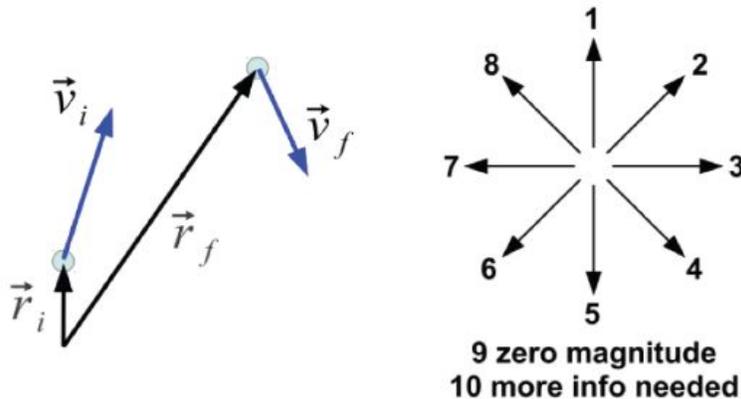


1. A baseball of mass = 0.145kg is travelling at a speed of $v = 67\text{m/s}$ when it bounces off a bat. Determine the magnitude of the force by the bat on the ball, assuming it bounces off with the same speed but in the opposite direction with constant force. The ball is crushed 0.025m.
2. An object's initial position and velocity (\vec{r}_i , \vec{v}_i) and final position and velocity (\vec{r}_f , \vec{v}_f) are shown on the figure below. Using the numbered direction arrows shown, indicate (by number) which arrow best represents the direction of the quantities listed below. If the quantity has zero magnitude or if more information is needed to determine the direction, indicate using the corresponding number listed below.



- Displacement (Δr)
 - Initial position vector
 - Average velocity (use understanding of the definition of velocity)
 - Change in velocity
 - Change in momentum
 - Acceleration (use understanding of the definition of acceleration)
3. A tennis ball with mass 0.5 kg flies towards Serena Willains with velocity $\langle 40, 5, 0 \rangle$ m/s. She hits it; contact with the racket is maintained for 0.01 seconds. After contacting the racket, the ball's velocity is $\langle -40, -5, 0 \rangle$ m/s, and its position is $\langle 0, 1, 0 \rangle$ m. Neglect any air resistance, friction, etc.
 - a. What is the contact force of the racket on the ball in this time interval?
 - b. After contacting the racket, the only force on the ball is gravity. Predict the position and velocity of the tennis ball 0.1 seconds after leaving the racket using a single time step.
 4. A soccer ball is kicked at an angle θ to the horizontal with an initial speed of V . You can ignore air resistance.
 - a. Calculate the horizontal distance down the field that the ball travels. Hint: use the momentum principle and draw it out
 - b. Calculate the peak of the arc of the kick. Hint: what is our Δt here?