Advanced Theoretical Physics
WS 09/10

Prof. Dr. Dieter Bauer
Dipl.-Phys. Andrea Sengebusch

Seminar 1

Keywords:

state variables (extensive and intensive), exact differential,

thermodynamic equilibrium,

equation of state,

reversible and irreversible processes

Questions:

1. Explain the differences between an ideal gas and a van der Waals gas. What happens at the so-called critical point? Calculate the crtitical volume V_c, the critical pressure p_c, and the critical temperature T_c.
2. How can temperatures be measured?

Assignment 1

Exact differentials

1.1 Let x, y, z be three state variables, and $F(x,y,z) = 0$ so that any of the three state variables may be written as a function of the two other ones. Show that

$$\left(\frac{\partial x}{\partial y}\right)_z = \left(\frac{\partial y}{\partial x}\right)_z^{-1} \qquad \text{and} \qquad \left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial z}\right)_x \left(\frac{\partial z}{\partial x}\right)_y = -1.$$

1.2 Let w be another state variable depending on two of the three state variables x, y, z. Show

$$\left(\frac{\partial x}{\partial w}\right)_z = \left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial w}\right)_z \qquad \text{and} \qquad \left(\frac{\partial x}{\partial y}\right)_z = \left(\frac{\partial x}{\partial y}\right)_w + \left(\frac{\partial x}{\partial w}\right)_y \left(\frac{\partial w}{\partial y}\right)_z.$$

Van der Waals equation of state

1.3 Calculate the second virial coefficient of a van der Waals gas.