
ERWIN AND MAXWELL TAKE ADVANTAGE OF SUPER CHEAP SEATS IN "DEPRESSURIZED COACH."
I HEAR PEOPLE IN FIRST CLASS GET COMPLIMENTARY AIR PRESSURE WITH THEIR CHAMPAGNE.

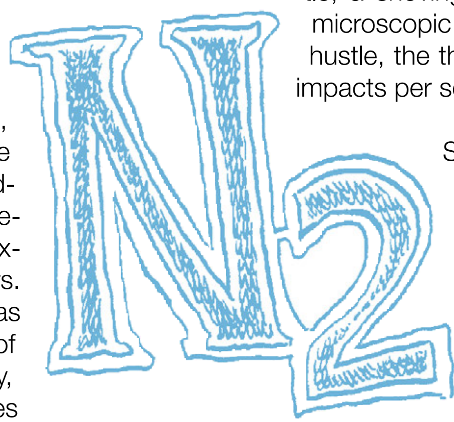
Vacuum and Air Pressure

Molecules on the Move

Some things are so ubiquitous, we forget that they are there at all. Air is one of those things. We breathe it, and it keeps our bodies from popping (and freezing). But the instances we are aware of the air around us, are usually those which involve the air pressure – or more specifically the change of it. Let it be the whirring of the vacuum cleaner, the popping of our ears when we sit in a plane, or just hearing the sound of laughter; air pressure is a central part of our lives, whether we are aware of it or not.

But What Is Air Pressure, Precisely?

First of all, what is commonly referred to as "air" is actually a mixture of several elements, all in their gaseous state. The major part of it, nearly four fifths, is nitrogen. More specifically, two nitrogen atoms bonded together. The next common element in the air, about one fifth, is oxygen – also bonded together in pairs. Roughly one percent is the noble gas argon, and about four hundredths of a percent is carbon dioxide. Finally, there is a large host of other gases which appear only in traces.



Crashes in the Air: Molecules on Speed

All of these air molecules don't just float – they whizz around with enormous speed. Nearly a thousand miles per hour is what an air molecule has on its odometer, on average! But they cannot enjoy a quiet ride for very long – the air molecules around us can only fly about a couple of nanometers, before they bump into another one. Well, these little buggers are sturdy, and such a collision doesn't break them. It just changes their direction, which is why the air around us can be thought of as the world's largest pinball machine – with billions of trillions of tiny playing balls!

So even on a lovely day, when the air seems to stand still, what is actually going on is a tumultuous hustle, a shoving and kicking of uncounted, microscopic molecules. And we feel this hustle, the thousands upon thousands of impacts per second – as air pressure.

So air is actually a quite dynamic substance, and this is why air appears to try to even out any differences in air pressure, whenever possible. If there is a lower air pressure somewhere, this means that there must be fewer molecules in that region, compared to everywhere else. Now imagine an analogy: picture a crowded room full of people, continuously bumping into one another. Then think of what would happen if you removed, say, one of the tables in this room. Suddenly, there would be an empty space, without any

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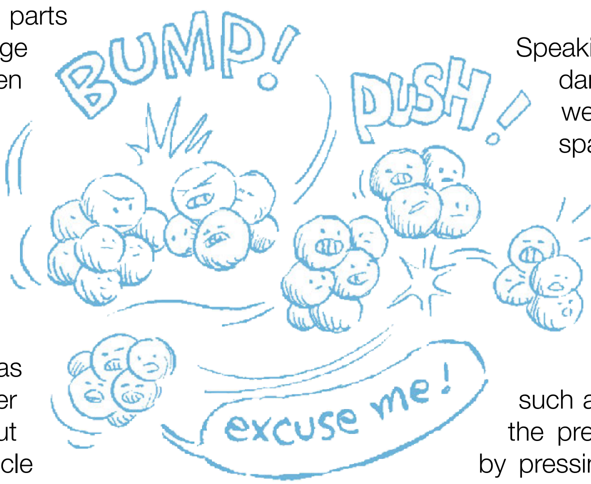
people in it. But soon, the first person would be pushed into the free space, and then another and another. Without any conscious effort by the people in the room, the empty space would be filled immediately. It's the same with differentials in air pressure: the air molecules don't specifically try to spread out evenly, it just happens automatically because of all the continuous bumping off of one another.

The Air Gets Thinner at the Top

There is one exception for this: the higher above the surface of the Earth you are, the lower the air pressure becomes. Why is that? Well, because of gravity, of course!

To understand this, it's crucial to realize the molecules in the air don't all have the same energy! By constantly bouncing off of one another, the molecules exchange some energy, granted. But here is a central fact of physical systems with many, many individual parts which constantly exchange energy: In the long run, when they are all in equilibrium, they won't all have precisely the same energy. Rather, some of them will have more, and some of them will have less, on average. Because of the constant energy exchange, which particle has more energy than the other will change very quickly. But the fact that some particle will have more energy than the average will always be the same. The same statement also holds for those which have less energy than the average.



So in fact, the distribution of energy among all the different air molecules will not change over time. There will always be some which have more energy than the others, and it's those particles, which can be also found higher up in the atmosphere. To run up against the pull of gravity, you need quite a lot of energy, and the more you have, the higher up you can go. Very high up, there are only those particles with the most energy, and there are very few of those. This is why the air gets thinner and thinner the higher up you go. For every five miles you are above the ground, the pressure in air drops by roughly three quarters. So there is no height at which the atmosphere just stops – rather, the air gets thinner and thinner and thus turns continuously into vacuum.

"Out of the Airlock with Him!"

Speaking of the vacuum – how dangerous is it, really? If one were to be kicked out of a space ship without any protective clothing, what would happen?

Well, one immediate thought would be that one should explode: The human body is made in such a way that it can withstand the pressure of the atmosphere, by pressing with a similar pressure from the inside, to reach an equilibrium. If the pressure from the outside is suddenly gone, shouldn't that internal pressure inflate, and finally pop a human body?

Actually, the fate of such an unfortunate person would not be quite as grim: The whole weight of the air onto our skin is only a few hundred kilograms. While certainly not very pleasurable, the human body – most importantly our skin and our arteries – are strong and flexible enough to withstand that. There is a part which would be ruptured immediately though: our lungs! Consisting of thousands of very fine bubbles, the difference in pressure would certainly rupture the lung of somebody being kicked out of an airlock. So first rule of surviving as long as possible in space: exhale! Then you might, in fact, survive a bit longer.

It would take a few seconds until your body would have used up all of the oxygen still in it. So, before you would become unconscious, there would still be enough time to realize how your body would expand a bit – but not burst! With no atmospheric pressure to hold them back, gases and fluids would begin to leave your body. Jim Le-Blanc, an astronaut who was accidentally exposed to near vacuum in 1965, reported that he could feel the saliva on his tongue boiling away. It wasn't hot, just going into the gaseous state, as if there was sparkling water in his mouth. By the way: LeBlanc was rescued after a few seconds, after he lost consciousness. He completely recovered, so our body seems to be sturdier than one would expect.

The accounts of several accidents (and, unfortunately, also animal experiments), revealed that the maximum time someone could be exposed to the vacuum and still survive, is about two minutes, one expects. But remember to exhale!