

The Ups and Downs of Physics

Description

It has been an interesting week!

On May 2nd, I went to the university where I did my undergraduate degree, and held a workshop on science communication (as I mentioned in my [last post](#)). I also had a new post pop up on Scientific American entitled ["A True Duck Hunt" Interview with Donovan Hohn](#), and I was going to write about both of them, until I went to a popular amusement park on May 7th and experienced something that had never happened to me before.

But for you to understand it, I'll have to back up a little.

Approximately seven or eight years ago, I worked at that exact amusement park for two spring/summer seasons in the merchandise section. I had been to that park many times throughout my life, and had long enjoyed the samplings of roller coasters and other rides that were present. I hadn't been scared of a roller coaster for a long time, not since I was a child, and believed that it would be fun to work there.

As all employees did, I started out as a cashier in a store, and rapidly got promoted to cash lead within that first year and really enjoyed the job! The second year, I was promoted to a manager, but I did not have as good a time, and stopped after that summer. But, due to a variety of situations, I hadn't been back since.

So, I was looking forward to heading back and seeing what had changed and go on the new rides that had popped up the last number of years. And, it was a blast! Had a great time with the friends I went with, and went on tons of rides.

But then, at around 3:30pm, we went on a wooden roller coaster and just as we were about to go down the first hill it stopped. We just sat there in the car, at around a 45-50 degree angle; all the while a voice kept stating over the loud speaker that there was a "delay" and a "technical issue."



Where my friends and I were stuck, right near the very top of the first hill.

Really makes you wonder about the faith you put in the hands of the engineers and ride operators, doesn't it?

During this stop, I spoke with my friends about what it means, how long we were going to spend up there, and then the ride started again (total elapsed time was only about 5 minutes).

Now, I do not know if I was more conscious of the ride, but it was much bumpier than usual, even leading into the flat stretch leading to the platform. That was, until it stopped AGAIN.

This time, after three minutes, the ride attendants manually released our harnesses and had us venture along a rickety wooden walkway to the platform. I spoke to the manager there, and our compensation was a "front of the line" treatment of any coaster of our choice. After a brief discussion with my friends, we decided on the one close-by.

As we made our way up to the next ride, we were told that we would be seated at the very back on the next car. But, to our surprise, THAT ride broke as well. So, the manager told us we were now able to receive two "front of the line" treatments, but not before my friend asked if we could get a free ice cream sandwich in lieu of that. I proposed cash, but he rejected both.

We then made our way to the first of our new set of coasters, and were understandably nervous. After all, two rides had broken, and we were not feeling confident on the third time being the charm.

But, to all our surprise, the ride went off without a hitch. The ride was thrilling and totally alleviated any and all stress we might have had regarding the safety and maintenance of roller coasters at an amusement park.

The second of the "front of the line" coasters was one of the busiest in the park, and we had visited it much earlier in the day. This time, sitting in the back, we all strapped in and made jokes until the ride started up the first hill.

You could tell that all of us were thinking the exact same thing: Please don't break! And it didn't.

But what did happen was just as interesting.

As we went up the first hill, the drop following was a nail-biting 75 degrees and the cars quickly accelerated to approximately 125 km/hour (or 77 mph) for over 3 minutes, according to the ride's website. Quite a ride!



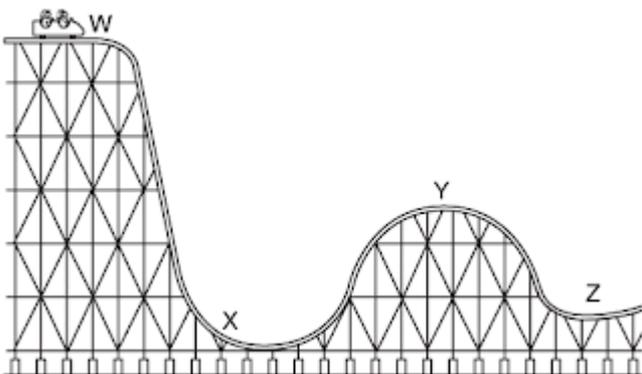
Watch out for that first step â€¦. itâ€™s a DOOZY

The first time I had gone on it earlier that day, it was an exciting ride. But this time, seated at the very back, it was much more intense. For a brief moment, as I came out of the first drop, black spots appeared in my vision from the intense G forces.

It was a thrilling and adrenaline-pumping ride, which afterward left my friends and I utterly exhausted. It was just that draining.

But, it got me thinking about the physics of it all.

When the car is pulled up the hill on the track, it slowly builds up **potential energy** (stored energy) that will be converted to **kinetic energy** (motion) once it falls [see point W on the picture below]. Therefore, when the car reaches the top of the hill and begins its descent, all that stored energy is converted into the energy of motion, helped along by our old friend gravity [point X].



A roller coaster at the top of the hill (W) has an abundance of potential energy, but no kinetic. But, after the first drop at point X, all the stored (potential) energy is converted into the energy of motion (kinetic). Approaching point Y, potential energy is regained as kinetic is lost, which then is switched at point Z.

Basically, each loss in height corresponds to a gain of speed (potential to kinetic), and each gain in height corresponds to a lack of speed (kinetic to potential).

As you begin to fall, that momentary sensation where you are lifted out of your seat is known as **negative G forces** (or negative Earth's gravity), where you experience the sensation of feeling like you weigh less than usual. In contrast, when you come out of the dive and go up the next hill, you experience **positive G forces** (or increased Earth's gravity) and feel you weigh more than normal.

The best way to think about it, at least for me, is by using the example of NASA's infamous "Vomit Comet," which trains astronauts how to handle zero G situations, such as being in space.

What they do is fly in a series of parabolic arcs, similar to those that a roller coaster experiences. The only difference is that it is much, much faster, and so the G forces you feel are more pronounced and sustained.

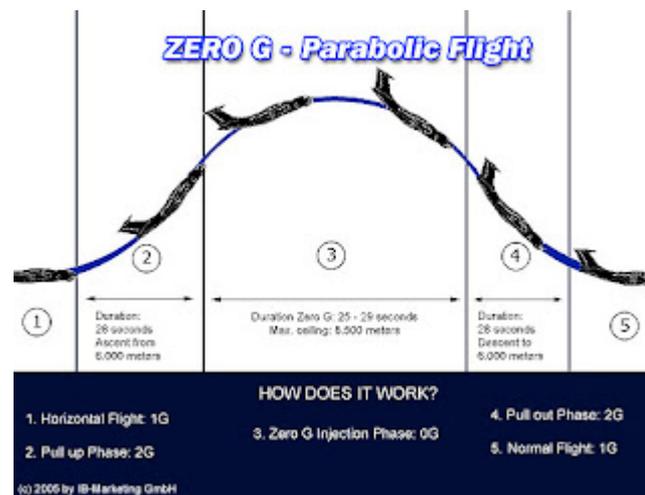
But, for every yin there is a yang, and when the plane goes up, you experience the proportional positive G's.

For example, if you weigh 150 pounds, and go up on the vomit comet, on a stable and level flight, you would weigh 1G (or Earth's gravity), or 150 pounds.

When you begin to go up the arc, you will experience 2G (or double the Earth's gravity) and it will feel like you weigh 300 pounds.

But, when you approach the top of the arc and begin to go down, you will experience 0G (known as weightlessness) and will weigh 0 pounds.

And then the whole process begins again.



Provided by: [SpaceTravellers](#)

There are other forces acting upon you during a roller coaster ride as well, such as centripetal and centrifugal forces, which help you stay in your seat instead of falling out during a loop-de-loop.

Centrifugal forces are pushing you to the outside of the loop (this is what you feel when you go around a sharp turn and your body is thrust away from the direction of the turn), while **centripetal forces** are balancing those outward forces and keeping you in your seat throughout the loop – even if your stomach may be left on the starting platform.

In fact, most rides that have loops would be safe without restraining devices, based on the physics alone. Luckily for us, there are laws against that, so engineers and designers of coasters need to have

them equipped on all rides to keep everyone safe in the event that something does go wrong.

So, the next time you are screaming your lungs out as you plummet to the Earth on a steel or wooden track, give a quick shout out to physics for making it all possible.

I would like to thank the lovely and talented **Summer Ash**, an astrophysicist (who can be found [here](#) on **Twitter**). She was invaluable in helping me remember my Grade 12 physics, and made sure the science and explanations made perfect sense.

Category

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Author

mrmanly2hotmail-com

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