MECHANICS CLASSWORK IV: ANSWERS

1. (i) $K'_{\text{tot before}} = \dfrac{p'^2_{A\,\text{before}}}{2m_A} + \dfrac{p'^2_{B\,\text{before}}}{2m_B}$

$= \dfrac{\mu^2 U^2}{2}\left(\dfrac{1}{m_A} + \dfrac{1}{m_B}\right)$ ← $\dfrac{m_B + m_A}{m_A m_B} = \dfrac{1}{\mu}$

$= \frac{1}{2}\mu U^2$

(ii) Sim'ly $K'_{\text{tot after}} = \dfrac{p'^2_{A\,\text{after}}}{2m_A} + \dfrac{p'^2_{B\,\text{after}}}{2m_B} = \frac{1}{2}\mu V^2$

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2. (i) Elastic coll: $K'_{\text{tot before}} = K'_{\text{tot after}} \Rightarrow U^2 = V^2$.

$\Rightarrow |U| = |V| \Rightarrow c = 1$

(ii) Completely inelastic: particles stick together after coll $\Rightarrow V = 0 \Rightarrow c = 0$

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3. Just before 1st bounce ball is moving down at speed u given by $\frac{1}{2}mu^2 = mgH \Rightarrow u = (2gH)^{1/2}$.

Just after 1st bounce ball is moving up at speed $v_1 = cu$

$\therefore$ Max ht reached given by $mgh_1 = \frac{1}{2}mv_1^2$

$\rightarrow h_1 = \frac{1}{2g}c^2 2gH = c^2 H$

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4. (i) Just before 2nd bounce ball moving down at $v_1 = cu$

Just after ... up at $v_2 = cv_1 = c^2 u$

$\therefore v_2 = c^2(2gH)^{1/2}$

(ii) Just after n^{th} bounce ball moving up at $v_n = cv_{n-1}$
At each bounce speed changes by factor c
After 1 bounce $v_1 = cu$ → after n bounces $v_n = c^n u$
$\therefore v_n = c^n (2gH)^{\frac{1}{2}}$

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5 For an object moving up from the ground at v, the time taken to hit ground again is found by solving $z = z_0 + v_0 t - \frac{1}{2} g t^2$ for the time at which $z = 0$, assuming $z_0 = 0$ & $v_0 = v$ → $0 = 0 + vt - \frac{1}{2} g t^2$

→ $t = 0$ or $\frac{2v}{g}$ i.e. $\Delta t_n = \frac{2}{g} v_n = c^n \frac{2}{g} (2gH)^{\frac{1}{2}} = c^n \left(\frac{8H}{g}\right)^{\frac{1}{2}}$

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6. $T = \ln(\Delta t_n) = \ln\left\{c^n \left(\frac{8H}{g}\right)^{\frac{1}{2}}\right\} = n \ln c + \frac{1}{2} \ln\left(\frac{8H}{g}\right)$

(i) $\ln c = -0.163$ → $c = 0.85$

(ii) $\frac{1}{2} \ln\left(\frac{8H}{g}\right) = -0.469$ → $H = 0.5\,m$
