

1. A certain gas obeys the equation of state $U(S, V, N) = aS^7/V^4N^2$, where a is a dimensioned constant. Here U represents the internal energy of the gas, S the entropy, V the volume and N the fixed number of particles of the system.

- (a) Let such a gas be filled in a box of volume V and the internal energy of the system be U . A partition is placed to divide the box into two equal parts, each having volume $V/2$. For each part, the internal energy is now αU and the dimensioned constant be βa . Obtain α and β . [3]

$\alpha =$	$\beta =$
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- (b) The temperature T can be expressed in terms of the derivative of internal energy as [2]

$$T = \left(\frac{dU}{dS} \right)_{V, N}$$

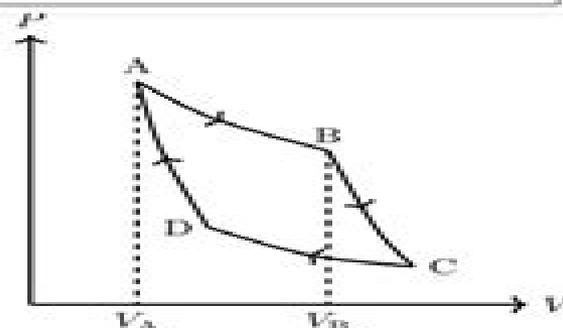
where the subscripts indicate that the differentiation has been carried out keeping V and N constant. In a similar way, express pressure P in terms of a derivative of the internal energy.

$P =$

- (c) Find the equation of state of the given system relating P , T , and V . [1]

$P =$

- (d) One mole of this gas executes a Carnot cycle ABCDA between reservoirs at temperatures T_1 and T_2 ($T_1 > T_2$). Obtain the heat change in the process AB (Q_{AB}) and work done by the system in the processes AB and BC (W_{AB} , W_{BC}) of the cycle. Express your answers only in terms of temperatures T_1 , T_2 , volumes V_A , V_B , and the other constants. [7]



$Q_{AB} =$

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Minjie Lin



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