

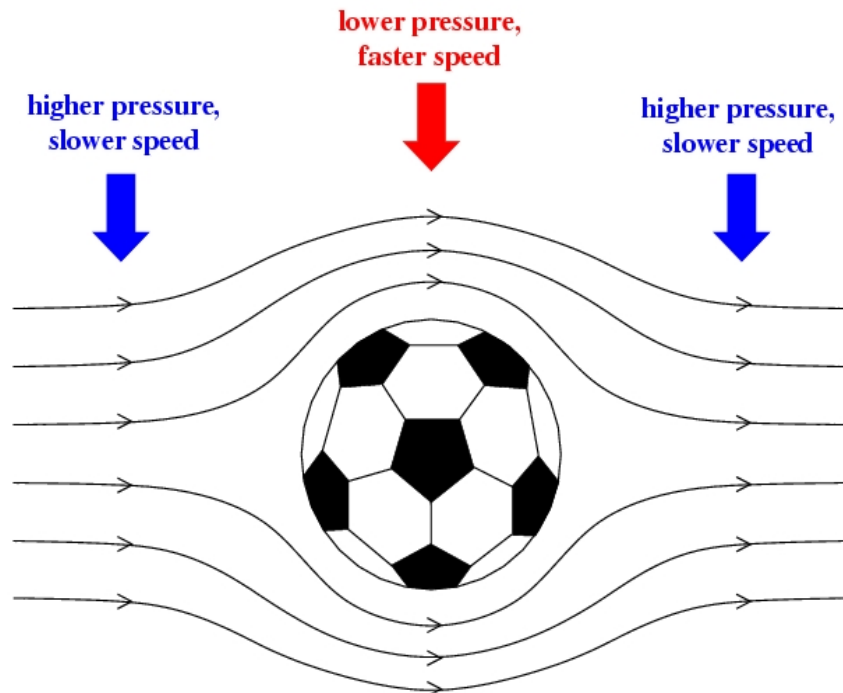
FORCES ON A SOCCER BALL

From *How Things Work*

There are three general forces that act upon the flight of the ball: Gravity, Drag & the Magnus Force.

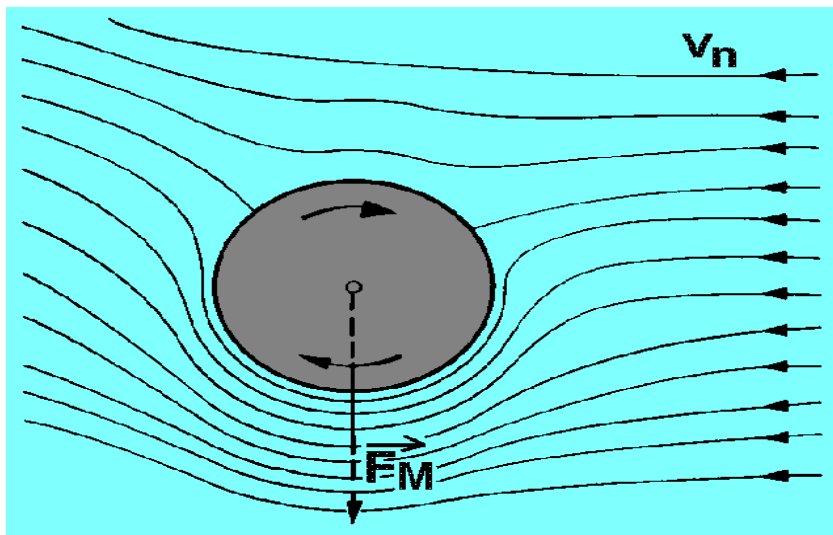
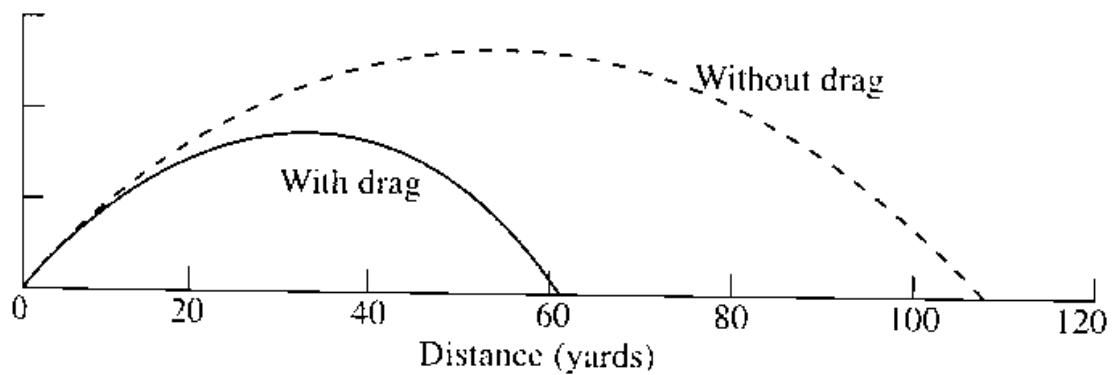
Gravity: During the first half of the ball's flight, it has enough Kinetic Energy to fly against the downward pull of gravity. After the first half, the ball falls downwards, pulled by gravity.

Drag: A friction-like force that has a slowing effect on the horizontal velocity of the ball. It is also the force of air on objects moving through it. At higher speeds, drag has larger effects on the speed of the ball. The diagram to the left shows the air pressure around the flying soccer ball. Bernoulli's Principle comes into effect here. The air moving over the surface of the soccer ball is going faster than the air around the ball, creating decreased air pressure on the ball (as per Bernoulli's principle). In the diagram below, there is a graph of a soccer ball kicked at 70 mph at a 45 degree angle. The flight distance is shown without and with drag, which causes a difference of around 50 meters.



From *Science of Soccer*

Magnus Force: This force applies to any ball moving through the air with spin. This spin causes the air to take a different pattern around the ball, making the ball go left, right, up or down. It is behind things such as a curveball in baseball and a corner kick spinning into the net in soccer. The Magnus force "acts at right angles both to the velocity and to the axis of spin" (Wesson 161). Very simply, it causes an imbalance in forces on either side of the ball. This can cause the ball to move sideways, up and down in "random" patterns.



USEFUL REFERENCES

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