Sound speed in water

(a) Show that the internal energy density of a sound wave in water is

$$U = \frac{1}{2} B \delta^2$$

where $B \equiv -V \partial p / \partial V$ is the bulk modulus, the shear modulus $G = 0$ for fluids, and $\delta = \text{Tr } u_{ij}$ is the dilation.

(b) Assuming a plane wave of the form

$$\mathbf{u}(\mathbf{r}, t) = u_0 \, \hat{\mathbf{x}} \, e^{ikx - \omega t},$$

show that the sound speed $v \equiv \omega / k = \sqrt{B/\rho}$.

(c) Evaluate the speed of sound in water, given the density $\rho = 1$ g/cm^3 and bulk modulus $B = 2$ GPa.