE IT.

It's just so embarrassing, I've had to hide all break in the IT room. At least Harrison made it - to be honest he was the only one who deserved it. He is always in the maths department at break so I went to congratulate him, but not the others. This is the last time I'm doing any stupid extracurricular task at this school.

It's a joke.

I've got go to a stupid meeting this afternoon, probably tell me how bad I was.

No thanks...

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Week 2: End



Interviewer: After such a tough week how did you feel when you saw the results sheet?

Morgan: Shocked! Honestly, I didn't even think I was in with a chance of getting through! I'm a big fan of the team we ended up with.

Charlotte: Me too!

Morgan: Harrison, I heard they caught you rummaging through some bins?

Johanna: My mum mentioned that.

Harrison: I had my reasons; I was trying to get the school started on recycling.

Charlotte: I thought it was a really good idea.

Harrison: Thanks, it didn't stop me getting through. It's nothing compared to the problems you had that week.

Charlotte: I didn't think I would even have a model to show at the fair after all the setbacks. That reminds me, thank you so much for helping me out at the fair. I definitely wouldn't have been able to get everything set up in time without you!

Harrison: It's okay, I didn't really like seeing you stressed, plus it seemed like you had a good chance of getting through.

Morgan: Of course Harrison wanted to help you out.

Harrison: Uhh....Well..

Johanna: Oh and by the way Morgan, how's Connie?

Morgan: Watch it!

Interviewer: **Let's move on. You guys seem like a solid team now but you four weren't the original team were you?**

Harrison: Ben was our fourth member but he had to drop out due to his other commitments.

Johanna: I'm not surprised he always seems to be busy taking part in everything-

Morgan: Yeah he is always trying to get me involved, can never keep up with that kid.

Johanna: I hardly ever see him!

Harrison: Thinking about it, I think I even saw him at chess club last week!

Morgan: I mean, I'm still gutted that Ben dropped out, but I was happy with the substitution.

Johanna: We're not a football team!

Charlotte: At the end of the day we all worked really hard and managed to get through to the national competition, I still can't believe it!

Johanna: I am really grateful that you guys picked me as "substitute".

Interviewer: What kind of things were you looking for in your new team member?

Morgan: An engineer would have been good, my Redemption was still broken at this point and I didn't know what to do with myself-

Charlotte: No wonder you kept inviting me round, all you did was moan about it the whole time anyway.

Morgan: Sorry. To be fair it's probably good it broke, its why I started the project in the first place. Who did you want originally Char?

Charlotte: Definitely a girl!! I didn't want to be outnumbered by three boys!

Morgan: Nothing wrong with three boys...

Charlotte: Whatever, well originally I wanted to pick one of the gymnastics girls, but then I realised we needed to pick the person who would put the most effort into our project and give us the biggest chance of winning.

Harrison: I guess we were also looking for someone who was committed to the project, after all we knew that it was going to be an awful lot of work to do on top of all the schoolwork we already had.

Johanna: Obviously I was the perfect choice then!... I'm joking don't worry.

Charlotte: *Giggles* At the end of day, I thought Johanna's model was the best and she works really hard so it was a pretty simple decision.

Harrison: It really didn't take us that long to decide

Morgan: Yeah to be fair, Johanna's was absolutely top notch.

Interviewer: So Johanna ended up as your ‘substitute’...What made you pick her model over everyone else’s?

Harrison: Scientifically, it seemed to be the most advanced.

Morgan: Pacman, I still love the fact that you did Pacman, I bet it was me that inspired it all, right? *smirks at Johanna*.

Johanna: In your dreams Morgan.

Harrison: You could really see how many hours she’d put into it.

Morgan: How long did you spend in the end?

Johanna: Well, because of the glitter incident I could only work on it in the week... So I’d probably spent about 10 hours on it.

Morgan: I was pretty similar actually-

Harrison: That reminds me. Morgan, did you even go to any of the model building sessions?

Morgan: I thought I’d only missed one?

Harrison: There was one on Tuesday at lunch as well.

Charlotte: Oh, whoops.

Johanna: I went to both.

Harrison: It wasn’t a great turnout. Ben told me you were working on your project at home.

Morgan: It’s the most hours I’ve ever put into anything to be honest, I’m really happy with how it ended up though. Didn’t hit any massive setbacks.

Charlotte: Alright for some, I had an absolute nightmare!

Johanna: Oh no! What happened?

Charlotte: My little brother completely ruined my model on Tuesday night, I had to restart the whole thing on Wednesday! I just about managed to get it finished on time.

Morgan: Ahhhhhhh, I wondered why you were being so moody! I was trying to figure out what I did wrong!

Charlotte: Yeah I'm really sorry about that, I was just super stressed out!

Interviewer: Johanna, you must have had an inkling they were going to pick you?

Johanna: Like I said I'm super grateful they did, but to be honest I didn't really think they would-

Morgan: Really? How come?

Johanna: We never really spoke before and at the time I didn't think you guys liked me that much. I guess the model must have swayed it.

Morgan: I'm surprised we got on so well after I clobbered you the morning of the poster hand in, still sorry about that by the way.-

Johanna: I'd completely forgotten about it.

Morgan: Damn, I could have gotten away with that one.

Interviewer: Looking back, were you all sceptical of how you would be able to work as team?

Johanna: I usually work better on my own, plus me and Charlotte weren't exactly on speaking terms *winks at charlotte*.

Charlotte: I can't believe we fell out over something so stupid.

Morgan: Yeah, the first meeting was a little bit tense. Me and Harrison just tried to twiddle our thumbs and keep our heads down.

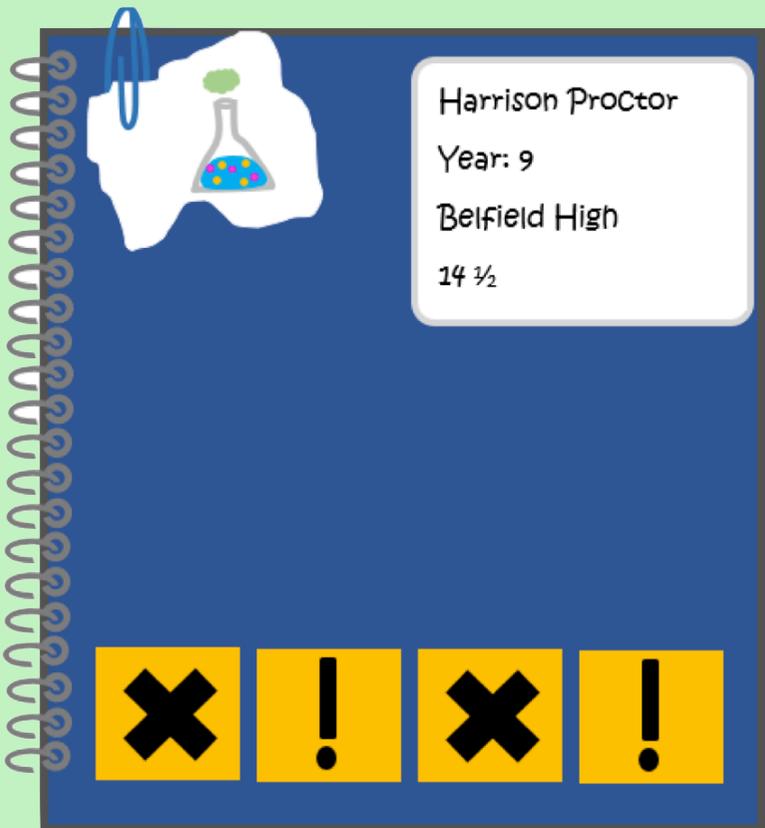
Harrison: The atmosphere wasn't as friendly as it could have been. After that I wasn't sure how I would cope working in a team.

Charlotte: But look at how far we've come as a team now.

Harrison: It's unbelievable! You guys have all been really nice to me; I reckon I would be happy to work in a team again, especially with you lot!

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Week 3: Harrison



Monday 29/01/2018 5:09pm

So after having such a busy week at school, and NATS only being around the corner, I have decided that I need to concentrate on my schoolwork. Fair enough, winning a national science competition will probably help me become a famous scientist, but how will that be useful if I haven't managed to pass all my exams!

I managed to find out that we have a surprise maths test on Wednesday. Sometimes I think teachers only do it to watch us squirm in our seats!

The joke is on them though, if the maths department wanted it to be a surprise they shouldn't have been discussing it so loudly within an earshot of students.



I think I am going to have to warn the others in the NATS group about the surprise. It only seems fair, and as we are all so determined to win I think that has made everyone closer. I would even go as far as to say that Johanna and Charlotte appear to be getting on at the minute!

I don't want to speak too soon, but today our first official group meeting went really well.

Mr Brady appointed Morgan as the leader, he is not the obvious choice but I'm pleased. He is definitely a people person and I am sure he will step up to the challenge. I am not sure that Johanna would agree she had a face like thunder for a good 15 minutes!

We haven't decided on a project yet but that is the least of my worries for tonight...

I think I am going to start with revising trigonometry first, that always seems to come up!

Tuesday 30/01/2018 4:30pm

Another long day.

I spent all my free time today revising for the surprise test and now my evening is going to be spent doing all my research for NATS. We have already divided up the topics between ourselves, all of which relate to green chemistry and a green future.

How did I forget to mention! Yesterday, Mr Brady said he has managed to pull some strings, so now we are going to visit the green chemistry centre at the University of York! He said it'll be great for inspiration! I wonder if I will get mistaken for a student... or maybe even a professor!

Yesterday, in our meeting, I nominated the idea of picking one of York's research projects to 'makeover' (as Charlotte put it). Everybody loved it! I have only had time for a quick read about them but cannot decide on my favourite yet.

Under the erratic leadership of Morgan, we are all going to research and present individual topics (although I think Charlotte and Johanna are actually going to be working together for some parts). We are then going to bring all of our research together in a presentation at NATS.

It sounds like a lot of work but I think we have actually come up with the best way for us to present a green future.

I volunteered to work on explaining exactly what green chemistry is (which may be useful to know, seeing as though that it what our project is on) as well as why it's so important and how it has developed over the years.

I bet I can get all of my research done tonight if I get started on it now

What is green chemistry?

The purpose of green chemistry is to design and produce chemicals in a sustainable way in order to minimise environmental and health impacts.

Why do we need green chemistry?

Green chemistry helps to protect the environment by reducing the use of fossil fuels and using fewer raw materials. Some chemicals that were previously used are now known to be toxic and possibly cause cancer. Green chemistry is used to find alternative chemicals in place of these harmful ones.

Green chemists are identifying old, out-dated methods in the chemical industry and forming new, safer and greener alternatives to these methods. A typical chemical reaction involves adding chemicals and a solvent to a reaction flask. The chemicals, also known as reactants, will undergo a chemical reaction, which produces a useful product along with some waste. A lot of reactions also require high temperatures or pressures in order to speed up the rate of the reaction, but this uses lots of energy. Most of this energy comes from non-renewable sources i.e. fossil fuels.

A greener chemical reaction differs from typical chemical reactions in that they are better for the environment:

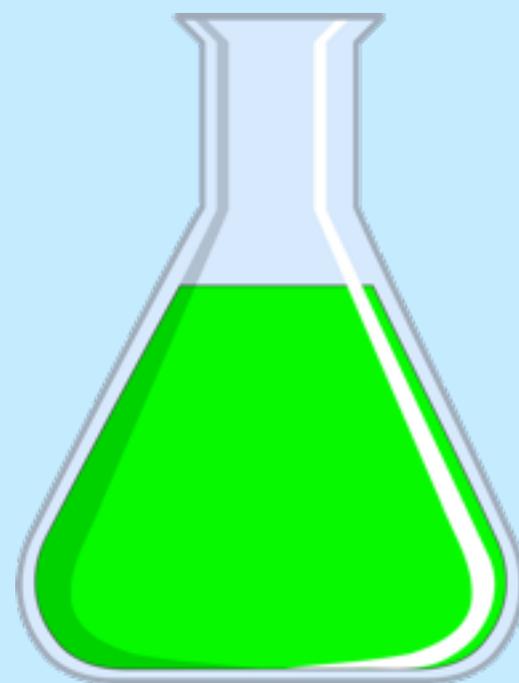
Less waste is produced;

Raw materials and solvent are recycled wherever possible;

Raw materials are replaced by renewable ones;

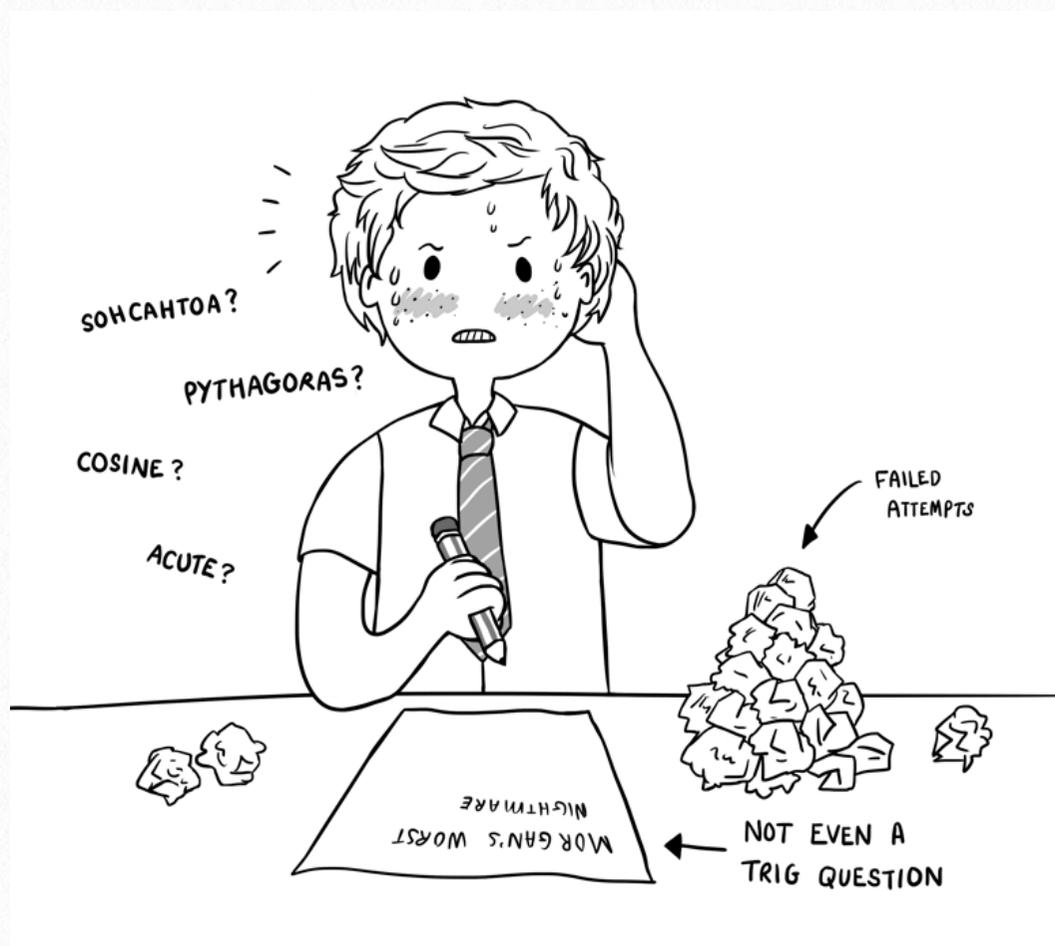
Lower temperatures and pressures are used which lowers energy use;

Less hazardous chemicals are used which makes it safer for workers.



Wednesday 31/01/2018 6:04pm

After all of the panicking about this surprise maths test, it turns out there was no need at all! It was the easiest test I think I have ever done, even a year 7 could have done it! After looking around at everyone else in the classroom I think they all felt the same way.



Well, everyone except Morgan!

I've only just got home, Morgan arranged a NATS meeting after school, which overran (as always) Grandma wasn't overly impressed as my tea had gone cold by the time I walked in. I don't think she quite appreciates how hectic and demanding a scientist's life can be!

During the meeting we planned how our presentation is going to tie in everybody's research. Morgan is going to make a massive poster on solvents and Johanna is going to do some sort of wacky experiment too.

That leaves Charlotte and myself; maybe we could work on something together.

I cannot wait for our trip tomorrow; we can all get a proper idea of the green chemistry research happening right now!

Thursday 01/02/2018 11:34pm

I cannot believe how late it is! I am going to need a serious catch-up on sleep this weekend. I would love to be able to nap all day tomorrow, but I imagine we are going to be ridiculously busy getting everything ready for NATS.

It's only next week!

Today has been one of the best days in my entire life! I can now actually say I have been to a University, but not just any university, I have been to the University of York, one of the best in the whole country!

Do you know what is even better? This morning we were given a guided tour of the labs that all of the York students work in.

Walking around the labs with specs and a lab coat on really did make me feel like I belong in there! The others were really impressed too, although perhaps Morgan was more just impressed with all the fizzing and explosions.

I even caught Charlotte comparing the colour of some fancy solution to her nail varnish at one point! Johanna seemed a little bit quiet, but like me, I think she was just taking it all in.

After the tour we were taken up to the green chemistry department; I didn't think I anything could be more impressive than the labs, but boy was I wrong! We met professors (yes, actual professors!) of green chemistry. They told us all about their latest research projects, which I may have had more than a few questions about... I hope I didn't embarrass myself.

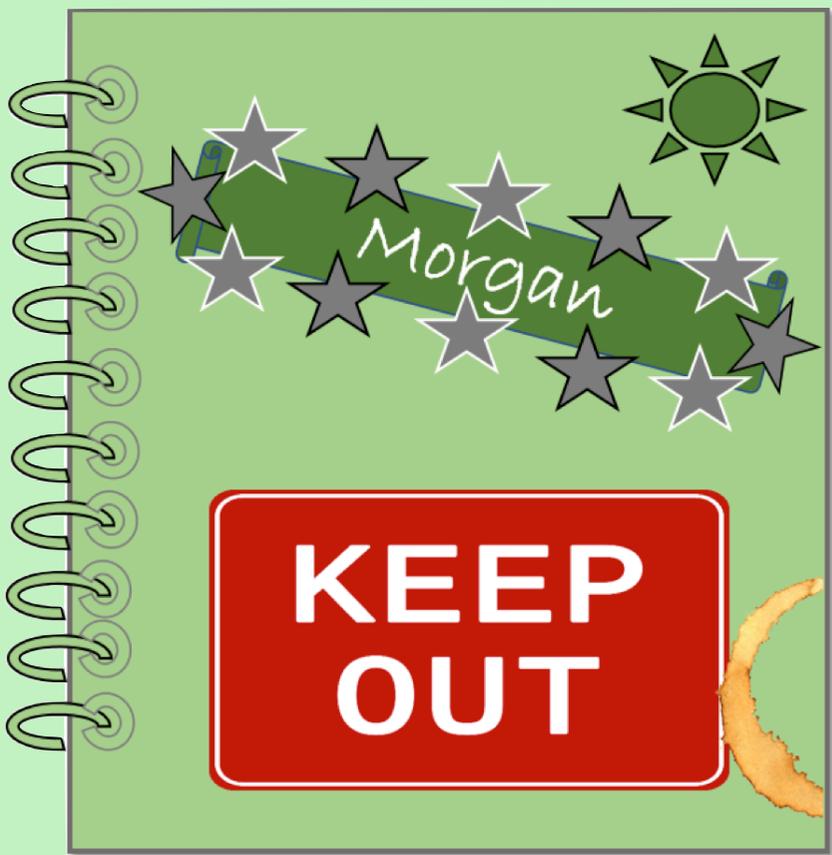
Morgan says we should all have a sleep on it and then tomorrow we can have a vote for our favourite project, it's probably for the best.

Right. I am going to try and go to sleep. Although that's easier said than done with this playing on my mind all night!



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Week 3: Morgan



Monday Afternoon

My project really must have made a lasting impression. I didn't even know I was capable - maybe I'm a better scientist than I originally thought?

I should probably explain myself. When telling stories, I guess it's better to start with the beginning and work through, rather than starting at the end and working backwards. Although I don't want to be stunting my creativity now.

The NATS crew (my group for the science competition!) had a meeting with Mr Brady today and we are all going to New York University to have a look at their green chemistry research! I cannot believe it! I'm going to get to see how actual real scientists work!



I absolutely love travelling, I've never been in a plane before!

I hope we have time to look around properly! There is one thing I am a little bit confused about - I have no idea how we are going to fly and look around in just a day. They are the adults, they will have it all figured out, I am not exactly complaining!

But, my main point for today is that Mr Brady chose me, YES, ME! To be the team leader for our group. I mean, I almost didn't even do this project and look at where I've got to now.

I feel invincible.

I reckon I'd have it in me to even ask out Connie right now. Actually, no that is a stupid idea, I'm not going to...not until I am famous anyway! Then she'll definitely say yes!

Anyhow, we obviously won't even have a chance of winning. The competition seems so fierce, there are so many schools competing. We may as well give it our best shot anyway.

Harrison came up with a GENIUS idea! He was under my leadership at this point so I can take some of the credit. He thought about basing our project on one of the research projects at the Uni! It might help us stand out from the crowd, I bet no other teams have thought of this. After all, no other teams have a Harrison!

I'm going to get an early night, I need to feel my freshest for this week.

I have a team to impress now.

I have MY team to impress.

Tuesday Morning

This team leader role is already starting to become a bit daunting. I woke up to a moany text from Char this morning; concerning my first act as team leader. Basically, I put her and Johanna in a pair for the project. This may seem like I've gone mad with power, or I'm trying to split the group apart.

But hear me out...

There has been tension between those two since the start. It's something I figured needed to be sorted out as soon as possible. We can't have a team being split up by rivalry. Especially since it seems to be based around absolutely nothing.

I hate being on the wrong side of Char - hopefully she will see my logic with time.

Tuesday Afternoon

There has been an update.

One that actually answers quite a few questions. Char may have informed me that we are going to the University of York, rather than New York...



Whoops. I should have seen this coming. It did all seem a bit too good to be true. Getting there and back in a day AND going to the competition did make me think that we would be a bit rushed for time.. I asked my mum about York and she said it is incredible. She always knows loads about this kind of stuff.

All hope is not lost yet.

Tuesday Evening

I feel bad for writing in my diary rather than doing work on the project, this probably isn't the smartest move but at least it's something productive. The work is actually going well, but it's difficult!

When I do too much science, my brain turns into jelly. I can't think properly until I have a break. My breaks are amazing, they mostly involve eating half my body weight in snacks so there is no wonder I choose to take one every 10 minutes!

Spike is so attention hungry this evening, I don't think he is a fan of my project, or anything that distracts from him for that matter. What can I say, the king likes his attention!

Principles of Green Chemistry

Green Chemistry is a term generally used to describe the development of more environmentally friendly, sustainable chemical products and processes and follows a set of principles described below:

Preventing waste: try to avoid making waste rather than treating it or cleaning it up after it has been created

Atom economy: make sure as much of the raw materials/chemicals used in the process are incorporated into the final product as possible (which again helps avoid waste)

Safer synthesis: substitute hazardous (toxic or environmentally damaging) chemicals used in a reaction for safer ones.

Safer chemicals: design chemical products that are less harmful but still perform the role they are meant to.

Safer solvents: Choose the safest (least toxic/environmentally damaging) solvent possible and use as little of it as possible

Design energy efficient reactions: choose chemical processes that need less energy for example by carrying out reactions that don't need heating or cooling.

Use renewable feedstocks: A feedstock is the raw material/chemical that is used in an industrial process. It is important that these feedstocks are renewable to reduce strain on the environment. An

example of a renewable material would be sugarcane, since the crop can be regrown.

Design for degradation: design chemical products so that at the end of their use they break down into non-harmful substances and do not persist ('hang around') in the environment.

Real-time pollution prevention: Check reactions as they are happening and stop them as soon as they have reached completion to make sure that the product doesn't break down or continue to react and form unwanted (and potentially) harmful byproducts.

Safer chemistry: reduce the potential for accidents by choosing chemicals and the way they are used that are less likely to cause explosions, fires or be released into the atmosphere.



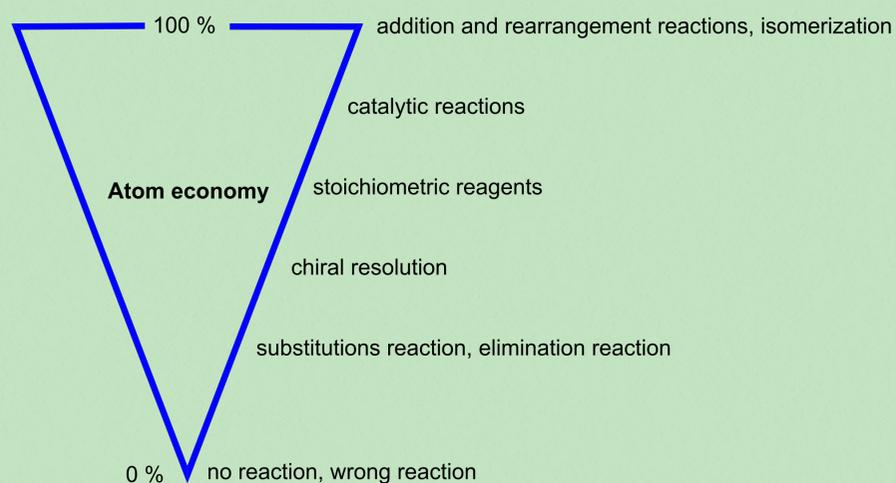
Atom Economy

Atom economy is a way of measuring how efficient/green a chemical reaction is, by looking at how many atoms are incorporated into the product and how many are wasted. The higher the atom economy, the more environmentally friendly the reaction as fewer atoms are wasted. It is calculated like so:

$$\text{Atom Economy \%} = \frac{\text{Mr of desired product}}{\text{Sum of Mr of all products}} \times 100$$

(The Mr is the relative atomic weight of an atom, and is calculated by adding together the number of protons and neutrons in the nucleus. For example, the Mr of carbon is 12 because it has 6 protons and 6 neutrons)

Designing syntheses so that there are as few side reactions (leading to unwanted by-products) as possible increases atom economy.



Wednesday afternoon

What I have never needed on a Wednesday afternoon?

A SURPRISE maths test.

Saying this, it didn't go terribly but some warning would have gone down nicely. Harrison managed to finish the test in 5 minutes...5 minutes!

I honestly don't know how he does it, he is actually a genius! So glad we have him on our team.

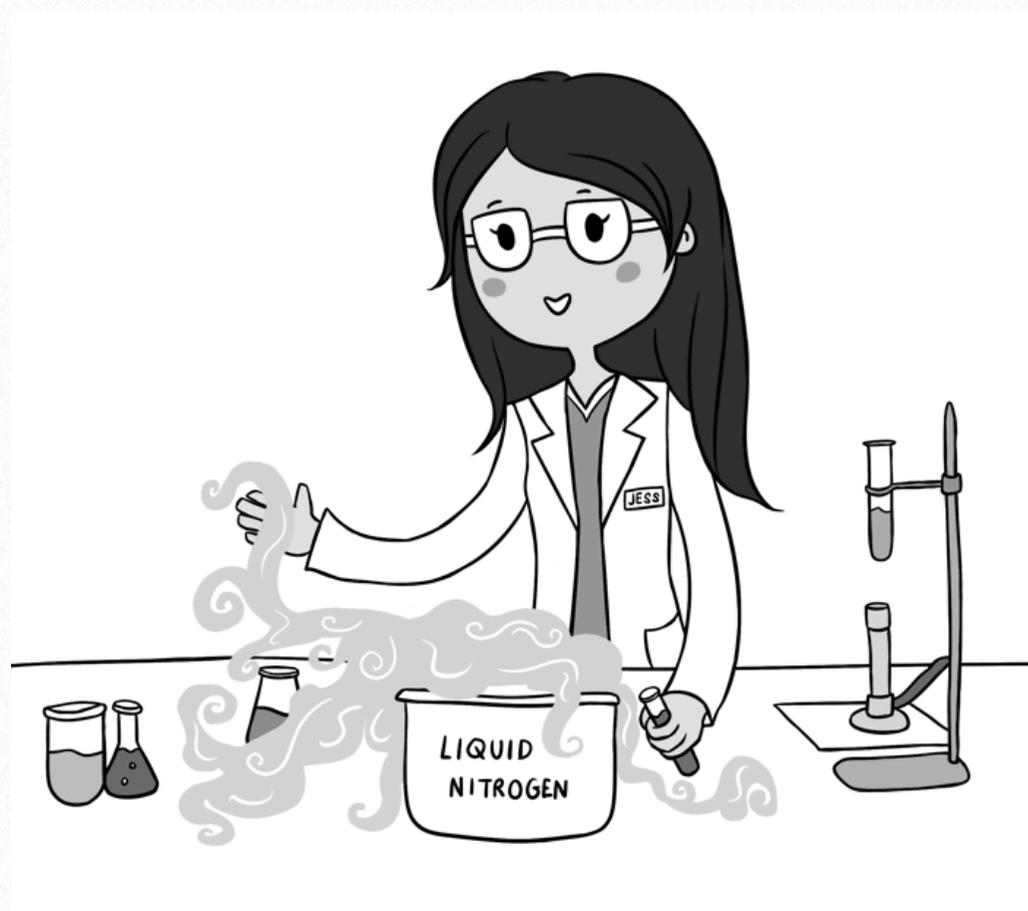
Anyway, no time to worry about schoolboy problems anymore, I'm not going to school tomorrow! Officially off to university, well, for a day, but everyone has to start somewhere.

Thursday evening

University. Is. Amazing. There is so much to do and to see that I didn't even know existed! Where do I even start, science or sport? Accommodation or clubs?

Ok, chronological storytelling is smart.

We were taken round the labs which were nothing like I'd ever seen before. I felt like I was in the evil lair in an action movie. There were students 'cough' villains 'cough' mixing all kinds of dangerous looking chemicals.



Was she using liquid nitrogen!?

I didn't even know that stuff was real. It all felt like something out of a space age film. I've heard you can freeze flowers in them and smash them with a hammer.

Mum wouldn't be able to tell me off, I can say I learnt it at university! Perfect plan as always.

The four of us looked around the entire campus. The football pitches looked incredible, I reckon if I get some practice in with Ben and the boys I'd be sure to make the team. There were just so many pitches and even the changing rooms looked fancy. Harrison seemed less keen on the sports, I might invite him down to football next week. It would be good to get him involved.

I caught him staring at Char a couple of times today as well. I should probably bring it up with him but I wouldn't even know what I'd say.

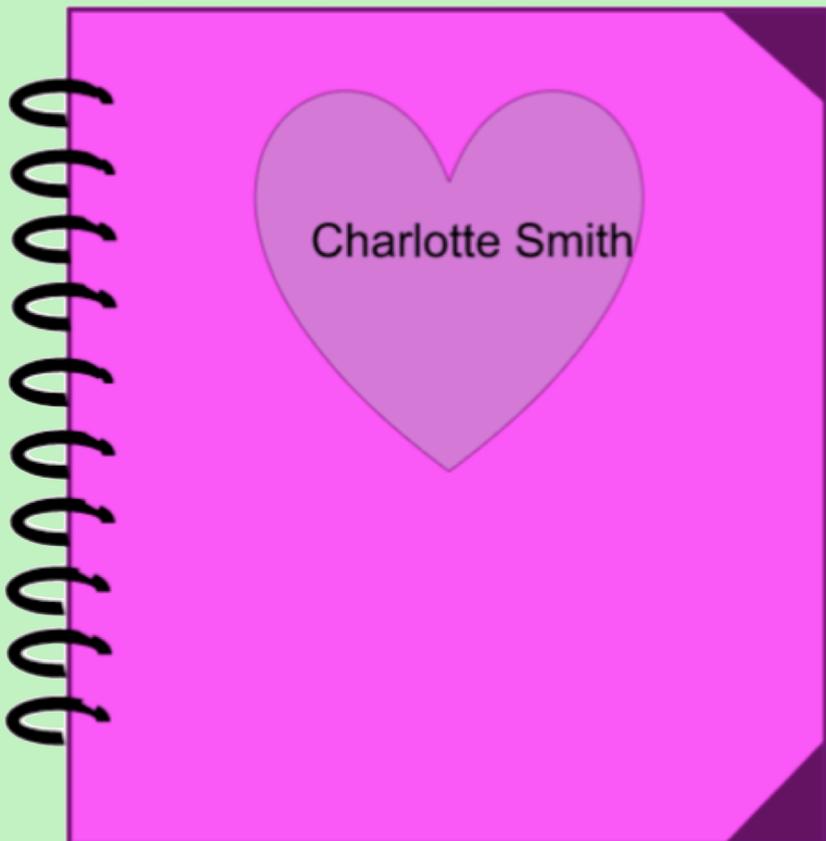
Does Char know?

Does she like him too?

Probably safer to bring this all up after the competition, wouldn't want to ruin team morale over "who fancies who".

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Week 3: Charlotte



Monday:

7:43 am

We went to visit my Grandparents this weekend and got back so late last night that I nearly slept straight through my alarm this morning!

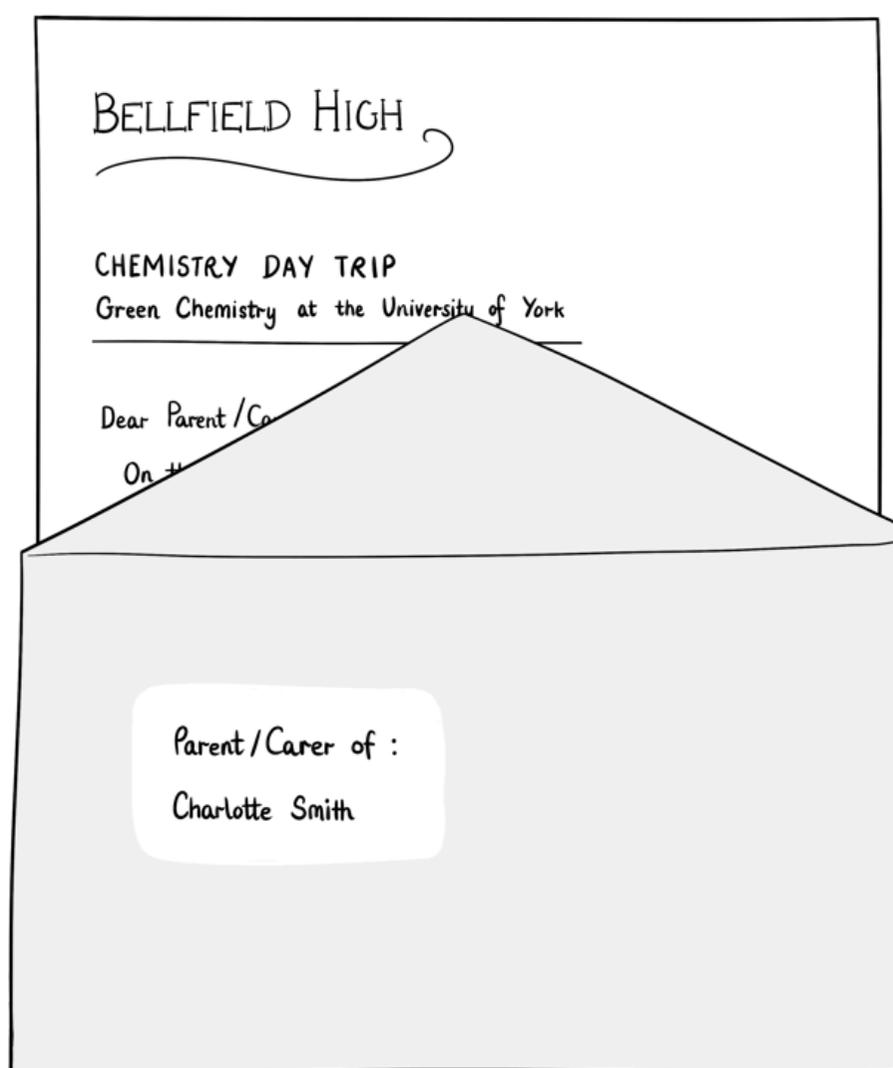
This would have been the worst day to be late - we're meeting Mr Brady to discuss the NATS project. Every time I think about Johanna being on the team I just get annoyed.

I hope she won't be too controlling and try and to take over...

6:09 pm

We're going on a trip!

ANOTHER DAY OFF SCHOOL!



I've never been to a university before; I wonder what they're like? I think you must have to be super intelligent to go there.

Harrison is definitely clever enough.

Mr Brady picked Morgan to be the leader for our group - I'm not sure how good he'll be though. Afterall, he does has the organisational skills of a teapot, but I'm sure he'll try his best.

At least it wasn't Johanna!

In the meeting we started to divide up the research topics for our NATS project. Johanna and I both wanted to do green chemical synthesis so Morgan said we should work together on it...

How unfair!!

Why would he make me work with her when he knows we don't get on?

Sometimes I wonder why I'm friends with him.

I suppose I should do some research tonight and try and get ahead of Johanna. I don't want her showing me up and making me look bad.

She's probably done millions of pages already, so I'd best get on.

Tuesday:

7:31 am

I stayed up for hours and hours trying to do my research but I couldn't find anything useful. I just don't know what to look for.

Why did I pick such a hard topic?

I'm going to go to the school library at lunch time and see if I can find anything there, if not I may have to ask Johanna for help...

12:58 pm



There's nothing else for it; I admit defeat.

This is going to be so embarrassing!

8:12 pm

Problem solved!

I had English with Johanna last lesson today so I decided I'd have to ask her then. To be honest she was actually really nice about it and didn't gloat at all. She had found some really helpful books in the library yesterday, so after the lesson she took me there and helped me to find them.

She knows that place inside out!

We even did some research together and came up with some really cool plans for the project.

Who would have thought we could be friends?

While we were in the library Johanna mentioned some of my friends in the hockey team, including Sarah, weren't being very nice to her friend Mona. I don't know Mona very well but she seems like a nice girl, and the hockey girls can be quite mean sometimes.

I think I'll talk to them about it next time we have training and get them to stop.

After all, one good deed deserves another, right?

Wednesday:

7:28 am

I finally managed to get my research done last night using the books Johanna told me about.

Just in time for the group meeting this afternoon!

Route Selection

There can be many different ways to create a product in the chemical industry; this means it is important to find the most environmentally friendly method. Therefore manufactures need to make sure they pick the route that creates less waste, reduces the amount of energy they use and make sure they don't use hazardous or toxic chemicals.

10:04 am

I saw Harrison this morning and he seemed really stressed.

I wonder if he's having problems with his research too?

8:27 pm

The group meeting went well, I think our project is going to be really good! It's got loads of science in and there are even some experiments!

Harrison seemed a lot happier in the meeting; he said something about having a surprise maths test today, so that must be what he was stressing about this morning.

I'm glad he's feeling better now though.

After the meeting I had to go straight to hockey with Sarah. Mona seemed a lot happier so my chat with the girls must have done the trick.

Call me the Queen of conflict resolution!

Thursday:

6:19 am

IT'S TRIP DAY!

The excitement almost makes up for having to be up this early in the morning.

I'm so excited to look round an actual university!

12:21 pm

I'm having the best day!

The green chemistry labs were amazing; they were like the really posh labs you see on TV! We got to see some of the students doing some fancy experiments and we even got to wear lab coats and goggles like real scientists!

Even Morgan was asking loads of questions!

It's very unlike him to be interested in education.

After we went to the labs we met with the green chemists and told them about our project plan. They seemed really impressed and gave us loads of helpful ideas and tips.

I think we're in with a really good chance of winning NATS now!



8:19 pm

University is HUGE.

It's like 1000 times bigger than school and there are so many students!

We've had a guided tour round the campus; there were loads and loads of buildings, a gym, sports fields and a massive library.

We are on our way back now, I am so tired but it was so worth it.

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Week 3: Johanna



Sunday Night

I have been super busy, I haven't had time to write -mainly with Mona's brother's birthday party.

Yep it's as bad as it sounds!

To be honest I did expect some of the hockey team to be there too, I'm glad they weren't. Mona wasn't much fun either, even after I helped her with the Maths Trigonometry homework.

Ungrateful or what?

Anyway, group progress update; guess who made it to NATS?

Clearly I was the best option - I bet that took a lot for Charlotte to admit. I am going to take the high ground; they did pick me after all. Tomorrow we will find out what the project is on.

This time, I promise you I have no idea.

Monday Lunch

What a morning!

The presentation theme is "future of green chemistry" which is cool - maybe we'll see the return of mad scientist Johanna and her crazy demos. That's what Harrison must have thought, I genuinely have never seen him so excited! He even had, by my own admission, a great idea for our trip to the University of York: making over one of their syntheses.

That's right, as a treat for making the team we get to go to their amazing green chemistry department.

Better still, Mr Brady is taking us so I won't have mum glaring over me for a whole day - good job Ben had his priorities all wrong in the end!

The trouble started when it came to picking subtopics.

I really wanted to do green synthesis, which is logical because it's MOST LIKE CATALYSIS!

But no, Charlotte doesn't do logical.

How that links to elements I will never know.

Of all people, Morgan stepped in... he's our leader; but he's certainly going to have to toughen up and actually turn up to the meetings, if he wants to be a good one..

If that wasn't enough, Mona has thrown in a real curve ball.

She's being quiet and cagey about the hockey qualifiers this week. I'm not surprised - the team haven't got a chance without me.

Even so, I think I will do some digging...

Monday Afternoon

Mission 'find out what's wrong with Mona' is complete.

I sat behind some of the hockey team in History and they were talking about extra practise after school. I decided to check it out.

My suspicions were true, Mona wasn't there.

It must be because they hadn't told her about it, she never misses practice.

Then I realised why... guess who is the new hockey captain? ...

Sarah, Charlotte's backstabbing best friend.

It all clicked.

Mona has been kicked off the team because of me. Worse still, if mum finds out I'm toast.

I seriously need a plan!

How to achieve a green synthesis

Better use of catalysts

Preventing or decreasing the use of toxic heavy metal catalysts. Development of specialised catalysts specific for a process.

Alternative synthesis routes

There is often more than one way to make a product, selecting the best method is a fine balance between for example: the number of steps, temperature dependence and avoiding hazardous chemicals.

Substitute toxic chemicals

If possible, toxic chemicals should be avoided. You must also consider minimising the use of ones that could be harmful to the environment to make the process greener

Adopt more energy efficient methods

One way to decrease heating costs is to capture and use the heat generated from one reaction to drive another reaction that depends on high temperatures to work. A reaction that gives out heat is called exothermic.

Renewable Resources

To become greener industry has to make sure that the feedstock for their reactions comes from renewable and sustainable sources.

Reducing waste

Choosing synthesis routes that have fewer waste products is a method to become greener. These waste products could also be used for other purposes, or sold on to other companies that need it as a feedstock.

Health and Safety

Health and safety is important in industry because of the dangers surrounding some chemical reactions. Despite there being so many industrial factories around the world, only a handful of accidents happen each year because of the techniques put in place to make reactions safer. Health and Safety is a very important aspect of green chemistry

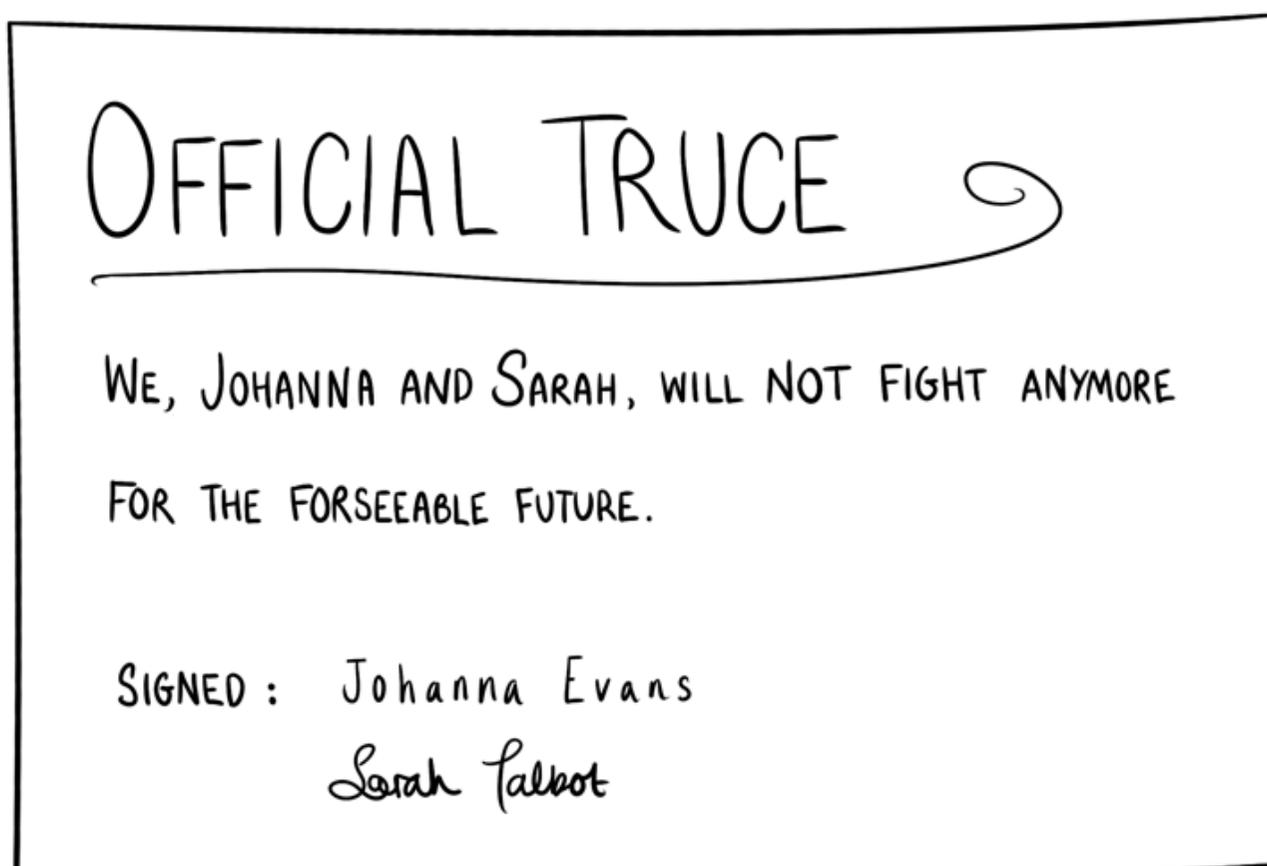
Tuesday Morning

I have made progress with Mona.

Last night I paid my favourite person (Sarah) a visit. I pulled my trump card, she really struggles with maths.

I gave her an offer she couldn't refuse - to help with her rock-hard trigonometry homework if she included Mona in the hockey team.

I have kept my half of the bargain now let's see what she's made of. After all, if I was still part of the team I would be captain and not her.



Tuesday Night

Literally, been a walking zombie!!

After all the Sarah drama I stayed up super late researching legislation. I almost fell asleep in English; that's what soppy Romeo and Juliet does to you.

Truth be told, I didn't really want to bother with the library tonight. With all the research mounting up for Thursday and Charlotte asking me for help - how could I not?

That's right. Charlotte asked ME for help.

I was as shocked as you... but surprisingly it was fun. We talked for ages, so much that we got told off for laughing by the librarian. Her face was a picture when she saw it was me. Charlotte is a completely different person without her "friends". Amazingly she barely mentioned them. She spent most of it talking about: Morgan's lizard, Harrison and gymnastics. I spent most of the time talking about Mona. Not sure she even knows her.



Wednesday Lunch

This morning I was greeted by last night's fish fingers left on the side; clearly someone fell asleep before tea...

Whoops!

Thank goodness mum had an early meeting! Having a surprise maths test was really sneaky, and could have gone one of two ways, but with all the help I had given to Mona and Sarah, I was super prepared.

At least things are pretty chilled out on the NATS front; Charlotte and I did so much work last night so the meeting this afternoon should be a breeze. It looks like Harrison will be okay, he must have done tonnes for the project.

The wildcard is Morgan.

Wednesday Afternoon

The meeting went great; everyone seems really into it. All the research is ready and I can't wait for tomorrow - even if the day off means I won't find out my maths test result till next week.

Now I need to do my good deed for the day; cheering on Mona is so embarrassing but if it's what is needed to win the big game and keep Sarah in check - then so be it.

Thursday morning

I'm really excited! Today's the day we get to go to an actual University and I have the day off.

At least I know Mona will be okay... guess who scored the winning goal?

She was amazing, which was a relief as they had my winning streak to maintain. I think she appreciated my contribution of a very acrobatic, loud if not slightly mistimed cheerleader - who knew dance would come in handy somewhere!

Realistically, Mona was probably more relieved to be included.

Captain Sarah must have seen sense ... I wonder how that could have happened? ;)

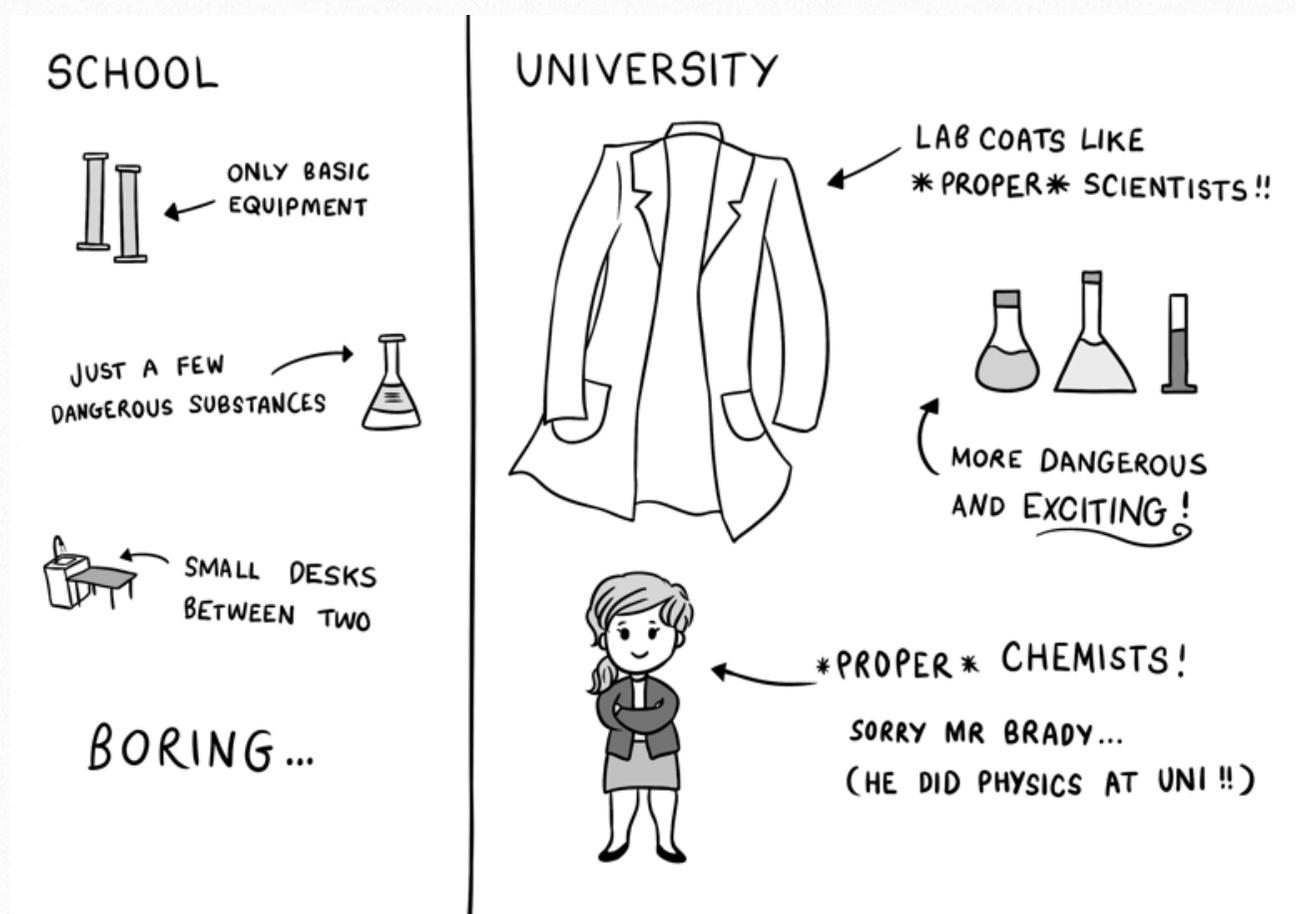
Thursday lunch

I have to be quick: tours, talks and textbooks - I haven't had a moment to breathe.

I love it.

Green chemistry was great. We looked around their labs; ours look so shabby in comparison but that didn't stop Mr Brady showing me up with my mad scientist experiments.

I'm not going to lie, I loved it really and secretly they were impressed too.



Harrison was the biggest surprise of the day, the question and answer session was just dominated by him. Obviously, I knew the answers but I really didn't want to steal his thunder - he's the budding scientist after all.

Got to go, the group are waiting for me, we are off on a tour of the Uni.

They had better not leave without me - this place is so big I could be lost FOREVER.

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Week 3: End



Interviewer: So, this is the question we all want to know the answer to, who came out top in the maths test?

Morgan: Me, obviously...

Johanna: Yeah...and pigs can fly! Not to boast but I did extremely well in that test.

Charlotte: At least you tried Morgan.

Harrison: Was it that bad? You can only do your best. I only did so well because all the stress made me revise.

Morgan: Wait, how can you stress about a surprise test?

Charlotte: Harrison...did you know about the test?

Harrison: Erm...I might have accidentally overheard...some words...about maths...which may have involved a test...

Johanna: I can't believe you were eavesdropping on some teachers!

Harrison: It was an accident, wrong place, wrong time.

Morgan: I don't buy it. I reckon you definitely had some spy equipment, I could see you in a pair of night vision goggles.

Johanna: You rebel, as if you gave me a hard time for finding about that model.

Charlotte: How come you didn't tell us!

Harrison: I really wanted to tell you guys I knew, but I thought you might have all thought I was cheating.

Morgan: I don't think revision could have saved me.

Johanna: Yeah I was too busy that week to even fit any in.

Charlotte: I didn't even have a test, my teacher must have forgot.

Morgan: Your class has so much more fun!

Interviewer: He may not be the most mathematically skilled, but what did you think when Mr Brady chose Morgan as group leader?

Johanna: Initially, the worst idea he has ever had!

Harrison: I was kind of hoping that Mr Brady might have picked me to be honest...I thought it was a good chance for me to prove to myself.

Morgan: Even I wouldn't have picked me, to be fair you are the obvious choice.

Johanna: Like I said that was only my initial opinion! Overall I thought you stepped up to the plate; you were pretty organized in the end

Charlotte: I think you did a really good job Morgan.

Harrison: Yeah, no offence to anyone else but I don't think we could have had a better leader!

Morgan: Guys, you're making me blush!

Johanna: Clearly not as much as you do when Connie is around!

Morgan: Get off my back! I will ask her out eventually...

Harrison: Yeah...might be an idea to ask her before the next ice age though Morgan!

Interviewer: Morgan, what was your first act as leader?

Morgan: I tried to organise 'milkshake Thursdays' but it sadly didn't catch on.

Johanna: I think she means about the project Morgan.

Charlotte: It was actually to divide up the topics, although that got a bit tricky when me and Johanna wanted to do the same one...

Morgan: Yeah you two weren't exactly BFFs when we first started either, I thought pairing you up would bring the team closer. Char, you were delighted if I remember rightly?

Charlotte: Of course I wasn't!

Johanna: I can't say I was too thrilled either

Harrison: It worked out okay in the end though didn't it. Don't mean to brag either, but I came up with the idea of making over one of York's syntheses as our finale!

Johanna: It was definitely a lot better than I expected and all credit to you, that was an amazing idea

Morgan: Harrison yet again being a real scientist

Harrison: You have made my day!

Johanna: And you have the lab coat to prove it

Harrison: Yeah, the lab coat that also doubles up as a dressing gown!

Morgan: You seem to live in that thing, and how have you managed to keep it so clean. So impressive, mine was white for about 20 minutes.

Charlotte: Well Harrison probably doesn't miss his mouth 99% of the time when he's eating, unlike you.

Johanna: Or get covered in mysterious stains

Morgan: I have been considering buying a bib

Interviewer: I am not sure you could get away with wearing that at the University of York, did you all have a good day?

Harrison: I have to say it was the single most amazing experience I have ever had. I could tell you all about it for hours and hours, how long have you got?

Charlotte: Probably not long enough, it's all you've been talking about since we got back!

Harrison: Haha, sorry, I will admit that I do get a bit carried away sometimes.

Johanna: It's fine, I think you all know I'm a bit guilty of that too.

Charlotte: I think you two are starting to rub off on me, even I thought the green chemistry department was great.

Morgan: Everything was so high tech there, the labs were amazing! It didn't even seem real. There were whizzes, pops, bangs and white coats everywhere. I really could see myself in a place like that.

Johanna: Were my demos not exciting enough for you Morgan?

Morgan: They were fun, don't get me wrong... But a little more fire/flashes/explosions wouldn't have gone unnoticed

Harrison: Well you seemed very happy when she let you have a go with them in rehearsals, even if you did mess them up a couple of times!

Johanna: Well when you added too much, there were definitely enough explosions!

Morgan: Go big or go home.

Interviewer: Does this make you want to go to uni?

Morgan, Charlotte, Harrison and Johanna: YES!

Interviewer: With the national competition fast approaching, did it put strain on you guys as a team?

Morgan: We started a little bit rocky, but things couldn't be better now! Can't believe how childish we all were.

Johanna: A lot of that is down to you Morgan! I was probably the most childish of the lot of us. If you hadn't forced me and Charlotte to work together I'm pretty sure we would still be "sworn enemies"

Morgan: Thank you! All in a day's work for a top group leader eh?

Harrison: And I have to admit, I found it a bit difficult to get involved in group meetings at the beginning, especially with all the tension.

Morgan: Can't get you to shut up now!

Johanna: Unless you're stressing over a surprise maths test

Charlotte: Hey! Maths is a very stressful subject, I would have been stressing too if I'd had a test.

Harrison: Thanks Charlotte...You can joke but I can tell you guys are much happier now I talk more.

Interviewer: Juggling schoolwork and NATS must have been difficult, how did you manage to fit it all in?

Harrison: Once I had the maths test out of the way I could focus on NATS. It was a challenging week, but I am quite used to spending lots of hours on studying, so researching for NATS wasn't that different for me.

Morgan: It was hard! Definitely manageable though, just had to organise myself a bit. Which is something I have DEFINITELY gotten better at over the last few weeks.

Johanna: You think your week was hard! NATS was a welcome distraction from what my "best friend" put me through with that stupid hockey team.

Charlotte: Yeah, I had to do all my NATS research whilst trying to resolve the hockey team drama, so you guys had it easy!

Johanna: Wait, you spoke to them too? So I wasted my trump card on Sarah for nothing.

Charlotte: What trump card?

Johanna: I said I would help her with her maths if she let Mona play in the hockey team. More importantly, What did you do?

Charlotte: Just had a little chat with them, used my influence you know?

Morgan: "Influence"? Woah, check this guy out!

Interviewer: So, you must have been well prepared for NATS?

Johanna: Obviously, I don't know about you guys, but I knew the presentation off by heart; we had practised it literally 1000 times.

Charlotte: And we had a really good topic to present.

Harrison: Yeah, I think that a good topic, fantastic teamwork and a motivating leader are the perfect formula for success. I think we were all a bit stressed but we helped each other through it.

Morgan: Yeah everyone was quite stressed at times; I like to think I lightened the mood with a cheeky cartwheel here and there.

Johanna: You definitely tried your best, we can always rely on you for a good laugh.

Morgan: Organising everyone was the hardest work! You were all amazing, but distributing the work evenly and deciding topics really took some thought.

Interviewer: So, Morgan. Were you responsible for organising presentation too?

Morgan: Well yes. Yes I was. Team! Why don't you tell everyone what you did!

Charlotte: Me and Harrison had the most important job, we introduced the project.

Harrison: Yeah, we thought it would be best to first introduce our audience into what exactly is green chemistry.

Charlotte:After that everyone spoke about their different topics individually.

Johanna: Then came the main event

Morgan: Yeah! The best bit! The foam went absolutely everywhere.

Johanna: I can't believe you got so carried away... again!

Harrison: Science is not always all about the practicals you know...it can be quite fun to get your teeth into a gripping concept.

Charlotte: Hmm... I think I still prefer the demonstrations!

Morgan: So... Scorecount? Is that 1-0 to team demonstration? I think it might be...

Harrison: Anyway...moving on... after the demonstrations we presented the 'makeover'!

Interviewer: I am guessing you aren't referring to Morgan's transformation into a power crazy leader?

Harrison: Haha, no I'm not. After our trip to university we decided to use one of their research projects in our final presentation.

Johanna: Don't be so modest Harrison, you did come up with that idea!

Charlotte: With some inspiration from me obviously - 'makeover'.

Morgan: After careful consideration, I chose to accept Harrison's idea.

Interviewer: So what was this makeover actually on?

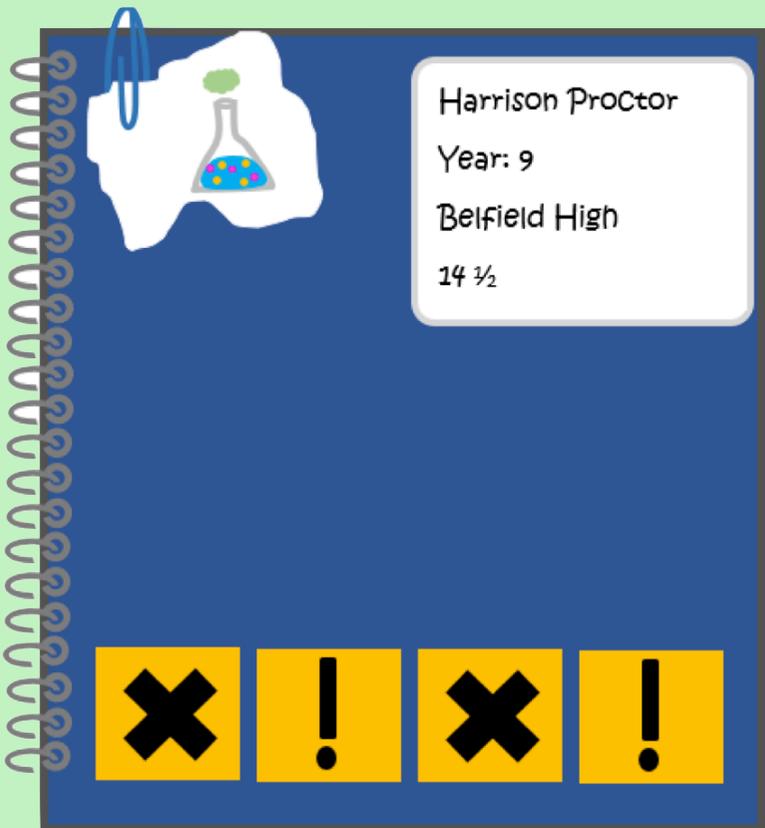
Johanna: Orange peel.

Morgan: I think she needs a bit more detail than that.

Johanna: Have a look at our poster and you will find out!

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Week 4: Harrison



Tuesday 06/02/2018 5:09pm

Stressed doesn't even close to describing how I am feeling right now.

The last 5 days have been absolutely jam-packed for the NATS crew.

I had my doubts about how well Morgan would be able to handle the responsibility of reaching our deadline, but he really has proved me wrong.

As I am writing this diary entry, I am not sat in boring Bellfield, but in a fancy hotel restaurant somewhere in the heart of London. Don't ask me the exact whereabouts because frankly I have no idea; this place is absolutely massive.



Johanna really has transformed from a monster into a half-decent human being.

We got the train down this morning with Mr Brady, and were given specific tickets allocated to us.

Johanna was meant to be sat next to Charlotte.

She must have figured that I wouldn't have minded that seat, and so volunteered to switch with me.

Me and Charlotte then spent most of the journey chatting about NATS and how excited we were to be heading to London. I think she had some new perfume on.

Remarkably, there was only one mishap on the way down

But I am sure you can guess out of the four of us who managed to get lost...

Somehow, Morgan managed to not notice that all of us had got off of the train. Mr Brady really wasn't impressed, but I don't think he was that surprised either.

We then had to get back onto another train to try and find him. By this point I think Mr Brady had started to panic...London is a big place.

Luckily, we found him at the next stop, just sat on a bench. And STILL playing his silly games console! I think he eventually realised how much panic he had caused, I could tell he felt a little bit bad about it all!

I am going to get an early night to try and prepare myself the best I can for tomorrow.

Wednesday 07/02/2018 5:09pm

I am actually so much closer to fulfilling my dream of becoming a famous scientist!

Not only did we absolutely smash the presentation this afternoon; I am currently sat in a new personalised lab coat. We all got one as a present from Johanna, it definitely gave us an edge in the presentation. We all looked so professional!

Morgan has got his covered in food stains and mud already. To be honest, I am not quite sure how he has managed that, we haven't even been outside today!

After spending all afternoon watching everyone else's presentations, I would say there is a good deal of competition. A couple of other groups even had demonstrations, I am not sure Johanna liked that. Her experiment was more interesting than any of the other ones anyway.

I was sat next to Johanna this afternoon, she was making jokes and chatting during the other presentations. It was a bit rude of her but I couldn't help but laugh along. We ended up having a really good chat.

I thanked her for letting me sit next to Charlotte and admitted to her how nervous I had been for today. Not that I mentioned it to the others, but I didn't sleep a wink last night to busy perfecting my part of the presentation!

Thursday 08/02/2018 5:09pm

This morning didn't get off to the best of starts.

We were all having breakfast, Mr Brady had gone to answer an 'emergency' phone call from his substitute teacher. Apparently, his year 7 class had decided to swap all of the whiteboard pens for permanent markers. The teacher hadn't realised until she came to clean the board at the end of the lesson!

I think I should tell Mr Brady that I read somewhere about this solvent called acetone, which can remove permanent marker. I should tell him but he probably already knows, being a science teacher and all.

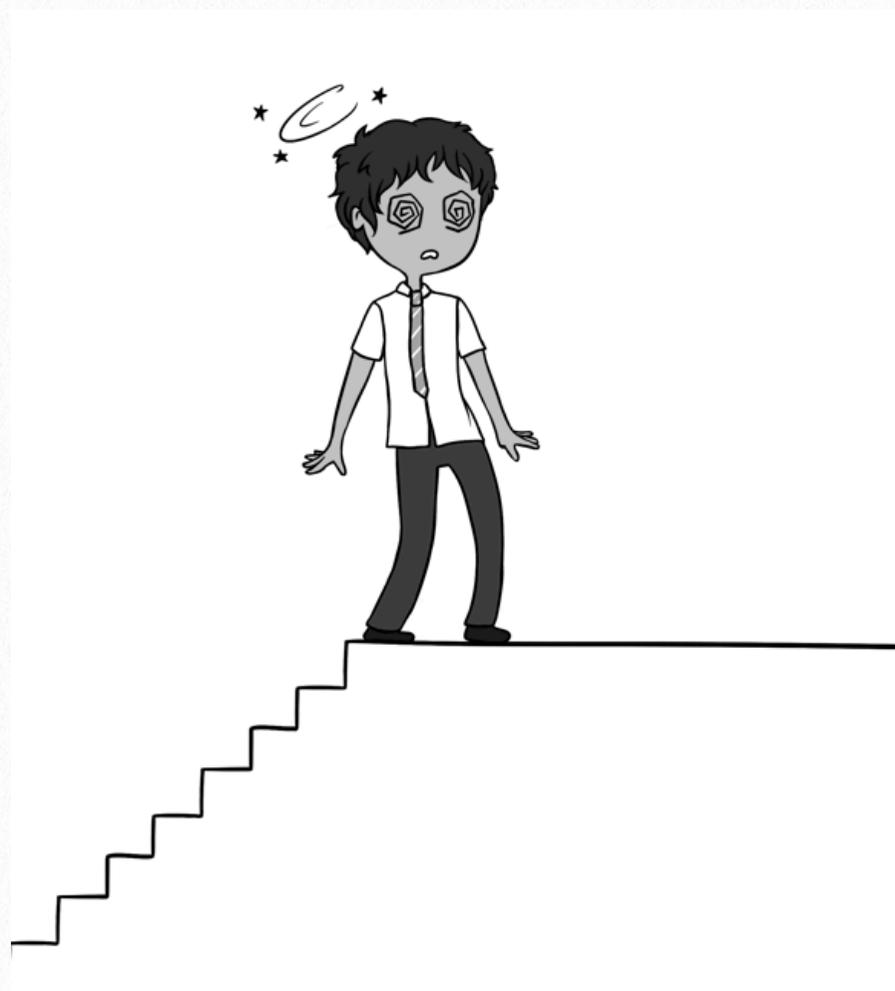
Anyway, back to my story. Morgan was adamant that we were going to the London Dungeon after the London Eye. I think his leadership role may have gone to his head, he has turned power mad!

He wouldn't even listen to my idea of visiting the national science museum. We are here on a science trip!!!

I gave up asking after a good half an hour.

I think Charlotte actually noticed I was a bit annoyed and so decided that we were going to fit in all three activities!

The London Eye wasn't my favourite; it isn't really an ideal attraction for someone who is terrified of heights! This is the boy who gets vertigo when he goes up the stairs to Maths every morning!



I was pleasantly surprised by the London Dungeon, the obvious highlight was when Charlotte and Johanna decided to run ahead, and then jump out at Morgan and I. Morgan let out such an embarrassing, girlish scream!! I actually thought it was Charlotte or Johanna at first!

After we had recovered from our laughing fits, we decided to head to the national science museum, much to Morgan's disgust.

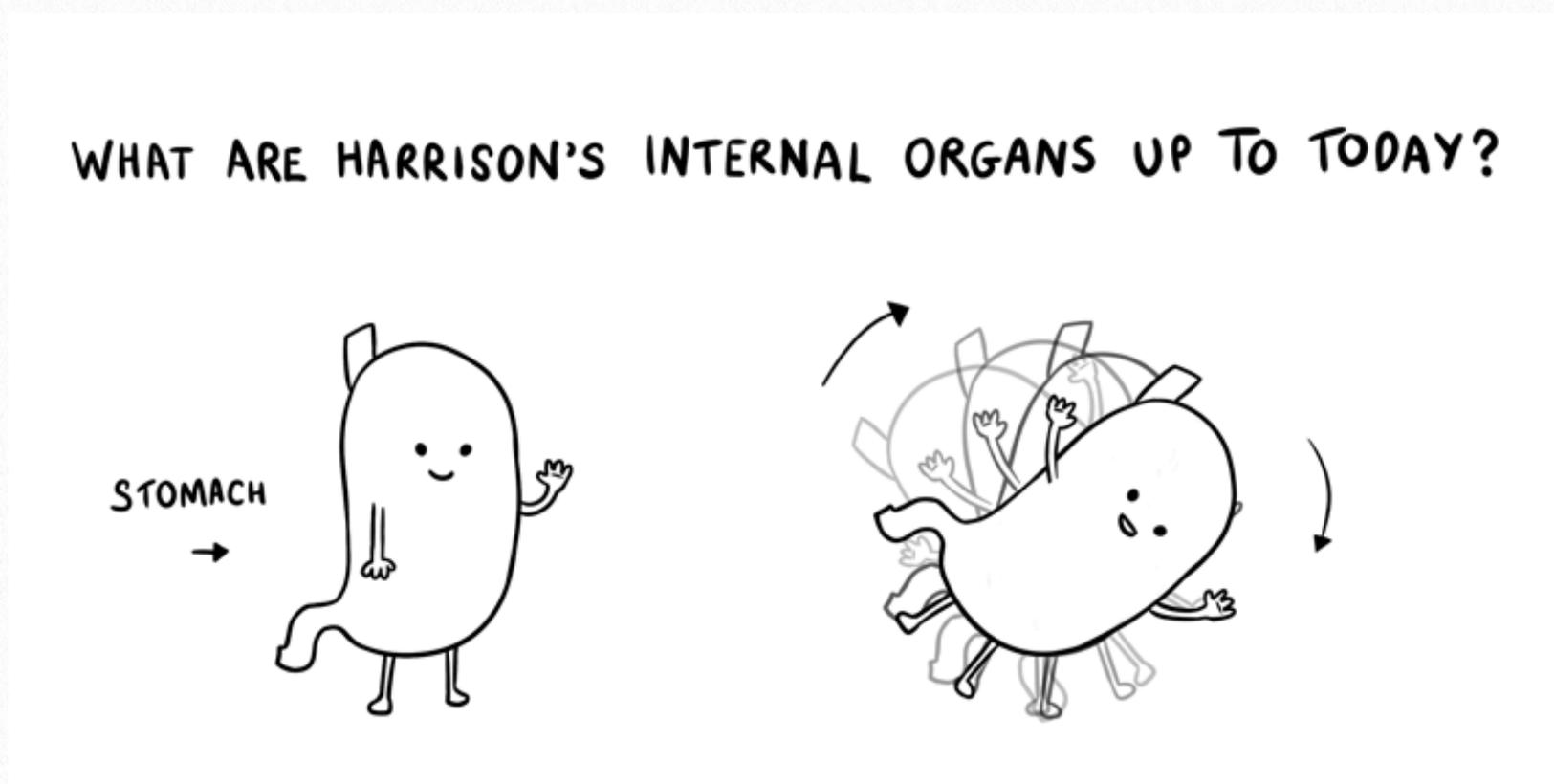
I don't think the others realised how cool it was going to be, I already knew that it was not just a typical museum. Mr Brady and I ended up being tour guides for the group. He knows what he is talking about and I know the place like the back of my hand!

I am so shattered from a long day sightseeing, and I still haven't caught up on my sleep from the other night.

Another big day tomorrow...results day!

Friday 09/02/2018 8:30am

I couldn't even manage my breakfast this morning...

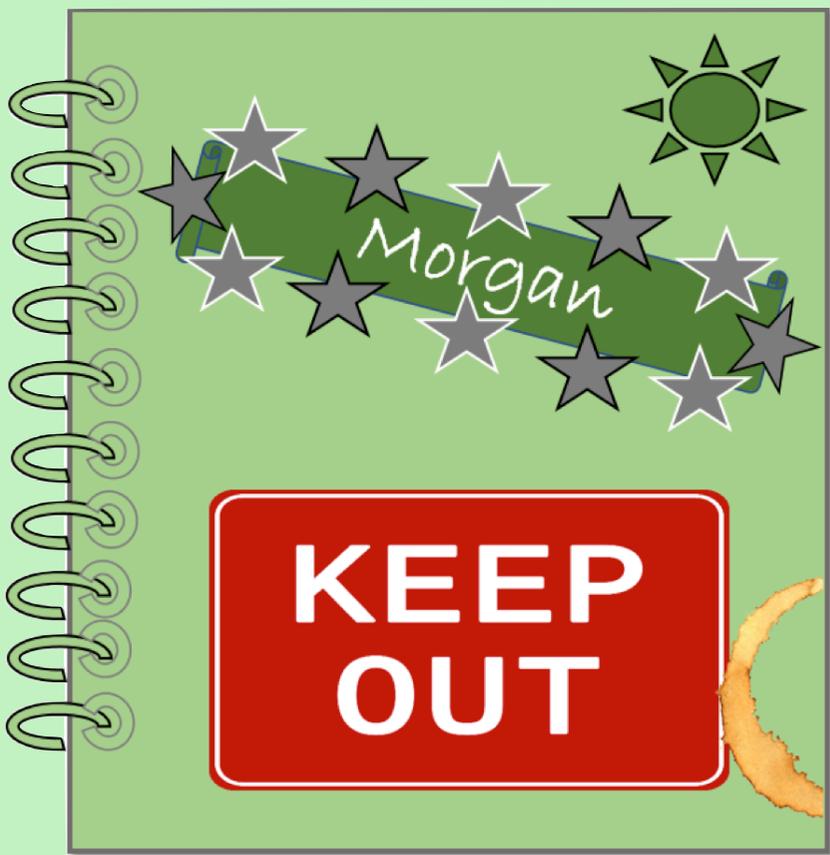


It is probably best to write a full diary entry after we have got the hard bit out of the way. Morgan is telling me to hurry up and get ready or we will be late...I feel like this is the wrong way round!

Wish us luck!

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Week 4: Morgan



Tuesday Morning

Fanfare Sounding

Here it is. The first day of the rest of our lives. I felt so pumped when I got out of bed this morning. I should invest in getting some theme music, then maybe everyday would be this exciting.

I just have to make my team proud; I would hate to disappoint them, or Mr. Brady.

Even so, I can't really turn down spending some time in London, it'll be a good trip whatever happens! Who knows, maybe I'll learn something. Or maybe even teach something!

Tuesday evening

I let my team down today, can't believe I messed up. Being team leader is hard, much harder than I imagined.

I really need to step up to the challenge.

We had to use the London Underground, this is an entirely new concept to me. I'm not excusing myself, but it may explain the moronic behavior. It all started when Johanna asked to use my portable lightning console, which I was fine with, obviously. If I play games in a moving car for a long time it makes my eyes go funny anyway. I figured it would be the same on a train.

It was fun looking out of the window, I just imagined I was in a cool rap video.

After a short while, I looked over and saw Johanna with a big grin smeared across her face.

Basically it had turned out she had beaten my high score! Me... Morgan...surely not.

This was my thing!

If I'm being honest, I was secretly impressed, but this did mean that I would have to get a new high score. The pressure was on.

I was getting very competitive and started to forget the world around me even existed. My gaming tunnel vision was in full force. All I could see was Johanna's score in the top left corner of my screen: 32000 points. With my own score rapidly increased in the top right. 29000. 29500. 30000. 30500. I heard Johanna say something but this really was not the time. Whatever it was, it could wait. 31000. 31500. ALMOST THERE! 32000. 32500. 33000. 33500...

I hear a mechanical clicking sound and the world around me suddenly snaps back into focus.



The train door had shut. Johanna was gone.

I looked up to see her and the others stood on the platform. The train slowly starts to pull away again. There is a sudden moment of realization, Johanna had been calling me to say it was time to get off.

After all the hassle and panic, it didn't turn out to be the end of the world. I just got off at the next stop and waited, the NATS crew and Mr. Brady turned up after a few minutes. No-one looked happy with me but I wasn't even told off. I think it might have been one of those situations where an adult isn't annoyed, just disappointed. Which I always find to be much worse.

It's time to step up. I need to keep my eye on the prize. Especially if I'm ever hoping to win one.

Wednesday morning

The hotel was so fancy! Despite the nerves and a bit of tossing and turning, I slept incredibly.

This really is it now. Bring it on!

Wednesday evening

Honestly where do I even begin. My team were amazing! Everyone came together so well and I honestly couldn't be prouder. I think the main issue was getting food and mud all over Johanna's present. Which, if I haven't already said: she bought us all personalised lab coats! It was so sweet of her, I couldn't stop thanking her!

I could not stop looking at myself in the mirror and may have even taken a little snap to send to my mum. I reckon, if I do science homework in this I could actually get better marks, getting into character and all that.

The scary bit is over, everyone can breathe. The whole crew has crashed, I kind of wanted to go exploring around the hotel but no-one else was keen. This was probably for the best because I would have:

- a) Broken something
- b) Accidentally trespassed
- c) Got lost (again)
- d) All of the above

So, bed it is.

Today was amazing (pretty sure I already said that, but it really was). Got to rest, celebrations in London tomorrow!

Thursday evening

London is truly awesome. The streets, the attractions and the general size of everything was just incredible. We have been absolutely everywhere, the NATS crew is somehow even more exhausted than yesterday, me included this time!

Anyway, after a slight disagreement with Harrison, we ended up going to the London Eye, the dungeons and the science museum.

The dungeons were so well made, there was so much gruesome stuff! I wasn't scared though. The girls tried to make us jump, I didn't even flinch! You have to get up pretty early to catch me out.

I will admit now that I was wrong about the science museum, I thought it was going to be so boring and we would have to read loads or take a test to get in or something.

THERE IS SO MUCH COOL STUFF.

The space area really got me, the only thing missing was an alien section. They might be renovating it or something...

We also grabbed something for Mr. Brady as a thanks for helping us through all this. It was my idea, Harrison and I created a diversion whilst the girls ran into the shop.

I think this might have to be goodnight, for once I actually might be the first in bed.

Friday Morning

I'm stressed.

Today we find out.

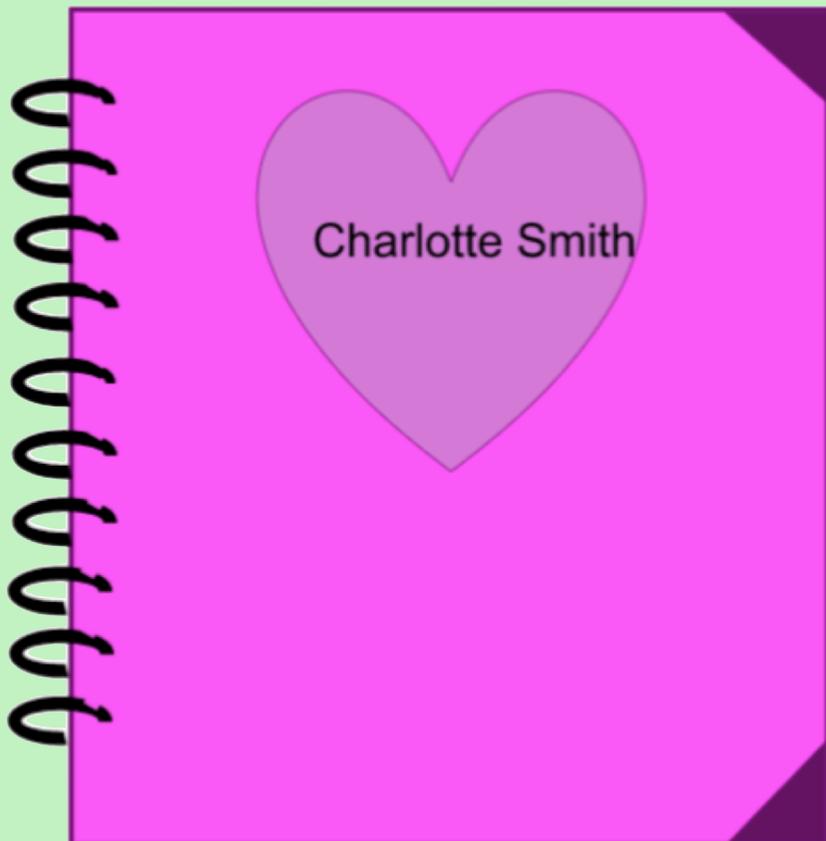
This is it.

I'm sure it'll be fine, always is.

Wish us luck!

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Week 4: Charlotte



Tuesday

8:46 am

We're off to NATS!

I've spent the whole morning trying to decide what to pack - think of how many outfits I'll need for a trip to London.

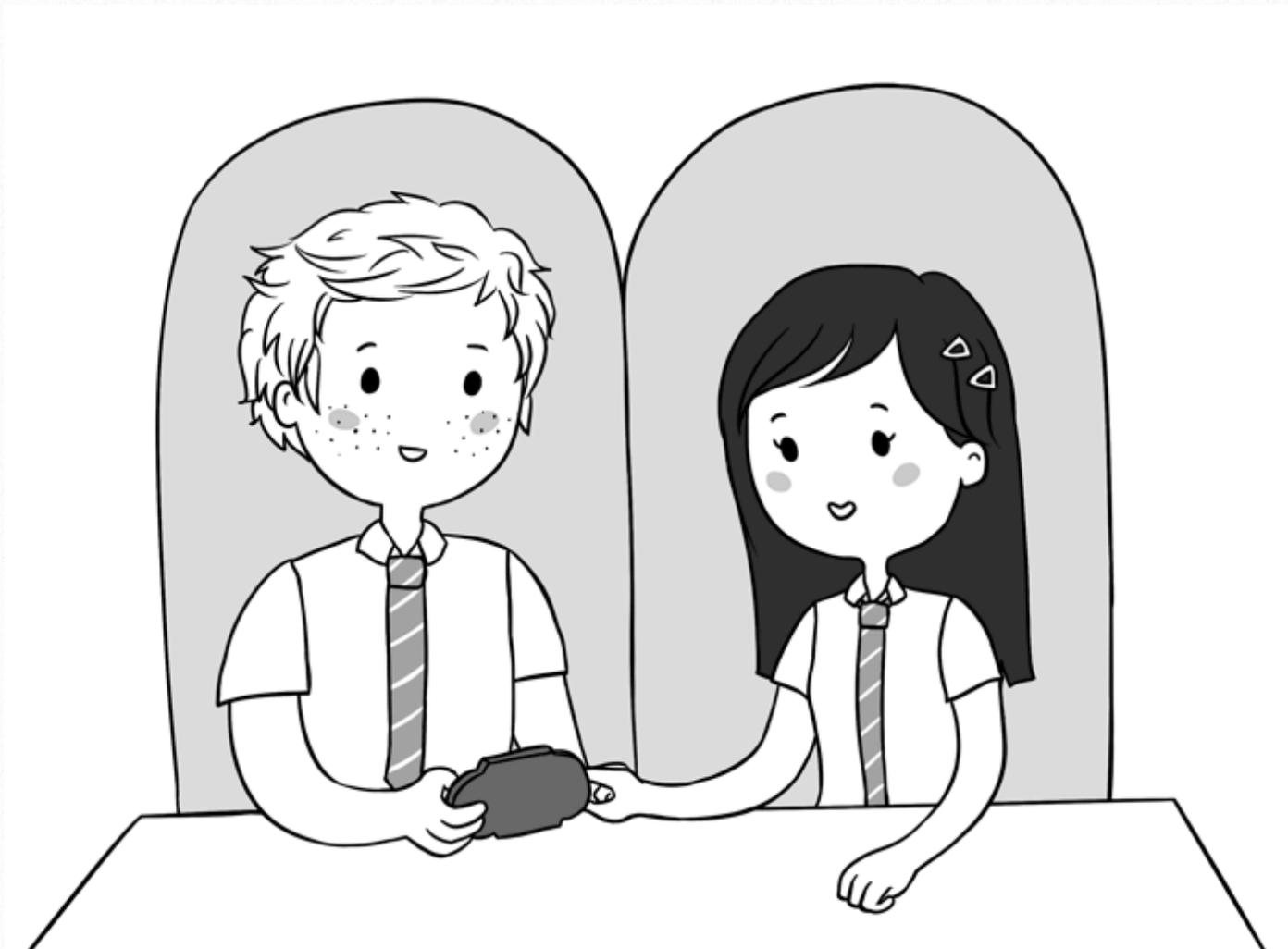
Mr Brady is taking us on the train for our presentation tomorrow. We even get to go sightseeing on Thursday!

6:28 pm

What a dramatic journey!

When we got on the train, Harrison and Johanna made a big fuss over swapping seats, which I thought was strange.

Why would Johanna want to sit next to Morgan?



First stop when we got to London was our hotel. It seemed like a really simple journey but guess who managed to go and get himself lost on the tube?

Of course it was Morgan!

It turned out okay though; we managed to find him pretty quickly and he hadn't caused too much trouble while he was unsupervised.

When we got to the hotel we were all shocked - it's honestly the nicest building ever! It's so fancy and posh; I don't know how the school managed to afford to let us stay here. It's got big spiral staircases, about a million TV's and butlers who will bring you anything you want.

Mr B said we weren't allowed to ask for anything, and seemed pretty serious about it.

Wednesday

9:03 am

This afternoon we're going to the Albert Hall to do our presentation for the NATS competition. I'm a little bit nervous, but we've practised a billion times so hopefully it will be fantastic.

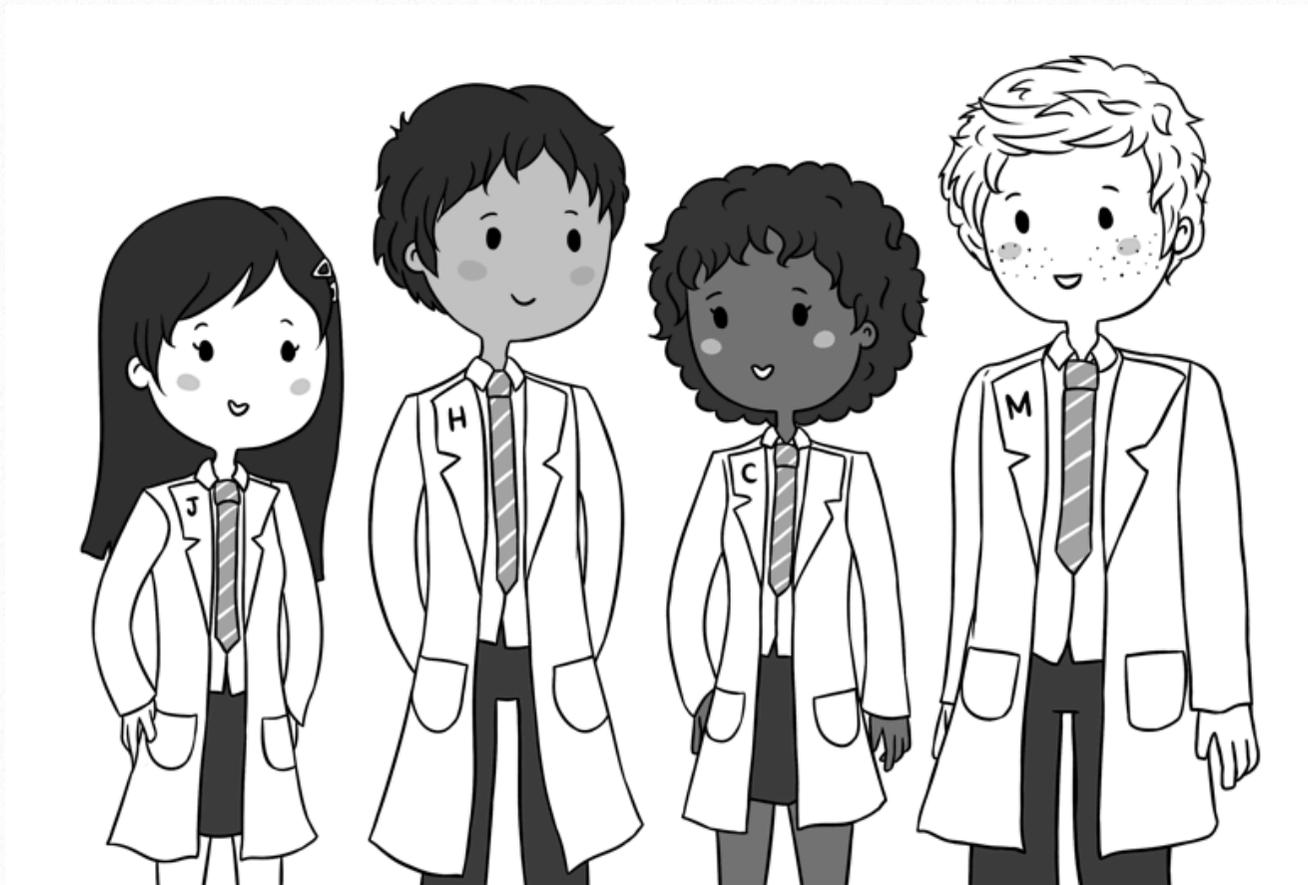
Everyone seemed a bit quiet at breakfast; I guess they must be nervous too.

7:49 pm

The presentation is done and we were great!

When we got to the Albert Hall we found out our group was the second to last presentation, which meant we had to wait around for AGES watching the other schools before our turn. At least we got to check out the competition though.

Personally, I still think we were the best - maybe I'm a bit biased...



Like a little team of real scientists.

I think I'll try and get an early night tonight. Tomorrow Mr B is taking us sightseeing and I want to be wide awake so I don't miss anything!

Thursday

7:13 am

Team NATS take on London!

Today we're going to be proper tourists and go and visit all the sights.

I want to see EVERYTHING!

Last time I came to London with my family I was too small to remember it properly. I hope we get to see the London Eye and Buckingham Palace and go shopping in Harrods...

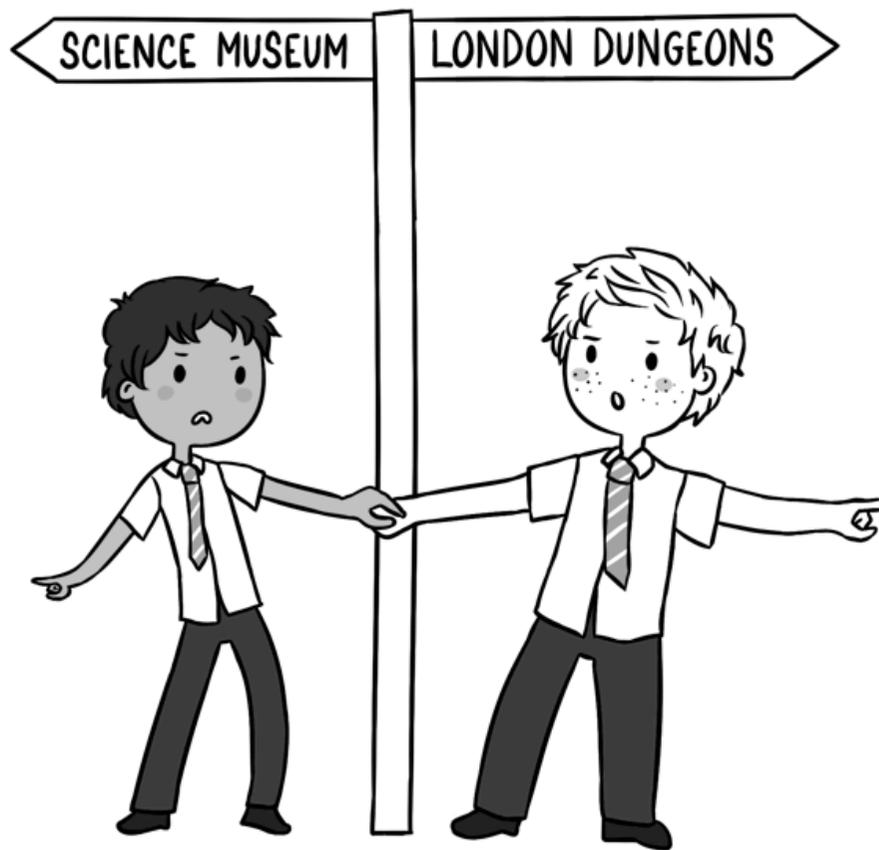
9:34 am

Maybe there are too many sights for us to see everything in one day... Everyone wants to go somewhere different.

I suggested we could try and go to both; I could see Harrison really wanted to go to the science museum.

8:29 pm

I'm exhausted - I think we've walked all the way around London today!



Mr B took us on the London eye as a treat for doing so well yesterday. It was amazing; you go up so high you can see all the way across London! I don't think poor Harrison enjoyed it as much as the rest of us though; he looked a bit green the whole way round.

At the Dungeons, Morgan screamed more than the rest of us even though it was his idea to go there. When we were walking round Johanna and I decided to scare the boys as payback for their argument this morning - they were terrified!

Next time they'll think twice before squabbling.

I think we even scared Mr B a bit, not that he would admit it.

The science museum was great too - I didn't realise how big it was. There were so many exhibits; they even had space ships! When Mr B was a bit distracted we snuck off to the shop and bought him a little souvenir as a thank you for bringing us on the trip.

I hope he likes it.

Tonight is our last night in London so we gave Mr B his present; he thought it was great.

I'll be quite sad when NATS is over and we have to go home, I've had so much fun and I think we're all starting to get on really well now. Although, I am excited to find out if we won tomorrow...

Fingers crossed!

Friday

8:39 am

Today's the day!

I'm starting to get a bit nervous now. I think everyone else is nervous too.

Harrison didn't even eat any breakfast - which is odd because the breakfast at this hotel is AMAZING.

If we don't win it's not the end of the world. I think we all did really well and we've learnt so much. We'll just have to just wait and see.

We're going back to the Albert Hall at 10 to find out...

Wish us luck!

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Week 4: Johanna



Monday Night

It feels like a millennium since I last wrote in here. With all the presentation prep this was my lowest priority, but don't worry that's all behind me now...

At least until tomorrow.

Speaking of which I've got to get going, it's like mission impossible getting ready for London and being in bed in time.

I might have to ask mum for help - lucky me!

Tuesday Lunch

Why are mothers so annoying!

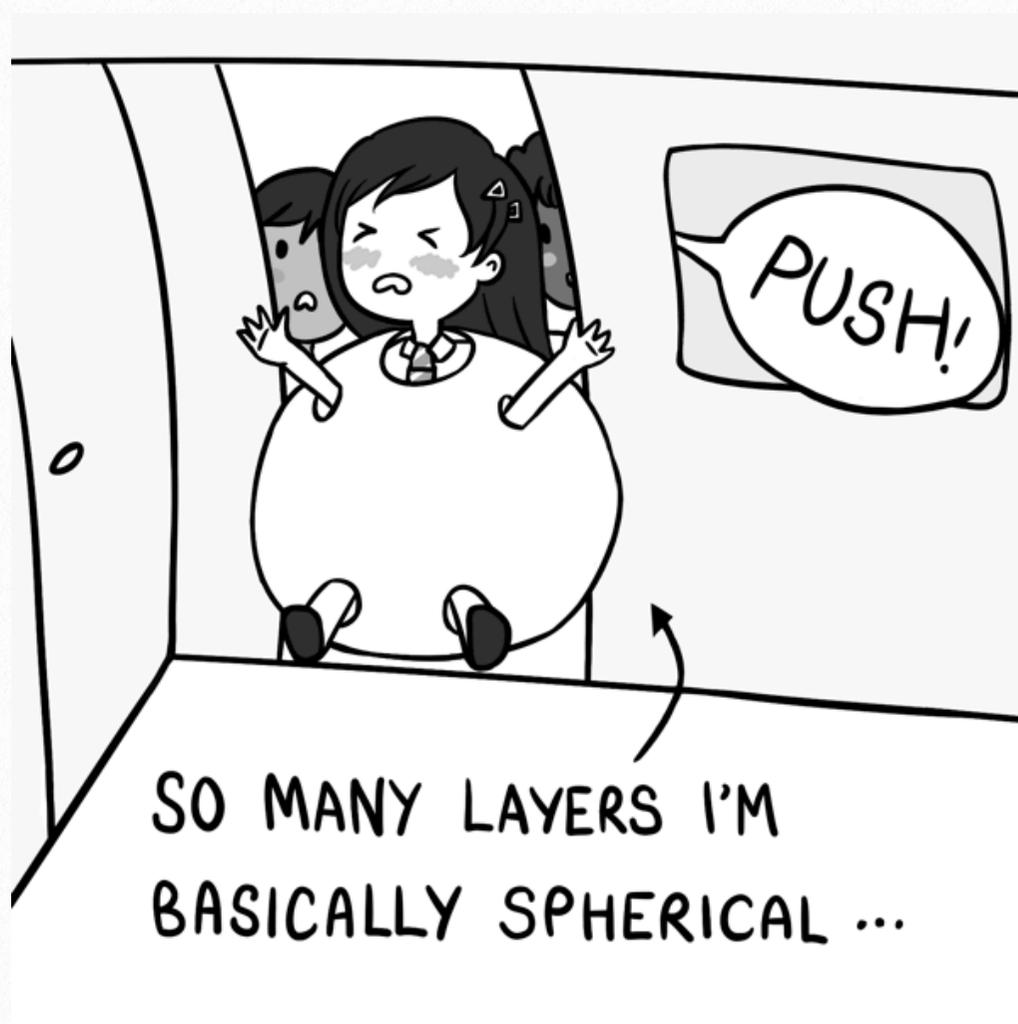
She controls everything.

I was already going to be up at ridiculous O'clock, even before she got me up 2 hours early! She packed my bag but not with anything useful, just enough food to feed the 5000 and about 50 pairs of socks.

But no...she wasn't finished.

When I was finally functioning enough to get changed, I was forced to wear so many layers that I looked like Mr Blobby. Charlottes face when she saw me...

How embarrassing.



Anyway, guess who's just beat Morgan's high score on his games console...he insists it's beginners luck. I certainly impressed Charlotte - she said no-one has ever beaten Morgan at that game before!

That will teach him for spending all his time on the stupid thing instead of studying.

I'm just glad Morgan brought it, this journey is so long.

I wish I'd brought another book.

Tuesday Night

What an idiot!

How Morgan manages to 'function day to day' is a miracle when he can't even get off the tube at the right stop. He only had to follow us, it's not that hard. I bet Spike could do it. All because he was so hung up that I have that stupid high score...

Get over it!

Everyone else has, except Charlotte who maybe was a tad harsh with the teasing.

The tube was so hot and claustrophobic, I couldn't wait to be out of there. Honestly, I thought Morgan was behind me but obviously not...

Don't blame me I'm not his babysitter!

If Harrison hadn't of wanted to sit next to Charlotte, oh sorry "a window seat", on the train, none of this would have ever happened.

Boys are so annoying..

Wednesday Morning

Today's the day! I can't wait!

Finally, I can get rid of this 10-tonne weight in my suitcase. It's mainly demo and presentation stuff but I also got the NATS crew a present each ...

A personalised lab coat!

Truth be told, I have wanted one for ages and this was the perfect excuse. I know the boys will like them I just hope it is stylish enough for Char.

I mean Charlotte...

I must have been around Morgan too long!

Wednesday Night

That was a long day! I think I'm the only one still awake.

We were doing our presentation second to last, everyone seemed to think that was terrible - I thought that made us memorable.

Plus, we could check out the competition - not that there was any...

That's what I told Harrison anyway.

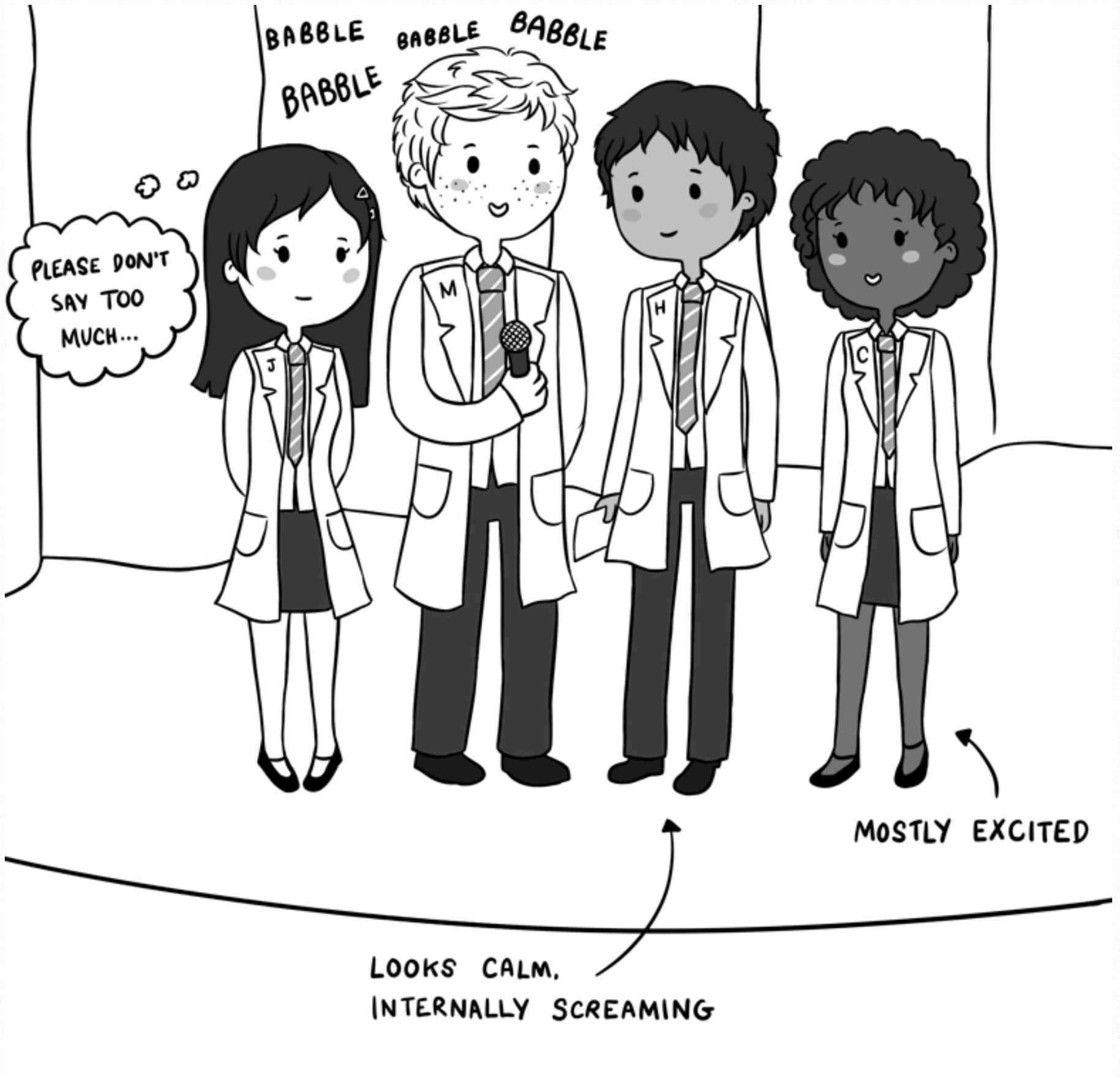
It's amazing how he manages to even write in a maths test let alone get 100 % when he gets that nervous. Apparently, he was practising all night... he should have woken us up, otherwise I didn't really see the point.

At least when I joked about the other teams he laughed, but honestly one guy really did look like Fireman Sam.

Okay, I admit it was partly an act - some of the teams were okay.

Obviously the lab coats swayed it, the other teams didn't even consider a dress code. More importantly the team loved it. Harrison even wore it for dinner, which was awkward when everyone else in the restaurant was in shirt and tie. Morgan being Morgan couldn't go 5 minutes without spilling something on it. Surprisingly, he did admit it and Charlotte did manage to get most of it out before we went on stage.

She had so many makeup products you would have thought she was the one doing the demo...



Oh, by the way,

The presentation...

We smashed it!

Thursday Morning

Trouble in paradise - and before you ask, no it wasn't my fault.

Of all people, Harrison and Morgan are to blame.

All because they wanted to do different things today, how stupid! I didn't get involved, mainly because Mona was on the phone and she really wanted to listen in...

Typical.

Charlotte soon kicked the boys into line by suggesting a decent compromise. It looks like we are going to the dungeons, London eye and the science museum.

I will leave you to work out who suggested what...

Mr Brady wasn't faring much better; some stupid year 7 class swapped whiteboard pens for permanent marker.

If Morgan wasn't here I would have put money on it being him...

But then again, he has taken NATS pretty seriously, so maybe not.

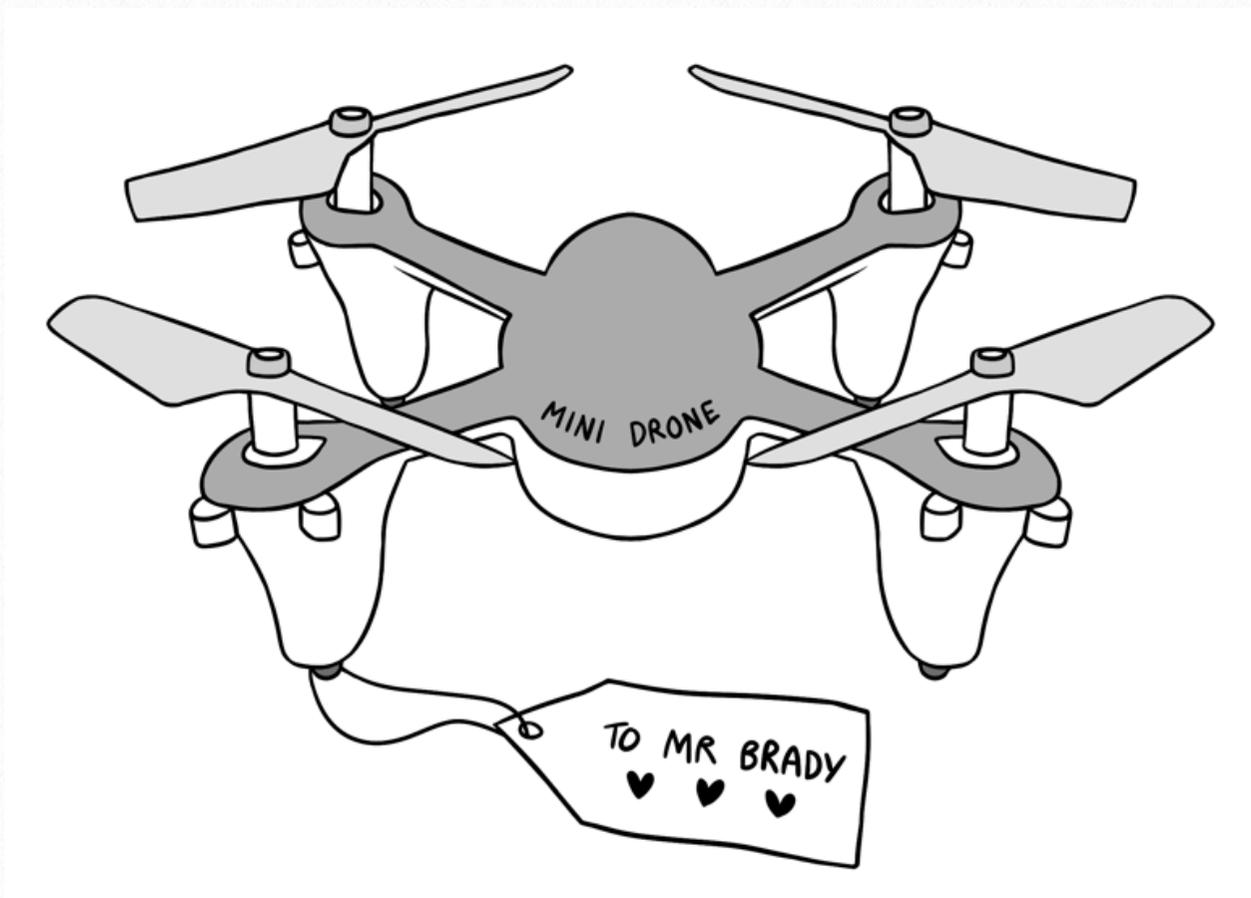
Thursday Afternoon

After all this morning's drama, today has been great!

Except the science museum - Mr Brady and Harrison dragged us round everything...

And I mean everything.

It was worse than being with mum - they wonder why I know so many random facts. At least the gift shop was good, I can't wait to see Mr Brady's face when we give him his present.



Speaking to Mona made me think to bring her back a souvenir, I knew exactly what to get her. What better than a new bag with the London sites on it to hold all her art stuff. On the London eye I wasn't so sure if I might need to buy another one - Harrison had gone a very strange colour and I don't think he would like to use Charlotte's designer satchel as a sick bag ;).

The highlight of the day was the dungeons - for us girls anyway.

We arranged a little surprise for the boys.

How could we not?

So, we hid behind some of the dummies and when they came looking for us we jumped out! Morgan has the girliest scream I have ever heard, everyone turned around and stared at us! That was probably the most uncomfortable bit for Harrison.... annoyingly.

It's a shame this trip has to end, it's just been so fun.

Even if we don't win - which I doubt, I have made some cool friends.

I just hope things don't go back to geeky class swat Johanna ...

Friday Morning

Normally, I would avoid everyone when I am this stressed but I owe it to the team to give them as many pep talks as they need.

I feel like it's only me who believes in us, I guess we'll just have to wait and see...

Wish us luck!

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Week 4: The NATS



Presenter: Here we are at the 2016 NATS competition; we are about to announce our winners so please can we have complete silence in the room.

Whole room: Shhhhhh...

Morgan: Woah, I can't believe how quickly a room of hundreds of people can turn completely silent.

Harrison: For goodness sake Morgan! You need to shut up!

Morgan: Whoops

Mr Brady: Morgan! Shhhh!

Presenter: So now it is time to reveal our top 3!

In third place we have...

REDSHORE ACADEMY

Johanna: As if fireman sam came third!

Harrison: I think their presentation was the one we chatted all the way through...

Morgan: Wait! We haven't been called out. Is that good or bad?

Johanna: Of course it is good!

Charlotte: Don't worry Morgan, we can still win, they have first and second to announce yet.

Johanna: I am still holding out for first place.

Harrison: Don't jinx it! We do have a good chance though.

Mr Brady: Do you really think so? I am so nervous.

Morgan: Cheers for the vote of confidence Sir!

Presenter: Well done Redshore! Now if we can have some quiet again, we have second place to announce.

Morgan: I hope we aren't second, their prize is rubbish!

Johanna, Charlotte, Harrison, Mr Brady: Shhhhhh Morgan!

Presenter: So in a second place we have...

NORTHBURN GRAMMAR

Charlotte: Harrison, is that sweat on your forehead?

Morgan: Yeah you are looking very shiny. Are you ok?

Harrison: Yeah fine, I am just warm. Is it hot in here? Can we open a window? Is anyone else hot?

Johanna: Maybe if you took your lab coat off...

Morgan: Harrison you are looking a bit peaky?

Harrison: I AM JUST NERVOUS OK!

Johanna: Shhhhh, I am getting fed up of telling Morgan to shut up, don't you start too.

Morgan: You can't talk Johanna, you have bitten your nails to shreds.

Mr Brady: Come on, I think you all need to calm down a bit.

Presenter:

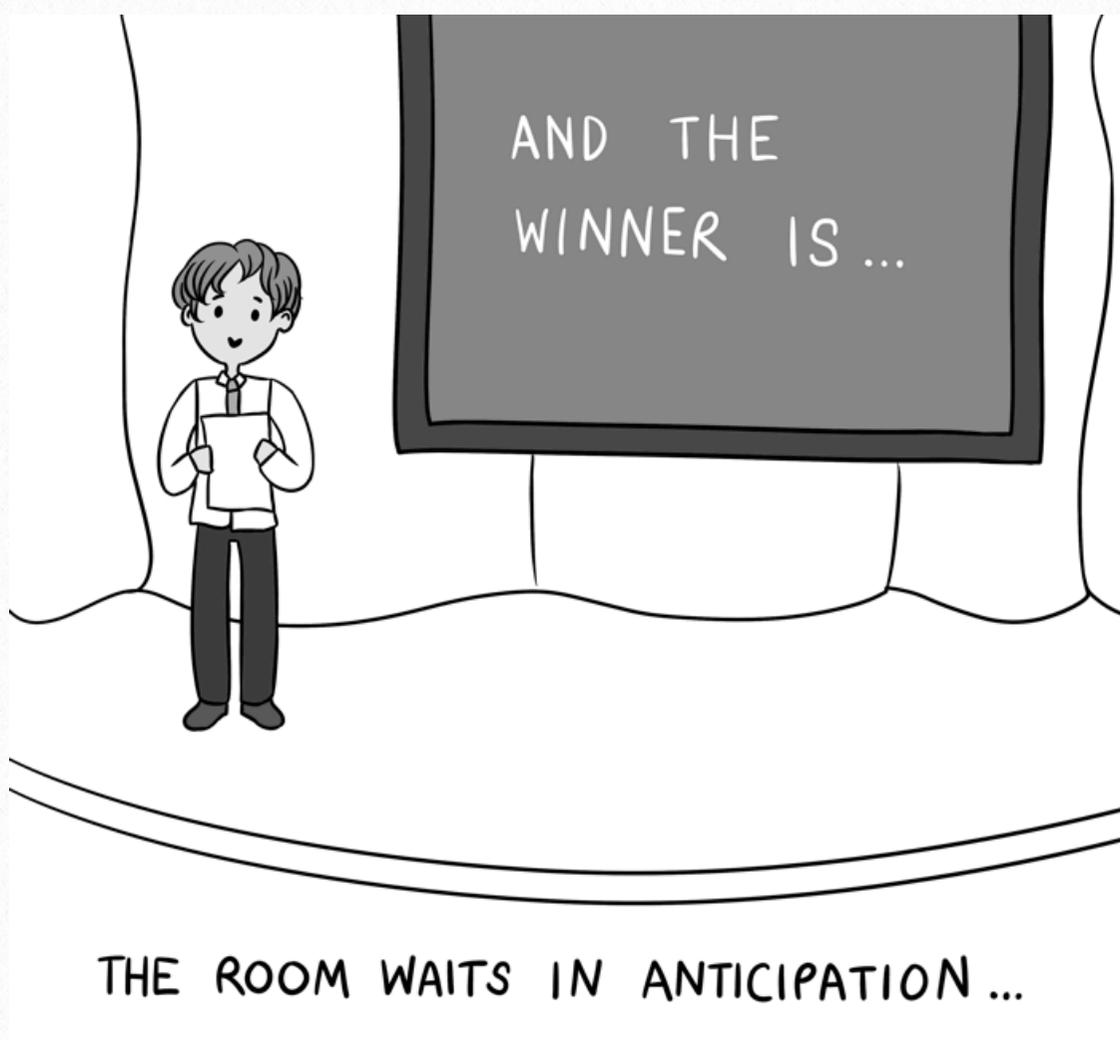
So here is the big one.

The one you've all been waiting for.

In first place and the winner of the 2016 NATS competition is...

Mr Brady: Just remember, it doesn't matter if you win or lose, you have done me proud as your science teacher. I remember when I was your age -

NATS crew: Shhhhhhh Sir!



BELLFIELD HIGH!

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Week 4: End



Interviewer: So you won! Tell us about how you found out!

Morgan: Well, being telepathic...

Charlotte: Really?!

Morgan: Yes! Basically, I get this weird feeling in my head and-

Charlotte: Shut up Morgan.

Morgan: Thought I had you there.

Harrison: Well, we didn't actually find out via Morgan's telepathy, instead we just went to the awards ceremony on Friday.

Johanna: Morgan's way sounded so much more exciting!

Harrison: Back to the original question, yeah we were all sat in this big assembly hall with the judges announcing each group's overall points up to the winner.

Morgan: It took soooooo long, literally like 5 minutes. It got so tense.

Harrison: We all started looking at each other as we realised our name hadn't been called out yet. They announced we had WON, Mr Brady practically fell off of his chair and we all leapt up and started making our way to the stage.

Charlotte: Where we would have all collected our award with dignity if it hadn't of been for poor Johanna...

Morgan: There may have been a slight tumble as you walked on stage if I recall?

Johanna: Excuse me, I could have won an oscar for my amazing stunt girl fall!

Charlotte: You did style it out pretty well

Harrison: And to think we all agreed we weren't going to mention that again.

Johanna: I'm so over it now, looking back I think I would have laughed as well!

Interviewer: Did you ever expect to win?

Charlotte: I hoped we would! But I wasn't sure if we'd actually pull it off, there were a lot of other good teams at NATS.

Morgan: Yeah. They were decent, not quite 'NATS crew' standard.

Johanna: That's more like it Morgan! I always thought we had a good shot. It was you guys that made me so worried about it.

Morgan: To be honest I did have some doubts, but it was probably more just nerves than anything.

Harrison: Scientifically speaking...

Morgan, Johanna, Charlotte: *groan*

Harrison: Now now, all I was going to say was we had the best and most complex science, something which I think really impressed the judges!

Johanna: There was me thinking it was the personalised lab coats!

Charlotte: Well if the judges had any sense of style they would definitely have given us extra points for those, we were obviously the best dressed team!

Morgan: Ours was definitely the most fun as well, I mean, that foam almost hit the ceiling...and the judges.

Johanna: It definitely made us more memorable... even if at the time I wasn't overly impressed.

Morgan: Whoops!

Interviewer: What made you the best team?

Johanna: Simply, because we were the best.

Charlotte: It definitely seemed like we'd put a lot more time and work into our presentation than some of the other groups, the judges must have noticed that too. Oh, and of course my introduction was amazing.

Harrison: Don't you mean ours? It was a really good introduction that WE did, WE definitely caught the judges attention!

Morgan: *cough* Trouble in paradise? *cough*

Charlotte: What?

Johanna: Oh, nothing. Your introduction was really good and on the whole our sections went really well, much better than we practiced anyway.

Morgan: Might have something to do with the leader pulling it all togeth-

Johanna: I think it was more of a team-

Harrison: Look at how happy he is...let him have his moment!

Morgan: Why thank you Harrison, I'm glad someone appreciates me.

Interviewer: So you went down to London for the national competition, did you get any time for sightseeing?

Charlotte: It was amazing! Where do I start? So much happened - maybe we should just each pick our favourite moment

Johanna: Dungeons.

Charlotte: Definitely! Scaring Morgan and Harrison when we jumped out at them is probably the highlight of my year.

Morgan: You didn't make me jump.

Johanna: No...just scream.

Harrison: It was quite high-pitched if I recall.

Johanna: That was amazing, although I enjoyed our mission to get the souvenir for Mr Brady.

Morgan: You were only meant to pick one favourite. Surprisingly, the museum was my favourite.

Harrison: I knew you would love it! Guess which was my favourite part?

Johanna: What's with the dramatic build up... surely it can't be the London eye!

Harrison: Being the tour guide with Mr Brady!

Charlotte: I wasn't sure whether we would ever manage to get you two to leave!

Interviewer: **What is next for the NATS crew? Perhaps a worldwide tour? Paris, Milan...**

Harrison: Well this experience has certainly confirmed the fact that I could be a famous scientist one day.

Johanna: There's no could be about it!

Harrison: I hope so, but as for the crew as a whole, I reckon we have a few more science competitions left in us yet!

Morgan: Yeah! We can go on tour, just like a travelling circus!

Charlotte: You do make a very convincing clown...

Johanna: Surely Morgan would have to be the ringleader

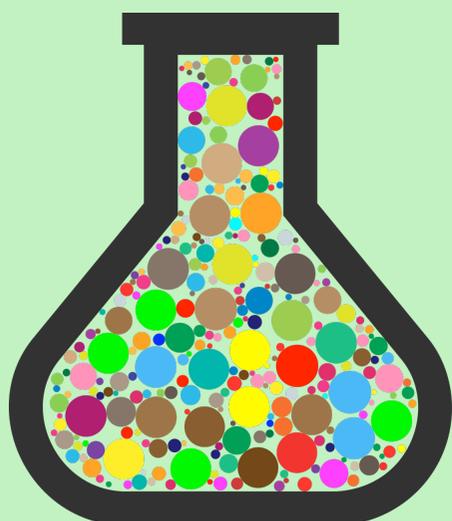
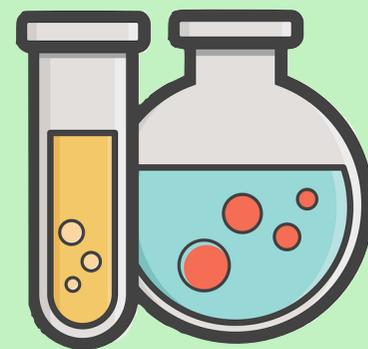
Harrison: I am not sure I can deal with this low level of professionalism...just kidding I would love to work with you guys again!

Morgan: I am also planning to write my autobiography, it will be in all good book shops next year!

Everyone: *groan*

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Activity Pack



The Green Formula: Activity Pack

Introduction

The Green Formula Activity pack has a variety of green chemistry experiments, some of which can be done at home and some that can be tried in the classroom. Charlotte, Morgan, Harrison and Johanna have also written some quiz questions to test your knowledge of the science discussed in the book.

Experiments – Kitchen Chemistry

1. Orange Peel – Marmalade
2. Red Cabbage pH indicator
3. Making Jelly with Warm Water

Experiments – Classroom Chemistry

4. Green Glue – Biomimicry
5. Metrics with Sweets!
6. Potato Battery
7. Acid-Base Catalysis
8. Testing Ozone

Quiz/Crosswords

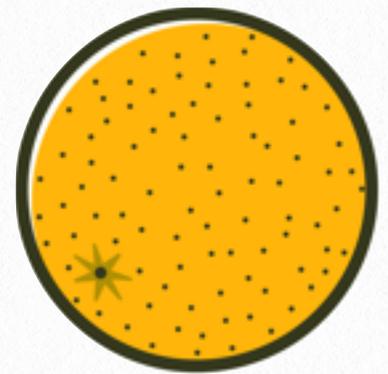
9. Harrison's Cryptic Crossword
10. Crossword Answers
11. The Green Formula Quiz
 - Morgan's Quiz
 - Charlotte's Questions
 - Harrison's Quiz
 - Johanna's Questions
12. The Green Formula Quiz Answers
13. Multiple Choice Quiz Template

1. Orange peel – marmalade (waste stream management)

Introduction to the chemistry

The jam making process is very chemistry based, with its ingredients being simplified to a mix of sugar, acid and pectin.

Pectins are usually found in the peels and core of a fruit, and act as the cement that maintains cell structure and hold these cells together. It's these pectins that turn fruit juice to jam! Boiling the peel/core releases the pectin, when they are out of the core they can form around the water molecules and trap them.



Sugar adds sweetness and maintains the colour of the jam. As well as this sugar can “pull” water away from the pectin molecules helping the gelling process. When sugar “pulls” the water it stops it from being available for attack by microbes and bacteria, hence why jam can last so long.

The gelling process also needs some acid. When the pectin molecules get released from the peel/core they repel each other in the water (as they are negatively charged). When the acid is added, this can neutralise the negative charges and enable the pectin to create the gel network. The best pH for jam is in-between 2.8 and 3.3 (quite acidic).

Ingredients/Equipment:

Oranges (4)

Water (1.7 L)

Sugar (1 kg)

Muslin Bag (or any alternative)

Sieve

Large Saucepan

Method

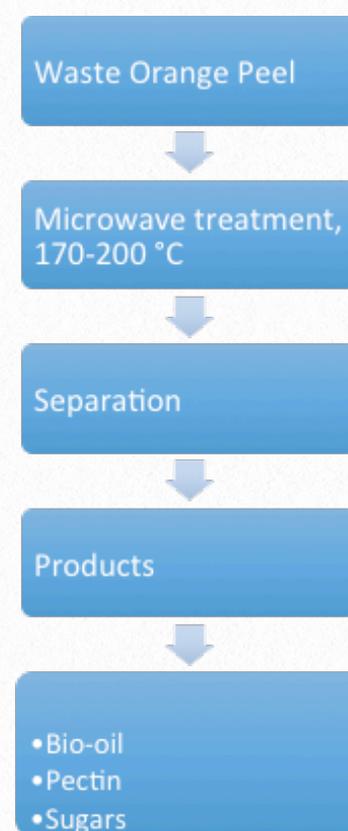
1. Half the oranges and, into the saucepan, squeeze as much juice out of them as possible.
2. Scoop out all the pulp onto a sieve above the saucepan and squeeze it even more to get as much juice as possible.

3. Shred the remaining peel and pith and put it into the muslin bag with the pulp that was in the sieve.
4. Add the bag to the saucepan along with the water.
5. Bring the liquid to a simmer and cook for 1 – 1.5 hours.
6. Once finished remove the bag and carefully squeeze (wait until the bag has cooled) and discard the bag and its contents (preferably into food waste/compost if you have this!).
7. Add the sugar to the pan and warm gently until it is dissolved.
8. When the sugar is dissolved bring to the boil and boil for 10 minutes.
9. Leave to cool for 10 minutes. If there is any scum on top, remove with a spoon.
10. You've now made your marmalade! Store in jars, or tubs in the fridge.

Link to green chemistry

One of core green chemistry principles is to reduce waste, or to take things previously thought of as waste and turn it into something useful. The food supply chain can have many wastes, orange peel is only one example. Once the juice is extracted over 50% of the mass of the original orange is now waste. This leads to 15.6 million tonnes of citrus peel waste per year(1). These wastes can still contain lots of very useful chemicals (such as pectin) that can be used elsewhere. Studies have been conducted in using microwaves to treat the orange peel to create useful products; the simplified process is seen below(2).

Continuous microwave processors can operate at several tonnes per hour, producing several marketable products. Using orange peel to produce marmalade is just a simple example of making the most out of a potential waste product, in industry the potential of reusing waste is much more diverse.



1. Bampidis, V. A.; Robinson, P. H., Citrus by-products as ruminant feeds: A review. Anim. Feed Sci. Technol. 2006, 128 (3-4), 175-217.

2. Balu, A. M.; Budarin, V.; Shuttleworth, P. S.; Pfaltzgraff, L. A.; Waldron, K.; Luque, R.; Clark, J. H., Valorisation of Orange Peel Residues: Waste to Biochemicals and Nanoporous Materials. ChemSusChem 2012, 5 (9), 1694-1697.

2. pH indicator from red cabbage

Introduction to the Chemistry

Red cabbage contains an indicator pigment molecule called flavin. This is a water-soluble pigment that is also found in other fruit and vegetables like in red onion skin and apple skin. In acidic conditions this pigment is red in colour, neutral solutions are purple and basic solutions are green/yellow. This enables the use of cabbage juice to identify where on the pH scale different solutions are.

Ingredients/Equipment

Red cabbage

(optional) Ice cube tray

Beakers/Clear Cups

Vinegar

Baking Soda

Water

(Optional – other acidic/basic solutions – lemon juice, washing powder etc)

Knife

Saucepan

Strainer

Method

Preparing the indicator

1. Chop up half of a red cabbage. Place the chopped cabbage into a saucepan with water.
2. Bring to a boil, and then let it sit for 30 minutes to cool.
3. Pour the contents of the saucepan through a strainer into a large bowl. (The cabbage waste can be composted)
4. The dark purple liquid in the bowl is the pH indicator liquid.
5. (Optional) Pour the liquid into ice cube tray and freeze, if you have time.



pH experiment

1. Fill one beaker/cup with water, one with vinegar, and one with baking soda and water.
 2. Squirt some (10 ml) of the indicator liquid in each, (or place the indicator ice cube inside) to see the colour changes.
 3. Test other household solutions to identify the acidity of them! (NB. Do not use Bleach or other cleaning products!)
- Coke/Fizzy Drinks
 - Lemon Juice
 - Shampoo
 - Mouthwash
 - Orange Juice
 - Apple Juice
 - Milk

Link to Green Chemistry

In the chemical industry there's now an increased pressure to stop using crude oil (or other non-renewable materials) as a feedstock to create chemicals. In this experiment the feedstock for the pH indicator comes from a renewable source, a red cabbage, which is a type of biomass. Biomass is a term given to all plant material, and the challenge of green chemistry is to convert this feedstock into useful chemicals in a low energy, non-toxic manner. However, currently most of chemicals are made from crude oil as using biomass is not yet technically and economically practical.

3. Can Jelly be made with just warm water?

Introduction to the Chemistry

Gelatin is made from long strings of amino acids, which have an affinity for each other, and form a triple matrix. When the gelatin is heated up, these bonds loosen and turn the gelatin into a liquid. Gelatin can also form hydrogen bonds with water, this is how the jelly forms. This experiment is designed to see if jelly can be formed without using boiling water to overcome the bonds in gelatin, and just use warm water instead, thus conserving energy.

Materials

2 Boxes of gelatin mix (any flavour)

2 bowls

Spatula

Boiling water

Cold Water

Warm Water

Measuring Jug

Cling film

A Fridge

Timer/Clock

Method

1. In the first mixing bowl, pour a packet of the gelatin mix and follow the instructions.
2. Add 250 mL of boiling water and stir
3. Add 250 mL of cold water
4. Cover with cling film
5. Next, in the other mixing bowl pour the other packet of gelatin mix in.
6. Pour 500 mL of warm water (40-50°C) inside and stir (it may take longer this time)
7. Cover the bowl with cling film
8. Keep in the fridge for 4 hours
9. After 4 hours check on the consistencies of the two jellies, which has set firmer? Which is the correct consistency?

Link to Green Chemistry

This links to the green chemistry principle of designing more energy efficient and safer industrial processes. Replacing the boiling water with warm water is like running a reaction at a lower temperature to achieve the same results. Not using boiling water removes the risk of being burnt, therefore makes the reaction less hazardous. In industry removing unnecessary hazardous reagents or procedures is important to remove the risk of industrial accidents.

4. Green Glue (Biomimicry)

Intro to the chemistry

The principle of biomimicry is the science of taking nature's biological blueprints and trying to replicate them synthetically. Nature has found many incredible solutions to problems through evolution; biomimicry makes the most of this. The front of the bullet trains in Japan mimic the beak of a kingfisher bird, as they were found to not create a splash when they hit the water. This led to an increase in speed and reduction of energy use.

Glues are traditionally derived from crude oil, a non-renewable fossil fuel. They can often contain many toxic chemicals, which can pollute the land and water if placed in landfill. Recycling materials that contain glue is also hard or even impossible, even if the material the glues holding together is recyclable!



Casein is the main protein in milk and cheese, it is in a soluble form as a calcium salt. The addition of an acid (ethanoic acid is the main component in vinegar other than water) causes the milk to curdle. The resulting curd contains the now insoluble form of casein; it is the polymerisation of these casein molecules that forms the strong glue. A base is then used to neutralise the curds, in this case we use baking soda.

Ingredients/Equipment

Beakers/measuring cylinders

Hot water

Powdered milk (Ordinary milk will do, but it needs to be heated)

Vinegar

Paper towels

Stirrer

Baking Soda

Spoon

Wooden lollypop sticks

Small weights (10 N for example)

Method

Making the glue:

1. Put 2 tablespoons of powdered milk in a beaker.
2. Add 60 mL of hot water into the beaker as well and stir until dissolved.
3. Add 15 mL of vinegar and stir, your mixture will split into curds (solid chunks) and whey (a yellowish liquid). Stir until separated (add more vinegar if the milk doesn't separate well).
4. Using the spoon remove the curd, and dry on paper towels.
5. Dispose of the whey (use a large waste bowl)
6. Place curd back into the now empty beaker, and break it up as much as possible with the spoon.
7. Add 15 mL hot water and stir.
8. Add a very small amount of baking soda, $\frac{1}{4}$ of a teaspoon and mix. There should be a bit of foaming, and the curd should become smoother.
9. Your glue is complete! The glue should look like a thick liquid or paste. If too thick, add a splash more water. If too lumpy add another $\frac{1}{4}$ of a teaspoon of baking soda.
10. The glue can be kept for up to a week if placed in a fridge.

Testing the glue:

The glue can be tested in many ways, here is described how to make and compare lollypop stick bridges.

1. Place 2 stacks of books, chairs, tables or whatever is convenient about 10 cm apart from each other.
2. Measure 3 cm in from one end of the stick and draw a line across the stick.
3. Place glue evenly on this 3 cm section.
4. Take another stick and overlap the two together (ensuring there is only 3 cm of overlap). Hold together and give time for the glue to set.
5. You have created the "bridge", its time to test the strength of your creation.
6. Place the glued sticks across the gap you created in step 1.

7. Either place or hang weights from the centre of the bridge, adding 10 N at a time.
8. Measure how much weight the bridge can take, and compare to other groups in the class. Who made the best glue?

Link to Green Chemistry

Glues work by the production of long polymer chains, which hold the two surfaces together. In the experiment above the long chain is the milk protein. As the glue made above is completely organic it can decompose and will not harm the environment. This makes it inherently green.

If the glue were made from crude oil and solvents from the chemical industry, it would not be able to decompose. Any method to remove the glue (e.g burning) would release dangerous and toxic fumes, which would harm the environment and impact human health.

Green chemistry is looking to produce glues within industry with no toxic solvents, with materials that can be recovered with no harm to the environment and human health, but still being able to perform competitively with existing industrial glues. A specific example is the development of switchable adhesives for carpet tiles, which allow separation and recycling of the components in the tiles. Previous glues in carpet tiles have not been recyclable with the majority of the components ending up in landfill at end-of-life.

5. Metrics with M&Ms/Coloured Sweets

Intro to the chemistry

Conventional yield equations do not consider the potential wastes from the products production.

$$\text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} * 100 \%$$

A process may have a >99% yield but also creates a large amount of waste, which makes it not very green. E factor is one of the simplest metrics to quantify how wasteful a process is. It is defined as:

$$\text{E Factor} = \frac{\text{mass of total waste}}{\text{mass of product}}$$

Therefore the aim for E factor is zero - where all the materials that go into the system end up in the product or are recycled (e.g. solvent).

Another important metric within green chemistry is atom economy, this is defined as:

$$\text{Atom Economy \%} = \frac{\text{Mr of desired product}}{\text{Sum of Mr of all products}} * 100$$

Reducing the by-products a reaction has will increase the atom economy percentage. A perfect atom economy would be 100 % where there is only 1 product and no by-products/waste products. The main downside of atom economy is that it doesn't include catalysts, solvents and doesn't account for by products being re-used or re-cycled.

Experiment

This experiment will allow students to identify E-factor and the visual benefits of reducing waste in a process. Simple atom economy reactions can be also be demonstrated with M&Ms.

Materials

1 Bag of M&Ms per student

Calculators available per student

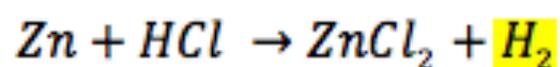
Method

E Factor

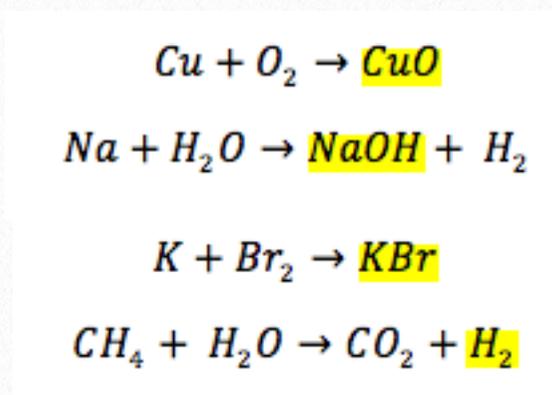
1. Firstly describe the basics of the E factor metric, as shown above.
2. Hand out the bags of M&Ms, make sure they aren't eaten straight away!
3. Get the students to choose one colour, and calculate the E-factor as if the colour they chose was their product. Compare E factor results.
4. Compare the E factor results to industrial processes (From Pharmaceuticals = 250 all the way to Petrochemicals = 0.1)
5. Discuss waste reduction methods with the class, can refer to the 12 principles of green chemistry (promote inclusion with students allowed to eat their M&M 'waste' if they have a good ideas).
6. After a class discussion about E factor and waste reduction, students can now calculate their E factor again (assuming they have eaten some of their waste M&Ms when answering questions). Compare improved E-factor results

Atom Economy

1. Atom economy should be explained to students including a definition/calculation.
2. For the purpose of this demonstration a simple equation, such as making hydrogen from Zinc and Hydrochloric acid, should be used.



3. Assign a colour for each atom in the reaction scheme.
4. Ask the students to balance each scheme.
5. Using the periodic table and the calculators provided calculate the atom economy for each reaction (more shown below, desired products highlighted).



Extension: Compare the atom economy for the production of hydrogen using Zn and HCl and methane and steam. Which is the greener process?

Link to Green Chemistry

Metrics are a very important method in which chemists can identify whether a reaction they are conducting is considered green or not. It also allows an easy way to compare different reactions in order to decide which one is greener. The quantification of the greenness of a reaction can unify research in green chemistry.

6. Potato Battery

Intro to the Chemistry/Link to Green Chemistry

The goal of producing environmentally friendly and efficient energy is a challenge which science and engineering faces currently. The demand for other sources of energy that are not based on fossil fuels is increasing further and further in order to reduce the global CO₂ emissions. Alternative sources of energy like solar and wind are the first step to achieving this. A form of alternative energy production is fuel cells. A fuel cell (similar to a battery) uses electrochemistry, a chemical redox reaction, to convert chemical energy into electricity. In this experiment we explore alternative sources of energy by creating energy from a potato.

Materials

Large Potato

2 Pennies or 2ps (better as they are larger)

2 Zinc-plated nails

3 pieces of copper wire

A small light bulb or LED

Knife

(Crocodile clips if these are available)

Method

1. Cut the potato in half, and cut a slit in each half of the potato for the pennies.
2. Wrap some of the copper wire round each penny, a different piece of wire for each penny.
3. Place the pennies into the slits in the potatoes.
4. Wrap the last piece of copper wire round one of the zinc-plated nails and stick this into one of the potato halves.
5. Take the wire connected to the penny in the half of the potato that has the nail in and wrap this around the other nail. Stick this nail into the other half of the potato.
6. Finally connect the 2 loose ends of the copper wire to the bulb/LED and it will light up!

7. Acid-Base Catalysis

Introduction to the Chemistry

Enzymes are special types of catalysts made of proteins. They are found in all living things, not just the human body, for instance in yeast. Yeast contains the enzyme catalase, which breaks down hydrogen peroxide (H_2O_2) into Oxygen and Water. The reaction can be recognised as working as bubbles of Oxygen gas will form. Enzymes can be very sensitive to pH and temperature, with high temperatures and extreme pHs potentially denaturing the enzyme. This experiment is to test how effectively the enzyme works in breaking down hydrogen peroxide in differing pH environments.

Materials

6 beakers

Permanent marker pen

5 clean spatulas

Distilled water

Baking soda

Set of measuring teaspoons.

Measuring cylinder

Hydrogen peroxide

Dry yeast

Rulers

Lemon Juice

Method - Prep

1. Label 5 of the beakers as follows:

1 – Control (Neutral)

2 – Low Acid (pH 4-6)

3 - High Acid (pH 2-3)

4 – Low Base (pH 8-9)

5 – High Base (pH 10-11)

- Put one spatula in each of the 5 beakers, and remember to never move a spatula from one beaker to another.
- In the last beaker add 100 mL of water to 2 teaspoons of baking soda, and stir until it is dissolved. Label this beaker: Base.

Method – Experiment

- Demonstrate the control, add 10 mL of distilled water into beaker 1 (the control). Stir in 20 mL of hydrogen peroxide. Finally stir in 1/8 teaspoon of yeast. Record on the side of the beaker the height the bubbles reach.
- Ask students to formulate a table, similar to the one below, with predictions of bubble height.

Beaker	Predicted Bubble Height	Actual Bubble Height
1-Control		
2-Low Acid		
3-High Acid		
4-Low Base		
5-High Base		

- Split the students into groups of 4, with each member of the group tasked with completing one of the following experiments on beakers 2-5.
- Acid Beakers – Add 5 ml of lemon juice to beaker 2, and 10 mL of lemon juice to beaker 3. Add 20 mL of hydrogen peroxide to 2 and 3. Add 1/8 teaspoon of yeast to 2 and 3. Record the height of the bubbles.
- Base Beakers – Add 5ml of the baking soda solution to beaker 4, and 10mL of the solution to beaker 5. Add 20 mL of hydrogen peroxide to 4 and 5. Add 1/8 teaspoon of yeast to 4 and 5. Record the height of the bubbles.
- Get students to compare results with other groups, potentially discuss anomalous results, similarities/differences between predicted bubble height and actual bubble height.

Results

The bubble height should be highest in the control, second highest in the low acid and low base conditions and should be the smallest in high acid and high base beakers. The catalase enzyme works best at pH 7 (neutral), the addition of an acid or base damages the enzyme meaning it is less likely to work effectively, therefore less bubbles.

Further Experiment

- This experiment can be combined with the red cabbage pH indicator experiment, so the students receive a visual representation of whether the solution is acidic or basic.
- This experiment could also be repeated/run along side an experiment comparing temperature difference with bubble height. The control could be room temperature and experiment variables range from 0°C to 60°C.

Link to Green Chemistry

One of the principles of green chemistry is to replace traditional stoichiometric experiments with catalytic reactions. Catalysts reduce the activation energy required for a reaction, increase the reaction rate and can reduce the number of steps in a process - this makes the reactions more time and energy efficient. Catalysts can be recovered and reused and catalytic processes can give less waste than the stoichiometric equivalents, this ensures efficient resource management.

8. Testing for Ozone in the Environment

Introduction to the Chemistry

Ozone is a molecule that is very important in the atmosphere as it protects us from harmful Ultraviolet radiation from the sun. However, ground level ozone can cause many health problems for humans when it is breathed in. Ozone can be formed at ground level when Nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react together in the presence of sunlight. This experiment outlines how to create ozone-testing strips and subsequently test the environment around you.

Materials: Per group of students (at least 4 students per group)

Large beaker (600 mL capacity)

Distilled water

2 g of cornstarch (1/2 teaspoon)

Bunsen burner/Hot plate

Ceramic plate

Stirrer

Potassium Iodide (1/8 teaspoon)

Coffee filter

Paintbrush

Scissors

Tape

Spray bottle

Teaspoon Measuring set

Safety goggles, gloves



Method

1. Measure 250 mL of distilled water into the large beaker
2. Stir in 2 g of cornstarch.

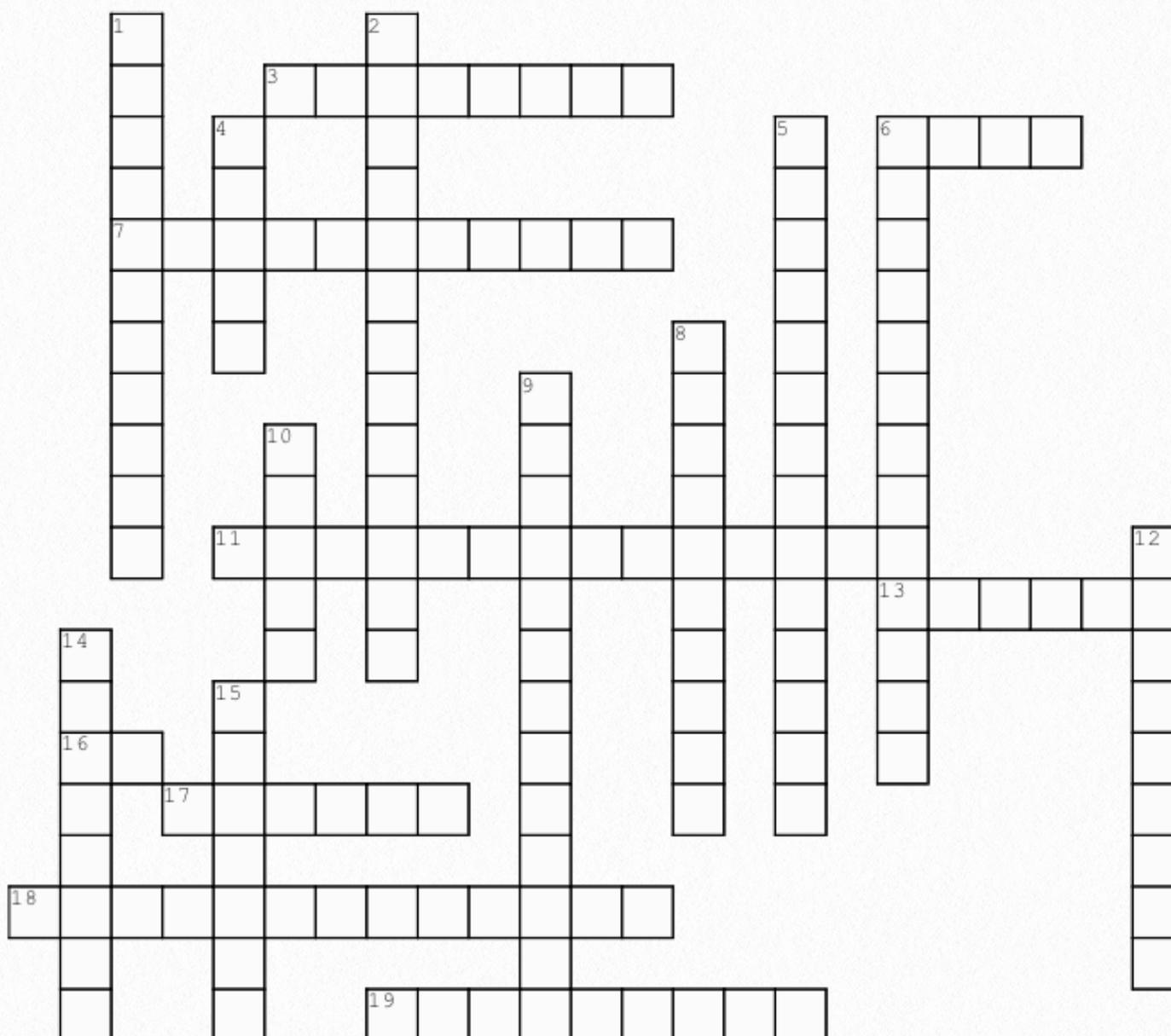
3. Heat the mixture over a medium flame/hot plate until the mixture thickens and becomes a little translucent.
4. Add 1/8 teaspoon of potassium iodide and stir
5. Let the mixture cool.
6. Place the coffee filter on the plate, using the brush (and gloves) coat both sides of the filter.
7. Leave the papers to dry in a dark place.
8. Once they have dried, cut the papers into thin strips.
9. Decide on locations you would like to test the ozone levels, possible suggestions below:
 - Classroom
 - School playground
 - School car park
 - Closest part of the school to the nearest road
 - Furthest point of the school from the nearest road.
10. Spray the strip with distilled water, and tape it to hang in each location, make sure the strips are not in direct sunlight.
11. Leave the strips for eight hours.
12. Once the eight hours is up, take the strips down (don't forget to mark the strips to remember where they were hung) and spray them with more distilled water. The darker the purple colour the more ozone was in the air at that location.

Link to Green Chemistry

Human health is an important part of green chemistry – surface level ozone can cause issues with the lungs. The ozone is created by anthropogenic emissions, from cars and factories, therefore is a pollutant. Synthetic methods should be designed so that they do not generate chemicals harmful to the environment or human health.

Harrison's Cryptic Crossword

Complete the crossword below



Created with TheTeachersCorner.net [Crossword Puzzle Generator](http://TheTeachersCorner.net/Crossword-Puzzle-Generator)

Across

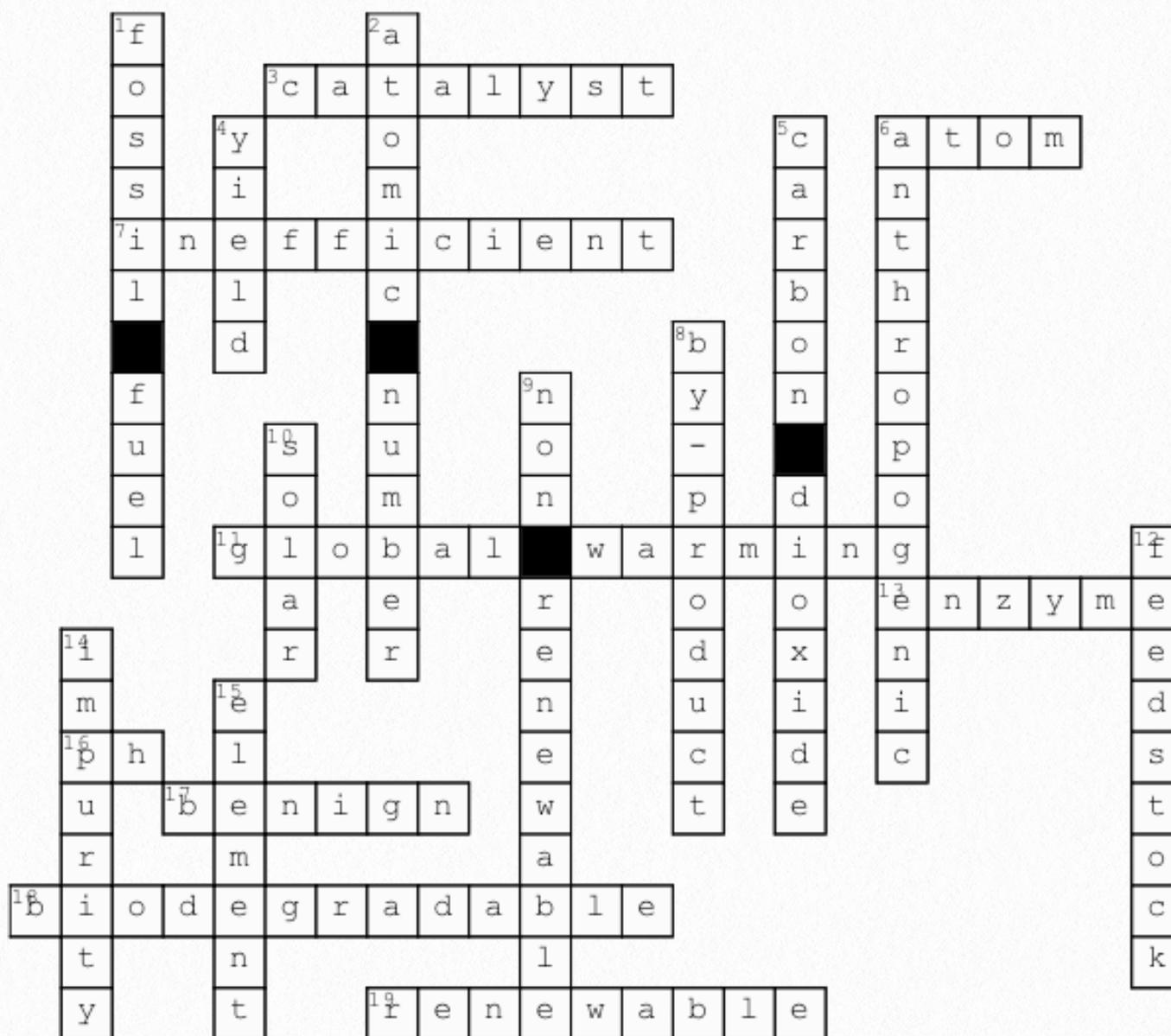
3. A substance that can increase the rate of reaction, but remains unchanged during the reaction
6. The name given to the smallest particle of a chemical element
7. A process that gives a lot of waste, has unnecessary steps
11. The increase in the earth's temperature because of the greenhouse effect
13. A biological catalyst
16. A measure of acidity
17. A substance is harmless and has no effect on the environment or human health
18. Something capable of being broken down by living things, such as bacteria and microorganisms
19. A source of energy that is not depleted when used

Down

1. Fuels formed from hydrogen and carbon over millions of years E.g. crude oil
2. The name given to the number of protons in the nucleus of an atom
4. The amount of product obtained from a chemical reaction
5. A heat trapping gas that contributes to global warming
6. Refers to man-made sources e.g. CO₂ emissions
8. An unwanted product in a chemical reaction
9. A source of energy that will eventually run out
10. A renewable energy source that comes from the sun
12. The source of a starting material for a chemical reaction, can be from a renewable source
14. A material that has contaminated a pure substance
15. A substance made from only one type of atom

Harrison's Cryptic Crossword

Complete the crossword below: black cells indicate a space between words.



Created with TheTeachersCorner.net Crossword Puzzle Generator

Across

3. A substance that can increase the rate of reaction, but remains unchanged during the reaction (**catalyst**)
6. The name given to the smallest particle of a chemical element (**atom**)
7. A process that gives a lot of waste, has unnecessary steps (**inefficient**)
11. The increase in the earth's temperature because of the greenhouse effect (**global warming**)
13. A biological catalyst (**enzyme**)
16. A measure of acidity (**ph**)
17. A substance is harmless and has no effect on the environment or human health (**benign**)
18. Something capable of being broken down by living things, such as bacteria and microorganisms (**biodegradable**)
19. A source of energy that is not depleted when used (**renewable**)

Down

1. Fuels formed from hydrogen and carbon over millions of years E.g. crude oil (**fossil fuel**)
2. The name given to the number of protons in the nucleus of an atom (**atomic number**)
4. The amount of product obtained from a chemical reaction (**yield**)
5. A heat trapping gas that contributes to global warming (**carbon dioxide**)
6. Refers to man-made sources e.g. CO2 emissions (**anthropogenic**)
8. An unwanted product in a chemical reaction (**by-product**)
9. A source of energy that will eventually run out (**non-renewable**)
10. A renewable energy source that comes from the sun (**solar**)
12. The source of a starting material for a chemical reaction, can be from a renewable source (**feedstock**)
14. A material that has contaminated a pure substance (**impurity**)
15. A substance made from only one type of atom (**element**)

11.The Green Formula Quiz

Below are 4 multiple choice quizzes written by Morgan, Charlotte, Harrison and Johanna based on the chemistry in their scientific diaries. Each quiz is out of 15, can you answer them all correctly?



Morgan's Quiz:

1. What does a solute dissolve into?

- A. Solvent
- B. Water
- C. Sand

2. If something can dissolve in a solvent it is described as..?

- A. Salty
- B. Soluble
- C. Insoluble

3. Which of the following is insoluble in water?

- A. Sand
- B. Salt
- C. Orange squash

4. Sea water can be described as...?

- A. Sweet
- B. A Element
- C. A Solution

5. How are solvents used in Dry cleaning?

A. Similar intermolecular interactions as the stain, to remove it.

B. To change the colour of the clothes

C. To shrink the clothes

6. What solvent is the main ingredient in nail polish remover?

A. Water

B. Acetone

C. Lemon Juice

7. What solvent is commonly used in perfumes?

A. Ethanol

B. THF

C. Hexane

8. Which of the following describes the ideal solvent?

A. Smelly, Green, Gloopy

B. Expensive, Toxic, Dirty

C. Not harmful to environment, non-toxic, easy to recycle.

9. What is the Mr of Carbon?

A. 11

B. 12

C. 32

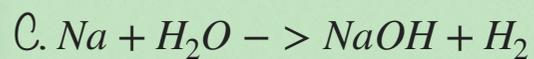
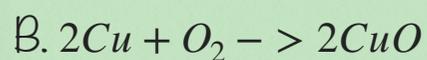
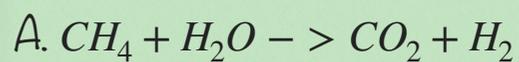
10. What is the Mr of Oxygen?

A. 16

B. 19

C. 15

11. Which of the following reactions has the highest atom economy?



12. What word describes the raw material/chemical used in an industrial process?

A. Products

B. Intermediates

C. Feedstock

13. Which of the following is the example of a renewable feedstock?

- A. Naptha
- B. Crude Oil
- C. Sugar Cane

14. If your reaction produces another substance that isn't your desired product what is this other substance called?

- A. By-product
- B. Reactant
- C. Intermediate

15. Perchloroethylene (PCE) is a solvent used in dry cleaning but there are concerns it is harmful to human health, which of the following is a safer alternative to PCE?

- A. Ethanol
- B. Acetone
- C. Liquid CO₂ / Silicone Solvents

Charlotte's Questions

1. Who organised the periodic table?

- A. Albert Einstein
- B. Marie Curie
- C. Dimitri Mendleev

2. What charge does a neutron have?

- A. None (0)
- B. +1
- C. -1

3. What charge does a proton have?

- A. -1
- B. +1
- C. None (0)

4. What charge does a electron have?

- A. -1
- B. None (0)
- C. +1

5. How would you describe protons, neutrons and electrons?

- A. Atoms
- B. Elements
- C. Subatomic particles

6. If there's only one type of atom in a substance what is this substance called?

- A. A mixture
- B. An element
- C. A compound

7. If elements have similar properties where are they on the periodic table?

- A. Close together
- B. Opposite sides
- C. The periodic table is random

8. What is the atomic weight of Helium?

- A. 8
- B. 2
- C. 4

9. *If an element is rapidly running out it is described as a ... element?*

- A. *Abundant*
- B. *Sustainable*
- C. *Critical*

10. *How do we ensure that all the elements are around for future generations?*

- A. *Elemental Sustainability*
- B. *Elemental Spending*
- C. *Stop using all elements*

11. *What critical element is most commonly used in batteries?*

- A. *Sodium*
- B. *Lithium*
- C. *Magnesium*

12. *Which critical element is used in smart phones, display screens and solar panels?*

- A. *Indium*
- B. *Carbon*
- C. *Silicon*

13. *Rare earth elements could be used for ..?*

A. *Footballs*

B. *Balloons*

C. *Magnets*

14. *What critical element is widely used in catalytic converters?*

A. *Carbon*

B. *Platinum*

C. *Indium*

15. *How many tonnes of electrical waste is there per year worldwide?*

A. *1 Million*

B. *5 Million*

C. *50 Million*

Harrison's Questions

1. Which of the following is a fossil fuel?
 - A. Oil
 - B. Bio-diesel
 - C. Hydro-electric power

2. What are solar power and wind power examples of?
 - A. Non-Renewable Energy
 - B. Renewable Energy
 - C. Fossil Fuels

3. What effect leads to Global Warming?
 - A. The glasshouse effect
 - B. The greenglobe effect
 - C. The greenhouse effect

4. Which of the following is a greenhouse gas?
 - A. Methane
 - B. Oxygen
 - C. Nitrogen

5. What is one of the main sources of Carbon Dioxide?
 - A. Photosynthesis
 - B. Producing electricity from solar energy
 - C. Burning of fossil fuels.

6. What's one of the many disadvantages of global warming?

- A. Sea level rise
- B. Temperature decrease
- C. Sea level lowering

7. How do plants remove Carbon Dioxide from the atmosphere?

- A. Respiration
- B. Photosynthesis
- C. Polymerisation

8. What is the name given to a substance released into the environment that has negative effects?

- A. An impurity
- B. Benign
- C. A Pollutant

9. What happens when smog reacts with NO_x from car exhausts in the presence of sunlight?

- A. Carbon dioxide is produced
- B. Photochemical smog, Ozone is produced
- C. Methane is produced

10. What environmental issue can Sulphur Dioxide lead to?

- A. Smog
- B. The greenhouse effect
- C. Acid rain

11. What effect can acid rain have on the environment?

- A. Destroy forests
- B. Remove carbon dioxide from the atmosphere
- C. Produce smog

12. What is the main source for synthetic chemicals?

- A. Plant Materials
- B. Waste materials
- C. Crude oil

13. Which polymer can be made from sugarcane?

- A. PVC
- B. Polyethylene
- C. Polystyrene

14. What benefit is there of recycling paper?

- A. Reduce deforestation
- B. Better quality paper
- C. Increase Deforestation

15. What's one of the benefits of recycling plastics?

- A. More Landfill
- B. Increase emissions
- C. Less crude oil reserves are being used

Johanna's Questions

1. *What effect does a catalyst have on a chemical reaction?*

A. Slows it down

B. Heats it up

C. Speeds it up

2. *Whats effect does the reaction have on the catalyst?*

A. It's used up in the reaction

B. None, remains unchanged

C. It changes state.

3. *What name is given to the energy needed to start a reaction?*

A. The activation energy (

B. Reaction Energy

C. Endothermic

4. *What effect does a catalyst have on the energy needed to start a reaction?*

A. Increased it

B. Has no effect

C. It reduces it

5. What's one of the potential downsides of using a catalyst?

- A. Expensive
- B. Efficient
- C. Effective

6. What is the Haber process used to make?

- A. Carbon dioxide
- B. Ammonia
- C. Polyethene

7. What word is used to describe a catalyst that is in a different phase to the reactants?

- A. Heterogenous
- B. Homogenous
- C. Superogenous

8. What is one of the advantages of heterogenous catalyts?

- A. They are In the same state as the products
- B. Slows down the reaction
- C. They can be filtered away from products easily

9. Photocatalysis occurs using what type of energy?

- A. Nuclear energy
- B. Light energy
- C. Wave energy

10. What is the name given to biological catalysts?

- A. Enzymes
- B. Inzymes
- C. Onzymes

11. Why are enzymes considered green?

- A. They are all coloured green
- B. They work in very mild conditions
- C. They produce a lot of waste

12. If an enzyme is a “keyhole” what could be called the “key”?

- A. Active Site
- B. The sibstrate
- C. The substrate

13. How can catalysts be made more green?

- A. Do not use toxic heavy metal catalysts
- B. Be made from critical elements
- C. Require high temperatures to operate

14. What is the term given to a reaction that gives out heat?

- A. Endothermic
- B. Hothermic
- C. Exothermic

15. Which of these is an important aspect of green chemistry in industry?

- A. Increasing landfill
- B. Health and Safety
- C. Reducing Efficiency

12. The Green Formula Quiz Answers

Morgan's Quiz

1. A
2. B
3. A
4. C
5. A
6. B
7. A
8. C
9. B
10. A
11. B
12. C
13. C
14. A
15. C

Your Score: ____ / 15

Charlotte's Questions

1. C
2. A
3. B
4. A
5. C
6. B
7. A
8. C
9. C
10. A
11. B
12. A
13. C
14. B
15. C

Your Score: ____ / 15

Harrison's Questions

1. A
2. B
3. C
4. A
5. C
6. A
7. B
8. C
9. B
10. C
11. A
12. C
13. B
14. A
15. C

Your Score: ____ / 15

Your Total Score : ____ / 60

Johanna's Quiz

1. C
2. B
3. A
4. C
5. A
6. B
7. A
8. C
9. B
10. A
11. B
12. C
13. A
14. C
15. B

13. Quiz Template

Now you have tried the quizzes set by Morgan, Charlotte, Harrison and Johanna below is a template for your own quiz to test your friends! Write 15 questions about green chemistry (or any chemistry topic you have been studying in class) and write your answer by either A, B or C. Then create 2 false answers to try and catch your classmates out! (Make sure to make a note of your answers on the next page.)

Quiz Name:

1.

A.

B.

C.

2.

A.

B.

C.

3.

A.

B.

C.

4.

A.

B.

C.

5.

A.

B.

C.

6.

A.

B.

C.

7.

A.

B.

C.

8.

A.

B.

C.

9.

A.

B.

C.

10.

A.

B.

C.

11.

A.

B.

C.

12.

A.

B.

C.

13.

A.

B.

C.

14.

A.

B.

C.

15.

A.

B.

C.

Your Quiz Answers:

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

14.

15.

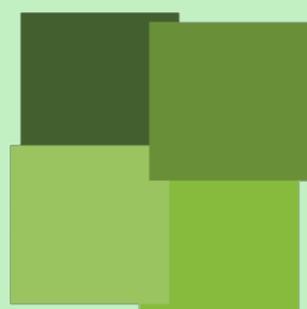
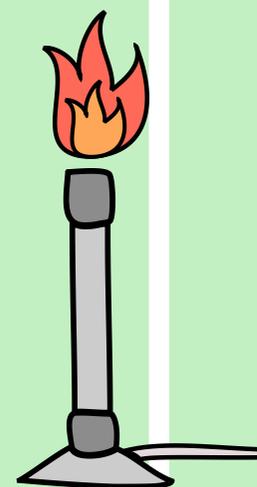
Your Score: _____ / 15



Join Harrison, Charlotte, Morgan, and Johanna on their thrilling science adventure....

Follow the lives of the four budding scientists on their journey to the National Awards for Technology and Science! The subject of this years presentation is **green chemistry**, with each of our year 9 students researching a different and exciting topic including solvents, enzymes and pollution.

Learn about the key principles of green chemistry from the individual scientific diaries and try some experiments found in the activity pack to see how green chemistry can impact everyday life!



**Green
Chemistry**
Centre of Excellence

Cover Design and Illustrations by TTCS Eastwood

Activation Energy

The minimum energy a process must reach in order to react and give

Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 6 - Week 1: Johanna

Active Site

A section within an enzyme or catalyst, which the reagent binds to

Related Glossary Terms

Drag related terms here

Ambient

Relating to the surrounding environment, an ambient temperature refers to the temperature

Related Glossary Terms

Drag related terms here

Anthropogenic

This refers to man-made sources, e.g. CO₂ anthropogenic emissions from burning fossil fuels and biomass. CO₂ naturally produced by respiration

Related Glossary Terms

Drag related terms here

Atom

The smallest particle of a chemical element that can exist

Related Glossary Terms

Drag related terms here

Atomic Number

The number of protons in the nucleus of an atom

Related Glossary Terms

Drag related terms here

Auxiliary Substance

The substances used in a synthesis that do not appear in the stoichiometric equation (i.e. solvents, drying and separating agents etc.)

Related Glossary Terms

Drag related terms here

Bio-derived

When a substance has been manufactured from a living (or once living)

Related Glossary Terms

Drag related terms here

By-product

An unintended and often unwanted product formed alongside the desired product

Related Glossary Terms

Drag related terms here

Carbon Cycle

This refers to the carbon recycled on earth, there are processes that release carbon into the atmosphere (E.g: respiration) and processes that remove it from the atmosphere such as (E.g: photosynthesis)

Related Glossary Terms

Drag related terms here

Coal

A fuel made from dead trees and other vegetation that did not rot fully

Related Glossary Terms

Fossil Fuel

Cradle to Grave

This related to the environmental impact associated with a product throughout its entire lifecycle. This range from the formation of the product and its components to its use and final disposal

Related Glossary Terms

Drag related terms here

Dipole moment

A charge difference separated by a distance

Related Glossary Terms

Drag related terms here

Electrons

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Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 5 - Week 1: Charlotte

Element

A substance made from only one type of atom

Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 5 - Week 1: Charlotte

Enzyme

A biological catalyst found in all living things

Related Glossary Terms

Drag related terms here

Fertiliser

A chemical or natural substance added to soil or land to increase its f

Related Glossary Terms

Drag related terms here

Fossil Fuel

Fuels formed from hydrogen and carbon over millions of years (E.g: oil, natural gas and coal)

Related Glossary Terms

Coal, Natural Gas, Non-renewable, Oil

Global Warming

This is the increase in the earth's temperature due to the greenhouse effect.

Related Glossary Terms

Drag related terms here

Green Technology

Technology whose use is intended to reduce or reverse the effects of activity on the environment

Related Glossary Terms

Drag related terms here

Greenhouse effect

Some heat escapes from earth's surface into space. Gases called 'greenhouse gases' trap heat and radiate it back to the surface keeping earth warm.

Related Glossary Terms

Drag related terms here

Immiscible

Two fluids that will not mix under normal conditions

Related Glossary Terms

Drag related terms here

Impurity

A material that has contaminated a pure substance

Related Glossary Terms

Drag related terms here

Inefficient

A process that produces a lot of waste, giving a low yield

Related Glossary Terms

Drag related terms here

Leaching

The draining of a chemical away from the source (E.g: into water)

Related Glossary Terms

Drag related terms here

Natural Gas

This is made of marine organisms that formed layers under the ocean.

Related Glossary Terms

Fossil Fuel

Neutrons

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Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 5 - Week 1: Charlotte

Non-hazardous reagent

Chemicals that are not harmful to people, wildlife or the environment

Related Glossary Terms

Drag related terms here

Index

Find Term

Non-renewable

A natural resource or energy source that is depleted by use and has the potential to run out

Related Glossary Terms

Fossil Fuel

Oil

This is made of marine organisms that formed layers under the ocean.

Related Glossary Terms

Fossil Fuel

Petrochemicals

A chemical retrieved or derived from petrol or natural gas

Related Glossary Terms

Drag related terms here

pH

A measure of the acidity of a solution

Related Glossary Terms

Drag related terms here

Pharmaceuticals

Compounds manufactured for use as medicinal drugs

Related Glossary Terms

Drag related terms here

Pollutant

A substance that pollutes something, such as water or the atmosphere

Related Glossary Terms

Drag related terms here

Protons

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Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 5 - Week 1: Charlotte

Renewable

A natural resource or source of energy that is not depleted when used

Related Glossary Terms

Drag related terms here

Index

Find Term

Chapter 3 - Week 1: Harrison

Solar Cell

A device that converts solar radiation into electricity

Related Glossary Terms

Drag related terms here

Substrate

The same as a reagent, this term is often used in biological reactions

Related Glossary Terms

Drag related terms here

Sustainability

The avoidance of the depletion of natural resources

Related Glossary Terms

Drag related terms here

Thermodynamics

This relates different forms of energy for the likelihood a chemical process occurring

Related Glossary Terms

Drag related terms here

Yield

The amount of product gained from a chemical reaction

Related Glossary Terms

Drag related terms here