Name: ____________________________

Thermodynamic States

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 contour map represents possible measured values for a kilogram of water vapor. Without pointing to it or marking it, have one member of your group select a location (a state) on the contour map. Describe the state so that another member of the group can mark it. How many pieces of information do you need to specify the state?

Materials: Need a graph with $U(T, p)$ with T and p axes only, no states.

Gets at the idea that you only need two variables to specify the state. Cartesian or polar coordinates might come up as another example- talk about how axes have different dimensions.

Coordinate: Find your state on the new graph. Specify your state in as many ways as possible.

Materials: Need a graph with $U(T, p)$ with T, p, S, V contours, no states.

Gets at the idea that you can specify the state with any two of the four variables.

Note: Students might try to over-specify the state. Ask how many of the 3 or 4 variables you can independently pick. Maybe as a WCD have 3 groups each specify a different variable

Explore: Choose a second, nearby state and mark it on the graph. In as many different ways as you can, describe how to get from your old state to your new state.

Learning Goal: Gets at the idea that you need to specify changes in two variables (constant is a specified change of zero)

Follow-up question: How many pieces of information did you have to give to describe a path? Could you have given less information?

Can you find a nearby state where the path involves holding one of the thermodynamic variables constant? 2 variables? 3 variables?

Gets at the idea that you can specify one variable to be constant. If you try to specify 2 (or 3) variables to be constant, then the new state is the same as the old state (you haven't gone anywhere).

New Representation: Can you find the states you have been considering on these alternate representations:

(1) A rubber sheet that can be stretched and squished so that the S and V contours are straight and perpendicular to each other.
(2) A plastic surface whose height represents the internal energy of the system.
    Students will need to be told what the axes represent.

Materials: Need $U(S, V)$ with S, V, T, P contours.

Learning Goal: The set of numbers that describes a state is unique and can be located on different representations of the system.

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.