WHY IS THERE AIR?

BY

ALAN MALONE

A few years back, Bill Cosby's girlfriend, who was a philosophy major, posed the question, "Why is there air?" I never fully realized the importance of that question until I spent nine years skydiving and then got a job as a physics teacher and had to learn a bunch of equations about accelerated motion.

Then I finally understood why there is air. It is to keep skydivers from falling too fast. The standard duration of a free-fall jump, at least back when I was casting my body out of airplanes, was thirty seconds. We would get into a small airplane that would climb to 7200 feet above the ground, whereupon we would jump out, fall for thirty seconds, and then open our 'chutes, with about ten seconds left over to take care of emergencies.

If it were not for air, we jumpers would have had to get up to about fifteen thousand feet, or the better part of three miles and we would have accelerated downward for thirty seconds at 9.8 meters per second squared, just like everything else that falls freely near the surface of the earth, if you don't count air resistance.

What's more, we would have built up a downward velocity in the neighborhood of 660 miles per hour, or about 86% the speed of sound. I guess that would have been all right with the neighbors, since it takes around 768 miles per hour to create a sonic boom. (It also takes air to make a sonic boom.) But, from

the standpoint of the jumpers, I can think of two major objections to jumping without air:

- The parachute wouldn't open. (I guess that's good – Imagine what the opening shock would feel like!)
- The airplane wouldn't fly without air. The motor wouldn't run, and if it did, the wings wouldn't work.

Now, I must candidly admit that the airplane is not my business. It's somebody else's problem to get me up there. And the problem of hypoxia at 15000 feet would not affect us, since we'd already have suffocated from lack of oxygen if there were no air.

So anyway, if you're someone like me who takes time to be thankful for things, be a little thankful for air.

What actually happens to a jumper is that he *floats* down from his jump altitude. As he exits the plane, he already has a forward velocity of around sixty or seventy knots, the speed that most jump pilots use on jump run. When he turns loose of the wing strut, he probably starts accelerating downward at pretty close to 9.8 m/s^2, just like the book says, since his initial *downward* velocity is zero (provided that he has a good jump pilot who knows how to maintain altitude on jump run).

Believe me, when you turn loose of that airplane, you really go *down*. At one time, a bunch of us got to speculating how close we were coming to hitting the tail of the airplane during

our exits. So we tried to reach up and slap the horizontal tail as we left the door. Nobody was able to touch the tail. Then (this is *so* typical of jumper psychology!) somebody procured a broom stick, and we tried to hit the stabilizer of the jump ship with that. Nobody ever got close. We concluded that the rate of downward acceleration was immense.

Assuming that the initial second is spent accelerating downward at around 9.8 m/s^2, consider the speed at which anything is dropping after that first second. Look up at the ceiling of the room you're in right now. It's probably around 10 feet high. That's just a little less than two thirds the vertical distance covered by this jumper every second, at the end of his first second of free-fall. And it's all downhill from there, to coin a phrase.

As you continue to pick up downward speed, however, the air through which you are falling starts to do its job. Air is made of a bunch of little bitty particles called molecules. They are very tiny, but that makes no never-mind, since there are a lot of them. The number of air particles in a volume about like the pillow on your bed is about six million times as big as the *age of the universe in seconds!*

Wow, Mr. Science – I'm sure glad I took physics instead of biology!

So anyway, you run into a bunch of particles as you fall, and the faster you go, the more you run into per second; and what's more, the harder you hit them. The net effect is that, as you continue to build up speed, the air resists further acceleration according to the square of how much your speed increases. Like, if your downward speed triples, the resistance

of the air increases *nine* times. If it increases five times, the air resistance increases *twenty-five* times.

To cut to the chase, when a skydiver of average density has fallen for about twelve seconds, the air resistance becomes so great that he quits accelerating. He has reached what we call *terminal velocity*, the fastest speed he can attain in the normal position, belly to earth and arms and legs hanging out to the four corners. In other words, he is lying on the air, as he may lie on an air mattress out on the beach. The sensation, except for the immense blast of wind, is that of floating in a pool of water.

Now comes a problem for beginners. There is no source of stability in freefall except for a total symmetry of body position. The tiniest amount of difference in air drag between your left side and your right side creates instant roll. If your feet resist the flow of air more than your head, or vice versa, you will pitch. Worst of all, if your body is twisted or bent, you will immediately begin to turn.

So, from the very first jump, the novice is instructed to reach for the corners. While he's standing in front of his instructor, he is told to arch his back as much as he can, and to reach his arms and legs out. This is the initial stable, face-to-earth, position, called the cross. It pretty well takes care of the pitch and roll problems, but the turn conundrum is a different story.

In the initial jumps, the 'chute opens almost immediately, so the body doesn't have time to accumulate much downward velocity. But shortly after a student makes his first free-fall jump, which is what is called a "jump and dump," he is told to hold the spread position for six seconds before pulling the

ripcord. This is the first time the air has a chance to do its thing to his otherwise stable fall.

What happens to most jumpers at this stage is that they start an uncontrolled turn, and the chute comes out with twisted risers, sort of the same effect you get sitting on a kid's swing and winding the chains up over your head. After the canopy inflates, it forces the lines and/or risers to untwist, and the jumper gets a few swirls to add to the thrill of the moment.

By the way, six seconds is a heck of a long time for a beginner in freefall. Something happens to the human brain in times like these, and subjective time is dilated by a considerable amount. Subjectively, the jumper experiences what usually feels like a much longer time during which he's falling freely. I'm pretty sure this is a psychological phenomenon, since I've done the calculations, and the jumper is not near enough to the speed of light to experience the effects of special relativity.

Anyhow, as he gains experience, the beginning jumper jumps from increasingly higher altitudes and delays pulling the ripcord longer and longer. At this stage of the game, I was having persistent problems with uncontrolled heading changes. Apparently I was twisting my torso, or my arms were not reaching out symmetrically, or something like that. I was not going anywhere near terminal velocity, and I was already "zeeing out," meaning that I'd have to enter the letter Z in my logbook, meaning uncontrolled freefall.

At this time there was a program on T.V. called *Ripcord*. All of us jumpers watched it religiously. It had a lot of freefall footage, as the heroes defeated the bad guys by skydiving at them. In one episode I particularly remember that the bad guys

were escaping with the bank loot in a single-engine Cessna. The good guys, in another Cessna that had the door removed for jumping purposes, flew up above the bad guys' Cessna and one of the jumpers climbed down onto the tail of the bad guys' airplane.

He reached down with his hand and wiggled the elevator. The bad guy flying remarked that there seemed to be something wrong with the plane. Then the good guy, who was now straddling the rear of the fuselage like a horse, hollered to him that he was going to make them crash if they didn't give up immediately.

The bad guy agreed to land at the nearest airport and surrender to the authorities, whereupon the good guy, the jumper, rolled off the back of the airplane and skydove to safety.

Well, as I said, it had lots of freefall footage, and we all enjoyed watching it.

During Hurricane Betsy, so legend has it, one of the club members decided to evacuate. He threw his jump gear and his television set into the trunk of his car and took off. It wasn't till he had reached Kenner that he remembered that he had left behind his wife and two kids. That's a true story.

So one evening I was watching *Ripcord*, and the cameraman was filming one of the skydivers from behind. I got a good close-up of the guy's leg position, and noticed that he raised one of his feet. I didn't know why he had done that, and none of my instructors had mentioned foot-raising as one of the options for directional control. But I stored the episode in my memory banks.

A week or so later, I got word that some guys were jumping in Hammond, Louisiana. I drove up there and unloaded my parachuting rig. There was a plane there and about half a dozen jumpers. Nobody from our club was present. I was kind of on my own.

The next jump was going to be a 20-second delay from 4500 feet. I had never been to terminal velocity before, much less delaying my opening by that long. But *these guys didn't know I was just a student!*

I thought it might be interesting to try a delayed freefall, and 'chuted up with the rest of the guys on the lift. I figured, what the hell, if things got too out of control, I could pull high and ride my canopy down. There wasn't enough wind that day to blow me too far away from the target.

I made a stable exit, hit an arch and started falling. Several seconds into the jump, I started drifting around to the left. My instructors had been telling me to bend my body in the opposite direction when this stuff started, and I had been trying to do that, without success.

I wasn't turning very fast, but I also wasn't having any luck arresting the turn. Then I thought about the *Ripcord* guy. I was disgusted enough at this turn of events (to coin a phrase) to try just about anything at this point, so I raised my right foot.

Immediately the left turn stopped. In fact, I started turning a little bit to the right. So I lowered my right foot a little bit and raised my left foot. It worked. I was overcontrolling, but for the first time, I had a sense of directional control.

Shortly after that, I experienced my first terminal velocity opening shock, which wasn't as bad as everyone said it was going to be, and I rode the 'chute down to the ground with a great feeling of satisfaction. As I recall, I made two more jumps that day, one from 7200 feet, a thirty-second delay. It seemed like an eternity, with my dilated time sense, giving me a whole lot more freefall for my money than I had ever experienced before. As I continued to work my leg trick, I started to get the hang of it, and my body, bit by bit, relaxed into what they call the "frog" position used by experienced jumpers.

So that's how I got stable. In years to come, I used the leg raising trick with my students, and they all made rapid progress in gaining control of their bodies in freefall.

It's been over forty years since I've made a jump. I think it must be like riding a bike, though. I doubt that I'd have any trouble with stability if I made one more jump as a bucket-list item. The bones are more brittle than they used to be and I have arthritis in my hands, my back, and my left knee. I've probably spent enough time in plaster for one lifetime; but George Bush celebrated his eightieth birthday with a sport jump. Who knows, with the help of my friend the air, I may have just one more jump in me.