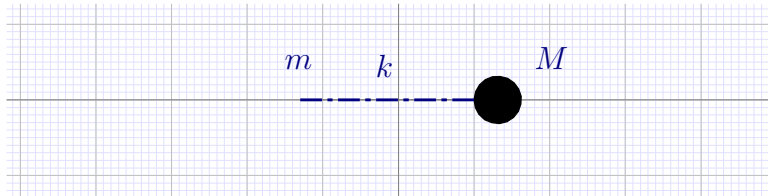


# HOMEWORK 1

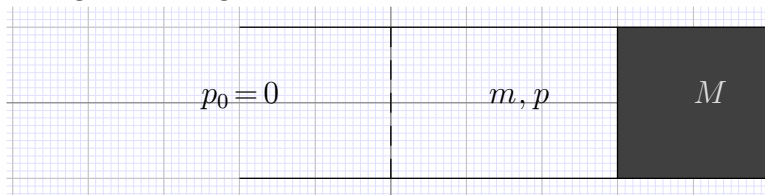
Due date: March 10, 2017, 11:55PM.

In the novel and follow-on movie *The Martian*, the *Hermes* spaceship is deliberately breached in order to vent atmosphere into space and produce a braking thrust due to the reaction force of the escaping air. In this assignment you are to verify whether the desired reduction of velocity by 30 m/s is possible.

1. Construct a 0D model of the problem: model the *Hermes* as two point masses  $m$ ,  $M$  connected by a spring with stiffness constant  $k$ . Mass  $M$  is the total mass of the *Hermes*,  $m$  is the mass of the air. The spring models the compressed atmosphere. It stores potential energy  $\Pi = pV$ , with  $p$  the pressure inside the spaceship and  $V$  its volume. The potential energy of a spring compressed by  $x$  w.r.t. equilibrium length is  $kx^2/2$ , hence  $kx^2 = 2pV$ . Provide realistic estimates of physical values and compute the *Hermes* deceleration.



2. Construct a 1D model of the problem: model the *Hermes* as a Riemann problem and compute the deceleration. Solve the problem analytically, and be careful to account for the moving boundary condition at the right of the gas domain that accounts for the deceleration of the *Hermes*.



3. Construct a numerical 1D model of the problem using BEARCLAW. Use the same geometry as in 2.
4. Construct a numerical 2D model of the problem using BEARCLAW. Include a somewhat realistic model of the various side structures of the ship.

