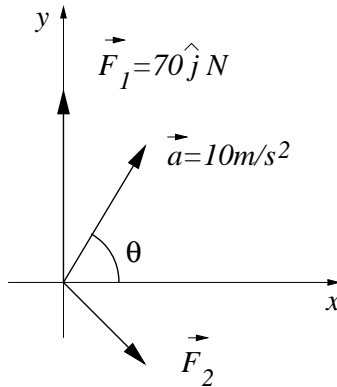


Problem 4: Force and Acceleration (25 pts)

A particle of mass $m = 5\text{kg}$, is momentarily at rest at $x = 0$ at $t = 0$. It is acted upon by two forces \vec{F}_1 and \vec{F}_2 . $\vec{F}_1 = 70\hat{j}\text{N}$. The *direction* and *magnitude* of \vec{F}_2 are *unknown*. The particle experiences a *constant acceleration*, \vec{a} , in the direction as shown. Note: $\sin \theta = 4/5$, $\cos \theta = 3/5$, and $\tan \theta = 4/3$. Neglect gravity.

- Find the missing force \vec{F}_2 . Either give *magnitude* and *direction* of \vec{F}_2 or its components. Plot \vec{F}_2 on the figure. What angle does \vec{F}_2 make to the x -axis?
- What is the *velocity vector* of the particle at $t = 10\text{sec}$?
- What *third* force, \vec{F}_3 , is required to make the acceleration of the particle zero? Either give *magnitude* and *direction* of \vec{F}_3 or its components.
- What is the *vector sum* of the three forces: $\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = ?$



Solution:

(a) $F_{2x} = ma_x - F_{1x} = 5 \times 10 \times \cos \theta - 0 = 30\text{N}$.

$F_{2y} = ma_y - F_{1y} = 5 \times 10 \times \sin \theta - 70 = -30\text{N}$.

$\vec{F}_2 = (30, -30)\text{N}$.

(b) $\vec{v} = 10 \times \vec{a} = (60, 80)\text{m/s}$, or

$|\vec{v}| = 100\text{m/s}$ with direction θ relative to x -axis.

(c) The force \vec{F}_3 cancel the total acceleration. So $\vec{F}_3 = -m\vec{a}$.

$\vec{F}_2 = (-30, -40)\text{N}$.

(d) $\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = (0, 70) + (30, -30) + (-30, -40) = (0, 0) = 0$.