

# HOW THINGS FLY IN SPACE



I'M ANDREW. I'M AN **EXPLAINER** HERE AT THE MUSEUM. LET ME EXPLAIN SOME OF THE FASCINATING FACTS ABOUT GETTING TO AND MOVING AROUND IN SPACE.

**Beyond Earth's atmosphere, only two forces affect flight: weight and thrust. In the vacuum of space, there is no air. Without air there is no air pressure to create lift and there are no air molecules to cause drag.**

## Weight

Are you weightless in space? Not really. Weight is the force of gravity acting on the mass of an object. Although we talk about astronauts experiencing weightlessness, objects in space have mass and the force of gravity affects them. In fact, gravity is what holds a spacecraft in orbit. Without gravity, the spacecraft would fly off in a straight line.

If gravity is pulling on an orbiting spacecraft, why doesn't it fall to Earth? The spacecraft is falling, but it is moving forward as fast as it is falling. The path of an orbiting spacecraft matches the curve of the Earth. Even before space travel, Isaac Newton imagined shooting a cannon ball from a mountain fast enough for it to move beyond the Earth before it fell to Earth.

## COMPARISON CHART

IF YOU WEIGH 70 POUNDS HERE ON EARTH, YOU WOULD WEIGH:

About 26 pounds on Mercury



About 63 pounds on Venus

70 POUNDS ON EARTH



About 12 pounds on Moon

About 26 pounds on Mars



About 165 pounds on Jupiter



About 74 pounds on Saturn



About 62 pounds on Uranus

About 79 pounds on Neptune



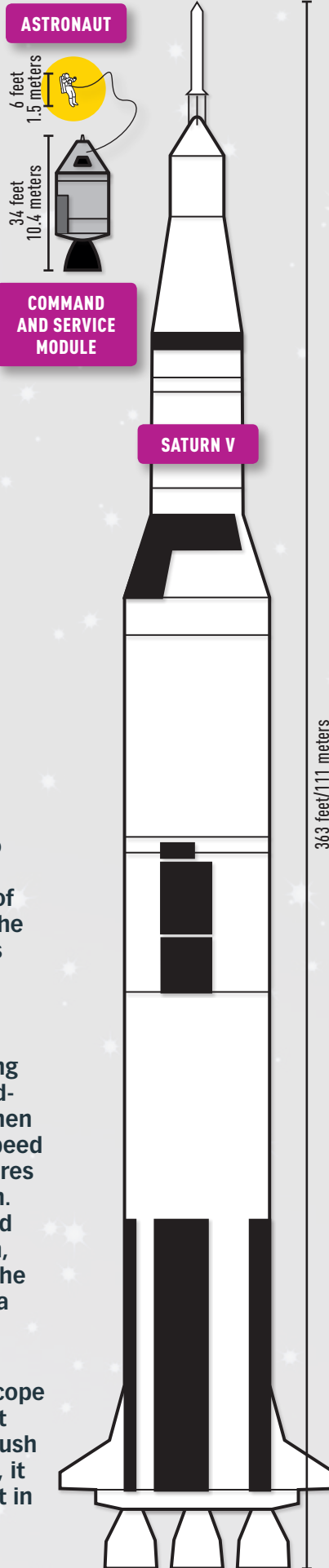
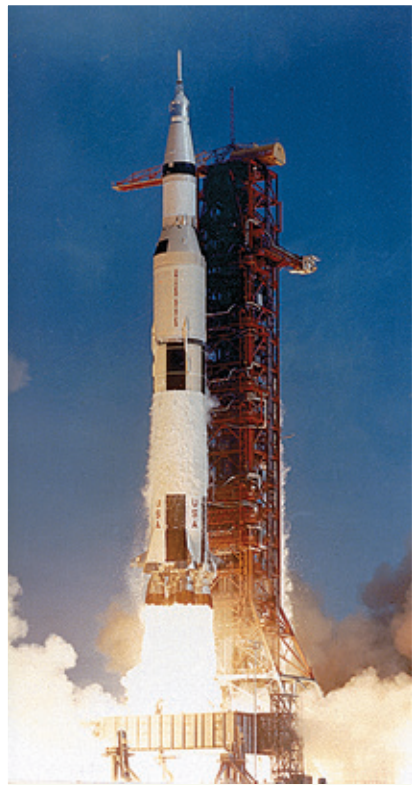
About 5 pounds on Pluto

AND, ABOUT 1,895 POUNDS ON THE SUN!

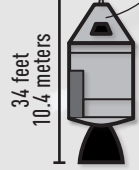
## CHECK IT OUT!

TRY OUT NEWTON'S CANNON AND LEARN WHY YOU ARE NOT REALLY WEIGHTLESS IN SPACE.





ASTRONAUT



COMMAND AND SERVICE MODULE

SATURN V

363 feet/111 meters

## Thrust

Spacecraft use rocket engines to create thrust. By firing a thruster in one direction, a spacecraft will move in the opposite direction. To rotate, the spacecraft fires a pair of thrusters located on the sides of the spacecraft. To stop rotating, the spacecraft fires a pair of thrusters aimed in the opposite direction.

Thrusters can be used to change speed. When traveling through space, a spacecraft fires rear-facing thrusters to speed up and forward-facing thrusters to slow down. When in orbit, things are different. To speed up while in orbit, the spacecraft fires a thruster in the forward direction. This drops it into a lower orbit, and increases its speed. To slow down, the spacecraft fires a thruster in the rear direction. This pushes it into a higher orbit, and slows it down.

Spacecraft sometimes use gyroscopes to maneuver. A gyroscope is a device with heavy wheels that spin very fast. If there is a small push on the gyroscope in one direction, it will resist and push the spacecraft in the other direction.

### CAN YOU FIND THIS?

SEE IF YOU CAN FIND THE THRUSTERS ON THE APOLLO 11 COMMAND MODULE, COLUMBIA, LOCATED IN MILESTONES OF FLIGHT (GALLERY 100), OR ONLINE.



How do rocket engines work? Unlike jet engines, rocket engines don't need air. There is an oxidizer inside the rocket engine that helps fuel burn. When the oxidizer and fuel are ignited, the engine produces thrust. With no drag to slow it down, the spacecraft will keep moving in the same direction.

The Saturn V rocket was used to send astronauts to the moon.

Do you **SEE HOW SMALL THE COMMAND MODULE AND ASTRONAUTS ARE** compared to the rocket? That's because it requires that much power to send even small objects into space!

The Saturn V rocket was packed with fuel and engines that created awesome thrust to push the Apollo spacecraft into space. In fact, when it was full of fuel it weighed more than about 400 elephants and held enough fuel for a car to drive around the world 800 times!

### TAKE A LOOK!

SEE A FOUR-FOOT-HIGH MODEL OF THE SATURN V ROCKET IN THE JAMES S. MCDONNELL SPACE HANGAR AT THE NATIONAL AIR AND SPACE MUSEUM'S STEVEN F. UDVAR-HAZY CENTER, OR ONLINE.

