$\Rightarrow q = 2u\sqrt{3} - u\sqrt{3}(1 - e)$

$= u\sqrt{3} + eu\sqrt{3}$

$\Rightarrow q = u\sqrt{3}(1 + e)$

$\Rightarrow$ velocity of 2nd sphere after impact $= u\sqrt{3}(1 + e)\vec{i}$

$K.E._{before} = \frac{1}{2}(m)(4u)^2$

$= 8mu^2$

$K.E._{after} = \frac{1}{2}(m)[\{u\sqrt{3}(1 - e)\}^2 + \{2u\}^2] + \frac{1}{2}(m)[u\sqrt{3}(1 + e)]^2$

$= \frac{m}{2}[3u^2(1 - 2e + e^2) + 4u^2 + 3u^2(1 + 2e + e^2)]$

$= \frac{m}{2}[10u^2 + 6e^2u^2]$

$= mu^2(5 + 3e^2)$

Loss $= 8mu^2 - mu^2(5 + 3e^2)$

$= 3mu^2 - 3mu^2e^2$

$= 3mu^2(1 - e^2)$

Q. 4. (i)

	Before	**(Mass)**	**After**
A:	$\frac{u}{2}\vec{i} + \frac{u\sqrt{3}}{2}\vec{j}$	m	$p\vec{i} + \frac{u\sqrt{3}}{2}\vec{j}$
B:	$0\vec{i} + 0\vec{j}$	m	$q\vec{i} + 0\vec{j}$

$$\tan\theta = \frac{\frac{u\sqrt{3}}{2}}{p} = \frac{u\sqrt{3}}{2p}$$

Momentum in the $\vec{i}$ – direction is conserved

$\Rightarrow m\left(\frac{u}{2}\right) + m(0) = m(p) + m(q)$ … divide by m

$\Rightarrow p + q = \frac{u}{2}$

$\Rightarrow 2p + 2q = u$ **Equation 1**

$\frac{p - q}{\frac{u}{2} - 0} = -e$

$\Rightarrow p - q = -\frac{eu}{2}$

$2p - 2q = -eu$ **Equation 2**

Adding equations **1** and **2** we get

$4p = u(1 - e)$

$\Rightarrow p = \frac{u}{4}(1 - e)$

$q = \frac{u}{2} - p$ … from **Equation 1**

$\Rightarrow q = \frac{u}{2} - \frac{u}{4}(1 - e) = \frac{u}{4} + \frac{ue}{4} = \frac{u}{4}(1 + e)$

$\tan\theta = \frac{u\sqrt{3}}{2p}$

$\Rightarrow p = \frac{u\sqrt{3}}{2\tan\theta}$

$\Rightarrow \frac{u\sqrt{3}}{2\tan\theta} = \frac{u}{4}(1 - e)$ … multiply by $\frac{2}{u}$

$\Rightarrow \frac{\sqrt{3}}{\tan\theta} = \frac{1}{2}(1 - e)$

$\Rightarrow (1 - e)\tan\theta = 2\sqrt{3}$

$\Rightarrow \tan\theta = \frac{2\sqrt{3}}{1 - e}$