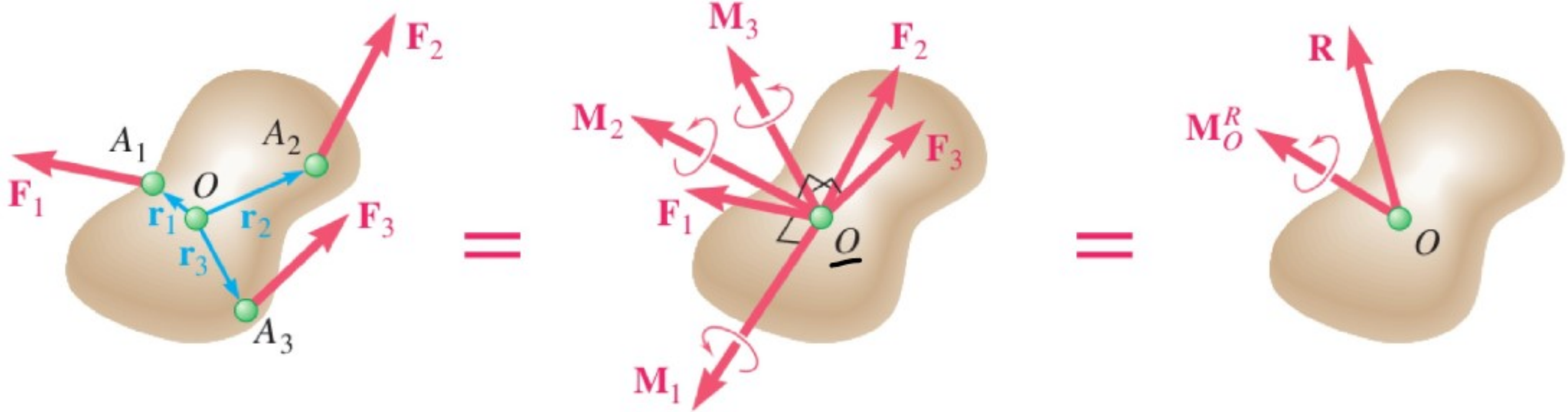
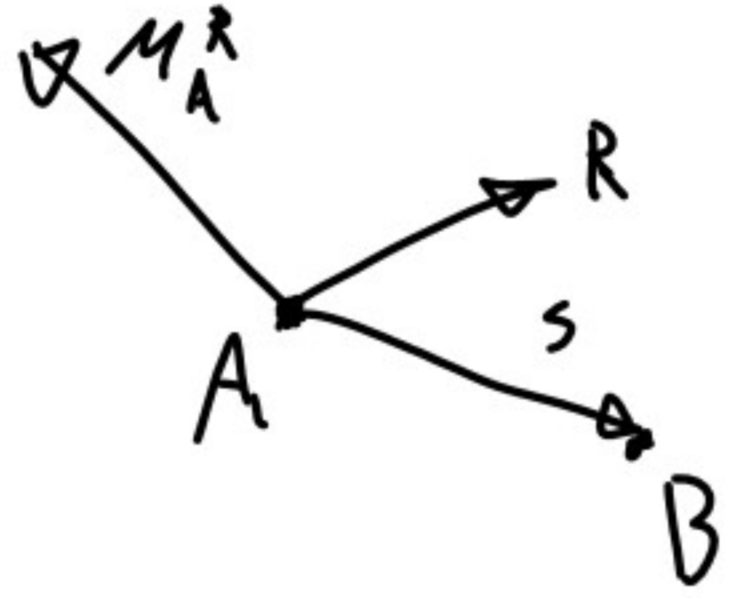
Simplification of Forces

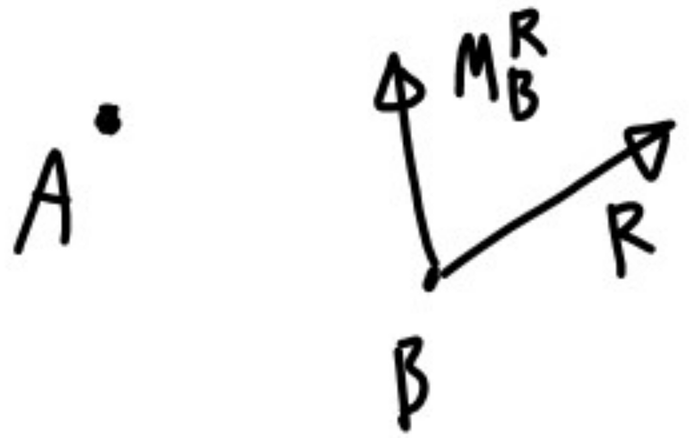
$$\vec{R} = \sum \vec{F} \qquad \vec{M}_O^R = \sum \vec{M}_O = \sum (\vec{r} \times \vec{F})$$



$\mathbf{F}_2$
A_1
A_2
$\mathbf{F}_1$
O
$\mathbf{r}_1$
$\mathbf{r}_2$
$\mathbf{F}_3$
$\mathbf{r}_3$
A_3
=
$\mathbf{M}_3$
$\mathbf{F}_2$
$\mathbf{M}_2$
$\mathbf{F}_3$
$\mathbf{F}_1$
O
$\mathbf{M}_1$
=
$\mathbf{R}$
$\mathbf{M}_O^R$
O

$$\vec{M}_B^R = \vec{M}_A^R + \vec{s} \times \vec{R}$$





- Equivalent Systems

$$\sum \vec{F} = \sum \vec{F}' \qquad \sum \vec{M}_O = \sum \vec{M}_O'$$

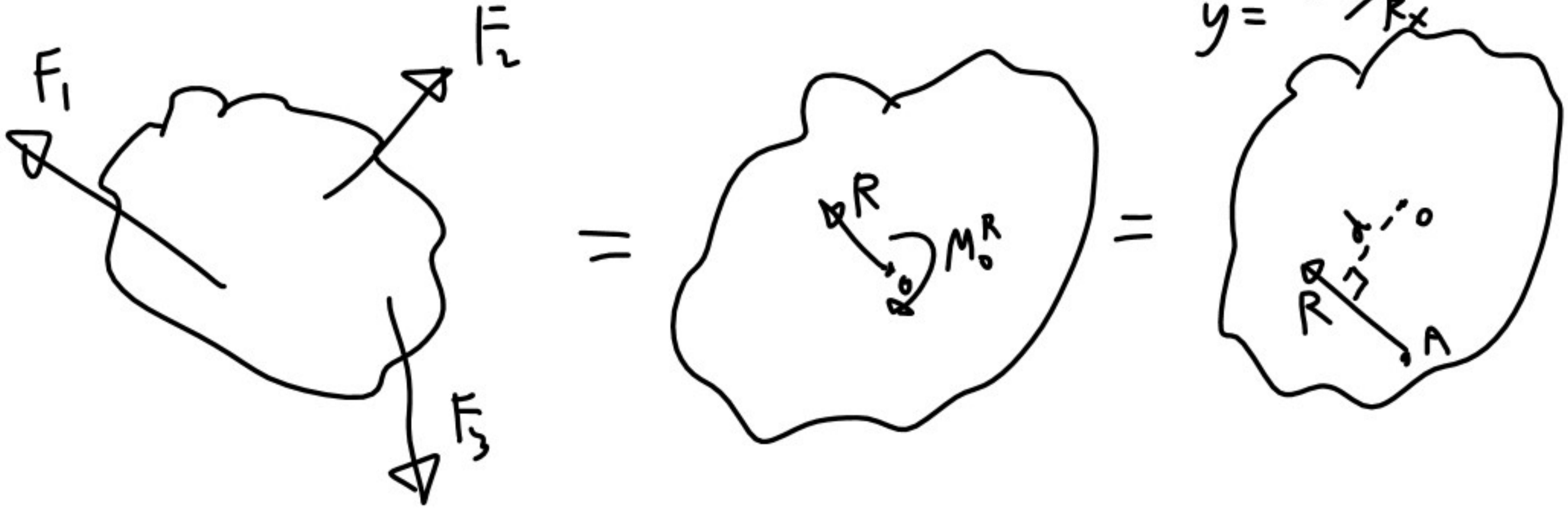
Simplification Special cases

1. Particle
2. Coplanar

$$d = \frac{M_O^R}{R}$$

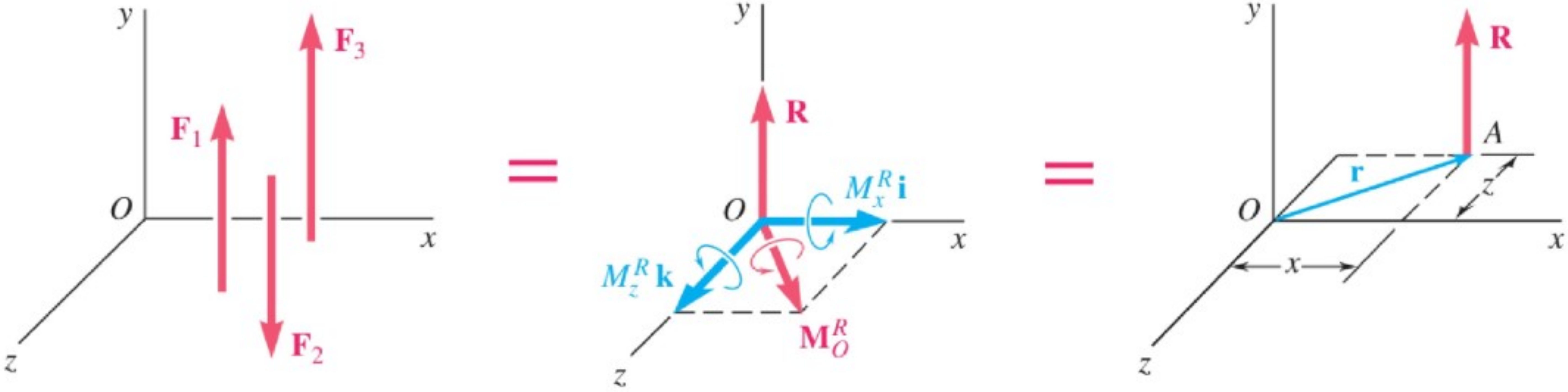
$$x = \frac{M_O^R}{R_y}$$

$$y = \frac{-M_O^R}{R_x}$$

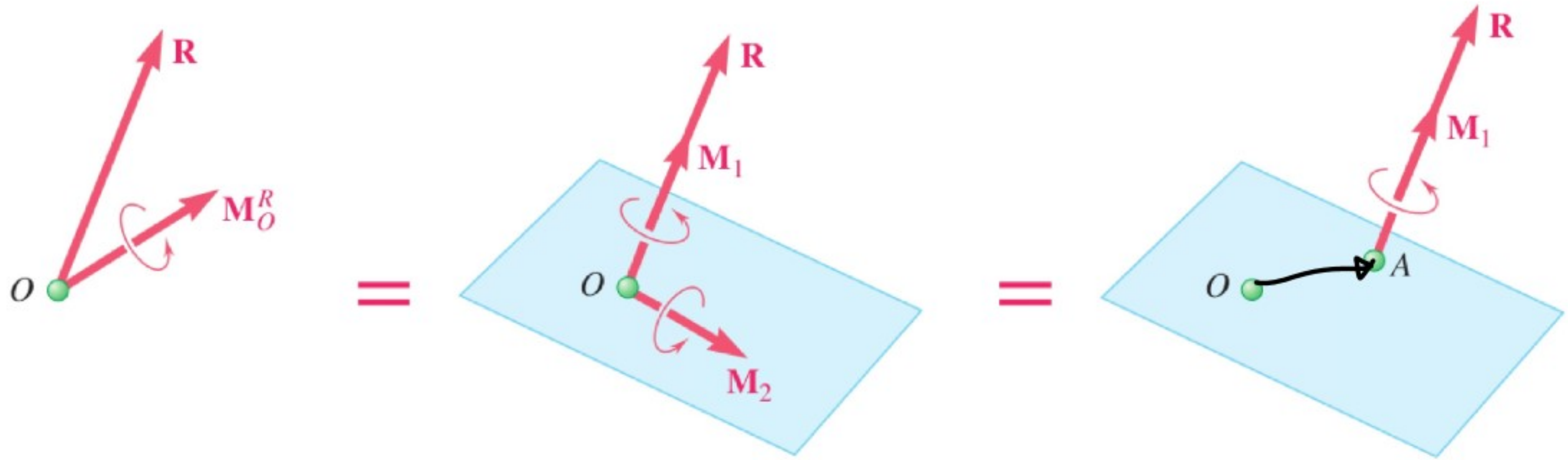


· 3. Parallel Forces

$$\vec{r} \times \vec{R} = \vec{M}_O^R$$



4. Wrench



3.114 A couple of magnitude $M = 80$ lb·in. and the three forces shown are applied to an angle bracket. (*a*) Find the resultant of this system of forces. (*b*) Locate the points where the line of action of the resultant intersects line *AB* and line *BC*.

$\vec{F}_1 = -10j$

$\vec{F}_3 = -40i$

$\vec{F}_2 = 25\cos 60\, i + 25\sin 60\, j$

$= 12.5i + 21.7j$

$\vec{R} = -27.5i + 11.7j$ lb

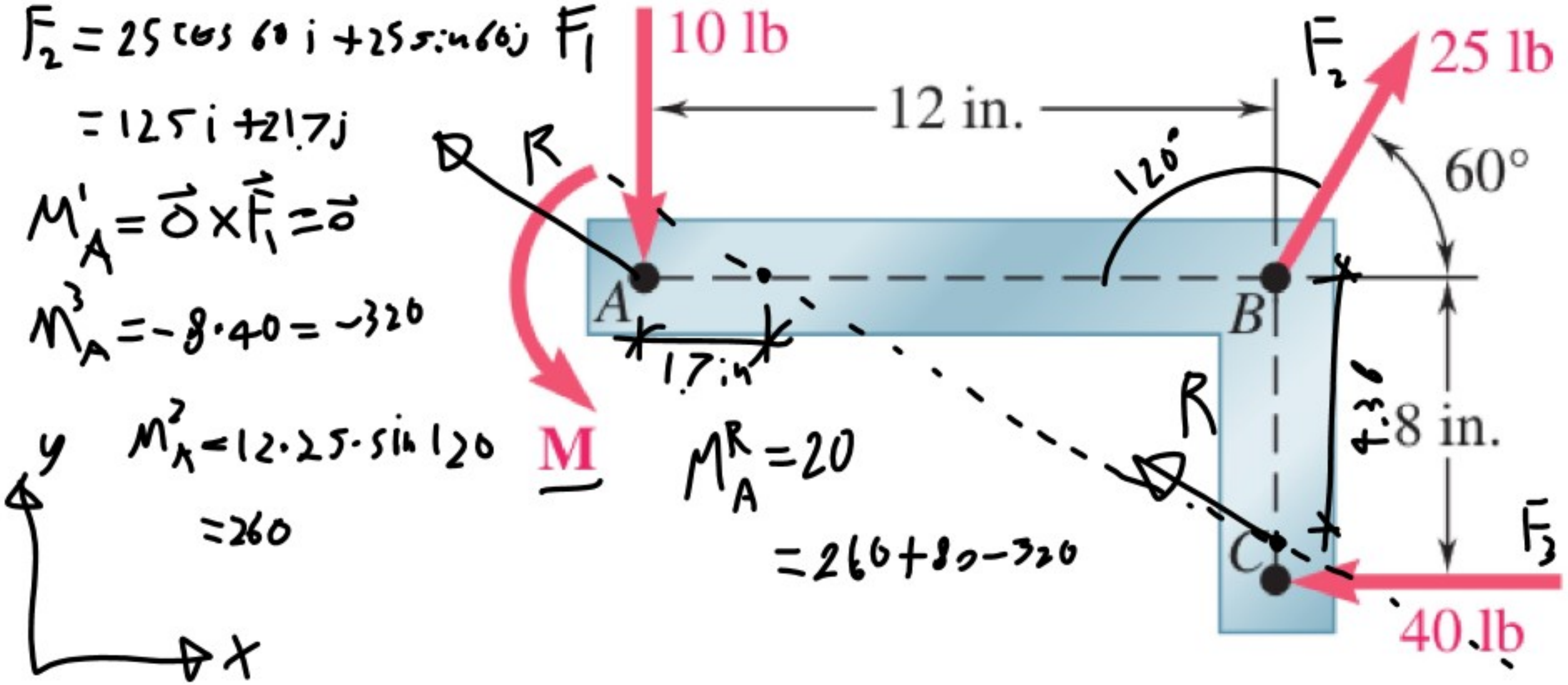
$R = 30$ lb

$M_A^1 = \vec{0} \times \vec{F}_1 = \vec{0}$

$M_A^3 = -8 \cdot 40 = -320$

$M_A^2 = 12 \cdot 25 \cdot \sin 120$

$= 260$



$M_A^R = 20$

$= 260 + 80 - 320$

$d = M_A^R / R = \frac{20}{30} = 2/3$

$x = M_A^R / R_y = 20/11.7$

$= 1.7$ in

$y = -M_B^R / R_x = 4.36$

$$\vec{M}_B^R = M_A^R + \vec{s} \times \vec{R}$$

$$\vec{s} = 12i$$

$$R = -27.5i + 11.7j$$

$$= 20k + 12i \times -27.5i + 11.7j$$

$$= 20k + \left| \begin{array}{ccc|cc} i & j & k & i & j \\ 12 & 0 & 0 & 12 & 0 \\ -27.5 & 11.7 & 0 & -27.5 & 11.7 \end{array} \right.$$

$$= 20k - 12 \cdot 11.7k$$

$$= -120.4k = \vec{M}_B^R$$