1996

5 (a)

	mass	velocity before	velocity after
	2m	u	v_1
	m	$-2u$	v_2

PCM $\quad 2m(u) + m(-2u) = 2mv_1 + mv_2$ 5

$$2v_1 + v_2 = 0 \qquad \text{eq...1}$$

NEL $\quad v_1 - v_2 = -e(u + 2u)$ 5

$$v_1 - v_2 = -3eu \qquad \text{eq...2}$$

Solve equations 1 and 2

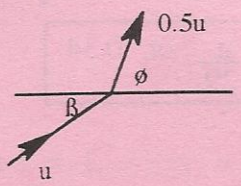
$$v_1 = -eu \quad \text{and} \quad v_2 = 2eu$$ 5

$E_1 = 0.5(2m)u^2 + 0.5(m)(4u^2) = 3mu^2$ 5

$E_2 = 0.5(2m)e^2u^2 + 0.5(m)4e^2u^2 = 3me^2u^2$

$$\Rightarrow \quad \frac{E_2}{E_1} = \frac{3me^2u^2}{3mu^2} \quad \Rightarrow \quad e = \sqrt{\frac{E_2}{E_1}}$$ 5 25

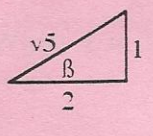
(b)



velocity in vertical direction does not change, therefore

$u \sin\beta = 0.5u \sin\phi$

$$\sin\phi = 2\sin\beta = \frac{2}{\sqrt{5}}$$ 5



$$\Rightarrow \quad \cos\phi = \frac{1}{\sqrt{5}}$$

PCM $\quad mu\cos\beta + m(0) = m(0.5u\cos\phi) + mv_2$ 5

NEL $\quad 0.5u\cos\phi - v_2 = -e\{u\cos\beta - 0\}$ 5

$$0.5u\cos\phi + v_2 = u\cos\beta$$

$$0.5u\cos\phi - v_2 = -eu\cos\beta$$

$$u\cos\phi = (1-e)u\cos\beta$$ 5

$$\frac{1}{\sqrt{5}} = (1-e)\frac{2}{\sqrt{5}}$$

$$\Rightarrow \quad e = 0.5$$ 5 25