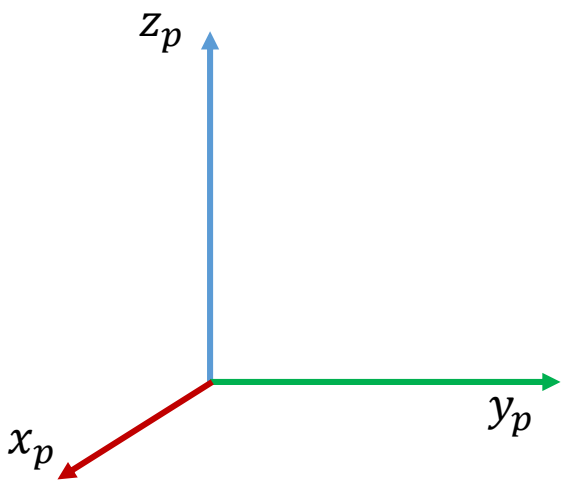
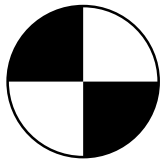
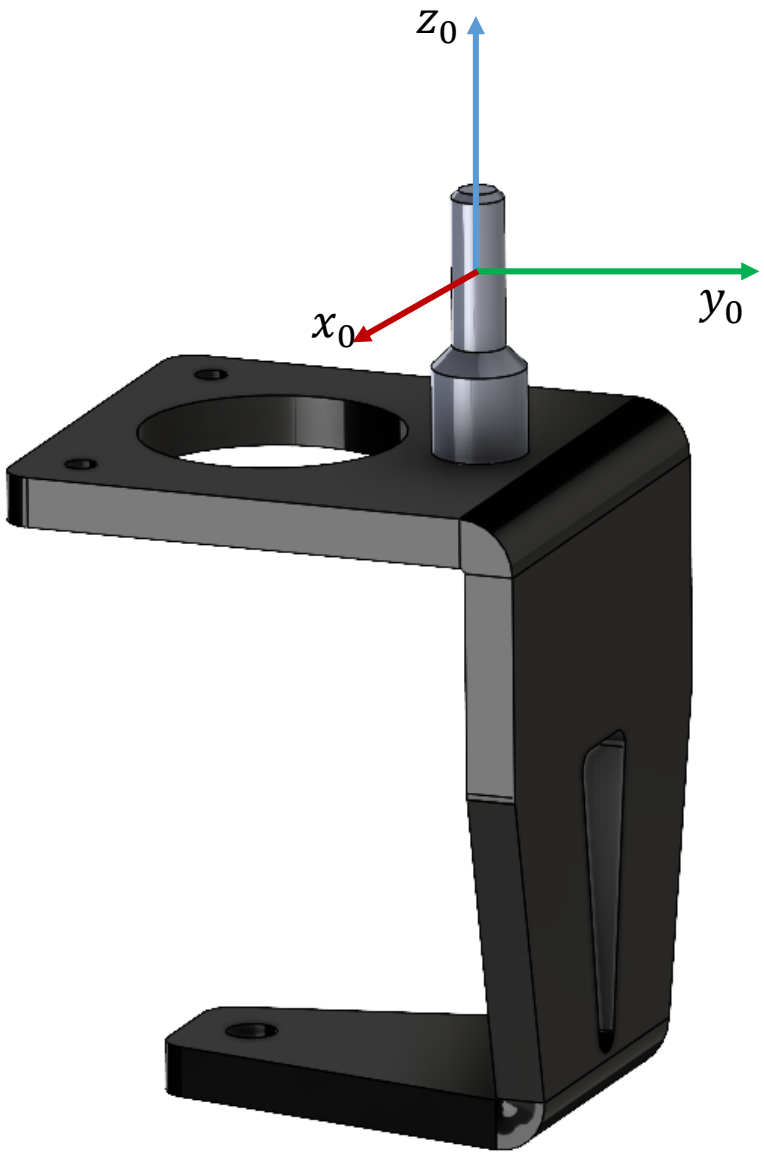




Kinova

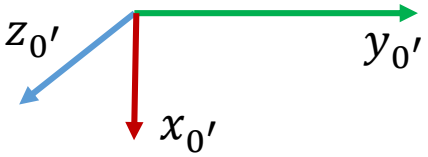
Modèle dynamique

Base



Denavit-Hartenberg

$R_{y_0,\pi/2}$



Solide 1

$$I(G_1, S_1) = \begin{bmatrix} I_{xx_1} & 0 & 0 \\ 0 & I_{yy_1} & 0 \\ 0 & 0 & I_{zz_1} \end{bmatrix}_{(\overrightarrow{x_1}, \overrightarrow{y_1}, \overrightarrow{z_1})}$$

$$\overrightarrow{O_1G_1} = b_1\overrightarrow{x_1}$$
$$\overrightarrow{O_1A_1} = l_1\overrightarrow{x_1}$$

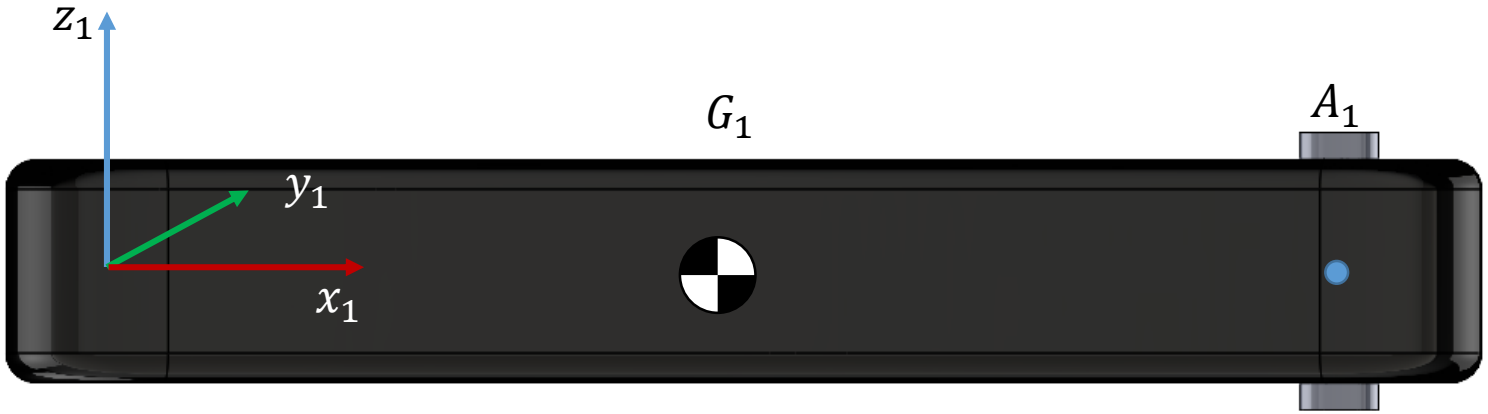
$$I_{xx_1} = 15449.15\ kg.mm^2$$
$$I_{yy_1} = 328261.04\ kg.mm^2$$
$$I_{zz_1} = 329660.90\ kg.mm^2$$

$b_1 = -0.05889216\ m$

$l_1 = 120\ mm$

$m_1 = 0{,}172\ kg$

$V_1 = 76225.68\ mm^3$



Solide 1 Rever

$$I(G_1, S_1) = \begin{bmatrix} I_{xx_1} & 0 & 0 \\ 0 & I_{yy_1} & 0 \\ 0 & 0 & I_{zz_1} \end{bmatrix}_{(\overrightarrow{x_1}, \overrightarrow{y_1}, \overrightarrow{z_1})}$$

$$\overrightarrow{A_1 G_1}_{R_2} = b_1 \overrightarrow{x_1}$$
$$\overrightarrow{A_1 O_1}_{R_2} = l_1 \overrightarrow{x_1}$$

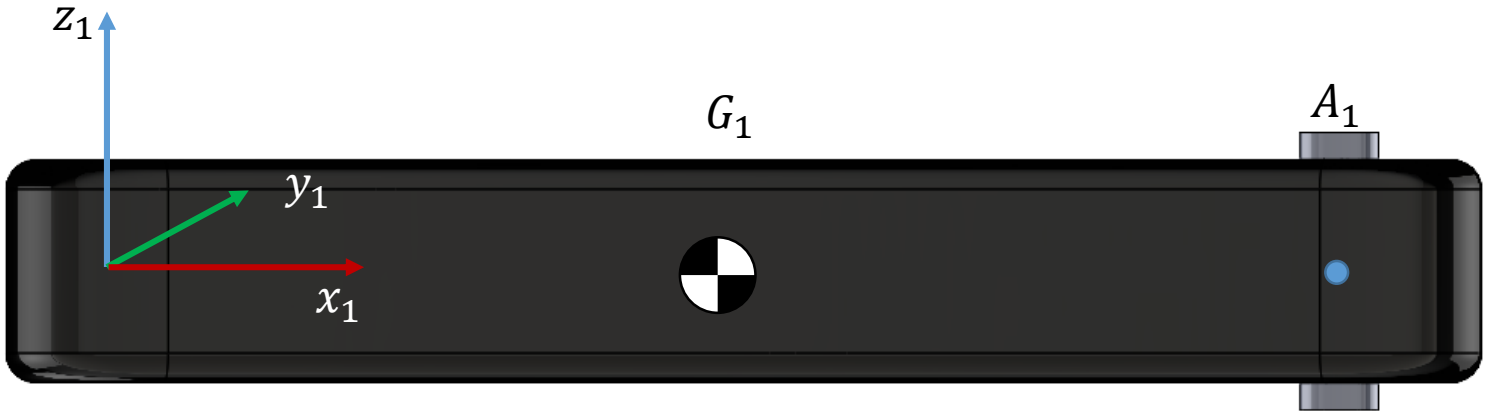
$$I_{xx_1} = 0.00001545\ kg.m^2$$
$$I_{yy_1} = 0.00032826\ kg.m^2$$
$$I_{zz_1} = 0.00032966\ kg.m^2$$

$b_1 = -0.05889216\ m$

$l_1 = -120\ mm$

$m_1 = 0{,}172\ kg$

$V_1 = 76225.68\ mm^3$



Solide 2

$$I(G_2,S_2)=\begin{bmatrix} I_{xx_2} & I_{xy_2} & 0 \\ I_{xy_2} & I_{yy_2} & 0 \\ 0 & 0 & I_{zz_2} \end{bmatrix}_{(\overrightarrow{x_2},\overrightarrow{y_2},\overrightarrow{z_2})}$$

$$\overrightarrow{O_2G_2}=a_2\overrightarrow{x_2}+b_2\overrightarrow{y_2}$$
$$\overrightarrow{O_2A_2}=l_{21}\overrightarrow{x_2}+l_{22}\overrightarrow{y_2}$$

$I_{xx_2}=4.434e-05\ kg.m^2$
$I_{yy_2}=2.0119e-04\ kg.m^2$
$I_{zz_2}=2.0547e-04\ kg.m^2$

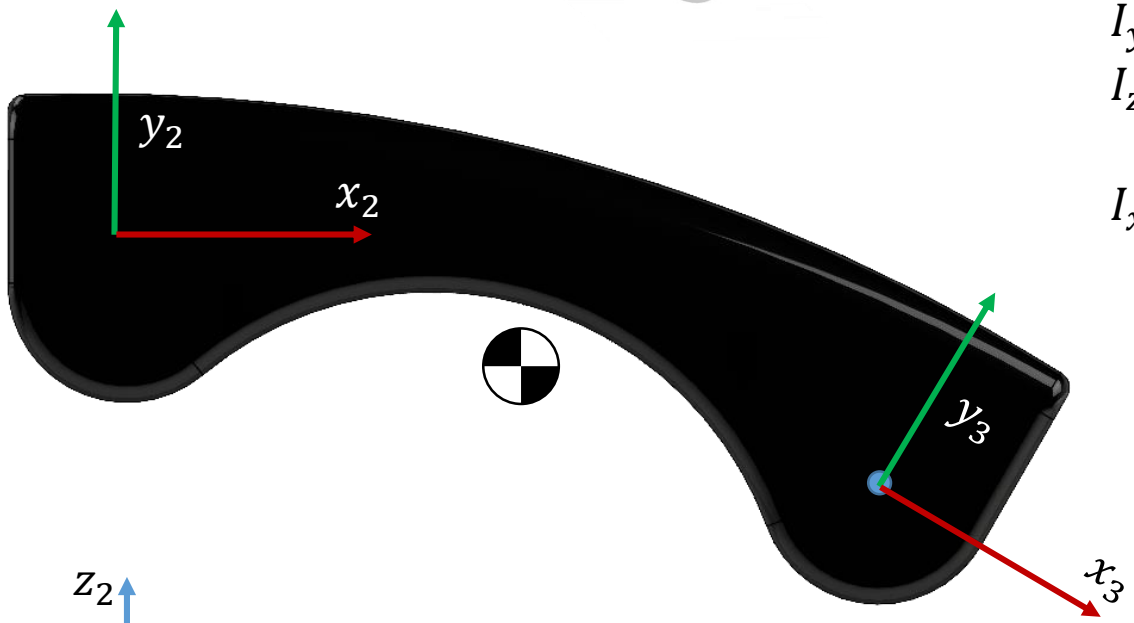
$I_{xy_2}=-4.528e-05 kg.m^2$

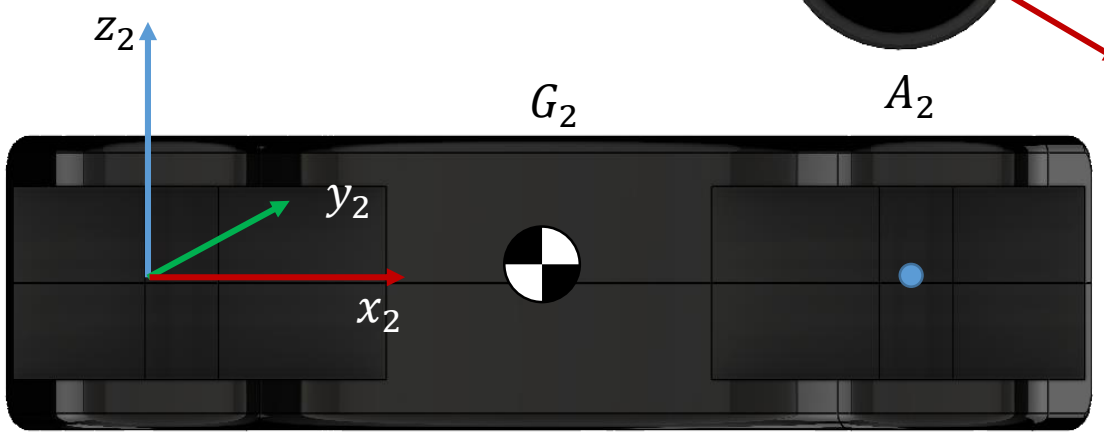
$a_2=0.0476925\,m$
$b_2=0.00114713\,m$

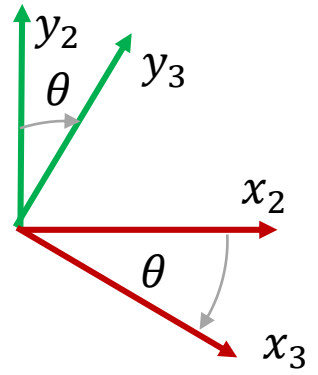
$l_{21}=0{,}08842\ m$
$l_{22}=0{,}02369\ m$

$m_2=0{,}164\ kg$

$V_2=7.613e-05\ m^3$







Solide 2 V2

$$I(G_2, S_2) = \begin{bmatrix} I_{xx_2} & 0 & 0 \\ 0 & I_{yy_2} & 0 \\ 0 & 0 & I_{zz_2} \end{bmatrix}_{(\overrightarrow{x_2}, \overrightarrow{y_2}, \overrightarrow{z_2})}$$

$$\overrightarrow{O_2G_2} = a_2\overrightarrow{x_2} + b_2\overrightarrow{y_2}$$

$$\overrightarrow{O_2A_2} = l_{21}\overrightarrow{x_2}$$

$I_{xx_2} = 0.00003221\ kg.m^2$

$I_{yy_2} = 0.00021332\ kg.m^2$

$I_{zz_2} = 0.00020547\ kg.m^2$

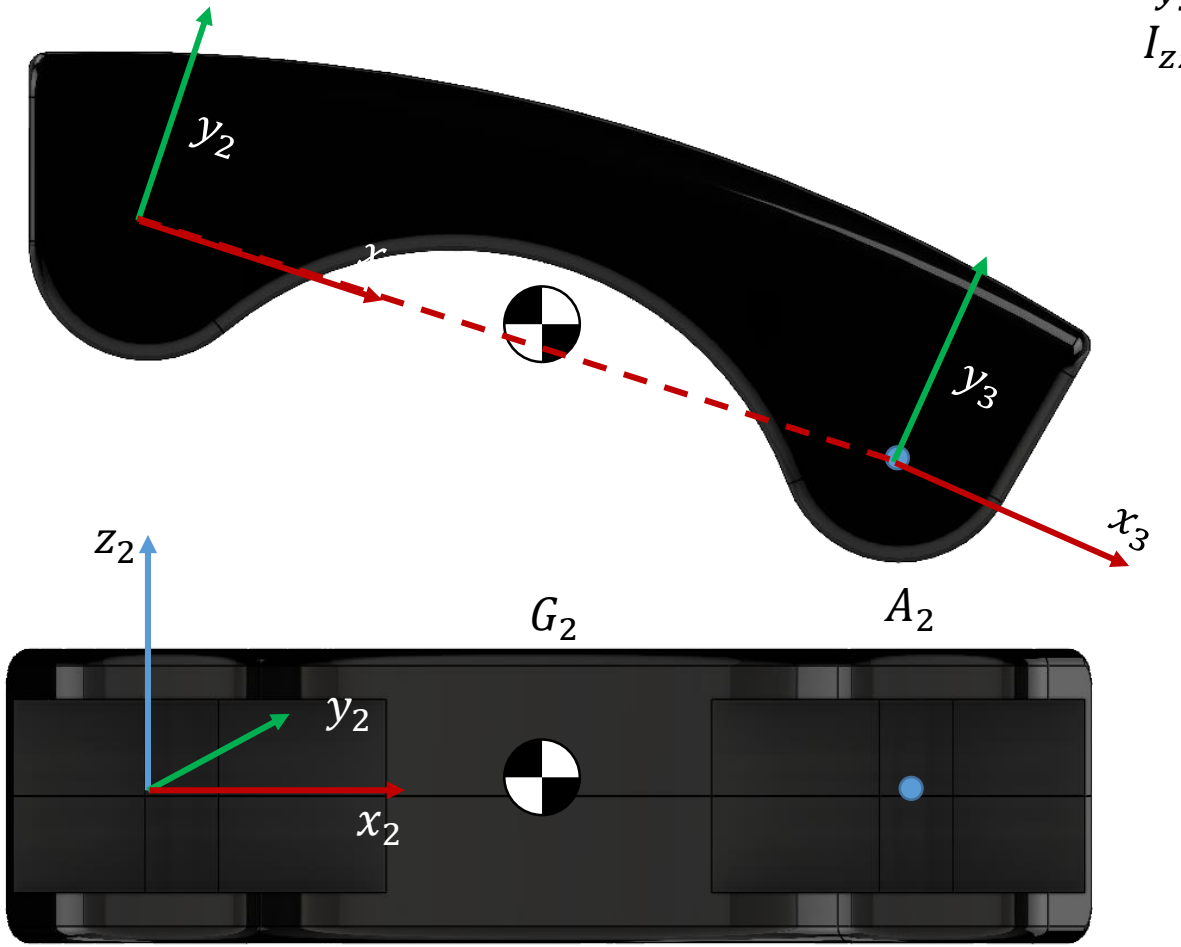
$a_2 = 0.04577052\ m$

$b_2 = 0.01345177\ m$

$l_{21} = 0{,}09154\ m$

$m_2 = 0{,}164\ kg$

$V_2 = 7.613e-05\ m^3$



Solide 2 V2 Reverse

$$I(G_2, S_2) = \begin{bmatrix} I_{xx_2} & 0 & 0 \\ 0 & I_{yy_2} & 0 \\ 0 & 0 & I_{zz_2} \end{bmatrix}_{(\overrightarrow{x_2},\overrightarrow{y_2},\overrightarrow{z_2})}$$

$$\overrightarrow{A_2G_2}_{R_3} = a_2\overrightarrow{x_2} + b_2\overrightarrow{y_2}$$
$$\overrightarrow{A_2O_2}_{R_3} = l_{21}\overrightarrow{x_2}$$

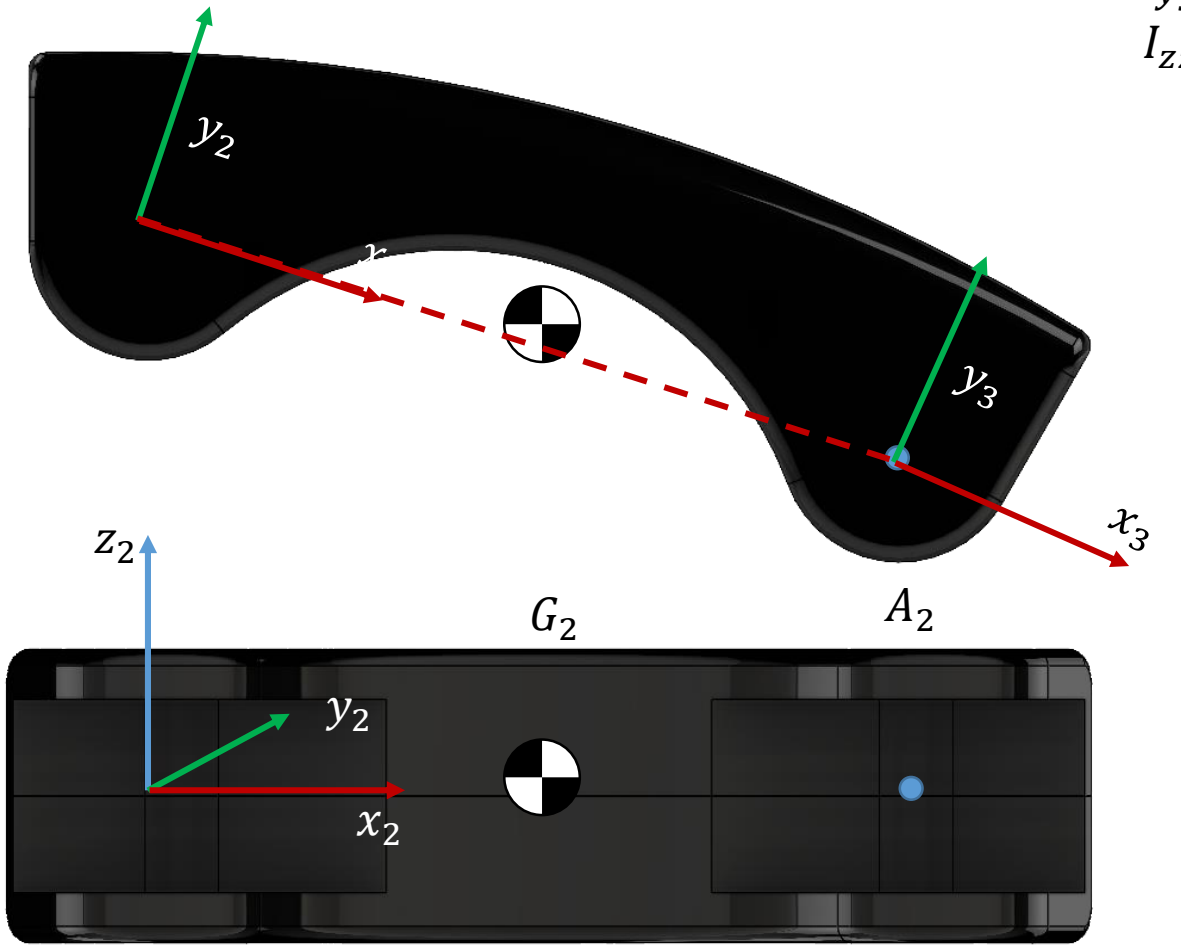
$I_{xx_2} = 0.00003221\ kg.m^2$
$I_{yy_2} = 0.00021332\ kg.m^2$
$I_{zz_2} = 0.00020547\ kg.m^2$

$a_2 = -0.04577052\ m$
$b_2 = 0.01345177\ m$

$l_{21} = -0{,}09154\ m$

$m_2 = 0{,}164\ kg$

$V_2 = 7.613e-05\ m^3$



Solide 3

$$I(G_3, S_3) = \begin{bmatrix} I_{xx_3} & 0 & 0 \\ 0 & I_{yy_3} & 0 \\ 0 & 0 & I_{zz_3} \end{bmatrix}_{(\overrightarrow{x_3}, \overrightarrow{y_3}, \overrightarrow{z_3})}$$

$$\overrightarrow{O_3G_3} = b_3\overrightarrow{x_3}$$
$$\overrightarrow{O_3A_3} = l_3\overrightarrow{x_3}$$

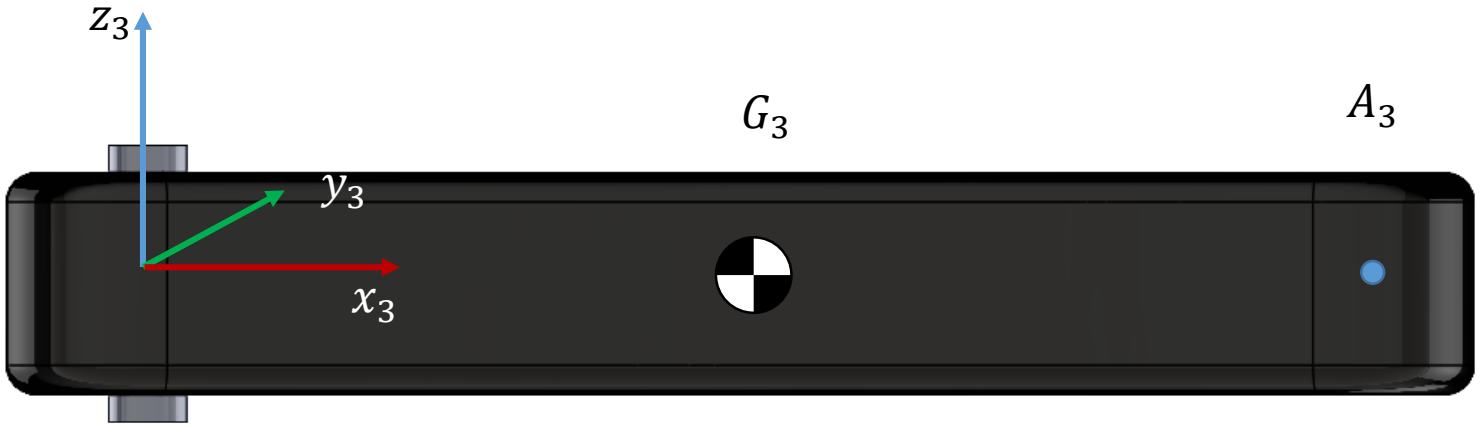
$$I_{xx_3} = 0.00001545\ kg.m^2$$
$$I_{yy_3} = 0.00032826\ kg.m^2$$
$$I_{zz_3} = 0.00032966\ kg.m^2$$

$b_3 = 0{,}06111\ m$

$l_3 = 0{,}120\ m$

$m_3 = 0{,}172\ kg$

$V_3 = 76225.68\ mm^3$



Solide 3 Rever

$$I(G_3, S_3) = \begin{bmatrix} I_{xx_3} & 0 & 0 \\ 0 & I_{yy_3} & 0 \\ 0 & 0 & I_{zz_3} \end{bmatrix}_{(\overrightarrow{x_3},\overrightarrow{y_3},\overrightarrow{z_3})}$$

$$\overrightarrow{A_3G_3}_{|R_4} = b_3\overrightarrow{x_3}$$
$$\overrightarrow{A_3O_3}_{|R_4} = l_3\overrightarrow{x_3}$$

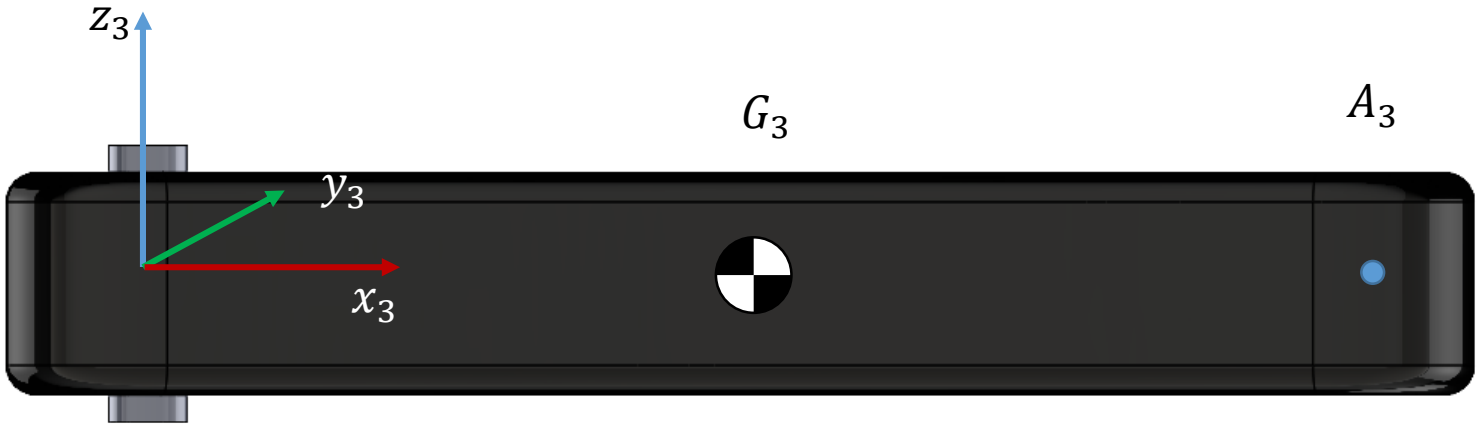
$$I_{xx_3} = 0.00001545\ kg.m^2$$
$$I_{yy_3} = 0.00032826\ kg.m^2$$
$$I_{zz_3} = 0.00032966\ kg.m^2$$

$$b_3 = -0.06110784\ m$$

$$l_3 = -0{,}120\ m$$

$$m_3 = 0{,}172\ kg$$

$$V_3 = 76225.68\ mm^3$$



Solide 4

$$I(G_4, S_4) = \begin{bmatrix} I_{xx_4} & 0 & I_{xz_4} \\ 0 & I_{yy_4} & 0 \\ I_{xz_4} & 0 & I_{zz_4} \end{bmatrix}_{(\overrightarrow{x_4}, \overrightarrow{y_4}, \overrightarrow{z_4})}$$

$$\overrightarrow{O_4G_4} = a_4\overrightarrow{x_4} + c_4\overrightarrow{z_4}$$
$$\overrightarrow{O_4A_4} = l_{14}\overrightarrow{x_4} + l_{34}\overrightarrow{z_4}$$

$$I_{xx_4} = 0.00078841\ kg.m^2$$
$$I_{yy_4} = 0.00084184\ kg.m^2$$
$$I_{zz_4} = 0.00025806\ kg.m^2$$

$$I_{xz_4} = 0.00002960\ kg.m^2$$

$$a_4 = 0.03208716\ m$$
$$c_4 = 0.07885968\ m$$

$$l_{14} =$$
$$l_{34} =$$

$$m_4 = 0{,}338\ kg$$

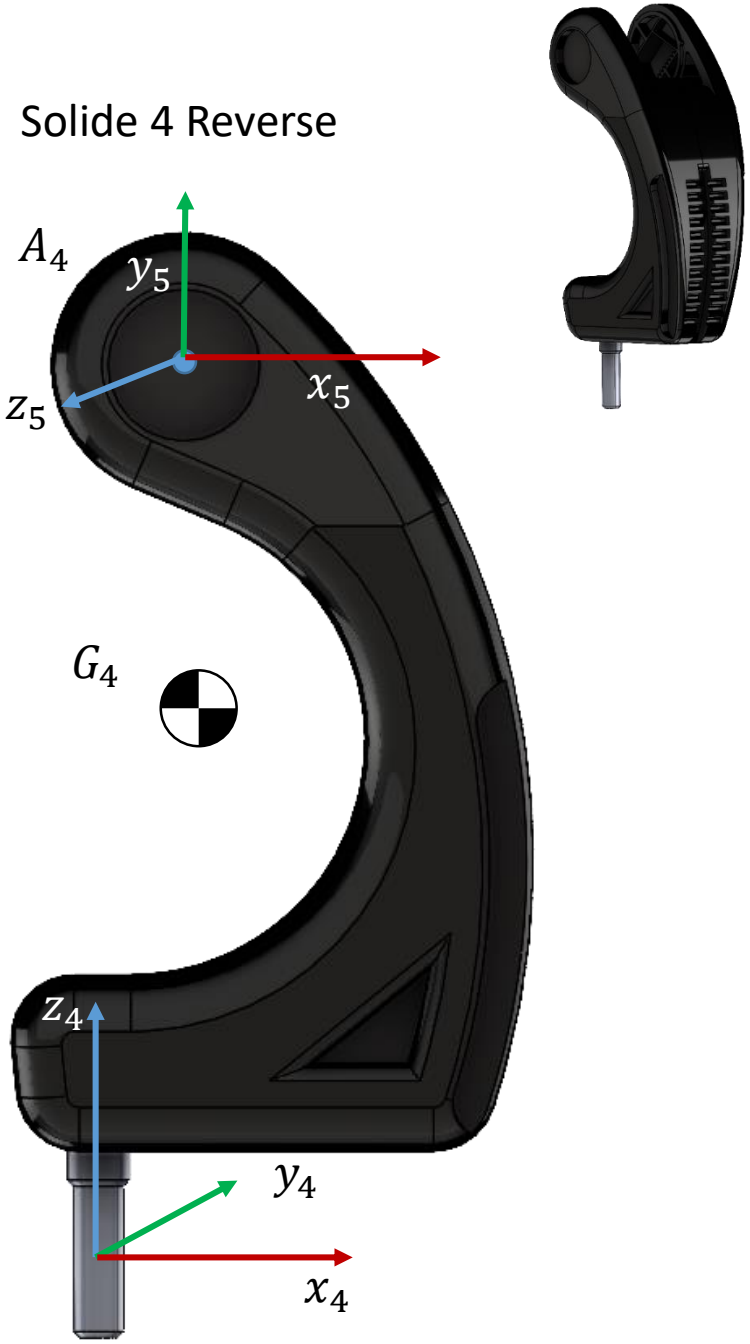
$$V_4 = 0.00013636\ m^3$$

Cas pivot $l_{14} = 0{,}01354\ m$, $l_{34} = 0{,}14202\ m$

Cas liaison pignon-crémaillère.

Faisable dans biorbd ?

Solide 4 Reverse



$$I(G_4, S_4) = \begin{bmatrix} I_{xx_4} & 0 & I_{xz_4} \\ 0 & I_{yy_4} & 0 \\ I_{xz_4} & 0 & I_{zz_4} \end{bmatrix}_{(\overrightarrow{x_5}, \overrightarrow{y_5}, \overrightarrow{z_5})}$$

$$\overrightarrow{A_4G_4}_{|R_5} = a_4\overrightarrow{x_4} + b_4\overrightarrow{y_4}$$
$$\overrightarrow{A_4O_4}_{|R_5} = l_{14}\overrightarrow{x_4} + l_{24}\overrightarrow{y_4}$$

$$I_{xx_4} = 0.00078841\ kg.m^2$$
$$I_{yy_4} = 0.00025806\ kg.m^2$$
$$I_{zz_4} = 0.00084184\ kg.m^2$$

$$I_{xy_4} = 0.00002960\ kg.m^2$$

$$a_4 = 0.01854824\ m$$
$$b_4 = -0.06316296\ m$$

$l_{14} =$
$l_{34} =$

$m_4 = 0{,}338\ kg$

$$V_4 = 0.00013636\ m^3$$

Cas pivot $l_{14} = -0{,}01354\ m$
$l_{24} = -0{,}14202\ m$

Cas liaison pignon-crémaillère.

Faisable dans biorbd ?

Solide 5

$$I(G_5, S_5) = \begin{bmatrix} I_{xx_5} & I_{xy_5} & I_{xz_5} \\ I_{xy_5} & I_{yy_5} & I_{yz_5} \\ I_{xz_5} & I_{yz_5} & I_{zz_5} \end{bmatrix}_{(\overrightarrow{x_5}, \overrightarrow{y_5}, \overrightarrow{z_5})}$$

$$\overrightarrow{O_5G_5} = a_5\overrightarrow{x_5} + b_5\overrightarrow{y_5} + c_5\overrightarrow{z_5}$$
$$\overrightarrow{O_5A_5} = l_{15}\overrightarrow{x_5} + l_{35}\overrightarrow{z_5}$$

$I_{xx_4} = 0.00012693\ kg.m^2$
$I_{yy_5} = 0.00699861\ kg.m^2$
$I_{zz_5} = 0.00700635\ kg.m^2$

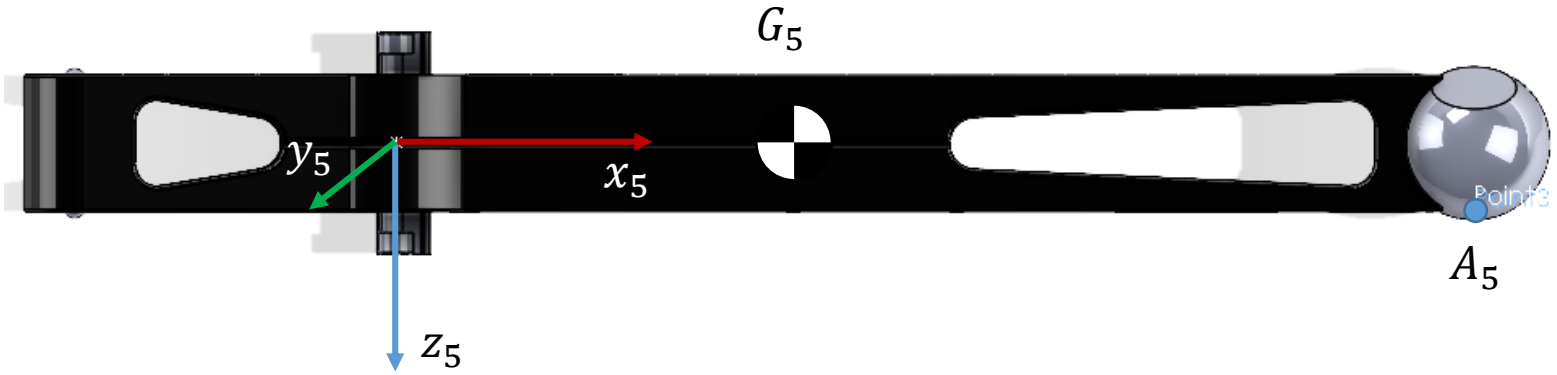
$I_{xy_5} = -0.00001377\ kg.m^2$
$I_{yz_5} = -0.00000036\ kg.m^2$
$I_{xz_5} = -0.00000427\ kg.m^2$

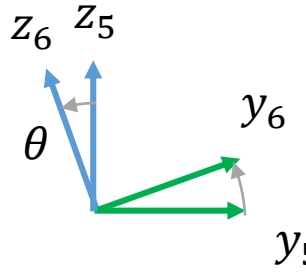
$a_5 = 0{,}09771349$ m
$b_5 = 0{,}01067939$ m
$c_5 = 0{,}00003686\ m$

$l_{15} = 0{,}25326\ m$
$l_{35} = 0{,}01602\ m$

$m_5 = 0{,}392\ kg + 0{,}11919kg$
$m_5 = 0{,}51119\ kg$

$V_5 = 0{,}000149287\ m^3$





$\theta = 30°$

Solide 5 Reverse

$$I(G_5, S_5) = \begin{bmatrix} I_{xx_5} & I_{xy_5} & I_{xz_5} \\ I_{xy_5} & I_{yy_5} & I_{yz_5} \\ I_{xz_5} & I_{yz_5} & I_{zz_5} \end{bmatrix}_{(\overrightarrow{x_5}, \overrightarrow{y_5}, \overrightarrow{z_5})}$$

$$\overrightarrow{A_5G_5}_{|R_6} = a_5\overrightarrow{x_6} + b_5\overrightarrow{y_6} + c_5\overrightarrow{z_6}$$
$$\overrightarrow{A_5O_5}_{|R_6} = l_{15}\overrightarrow{x_6} + l_{25}\overrightarrow{y_6} + l_{35}\overrightarrow{z}$$

$I_{xx_4} = 0.00012720\ kg.m^2$
$I_{yy_5} = 0.00700069\ kg.m^2$
$I_{zz_5} = 0.00700400\ kg.m^2$

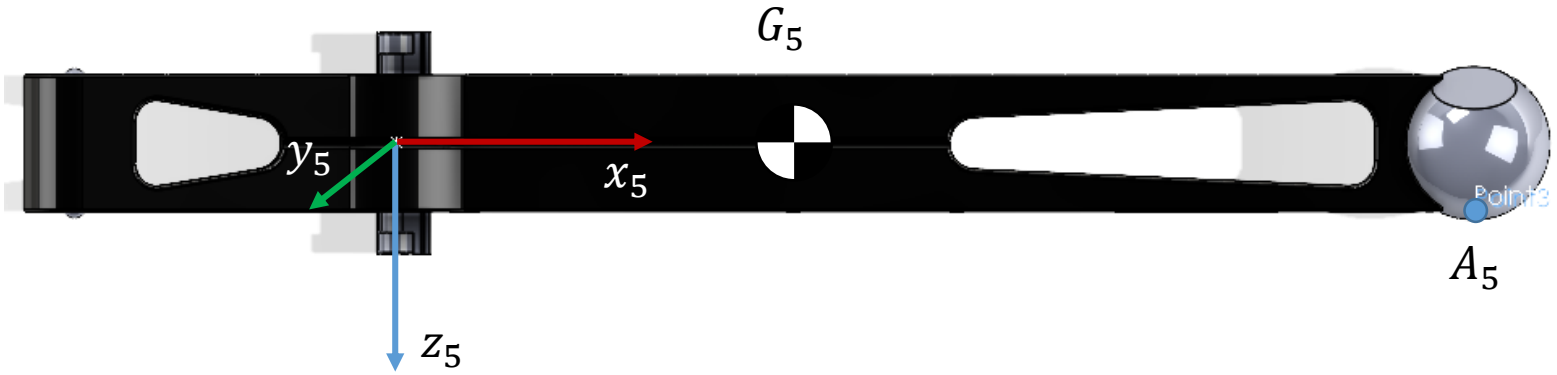
$I_{xy_5} = 0.00003720\ kg.m^2$
$I_{yz_5} = -0.00000367\ kg.m^2$
$I_{xz_5} = -0.00002641\ kg.m^2$

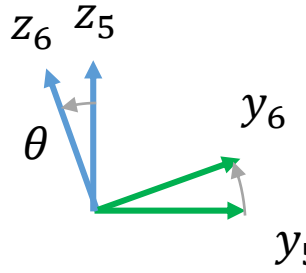
$a_5 =$ -0.15598555 m
$b_5 =$ 0.00009557 m
$c_5 =$ -0.01851262 m

$l_{15} = -0.25360\ m$
$l_{25} = -0.00990\ m$
$l_{35} = -0{,}01278\ m$

$m_5 = 0{,}392\ kg + 0{,}11919kg$
$m_5 = 0{,}51119\ kg$

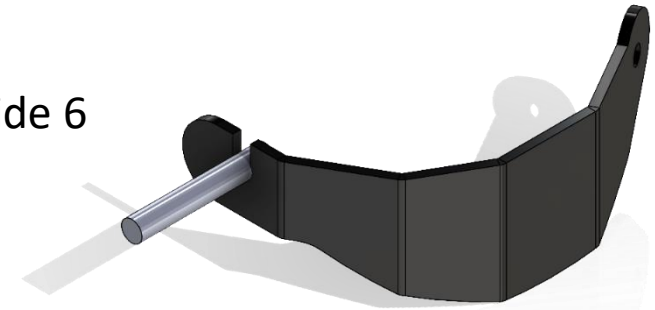
$V_5 = 0{,}000149287\ m^3$

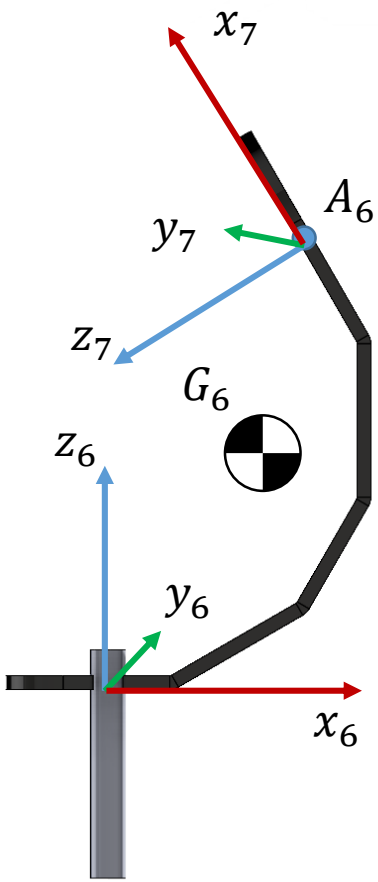




$\theta = 30°$

Solide 6





$$I(G_6, S_6) = \begin{bmatrix} I_{xx_6} & I_{xy_6} & I_{xz_6} \\ I_{xy_6} & I_{yy_6} & I_{yz_6} \\ I_{xz_6} & I_{yz_6} & I_{zz_6} \end{bmatrix}_{(\overrightarrow{x_6}, \overrightarrow{y_6}, \overrightarrow{z_6})}$$

$$\overrightarrow{O_6G_6} = a_6\overrightarrow{x_6} + b_6\overrightarrow{y_6} + c_6\overrightarrow{z_6}$$
$$\overrightarrow{O_6A_6} = l_{16}\overrightarrow{x_6} + l_{36}\overrightarrow{z_6}$$

$I_{xx_6} = 0.00012751\ kg.m^2$
$I_{yy_6} = 0.00015371\ kg.m^2$
$I_{zz_6} = 0.00004567\ kg.m^2$

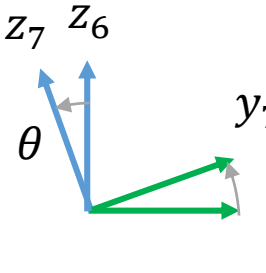
$I_{xy_6} = 0.00000695\ kg.m^2$
$I_{yz_6} = 0.00000686\ kg.m^2$
$I_{xz_6} = 0.00004329\ kg.m^2$

$a_6 = 0.03291972\ m$
$b_6 = 0.00776230\ m$
$c_6 = 0.03895646\ m$

$l_{16} = 0{,}03352\ m$
$l_{36} = 0{,}10130\ m$

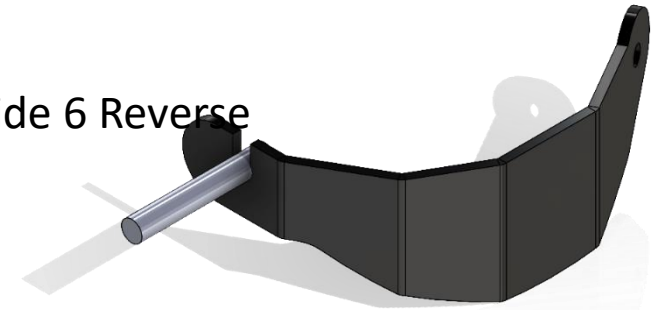
$m_6 = 0{,}08658000\ kg$

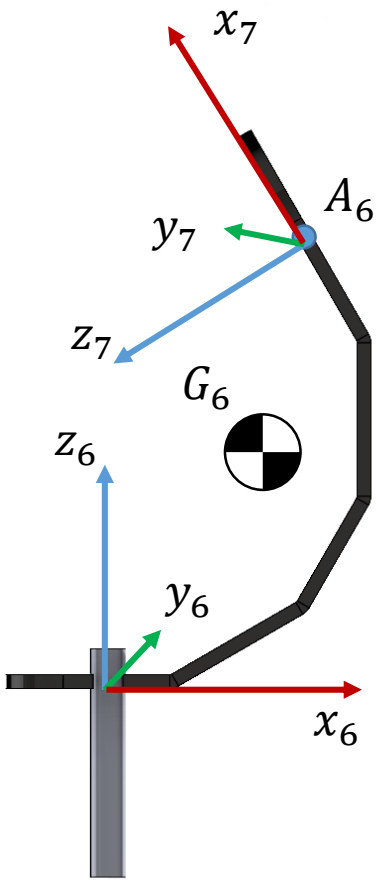
$V_6 = 0.00001665\ m^3$



$\theta = -120°$
ou
$\theta = 240°$

Solide 6 Reverse





$$I(G_6, S_6) = \begin{bmatrix} I_{xx_6} & I_{xy_6} & I_{xz_6} \\ I_{xy_6} & I_{yy_6} & I_{yz_6} \\ I_{xz_6} & I_{yz_6} & I_{zz_6} \end{bmatrix}_{(\overrightarrow{x_7}, \overrightarrow{y_7}, \overrightarrow{z_7})}$$

$$\overrightarrow{A_6G_6}_{|R_7} = a_6\overrightarrow{x_7} + b_6\overrightarrow{y_7} + c_6\overrightarrow{z_7}$$
$$\overrightarrow{A_6O_6}_{|R_7} = l_{16}\overrightarrow{x_7} + l_{36}\overrightarrow{z_7}$$

$${}^7I_{xx_6} = 0.00001992\ kg.m^2$$
$${}^7I_{yy_6} = 0.00002956 kg.m^2$$
$${}^7I_{zz_6} = 0.00001338\ kg.m^2$$

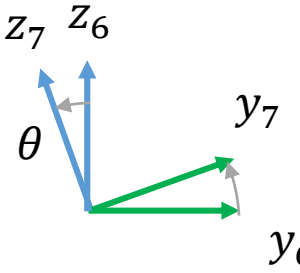
$${}^7I_{xy_6} = 0.00000048\ kg.m^2$$
$${}^7I_{yz_6} = -0.00000182\ kg.m^2$$
$${}^7I_{xz_6} = -0.00001098\ kg.m^2$$

$$a_6 = -0.05369029\ m$$
$$b_6 = 0.00776230\ m$$
$$c_6 = 0.03169498\ m$$

$$l_{16} = 0{,}07097\ m$$
$$l_{36} = 0{,}07968\ m$$

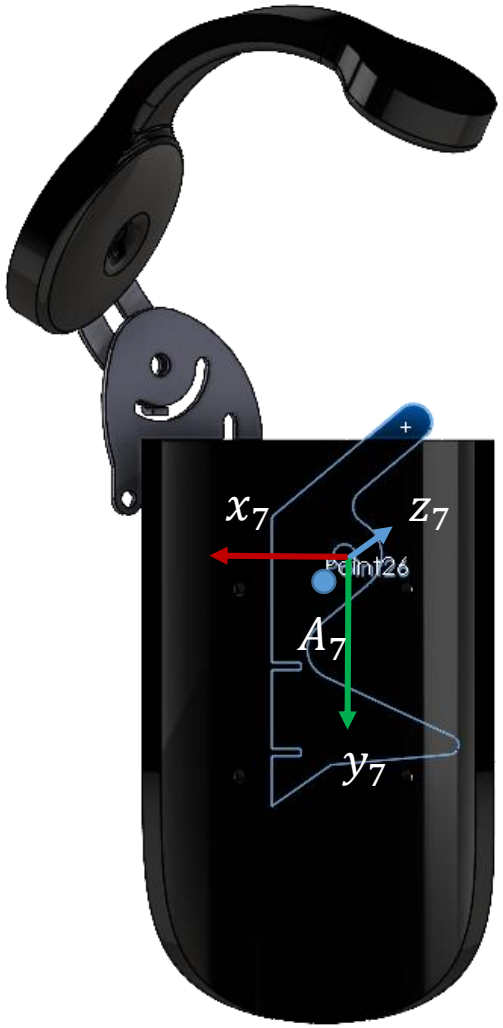
$$m_6 = 0{,}08658000\ kg$$

$$V_6 = 0.00001665\ m^3$$



$\theta = -120°$
ou
$\theta = 240°$

Solide 7



$$I(G_7, S_7) = \begin{bmatrix} I_{xx_7} & I_{xy_7} & I_{xz_7} \\ I_{xy_7} & I_{yy_7} & I_{yz_7} \\ I_{xz_7} & I_{yz_7} & I_{zz_7} \end{bmatrix}_{(\overrightarrow{x_5}, \overrightarrow{y_5}, \overrightarrow{z_5})}$$

$$\overrightarrow{O_7G_7} = a_7\overrightarrow{x_7} + b_7\overrightarrow{y_7} + c_7\overrightarrow{z_7}$$
$$\overrightarrow{O_7A_7} = l_{17}\overrightarrow{x_7} + l_{37}\overrightarrow{z_7}$$

$I_{xx_7} = 0.00255786\ kg.m^2$
$I_{yy_7} = 0.00098183\ kg.m^2$
$I_{zz_7} = 0.00240229\ kg.m^2$

$I_{xy_7} = 0.00000966\ kg.m^2$
$I_{yz_7} = -0.00089959\ kg.m^2$
$I_{xz_7} = -0.00019222\ kg.m^2$

$a_7 = 0{,}02748935\ m$
$b_7 = -0.03834733\ m$
$c_7 = 0.05151232\ m$

$l_{17} = ?$
$l_{37} = ?$

$m_7 = 0{,}35022\ kg$

$V_7 = 200437.864\ mm^3$

Notes de calcul

Masse(Sphere + solide 6 + solide 7 part 1) = 274 g
V(Sphere + solide 6 + solide 7 part 1) = 40167.19 mm3
V(solide 6) = 16647.92 mm3
V(solide 7 part 1) = 13031.10 mm3
V(Sphere)= 22859.34 mm3

fracV(Sphere) = 22859.34 / (16647.92+ 13031.10+ 22859.34) = 0.435
fracV(solide 6) = 16647.92 / (16647.92+ 13031.10+ 22859.34) = 0.435

M(Sphere) = 0,435 * 274 = 119.19 g
M(Solide6) = 0.316 * 274 = 86.58 g
M(solide 7 part 1) = (1- 0.316- 0,435) * 274 = 68.22 g