Elastic Collisions in One Dimension (Chapter 4)

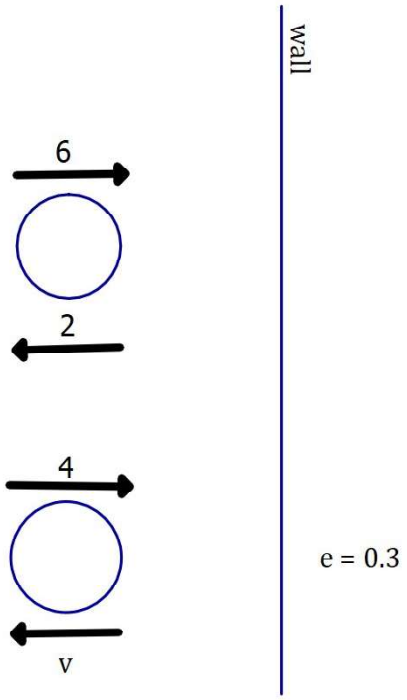
Newton's Law of Restitution

$$0 \le e \le 1$$

$$e = \frac{\text{speed of separation}}{\text{speed of approach}}$$

Inelastic, e = 0
- plasticine
- particles immediately stop on collision and form one particle
- kinetic energy lost in collision

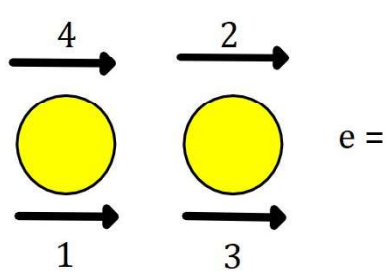
Perfectly elastic, e = 1
- table tennis ball (0.95)
- all kinetic energy is conserved

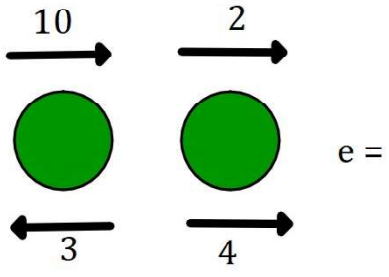


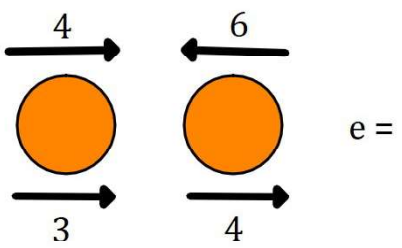
Ex 4B Q1-4

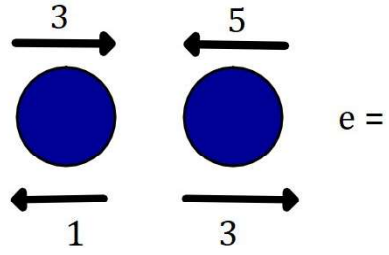
2 balls colliding

Speed of separation and speed of approach







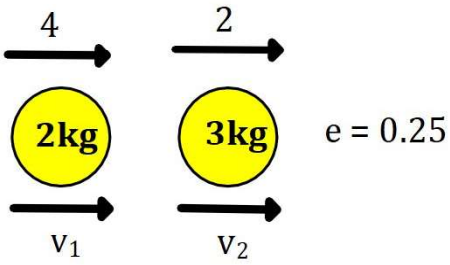


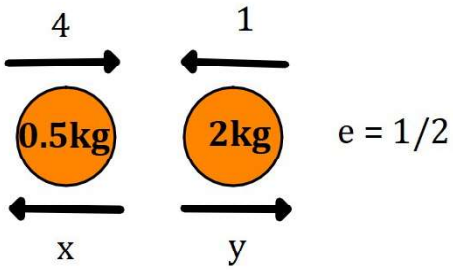
Newton's Law of Restitution

$$e = \frac{\text{speed of separation}}{\text{speed of approach}}$$

2 balls colliding

Speed of separation and speed of approach





Example 3

Two particles A and B of masses 200 g and 400 g respectively are travelling in opposite directions towards each other on a smooth surface with speeds 5 m s^{-1} and 4 m s^{-1} respectively. They collide directly, and immediately after the collision have velocities v_1 m s^{-1} and v_2 m s^{-1} respectively, measured in the direction of motion of A before the collision.

Given that the coefficient of restitution between A and B is $\frac{1}{2}$, find v_1 and v_2.

Find the velocities after the collision

- Use Newton's Law of Restitution
- Use PCLM

	Before collision	
a $e = \frac{1}{2}$	$6\,\text{m s}^{-1}$ →	At rest
	A (0.25 kg)	B (0.5 kg)
b $e = 0.25$	$4\,\text{m s}^{-1}$ →	$2\,\text{m s}^{-1}$ →
	A (2 kg)	B (3 kg)
c $e = \frac{1}{7}$	$8\,\text{m s}^{-1}$ →	$6\,\text{m s}^{-1}$ ←
	A (3 kg)	B (1 kg)
d $e = \frac{2}{3}$	$6\,\text{m s}^{-1}$ →	$6\,\text{m s}^{-1}$ ←
	A (400 g)	B (400 g)
e $e = \frac{1}{5}$	$3\,\text{m s}^{-1}$ →	$12\,\text{m s}^{-1}$ ←
	A (5 kg)	B (4 kg)

Ex 4A Q3-6

Two small spheres P and Q have mass $3m$ and $4m$ respectively. They are moving towards each other in opposite directions on a smooth horizontal plane. P has speed $3u$ and Q has speed $2u$ just before the impact. The coefficient of restitution between P and Q is e.

a Show that the speed of Q after the collision is $\frac{u}{7}(15e + 1)$.

b Given that the direction of motion of P is unchanged, find the range of possible values of e.

c Given that the magnitude of the impulse of P on Q is $\frac{80mu}{9}$, find the value of e.

Ex 4A Q7, 10, 8, 9

For 8 and 9, find what e is, and remember that $0 \leq e \leq 1$!