your name_____

Physics 831 Quiz #6 - Friday, Oct. 25 2013

Everyone should answer problem 1. You can then choose between numbers 2 and 3 – or do both for extra credit.

1. (5 pts) At time t_0, the density of ink molecules in a fluid is given by the expression,

$$\rho(x, t = 0) = \rho_0 + a \sin kx.$$

The ink molecules diffuse according to a diffusion constant D. Find the density of ink molecules as a function of time?

2. An ideal gas of particles of mass m is initially at a temperature T_0, has zero collective velocity, and as far as one cares to look, the number density profile initially has an exponential profile in the x direction:

$$\rho(x, t = 0) = \rho_0 e^{-x/\lambda}.$$

The gas then expands expands hyrodynamically.

   (a) (5 pts) What is the temperature, $T(x, t)$?

   (b) (5 pts) What is the density profile, $\rho(x, t)$?

3. A gas of particles of mass m is initially confined to an extremely small slice in the x direction. The confining walls, then move at constant velocities of V and $-V$, so that the positions of the walls are

$$X_{\text{left}} = -Vt, \quad X_{\text{right}} = Vt.$$

The collective velocity of the hydrodynamically expanding gas is,

$$v_x(x, t) = x/t, \quad |x| < Vt.$$

The extent of the confining regions along the y and z directions is fixed, and the number of gas particles between the expanding walls is fixed. At time τ_0 the number density is ρ_0 and the temperature is T_0,

$$\rho(x, \tau_0) = \rho_0, \quad T(x, \tau_0) = T_0.$$

   (a) (5 pts) What is the density of the gas, $\rho(x, t)$, as a function of time?

   (b) (5 pts) What is the temperature of the gas, $T(x, t)$, as a function of time?