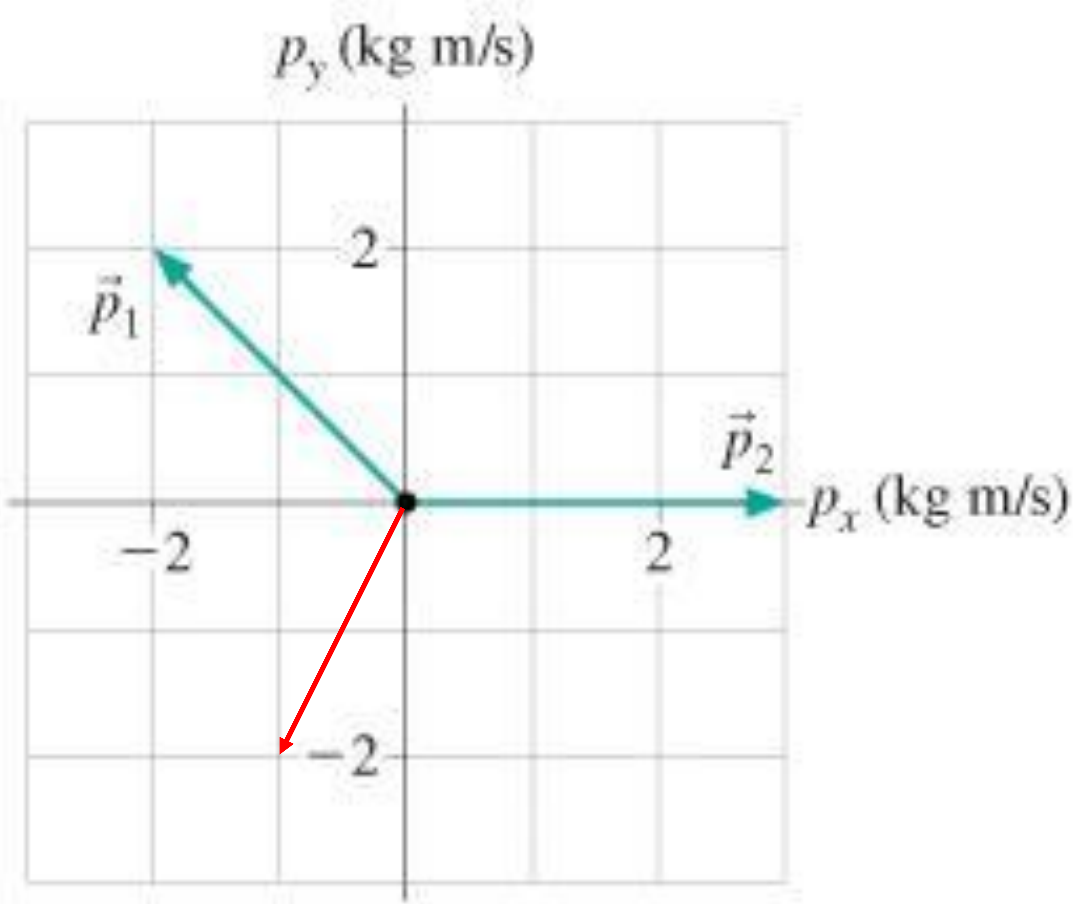
An object at rest explodes into three fragments. (Figure 1) shows the momentum vectors of two of the fragments. What is p_x ; p_y of the third fragment?



So P1 + P2 + P3 = 0
P3 = –P1 – P2

get the components of each, negate and add
P1x = –2
P1y = +2
P2x = +3
P2y = 0

P3x = –(–2 +3) = –1
P3y = –(2+0) = –2

Problem 43P

A vessel at rest explodes, breaking into three pieces. Two pieces, having equal mass, fly off perpendicular to one another with the same speed of 30 m/s. The third piece has three times the mass of each of the other pieces. What is the direction and magnitude of its velocity immediately after the explosion ?

The vessel is an isolated system on which no external forces are acting. This implies that the total linear momentum of the system is conserved. Since the vessel is initially at rest, the initial linear momentum of the system is zero. Since the total linear momentum is conserved, the final linear momentum of the system must also be zero. Figure 9.9 shows schematically the direction of the three fragments in which the vessel explodes. The problem states that $m_1 = m_2$ and that $m_3 = 3\ m_1$. Assuming that the total mass of the system is conserved we conclude that

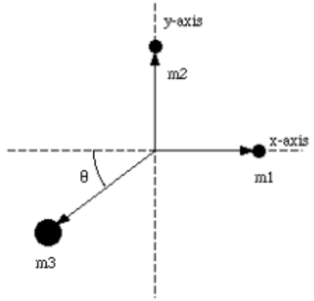


Figure 9.9. Problem 39P.

$$m = m_1 + m_2 + m_3 = 5\,m_1$$

or

$$m_1 = \frac{m}{5}$$

The problem also states that $v_1 = v_2 = 30$ m/s. Conservation of linear momentum along the x-axis and along the y-axis requires

$$p_x = m_1 v_1 - m_3 v_3 \cos(\theta) = m_2 v_2 - m_3 v_3 \cos(\theta) = 0$$

$$p_y = m_2 v_2 - m_3 v_3 \sin(\theta) = 0$$

These two equations can be rewritten in the following manner

$$\cos(\theta) = \frac{m_2 v_2}{m_3 v_3}$$

$$\sin(\theta) = \frac{m_2 v_2}{m_3 v_3}$$

These two equation can be combined to give

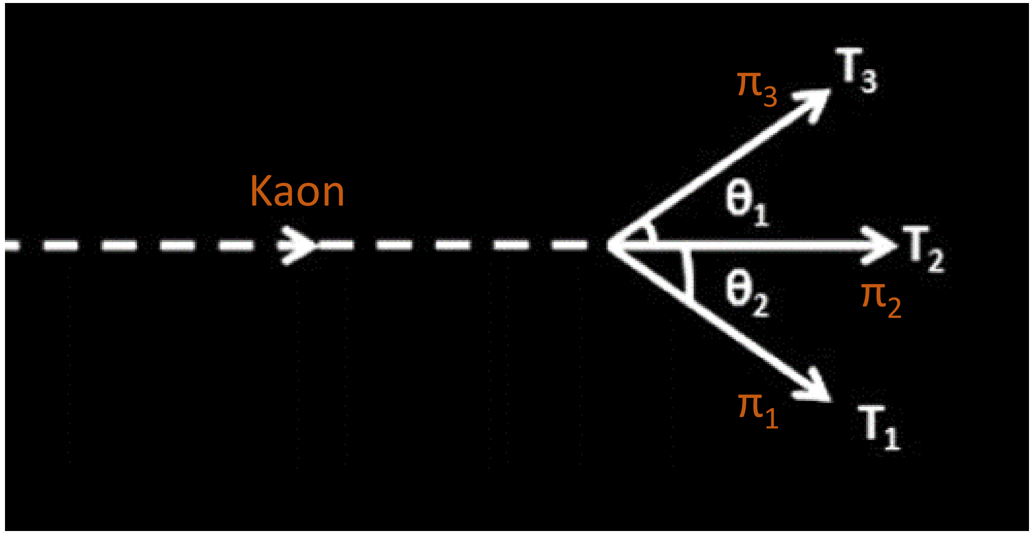
tan ([theta]) = 1

or

[theta] = 45deg.

The velocity of the third fragment can now be obtained easily

$$v_3 = \frac{m_2 v_2}{m_3 \cos(\theta)} = \frac{m_1 v_2}{3\,m_1 \cos(\theta)} = 14 \text{ m/s}$$



Kaon
π_3
T_3
θ_1
T_2
θ_2
π_2
π_1
T_1