(iv) $m_1 = \frac{5}{5} = 1, m_2 = \frac{5}{2\frac{1}{2}} = 2$

$\therefore \tan\theta = \pm\frac{1-2}{1+(1)(2)}$

$= \pm\frac{1}{3} = 0.3333$

$\therefore \theta = 18°\ 26'$ (Since θ is acute)

Q. 5. (i) $u_1 = 5\cos\theta\vec{i} + 5\sin\theta\vec{j}$

$= 5\left(\frac{4}{5}\right)\vec{i} + 5\left(\frac{3}{5}\right)\vec{j}$

$= 4\vec{i} + 3\vec{j}$

$u_2 = -4\sqrt{2}\cos 45°\vec{i} + 4\sqrt{2}\sin 45°\vec{j}$

$= -4\vec{i} + 4\vec{j}$

Before	(Mass)	After
$4\vec{i} + 3\vec{j}$	2	$p\vec{i} + 3\vec{j}$
$-4\vec{i} + 4\vec{j}$	3	$q\vec{i} + 4\vec{j}$

$2(4) + 3(-4) = 2p + 3q$

$\Rightarrow 2p + 3q = -4$

$\frac{p-q}{4+4} = \frac{-7}{8}$

$\Rightarrow p - q = -7$

Solving these gives $p = -5, q = 2$.

(ii) $-5\vec{i} + 3\vec{j}, 2\vec{i} + 4\vec{j}$ m/s

(iii) $\text{K.E.}_{\text{before}} = \frac{1}{2}(2)(4^2 + 3^2) + \frac{1}{2}(3)((-4)^2 + 4^2)$

$= 73$ J

$\text{K.E.}_{\text{after}} = \frac{1}{2}(2)((-5)^2 + 3^2) + \frac{1}{2}(3)(2^2 + 4^2)$

$= 64$ J

Loss $= 73 - 64 = 9$ J

Q. 6.

Before	(Mass)	(After)
$5\vec{i} + 4\vec{j}$	5	$p\vec{i} + 4\vec{j}$
$-2\vec{i} - 3\vec{j}$	10	$q\vec{i} - 3\vec{j}$

$5(5) + 10(-2) = 5p + 10q$

$\Rightarrow p + 2q = 1$

$\frac{p-q}{5+2} = \frac{1}{7}$

$\Rightarrow p - q = -1$

Solving these gives: $p = -\frac{1}{3}, q = \frac{2}{3}$.

(i) $-\frac{1}{3}\vec{i} + 4\vec{j}$

(ii) $\frac{2}{3}\vec{i} - 3\vec{j}$

$\text{K.E.}_{\text{before}} = \frac{1}{2}(5)(25 + 16) + \frac{1}{2}(10)(4 + q)$

$= 102.5 + 65$

$= 167.5$ J

$\text{K.E.}_{\text{after}} = \frac{1}{2}(5)\left(\frac{1}{9} + 16\right) + \frac{1}{2}(10)\left(\frac{4}{9} + 9\right)$

$= \frac{725}{18}$

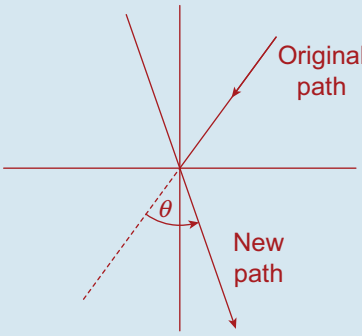
$= \frac{850}{18}$

$= \frac{1,575}{18}$

$= 87.5$ J

Loss $= 167.5 - 87.5 = 80$ J **QED**

(iii)



$M_1 = \frac{-3}{-2} = \frac{3}{2}; \quad M_2 = \frac{-3}{\frac{2}{5}} = \frac{-9}{2}$

$\tan\theta = \pm\frac{\frac{3}{2} + \frac{9}{2}}{1 - \frac{27}{4}} = \pm\frac{24}{23}$

$\tan\theta = \frac{24}{23}$, since θ is acute.

Q. 7.

Before	(Mass)	(After)
$p\vec{i} + q\vec{j}$	4	$0\vec{i} + q\vec{j}$
$0\vec{i} + 0\vec{j}$	m	$r\vec{i} + 0\vec{j}$

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

$\Rightarrow 4p = mr$

N.E.L.

$\frac{0-r}{p-0} = -\frac{4}{7}$

$\Rightarrow 4p = 7r$

$\Rightarrow m = 7$