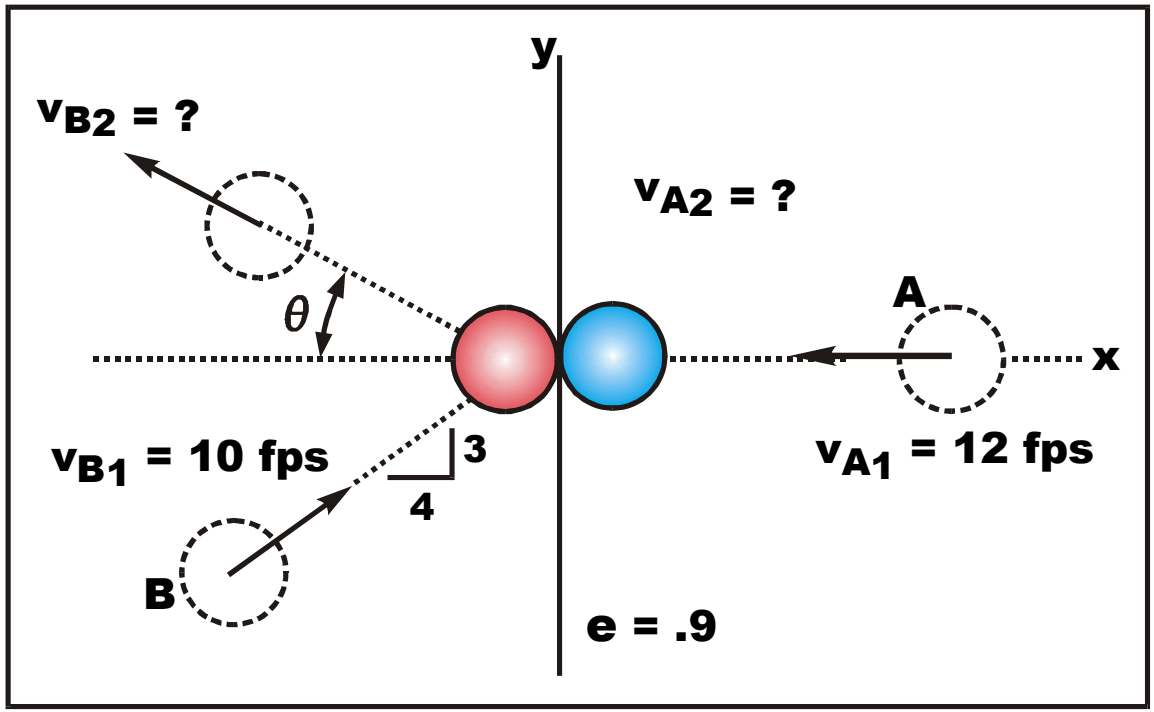
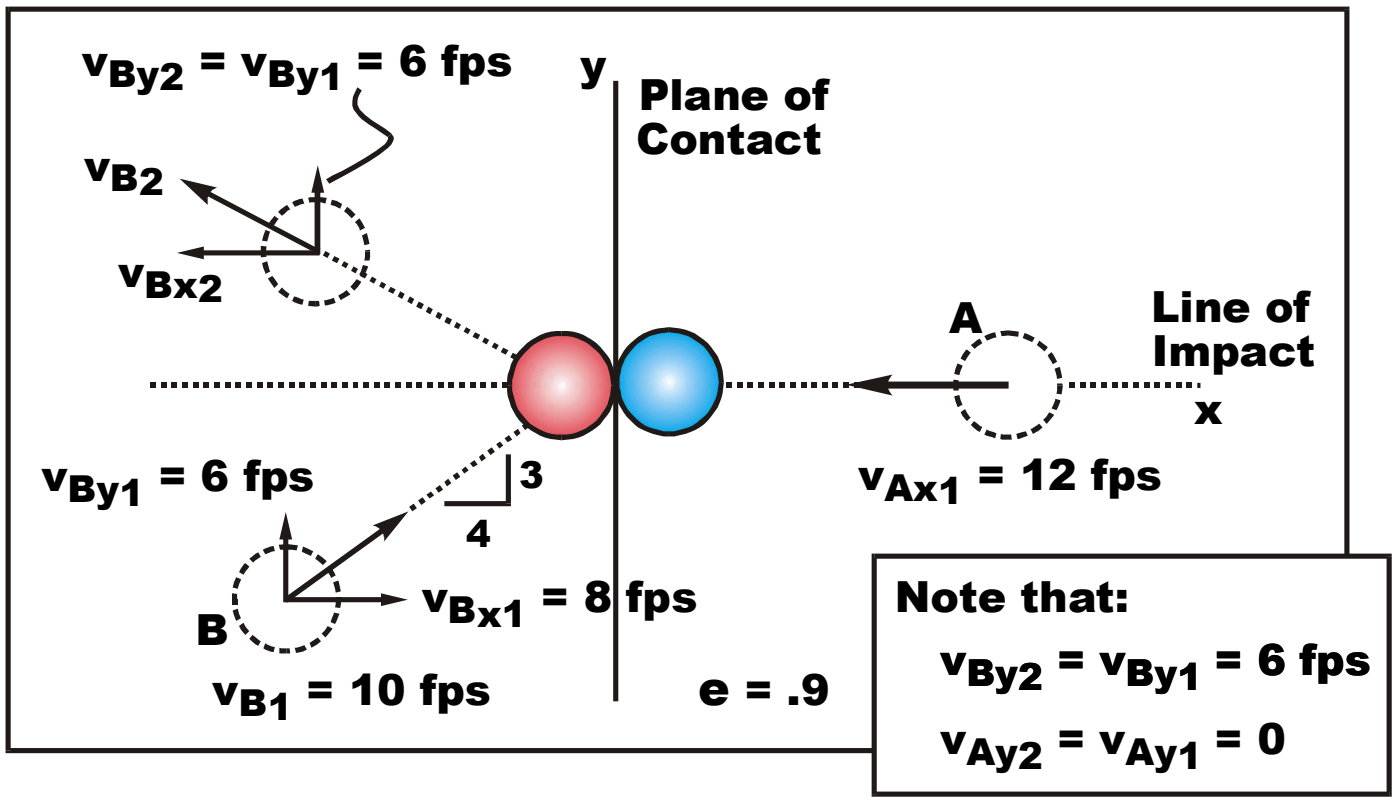
Particle Impact: Ex Prob 2 (Semi-Oblique)

For the impact problem shown below, please determine the velocities of particles A and B after impact. (A and B are identical, thus mass A = mass B)

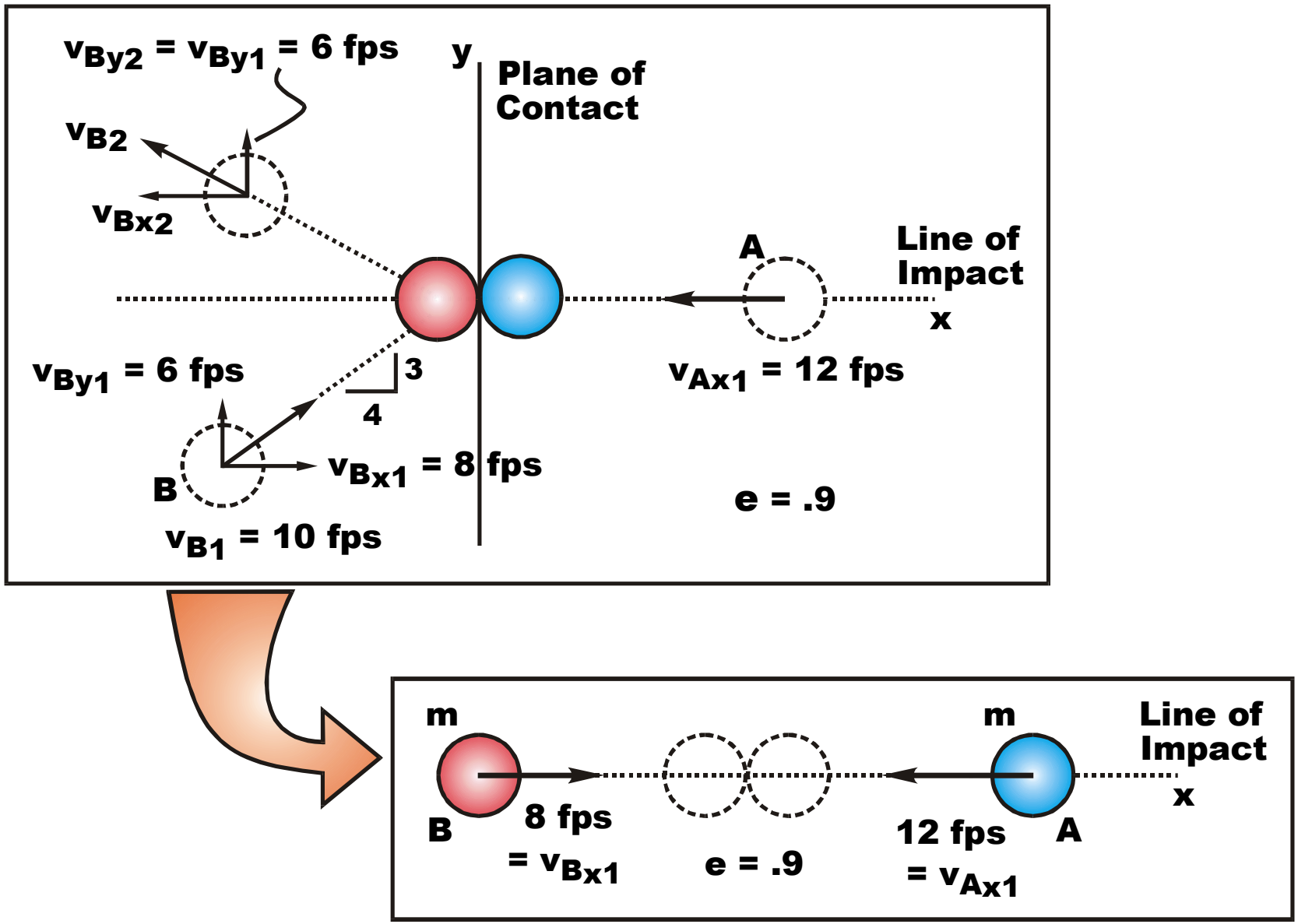


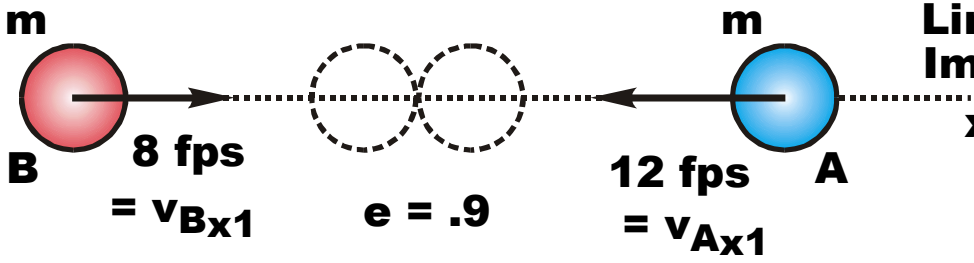
Think! It seems that v_{B2} will be at some angle as shown. What about v_{A2}?

Identify Plane of Contact, Line of Impact,
and resolve vectors into components.



What about v_{A2}? If there is no impulse of friction along the plane of contact, then no y momentum can be imparted to A. So, v_{A2} will act along the x axis. It's y component will remain zero. (That's why I call this a "semi-oblique" problem.)


$v_{By2} = v_{By1} = 6$ fps
y
Plane of Contact
v_{B2}
v_{Bx2}
A
Line of Impact
x
$v_{By1} = 6$ fps
3
4
$v_{Ax1} = 12$ fps
$v_{Bx1} = 8$ fps
B
e = .9
$v_{B1} = 10$ fps
m
m
Line of Impact
B
8 fps
$= v_{Bx1}$
e = .9
12 fps
$= v_{Ax1}$
A
x



$\xrightarrow{+}$ $m_A v_{Ax1} + m_B v_{Bx1} = m_A v_{Ax2} + m_B v_{Bx2}$

$\xrightarrow{+}$ $e = \dfrac{(v_{Bx2} - v_{Ax2})}{(v_{Ax1} - v_{Bx1})}$

$\xrightarrow{+}$ $m(+8) + m(-12) = mv_{Ax2} + mv_{Bx2}$

$-4 = v_{Ax2} + v_{Bx2}$ ①

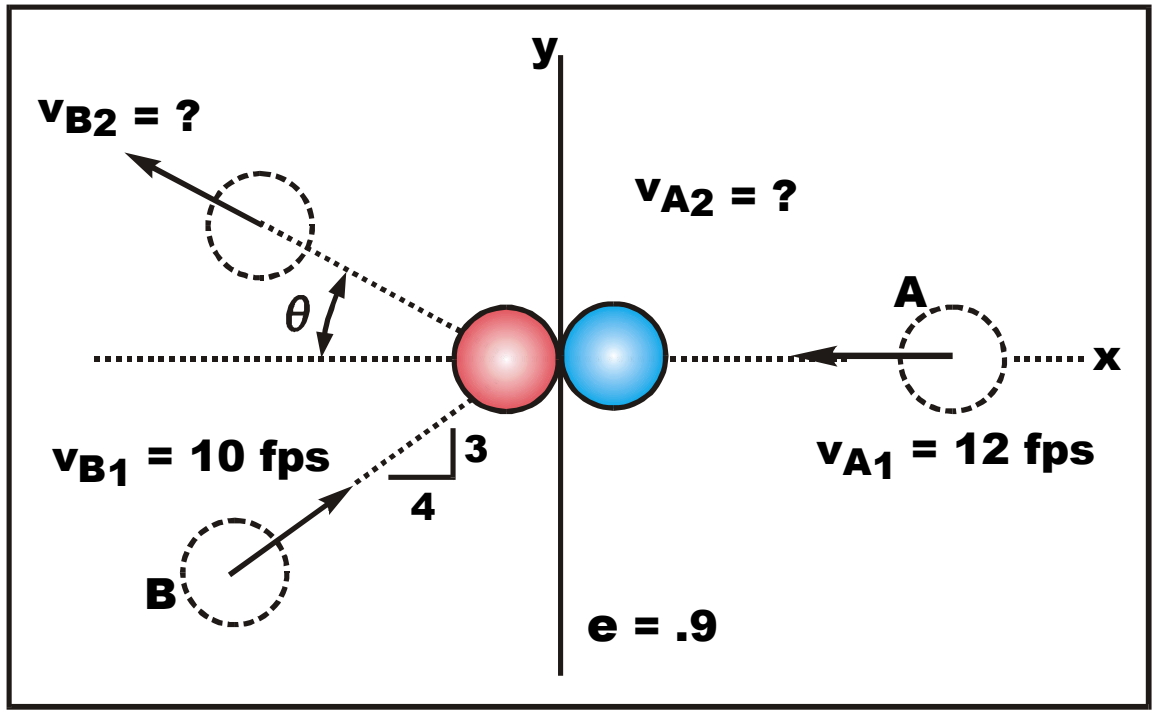
$\xrightarrow{+}$ $e = \dfrac{(v_{Bx2} - v_{Ax2})}{(v_{Ax1} - v_{Bx1})}$ $\quad .9 = \dfrac{v_{Bx2} - v_{Ax2}}{-12 - (8)}$

$-20(.8) = -18 = v_{Bx2} - v_{Ax2}$ ②

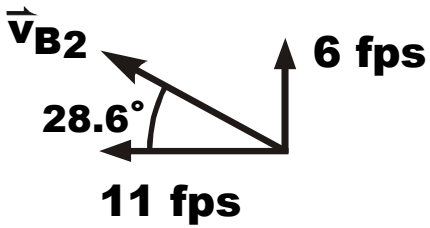
Solve equations ① and ②:

$v_{Bx2} = -11 \text{ fps} = 11 \text{ fps} \leftarrow$

$v_{Ax2} = +7 \text{ fps} \rightarrow$

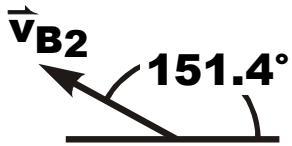


Calculate the final magnitude and angle of $\vec{v}_{B2}$:



$$\vec{v}_{B2} = [\, -11\,\hat{i} + 6\,\hat{j}\,] \text{ fps}$$

$$= [\, 12.53 \text{ fps} @ 151.4^\circ]$$



$$\vec{v}_{A2} = 7 \text{ fps} \longrightarrow$$