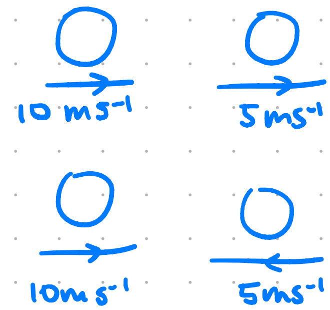
Elastic Collisions in 1-DIMENSION

Standing speed



$10 - 5 = 5\ ms^{-1}$

$10 + 5 = 15\ ms^{-1}$

Speed of approach, $|v_1 - v_2|$ ⟸

absolute is usually ignored in calculations.

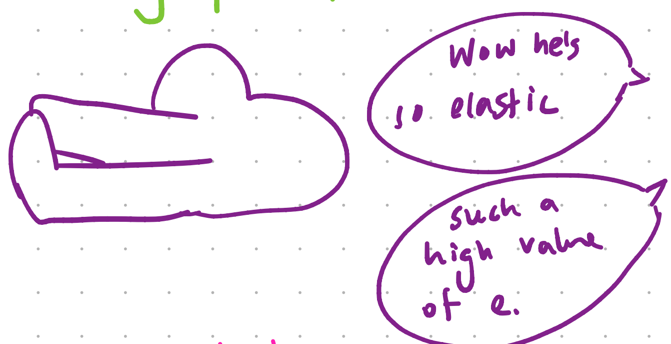
Newton's Law of Restitution AKA "NLOR"

coefficient of restitution, $e = \dfrac{\text{standing speed before collision}}{\text{standing speed after collision}}$

$e = 1$: perfectly elastic

$0 < e < 1$: elastic

$e = 0$: perfectly inelastic

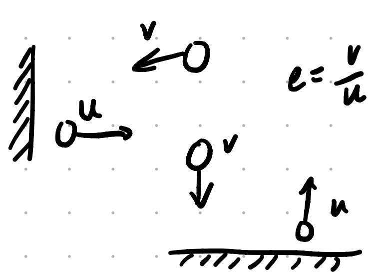


The key to solving problems in this chapter:

Apply PCOM to get 1st equation
Apply NLOR to get 2nd equation

} simultaneous equations

Smooth planes



$e = \frac{v}{u}$ (when other thing isn't moving)

⚠ DO NOT APPLY CONSERVATION OF ENERGY. (but momentum IS conserved)

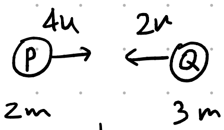
KE is <u>NOT</u> conserved when $0 < e < 1$

Ex (4D)

Q×wall $e = \frac{2}{3}$

(5)

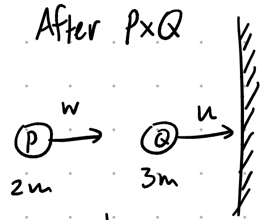
Before



Taking ($\rightarrow$) as positive,

PCOM: $\Sigma p = 8mu - 2mu$
$= 6mu$

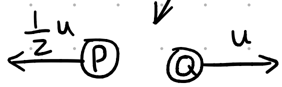
After P×Q



PCOM: $\Sigma p = 2mw + 3mu$
$= 2mu$

$2mw + mu = 0$

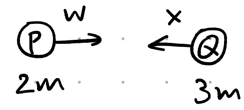
$w = -\frac{u}{2}$



NLOR: $\frac{u + \frac{1}{2}u}{4u + 2u} = \frac{\frac{3}{2}u}{6u} = \frac{1}{4} = e$

use coefficient of restitution later in 2nd P×Q collision

After Q×Wall

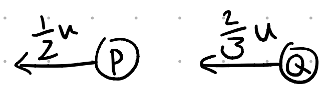


NLOR: $e = \frac{2}{3} = \frac{x}{u}$

$3y = 2u$

$y = \frac{2}{3}u$

(to the left since Q cannot go right)



PCOM: $\Sigma p = -mu - 2mu$
$= -3mu$

(p of P is $2m(-\frac{1}{2}u)$)

After P×Q

PCOM: $\Sigma p = -2mv_1 - 3mv_2$
$= -3mu$ — (1)'

(since $v_1 > v_2$)

NLOR: $\frac{v_1 - v_2}{|y - x|}$

$= \frac{v_1 - v_2}{|-\frac{2}{3}u + \frac{1}{2}u|}$

$= \frac{v_1 - v_2}{|-\frac{1}{6}u|} = \frac{v_1 - v_2}{\frac{1}{6}u}$

$= \frac{6}{u}(v_1 - v_2) = \frac{1}{4} = e$

$v_1 - v_2 = \frac{1}{24}u$ — (2)

(2)×2 : $2v_1 - 2v_2 = \frac{1}{12}u$ — (2)'

(1) - (2)' : $5v_2 = 3u - \frac{1}{12}u$

$5v_2 = \frac{35}{12}u$

$v_2 = \frac{7}{12}u$

$v_1 = v_2 + \frac{u}{24} = \left(\frac{7}{12} + \frac{1}{24}\right)u$

$= \frac{5}{8}u$

Answer: $\begin{cases} v_1 = -\frac{5}{8}u \\ v_2 = -\frac{7}{12}u \end{cases}$

(-ve sign added for direction)

LOTS OF WORK, BUT NOT DIFFICULT. JUST BE CAREFUL.