Department of Physics
The Ohio State University

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Seventh Problem Set for Physics 846 (Statistical Physics I)

Fall quarter 2003

Important dates: Nov 11 no class, Nov 27 no class, Dec 11 9:30am-11:18am final exam

Due date: Tuesday, Nov 18

19. Shape of a lambda line

8 points

A PVT system has a line of continuous phase transitions (a lambda line) separating two phases, I and II, of the system. The molar heat capacity c_P and the thermal expansivity α_P are different in the two phases. Compute the slope $(dP/dT)_{\text{coex}}$ of the λ line in terms of the temperature T, the molar volume v, $\Delta c_P = c_P^I - c_P^{II}$, and $\Delta\alpha_P = \alpha_P^I - \alpha_P^{II}$. (Hint: Look at our derivation of the Clausius-Clapeyron equation and keep in mind which quantities you could use instead of the chemical potential μ in the case of a continuous phase transition.)

20. Coin tossing

10 points

Three coins are tossed. This can be represented by a sample space S of eight elements, $S = \{TTT, TTH, THT, THH, HTT, HTH, HHT, HHH\}$, each of which has the same probability 1/8. Answer the following questions by explicitely writing down the events as subsets of the sample space S.

a) Find the probability of getting *no heads*.

b) Find the probability of getting *at least one head*.

c) Find the probability of getting *at least two heads*.

d) Show that the event "heads on the first coin" and the event "tails on the last coin" are independent.

e) Show that the event "exactly two coins heads" and the event "three coins heads" are dependent and mutually exclusive.

Hint: You may want to wait with working on this problem until after Thursday's class.

21. Characteristic function

12 points

Consider an exponentially distributed stochastic variable X, i.e., a stochastic variable with

$$P_X(x) = \begin{cases} 0 & x < 0 \\ Ce^{-\lambda x} & x \geq 0 \end{cases}$$

with two constants C and λ.

a) Determine the constant C as a function of λ.

b) Calculate the characteristic function $f_X(k)$ for this variable.

c) Calculate all moments of X.

d) Calculate all cumulants of X.

Hint: You may want to wait with working on this problem until after Thursday's class.