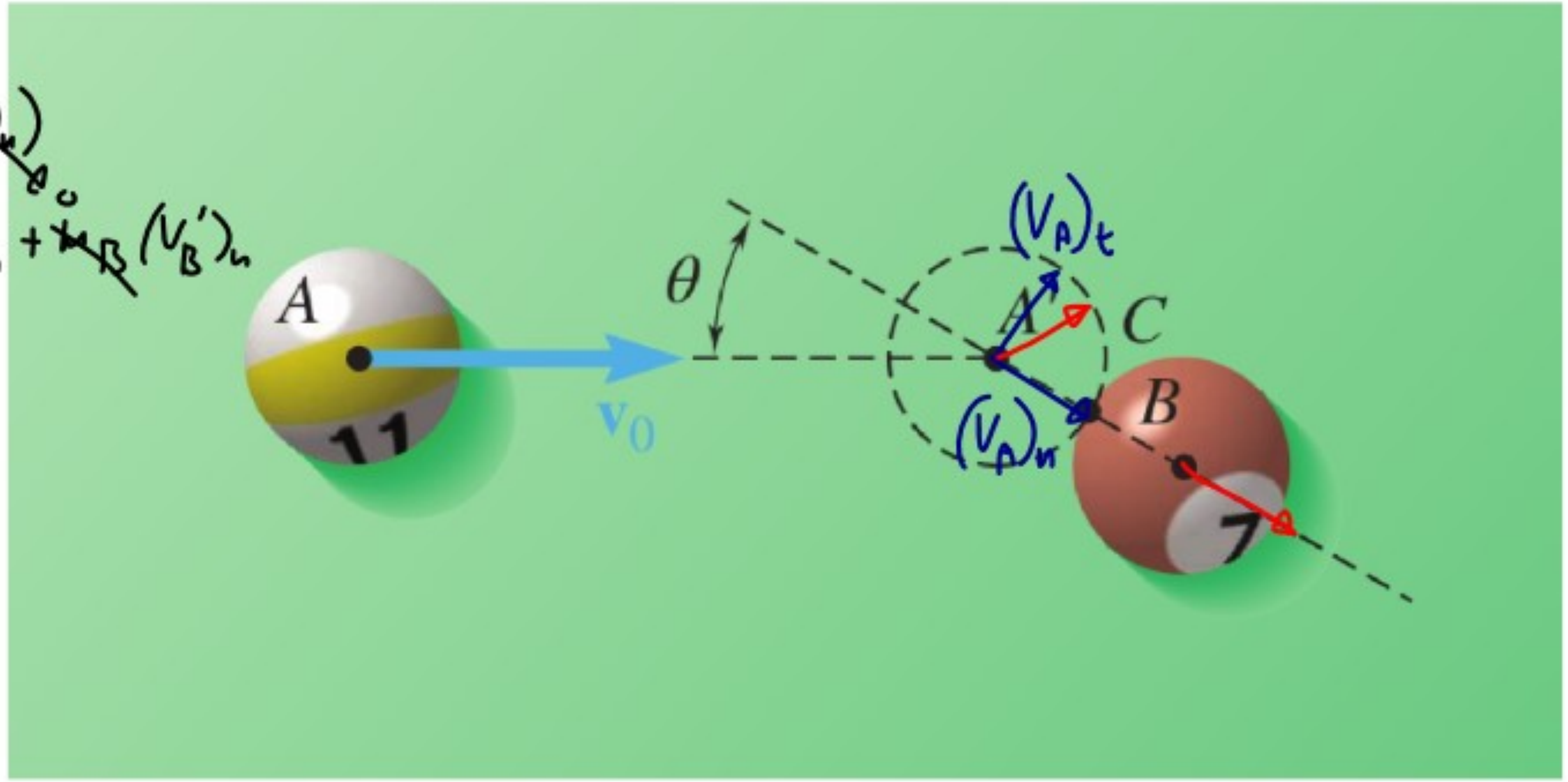
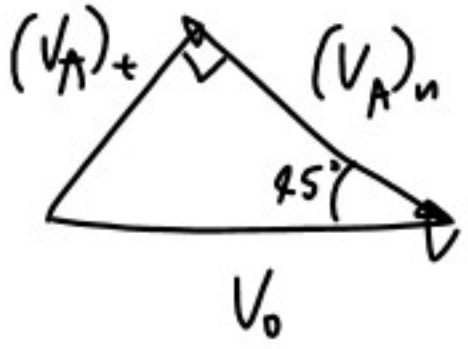
Two identical billiard balls can move freely on a horizontal table. Ball A has a velocity $\mathbf{v}_0$ as shown and hits ball B, which is at rest, at a point C defined by $\theta = 45°$. Knowing that the coefficient of restitution between the two balls is $e = 0.8$ and assuming no friction, determine the velocity of each ball after impact.

$(V_B')_n - (V_A')_n = e((V_A)_n - \cancel{(V_B)_n})$ 0

$\cancel{m_A}(V_A)_n + \cancel{m_B(V_B)_n} = \cancel{m_A}(V_A')_n + \cancel{m_B}(V_B')_n$ 0





$(V_A)_t = V_0 \sin 45$

$(V_A)_n = V_0 \cos 45$

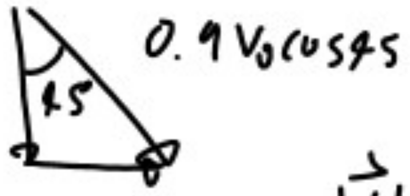
$V_B = 0$

$$(V_B')_n - (V_A')_n = 0.8\, V_0 \cos 45$$

$$(V_B')_n = 0.8 V_0 \cos 45 + (V_A')_n$$

$$= 0.8 V_0 \cos 45 + 0.1\, V_0 \cos 45$$

$$= 0.9\, V_0 \cos 45$$



$$\vec{V}_B' = 0.9\, V_0 \cos 45 \sin 45\, i - 0.9\, V_0 \cos 45 \cos 45\, j$$

$$= 0.45 V_0\, i - 0.45 V_0\, j$$

$$(V_A')_n + (V_B')_n = (V_A)_n$$

$$= V_0 \cos 45$$

$$(V_A')_n + 0.8\, V_0 \cos 45 + (V_A')_n = V_0 \cos 45$$

$$2(V_A')_n = V_0 \cos 45 - 0.8\, V_0 \cos 45 = 0.2\, V_0 \cos 45$$

$$(V_A')_n = 0.1 V_0 \cos 45$$

$$\cos 45 = \sin 45$$

$$\cos^2 45 = 0.5$$

$$(\vec{V}_A')_n = 0.1V_0\cos45\sin45\, i - 0.1V_0\cos45\cos45\, j$$

$$= 0.05V_0\, i - 0.05V_0\, j$$

$$(V_A')_t = (V_A)_t = V_0\sin45$$

$$(V_A')_t = V_0\sin45\cos45\, i + V_0\sin45\sin45\, j$$

$$= 0.5V_0\, i + 0.5V_0\, j$$

$$V_A' = (V_A')_t + (V_A')_n$$

$$= V_0(0.05+0.5)\, i + V_0(-0.05+0.5)\, j$$

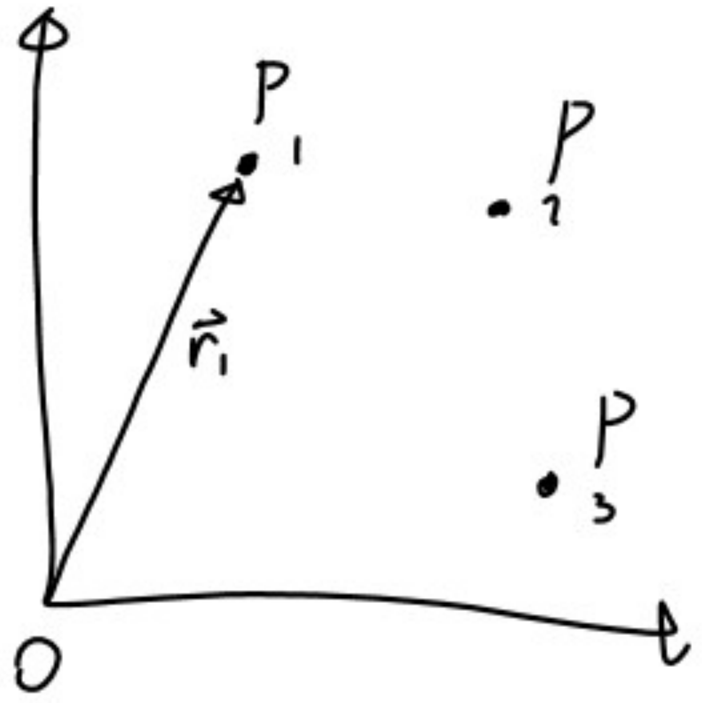
$$= 0.55V_0\, i + 0.45V_0\, j$$

Systems Particles

$$\vec{F}_i + \sum_{j=1}^{n} \vec{f}_{ij} = m_i \vec{a}_i$$

$\vec{F}_i$ external force on P_i

$\vec{f}_{ij}$ force on P_i from P_j

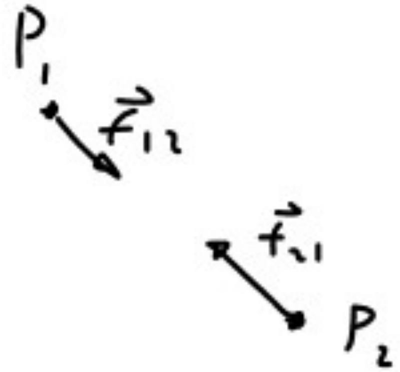


$$\vec{F}_1 + \vec{f}_{12} + \vec{f}_{13} = m_1 \vec{a}_1$$

Moments about O

$$\vec{r}_i \times \vec{F}_i + \sum_{j=1}^{n} \vec{r}_i \times \vec{f}_{ij} = \vec{r}_i \times m_i \vec{a}_i$$

$$\sum_{i=1}^{n} \sum_{j=1}^{n} \vec{f}_{ij} = 0$$



$$\vec{f}_{12} = -\vec{f}_{21}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{n} \vec{r}_i \times \vec{f}_{ij} = 0$$

$$\sum_{i=1}^{n} \vec{F}_i = \sum_{i=1}^{n} m_i \vec{a}_i$$

$$\sum_{i=1}^{n} \vec{r}_i \times \vec{F}_i = \sum_{j=1}^{n} \vec{r}_i \times m_i \vec{a}_i$$

Momentum of a System of Particles

$\vec{L}_i = m_i \vec{v}_i$

$$\vec{L} = \sum_{i=1}^{n} m_i \vec{v}_i = \sum_{i=1}^{n} \vec{L}_i$$

$$\vec{H}_o = \sum_{i=1}^{n} \vec{r}_i \times m_i \vec{v}_i$$

$$\sum_{i=1}^{n} \vec{F}_i = \dot{\vec{L}}$$

$$\sum_{i=1}^{n} (M_o)_i = \dot{\vec{H}}_o$$

Motion of mass center

$$m\bar{r} = \sum_{i=1}^{n} m_i \vec{r}_i \qquad m\bar{x} = \sum_{i=1}^{n} m_i x_i$$

$$\sum_{i=1}^{n} \vec{F}_i = m\bar{a}$$

$\bar{r}$ location of mass center

m total system mass

$\bar{a}$ acceleration of mass center