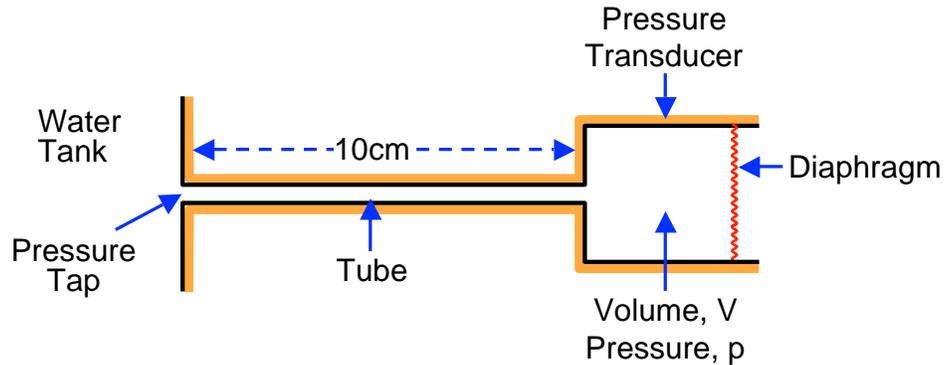


**Problem 520A**

A pressure transducer is connected to a large water tank for the purpose of measuring the unsteady pressures in that tank. The connection is made by means of a 10cm long section of rigid tube whose internal diameter is 3mm:



The tube and the internal cavity of the transducer are completely filled with water. The deformation of the diaphragm in the transducer is such that the internal cavity volume,  $V$ , increases with the cavity pressure,  $p$ , according to  $V = a + bp$  where  $a$  and  $b$  are constants. The value of  $b$  in this particular transducer is  $10^{-11} \text{ m}^3/\text{Pa}$ .

By determining the relation between the pressure in the tank and the transducer cavity pressure, find the natural frequency (in  $\text{Hz}$ ) of the transducer and its connection. (Note: this will, in practice, be the frequency at and above which the transducer will fail to respond accurately to the tank pressures.) Assume the density of the water is  $1000 \text{ kg/m}^3$ . Neglect the wall shear stress inside the tube.