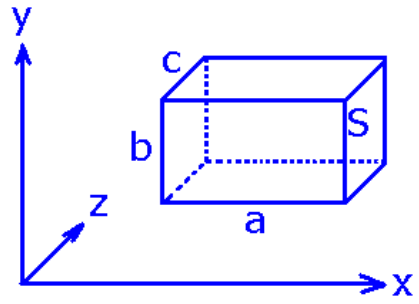
Solution to Exercise 9.1.

Consider a gas of particles contained in a rectangular box



When a single particle hits the wall of the box labeled with area $S=bc$, it changes its momentum by an amount $2p_x$. The time interval between two consecutive hits is $2a/v_x$, and hence the average force on area S, produced by a single particle, is v_xp_xa, and the average pressure is $v_xp_x/(abc)=v_xp_x/V$, where V is box volume. Energy equipartition between three degrees of freedom gives the average value $<v_xp_x>=vp/3$, and hence the pressure produced by a single particle is $vp/3V$. If we have N particles with momentum p, the pressure is $vpN/3V=vpn/3$, where $n=N/V$ is number density of particles with momentum p. When we have many particles described by a continuous distribution in momentum p, we replace n by $n(p)dp$ and integrate to obtain

$$P = \frac{1}{3}\int_0^\infty vpn(p)\,dp.$$

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