[tex132] Hydrostatic pressure

The chemical potential in a homogeneous fluid is a function $\mu = \mu_0(p, T)$ such as calculated in [tex17] for the classical ideal gas. What remains uniform throughout the fluid in the presence of a uniform gravitational field is the potential

$$\mu = \mu_0(p, T) + mgz = \text{const.},$$

where m is the mass of the fluid particle, g is the acceleration due to gravity, and the z-direction is against the field. For a fluid of negligible compressibility derive from the condition $d\mu/dz = 0$ the familiar result for the hydrostatic pressure,

$$p(z) = p_0 - \rho g z,$$

where $\rho = Nm/V$ is the (average) mass density of the fluid.

Solution: