

Adding 3-D Vectors (Solution)

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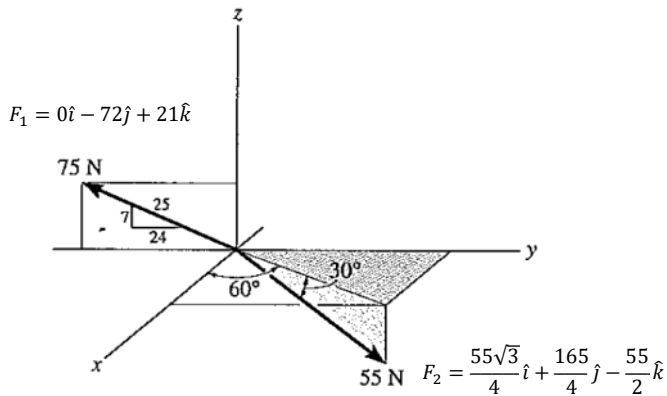
2-42. Determine the magnitude and the coordinate direction angles of the resultant force.

Q2-42 from Statics & Mechanics of Materials 2e by Hibbeler

Why: Resultant force describes the total force felt by the object and dictates how it moves

Steps:

1. Express each force as a cartesian vector.
2. Add components to find resultant vector.
3. Determine cosine direction angles.



$$\frac{z}{75} = \frac{7}{25} \Rightarrow z = 75 * \frac{7}{25} = 21 \text{ N}$$

$$\frac{y}{75} = \frac{24}{25} \Rightarrow z = 75 * \frac{24}{25} = 72 \text{ N}$$

$$F_{2,z} = -55 \sin(30) = -\frac{55}{2}$$

OR

$$F_{2,z} = 55 \cos(120) = -\frac{55}{2}$$

$$F = 55 \cos(30) = \frac{55\sqrt{3}}{2}$$

$$F_{2,x} = F \cos(60) = \frac{55\sqrt{3}}{4}$$

$$F_{2,y} = F \cos(90 - 60) = \frac{165}{4}$$

OR

$$F_{2,y} = F \sin(60) = \frac{165}{4}$$

$$F_R = F_1 + F_2$$

$$F_{R,x} = F_{1,x} + F_{2,x} = 0 + \frac{55\sqrt{3}}{4} = \frac{55\sqrt{3}}{4}$$

$$F_{R,y} = F_{1,y} + F_{2,y} = -72 + \frac{165}{4} = -\frac{123}{4}$$

$$F_{R,z} = F_{1,z} + F_{2,z} = 21 - \frac{55}{2} = -\frac{13}{2}$$

$$|F_R| = \sqrt{\left(\frac{55\sqrt{3}}{4}\right)^2 + \left(-\frac{123}{4}\right)^2 + \left(-\frac{13}{2}\right)^2} = \sqrt{1555} \approx 39.43$$

$$\alpha = \cos^{-1}\left(\frac{55\sqrt{3}}{4\sqrt{1555}}\right) = 53.85^\circ$$

$$\beta = \cos^{-1}\left(\frac{-123}{4\sqrt{1555}}\right) = 141.2^\circ$$

$$\gamma = \cos^{-1}\left(\frac{-13}{2\sqrt{1555}}\right) = 99.49^\circ$$

$$\vec{F}_R = 39.43 \text{ N } \alpha = 53.85^\circ, \beta = 141.2^\circ, \gamma = 99.49^\circ$$