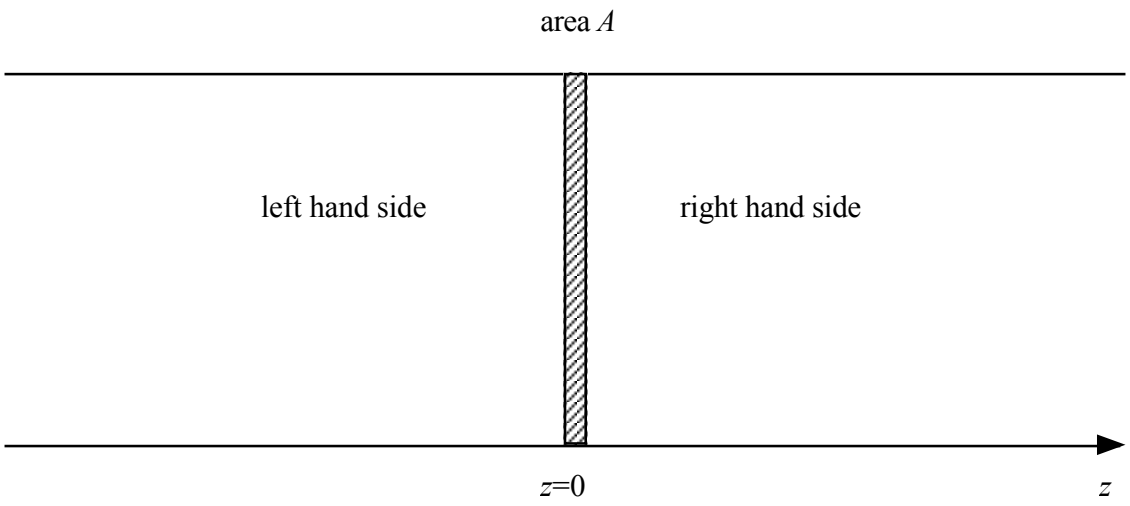

Consider a cylinder of large cross-sectional area A and of infinite length, as shown above. In the middle of the length, at $z = 0$, there is a wall that divides the cylinder in half. Imagine that on the right had side of this wall a particle of mass m will feel a potential energy $(\frac{1}{2})kz^2$, and that on the left hand side of this wall the same particle will feel a potential energy of $g|z|$.

Suppose that the wall conducts heat, but is impermeable to such particles (particles cannot pass through it) and is fixed (it cannot move). A total of N such particles are placed in the cylinder, half on the left side and half on the right side. The system then relaxes to equilibrium at a temperature T.

a) How does the density of particles vary with z on the right hand side? on the left hand side? Express your answer in terms of T, N and A. [20 points]

b) What is the jump in pressure across the wall? [25 points]

Now suppose that the wall is replaced by a porous wall, so that particles may pass through it, but the wall remains fixed in place. The total number of particles remains fixed at N. The system again relaxes to equilibrium.

c) What is the ratio of the number of particles on the right hand side of the wall to the number on the left hand side? How does this ratio vary with temperature T? [30 points]

d) What is the jump in pressure across the wall? [25 points]