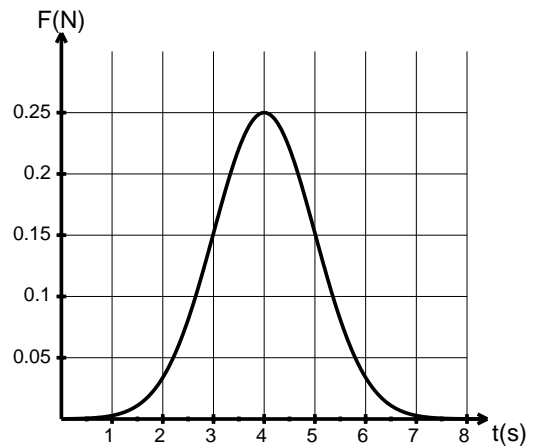


**Momentum and Impulse: Extra Practice**

1. A soccer ball is travelling towards a soccer player at 12 m/s (the mass of the soccer ball is 430 grams). After the player kicks the ball it travels back in the direction that it came from at 23 m/s.
  - a. Find the impulse exerted on the ball (recall impulse equals the change in momentum).
  - b. From the impulse calculated in part "a" and given that the soccer players foot was in contact with the ball for 0.75 seconds, calculate the average force exerted on the ball by the players foot.
  
2. The graph to the right shows the force vs time profile for a billiard ball bouncing off a bumper. The force (F) is in a direction directly perpendicular to the bumper.
  - a. Find the impulse exerted on a billiard ball bouncing off the bumper.
  - b. If the initial velocity of the billiard ball is -2.1 m/s (i.e. towards the bumper) and the mass of the billiard ball is 160 grams, what is the final velocity of the billiard ball?

**Answers:**

- 1a. 15.1 kg·m/s [away from the kicker]      1b. 20.1 N [away from the kicker]  
 2a. 0.65 N·s [away from the bumper]      2b. 1.96 m/s [away from the bumper]