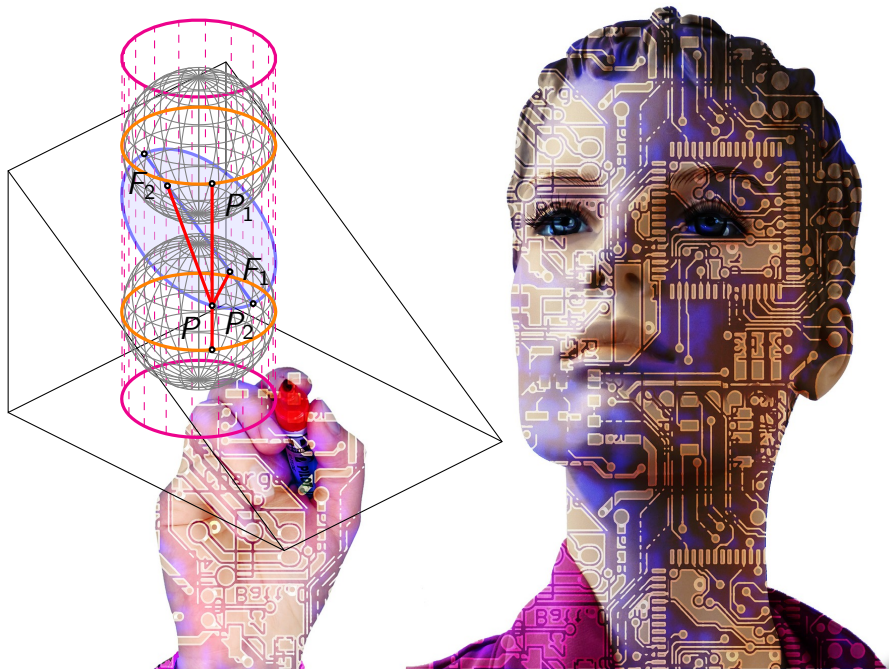


TikZ!!







```
\documentclass{article}
\usepackage{tikz}

\begin{document}

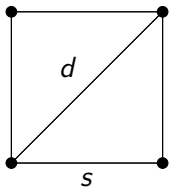
\begin{tikzpicture}
    ... tikz code here ...
\end{tikzpicture}

\end{document}
```

```

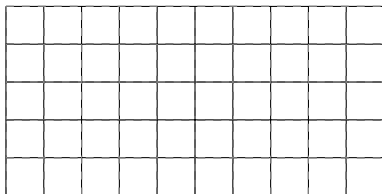
\begin{tikzpicture}
\draw (0,0) -- node[below] {$s$} (1,0) -- (1,1) --
(0,1) -- (0,0);
\filldraw (0,0) circle (1pt);
\filldraw (1,0) circle (1pt);
\filldraw (1,1) circle (1pt);
\filldraw (0,1) circle (1pt);
\draw (0,0) -- (1,1);
\draw (0,0) -- node[above left] {$d$} (1,1);
\end{tikzpicture}

```



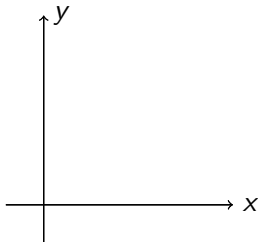
## grids

```
\draw (0,0) grid (10,5); \draw[dashed] (0,0) grid  
(10,5); \draw[dashed, gray] (0,0) grid (10,5);
```



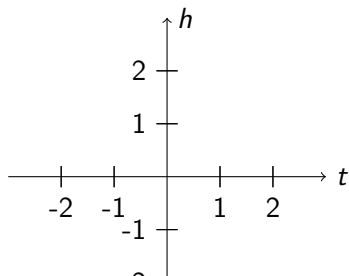
## axes

```
\draw [->] (-1,0) -- (5,0) node[right] {x} ;  
\draw [->] (0,-1) -- (0,5) node[right] {y} ;
```



## for loops

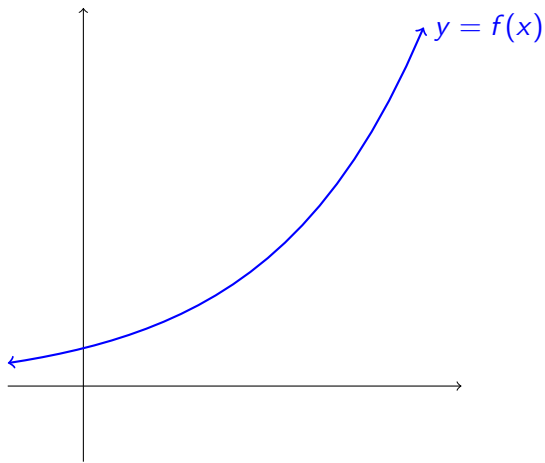
```
\draw[->] (-3,0) -- (3,0) node[right] {t};  
\draw[->] (0,-3) -- (0,3) node[right] {h};  
\foreach \x in {2,-1,1,2}  
  \draw[->] (\x, .2) -- (\x, -.2);  
\foreach \y in {2,-1,1,2}  
  \draw[->] (-.2, \y) -- (.2, \y);  
\foreach \x in {2,-1,1,2}  
  \draw[->] (\x, .2) -- (\x, -.2) node[below] {\x};  
\foreach \y in {2,-1,1,2}  
  \draw[->] (-.2, \y) node[left] {\y} -- (.2, \y);
```





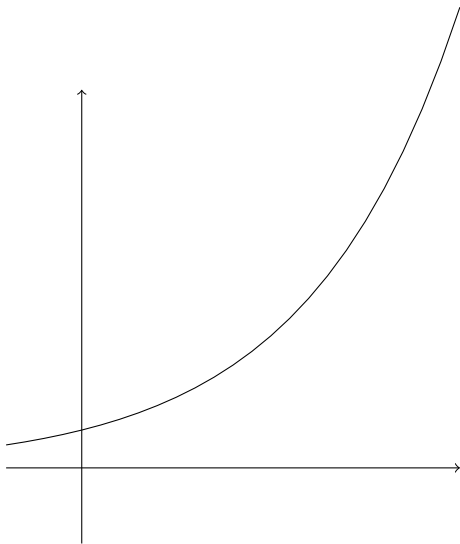
## Graphing with plot

Let's graph  $f(x) = \frac{1}{2}e^{x/2}$ .



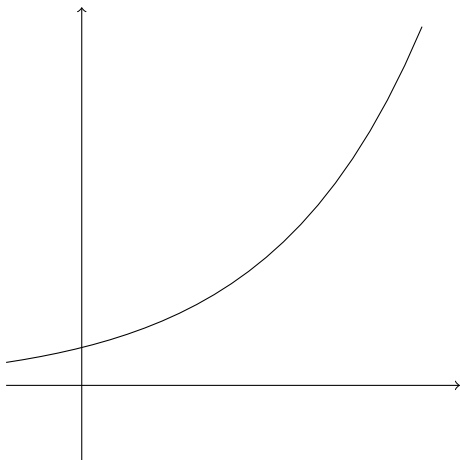
## Graphing with plot

```
\draw plot[domain=-1:5] (\x, {.5*exp(.5*\x)});
```



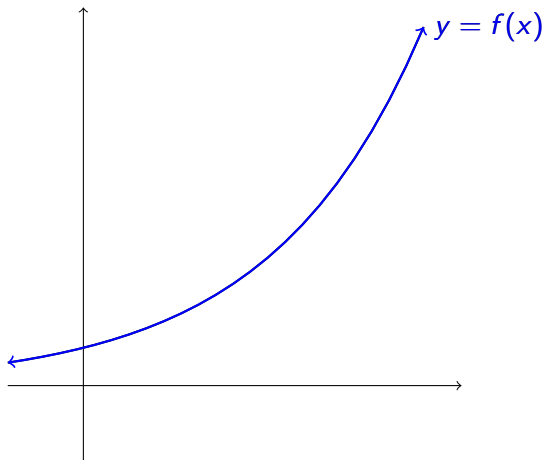
## Graphing with plot

```
\draw plot[domain=-1:4.5] (\x, {.5*exp(.5*\x)});
```



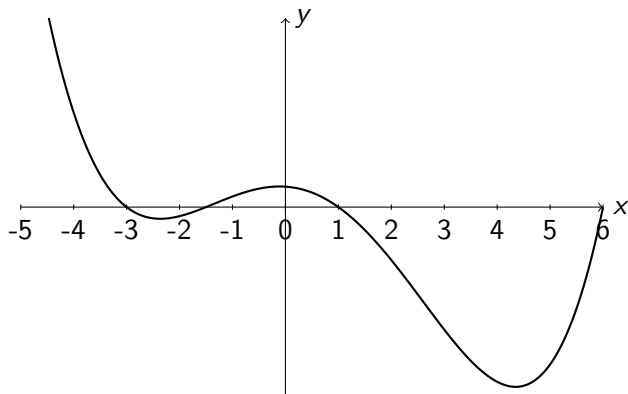
## Graphing with plot

```
\draw[thick, blue, <->] plot[domain=-1:4.5] (\x,  
{.5*exp(.5*\x)}) node[right] {$y=f(x)$};
```



## Graphing with plot

Let's graph  $f(x) = (x + 3)(x - 1)(x - 6)(x + 1.5)$ .



## Graphing with plot

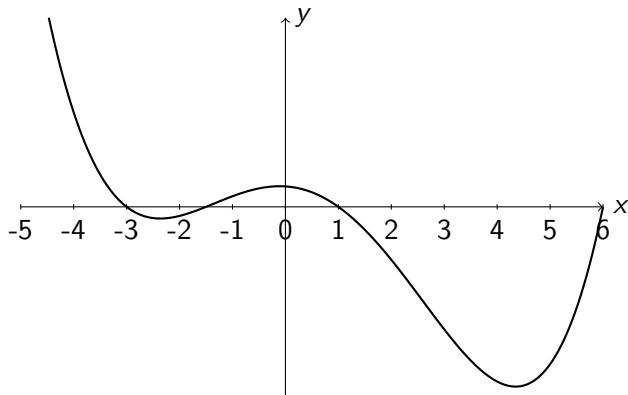
```
\draw plot[domain=-4.47:6]
  (\x, {(\x+3)*(\x-1)*(\x-6)*(\x+1.5)});
```

Two fixes:

- ▶ scale the function itself
- ▶ scale the whole picture

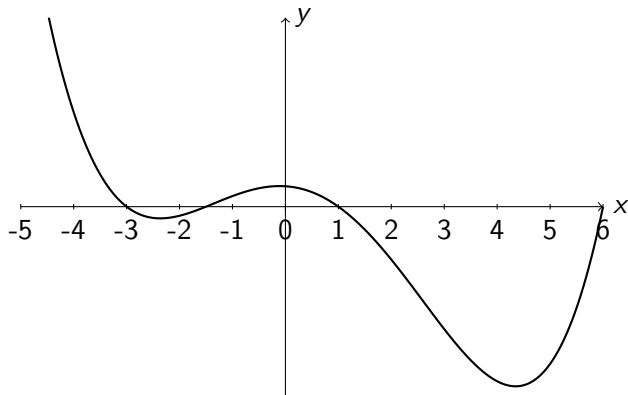
## Graphing with plot

```
\draw[thick] plot[domain=-4.47:6] (\x,  
{.02*(\x+3)*(\x-1)*(\x-6)*(\x+1.5)});
```



## Graphing with plot

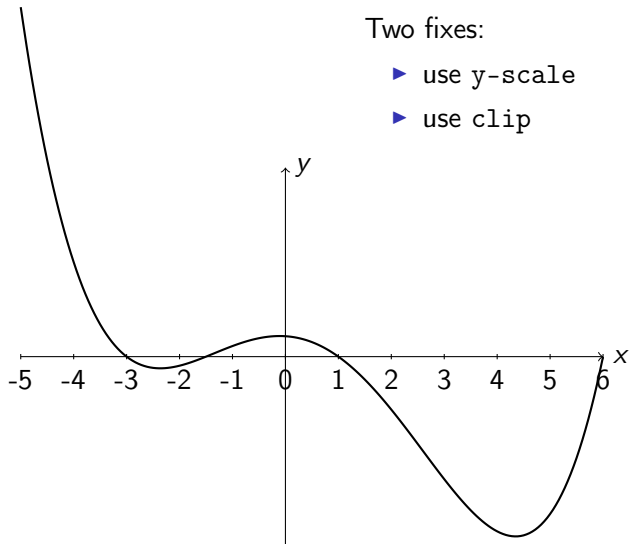
```
\begin{scope}[yscale=.02]  
  \draw[thick] plot[domain=-4.47:6]  
    (\x, {(\x+3)*(\x-1)*(\x-6)*(\x+1.5)});  
\end{scope}
```





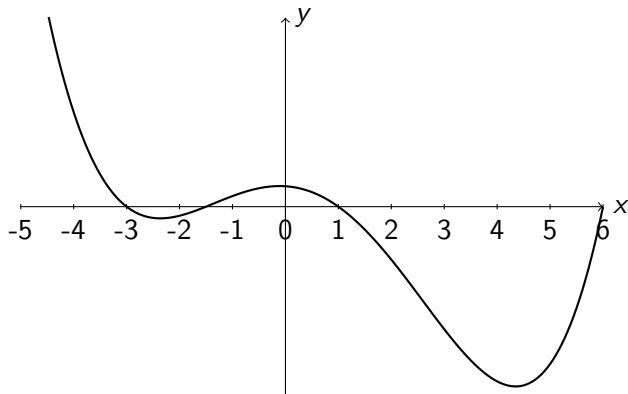
## Using clip

What happens if I don't want to be so careful about the domain?



## Using clip

```
\begin{scope}  
\clip (-5,-5) rectangle (6,5);  
\draw[thick] plot[samples=100, smooth, domain=-5:6]  
(\x, {.02*(\x+3)*(\x-1)*(\x-6)*(\x+1.5)});  
\end{scope}
```



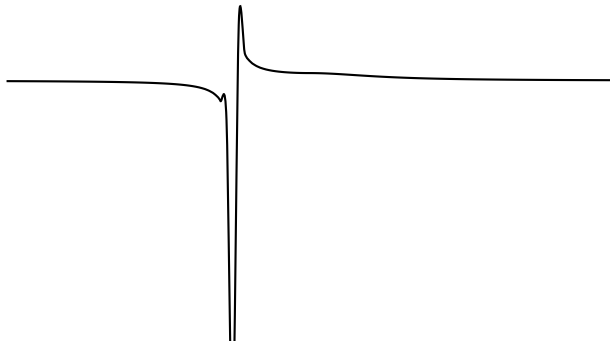
## Weird graphing issues

When using `plot`, weird stuff can happen near  $x=0$ .

Fix it by graphing with two different domains.

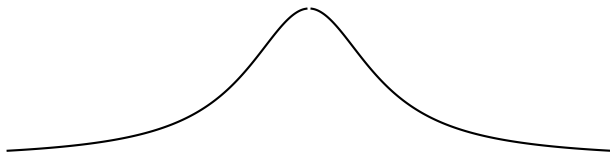
**Ex:** Graph  $y = \frac{2}{1+x^2}$ .

```
\begin{tikzpicture}[yscale=.05]
\draw[thick] plot[samples=100, smooth, domain=-4:4]
(\x, {2/(1+\x^2)});
\end{tikzpicture}
```



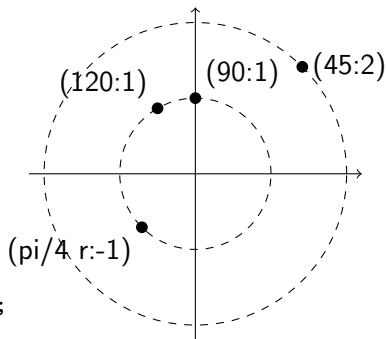
## Weird graphing issues

```
\begin{tikzpicture}  
\draw[thick] plot[samples=100, smooth, domain=.02:4]  
(\x, {2/(1+\x^2)});  
\draw[thick] plot[samples=100, smooth, domain=.02:4]  
(-\x, {2/(1+\x^2)});  
\end{tikzpicture}
```



# Polar Coordinates

```
\draw[dashed] (0,0) circle (1);  
\draw[dashed] (0,0) circle (2);  
  
\filldraw (45 : 2) circle (2pt);  
\filldraw (90 : 1) circle (2pt);  
\filldraw (120 : 1) circle (2pt);  
\filldraw (pi/4 r : -1) circle (2pt);
```

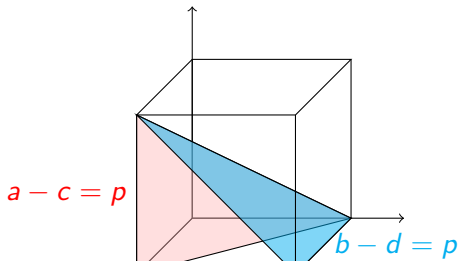


## 3D

```

\begin{tikzpicture}[x={(-.353cm,-0.353cm)}, y={(1cm,0cm)},
z={(0cm,1cm)}, scale=.7]
\draw[->] (0,0,0) -- (4,0,0); % x-axis
\draw[->] (0,0,0) -- (0,4,0); % y-axis
\draw[->] (0,0,0) -- (0,0,4); % z-axis
... axes ...
\draw (0,0,0) -- (3,0,0) -- (3,3,0) -- (0,3,0) -- cycle;
\filldraw[fill=pink, fill opacity=.5] (3,0,3) - (0,3,0) - (3,0,0)
- node[left, red, opacity=1] {$a-c=p$} (3,0,3);
\filldraw[fill=cyan, fill opacity=.5] (3,0,3) - (0,3,0) -
node[right, cyan, opacity=1] {$b-d=p$} (3,3,0) - cycle;
\end{tikzpicture}

```



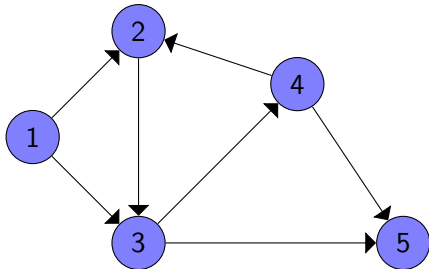
## Defining Styles

```
\tikzstyle{vertex}=[circle, minimum size=20pt,  
draw=black, fill=blue!30]
```

```
\foreach \pos/\name in {  
{(0,0)/1},  
{(2,2)/2},  
{(2,-2)/3},  
{(5,1)/4},  
{(7,-2)/5}}
```

```
\node[vertex] (\name) at \pos {${\name$}};
```

```
\foreach \source/\dest in {  
{1/2}, {1/3}, {2/3}, {4/2}, {3/4}, {4/5}, {3/5}}  
\draw[->, >= triangle 90] (\source) -- (\dest);
```



## tangent lines

First, you need some libraries:

```
\usepackage{tikz}
\usetikzlibrary{decorations.markings,
                decorations.pathmorphing,
                calc, intersections}
\begin{document}
...
```

Immediately before the tikzpicture, define the tangent style:

```
\tikzstyle{tangent}=[.....]
\tikzstyle{use tangent}=[.....]
\begin{tikzpicture}
...
\end{tikzpicture}
```



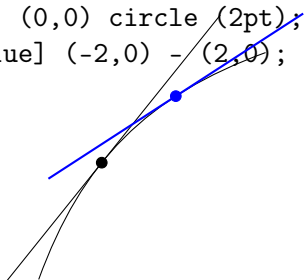
## tangent lines

```
\tikzstyle{tangent}=[
decoration={
  markings,% switch on markings
  mark=
    at position #1
    with
    {
      \coordinate (tangent point-\pgfkeysvalueof{
        /pgf/decoration/mark info/sequence number})
        at (0pt,0pt);
      \coordinate (tangent unit vector-\pgfkeysvalueof{
        /pgf/decoration/mark info/sequence number})
        at (1,0pt);
      \coordinate (tangent orthogonal unit vector-\pgfkeysvalueof{
        /pgf/decoration/mark info/sequence number})
        at (0pt,1);
    }
  },
postaction=decorate]

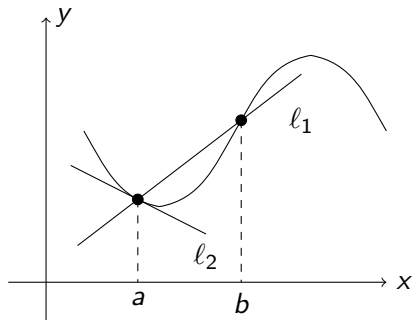
\tikzstyle{use tangent}=[shift=(tangent point-#1),
  x=(tangent unit vector-#1),
  y=(tangent orthogonal unit vector-#1)]
```

## tangent lines

```
\draw[tangent=0.4][tangent=0.4,tangent=0.7] (1,1)
to[out=70, in=200] (4,4);
\filldraw[use tangent=1] (0,0) circle (2pt);
\draw[use tangent=1] (-2,0) -- (2.5,0);
\filldraw[use tangent=2, blue] (0,0) circle (2pt);
\draw[use tangent=2, thick, blue] (-2,0) -- (2,0);
```



tangent lines



## tangent lines

```
\begin{tikzpicture}
\draw[->] (-.5,0) -- (4.5,0) node(xline)[right] {$x$};
\draw[->] (0,-.5) -- (0,3.5) node(yline)[right] {$y$};

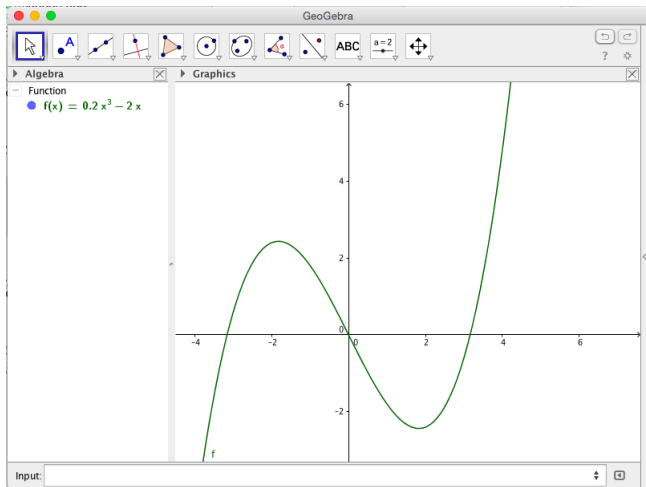
\draw[tangent=0.2, tangent=0.4] (.5,2)
    to[out=-60,in=170] coordinate[pos=.8] (A) (1.5,1)
    to[out=10,in=-120] (2.5,2)
    to[out=60,in=-170] coordinate[pos=.1] (B) (3.5,3)
    to[out=-10,in=120] (4.5,2);

\filldraw (A) circle (2pt);
\filldraw (B) circle (2pt);

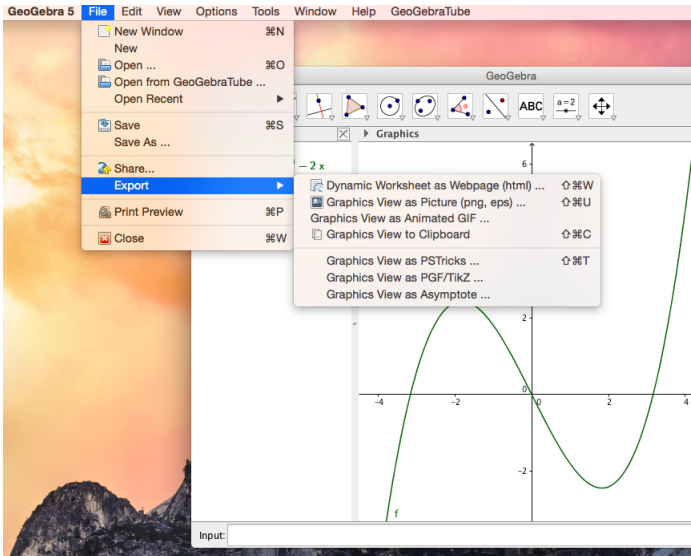
\draw[shorten >= -1cm, shorten <= -1cm] (A) to (B) node[right, xshift=.5cm] {tangent};
\draw[use tangent=1] (-1,0) -- (1,0) node[below] {$\ell_2$};

\draw[dashed] (A) -- (A |- xline) node[below] {$a$};
\draw[dashed] (B) -- (B |- xline) node[below] {$b$};
\end{tikzpicture}
```

# Geogebra will give you TikZ Code



# Geogebra will give you TikZ Code



The screenshot displays the GeoGebra 5 software interface. The 'File' menu is open, and the 'Export' option is selected. A sub-menu is visible, listing various export options for the graphics view. The main workspace shows a coordinate plane with a green parabola labeled 'f' and a line labeled '-2x'. The x-axis ranges from -4 to 4, and the y-axis ranges from -2 to 6. The origin is labeled '0'. The input field at the bottom is empty.

GeoGebra 5 File Edit View Options Tools Window Help GeoGebraTube

New Window ⌘N  
New  
Open ... ⌘O  
Open from GeoGebraTube ...  
Open Recent ▶  
Save ⌘S  
Save As ...  
Share...  
Export ▶  
Print Preview ⌘P  
Close ⌘W

Dynamic Worksheet as Webpage (html) ... ⌘⌘W  
Graphics View as Picture (png, eps) ... ⌘⌘U  
Graphics View as Animated GIF ...  
Graphics View to Clipboard ⌘⌘C  
Graphics View as PSTricks ... ⌘⌘T  
Graphics View as PGF/TikZ ...  
Graphics View as Asymptote ...

Input:

# Geogebra will give you TikZ Code

The screenshot shows the 'GeoGebra to PGF Export' dialog box. The settings are as follows:

X units (cm)	1.0	Picture width	12.10450800760389
Y units (cm)	1.0	Picture height	9.87143497861491
x Min	-4.5113714583	x Max	7.593136549245708
y Min	-3.2991746227	y Max	6.572260355827622

Document font size: 10 pt      Format: LaTeX (article class)

Use Gnuplot to plot functions       Display the symbol for points

Grayscale

Buttons: Generate PGF/TikZ code, Save As, Copy to Clipboard

```
\begin{document}
\definecolor{qqwuqq}{rgb}{0.,0.39215686274509803,0.}
\begin{tikzpicture}[line cap=round,line join=round,>=triangle 45,x=1.0cm,y=1.0cm]
\draw[>,color=black] (-4.511371458358183,0) -- (7.593136549245708,0);
\foreach \x in {-4.,-2.,2.,4.,6.}
\draw[shift={(\x,0)},color=black] (0pt,2pt) -- (0pt,-2pt) node[below] {\footnotesize $\x$};
\draw[>,color=black] (0.,-3.2991746227872896) -- (0.,6.572260355827622);
\foreach \y in {-2.,2.,4.,6.}
\draw[shift={(0,\y)},color=black] (2pt,0pt) -- (-2pt,0pt) node[left] {\footnotesize $\y$};
\draw[fill=black] (0pt,-10pt) node[right] {\footnotesize $S$};
\clip(-4.511371458358183,-3.2991746227872896) rectangle (7.593136549245708,6.57222);
\draw[line width=1.2pt,color=qqwuqq,smooth,samples=100,domain=-4.511371458358183:7.593136549245708]
\begin{scriptsize}
\draw[fill=qqwuqq] (-3.5096190715219993,-3.0278666846858227) node {\footnotesize $f$};
\end{scriptsize}
\end{tikzpicture}
\end{document}
```



# The End

