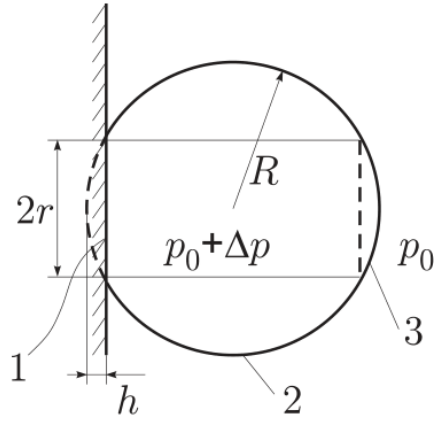
1. Volleyball (8 pts)

1) $F = \Delta p\, S$, where $S = \pi r^2$ is the segment base surface. It is easy to see that $r^2 = (2R - h)h$, hence $F = \Delta p\, \pi h(2R - h) \approx 120\,\mathrm{N}$.

2) During the collision the ball is deformed as shown in Figure: the envelope is not stretchable, hence it retains the spherical shape (except where in touch with the wall). Using the approximation $h \ll R$ we can neglect the term h^2 in the expression for the force. Then, the force is proportional to h, ie. the ball behaves as a spring of stiffness $k = 2\pi R\Delta p$. According to the energy conservation law $mv^2 = 2\pi R\Delta p\, h^2$, hence $h = v\sqrt{m/2\pi R\Delta p} \approx 11\,\mathrm{mm}$.



3) This is the half of the harmonic oscillations period, $\tau = \pi\sqrt{m/2\pi R\Delta p} = \sqrt{\pi m/2R\Delta p} \approx 18\,\mathrm{ms}$.

4) Let us use the ball's system of reference. The envelope surface element dS is exerted by the force of inertia $dF_i = a\, m\, dS/4\pi R^2$, where $a = \Delta p\, \pi h(2R - h)/m$. Thus, $dF_i = \Delta p\, h(2R - h)\, dS/4R^2$. In order to keep the spherical shape, this force has to be compensated by the force due to the excess pressure $dF_r = \Delta p\, dS$, hence $h(2R - h) < 4R^2$. This condition is always satisfied, no additional constraint is needed. Notice that we considered only the worst case requiring the largest compensating force when the force of inertia is normal to the surface. *Remark:* The case of stretchable envelope is completely different, sphericity disappears over all the surface (try to press a balloon against a glass!).