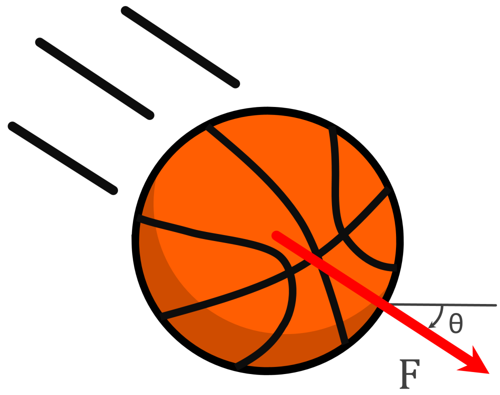
Basketball Throw



A basketball player is throwing the ball with angle θ and force F as shown in the figure. The acceleration of the ball at that instant is $-50\ \mathrm{m/s^2}$ in the y-direction and $40\ \mathrm{m/s^2}$ in the x-direction. Moreover, the resultant force in the y-direction exerted by the player on the ball is $F_y = -10$ N. What is the value of the angle θ? Take $g = 10\ \mathrm{m/s^2}$.

Using known expressions:

$$\sum F_x = m \cdot a_x \tag{1}$$

$$\sum F_y = m \cdot a_y \tag{2}$$

Given:

Acceleration in x-direction: $a_x = 40\ \mathrm{m/s^2}$
Acceleration in y-direction: $a_y = -50\ \mathrm{m/s^2}$
Resultant force in y-direction: $F_y = -10$ N
Gravitational constant: $g = 10\ \mathrm{m/s^2}$

Solution:

Equation 1 and 2 become.

$$\sum F_x = m \cdot a_x = F\cos\theta \tag{3}$$

$$\sum F_y = m \cdot a_y = -F\sin\theta - m \cdot g \tag{4}$$

It is given that the net resultant force in the y-direction is equal to 10 N pointing in the negative y-direction, thus $-F\sin\theta = -10$ N. Together with the known value of the acceleration in the y-direction, the mass can be solved using Equation 4.

$$\sum F_y = m \cdot a_y = F\sin\theta - m \cdot g \quad \Rightarrow \quad -50 \cdot m = -10 - 10 \cdot m \quad \Rightarrow \quad m = 0.25 \text{ kg} \tag{5}$$

Inserting this mass in Equation 3 gives.

$$\sum F_x = m \cdot a_x = F\cos\theta \quad \Rightarrow \quad 0.25 \cdot 40 = F\cos\theta \quad \Rightarrow \quad F\cos\theta = 10 \text{ N} \tag{6}$$

We have the following equations:

$$F\cos\theta = 10 \text{ N} \tag{7}$$

$$-F\sin\theta = -10 \text{ N} \tag{8}$$

We have two equations (Equation 7 and 8) and two unknowns, thus the angle θ can be solved.

$$\frac{F\sin\theta}{F\cos\theta} = \tan\theta = \frac{10}{10} = 1 \quad \Rightarrow \quad \theta = \arctan(1) = 45^\circ \tag{9}$$