

## The physics in Skateboarding

By Ethan Benatar

When most people think of skating, they think of gravity defying tricks that skaters pull off which may look all but possible for the average person to pull off but understanding the physics of skateboarding is key to progressing in the sport. It is true that there are skate tricks that only pros can pull off, skating like all sports involves a progression that all skaters go through. In this essay I will attempt to explain the physics of skateboarding to simplify the tricks that may look impossible for the average person to pull off.

While a skateboard is a simple object compiled with a piece of wood, grip tape, wheels, trucks, bolts, and bearings there is a vast number of things that can be done with a skateboard. In most skater's progressions after learning how to ride a board the next step is getting down the basic tricks as this opens a window for skaters to progress further into the sport. One of the most basic tricks a progressing skater can learn is an ollie. Even this trick looks quite difficult to someone who has no knowledge on how to execute the trick. The ollie is comprised of two motions; the first motion being to push down on the tail of the board to create a pop motion followed by sliding your foot across the board to level the board out again as you land. When looking at skating, what most people overlook is the actual physics behind the trick explaining why that happens. Starting with the first motion, pushing down on the tail to create pop exerts a normal force on the tail and this causes the board to pop up. Newton's third law can explain why the board pops up because of a skater pushing down on the tail. Because every force has an equal and opposite force, explained by Newton's third law, when a skater jumps after they push down on the tail the normal force, they applied is then applied in the opposite direction causing the board to pop up and follow the feet of the skater as they jump. In the second motion when a skater slides their foot across the board exerting a small horizontal force to level out the board. In most cases one would

expect that by sliding their foot it would cause a skater to lose hold of the board, but the grip tape on the board increases the friction the person's foot experiences as it slides across the board allowing the board to almost stick to the skater's feet. Lastly the board and the skater fall back down to the ground to the gravitational force that is applied by earth's gravitational field. While skating is hard, understanding the physics of it can help one improve their execution of the various tricks that can be done on a skateboard.

While the ollie is an easy trick, even harder tricks can easily be explained and taught using the applications of real-world physics. The kick flip, one of the most popular and iconic tricks in skateboarding, can also be broken down by the laws of physics. To do a kick flip a skater must pop down on their board, as explained in the paragraph earlier, but instead of sliding their foot across the board they must slide their foot outward to create the flip motion of the board. Most people wonder how such a motion is possible to do on a skateboard. By flicking outward, an angular vertical force is applied on the board causing one side of the board to flip as the force brings the board out of equilibrium. Because of this the board rotates in a flip motion hence the name kick flip. The amount of force applied to the outward flick determines the rotation of the board so the harder one flicks the more rotations can be accomplished when attempting the trick resulting in a 720- or 1080-degree flip (kick flip is also referred to as a 360-degree flip). While skating does involve a lot of flip tricks, tricks where the board flips in a certain motion, other popular tricks such as the 180 can be broken down by real world physics. To do a 180 a skater must rotate their board along with their body in a half circle motion landing opposite to the position they started in hence the name 180. The physics of this trick is more complicated than other skate tricks as this motion involves rotation and momentum. When attempting this trick, a skater starts by rotating his upper body clockwise while moving his lower body and board in a counterclockwise motion. The rotation of his upper body creates angular momentum for his upper body and the rotation for his lower body creates an equal angular momentum in the opposite direction to cancel out

the momentum generated by the rotation of his upper body. To match the momentum of his lower body (which is moving in a 180-degree rotation) the skater extends their arms as he rotates back into his initial stance increasing the rotational inertia of his upper body since his angular momentum is dictated by his angular velocity and rotational inertia ( $H=I\omega$   $H$ = rotational momentum,  $I$ = rotational inertia,  $\omega$ = angular velocity). Understanding the physics behind these motions helps skaters progress better and faster as mastering skating extends beyond just execution of the tricks but a conceptual understanding of how and why the trick works.

While skating to the average person may look impossible, understanding the physics of skating helps simplify the complexity of skating and breaks it down into something that seems all but impossible. Even though this is true it does not make skating any easier as the only way to progress in the sport is through practice and arduous work, but it does provide understanding to skaters on the tricks known to skateboarding. In my personal experience skating, you build a keen sense of comfort when executing tricks when you understand how they're done and the sciences behind what you're trying to do on a board as skating is very scary and dangerous in some cases and takes a lot of commitment when progressing and learning new things, so by understanding the science and concepts of these tricks I as a skater was able to further my own progression in the sport.

Physics of skateboarding, real world physics problems

<https://www.real-world-physics-problems.com/physics-of-skateboarding.html#:~:text=The%20Physics%20of%20Skateboarding%20An%20understanding%20of%20the,is%20useful%20from%20a%20performance%20point%20of%20view.>