Lecture 11: Section 1

Tuesday, January 25, 2022 8:49 AM

*. $\vec{F} = \vec{F}^{C} + \vec{F}^{NC}$ ME is not conserved

$W = W^{C} + W^{NC}$

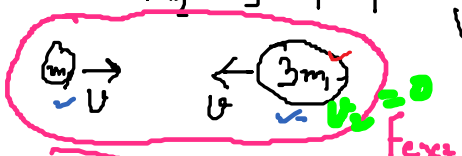
*. Collisions →

- Elastic: $Q = 0$, $K.E_i = K.E_f$, $P_i = P_f$
- Inelastic: $Q \neq 0$

	Initial	Final
m_1	v_1	v_1'
m_2	v_2	v_2'

$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2 + Q$

Ex: Initially m_1, $m_2 = 3m_1$; Final $v_1 = ?$, $v_2 = ?$



$F_{ext} = 0$

Elastic

$P_i = P_f$

$m_1v - 3m_1v = m_1v_1 + 3m_1v_2$

$\Rightarrow \boxed{v_1 = -2v - 3v_2}$

k.E: $\frac{1}{2}m_1v^2 + \frac{1}{2}3m_1v^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}3m_1v_2^2$

$K.E_i = \frac{1}{2}m_1v^2 + \frac{1}{2}3m_1v^2$, $K.E_f =$

$4v^2 = v_1^2 + 3v_2^2$

$= (-2v - 3v_2)^2 + 3v_2^2$

$4v^2 = 4v^2 + 9v_2^2 + 12vv_2 + 3v_2^2$

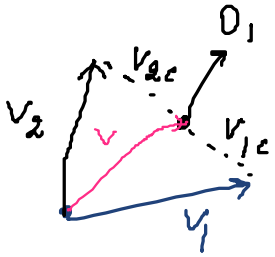
$\boxed{12(vv_2 + v_2^2) = 0}$

$v_2 = 0, -v$

$v_2 = 0$	$v_2 = -v$
$v_1 = -2v$	$v_1 = v$

C.M frame of reference →

(m) v_1, v_1' $\quad \vec{V}' = \frac{m_1v_1' + m_2v_2'}{m_1 + m_2}$



(m) v_2, v_2' $\quad P_{1c} = m_1v_{1c} = m_1(\vec{v_1} - \vec{V}) = \frac{m_1m_2}{m_1 + m_2}(\vec{v_1} - \vec{v_2})$

$+$

$\rightarrow P_{2c} = m_2v_{2c} = m_2(\vec{v_2} - \vec{V}) = -\frac{m_1m_2}{m_1 + m_2}(\vec{v_1} - \vec{v_2})$

C.M

$\rightarrow v_{1c} - v_{2c} = (v_1 - v_2) - \frac{(m_1 v_1 + m_2 v_2)}{m_1 + m_2} = (v_1 - v_2)$

C.M

$P_i = P_{1c} + P_{2c} = 0 \Rightarrow P_f = P_{1c}' + P_{2c}' = 0$

Elastic Collision →

$m_1 v_{1c} - m_2 v_{2c} = 0 \Rightarrow \boxed{v_{2c} = \frac{m_1}{m_2} v_{1c}}$, $v_{2c}' = \frac{m_1}{m_2} v_{1c}'$

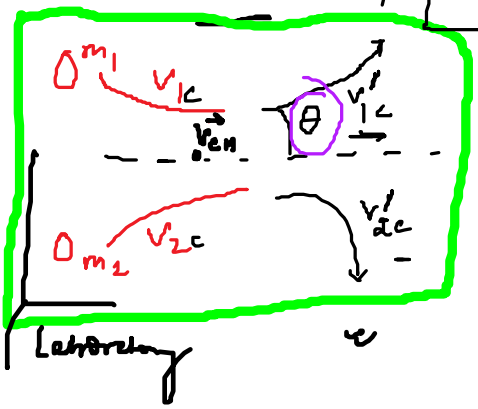
K.E$_i$ = K.E$_f$

$\frac{1}{2} m_1 v_{1c}^2 + \frac{1}{2} m_2 v_{2c}^2 = \frac{1}{2} m_1 v_{1c}'^2 + \frac{1}{2} m_2 v_{2c}'^2$

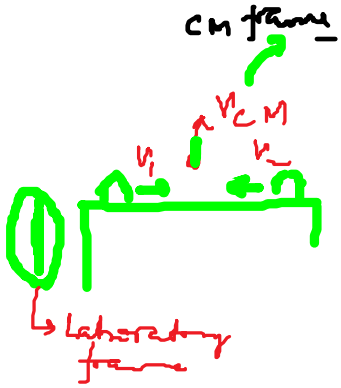
$\frac{1}{2}\left[m_1 + \frac{m_1^2}{m_2}\right] v_{1c}^2 = \frac{1}{2}\left[m_1 + \frac{m_1^2}{m_2}\right] v_{1c}'^2$

$\boxed{v_{1c}^2 = v_{1c}'^2}$ & $\boxed{v_{2c}^2 = v_{2c}'^2}$

Elastic



Changing Scattering angle.



Example →

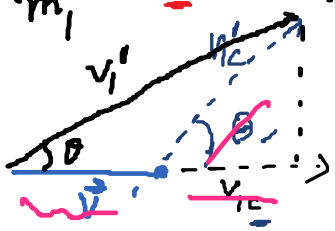
Elastic

Rest

Laboratory :-

$0 \rightarrow v_1$ $\quad$ 0 c

m_1 $\quad$ m_2



$\vec{V} = \frac{m_1 v_1 + m_2 \overset{0}{v_2}}{m_1 + m_2} = \frac{m_1 v_1}{m_1 + m_2}$ c

CM

$v_{1c} = v_1 - v = \frac{m_2 v_1}{m_1 + m_2}$ c

$= v_1 - \left(\frac{m_1 v_1}{m_1 + m_2}\right)$

$\Rightarrow \frac{v}{v_{1c}} = \frac{m_1}{m_2}$

$v_{2c} = v_2 - v = -\frac{m_1 v_1}{m_1 + m_2}$

$v_{1c}' = v_{1c}$

$\tan\theta = \frac{v_{1c}' \sin\theta}{} = v_{1c} \sin\theta$

$$\tan\theta = \frac{V_{1c}' \sin\phi}{V + V_{1c}' \cos\phi} = \frac{V_{1c}\sin\phi}{V + V_{1c}\cos\phi}$$

$$\frac{V}{V_{1c}} =$$

$$\tan\theta = \frac{\sin\phi}{\frac{V}{V_{1c}} + \cos\phi}$$

$$\tan\theta = \frac{\sin\phi}{\frac{m_1}{m_2} + \cos\phi}$$

Oscillation:

- Undamped
- Damped
- Forced damped oscillation