

# Physics 3410 Homework #5

5 problems

Due by February 29

▷ 1.

Find an expression for the temperature of a paramagnet with  $N$  dipoles and  $U$  dipoles pointing upward (with an external magnetic field pointing down). What is the temperature when half the dipoles point upward?

▷ 2.

A container of water begins with a heat capacity of 500 J/K (constant) and a temperature of 70° C. It cools in a room at 10° C until it too reaches that temperature; the temperature of the room does not change.

(a) What is the change in the entropy of the room during the cooling? (It's not zero.)

(b) What is the change in the entropy of the water? (It's not zero either.)

(c) What is the net change in the entropy of the Universe? Does it obey the Second Law?

▷ 3.

Consider an ideal gas with  $N$  particles that increases in volume by 10%, at a constant temperature  $T$  (and energy  $U$ ).

(a) What is the change in the gas's entropy?

(b) What is the work done by the gas on the environment?

(c) What is the heat flow  $Q$ ? Does it flow in or out? How is it related to the entropy?

▷ 4.

Given the thermodynamic identity:

$$dU = T dS - P dV + \mu dN$$

(a) Find  $\left(\frac{\partial U}{\partial V}\right)_{S,N}$

(b) Suppose a system at standard temperature and pressure contracts from 0.50 m<sup>3</sup> to 0.48 m<sup>3</sup>, and the energy increases by 2 J. What is the change in the system's entropy?

▷ 5.

If  $a = b \ln c$  and  $b = \ln(cd)$ , find  $\left(\frac{\partial a}{\partial c}\right)_b$  and  $\left(\frac{\partial a}{\partial c}\right)_d$  in terms of  $b$  and  $c$ .