

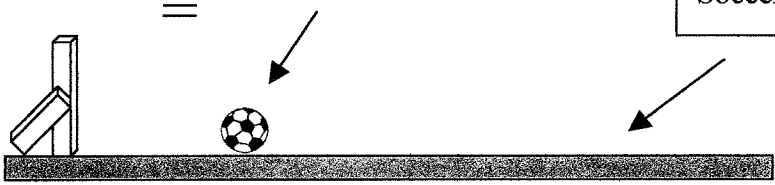
Hitting soccer ball with rolling motion with a longer force over time.

(ie, with the whole front of shoe)



Soccer Ball

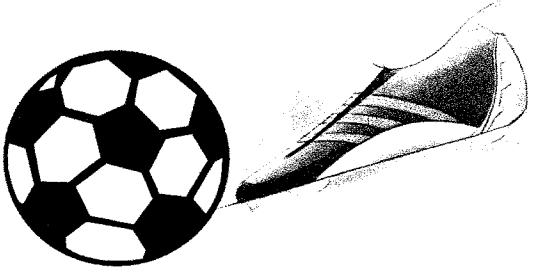
Soccer Field



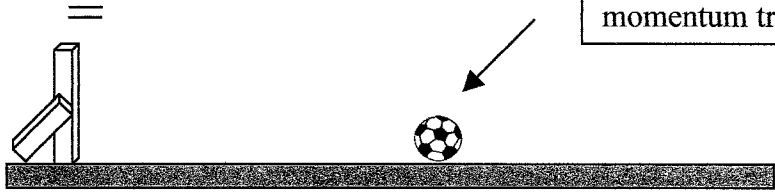
Goal

Hitting soccer ball with sudden hit with a shorter force over time.

(ie, with the tip of your shoe)



As you can see, the ball did not go as far because of the momentum transfer.



Not sure if this is correct terminology

Soccer Cleat: <http://lineweights.com/page/20/>

Soccer Ball: <http://www.clipart.com/clipart-4562.html>

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Math/Physics
5/12/11

Momentum and Soccer

Have you ever wondered why a soccer ball rolls as fast as it does and travels as far as it does? The biggest two factors to this answer are momentum and impulse; momentum probably more so than impulse. Momentum is the product of an object's mass and its velocity. Impulse is determined by the amount of force and how long the force is applied. The greater the impulse applied to an object, the greater the change in momentum will be. Momentum is simply something that gets transferred through objects and typically shows movement, whether it be acceleration or negative acceleration.

Impulse can be broken down into simpler terms. Let's say there is an object, and it is moving with a constant momentum, but then it suddenly changes. In order for that to happen, one of two things has to change, or in some cases both, —the two things are mass and velocity. So when the momentum changes it's because one of those two factors changes. Out of the two, the most common variable to change is the velocity, what is the result? Acceleration—and the acceleration changes depending on the amount of force acting upon it. Based on the definition of acceleration, when there is more push or pull on an object, there will be a great acceleration. In addition, the word impulse comes from the relation of the product of these two factors of force and time.

How does this relate to soccer? Another important thing about impulse is how long the force acts upon the object. For example, if you put force on something for an instant, the object moves abruptly. But if you put that same amount of force on the object over an extended amount of time, the object will continue to move at a slower speed but

for a longer time. This is where the relationship to soccer comes in. Think about a soccer ball, and think about someone using all of the strength he can muster to hit a soccer ball on the ground.

For this example, let's say the soccer player was trying to hit the ball to the goal from the middle of the field. He could do one of two things. He could hit the ball as hard as he can, but have his foot literally hit the ball and bounce back off of it. If he were to do this, the ball would have an instantly high velocity, because there was such a great force exerted onto the ball. The other thing he could do would be to kick the ball with the same amount of strength, but instead of kicking it and having his foot bounce off, he could have his foot "roll" with the ball. When that rolling occurs, it means the ball gets more time with the foot pushing against it, which inevitably gives it more of a thrust forward, thus making it travel farther than the kick in the first example. This time-force ratio is saying that the longer a push is happening the greater the change in the soccer ball's momentum. The reason that the follow through kick is important is because when kicking a ball you always want it to go as far as it can. The reason your foot position matters is because when you have that "rolling" motion it gives a more flowing force, rather than a quick abrupt one. In conclusion, when you put these two ideas together you get a "perfect" shot, with both a long distance and powerful kick!

Calculation:

Momentum is given to the soccer ball by the force of the leg through its impulse. It is when a force is exerted onto the ball of a certain length of time.

The equation for this is:

$$\text{Impulse} = \text{force} * \text{time}$$

Example:

If the force of your foot hitting the soccer ball is 20N and it is using that force on it for 3 seconds, what is its impulse?

$$I = 20\text{N} * 3\text{S}$$

$$20 * 3 = 60$$

$$\text{Answer} = 60 \text{ N*S}$$

Momentum is the transfer of movement from one object to another.

To find momentum we can use the equation:

$$\text{Momentum} = \text{mass} * \text{velocity}$$

Example:

If the mass of your leg is 11 kg and it is moving with the velocity of 1 m/s towards the ball, what is its momentum?

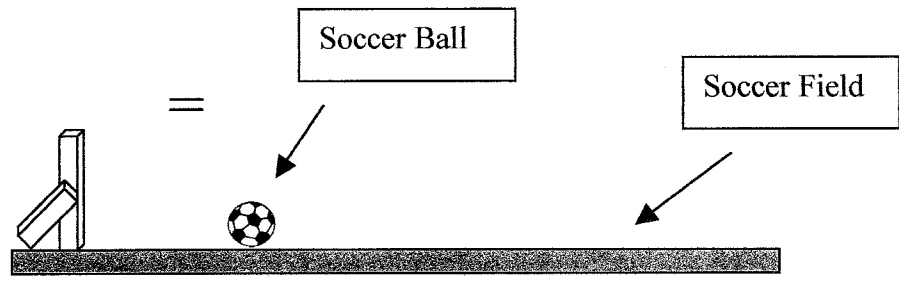
$$P = 11\text{kg} * 1 \text{ m/s}$$

$$11 * 1 = 11$$

$$\text{Answer} = \text{Your leg's momentum is } 11 \text{ Kg*m/s}$$

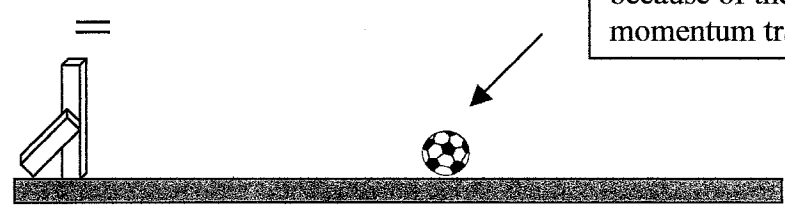
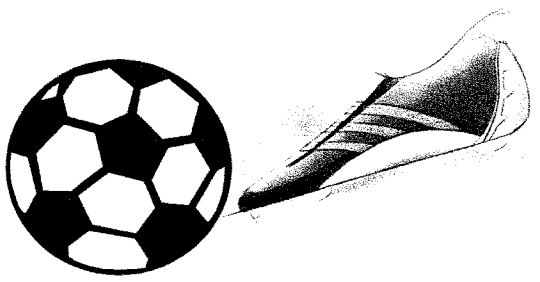
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