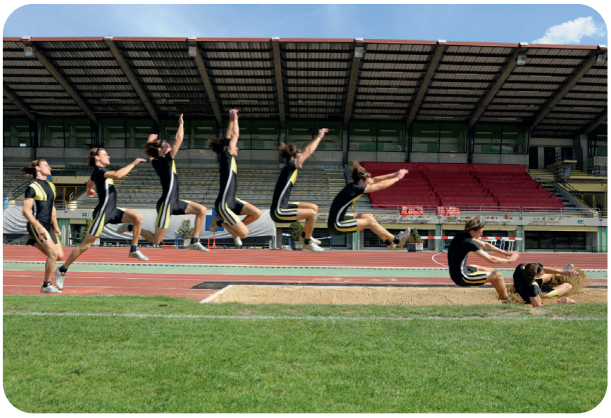
The physics behind the long jump



The long jump is a thrilling event in track and field where athletes combine speed, strength, and technique to leap as far as possible into a sandpit. The physics behind the long jump involves understanding the principles of motion, force, and energy. In the long jump, achieving maximum distance requires a combination of speed, the optimal take-off angle, and proper body positioning. By understanding the physics of horizontal velocity, vertical velocity, and projectile motion, athletes can fine-tune their technique to jump farther. Mastering these principles allows long jumpers to push their limits and achieve impressive results.

Speed and horizontal velocity

One of the most important factors in the long jump is the speed at which the athlete runs before take-off. The faster an athlete runs, the greater their horizontal velocity, which translates directly into the distance covered in the air. The force exerted by the legs during the jump adds vertical velocity, but horizontal velocity remains a major factor in determining how far the athlete will jump.

Take-off angle and vertical velocity

At take-off, the athlete's body must generate both vertical and horizontal velocity. The take-off angle plays a crucial role in maximising the horizontal distance. The ideal angle for a long jump is typically around 20 to 22 degrees. If the take-off angle is too steep or too flat, the athlete may lose horizontal speed or not gain enough height. The height achieved during the jump depends on the vertical velocity at take-off.

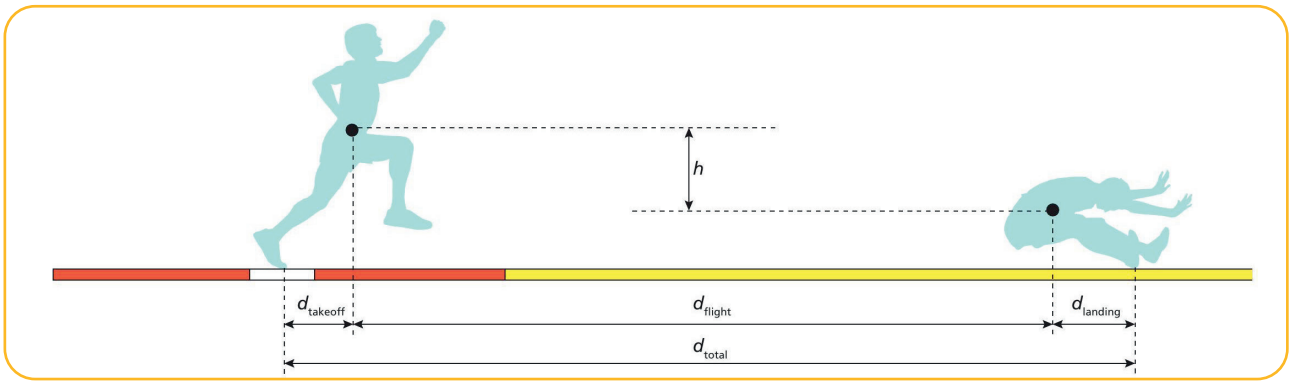
Projectile motion and flight path

Once airborne, the jumper follows a parabolic trajectory due to gravity. The horizontal velocity remains constant during flight (neglecting air resistance), while gravity continuously decelerates the vertical motion. The time the athlete spends in the air depends on the vertical velocity at take-off. The total time of flight can be calculated by:

$$t = \frac{2Vy0}{g}$$

where v_{y0} is the vertical component of the initial velocity and g is the acceleration due to gravity.

to fine-tune: *perfezionare*
to neglect: *trascurare*
steep: *ripido*



1 Complete the sentences with the missing expressions.

1. The long jump is a popular event in ..... where athletes try to jump as far as possible.
2. It requires a mix of speed, strength, ... to achieve great results.
3. The science behind the jump is based on motion, force, ...
4. To reach the greatest distance, athletes need speed and the .....
5. Understanding projectile motion helps athletes .....
6. The faster the athlete runs, the greater the ..... before take-off.
7. Horizontal velocity is a key factor in determining the .....
8. The ideal take-off angle is usually around .....
9. During flight, the jumper follows a ..... because of gravity.
10. While in the air, horizontal velocity stays constant when we ignore .....

2 Match each concept with the right definition.

1.	Horizontal velocity	**a.**	The curve followed by the athlete while in the air.
2.	Vertical velocity	**b.**	It helps determine how high the jumper rises.
3.	Take-off angle	**c.**	It pulls the athlete downwards during flight.
4.	Projectile motion	**d.**	The angle that helps maximise jumping distance.
5.	Gravity	**e.**	It influences how far the athlete travels forward.
6.	Speed before take-off	**f.**	The initial running pace before leaving the ground.
7.	Parabolic trajectory	**g.**	A force that slightly slows motion in the air.
8.	Air resistance	**h.**	The type of motion experienced once airborne.

3 Answer the questions.

1. Explain why speed before take-off is important for long jump.
2. Describe the role of the take-off angle in jumping far.
3. What happens to the athlete's body during flight?
4. How can understanding physics help athletes improve their performance?

4 Imagine you are a coach for a long jumper. Using what you learned from the text, create a short training plan to help your athlete jump farther.