Classical probability distribution $P_{CL}(x)$

The classical probability density for a particle moving with velocity $v(x) = \frac{dx}{dt}$ can be obtained by computing the average value of a function of the position coordinate $\langle f(x)\rangle$ during time T

$$\langle f(x)\rangle = \frac{1}{T}\int_0^T f(x(t))\,dt$$

but we can write $dx = \frac{dx}{dt}\cdot dt$ then

$$\langle f(x)\rangle = \frac{1}{T}\int_0^T f(x(t))\,\frac{dx}{dx/dt}$$

$$\langle f(x)\rangle = \frac{1}{T}\int_0^{x_0} \frac{f(x)\,dx}{v(x)} = \int_0^{x_0} f(x)\,P_{CL}(x)\,dx$$

where $P_{CL}(x) = \frac{1}{T v(x)}$ and $x_0 = x(t=T)$.

Notice that if $v(x)$ is constant such that $x_0 = vT$ then $P_{CL} = \frac{1}{x_0}$ i.e. every position between 0 and x_0 is equally likely.