The Dude sends his bowling ball down the lane toward the geometrically arranged pins at the far end. The ball slides without rolling at first on the highly polished and perfectly horizontal maple floor, but it eventually catches and thereafter rolls without sliding. Discuss what happens to the ball while it is on the floor (but before it hits the pins) in terms of horizontal forces, various energies, and momentum. Focus on the early period when the floor is essentially frictionless and then the later period when friction is important, plus the transition between those two.

Friction causes energy to convert among the various kinds

When the Dude throws the bowling ball down the lane, the force of his throw is initially a horizontal unbalanced force towards the direction of the pins, so that the bowling ball accelerates in that direction. It slides down the polished lane with high kinetic energy and momentum. However, **when it starts to roll, the non-skidding frictional force between the lane and the ball provides an unbalanced torque on the ball. This causes some of its kinetic energy to turn into rotational energy, as well as be lost due to the nonconservative nature of frictional force**. Therefore, the ball will slow down, causing the momentum to decrease as well.

Ball does not originally observe the rolling condition

kinetic friction is one of the variables that change from stage to another in the bowling balls trip down the lane. This friction is what would cause the bowling ball to spin/roll, this is the effect that the friction has on the ball. **When the ball is just sliding it is frictionless. Another thing is that the ball has such a great speed at the initial release that the speed of the rotations does not match with the linear velocity resulting in the sliding on the lane floor**. Friction would be pointing back towards the man while the momentum of the ball is forward as it continues to go in that direction. The normal force would be pointing upward towards the center of the mass of the ball.

Friction also changes the center of mass speed

After the bowling ball left your hand, the only horizontal force on the ball be the force of friction opposing the motion of the ball. The mass and velocity of the ball upon release would give the momentum of the ball as it travels along the floor. Earlier on, the ball would have a higher velocity giving the ball a higher momentum. As the ball continued to travel down the lane, **there would be an increase in the frictional force exerted on the ball causing a negative acceleration. A negative acceleration would decrease the balls velocity** which in turn would also decrease the momentum. The kinetic energy of the ball would be from the kinetic energy exerted on the ball from the individual rolling it. As the ball fell, some potential gravitational energy would be converted to kinetic as well. **Kinetic energy would be transferred out of the system due to the additional factor of friction.**

After the Dude's ball is rolling, and just before it hits the pins, describe the instantaneous velocity at the very highest point on the ball and estimate the speed there. Hint: estimate the data your need about a typical bowling ball's behavior from this

Good explanation of all the relevant factors, one minor error

Tangential velocity of the ball is the radius if the ball times the angular velocity. The radius of an adult's bowling ball would be approximately about 0.020m. Angular velocity is determined by the change in theta over the change in time. Over the courses of the roll, **it's estimated the bowling ball completed 25 full rotations** giving change in theta as 25[(360*pi)/180] = 25(6 radians) = **150 radians**. It took the ball an estimated 4 seconds to reach the end of the lane. As a result, **the angular velocity would be 150 rad/4 sec = 38 rad/sec.** Now **tangential velocity can be found (38 rad/sec)(0.020m) = about 0.5m/s** which is the velocity of the ball just before impact.

Straightforward, complete, and correct

At any point in the motion where the ball is in contact with the ground, the ball is not moving relative to the ground, but they move with each other in the rolling motion, giving it a velocity of 0. The ball still moves with a velocity, v, which is equal to the **radius, r, of the ball times its rotational velocity, w. In the video, the ball seems to take about 3 seconds to travel down the 60 foot lane, giving a velocity of about 20 ft/s, or about 6 m/s.** Since the velocity at the highest point on the ball opposite to the contact point on the ground has a value of 2v, the instantaneous velocity at the top of the ball will be about 12 m/s.

Works the problem two different ways, gets same answer!

After playing the video at 0.25 speed many times while using a stopwatch, I estimate that the ball is rotating at about 16 revelations per second. With the average bowling ball being about **20 cm or 0.20 meters in diameter**, the tangential velocity would be about **0.2 m * pi * 16 rps or about .2 m * 3 * 16 rps or 0.6 m * 16 rps or about 9 meters per second relative to the ball.** To an observer, **the ball travels the length of the lane or about 18 meters in 2 seconds according to the video which gives the entire ball a velocity of 18 m / 2 sec or 9 m/s, this would be added to the tangential velocity for a grand total of 18 m/s at the top of the ball relative to an observer.**