The science of re-entry

After six months of living and working on board the International Space Station, astronauts have to make their way back down to Earth. Three of them cram into the Soyuz capsule, with not much more room than the back seat of a car, and drop the 400 kilometres out of orbit and back down to Earth.

After the capsule detaches from the space station, a quick blast on the thrusters slows it down and gravity does the rest, pulling it back to Earth.

The capsule slows from about 28,000 kilometres an hour in orbit, and drops into the earth's atmosphere, streaking across the sky at 800 kilometres an hour. And this is a pretty bumpy ride and one of the most dangerous parts of the mission.

We have to get the re-entry angle just right. Too shallow and the capsule will bounce off the atmosphere like a skimming stone and off out into space. Too steep, the capsule will burn up on re-entry.

Even getting the angle just right means the capsule glows white hot, which is why it has a special protective heat shield, and this is because of friction with the earth's atmosphere.

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It's just the force of gravity that brings the astronauts back to Earth. As Isaac Newton may have once said, "what goes up must come down". But slowing the astronauts down, well that's a completely different matter - how on Earth do you stop something that's travelling at 17,000 mph?

Well, to be honest with you, it's the earth's atmosphere that does most of the work. As the craft enters the atmosphere the air rushing past the craft creates friction, and that force, which is also known as 'air resistance' or 'drag', that slows the aircraft down.

But if something rubs past another object fast enough, like air whooshing past a spacecraft at high speed, then things are going to get extremely hot, because friction creates heat.

Just like, you know when you get your hands and you rub them together really, really hard, then they get hot as well.

Now people in the olden days used this idea of friction creating heat to rub sticks together to make fire. But that used to take a long time, so instead I'm going to use this drill and I'm going to do it on this little bit of wood and see if we can create some heat.

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So what we can see with our heat sensitive camera is that as the drill whizzes round it rubs against the plank so much that it creates enough friction and heat to create the smoke.

There you go... can you see the smoke that's coming off… just there… now that is because the heat is being created by the friction… the friction of the drill rubbing on the wood… and I can smell the smoke as well from here.

So there you go - friction creates heat.

So if like the astronauts' capsule, you're travelling through the earth's atmosphere, things do get extremely hot, over 1600 degrees Celsius, that's hot enough to melt steel!

And for the final few miles the astronauts have another trick to help them. The capsule unfurls huge parachutes. The largest is 10,000 square metres – about as large as four tennis courts – a massive surface area that catches the air, acting like a natural break. This slows the craft down to a safe speed, bringing the astronauts safely back to Earth.