MIT Department of Mechanical Engineering
2.25 Advanced Fluid Mechanics

Problem 1.10
This problem is from "Advanced Fluid Mechanics Problems" by A.H. Shapiro and A.A. Sonin

The Swiss scientist Auguste Picard developed a navigable diving vessel, the "bathyscape", to investigate the ocean at great depths (http://en.wikipedia.org/wiki/Bathyscaphe). In 1960, his son Jacques, accompanied by Lt. Don Walsh of the U.S. Navy, reached a depth of 10,916 m in the Pacific's Mariana Trench.

Suppose that the ocean is at constant temperature, has a density of $1030\,\mathrm{kg/m^3}$ at sea level, and is characterized by a constant isothermal bulk compressibility

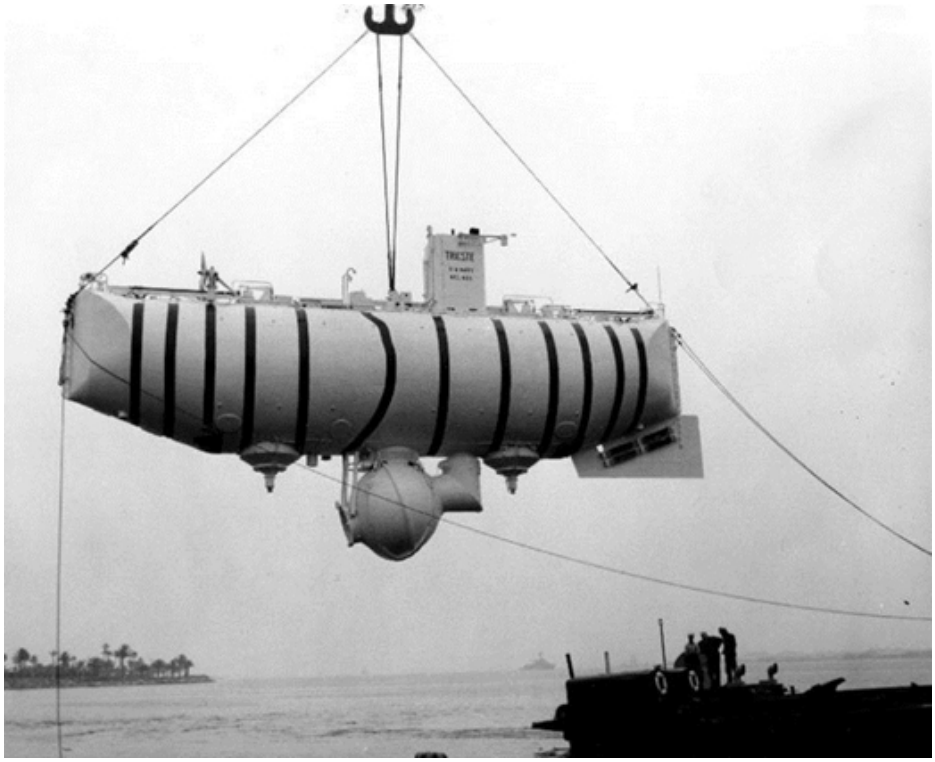
$$\kappa_T \equiv \frac{1}{\rho}\left(\frac{\partial \rho}{\partial p}\right)_T = 4.6 \times 10^{-10}\,\mathrm{m^2/N}. \tag{1.10a}$$

Compute the pressure at a depth of 11 km,

(a) assuming the density is constant at the sea level value, and

(b) taking the water's compressibility into account.

For part (b), derive an expression for the pressure as a function of depth below the surface, considering the sea level density ρ_0 and pressure p_0, as well as κ_T, as given quantities.



Courtesy of the U.S. Naval History Center. Photograph in the public domain.

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