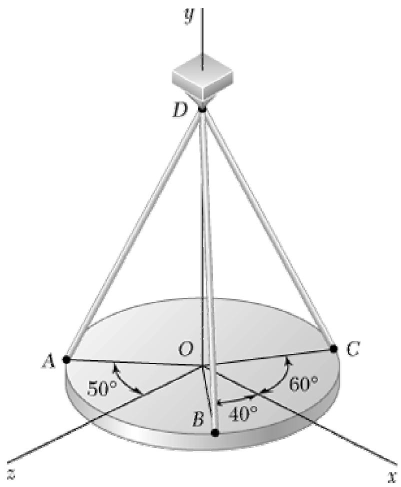
PROBLEM 2.77



A horizontal circular plate is suspended as shown from three wires which are attached to a support at *D* and form 30° angles with the vertical. Knowing that the *x* component of the force exerted by wire *AD* on the plate is 220.6 N, determine (*a*) the tension in wire *AD*, (*b*) the angles θ_x, θ_y, and θ_z that the force exerted at *A* forms with the coordinate axes.

SOLUTION

(*a*) $$F_x = F\sin 30°\sin 50° = 220.6\text{ N (Given)}$$

$$F = \frac{220.6\text{ N}}{\sin 30°\ \sin 50°} = 575.95\text{ N}$$

$$F = 576\text{ N} \blacktriangleleft$$

(*b*) $$\cos\theta_x = \frac{F_x}{F} = \frac{220.6}{575.95} = 0.3830$$

$$\theta_x = 67.5° \blacktriangleleft$$

$$F_y = F\cos 30° = 498.79\text{ N}$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{498.79}{575.95} = 0.86605$$

$$\theta_y = 30.0° \blacktriangleleft$$

$$F_z = -F\sin 30°\cos 50°$$

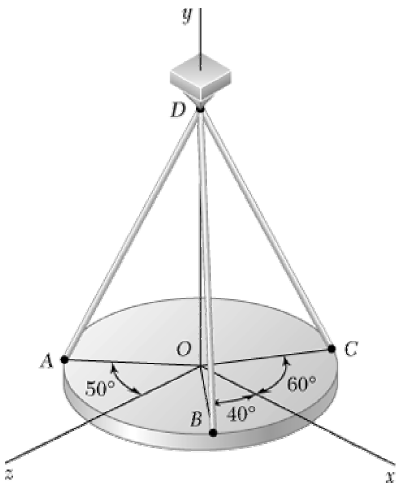
$$= -(575.95\text{ N})\sin 30°\cos 50°$$

$$= -185.107\text{ N}$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{-185.107}{575.95} = -0.32139$$

$$\theta_z = 108.7° \blacktriangleleft$$

PROBLEM 2.78



A horizontal circular plate is suspended as shown from three wires which are attached to a support at *D* and form 30° angles with the vertical. Knowing that the *z* component of the force exerted by wire *BD* on the plate is –64.28 N, determine (*a*) the tension in wire *BD*, (*b*) the angles θ_x, θ_y, and θ_z that the force exerted at *B* forms with the coordinate axes.

SOLUTION

(*a*)

$$F_z = -F \sin 30° \sin 40° = -64.28 \text{ N} \ \ \text{(Given)}$$

$$F = \frac{64.28 \text{ N}}{\sin 30° \sin 40°} = 200.0 \text{ N} \qquad F = 200 \text{ N} \blacktriangleleft$$

(*b*)

$$F_x = -F \sin 30° \cos 40°$$

$$= -(200.0 \text{ N}) \sin 30° \cos 40°$$

$$= -76.604 \text{ N}$$

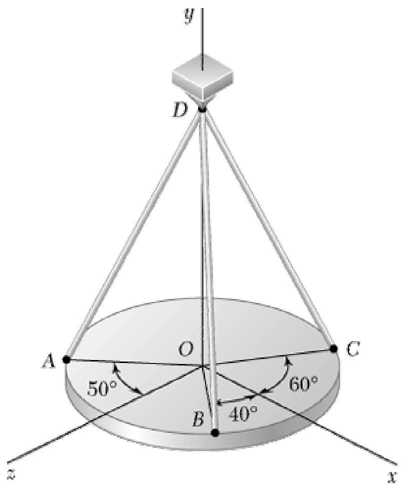
$$\cos\theta_x = \frac{F_x}{F} = \frac{-76.604}{200.0} = -0.38302 \qquad \theta_x = 112.5° \blacktriangleleft$$

$$F_y = F \cos 30° = 173.2 \text{ N}$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{173.2}{200} = 0.866 \qquad \theta_y = 30.0° \blacktriangleleft$$

$$F_z = -64.28 \text{ N}$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{-64.28}{200} = -0.3214 \qquad \theta_z = 108.7° \blacktriangleleft$$



PROBLEM 2.79

A horizontal circular plate is suspended as shown from three wires which are attached to a support at D and form 30° angles with the vertical. Knowing that the tension in wire CD is 120 lb, determine (*a*) the components of the force exerted by this wire on the plate, (*b*) the angles θ_x, θ_y, and θ_z that the force forms with the coordinate axes.

SOLUTION

(*a*)

$$F_x = -(120\text{ lb})\sin 30°\cos 60° = -30\text{ lb}$$

$$F_x = -30.0\text{ lb} \blacktriangleleft$$

$$F_y = (120\text{ lb})\cos 30° = 103.92\text{ lb}$$

$$F_y = +103.9\text{ lb} \blacktriangleleft$$

$$F_z = (120\text{ lb})\sin 30°\sin 60° = 51.96\text{ lb}$$

$$F_z = +52.0\text{ lb} \blacktriangleleft$$

(*b*)

$$\cos\theta_x = \frac{F_x}{F} = \frac{-30.0}{120} = -0.25$$

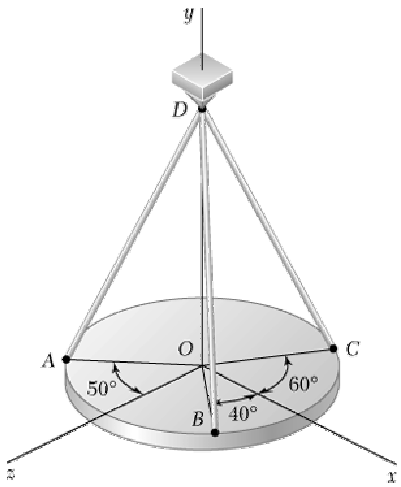
$$\theta_x = 104.5° \blacktriangleleft$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{103.92}{120} = 0.866$$

$$\theta_y = 30.0° \blacktriangleleft$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{51.96}{120} = 0.433$$

$$\theta_z = 64.3° \blacktriangleleft$$



PROBLEM 2.80

A horizontal circular plate is suspended as shown from three wires which are attached to a support at D and form 30° angles with the vertical. Knowing that the x component of the forces exerted by wire CD on the plate is –40 lb, determine (a) the tension in wire CD, (b) the angles θ_x, θ_y, and θ_z that the force exerted at C forms with the coordinate axes.

SOLUTION

(a)

$$F_x = -F\sin 30°\cos 60° = -40 \text{ lb (Given)}$$

$$F = \frac{40 \text{ lb}}{\sin 30° \cos 60°} = 160 \text{ lb}$$

$$F = 160.0 \text{ lb} ◀$$

(b)

$$\cos\theta_x = \frac{F_x}{F} = \frac{-40}{160} = -0.25$$

$$\theta_x = 104.5° ◀$$

$$F_y = (160 \text{ lb})\cos 30° = 103.92 \text{ lb}$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{103.92}{160} = 0.866$$

$$\theta_y = 30.0° ◀$$

$$F_z = (160 \text{ lb})\sin 30°\sin 60° = 69.282 \text{ lb}$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{69.282}{160} = 0.433$$

$$\theta_z = 64.3° ◀$$

PROBLEM 2.81

Determine the magnitude and direction of the force $\mathbf{F} = (800\text{ lb})\mathbf{i} + (260\text{ lb})\mathbf{j} - (320\text{ lb})\mathbf{k}$.

SOLUTION

$$F = \sqrt{F_x^2 + F_y^2 + F_z^2} = \sqrt{(800\text{ lb})^2 + (260\text{ lb})^2 + (-320\text{ lb})^2} \qquad F = 900\text{ lb} \blacktriangleleft$$

$$\cos\theta_x = \frac{F_x}{F} = \frac{800}{900} = 0.8889 \qquad \theta_x = 27.3° \blacktriangleleft$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{260}{900} = 0.2889 \qquad \theta_y = 73.2° \blacktriangleleft$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{-320}{900} = -0.3555 \qquad \theta_z = 110.8° \blacktriangleleft$$

PROBLEM 2.82

Determine the magnitude and direction of the force $\mathbf{F} = (400\text{ N})\mathbf{i} - (1200\text{ N})\mathbf{j} + (300\text{ N})\mathbf{k}$.

SOLUTION

$$F = \sqrt{F_x^2 + F_y^2 + F_z^2} = \sqrt{(400\text{ N})^2 + (-1200\text{ N})^2 + (300\text{ N})^2} \qquad F = 1300\text{ N} \blacktriangleleft$$

$$\cos\theta_x = \frac{F_x}{F} = \frac{400}{1300} = 0.30769 \qquad \theta_x = 72.1° \blacktriangleleft$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{-1200}{1300} = -0.92307 \qquad \theta_y = 157.4° \blacktriangleleft$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{300}{1300} = 0.23076 \qquad \theta_z = 76.7° \blacktriangleleft$$

PROBLEM 2.83

A force acts at the origin of a coordinate system in a direction defined by the angles $\theta_x = 64.5°$ and $\theta_z = 55.9°$. Knowing that the y component of the force is –200 N, determine (*a*) the angle θ_y, (*b*) the other components and the magnitude of the force.

SOLUTION

(*a*) We have

$$(\cos\theta_x)^2 + (\cos\theta_y)^2 + (\cos\theta_z)^2 = 1 \Rightarrow (\cos\theta_y)^2 = 1 - (\cos\theta_y)^2 - (\cos\theta_z)^2$$

Since $F_y < 0$ we must have $\cos\theta_y < 0$

Thus, taking the negative square root, from above, we have:

$$\cos\theta_y = -\sqrt{1 - (\cos 64.5°)^2 - (\cos 55.9°)^2} = -0.70735 \qquad \theta_y = 135.0° \blacktriangleleft$$

(*b*) Then:

$$F = \frac{F_y}{\cos\theta_y} = \frac{-200 \text{ N}}{-0.70735} = 282.73 \text{ N}$$

and

$$F_x = F\cos\theta_x = (282.73 \text{ N})\cos 64.5° \qquad F_x = 121.7 \text{ N} \blacktriangleleft$$

$$F_z = F\cos\theta_z = (282.73 \text{ N})\cos 55.9° \qquad F_y = 158.5 \text{ N} \blacktriangleleft$$

$$F = 283 \text{ N} \blacktriangleleft$$

PROBLEM 2.84

A force acts at the origin of a coordinate system in a direction defined by the angles $\theta_x = 75.4°$ and $\theta_y = 132.6°$. Knowing that the z component of the force is –60 N, determine (*a*) the angle θ_z, (*b*) the other components and the magnitude of the force.

SOLUTION

(*a*) We have

$$\left(\cos\theta_x\right)^2 + \left(\cos\theta_y\right)^2 + \left(\cos\theta_z\right)^2 = 1 \Rightarrow \left(\cos\theta_y\right)^2 = 1 - \left(\cos\theta_y\right)^2 - \left(\cos\theta_z\right)^2$$

Since $F_z < 0$ we must have $\cos\theta_z < 0$

Thus, taking the negative square root, from above, we have:

$$\cos\theta_z = -\sqrt{1 - \left(\cos 75.4°\right)^2 - \left(\cos 132.6°\right)^2} = -0.69159 \qquad \theta_z = 133.8° \blacktriangleleft$$

(*b*) Then:

$$F = \frac{F_z}{\cos\theta_z} = \frac{-60 \text{ N}}{-0.69159} = 86.757 \text{ N} \qquad F = 86.8 \text{ N} \blacktriangleleft$$

and

$$F_x = F\cos\theta_x = \left(86.8 \text{ N}\right)\cos 75.4° \qquad F_x = 21.9 \text{ N} \blacktriangleleft$$

$$F_y = F\cos\theta_y = \left(86.8 \text{ N}\right)\cos 132.6° \qquad F_y = -58.8 \text{ N} \blacktriangleleft$$

PROBLEM 2.85

A force **F** of magnitude 400 N acts at the origin of a coordinate system. Knowing that $\theta_x = 28.5°$, $F_y = -80$ N, and $F_z > 0$, determine (*a*) the components F_x and F_z, (*b*) the angles θ_y and θ_z.

SOLUTION

(*a*) Have

$$F_x = F\cos\theta_x = (400 \text{ N})\cos 28.5° \qquad F_x = 351.5 \text{ N} \blacktriangleleft$$

Then:

$$F^2 = F_x^2 + F_y^2 + F_z^2$$

So:

$$(400 \text{ N})^2 = (352.5 \text{ N})^2 + (-80 \text{ N})^2 + F_z^2$$

Hence:

$$F_z = +\sqrt{(400 \text{ N})^2 - (351.5 \text{ N})^2 - (-80 \text{ N})^2} \qquad F_z = 173.3 \text{ N} \blacktriangleleft$$

(*b*)

$$\cos\theta_y = \frac{F_y}{F} = \frac{-80}{400} = -0.20 \qquad \theta_y = 101.5° \blacktriangleleft$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{173.3}{400} = 0.43325 \qquad \theta_z = 64.3° \blacktriangleleft$$

PROBLEM 2.86

A force **F** of magnitude 600 lb acts at the origin of a coordinate system. Knowing that $F_x = 200$ lb, $\theta_z = 136.8°$, $F_y < 0$, determine (*a*) the components F_y and F_z, (*b*) the angles θ_x and θ_y.

SOLUTION

(*a*)

$$F_z = F\cos\theta_z = (600 \text{ lb})\cos 136.8°$$

$$= -437.4 \text{ lb} \qquad F_z = -437 \text{ lb} ◀$$

Then:

$$F^2 = F_x^2 + F_y^2 + F_z^2$$

So:

$$(600 \text{ lb})^2 = (200 \text{ lb})^2 + (F_y)^2 + (-437.4 \text{ lb})^2$$

Hence:

$$F_y = -\sqrt{(600 \text{ lb})^2 - (200 \text{ lb})^2 - (-437.4 \text{ lb})^2}$$

$$= -358.7 \text{ lb} \qquad F_y = -359 \text{ lb} ◀$$

(*b*)

$$\cos\theta_x = \frac{F_x}{F} = \frac{200}{600} = 0.333 \qquad \theta_x = 70.5° ◀$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{-358.7}{600} = -0.59783 \qquad \theta_y = 126.7° ◀$$