

STEP II, 1999, Q10

- 10 N particles $P_1, P_2, P_3, \dots, P_N$ with masses $m, qm, q^2m, \dots, q^{N-1}m$, respectively, are at rest at distinct points along a straight line in gravity-free space. The particle P_1 is set in motion towards P_2 with velocity V and in every subsequent impact the coefficient of restitution is e , where $0 < e < 1$. Show that after the first impact the velocities of P_1 and P_2 are

$$\left(\frac{1 - eq}{1 + q}\right)V \quad \text{and} \quad \left(\frac{1 + e}{1 + q}\right)V,$$

respectively.

Show that if $q \leq e$, then there are exactly $N - 1$ impacts and that if $q = e$, then the total loss of kinetic energy after all impacts have occurred is equal to

$$\frac{1}{2}me(1 - e^{N-1})V^2.$$



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