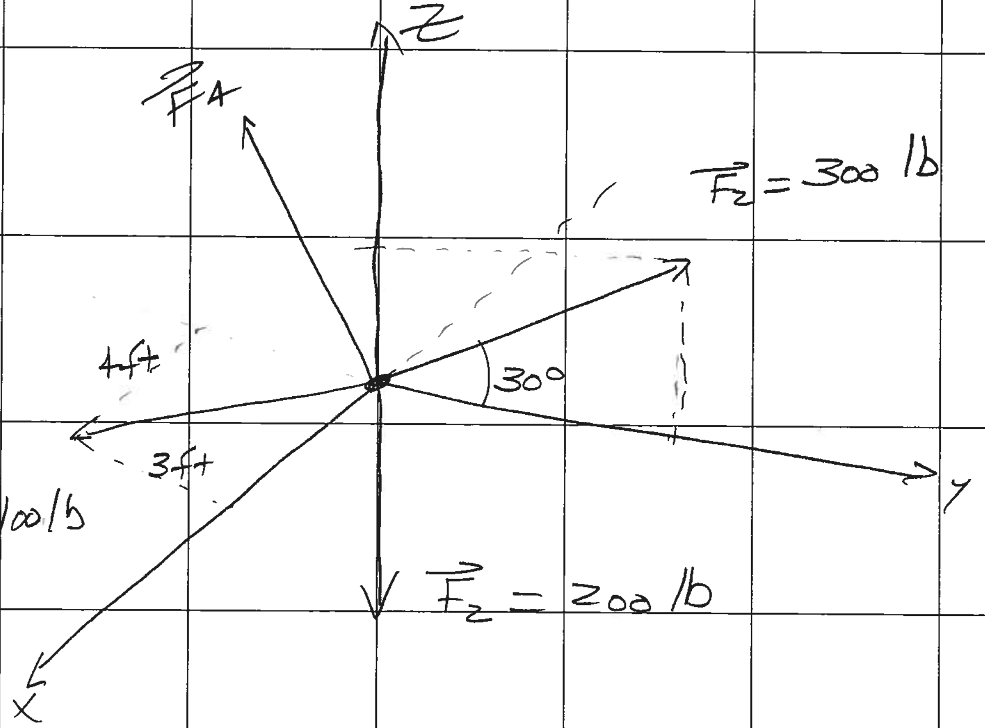
The particle shown is in equilibrium under the action of four forces as shown in the free body diagram. Determine the magnitude and the coordinate direction angles of the unknown Force, $\vec{F_4}$. Force $\vec{F_1}$ is in the x-y plane, force $\vec{F_2}$ aligned with the vertical z-axis. Force $\vec{F_3}$ is in the yz plane.



The first step is to prepare the F.B.D as shown above.

The next step is to express each vector in Cartesian vector coordinates

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By inspection

(1) $\vec{F}_1 = \frac{4}{5}(100)\,\hat{i} - \frac{3}{5}(100)\,\hat{j} + 0\,\hat{k}$

(2) $\vec{F}_1 = 80\,\hat{i} - 60\,\hat{j} + 0\,\hat{k}$

By inspection

(3) $\vec{F}_3 = 0\,\hat{i} + \cos 30\,(300)\,\hat{i} + \sin 30\,(300)\,\hat{k}$

(4) $\vec{F}_3 = 0\,\hat{i} + 46.28\,\hat{i} + 150\,\hat{k}$

By inspection

(5) $\vec{F}_2 = 0\,\hat{i} + 0\,\hat{j} - 200\,\hat{k}$

Unknown Vector

(6) $\vec{F}_4 = F_{4x}\,\hat{i} + F_{4y}\,\hat{j} + F_{4z}\,\hat{k}$

Scalar Equations of Equilibrium

$\sum F_x = 0$

(7) $80 + 0 + 0 + F_{4x} = 0$

$F_{4x} = -80$ lb

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$\Sigma F_y = 0$

(8) $-60 + 46.28 + 0 + F_{4y} = 0$

$F_{4y} = -13.72$ lb

$\Sigma F_z = 0$

(9) $0 + 150 - 200 + F_{4z} = 0$

$F_{4z} = +50$ lb

$\therefore$

(10) $\vec{F_4} = -80\,\hat{i} - 13.72\,\hat{j} + 50\,K$ (lb)

The magnitude of the vector is given as

(11) $|\vec{F_4}| = \sqrt{(-80)^2 + (-13.72)^2 + (50)^2}$

(12) $|\vec{F_4}| = 95.3$ lb

The unit vector in the direction of $\vec{F_4}$

(13) $\hat{n}_{F_4} = -\frac{80}{95.3}\hat{i} - \frac{13.72}{95.3}\hat{j} + \frac{50}{95.3}\hat{K}$

(14) $\hat{n}_{F_4} = -.840\,\hat{i} - .144\,\hat{j} + .525\,\hat{K}$

(15) Check $\sqrt{(-.840)^2 + (-.144)^2 + .525^2} = 1.001$ ok

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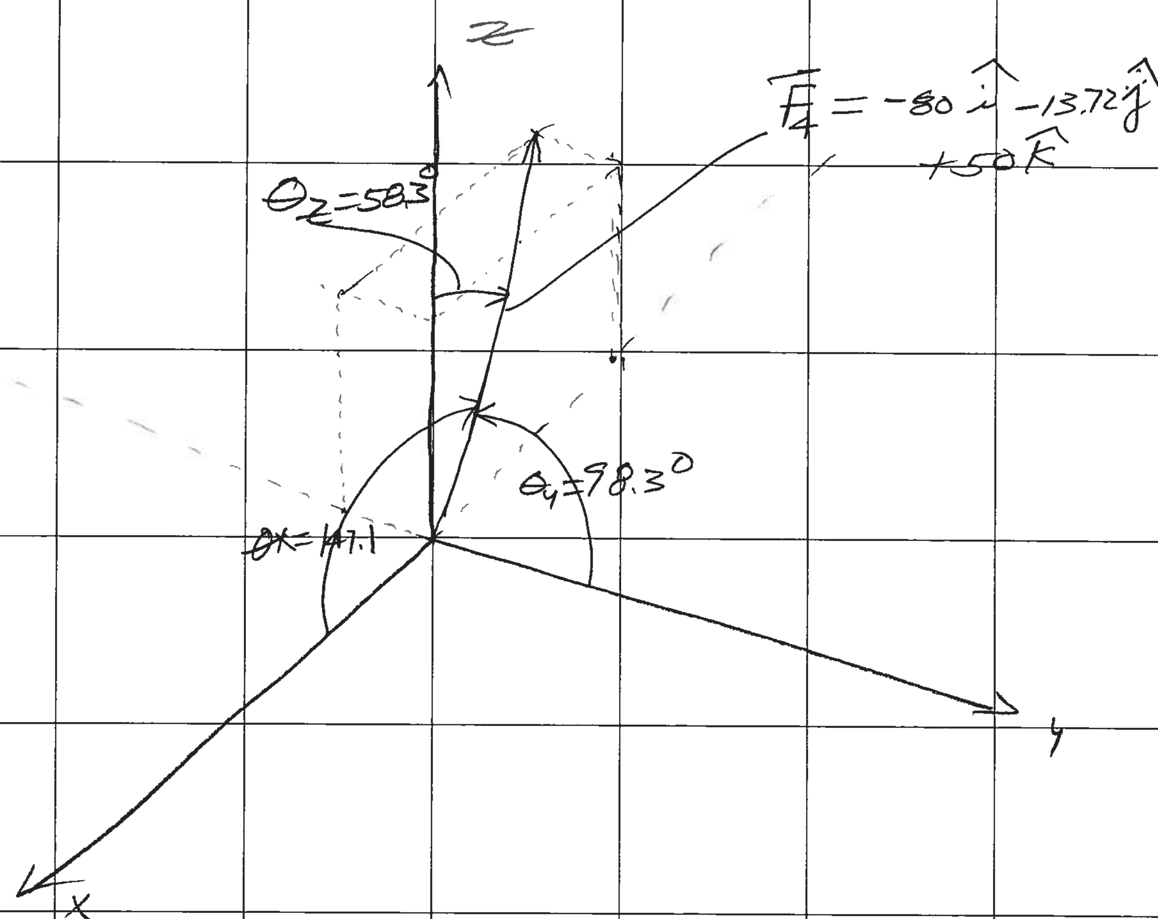
(16) $\theta_x = \cos^{-1}(-.840) = 147.1^\circ$

(17) $\theta_y = \cos^{-1}(-.144) = 98.3^\circ$

(18) $\theta_z = \cos^{-1}(.525) = 58.3^\circ$



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