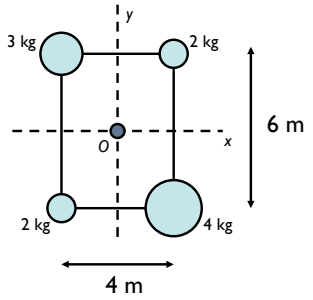
Problem 8.32

What torque will produce an angular acceleration of 1.5 rad/sec/sec about:

a.) the "y" axis:

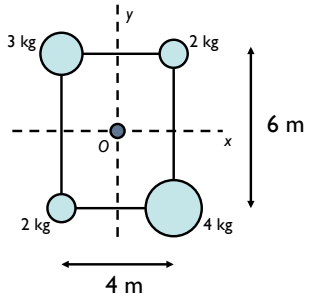


What torque will produce an angular acceleration of 1.5 rad/sec/sec about:

a.) the "y" axis:

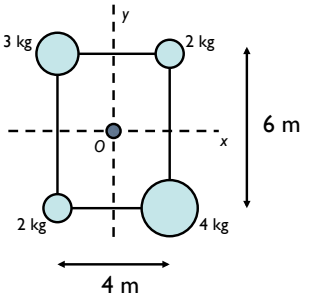
a.) Newton's Second Law, rotational style, states that $\Gamma_{net} = I\alpha$, where the "I" term is the moment of inertia about the axis in question. We know α and we are looking for Γ_{net}, so this is really an exercise in determining moment of inertia. To do that for the "y" axis, we need to determine the distance each mass is from the "y" axis, or it's "x" coordinate. With that, we can write:

$$I_y = \sum m_i x_i^2$$



a.) (con't.) Executing that operation:

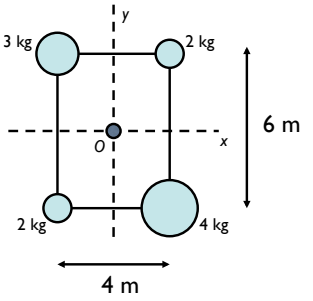
$$I_y = \sum m_i x_i^2$$
$$= (2\text{ kg})(2\text{ m})^2 + (2\text{ kg})(2\text{ m})^2 + (3\text{ kg})(2\text{ m})^2 + (4\text{ kg})(2\text{ m})^2$$
$$= 44\text{ kg} \bullet \text{m}^2$$



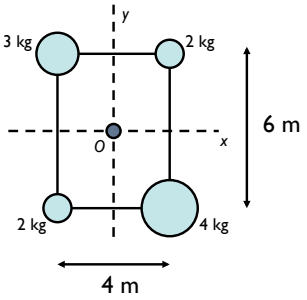
That leaves us with:

$$\Gamma_{net} = (44\text{ kg} \bullet \text{m}^2)(1.5\text{ rad/sec}^2)$$
$$= 66\text{ kg} \bullet \text{m}^2/\text{sec}^2$$

b.) For the "x" axis:



b.) For the "x" axis:



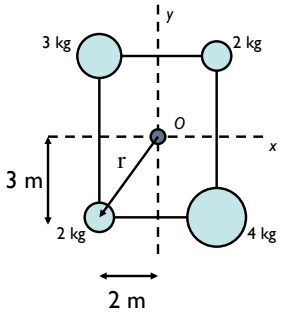
$$I_x = \sum m_i y_i^2$$
$$= (2\text{ kg})(3\text{ m})^2 + (2\text{ kg})(3\text{ m})^2 + (3\text{ kg})(3\text{ m})^2 + (4\text{ kg})(3\text{ m})^2$$
$$= 99\text{ kg} \bullet \text{m}^2$$

That leaves us with:

$$\Rightarrow \quad \Gamma_{net} = (99\text{ kg} \bullet \text{m}^2)(1.5\text{ rad/sec}^2)$$
$$= 148.5\text{ kg} \bullet \text{m}^2/\text{sec}^2$$

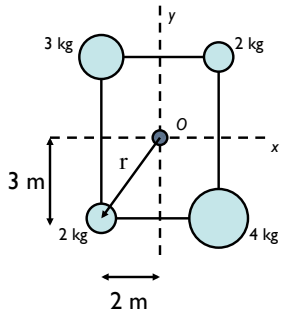
5.)

c.) For the axis perpendicular to the page and through "O:"



6.)

c.) For the axis perpendicular to the page and through "O:"



This is a little trickier because the "distance between the mass and axis" is the radial distance between "O" and each body. In all cases, this is "r," where:

$$r = \sqrt{(2\text{ m})^2 + (3\text{ m})^2}$$
$$= \sqrt{13}\text{ m}$$

So for the "O" axis:

$$I_x = \sum m_i r^2$$
$$= (2\text{ kg})(\sqrt{13}\text{ m})^2 + (2\text{ kg})(\sqrt{13}\text{ m})^2 + (3\text{ kg})(\sqrt{13}\text{ m})^2 + (4\text{ kg})(\sqrt{13}\text{ m})^2$$
$$= 143\text{ kg} \bullet \text{m}^2$$

$$\Rightarrow \quad \Gamma_{net} = (143\text{ kg} \bullet \text{m}^2)(1.5\text{ rad/sec}^2)$$
$$= 214.5\text{ kg} \bullet \text{m}^2/\text{sec}^2$$

7.)