

**ASSIGNMENT 2**  
**THERMAL PHYSICS 2009**

**DUE: Friday 23<sup>rd</sup> October 2009 at 4pm**

**Question 1 (based on Carter, Problem 8.8)**

The equations of state of a van der Waals gas in terms of specific values are:

$$\left(P + \frac{a}{v^2}\right)(v - b) = RT$$

$$u = \frac{3}{2}RT - \frac{a}{v}$$

A van der Waals gas undergoes an isothermal expansion from specific volume  $v_1$  to specific volume  $v_2$ .

- (i) Calculate the change in the specific Helmholtz function for this process.
- (ii) Calculate the change in the specific internal energy  $U$  for this process.
- (iii) Hence (or otherwise), calculate the change in entropy for this isothermal expansion.

**Question 2 (adapted from Carter, Problem 8.1)**

A van der Waals gas and an ideal gas are originally at the same pressure, temperature and volume. If each gas undergoes a reversible isothermal compression, which gas will experience the greater change in entropy?

Hint: Use the Maxwell relation derived from the Helmholtz potential. Incidentally, the Helmholtz potential is the appropriate potential for constant temperature processes.

**Question 3 (adapted from Carter, Problem 10.2)**

The equations of state of an ideal gas is given by:

$$PV = nRT$$

$$U = \frac{1}{\gamma - 1}nRT$$

- (i) Show that these equations violate the Third Law of Thermodynamics

Hint: Examine the consequences of the third law in terms of expansivity, slope of phase transition curves or heat capacities and show that at least one of these consequences is violated by the ideal gas equations.