Galilean transformation

Let U be the transformation

$$U = 1 - i\epsilon G_1 - \tfrac{1}{2}\epsilon^2 G_1^2$$

where

$$G_1 = \frac{m}{\hbar} X_1$$

Show that for $\epsilon^4 = \epsilon^3 = 0$ we have

$$U^{-1} P_1 U = P_1 - \epsilon m, \quad U^{-1} P_2 U = P_2, \quad U^{-1} P_3 U = P_3 \tag{1}$$

and

$$U^{-1} H U = H - \epsilon P_1 + \tfrac{1}{2}\epsilon^2 m \tag{2}$$

where

$$H = \frac{1}{2m}\left(P_1^2 + P_2^2 + P_3^2\right)$$