The Physics of the Actual Game of Basketball: Analytical Essay

The physics of the actual game of basketball is very interesting.

Firstly the physics of the basketball itself.

When you dribble a basketball, your hand and gravity both push the ball towards the ground . As it drops, the ball accelerates and speeds up. It wants to stay in motion so the ball pushes into the ground when it hits, compressing the air inside. The ground pushes up with an equal, but opposite amount of force resulting in the ball bouncing back up into your hand. The energy in the compressed air is transferred back to the ball pushing it back into motion. If you were to take your hand away and stop dribbling, the ball would continue to bounce due to Newton’s first law, but would slow down and eventually stop due to friction.

Why do basketballs have bumps/ pebbling?

When forces collide, friction naturally slows things down over time. More bumps on a basketball, more points of contact and surface area increases. This means friction acting on the ball and a surface it comes into contact with increases. This gives the ideal grip for a player, allowing for faster passes and complex movements without fear the ball will slip out of the players hand.

Some interesting facts about basketball:

-71% of airtime when jumping is spent near the apex, creating an illusion of floating. Some may think the time is 50-50 between the bottom and top half of the jump but it's the opposite. But if you think about it, you're moving fastest the moment you leave the ground. Every instant after liftoff, you slow down because you are acting against gravity. Therefore you will decelerate by 9,8 ms^-2 until you reach zero vertical speed for a brief instant at the peak of your jump. After that, your speed increases again in the downwards direction, as you fall back down. This means that the top half of your jump (in terms of height) is also the slower half, and so it takes more time to cover that half.

-To make a lay up or a moving shot players have to account for their momentum and the balls. In the 1600s, Galileo dropped a rock from the mast of a moving ship, and found that it fell at the base of the mast, not behind the mast. Other scientists believed the rock would fall behind the mast, and even claimed they'd seen that happen, but Galileo actually did the experiment to see for himself. Try to imagine being someone who was watching this experiment from the shore. From your perspective, Galileo's ship is moving sideways, and so for the rock to land at the base of the mast, the rock must move sideways as it falls. Galileo understood what others before him had not when he let go of the rock, in addition to its downwards motion, it continued to move sideways with the same speed as the ship. So how does relative motion have to do with basketball?

When a basketball player makes a shot while running, they're in the same situation as the

galileo. Less experienced players often miss their layups because they tend to push the ball forwards towards the hoop, instead of throwing it straight up. But a trained player knows to throw the ball up instead. The player's forward speed is added to the ball's speed, and if they don't account for this, they'll miss the shot. Similarly, if a player moves from left to right while shooting, and aims for the center of the rim, the ball will miss and land to the right of the rim. To make any moving shot, players need to correctly account for how their speed is added to the ball's speed.

-Finally, the basketball is 1.5% lighter than its true weight. A basketball is surrounded by air and air pressure increases with depth. This means that the air underneath the ball pushes up with a greater force than the air above it. This pressure difference creates an upwards buoyant force on the basketball. Archimedes taught us that the magnitude of this buoyant force equals the weight of the fluid (in our case, air) displaced by the object.

If we plug in the numbers we find that the ball experiences a upwards force 1.5% of its weight.

Maths

Maths plays a huge role in determining how well a player plays. Various statistics help define this, for example the points per game average. The total number of points scored divided by the total number of games players. This is the same for all the other major statistical averages; rebounds, assists, blocks, shots, steals and minutes played per game.

Ratios

One of the key numbers that coaches look at is a player’s turnover to assist ratio. This is especially important for the backcourt that are charged with the responsibility of running an offense. The ratio is determined by taking the number of assists a player averages and dividing this total to the players' number of turnovers per game. For instance, a player that averages 9 assists per contest and 3 turnovers has an assist to turnover ratio of 3 to 1,

Percentages

Field goal shooting percentages are calculated by taking the number of shots a player makes and dividing that total by the number of shots attempted. Any shooting percentage near 50 percent is considered very good. Accordingly, a player that hits 11 shots on 20 attempts has a shooting percentage of 55 percent or .550. Free throw shooting percentages and 3-point field goal percentages are also done this way. For example one of the best shooters james harden averages 44% from the field, 37% from the three point line and 90% from the free throw

Strategy

Mathematics comes into play in close games. A coach will decide to foul players with poor free throw shooting percentages in the final minutes if his team is behind in hopes of the player missing the foul shots and allowing his team to get the ball back and score. In the NBA, a 24-second shot clock forces a team to shoot the ball at the end of a quarter, which can determine whether or not the team will get the ball back with any time left on the clock. Consider a team that gains possession of the ball with 42 seconds left in a quarter. Doing the math, they

know that if they shoot the ball any time after 18 seconds has gone off the clock, the other team can hold the ball for a last shot because there will only be 24 seconds left in the quarter. Some teams opt to shoot quickly, knowing that even if the other squad uses its entire 24 seconds to shoot, there will still be time left for them to get in a last shot.