Name: _____ Date: _____

How Do Drones Fly?

Reading level 11 (7th grade) · 1318 words

Noor sets a small quadcopter on the workshop floor and steps back. It has four propellers, a flat board of electronics and a battery taped underneath, and her robotics club has spent weeks building it. They have argued all week about two questions. How do drones fly? And how do drones work, when nobody sits inside to steer? Noor says the answer comes in two halves. One half is about air. The other half is about a very fast computer.

Start with the air. The propellers are rotors, and NASA describes how they make lift. When a solid object turns a flow of air, the lift pushes the other way. Each rotor throws air down, so the machine is pushed up. NASA's lift equation says lift grows with the square of the speed. A blade that spins twice as fast makes about four times the lift. With no air, or no movement through it, there is no lift at all.

A spinning rotor also twists the machine the other way. A helicopter fixes that with a tail rotor, but a quadcopter fixes it with balance. Two rotors turn clockwise and two turn counterclockwise, so the twists cancel to zero. The idea is old. In 1907 a French machine, the Breguet-Richet Gyroplane, used two rotor sets turning each way. It lifted a pilot about two feet off the ground. It was not a free flight, because four men held it steady. Noor likes that her club's design still uses the same trick.

Steering uses nothing but speed. To tip forward, back or sideways, the machine spins one rotor, or two neighbors, faster and the rest slower. To turn without tipping, it speeds up one pair that spins the same way, so the twists no longer cancel. A helicopter changes the angle of its blades as they turn. A quadcopter usually does not. The person flying only asks for a result. In one flight mode that uses GPS, the sticks ask for acceleration, like a car's gas pedal, and letting go makes the machine level out and brake.

Why did it take so long? Noor wonders how anyone ever flew one by hand. An early four-rotor helicopter built for the US Army flew about a hundred times, but in hover its pilot had so much to do that trying to fly sideways was too much. Four-rotor machines stayed a curiosity until small drones arrived. A light drone is simple for a computer to control. Then, between 2005 and 2010, cheap flight controllers, tiny sensors, GPS and cameras all arrived at once.

That computer is the flight controller, and it starts with senses. An inertial measurement unit, or IMU, puts accelerometers and gyroscopes on one chip. It reports how fast the machine is speeding up and how fast it is turning, and gyroscopes this tiny are cheap enough to sit inside smartphones. A pressure sensor adds height, because air pressure drops as you climb. Together these parts tell the controller how the machine is moving. Each motor also has a speed control, a small circuit that sets how fast it spins.

The software loop is easy to describe. Compare where the machine should be with where it is, find the error, and push against it. Most flight software does this with a PID controller, the same idea as cruise control adding power when a car meets a hill. One open-source system can run this loop 400 times a second, so it can correct every 2.5 thousandths of a second. A push that is too weak lets the machine wander, and a push that is too strong makes it twitch. Builders are told to raise the settings very slowly.

Outdoors, GPS adds position. GPS.gov says a phone is typically right to about 16 feet under open sky, and worse near buildings, bridges and trees. Some drones can also fly home on their own, and in one open-source version the machine first climbs to a set height and then flies straight back. It will not do this without a good position fix from GPS and a compass. Makers also list cameras and an infrared sensor for spotting things in the way.

The camera rides on a gimbal, a set of three pivoting frames. An IMU tells three small motors how to move, so the picture stays level while the machine leans. Video can also fly down to goggles or a screen. That is first-person view, or FPV. Some cameras show heat. In 2024 a sheriff's drone team in Wyoming found a lost woman at night this way, because her body heat showed clearly against the woods. Noor decides the club's first camera can wait until the flying is steady.

Nearly all hobby drones run on lithium polymer batteries, and flight time is the price. One maker lists 34 minutes for a small camera drone, in a lab test with no wind. A popular early model from 2013 was listed at about 15 minutes. Flights of several hours have been certified, but only on heavy machines that carry a very large battery. Noor checks the weight of her own battery and thinks about that trade, because the machine has to lift whatever it carries.

The same chemistry needs care. The FAA says all lithium-ion batteries can overheat in a process called thermal runaway. It can happen with no warning if one is damaged, wet or overcharged. A city fire department adds plain rules. Use only the charger that came with the device, and stop using a battery that smells odd or has changed color. On a plane, spare lithium batteries go in carry-on bags, never checked ones. Noor makes the rules into a poster for the club wall.

Before the first flight, Noor reads the rules aloud. In the United States, the FAA treats a drone as an aircraft. These are the rules in fall 2026, and they can change. One that weighs 250 grams or more, a bit over half a pound, must be registered. The owner has to be 13 or older, so for a younger owner, someone 13 or older registers it. Anyone flying just for fun must also pass TRUST, a free online safety test, and wrong answers can be fixed before the certificate is issued. Flying for work is different. It needs a remote pilot certificate, and you must be at least 16.

Where you may fly comes from one fact: other aircraft can fly low, and not only near airports. So people flying for fun must keep the drone in sight, give way to other aircraft and stay at or

below 400 feet in open airspace. Near an airport they need FAA approval first, and an app can give it in near real time. Flying over wildfires, hurricanes and rescues is not allowed, and the FAA says it gets more than 100 reports a month of drones near airports.

Since September 16, 2023, drones that must be registered also have to carry Remote ID. It means a drone in flight broadcasts who it is and where it is, so the FAA and police can find the person flying when a drone goes where it should not. There are three ways to comply, because the drone can be built with it, carry an add-on module, or fly only inside a special FAA-recognized area. With a module, the person flying must keep the drone in sight.

Drones also do real work. In North Carolina, a farm expert from the state university used one to reseed hay fields and riverbanks wrecked by a hurricane. The Interior Department lists wildfires, wildlife monitoring and volcano watching among its drone jobs. It says drones gather data more safely, and at lower cost. In 2014 the FAA approved six film companies to fly them for movies. Back at the workbench, Noor lets go of her sticks. The machine twitches once, then hangs in the air.

Questions

1. Why do a quadcopter's rotors turn two clockwise and two counterclockwise?

A. So the twists cancel to zero
B. So it can fly backward
C. So it makes less noise

2. According to NASA's lift equation, what happens to lift if a blade spins twice as fast?

A. It doubles
B. It becomes about four times as big
C. It stays the same

3. What does the flight controller's PID loop do?

A. It charges the battery
B. It films the flight
C. It compares where the drone is with where it should be and corrects the error

4. In the battery screens, "thermal runaway" describes a battery that

A. overheats in a chain reaction
B. runs out of charge quickly
C. weighs too much

5. Why must recreational flyers keep a drone within sight?

A. Drones have no cameras
B. The battery would die
C. Other aircraft can fly low, and the person flying needs to see them

6. What does Remote ID let the FAA and police do?

A. Slow a drone down

B. Find the person flying a drone that is somewhere it should not be

C. Charge its battery

Words to know

rotor: spinning blade

IMU: motion-sensor chip

gimbal: pivoting camera mount

quadcopter: four-rotor drone

certified: officially approved

Answer key: How Do Drones Fly?

1. A. So the twists cancel to zero
2. B. It becomes about four times as big
3. C. It compares where the drone is with where it should be and corrects the error
4. A. overheats in a chain reaction
5. C. Other aircraft can fly low, and the person flying needs to see them
6. B. Find the person flying a drone that is somewhere it should not be