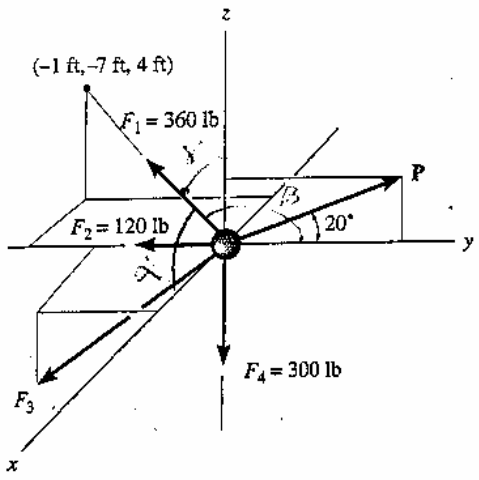
ENG 243 – Statics
Test No. 1 – Spring 2004

Problems 1 and 2 relate to the picture shown:



1. Express F_1 as a Cartesian vector. Determine the coordinate direction angles for that vector.

$\vec{r}_1 = -1\hat{i} - 7\hat{j} + 4\hat{k}$

$r_1 = \sqrt{1^2 + 7^2 + 4^2} = 8.124$

$\hat{u}_1 = \frac{-1}{8.124}\hat{i} + \frac{-7}{8.124}\hat{j} + \frac{4}{8.124}\hat{k}$

$= -.1231\hat{i} - .8616\hat{j} + .4924\hat{k}$

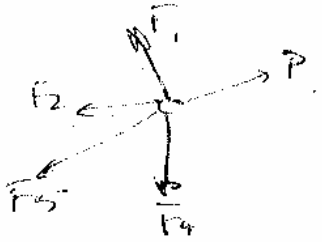
$\vec{F}_1 = 360 \cdot \hat{u}_1 = -44.32\hat{i} - 310.2\hat{j} + 177.3\hat{k}$

$\cos\alpha = -.1231, \quad \alpha = 97.07°$

$\cos\beta = -.8616, \quad \beta = 149.5°$

$\cos\gamma = .4924, \quad \gamma = 60.5°$

2. If force P has a magnitude of 640 lbs, determine the Cartesian vector $\mathbf{F_3}$ necessary so that the ball remains in equilibrium.



$\vec{F}_1 = -44.32\hat{i} - 310.2\hat{j} + 177.3\hat{k}$

$\vec{F}_2 = 0\hat{i} - 120\hat{j} + 0\hat{k}$

$\vec{F}_4 = 0\hat{i} + 0\hat{j} - 300\hat{k}$

$\vec{P} = 640(0\hat{i} + \cos 20\hat{j} + \sin 20\hat{k}) = 0\hat{i} + 601.4\hat{j} + 218.9\hat{k}$

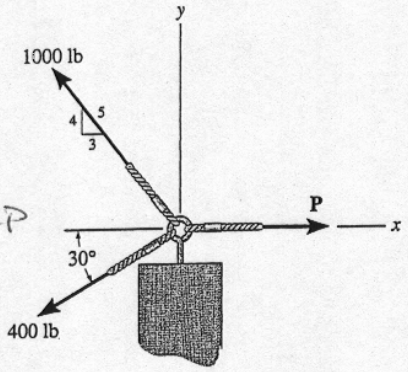
$\Sigma\vec{F} = 0 = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \vec{P}$

$= \{(-44.32 \; \text{lb}) + (-310.2 - 120 + 601.4)\hat{j} + (177.3 - 300 + 218.9)\hat{k}\}$

$+ \vec{F}_3$

$F_3 = \{44.32\hat{i} + (-171.2)\hat{j} - 96.2\hat{k}\}$ lb

3. In the figure shown, there are two possible magnitudes for **P** such that the magnitude of the resultant of all three forces is 800 lbs. Determine one of them.



$$\Sigma F_x = -\tfrac{3}{5}(1000) - 400\cos 30 + P$$
$$= P - 946.4$$

$$\Sigma F_y = \tfrac{4}{5}(1000) - 400\sin 30^\circ$$
$$= 600$$

$$R^2 = F_x^2 + F_y^2$$
$$800^2 = (P - 946.4)^2 + 600^2$$
$$280{,}000 = P^2 - 1892.8P + 895{,}692$$
$$0 = P^2 - 1892.8P + 615{,}692$$
$$P = \frac{+1892.8 \pm \sqrt{1892^2 - 4(1)(615692)}}{2}$$

$P = 417.3$ or $P = 1475.5$