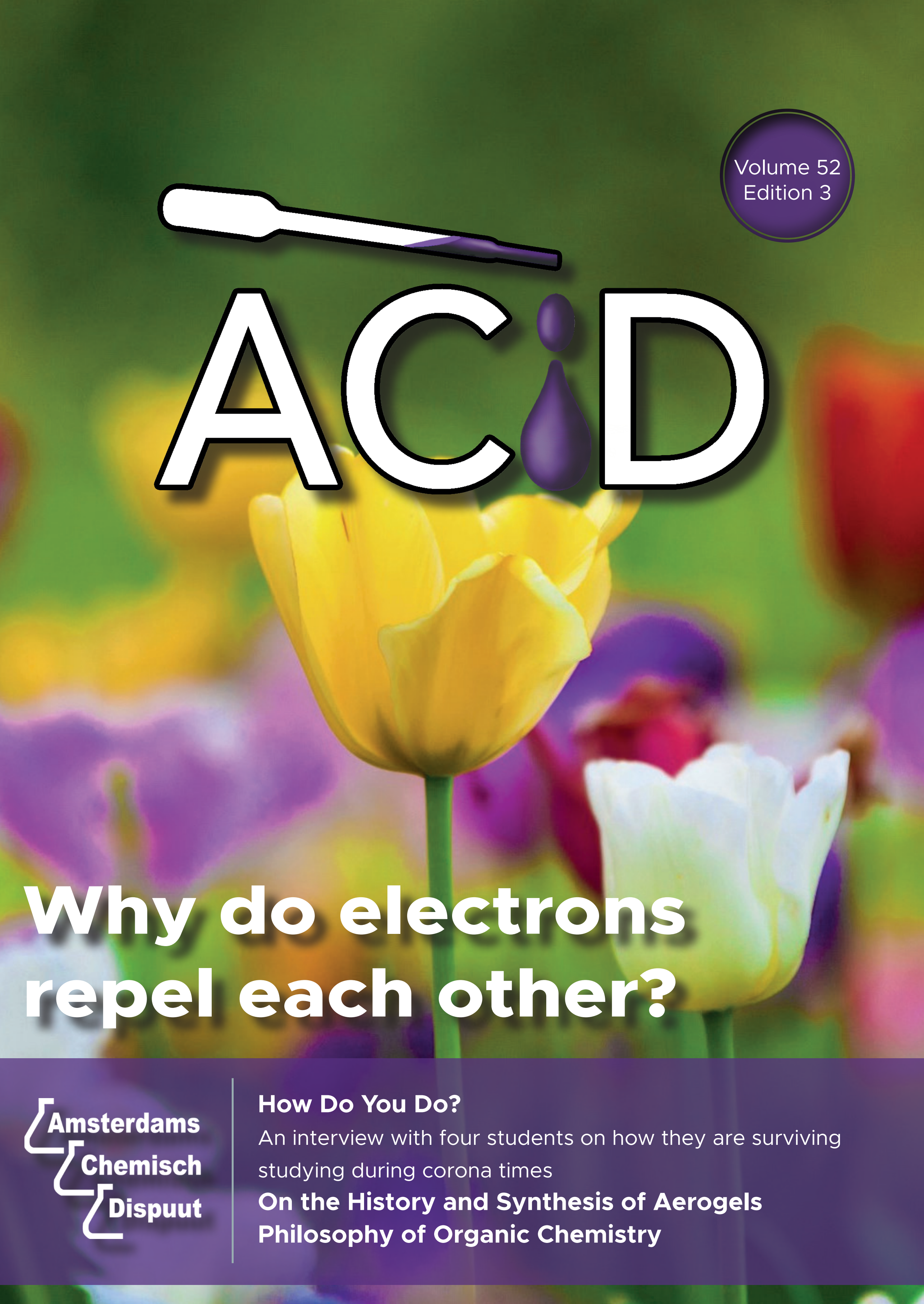

Volume 52
Edition 3

ACID

Why do electrons repel each other?

Amsterdams Chemisch Dispuut

How Do You Do?
An interview with four students on how they are surviving studying during corona times

On the History and Synthesis of Aerogels

Philosophy of Organic Chemistry

Colophon

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From the Editor

Dear reader,

This spring was quite chaotic if you have followed the news; so what is more wonderful than taking a break to read the new edition of AC!D? Our always-excited committee has prepared wonderful pieces with all the help of people wanting to participate in interviews! As a result, this edition contains several interesting topics: we go from student interactions with the rubric 'Chemistry vs. ...' and the new one 'How do you do?' to new information from the OC, and further on to a delicious recipe. All this with a beautiful lay-out! We also included chemistry-related subjects where we investigate, for instance, aerogels, which prove to be an awesome material. Another highly interesting piece is the origin of why electrons repel each other according to one of the most accurate scientific theories. We sincerely hope these topics will blow your mind, as these did with ours. Finally, there is some more news that will change the whole bachelor as we know it... Curious already? Well, we're certainly not going to keep you occupied any longer.

On behalf of our entire editing team,
Siebe Lekanne Deprez

Content

From the Chair

Dear ACD'ers,

I am delighted that it is already time for me to compose another message to you. We've left the cold days of winter behind us, although I believe the April weather feels differently about that. Despite the snowy days of February being a lot of fun, I believe having some nice weather and being able to go for a walk or a run is astonishingly better for our mental and physical health. The weather also might give the ACD an opportunity to host some small scale physical activities. Although the cold didn't stop us from trying to organize activities online.

First of all, the SLA has been able to entertain us some more in the past months. First an online escape room battle was created in which teams consisting of both bachelor and master students tried to puzzle their way to victory. On April fool's day they also organized an 'old skool' game tournament, which probably wasn't the activity that they had planned for us half a year ago. However it was still nice to have a laugh and play games like hangman and Pictionary.

Furthermore, the ABC hosted a variety of activities, including some online drinks through Gather.Town and a bonding night with Helios, the association of Dutch Studies. The biggest activity they hosted was an online cocktail workshop, requiring committee members to travel through parts of the Netherlands to deliver the packages at home to the members. After the exams were over, 50 people could join and were able to create 4 different cocktails with the provided ingredients. The ABC is also trying to create some physical activities in the coming months. Besides that, we've set up a buddy programme with the board that matches the first year bachelor or master students with our more experienced members in groups of four. This enables students to ask questions regarding their studies or to just have a chat and meet some new people. We have kickstarted the program with a Meet & Greet event and hope it will be successful in the coming months.
Alongside of all these fun activities, some more serious activities were also held, such as our semi-annual general assembly in February, where we picked the next members for the solicitation committee (SoCo). It feels weird that our second term as board members is already closer to finishing than expected. A few weeks after the general assembly the annual PAC symposium in March was held online for the first time, where we were blessed with a lecture from Nobel laureate Stanley Whittingham on the evolution of lithium-ion batteries. Without his research we wouldn't even have been able to work with our laptops and mobile phones as efficiently as we have had to do this past year. Furthermore, our own LEC organized a PhD lecture for our members to learn more about research opportunities at the UvA and VU. They also organized a radiation lecture, which was a little less successful due to the radiation provided by the sun that afternoon. Nevertheless, some interesting applications of radiation in medicine and sunflowers (real and painted ones) were discussed.

Last but not least, I want to say something to everyone: I want to wish the best of luck to everyone with their studies in the last months of the second semester. Even if it includes working on some bachelor and master courses, bachelor students starting on their final project, or master students finishing their thesis and their time as a student at the UvA. Despite motivation being a hard thing to find sometimes, you can all do this!

Your Chairman,
Floris Blom

Het wel en wee van de OC part 3

Sverre Overdijk

Dear reader,

Quite some time has passed since writing the last Wel en Wee and writing the one you are currently reading. So, the information density will be quite high this time. To start off, in normal situations we would have an OC-week coming up, where you can obtain more knowledge about what the OC does and who the OC-members are. This of course can't take place this year, so some other ways of reaching you (the student) will be carried out. This currently means that most of you have seen one of my fellow OC members during one of your lectures or will very soon. Also, you may have seen the general announcement in the ToDahLoo of May the first.

Furthermore, we would like to ask you again to fill out the evaluations. We see the response rates are slowly increasing, so thank you very much for those filling them out steadily. The reason it is so important to fill them out, is that if the response rate is lower than 30 percent, a lecturer can write the evaluations off as not representing enough students. So, I would like to take this opportunity to ask you not only to fill them in yourself, but also give your fellow students a reminder that the course evaluations actually matter and help increase the quality of your education.

Furthermore, the new OER-A/B and TER-A/B have been evaluated and quite a lot of changes have been made. For starters, in the OER-B, all the passing rules of the new first year curriculum have been added, as well as the substitute requirements for first year courses of the former curriculum. Where appropriate 'sweeping exams' (veeg tentamens) will be provided for disappearing courses. If, for next year, you want to know what the new passing requirements of the old first year's courses will be, you can find this in the updated OER-B.

On some changes the OC is not on board with the proposals. As one major obstacle there is the proposed rule about the obligatory attendance of seminars. The new OER-A and TER-A state that it would be required for every student to attend seminars, unless stated otherwise. Whereas the current rule states the inverted situation, where no attendance is required, unless stated otherwise. Reasoning behind this would be that students find it unclear if seminars are obligatory for certain courses right now. However, we as OC think that just making everything obligatory is not the right way to provide clearness.

We also received a letter signed by a few students concerning a course with unclear restrictions for the exam. To add to this the students also felt that the exam was either too long or too difficult, and that the grades were not representative for the course. With the information from the course evaluation and the letter the OC can contact the lecturer about the issues and give follow up on such matters.

In the next Wel en Wee, I will keep you up to date about the changes in the OER and TER, as well as any other relevant developments.

OC mail: ocs-science@uva.nl
OC page: student.uva.nl/sck/content/az/opleidingscommissie/opleidingscommissie

A New Curriculum for the Bachelor Chemistry!

Sape Kinderman

The new curriculum for the bachelor Chemistry has arrived! The first year of this renewed program will start on September 1st. The backbone of the chemistry program will be formed by the four themes that showcase the strengths of Chemistry at UvA and VU in Amsterdam.

Chemistry of life	Synthesis & sustainability	Analytics & photonics	Quantum & computing

How did this happen?

Already in 2016 a committee started to work on ideas on how to re-shape the Chemistry curriculum. The initial plan that arose from this work had to be abandoned in 2017, after it became clear that the merger of UvA and VU bèta stopped. In 2018 a successful re-accreditation took place and again a committee was formed with the task to develop a new curriculum. Right from the beginning, students were invited as well. It resulted in a thoughtful process during which a new study program evolved. It was shaped by many discussion sessions, and input from UvA/VU staff-members ánd students.

What are the strengths?

A number of features really stand out. To begin with: the four themes. These themes have a strong link to the research priorities in Amsterdam and to societal challenges. Additionally, we hope that they are attractive to prospective students. Secondly, there is more emphasis on the molecular life sciences, the use of computers, and data analysis in chemistry. Thirdly, students will be able to shape their own study path by taking courses from themes of their interest, while at the same time being able to drop a theme they dislike. Finally, tutoring, academic skills and orientation will be rewarded with credits. The orientation on study and career will be a fixed part of year 2 and 3 and the ACD will be involved as well!

Will things change for current students?

Yes and no. If you are a second or higher year student little to no consequences are to be expected. If you are a first or second year student that needs to re-take several courses from year 1, it will be different. Courses from the old curriculum will have disappeared and been replaced by others. Not all topics will return in equal portions or in the same period. In case you missed the information meeting, check out the general BSc SKJD site on Canvas!

We are looking forward to seeing the new curriculum getting started after the summer holidays as an attractive, renewed and high quality Chemistry program with lots of options for everyone personally. Spread the word!

Why Do Electrons Repel Each Other?

Siebe Lekanne Deprez

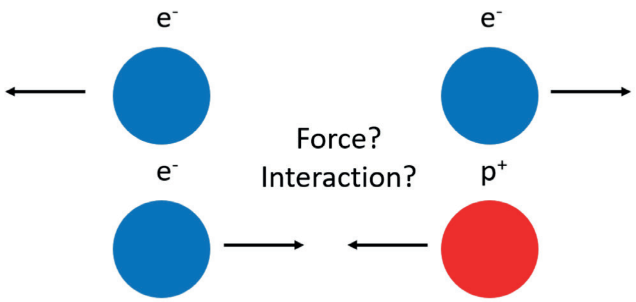

Figure 1. Overview of the two possible outcomes involving charged particles. Either the particles are both negatively or positively charged – causing repulsion – or the particles are oppositely charged which results in attraction.

As someone who is interested in theoretical and computational chemistry, I must admit that I am obsessed with particles, especially photons and electrons. And why wouldn't I? Photons are crucial for us to experience and see the world as we know it, and electrons are incredibly important in chemistry. In fact, the primary reason why everyday objects have volume is because electrons repel each other. But, let us think a bit about that last part. What exactly causes electron repulsion? We know it has something to do with charged particles causing an attractive or repulsive force (Figure 1) because that is something what we have learned in high school and at university[1] after all, right? This is precisely the subject for today and I will try to explain it in three parts. First, we will venture into the direction of quantum field theory (QFT)[2] for just a little bit. From that framework, the concept and importance of virtual particles will be introduced. Finally, we will look at Feynman Diagrams to discover the 'real' source of electron-electron repulsion where there lies a beautiful connection between photons and electrons. As a disclaimer: I will mention only one simple formula and the article is written for both Bachelor and Master students, so fear not!

What we know so far, is that there is a force, called the electromagnetic force, that causes negatively charged particles to repel each other and oppositely charged particles to attract each other. This is the classical picture of interactions between electrons. However, one could ask the question how the force is mediated between the particles: how do the particles feel each other while they are separated from each other by some space in between? Physicists asked the same question around 1950 and developed a new theory, called quantum electrodynamics (QED) which was the first quantum field theory. It was quite an advancement because it connected two other theories called quantum mechanics and spe-

1 #HardLife for 'Natuurkunde voor chemici'

2 For the ones that are curious: QFT is one of the most successful and precise scientific theories that exists at the moment because it predicts the correct value of the g-factor up to crazy detail. On the other hand, it also makes the worst prediction ever when scientists use the theory to determine the vacuum energy density (google 'vacuum catastrophe').

cial relativity with each other, or in more simple words: finding a way to describe the interactions between extremely fast-moving matter and light without knowing where they are precisely. Obviously, this is easier said than done.

As it turns out, QED is incredibly difficult to understand, but physicists found a way to explain the theory in a conceptual (and visually appealing) manner: Feynman diagrams (Figure 2). The diagram includes a time and space axis and shows a progress through time, which is basically the same as tracking a reaction through the reaction coordinate ζ. Particles are written as a variety of lines such as a straight line for electrons and a curly line for photons. We will only consider electrons and photons in this article. In Figure 2, two electrons are shown that move through time while sitting still because their line is purely horizontal. You can see that, at a certain moment, an electron emits a photon. But why does that happen? This is one of the extraordinary conclusions from QED: the force carriers of the electromagnetic force are photons. So, what we think of as a 'force' between electrons is actually an exchange of photon(s). Amazing isn't it? Returning to the diagram, we see that a short moment later, the other electron absorbs a photon and starts moving. Note that the electrons move apart from each other, but there is no reason at this moment why they should do that. Normally we would say that electrons repel each other by their charges, but charges occupy a different role in QED, meaning that electrons can either move towards or away from each other through photon exchange. I will come back to the concept charge later. Nevertheless, the interaction between two electrons occurs by photon exchange, but there is just one remark: we will never be able to detect the photon.

At first glance this seems ridiculous. Why can't we simply measure photons with a measuring device? But, here is where quantum mechanics becomes important with the famous Heisenberg relationship that is rewritten[3] in Figure 3. The implication of the relationship tells us that particles can be created and destroyed from nothing (relatively large ΔE) provided that the life span of the particle is short enough (small Δt). Such small life spans are not detectable and the black box shows the region in which virtual particles are created and destroyed. To the observer it seems like the

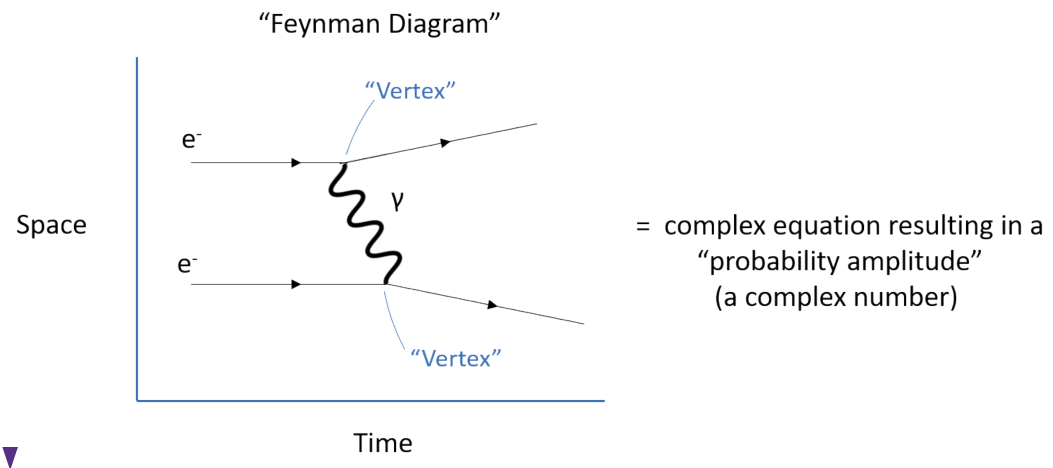

Figure 2. Example of a Feynman Diagram. On the y axis the space component is represented, which can be seen as the x direction or eventually the x,y,z directions (3D). The x axis indicates the progress of an interaction. In this case, two electrons (e-, straight lines) move away from each other by exchanging one photon (γ, curly line).

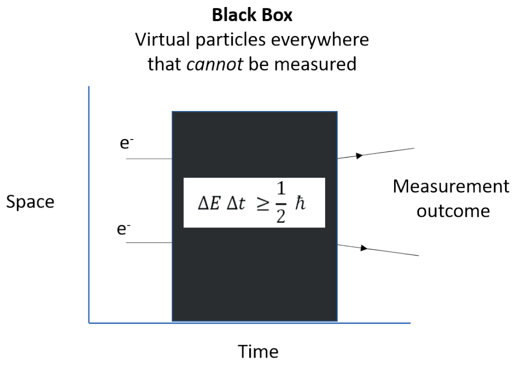

Figure 3. The 'black box' explanation of virtual particles. Due to Heisenberg's uncertainty principle, particles can come into existence for a ridiculously short time. The life span of these particles is so short in fact that they cannot be measured, hence the name 'virtual particles', just like how 'virtual orbitals' in molecules are not occupied.

electrons are moving away or towards each other in empty space, which is classically explained as the electromagnetic force.

The black box also implies that we simply do not know what happens in the black box. It could be that one photon is created but why stop at one? Why not have two photon exchanges, or three or even more? We simply do not know what happens in the black box region and you can in fact create infinitely many Feynman Diagrams that describe just the interaction between two electrons. Whatever happens within the black box cannot be measured and we only measure the outcome! So, the inconvenience is that we still cannot explain why two electrons repel each other since we do not know what exactly happens during the interaction that leads to a repulsive outcome.

This inconvenience can luckily be solved for which we have to return to the Feynman diagrams. One of the main reasons for using Feynman diagrams is that the diagrams are very complex equations in disguise that result in just a single, complex number called a probability amplitude (Figure 2). This probability amplitude highlights the quantum nature since the amplitude is proportional to the chance that a certain interaction takes place. More importantly, the amplitude becomes smaller and smaller for more complicated diagrams. Another powerful advantage of using Feynman diagrams is that it solves the black box problem. By considering multiple Feynman diagrams, two electrons are in a superposition of all chosen diagrams, i.e. the electrons experience all chosen interactions when they are in this superposition. Thus, every diagram contributes to the overall interaction that we measure in the end.

Combining the superposition feature of electrons with the fact that the probability becomes smaller for more complicated diagrams, it looks like a procedure can be applied (Figure 4): first we select a number of Feynman diagrams for which we expect the result to converge i.e. does not change if we add more diagrams, then we take the sum of all amplitudes and square the results. Here, the concept 'charge' returns because it signifies the imaginary part of the probability amplitude. In other words, the amplitudes cancel each other for the attractive interaction between two electrons.

3 You can either write it in the form $\Delta p \Delta x = h/4\pi$ or as $\Delta E \Delta t = h/4\pi$ by substituting $p = \Delta E/v$ and $dx = v\Delta t$.

4 Note that there are some requirements such as the charge needs to be conserved, matter/antimatter ratio should be the same and the time direction needs to be conserved. This is known as the 'CPT' requirement and it highlights the symmetries of particle interactions, i.e. why interactions between certain particles take place.

5 Double meaning: the equations are very sophisticated and involve complex numbers.

6 1/137 times smaller per vertex which is $1/\alpha$ with α being the fine structure constant.

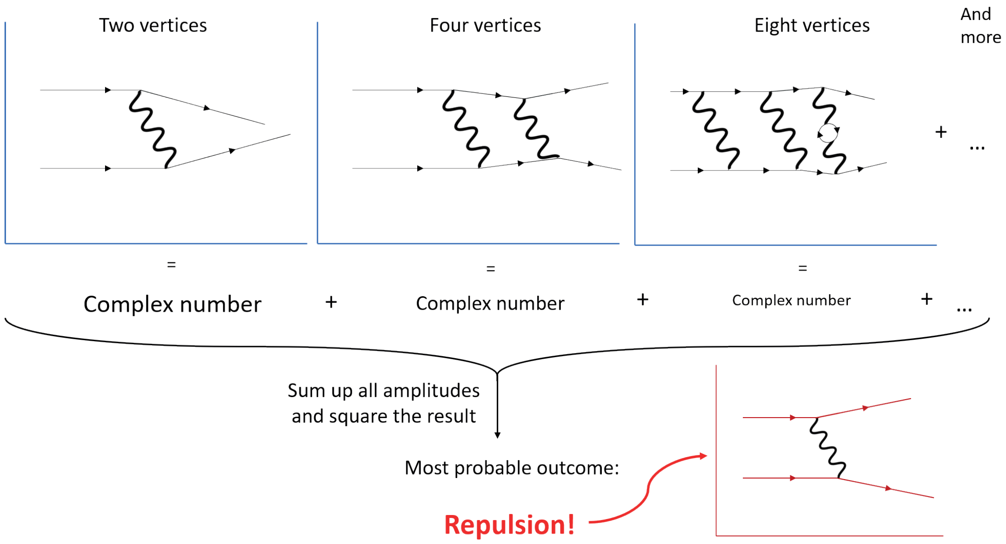

Figure 4. General procedure for determining the most probable outcome of the electron-electron interaction. The total contribution of each diagram gives one final result, which is that electrons repel each other. Note that the above diagrams are just examples and in practice there are many more different situations for which one can account for, involving two, four, six, eight and more vertices.

So, To summarize, I introduced you to the basic concept of QED, namely a quantum mechanical way to view the electromagnetic force. There we have seen that Feynman diagrams are very useful in understanding interactions between particles and that they can visualize the crucial 'virtual particles'. Finally, electrons are somehow able to experience multiple interactions at once due to the existence of virtual particles, which is signified by each diagram. By taking into account every contribution of a diagram, one final result is obtained: repulsion!

If you are interested in learning more about the nature of electric charge, forces and particles without needing to deal with the hideous math, I recommend the videos listed below. These are real and precious 'gems' in the (polluted) YouTube environment.

Very useful sources that explain the concepts of QED visually (and the concepts 'charge' and 'spin'):

Science Asylum. What is a Quantum Field.
https://www.youtube.com/watch?v=Y7Ac8zKTD-E (accessed April 4, 2021).

ScienceClic English. Quantum Field Theory visualized.
https://www.youtube.com/watch?v=MmG2ah5Df4g (accessed April 5, 2021).

ScienceClic English. Quantum Electrodynamics and Feynman Diagrams.
https://youtu.be/X-FEU4mQWtE (accessed April 5, 2021).

How Do You Do?

Part 1

What is your name and how do you feel in general?
Hi! I'm Jesper Ruiter and I'm currently in my first year of the Chemistry master (analytical track). It is going pretty well in general despite the circumstances. Of course, it is a strange time period, but I think I have become accustomed to the situation.

How do you typically study and did something change due to the lockdown?
Before the lockdown, I had to travel between Lelystad and Amsterdam by train every day during which I read through my notes. When I then came home, I studied the slides with the book next to me, but now that I'm in the Master I don't use as many books anymore as I used to. The noticeable difference between now and before the lockdown is that the lectures are being recorded. I find this useful because I can return more easily to difficult parts of the lectures which makes studying more convenient.

Can you name some benefits of the lockdown period?
Yes definitely! First of all, I mentioned before that I had to travel between Lelystad to Amsterdam which took two hours every day. Now that I don't have to travel anymore, I have much more time to study or to do other (fun) activities. Also, the lectures are now being recorded and I spend less money!

With what are you completely done with?
I detest the fact that I constantly have to think about the limitations/measurements when I'm outside as well as inside with multiple people. A year ago, most people didn't bother about wearing masks and keeping 1.5m distance at all... Another thing that I'm not a fan of, is that the sporting competitions have been cancelled.

What is your favourite fun fact of the year?
This is a hard one, but I think I know one: I listen to multiple podcasts including 'Just Interesting Podcasts' which has a rubric called 'what have you learned this week'. During one episode the question was how the bird of Twitter is called. I never thought about it before and it turns out the bird on Twitter's icon is called Larry T Bird!

What are you looking forward to?
I look forward to traveling to the university without having to take into account the measurements. I would love to meet my fellow students for the first time in real life.

Most enjoyable thing you have experienced this year so far?
Getting a Bachelor's degree. I enjoyed my bachelor project very much; it was not just a 'filler' but a project that could really aid the research group. When I finished my thesis, I received many positive reactions and much positive feedback from the group which led to me being even more motivated for the master education!

Name something you couldn't do because of COVID-19 that you normally would do.
Going out for dinner together with some friends and watching a movie in the cinemas thereafter. This will be the first thing that we will do once it is possible again.

What is your name and how do you feel in general?
Hi, I'm Eveline Klute, third year bachelor student and I'm doing okay! I really miss the social part about studying, but I luckily have enough self-discipline to study on my own. It is hanging and swinging. I live with two housemates which really helps with keeping in contact with people of my age and I'm really happy with them.

How do you typically study and did something change due to the lockdown?
I do believe some things have changed. I used to study a lot at the university and often I would stick around after a lecture and then study with some friends at the VU, for example. Studying at home is less motivating for me. I also notice that I find it harder to ask questions. If you ask a fellow student a question on WhatsApp, you often get a delayed response and then you have already forgotten what your question was exactly. If you see each other in real life, you are simultaneously busy with the material and it is easier to mention what you don't understand. The barrier to ask questions during a tutorial is also higher for me. Normally, you can ask the tutor a quick question personally, but now everyone can tune in to your question. Moreover, you now no longer have those quick chats with fellow students.

Can you name some benefits of the lockdown period?
I think my sleeping pattern has become better. Before lockdown, I had to travel from Utrecht to Amsterdam which is from door to door about an hour of travel time. I used to get up at 7 am and now 8 am or later, so I have more hours of sleep. Having the opportunity to listen to your lectures in your own time is nice, but in my opinion this doesn't weigh out to the social aspect of studying. I also miss the shared feeling of not understanding something; that you can ask: ' Did you understand that?' and that a fellow student can be like 'Nope'. It makes it easier to notice that it is not just you not understanding the material and that you should not panic. Due to the lockdown I also started going on walks more, but I guess that that is just my replacement for the lot of cycling I used to. Oh, and I started listening to podcasts more.

With what are you completely done with?
I'm actually done with the all-present non-spontaneity. You really have to discuss what you are going to do, when you are going to do it, and sometimes you have to reschedule because a friend had to be tested or a housemate had tested positive. Additionally, you can no longer invite more people spontaneously. You want to say 'yes' when someone asks if they can bring a friend, but that is not possible anymore. I would also love to be able to go on spontaneous trips again; now everything is still closed. Lastly, I miss meeting new people; the past year I've mostly just seen my bubble of friends.

What are you looking forward to?
Yeah, as I mentioned before, I'm really looking forward to meeting new people and actually I am also very hyped for going to a festival again: the perfect place for meeting new people.

Most enjoyable thing you have experienced this year so far?
Well, I was still able to continue training for pole dancing. Since I'm an instructor in this sport, I was allowed to rent the training room which was great. Training really gives me energy; I love sports and am really happy that I was allowed to train. I also started regular dancing and I really love that outside classes are allowed again. It allows me to meet new people as well, learn a dance together and just share in that hyped energy.

Butter Chicken

by Tim Lugtenburg

This time I will discuss a recipe for one of my favourite Indian dishes: butter chicken! (which is known in India as *murgh makhani*) Where I usually just order it for takeout, this time I thought let's see what they actually do to prepare those delicious meals. The origin of this dish is closely tied to another Indian classic: *tandoori chicken*. In the 1950s, chef Kundan Lal Gujral was looking for a way to diminish waste, so he decided to use the leftover tandoori chicken in a sauce of tomatoes and butter to soften it up: butter chicken was born.

Ingredients:

First marination
- ½ kg chicken thighs
- ¾ tbsp lemon juice
- ¼ tsp salt
- ½ tsp paprika powder

Second marination
- ¾ tsp dried fenugreek leaves*
- ⅛ tsp turmeric
- ¾ tsp garam masala
- ¾ tbsp oil
- 1 tbsp ginger garlic paste 1:1
- ½ cup full Greek yogurt

For the gravy
- 2 tbsp butter
- 1 tsp ginger garlic paste 1:1
- 1 cinnamon piece 2 inch
- 2 green cardamoms
- 2 cloves
- 4 large tomatoes (500 g)
- 16 to 18 cashew nuts
- 1 tsp paprika powder
- ½ to ¾ tsp garam masala
- ½ tbsp crushed fenugreek leaves*
- ¼ tbsp sugar
- salt as needed
- 80 to 100 ml cooking cream
- 2 tbsp coriander leaves

* If you manage to find them, I didn't at 4 different stores

Recipe:

Ideally you should begin a day in advance. This will allow the chemistry of the marination to work its magic and tenderize your chicken to perfection.

The day before:

1. Marinate chicken with lemon juice, chili powder and salt for 20 minutes.

2. Marinate again with yogurt, dried fenugreek leaves, oil, turmeric, ginger garlic paste, and garam masala powder.

3. Cover and rest in the refrigerator for at least 12 hours. You can keep it as long as 48 hours. The longer the chicken rests in the marinade, the more tender it will be after cooking.

Day of eating:

1. Add the cashews to a blender along with the tomatoes. Make a smooth puree.

2. Prepare the ginger garlic paste.

3. Grill the chicken in an oven at 240 °C for 20 to 30 min depending on chunk size.

4. Heat a lidded pan with butter and sauté the cinnamon, cloves and cardamoms for a minute.

5. Add ginger garlic paste and fry till it turns fragrant.

6. Add the tomato cashew puree.

7. Add paprika powder, sugar and salt.

8. Mix and cook until the tomato puree becomes a thick paste and begins to leave the sides of the pan.

9. Add around 1 cup water, more or less depending on your desired consistency.

10. Bring to a boil and let simmer for 3 to 5 min.

11. Add chicken and simmer for another 5 minutes.

12. Add garam masala and crushed fenugreek leaves.

13. Stir and simmer for about 2 to 3 minutes. Pour the chilled cooking cream and switch off the stove.

14. Garnish the dish with coriander leaves and extra cream if desired. Serve with rice and/or naan bread.

Chemical detail:

Even the most simple processes in the kitchen involve a lot of chemistry; in this case we take a short look at the chemistry behind marination.

Marination is mostly caused by an acidic environment or by enzymes. The lemon juice provides the acidity in the form of citric acid and the Greek yogurt provides it in the form of lactic acid. The research about this is not definitive, but it is likely that the low pH helps denature the protein in the meat, thereby making it more tender and allowing the meat protein matrix to hold more water, where the enzymes present in the meat accomplish the same tenderness by breaking down the muscles connective tissue.

And as the effect only penetrates shallowly into the meat, to maximize its efficiency you want to allow it enough time and have small chunks of chicken.

1. https://www.indianhealthyrecipes.com/butter-chicken/
2. https://www.thebetterindia.com/75100/butter-chicken-history-kundan-lal-gujral/
3. https://www.popsci.com/marinate-meat-in-yogurt/

A big thank you to all committee members! Your efforts made this year a little less bleak!

How Do You Do?

Part 2

What is your name and how do you feel in general?
My name is Sabela Vega Ces. My mood has been irregular during this year. But in general, I would say I feel happy with the courses but weird with the routine.

How do you typically study?
I try to keep a daily routine, even without going outside I always change my clothes to try to separate the rest time and the study time. I always need to turn off my phone to study.

Can you name some benefits of the lockdown period?
The main benefit is the flexibility. You can follow the courses wherever you are. I started my master in Spain (I am Spanish) and that was great because I could enjoy my family and my friends for a few months. Now I am in Amsterdam and sometimes it is hard to be alone for so many days. Also, in my opinion they should continue recording the lectures, it is much easier to follow the course because sometimes you need to skip some lectures but then you can catch up later.

With what are you completely done with?
I am done with the loneliness. It is the worst part by far. I am a very sociable person and being abroad without knowing so many people is hard. Moreover, now with the pandemic, meeting new people is almost impossible (also I am cautious to not get infected). I try to get in contact with some people from the master, but I feel it can be awkward sometimes.

What is your favourite fun fact of the year?
For me the most curious thing has been to meet people by zoom. I feel like I'm in Black Mirror sometimes.

What are you looking forward to?
I am very excited for the summer. I really want to go back to Barcelona and see my family and friends again. Also, I think the next semester is going to be much better with the master thesis, going to the laboratory daily, meeting new people. That is what I need. And I am quite tired of studying, I have been stressed for many months, with the laboratory I feel more relaxed and less pressure.

Most enjoyable thing you have done this year so far?
Perhaps it sounds boring but... learning. I have learnt so many useful and interesting things in this master, not only related to chemistry. Also, I have improved my English, and I have matured a lot living alone and dealing with so many responsibilities.

Name something you couldn't do because of COVID-19 that you normally would do.
Playing football... I would have loved to join a team in Amsterdam. I miss doing sports but especially playing football. Also, obviously, hanging out with friends and meeting new people. My experience could be much better but what can I do?

What is your name and how do you feel in general?
I'm Mike Meulendijks and currently a first year bachelor Chemistry student. Overall, I feel okay and I'm liking all the courses so far, especially organic chemistry! I'm just my happy and energetic self and really enthusiastic about the practicals in the lab. The group and the practical supervisors are amazing.

How do you typically study and did something change due to the lockdown?
I usually did not study a lot in high school, but was rather busy with extracurricular activities such as the student council. I actually learn most effectively from going to the classes, paying attention to the explanations and doing something completely different afterwards. Even at university, this tactic still works best: I go to the lectures and then make the assignments. I'm not using the books much, since reading doesn't work for me.

Can you name some benefits of the lockdown period?
I have a lot more time for the university and I expect that once the lockdown is over, it will diminish a lot. Another benefit is that I have a lot of free time and that I can work out in the evening. I don't have to cycle from place to place and once the lockdown is over, I need to spend an hour travelling to uni again.

With what are you completely done with?
I would like to get to know my fellow first year students better. So far, I know that most first year (and higher year) students are active within the association, but I don't get to speak with the more quiet ones. I would love to learn where they are from, why they decided to study chemistry, their hobbies etc.; all the small things. Hopefully, we can see each other in a physical lecture soon and be like 'I don't understand a thing. How about you?' Mostly, I'm missing the little things, even the rows in front of the coffee machine during the break.

What is your favourite fun fact of the year?
Mike's eyes immediately lit up during this question, since he is known to present fun facts to his group of friends. This time he came forward with not really a 'Did you know' but rather a funny coincidence: this year the police rolled up a hemp farm in an ice cream shop named none other than 'Pablo's ijscobar' (with Pablo Escobar being a famous drugs baron)

What are you looking forward to?
I'm looking forward to getting to know the first year students better and experiencing those small things mentioned above. I'm both scared of and curious about computational chemistry in my second year, thinking it will come in handy for the future. I'm wondering if it would suit me.

Most enjoyable thing you have experienced this year so far?
Non-study related I restyled my bedroom to create a study and relaxation area and I also started doing Mixed Martial Arts (MMA). During the lockdown I've been training for this sport more often and I really like it. I didn't take up anything strange, but I still want to buy a small fish. I've got a big bowl and would like to make this a home for the fish which can then join me during an online lecture or exam. I will have to wait until the stores open up again, I guess. Now more study related, I really love the practical labdays. It can be stressful at the time itself , but feels really good afterwards in the sense that you know you've accomplished something again. In the beginning, I felt a bit uneasy in the lab, but now that I know a bit more, I start to like those days more and more. Everything feels a bit more familiar. I'm happy that I feel at home with this bachelor!

On the History and Synthesis of Aerogels

Michelle van Dongen

Aerogels, the least dense solid in the world containing up to 99.8% of air, can you believe it? These gels are nowadays one of the most extensively studied materials and have caught the attention of many YouTube-viewers this and past year through the delightful videos of Veritasium and Nile Red (If you ever need a break from studying, these YouTube videos are the best, believe me). But what are these somewhat futuristic looking materials exactly? How did they come to be, how are they made and what makes them so special?

History of Aerogels

As with most great inventions, this material also originated from a bet. The legend goes that in the late 1920s, the American chemistry professor Samuel Kistler placed a bet with colleague Charles Learned to be the first to replace the liquid with a gas in 'jellies' without damaging the internal structure.[1] In this way, Kistler could prove that a gel was not a gel due to its liquid properties, but rather due to its network of nanopores. His persistence paid off and in 1931 he was able to publish his findings in Nature and to share them with the world.

Synthesis of aerogels

Besides their magical appearance, their synthesis is probably what really excites the chemists in us, since it makes use of the supercritical fluid phase. Ever wondered when you would use your knowledge from your Thermodynamics course? Well, read on. The first step in the synthesis is the formation of an alcogel, a gel with an alcohol, often methanol, inside its pores.[1] This alcohol can't just be evaporated out of the gel, since this would cause the gel structure to contract due to capillary forces. The pores, your whole structure, would collapse onto each other. Therefore, a different method was needed and scientists turned to the properties of the supercritical fluid phase, since this phase (Figure 1) exhibits characteristics of both the liquid as the gas phase. It is still able to dissolve other compounds like a liquid can, but it is also able to diffuse like a gas.[2] Most important for this synthesis is that the supercritical fluid phase does not exhibit a liquid's surface tension and therefore has no capillary action upon being removed from the gel, as is the case during evaporation. In other words, the gel structure will not be initiated to collapse onto itself! For the supercritical drying/fluid extraction, the alcohol inside the pores can first be replaced by liquid CO_2-gas, but this is not necessary. Overall, the following steps are undertaken in this process:

1. The gel is pressurized and heated past its critical point: the point where there is no difference between gas and liquid. During this step, the density of the gaseous species becomes larger, while that of the liquid becomes smaller. Once the gaseous and liquid phase have the same density, both phases start to mix and you acquire the supercritical liquid phase. The pressurization and heating is important to be carried out slowly, since heating it up too fast can still cause too excessive solvent expansion in the pores and cracking of your gel.
2. The next step is to depressurize the gel, while keeping it above the critical temperature. This enables a direct transition from the supercritical fluid into the gas phase of the solvent. Solvent molecules occupying the pores of the gel are released as a gas and the supercritical fluid becomes less dense. You should not let the pressure drop too fast to prevent cracks as well.

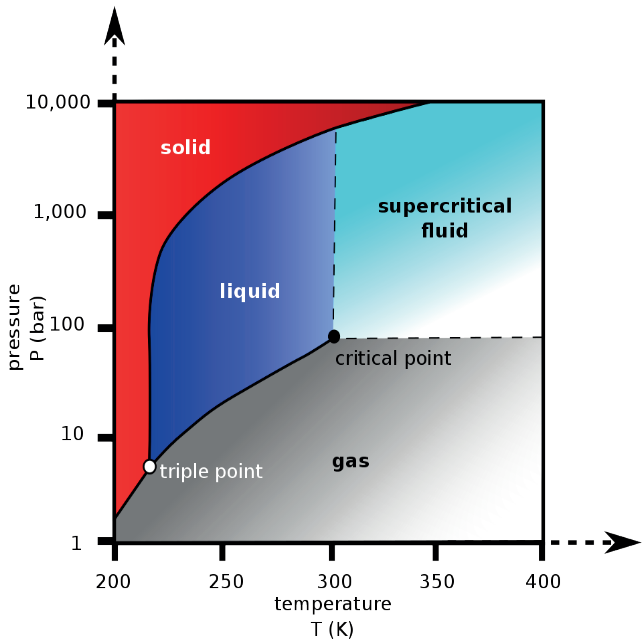

Figure 1. Phase diagram illustrating the critical point and supercritical fluid

Why are the silica aerogels so pretty blue?

If you already know why the sky is blue, this answer is easy to predict. The moment white light encounters the silica molecules, which are larger than the wavelength of light, the shorter wavelengths such as blue and violet are reflected more easily. These scattered blue and violet wavelengths are the ones detected by our eyes, and since our eyes are even more sensitive to blue wavelengths, voilá, we can experience this silica aerogel as the beautiful futuristic blue sky.

Did this article spark your interest into aerogels? You can find out more about them and their synthesis on this website:
http://www.aerogel.org/

3. The third step is to remove the gel from the heat source and let it cool down. After cooling down, the amount of solvent to condense back into a liquid is so small that it immediately becomes a gas.
4. After all the solvent is removed in this way, you are left with your aerogel, now filled with air where there was previously liquid. If you still have cracks in your aerogel, you might consider switching to a hexagonic gel structure,[2] once more enforcing the phrase 'Hexagons are the Bestagons'.

Types of aerogels and their future

So, what kind of different aerogels are out there? These materials are not really restricted in their composition and a general definition for an aerogel is actually that it is "an open-celled, mesoporous, solid foam composed of a network of interconnected structures with a porosity of at least 50%."[3] As long as your structure complies to the porosity requirement, it can be named an aerogel. The most famous aerogels are the blue futuristic ones which are made of silica (as depicted in at the start of the article). This silica has experimentally been the most studied and is even used in spacecrafts mostly for its insulating properties, since gas phase heat conduction is very poor with those small pores.[4] They have also been used to 'waterproof' objects, one of which human skin. Other common types are the carbon and metal oxide based aerogels which are used for different means. These types also exhibit good electrical conductivity, favoring their use in electrodes and batteries. Although scientists are already on their way, still lots of improvement is necessary to make the gels less expensive, stronger and their synthesis less hazardous.[1] With the right development they might become a cornerstone in the future of green technology for their insulation and electrical conductivity.

1. How Stuff Works. https://science.howstuffworks.com/aerogel.htm (Accessed 3-05-2021).
2. YouTube: Nile Red How to make aerogels https://www.youtube.com/watch?v=Y0HfmYBlF8g&t=1580s (Accessed too many times, because I couldn't stop rewatching some parts).
3. Aerogel.org. http://www.aerogel.org/ (Accessed on 1-05-2021).
4. NASA. Aerogels: Thinner, Lighter, Stronger. https://www.nasa.gov/topics/technology/features/aerogels.html (Accessed on 1-05-2021).

Philosophy of Organic Chemistry

Tim Lugtenburg

Of course, us chemists already know all about organic chemistry and most of us have had a philosophy of science course here and there. Academic philosophy often discusses the philosophy of physics or of science in general, but not much can be found for philosophy of (organic) chemistry, making it a novel area to explore. So, to change things up a bit, let's delve into some things philosophy has to say about organic chemistry.

Background

Interesting to note beforehand is that all the natural sciences were once grouped under philosophy, with the natural sciences being called *natural philosophy*. Once the great success of the scientific method for the establishment of truth was seen for these natural sciences, they increasingly started to form their own field and to separate it from the non empirically verifiable types of philosophy. However, this shared origin does mean that philosophy and science have a lot in common and that their questions can sometimes overlap.

Many philosophical questions can be asked about organic chemistry, but the one I will focus on today has to do with the philosophical foundations of the field. Since organic chemistry has arguably one of the most distinctive ways of visualizing/summarizing explanations, namely electron pushing, it has an intriguing combination of experimental and theoretical components. The paper which led me to the question we will discuss today and whose arguments I will explain has polemically worded it as: *"Is organic chemistry a science?"* [1] To specify the issue a bit further, I will change it to: *"How can we best characterize the scientific nature of organic chemistry?"*

Is organic chemistry a science?

First of all, this paper's authors also found the attention for philosophy of organic chemistry lacking, while the Nobel prize winning chemist Linus Pauling has said that chemistry is especially suited to play an integrative role within the sciences, making it a more inviting candidate for philosophical discussion. For this reason, answering the question *"Is organic chemistry a science?"* is of importance: it may provide a framework for understanding science as a whole.

This question is not that straightforward to answer, however. Of course, organic chemistry has many characteristics of a science and surely makes use of the scientific method, but does it stand at the same level as applied science/technology/engineering regarding its scientific characteristics, or is it closer to physics? Moreover, merely making use of the scientific method is a rather slim definition of science, philosophically speaking. In Kant's more strict definition,[2] chemistry is not considered a proper natural science:

''Natural science would now be either properly or improperly so-called natural science, where the first treats its object wholly according to a priori principles, the second according to laws of experience.''

Rather, he would describe it as a systematic art:[3]

''If, [...], the grounds or principles themselves are still in the end merely empirical, as in chemistry, for example, and the laws from which the given

facts are explained through reason are mere laws of experience, then they carry with them no consciousness of their necessity (they are not apodictically certain), and thus the whole of cognition does not deserve the name of a science in the strict sense; chemistry should therefore be called a systematic art rather than a science."

Another definition is that of the one made by Karl Popper, who defines science by demarcating it from pseudoscience and nonscience. For him, science is the body of knowledge which has come about by coming up with a hypothesis, trying to falsify it and failing to do so after numerous attempts. This does justice to the definition of science as that which makes use of the scientific method, but is difficult to maintain when looking at science in practice: usually one is more encumbered with trying to get an experiment to work (and rightly so, as this is often difficult enough) rather than trying to show why the hypothesis does not work.

The second approach the authors discuss is the reduction of the theories within chemistry to the more fundamental theories that are the underlying basis. For instance, the processes underlying biology or neuroscience might be reduced to chemical ones in this view (which in turn is what makes chemistry suitable for playing an integrative role between a number of fields) and chemistry itself to the laws of physics. Whether this is true for a field depends on if it has its own complete explanations for phenomena, or if it actually relies on explanations from more fundamental sciences to which it may be partly reduced to. This, however, does not mean that the less fundamental science can then be scrapped. If we were to adhere to the idea that organic chemistry can be reduced to the laws of physics, physicists would still have a hard time knowing how to synthesize compounds without the framework of organic chemistry.

Reducing chemistry to physics

Some components of chemistry have been shown to be reducible to physical theories such as the reduction of thermodynamics to statistical mechanics or the reduction of Arrhenius' law to Eyring's absolute rate theory.[4] The author of another paper, Ochiai, argues however, that while this is relatively straightforward for some of the physical chemical theories, trying to do the same for especially organic chemistry is much more difficult.[5] The reason for this is that you lose a lot of the explaining power in this process as reducing it to e.g. quantum mechanics does not feature the same concepts such as acidity/basicity, functional groups etc. that make organic chemistry so useful for the synthesis of compounds. While indeed the synthesis of compounds seems to be aimed at technology/application of the field, mechanistic understanding and application go hand in hand.

So, is it a science?

We have seen some approaches to the question about the philosophical foundations of organic chemistry. The first paper discussed two ways about how to make progress with characterizing organic chemistry which were to either reduce it to something else or to use a demarcation criterion like Karl Popper. The other paper gave an argument for whether chemistry can be reduced to physics and concluded that while this is at present possible for some theories within chemistry, it is difficult to argue this for organic chemistry with its unique features.

Personally, because the empirical and experimental components of chemistry are crucial to its effectivity and craft skills/tacit knowledge are required to perform the experiments well, I find Immanuel Kant's ideas about chemistry as a systematic art already formulated in 1786 somewhat appealing, although I would prefer a more robust definition. Still, not all has been said about this since other ideas regarding this topic all have their own strengths and everyone is free to disagree with the points made, which is the hallmark of philosophy. As the field of philosophy of chemistry is still rather young, it will be interesting to see what it brings in the future.

1. Kirschning A, Reydon TA. Is organic chemistry science – and does this question make any sense at all? Beilstein J Org Chem. 2015 May 27;11:893-6. doi: 10.3762/bjoc.11.100. PMID: 26124891; PMCID: PMC4464446. (main inspiration for this article)
2. Weisberg, Michael, Paul Needham, and Robin Hendry, "Philosophy of Chemistry", *The Stanford Encyclopedia of Philosophy* (Spring 2019 Edition), Edward N. Zalta (ed.), https://plato.stanford.edu/archives/spr2019/entries/chemistry/. (general entry on the philosophy of chemistry in the Stanford Encyclopedia of Philosophy)
3. https://escholarship.org/uc/item/7qw2r7hp#main (philosophical dissertation on Kant's philosophy of chemistry)
4. Hettema, H. (2012). Reducing chemistry to physics: *limits, models, consequences.* (philosophical dissertation on whether chemistry can be reduced to physics)
5. http://www.hyle.org/journal/issues/19-2/ochiai.htm (their website looks like those from the beginning of the internet, but they have some interesting papers)

Chemistry vs. Art History

Siebe Lekanne Deprez

Although many of us have visited at least one art museum in our lives (you should feel deeply ashamed if you haven't!), what do we actually know about art history apart from the basic knowledge acquired during Culterele Kunstzinnig Vorming? This edition, we decided to connect with our inner artists and talk to an Art History student.

The Art History Student on Chemistry

First of all, what is your name and why do you study Art History?
My name is Rosanne and I study Art History (first year) because I find it very compelling. I like to look at art throughout history and through the eyes of people from the past. In this way, art gets more personal and you get to know the context of why someone made an art piece, which makes the study very interesting.

What do you think Chemistry entails?
Probably performing a lot of experiments in the lab and researching all kind of things like natural processes.

Who is 'the' Chemistry student?
The first thing that comes up is the 'mad scientist': someone with chaotic hair and a (originally white) dirty lab coat with holes in it, and that always appears to be confused and busy. But, when I look past the stereotype, I think there is a lot of variation among the chemistry students and they all are very interesting people.

How do Chemistry students overestimate themselves?
I think they overestimate themselves in thinking that they know everything about the world around us. Since chemistry is abundantly present in many areas of expertise, the risk is that the students think that they can explain more than they can because it lays out of their domain. Take for example cooking. It is clear that chemistry plays a major role in the cooking processes, but that doesn't mean that you are an amazing cook!

What are Art History students better at than Chemistry students?
Looking from different aspects at a certain painting or art piece and seeing these aspects in their (historical) context. You can ask yourself: what were the cultural factors? Or the political ones? This certain view can be extended to the ordinary life in which you look at things from multiple angles. Let's say that someone is angry. You can choose to respond in an angry manner also, or you could ask yourself which factors are causing that person to be angry and respond appropriately.

What are Chemistry students better at?
This also has to do with the wide applications of chemistry, but then the other way around. Chemistry students have a lot of background knowledge because they study a wide variety of processes. Maybe this causes students to be more accurate and precise since they can better consider which factors or deviations would have large consequences.

What do you think is the major difference and the major similarity between Chemistry and Art History students?
The major difference is that chemistry students have more practical experience because of performing lab experiments. Art History involves mostly theoretical knowledge like knowing the

composition of an art piece and knowing how it was made, but we do not make them ourselves. In chemistry you learn about processes and subsequently try them out in the lab.
The major similarity is the idea of 'action-reaction' and 'cause-consequence', namely that actions have implications. Whether it is about figuring out what happens during a chemical reaction or figuring out why a certain art piece was made and its impact, it comes down to the same principle.

What do Chemists do all day?
In general: being busy in the lab all day and trying not to cause explosions. I also think that chemistry students spend a lot of time cleaning!

The Chemistry Student on Art History

What is your name and why do you study Chemistry?
My name is Xander and I'm in my second year of Chemistry. My choice for chemistry was not without some doubts: I knew already for a long time that I wanted to apply for a beta study, but the requirement was that it shouldn't involve too much math. I realised that chemistry was my favourite subject in school and I liked the practical aspect of chemistry. So, I started to study Chemistry.

What do you think Art History entails?
Basically just art and history. A little bit more elaborated: I think Art History is about studying different art styles throughout history in which certain artists are studied more in detail because of their historical importance.

Who is 'the' Art History student?
I think the art history student is someone that has an exquisite taste because he/she knows a lot about art. I also guess that the student has much background knowledge due to the history aspect of the study. On a more personal side, 'the' student is idealistic and stubborn since he/she is convinced about the beauty of paintings and cannot be persuaded otherwise.

How do Art History students overestimate themselves?
They overestimate themselves in judging their self-made art/paintings. Don't get me wrong, I think their paintings are actually great, but I doubt that the self-made art will end up in the same books from which they study.

What are Chemistry students better at than Art History students?
Approaching problems by the means of an analytical perspective, i.e. tackle a problem from different views and think deterministically.

What are Art History students better at?
Art history students are better in communicative skills. For example, they tell a story or explain a (arbitrary) topic more enthusiastically and more interestingly. On the other hand, art history students can also be more boring than chemistry students because the former wants to talk solely about art and paintings.

What do you think is the major difference and the major similarity between Chemistry and Art History students?
As a major difference I think that art history students are more stubborn and have a strong opinion about a topic, while chemistry students are often more nuanced and view the same topics from multiple angles.
The major similarity is that both students live in their own niche world; both chemistry and art history aren't the most popular choices and the students have little contact with other bachelors.

What do Art History students do all day?
Looking at paintings.

Smaakmatrix

Inspired by the Parool

Brilliant

Scientific

Beer-related

- NileRed videos on Youtube. Go watch them!

- The Blad-Committee is looking for new members!

- Finally being able to enjoy a drink on a terrace

- The gifts for all graduated active committee members

- 'Zondag met Lubach' sadly ended, but luckily we still have 'Even tot Hier'

- Myrthe not being able to spell reprot, wait repotr, whatever

Horrible