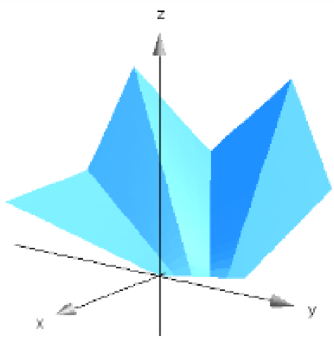

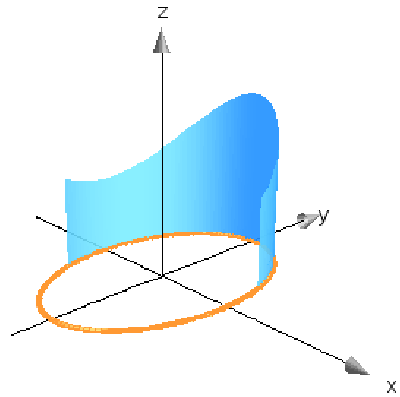

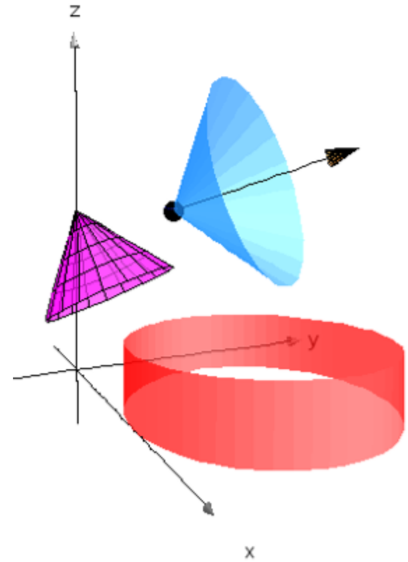

Geo3D, a library for 3D-graphs with TI-Nspire CAS

Presentation, syntax and examples

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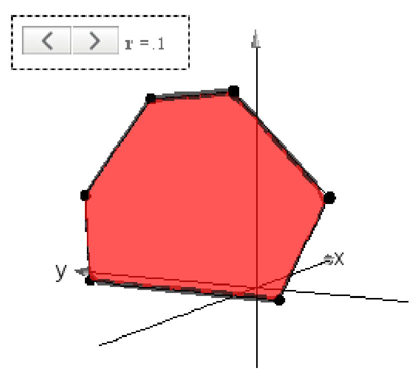

This library was developed at École de technologie supérieure for a multiple variable calculus class. Because the 3D interface of TI Nspire CAS 3.6 offers only the possibility of plotting surfaces or parametric curves (and does not include features to produce thick curves, vectors or points for examples), the library geo3d give functions that produce parametric equations of many 3D objects that we can now plot easily.

The next pages were created in a PublishView file that you can open if you have access to the software TI-Nspire. Then, you will be able to turn a graph or to add a line in a Calculus Page in order to draw a new object in a graph. You can find this file, EnglishDocGeo3D.tnsp, and other documents at

http://seg-apps.etsmtl.ca/nspire/librairies.html.

If you are not already familiar with geo3d, we suggest you to begin with "How to use this library" at page 11.

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Sphere, vector and disk

$a:=\{0,2,3\}$	$\{0,2,3\}$
$b:=\{2,3,4\}$	$\{2,3,4\}$
$v:=b-a$	$\{2,1,1\}$
$g1:=geo3d\backslash sphere(a,0.3)$	$\{0.3\cdot\cos(t)\cdot\sin(u),0.3\cdot\sin(t)\cdot\sin(u)+2,0.3\cdot\cos(u)+3\}$
$g2:=geo3d\backslash thickvec(a,b,0.05):g3:=\text{right}(g2,3)$	
Place these 6 functions into 2 parametric graphs to plot the cylinder and the cone.	
$\{0.014678\cdot\cos(t)\cdot u-0.017977\cdot\sin(t)\cdot u-0.106103\cdot u+2,0.007339\cdot\cos(t)\cdot u+0.035954\cdot\sin(t)\cdot u-0.053052\cdot u+3,^{-}0.036696\cdot\cos(t)$ ▸	
$g4:=geo3d\backslash disk(1.5,a,v)$	$\{0.174346\cdot\cos(t)\cdot u-0.213529\cdot\sin(t)\cdot u,0.087173\cdot\cos(t)\cdot u+0.427058\cdot\sin(t)\cdot u+2,3-0.435864\cdot\cos(t)\cdot u\}$
$g5:=geo3d\backslash ring(1.2,2,\{3,2,0\},\{0,0,1\})$	$\{\cos(t)\cdot(0.254648\cdot u+1.2)+3,\sin(t)\cdot(0.254648\cdot u+1.2)+2,0\}$
$geo3d\backslash putg(1,5)$	*Done*

Syntax

All points and vectors are lists of 3 real numbers:

point = {x, y, z}   vector = {x, y, z}

sphere(*center, radius***)**

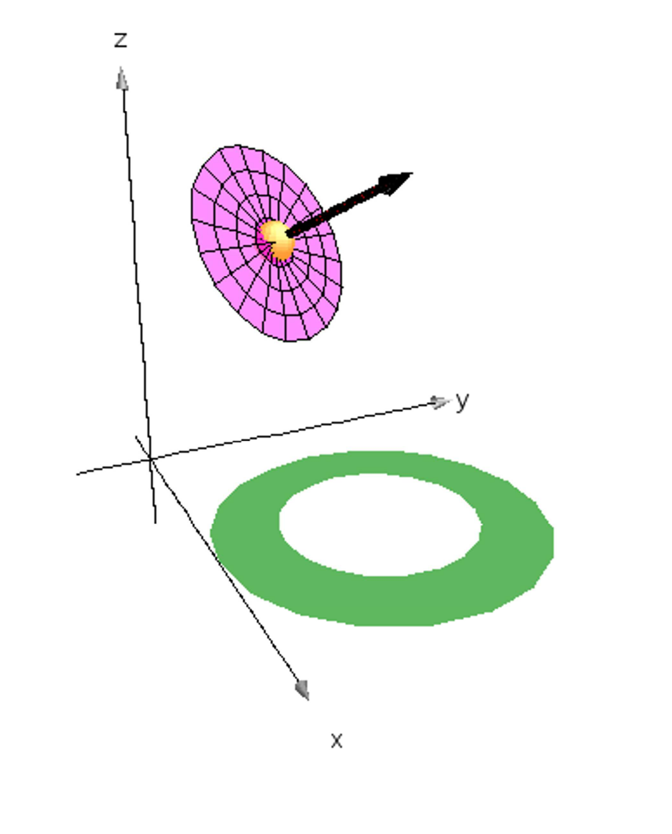
disk(*radius, center, normal vector***)**

ring(*radius min, radius max, center, normal vector***)**

thickvec(*a, b, radius***)**
to create a thick vector from point *a* to point *b*, with a choosen "radius".

vec(*a, b***)**
to create a vector from point *a* to point *b*

See remark on vec and thickvec in #9 at page 11.



Circle, ribbon and thick curve

$a{:=}\{0,2,3\}{:}b{:=}\{2,3,4\}{:}v{:=}b-a{:}g5{:=}geo3d\backslash circle(1.3,a,v){:}g6{:=}geo3d\backslash thickcurve(g5,0.1)$

Warning: thickcurve( ) requires many computations. Use ribbon( ) on the calculator. Functions x(t), y(t) and z(t) must be derivable.

$$\left\{0.1\cdot\cos\left(\left(2\cdot\text{floor}\left(\frac{\cos(t)}{|\cos(t)-0.204124\cdot\sin(t)|+0.860026}-\frac{0.204124\cdot\sin(t)}{|\cos(t)-0.204124\cdot\sin(t)|+0.860026}\right)+1\right)\cdot\sin^{-1}\left(\frac{}{\sqrt{\text{floor}\left(\frac{0.710059}{(\cos(t))^2+7.10059\text{E}{-15}\cdot\sin(t)}\right.}}\right.\right.\right. \blacktriangleright$$

$g7{:=}geo3d\backslash thickcurve\left(\left\{2+2\cdot\cos(t),2+\sin(t),1-\frac{t}{10}\right\},0.2\right){:}g8{:=}geo3d\backslash ribbon\left(\left\{2+2\cdot\cos(t),2+\sin(t),1-\frac{t}{10}\right\},0.2,\{0,0,1\}\right)$

Warning: thickcurve( ) requires many computations. Use ribbon( ) on the calculator. Functions x(t), y(t) and z(t) must be derivable.

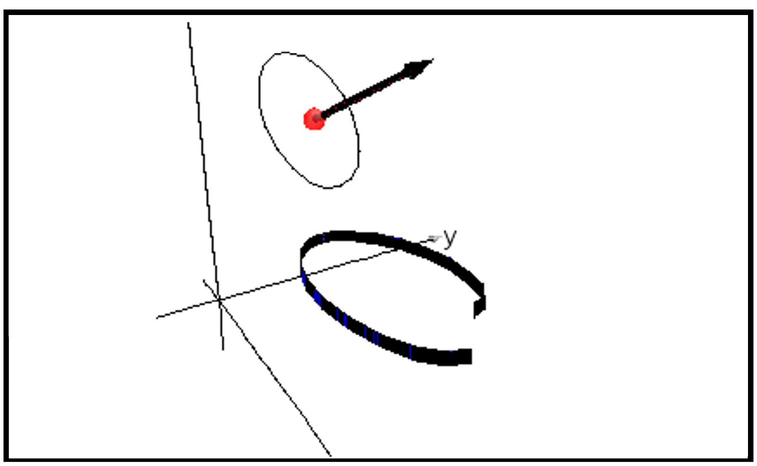
$$\left\{2\cdot\cos(t)+2,\sin(t)+2,\frac{-t}{10}+0.063662\cdot u+0.9\right\}$$

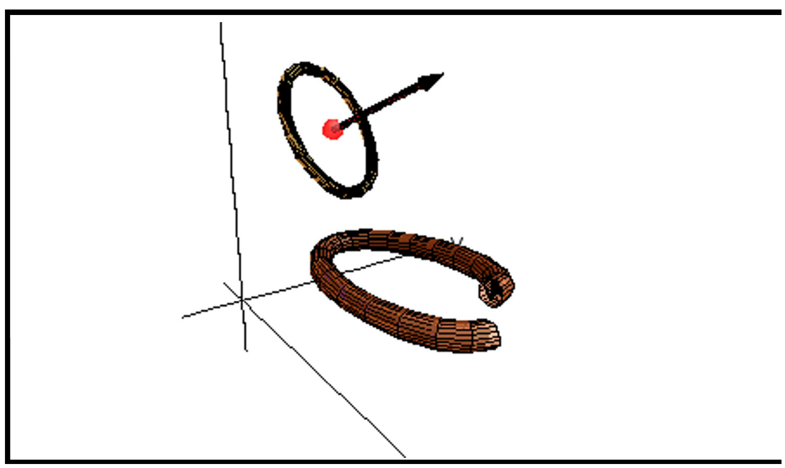
Syntax

circle(*radius, center, normal vector***)** where *centre* and *vector* are lists of 3 real numbers

ribbon(*curve, thickness, vector***)** where *curve* is a list of 3 functions in t : {x(t), y(t), z(t)}
to create a ribbon along the *curve*, parallel to the choosen *vector*, in order to make the curve thicker
*See remark on ribbons at page 5***.**

thickcurve(*curve, radius***)** where *curve* is a list of 3 differentiable functions in t : {x(t), y(t), z(t)}
to create a pipe arroundthe *curve* in order to make the curve thicker





Cone and cylinder

For this example, we have used a Note sheet instead of a Calculator sheet to define objects.
Advantages :
– We can modify some item anywhere in the page and everything will be ajusted. We don't have to work in a linear way.
– We can insert text and math boxes.
Inconvenience : slower.

a:={0,2,3}:b:={3,4,4}:v:=b−a ▸ {3,2,1}

p:={0,0,0} ▸ {0,0,0}

g1:=geo3d\sphere(a,0.2)
▸ $\{0.2\cdot\cos(t)\cdot\sin(u), 0.2\cdot\sin(t)\cdot\sin(u)+2, 0.2\cdot\cos(u)+3\}$

The blue cone:

g3:=geo3d\cone$\left(a,2,\frac{\pi}{4},v\right)$
▸ $\left\{\frac{3\cdot\sqrt{182}\cdot\cos(t)\cdot u}{91\cdot\pi}-\frac{4\cdot\sqrt{13}\cdot\sin(t)\cdot u}{13\cdot\pi}+\frac{3\cdot\sqrt{14}\cdot u}{7\cdot\pi},\frac{2\cdot\sqrt{182}\cdot c}{91\cdot}\right.$

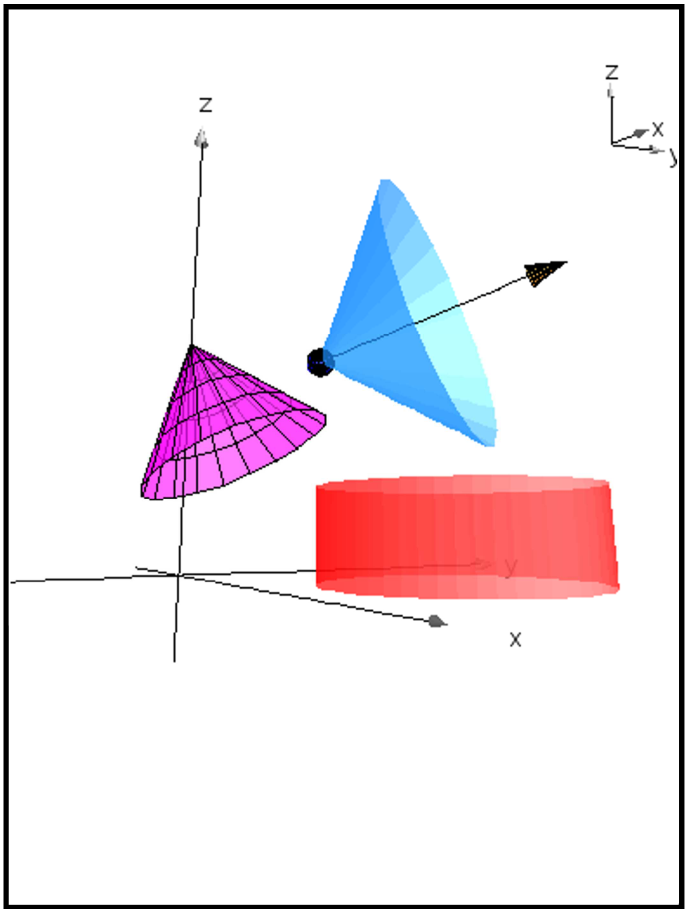
The pink cone:

g4:=geo3d\cone$\left(\{0,0,3\},1.7,\frac{\pi}{5},\{1,1,-3\}\right)$
▸ $\{^{-}0.251461\cdot\cos(t)\cdot u-0.278\cdot\sin(t)\cdot u+0.163156\cdot u,^{-}0.25146$

g5:=geo3d\vec(a,b):g6:=right(g5,3)
▸ $\{0.010948\cdot\cos(t)\cdot u-0.027309\cdot\sin(t)\cdot u-0.127608\cdot u+3,0.0$

The red cylinder:

g7:=*geo3d\cylinder*(1.5,{3,2,0},{3,2,1})
▸ $\left\{1.5\cdot\cos(t)+3,1.5\cdot\sin(t)+2,\frac{u}{\pi}\right\}$



Syntax

cylinder(*radius, center base 1, center base 2***)**
where *centers* are lists of 3 real numbers

cone(*apex, height, angle, vector of axis of symetry***)**
where *apex* and *vector* are lists of 3 real numbers

Polygon

$$g1:=geo3d\backslash polygon\left(\begin{bmatrix} -1 & 4 & 0 \\ -1 & 4 & 2 \\ -1 & 2 & 4 \\ -1 & 0 & 4 \\ -1 & -2 & 2 \\ -1 & -1 & 0 \end{bmatrix}\right)$$

In ATTRIBUTES, put the number of t−wires equal to nXm+1, where n is the number of vertices and m any integer such that m≥1.

$$\left\{\frac{\text{floor}\left(\frac{2\cdot\pi}{|t-2\cdot\pi|+2\cdot\pi}-\frac{t}{|t-2\cdot\pi|+2\cdot\pi}\right)\cdot(u-\pi)+\text{floor}\left(\frac{t}{|t|+2\cdot\pi}\right)\cdot}{\pi}\right.$$

$$g2:=geo3d\backslash polyreg(\{1,2,0\},\{0,0,1\},\{0.2,2.2,0\},5)$$

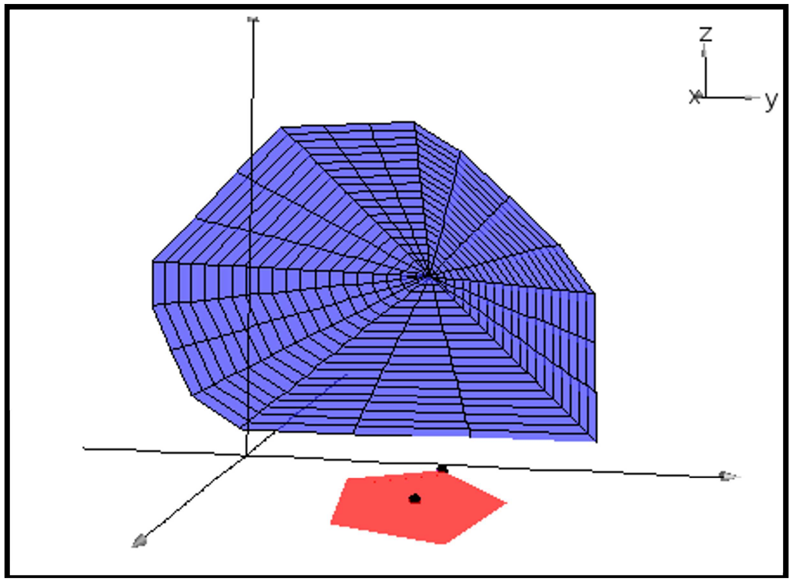
$$\left\{-0.254648\cdot\cos\left(\frac{2\cdot\pi\cdot\text{floor}\left(\frac{11\cdot t}{4\cdot\pi}\right)}{5}\right)\cdot u-0.063662\cdot\sin\left(\frac{2\cdot\pi\cdot\text{f}}{}\right.\right.$$

$$g3:=geo3d\backslash sphere(\{1,2,0\},0.05)$$

$$\{0.05\cdot\cos(t)\cdot\sin(u)+1,0.05\cdot\sin(t)\cdot\sin(u)+2,0.05\cdot\cos(u)\}$$

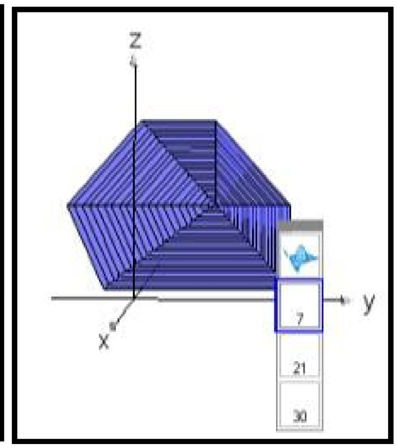
$$g4:=geo3d\backslash sphere(\{0.2,2.2,0\},0.05)$$

$$\{0.05\cdot\cos(t)\cdot\sin(u)+0.2,0.05\cdot\sin(t)\cdot\sin(u)+2.2,0.05\cdot\cos(u$$



As seen above, resolution of the irregular polygon is not good:
vertices are not sharp.

So we adjust the number of t−wires to
6 X 1 + 1 = 7
Then, we hide the wires.
(figure lower right).

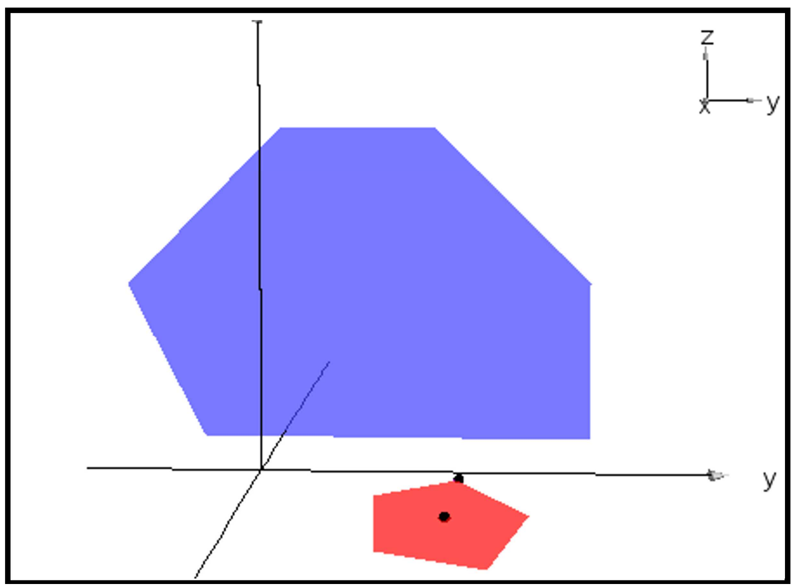


Syntax

polygon(*list of vertices or matrice nX3***)**
to create **convex** polygons

polyreg(*center, normal vector, vertex, nb of sides***)**
to create regular polygons

Remark
If points a,b,c,d are already defined, for example
a:={0,1,2} b:={1,1,2} c:={1,0,2} d:={0,0,2}
we can plot the polygon abcd (filled) with
polygon({a,b,c,d}**)**
then Nspire transforms this list into a matrix when we press Enter.



Empty polygon (perimeter)

$$g1:=geo3d\backslash perimeter\left(\begin{bmatrix} -1 & 4 & 0 \\ -1 & 4 & 2 \\ -1 & 2 & 4 \\ -1 & 0 & 4 \\ -1 & -2 & 2 \\ -1 & -1 & 0 \end{bmatrix}\right)$$

In ATTRIBUTES, put the number of t−wires equal to nXm+1, where n is the number of vertices and m any integer such that m≥1.

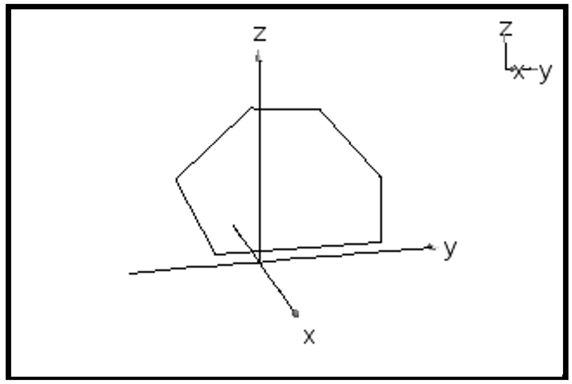
$$\left\{ -\text{floor}\left(\frac{2\cdot\pi}{|t-2\cdot\pi|+2\cdot\pi}-\frac{t}{|t-2\cdot\pi|+2\cdot\pi}\right)-\text{floor}\left(\frac{t}{|t|+2\cdot\pi}\right)-1, \frac{4\cdot(3\cdot t-\pi)\cdot \text{floor}\left(\cdots\right.}{\cdots} \right.$$

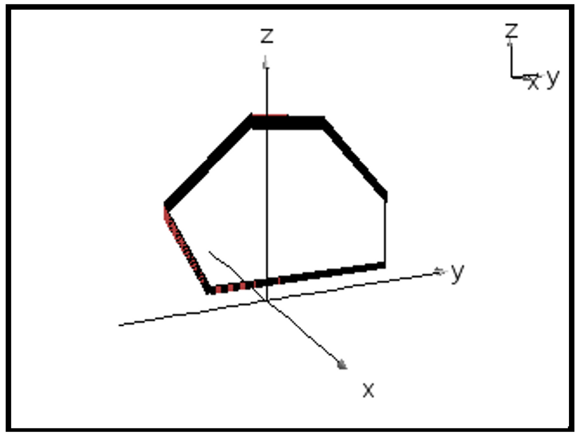
$$g2:=geo3d\backslash ribbon(g1,0.3,\{0,0,1\})$$

$$\left\{ -\text{floor}\left(\frac{2\cdot\pi}{|t-2\cdot\pi|+2\cdot\pi}-\frac{t}{|t-2\cdot\pi|+2\cdot\pi}\right)-\text{floor}\left(\frac{t}{|t|+2\cdot\pi}\right)-1, \frac{4\cdot(3\cdot t-\pi)\cdot \text{floor}\left(\cdots\right.}{\cdots} \right.$$

$$g3:=geo3d\backslash ribbon(g1,2,\{1,0,0\})$$

$$\left\{ -\text{floor}\left(\frac{2\cdot\pi}{|t-2\cdot\pi|+2\cdot\pi}-\frac{t}{|t-2\cdot\pi|+2\cdot\pi}\right)-\text{floor}\left(\frac{t}{|t|+2\cdot\pi}\right)+\frac{2\cdot u}{\pi}-2, \frac{4\cdot(3\cdot t-\pi)\cdot \text{f}\cdots}{\cdots} \right.$$





Syntax

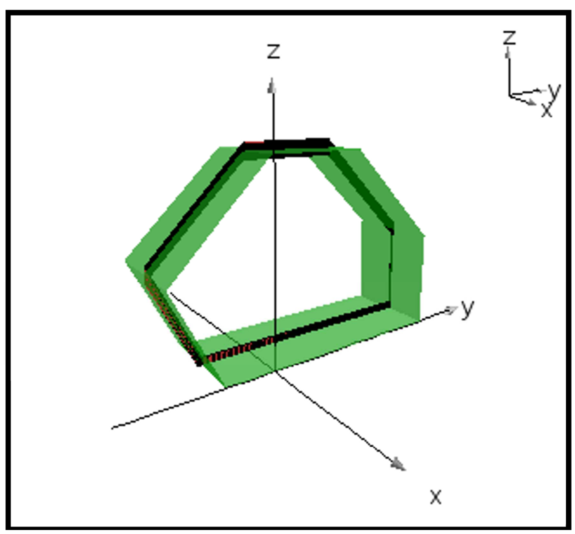
perimeter(*list of vertices or mat. nX3***)**

Remark on ribbons

Because the perimeter g1 is defined with floor functions, it is not derivable. So we can not use "thickcurve(g1, 0.3)" to make a pipe of radius 0.3 around the perimeter.

To have a better view of the perimeter, we can use "ribbon(g1, 0.3, {0,0,1})" and we will have a ribbon of width 0.3 that is parallel to the z axis. We can use "ribbon(g1,2,{1,0,0})" to create a ribbon of width 2 parallel to the x axis.

Again, we have to adjust the number of t−wires in order to produce a nice polygon with sharp vertices.



Broken line

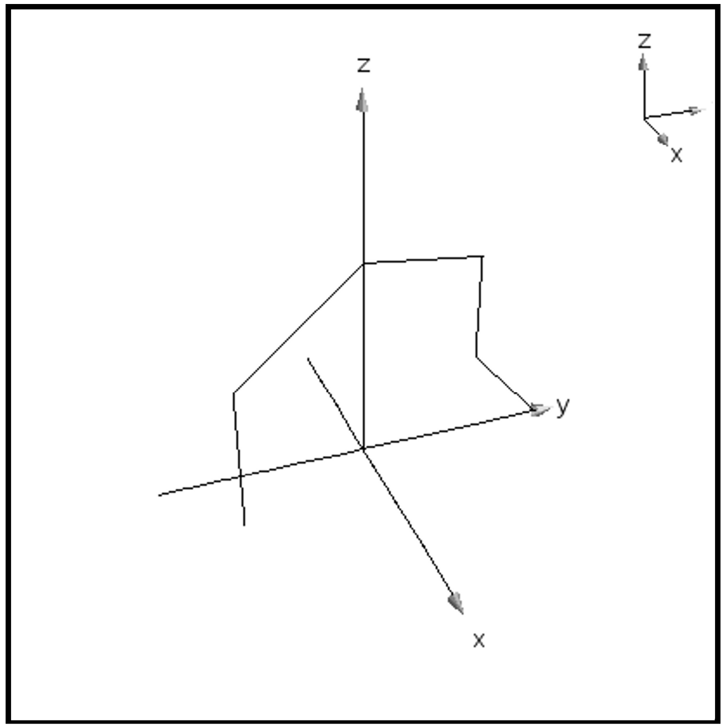
$$g1:=geo3d\backslash brokenline\left(\begin{bmatrix} 0 & 3 & 0 \\ -2 & 3 & 0 \\ -2 & 3 & 2 \\ 0 & 0 & 3 \\ 1 & -2 & 2 \\ 1 & -2 & 0 \end{bmatrix}\right)$$

In ATTRIBUTES, put the number of t−wires equal to (n−1)Xm+1, where n is the number of vertices and m any integer such that m≥1.

$$\left\{ -\left((5\cdot t-2\cdot \pi)\cdot \text{floor}\left(\frac{5\cdot t}{|5\cdot t-2\cdot \pi|+10\cdot \pi}-\frac{2\cdot \pi}{|5\cdot t-2\cdot \pi|+10\cdot \pi}\right)+(5\cdot t- \right.\right.$$

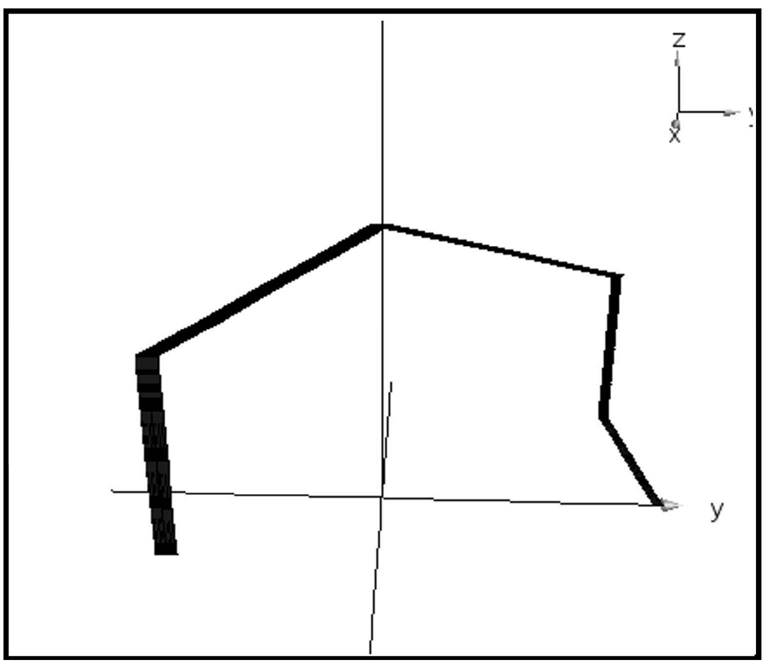
$$g3:=geo3d\backslash ribbon(g1,0.2,\{0,1,0\})$$

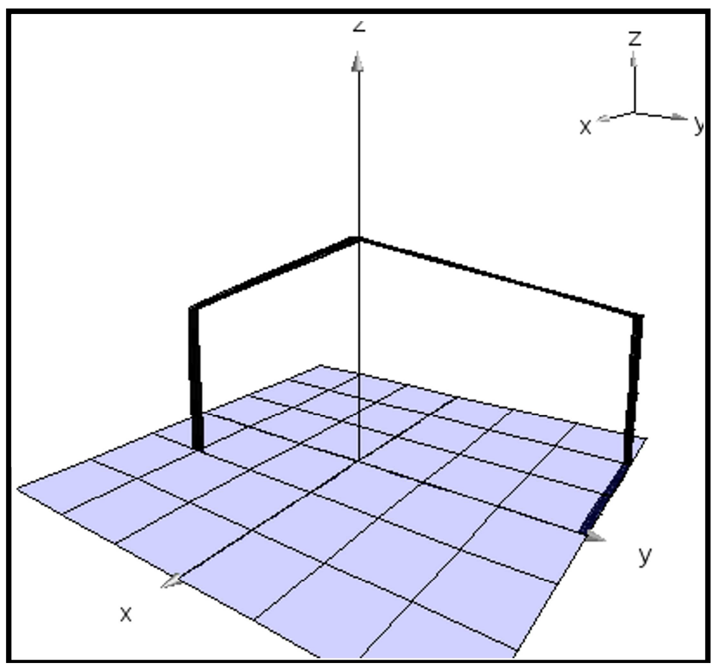
$$\left\{ -\left((5\cdot t-2\cdot \pi)\cdot \text{floor}\left(\frac{5\cdot t}{|5\cdot t-2\cdot \pi|+10\cdot \pi}-\frac{2\cdot \pi}{|5\cdot t-2\cdot \pi|+10\cdot \pi}\right)+(5\cdot t- \right.\right.$$



Syntax

brokenline(*list of vertices or matrice nX3***)**





Rotations

$p:=\{2,2,0\}:v:=\{0,4,4\}$ $\{0,4,4\}$

$g1:=geo3d\backslash sphere(p,0.15)$
$\{0.15\cdot\cos(t)\cdot\sin(u)+2,0.15\cdot\sin(t)\cdot\sin(u)+2,0.15\cdot\cos(u)$ ▸

$g4:=geo3d\backslash cone(\{0,0,0\},3,0.5,\{0,0,1\})$
$\{0.52168\cdot\cos(t)\cdot u,0.52168\cdot\sin(t)\cdot u,0.95493\cdot u\}$

$g5:=geo3d\backslash rotaroundaxis(\pi,g4,p,v)$
$\{4.-0.52168\cdot\cos(t)\cdot u,0.95493\cdot u+2,0.52168\cdot\sin(t)\cdot u-2$ ▸

$geo3d\backslash proj(\{0,0,0\},p,v)$ $\{2,1,^-1\}$

$g6:=geo3d\backslash disk(\sqrt{6},\{2,1,^-1\},v)$
$\left\{2-\frac{\sqrt{6}\cdot\sin(t)\cdot u}{\pi},\frac{\sqrt{3}\cdot\cos(t)\cdot u}{\pi}+1,\frac{^-\sqrt{3}\cdot\cos(t)\cdot u}{\pi}-1\right\}$

$g7:=p+t\cdot v$ $\{2,4\cdot t+2,4\cdot t\}$

$g8:=geo3d\backslash circle(\sqrt{6},\{2,1,^-1\},v)$
$\{2-\sqrt{6}\cdot\sin(t),\sqrt{3}\cdot\cos(t)+1,^-\sqrt{3}\cdot\cos(t)-1\}$

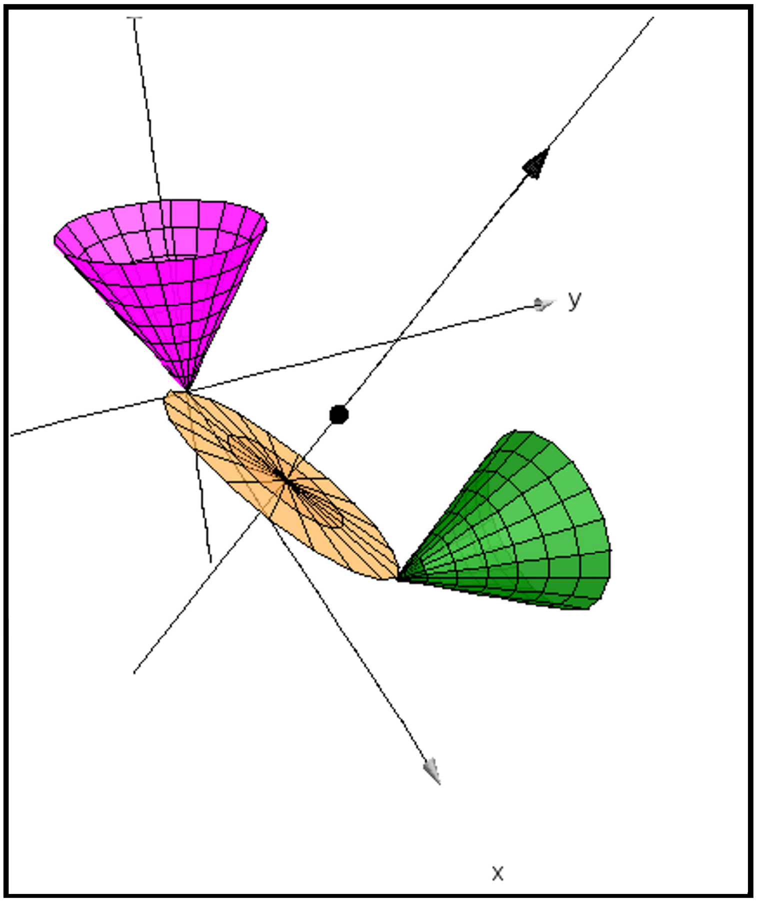
$g9:=geo3d\backslash rotaroundaxis\left(\frac{^-\pi}{2},g4,p,v\right)$
$\{0.368884\cdot\sin(t)\cdot u-0.675237\cdot u+0.585786,^-0.368884\cdot$ ▸

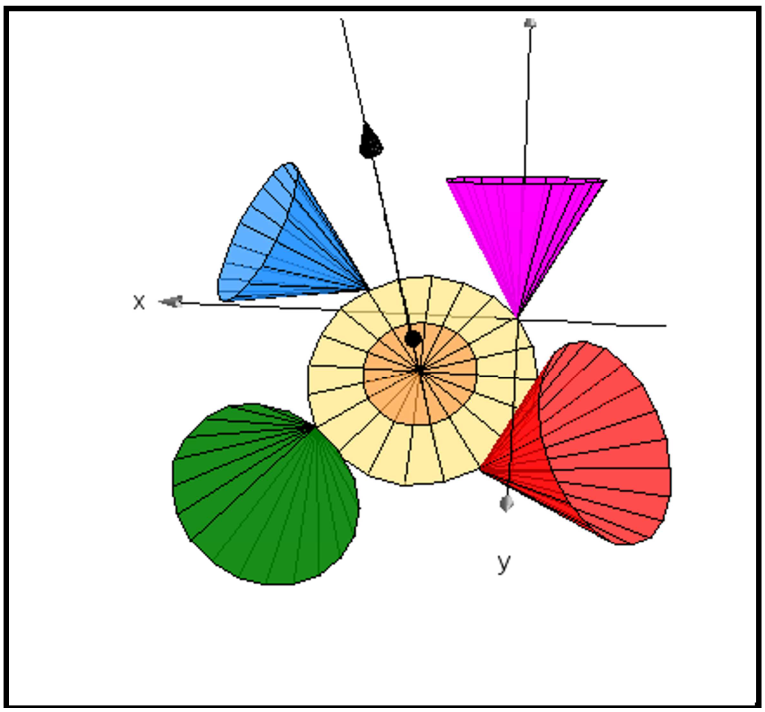
$g10:=geo3d\backslash rotaroundaxis\left(\frac{\pi}{2},g4,p,v\right)$
$\{^-0.368884\cdot\sin(t)\cdot u+0.675237\cdot u+3.41421,0.368884\cdot c$ ▸

$g2:=geo3d\backslash vec(p,p+v):g3:=\text{right}(g2,3)$

Place these 6 functions into 2 parametric graphs to plot the segment and the cone.

$\{2-0.049232\cdot\sin(t)\cdot u,0.034813\cdot\cos(t)\cdot u-0.11254\cdot u+6$ ▸





Rotations

$p:=\{2,2,0\}:v:=\{0,0,4\}$ $\{0,0,4\}$

$g1:=geo3d\backslash sphere(p,0.15)$
$\{0.15\cdot\cos(t)\cdot\sin(u)+2,0.15\cdot\sin(t)\cdot\sin(u)+2,0.15\cdot\cos(u)\}$

$g2:=geo3d\backslash vec(p,p+v):g3:=\mathrm{right}(g2,3)$

Place these 6 functions into 2 parametric graphs to plot the segment and the cone.

$\{0.049232\cdot\cos(t)\cdot u+2,0.049232\cdot\sin(t)\cdot u+2,4-0.159155\cdot u\}$

$g4:=geo3d\backslash cone(\{0,0,0\},3,0.5,\{0,0,1\})$
$\{0.52168\cdot\cos(t)\cdot u,0.52168\cdot\sin(t)\cdot u,0.95493\cdot u\}$

$g5:=geo3d\backslash rotaroundaxis(\pi,g4,p,v)$
$\{4.-0.52168\cdot\cos(t)\cdot u,4.-0.52168\cdot\sin(t)\cdot u,0.95493\cdot u\}$

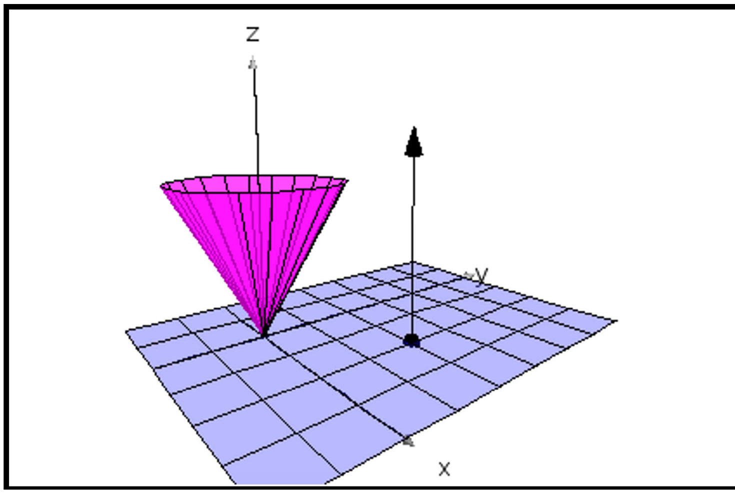
$g6:=geo3d\backslash disk(\sqrt{8},p,v)$
$\left\{\frac{2\cdot\sqrt{2}\cdot\cos(t)\cdot u}{\pi}+2,\frac{2\cdot\sqrt{2}\cdot\sin(t)\cdot u}{\pi}+2,0\right\}$

$g7:=p+t\cdot v$ $\{2,2,4\cdot t\}$

$g8:=geo3d\backslash circle(\sqrt{8},p,v)$
$\{2\cdot\sqrt{2}\cdot\cos(t)+2,2\cdot\sqrt{2}\cdot\sin(t)+2,0\}$

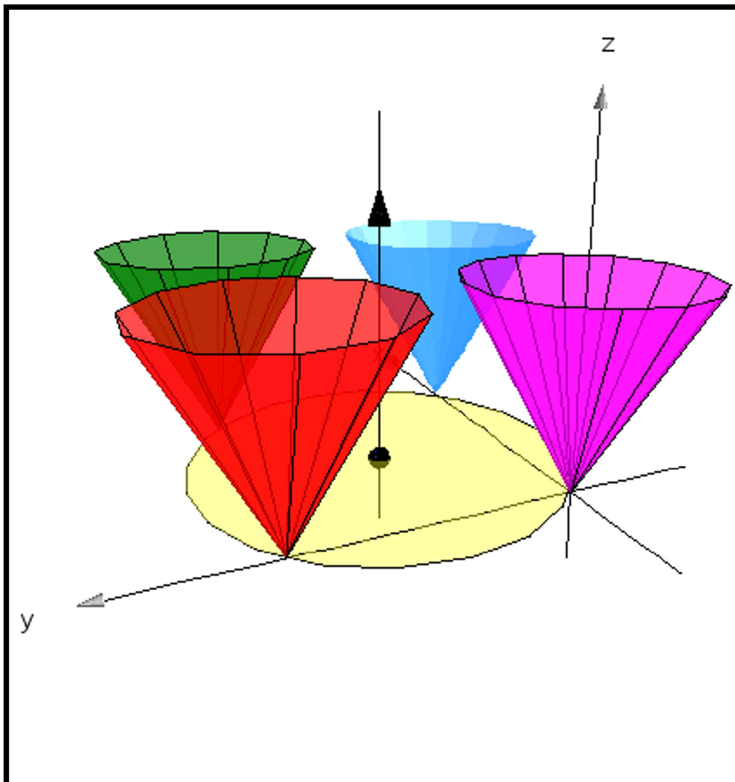
$g9:=geo3d\backslash rotaroundaxis\left(\frac{-\pi}{2},g4,p,v\right)$
$\{0.52168\cdot\sin(t)\cdot u,4.-0.52168\cdot\cos(t)\cdot u,0.95493\cdot u\}$

$g10:=geo3d\backslash rotaroundaxis\left(\frac{\pi}{2},g4,p,v\right)$
$\{4.-0.52168\cdot\sin(t)\cdot u,0.52168\cdot\cos(t)\cdot u,0.95493\cdot u\}$



Syntax

rotaroundaxis(*angle, object, center, vector***)**
where *object* is a list of 3 parametric functions,
center is any point on the axis of rotation,
vector is parallel to axis of rotation



Curtain and parallelogram

$\frac{\ }{5}+0.16\cdot y^2+1$

$g1:=\left\{\frac{t^2}{4}-2,t,0\right\}$ $\left\{\frac{t^2}{4}-2,t,0\right\}$

g2:=geo3d\curtain(z2(x,y),g1[1],g1[2],-3,3)

$\left\{\frac{36\cdot u^2-36\cdot \pi\cdot u+\pi^2}{4\cdot \pi^2},\frac{3\cdot (2\cdot u-\pi)}{\pi},-0.026469\cdot (t-2\cdot \pi)\cdot \left(u^4-6.28319\cdot u^3+13.9271\cdot u^2\cdot\right.\right.$

a:={-1,4,0}:v1:={-2,1,0}:v2:={-2,-2,0} {-2,-2,0}

g5:=geo3d\parallelog(a,v1,v2) $\left\{\frac{-t}{\pi}-\frac{2\cdot u}{\pi}-1,\frac{t}{2\cdot \pi}-\frac{2\cdot u}{\pi}+4,0\right\}$

g6:=geo3d\sphere(a,0.2)

$\{0.2\cdot \cos(t)\cdot \sin(u)-1,0.2\cdot \sin(t)\cdot \sin(u)+4,0.2\cdot \cos(u)\}$

g7:=geo3d\thickvec(a,a+v1,0.05):g8:=right(g7,3)

Place those 6 functions into 2 parametric graphs to plot the cylinder and the cone.

$\{-0.016411\cdot \sin(t)\cdot u+0.106103\cdot u-3,-0.032822\cdot \sin(t)\cdot u-0.053052\cdot u+5,-0.036696\cdot c$

g9:=geo3d\thickvec(a,a+v2,0.05):g10:=right(g9,3)

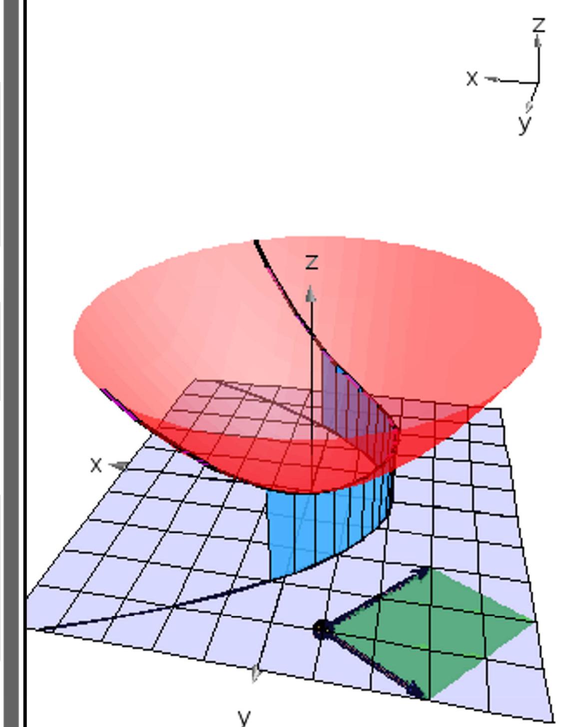
Place those 6 functions into 2 parametric graphs to plot the cylinder and the cone.

$\{0.032822\cdot \sin(t)\cdot u+0.106103\cdot u-3,-0.032822\cdot \sin(t)\cdot u+0.106103\cdot u+2,-0.046417\cdot c$

g3:=geo3d\ribbon(g1,0.1,{1,0,0}) $\left\{\frac{t^2}{4}+0.031831\cdot u-2.05,t,0\right\}$

g4:=geo3d\ribbon({g1[1],g1[2],z2(g1[1],g1[2])},0.1,{1,0,0})

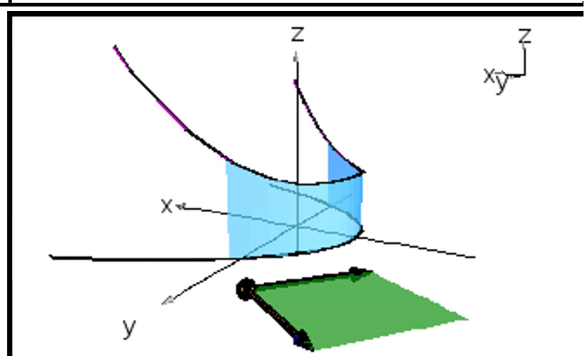
$\left\{\frac{t^2}{4}+0.031831\cdot u-2.05,t,\frac{t^4}{80}-0.04\cdot t^2+\frac{9}{5}\right\}$



Syntax

curtain(*f(x,y), x(t), y(t), tmin, tmax***)**
to create a vertical "curtain" located between the surface *z=f(x,y)* and the plane z=0, on the curve described by *x(t)* and *y(t)*, for t between *tmin* and *tmax***.**

parallelog(*vertex, vector1, vector2***)**



Simple animation

DelVar vx,vy,r — *Done*

$z2(x,y):=\frac{-x^2}{6}-\frac{y^2}{2}+2$ — *Done*

$n:=\left\{\frac{d}{dx}(z2(x,y)),\frac{d}{dy}(z2(x,y)),-1\right\}$ — $\left\{\frac{-x}{3},-y,-1\right\}$

$nv:=n|x=vx \text{ and } y=vy$ — $\left\{\frac{-vx}{3},-vy,-1\right\}$

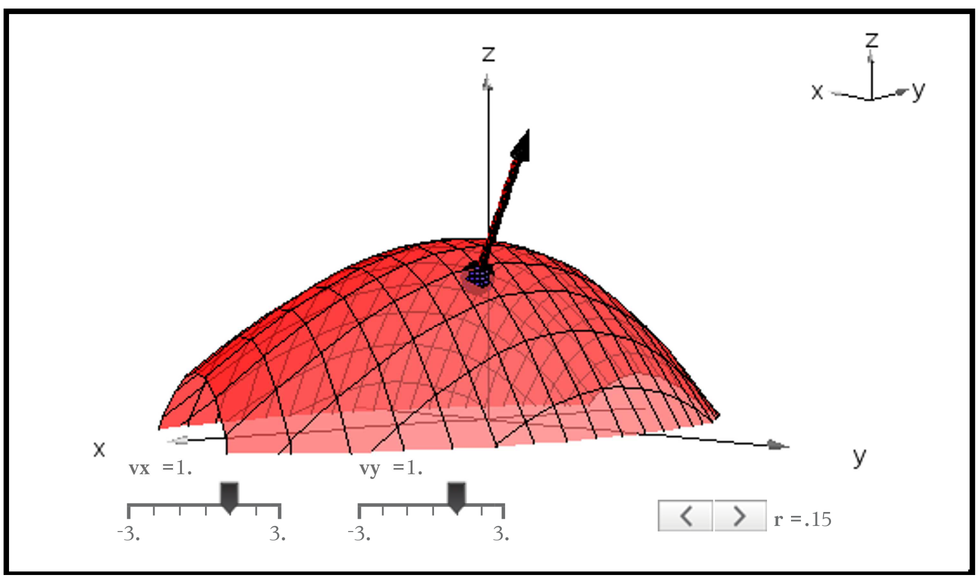
$p:=\{vx,vy,z2(vx,vy)\}$: $g1:=geo3d\backslash sphere(p,r)$ — $\left\{r\cdot\cos(t)\cdot\sin(u)+vx,r\cdot\sin(t)\cdot\sin(u)+vy,r\cdot\cos(u)-\frac{vx^2}{6}-\frac{vy^2}{2}+2\right\}$

$g2:=geo3d\backslash thickvec(p,p-nv,0.03)$:$g3:=\text{right}(g2,3)$

Place those 6 functions into 2 parametric graphs to plot the cylinder and the cone.

$$\left\{0.00547\cdot\sqrt{vx^2+9\cdot(vy^2+1)}\cdot\cos\left(\sin^{-1}\left(\frac{vx}{\sqrt{9\cdot\text{floor}\left(\frac{9}{vx^2+9\cdot(vy^2+1)}\right)+9\cdot\text{floor}\left(\frac{-9}{vx^2+9\cdot(vy^2+1)}\right)+vx^2+9\cdot(vy^2+1)}}\right)\cdot\left(2\cdot\text{floor}\left(\frac{vy}{|vy|+1}\right)+1\right)\right.\right.$$

$vx:=1$: $vy:=1$: $r:=0.15$ — 0.15



In order to create an animation, you must first define the objects, and THEN add sliders.

If you want to modify an object after the insertion of sliders, you must first use "DelVar" in a calculator page to delete the variables.

How to use this library

How to use this library

(We follow the example of *conics.tns* from Philippe Fortin)

1. First of all, points and vectors must be in list format: $\{x,y,z\}$.

For example: $\mathbf{p}:=\{4,0,1\}$: $\mathbf{q}:=\{0,1,0\}$: $\mathbf{r}:=\{0,0,5\}$ ▸ $\{0,0,5\}$

$\mathbf{g1}:=geo3d\backslash polygon(\{\mathbf{p},\mathbf{q},\mathbf{r}\})$ ▸ $\left\{\frac{2\cdot(t-2\cdot\pi)\cdot(u-\pi)}{\pi^2},\frac{t}{2\cdot\pi},\frac{^-(t-2\cdot\pi)\cdot(4\cdot u+\pi)}{2\cdot\pi^2}\right\}$

2. Make sure the library document *geo3d.tns* is in the MyLib folder.

3. **Refresh Libraries** (on the handheld, with O.S. 3.6, press [menu] [1] [7] [1]).

4. Open the TI−Nspire™ application in which you want to use a function or program from the library.

N.B. **Functions must be called in a Calculator page** (not in a Graphs page).

5. Open the Catalog and use the library tab to find and insert the object. You can see the parameters required at the bottom of the catalog. You can also type the complete name with the keyboard.

6. Each function of the library returns a list of 3 functions in t and u (execpt for vec and thickvec, see # 9). You must place this list in a variable , for example, g1, then place this list into the Functions Editor of a 3D graph in parametrical mode :

$xp1(t,u):=\mathbf{g1}[1]$ $yp1(t,u):=\mathbf{g1}[2]$ $zp1(t,u):=\mathbf{g1}[3]$

This can be done with a program: just type $geo3d\backslash putg(1,5)$ and functions g1 to g5 will be placed into the editor.

7. If you don't see an object, maybe it's because of its Attributes: try to choose **Surface + Wire**.

8. **Be careful: you must watch the number and the type of the parameters.**

9. Function **vec**, to create a vector, is different : it produces a list of **6** functions (instead of 3) that must be placed into 2 parametrical graphs. One to plot a segment and the other to plot the head of the vector, a little cone. (Functior thickvec, to create a thick vector, produces a list of 6 functions: 3 for the cylinder and 3 for the cone.) For example, to trace a vector from point **p** to point **q**:

$\mathbf{g2}:=\mathbf{geo3d\backslash vec(p,q)}$

▸ $\left\{\frac{2\cdot t}{\pi},1-\frac{t}{2\cdot\pi},\frac{t}{2\cdot\pi},0.011258\cdot\cos(t)\cdot u-0.011941\cdot\sin(t)\cdot u+0.150053\cdot u,^-0.002814\cdot\cos(t)\cdot u-0.047762\cdot\sin(t)\cdot u-0.03751\right.$

$\mathbf{g3}:=\text{right}(\mathbf{g2},3)$

▸ $\{0.011258\cdot\cos(t)\cdot u-0.011941\cdot\sin(t)\cdot u+0.150053\cdot u,^-0.002814\cdot\cos(t)\cdot u-0.047762\cdot\sin(t)\cdot u-0.037513\cdot u+1,0.037513\cdot$

then, if it's not already done, put **g2** and **g3** into the Functions Editor of a 3D graph page in parametric mode.

Syntax

SYNTAX OF LIBRARY GEO3D

Points and vectors are in list format: P={x,y,z} v={x,y,z}.

geo3d\brokenline (*list of vertices* or *matrice nX3*)

geo3d\circle (*radius*, *center*, *normal vector*)

geo3d\cone (*apex*, *height*, angle, *vector of axis of symetry*)

geo3d\curtain (*f*(*x*,*y*), *x*(*t*), *y*(*t*), *tmin*, *tmax*)

geo3d\cylinder (*radius*, *center base* 1, *center base* 2)

geo3d\disk (*radius*, *center*, *normal vector*)

geo3d\parallelog (*vertex*, *vector1*, *vector2*)

geo3d\perimeter (*list of vertices* or *matrice nX3*)

geo3d\polygon (*list of vertices* or *matrice nX3*) for a convex polygon

geo3d\polyreg (*center*, *normal vector*, *one vertex*, *number of sides*) for a regular polygon

geo3d\putg (*i*, *j*) to write gi ... gj in the parametric Editor

geo3d\ribbon (*curve*, *thickness*, *vector*)

geo3d\ring (*radius* min, *radius* max, *center*, *normal vector*)

geo3d\rotaroundaxis (angle, *object*, *center*, *vector of axis of rotation*)

geo3d\segment (*a*,*b*)

geo3d\sphere (*center*, *radius*)

geo3d\thickcurve (*curve*, *radius*)

geo3d\thickvec (*a*, *b*, *radius*)

geo3d\vec (*a*, *b*)

The library geo3d also contains many private functions. We chose to declare only 20 public functions to keep the menu simple for occasional users. But the private functions can be used even if we don't see them in the menu. The syntax is written (in French) in the geo3d.tns file.

Warning: this library is new and not completely tested. You may find some errors.

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