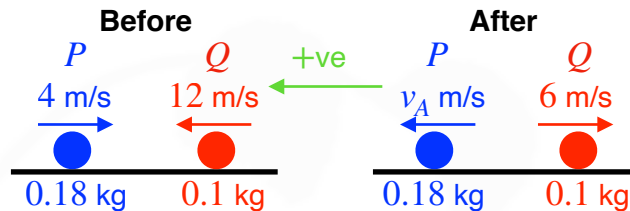


Coefficient of Restitution

Starter

1. **(Review of last lesson)** The masses of two particles, P and Q , are respectively 0.18 kg and 0.1 kg . They are moving directly towards each other at speeds of 4 m/s and 12 m/s respectively. After they collide the direction of motion of each particle is reversed and the speed of Q is 6 m/s . Find P 's speed after impact.

Working:



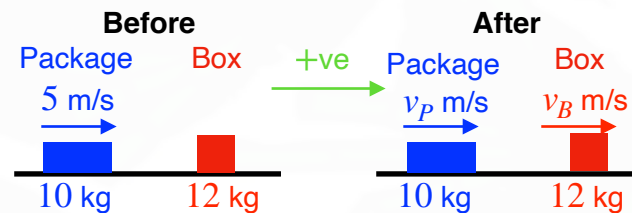
Notice the **positive** direction.

$$\begin{aligned} \text{CoM: } 0.1 \times 12 - 0.18 \times 4 &= 0.18v_A - 0.1 \times 6 \\ 0.48 &= 0.18v_A - 0.6 \\ v_A &= 6 \end{aligned}$$

P 's speed after impact is 6 m/s .

- E.g. 1** In a warehouse a package of mass 10 kg moving at 5 m/s collides with a stationary box of mass 12 kg . If the coefficient of restitution is 0.1 , find the speed of each after the collision.

Working:



$$\begin{aligned} \text{CoM: } 10 \times 5 &= 10v_P + 12v_B && \text{where } v_B > v_P \\ 50 &= 10v_P + 12v_B \end{aligned}$$

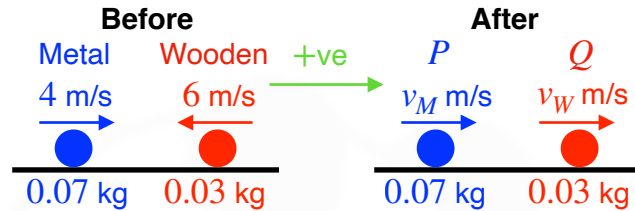
$$\begin{aligned} \text{NLI: } 0.1 \times 5 &= v_B - v_P \\ 0.5 &= v_B - v_P \end{aligned}$$

$$\text{Solve simultaneously: } v_B = 2.5 \quad v_P = 2$$

The speed of the box is 2.5 m/s and the speed of the package is 2 m/s .

E.g. 2 A metal ball of mass 70 grams is moving at 4 m/s when it collides with a wooden ball of mass 30 grams, which is moving in the same line of direction at 6 m/s. Given that $e = 0.5$, find the velocities of the balls after the collision.

Working: The wooden ball must be moving in the opposite direction otherwise the metal ball would not catch it up.



$$\text{CoM: } 0.07 \times 4 - 0.03 \times 6 = 0.07v_M + 0.03v_W \quad \text{where } v_W > v_M$$

$$0.1 = 0.07v_M + 0.03v_W$$

$$\text{NLI: } 0.5 \times (6 - -4) = v_W - v_M$$

$$5 = v_W - v_M$$

$$\text{Solve simultaneously: } v_M = -0.5 \quad v_W = 4.5$$

Both balls change direction with the metal ball travelling at 0.5 m/s and the wooden ball travelling at 4.5 m/s.

E.g. 3 A ball hits a wall with speed 1.8 m/s and rebounds at 1.2 m/s. Find e .

Working: NLI: $1.8e = 1.2 \Rightarrow e = \frac{2}{3}$

E.g. 4 An ice hockey player hits a puck at 10 m/s which hits a wall 12 m away. Given that the coefficient of restitution is 0.6 and ignoring friction, find the time it takes for the puck to return to the player.

Working: NLI: Velocity on return = $0.6 \times 10 = 6$ m/s

$$\text{Time from player to wall} = \frac{12}{10} = 1.2$$

$$\text{Time from wall to player} = \frac{12}{6} = 2$$

Total time to return to player is 3.2 seconds.

Video: [Newton's law of restitution](#)

Video: [Collisions involving e](#)

Video: [Wall collisions involving e](#)

[Momentum involving e EQ](#)

[Solutions to Starter and E.g.s](#)

Exercise

p72 3C Qu 1-8 (red 9–18)