



Why are astronauts weightless in space?

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Here's the surprising truth: astronauts on the International Space Station experience about 90% of Earth's gravitational pull. The ISS is only 400km up — barely a scratch on the surface compared to Earth's 6,400km radius. Gravity up there is almost the same as on the ground. So why do astronauts float?

Because they're in free fall. The station, and everything in it, is falling towards Earth constantly — but moving horizontally so fast that they keep missing. They and the station are falling at exactly the same rate, so relative to each other, there's no gravitational force felt. It's the same as jumping off a diving board: for the moment you're falling, you're weightless. The astronauts' weightlessness is permanent only because they never stop falling.

Stand in a lift. When the lift accelerates downward rapidly, you feel lighter — your feet press less on the floor. If the cable snapped and the lift fell freely, you'd float off the floor entirely — free fall, zero effective gravity, until impact. The ISS is a lift in permanent free fall, just moving sideways so fast that it keeps missing the ground. Weightlessness isn't the absence of gravity — it's the absence of anything opposing your fall.

What does long-term weightlessness do to the body?

Without gravity resisting movement, muscles and bones don't need to work as hard to hold you up. Over months, they deteriorate. Astronauts lose muscle mass and bone density at rates far faster than on Earth. Fluid shifts upward in the body (without gravity pulling it to the legs), causing puffy faces and increased pressure in the skull — which may contribute to the vision problems many astronauts develop. To slow these effects, ISS astronauts exercise 2 hours a day, 6 days a week, using specially designed resistance equipment. Even so, returning astronauts after 6-month missions often can't walk unaided for the first few days.

What about deep space?

For future missions to Mars (a 7-9 month journey each way), the health effects of extended weightlessness are a serious problem. Proposed solutions include rotating

spacecraft (creating artificial gravity through centrifugal force) and pharmaceutical interventions to preserve bone and muscle density. These are active areas of research — and among the reasons why Mars missions are more difficult than simply building a bigger rocket.