Main course:
An ideal gas \((C_v = \frac{5}{2} R)\) is expanded adiabatically against a constant pressure of 1 atm until it doubles in volume. If the initial temperature is 25°C, and the initial pressure is 5 atm, calculate \(T_2\) (the final temperature after expansion). Then, calculate \(q\), \(w\), and \(\Delta U\) for the process.

Dessert:
1. (First law) In a given change in state, 44J of work is obtained from a system and the internal energy increases by 170J. If the temperature of the system rises by 10K, what is the heat capacity of the system?
   (Is the heat capacity measured here \(C_v\) or \(C_p\)? Or, is there not enough information given?)

2. (Gas expansion/compression) Three moles of an ideal gas expand isothermally against a constant external pressure of 100kPa from \(20dm^3\) to \(60dm^3\). Compute \(q\), \(w\), \(\Delta U\).

3. (Gas expansion/compression) Three moles of an ideal gas expand isothermally and reversibly from \(60dm^3\) to \(20dm^3\). Compute \(q\), \(w\), \(\Delta U\).

4. (Euler’s exactness criterion; state function) Show that the differential \(df\) is inexact:
   \[
   df = dx - \frac{x}{y} dy
   \]
   Hence, \(f\) is dependent on the path of integration and is not a state function. However, we can define a new function \(g\) by:
   \[
   dg = \frac{1}{y} df
   \]
   Which has the property that \(dg\) is exact (i.e. \(\int dg = 0\)). Prove that \(dg\) is exact.

Hints for the problem set:
- For problem 2(b), consult SAB:
  - Section 1.7: Critical phenomena (p.16)
  - Section 1.8: van der Waals equation (p.17)
  - Especially Examples 1.7 and 1.8 (p.20-21)