SCHOOL OF MATHEMATICS AND PHYSICS

Applications of vectors: Conservation of momentum

Introduction

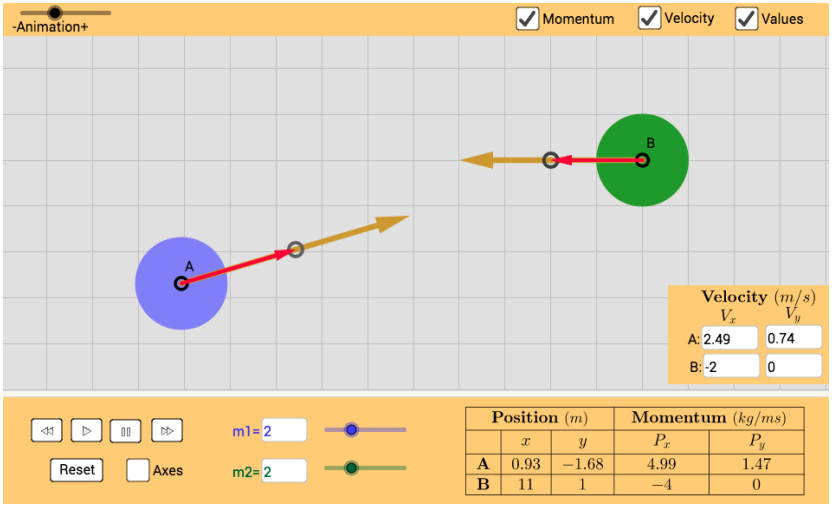
Recall that **momentum** is a vector property of a moving object. It is a scalar multiple of the velocity of the object, that is

$$\textbf{momentum} = \textbf{mass} \text{ times } \textbf{velocity}.$$

The important property of momentum is that it is conserved in collisions. That is, when objects collide, the total momentum before collision is equal to the total momentum after collision.

Use the following simulation to explore the conservation of momentum. In the simulation we asume that the collisions are elastic, that is, the total **kinetic energy** of the two bodies after the collision is equal to their total kinetic energy before the collision. Click on the link below or type the URL into your browser's address bar.

https://teaching.smp.uq.edu.au/scims/Calculus/Collisions.html



How to use the simulation

- You can drag points A and B to change the position of the balls.
- Activate the box **Axes** to help you set the position of the balls.
- Change the velocity by activating **Velocity box**.
- Change the mass (kilograms) of the balls by dragging the sliders **m1** and **m2**.
- Activate the **Momentum box** to show vectors.

Problems

1. A ball A with mass $m_1 = 2.5$ kg travels at 3 m/s east and strikes a ball B with mass $m_2 = 3.2$ kg traveling at 2 m/s west. If the velocity of the ball A after the collision is -2.61 m/s, find the velocity of ball B after the collision.

   Use the simulation to check your result.

   Remark: The position of the two balls must be defined on same line parallel to the x-axis.

2. A ball A with mass $m_1 = 2.2$ kg travels at 3 m/s east and strikes a resting ball B with mass $m_2 = 2.2$ kg.

   Use the simulation to help you solve the following:

   i) The positions of the balls A and B are $(0, 0)$ and $(8, 0)$, respectively. If the velocity of the ball B after the collision is $v_{Bf} = 2\,\mathbf{i} + 0\,\mathbf{j}$, calculate the velocity of ball A after the collision.

   ii) Now, consider that the positions of the balls A and B are $(0, 1)$ and $(8, 0)$, respectively. If the velocity of the ball A after the collision is $v_{Af} = 0.48\,\mathbf{i} + 1.1\,\mathbf{j}$, calculate the velocity of ball B after the collision.

   iii) For each part i) and ii), explain the behaviour vectors momentum and velocity, after the collision.