Exam #3: Thermodynamics, fluids, oscillations, and waves

Name: /30

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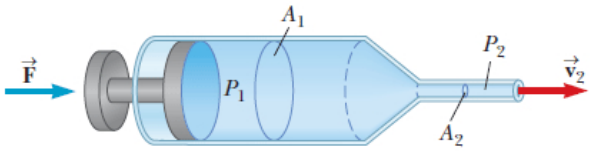
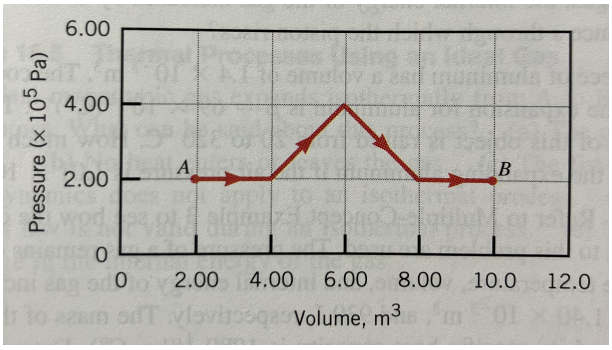
1. Make a sketch that shows how the elastic potential energy, gravitational potential energy, and kinetic energy change during one oscillation of a spring that is hanging vertically. Let $t = 0$ correspond to the time that the spring is at its equilibrium length and the mass on the spring is moving upward. [6 pts]

2. A hypodermic syringe contains medicine with the density of water ($\rho = 1000$ kg/m^3). The barrel of the syringe has a cross-sectional area of $A_1 = 2.5 \times 10^{-5}$ m^2; the needle has a cross-sectional area of $A_2 = 1.0 \times 10^{-8}$ m^2. A force of magnitude 2.00 N is exerted on the plunger, making medicine squirt from the needle. Determine the medicine's flow speed through the needle. Assume that atmospheric pressure is 101.3 kPa and that the syringe is horizontal. Note that when the plunger is not being pushed, the pressure P_1 must equal atmospheric pressure, otherwise the medicine would be flowing into or out of the syringe. In other words, when a force is exerted on the plunger, the pressure at P_1 must equal atmospheric pressure plus whatever additional pressure is provided by the plunger. [8 pts]



3. A monatomic ideal gas expands from point A to point B along the path shown in the diagram. Assume that the number of moles of gas remains fixed. (a) Determine the work done by the gas. (b) The temperature of the gas at point A is 185 K. What is its temperature at point B? (c) How much heat has been added or removed from the gas during the process? [8 pts]



4. The lowest note on a guitar with standard tuning is E2 ("low E"), which has a frequency of 82.4 Hz. When you pluck the string you produce sound at 82.4 Hz and also at several harmonics. If you press down on the low E string while plucking it, you create different notes (as well as different harmonics) by effectively changing the length of the string. If the low E string has a length of L, how far down the string should you press it so that the fundamental frequency of the new note is the same as the second harmonic of E2? [4 pts]

5. The figure below is a snapshot of a transverse traveling wave at $t = 0$ s. The wave is traveling to the left at 1 m/s. Write down the wave model for this wave. [4 pts]