9.7: Problems

Problem 9.7.1

Determine whether the following differentials are exact or inexact. If they are exact, determine $u = u(x, y)$.

1. $du = (2ax + by)dx + (bx + 2cy)dy$
2. $du = (x^2 - y^2)dx + (2xy)dy$

Problem 9.7.2

Determine whether dz is exact or inexact. If it is exact, determine $z = z(P, T)$.

$$dz = -\frac{RT}{P^2}dP + \frac{R}{P}dT$$

Problem 9.7.3

From Equation 9.7.4, and using the fact that G is a state function, prove that the change in entropy (ΔS) of one mole of an ideal gas whose pressure changes from an initial value P_1 to a final value P_2 at constant temperature is:

$$\Delta S = -R \ln \frac{P_2}{P_1}$$

Problem 9.7.4

From Equations 9.7.1-9.7.3, and using the fact that U, H and A are state functions, derive the three corresponding Maxwell relations.

Answer

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Problem 9.7.5

Given the following differential:

$$dz = xydx + 2ydy$$

a. Determine if it is exact or inexact. If it is, obtain $z(x, y)$
b. Calculate the line integrals $\int_c dz$ for the paths enumerated below:
   1. the line $y = 2x$ from $x = 0$ to $x = 2$
   2. the curve $y = x^2$ from $x = 0$ to $x = 2$
   3. any other path of your choice that joins the same initial and final points.

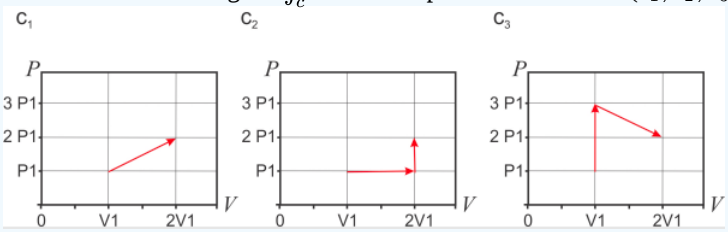
Problem 9.7.6

For a mole of a perfect monoatomic gas, the internal energy can be expressed as a function of the pressure and volume as

$$U = \frac{3}{2}PV$$

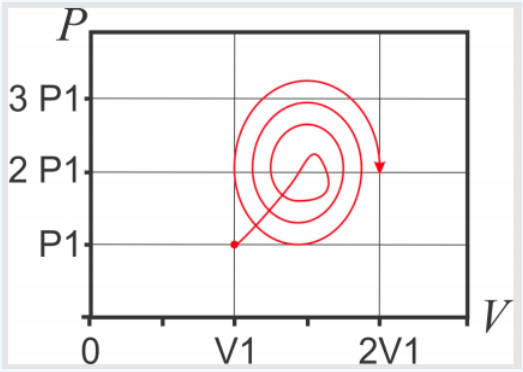
a. Write the total differential of U, dU.

b. Calculate the line integrals $\int_c dU$ for the paths shown below (c_1, c_2, c_3):



c. Calculate $U(V_f, P_f) - U(V_i, P_i)$ and compare with the results of b) (Note: f refers to the final state and i to the initial state).

d. Considering your previous results, calculate $\int_c dU$ for the path below:



As defined in Section 9.3,

$$dU = T(S,V)dS - P(S,V)dV \tag{9.7.1}$$

$$dH = T(S,P)dS + V(S,P)dP \tag{9.7.2}$$

$$dA = -S(T,V)dT - P(T,V)dV \tag{9.7.3}$$

$$dG = -S(T,P)dT + V(T,P)dP \tag{9.7.4}$$