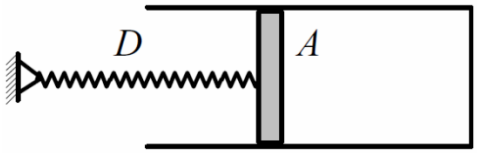
Applied Physics – Problem set #8

1. A glass tube with one closed end contains air that is sealed off by a column of mercury with height h. If we hold the tube vertically, the height of the air column is L_1 or L_2 depending on whether the closed end or the open end is facing upwards. The density of mercury is ρ. Express the atmospheric pressure!

2. A 20dkg glass mug with temperature 20ºC ($c_g = 0.84\,\frac{\text{kJ}}{\text{kgK}}$) holds 0.5-liter non-alcoholic beverage also at 20ºC ($c_b = c_w = 4.2\,\frac{\text{kJ}}{\text{kgK}}$). How many dkg ice at -5ºC has to be added ($c_i = 2.09\,\frac{\text{kJ}}{\text{kgK}}, L_f = 334\,\frac{\text{kJ}}{\text{kgK}}$) to the beverage so that we end up with a final temperature of 4ºC for our drink?

3. A thermally insulating 44.8dm^3 cylinder with horizontal axis is split into two by a thin, thermally insulating piston. The left side has a 200W heating coil installed to warm up the gas. Initially the piston is at the middle, and both sides contain monatomic gas at 10^5Pa pressure. How long does the heating coil have to be turned on so that the gas on the right side get compressed to half of its original volume?

4. A cylindrical container is filled with nitrogen at 100kPa pressure and 300K temperature. The cross-sectional area of the cylinder is 100cm^2, the initial volume of the gas is 1 liter, the atmospheric pressure is also 100kPa. The piston can move without any friction, and it has a spring with 5kN/m spring constant attached. What will be the pressure of the gas if we raise its temperature to 600K?



5. A thermally insulating vertical cylinder with cross-sectional area 1dm^2 and height 2dm contains air, and it is sealed off from above by a very light piston. How much weight must be placed on top of the piston, so that the volume decreases by half? What is T_2, if T_1=300K? What is the change in potential energy for the weight? How much work is done on the gas?

<u>Homework 8</u>

1. A sealed 100-liter container is filled with helium at $4\cdot10^5$Pa pressure and 7ºC temperature. What will be the pressure in the gas if its temperature is raised by 70ºC? How much heat is required for this?

2. An ideal gas expanding at constant pressure does 200J work. How much heat does it receive in the meantime if its adiabatic exponent is κ=1.4?

3. A thermally insulating vertical cylinder with a cross-sectional area of 100cm^2 is sealed off by a thermally insulating piston of 20kg. The height of the air column inside the cylinder is 50cm, the temperature of the air is 300K.
(a) What is the pressure inside the air at this moment, if the atmospheric pressure is $p_0 = 10^5$Pa?
A 250kg weight is placed on top of the piston.
(b) What will be the pressure, temperature inside the air, and how tall will be the air column?
(c) How much work is done on the gas after placing the extra weight on top of the piston?