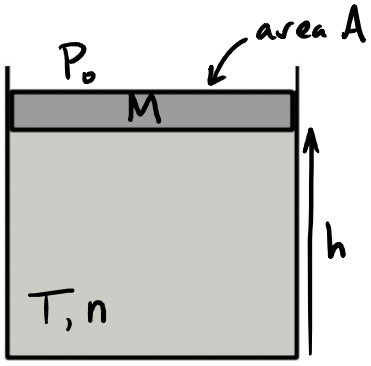
Physics 157 oscillations worksheet



A cylinder with gas at constant temperature T has a piston of mass M which can move freely up and down. We would like to calculate the oscillation frequency of the piston if it is displaced up or down.

use: M = 200kg, g = 10m/s^2, P_0 = 100kPa, A = 0.03m^2, T=300K, nR = 5J/K

a) Draw a free body diagram for the piston showing the vertical forces. Calculate the magnitude of the net upwards force on the object as a function of the height h of the piston.

Your answer should be a function of h.

c) Sketch a graph of the net upward force on the piston vs the height of the piston

d) What is the equilibrium height of the piston?

e) What is the oscillation frequency ω?

f) **Extra:** if we have larger amplitude oscillations, how do you think the displacement as a function of time would differ from a pure sinusoidal function?

Hint: if the restoring force as a function of position is F(x), then the equilibrium position can be found using $F(x_{eq}) = 0$. The effective k for the system is then the magnitude of the slope of the graph of F(x) at this equilibrium position, that is

$$k = |F'(x_{eq})|$$

The angular frequency is related to this by $\omega = (k/m)^{1/2}$