Physics in the 2024 Olympics

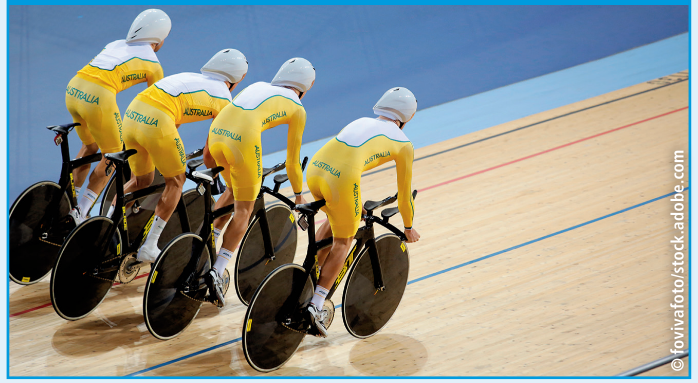
1 As the sprinters push back hard against the starting blocks, Newton's third law says that the starting blocks push back on the athletes, launching them towards the finishing line

2 High jumpers curve their bodies as they go over the bar, allowing their centre of gravity to pass under the bar

3 Javelin throwers know all about projectile motion

4 Golf balls have dimples that mean, surprisingly, they are more aerodynamic than if they were smooth

5 Track cyclists' bikes are a marvel of engineering, as are their aerodynamic helmets and suits



6 Fencers move so fast that electrical circuits are needed to judge who struck first

7 Taekwondo players also use electrical sensors to detect when a successful strike has landed

8 Conservation of angular momentum means that divers can increase their rate of rotation by pulling in their limbs and tucking up their bodies

As I write this article, the Paris Summer Olympics of 2024 have just come to an end. Athletes from around the world have demonstrated what seemed almost superhuman abilities. And physics is at the heart of everything. Describing the physics of all Olympic sports would require a full volume of Physics Review – at least.

On the athletics field, Newton's laws reign supreme. As sprinters sets off, they push hard against the starting blocks, and Newton's third law ensures that the blocks push back on them (1). High jumpers curve their bodies so that their centre of gravity travels below the bar (2).

Shot putters and javelin throwers must launch their projectiles at the correct angle for maximum range. In theory, this is 45° for a simple point-like projectile launched in a vacuum through a uniform gravitational field. However, in practice, the aerodynamic properties of the projectile mean that things are not so simple (3).

Aerodynamics is critical in ball sports, which all use balls of different sizes, weights, surface textures and so on, all suited to their particular use. Golf balls have a dimpled surface (4), and this affects the way air flows around the ball in such a way that it reduces drag, so that the ball goes faster and further. The fuzz on a tennis ball has a similar effect when the ball is new, but with use the fuzz may increase drag. The fuzz also increases the effect that spin – an important element of skilful play – has on the flight of the ball. Analysing the motion of balls requires a study of fluid dynamics, and this is also of prime importance in swimming, alongside buoyancy and Archimedes's principle.

Technology and engineering play a huge part in sport, from the materials used to make tennis rackets and trampolines, to the amazing designs of the bicycles used in track cycling (5). Fencers move their blades so fast that it can be very difficult for judges to tell when a successful attack has been made, especially when both athletes strike simultaneously (6). Wearing a conductive jacket means that when a blade makes contact, an electrical circuit is closed and a light illuminates to show the hit. Taekwondo players use a similar system to detect when and where a punch or kick has landed (7).

Gymnasts, trampolinists and divers do not just travel in straight lines – they rotate and spin as they do so. Once they are in the air their angular momentum remains constant, but they can change how fast they spin by pulling in their limbs and tucking up their bodies (8).

You do not need to have a physics degree to be a great gymnast, but Olympic athletes certainly have an intuitive understanding of the laws of physics, and their coaches and technical support staff use technology to analyse their performance, and materials science and engineering to enhance it.

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