1. **Background:** The total differentials of \(U\) and \(H\) are:

\[
\begin{align*}
dU &= \left( \frac{\partial U}{\partial V} \right)_T \, dV + \left( \frac{\partial U}{\partial T} \right)_V \, dT \\
&= \left( \frac{\partial U}{\partial V} \right)_T \, dV + C_V \, dT
\end{align*}
\]

\[
\begin{align*}
dH &= \left( \frac{\partial H}{\partial P} \right)_T \, dP + \left( \frac{\partial H}{\partial T} \right)_P \, dT \\
&= \left( \frac{\partial H}{\partial P} \right)_T \, dP + C_P \, dT
\end{align*}
\]

This problem explores the relationship between the partials with respect to \(V\) and \(P\).

**Problem:** Given that for an ideal gas \(\left( \frac{\partial U}{\partial V} \right)_T = 0\), show that \(\left( \frac{\partial H}{\partial P} \right)_T = 0\).

[Hint: for an ideal gas you can use \(PV = nRT\)][Try Chapter 9 Problems 7 and 12, first]

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2. One mole of an ideal monatomic gas (\(C_V = 3/2 \, nR\)) does \(-1000\) J of work in a reversible expansion from 1.00 L initial volume and 10.0 atm initial pressure (that is, \(w = -1000\) J). The process is at a constant temperature of 25.0°C. What is the final volume? [Try Chapter 9 Problem 21, first]

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3. Repeat problem 2 but assume the process is a reversible adiabatic expansion from the same initial state. Note that the temperature will change in the process. What is the final temperature? What is the final volume? [Try Chapter 9 Problems 23 and 25, first]

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4. This problem is the general version of Problem 1:

Show that:

\[
\left( \frac{\partial H}{\partial P} \right)_T = \left( \frac{\partial U}{\partial V} \right)_T \left( \frac{\partial V}{\partial P} \right)_T + P \left( \frac{\partial V}{\partial P} \right)_T + V
\]

Show all your work with reasons for each step. For example: “since \(H\) is a state function,” “from the definition of heat capacity,” or “dividing by \(dP\) gives the desired result” are typical statements. If you use a partial derivative relationship that has a name, if you choose not to derive the relationship, just state the corresponding relationship name (e.g. “from the chain rule” or “from the Euler chain rule”).