

Hi,

Sometimes what's difficult is know how to start on a problem. In problem 2.1, you started with the potential $S(T,P)$, which I can see how it works out. But I would have started out with $G(T,P)$ because that was the definition for Gibbs free energy. Was there something from the question that told you you should use $S(T,P)$ right away, or was it a random walk thing that one eventually stumbles on?

For question 2.2. Bascially we are converting from $U(S,V)$ to $U(T,P)$, why didn't the solution use Legendre transform to do it.

thank you

For problem 2.1

In this problem, $S(T,P)$ is not a potential. The problem states with an expression for the total differential of S as a function of T and P because those are the relevant variables in the problem.

The statement of the problem asks you to find the total heat transferred during isothermal compression.

From the first law, we have:

$$dU=dQ+dW$$

$$dU=TdS-PdV$$

$$dQ=TdS..$$

Therefore, the solutions express dS as a function of T and P . We do this to obtain a change in entropy of the system as a function of experimentally accessible quantities, such as compressibilities, thermal expansions, etc.

If you started with the definition of $G(T,P)$, which is the natural potential when pressure and temperature must be held constant, it would be difficult to extract directly the heat and work for the isothermal compression. In the solution, heat comes out directly from the first law.

For Problem 2.2

We are not asked to find a potential $\Phi(T,P)$, we are asked to find an expression for U as a function of (T,P) . There is a big difference between these two problems:

When you do a Legendre Transform, you do not loose any information that was originally contained in the expression for U .

On the other hand, when you express the internal energy as a function of intensive variables P and T , you need to find something else regarding the material's properties, such as C_p , α , etc.

Now, since the internal energy is a state function and its differential is perfect, it is possible to express dU as a function of any pair of thermodynamic variables, as long as we can describe what the partial derivatives with respect to changes in those variables are.