Why are the orbiting astronauts weightless?

Wrong answers:

~~There's no gravity because there's no air.~~

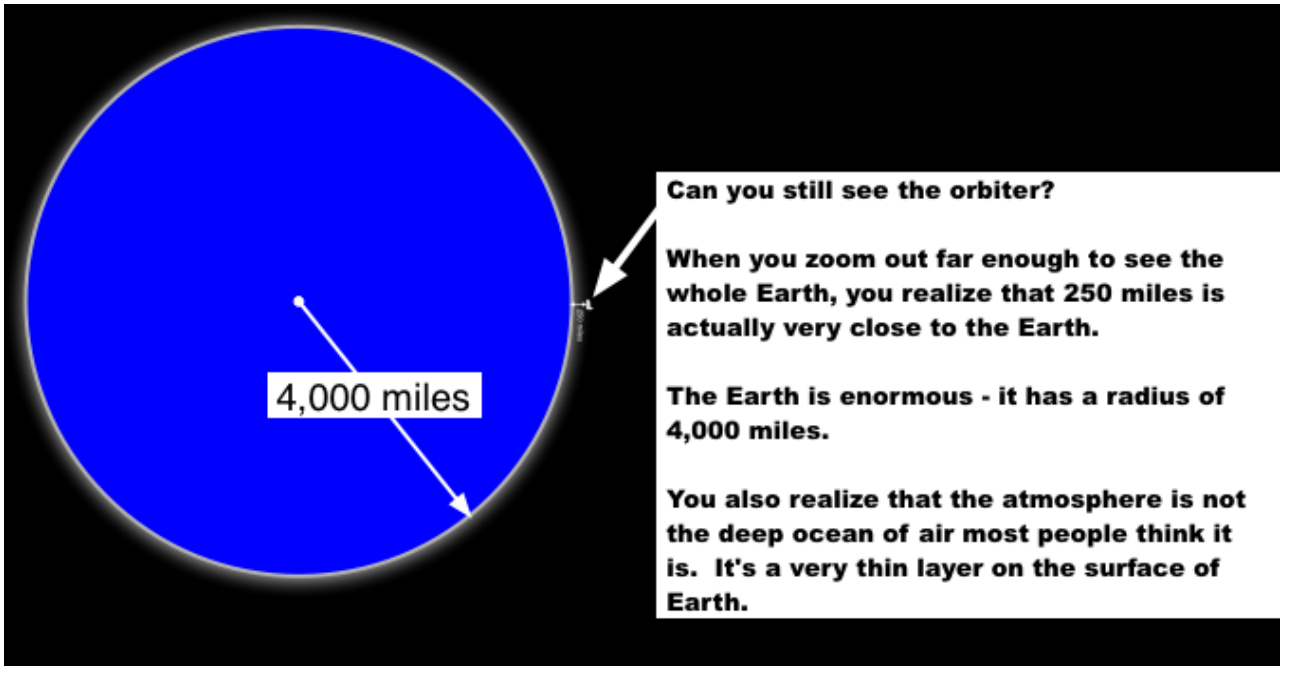
The moon has no air and still has gravity.

~~There's no gravity in space.~~

Then what holds the moon in its orbit, or the Earth in its orbit?

~~They're really really far away~~

Nope. See next page.



So why the heck are they weightless?

Have you ever been in a car that goes too fast over a hill and you catch a little air?

Or ridden in a free-fall ride?

Describe that feeling of falling.

Coincidence! That's the feeling of weightlessness.
The astronauts get that feeling 24/7.

THOUGHT EXPERIMENT: you're in an elevator, holding a bag of groceries. You push the button to go down and SNAP! the cable breaks. As you begin to fall, you feel that weightless feeling, scream and let go of the groceries. Do they…

- ☐ Go up.
- ☐ Go down.
- ☒ Stay where they are because they fall with you.

HINT: Do heavier objects fall faster than light ones if drag is not a factor?

Things fall at the same rate if air is not a factor. The bag seems to hover in front of you, as if weightless.

Same thought experiment. What if you were standing on a scale - what would it read?

- ☐ More than your weight.
- ☐ Same as your weight.
- ☐ Less than your weight (but not zero.)
- ☒ Zero.

Things fall at the same rate if air is not a factor. So your feet aren't really pressing onto the scale at all.

So many coincidences!

Zero-g feels like Free Fall.

Things in Free Fall hover as if weightless.

And scales read zero in Free Fall

Zero-g is not a space thing.

It's an orbit thing. How do we put something in orbit?

When you throw something to the side, gravity bends its path downward into a curve.

But the Earth is round!

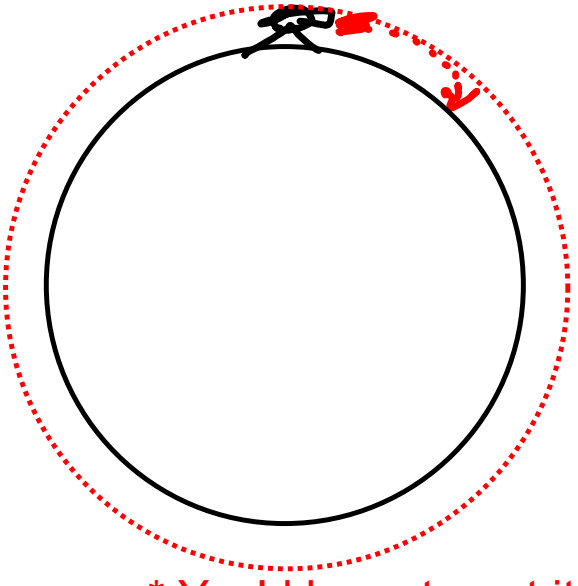
How hard would you have to throw so that the curve downward matched the Earth's roundness?

Newton's Cannon

(A late 1600s thought experiment)

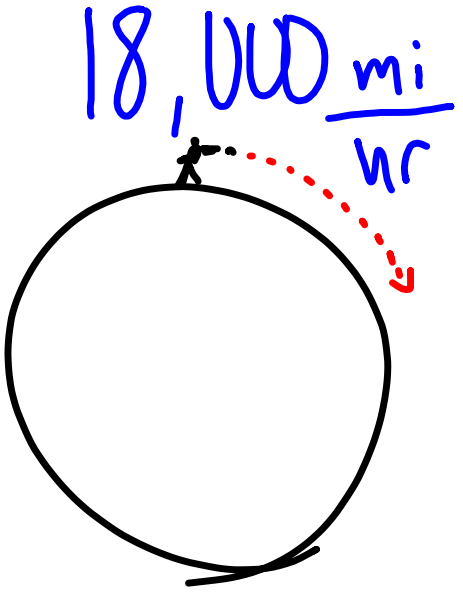
Newton calculated that an object shot at

18,000 mi/hr



would have a path whose curve matched the curvature of the Earth. It would fall AROUND the earth FOREVER.*

* You'd have to get it out of the atmosphere first. At those speeds, it would burn up due to drag.

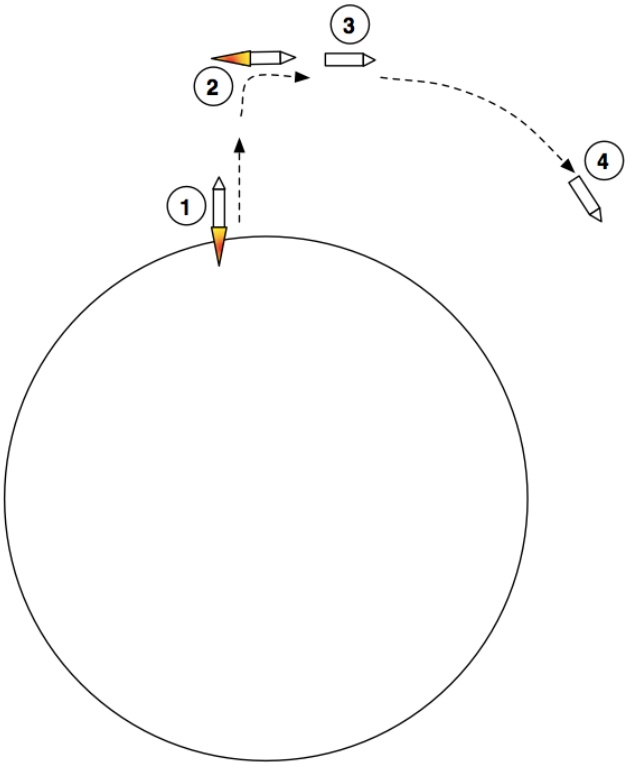


Orbit is free fall...

AROUND the Earth at just the right speed to never hit.

Of course, in Newton's time, they had no way to get an object to 18,000 mi/hr, let alone get it out of the atmosphere.

How do we put something in orbit?



1. Get up out of the atmosphere.

2. Aim to the side and get to 18,000 mi/hr

3. Shut off the engines.

4. Fall - around and around the Earth.

Orbit is Free Fall...

...around the Earth at just the right speed to miss.

Free Fall looks and feels just like zero-g (weightlessness.)