5 (b)

PCM $\qquad mu_1 + mu_2 = mv_1 + mv_2$ $\qquad\qquad$ 5

NEL $\qquad v_1 - v_2 = -e(u_1 - u_2)$ $\qquad\qquad$ 5

$$v_1 = \tfrac{1}{2}u_1(1-e) + \tfrac{1}{2}u_2(1+e)$$
$$v_2 = \tfrac{1}{2}u_1(1+e) + \tfrac{1}{2}u_2(1-e)$$

5

$$
\begin{aligned}
\text{Impulse} &= |mv_2 - mu_2| \\
&= \tfrac{1}{2}mu_1(1+e) + \tfrac{1}{2}mu_2(1-e) - mu_2 \\
&= \tfrac{1}{2}mu_1(1+e) - \tfrac{1}{2}mu_2(1+e) \\
&= \tfrac{1}{2}m(u_1 - u_2)(1+e) \\
&= \tfrac{1}{2}mu(1+e)
\end{aligned}
$$

OR

$$
\begin{aligned}
\text{Impulse} &= |mv_1 - mu_1| \\
&= \left|\tfrac{1}{2}mu_1(1-e) + \tfrac{1}{2}mu_2(1+e) - mu_1\right| \\
&= \left|-\tfrac{1}{2}mu_1(1+e) + \tfrac{1}{2}mu_2(1+e)\right| \\
&= \left|-\tfrac{1}{2}m(u_1 - u_2)(1+e)\right| \\
&= \tfrac{1}{2}mu(1+e)
\end{aligned}
$$

5

$$
\begin{aligned}
\text{Loss in KE} &= \tfrac{1}{2}m\{u_1^2 + u_2^2 - v_1^2 - v_2^2\} \\
&= \tfrac{1}{2}m\left\{\begin{aligned}&u_1^2 + u_2^2 - \left(\tfrac{1}{4}u_1^2[1-2e+e^2] + \tfrac{1}{2}u_1u_2[1-e^2] + \tfrac{1}{4}u_2^2[1+2e+e^2]\right)\\&- \left(\tfrac{1}{4}u_1^2[1+2e+e^2] + \tfrac{1}{2}u_1u_2[1-e^2] + \tfrac{1}{4}u_2^2[1-2e+e^2]\right)\end{aligned}\right\} \\
&= \tfrac{1}{2}m\{u_1^2 + u_2^2 - (\tfrac{1}{4}u_1^2[2+2e^2] + u_1u_2[1-e^2] + \tfrac{1}{4}u_2^2[2+2e^2])\} \\
&= \tfrac{1}{2}m\{\tfrac{1}{2}u_1^2 + \tfrac{1}{2}u_2^2 - (\tfrac{1}{2}u_1^2e^2 + u_1u_2[1-e^2] + \tfrac{1}{2}u_2^2e^2)\} \\
&= \tfrac{1}{2}m\{\tfrac{1}{2}u_1^2[1-e^2] + \tfrac{1}{2}u_2^2[1-e^2] - u_1u_2[1-e^2]\} \\
&= \tfrac{1}{4}m[1-e^2]\{u_1^2 + u_2^2 - 2u_1u_2\} \\
&= \tfrac{1}{4}m[1-e^2]\{u_1 - u_2\}^2 \\
&= \tfrac{1}{4}mu^2[1-e^2]
\end{aligned}
$$

5 $\qquad$ 25