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In[1038]:= ClearAll["Global`*"]

(* http://mini.pw.edu.pl/~porter/cc/psw/psw_cw2.pdf *)
(* System: Two bars and a cone *)

(* ----- Global Variables ----- *)
$Density := 1;

(* ----- Functions ----- *)

$I[$Integral_, x_, y_, z_] := {
  {$Integral[y^2 + z^2],
   -$Integral[x * y],
   -$Integral[x * z]},
  {-$Integral[x * y],
   $Integral[x^2 + z^2],
   -$Integral[y * z]},
  {-$Integral[x * z],
   -$Integral[y * z],
   $Integral[y^2 + x^2]}};

$IPointFun[x_, y_, z_, m_] :=
m * {
  {y^2 + z^2, -x * y, -x * z},
  {-x * y, x^2 + z^2, -y * z},
  {-x * z, -y * z, x^2 + y^2}};

$PlotInertiaTensor[I_, a_] := Show[ContourPlot3D[
  {{ix, iy, iz}.I.{ix, iy, iz} == 1}, {ix, -a, a}, {iy, -a, a}, {iz, -a, a}]]

$Angle = -30 °;
$RotationY = 
$$\begin{pmatrix} \cos[\$Angle] & 0 & \sin[\$Angle] \\ 0 & 1 & 0 \\ -\sin[\$Angle] & 0 & \cos[\$Angle] \end{pmatrix}$$
;

(* Cone *)
$ConeR =  $\sqrt{3}$ ;
$ConeSlant =  $2\sqrt{3}$ ;
$ConeH =  $\sqrt{\$ConeSlant^2 - \$ConeR^2}$ ;

$ConeIntegralVariables[r_, h_, a_] := $Density  $(r^2 \pi) / h^2 \int_1^{h+1} a * z^2 dz$ ;
$ConeIntegral[a_] := $ConeIntegralVariables[$ConeR, $ConeH, a];
$ConeMass = $ConeIntegral[1];
$ConeCenterOfMass :=

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{ $ConeIntegral[0], $ConeIntegral[0], $ConeIntegral[z] } / $ConeMass;
$ICone = $I[$ConeIntegral, 0, 0, z];

(* Bar Y *)
$BarYIntegral[a_] := $Density  $\int_{-1}^1 a \, dy$ ;
$BarYMass = $BarYIntegral[1];
$BarYCenterOfMass :=
{ $BarYIntegral[0], $BarYIntegral[y], $BarYIntegral[0] } / $BarYMass;
$IBarY = $I[$BarYIntegral, 0, y, 0];

(* Bar Z *)
$BarZIntegral[a_] := $Density  $\int_0^1 a \, dz$ ;
$BarZMass = $BarZIntegral[1];
$BarZCenterOfMass :=
{ $BarZIntegral[0], $BarZIntegral[0], $BarZIntegral[z] } / $BarZMass;
$IBarZ = $I[$BarZIntegral, 0, 0, z];

(* All *)
$MassAll = $ConeMass + $BarYMass + $BarZMass;
$CenterOfMassAll =
( $ConeMass * $ConeCenterOfMass + $BarYMass * $BarYCenterOfMass +
$BarZMass * $BarZCenterOfMass ) / $MassAll;

$IAll = $ICone + $IBarY + $IBarZ;
$IAllPoint = $IPointFun[
$CenterOfMassAll[[1]],
$CenterOfMassAll[[2]],
$CenterOfMassAll[[3]],
$MassAll];
$IAllCenter = $IAll - $IAllPoint;
$IAllCenterRotated = $RotationY.$IAllCenter.Transpose[$RotationY];

$A = {0, 1, 0};

(* Prints *)
Print["----- Properties -----"]
Print["Cone Mass: ", $ConeMass];
Print["Cone Center Of Mass: ", $ConeCenterOfMass];
Print["BarY Mass: ", $BarYMass];
Print["BarY Center Of Mass: ", $BarYCenterOfMass];
Print["BarZ Mass: ", $BarZMass];
Print["BarZ Center Of Mass: ", $BarZCenterOfMass];
Print["All Mass: ", $MassAll];

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Print["All Center Of Mass: ", $CenterOfMassAll];

Print["----- Inertia Tensors around (0,0,0) -----"]
Print["Cone : ", N[MatrixForm[$ICone]]];
Print["BarY : ", N[MatrixForm[$IBarY]]];
Print["BarZ : ", N[MatrixForm[$IBarZ]]];

Print["----- Inertia Tensor All around (0,0,0) -----"]
Print[N[MatrixForm[$IAll]]];

Print["----- Inertia Tensors All Point -----"]
Print[N[MatrixForm[$IAllPoint]]];

Print["----- Inertia Tensors All Center -----"]
Print[N[MatrixForm[$IAllCenter]]];

Print["----- Inertia Tensors All Center Rotated -----"]
Print[N[MatrixForm[$IAllCenterRotated]]];

(* Plots *)
$a = 1;

Print["----- Inertia Tensors All around (0,0,0) -----"]
$PlotInertiaTensor[$IAll, $a]
Print["----- Inertia Tensors All Center -----"]
$PlotInertiaTensor[$IAllCenter, $a]
Print["----- Inertia Tensors All Center Rotated -----"]
$PlotInertiaTensor[$IAllCenterRotated, $a]

----- Properties -----
Cone Mass:  $7\pi$ 
Cone Center Of Mass:  $\left\{0, 0, \frac{85}{28}\right\}$ 
BarY Mass: 2
BarY Center Of Mass: {0, 0, 0}
BarZ Mass: 1
BarZ Center Of Mass:  $\left\{0, 0, \frac{1}{2}\right\}$ 
All Mass:  $3 + 7\pi$ 
All Center Of Mass:  $\left\{0, 0, \frac{\frac{1}{2} + \frac{85\pi}{4}}{3 + 7\pi}\right\}$ 
----- Inertia Tensors around (0,0,0) -----

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Cone : 
$$\begin{pmatrix} 214.257 & 0. & 0. \\ 0. & 214.257 & 0. \\ 0. & 0. & 0. \end{pmatrix}$$

BarY : 
$$\begin{pmatrix} 0.666667 & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0.666667 \end{pmatrix}$$

BarZ : 
$$\begin{pmatrix} 0.333333 & 0. & 0. \\ 0. & 0.333333 & 0. \\ 0. & 0. & 0. \end{pmatrix}$$

----- Inertia Tensor All around (0,0,0) -----

$$\begin{pmatrix} 215.257 & 0. & 0. \\ 0. & 214.59 & 0. \\ 0. & 0. & 0.666667 \end{pmatrix}$$

----- Inertia Tensors All Point -----

$$\begin{pmatrix} 181.014 & 0. & 0. \\ 0. & 181.014 & 0. \\ 0. & 0. & 0. \end{pmatrix}$$

----- Inertia Tensors All Center -----

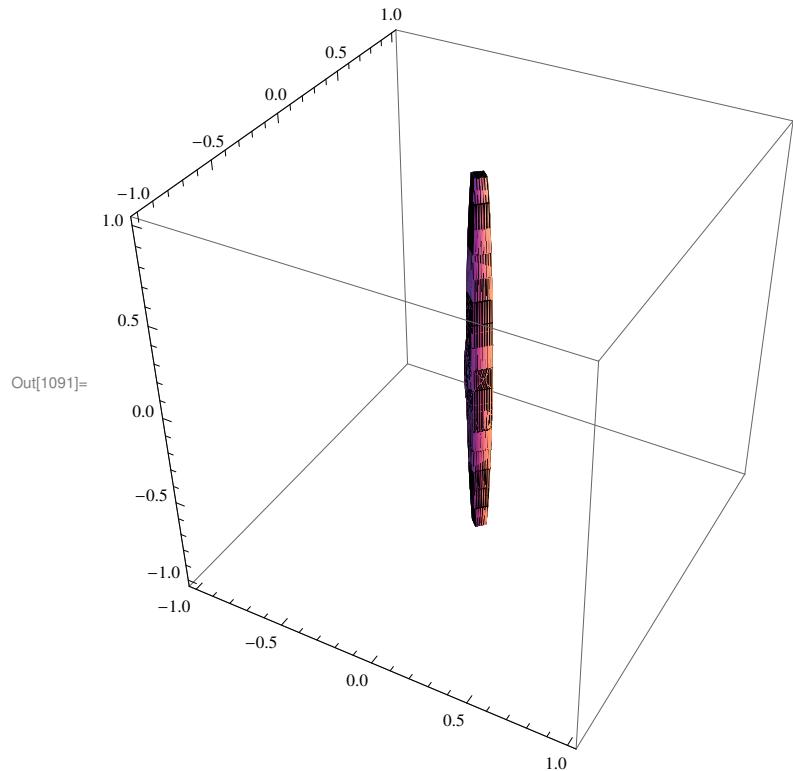
$$\begin{pmatrix} 34.2424 & 0. & 0. \\ 0. & 33.5758 & 0. \\ 0. & 0. & 0.666667 \end{pmatrix}$$

----- Inertia Tensors All Center Rotated -----

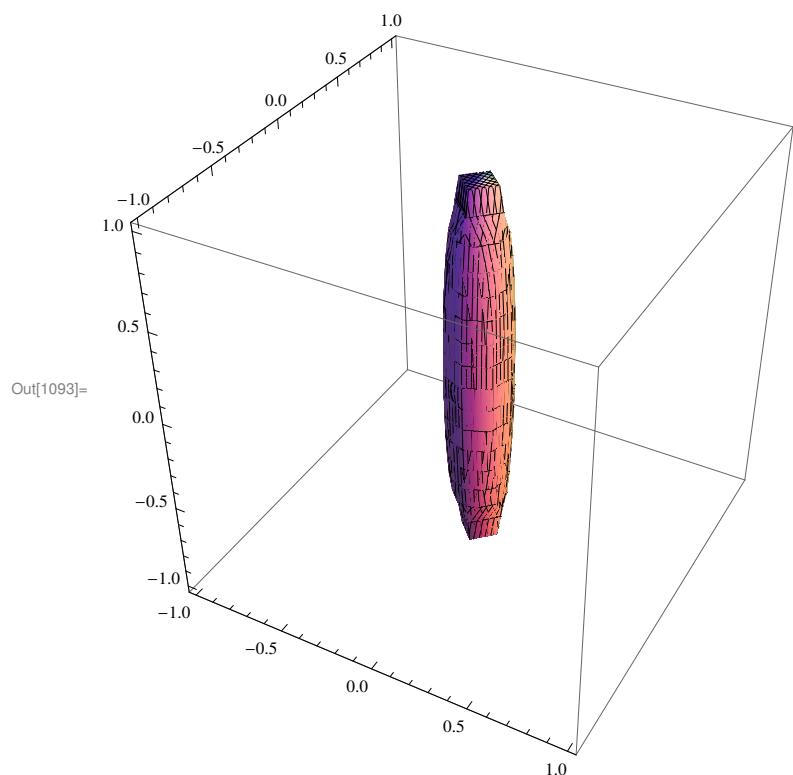
$$\begin{pmatrix} 25.8485 & 0. & 14.5387 \\ 0. & 33.5758 & 0. \\ 14.5387 & 0. & 9.06061 \end{pmatrix}$$

----- Inertia Tensors All around (0,0,0) -----

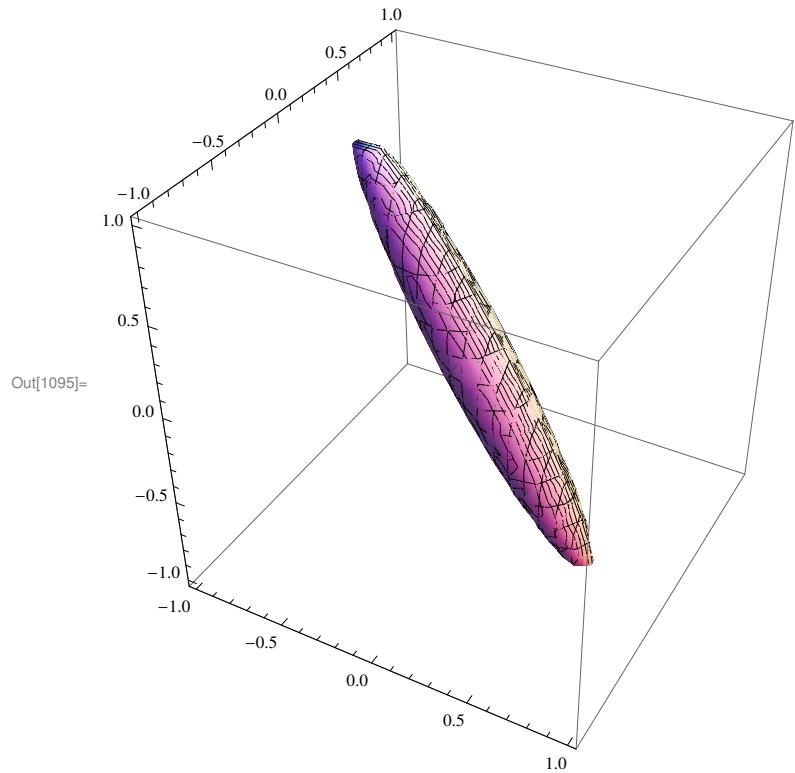
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----- Inertia Tensors All Center -----



----- Inertia Tensors All Center Rotated -----



In[1096]:=