

SOME SCIENCE OF DRAGONFLY HELICOPTERS

More about Dragonfly Helicopters at sciencetoymaker.org.

The Dragonfly Helicopter is a good way to understand Sir Isaac Newton's famous 3 Laws of Motion. The Third Law of Motion is about how for every action there is an opposite reaction. You can feel it when helicopters throw air down (the action) and the helicopter goes up (the reaction). You can experience action/reaction visually and tactually when you push someone on a swing. Of course they are pushed forward (the action) but pay attention and you can feel a force pushing on your hands (the reaction).

Newton's Second Law of Motion has to do with the relationship of Force, Mass and Acceleration. It is usually written as $F=MA$ and can be algebraically rearranged $A=F/M$, etc. So the Dragonfly wings are so delicate because they are also very low mass (mass is often the same as weight on Planet Earth). That's why the Dragonfly accelerates so fast against the force of gravity. We could also increase acceleration by increasing force. We use a very high-quality model airplane rubber band for that reason, and you can increase force by winding up the helicopter until it takes more force to wind. Both increasing force and decreasing mass will result in more acceleration for your helicopter.

Newton's First Law of Motion says that (a.) objects stay still unless a force acts on them, and (b.) they keep moving unless a force acts on them to stop. Part b is somewhat counterintuitive because friction is such a ubiquitous (that means it is everywhere) force on Earth, so it seems to slow everything down. But it is profoundly responsible for keeping Planet Earth spinning and rotating around the Sun! Your helicopter will not fly unless you make a force act on it (by winding).

Did you know that we live at the bottom of an ocean of air? We live in a part called the troposphere where all weather occurs. If you google "How High is the Sky, Krulwich Wonders" it will change the way you look at the world.

Air is a mix of gases: Nitrogen, Oxygen, Carbon Dioxide and very small amounts of other gasses. Did you know that both liquids and gasses are fluids? Colloquially we say that only liquids are fluids, but in scientific terms, fluids refer both to incompressible liquids and compressible gasses. Fluid Dynamics is the study of fluids—gases and liquids--in motion.

Did you know that air has mass, but its density is about 800 times less than water? The wings are made from Expanded Polystyrene (EPS) foam, which is also low-density. Some EPS foams are only 5 times denser than air itself.

Rubber bands use a different mechanism at the atomic level than springs do. If you google "Richard Feynman Rubber Band" there is a very interesting video, explained by the great physicist.

DRAGONFLY HELICOPTER CARE: Avoid extreme heat (car dashboard) or cold (below freezing). Rubber bands tend to break in cold weather. Do not store with propeller bent (it will warp the propeller eventually). Do not store the rubber band in sunlight. More about the Dragonfly Helicopter at [**sciencetoymaker.org**](http://sciencetoymaker.org)

Eventually I hope to make a video about the science of helicopters. If you have anything to add or other feedback, please contact me, Slater, via contact at sciencetoymaker.org