Physics 613 Last Exam

Due: In class, Thursday, March 11, 2 PM
(Problems #1 and #2)

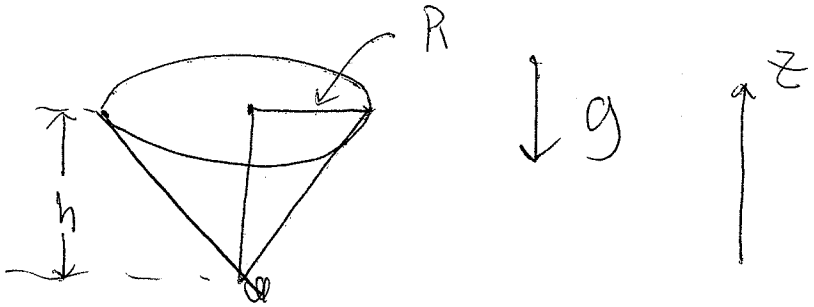
In Toner's office, 12 noon, Saturday, March 20
(@ 1 hour after Vernal Equinox!)
(Problem #3)

Problem 1) Consider a system of 2 particles contained in a box of volume V. The particles are distinguishable; each has the same mass m, and the interact with a potential that is $-\epsilon_0$ if the separation between the particles is $< a$, and 0 if their seperation is $> a$. In the microcanonical ensemble, calculate $T(E)$ and $P(V,E)$ for this system, assuming that $a^3 << V$.

1)(cont) How does the pressure behave at large positive energies, and at negative energies? Give a simple physical interpretation of your result in both of these limits.

---

2)



N identical point particles of mass m sit in a vertical cone of radius R and height h, with the point down, as shown. The cone is capped at the top so that none of the particles can escape. Gravity g acts in the negative z direction. The whole system is in equilibrium with its surroundings at a fixed temperature T.

a) Calculate the partition function, free

21 cont) system. What is the behavior of the specific heat at low temperature? At high temperature? How high must the temperature be for the high temperature limit to hold accurately?

b) Calculate the density (mean number) $\rho(z)$ inside the cone.

c) Calculate the pressure (P_{top}) at the top of the cone by considering $\left(\frac{\partial E}{\partial h}\right)_{M, T, \text{shape}}$ $\left(\frac{\partial F}{\partial h}\right)_{T,V}$ holding the shape of the cone (i.e., $\frac{R}{h}$) fixed.

d) What is $\frac{P_{top}}{\rho(z=h)}$? How could you have guessed this answer?