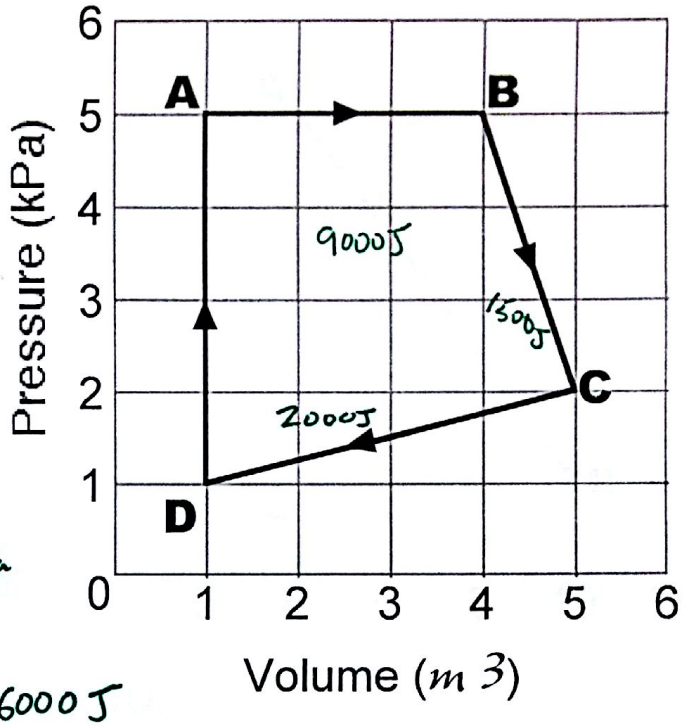
Thermodynamic Cycle: Class Example Problems

To the right is a P-V diagram that shows multiple step thermodynamic cycle.



1. What is the name of the thermal dynamic process as the gas goes from point "A" to point B"? ISOBARIC

2. What is the name of the thermal dynamic process as the gas goes from point "D" to point "A"? ISOCHORIC / ISOVOLUMETRIC

3. How much work is done as a gas undergoes a change along the curve from point "B" to "C"? AREA $W_{BY} = 3500\ J$ CONVERT TO Pa

4. How much work is done as a gas undergoes a change along the curve from point "C" to "D"? AREA $W_{BY} = -6000\ J$

5. How much *NET* work is done on or by the gas as it undergoes a change along the curve from point "A" to "B" to "C" to "D" and back to "A"? AREA $W_{NET\ BY} = +12500\ J$

6. If the PV diagram above is for 2 moles of a gas then what is the gas's temperature at point "A"? $PV = nRT$ $(5000)(1) = 2(8.31)T$ $300\ K = T$

7. If the PV diagram above is for 2 moles of a gas then what is the gas's temperature at point "D"? $60.2\ K = T$

8. If the PV diagram above is for 2 moles of a gas then what is the change in internal energy of the gas during the process from "D" to "A"? $U = \frac{3}{2}nR(\Delta T)$ $+5978\ J$

9. How much thermal energy is added to the gas as it undergoes a change from point "D" to "A"? $\Delta U = Q + W$ $\Delta U = Q$ $5978\ J$

10. How much work is done either on or by the system during the process from "D" to "A"? NONE

11. How much work is done either on or by the surroundings from the process from "B" to "C"? → TO THE GAS → $-3500\ J$ ~~BY THE GAS~~

12. How much work is done either on or by the surroundings during the cycle from A to B to C to D? → TO THE GAS → $-12500\ J$

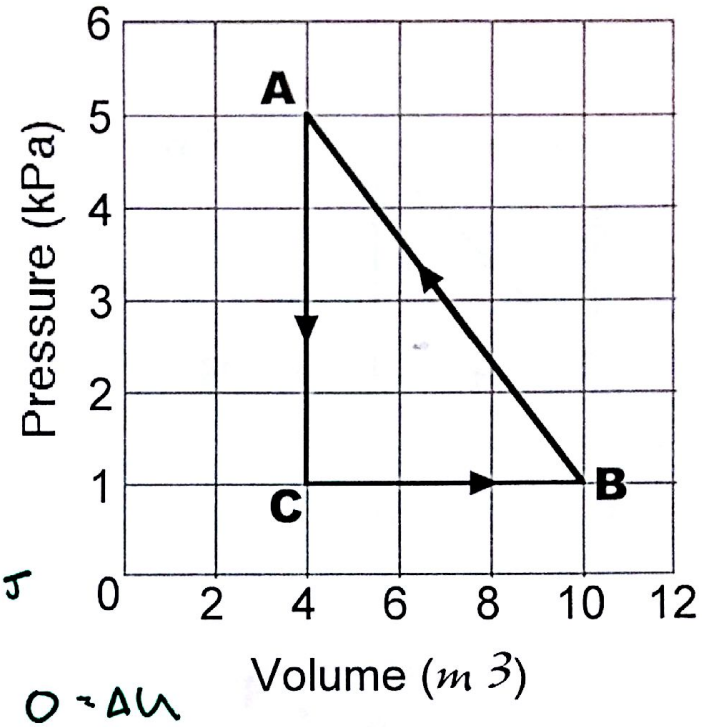
13. If 15 kJ of thermal energy is entered into the system shown from the P-V diagram, then what is the change in internal energy?

~~$\Delta U = Q + W$~~ $0 = \Delta U$

~~$Q = 15\ kJ$~~

Thermodynamic Cycle: Class Example Problems

To the right is a P-V diagram that shows a thermal dynamic cycle.



14. What is the name of the thermal dynamic process as the gas goes from point "B" to point "C"? ISOBARIC

15. What is the name of the thermal dynamic process as the gas goes from point "C" to point "A"? ISOCHORIC

16. How much *NET* work is done as a goes undergoes a change along the curve from point "A" to "B" to "C" to "A" again? $W_{ON} = 12000\ J$ $W_{BY} = -12000\ J$

17. If 20 kJ of thermal energy is entered into the system shown from the P-V diagram, then what is the change in internal energy of the cycle? $0 = \Delta U$ CYCLE

18. If this process occurs to a system containing 4 moles of gas then what is ~~the temperature~~ at location "B?" $PV = nRT$ $(1000)(10) = 4(8.31)T$ $T = 300.8\ K$

19. If this process occurs to a system containing 4 moles of gas then what is the change in internal energy ~~during the process~~ from "A" to "C?" $\Delta U = \frac{3}{2} n(PV) = \frac{3}{2}(4000)(4)$ ~~FIND FOR AT~~ $\Delta U = -24000\ J$

20. How much work is ~~done by the system~~ during the process from "C" to "B?" $W_{BY} = +6000\ J$

21. How much work is done by the surroundings during the process from "B" to "A?" $W_{ON} = +18000\ J$

22. How much thermal energy is added or removed to/from the system from "C" to "B," if this process occurs to a system containing 4 moles of gas?

23. $\Delta U = \frac{3}{2} nRT$ $\Delta U = Q_{IN} + W_{ON}$ WORK DONE BY GAS $= -W_{ON}$

$$\frac{3}{2}(1000)(+6) = Q_{IN} + -6000\ J$$

$$9000 = Q_{IN} + -6000\ J$$

~~-15000~~ $+15000\ J = Q_{IN}$

$\Delta U = Q + W_{ON}$

$\Delta Q = \Delta U - W_{ON}$

$-\frac{5}{2}nR\Delta T$

PV Diagram Worksheet

Show your work on a separate piece of paper. $\frac{3}{2}nR\Delta T - W_{ON}$ ΔPV

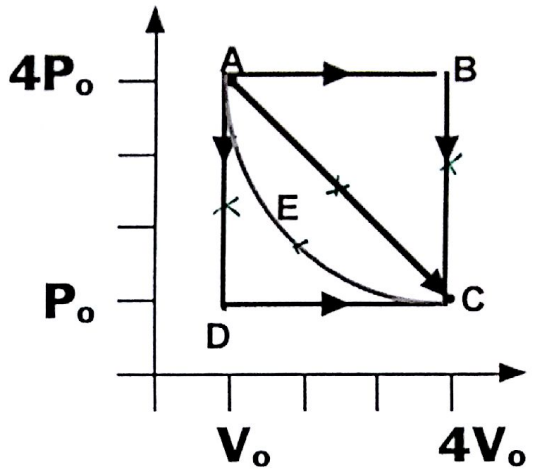
1. Which process(es) shows a ΔQ equal to $5/2nR\Delta T$?

2. Which process(es) show a W=0? B→C A→D

3. Which process shows a decrease in temperature?

   B → C

   A → D



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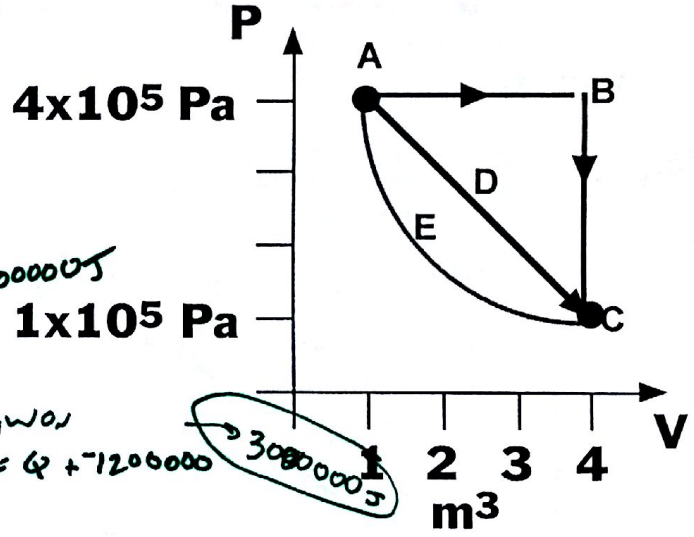
4. For the graph to the right, assuming no molecules are allowed to escape, show that states A and C are at the same temperature.? SAME PV

5. How much work is done along the path from A to B? AREA $W_{ON} = -1200000J$

6. How much thermal energy is added from state A to B is this represents 3 moles of an ideal gas? $\Delta U = Q + W_{ON}$ $\Delta U = \frac{3}{2}\Delta PV$ $\frac{3}{2}(4\times10^5)(3) = Q + -1200000$ $3000000J$

7. How much work is done from states B to C?



8. Is positive work done **on** the surroundings or **by** the surroundings as the system under goes a change along A → D → C?

SINCE VOLUME IS INCREASING

$+W_{BY\ GAS}$

(THIS WS PHRASES DIFFERENTLY ... $W_{BY\ GAS}$ → ON THE SURROUNDINGS

$W_{ON\ GAS}$ → BY THE SURROUNDINGS)

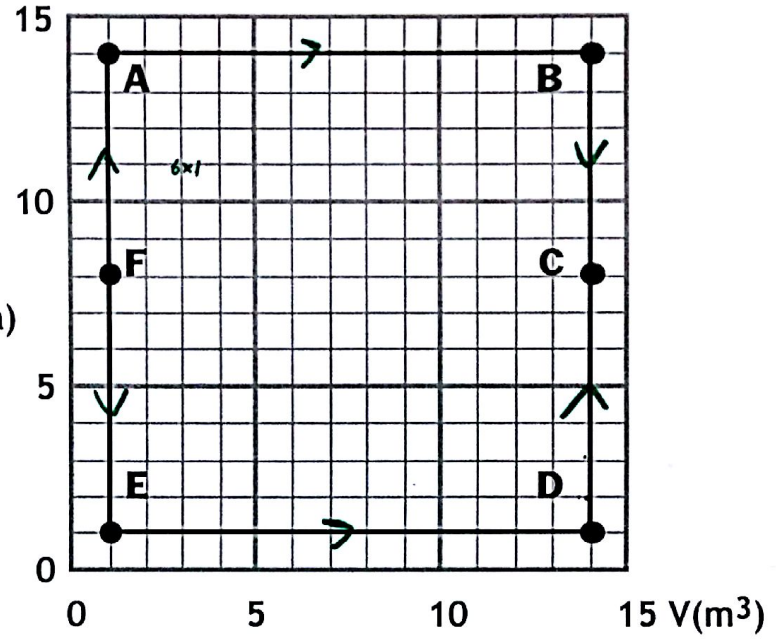
PV Diagram Worksheet

Show your work on a separate piece of paper.

9. Assuming the molecules cannot escape the system. Rank the internal energy from highest to lowest. B, C, A, D, F, E

10. Rank the six points according to their temperatures from highest to lowest. SAME

11. There are two possible paths between state F and C. They are F→A→B→C or F→E→D→C. Consider the process of F→A, B→C, ~~F→E~~, D→C. Which process shows the greatest amount of heat flowing into the system and least amount of heat flowing into the system? BIGGEST ΔU WHEN W=0 LEAST → WEIRD QUESTION B/C OF NEGATIVE $\Delta U = Q$



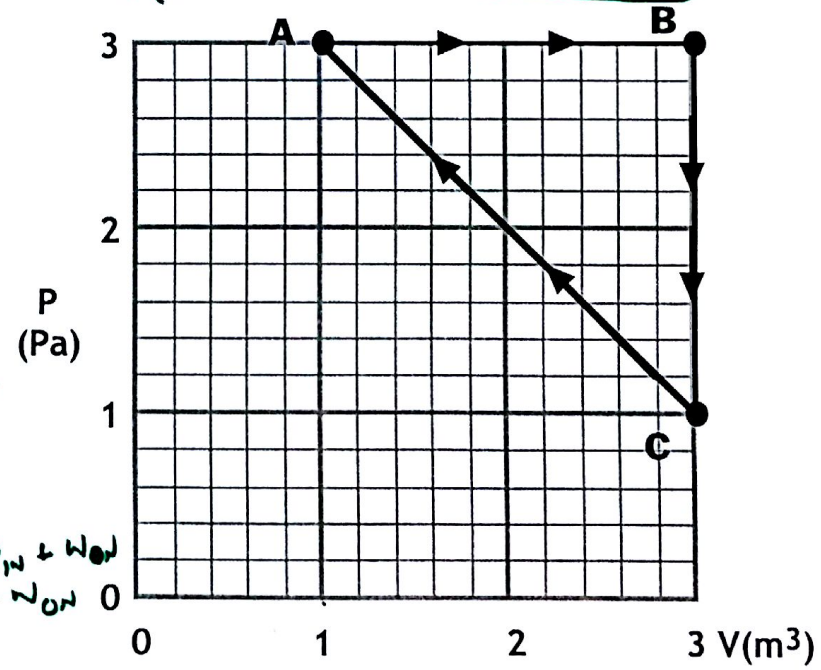
12. How much thermal energy flows from the system from D→E? $\Delta U = \frac{3}{2} nR\Delta T$ ← $\Delta U = Q_{IN} + W_{ON}$ $\frac{3}{2}(1 \times 12) = Q + -13$ = +32.5 J

13. How much work is done by the surroundings from C→A? AREA $W_{ON} = 2J$

14. How much work is done by the gas in the system from A→B? $W_{BY} = 6J$

15. How much work is done by the surroundings in the cycle A→B→C? $W_{ON} = -2J$

16. Does thermal energy flow into or out of the system during the cycle, A→B→C? IN = $\Delta U = Q_{IN} + W_{ON}$ $Q_{IN} = -W_{ON}$



17. In the process from A→B, how much thermal energy flows from the environment?

$\Delta U = \frac{3}{2}(nR)$ ← $\Delta U = Q_{IN} + W_{ON}$

$\frac{3}{2}(3n \cdot 2) = Q_{IN} + -6$

$+15\,J = Q_{IN}$