568.

Problem 41.43 (RHK)

We have to prove that for a stream of bullets striking a plane surface at normal incidence the "*pressure*" *is twice the kinetic energy density in the stream above the surface*; *we may assume that the bullets are completely absorbed by the surface*.

Solution:

Let the number density of the bullets incident normally on a plane surface be n. Let the mass of each bullet be m and the speed of the bullets be v. We consider a unit area of the plane surface on which the stream of bullets is striking. We assume that the bullets are completely absorbed by the surface.

The energy density in the stream above the surface will be the product of the number of bullets contained per unit volume, which is n, and the kinetic energy of each bullet, which is $mv^2/2$. We have

$$\text{energy density of the stream of bullets} = \frac{mnv^2}{2}.$$

Amount of momentum transferred per unit time to the plane surface due to absorption of the stream of bullets will be the product of number of bullets contained in the cylinder of unit cross section and length v, which is nv, and the momentum of each bullet, which is mv. Therefore, the “pressure” experienced by the surface because of absorption of stream of bullets will be mnv^2, which is twice the energy density in the stream above the surface.