

Here is data for nine states, taken from a take-home version of the PDM:

David R. started putting a table in here.

	F_L :	F_L :	F_L :
x_R :	F_R :	F_R :	F_R :
	x_L :	x_L :	x_L :
x_R :	F_R :	F_R :	F_R :
	x_L :	x_L :	x_L :
x_R :	F_R :	F_R :	F_R :
	x_L :	x_L :	x_L :

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1. What does each cell represent? Each row or column?

2. It takes TWO graphs to plot all this data. Why?

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3. Notice that the graphs are correlated. How?

4. Draw/label the processes State 1 to State 2 to State 3 to State 4 on each graph.

5. For the PDM, the analogue of the First Law and the thermodynamic identity are:

$$\Delta U = W_L + W_R \quad (1)$$

$$dU = \bar{d}W_L + \bar{d}W_R \quad (2)$$

$$dU = F_L dx_L + F_R dx_R \quad (3)$$

$$dU = F_L dx_L + F_R dx_R \quad (4)$$

$$dU = F_L dx_L + F_R dx_R \quad (5)$$

$$\Delta U = \int F_L dx_L + \int F_R dx_R \quad (6)$$

Find ΔU from state 1 to state 3 along (at least) two different paths. What can you say about the values of ΔU , W_L , and W_R along the different paths.

You may wonder why the thermodynamic identity treats the four variables asymmetrically? Let's explore this asymmetry.

6. Pull on the right-hand side of your PDM. You are doing work. Where does the energy go?

A Legendre transformation is a mathematical manipulation of the state variables. Define a new state variable B by:

$$B = U - F_L x_L$$

7. Find dB

8. If we do a Legendre transformation to the new state variable B , we have:

$$dB = -x_L dF_L + F_R dx_R \quad (7)$$

$$\Delta B = \int -x_L dF_L + \int F_R dx_R \quad (8)$$

$$\Delta B = \int -x_L dF_L + \int F_R dx_R \quad (9)$$

9. How do you calculate ΔB on your graphs?
10. Suppose your experimental set-up has no tape on the left-hand side. (Right-hand measuring tapes have not yet been developed.) For what process can you find ΔB but NOT ΔU ?