



# How GPS Knows Where You Are

Satellites, atomic clocks and a little help from Einstein

# The system by the numbers

31

working satellites,  
about

12,550

miles up

2

trips around Earth  
each day

4

satellites needed for a  
fix

The system is run by the U.S. Space Force and is free for anyone in the world to use.

# How your phone finds itself

1

## **Each satellite broadcasts the time**

From an onboard atomic clock

2

## **Your receiver notes when each signal arrives**

The delay tells how far away the satellite is

3

## **Three distances pin your position**

Like circles that cross at one point

4

## **A fourth fixes your own clock**

Your phone's clock isn't accurate enough alone

# Einstein keeps GPS honest

## Two effects on the clocks

- Fast-moving clocks run slow (special relativity)
- Clocks in weaker gravity run fast (general relativity)
- Together, satellite clocks gain about 38 microseconds a day

## Why it matters

- Light travels about 7 miles in 38 microseconds
- Uncorrected, positions would drift about 6 miles a day
- Engineers set the satellite clocks slow before launch

# Remember

Every time you use a map app, you're using relativity.