

# {Ti**k**Z/P**G**Fplots 常用图形绘制合集}

TikZ & PGF 那些年，我们一直没画好的图像

Version N/A from N/A

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# 1 内容说明

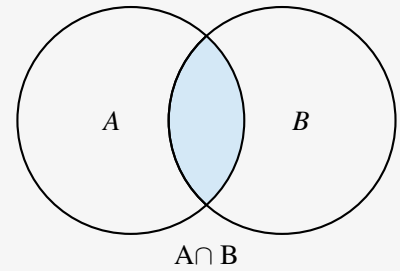
这部分内容是我收集的在中学学习阶段教师用到的常见的作图。资源来源于诸多作者如[向禹老师](#)、[Banach Spaces](#)、[latexstudio](#)等。

## 2 集合部分的常用图形（Venn 图）的 TikZ 实现

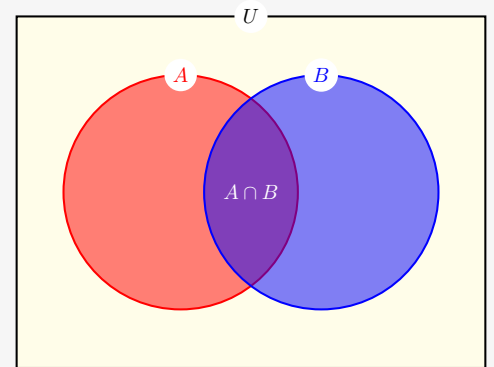
### 2.1 集合关系的 Venn 图

#### 1. 两个集合的交集

```
1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \firstcircle;
4     \fill[filled] \secondcircle;
5   \end{scope}
6   \draw[outline] \firstcircle node[left] {$A$};
7   \draw[outline] \secondcircle node[right] {$B$};
8 \end{tikzpicture}
```

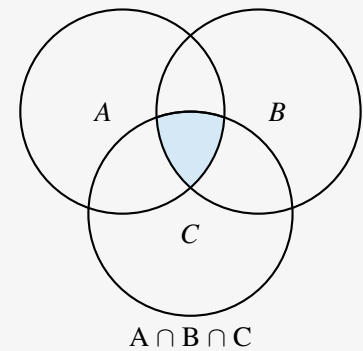


```
1 \begin{tikzpicture}
2   \coordinate (O) at (0,0); \coordinate (NE) at (4,3); \coordinate (SW) at ($(O)
3     )!-1!(NE)$);
4   \filldraw[draw=black,fill=yellow!10!white,line width=1pt] (SW) rectangle (NE);
5   \filldraw[draw=red,fill=red, fill opacity=0.5, line width=1pt] \circleA;
6   \filldraw[draw=blue,fill=blue, fill opacity=0.5, line width=1pt] \circleB;
7   \node[set label] at (O |- NE) {$U$};
8   \node[set label,text=red] at ($(\centerA) + (90:\radius)$) {$A$};
9   \node[set label,text=blue] at ($(\centerB) + (90:\radius)$) {$B$};
10  \node[color=white] at (O) {$A \cap B$};
11 \end{tikzpicture}
```



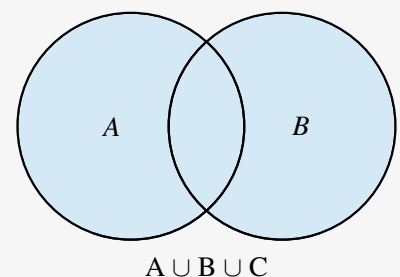
#### 2. 三个集合的交集

```
1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \firstcircle;
4     \clip \secondcircle;
5     \fill[filled] \thirdcircle;
6   \end{scope}
7   \draw[outline] \firstcircle node[left] {$A$};
8   \draw[outline] \secondcircle node[right] {$B$};
9   \draw[outline] \thirdcircle node[below] {$C$};
10  \node[anchor=north] at (current bounding box.south) {$A \cap B \cap C$};
11 \end{tikzpicture}
```



#### 3. 两个集合的并集

```
1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \firstcircle \secondcircle \thirdcircle;
4     \fill[filled] \firstcircle \secondcircle;
5   \end{scope}
6   \draw[outline] \firstcircle node[left] {$A$};
7   \draw[outline] \secondcircle node[right] {$B$};
8   \draw[outline] \thirdcircle node[below] {$C$};
9   \node[anchor=north] at (current bounding box.south) {$A \cup B \cup C$};
10 \end{tikzpicture}
```

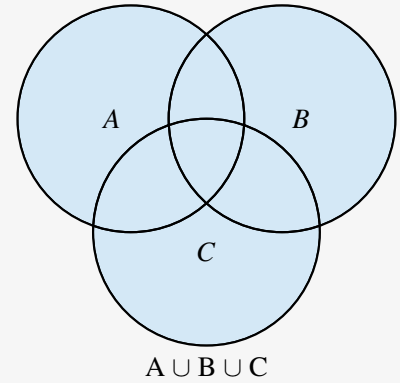


#### 4. 三个集合的并集

```

1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \firstcircle \secondcircle \thirdcircle;
4     \fill[filled] \firstcircle \secondcircle \thirdcircle;
5   \end{scope}
6   \draw[outline] \firstcircle node[left] {$A$};
7   \draw[outline] \secondcircle node[right] {$B$};
8   \draw[outline] \thirdcircle node[below] {$C$};
9   \node[anchor=north] at (current bounding box.south) {A $\cup$ B $\cup$ C};
10 \end{tikzpicture}

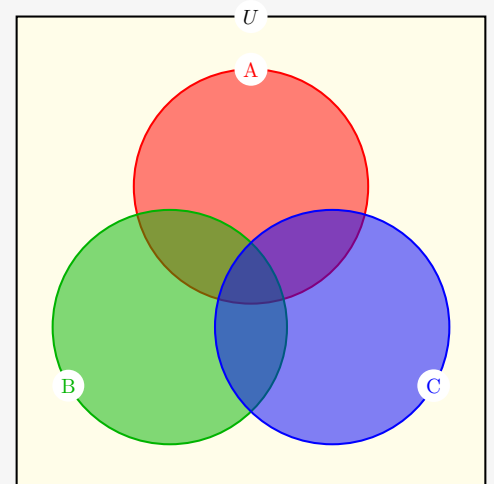
```



```

1 \begin{tikzpicture}
2   \coordinate (O) at (0,0);
3   \coordinate (NE) at (4,4.5);
4   \coordinate (SW) at (-4,-3.5);
5   \filldraw[draw=black, fill=yellow!10!white,line width=1pt] (SW) rectangle (NE);
6   \filldraw[draw=\colorA,fill=\colorA,fill opacity=0.5,line width=1pt] \circleA;
7   \filldraw[draw=\colorB,fill=\colorB,fill opacity=0.5,line width=1pt] \circleB;
8   \filldraw[draw=\colorC,fill=\colorC,fill opacity=0.5,line width=1pt] \circleC;
9   \drawLabels
10 \end{tikzpicture} %

```

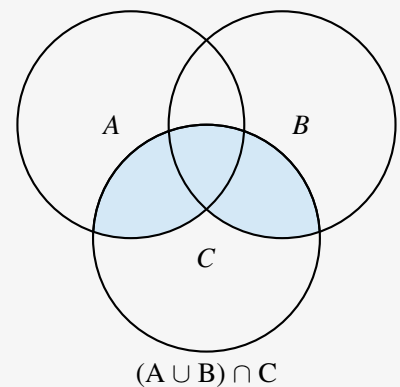


#### 5. 两个集合的并集与第三个集合的交集

```

1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \firstcircle \secondcircle;
4     \fill[filled] \thirdcircle;
5   \end{scope}
6   \draw[outline] \firstcircle node[left] {$A$};
7   \draw[outline] \secondcircle node[right] {$B$};
8   \draw[outline] \thirdcircle node[below] {$C$};
9   \node[anchor=north] at (current bounding box.south) {(A $\cup$ B) $\cap$ C};
10 \end{tikzpicture}

```

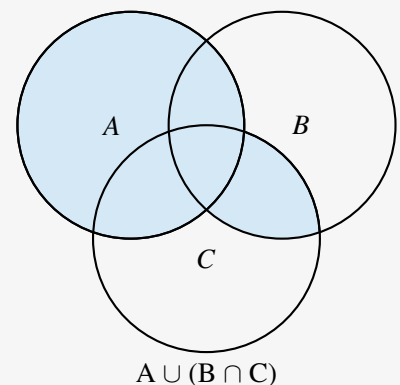


#### 6. 两个集合的交集并上第三个集合

```

1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \secondcircle;
4     \fill[filled] \thirdcircle;
5   \end{scope}
6   \fill[filled] \firstcircle;
7   \draw[outline] \firstcircle node[left] {$A$};
8   \draw[outline] \secondcircle node[right] {$B$};
9   \draw[outline] \thirdcircle node[below] {$C$};
10   \node[anchor=north] at (current bounding box.south) {A $\cup$ (B $\cap$ C)};
11 \end{tikzpicture}

```

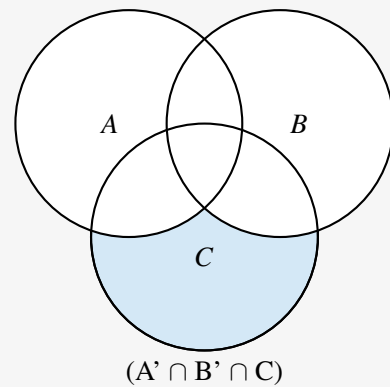


#### 7. 两个集合的补集的交交上第三个集合

```

1 \begin{tikzpicture}
2   \begin{scope}
3     \fill[filled] \thirdcircle;
4     \fill[white] \firstcircle;
5     \fill[white] \secondcircle;
6   \end{scope}
7   \draw[outline] \firstcircle node[left] {$A$};
8   \draw[outline] \secondcircle node[right] {$B$};
9   \draw[outline] \thirdcircle node[below] {$C$};
10  \node[anchor=north] at (current bounding box.south)
11    {(A' $\cap$ B' $\cap$ C)};
12 \end{tikzpicture}

```

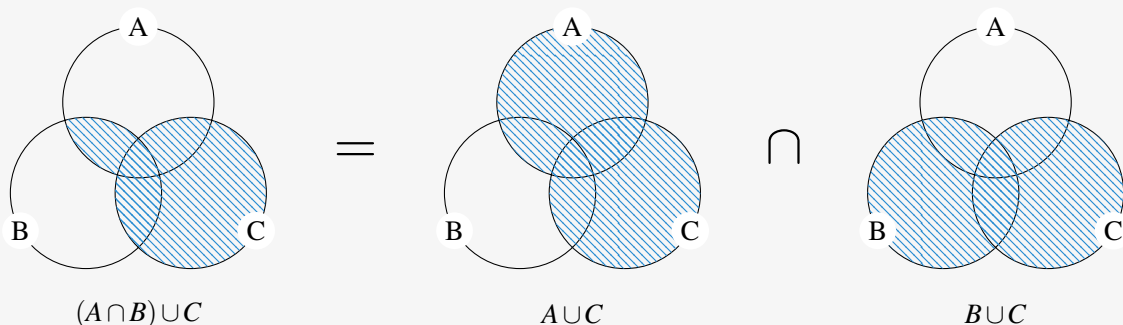
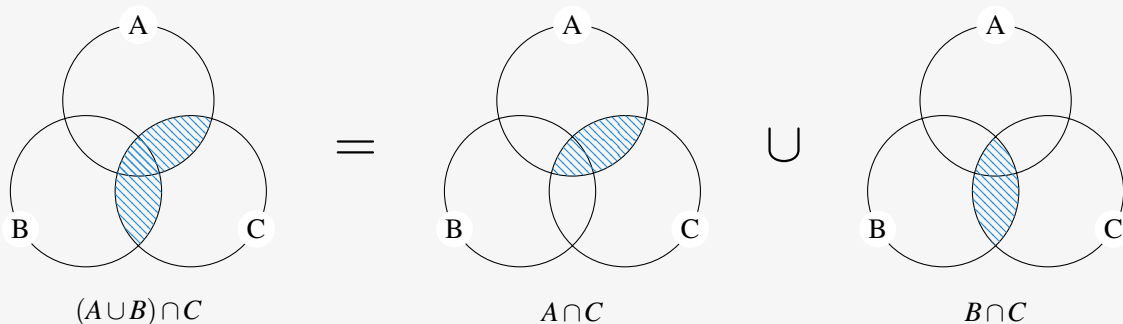
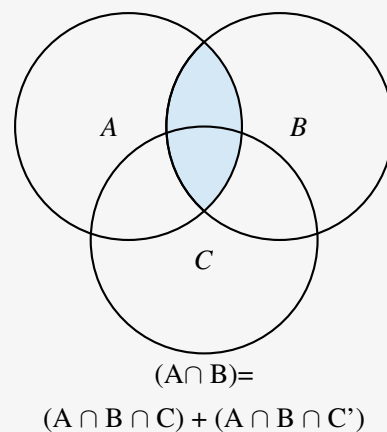


## 2.2 集合运算的 Venn 图表示

```

1 \begin{tikzpicture}
2   \begin{scope}
3     \clip \firstcircle;
4     \fill[filled] \secondcircle;
5   \end{scope}
6   \draw[outline] \firstcircle node[left] {$A$};
7   \draw[outline] \secondcircle node[right] {$B$};
8   \draw[outline] \thirdcircle node[below] {$C$};
9   \node[anchor=north,align=center] at (current bounding box.south)
10    {(A $\cap$ B) = ((A $\cap$ B $\cap$ C) + (A $\cap$ B $\cap$ C'))};
11 \end{tikzpicture}

```

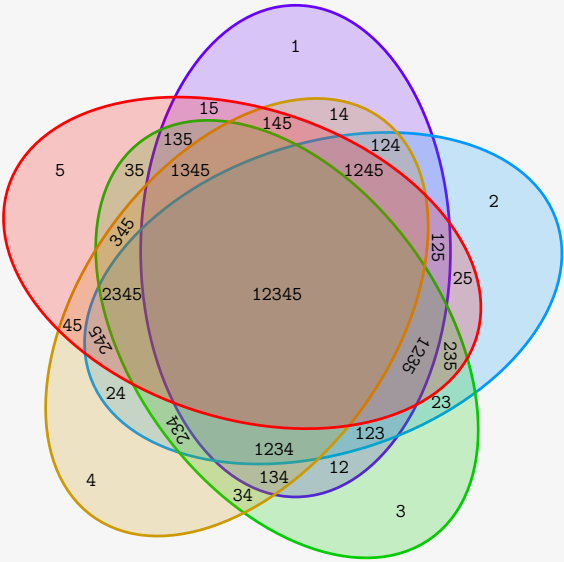
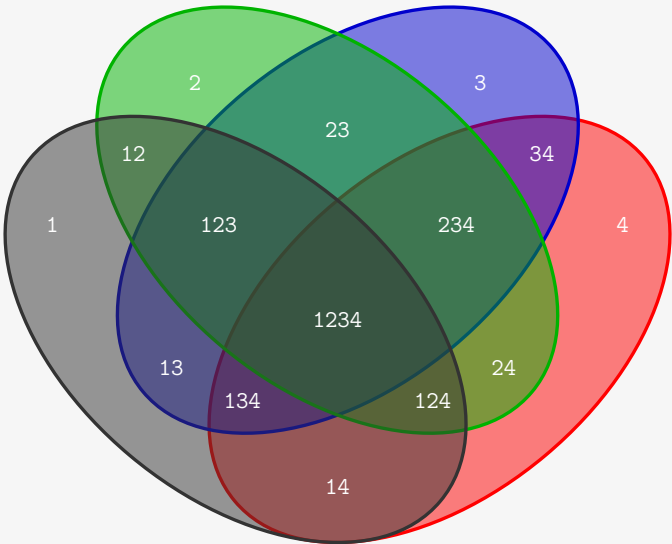


```

1 \documentclass[border=0mm]{standalone}
2 \usepackage{amsmath}
3 \usepackage{tikz}
4 \def\drawEllipse#1#2{\draw[draw=#1,fill=#1,fill opacity=0.5,line width=2pt] #2 circle [x radius=5.62, y radius=3.46];}
5 \def\xshift{2.8}
6 \def\yshift{3}
7 \begin{document}

```

```
8
9 \begin{tikzpicture}
10 \begin{scope} [rotate=40]
11 \drawEllipse{red}{(\xshift,0)}
12 \end{scope}
13 \begin{scope} [rotate=40]
14 \drawEllipse{blue!80!black}{(\xshift,\yshift)}
15 \end{scope}
16 \begin{scope} [rotate=-40]
17 \drawEllipse{green!70!black}{(-\xshift,\yshift)}
18 \end{scope}
19 \begin{scope} [rotate=-40]
20 \drawEllipse{black!80!white}{(-\xshift,0)}
21 \end{scope}
22 \begin{scope} [color=white,font=\ttfamily\Large]
23 \node at (0, 2) {1234};
24 \node at (0, -1.5) {14};
25 \node at (0, 6) {23};
26 \node at (-6, 4) {1};
27 \node at (6, 4) {4};
28 \node at (-3, 7) {2};
29 \node at (3, 7) {3};
30 \node at (-4.3, 5.5) {12};
31 \node at (4.3, 5.5) {34};
32 \node at (2.5, 4) {234};
33 \node at (-2.5, 4) {123};
34 \node at (-3.5, 1) {13};
35 \node at (3.5, 1) {24};
36 \node at (-2, 0.3) {134};
37 \node at (2, 0.3) {124};
38 \end{scope}
39 \end{tikzpicture}
40
41 \end{document}
```



```
1 \documentclass[border=0.1mm]{standalone}
2 \usepackage{tikz}
3
4 \definecolor{colorA}{HTML}{6600FF}
5 \definecolor{colorB}{HTML}{0099FF}
6 \definecolor{colorC}{HTML}{00CC00}
7 \definecolor{colorD}{HTML}{CC9900}
8 \definecolor{colorE}{HTML}{FF0000}
9
10 \def\centerPoint{}
11
12 \def\drawEllipse#1{\draw[draw=#1,fill=#1,fill opacity=0.2,line width=2pt] (0.6,1.375) circle [x radius=5, y radius=7.935];}
```

```

13 \begin{document}
14
15 \begin{tikzpicture} [x=8mm,y=8mm]
16 \drawEllipse{colorA}
17 \begin{scope} [rotate=-72]
18 \drawEllipse{colorB}
19 \end{scope}
20 \begin{scope} [rotate=-144]
21 \drawEllipse{colorC}
22 \end{scope}
23 \begin{scope} [rotate=144]
24 \drawEllipse{colorD}
25 \end{scope}
26 \begin{scope} [rotate=72]
27 \drawEllipse{colorE}
28 \end{scope}
29 \begin{scope} [,font=\ttfamily\Large]
30 \node at (0, 0) {12345};
31 \node at (0.6, 8) {1};
32 \node at (7, 3) {2};
33 \node at (4, -7) {3};
34 \node at (-6, -6) {4};
35 \node at (-7, 4) {5};
36 \node at (-2.2, 6) {15};
37 \node at (0, 5.5) {145};
38 \node at (2, 5.8) {14};
39 \node at (3.5, 4.8) {124};
40 \node at (2.8, 4) {1245};
41 \node[rotate=-90] at (5.2, 1.5) {125};
42 \node at (6, 0.5) {25};
43 \node[rotate=-90] at (5.6, -2) {235};
44 \node[rotate=-120] at (4.5, -2) {1235};
45 \node at (3, -4.5) {123};
46 \node at (2, -5.6) {12};
47 \node at (-0.1, -5.9) {134};
48 \node at (-1.1, -6.5) {34};
49 \node[rotate=120] at (-3.2, -4.4) {234};
50 \node at (-5.2, -3.2) {24};
51 \node[rotate=120] at (-5.7, -1.5) {245};
52 \node at (-5, 0) {2345};
53 \node at (-6.6, -1) {45};
54 \node[rotate=55] at (-5, 2) {345};
55 \node at (-0.1, -5) {1234};
56 \node at (5.3, -3.5) {23};
57 \node at (-3.2, 5) {135};
58 \node at (-4.6, 4) {35};
59 \node at (-2.8, 4) {1345};
60 \end{scope}
61 \end{tikzpicture}
62
63 \end{document}

```

```

1 \documentclass[border=0mm]{standalone}
2 \usepackage[rgb]{xcolor}
3 \usepackage{tikz}
4 \usepackage{bitset}
5 \usepackage{xstring}
6 \usepackage{ifthen}
7 \usepackage{xparse}
8 \ExplSyntaxOn
9 \NewDocumentCommand\intervaldef{mm}{\tl_set:Nx {#1} {\fp_to_int:n {#2}}}
10 \NewDocumentCommand\realevaldef{mm}{\tl_set:Nx {#1} {\fp_eval:n {#2}}}
11 \ExplSyntaxOff
12 %
13 \makeatletter
14 \def\prepareGray#1{
15   \def\num{#1}%

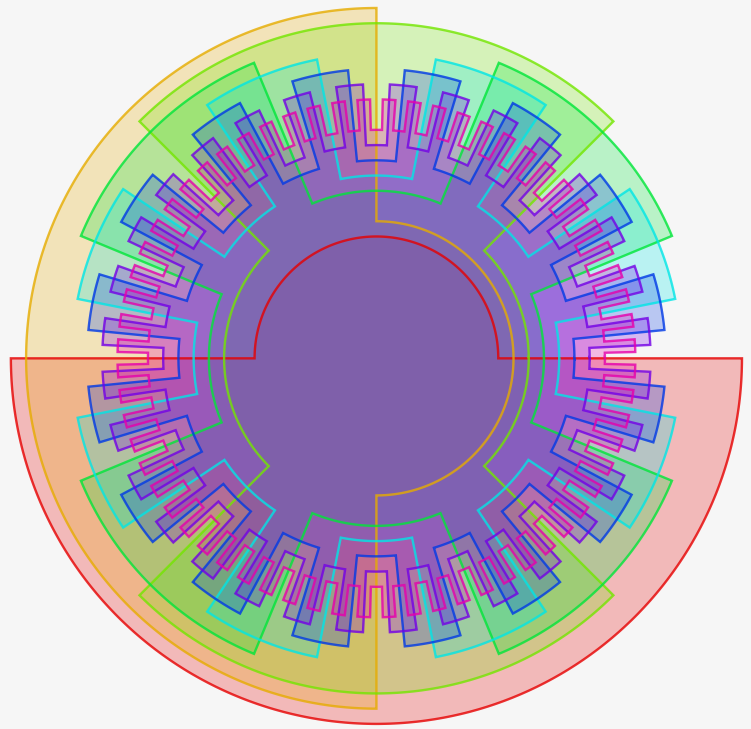
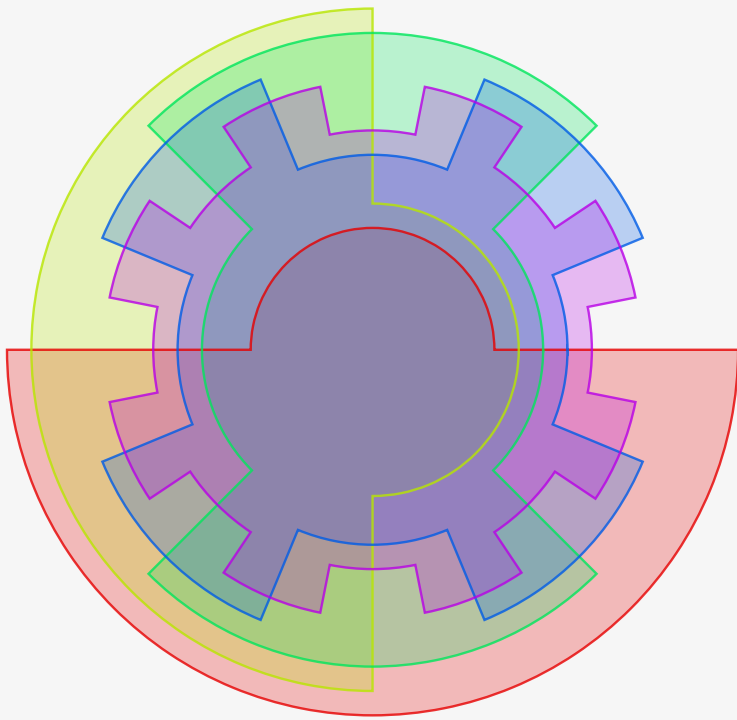
```



```

16 \intervaldef\mesh{2^\num}%
17 \intervaldef\meshminusone{\mesh-1}%
18 %
19 \foreach \i in {0,...,\meshminusone}{
20   \bitsetSetDec{gray}{\i}%
21   \bitsetLet{gray2}{gray}%
22   \bitsetShiftRight{gray2}{1}%
23   \bitsetXor{gray}{gray2}%
24   \edef\@graystr{\bitsetGetBin{gray}{\num}}%
25   \foreach \j in {1,...,\num} {%
26     \StrChar{\@graystr}{\j}[\@graychar]%
27     \expandafter\xdef\csname gray\i,\j\endcsname{\@graychar}%
28   }
29 }
30 }
31 \def\gray#1#2{\csname gray\the\numexpr#1\relax,\the\numexpr#2\relax\endcsname}%
32 \def\mainR{1}%
33 \def\@prepareVenn#1{%
34   \realevaldef\subR{(\num+1-#1)/(2*\num)}%
35   \realevaldef\prevR{\mainR-\subR}%
36   \def\prevAngle{0}%
37   \def\prevGrayChar{0}%
38   \edef\pathstring{(\prevAngle:\prevR)}%
39   %
40   \foreach \t in {1,...,\meshminusone,0} {%
41     \edef\currentGrayChar{\gray{\t}{#1}}%
42     \ifthenelse{\equal{\t}{0}}{\edef\t{\mesh}}{}%
43     %
44     \realevaldef\currentAngle{360*\t/\mesh}%
45     \ifthenelse{\equal{\currentGrayChar}{1}}{%
46       \realevaldef\currentR{\mainR+\subR}%
47     }{
48       \realevaldef\currentR{\mainR-\subR}%
49     }
50     \ifthenelse{\equal{\prevGrayChar}{\currentGrayChar}}{%
51       \xdef\pathstring{\pathstring\space arc (\prevAngle:\currentAngle:\currentR)}
52     }{
53       \xdef\pathstring{\pathstring\space arc (\prevAngle:\currentAngle:\prevR) -- (\currentAngle:\currentR)}
54     }%
55     \global\let\prevR\currentR
56     \global\let\prevAngle\currentAngle
57     \global\let\prevGrayChar\currentGrayChar
58   }%
59   \expandafter\xdef\csname vennPath#1\endcsname{\pathstring}
60   \realevaldef\hue{round((#1-1)/\num, 4)}
61   \xglobal\definecolor{vennColor#1}{hsb}{\hue,1,0.9}
62 }
63 \def\@fillVenn#1{\fill[fill=vennColor#1,fill opacity=0.25]\@nameuse{vennPath#1} -- cycle;}
64 \def\@drawVenn#1{\draw[draw=vennColor#1,line width=1.4pt,draw opacity=0.8]\@nameuse{vennPath#1} -- cycle;}
65 \def\drawVenn#1{
66   \prepareGray{#1}
67   \foreach \x in {1,...,#1} {
68     \@prepareVenn{\x}
69     \@fillVenn{\x}
70   }
71   \foreach \x in {1,...,#1} {
72     \@drawVenn{\x}
73   }
74 }
75 \makeatother
76 \def\NumberOfSets{8}
77 \begin{document}
78 \begin{tikzpicture}[x=5cm,y=5cm,font=\Huge\ttfamily]
79 \drawVenn{\NumberOfSets}
80 \end{tikzpicture}
81 \end{document}

```



## 3 常见函数图像的 TikZ 实现

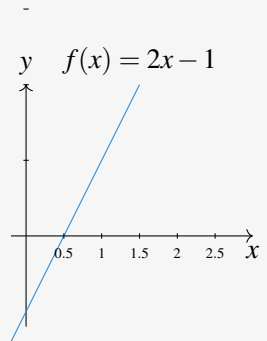
### 3.1 常用函数的 TikZ 绘制

#### 1. 一次函数

```

1 \begin{tikzpicture}
2   \draw[>-] (-0.2,0)--(3,0) node[below] {$x$};
3   \draw[>-] (0,-1.2)--(0,2) node[above] {$y$};
4   \draw[domain=-0.2:1.5,draw=blue] plot (\x,{2*\x-1}) node[above] {$f(x)=2x-1$};
5   \foreach \x in {0.5,1,...,2.5}
6     \draw (\x cm,1pt) -- (\x cm,-1pt) node[anchor=north] {\tiny $\x$};
7   \foreach \y in {1,2,3}
8     \draw (1pt,\y cm) -- (-1pt,\y cm);
9 \end{tikzpicture}

```

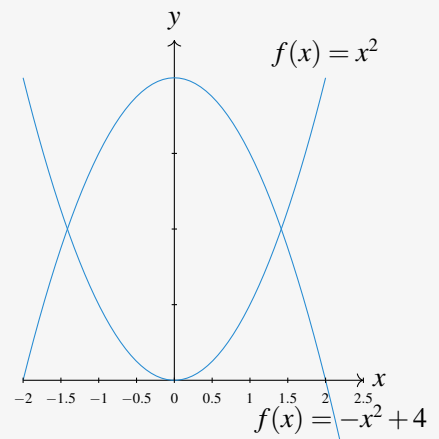


#### 2. 二次函数

```

1 \begin{tikzpicture}
2   \draw[>-] (-2,0)--(2.5,0) node[right] {$x$};
3   \draw[>-] (0,0)--(0,4.5) node[above] {$y$};
4   \draw[domain=-2:2,draw=blue,samples=60] plot (\x,{(\x)^2}) node[above] {$f(x)=x^2$};
5   \draw[domain=-2:2.2,draw=blue,samples=60] plot (\x,{-(\x)^2+4}) node[above] {$f(x)=-x^2+4$};
6   \foreach \x in {-2,-1.5,...,2.5}
7     \draw (\x cm,1pt) -- (\x cm,-1pt) node[anchor=north] {\tiny $\x$};
8   \foreach \y in {1,2,3}
9     \draw (1pt,\y cm) -- (-1pt,\y cm);
10 \end{tikzpicture}

```

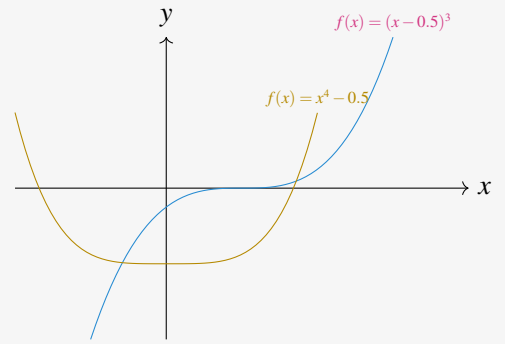


#### 3. 多次函数

```

1 \begin{tikzpicture}
2 \draw[->] (-1.2,0)--(1.2,0) node[right] {$x$};
3 \draw[->] (0,-1)--(0,1) node[above] {$y$};
4 \draw[domain=-1:1,draw=blue,samples=60] plot (\x,{(\x)^3}) node[above,
5 scale=0.6,color=magenta] {$f(x)=x^3$};
\end{tikzpicture}

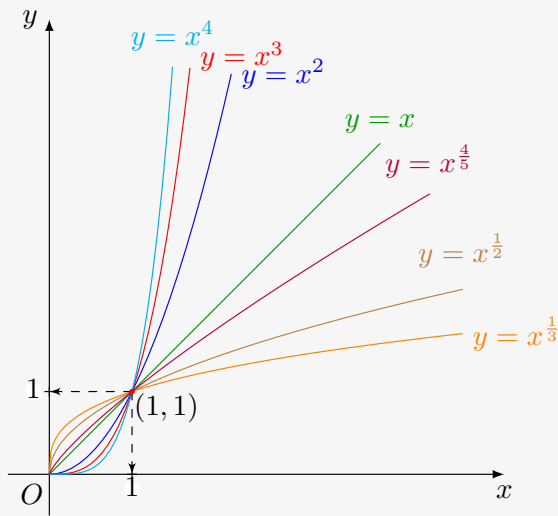
```



```

1 \begin{tikzpicture} [fun/.style={domain=0:5,samples=200}]
2 \tkzInit[xmin=-0.5,xmax=5,ymin=-0.5,ymax=5]
3 \tkzDrawXY[noticks,>=latex]
4 \draw[domain=0:4,green!60!black] plot (\x,\x) node[above] {$y=x$};
5 \draw[domain=0:2.2,blue] plot (\x,\x^2) node[right] {$y=x^2$};
6 \draw[domain=0:1.7,red] plot (\x,\x^3) node[above=4pt,right] {$y=x^3$};
7 \draw[domain=0:1.49,cyan] plot (\x,\x^4) node[above=2pt] {$y=x^4$};
8 \draw[fun,brown] plot (\x,\x^{0.5}) node[above=4pt] {$y=x^{\frac{1}{2}}$};
9 \draw[fun,orange,samples=300] plot (\x,\x^{0.33}) node[right] {$y=x^{\frac{1}{3}}$};
10 \draw[fun,purple,domain=0:4.6,samples=300] plot (\x,\x^{0.8}) node[above=2pt] {$y=x^{\frac{4}{5}}$};
11 \tkzDefPoints{0/0/O,1/1/A,1/0/I,0/1/J}
12 \tkzLabelPoints[left=6pt,below] (O)
13 \tkzDrawPoints[shape=cross] (I,J)
14 \tkzShowPointCoord[xlabel=$1$,
15 ylabel=$1$] (A)
16 \tkzDrawPoint[fill=red,size=1.5pt,color=red] (A)
17 \node at (0.9,0.8) [below,right] {$ (1,1) $};
18 \end{tikzpicture}

```

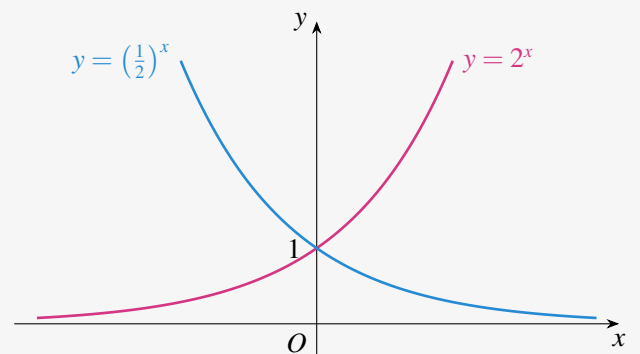


### 3.2 指数函数图像的 TikZ 绘制

```

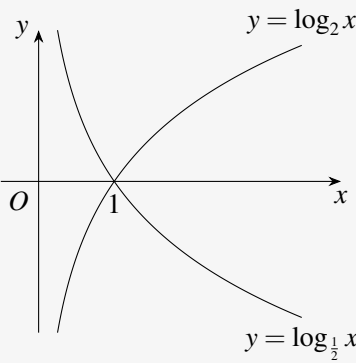
1 \begin{tikzpicture}[samples=100]
2 \draw[-Stealth] (-4,0)--(0,0) node[below left] {$0$}--(4,0) node[below] {
3 $x$};
4 \draw[-Stealth] (0,-0.5)--(0,4) node[left] {$y$};
5 \draw[domain=-3.7:1.8,line width=1pt,draw=magenta] plot (\x,{2^(\x)})
6 node[right,color=magenta] {$y=2^x$};
7 \draw[domain=3.7:-1.8,line width=1pt,draw=blue] plot (\x,{2^(-\x)}) node[
8 left,color=blue] {$y=\left(\frac{1}{2}\right)^x$};
9 \node at (-0.3,1) {$1$};
\end{tikzpicture}

```



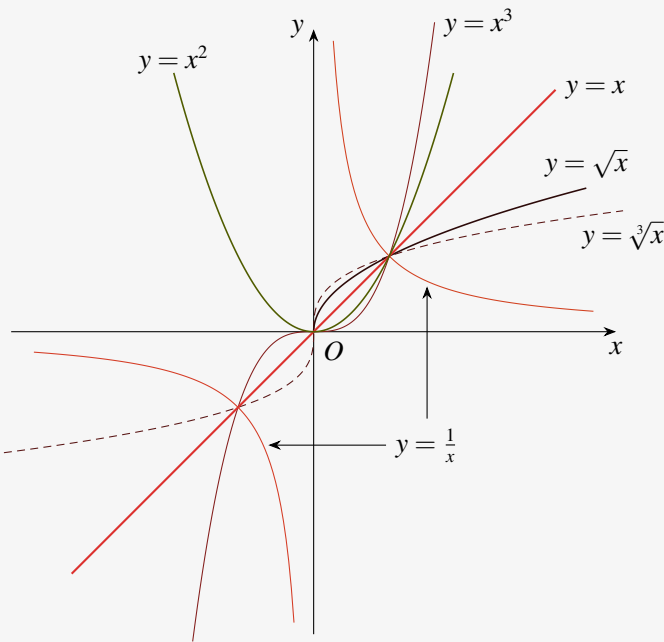
3.3 对数函数的 TikZ 图像绘制

```
1 \begin{tikzpicture}[samples=100]
2 \draw[-Stealth] (-0.5, 0) -- (0, 0) node[below left] {$0$}
3 -- (4, 0) node[below] {$x$};
4 \draw[-Stealth] (0, -2)
5 -- (0, 2) node[left] {$y$};
6 \node at (1, -0.3) {$1$};
7 \draw[domain=-2:1.8] plot ({2^(\x)}, \x)
8 node[above] {$y=\log_2 x$};
9 \draw[domain=2:-1.8] plot ({2^(-\x)}, \x)
10 node[below] {$y=\log_{\frac{1}{2}} x$};
11 \end{tikzpicture}
```



3.4 幂函数图像的 TikZ 绘制

```
1 \begin{tikzpicture}[samples=100]
2 \draw[-Stealth] (-4, 0) -- (0, 0) node[below right] {$0$} -- (4, 0) node[below] {
3   $x$};
4 \draw[-Stealth] (0, -4) -- (0, 4) node[left] {$y$};
5 \draw[domain=-1.6:1.6, draw=red!60!black] plot (\x, {(\x)^3}) node[right] {
6   $y=x^3$};
7 \draw[densely dashed, domain=-1.6:1.6, draw=red!40!black] plot ({(\x)^3},
8   \x) node[below] {$y=\sqrt[3]{x}$};
9 \draw[semithick, domain=0:1.9, draw=red!20!black] plot ({(\x)^2}, \x) node[
10   above] {$y=\sqrt{x}$};
11 \draw[thick, domain=-3.2:3.2, draw=red] plot (\x, \x) node[right] {$y=x$};
12 \draw[domain=0.26:3.7, draw=orange!60!red] plot (\x, {1/(\x)});
13 \draw[domain=-0.26:-3.7, draw=orange!40!red] plot (\x, {1/(\x)});
14 \node (a) at (1.5, -1.5) {$y=\frac{1}{x}$};
15 \draw[-Stealth] (a.west) -- (-0.6, -1.5);
16 \draw[-Stealth] (a.north) -- (1.5, 0.6);
17 \draw[semithick, domain=-1.85:1.85, draw=green!60!black] plot (\x, {(\x)
18   ^2});
19 \node at (-1.85, 3.6) {$y=x^2$};
20 \end{tikzpicture}
```



3.5 周期函数的 TikZ 绘制

3.6 其他函数图像的 TikZ 绘制

3.7 三角函数的 TikZ 绘制

3.7.1 正、余弦和正切函数

1. 正弦函数

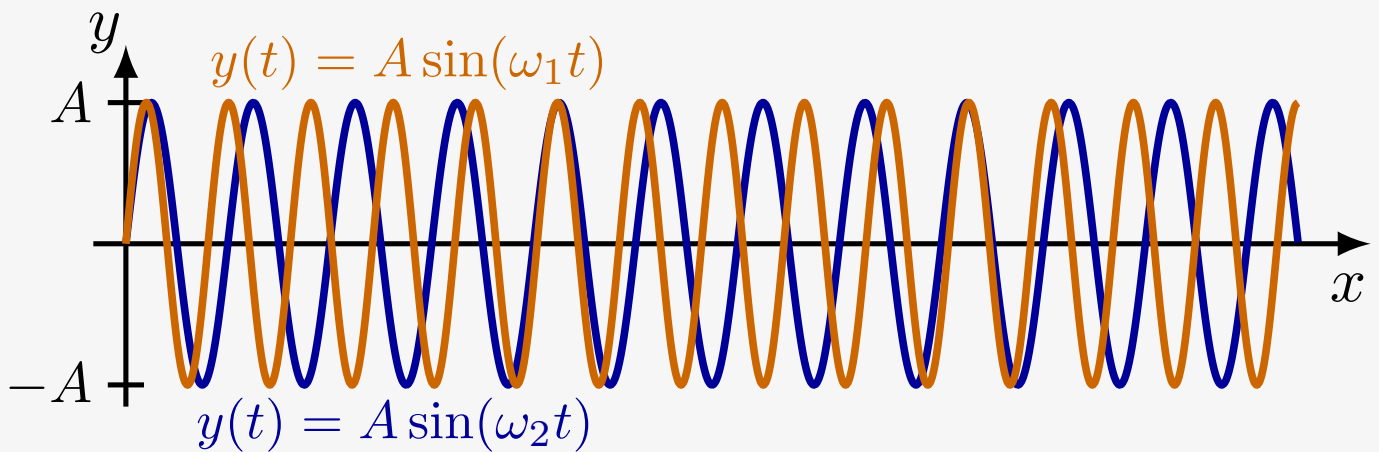
平移

```
1 \colorlet{mypurple}{blue!50!red!80}
2 \colorlet{metalcol}{blue!25!black!30!white}
3
4 \def\tick#1#2{\draw[thick] (#1) ++ (#2:0.1) --++ (#2-180:0.2)}
5
6 \def\xmax{6.48}
```

```

7 \def\ymax{0.9}
8 \def\A{0.78}
9 \def\s{4.7*\A}
10 \def\N{400}
11 \def\fa{1.775}
12 \def\fb{2.20}
13
14 \begin{document}
15
16 \begin{tikzpicture}
17   \draw[->,thick] (-0.2*\ymax,0) -- (0.4+\xmax,0) node[right=4,below left=1] {$x$};
18   \draw[->,thick] (0,-\ymax) -- (0,0.2+\ymax) node[below=2,above left=-3] {$y$};
19   \tick{0,\A}{0} node[scale=0.9,left=-1] {$A$};
20   \tick{0,-\A}{0} node[scale=0.9,left=-1] {$-A$};
21   \draw[myblue,very thick,samples=\N,smooth,variable=\x,domain=0:\xmax]
22     plot(\x,{\A*sin(360*\fa*\x)});
23   \draw[myred,very thick,samples=\N,smooth,variable=\x,domain=0:\xmax]
24     plot(\x,{\A*sin(360*\fb*\x)});
25   \node[above right=-1,myred,scale=0.85] at (0.7/\fa,\A) {$y(t)=A\sin(\omega_1 t)$};
26   \node[below right=-1,myblue,scale=0.85] at (0.7/\fb,-\A) {$y(t)=A\sin(\omega_2 t)$};
27 \end{tikzpicture}
28
29 \end{document}

```



```

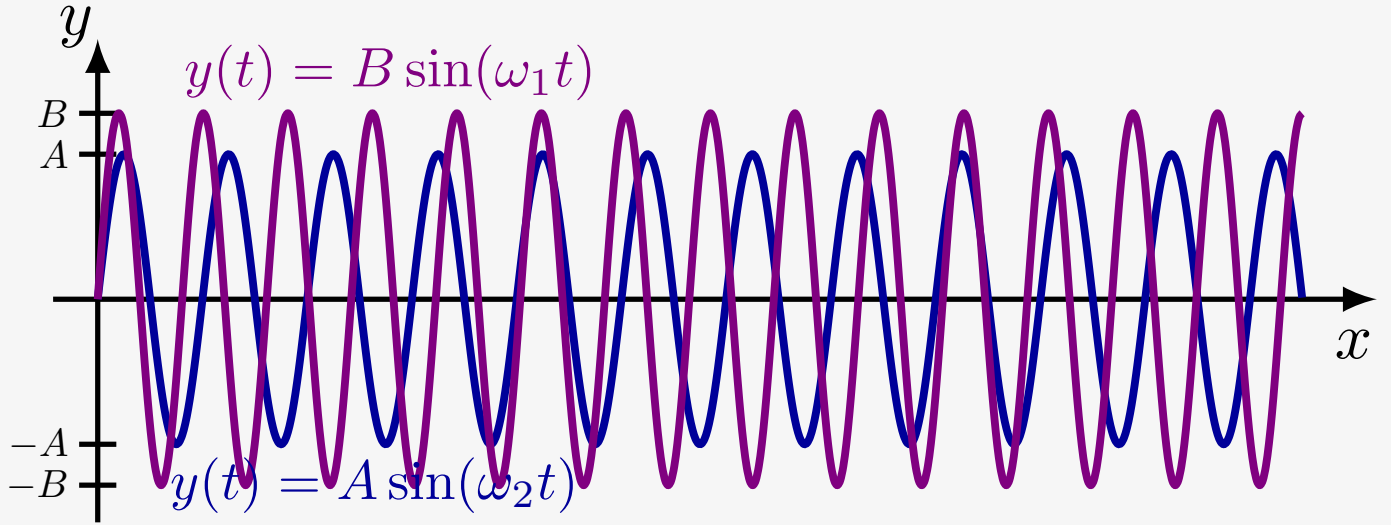
1 \colorlet{mypurple}{blue!50!red!80}
2 \colorlet{metalcol}{blue!25!black!30!white}
3
4 \def\tick#1#2{\draw[thick] (#1) ++ (#2:0.1) --++ (#2-180:0.2)}
5
6 \def\xmax{6.48}
7 \def\ymax{1.2}
8 \def\A{0.78}
9 \def\B{1}
10 \def\s{4.7*\A}
11 \def\N{400}
12 \def\fa{1.775}
13 \def\fb{2.20}
14
15 \begin{document}
16
17 \begin{tikzpicture}
18   \draw[->,thick] (-0.2*\ymax,0) -- (0.4+\xmax,0) node[right=4,below left=1] {$x$};
19   \draw[->,thick] (0,-\ymax) -- (0,0.2+\ymax) node[below=2,above left=-3] {$y$};
20   \tick{0,\A}{0} node[scale=0.6,left=-1] {$A$};
21   \tick{0,-\A}{0} node[scale=0.6,left=-1] {$-A$};
22   \tick{0,\B}{0} node[scale=0.6,left=-1] {$B$};
23   \tick{0,-\B}{0} node[scale=0.6,left=-1] {$-B$};
24   \draw[myblue,very thick,samples=\N,smooth,variable=\x,domain=0:\xmax]
25     plot(\x,{\A*sin(360*\fa*\x)});

```

```

26 \draw[violet,very thick,samples=\N,smooth,variable=\x,domain=0:\xmax]
27   plot(\x,{\B*sin(360*\fb*\x)});
28 \node[above right=-1,violet,scale=0.85] at (0.7/\fa,\B) {$y(t)=B\sin(\omega_1 t)$};
29 \node[below right=-1,myblue,scale=0.85] at (0.7/\fb,-\A) {$y(t)=A\sin(\omega_2 t)$};
30 \end{tikzpicture}
31
32 \end{document}

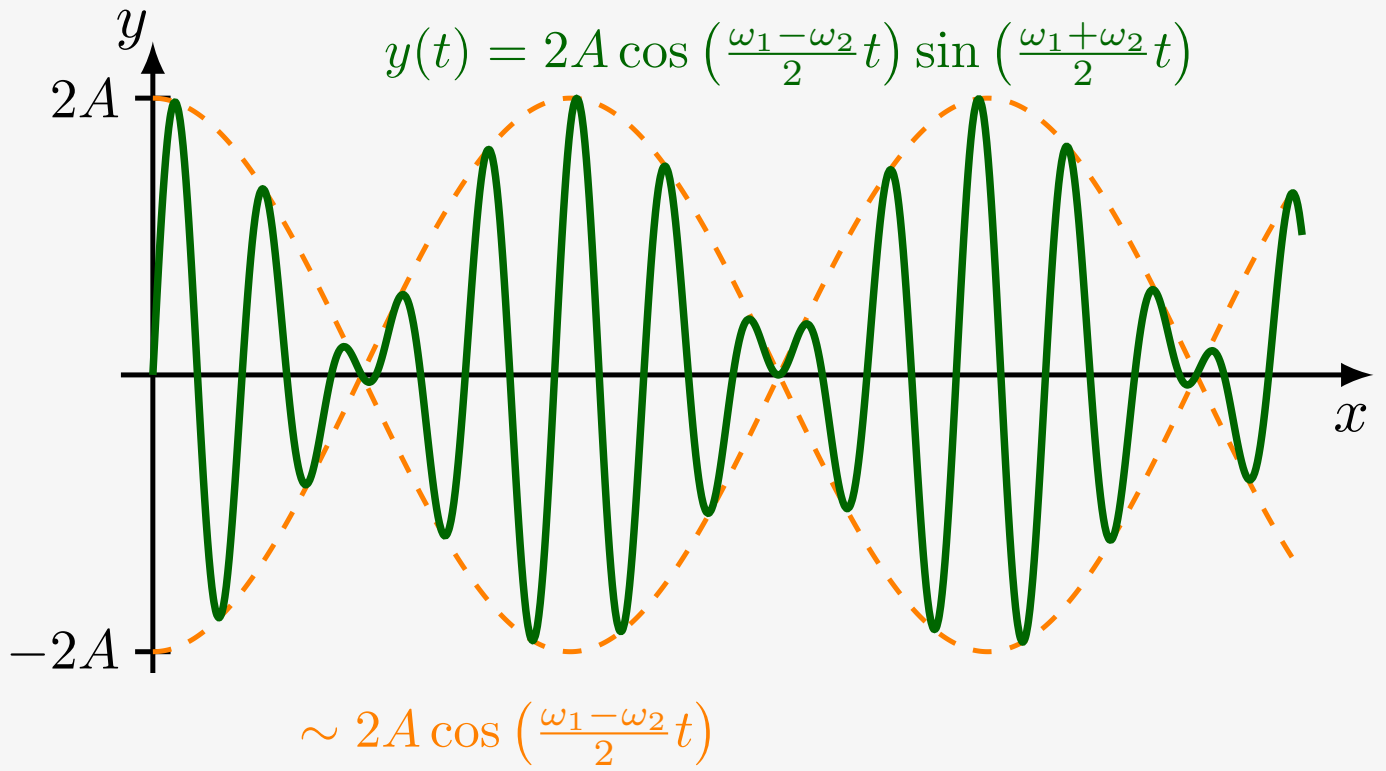
```



```

1 \colorlet{mypurple}{blue!50!red!80}
2 \colorlet{metalcol}{blue!25!black!30!white}
3 \tikzstyle{vvec}=[->,vcol,very thick,line cap=round]
4 \tikzstyle{node}=[xcol,scale=0.8]
5 \tikzstyle{metal}=[draw=metalcol!10!black,rounded corners=0.1,
6   top color=metalcol,bottom color=metalcol!80!black,shading angle=10]
7 \tikzstyle{ring}=[metalcol!20!black,double=metalcol!70!black,double distance=1.2,line width=0.3]
8 \tikzstyle{rope}=[brown!20!black,double=brown!70!black,
9   double distance=1.2,line width=0.6]
10 \tikzstyle{wood}=[draw=brown!80!black,rounded corners=0.1,
11   top color=brown!80,bottom color=brown!80!black!80,shading angle=10]
12 \def\tick#1#2{\draw[thick] (#1) ++ (#2:0.1) --++ (#2-180:0.2)}
13
14 \def\xmax{6.48}
15 \def\ymax{0.9}
16 \def\A{0.78}
17 \def\s{4.7*\A}
18 \def\N{400}
19 \def\fa{1.775}
20 \def\fb{2.20}
21
22 \begin{document}
23
24 \begin{tikzpicture}
25 \draw[>-,thick] (-0.2*\ymax,0) -- (0.4+\xmax,0) node[right=4,below left=1] {$x$};
26 \draw[>-,thick] (0,-\ymax-\A) -- (0,0.2+\ymax+\A) node[below=2,above left=-3] {$y$};
27 \tick{0,2*\A}{0} node[scale=0.9,left=-1] {$2A$};
28 \tick{0,-2*\A}{0} node[scale=0.9,left=-1] {$-2A$};
29 \draw[orange,thick,dashed,samples=2*\N,smooth,variable=\x,domain=0:\xmax]
30   plot(\x,{ 2*\A*cos(180*(\fa-\fb)*\x)})
31   plot(\x,{-2*\A*cos(180*(\fa-\fb)*\x)});
32 \draw[green!40!black,very thick,samples=\N,smooth,variable=\x,domain=0:\xmax]
33   plot(\x,{ 2*\A*sin(180*(\fa+\fb)*\x)*cos(180*(\fa-\fb)*\x)});
34 \node[above right=-1,green!40!black,scale=0.85] at ((4.9/(\fa+\fb)),2*\A)
35   {$y(t)=2A\cos\left(\frac{\omega_1-\omega_2}{2}t\right)\sin\left(\frac{\omega_1+\omega_2}{2}t\right)$};
36 \node[below right=5,orange,scale=0.85] at ({0.23/(\fb-\fa)},-2*\A)
37   {$\sim 2A\cos\left(\frac{\omega_1-\omega_2}{2}t\right)$};
38 \end{tikzpicture}
39 \end{document}

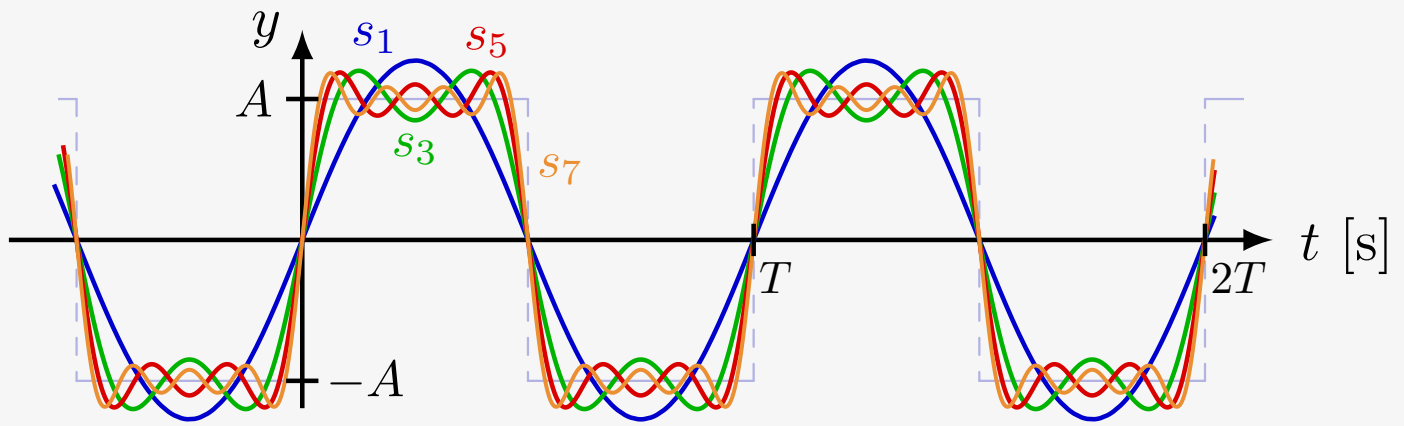
```



```

1 \begin{tikzpicture}
2   \message{^^JSquare wave synthesis - time}
3   \def\xmin{-0.65*\T}
4   \def\T{(0.465*\xmax)}
5   \begin{scope}
6     \clip ({-0.54*\T},-1.1*\A) rectangle (0.97*\xmax,1.1*\A);
7     \foreach \i [evaluate={\x=\i*\T/2;}] in {-2,...,4}{
8       \ifodd\i
9         \draw[myblue!80!black!30,line cap=round] (\x,{-\A}) --++ ({\T/2},0);
10        \draw[myblue!80!black!30,dashed,thin,line cap=round]
11          ({\x+\T/2},{-\A}) --++ (0,2*\A);
12      \else
13        \draw[myblue!80!black!30,line cap=round] (\x,{\A}) --++ ({\T/2},0);
14        \draw[myblue!80!black!30,dashed,thin,line cap=round]
15          ({\x+\T/2},{\A}) --++ (0,-2*\A);
16      \fi
17    }
18  \end{scope}
19  \draw[->,thick] (0,\ymin) -- (0,\ymax) node[left] {\$y\$};
20  \draw[->,thick] ({\xmin},0) -- ({\xmax},0) node[below=1, right=1] {\$t\$ [s]};
21  \draw[xline,samples=\N,smooth,variable=\t,domain=-0.55*\T:0.94*\xmax]
22    plot(\t,{\f{1}});% node[pos=0.3,above] {\$n=1\$};
23  \draw[xline,mygreen,samples=3*\N,smooth,variable=\t,domain=-0.54*\T:0.94*\xmax]
24    plot(\t,{\f{1}}+\f{3});
25  \draw[xline,myred,samples=5*\N,smooth,variable=\t,domain=-0.53*\T:0.94*\xmax]
26    plot(\t,{\f{1}}+\f{3}+\f{5});
27  \draw[xline,myorange,line width=0.7,samples=7*\N,smooth,variable=\t,domain=-0.52*\T:0.94*\xmax]
28    plot(\t,{\f{1}}+\f{3}+\f{5}+\f{7});
29  \node[myblue, above,scale=0.9] at ({0.16*\T},1.20*\A) {\$s_1\$};
30  \node[mygreen, below,scale=0.9] at ({0.25*\T},0.88*\A) {\$s_3\$};
31  \node[myred, above,scale=0.9] at ({0.41*\T},1.17*\A) {\$s_5\$};
32  \node[myorange,right,scale=0.9] at ({0.48*\T},0.50*\A) {\$s_7\$};
33  \tick{{\T},0}{90} node[below right=-2,scale=0.8] {\$T\$};
34  \tick{{2*\T},0}{90} node[below right=-2,scale=0.8] {\$2T\$};
35  \tick{0,{\A}}{0} node[left=-1,scale=0.9] {\$A\$};
36  \tick{0,{-\A}}{180} node[right=-2,scale=0.9] {\$-A\$};
37 \end{tikzpicture}

```

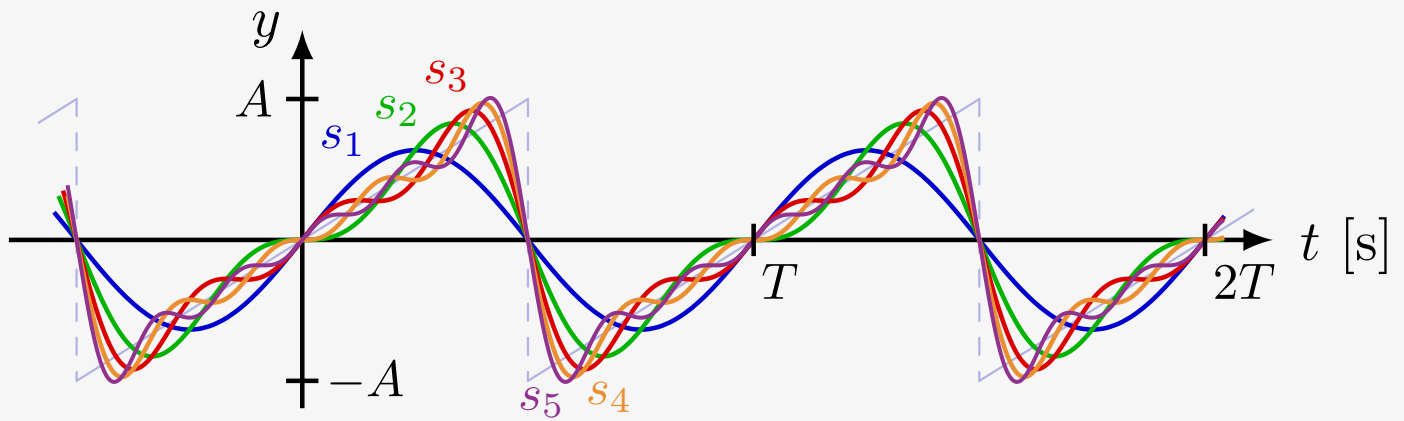


```

1 \begin{tikzpicture}
2   \message{^^JSawtooth wave synthesis - time}
3   \def\xmin{-0.65*\T}   % max x axis
4   \def\T{(0.465*\xmax)} % period
5   \def\f#1{\A*2/\pi/(#1)*(-1)^(#1-1)*sin(360/\T*#1*Mod(\t,\T))} %Mod(360*#1*\t/\T,360)
6   \begin{scope}
7     \clip ({0.9*\xmin},-1.1*\A) rectangle (0.98*\xmax,1.1*\A);
8     \foreach \i [evaluate={\x=\i*\T-\T/2;}] in {-2,...,4}{
9       \draw[myblue!80!black!30,line cap=round]
10        (\x,-\A) --++ ({\T},2*\A);
11       \draw[myblue!80!black!30,dashed,thin,line cap=round]
12        ({\x+\T},\A) --++ (0,-2*\A);
13     }
14   \end{scope}
15   \draw[->,thick] (0,\ymin) -- (0,\ymax) node[left] {$y$};
16   \draw[->,thick] ({\xmin},0) -- ({\xmax},0) node[below=1,right=1] {$t$ [s]};
17   \draw[xline,samples=\N,smooth,variable=\t,domain=-0.55*\T:0.95*\xmax]
18     plot(\t,{\f{1}});
19   \draw[xline,mygreen,samples=2*\N,smooth,variable=\t,domain=-0.54*\T:0.95*\xmax]
20     plot(\t,{\f{1}+\f{2}});
21   \draw[xline,myred,samples=3*\N,smooth,variable=\t,domain=-0.53*\T:0.95*\xmax]
22     plot(\t,{\f{1}+\f{2}+\f{3}});
23   \draw[xline,myorange,samples=4*\N,smooth,variable=\t,domain=-0.52*\T:0.95*\xmax]
24     plot(\t,{\f{1}+\f{2}+\f{3}+\f{4}});
25   \draw[xline,mypurple,line width=0.7,samples=5*\N,smooth,variable=\t,domain=-0.52*\T:0.95*\xmax]
26     plot(\t,{\f{1}+\f{2}+\f{3}+\f{4}+\f{5}});
27   \node[myblue, above,scale=0.9] at ({0.09*\T}, 0.47*\A) {$s_1$};
28   \node[mygreen, above,scale=0.9] at ({0.21*\T}, 0.68*\A) {$s_2$};
29   \node[myred, above,scale=0.9] at ({0.32*\T}, 0.93*\A) {$s_3$};
30   \node[myorange,below,scale=0.9] at ({0.68*\T},-0.88*\A) {$s_4$};
31   \node[mypurple,below,scale=0.9] at ({0.53*\T},-0.92*\A) {$s_5$};
32   \tick{{\T},0}{90} node[below right=-2,scale=0.9] {$T$};
33   \tick{{2*\T},0}{90} node[below right=-2,scale=0.9] {$2T$};
34   \tick{0,{\A}}{0} node[left=-1,scale=0.9] {$A$};
35   \tick{0,{-\A}}{180} node[right=-2,scale=0.9] {$-A$};
36 \end{tikzpicture}

```

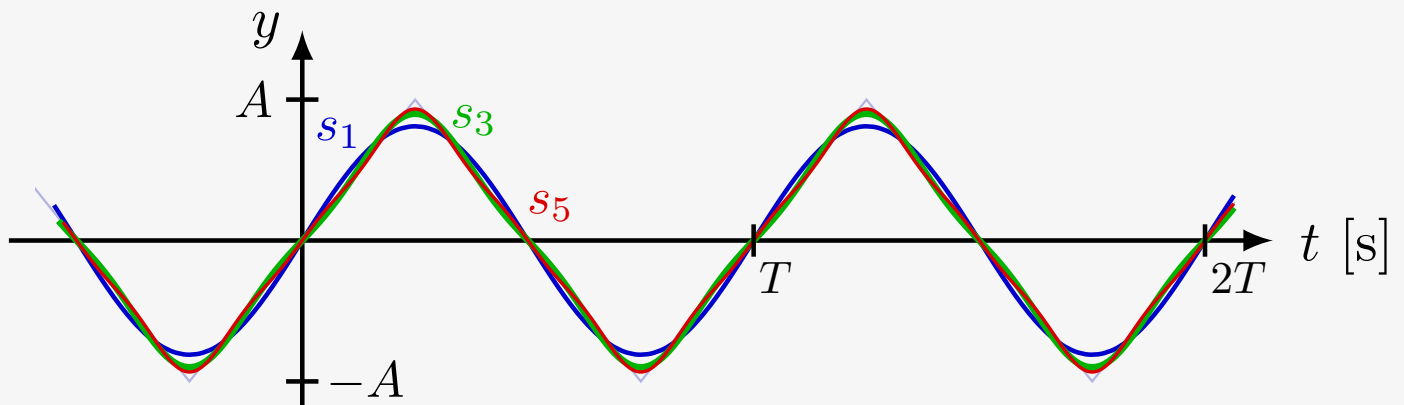




```

1 \begin{tikzpicture}
2   \message{^^JTriangle wave synthesis - time}
3   \def\xmin{-0.65*\T} % max x axis
4   \def\T{(0.465*\xmax)} % period
5   \def\f#1{\A*8/\pi^2/(#1)^2*(-1)^((#1-1)/2)*sin(360/\T*#1*Mod(\t,\T))} %Mod(360*#1*\t/\T,360)
6   \begin{scope}
7     \clip ({-0.59*\T},-1.1*\A) rectangle (0.96*\xmax,1.1*\A);
8     \draw[myblue!80!black!30,line cap=round]
9       \foreach \i [evaluate={\x=\i*\T;}] in {-2,...,4}{
10        (\x,0) --++ ({0.25*\T},\A) --++ ({\T/2},-2*\A) --++ ({0.25*\T},\A)};
11   \end{scope}
12   \draw[->,thick] (0,\ymin) -- (0,\ymax) node[left] {$y$};
13   \draw[->,thick] ({\xmin},0) -- (\xmax,0) node[below=1,right=1] {$t$ [s]};
14   \draw[xline,samples=\N,smooth,variable=\t,domain=-0.55*\T:0.96*\xmax]
15     plot(\t,{\f{1}}); % node[pos=0.3,above] {$s_1$};
16   \draw[xline,mygreen,line width=1.2,samples=2*\N,smooth,variable=\t,domain=-0.54*\T:0.96*\xmax]
17     plot(\t,{\f{1}}+\f{3});
18   \draw[xline,myred,line width=0.6,samples=3*\N,smooth,variable=\t,domain=-0.53*\T:0.96*\xmax]
19     plot(\t,{\f{1}}+\f{3}+\f{5});
20   \node[myblue, above,scale=0.9] at ({0.08*\T},0.53*\A) {$s_1$};
21   \node[mygreen, above,scale=0.9] at ({0.38*\T},0.62*\A) {$s_3$};
22   \node[myred, above,scale=0.9] at ({0.55*\T},0.01*\A) {$s_5$};
23   \tick{{\T},0}{90} node[below right=-2,scale=0.8] {$T$};
24   \tick{{2*\T},0}{90} node[below right=-2,scale=0.8] {$2T$};
25   \tick{0,{\A}}{0} node[left=-1,scale=0.9] {$A$};
26   \tick{0,{-\A}}{180} node[right=-2,scale=0.9] {$-A$};
27 \end{tikzpicture}

```



```

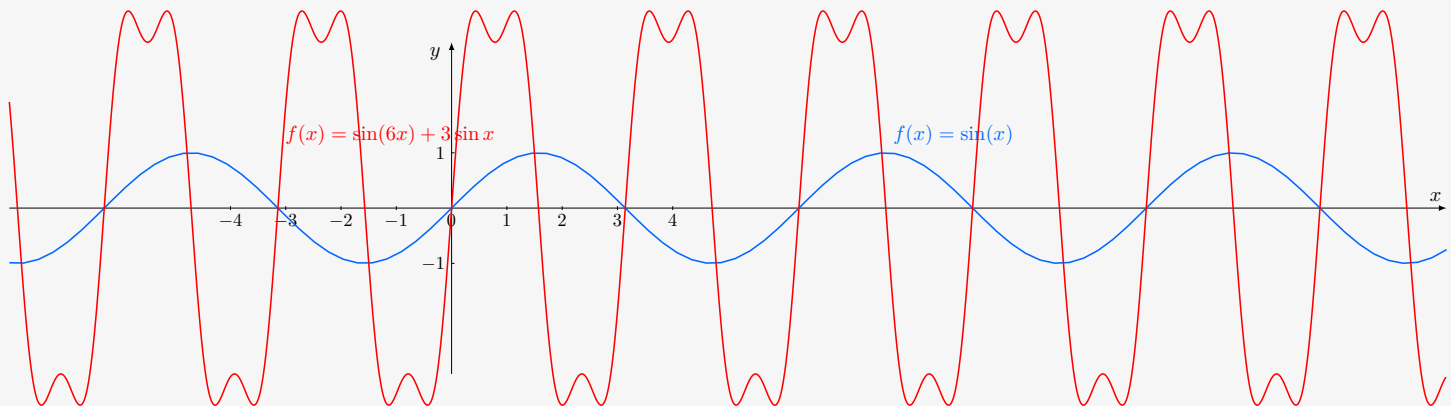
1 \documentclass{ctexart}
2 \usepackage{ctex}
3 \usepackage{amsmath} % for \dfrac
4 \usepackage{tikz}
5 \tikzset{>=latex} % for LaTeX arrow head

```

```

6 \usepackage{pgfplots} % for the axis environment
7
8 % split figures into pages
9 \usepackage[active,tightpage]{preview}
10 \PreviewEnvironment{tikzpicture}
11 \setlength\PreviewBorder{0pt}%
12 \def\xa{-8}
13 \def\xb{18}
14 \def\ya{-3}
15 \def\yb{3}
16 \def\N{100}
17 \begin{document}
18 \begin{tikzpicture}
19 \draw[->](\xa,0) -- (\xb,0) node[above=6pt,left=-1pt] {$x$};
20 \draw[->](0,\ya) -- (0,\yb) node[below=6pt,left=2pt] {$y$};
21 \foreach \X in {-4,-3,...,4}
22 \draw (\X cm,1pt) -- (\X cm,-1pt)
23 node[below,scale=0.9] at (\X,0) {$\X$};
24 \foreach \Y in {-1,1}
25 \draw (0pt,\Y cm) -- (1.5pt,\Y cm) node[left,scale=0.9] at (0,\Y) {$\Y$};
26 \def\ea{0.28}
27 \def\eb{0.26}
28 \draw[color=blue!60!cyan,thick,samples=\N,domain=\xa:\xb]
29 plot(\x,{sin(\x r)})
30 node[above right] at (5*pi/2,1) {$f(x)=\sin(x)$};
31 \draw[color=red,thick,samples=2000,domain=\xa:\xb]
32 plot(\x,{sin(6*\x r)+4*sin(2*\x r)})
33 node[above right] at (-2*pi/2,1) {$f(x)=\sin(6x)+3\sin x$};
34 \end{tikzpicture}
35 \end{document}

```



```

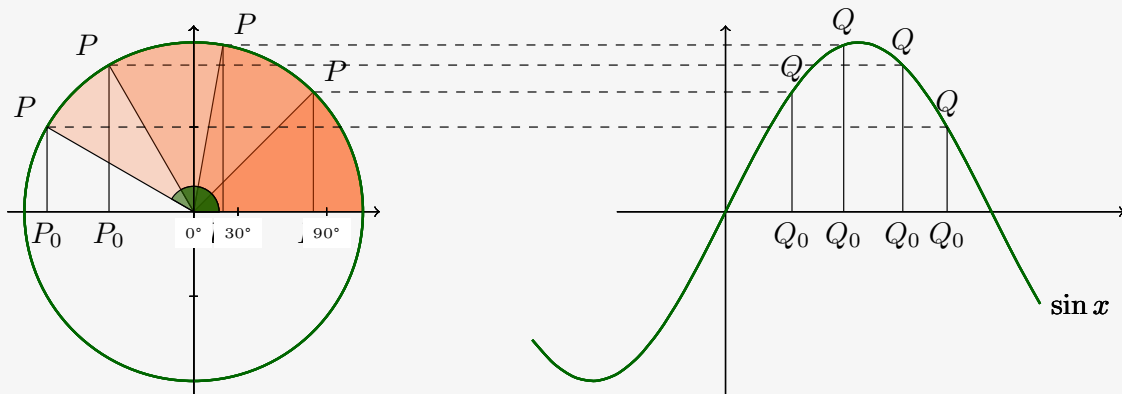
1 \begin{tikzpicture}
2 \foreach \iangle in {45,80,120,150}{
3 \fill[fill=orange!60!red,fill opacity=0.2](0,0) -- (0:2) arc (0:\iangle:2) -- cycle;
4 \filldraw[fill=green!40!black,fill opacity=0.5](0,0) -- (0:0.3) arc (0:\iangle:0.3) -- cycle;
5 \draw[->](-2.2,0) -- (2.2,0);
6 \draw[->](0,-2.2) -- (0,2.2);
7 \draw[thick,draw=green!40!black](0,0) circle (2);
8 \coordinate[label=\iangle:$P$](P) at (\iangle:2);
9 \coordinate[label=below:$P_0$](P0) at (P|-0,0);
10 \draw(0,0) -- (P);
11 \draw(P) -- (P0);
12 \draw[->](5,0) -- (11,0);
13 \draw[->](0,-2.2) -- (0,2.2);
14 \draw[->](2*pi,-2.2) -- (2*pi,2.2);
15 \draw[thick,domain=4:10,smooth,draw=green!40!black] plot(\x,{2*sin(\x r)}) node[right] {$\sin x$};
16 \foreach \t in {0,30,90}{
17 \draw(({rad(\t)},-0.05) -- ({rad(\t)},0.05);
18 \node[below,outer sep=2pt,fill=white,font=\tiny]
19 at(({rad(\t)},0) {$\ang{\t}$};
20 \foreach \y in {-1,1}{\draw(-0.05,\y) -- (0.05,\y);}
21 \coordinate[label=above:$Q$](Q) at(({rad(\iangle+360)},{2*sin(\iangle+360)});
22 \coordinate[label=below:$Q_0$](Q0) at(Q|-0,0);

```

```

23 \draw (Q) -- (Q0);
24 \draw[dashed] (P) -- (Q);
25 }
26 \end{tikzpicture}

```

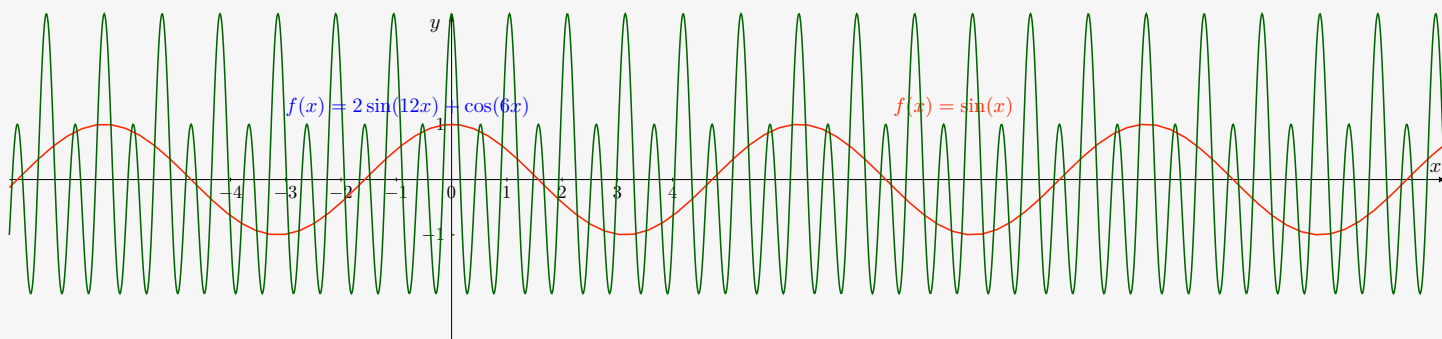


## 2. 余弦函数

```

1 \documentclass{ctexart}
2 \usepackage{ctex}
3 \usepackage{amsmath}
4 \usepackage{tikz}
5 \tikzset{>=latex}
6 \usepackage{pgfplots}
7 \usepackage[active,tightpage]{preview}
8 \PreviewEnvironment{tikzpicture}
9 \setlength\PreviewBorder{0pt}%
10 \def\xa{-8}
11 \def\xb{18}
12 \def\ya{-3}
13 \def\yb{3}
14 \def\N{100}
15 \begin{document}
16 \begin{tikzpicture}
17 \draw[->](\xa,0)--(\xb,0) node[above=6pt,left=-1pt]{$x$};
18 \draw[->](0,\ya)--(0,\yb) node[below=6pt,left=2pt]{$y$};
19 \foreach \X in {-4,-3,...,4}
20 \draw (\X cm,1pt)--(\X cm,-1pt)
21 node[below,scale=0.9] at (\X,0) {$\X$};
22 \foreach \Y in {-1,1}
23 \draw (0pt,\Y cm)--(1.5pt,\Y cm) node[left,scale=0.9] at (0,\Y) {$\Y$};
24 \def\ea{0.28}
25 \def\eb{0.26}
26 \draw[color=orange!30!red,thick,samples=\N,domain=\xa:\xb]
27 plot(\x,{cos(\x r)})
28 node[above right] at (5*pi/2,1) {$f(x)=\sin(x)$};
29 \draw[color=green!40!black,thick,samples=2000,domain=\xa:\xb]
30 plot(\x,{2*cos(12*\x r)+cos(6*\x r)})
31 node[above right,color=blue] at (-2*pi/2,1) {$f(x)=2\sin(12x)+\cos(6x)$};
32 \end{tikzpicture}
33 \end{document}

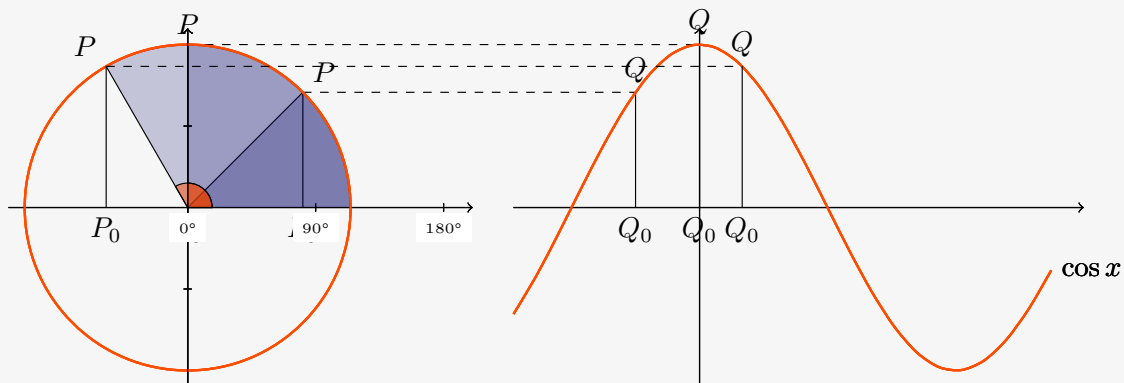
```



```

1 \begin{tikzpicture}
2 \foreach \iangle in {45,90,120}{
3 \fill[fill=blue!40!black,fill opacity=0.2] (0,0) -- (0:2) arc (0:\iangle:2) -- cycle;
4 \filldraw[fill=orange!60!red,fill opacity=0.5] (0,0) --(0:0.3) arc (0:\iangle:0.3) -- cycle;
5 \draw[>-] (-2.2,0) -- (3.5,0);
6 \draw[>-] (0,-2.2) -- (0,2.2);
7 \draw[thick,draw=orange!60!red] (0,0) circle (2);
8 \coordinate[label=\iangle:$P$] (P) at (\iangle:2);
9 \coordinate[label=below:$P_0$] (P0) at (P |- 0,0);
10 \draw (0,0) -- (P);
11 \draw (P) -- (P0);
12 \draw[>-] (4,0) -- (11,0);
13 \draw[>-] (0,-2.2) -- (0,2.2);
14 \draw[>-] (2*pi,-2.2) -- (2*pi,2.2);
15 \draw[thick,domain=4:10.6,smooth,draw=orange!60!red] plot(\x,{2*cos(\x r)}) node[right] {$\cos x$};
16 \foreach \t in {0,90,180} {
17 \draw ({rad(\t)},-0.05) -- ({rad(\t)},0.05);
18 \node[below,outer sep=2pt,fill=white,font=\tiny]
19 at ({rad(\t)},0) {\ang{\t}};
20 \foreach \y in {-1,1} {\draw (-0.05,\y) -- (0.05,\y);}
21 \coordinate[label=above:$Q$] (Q) at ({rad(\iangle+270)},{2*cos(\iangle+270)});
22 \coordinate[label=below:$Q_0$] (Q0) at (Q |- 0,0);
23 \draw (Q) -- (Q0);
24 \draw[dashed] (P) -- (Q);
25 }
26 \end{tikzpicture}

```



### 3. 正切函数

```

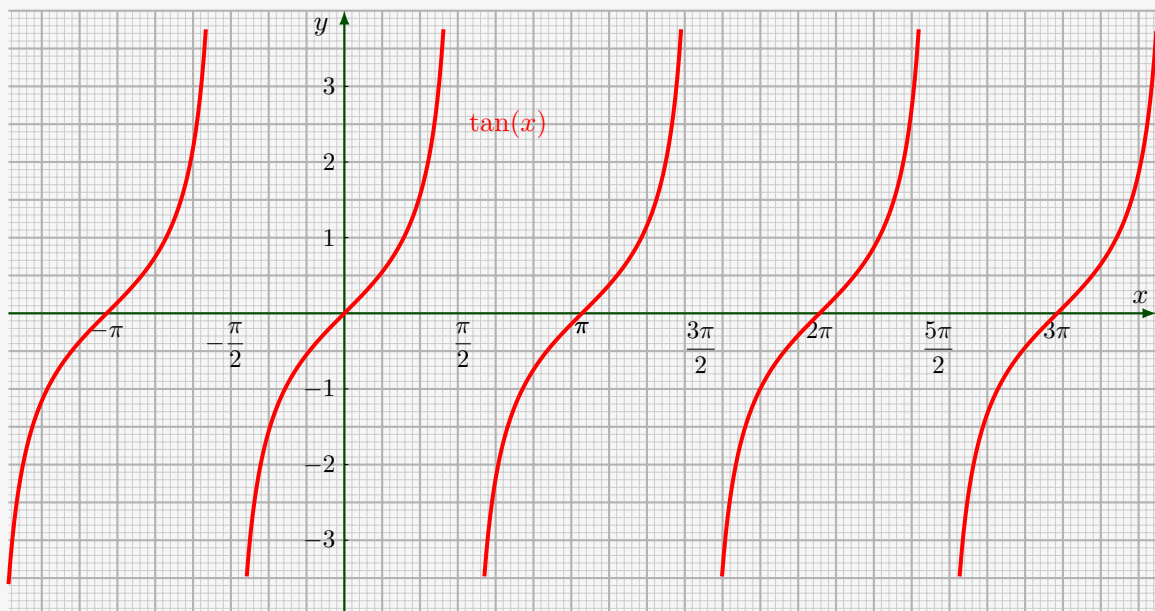
1 \documentclass{ctexart}
2 \usepackage{ctex}
3 \usepackage{amsmath} % for \dfrac
4 \usepackage{tikz}
5 \tikzset{>=latex} % for LaTeX arrow head
6 \usepackage{pgfplots} % for the axis environment
7
8 % split figures into pages
9 \usepackage[active,tightpage]{preview}
10 \PreviewEnvironment{tikzpicture}
11 \setlength\PreviewBorder{0pt}%
12 \def\xa{-4.44}
13 \def\xb{10.735}
14 \def\ya{-4}
15 \def\yb{4}
16 \def\N{100}
17 \begin{document}
18 \begin{tikzpicture}
19 \draw[xstep=0.1,ystep=0.1,very thin, color=gray!40!white,fill=blue!5!white] (\xa,\ya) grid (\xb,\yb);
20 \draw[xstep=0.5,ystep=0.5,thick, color=gray!60!white,fill=blue!5!white] (\xa,\ya) grid (\xb,\yb);
21 \draw[>,thick,draw=green!30!black] (\xa,0) -- (\xb,0) node[above=6pt,left=-1pt] {$x$};
22 \draw[>,thick,draw=green!30!black] (0,\ya) -- (0,\yb) node[below=6pt,left=2pt] {$y$};

```

```

23 \draw[]
24     node[below,scale=0.9] at ( -pi, 0) {$-\pi$}
25     node[below,scale=0.9] at ( -pi/2, 0) {$-\dfrac{\pi}{2}$}
26     node[below,scale=0.9] at ( pi, 0) {$\pi$}
27     node[below,scale=0.9] at ( pi/2, 0) {$\dfrac{\pi}{2}$}
28     node[below,scale=0.9] at ( pi, 0) {$\pi$}
29     node[below,scale=0.9] at (3*pi/2, 0) {$\dfrac{3\pi}{2}$}
30     node[below,scale=0.9] at (2*pi, 0) {$2\pi$}
31     node[below,scale=0.9] at (5*pi/2, 0) {$\dfrac{5\pi}{2}$}
32     node[below,scale=0.9] at (3*pi,0) {$3\pi$};
33 \foreach \Y in {-3,-2,-1,1,2,3}
34 \draw (0pt,\Y cm) -- (1.5pt,\Y cm) node[left,scale=0.9] at (0,\Y) {$\Y$};
35 \def\ea{0.28}
36 \def\eb{0.26}
37 \draw[line width=1.5pt,draw=red]
38     plot[samples=\N,domain= \xa : -pi/2-\eb] (\x, {\tan(\x r)})
39     plot[samples=\N,domain= -pi/2+\ea: pi/2-\eb] (\x, {\tan(\x r)})
40     plot[samples=\N,domain= pi/2+\ea: 3*pi/2-\eb] (\x, {\tan(\x r)})
41     plot[samples=\N,domain= 3*pi/2+\ea: 5*pi/2-\eb] (\x, {\tan(\x r)})
42     plot[samples=\N,domain= 5*pi/2+\ea: \xb ] (\x, {\tan(\x r)})
43     node[samples=\N,right=-2pt,color=red] at (pi/2,2.5) {$\tan(x)$};
44 \end{tikzpicture}
45 \end{document}

```



```

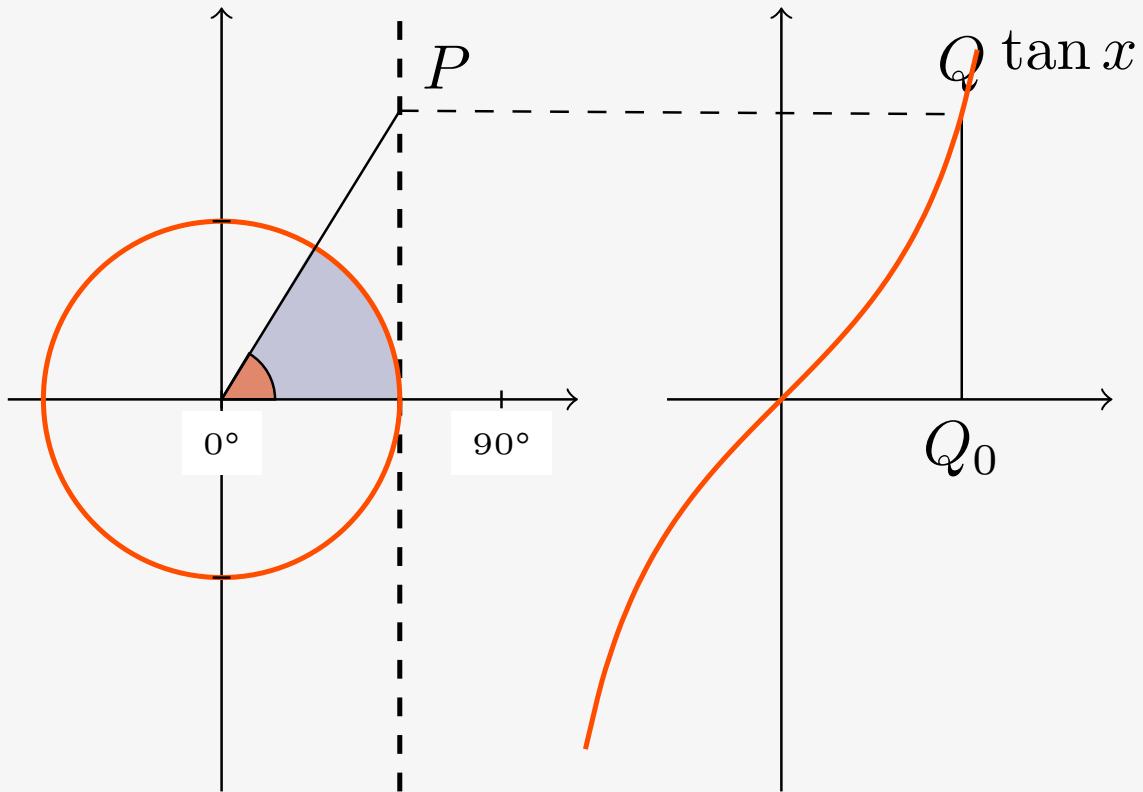
1 \documentclass[border=0pt]{standalone}
2 \usepackage{tikz}
3 \usepackage{siunitx}
4 %\newcommand{\iangle}{120}
5 \begin{document}
6     \begin{tikzpicture}
7 \foreach \iangle in {45}{
8         \fill[fill=blue!40!black,fill opacity=0.2]
9             (0,0) -- (0:1) arc (0:\iangle+14:1) -- cycle;
10        \filldraw[fill=orange!60!red,fill opacity=0.5]
11            (0,0) --(0:0.3) arc (0:\iangle+14:0.3) -- cycle;
12        \draw[->] (-1.2,0) -- (2,0);
13        \draw[->] (2.5,0) -- (5,0);
14        \draw[->] (0,-2.2) -- (0,2.2);
15        \draw[thick,dashed] (1,-2.2) -- (1,2.2);
16        \draw[->] (pi,-2.2) -- (pi,2.2);
17        \draw[thick,draw=orange!60!red] (0,0) circle (1);
18        \coordinate[label=\iangle:$P$] (P) at (1,{\tan(\iangle r)});
19        \coordinate[label=above:$Q$] (Q) at ({rad(\iangle+193)},{\tan(\iangle+193)});
20        \coordinate[label=below:$Q_0$] (Q0) at (Q |- 0,0);
21        \draw (Q) -- (Q0);
22        \draw[dashed] (P) -- (Q);
23        \draw (0,0) -- (P);

```

```

24 \draw[thick,domain=0.65*pi:1.35*pi,smooth,draw=orange!60!red] plot(\x,{tan(\x r)}) node[right]
    {\tan x};
25 %% =====
26 \foreach \t in {0,90} {
27     \draw ({rad(\t)},-0.05) -- ({rad(\t)},0.05);
28     \node[below,outer sep=2pt,fill=white,font=\tiny]
29         at ({rad(\t)},0) {\ang{\t}};
30 }
31 \foreach \y in {-1,1} {
32     \draw (-0.05,\y) -- (0.05,\y);
33 }
34 }
35 \end{tikzpicture}
36 \end{document}

```



```

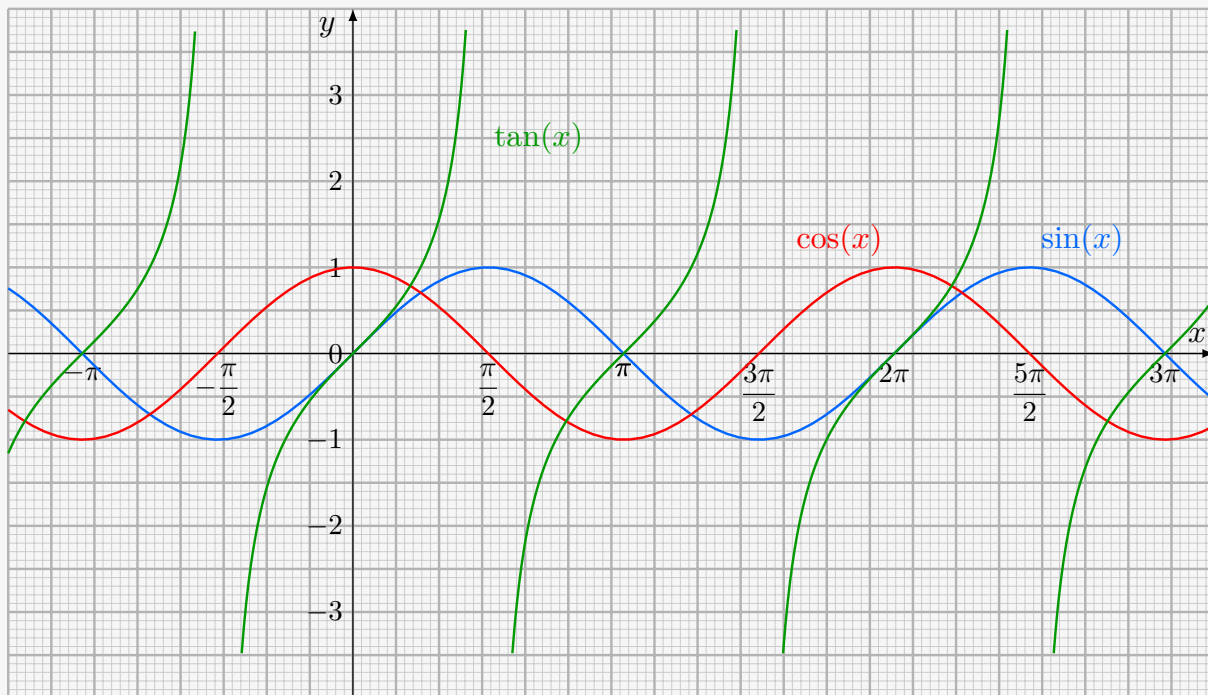
1 \draw[->] (\xa,0) -- (\xb,0) node[above=6pt,left=-1pt] {\x$};
2 \draw[->] (0,\ya) -- (0,\yb) node[below=6pt,left=2pt] {\y$};
3 \draw[]
4     node[below,scale=0.9] at (-pi, 0) {\$-\pi$}
5     node[below,scale=0.9] at (-pi/2, 0) {\$-\dfrac{\pi}{2}$}
6     node[below,scale=0.9] at (pi, 0) {\$\pi$}
7     node[below,scale=0.9] at (pi/2, 0) {\$\dfrac{\pi}{2}$}
8     node[below,scale=0.9] at (pi, 0) {\$\pi$}
9     node[below,scale=0.9] at (3*pi/2, 0) {\$\dfrac{3\pi}{2}$}
10    node[below,scale=0.9] at (2*pi, 0) {\$2\pi$}
11    node[below,scale=0.9] at (5*pi/2, 0) {\$\dfrac{5\pi}{2}$}
12    node[below,scale=0.9] at (3*pi, 0) {\$3\pi$};
13 \draw[]
14     node[left,scale=0.9] at (0, 3) {\$3$}
15     node[left,scale=0.9] at (0, 2) {\$2$}
16     node[left,scale=0.9] at (0, 1) {\$1$}
17     node[left,scale=0.9] at (0, 0) {\$0$}
18     node[left,scale=0.9] at (0, -1) {\$-1$}
19     node[left,scale=0.9] at (0, -2) {\$-2$}
20     node[left,scale=0.9] at (0, -3) {\$-3$};
21 \def\ea{0.28}
22 \def\eb{0.26}
23 \draw[color=blue!60!cyan,thick,samples=\N,domain=\xa:\xb]
24     plot(\x,{sin(\x r)})
25     node[above right] at (5*pi/2,1) {\$\sin(x)$};
26

```

```

27 \draw[thick,color=red,samples=\N,domain=\xa:\xb]
28   plot(\x,{cos(\x r)})
29   node[above left] at (2*pi,1) {\cos(x)};
30 \draw[thick,draw=green!60!black]
31   plot[samples=\N,domain=\xa : -pi/2-\eb] (\x,{tan(\x r)})
32   plot[samples=\N,domain=-pi/2+ea: pi/2-\eb] (\x,{tan(\x r)})
33   plot[samples=\N,domain= pi/2+ea: 3*pi/2-\eb] (\x,{tan(\x r)})
34   plot[samples=\N,domain= 3*pi/2+ea: 5*pi/2-\eb] (\x,{tan(\x r)})
35   plot[samples=\N,domain= 5*pi/2+ea: \xb] (\x,{tan(\x r)})
36   node[samples=\N,right=-2pt,color=green!60!black] at (pi/2,2.5) {\tan(x)};
37 \end{tikzpicture}
38 \end{document}

```



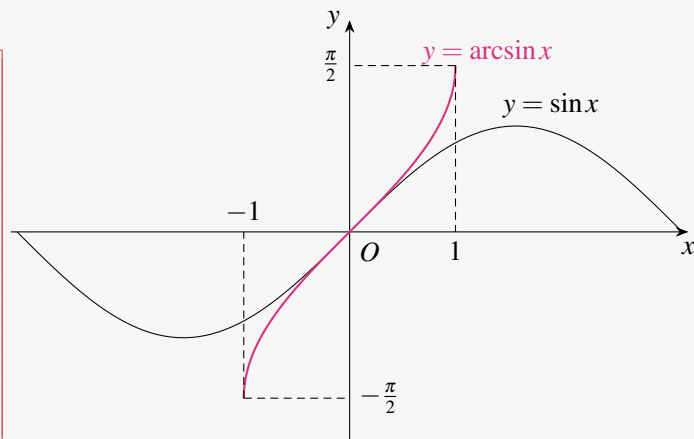
### 3.7.2 三角函数的反函数

#### 1. 反正弦函数

```

1 \begin{tikzpicture}[samples=100,scale=1.4]
2 \draw[-Stealth] (-3.2,0)--(0,0)node[below right]{$0$}--(3.2,0)node[
3   below]{$x$};
4 \draw[-Stealth] (0,-2)--(0,2)node[left]{$y$};
5 \draw[domain=-pi:pi]plot(\x,{sin(\x r)});
6 \draw[semithick,domain=-pi/2:pi/2,draw=magenta,thick]plot({sin(\x r)},
7   \x);
8 \node at (1.9,1.2) {$y=\sin x$};\node[color=magenta] at (1.3,1.7) {$y=
9   \arcsin x$};
10 \draw[densely dashed] (1,pi/2)--(1,0)node[below]{$1$}
11 (1,pi/2)--(0,pi/2)node[left]{$\frac{\pi}{2}$};
12 \draw[densely dashed] (-1,-pi/2)--(-1,0)node[above]{$-1$}
13 (-1,-pi/2)--(0,-pi/2)node[right]{$-\frac{\pi}{2}$};
14 \end{tikzpicture}

```

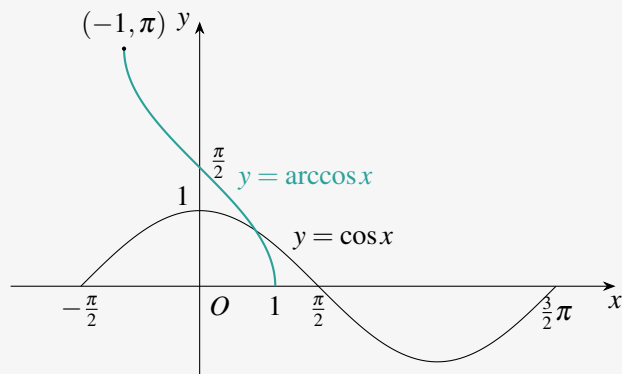


#### 2. 反余弦函数

```

1 \begin{tikzpicture}[samples=100]
2 \draw[-Stealth](-2.5,0)--(0,0)node[below right]{$O$}--(5.5,0)node[
   below]{$x$};
3 \draw[-Stealth](0,-1.2)--(0,3.5)node[left]{$y$};
4 \draw[domain=-pi/2:3*pi/2]plot(\x,{cos(\x r)}); \node[color=cyan] at
   (1.4,1.4) {$y=\arccos x$};
5 \draw[semithick,domain=0:pi,thick,draw=cyan]plot((cos(\x r)),\x);
6 \node at (1.9,0.6) {$y=\cos x$};
7 \node[left]at (0,1.2) {$1$}; \
8 \node[below] at (-pi/2,0) {$-\frac{\pi}{2}$};
9 \node[below]at (pi/2,0) {$\frac{\pi}{2}$};
10 \node[below]at (1,0) {$1$}; \node[right]at (0,1.63) {$\frac{\pi}{2}$};
11 \node[below]at (3*pi/2,0) {$\frac{3\pi}{2}$};
12 \fill(-1,pi)circle(0.8pt)node[above]{$(-1,\pi)$};
13 \end{tikzpicture}

```

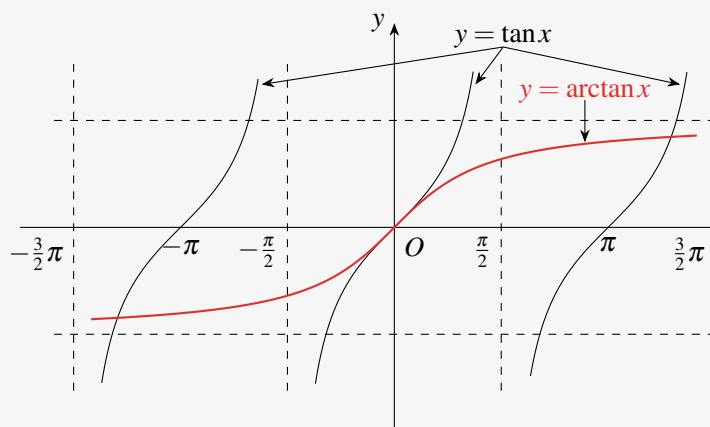


### 3. 反正切函数

```

1 \begin{tikzpicture}[samples=100,scale=0.9]
2 \draw[-Stealth](-5.5,0)--(0,0)node[below right]{$O$}--(5.5,0)node[
   below]{$x$};
3 \draw[-Stealth](0,-3)--(0,3)node[left]{$y$};
4 \draw[domain=-4.3:-2]plot(\x,{tan(\x r)});
5 \draw[dashed](-3*pi/2,-2.4)--(-3*pi/2,2.4);
6 \draw[dashed](-pi/2,-2.4)--(-pi/2,2.4);
7 \draw[dashed](pi/2,-2.4)--(pi/2,2.4);
8 \draw[dashed](3*pi/2,-2.4)--(3*pi/2,2.4);
9 \draw[domain=-1.16:1.16]plot(\x,{tan(\x r)});
10 \draw[domain=2:4.3]plot(\x,{tan(\x r)});
11 \node[below left]at (-3*pi/2,0) {$-\frac{3\pi}{2}$};
12 \node[below left]at (3*pi/2,0) {$\frac{3\pi}{2}$};
13 \node[below left]at (pi/2,0) {$\frac{\pi}{2}$}; \node[below left]at (-pi/2,0) {
   $-\frac{\pi}{2}$};
14 \node[below]at (pi,0) {$\pi$}; \node[below]at (-pi,0) {$-\pi$};
15 \node(a)at (1.6,2.8) {$y=\tan x$}; \node[color=red] (b) at (2.8,2) {$y=
   \arctan x$};
16 \draw[semithick,domain=-1.35:1.35,thick,draw=red]plot((tan(\x r)),\x);
17 \draw[dashed](-5,pi/2)--(5,pi/2)(-5,-pi/2)--(5,-pi/2);
18 \draw[-Stealth](2.8,1.87)--(2.8,1.25);
19 \draw[-Stealth](1.6,2.65)--(-1.95,2.1);
20 \draw[-Stealth](1.6,2.65)--(1.19,2.1); \draw[-Stealth](1.6,2.65)
   --(4.2,2.1);
21 \end{tikzpicture}

```



## 3.8 圆锥曲线的 TikZ 绘制

### 圆锥曲线的产生

```

1 \documentclass[border=0mm]{standalone}
2 \usepackage{tikz,times}
3 \usepackage{verbatim}
4 \usepackage[active,tightpage]{preview}
5 \PreviewEnvironment{tikzpicture}
6 \setlength\PreviewBorder{10pt}
7 \tikzset{fontscale/.style = {font=\relsize{#1}}}
8 \usetikzlibrary{arrows}
9 \usetikzlibrary{decorations.markings}
10 \tikzset{->-/.style={decoration={
11   markings,
12   mark=at position #1 with {\arrow{triangle 45}}},postaction={decorate}}}
13
14 \begin{document}
15 \begin{tikzpicture}[xscale=1.5,yscale=0.8]
16 \draw[green!40!black,thick] (-3,3) ellipse (2 and 0.5);

```



```

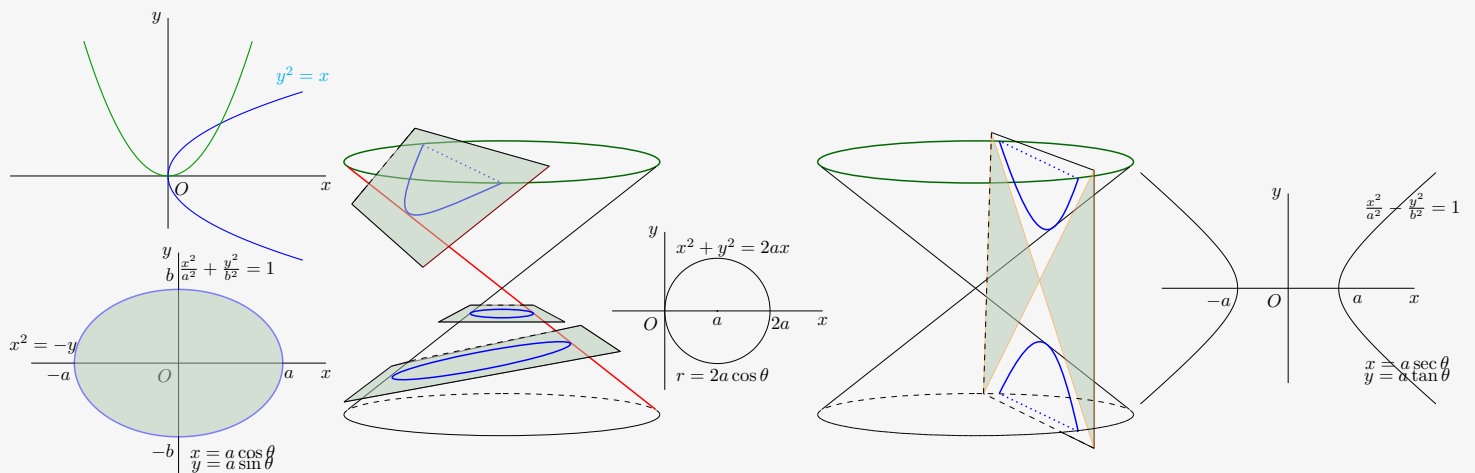
17 \draw[green!40!black,thick] (3,3) ellipse (2 and 0.5);
18 \draw[red,thick] (-4.95,2.88) -- (-1.05,-2.88);
19 \draw[] (-4.95,-2.88) -- (-1.05,2.88);
20 \draw[] (4.95,2.88) -- (1.05,-2.88);
21 \draw[] (4.95,-2.88) -- (1.05,2.88);
22
23 \draw[fill=green!30!black!30!white,opacity=0.5] (-2.6,-0.4) -- (-3.4,-0.4)--(-3.8,-0.8)--(-2.2,-0.8);
24 \draw[blue, thick] (-3,-0.6) ellipse (0.4 and 0.1);
25 \draw[] (-3.8,-0.8) -- (-2.2,-0.8);
26 \draw[] (-3.8,-0.8) -- (-3.4,-0.4);
27 \draw[] (-2.2,-0.8) -- (-2.6,-0.4);
28 \draw[] (-3.4,-0.4) -- (-3.3,-0.4);
29 \draw[] (-2.6,-0.4) -- (-2.7,-0.4);
30 \draw[dashed] (-2.7,-0.4) -- (-3.3,-0.4);
31 \node[] at (-.2,-0.4) {
32 \begin{tikzpicture}[samples=100]
33 \draw[smooth] (-1,0) -- (0,0) node[below left] {$O$} -- (3,0) node[below] {$x$};
34 \draw[smooth] (0,-1.5) -- (0,1.5) node[left] {$y$};
35 \draw plot[tension=1,smooth cycle] coordinates{(0,0) (1,1) (2,0) (1,-1)};
36 \node [below] at (2.2,0) {$2a$}; \node [below] at (1,0) {$a$};
37 \fill(1,0) circle(0.5pt);
38 \node at (1.1,-1.2) {$x=2a\cos\theta$};
39 \node at (1.3,1.2) {$x^2+y^2=2ax$};
40 \end{tikzpicture}};
41
42 \draw[fill=green!30!black!30!white,opacity=0.5] (-5,-2.7) -- (-1.5,-1.5) -- (-2,-0.88) -- (-4.4,-1.85);
43 \draw[rotate around={20:(-3.26,-1.72)}, blue, thick] (-3.26,-1.72) ellipse (1.2 and 0.2);
44 \draw[] (-5,-2.7) -- (-1.5,-1.5);
45 \draw[] (-5,-2.7) -- (-4.4,-1.85);
46 \draw[] (-4.4,-1.85) -- (-4.1,-1.7);
47 \draw[] (-1.5,-1.5) -- (-2,-0.88);
48 \draw[] (-2,-0.88) -- (-2.3,-1);
49 \draw[dashed] (-2.3,-1) -- (-4.1,-1.7);
50 \node[left] at (-5,-1.7) {
51 \begin{tikzpicture}[samples=200,scale=1.4]
52 \draw[smooth] (-2,0) -- (0,0) node[below left] {$O$} -- (2,0) node[below] {$x$};
53 \draw[smooth] (0,-1.5) -- (0,1.5) node[left] {$y$};
54 \draw[domain=0:2*pi,thick,draw=blue,fill=green!30!black!30!white,opacity=0.5] plot({1.414*cos(\x r)},{sin(\x r)});
55 \node[left=-1pt] at (0,1.2) {$b$}; \node[left=-1pt] at (0,-1.2) {$-b$};
56 \node[below] at (-1.63,0) {$-a$}; \node[below] at (1.5,0) {$a$};
57 \node at (1.4,1.3) {$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$};
58 \node[align=flush center] at (1.4,-1.3) {$x=a\cos\theta$} \[-2mm]
59 $y=a\sin\theta$;
60 \end{tikzpicture}
61 };
62
63 %% =====
64 \draw[blue,thick] (-4,3.4) .. controls (-4.5,1.2)
65 and (-4.2,1.5) .. (-3,2.5);
66 \draw[dotted, blue, thick] (-4,3.4) -- (-3,2.5);
67 \draw[red] (-2.4,2.9) -- (-4,0.5);
68 \draw[] (-2.4,2.9) -- (-4.1,3.8) coordinate (A);
69 \draw[] (-4,0.5) -- (-4.9,2) coordinate (B);
70 \draw[dashed] (A) -- (B);
71 \draw[] (A) -- (-4.28,3.4);
72 \draw[] (B) -- (-4.7,2.45);
73 \draw[fill=green!30!black!30!white,opacity=0.5] (-2.4,2.9) -- (-4,0.5) -- (-4.9,2) -- (-4.1,3.8) -- cycle;
74 \node[left] at (-5,2.5) {
75 \begin{tikzpicture}[samples=100]
76 \draw[smooth] (-3,0) -- (0,0) node[below right] {$O$} -- (3,0) node[below] {$x$};
77 \draw[smooth] (0,-1) -- (0,3) node[left] {$y$};
78 \draw[semithick,domain=0:1.6,draw=blue] plot({(\x)^2},\x)
79 node[above,color=cyan] {$y^2=x$};
80 \draw[semithick,domain=0:1.6,draw=blue] plot({(\x)^2},-\x);
81 \draw[semithick,domain=-1.6:1.6,draw=green!60!black] plot(\x,{(\x)^2});
82 \node at (-1.6,-3.2) {$x^2=-y$};
83 \end{tikzpicture}};
84
85

```

```

86 \draw[] (4.5,-3.8) coordinate (A) -- (4.5,2.8) coordinate (B);
87 \draw[dashed] (A) -- (3.1,-2.5) coordinate (C);
88 \draw[] (B) -- (3.2,3.7) coordinate (D);
89 \draw[draw=orange,fill=green!30!black!30!white,opacity=0.5] (A) -- (B)--(C)--(D)--cycle;
90 \draw[dashed] (C) -- (D);
91 \draw[blue, thick] (4.3,-3.4) coordinate (E) .. controls (4,-0.9) and (3.8,-0.6) .. (3.3,-2.5) coordinate (F);
92 \draw[dotted, blue, thick] (E) -- (F);
93 \draw[blue, thick] (4.3,2.6) coordinate (G) .. controls (4,1) and (3.8,0.7) .. (3.3,3.5) coordinate (H);
94 \draw[dotted, blue, thick] (G) -- (H);
95 \draw[] (A) -- (4.1,-3.43);
96 \node[right] at (5,0) {\begin{tikzpicture}[samples=200,scale=1.2]
97 \def\a{0.8}
98 \def\b{2/3}
99 \draw[smooth] (-2,0)--(0,0)node[below left]{$O$}--(2,0)node[below]{$x$};
100 \draw[smooth] (0,-1.5)--(0,1.5)node[left]{$y$};
101 \draw[domain=-70:70] plot ({\a*sec(\x)}, {\b*tan(\x)});
102 \draw[domain=110:250] plot ({\a*sec(\x)}, {\b*tan(\x)});
103 \node[below] at (-1.1,0) {$-a$}; \node[below] at (1.1,0) {$a$};
104 \node at (1.1,1.3) {$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$};
105 \node[align=flush center] at (1.1,-1.3) {$x=a\sec\theta$\\[-2mm]
106 $y=b\tan\theta$};
107 \end{tikzpicture}};
108
109 \pgfpathmoveto{\pgfpoint{-1cm}{-3cm}}
110 \pgfpathharcto{2cm}{0.5cm}{0}{0}{0}{\pgfpoint{-3cm}{-3.5cm}}
111 \pgfpathmoveto{\pgfpoint{-5cm}{-3cm}}
112 \pgfpathharcto{2cm}{0.5cm}{0}{0}{-1}{\pgfpoint{-3cm}{-3.5cm}}
113 \pgfstroke
114
115 \pgfsetdash{{3pt}{3pt}}{0pt}
116 \pgfpathmoveto{\pgfpoint{-1cm}{-3cm}}
117 \pgfpathharcto{2cm}{0.5cm}{0}{0}{-1}{\pgfpoint{-3cm}{-2.5cm}}
118 \pgfpathmoveto{\pgfpoint{-5cm}{-3cm}}
119 \pgfpathharcto{2cm}{0.5cm}{0}{0}{0}{\pgfpoint{-3cm}{-2.5cm}}
120 \pgfstroke
121
122 \pgfsetdash{{3pt}{0pt}}{0pt}
123 \pgfpathmoveto{\pgfpoint{1cm}{-3cm}}
124 \pgfpathharcto{2cm}{0.5cm}{0}{0}{-1}{\pgfpoint{3cm}{-3.5cm}}
125 \pgfpathmoveto{\pgfpoint{5cm}{-3cm}}
126 \pgfpathharcto{2cm}{0.5cm}{0}{0}{0}{\pgfpoint{3cm}{-3.5cm}}
127 \pgfstroke
128
129 \pgfsetdash{{3pt}{3pt}}{0pt}
130 \pgfpathmoveto{\pgfpoint{1cm}{-3cm}}
131 \pgfpathharcto{2cm}{0.5cm}{0}{0}{0}{\pgfpoint{3cm}{-2.5cm}}
132 \pgfpathmoveto{\pgfpoint{5cm}{-3cm}}
133 \pgfpathharcto{2cm}{0.5cm}{0}{0}{-1}{\pgfpoint{3cm}{-2.5cm}}
134 \pgfstroke
135 \end{tikzpicture}
136 \end{document}

```

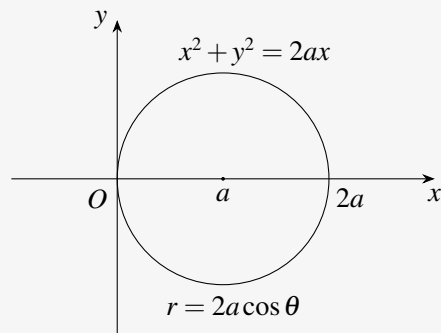


## 1. 在坐标系中的圆

```

1 \begin{tikzpicture} [samples=100]
2 \draw[-Stealth] (-1,0) -- (0,0) node[below left] {$O$} -- (3,0) node[below] {
   $x$};
3 \draw[-Stealth] (0,-1.5) -- (0,1.5) node[left] {$y$};
4 \draw plot[tension=1,smooth cycle] coordinates {(0,0) (1,1) (2,0) (1,-1)};
5 \node [below] at (2.2,0) {$2a$}; \node [below] at (1,0) {$a$};
6 \fill (1,0) circle (0.5pt);
7 \node at (1.1,-1.2) {$r=2a\cos\theta$};
8 \node at (1.3,1.2) {$x^2+y^2=2ax$};
9 \end{tikzpicture}

```

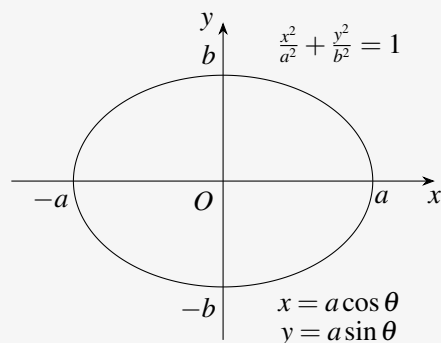


## 2. 椭圆的图像绘制

```

1 \begin{tikzpicture} [samples=200]
2 \draw[-Stealth] (-2,0) -- (0,0) node[below left] {$O$} -- (2,0) node[below] {
   $x$};
3 \draw[-Stealth] (0,-1.5) -- (0,1.5) node[left] {$y$};
4 \draw[domain=0:2*pi] plot ({1.414*cos(\x r)}, {sin(\x r)});
5 \node[left=-1pt] at (0,1.2) {$b$}; \node[left=-1pt] at (0,-1.2) {$-b$};
6 \node[below] at (-1.63,0) {$-a$}; \node[below] at (1.5,0) {$a$};
7 \node at (1.1,1.3) {$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$};
8 \node[align=flush center] at (1.1,-1.3) {$x=a\cos\theta$ \\ [-2mm]
   $y=a\sin\theta$};
9 \end{tikzpicture}

```

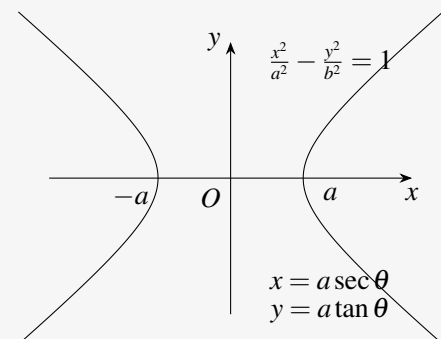


## 3. 双曲线的 tikz 实现

```

1 \begin{tikzpicture} [samples=200,scale=1.2]
2 \def\{a\}{0.8}
3 \def\{b\}{2/3}
4 \draw[-Stealth] (-2,0) -- (0,0) node[below left] {$O$} -- (2,0) node[below] {
   $x$};
5 \draw[-Stealth] (0,-1.5) -- (0,1.5) node[left] {$y$};
6 \draw[domain=-70:70] plot ({\{a\}*sec(\x)}, {\{b\}*tan(\x)});
7 \draw[domain=110:250] plot ({\{a\}*sec(\x)}, {\{b\}*tan(\x)});
8 \node[below] at (-1.1,0) {$-a$}; \node[below] at (1.1,0) {$a$};
9 \node at (1.1,1.3) {$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$};
10 \node[align=flush center] at (1.1,-1.3) {$x=a\sec\theta$ \\ [-2mm]
   $y=a\tan\theta$};
11 \end{tikzpicture}

```

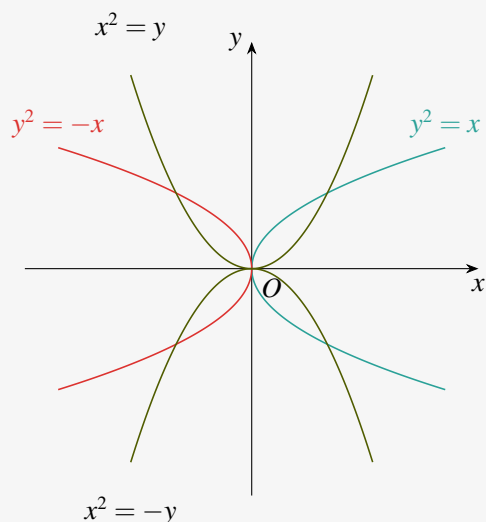


## 4. 抛物线的绘制

```

1 \begin{tikzpicture} [samples=100]
2 \draw[-Stealth] (-3,0) -- (0,0) node[below right] {$O$} -- (3,0) node[below] {
   $x$};
3 \draw[-Stealth] (0,-3) -- (0,3) node[left] {$y$};
4 \draw[semithick,domain=0:1.6,draw=cyan] plot ({(\x)^2}, {\x})
5 node[above,color=cyan] {$y^2=x$};
6 \draw[semithick,domain=0:1.6,draw=red] plot ({-(\x)^2}, {\x})
7 node[above,color=red] {$y^2=-x$};
8 \draw[semithick,domain=0:1.6,draw=cyan] plot ({(\x)^2}, {-\x});
9 \draw[semithick,domain=0:1.6,draw=red] plot ({-(\x)^2}, {-\x});
10 \draw[semithick,domain=-1.6:1.6,draw=green!60!black] plot (\x, {(\x)^2});
11 \node at (-1.6,3.2) {$x^2=y$};
12 \draw[semithick,domain=-1.6:1.6,draw=green!60!black] plot (\x, {-(\x)^2});
13 \node at (-1.6,-3.2) {$x^2=-y$};
14 \end{tikzpicture}

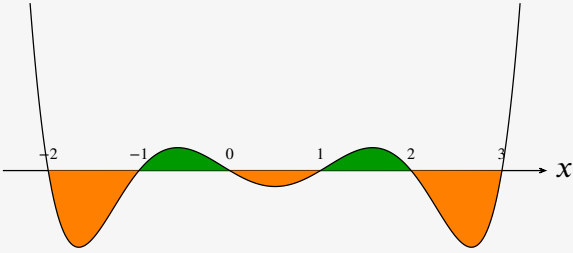
```



### 3.9 图像阴影填充面积与定积分

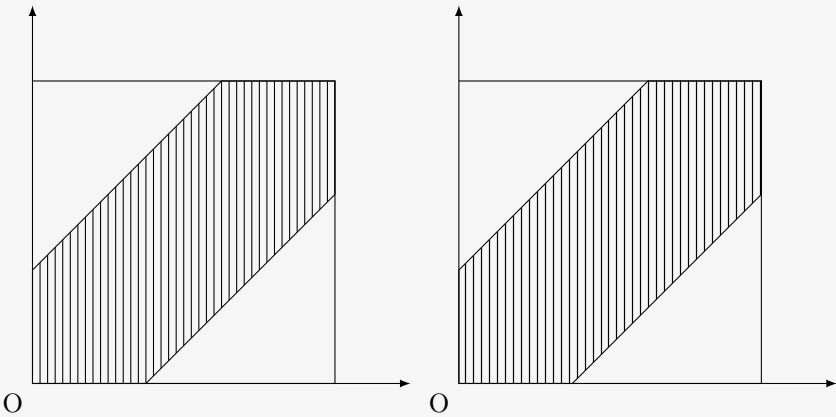
#### 1. 不等式的“穿针引线”法

```
1 \begin{tikzpicture} [smooth]
2 \draw[arrows={-Stealth[length=5pt, inset=3.5pt]}] (-2.5,0)
   -- (3.5,0) node (xaxis) [right=-1pt] {$x$};
3 \foreach \D/\C in {{-2:-1}/orange, {-1:0}/green!60!black
   , {0:1}/orange, {1:2}/green!60!black, {2:3}/orange}
4 \draw[color=black, domain=\D, fill=\C] plot (\x, {0.05*\x*(\x
   +2)*(\x+1)*(\x-1)*(\x-2)*(\x-3)});
5 \foreach \M in {{-2.2:-2}, {3:3.2}}
6 \draw[color=black, domain=\M] plot (\x, {0.05*\x*(\x+2)*(\x
   +1)*(\x-1)*(\x-2)*(\x-3)});
7 \foreach \N in {-2,-1,...,3}
8 \node[above] at (\N,0) {\tiny $\N$};
9 \end{tikzpicture}
```



#### 2. 线性规划

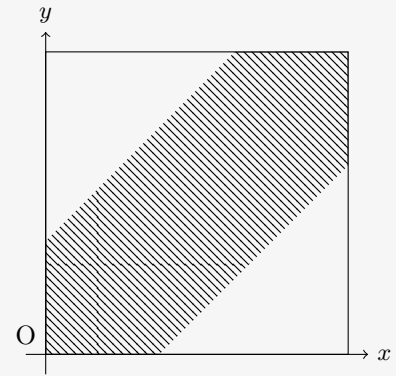
```
1 \documentclass{standalone}
2 \usepackage{tikz}
3 \usetikzlibrary{patterns}
4 \begin{document}
5   \begin{tikzpicture}
6     \draw[-latex] (0, 0) node[below left]{O}-- (5, 0);
7     \draw[-latex] (0, 0) -- (0, 5);
8     \draw (0, 0) -- (4, 0) -- (4, 4) -- (0, 4);
9     \draw[clip] (1.5, 0) -- (4, 2.5) -- (4, 4) -- (2.5, 4) -- (0, 1.5) -- (0, 0) -- cycle;
10    \foreach \x in {0, 0.1,...,5}{
11      \draw (\x, 0) -- (\x, 5);
12    }
13  \end{tikzpicture}
14  \begin{tikzpicture}
15    \draw[-latex] (0, 0) node[below left]{O}-- (5, 0);
16    \draw[-latex] (0, 0) -- (0, 5);
17    \draw (0, 0) -- (4, 0) -- (4, 4) -- (0, 4);
18    \path[draw, pattern=vertical lines] (1.5, 0) -- (4, 2.5) -- (4, 4) -- (2.5, 4) -- (0, 1.5) -- (0, 0) -- cycle;
19  \end{tikzpicture}
20 \end{document}
```



```

1 \documentclass{standalone}
2 \usepackage{tikz}
3 \usetikzlibrary{patterns}
4 \usetikzlibrary{datavisualization}
5 \begin{document}
6 \begin{tikzpicture}
7 \datavisualization[
8 school book axes,
9 x axis={label={\mathbf{x}}, ticks={major={at={}}}},
10 y axis={label={\mathbf{y}}, ticks={major={at={}}}},
11 ]
12 data{
13 \mathbf{x}, \mathbf{y}
14 0, 0
15 4, 4
16 };
17 \begin{scope}
18 \draw [draw=black] (0,0) rectangle (4,4);
19 \draw (0,0) node[above left]{0};
20 \draw (0,-2) node[below left]{\mathbf{-2}};
21 \clip (1.5, 0) -- (4, 2.5) -- (4, 4) -- (2.5, 4) -- (0,
22 1.5) -- (0, 0);
23 \draw [pattern=north west lines, draw=black] (0,0) rectangle
24 (4,4);
25 \end{scope}
26 \end{tikzpicture}
27 \end{document}

```



-2

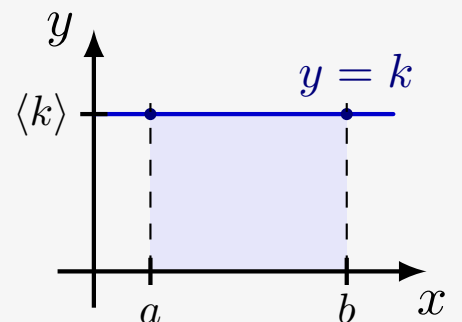
### 3. 定积分

```

1 \begin{tikzpicture}
2 \message{^^JConstant}
3 \def\mathbf{a}{0.17*\mathbf{xmax}} % first limit
4 \def\mathbf{b}{0.76*\mathbf{xmax}} % last limit
5 \def\mathbf{k}{0.65*\mathbf{ymax}} % constant value
6 \fill[myblue!10] (\mathbf{a},0) rectangle (\mathbf{b},\mathbf{k});
7 \draw[->,thick] (0,-0.15*\mathbf{ymax}) -- (0,\mathbf{ymax}) node[left]{\mathbf{y}};
8 \draw[->,thick] (-0.15*\mathbf{ymax},0) -- (\mathbf{xmax},0) node[right=1,below]{\mathbf{x}};
9 \draw[xline,line cap=round] (0,\mathbf{k}) -- (0.9*\mathbf{xmax},\mathbf{k})
10 node[mydarkblue,left=7,above=0,scale=0.9]{\mathbf{y=k}};
11 \fill[mydarkblue] (\mathbf{a},\mathbf{k}) circle(0.04) (\mathbf{b},\mathbf{k}) circle(0.04);
12 \draw[dashed] (\mathbf{a},0) --++ (0,1.07*\mathbf{k});
13 \draw[dashed] (\mathbf{b},0) --++ (0,1.07*\mathbf{k});
14 \tick{\mathbf{a},0}{90} node[below=-2.5,scale=0.8]{\mathbf{a}};
15 \tick{\mathbf{b},0}{90} node[below=-2.5,scale=0.8]{\mathbf{b}};
16 \tick{0,\mathbf{k}}{0} node[left=-1,scale=0.8]{\mathbf{k}};
17 \node at (-5,0.7){\mathbf{\int_a^b k dx = k(b-a)}};
18 \end{tikzpicture}

```

$$\int_a^b k \, dx = k(b - a)$$

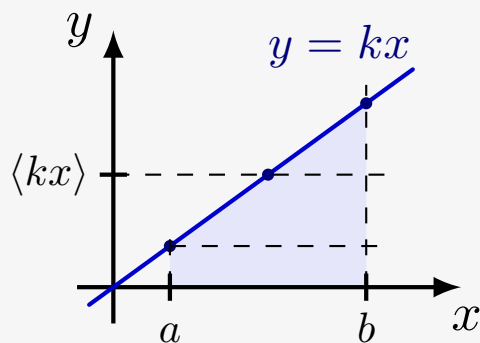


```

1 \begin{tikzpicture}
2   \message{^^JLinear}
3   \def\ax{0.17*\xmax} % first limit
4   \def\bx{0.76*\xmax} % last limit
5   \def\k{\ymax/\xmax} % slope coefficient
6   \fill[myblue!10] (\ax,0) -- (\ax,\k*\ax) -- (\bx,\k*\bx) |- cycle;
7   \draw[->,thick] (0,-0.15*\ymax) -- (0,\ymax+0.1) node[left] {$y$};
8   \draw[->,thick] (-0.15*\ymax,0) -- (\xmax+0.1,0) node[right=1,below] {$x$};
9   \draw[xline,line cap=round]
10    (-0.1*\ymax,-0.1*\k*\ymax) -- (0.9*\xmax,0.9*\k*\xmax)
11    node[mydarkblue,above left=-3,scale=0.9] {$y=kx$};
12   \fill[mydarkblue]
13    (\ax,\k*\ax) circle(0.04) (\bx,\k*\bx) circle(0.04)
14    ({(\bx+\ax)/2},{\k*(\bx+\ax)/2}) circle(0.04);
15   \draw[dashed] (\ax,0) --++ (0,1.25*\k*\ax);
16   \draw[dashed] (\bx,0) --++ (0,1.10*\k*\bx);
17   \draw[dashed] (0,{\k*(\bx+\ax)/2}) --++ (1.1*\bx,0);
18   \draw[dashed] (\ax,\k*\ax) --++ ({1.1*(\bx-\ax)},0);
19   \tick{\ax}{90} node[below=-2,scale=0.8] {\strut$a$};
20   \tick{\bx}{90} node[below=-2,scale=0.8] {\strut$b$};
21   \tick{0,{\k*(\bx+\ax)/2}}{0} node[left=-1,scale=0.8] {$\expval{kx}$};
22   \node at (-4.55,0.7) {$\displaystyle\int_{\ax}^{\bx} kx\,dx=\dfrac{k}{2}\left(b^2-a^2\right)$};
23 \end{tikzpicture}

```

$$\int_a^b kx \, dx = \frac{k}{2} (b^2 - a^2)$$

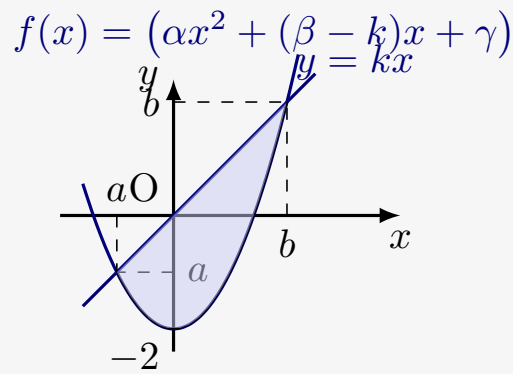


```

1 \begin{tikzpicture}
2   \draw (0,0) node[above left]{O};
3   \draw[thick,->] (-1,0) -- (2,0) node[below]{$x$};
4   \draw[thick,->] (0,-1.2) -- (0,1.2) node[left]{$y$};
5   \begin{scope}[scale=0.5]
6     \draw[thick,color=mydarkblue,domain=-1.6:2.5] plot (\x,\x) node at (3.2,2.7) {$y = kx$};
7     \draw[thick,color=mydarkblue,domain=-1.6:2.2,smooth] plot (\x,{\x * \x - 2}) node at (1.6,3.2) {$f(x)=\left(\alpha x^2+(\beta-k)x+\gamma\right)$};
8     \draw[dashed] (2,0) node [below]{$b$}--(2,2);
9     \draw[thin,dashed] (0,2) node [left]{$b$}--(2,2);
10    \draw[thin,dashed] (-1,0) node [above]{$a$}--(-1,-1);
11    \draw[thin,dashed] (0,-1) node [right]{$a$}--(-1,-1);
12    \draw (0,-2) node [below left]{$-2$};
13    \clip (-2.5,-2.5) |- (0,-2.5) |- (2.5,2.5) --cycle;
14    \clip [draw,domain=-2:2.2] plot (\x,{\x * \x - 2});
15    \draw [fill=myblue!20,opacity=0.5] (-2,-2) rectangle (2,2);
16  \end{scope}
17  \node[align=left] at (-4.55,0.7) {$\displaystyle\int_{\ax}^{\bx}\left(\alpha x^2+(\beta-k)x+\gamma\right)\,dx=\dfrac{\alpha}{3}\left(b^3-a^3\right)-\dfrac{(\beta-k)}{2}\left(b^2-a^2\right)+\gamma(b-a)$};
18  \node[align=left] at (-4.55,0.7) {$\displaystyle\int_{\ax}^{\bx}\left(\alpha x^2+(\beta-k)x+\gamma\right)\,dx=\dfrac{\alpha}{3}\left(b^3-a^3\right)-\dfrac{(\beta-k)}{2}\left(b^2-a^2\right)+\gamma(b-a)$};
19  \node[align=left] at (-4.55,0.7) {$\displaystyle\int_{\ax}^{\bx}\left(\alpha x^2+(\beta-k)x+\gamma\right)\,dx=\dfrac{\alpha}{3}\left(b^3-a^3\right)-\dfrac{(\beta-k)}{2}\left(b^2-a^2\right)+\gamma(b-a)$};
20 \end{tikzpicture}

```

$$\int_a^b (\alpha x^2 + (\beta - k)x + \gamma) \, dx = \frac{\alpha}{3} (b^3 - a^3) - \frac{(\beta - k)}{2} (b^2 - a^2) + \gamma(b - a)$$

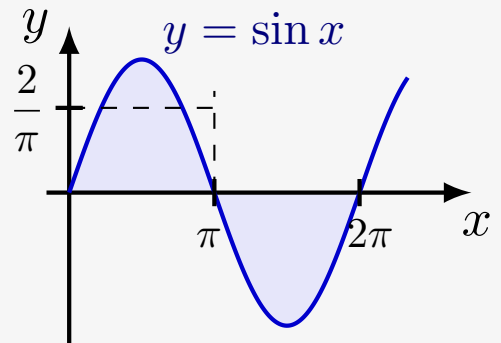


```

1 \def\xmax{3.2}
2 \begin{tikzpicture}
3   \message{^^JSine}
4   \def\ymax{1.0}
5   \def\T{0.60*\xmax}
6   \def\A{0.88*\ymax}
7   \fill[myblue!10,samples=\N,smooth,variable=\x,domain=0:\T]
8     plot(\x,{\A*sin(360/(\T)*\x)});
9   \draw[->,thick] (0,-\ymax) -- (0,\ymax+0.1) node[left] {$y$};
10  \draw[->,thick] (-0.15*\ymax,0) -- (0.80*\xmax+0.1,0) node[right=1,below] {$x$};
11  \draw[xline,samples=\N,smooth,variable=\x,domain=0:0.7*\xmax]
12    plot(\x,{\A*sin(360/(\T)*\x)});
13  \draw[dashed] (0,2*\A/pi) --++ (0.50*\T,0);
14  \draw[dashed] (0.5*\T,0) --++ (0,2.4*\A/pi);
15  \tick{\T/2,0}{90} node[left=1,below=-2,scale=0.8] {\strut$\pi$};
16  \tick{\T,0}{90} node[right=2,below=-2,scale=0.8] {\strut$2\pi$};
17  \tick{0,2*\A/pi}{0} node[left=-1,scale=0.8] {$\dfrac{2}{\pi}$};
18  \node[above right=-2,mydarkblue,scale=0.9] at (0.3*\T,\A) {$y=\sin x$};
19  \node at (-4.5,0.3) {$\displaystyle\int_0^{2\pi}\sin x\,dx=0$};
20 \end{tikzpicture}

```

$$\int_0^{2\pi} \sin x \, dx = 0$$



```

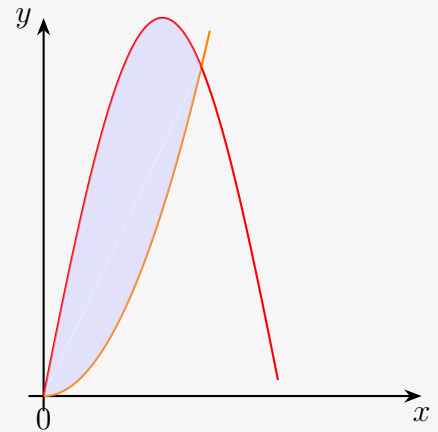
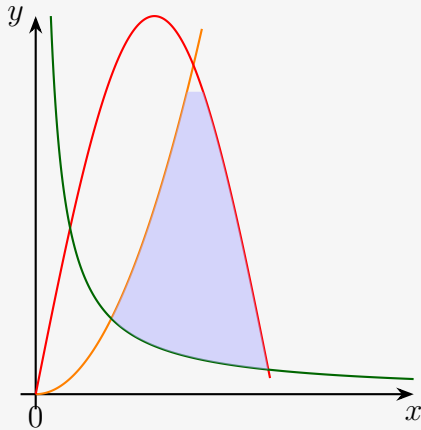
1 \documentclass[12pt,border=5pt]{standalone}
2 \usepackage{amsmath,tikz}
3 \usetikzlibrary{arrows.meta}
4 \begin{document}
5 \begin{tikzpicture}[thick]
6   \draw[thick,->,arrows = {-Stealth[reversed, reversed]}] (-0.2,0) -- (0,0) node[right,below] {0} -- (5,0) node[below] {$x$};
7   \draw[thick,->,arrows = {-Stealth[reversed, reversed]}] (0,-0.2) -- (0,5) node[left] {$y$};
8   \begin{scope}
9     \clip plot[samples=400,domain=0:2] (\x,{\x^2}) --++ (-3,0) --cycle;
10    %\path[fill=blue!10] (0,0) --plot[domain=0:pi] (\x,{5*\sin(\x r)}) --cycle;
11  \end{scope}
12  \draw[orange] plot[samples=400,domain=0:2.2] (\x,{\x^2});
13  \draw[red,domain=0:3.1] plot[samples=400] (\x,{5*\sin(\x r)});
14
15  \begin{scope}
16    \clip (0,0) plot[domain=0:2] (\x,{\x^2}) -- (5,2) -- (5,0) --cycle;
17    \clip plot[domain=1:5] (\x,{1/\x}) -- (5,0) -- (0,0) -- (0,5) --cycle;

```

```

18 \end{scope}
19
20 \begin{scope}
21 \draw[green!40!black] plot[samples=400,domain=0.2:5] (\x, {1/\x});
22 \clip plot[domain=0:2] (\x, {\x^2}) ---- (2,0) -- (5,0) --cycle;
23 \clip plot[domain=0.1:5] (\x, {1/\x}) -- (5,5) --cycle;
24 \clip plot[domain=0:pi] (\x, {5*sin(\x r)}) -- (0,0);
25 \path[fill=blue!30,opacity=0.5] (0,0) rectangle (5,5);
26 \end{scope}
27 \end{tikzpicture}
28 \end{document}

```



```

1 \documentclass[12pt,border=5pt]{standalone}
2 \usepackage{amsmath,tikz}
3 \usetikzlibrary{arrows.meta,intersections}
4 \begin{document}
5 \begin{tikzpicture}[thick]
6 \draw[thick,->,arrows = {-Stealth[reversed, reversed]}] (-0.2,0) -- (0,0) node[below] {$x$};
7 \draw[thick,->,arrows = {-Stealth[reversed, reversed]}] (0,-0.2) -- (0,5) node[left] {$y$};
8
9 \draw[name path=line1,orange] plot[samples=400,domain=0:2.2] (\x, {(\x)^2});
10 \draw[name path=line2,red,domain=0:3.1] plot[samples=400] (\x, {5*sin(\x r)});
11 %\draw[name intersections={of=line1 and line2,by={a,b}},red] (a) -- (b);
12 \path[name intersections={of=line1 and line2,by={a,b}},fill=blue!20,opacity=0.5] plot[domain=0:2.08] (\x, {5*sin(\x r)})
13 --plot[samples=400,domain=0:2.1] (\x, {(\x)^2}) --cycle;
14 \end{tikzpicture}
15 \end{document}

```

```

1 \begin{tikzpicture}[smooth]
2 \draw[arrows={-Stealth[length=5pt, inset=3.5pt]}] (-0.5,0) --
3 (2.1*pi,0) node (xaxis) [right=-1pt] {$x$};
4 \draw[arrows={-Stealth[length=5pt, inset=3.5pt]}] (0,-0.5) --
5 (0,2.5) node (yaxis) [above=-0.6pt] {$y$};
6 \draw (-0.18,-0.18) node (o) {$o$};
7 \draw[color=red,domain=0:2*pi,fill=green!20] plot (\x, {sin(\x r)});
8 \draw[color=black,domain=0:3,fill=gray,opacity=0.5] plot (\x
9 , 3*\x-\x^2) ;
10 \end{tikzpicture}

```





## 4 统计图的 TikZ 绘制

### 4.1 折线图的 TikZ 绘制

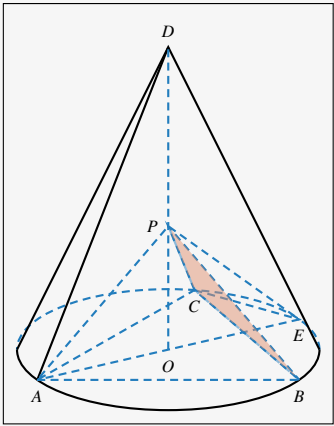
### 4.2 柱状图的 TikZ 绘制

### 4.3 饼图的 TikZ 绘制

## 5 几何图形的 TikZ 绘制

### 5.1 平面几何图形的 TikZ 绘制

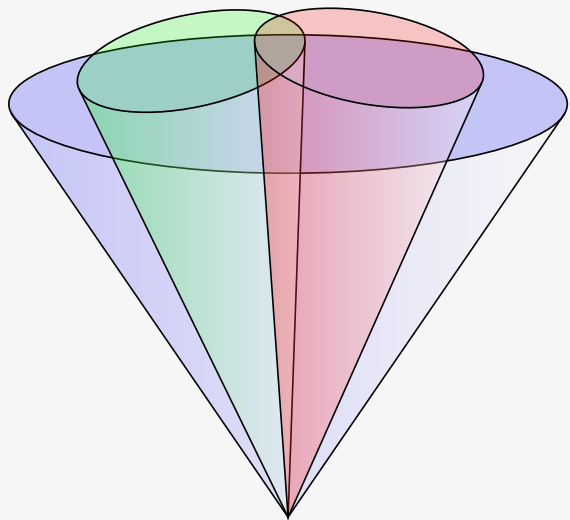
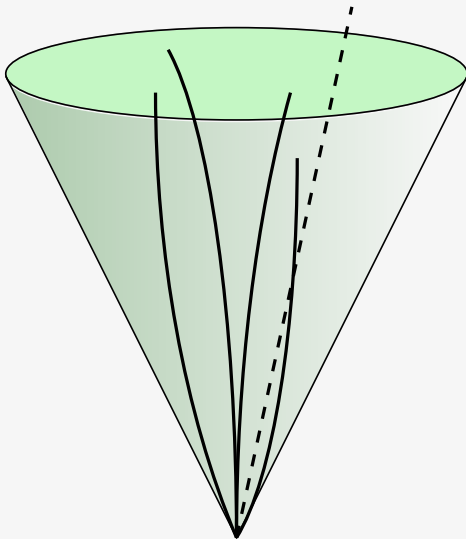
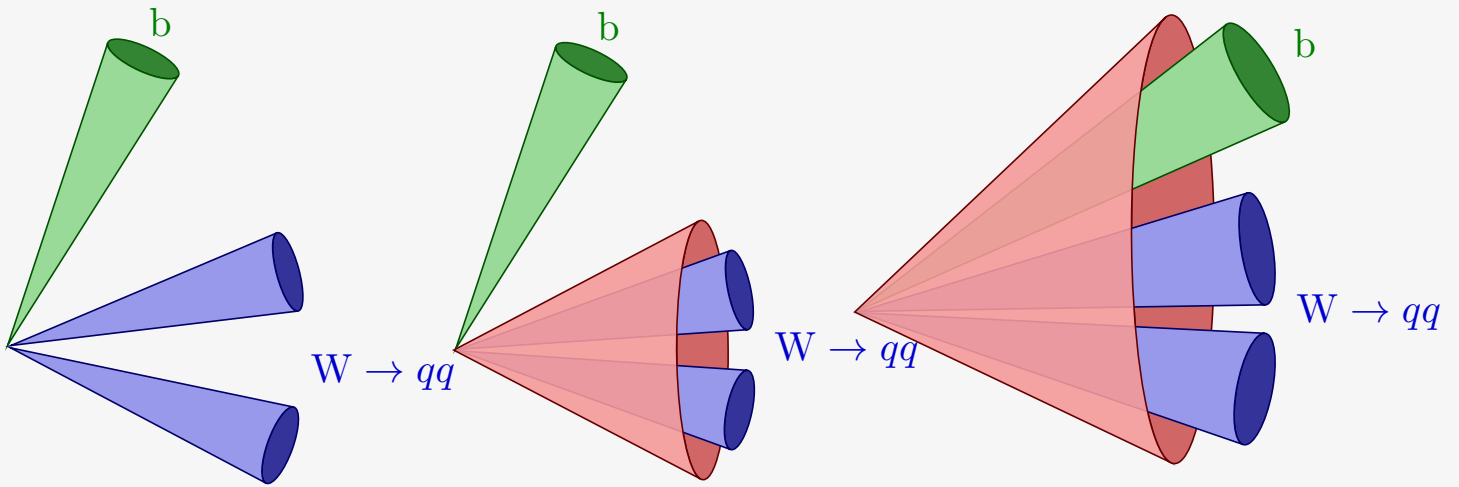
### 5.2 空间几何图形的 TikZ 绘制



```

1 \usetikzlibrary{math} % for \tikzmath
2 \tikzset{>=latex} % for LaTeX arrow head
3 \usetikzlibrary{decorations.pathreplacing} % for curly braces
4
5 \colorlet{myblue}{blue!70!black}
6 \colorlet{mydarkblue}{blue!40!black}
7 \colorlet{mygreen}{green!40!black}
8 \colorlet{myred}{red!65!black}
9 \tikzstyle{vector}=[->,very thick,myblue,line cap=round]
10 \tikzstyle{ptmiss}=[->,dashed,thick,myred,line cap=round]
11 \tikzstyle{cone}=[thin,blue!50!black,fill=blue!50!black!30] %,fill opacity=0.8
12 \tikzstyle{conebase}=[cone,fill=blue!50!black!50] %,fill opacity=0.8
13
14 \newcommand\jetcone[5][blue]{%
15   \pgfmathanglebetweenpoints{\pgfpointanchor{#2}{center}}{\pgfpointanchor{#3}{center}}
16   \edef\ang{#4/2}
17   \edef\e{#5}
18   \edef\vang{\pgfmathresult} % angle of vector OV

```



## 6 图像的大致图像的 TikZ 绘制

## 7 混合图形的 TikZ 绘制

## 8 PGFplots 实现杂例

本手册中的图像是使用TikZ-network library 或 TikZ。为每个图像指定用于此的代码。

```
1 \begin{tikzpicture}
2 \filldraw (-.2,.2) circle (2pt)
3 (.2,.2) circle (2pt);
4 \draw (0,0) circle (5mm) (-.3,-.1) .. controls (0,-.3) .. (.3,-.1);
5 \end{tikzpicture}
```

