

# A Student's Report on the 55th International Mathematical Olympiad

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## Abstract

This is an account of the 55th IMO from the perspective of one student. The diary and those provided by Geoff and Dominic should therefore be read simultaneously for a full understanding of the competition. For more information about the IMO see [www.imo-official.org](http://www.imo-official.org); for more information about British involvement in the competition see [www.bmoc.maths.org](http://www.bmoc.maths.org).

## Introduction

Greetings from BA flight 0059. I am sitting behind a passenger with an ancient Greek attitude to eating, namely that it should be done while reclining. To his left, his friend is watching *The Hobbit 2*, allowing me to test myself on the lines. The film is considerably improved by the lack of sound. In front and to my right, a passenger is taking full advantage of BA's policy allowing the use of e-cigarettes. Behind me and to my left, Geoff is attempting unsuccessfully to sleep. I assume that he has more leg room in his flying sleigh. To my left, Frank is writing in Mandarin. To my right, Joe is tackling a functional equation; his paper more littered with Fs than an episode of *The Thick Of It*. Across the aisle from him, Dominic is between two middle-aged women. I assume they paid extra for that. He is reading.

Surrounded by this surreal entourage, but with little appetite for a functional equation, no knowledge of mandarin, no e-cigarettes at hand, minimal interest in the films on offer and no reading book, I have decided to spend a moment beginning this student report. As usual, it will take the format of a diary, with a couple of appendices.

# Diary

## Sunday 29th June

*In which we are suspended in the sky for several hours*

We meet at Heathrow in an orderly fashion, dine at Wagamama's and start doing maths. Freddie, Frank and I have an extremely brief conversation about our final Cambridge entrance exam, which took place two days ago. This year's journey will be massively shorter than last year's for two reasons. Firstly, our flight leaves in the evening, so there's no need to spend 9 hours in a Holiday Inn outside Heathrow. Secondly, whereas last year we required three flights interspersed with long waits, this year we have the privilege of a direct flight from London to Cape Town. We board without palaver (airport security comes worryingly close to finding Dominic's contraband, but it seems that he has forgotten to pack it). We will share the flight with the Luxembourgise, but it's a big plane and Luxembourg is small, so I don't see them.



*This plane is larger than Luxembourg and there's still no room for my legs*

## Monday 30th June

*In which we remain suspended for several hours but eventually fall to the ground and are introduced to Cape Town*

Little changes for the remainder of the flight. Frank finds an innovative sleeping position. Joe finds several. Freddie is amused by Joe's most frequently adopted pose, which involves a very high elbow and a protruding tongue. Little can be said about the expression on Frank's face because it is pushed firmly into his fold-up table. Geoff manages to fall asleep. The vegetarian breakfast I am given is plain but pleasant, which is a relief after my incredibly rich dinner. Others have less luck with their Full English. Dominic describes the mashed potatoes as "cat vomit". Freddie concurs. The pilot and the senior flight assistant compete over who can make the greatest number of pointless announcements (for example, "As the pilot has just informed you, we will be putting the seatbelt sign on in approximately twenty minutes" – senior flight assistant, and "I won't be making any more announcements" – pilot).



*The autopilot would have sufficed.*

We land mid-morning and are taxied to our hotel, the Little Scotia guest-house, where we laze around all day. The weather is lovely until about 5 in the evening, at which point it becomes extremely cold. Winter in Cape Town is wintry. We are united with the Australians, two of whom (Seyoon "Seyoon" Ragavan and Alexander "Gunning" Gunning) are returning contes-

tants. Gunning is seriously good at maths. We have lunch at a fancy steak house, and dinner at the local Thai option. It is apparent that we would be well within our means to dine out at every opportunity throughout the two weeks, as the food is stupendously cheap. At dinner I am the unique patron with the TV in my field of vision, and am consequently asked to report on France's progress against the Nigerians frequently. The World Cup will coincide nicely with the IMO this year. Jill is in a prediction contest with her entire family, and the UNKs set up a similar, if less official, competition over the fortnight.

## Tuesday 1st July

*In which the training begins, in which we do lots of maths, and in which we watch football*



*I'd rather be at UCT than St. John's.*

Today is our first training exam. All three problems are thoroughly enjoyable, although it seems that we all need a bit of warming up (in both senses: we are all wearing at least 3 layers, and some of us are up to 5). UCT is among the most beautiful campuses we've seen – Dominic, whose obsession with BuzzFeed is becoming increasingly apparent, has read a listicle ranking it among the very top few in the world. We watch a replay of France

v Nigeria in the UCT cafeteria, and spend the next few hours tackling more maths.

The plan was initially to ascend Table Mountain today, both for a short hike and to get a better understanding of the geography of Cape Town. Unfortunately the horrendous weather means that Table Mountain is closed, or as Freddie puts it, “on strike”.

## Wednesday 2nd July

*In which we ascend Table Mountain, in which we set a paper for the Australians, and in which we watch football*

After today’s exam, we finally go to Table Mountain. The view from the cable car base station is spectacular, and as we ascend it becomes even more so. However, towards the top we enter the “tablecloth”, a recurrent bank of cloud covering the mountain for most of the winter. This makes the view from the top horrifically disappointing. Nonetheless, we enjoy a short walk around the surface of the table. The rocky terrain is conducive to amateur parkour. Shortly before descending, I buy a useful fleece, because the permanent cold is becoming unbearable.



*Should have gone to specsavers*

We spend the evening setting the Aussies their Cape Town Mathematical Olympiad paper. The CTMO is this year's edition of the annual friendly competition in which each team sets the paper for the other. We struggle to pick an easy geometry, but we are happy with our combinatorics question 2. Back in Heathrow, Freddie provided us with a number theoretic problem, which will be question 3. It is our designated "Gunning Stopper", designed to deprive him of full marks. I'm not optimistic.

I am reliably informed that tomorrow France and Germany will celebrate the centenary of World War I with a reenactment complete with real-life Germans running circles around real-life Frenchmen. Something to look forward to.

## Thursday 3rd July

*In which we do not watch the France v Germany match*

Today's exam contains a very doable three variable inequality and a revolting geometry question which nobody has a clue about (except for Gunning, who solves it). The third question is a very nice combinatorics problem which Gunning also solves, along with the only UNK sufficiently familiar with his skills in geometry to know not to bother with question 2 (me).



After our exam we embark on another walk – there isn't much else to do unless you have a full day, and we all enjoy walking. Frank stays behind and sleeps. This time we return to the Rhodes Memorial, which we visited

on Tuesday, and continue onto one of the many tracks up Table Mountain. The sloped ascent is on the western face of the mountain; on our side, an increasingly challenging gradient eventually gives way to a sheer cliff. Consequently routes starting in the east are reserved for serious climbers, so our path shuns any zigzagging in favour of a direct line to the foot of the cliff. This allows us to ascend quickly, and steal another nicely backdropped group photo. From on high we are able to identify the accommodation we will be occupying next week. I'm not particularly looking forward to it.

We do not watch France against Germany, because that match is not scheduled until tomorrow. My reliable informant, Dominic, more than makes up for his error by braving the rain to get the pizza.

## Friday 4th July

*In which we sit an Australian paper, in which we mark Australian scripts, and in which we watch the France v Germany match*

The Australian paper feels slightly harder than ours. We face a very difficult question of geometry, conceived by Seyoon, along with a not very difficult question of algebra, not conceived by Seyoon. I emerge from the exam room beaming after learning that multiple UNKs solved the number theoretic question 2 using the idea of the finite field of order  $p^2$ , a technique on which Freddie and I gave a talk at Oundle (unsurprisingly, Freddie and I used the very same technique). If there is one experience more satisfying than doing maths, it is other people doing maths that you once showed them.

## Saturday 5th July

*In which we win the Ashes, in which I train with the Irish and Trinidadian teams, and in which we do some geometry*

Among the central goals of the International Mathematical Olympiad is to encourage international co-operation and friendship, both in mathematics and in life. Contestants from wildly different cultural backgrounds get along well, and friendships are formed across geopolitical divides. A moving photo from this year shows the Ukrainian and Russian teams looking inseparable, as indeed they are for most of the competition.

Nevertheless, the reader will be relieved to hear that for the sixth consecutive year, the UNKs emerge victorious over the Aussies in the Mathematical



Ashes. Three cheers for Empire.

In the relaxed afternoon, I am invited to sit in on an Irish-Trinidadian training session. Luke Gardiner, the Irishman who has spent the year training with UNKs, suggests this. The session involves several nice geometry problems provided by the Trinidadians, followed by a not nice geometry problem provided by me. The teams are training at a high level, and I predict good performances for both in the upcoming competition.

The topic up for discussion this evening is a challenging but fun geometry problem from an old shortlist. This problem leads us on to a valuable conversation on the inner Soddy circle, and then to a useless conversation on whether any well known triangle centres live on it.

## Sunday 6th July

*In which we move to the IMO site, in which we complain a great deal, and in which we take a tour of Cape Town*

We check out of Little Scotia. Harvey and Frank manage to lose their



room key. Harvey is a notorious loser of keys, but this one, like the guest-house to which it belongs, is rather fetching and old fashioned, so it does seem a shame. Harvey is particularly thoughtless to realise that the key is gone 15 minutes before we mean to check out, after a full week of completely harmless moments in which to lose it.

This IMO will be exceptionally well organised. Throughout the week there will only be a tiny handful of issues. Most of those issues will occur today.

The first comes when we check in at the UCT lower campus. It appears that Frank, despite being on every relevant list, in the UK or in South Africa, printed or online, up-to-date or outdated, does not exist. Consequently it is only natural that he has not been assigned a room. We break the news to the organisers that, like everyone else on every single list, Frank does in fact exist. It remains the case, however, that the room doesn't. Frank will share with Warren. The second room-related issue is that Jill, the UK's "Observer with contestants", is not with contestants. Underage British tourists must be accompanied by a responsible adult, so the organisers have little choice but to find a room on our floor. This is an all-male building; Dominic will be the responsible adult.

The accommodation causes more problems throughout the day. In the foyer of our tower a polite notice reminds UCT students to bring their own heaters. This was not on the kit list we were issued by the UKMT, nor was it among the information sent to the UKMT by the IMO. In fact, nobody has brought a heater. Different teams get around this in different ways: some teams double up in rooms for added warmth (the rooms are for two, but are assigned to one each). Other teams cram into one or two rooms and buy a couple of heaters. One team buys a heater for every participant. Even considering the cold weather we are experiencing, the building seems abnormally cold; the UNKs set about determining why this is the case. We make two discoveries:

1. There is literally no central heating whatsoever.
2. The building is shaped like the emblem of the Isle of Man, so as to maximise surface area and keep the building as cold as possible.

We spend the afternoon touring Cape Town with one of the senior guides, Julian. Frank stays behind and sleeps. Julian is good at maths, and gives the school leavers a horrible integration that we determine to be non-trivial and then ignore. Julian is also a goldmine of insight into South African society, and we speak at length about the aftermath of apartheid and the

slow recovery the country is making. In the evening we encounter UCT food and start to long for the luxurious dining options of the pre-IMO camp.

## Monday 7th July

*In which we climb the Lion's Head, in which we fix up and look sharp, and in which we perform well at the opening ceremony*

The team wakes at an uncivilised hour and heads down for breakfast. I wake at a far more civilised hour and am handed a spare muffin as I join them ten minutes after we had originally intended to set off for Lion's Head. Frank stays behind and sleeps. This is a thoroughly enjoyable climb; we wind around the hill as we ascend, and are therefore granted views in every direction. To the East are the stunning cliffs of Table Mountain; to the West is the ocean. To the North, we look over Signal Hill and onto the city. On the far end of Signal Hill is a cannon which is fired at midday every day to communicate the time to the Dutch settlers who disappeared several centuries ago. At midday we are as close to Signal Hill as our path comes, but fail to hear the cannon (Harvey claims to have heard it).



The last section of the climb involves about 20 minutes of scrambling up

rocks. This turns out to be a good cardiovascular workout, largely because I haven't been keeping fit through exam season and am not as spritely as I was when I was a schoolboy. At the summit is a useful boulder which allows you to get a full panorama on your camera. Unfortunately none of us have decent panorama functions. We also encounter some American tourists who display traditional American friendliness by asking a series of inane questions about the IMO and offering to take a group photo for us.

We head back and regroup for the opening ceremony. Dominic carefully and systematically hands out UK memorabilia and problems to precisely those countries from whom he would like problems in return. This strategy is enormously successful. So far everything is going swimmingly.

I will take this opportunity to describe the uniform Dominic has provided. As per usual, we have a nicely coloured polo shirt. This year's nice colour is neon green. Dominic explains that his agenda is to discourage use of the polo shirt in Cambridge. As a popular destination for IMO contestants, Trinity College is saturated with IMO stash. We also have the usual dark blue blazer. The blazer and polo shirt are both unusual in bearing our generous sponsor's logo. We also have the usual tie, and a very wearable Pre-IMO camp Rugby shirt in place of the usual Pre-IMO camp hoodie. Finally, we have sleeveless V-neck sweaters, which are a nice surprise.



*Very nice.*

The ceremony is shockingly well organised. A professional compere is hired to introduce acts and conduct the roll call. The acts are all thoroughly enjoyable, and the speeches are survivable. Of particular note is a minor politician with a depressing spiel on numeracy rates in the Western Cape. She tells us that the number of students in the region taking remedial mathe-

matics climbed from 241,400 to 481,400 in the 30 months to December 2013. Some ingenious organiser had the idea of calling up countries in order of first participation in the IMO. This turns a usually tedious tradition into a wonderful history lesson, and also ensures that the UNKs can go up early for once.

Last year our performance, in which Sahl Khan was carried around on my shoulders and everyone else waved and smiled, was quite well received. To top that act, this year we distribute keyrings in addition to the usual acrobatics. In a strange development, deputy leaders go up with contestants. It is evident from some of their attire that they were not informed of this (Dominic is presentable). Perhaps in future Jill will be entitled to go up as well?

If the reader takes one important piece of information away from this report it should be the following: Joe is easier to carry than Sahl.



Going up early means that we are the first country to distribute souvenirs. These are well received (mathematicians seem to have good hand eye co-ordination). Overall our part in the opening ceremony has been a resounding success.

The headline performance at the ceremony is an impressive local circus troupe. The clown, and leader of the group, summons two painfully embar-

rassed audience members and forces them on a romantic date complete with music and an imaginary car. This comes across as inhumane, and I try my best not to condone the practice by laughing.

## Tuesday 8th July

*In which we sit an exam, in which we visit the Kirstenbosch Botanical Gardens, in which we encounter a taxi thief*

For a country whose history is so steeped in Christianity and Christendom that six colleges in Cambridge are named after Jesus, the UK certainly understands Zen a lot better than one might expect. Instead of cramming onto a noisy bus for the half-mile journey to the exam hall, we take a relaxed walk. Dominic gives a battle speech of which even Henry V would be proud, and we head into the exam.

Question 1 is very easy. The statement is intuitive enough, and a quick proof appears after one idea, which is not a strange idea to think up. Nobody takes more than half an hour on it. Question 2, it seems, is almost as simple. Everyone has the right ideas, although there appear to be one or two issues with write-up. Most of us are left with several hours to attack question 3, which is a huge improvement on last year's paper in which question 2 was hard enough to slow some of us down considerably and leave us with almost no time to tackle the very hard question 3. How, then, will the UNKs fare this time?

The good news is that we didn't score straight zeroes. Joe received a well-deserved mark for not being as rubbish as the rest of us.

Nevertheless, we retreat from the hall in relatively high spirits; we are half way through the IMO with no major casualties, and we still have a hard combinatorics question to tackle (at least, this is my prediction. And my predictions are never wrong).

In keeping with our focus on Zen, we shun the IMO site in favour of an outing. Relevant context: in the immediate aftermath of any competition exam, the participants spend anywhere between an hour and a day comparing solutions to various problems, predicting tomorrow's paper (which is futile because my predictions are never wrong) and predicting medal boundaries. Dominic suggests the Kirstenbosch Botanical Gardens. We clear this with the organisers beforehand to ensure that the leaders' group is not there. Bear this in mind. Once we have the go-ahead, most of us set off. Frank stays behind and sleeps.

The Gardens are well worth a visit. Warren, Joe and Harvey are barred from chasing the Guinea Fowl, but Freddie and I are not, because we are adults. I take full advantage of my extensive bird-chasing rights by chasing them on several occasions. It seems that I'm not the only adult to have interpreted the sign forbidding children from chasing the Guinea Fowl in this way: a video on youtube, entitled "Chasing Guinea fowl at Kirstenbosch", can only have been filmed by an equally sensible legalist.



As we make our way towards the taxi, we are queue-jumped by a fellow tourist with exemplary American English, and his two not-very-merry men. It appears that they have been waiting for a taxi, but have not taken the sensible precaution of booking one. Our taxi driver rightly refuses to serve them, and we board ourselves. Now it transpires that the three are from the leaders' party, which is worrying. We immediately stop talking to each other, and further negotiations take place via the taxi driver.

The group's kingpin asks the taxi driver to serve his party instead. The taxi driver refuses. We ask the taxi driver to start driving. The kingpin will not allow this. The kingpin asks the taxi driver to radio for another taxi. The taxi driver explains that the kingpin must call himself so as to leave his details. We ask the taxi driver to start driving. The kingpin will not allow this. The kingpin launches a tirade of complaints at the taxi and all of its inhabitants. The taxi driver wonders why the kingpin doesn't place a call. The kingpin explains that he refuses to pay international rates.

It will transpire that the kingpin is attending the IMO as a co-ordinator. Geoff and Dominic report that their meeting with him the following morning

was substantially more civilised than this one. I'd like to take this opportunity to thank him for the team's 40 marks on question 1.

## Wednesday 9th July

*In which we sit another exam, in which we are reunited with Geoff, and in which we mope*

Today's walk up to the exam is equally relaxing, although Dominic is on the deputy leaders' outing. We are thus without a battle speech as we enter the exam hall for the second time. I attribute our unhappy day to this. Instead of motivation from Dominic, the team splits up with the parting words from yours truly, "I'll bet you all a chocolate bar that question 6 is combinatorics". This is in response to a misguided theory that question 6 might be a hard functional equation.

Question 4 is straight forward; like last year's 4, it is a geometry question on which we will all score full marks. Happily for Geoff, this time we will use synthetic methods – even Warren, who resorted to Cartesian co-ordinates last year.

Now we come to the delicate subject of question 5. I should point out that this was the question responsible for the slight decline in the UK's performance compared to last year. Last year we submitted six complete solutions for three questions, five for one, two for one and none for one. This year the corresponding values were six, six, five and a half, two and a half, none and none. The biggest drop was on our fourth strongest question – the harder of the two mediums. In short, this year we averaged between three and four, whereas last year we averaged four. Children of a future age, take note: the mark of a top-ten country is the ability to consistently solve the medium problems.

## Thursday 10th July

*In which we go to the supposed end of Africa, in which we go to another supposed end of Africa, in which we do not go to the actual end of Africa, in which we see amazing wildlife and in which we are guests in a former township*

Today is the first excursion. Our convoy takes a dramatic road along the coast, with good views. Every so often we stop for a breath of fresh air

and a few photos. Slowly we are making our way down the Cape Peninsula, crossing the mountain range that runs along it every half an hour or so. We stop at Boulder Beach to meet a famous colony of penguins. Jill takes some really excellent photos. I manage to get a bird's eye view of a bird.



*Meta.*

We stop for lunch at Ocean View, a former township with a strong tradition of singing and dancing. They sing and dance for a few hours while we eat lunch. We then proceed to the Cape of Good Hope, which is the end of Africa. It is not the Westernmost point, nor the Southernmost point. Nor, in fact, is it the Southwesternmost. Another place which is not any of the above is Cape Point, which is also the end of Africa, and which we also visit.

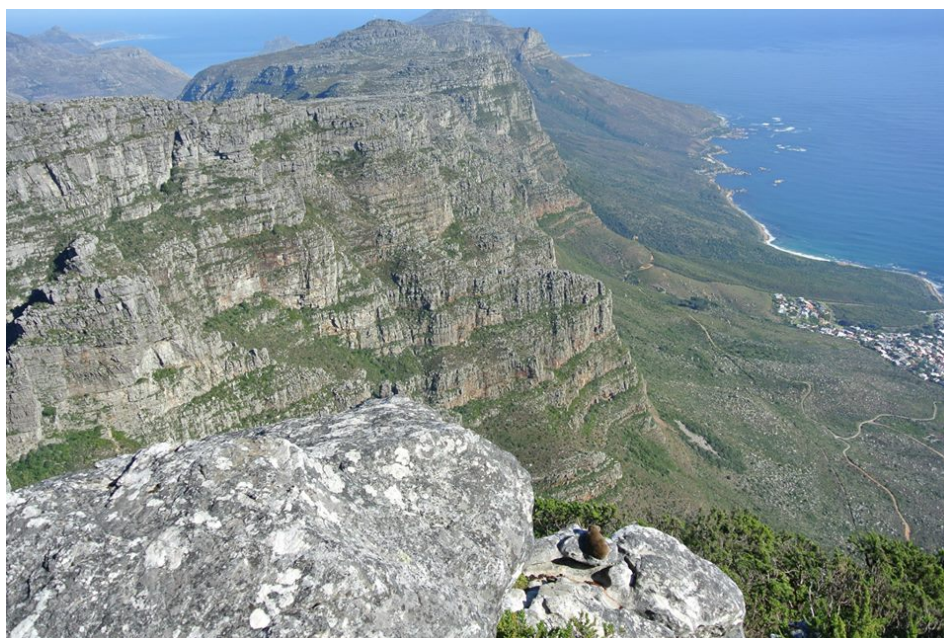
## Friday 11th July

*In which we take to Table Mountain and in which Joe takes to his bed*

We are confident that the quality of weather will peak today. Added to the fact that co-ordination continues and we have nothing to do, this makes Jill's suggestion to return to Table Mountain very popular. The weather is,



indeed, fantastic. The views in all directions are even better. We stroll along roughly the same route as last time, but the absence of cloud makes it much easier to understand the geography of the place. The sudden revelation of that which was once so confusing is a surreal experience, and not unlike the experience of being shown the solution to a maths problem on which you had not spent much time.



Earlier than expected we receive a text from Dominic with our final results, and there is much rejoicing, and some wailing and gnashing of teeth. Joe also starts to feel a bit ill. We head for food in the café, and soon after our meal we encounter Dominic. Now Jill returns to the site with those not up for a longer walk, while Freddie, Warren, Dominic and I set off on the more extensive walk around the entire tabletop.

By far the most exciting thing I see on top of Table Mountain is Mandy Patinkin. The legendary American actor (most famous for his role as Inigo Montoya in *The Princess Bride*) is currently based in Cape Town for the filming of the fourth season of *Homeland*. He is here on a walking trip with his wife (actress Kathryn Grody) and Adam Godley (whom I recognised as Elliott Schwarz from *Breaking Bad*), along with a few others whom I don't recognise. How exciting.

In the evening is the final jury meeting. The jury meets in a room

with no windows, so we are unable to spy as successfully as we did last year. Eventually we are texted the medal boundaries. Again, there is much rejoicing, wailing and gnashing of teeth.

## Saturday 12th July

*In which we hit the town, in which we fix up and look sharp, and in which we celebrate*

Another excursion will take place today. This will commence at an ungodly hour, so we have agreed to give ourselves some more time and to join the group by taxi. This strategy proves a hit. In town, we visit the impressive aquarium, as well as the marina. We take a joint group photo with our counterparts from the Democratic People's Republic of Korea.



*Delegates from a country notorious for infringing upon Human Rights pose with the North Koreans*

Half an hour after ordering fast food, we receive our meals and head for the buses. We are not yet in a rush, but perhaps I should have known better, based on the prevalent attitude towards service time in South Africa, than to buy a watch. Now we are in a rush. Luckily we're quite good at rushing,

and we catch the bus. Back at the site, we prepare for the closing ceremony by returning to our uniforms and preparing some gifts. I'm going to digress for a moment to tell you about this process.

One of the first IMO personalities we bumped into when we arrived at UCT was a large cube. It was made up of a wireframe cube of aluminium poles, and a fabric container with the design printed on to it. Each face was one of the colours in the Google logo, and the white face had the logo itself printed on. This design led us to call it the "google cube" and later the "gube". Being very large, it was difficult to do anything interesting with it, but it had several little siblings, one of which came in handy at the closing ceremony.

As is tradition, the UNKs will be handing out gifts to other contestants. This year's gifts are packs of cards. There are so many packs that we are able to give one to every participant, so we devise a plan to do so at the closing ceremony. We open the small gube, dismantle several cardboard boxes that have been used to deliver the cards, and line the walls and floor of the gube with cardboard for added support. Then we pack roughly 750 packs of cards into the cube, close it, wrap it in the Union Flag and begin the long trek to the Jameson hall for the closing ceremony. Needless to say, the gube is heavy.



The journey isn't all doom and gloom. We attract a curious crowd,

including the Ukrainians and the Aussies, wondering what is in the box and why it is so heavy. Not wanting to reveal our secret, I blurt out the first thing that comes to my head – Joe. This turned out to be a rather convincing lie. Joe’s illness has set in rapidly, so none of the other teams have noticed anything. Moreover, although Joe certainly wouldn’t fit inside the gube, he is very small, and the human brain has an immense capacity to hyperbolise. Gunning, dutifully explaining what he thinks is the situation to everyone in the vicinity, summarises as follows:

*“One: UNK1 is very small. Two: UNK1 isn’t here.”*

When we arrive at the Jameson hall we are greeted by a friendly security guard who lets us through with our unidentified 125kg package. Eventually common sense prevails and we are told to reveal what is in the box to the woman running the closing ceremony. Her message is a simple one: “no naked people, and no bombs”. Since our packs of cards are neither, we are happy to tell her the truth, but only on condition that she doesn’t share the good news with any participants.

The ceremony is almost as well executed as it was on Monday; the same compere keeps everything moving quickly, new acts are equally impressive, and today’s politician is more cheerful than the last. Unfortunately the stage is a bit cramped for the distribution of Bronze Medals. “Joyful Harmonies”, a really excellent choir, opens the proceedings with a memorable rendition of “Shosholoza” (friends with whom I spent two weeks in Spain at the beginning of August might wish that it had been slightly less memorable).

Throughout the presentation of the medals, one of the UNKs stands vigilantly by the cube, draped in the Union Flag, handing out packs of cards to every medallist. This proves harder than expected because it seems that in a lot of countries, extending an arm as far towards a person as possible with a pack of cards clearly visible in the corresponding hand while making eye contact with them and saying “congratulations” is not a well known way of communicating your intention to give them the cards. Never mind; the vast majority of medallists get a pack. After the ceremony, we enter the closing gala with the remaining cards and advertise them to deputy leaders, leaders, observers and non-medallists. Under a lot of pressure from the guides, we agree to allow them to take packs, and almost immediately find ourselves out of cards after about twenty guides take five packs each. We apologise to any participants who didn’t receive cards. Blame the guides.

The choir joins us again in the closing gala, which is down the road. We are surprised to discover that there will not be a sit down meal. At first this appears to be an interesting and admirable choice, but it leads to three problems. Firstly, people start heading off rapidly and the gala winds up

before it should. Secondly, it drastically reduces the amount of food people get, despite a well stocked buffet. You can't beat a plate. Thirdly, in the absence of food, other forms of sustenance become the focus, and the event becomes merrier than some might have foreseen.

A few weeks after the IMO, the UNKs receive an email (forwarded to us by Geoff) asking where the gubes were. On behalf of the team I would like to declare that we left our gube in the closing gala, that the Ukrainian team left one gube in our shower room, that I am not aware of the locations of any other gube, and that on the advice of counsel, I invoke my right under the Fifth Amendment not to answer any further questions.

## **Sunday 13th July**

*In which we execute a café crawl, in which we say many goodbyes, and in which we leave Cape Town*

Today is slow and somewhat depressing. We eat twice and play cards, and then head for the airport.

Frank flies straight to China, but we still have a seat for him. This massively relieves our legs; Geoff has an empty seat on one side and the aisle on the other, while Freddie and I strategically place Joe between us and divvy up his leg space à la Sykes-Picot. I spend the evening watching mediocre TV.

## **Monday 14th July**

*In which we get off the plane and in which we say our goodbyes*

I can think of literally nothing of interest to say about today other than that I recommend microchipped passports to everyone. I use mine for the first time at Heathrow and it is astonishingly fun. I should also congratulate Geoff, who once again entertains us all with a very funny certificate presentation ceremony. The goodbyes hardly need to be particularly dramatic, since we will be reconvening at the IMO lecture in September, and almost certainly many times after that in various combinations and at various training camps.

# Remarks

## 1 Scores

In line with previous student reports, I have undertaken to analyse the scores with ridiculous rigour. To start with, here they are:

#	Name	1	2	3	4	5	6	$\Sigma$	
1	Joe “Joseph” Benton	7	5	1	7	4	0	24	S
2	Gabriel Gendler	7	6	0	7	2	0	22	S
3	Frank “Asleep” Han	7	4	0	7	2	0	20	B
4	Freddie Illingworth	5	7	0	7	2	0	21	B
5	Warren “7 7 0 7 7 0” Li	7	7	0	7	7	0	28	S
6	Harvey “Even younger than Joe” Yau	7	6	0	7	7	0	27	S
7	Geoff “King of the IMO” Smith	40	0	1	42	0	0	83	P
8	Dominic Yeo	0	35	0	0	24	0	59	P
9	Min	5	4	0	7	2	0	18	B
10	Max	7	7	1	7	7	0	29	G

P=Participation, B=Bronze, S=Silver, G=Gold

I will start with UNKs 7 to 10. UNKs 7 and 8 are awarded marks for winning them in co-ordination. It is disappointing to note that despite both sweeping up a huge number of marks, neither was presented with more than a certificate of participation. UNK 9, the infamous Min, had a solid year, winning a Bronze medal for the second time in a row after a seven year medal drought starting in 2006. Since 1990, Max has won a gold medal every year; the winning streak continues despite our first year devoid of real gold medals since 2008. Worryingly, Max only just scraped a gold this year, thanks to Joe’s charity mark on question 3.

The most pleasing result of this year’s performance is that the three pensioners (myself, Frank and Freddie) were strictly beaten by the three youths. This bodes exceptionally well for the next few years; all three of Warren, Joe and Harvey will be eligible for Thailand and Hong Kong, while Joe and Harvey have a shot at Brazil, and Harvey might even go to Romania in 2018. If he does so, he will receive the IMO flag at the closing ceremony as part of the ritual introduction of the following year’s host country. None of the team will be eligible in 2019, but I’m sure many of us will be there in

other capacities.

Other notable properties of our set of scores:

With the exception of Warren, the scores were in reverse order of age. Apparently South Africa is No Country for Old Men.

For the second year running, Warren achieved a silver medal by earning full marks on all easy and medium problems and no marks whatsoever on the hard problems, hence the nickname “7 7 0 7 7 0” (which wasn’t quite short enough to catch on).

This year, three of the team had just finished school. Their destinations were Trinity College, Emmanuel College and Homerton College, all in Cambridge. The last time a team member did not go to Trinity was in 2004. The last time more than one team member did not go to Trinity was in 2000. The last time an outright majority of team members did not go to Trinity was 1996.

## 2 Thanks

Thanks go to:

- John Webb and the organisers of the IMO, who organised so wonderfully such a large event;
- The Australian team, who were excellent competition and better friends;
- Luke, who was a welcome addition to our training regime throughout the year;
- Oxford Asset Management, who have generously sponsored our training and our trip to the IMO;
- The UKMT, whose decades of excellent work has made the UK team what it is today;
- The myriad trainers who have taught at training camps; thanks in particular to Peter Neumann, Imre Leader and Richard Atkins, who host our training camps, and to Paul Russell, Joseph Myers, James Cranch, Robin Bhattacharyya, Vicky Neale, Vesna Kadelburg, James Gazet, Jack Shotton and the indispensable Gerry Leversha;
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- Jill, who was a wonderful companion at Oundle and the IMO;
- Dominic, who is a wonderful travel companion, a great friend, and a skilled deputy team leader;
- Geoff, who has been a great team leader since my first international competition, who is an excellent source of humour, an extraordinary diplomat, a good friend and who will certainly lead the IMO to new heights as its chairman;
- And finally the team, who were wonderful friends and travel companions, great walkers, excellent mathematicians, committed competitors, useful bridge players and ardent drinkers of tea.

### 3 An IMO Contestant's Apology

Perhaps my most vivid memory from the IMO was returning to Warren and Frank's room in UCT on Wednesday evening, having sat the second paper. Just as we had done every evening until then, and just as we had done every evening of every maths camp I had experienced over the past three years, we opened our pads, took out our pens and started work on some problems. As soon as I did so I teetered for a few seconds on the edge of a Kafkaesque existential crisis. The work I was doing was no longer useful; there would be no more olympiads, no more training camps, no more medals. There would certainly be no more need for Euclidean geometry, and I'm sure if I were ever to solve an inequality with Karamata again I would be laughed out of the room. So it was that for a few moments, I wondered whether the last three years of my life had been in vain.

I eventually convinced myself that they had not, and I'd like to tell you why, in an homage to G. H. Hardy's "A Mathematician's Apology". The first conclusion I drew was that competitions like this are valuable regardless of the mathematics they involve. Aside from providing a small boost to international co-operation and friendship, they introduce young mathematicians to people who might be recurring figures in their lives for many years. Mirzakhani and Avila, who recently won Fields Medals, might have met at IMO 1995; Gowers and Leader were colleagues on the British team in 1981, and have worked and written together since then. At Trinity in October, along with plenty of UK squad members, I will be reunited with three Australians,



two Dutchmen, a Hungarian and a Romanian, all of whom I met at an IMO or a related event.

The work itself might be described as “hobby maths”. A statement that we prove in competition is never particularly novel; it may not have been written down before appearing in the shortlist but it is comfortably within the reach of any serious mathematician, and often of any serious computer (as in the case of our geometry puzzles). On the other hand, the results we establish are secondary to the route we take to get there. The Olympiad, more than any other institution, rewards beauty, and finding a scenic route to a destination is in some ways as challenging as getting there.

I have often heard mathematicians compared to mountaineers. The challenge is to climb the mountain, and solve the problem; from that vantage point the next mountain, or theorem, comes into view. The better the surrounding region is known, the easier it might be to spot a route, but skill and experience are nonetheless required to make it across the ridge and up the rockface.

If this is the case, then the value of an olympiad becomes clear. We are not yet good enough to go out into unknown territory and climb without ropes to a seemingly unattainable peak, but we can certainly train for that by hiking around the known world. In doing so we often become surprisingly good walkers; the list of Fields Medallists, and even Senior Wranglers, with IMO experience is remarkable. Occasionally we discover corners of our territory as yet unvisited. The Olympiad’s most famous invention, Vieta Jumping, did not trigger a revolution in number theory, but it was certainly an insightful and beautiful idea. Most of all, we enjoy the walk, because although some of the paths we learn are rendered obsolete by a modern shortcut, although prize and glory sits atop some mountains and not others, and although some territory is charted and some is uncharted, in the end there is nothing but our mortal feet, and the immortal ground on which they tread.