

PHYS 6107, Homework 1
Due Friday, January 24, 2009

1. Read sections 1.4, 2.1, 2.3, 2.5, 2.6, 2.7 and redo examples/exercises 1.2, 2.6, 2.8, 2.9 from textbook.
2. The body temperature is 98 F. What is this temperature in Celsius, Kelvin unit?
3. An isolated container has two chambers. One chamber (with volume V_1) is filled with ideal gas at temperature T . The other chamber (volume V_2) is empty. The wall separating the chambers is then removed, and the gas fills the whole volume (V_1+V_2). What is the final temperature of the gas?
4. One mole of gas obeys Van der Waals equation of state:

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

Its internal energy is given by $E = cT - a/V$, where c is another constant. Calculate the molar heat capacities c_p and c_v .

5. One mole of ideal gas is initially at temperature T_0 and volume V_0 . Its volume is expanded quasi-statically to $2V_0$ at (a) constant temperature and (b) constant pressure. Calculate the work (done on the system), heat (absorbed by the system) and the change in internal energy, Helmholtz free energy, enthalpy and Gibbs free energy of the system in each case.
6. A steam turbine is operating at input temperature of 400°C and exhaust temperature of 20°C . What is the maximum amount of work W that the turbine can do for a given amount of heat input Q ?
7. The internal energy of a capacitor with charge Q is $E = Q^2/2C$, where C is the capacitance. A capacitor is charged under constant electrostatic potential V . Which thermodynamic potential is extremized in equilibrium? Use this potential to derive the equilibrium value of the capacitor's charge Q . (*Hint*: for a capacitor, V and Q play the role of generalized force and generalized coordinate respectively).