29. We use coordinates with +*x* rightward and +*y* upward, with the usual conventions for measuring the angles (so that the initial angle becomes 180 + 35 = 215°). Using SI units and magnitude-angle notation (efficient to work with when using a vector-capable calculator), the change in momentum is

$$\vec{J} = \Delta\vec{p} = \vec{p}_f - \vec{p}_i = (3.00\angle 90°) - (3.60\angle 215°) = (5.86\angle 59.8°).$$

(a) The magnitude of the impulse is $J = \Delta p = 5.86 \text{ kg} \cdot \text{m/s}$.

(b) The direction of $\vec{J}$ is 59.8° measured counterclockwise from the +*x* axis.

(c) Eq. 9-35 leads to

$$J = F_{\text{avg}}\Delta t = 5.86 \quad \Rightarrow \quad F_{\text{avg}} = \frac{5.86}{2.00\times 10^{-3}} \approx 2.93\times 10^{3} \text{ N}.$$

We note that this force is very much larger than the weight of the ball, which justifies our (implicit) assumption that gravity played no significant role in the collision.

(d) The direction of $\vec{F}_{\text{avg}}$ is the same as $\vec{J}$, 59.8° measured counterclockwise from the +*x* axis.