ball A and ball B both moving initially, 1-Dimension :
"1" stands for 'before' collision (initial) and "2" stands for 'after' collision (final)

$$\frac{(m_A - m_B)v_{A1} + 2m_B v_{B1}}{m_B + m_A} = v_{A2}$$

$$\frac{(m_B - m_A)v_{B1} + 2m_A v_{A1}}{m_B + m_A} = v_{B2}$$

It's dramatically more complicated in 2-D because only momentum is conserved separately in x and y dimensions. Kinetic energy is conserved when looking at the total final v of the balls (not the $v_{x\ final}$ and $v_{y\ final}$ separately)

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2-D both moving

Final V in x direction for ball A

$V_{\text{final X A}}$ =

$$= \frac{(m_A - m_B)(v_{AX}\cos\theta + v_{AY}\sin\theta) + 2m_B(v_{BX}\cos\theta + v_{BY}\sin\theta)}{m_B + m_A}\cos\theta - (v_{AX}\sin\theta + v_{AY}\cos\theta)\sin\theta$$

Final V in y direction for ball A

$V_{\text{final Y A}}$ =

$$= \frac{(m_A - m_B)(v_{AX}\cos\theta + v_{AY}\sin\theta) + 2m_B(v_{BX}\cos\theta + v_{BY}\sin\theta)}{m_B + m_A}\sin\theta + (v_{AX}\sin\theta + v_{AY}\cos\theta)\cos\theta$$

theta is the angle of approach to the horizontal, that is, between the line connecting the centers of mass and the horizontal (for example see next slide --->)

Final V in x direction for ball B

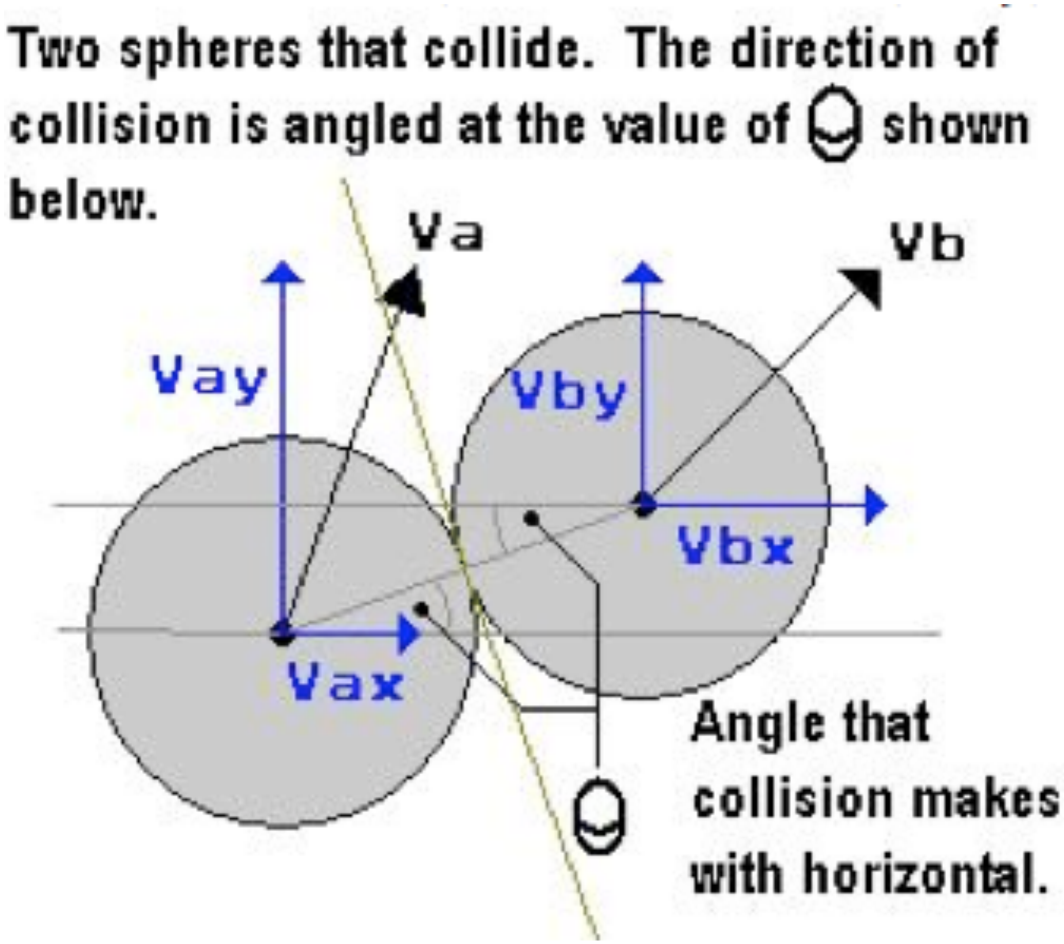
$V_{\text{final X B}}$ =

$$= \frac{(m_B - m_A)(v_{BX}\cos\theta + v_{BY}\sin\theta) + 2m_A(v_{AX}\cos\theta + v_{AY}\sin\theta)}{m_B + m_A}\cos\theta - (v_{BX}\sin\theta + v_{BY}\cos\theta)\sin\theta$$

Final V in y direction for ball B

$V_{\text{final Y B}}$ =

$$= \frac{(m_B - m_A)(v_{BX}\cos\theta + v_{BY}\sin\theta) + 2m_A(v_{AX}\cos\theta + v_{AY}\sin\theta)}{m_B + m_A}\sin\theta + (v_{BX}\sin\theta + v_{BY}\cos\theta)\cos\theta$$



To get the final Total velocities for each ball, use the values obtained for the components on previous slide in pythagoras equation ($v^2 = v_x^2 + v_y^2$)