6. Marbles of a common mass m approach a hard wall each with speed v along the $+y$-direction, as shown in the sketch, and bounce elastically from it.

A. (3 pts) What is the momentum change of each marble?

**(a) $\Delta p_y = -2mv$, $\Delta p_x = 0 = \Delta p_z$.

(b) $\Delta p_y = 2mv$, $\Delta p_x = 0 = \Delta p_z$.

(c) $\Delta p_y = -mv$, $\Delta p_x = 0 = \Delta p_z$.

(d) not enough information to tell.

In elastic collision with a wall, speed unchanged, vel. reversed.

$\Delta \vec{p} = \vec{p}_{final} - \vec{p}_{init} = -2mv\hat{j}$ ← y-di[rection]

B. (4 pts) What is the impulse on the wall?

(a) $\Delta p_y = -2mv$, $\Delta p_x = 0 = \Delta p_z$

**(b) $\Delta p_y = 2mv$, $\Delta p_x = 0 = \Delta p_z$

(c) $\Delta p_y = -mv$, $\Delta p_x = 0 = \Delta p_z$.

(d) not enough information to tell.

By third law, impulse on wall = − impulse on marble

$= -\underbrace{\Delta \vec{p}_{marble}}_{\text{part A}}$

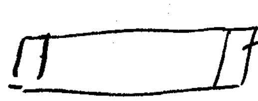
C. (3 pts) The marbles are uniformly spread so that they hit a surface A of the wall in a random fashion. Their density in space as they approach the wall is n (i.e. n is the number of particles per unit volume). What is the average force per unit area on the wall as a result of the collisions? [*Hint*: Think of the number of molecules that will hit the wall in a time interval Δt.]

(a) nmv.

(b).0.

**(c) $nm\langle v^2\rangle$.

(d) not enough information to tell.



wall, area A

half are going, half are coming

$v\Delta t$: $\frac{1}{2}$ the marbles in this length will hit the wall.

$= \frac{n}{2} \times \text{vol} = \frac{n}{2} \times (v\Delta t\, A)$

Mom to wall in Δt = Impulse to wall per collision × # collisions in time Δt

$= (2mv) \times \frac{n}{2} v \Delta t \cdot A$

$F = \frac{\text{mom to wall in } \Delta t}{\Delta t} = mv^2 n A.$

For force/unit area, divide by A.