**Advanced Dynamics**
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**Module No # 03**
**Lecture No # 16**
**Particle Impact – II**

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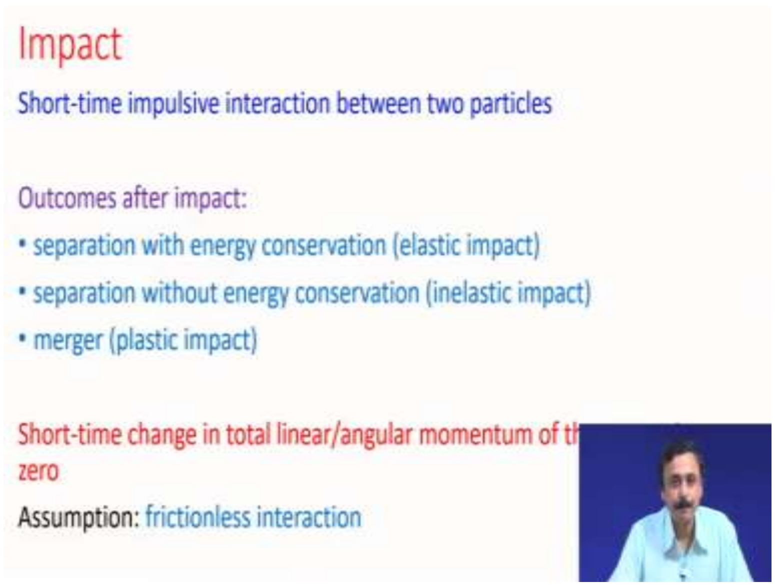


In this lecture, we are going to look at some problems and the application of the theory that we have developed.

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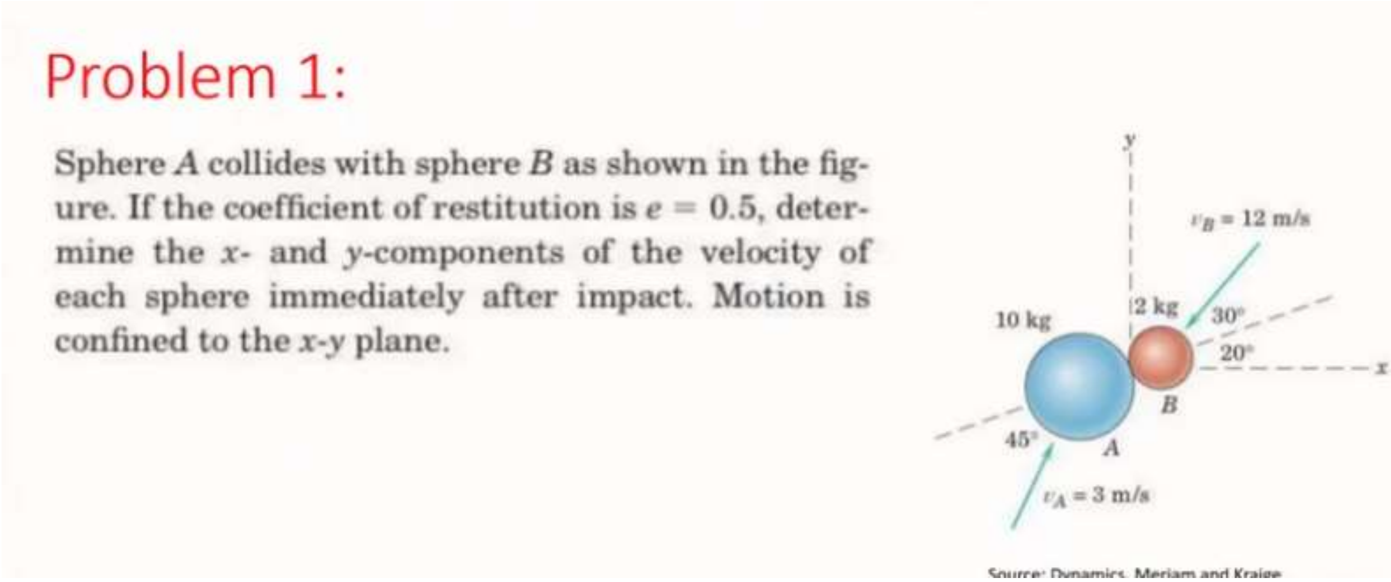


The first problem statement is shown above. The detailed solution is shown in the following 2 slides. We solve the problem first using the tangent-normal coordinates at the contact. Later, we transform the vectors in the x-y coordinates as discussed below in detail.

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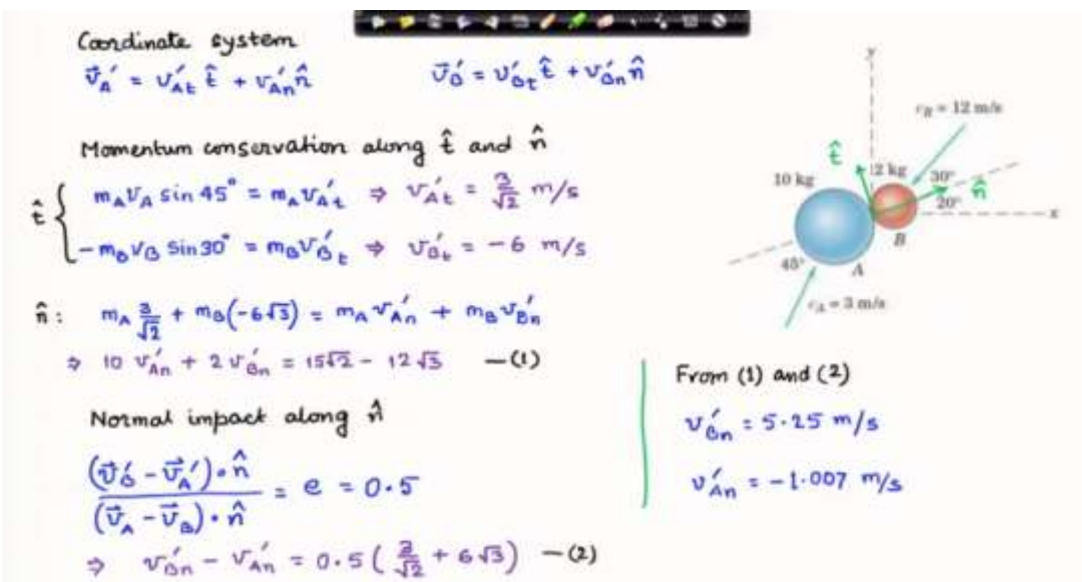

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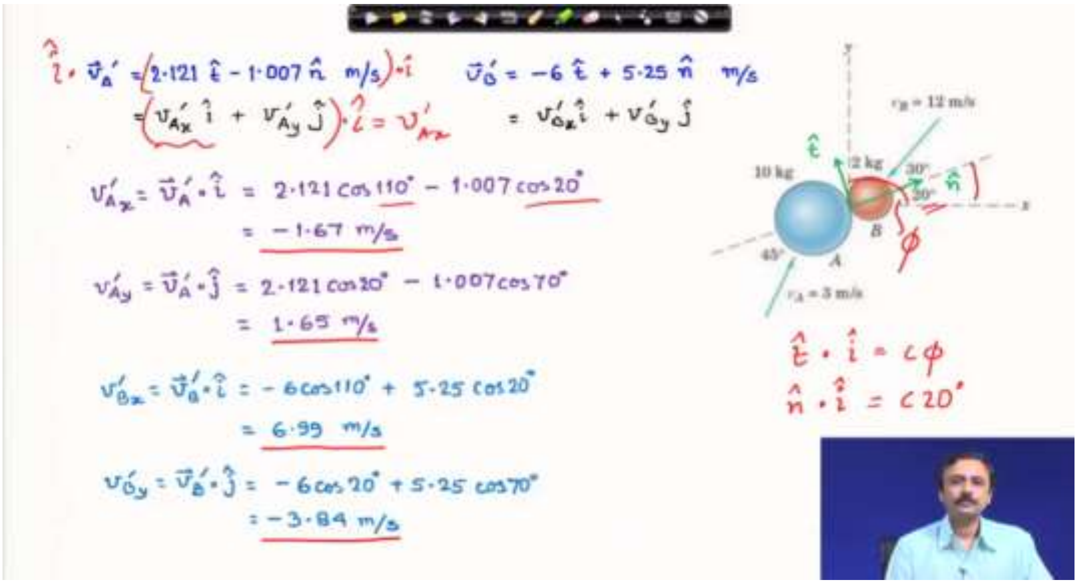


The final solution in terms of the components of the outgoing velocity vectors in the x-y coordinate system is presented in the slide above.

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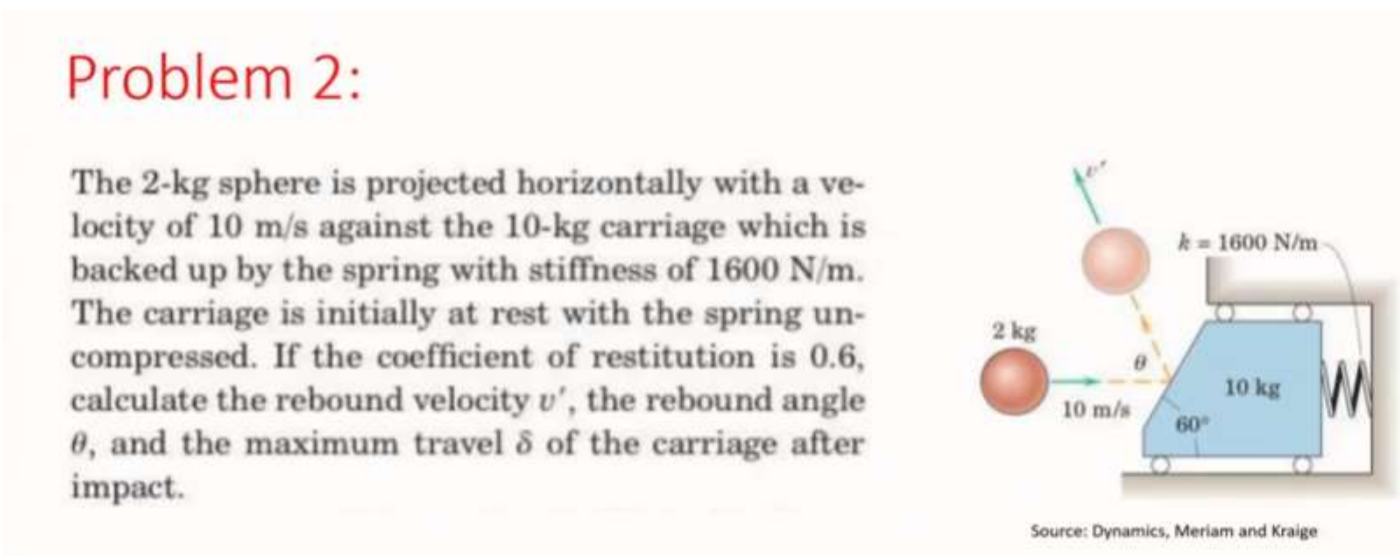


The second problem statement is presented above. The detailed solution steps are presented in the next 2 following slides.

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Coordinate system

$\vec{v} = 10\hat{i}$ m/s $= 10(-\cos 30^\circ\, \hat{n} + \sin 30^\circ\, \hat{t})$ m/s

$\vec{v}' = v_n'\, \hat{n} + v_t'\, \hat{t}$

$\vec{V} = 0$, $\quad \vec{V}' = V'\hat{i} = V'(-\cos 30^\circ\, \hat{n} + \sin 30^\circ\, \hat{t})$

Momentum conservation along $\hat{t}$ and $\hat{i}$

$\hat{t}$: $\quad m\vec{v}\cdot\hat{t} = m\vec{v}'\cdot\hat{t} \Rightarrow v_t' = 5$ m/s

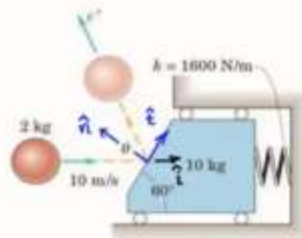
$\hat{i}$: $\quad m\vec{v}\cdot\hat{i} = m\vec{v}'\cdot\hat{i} + M\vec{V}'\cdot\hat{i}$

$\Rightarrow 2(10) = 2\left[v_n'(-\cos 30^\circ) + v_t'\cos 60^\circ\right] + 10V'$

$\Rightarrow 15 = -\sqrt{3}\, v_n' + 10V'$

Normal impact $\quad \dfrac{(\vec{v}' - \vec{V}')\cdot\hat{n}}{(0 - \vec{v})\cdot\hat{n}} = e = 0.6 \Rightarrow v_n' + V'\cos 30^\circ = 0.6(10\cos 30^\circ)$

$\Rightarrow v_n' + V'\dfrac{\sqrt{3}}{2} = 3\sqrt{3}$

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$$\left.\begin{aligned} -\sqrt{3}\, v_n' + 10V' &= 15 \\ v_n' + V'\frac{\sqrt{3}}{2} &= 3\sqrt{3} \end{aligned}\right\} \quad \begin{aligned} V' &= 2.087 \text{ m/s} \\ v_n &= 3.389 \text{ m/s} \end{aligned}$$

$\vec{v}' = 3.389\, \hat{n} + 5\, \hat{t}$ m/s

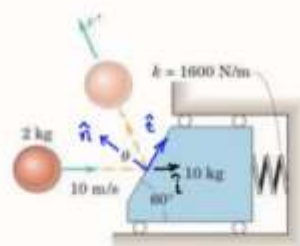
$|\vec{v}'| = 6.04$ m/s

$\cos\theta = (-\hat{i})\cdot\dfrac{\vec{v}'}{|\vec{v}'|} = -\dfrac{1}{6.04}\left[3.389\left(-\dfrac{\sqrt{3}}{2}\right) + 5\left(\dfrac{1}{2}\right)\right]$

$\Rightarrow \theta = 85.9^\circ$

$\vec{V}' = 2.087\, \hat{i}$ m/s

Energy conservation: $\frac{1}{2}MV'^2 = \frac{1}{2}k\delta^2 \Rightarrow \delta = \sqrt{\frac{M}{k}}\, V' = 0.165$ m



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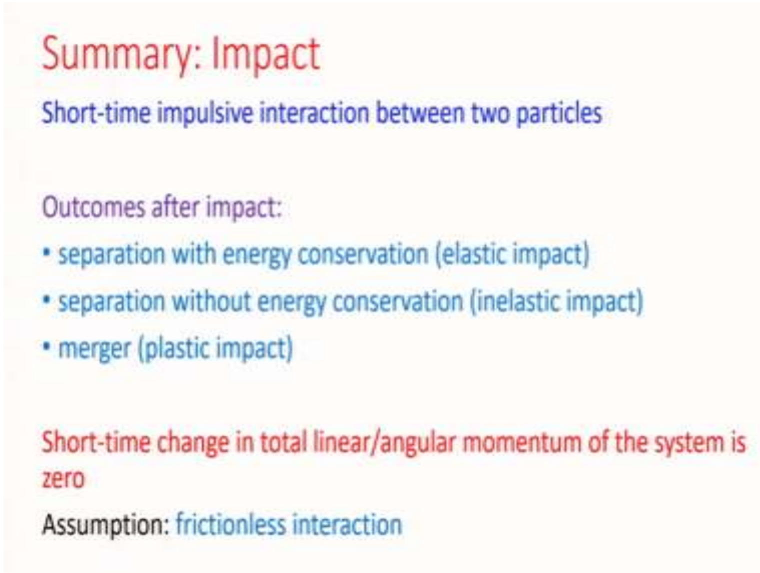


The summary of discussions in this lecture is presented above.