1

TikZ 空间立体几何

序　　言

由于各种原因，上期上传的 TikZ 绘图资源：高中数学 TikZ 绘图合集后有两部分内容没有完成，现在将空间几何部分的内容上传于此文档，内容编辑和搜集全程本人来做，若有问题请反馈至我的邮箱：yonguel487@qq.com.

内容概要

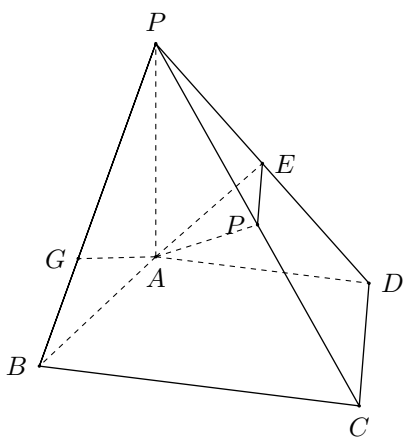
本部分内容主要是空间立体几何的图形绘制，高中数学教师下载学习颇有价值，这里强烈推荐。绘制的图形来自于 2019－2021 年全国高考真题卷的空间集合试题，考虑到严肃性和规范性，绘制过程中几乎没有采用彩色绘制、填充等。笔记来自于之前的模板：TikZ 数表数据科研绘图。

1.0 高中立体几何图形的 TIKZ 实现

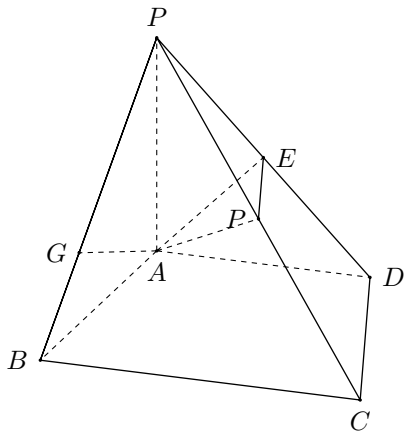
由于各种原因，上期上传的 TikZ 绘图资源：高中数学 TikZ 绘图合集后有两部分内容没有完成，现在将空间几何部分的内容上传于此文档，内容编辑和搜集全程本人来做，若有问题请反馈至我的邮箱：yonguel487@qq.com.

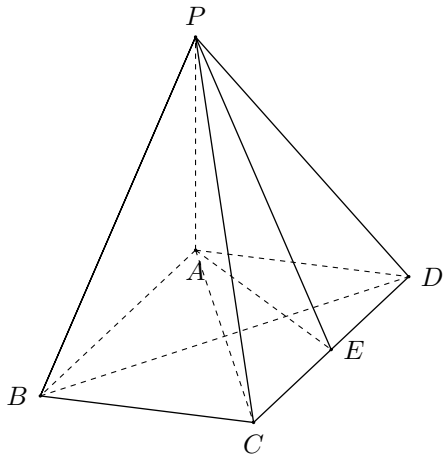
本部分内容主要是空间立体几何的图形绘制，高中数学教师下载学习颇有价值，这里强烈推荐。绘制的图形来自于 2019 – 2021 年全国高考真题卷的空间集合试题，考虑到严肃性和规范性，绘制过程中几乎没有采用彩色绘制、填充等。笔记来自于之前的模板：TikZ 数表数据科研绘图。

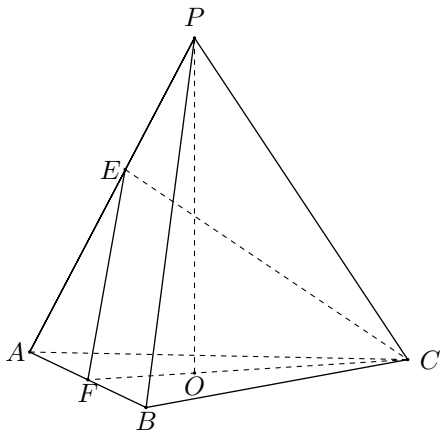
```
\begin{tikzpicture}[yscale=2,xscale=2,line width=0.5pt,tdplot_main_coords]
%% ========================================
\coordinate (A) at (2,0,0);
\coordinate (B) at (2,1,0);
\coordinate (C) at (0,1,0);
\coordinate (D) at (0,0,0);
\coordinate (A1) at (2,0,2);
\coordinate (B1) at (2,1,2);
\coordinate (C1) at (0,1,2);
\coordinate (D1) at (0,0,2);
\coordinate (E) at (1,1,0);
\coordinate (M) at (2,1,1);
\coordinate (N) at (1,0,1);
%% ========================================
```

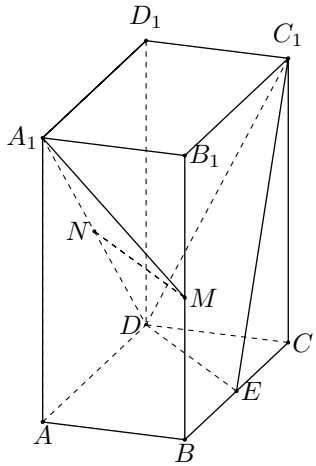


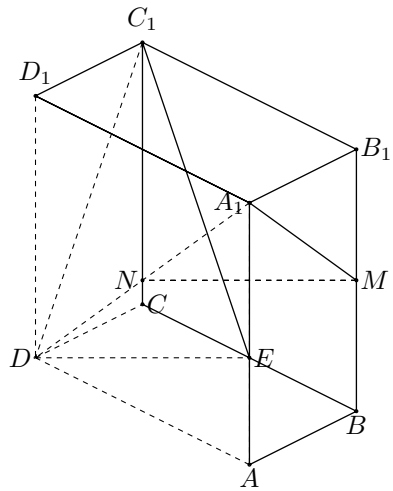

```
\begin{tikzpicture}[yscale=2,xscale=2,line width=0.5pt,tdplot
    _main_coords]
%% ========================================
\coordinate (A) at (2,0,0);
\coordinate (B) at (2,1,0);
\coordinate (C) at (0,1,0);
\coordinate (D) at (0,0,0);
\coordinate (A1) at (2,0,2);
\coordinate (B1) at (2,1,2);
\coordinate (C1) at (0,1,2);
\coordinate (D1) at (0,0,2);
\coordinate (E) at (1,1,0);
\coordinate (M) at (2,1,1);
\coordinate (N) at (1,0,1);
%% ========================================
```

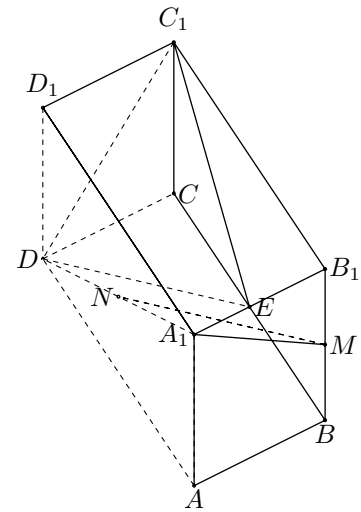

P
E
P
G
A
D
B
C

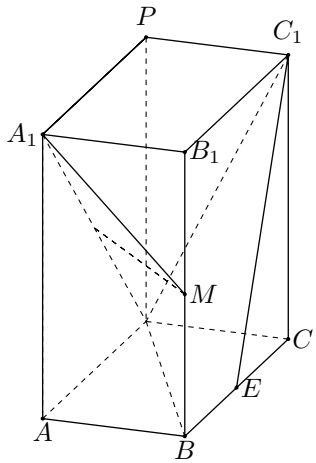

P
A
D
E
B
C

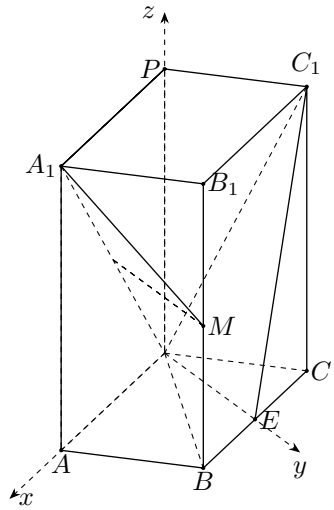

P
E
A
C
F
O
B

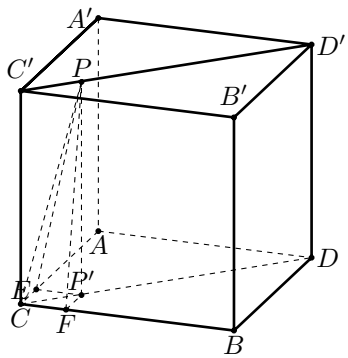

D_1
C_1
A_1
B_1
N
M
D
C
E
A
B

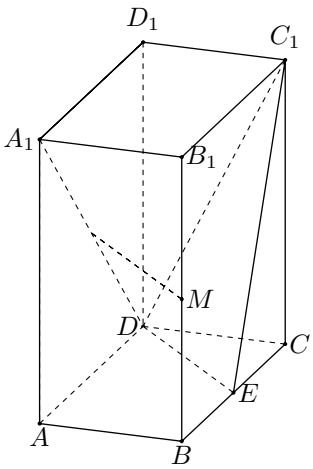

C_1
D_1
B_1
A_1
N
M
C
D
E
B
A

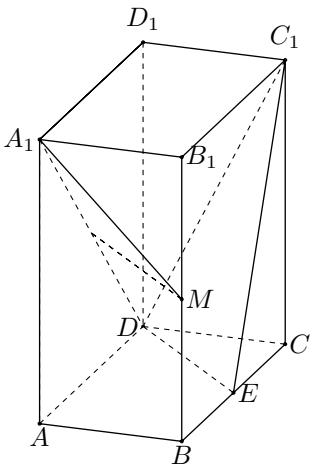

C_1
D_1
C
D
B_1
N
E
A_1
M
B
A

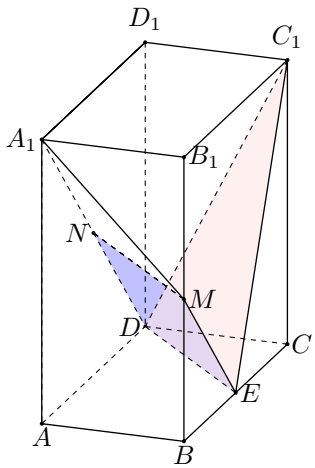

P
C_1
A_1
B_1
M
C
E
A
B


z
P
C_1
A_1
B_1
M
C
E
A
B
y
x


A'
D'
C'
P
B'
A
D
E
P'
C
F
B


D_1
C_1
A_1
B_1
M
D
C
E
A
B


D_1
C_1
A_1
B_1
M
D
C
E
A
B


D_1
C_1
A_1
B_1
N
M
D
C
E
A
B

2

不等式与线性规划

序　　言

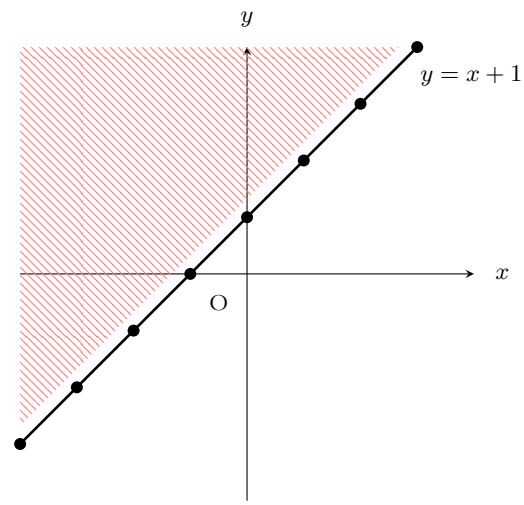
线性规划的第一步是定义一个目标函数，通常用于表示最大化或最小化的目标。这个函数通常是线性的，例如成本、利润或效益.

内容概要

线性规划与数学与图形的结合是一种有助于解决线性规划问题的方法，通常在高中数学教育中教授。这种方法结合了代数和几何的思维方式，使学生能够更好地理解线性规划问题.

```
\begin{tikzpicture}[scale=0.8,>=stealth,baseline=-11pt
    ]
\draw[->](-4,0) -- (4,0);\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\coordinate (A) at (-4,-3);\coordinate (B) at (3,4);
  \draw[line width=1pt](A)--(B);
  \fill[pattern color=red!50,pattern=north west lines] (
      [yshift=9pt] A)--([xshift=-9pt] B)--(-4,4)--cycle;
  \draw(3,3.5) node[right,fill=white,inner sep=1pt]{
      \footnotesize \(y=x+1\)};
  \fill (-4,-3) circle (3pt)(-3,-2) circle (3pt)(-2,-1)
      circle (3pt)
    (-1,0) circle (3pt)(0,1) circle (3pt)(1,2) circle (3
       pt)(2,3) circle (3pt);
  \fill (3,4) circle (3pt);
  \draw(0,-5) node {$x-y+1>0$};
\end{tikzpicture}
```

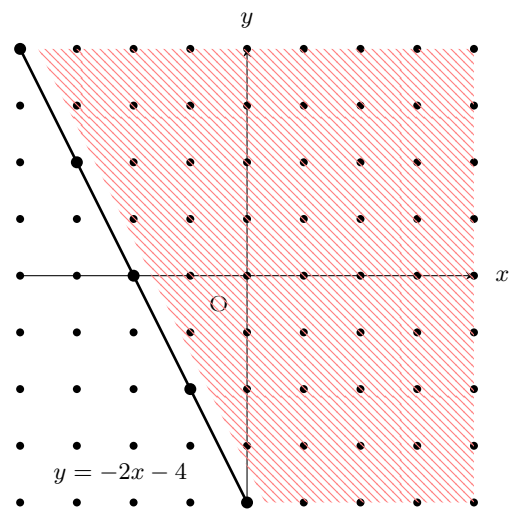
SCIENTIFIC DRAWING



$x - y + 1 > 0$

```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline=-11pt
    ]
\draw[->](-4,0) -- (4,0);\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\coordinate (A) at (-4,4)(B) at (0,-4);
  \draw[line width=1pt](A)--(B);
  \fill[pattern color=red!50,pattern=north west lines] (
      [xshift=9pt] A)--([xshift=9pt] B)--(4,-4)--(4,4)--
      cycle;
  \draw(-1,-3.5) node [left,fill=white,inner sep=1pt] {
      \footnotesize \(y=-2x-4\)};
  \fill (-4,4) circle (3pt)(-3,2) circle (3pt) (-2,0)
      circle (3pt);
  \fill (-1,-2) circle (3pt)(0,-4) circle (3pt);
  \draw(0,-5) node {\footnotesize $2x+y+4>0$};
\end{tikzpicture}
```

SCIENTIFIC DRAWING

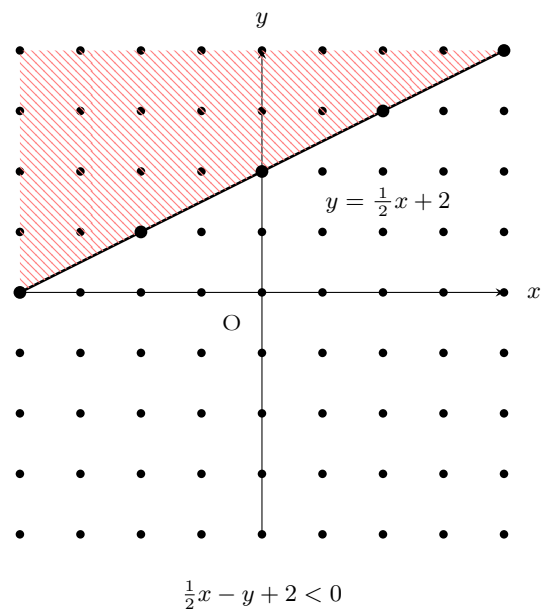


$2x + y + 4 > 0$

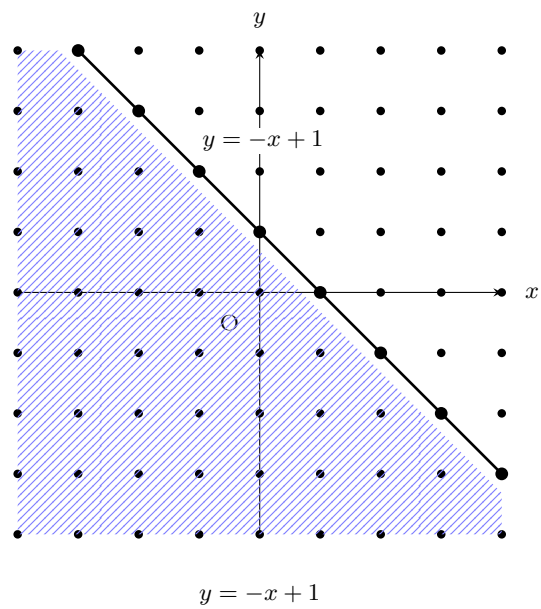
```
\begin{tikzpicture}[scale=0.8,>=stealth,baseline=-11pt]
\draw[->](-4,0) -- (4,0);\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
```

```
\draw(0,4.5) node {\footnotesize␣$y$};
\foreach \x in {-4,...,4}{\foreach␣\y␣in␣{-4,...,4}{\fill␣(\x,\y)␣circle␣(2pt);}}
\coordinate (A) at (-4,0);\coordinate (B) at (4,4);
  \draw[line␣width=1pt](A)--(B);
  \fill[pattern␣color=red!50,␣pattern=north␣west␣lines] (A)--(B)--(-4,4)--cycle;
  \draw(1,1.5) node[right,fill=white,inner␣sep=1pt]{\footnotesize␣\(y={\,1\,\over2}x+2 \)};
  \fill (-4,0) circle (3pt)(-2,1) circle (3pt);
  \fill (0,2) circle (3pt)(2,3) circle (3pt);
  \fill (4,4) circle (3pt);
  \draw(0,-5) node {\footnotesize␣$\frac{1}{2}x-y+2<0$};
\end{tikzpicture}
```

SCIENTIFIC DRAWING



$\frac{1}{2}x-y+2<0$



$y=-x+1$

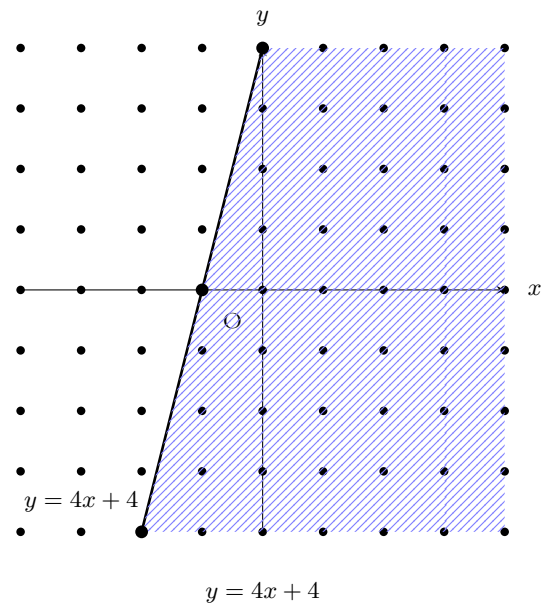
DEFINITION

```
  \begin{tikzpicture}[scale=0.4,␣>=stealth,␣baseline=-11pt]
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize␣0};
\draw(4.5,0) node {\footnotesize␣$x$};
\draw(0,4.5) node {\footnotesize␣$y$};
\foreach \x in {-4,...,4}{\foreach␣\y␣in␣{-4,...,4}{\fill␣(\x,\y)␣circle␣(2pt);}}
\coordinate (A) at (-3,4);
\coordinate (B) at (4,-3);
  \draw[line␣width=1pt](A)--(B);
  \fill[pattern␣color=blue!50,␣pattern=north␣east␣lines] ([xshift=-9pt] A)--([yshift=-9pt] B)--(4,-4)
      --(-4,-4)--(-4,4)--cycle;
  \draw(-1,2.5) node[right,fill=white,inner␣sep=1pt]{\footnotesize␣\(y=-x+1\)};
  \fill (-3,4) circle (3pt);
  \fill (-2,3) circle (3pt);
```

```
  \fill (-1,2) circle (3pt);
  \fill (0,1) circle (3pt);
  \fill (1,0) circle (3pt);
  \fill (2,-1) circle (3pt);
  \fill (3,-2) circle (3pt);
  \fill (4,-3) circle (4pt);
  \draw(0,-5) node {\footnotesize␣\(y=-x+1\)};
\end{tikzpicture}
```

```
 \begin{tikzpicture}[scale=0.4,␣>=stealth,␣baseline
     =-11pt]
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize␣O};
\draw(4.5,0) node {\footnotesize␣$x$};
\draw(0,4.5) node {\footnotesize␣$y$};
\foreach \x in {-4,...,4}{\foreach␣\y␣in␣{-4,...,4}{
    \fill␣(\x,\y)␣circle␣(2pt);}}
\coordinate (A) at (-2,-4);
\coordinate (B) at (0,4);
  \draw[line␣width=1pt](A)--(B);
  \fill[pattern␣color=blue!50,␣pattern=north␣east␣
      lines] (A)--(B)--(4,4)--(4,-4)--cycle;
  \draw(-2,-3.5) node[left,fill=white,inner␣sep=1pt]{
      \footnotesize␣\(y=4x+4\)};
  \fill (-2,-4) circle (3pt);
  \fill (-1,0) circle (3pt);
  \fill (0,4) circle (3pt);
  \draw(0,-5) node {\footnotesize␣\(y=4x+4\)};
\end{tikzpicture}
```

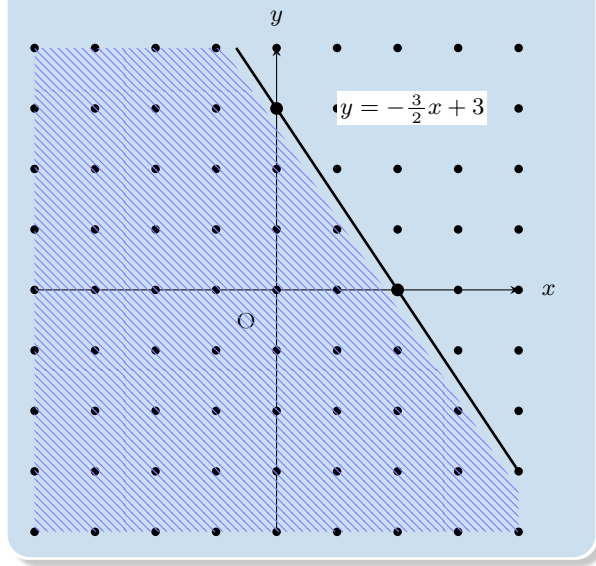
SCIENTIFIC DRAWING



$y = 4x + 4$

```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\coordinate (A) at ($ (-2/3,{-3/2*(-2/3)+3}) $);
\coordinate (B) at ($ (4,{-3/2*(4)+3}) $);
  \draw[line width=1pt](A)--(B);
  \fill[pattern color=blue!50,pattern=north west
    lines] ([xshift=-6pt] A)--([yshift=-9pt] B)
    --(4,-4)--(-4,-4)--(-4,4)--cycle;
  \draw(1,3) node[right,fill=white,inner sep=1pt]{
    \footnotesize \(y=-{\,3\,\over2}x+3 \)};
  \fill (0,3) circle (3pt);
  \fill (2,0) circle (3pt);
  \draw(0,-5) node {\footnotesize \(y=-{\,3\,\over2}x
    +3 \)};
\end{tikzpicture}
```

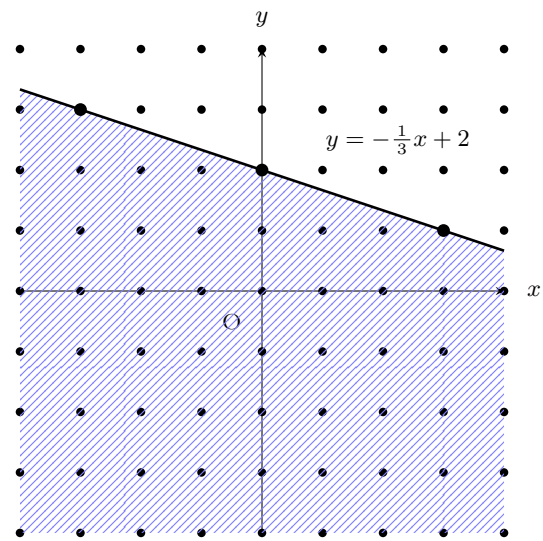
RESULTS



$y=-\frac{3}{2}x+3$

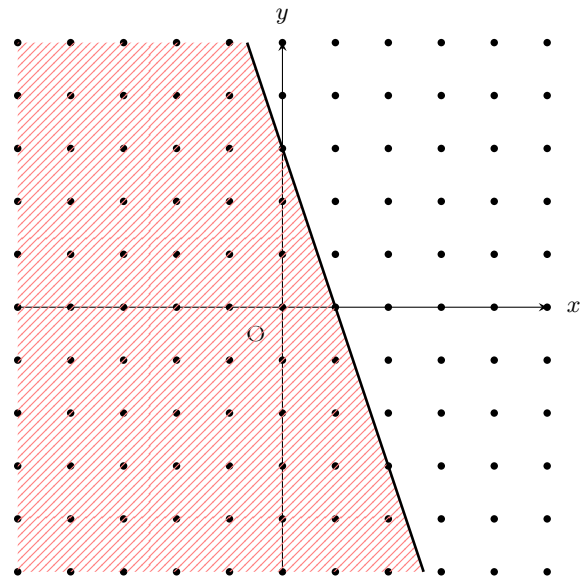
```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline=(
    current bounding box.north)]
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\coordinate (A) at ($ (-4,{-1/3*(-4)+2}) $);
\coordinate (B) at ($ (4,{-1/3*(4)+2}) $);
  \fill[pattern color=blue!50,pattern=north east
    lines] (A)--(B)--(4,-4)--(-4,-4)--cycle;
  \draw(1,2.5) node[right,fill=white,inner sep=1pt]{
    \footnotesize \(y=-{\,1\,\over3}x+2\)};
  \draw[line width=1pt](A)--(B);
  \draw(0,-5) node {\footnotesize \(y=-{\,1\,\over3}x
    +2\)};
  \fill (-3,3) circle (3pt);
  \fill (0,2) circle (3pt);
  \fill (3,1) circle (3pt);
\end{tikzpicture}
```

RESULTS

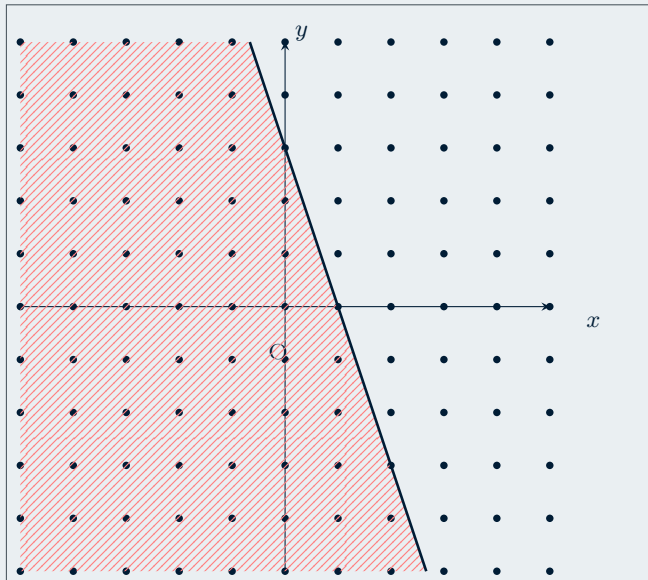


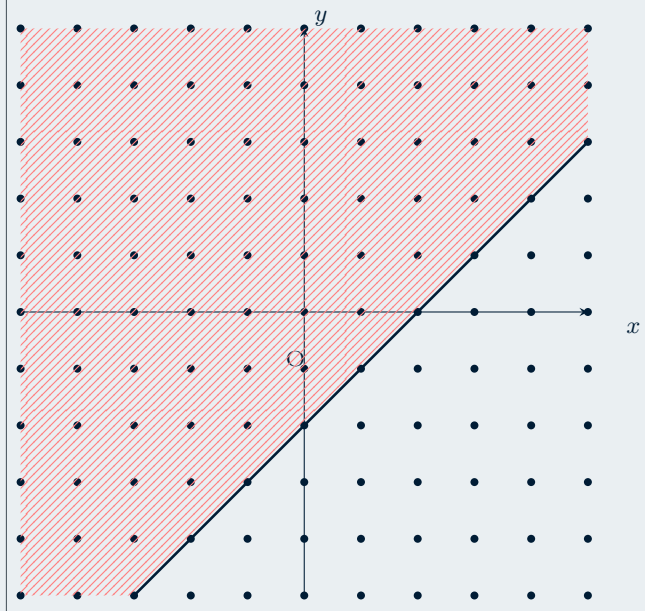
$y=-\frac{1}{3}x+2$

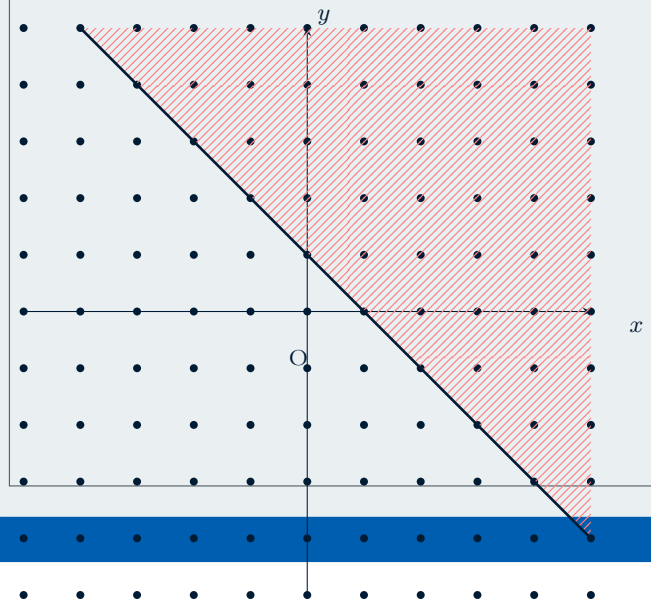
```
\begin{tikzpicture}[scale=0.36,>=stealth,baseline=(
    current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \coordinate (A) at ($ (-2/3,{-3*(-2/3)+3}) $);
  \coordinate (B) at ($ (8/3,{-3*(8/3)+3}) $);
  \fill[pattern color=red!50, pattern=north east
      lines] (A)--(B)--(-5,-5)--(-5,5)--cycle;
  \draw[line width=1pt](A)--(B);
\end{tikzpicture}
```



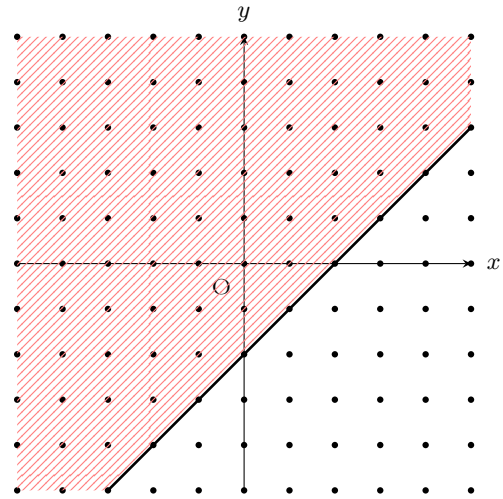
PRACTICE AND EXERCISES



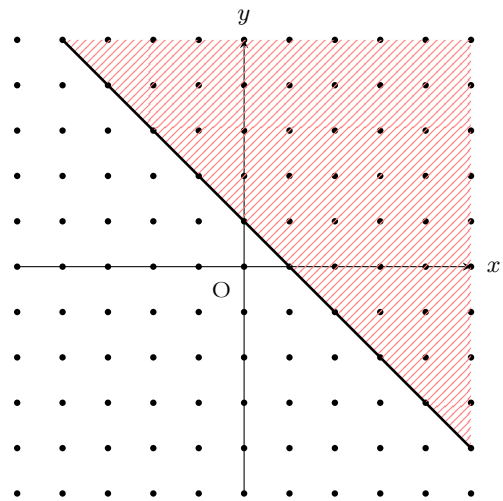




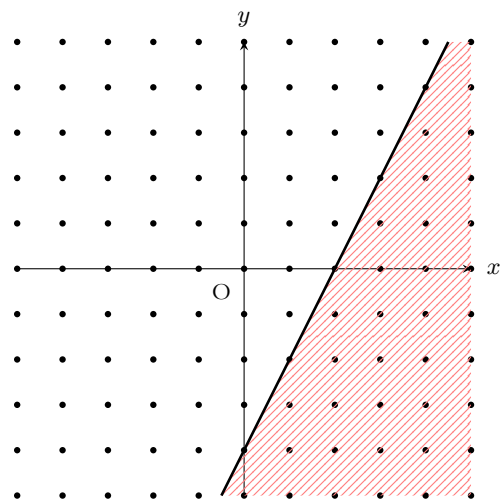
```
\begin{tikzpicture}[scale=0.36,>=stealth,baseline
    =(current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \coordinate (A) at (-3,-5);\coordinate (B) at
    (5,3);
\fill[pattern color=red!50, pattern=north east lines]
    (A)--(B)--(5,5)--(-5,5)--(-5,-5)--cycle;
  \draw[line width=1pt](A)--(B);
\end{tikzpicture}
```



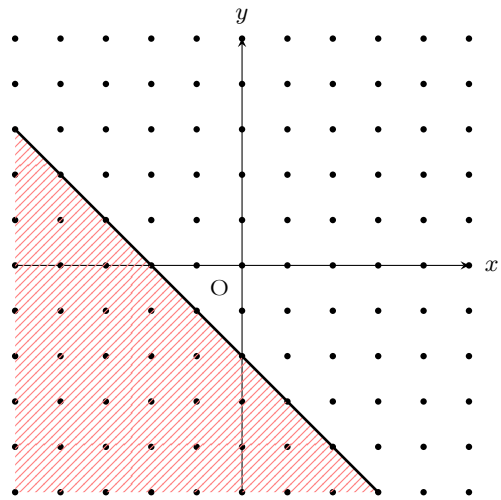

```
\begin{tikzpicture}[scale=0.36,>=stealth,baseline
    =(current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \coordinate (A) at (-4,5);
  \coordinate (B) at (5,-4);
  \fill[pattern color=red!50, pattern=north east
    lines] (A)--(B)--(5,5)--cycle;
  \draw[line width=1pt](A)--(B);
\end{tikzpicture}
```



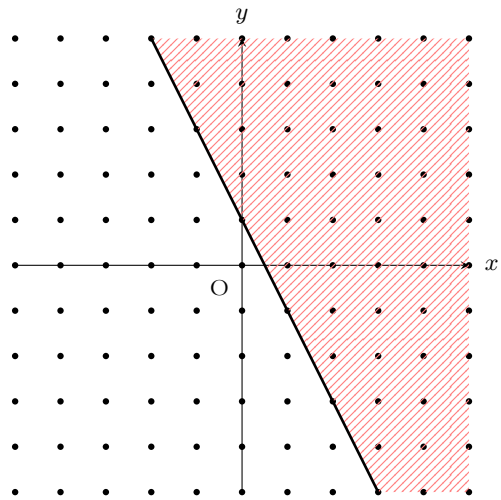

```
\begin{tikzpicture}[scale=0.36,>=stealth,baseline
    =(current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \coordinate (A) at (-1/2,-5);
  \coordinate (B) at (9/2,5);
  \fill[pattern color=red!50, pattern=north east
    lines] (A)--(B)--(5,5)--(5,-5)--cycle;
  \draw[line width=1pt](A)--(B);
\end{tikzpicture}
```



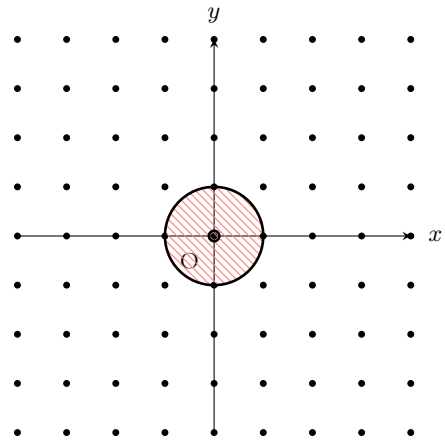
```
\begin{tikzpicture}[scale=0.36,>=stealth,baseline=(
    current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \coordinate (A) at (-5,3);\coordinate (B) at
      (3,-5);
  \fill[pattern color=red!50, pattern=north east
      lines] (A)--(B)--(-5,-5)--cycle;
  \draw[line width=1pt](A)--(B);
  \draw(0,-6) node {\footnotesize (\x,\y)};
  \draw(0,-6) node {\footnotesize (\x,\y)};
\end{tikzpicture}
```



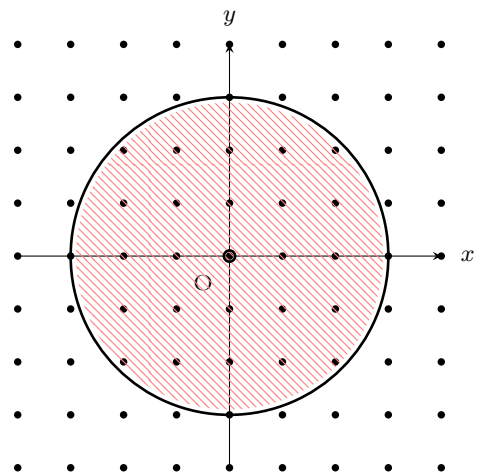

```
\begin{tikzpicture}[scale=0.36,>=stealth,baseline=(
    current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \coordinate (A) at (-2,5);\coordinate (B) at
      (3,-5);
  \fill[pattern color=red!50, pattern=north east
      lines] (A)--(B)--(5,-5)--(5,5)--cycle;
  \draw[line width=1pt](A)--(B);
\end{tikzpicture}
```



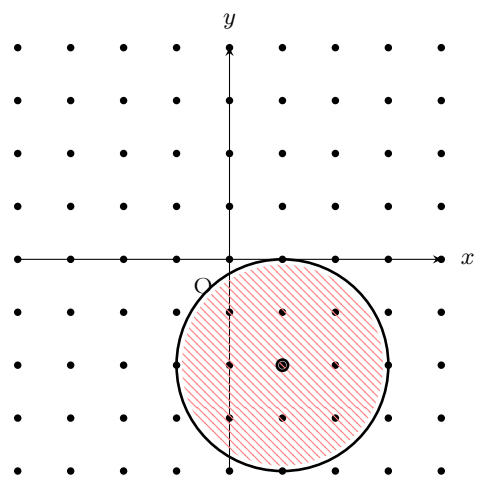
```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
\draw[->](-4,0)--(4,0);
\draw[->](0,-4)--(0,4);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
 \fill[pattern color=red!50, pattern=north west
    lines] (0,0) circle (1);
 \draw[line width=1pt] (0,0) circle (1);
 \draw[line width=1pt] (0,0) circle (3pt);
\end{tikzpicture}
```



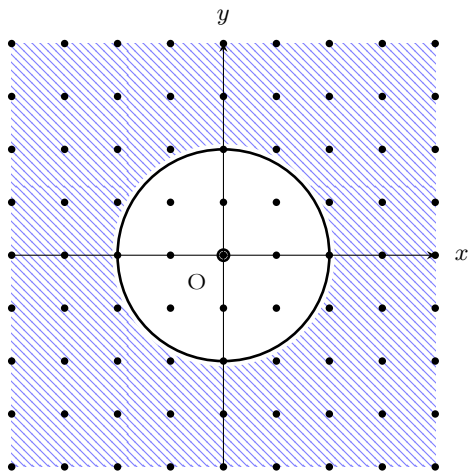

```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
 \fill[pattern color=red!50, pattern=north west
    lines] (0,0) circle (2.9);
 \draw[line width=1pt] (0,0) circle (3);
 \draw[line width=1pt] (0,0) circle (3pt);
\end{tikzpicture}
```



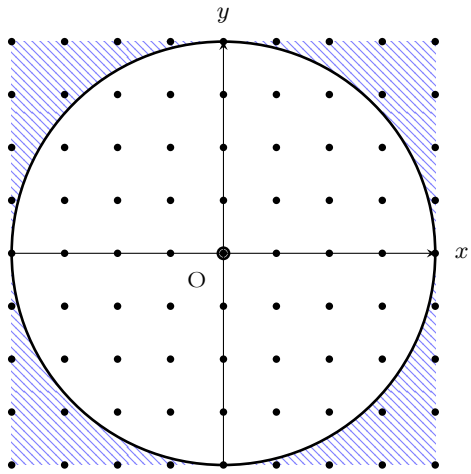

```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
 \fill[pattern color=red!50, pattern=north west
    lines] (1,-2) circle (1.9);
 \draw[line width=1pt] (1,-2) circle (2);
 \draw[line width=1pt] (1,-2) circle (3pt);
\end{tikzpicture}
```



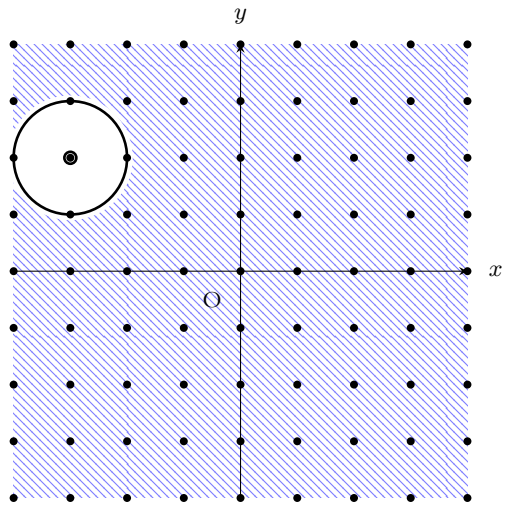
```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
  \fill[pattern color=blue!50,pattern=north west
      lines] (-4,-4)--(4,-4)--(4,4)--(-4,4)--cycle;
  \fill[color=white] (0,0) circle (2.1);
  \draw[line width=1pt] (0,0) circle (2);
  \draw[line width=1pt] (0,0) circle (3pt);
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



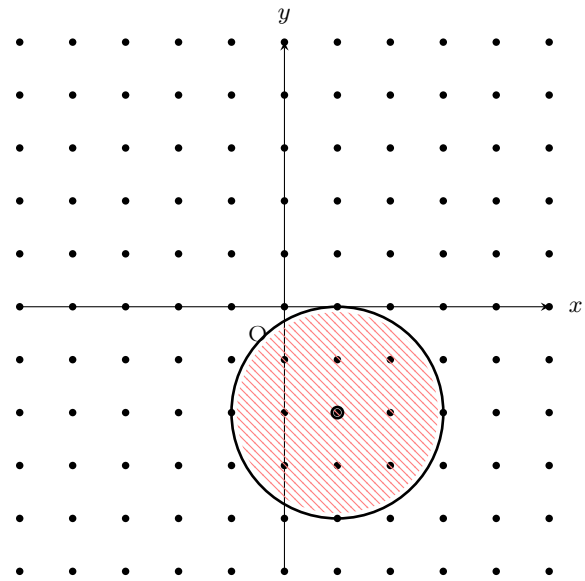

```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
  \fill[pattern color=blue!50,pattern=north west
      lines] (-4,-4)--(4,-4)--(4,4)--(-4,4)--cycle;
  \fill[color=white] (0,0) circle (4);
  \draw[line width=1pt] (0,0) circle (4);
  \draw[line width=1pt] (0,0) circle (3pt);
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



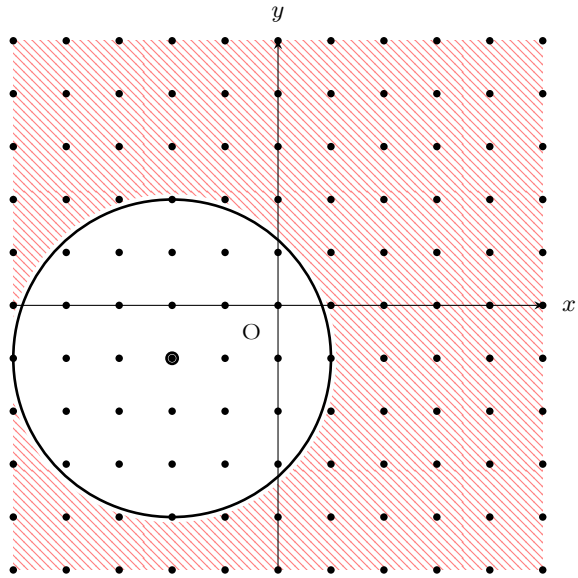

```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline
    =-11pt]
  \fill[pattern color=blue!50,pattern=north west
      lines] (-4,-4)--(4,-4)--(4,4)--(-4,4)--cycle;
  \fill[color=white] (-3,2) circle (1.1);
  \draw[line width=1pt] (-3,2) circle (1);
  \draw[line width=1pt] (-3,2) circle (3pt);
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



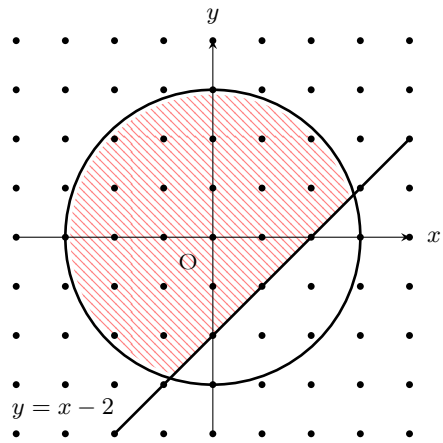
```
\begin{tikzpicture}[scale=0.36, >=stealth, baseline=(
    current bounding box.north)]
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
  \fill[pattern color=red!50, pattern=north west
      lines] (1,-2) circle (1.9);
  \draw[line width=1pt] (1,-2) circle (3pt);
  \draw[line width=1pt] (1,-2) circle (2);
\end{tikzpicture}
```



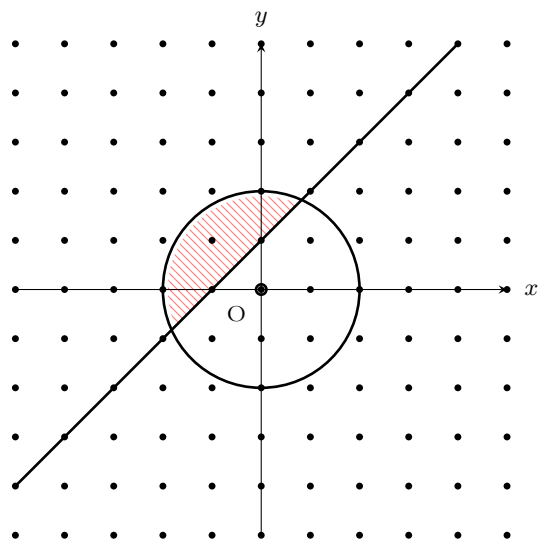

```
\begin{tikzpicture}[scale=0.36, >=stealth, baseline=(
    current bounding box.north)]
  \fill[pattern color=red!50, pattern=north west
      lines](-5,-5)--(5,-5)--(5,5)--(-5,5)--cycle;
  \fill[color=white] (-2,-1) circle (3.1);
  \draw[line width=1pt] (-2,-1) circle (3);
  \draw[line width=1pt] (-2,-1) circle (3pt);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



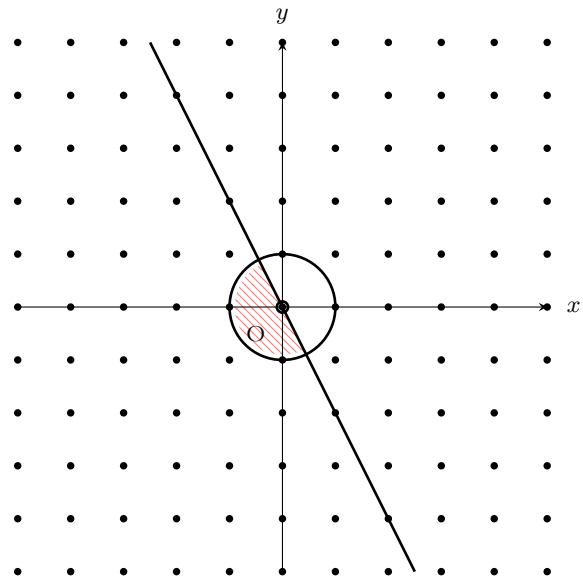
```
\begin{tikzpicture}[scale=0.4,>=stealth,baseline=(
    current bounding box.north)]
  \fill[pattern color=red!50,pattern=north west
      lines] (0,0) circle (2.9);
  \fill[color=white] (-2,-4)--(4,2)--(4,-4)--cycle;
  \draw[line width=1pt] (0,0) circle (3);
  \draw[line width=1pt] (-2,-4)--(4,2);
  \draw(-2,-3.5) node [left,inner sep=0pt] {
      \footnotesize $y=x-2$};
\draw[->](-4,0) -- (4,0);
\draw[->](0,-4) -- (0,4);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(4.5,0) node {\footnotesize $x$};
\draw(0,4.5) node {\footnotesize $y$};
\foreach \x in {-4,...,4}{\foreach \y in {-4,...,4}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



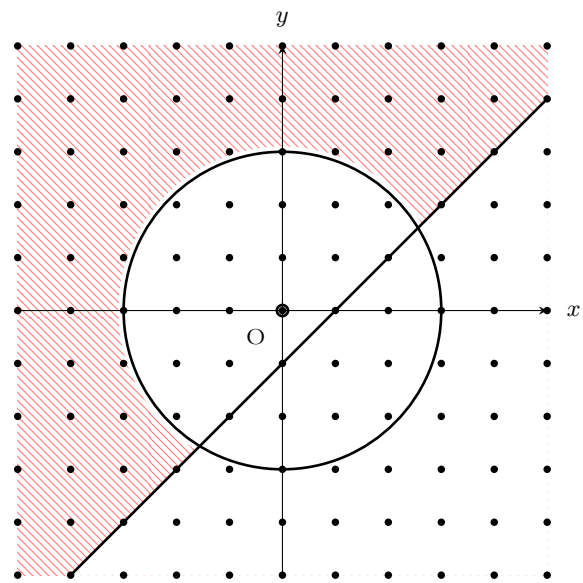

```
\begin{tikzpicture}[scale=0.32,>=stealth,baseline=(
    current bounding box.north)]
  \fill[pattern color=red!50,pattern=north west
      lines] (0,0) circle (1.9);
  \fill[color=white] (-5,-4)--(4,5)--(5,-5)--cycle;
  \draw[line width=1pt] (0,0) circle (2);
  \draw[line width=1pt] (0,0) circle (3pt);
  \draw[line width=1pt] (-5,-4)--(4,5);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize O};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



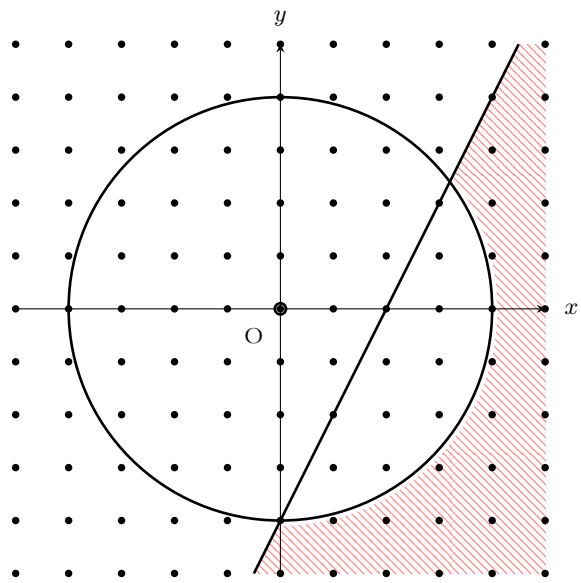
```
\begin{tikzpicture}[scale=0.32,>=stealth,baseline=(
    current bounding box.north)]
  \fill[pattern color=red!50,pattern=north west
      lines] (0,0) circle (0.9);
  \fill[color=white] (-2.5,5)--(2.5,-5)--(5,5)--
      cycle;
  \draw[line width=1pt] (0,0) circle (1);
  \draw[line width=1pt] (0,0) circle (3pt);
  \draw[line width=1pt] (-2.5,5)--(2.5,-5);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



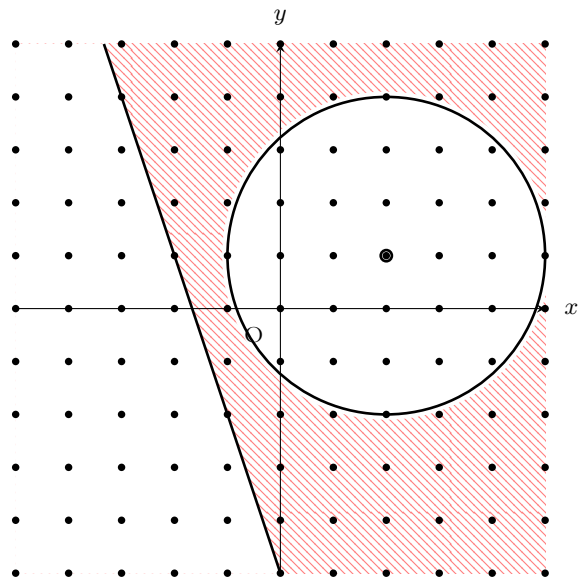

```
\begin{tikzpicture}[scale=0.32,>=stealth,baseline=(
    current bounding box.north)]
%\ifnum\DisplayToiFig>0
  \fill[pattern color=red!50,pattern=north west
      lines] (-5,-5)--(5,-5)--(5,5)--(-5,5)--cycle;
  \fill[color=white] (0,0) circle (3.1);
  \filldraw[color=white] (-4,-5)--(5,4)--(5,-5)--
      cycle;
  \draw[line width=1pt] (0,0) circle (3);
  \draw[line width=1pt] (0,0) circle (3pt);
  \draw[line width=1pt] (-4,-5)--(5,4);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```



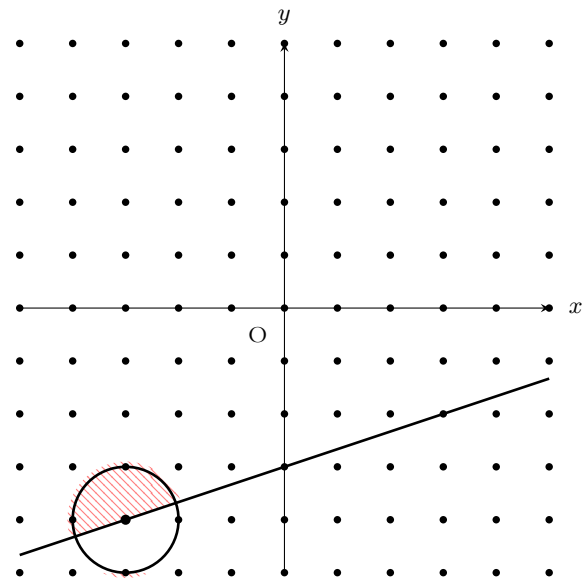
```
\begin{tikzpicture}[scale=0.32,>=stealth,baseline=(
    current bounding box.north)]
%\ifnum\DisplayToiFig>0
  \fill[pattern color=red!50,pattern=north west
      lines] (-5,-5)--(5,-5)--(5,5)--(-5,5)--cycle;
  \fill[color=white] (0,0) circle (4.1);
  \filldraw[color=white] (-0.5,-5)--(4.5,5)--(-5,5)
      --(-5,-5)--cycle;
  \draw[line width=1pt] (0,0) circle (4);
  \draw[line width=1pt] (0,0) circle (3pt);
  \draw[line width=1pt] (-0.5,-5)--(4.5,5);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```




```
\begin{tikzpicture}[scale=0.32,>=stealth,baseline=(
    current bounding box.north)]
%\ifnum\DisplayToiFig>0
  \fill[pattern color=red!50,pattern=north west
      lines] (-5,-5)--(5,-5)--(5,5)--(-5,5)--cycle;
  \fill[color=white] (2,1) circle (3.1);
  \filldraw[color=white] ($ (-10/3,{-3*(-10/3)-5}) $)
      --(0,-5)--(-5,-5)--(-5,5)--cycle;
  \draw[line width=1pt] (2,1) circle (3);
  \draw[line width=1pt] (2,1) circle (3pt);
  \draw[line width=1pt] ($ (-10/3,{-3*(-10/3)-5}) $)
      --(0,-5);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```

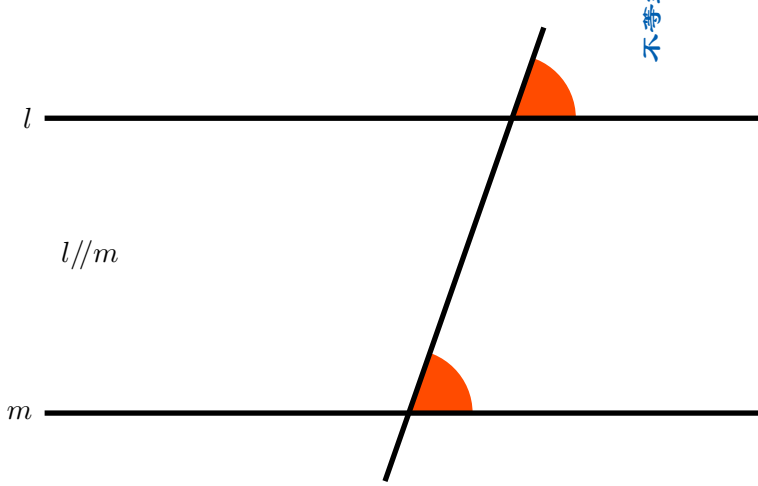


```
\begin{tikzpicture}[scale=0.32,>=stealth,baseline=(
    current bounding box.north)]
  \fill[pattern color=red!50,pattern=north west
      lines] (-3,-4) circle (1.1);
  \filldraw[color=white] ($ (-5,{(1/3)*(-5)-3}) $)
      --($ (5,{(1/3)*(5)-3}) $)--(5,-5)--(-5,-5)--
      cycle;
  \draw[line width=1pt] (-3,-4) circle (1);
  \draw[line width=1pt] (-3,-4) circle (2pt);
  \draw[line width=1pt] ($ (-5,{(1/3)*(-5)-3}) $)--($
       (5,{(1/3)*(5)-3}) $);
\draw[->](-5,0) -- (5,0);
\draw[->](0,-5) -- (0,5);
\draw(-0.5,-0.5) node {\footnotesize 0};
\draw(5.5,0) node {\footnotesize $x$};
\draw(0,5.5) node {\footnotesize $y$};
\foreach \x in {-5,...,5}{\foreach \y in {-5,...,5}{
    \fill (\x,\y) circle (2pt);}}
\end{tikzpicture}
```

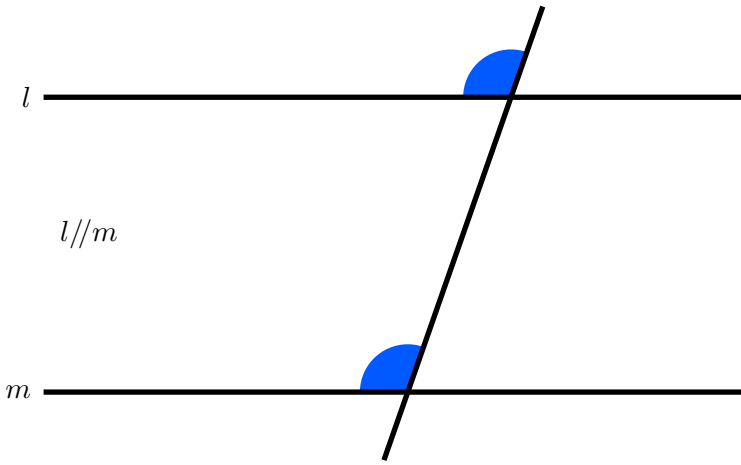


2.0 平行线的性质

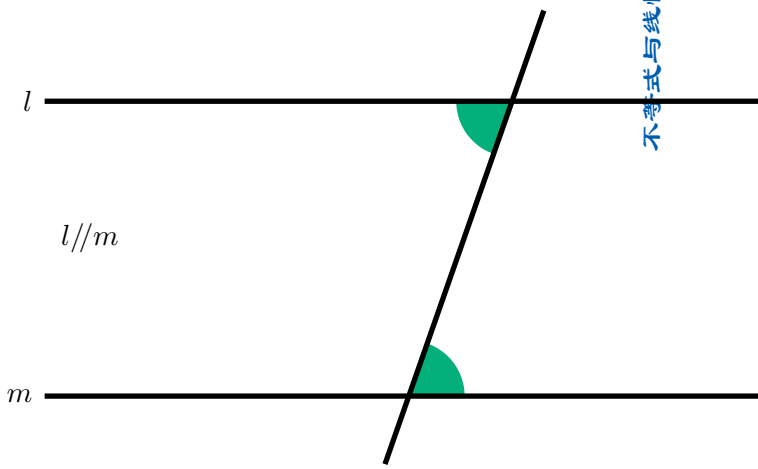
```
\begin{tikzpicture}[scale=3, line width=2pt]
\coordinate[label=left:$m$](A) at (0,0.3);
\coordinate(B) at (4,0.3);
\coordinate[label=left:$l$](C) at (0,1.6);
\coordinate (D) at (4,1.6);
\coordinate (S) at (1.5,0);
\coordinate (T) at (2.2,2);
\draw(0.2,1) node{\( l\myparallel m \)};
\path[name path=AB] (A)--(B);
\path[name path=CD] (C)--(D);
\path[name path=ST] (S)--(T);
\path [name intersections={of=AB and ST, by=X}];
\path [name intersections={of=CD and ST, by=Y}];
\begin{scope}
  \clip (Y)--(X)--(B)--cycle;
  \fill[CUDRed] (X) circle (8pt);
  \end{scope}
  \begin{scope}
  \clip (T)--(Y)--(D)--cycle;
  \fill[CUDRed] (Y) circle (8pt);
  \end{scope}
\draw(A)--(B);
\draw(C)--(D);
\draw(S)--(T);
\end{tikzpicture}
```



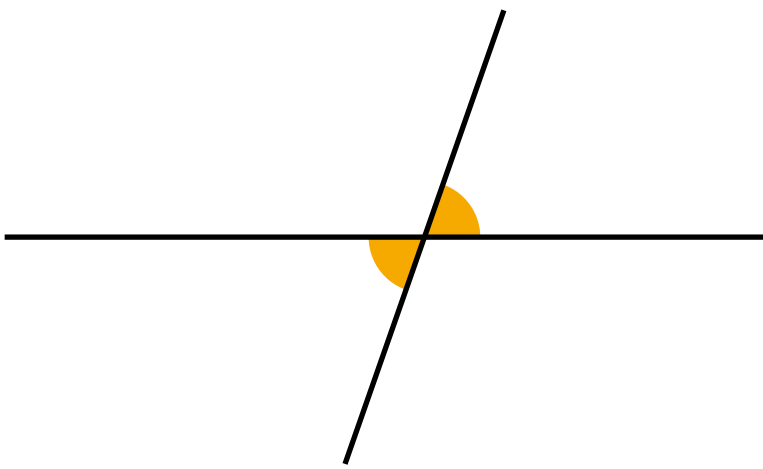
```
\begin{tikzpicture}[scale=3, line width=2pt]
\coordinate[label=left:$m$](A) at (0,0.3);
\coordinate(B) at (4,0.3);
\coordinate[label=left:$l$](C) at (0,1.6);
\coordinate (D) at (4,1.6);
\coordinate (S) at (1.5,0);
\coordinate (T) at (2.2,2);
\draw(0.2,1) node{\( l \myparallel m \)};
\path[name path=AB] (A)--(B);
\path[name path=CD] (C)--(D);
\path[name path=ST] (S)--(T);
\path [name intersections={of=AB and ST, by=X}];
\path [name intersections={of=CD and ST, by=Y}];
\begin{scope}
  \clip (Y)--(X)--(A)--cycle;
  \fill[CUDBlue] (X) circle (6pt);
  \end{scope}
  \begin{scope}
  \clip (T)--(Y)--(C)--cycle;
  \fill[CUDBlue] (Y) circle (6pt);
  \end{scope}
\draw(A)--(B);
\draw(C)--(D);
\draw(S)--(T);
\end{tikzpicture}
```



```
\begin{tikzpicture}[scale=3, line width=2pt]
\coordinate[label=left:$m$](A) at (0,0.3);
\coordinate(B) at (4,0.3);
\coordinate[label=left:$l$](C) at (0,1.6);
\coordinate (D) at (4,1.6);
\coordinate (S) at (1.5,0);
\coordinate (T) at (2.2,2);
\draw(0.2,1) node{\( l\myparallel m \)};
\path[name path=AB] (A)--(B);
\path[name path=CD] (C)--(D);
\path[name path=ST] (S)--(T);
\path [name intersections={of=AB and ST, by=X}];
\path [name intersections={of=CD and ST, by=Y}];
\begin{scope}
\clip (Y)--(X)--(B)--cycle;
\fill[CUDGreen] (X) circle (7pt);
\end{scope}
\begin{scope}
\clip (X)--(Y)--(C)--cycle;
\fill[CUDGreen] (Y) circle (7pt);
\end{scope}
\draw (A)--(B);
\draw (C)--(D);
\draw (S)--(T);
\end{tikzpicture}
```

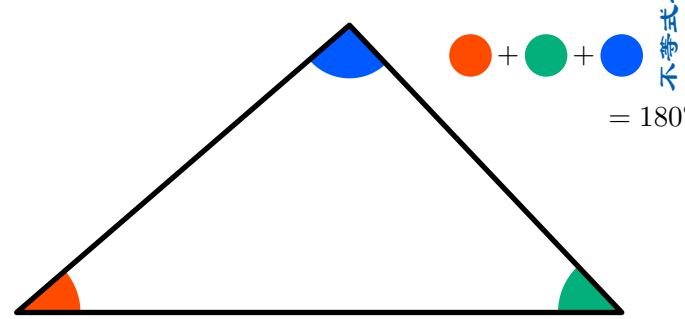



```
\begin{tikzpicture}[scale=3, line width=2pt]
\coordinate (A) at (0,0);
\coordinate (B) at (4,0);
\coordinate (S) at (1.5,-1);
\coordinate (T) at (2.2,1);
\path[name path=AB] (A)--(B);
\path[name path=ST] (S)--(T);
\path[name intersections={of=AB and ST, by=X}];
\begin{scope}
\clip (X)--(B)--(T)--cycle;
\fill[CUDOrange] (X) circle (7pt);
\end{scope}
\begin{scope}
\clip (S)--(X)--(A)--cycle;
\fill[CUDOrange] (X) circle (7pt);
\end{scope}
\draw (A)--(B);
\draw (S)--(T);
\end{tikzpicture}
```

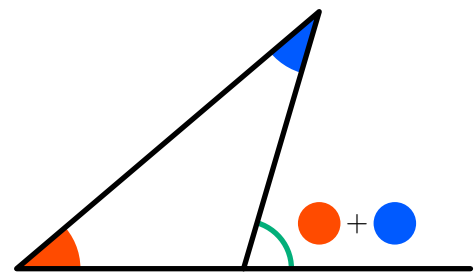


2.0 三角形的内角和

```
\begin{tikzpicture}[scale=3,␣line␣width=2pt]
\coordinate (O) at (0,0);
\coordinate (A) at (4,0);
\coordinate (B) at (2.2,1.9);
\begin{scope}
\clip (A)--(O)--(B)--cycle;
\fill[CUDRed] (O) circle (12pt);
\fill[CUDGreen] (A) circle (12pt);
\fill[CUDBlue] (B) circle (10pt);
\end{scope}
\draw[line␣join=round] (A)--(O)--(B)--cycle;
\fill[CUDRed] (3,1.7) circle (4pt);
\draw(3.25,1.7) node{$+$};
\fill[CUDGreen] (3.5,1.7) circle (4pt);
\draw(3.75,1.7) node{$+$};
\fill[CUDBlue] (4,1.7) circle (4pt);
\draw(4.2,1.3) node{$=180^\circ$};
\end{tikzpicture}
```

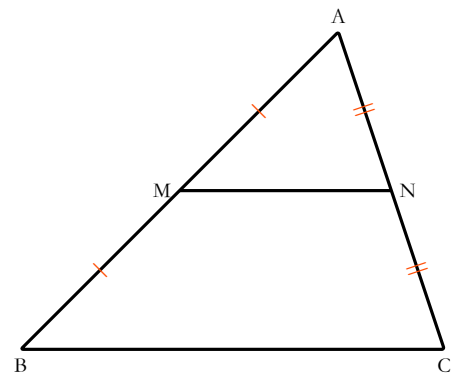


```
\begin{tikzpicture}[scale=3,␣line␣width=2pt]
\coordinate (O) at (0,0);
\coordinate (A) at (3,0);
\coordinate (B) at (2,1.7);
\coordinate (C) at (1.5,0);
\begin{scope}
\clip (O)--(B)--(C)--cycle;
\fill[CUDRed] (O) circle (12pt);
\fill[CUDBlue] (B) circle (12pt);
\end{scope}
\begin{scope}
\clip (A)--(C)--(B)--cycle;
\draw[CUDGreen] (C) circle (9pt);
\end{scope}
\draw[line␣join=round,␣line␣cap=round] (A)--(O)--(B)
    --(C);
\fill[CUDRed] (2,0.3) circle (4pt);
\draw(2.25,0.3) node{$+$};
\fill[CUDBlue] (2.5,0.3) circle (4pt);
\end{tikzpicture}
```

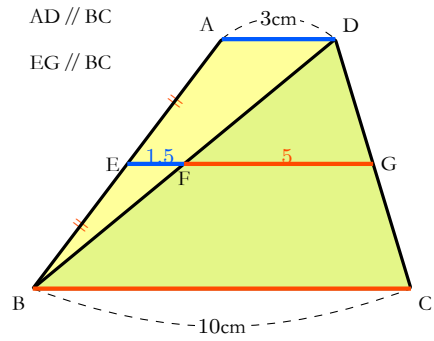


2.0 三角形中位线

```
  \begin{tikzpicture}[rotate=0,␣scale=1.4,>=stealth,
      very␣thick,
␣␣baseline={(␣[yshift=-24pt] current bounding box.
    north)}]
%\draw[help lines](-0.3,-1.3) grid (4.3,3.3);
\useasboundingbox(-0.3,-1.3) grid (4.3,3.3);

\scriptsize
%三角形の頂点を定義する
\coordinate[label=above:\textrm{A}] (A) at (3,3);
\coordinate[label=below:\textrm{B}] (B) at (0,0);
\coordinate[label=below:\textrm{C}] (C) at (4,0);

\coordinate[label=left:\textrm{M}](M) at ($(A)!0.5!(
    B)$);
\coordinate[label=right:\textrm{N}](N) at ($(A)
    !0.5!(C)$);

\draw[rounded␣corners=1pt] (B)--(C)--(A)--cycle;
\draw(M)--(N);
\large
\draw[CUDRed]($(A)!0.5!(M)$) node[rotate=atan(-1/1)]{
    \(-\)}
  ($(M)!0.5!(B)$) node[rotate=atan(-1/1)]{\(-\)}
  ($(A)!0.5!(N)$) node[rotate=atan(1/3)]{\(=\)}
  ($(N)!0.5!(C)$) node[rotate=atan(1/3)]{\(=\)};
\end{tikzpicture}
```



```
 \begin{tikzpicture}[rotate=0,␣scale=1,
␣␣baseline={(␣[yshift=-36pt] current bounding box.
     north)}]
%\draw[help lines](-0.3,-1.3) grid (4.3,3.3);
\useasboundingbox(-0.5,-0.3) grid (4.3,4);

\scriptsize
\coordinate[label=above␣left:\textrm{A}](A) at
     (2.5,3.3);
\coordinate[label=below␣left:\textrm{B}](B) at (0,0)
     ;%実際の長さの半分で描画
\coordinate[label=below␣right:\textrm{C}](C) at
     (5,0);
\coordinate[label=above␣right:\textrm{D}](D) at
     (4,3.3);
\coordinate[label=left:\textrm{E}](E) at ($(A)!0.5!(
     B)$);
\coordinate[label=right:\textrm{G}](G) at ($(D)
     !0.5!(C)$);

\visible<2>{\fill[CUDCream!80](A)--(B)--(D)--cycle;}
\visible<3>{\fill[CUDLime!70](C)--(B)--(D)--cycle;}

\draw[CUDRed]($(A)!0.5!(E)$) node[rotate=atan
     (-2.5/3.3)]{\(=\)};
\draw[CUDRed]($(E)!0.5!(B)$) node[rotate=atan
     (-2.5/3.3)]{\(=\)};

\draw[very␣thick,rounded␣corners=1pt](B)--(C)--(D)
     --(A)--cycle;
\draw[name␣path=lineEG,very␣thick](E)--(G);
\draw[name␣path=lineBD,very␣thick](B)--(D);
\path[name␣intersections={of=lineEG␣and␣lineBD,␣by=F}
     ];
\coordinate[label=below:\textrm{F}](F) at (F);

\draw[dashed](A) to[out=40,in=140]
  node[inner␣sep=1pt,fill=white]{\(3\textrm{cm}\)}(D)
       ;
\draw[dashed](B) to[out=-20,in=200]
  node[inner␣sep=1pt,fill=white]{\(10\textrm{cm}\)}(C
       );
\draw(.5,3.6)
  node{\(\textrm{AD}\,\raisebox{.1ex}{/\kern-.2em/}\,
       \textrm{BC}\)}
  ++(0,-.6)
  node{\(\textrm{EG}\,\raisebox{.1ex}{/\kern-.2em/}\,
       \textrm{BC}\)};

\visible<2>{\draw[ultra␣thick,CUDBlue](A)--(D);}
\visible<2->{\draw[ultra␣thick,CUDBlue](E)--
␣␣node[midway,xshift=0.2em,yshift=1ex]{\(1.5\)}(F);
  }
\visible<3->{\draw[ultra␣thick,CUDRed](F)--
␣␣␣␣node[midway,xshift=0.4em,yshift=1ex]{\(5\)}(G);
  \draw[ultra␣thick,CUDRed](B)--(C);
  }
```



2.0 三角形的面积

2.0 四边形的面积

2.0 圆的面积

2.0 四边形与圆面积