

# Chapter 9 Problem 5

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$$\begin{aligned}\frac{\hat{p}_1^2}{2m_1} + \frac{\hat{p}_2^2}{2m_2} &= \frac{\hat{P}^2}{2M} + \frac{\hat{p}^2}{2\mu} \\ \frac{\hat{P}^2}{2M} + \frac{\hat{p}^2}{2\mu} &= \frac{(\hat{p}_1 + \hat{p}_2)^2}{2(m_1 + m_2)} + \frac{(m_2\hat{p}_1 - m_1\hat{p}_2)^2 (m_1 + m_2)}{(m_1 + m_2)^2 2m_1m_2} \\ &= \frac{\hat{p}_1^2 + 2\hat{p}_1\hat{p}_2 + \hat{p}_2^2}{2(m_1 + m_2)} + \frac{m_2^2\hat{p}_1^2 - 2m_1m_2\hat{p}_1\hat{p}_2 + m_1^2\hat{p}_2^2}{2m_1m_2(m_1 + m_2)} \\ &= \frac{\hat{p}_1^2 + \frac{m_2}{m_1}\hat{p}_1^2 + \hat{p}_2^2 + \frac{m_1}{m_2}\hat{p}_2^2}{2(m_1 + m_2)} = \frac{\hat{p}_1^2}{2m_1} + \frac{\hat{p}_2^2}{2m_2}\end{aligned}$$