

Name: _____

Quantifying Change

Working in small groups (2 or 3 people), solve as many of the problems below as possible. Try to resolve questions within the group before asking for help. Each group member should then write up solutions in their own words.

Orient: The plot shows various thermodynamic quantities for water vapor in an insulated piston (cylindrical thermos with a movable top) at different states. From state (point) A to state (point) B , estimate the following quantities:

Verbal Description	Symbol	Estimate (with Units)
Change in volume:	$\Delta V_{A \rightarrow B}$	
Change in entropy:	$\Delta S_{A \rightarrow B}$	
Change in temperature:	$\Delta T_{A \rightarrow B}$	
Change in pressure:	$\Delta p_{A \rightarrow B}$	
Change in internal energy:	$\Delta U_{A \rightarrow B}$	

WCD: At what stage would you be willing to label these quantities with “d”s?

Explore: Pick two of the variables in the table and determine the rate of change of one with respect to the other from A to B . What experiment could you do to measure this rate?

WCD: Under what circumstances would you be willing to call this rate a derivative? Have students plot graphs of their functions to see how linear they are.

Follow-up: How would you represent this derivative symbolically? Some students write $\Delta U/\Delta T$ vs. dU/dT ; some students write subscript S vs. $A \rightarrow B$. A good opportunity to talk about how the derivative ought to depend on the value of S .

Interpret: Determine the reciprocal of the rate you calculated. How would you physically interpret this number?

WCD: What experiment would you do to measure this quantity?

WCD: The derivative can be flipped as long as the path is unchanged.

Follow-up: Are you willing to call this a derivative? How would you represent it symbolically?

Reinterpret: How does the rate you previously calculated change if instead you went from state B to state A ?

The derivative is the same

WCD: Many students will initially say that the derivative changes sign.

Activity Evaluation

What was the main point of this activity?

Describe one thing you understand as a result of this activity.

Describe one thing that is confusing after completing this activity.