There was a heated
argument in the grad lounge today. And I need your help in proving
that i am right and the other person is wrong.

We all know that:
dU (S,V) = (dU/dS)constantV*dS + (dU/dV)constantS*dV
and this corresponds to:
du (S,V) = T*dS - P*dV
and therefore
T= (dU/dS)constantV and P = -(dU/dV)constantS

--Everything above this line is true

One of us says that this same method can be applied for U as a
function of T and P That is:
dU (T,P) = (dU/dT)constantP*dT - (dU/dP)constantT*dP

--Line above is true. That is just math: expressing the differential
--of a a function of two variables.

and this corresponds to:
dU (T,P) = S*dT-V*dP

--Who is the scoundrel that says the above thing ? This must be an
--invented statement ? You see, the way we get to the equations of
--state is by comparing a mathematically true statement: dU (S,V) =
--(dU/dS)constantV*dS + (dU/dV)constantS*dV, with the first/second law
--combo: du (S,V) = T*dS - P*dV.

--And by the way, when we do this for other functions (F,G,H etc.) we
--are implicitly still using the first/second law combo.

--The scoundrel that claims that dU (T,P) = S*dT-V*dP is making it up.
--There is no such statement in thermodynamics.

and therefore:
S= (dU/dT)constantP and V = (dU/dP)constantT

The argument against this is that we know dU=T*dS-P*dV. But we
cannot say anything like U= TS-PV because we only know that dU= delQ
+ delW and that does not give info on the integral of dU

I can't say which is my argument for fear of being wrong in front of
the professor.

--If this does settle the score, I suggest you duel it out. I will be
--happy to referee. No seriously, I'll be happy to talk to you in
--person if more clarification is needed.

Gerd Ceder