

# 2012 年臺灣國際科學展覽會

## 優勝作品專輯

國家：India

編號：010062

作品名稱

Project Motion in Sports

得獎獎項

四等獎

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# SYNOPSIS

## Projectile motion in sports

A projectile refers to any body that is thrown in space and falls under the influence of gravity and the motion of such a body is called projectile motion. In this context we will ignore the effects of air resistance to make calculations easier. Through the usage of **trigonometric ratios and vectors** it is possible to accurately predict the position of a body after a certain time, the maximum height attained by it and the horizontal distance it covers from the point of projection.

Horizontal displacement or range of a projectile is the main index of performance in many cases of projectile motion. If air resistance is negligible, there is no net force in the horizontal direction ( $\Sigma F = 0$ ;  $a_x = 0$ )

Through this topic we aim to explain the science behind the performed actions and movements in sports such as **Golf, Football, Basketball and Javelin throw**.

### **Factors Affecting Distance traveled by a projectile:**

1. Relative height of release
2. Speed of Release
3. Angle of release

### Projectile Motion: Theory v/s reality

Theoretically optimal **angle** is about  $45^\circ$  however taking air resistance into consideration the angle reduces to about  $42^\circ$ . Long jumpers use angles of  $17-23^\circ$ . This is because when traveling at  $\sim 10$  m/s, there is not enough time to generate a large takeoff angle.

The game of Golf is based on the trajectory followed by the golf ball as it moves through the air and in this sport we have addressed issues such as the required **club face angle** and **swing speed** for the ball to go in the hole. For instance if we have a ten degree driver it will carry the ball lower than a 60 degree wedge and hence it can be deduced from the above statement that a greater angle of the club face launches the ball at a greater angle. Effects of Air resistance can be very large in case of golf. Therefore,

the golf ball has dimples on its surface to negate the effect of air resistance.

To depict the application of projectile motion in football, we have **shot a video** on our school's football field showing the **trajectory** followed by a football and have addressed issues like horizontal and vertical velocity required depending on the nature of the kick.

In the sport of Basketball we shot a video showing a student shooting a 3 pointer. Furthermore with the help of charts, we have calculated **the velocity required** for a basketball to go inside the hoop at different angles of projection such as **30, 45 and 60 degree**.

Finally we have included a question to determine whether **a ball hit by Sachin Tendulkar** will be a six or not using kinematical equations as well as equations related to projectile motion.

Hence by shedding light on this wonderful topic we attempt to reveal how an athlete's brain functions and through years and years of practice and hardwork he is able to accurately predict distances and achieve his goals.

## 評語

We suggest the following improvements of this project

- 1) A better understanding of calculus, especially the method of locating the extreme value of a function.
- 2) A better understanding of numerical approximation of solutions of differential equation. This is a practical way to handle air-resistance.
- 3) A deeper understanding of the mechanism of the motion of flight of a projectile. Explore what other factors such as rotation that may affect the trajectory.