Flipping Physics Lecture Notes:

2D Conservation of Momentum Example using Air Hockey Discs (known values calculations)

Here are my original calculations from the video. I measured the x and y displacements of both discs for 10 frames right before and after the collision.

Note: $\vec{v}_{yi_y}$ means the velocity of the yellow disc initial in the y-direction. I know it's a little bit confusing, but, if you have chosen to look at the "known value calculations", I think you can handle it.

$$\Delta t_{all} = 10 frames \times \frac{1 \sec}{240 frames} = 0.041\overline{6} \sec; \vec{v}_{yi_y} = 0$$

$$\vec{v}_{yi_x} = \frac{\Delta x_{yi}}{\Delta t} = \frac{x_{y2} - x_{y1}}{\Delta t} = \frac{12.1cm - 10.7cm}{0.041\overline{6}\sec} = 33.6\frac{cm}{s}$$

$$\vec{v}_{yf_x} = \frac{x_{y2} - x_{y1}}{\Delta t} = \frac{10.5 - 10.3}{0.041\overline{6}} = 4.8\frac{cm}{s}$$

$$\vec{v}_{yf_y} = \frac{y_{y2} - y_{y1}}{\Delta t} = \frac{17.0 - 17.4}{0.041\overline{6}} = -9.6\frac{cm}{s}$$

$$a^2 + b^2 = c^2 \Rightarrow v_{yf}{}^2 = v_{yf_x}{}^2 + v_{yf_y}{}^2 \Rightarrow v_{yf} = \sqrt{v_{yf_x}{}^2 + v_{yf_y}{}^2} = \sqrt{4.8^2 + \left(-9.6\right)^2} = 10.7331 \approx 10.7\frac{cm}{s}$$

$$\tan \ _{yf} = \frac{O}{A} = \frac{v_{yf_y}}{v_{yf_x}} \Rightarrow \ _{yf} = \tan^{-1}\left(\frac{v_{yf_y}}{v_{yf_x}}\right) = \tan^{-1}\left(\frac{-9.6}{4.8}\right) = -63.435 \approx -63.4^\circ$$

$$\Rightarrow \vec{v}_{yf} \approx 10.7\frac{cm}{s} @ 63.4^\circ S\ of\ E$$

$$\vec{v}_{rf_x} = \frac{x_{r2} - x_{r1}}{\Delta t} = \frac{15.0 - 13.7}{0.041\overline{6}} = 31.2\frac{cm}{s}$$

$$\vec{v}_{rf_y} = \frac{y_{r2} - y_{r1}}{\Delta t} = \frac{15.2 - 14.9}{0.041\overline{6}} = 7.2\frac{cm}{s}$$

$$a^2 + b^2 = c^2 \Rightarrow v_{rf}{}^2 = v_{rf_x}{}^2 + v_{rf_y}{}^2 \Rightarrow v_{rf} = \sqrt{v_{rf_x}{}^2 + v_{rf_y}{}^2} = \sqrt{31.2^2 + 7.2^2} = 32.0999 \approx 32.0\frac{cm}{s}$$

$$\tan \ _{rf} = \frac{O}{A} = \frac{v_{rf_y}}{v_{rf_x}} \Rightarrow \ _{rf} = \tan^{-1}\left(\frac{v_{rf_y}}{v_{rf_x}}\right) = \tan^{-1}\left(\frac{7.2}{31.2}\right) = 12.995 \approx 13.0^\circ$$

$$\Rightarrow \vec{v}_{rf} \approx 32.0\frac{cm}{s} @ 13.0^\circ N\ of\ E$$