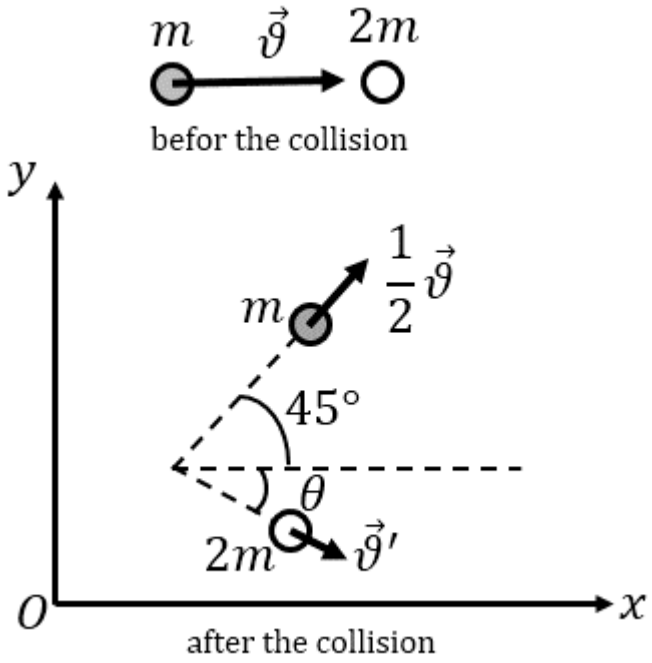
A particle mass m, traveling at a speed of v, strikes a stationary particle mass 2m. As a result the particle of mass m, is deflected through an angle of 45 degrees at a speed of v/2. What is the speed and direction of mass 2m?

Solution.

According to the law of conservation of momentum, the total momentum of an isolated system is constant:

$$m\vec{\vartheta} + 0 = \frac{1}{2}m\vec{\vartheta} + 2m\vec{\vartheta}'$$

$$\vec{\vartheta} = \frac{1}{2}\vec{\vartheta} + 2\vec{\vartheta}' \quad (1)$$



Let's find projections of (1) into coordinate axes:

Ox axis:

$$\vartheta = \frac{1}{2}\vartheta cos45° + 2\vartheta' cos\theta \quad (2)$$

Oy axis:

$$\frac{1}{2}\vartheta sin45° = 2\vartheta' sin\theta \quad (3)$$

From (3):

$$\vartheta' = \frac{\vartheta sin45°}{4sin\theta} \quad (4)$$

Let's substitute (4) into (2):

$$\vartheta = \frac{1}{2}\vartheta cos45° + 2\frac{\vartheta sin45°}{4sin\theta}cos\theta$$

$$2 = cos45° + \frac{sin45°}{tan\theta}$$

$$\frac{sin45°}{tan\theta} = 2 - cos45°$$

$$tan\theta = \frac{sin45°}{2 - cos45°} = \frac{0.7071}{1.2929} = 0.5469$$

$$\theta = 29°$$

Let's substitute the value of θ into (4):

$$\vartheta' = \frac{\vartheta sin45°}{4sin29°} = \frac{0.7071}{1.9392}\vartheta = 0.4\vartheta$$

Answer: $\vartheta' = 0.4\vartheta$, $\theta = 29°$