Les packages LaTeX préférés du professeur de physique-chimie
Sélection d'exemples d'utilisation

1–Introduction

Avertissement : ce document est destiné à des lecteurs connaissant les bases de LaTeX.

Contrairement à MSWord ou LibreOffice, un apprentissage est indispensable pour maîtriser LaTeX. Les débuts peuvent être décourageants. L'investissement en temps s'avère cependant payant : le rendu des documents réalisés est de grande qualité. LaTeX est très fort dès qu'il s'agit de réaliser des documents complexes comprenant des listes, des tableaux, des graphes et schémas…, plus encore si une table des matières, un index, une page de présentation, une bibliographie doivent compléter le document. Des liens hypertextes internes et externes, des références croisées peuvent aussi être ajoutés assez aisément. N'oublions pas que LaTeX est le langage utilisé dans la publication universitaire —thèses notamment— ainsi que celui préconisé par l'Association des Professeurs de Mathématiques dans l'élaboration des sujets d'examens. C'est surtout un réel plaisir que de trouver des méthodes permettant d'améliorer au fil du temps les documents.

Une bonne idée consiste à avoir prêt un document, sorte de banque, sur lequel on retrouvera des extraits de code permettant par simple copier-coller de disposer facilement de certaines techniques déjà expérimentées mais pas forcément fidèlement mémorisées. C'est l'un des objectifs de ce travail basé sur ma propre expérience de professeur de physique-chimie.

2–Ma distribution LaTeX et mon éditeur préféré

La distribution TeXlive est multiplateforme, elle me paraît donc préférable à MikTeX (Windows).
Consulter https ://www.tug.org/texlive/quickinstall.html

TeXmaker est de loin l'éditeur que j'utilise le plus souvent.

TeXworks est une excellente roue de secours. Bien que beaucoup moins convivial et austère, il est plus rapide et permet parfois une compilation là où TeXmaker échoue.

Sinon, il existe TeXstudio, très semblable à TeXmaker et Kile. Question de goûts et de succès dans l'installation et la configuration !

3–Mes 2 préambules préférés

Après avoir écrit le code sur l'éditeur de texte, il faut le compiler. Les compilateurs sont intégrés à l'éditeur.

Le compilateur pdflatex est rapide. Seules les polices latex sont utilisables. Il n'est pas possible d'utiliser le package pstricks pour dessiner. Seuls ces formats d'images sont acceptés : TODO

Le compilateur xelatex est moins rapide (cela a surtout du sens pour les gros documents). On peut utiliser toutes les polices installées sur le système ainsi que les 2 grands packages de dessin : pstricks et tikz. Davantage de formats d'images sont acceptés : TODO

Ci-après les préambules commentés que j'utilise. Il suffit de précéder une ligne de code par % pour que ce qui suit ne soit pas compilé, ou tout simplement pour ajouter un commentaire.

3.1–pdflatex

```
\documentclass[10pt,a4paper]{article}

% obligatoire --- options intéressantes: 11pt, 12pt, landscape

\usepackage[utf8]{inputenc}
\usepackage[T1]{fontenc}

% obligatoires gestion des accents notamment

\usepackage[upright]{fourier}

% police complète avec particularités de la typographie française.

\usepackage{xcolor}

% pour disposer de nombreuses possibilités de couleurs

\usepackage[left=.5cm,right=.5cm,top=.5cm,bottom=1.5cm]{geometry}

% important pour gérer les marges ---autres options: landscape, twocolumn
```

```
\usepackage{amsmath}
\usepackage{amsfonts}
\usepackage{amssymb}

% packages relatifs aux mathématiques

\usepackage{graphicx}

% package indispensable pour ajouter des images

\usepackage{titlesec}
\titleformat{\part}{\LARGE\bfseries\filcenter}{}{0pt}{}
\titlespacing*{\part}{0cm}{0cm}{0cm}
\titleformat{\section}{\Large\bfseries}{\thesection}{0pt}{--}
\titlespacing*{\section}{0cm}{0cm}{0cm}
\titleformat{\subsection}{\large\bfseries}{\thesubsection}{0pt}{--}
\titlespacing*{\subsubsection}{0cm}{0cm}{0cm}
\titleformat{\subsubsection}{\bfseries}{}{0pt}{}
\titlespacing*{\subsubsection}{0cm}{0cm}{0cm}

% package permettant de modifier le format des titres, les espaces à gauche, au-dessus et au-dessous des titres

\usepackage{tabularx}
\usepackage{array}
\usepackage{multirow}
\usepackage{makecell}
\usepackage{booktabs}

% packages gérant les tableaux

\usepackage{pgf,tikz}
\usepackage{chemfig}
\usepackage{pgfplots}
\usetikzlibrary{arrows,shapes,positioning}
\usetikzlibrary{patterns,shapes.geometric}
\usetikzlibrary{decorations.text}
\usetikzlibrary{decorations.pathmorphing}
\usetikzlibrary{decorations.pathreplacing}
\usetikzlibrary{decorations.markings}
\usetikzlibrary{decorations.footprints}
\usetikzlibrary{decorations.shapes}
\usetikzlibrary{decorations.text}
\usetikzlibrary{decorations.fractals}
\usetikzlibrary{through}
\usetikzlibrary{calc}
\usetikzlibrary{circuits.ee.IEC}
\tikzset{circuit declare symbol = Ameter}
\tikzset{set Ameter graphic ={draw,generic circle IEC, minimum size=5mm,info=center:A}}
\tikzset{circuit declare symbol = Vmeter}
\tikzset{set Vmeter graphic ={draw,generic circle IEC, minimum size=5mm,info=center:V}}
\tikzset{circuit declare symbol = generator}
\tikzset{set generator graphic ={draw,generic circle IEC, minimum size=5mm,info=center:G}}

% packages, bibliothèques et commandes globales gérant les dessins de type tikz

\usepackage{spverbatim}

% package interessant pour visualiser de longues lignes de code soit avec l'environnement spverbatim au lieu de verbatim, soit avec la commande \spverb au lieu de \verb

\usepackage{lipsum}

% package de faux texte latin pratique pour expérimenter une commande, un environnement...
```

```
\usepackage[french]{babel}
\DecimalMathComma % cette commande place convenablement la virgule dans les nombres

% indispensable pour gérer les règles typographiques françaises.

\setlength{\parindent}{0mm} % cette commande définit l'indentation (alinéa) des paragraphes
\setlength{\parskip}{2mm} % cette commande définit la distance entre 2 paragraphes
\pagestyle{empty} % cette commande empêche la numérotation des pages --- autres options: fancy
\renewcommand{\arraystretch}{1.5} % cette commande élargit les lignes des tableaux
\renewcommand{\baselinestretch}{1.3} % cette commande définit l'interligne
```

3.2–xelatex

```
\documentclass[10pt,a4paper]{article}

% obligatoire --- options intéressantes: 11pt, 12pt, landscape

\usepackage{xltxtra}

% obligatoire pour compiler avec xelatex

\usepackage{xcolor}

% pour disposer de nombreuses possibilités de couleurs

\usepackage[left=.5cm,right=.5cm,top=.5cm,bottom=1.5cm]{geometry}

% important pour gérer les marges ---autres options: landscape, twocolumn

\usepackage{amsmath}
\usepackage{amsfonts}
\usepackage{amssymb}

% packages relatifs aux mathématiques

\usepackage{graphicx}

% package indispensable pour ajouter des images

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\titleformat{\part}{\LARGE\bfseries\filcenter}{}{0pt}{}
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\titleformat{\section}{\Large\bfseries}{\thesection}{0pt}{--}
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\titlespacing*{\subsubsection}{0cm}{0cm}{0cm}
\titleformat{\subsubsection}{\bfseries}{}{0pt}{}
\titlespacing*{\subsubsection}{0cm}{0cm}{0cm}

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\usepackage[math-style=french]{unicode-math}
\setromanfont[Ligatures=TeX,Scale=1]{Linux Libertine O}
\setmathfont[Ligatures=TeX,Scale=1]{Asana Math}

% packages permettant le choix des polices texte et mathématiques. Aucune faute de syntaxe n'est tolérée pour le nom des polices choisies.

\usepackage{tabularx}
\usepackage{array}
\usepackage{multirow}
\usepackage{makecell}
\usepackage{booktabs}

% packages gérant les tableaux
```

```
\usepackage{pst-all,pst-optic}

% packages gérant les dessins de type pstricks

\usepackage{pgf,tikz}
\usepackage{chemfig}
\usepackage{pgfplots}
\usetikzlibrary{arrows,shapes,positioning}
\usetikzlibrary{patterns,shapes.geometric}
\usetikzlibrary{decorations.text}
\usetikzlibrary{decorations.pathmorphing}
\usetikzlibrary{decorations.pathreplacing}
\usetikzlibrary{decorations.markings}
\usetikzlibrary{decorations.footprints}
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\usetikzlibrary{decorations.fractals}
\usetikzlibrary{through}
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```

4–Exemples en PHYSIQUE

4.1–Subtilités avec du texte

```
\begin{enumerate}
\setcounter{enumi}{6}

\item $v'_B=\frac{10}{5}=2$~m/s
\item $m_A\cdot v'_A+m_B\cdot v'_B=p_G$ donc $3\cdot v'_A + 2\times 2=4$ donc $v'_A=0$
\item

\renewcommand{\arraystretch}{2}
\begin{tabular}{|l||*5{>{\centering\arraybackslash}p{15mm}|}}
\hline
$t$ en s & 6 & 7 & 8 & 9 & 10  \\
\hline
```

```
$x_A$ en m &10&10&10&10\\
\hline
$x_B$ en m &12&14&16&18&20\\
\hline
\end{tabular}
\item voir figure.
\item  ${E'}_c =\frac{1}{2}\cdot m_B\cdot {v'}_B^2 =\frac{1}{2}\times 2\times 2^2=4$~J
%\end{enumerate}
\item perte relative d'énergie cinétique:$\frac{7-4}{7}=43\%$ au moment du choc.
\item $x_B=2\cdot t$ donc $v=2$~m/s et $x_0=0$\qquad$x_B=2\cdot (t-5) +10$ donc
 $t_1=5$~s et $x_1=10$~m puisque le deuxième mouvement commence à l'instant 5~s
 et que $B$ est à l'abscisse 10~m
\end{enumerate}
```

7. $v'_B = \frac{10}{5} = 2$ m/s
8. $m_A \cdot v'_A + m_B \cdot v'_B = p_G$ donc $3 \cdot v'_A + 2 \times 2 = 4$ donc $v'_A = 0$
9.

t en s	6	7	8	9	10
x_A en m	10	10	10	10	10
x_B en m	12	14	16	18	20

10. voir figure.
11. $E'_c = \frac{1}{2} \cdot m_B \cdot v'^2_B = \frac{1}{2} \times 2 \times 2^2 = 4$ J
12. perte relative d'énergie cinétique : $\frac{7-4}{7} = 43\%$ au moment du choc.
13. $x_B = 2 \cdot t$ donc $v = 2$ m/s et $x_0 = 0$ $\quad$ $x_B = 2 \cdot (t-5) + 10$ donc $t_1 = 5$ s et $x_1 = 10$ m puisque le deuxième mouvement commence à l'instant 5 s et que B est à l'abscisse 10 m

4.2–Tableaux

```
\begin{tabularx}{\textwidth}{|l||>{\centering\arraybackslash} X|>{\centering\arraybackslash}X|>{\centering\arraybackslash}X|>{\centering\arrayba
\hline
générateur sur: &3~V&4,5~V&6~V&7,5~V&9~V&12~V\\\hline
U (en V)&&&&&&\\\hline
I (en A)&&&&&&\\\hline
R (en $\Omega$)&&&&&&\\\hline
\end{tabularx}
```

générateur sur :	3 V	4,5 V	6 V	7,5 V	9 V	12 V
U (en V)						
I (en A)						
R (en Ω)						

```
\renewcommand{\arraystretch}{1.2}
\begin{tabular}{l!{=}l}
$U_{AC}$&\makebox[3cm]{\dotfill V}\\
$U_{BC}$&\makebox[3cm]{\dotfill V}\\
$U_{AB}$&\makebox[3cm]{\dotfill V}\\
$I_{1}$&\makebox[3cm]{\dotfill A}\\
$I_{3}$&\makebox[3cm]{\dotfill A}\\
$I_{2}$&\makebox[3cm]{\dotfill A}\\
$I$&\makebox[3cm]{\dotfill A}\\
\end{tabular}
```

U_{AC} = ... V
U_{BC} = ... V
U_{AB} = ... V
I_1 = ... A
I_3 = ... A
I_2 = ... A
I = ... A

```
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
km&hm&dam&m&dm&cm&mm\\\hline
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}\\
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}\\
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}\\\hline

\end{tabular}

\begin{tabular}{|*{14}{c|}}
\hline
\multicolumn{2}{|c}{km$^2$}&\multicolumn{2}{|c}{hm$^2$}&\multicolumn{2}{|c}{dam$^2$}
&\multicolumn{2}{|c}{m$^2$}&\multicolumn{2}{|c}{dm$^2$}&\multicolumn{2}{|c}{cm$^2$}
&\multicolumn{2}{|c|}{mm$^2$}\\\hline
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}\\
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}\\\hline
\end{tabular}

\begin{tabular}{|*{21}{c|}}
\hline
\multicolumn{3}{|c}{km$^3$}&\multicolumn{3}{|c}{hm$^3$}&\multicolumn{3}{|c}{dam$^3$}
&\multicolumn{3}{|c}{m$^3$}&\multicolumn{3}{|c}{dm$^3$}&\multicolumn{3}{|c}{cm$^3$}
&\multicolumn{3}{|c|}{mm$^3$}\\\hline
&&&&&&&&&&&kL&hL&daL&L&dL&cL&mL&&&\\\hline
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}\\
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}\\
\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}
&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}&\makebox[5mm]{}\\\hline
\end{tabular}
```

km	hm	dam	m	dm	cm	mm

km^2		hm^2		dam^2		m^2		dm^2		cm^2		mm^2	

km^3			hm^3			dam^3			m^3			dm^3			cm^3			mm^3		
											kL	hL	daL	L	dL	cL	mL			

```
\begin{tabularx}{20cm}{|c !{=} >{\raggedleft\arraybackslash} X|c !{=}
>{\raggedleft\arraybackslash} X|c !{=} >{\raggedleft\arraybackslash} X|c !{=}
 >{\raggedleft\arraybackslash} X|}
\hline
```

```
$10$~m& km&$10$~m& cm&$10$~cm$^2$&  m$^2$&$10$~cm$^3$&  dm$^3$\\
\hline
$10$~h& s&$10$~cm$^3$& cL&$10$~mg&  g&$10$~L&  cm$^3$\\
\hline
$10$~min& s&$10$~mA& A&$10$~k$\Omega$&  $\Omega$&$10$~V&  mV\\
\hline
\end{tabularx}
```

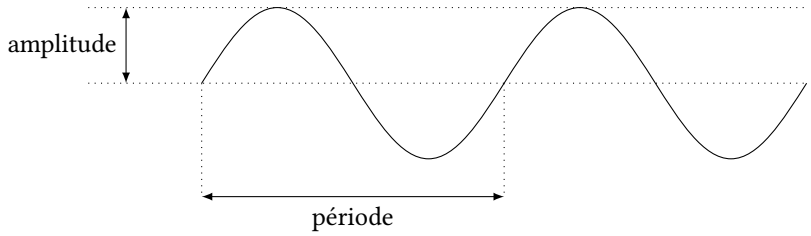
10 m =	km	10 m =	cm	10 cm^2 =	m^2	10 cm^3 =	dm^3
10 h =	s	10 cm^3 =	cL	10 mg =	g	10 L =	cm^3
10 min =	s	10 mA =	A	10 kΩ =	Ω	10 V =	mV

```
\renewcommand{\arraystretch}{2}
\begin{tabular}{|l||*6{>{\centering\arraybackslash}p{15mm}|}}
\hline
$t$ en s & 0 & 1 & 2 & 3 & 4 & 5 \\
\hline
$x_A$ en m &0&2&4&6&8&10\\
\hline
$x_B$ en m &15&14&13&12&11&10\\
\hline
\end{tabular}
```

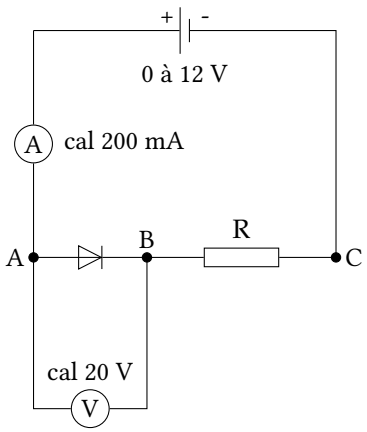
t en s	0	1	2	3	4	5
x_A en m	0	2	4	6	8	10
x_B en m	15	14	13	12	11	10

4.3–Dessins d' Électricité

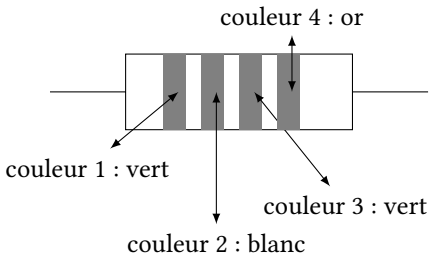
```
\begin{tikzpicture}
 \draw (0,0)sin(1,1)cos(2,0)sin(3,-1)cos(4,0)sin(5,1)cos(6,0)sin(7,-1)cos(8,0);
 \draw[latex-latex] (-1,1)--++(0,-1)node[left, midway]{amplitude};
\draw[latex-latex] (0,-1.5)--++(4,0)node[below, midway]{période};
\draw[dotted](-1.5,0)--(8,0);
\draw[dotted,yshift=1cm](-1.5,0)--(8,0);
\draw[dotted](0,0)--++(0,-1.5);
\draw[dotted,xshift=4cm](0,0)--++(0,-1.5);
  \end{tikzpicture}
```



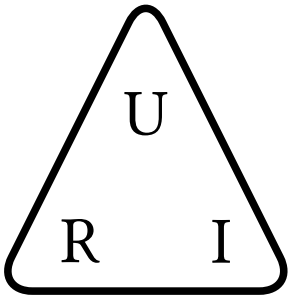

```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,0)to [battery={info={[yshift=-1em]+\quad -},info'={0 à 12~V}}]
 (4,0)--(4,-3)node[contact]{}node[right]{C}to[resistor={info'=$R$}](1.5,-3)
 node[above]{B}node[contact]{};
\draw (0,0)to[Ameter={info={[yshift=-1.3em,xshift=1.2cm]cal 200~mA}}](0,-3)
node[left]{A}node[contact]{}to[diode](1.5,-3);
%to[diode,rotate=180](0,3)node[left]{A}node[contact]{};
%Ameter={info={[yshift=-1.3em,xshift=1.2cm]cal 200~mA}}](0,0);
\draw (0,-3)--(0,-5)to[Vmeter={info={cal 20~V}}](1.5,-5)--(1.5,-3);
\end{tikzpicture}
```



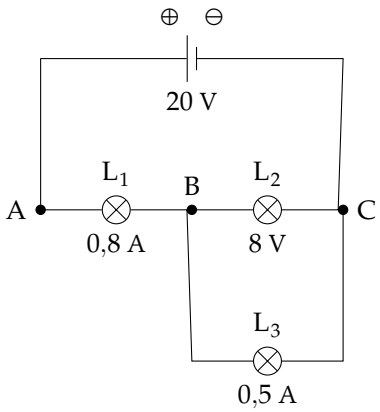

```
\begin{tikzpicture}
\draw(0,0)--(1,0)(1,-.5)rectangle++(3,1)(4,0)--(5,0);
\begin{scope}
\fill[gray](1.5,-.5)rectangle ++(.3,1);
\coordinate(c)at(1.7,0);
\node[left](d)at(1.7,-1){couleur 1: vert};
\draw[latex-latex](c)--(d);
\end{scope}
\begin{scope}[xshift=.5cm]
\fill[gray](1.5,-.5)rectangle++(.3,1);
\coordinate(c)at(1.7,0);
\node(d)at(1.7,-2){couleur 2: blanc};
\draw[latex-latex](c)--(d);
\end{scope}
\begin{scope}[xshift=1cm]
\fill[gray](1.5,-.5)rectangle++(.3,1);
\coordinate(c)at(1.7,0);
\node[right](d)at(1.7,-1.5){couleur 3: vert};
\draw[latex-latex](c)--(d);
\end{scope}
\begin{scope}[xshift=1.5cm]
\fill[gray](1.5,-.5)rectangle++(.3,1);
\coordinate(c)at(1.7,0);
\node(d)at(1.7,1){couleur 4 : or};
\draw[latex-latex](c)--(d);
\end{scope}
\end{tikzpicture}
```



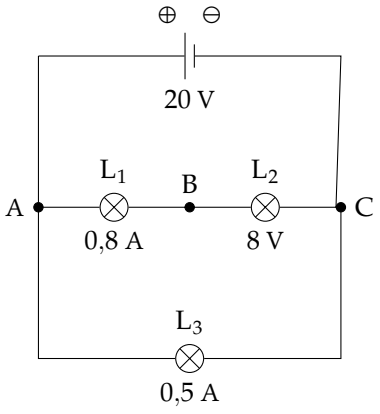

```
\begin{tikzpicture}[scale=2]
\draw[line width=1mm, rounded corners=5mm] (0,0) node [below=1.2cm]
{{\Huge U}}-- (-1,-2)node [yshift=-5mm,above right=1cm]
{{\Huge R}} -- (1,-2) node [yshift=-5mm,above left=1cm]{{\Huge I}}-- cycle;
\end{tikzpicture}
```




```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,0)to[battery={info'={$20$~V},info={$\oplus\quad\ominus$}}](4,0)
to[contact={at end,{info'={$C$}},rotate=90}](4,-2)--(4,-4)
to[bulb={info'={$L_3$},info={$0,5$~A}}](2,-4)to[contact={at end,info={$B$}}](2,-2)
to[bulb={info'={$L_1$},info={$0,8$~A}}](0,-2)
to[contact={at start,info={$A$},rotate=90}](0,0)(2,-2)
to[bulb={info={$L_2$},info'={$8$~V}}](4,-2);
\end{tikzpicture}
```

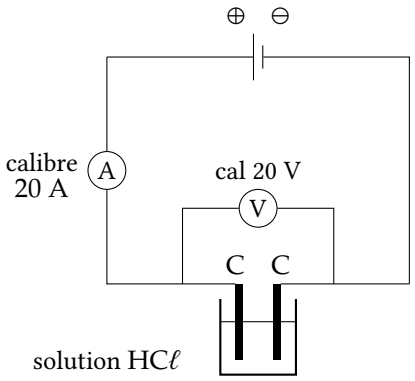



```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,0)to[battery={info'={$20$~V},info={$\oplus\quad\ominus$}}](4,0)
to[contact={at end,{info'={$C$}},rotate=90}](4,-2)
to[bulb={info'={$L_2$},info={$8$~V}}](2,-2)
to[contact={info={$B$}}](2,-2)to[bulb={info'={$L_1$},info={$0,8$~A}}](0,-2)
to[contact={at start,info={A},rotate=90}](0,0);
\draw (0,-2)--(0,-4)to[bulb={info={$L_3$},info'={$0,5$~A}}](4,-4)--(4,-2);
\end{tikzpicture}
```

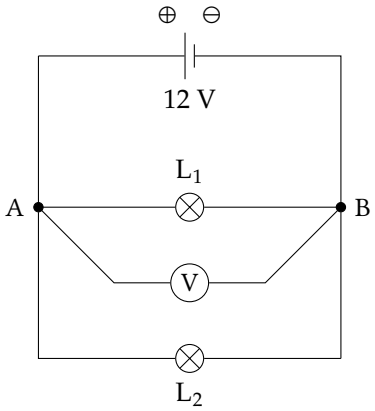



```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,1)to [battery={info={$\oplus\quad\ominus$}}](4,1)--(4,-2);
\draw (0,1)to[Ameter={rotate=-90,info'={$\stackrel{\text{{\normalsize calibre}}}{ 20~A}$}}]
(0,-2)--(1.7,-2)(2.3,-2)--(4,-2);
\fill (1.7,-2)node [above]{$C$}rectangle++(.1,-1);
\fill (2.3,-2)node [above]{$C$}rectangle++(-.1,-1);
\draw[thick](1.5,-2.2)--++(0,-1)--++(1,0)--++(0,1);
\draw(1.5,-2.5)--++(1,0);
```

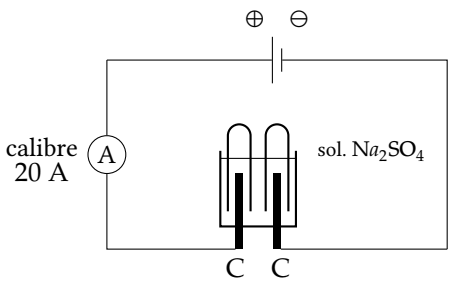
```
\node at (0,-3){solution $HC\ell$ };
\draw(1,-2)--(1,-1)to[Vmeter={info={cal 20~V}}](3,-1)--(3,-2);
\end{tikzpicture}
```



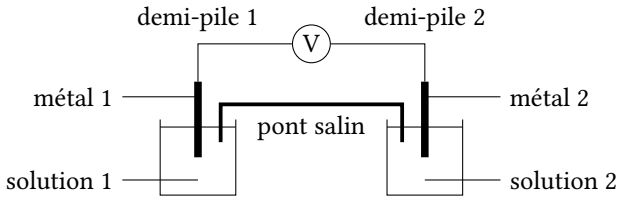

```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,0)to [battery={info={$\oplus\quad\ominus$},info'={$12~V$}}](4,0)
to[contact={info=B,rotate=-90}](4,-4);\draw(0,-2)to[bulb={info={$L_1$}}](4,-2);
%node[below]{B}node[contact]{};
\draw (0,0)to[contact={info={A},rotate=90}](0,-4)to[bulb={info'={$L_2$}}](4,-4);
\draw(0,-2)--(1,-3)to[Vmeter](3,-3)--(4,-2);
\end{tikzpicture}
```



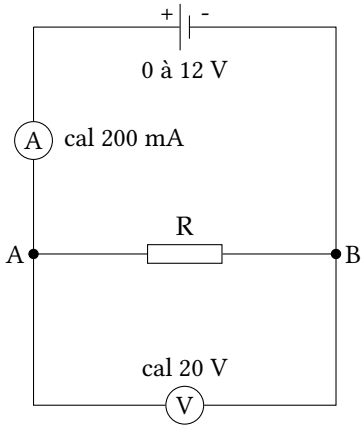

```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,.5)to [battery={info={$\oplus\quad\ominus$}}](4.5,0.5)--(4.5,-2);
\draw (0,0.5)to[Ameter={rotate=-90,info'={$\stackrel{\text{{\normalsize calibre}}}{ 20~A}$}}]
(0,-2)--(1.7,-2)(2.3,-2)--(4.5,-2);
\fill (1.7,-2)node [below]{$C$}rectangle++(.1,1);
\fill (2.3,-2)node [below]{$C$}rectangle++(-.1,1);
\draw[thick](1.5,-.7)--++(0,-1)--++(1,0)--++(0,1);
\draw(1.5,-.8)--++(1,0);
\node at (3.5,-.7){{\footnotesize sol. $Na_2SO_4$} };
\begin{scope}
\draw[thick](1.6,-1.5)--++(0,1)arc(180:0:.15)--++(0,-1);
\end{scope}
\begin{scope}[xshift=5mm]
\draw[thick](1.6,-1.5)--++(0,1)arc(180:0:.15)--++(0,-1);
\end{scope}
\end{tikzpicture}
```



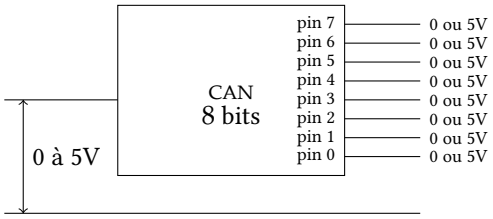
```
\begin{tikzpicture}[circuit ee IEC]
\begin{scope}
\draw (.5,.5)--++(0,.5)to[Vmeter]++(3,0)--++(0,-.5);
\draw [line width=.5mm](.8,-.3)--++(0,.5)--++(2.4,0)node[midway,below]{pont salin}--++(0,-.5);
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=5mm]{demi-pile 1}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(-1,0)node[left]{métal 1};
\draw(.5,-.8)--++(-1,0)node[left]{solution 1};
\end{scope}
\begin{scope}[xshift=3cm]
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=5mm]{demi-pile 2}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{métal 2};
\draw(.5,-.8)--++(1,0)node[right]{solution 2};
\end{scope}
\end{tikzpicture}
```



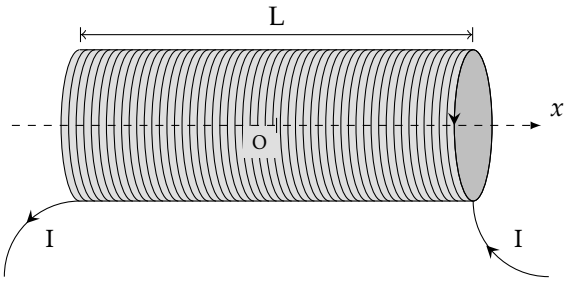

```
\begin{tikzpicture}[circuit ee IEC]
\draw (0,0)to [battery={info={[yshift=-1em]+\quad -},info'={0 à 12~V}}] (4,0)--(4,-3)
node[contact]{}node[right]{B}to[resistor={info'=$R$}](0,-3)node[left]{A}node[contact]{}to[Ameter={info={[yshift=-1.3em,xshift=1.2cm]cal 200~m
\draw (0,-3)--(0,-5)to[Vmeter={info={cal 20~V}}](4,-5)--(4,-3);
%to[resistor={info'=$R_1$}](0,-3)to[contact=at end](0,-3)node[left]{A}--;
\end{tikzpicture}
```




```
\begin{tikzpicture}[scale=.5]
\draw (0,0)rectangle (6,4.5) ;
\draw(-3,2)--(0,2);
\draw(-3,-1)--(8,-1);
\draw(6,1)node[left]{{\scriptsize pin 1}}--(8,1)node[right]{{\scriptsize 0 ou 5V}};%
\draw(6,.5)node[left]{{\scriptsize pin 0}}--(8,.5)node[right]{{\scriptsize 0 ou 5V}};
\draw(6,1.5)node[left]{{\scriptsize pin 2}}--(8,1.5)node[right]{{\scriptsize 0 ou 5V}};
\draw(6,2)node[left]{{\scriptsize pin 3}}--(8,2)node[right]{{\scriptsize 0 ou 5V}};
\draw(6,2.5)node[left]{{\scriptsize pin 4}}--(8,2.5)node[right]{{\scriptsize 0 ou 5V}};
\draw(6,3)node[left]{{\scriptsize pin 5}}--(8,3)node[right]{{\scriptsize 0 ou 5V}};
\draw(6,3.5)node[left]{{\scriptsize pin 6}}--(8,3.5)node[right]{{\scriptsize 0 ou 5V}};
\draw(6,4)node[left]{{\scriptsize pin 7}}--(8,4)node[right]{{\scriptsize 0 ou 5V}};
\node at(3,2){$\stackrel{CAN}{8~\text{bits}}$ };
\draw[<->](-2.5,-1)--(-2.5,2)node[right,midway]{0 à 5V};
\end{tikzpicture}
```

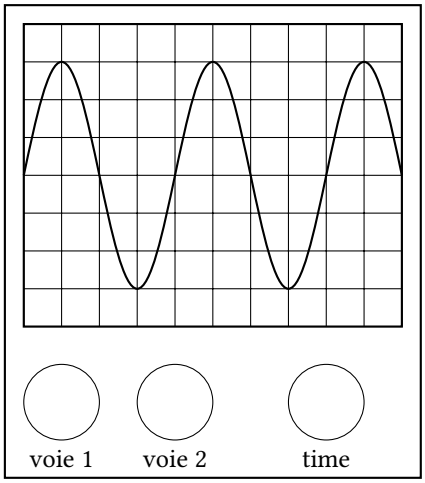



```
%simple flèche grande taille
\tikzstyle simplegros=[postaction={decorate,decoration={markings, mark=at position .5 with {\arrow[scale=1.5,>=stealth]{>}}}}]

%simple flèche grande taille reverse
\tikzstyle simplegrosrev=[postaction={decorate,decoration={markings, mark=at position .5 with {\arrow[scale=1.5,>=stealth]{<}}}}]


\begin{tikzpicture}[scale=1]
\filldraw [fill=gray!25,draw=black] (-2.6,0) ellipse (0.25cm and 1cm);

\filldraw [gray!25] (-2.6,-1) to [bend left=8] (-2.6,1) -- (2.6,1) to [bend right=8] (2.6,-1) -- cycle;

\foreach \x in {-2.5,-2.4,...,2.6}
{
\filldraw [fill=gray!25,draw=black] (\x,1) arc (90:270:0.25cm and 1cm); %arc elliptique
}

\filldraw [fill=gray!50] (2.6,0) ellipse (0.25cm and 1cm);
\draw [simplegros] (2.6,0) ellipse (0.25cm and 1cm);
\draw (-2.6,1) -- (2.6,1);
\draw (-2.6,-1) -- (2.6,-1);
\draw [ |<->|] (-2.6,1.2) -- (2.6,1.2) node [midway, above] {$L$};

\draw [->,-latex,dashed] (-3.5,0)--++(7,0) node [above right] {$x$};

\node at (-0,0) [below left,fill=gray!25] {\footnotesize O};
\draw (-0,0)--++(0,0.1) (-0,0)--++(0,-0.1);

\draw [simplegros] (-2.6,-1) to [bend right=45] ++(-1,-1) ;
\node at (-3,-1.5) {I};
\draw [simplegrosrev] (2.6,-1) to [bend right=45] ++(1,-1) ;
\node at (3.2,-1.5) {I};

\end{tikzpicture}
```

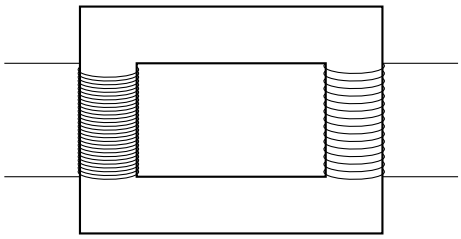



```
\begin{tikzpicture}[scale=.5]
\draw[thick](-.5,-4)rectangle (10.5,8.5) ;
\draw(0,0)grid (10,8) ;
\draw[thick](0,0)rectangle (10,8) ;
\begin{scope}
\draw[thick] (0,4) sin (1,7) cos (2,4) sin (3,1) cos (4,4);
\end{scope}
\begin{scope}[xshift=4cm]
\draw[thick] (0,4) sin (1,7) cos (2,4) sin (3,1) cos (4,4);
\end{scope}
\begin{scope}[xshift=8cm]
\draw [thick](0,4) sin (1,7) cos (2,4) ;
\end{scope}
```

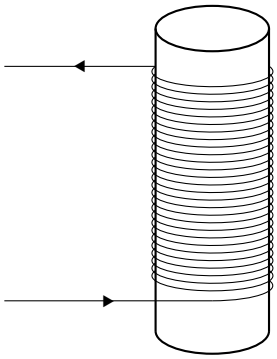
```
\draw [](1,-2)circle (1);
\node at(1,-3.5){voie 1};

\draw (4,-2)circle (1);
\node at(4,-3.5){voie 2};

\draw (8,-2)circle (1);
\node at(8,-3.5){time};
\end{tikzpicture}
```



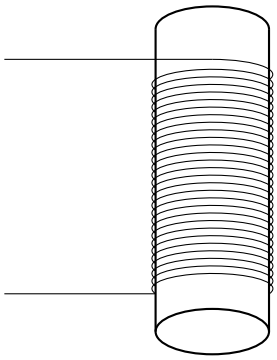

```
\begin{tikzpicture}[scale=.5]
\draw[thick](0,0)rectangle (8,6) ;
\draw[thick](1.5,1.5)rectangle (6.5,4.5) ;
\foreach \y in {1.7,1.8,...,4.5}\draw (0,\y)arc (160:380:.8 and .2);
\foreach \y in {1.7,1.9,...,4.5}\draw (6.5,\y)arc (160:380:.8 and .2);
\draw(-2,1.5)--(0,1.5);
\draw(-2,4.5)--(0,4.5);
\draw(8,1.5)--(10,1.5);
\draw(8,4.5)--(10,4.5);
\end{tikzpicture}
```



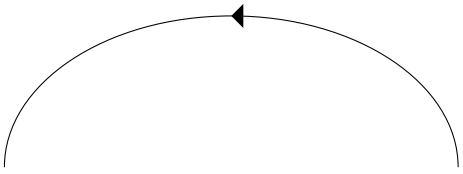
```
\begin{tikzpicture}
\draw(-2,1.4)--(.75,1.4)node [midway]{\blacktriangleright};
\draw(-2,4.5)--(0,4.5)node [midway]{\blacktriangleleft};
%\draw[thick](0,1)rectangle (1.5,5) ;
\draw[thick](0,1)--(0,5);
\draw[thick](1.5,1)--(1.5,5);
\draw[thick](0,1)arc(180:360:.75 and .3);
\draw[thick](.75,5)ellipse(.75 and .3);
\draw (.75,1.4)arc (270:380:.8 and .2);
\foreach \y in {1.8,1.9,...,4.5}\draw (0,\y)arc (160:380:.8 and .2);
\end{tikzpicture}
```



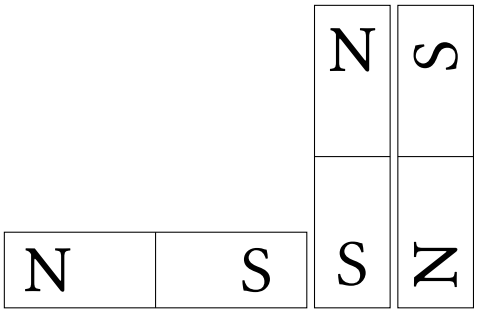
```
\begin{tikzpicture}[xscale=-1,rotate=180]
\draw(-2,1.4)--(.75,1.4);
\draw(-2,4.5)--(0,4.5);
%\draw[thick](0,1)rectangle (1.5,5) ;
\draw[thick](0,1)--(0,5);
\draw[thick](1.5,1)--(1.5,5);
\draw[thick](0,1)arc(180:360:.75 and .3);
\draw[thick](.75,5)ellipse(.75 and .3);
\draw (.75,1.4)arc (270:380:.8 and .2);
\foreach \y in {1.8,1.9,...,4.5}\draw (0,\y)arc (160:380:.8 and .2);
\end{tikzpicture}
```



```
\begin{tikzpicture}
\draw [postaction={decorate,draw,
decoration={markings,mark=at position .5 with
{\arrow[line width=.2mm]{triangle 90}} ;}}]
[ ] (0,0) arc (0 :180 :3 and 2) ;
\end{tikzpicture}
```

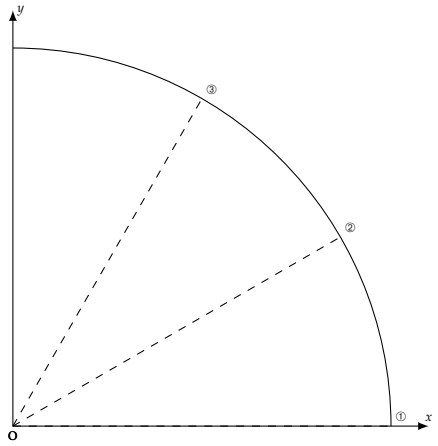


```
\begin{tikzpicture}
\draw (0,0)rectangle (4,1);
\draw(2,0)--++(0,1)node[midway,left=1cm]{\Huge N}node[midway,right=1cm]{\Huge S};
\end{tikzpicture}
\begin{tikzpicture}[rotate=90]
\draw (0,0)rectangle (4,1);
\draw(2,0)--++(0,1)node[midway,above=1cm]{\Huge N}node[midway,below=1cm]{\Huge S};
\end{tikzpicture}
\begin{tikzpicture}[rotate=90,transform shape]
\draw (0,0)rectangle (4,1);
\draw(2,0)--++(0,1)node[midway,left=1cm]{\Huge N}node[midway,right=1cm]{\Huge S};
\end{tikzpicture}
```



4.4–Dessins de Mécanique

```
\begin{tikzpicture}[scale=.5,transform shape]
\draw (0,10)arc (90:0:10);
\draw [latex-latex](0,11)node[right]{$y$}|-(11,0)node[above]{$x$};
\foreach \a/\b in {0/\ding{192},30/\ding{193},60/\ding{194}}\draw[dashed](0,0)node[below]{O}--(\a:10)node[above right]{\b};
\end{tikzpicture}
```

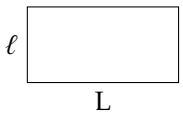



```
\begin{minipage}{5cm}
\begin{center}
Aire du rectangle:
\end{center}
\[\boxed{S=L\cdot\ell}\]
\begin{center}
\begin{tikzpicture}
\draw(0,0)-|(2,1)node[pos=.25,below]{$L$}-|(0,0)node[pos=.75,left]{$\ell$};
\end{tikzpicture}
\end{center}
\end{minipage}
\begin{minipage}{5cm}
\begin{center}
Aire du cercle:
\end{center}
\[\boxed{S=\pi\cdot R^2}\]
\[\pi=3,14\]
\begin{center}
\begin{tikzpicture}
\draw(0,0)circle(1.5);
\draw(0,0)--++(1.5,0)node[pos=.5,above]{$R$};
\end{tikzpicture}
\end{center}
\end{minipage}
\begin{minipage}{5cm}
\begin{center}
Volume du pavé:
\end{center}
\[\boxed{V=L\cdot\ell\cdot h}\]
\begin{center}
\begin{tikzpicture}
```

```
\draw(0,0)-|(2,1)node[pos=.25,below]{$L$}-|(0,0)node[pos=.75,left]{$h$};
\draw(2.5,.5)|-(.5,1.5);
\draw[dashed](.5,1.5)|-(2.5,.5);
\draw[dashed](0,0)--(.5,.5);
\draw(2,0)--++(.5,.5)node[pos=.5,right]{$\ell$};
\draw(2,1)--++(.5,.5);
\draw(0,1)--++(.5,.5);
\end{tikzpicture}
\end{center}
\end{minipage}
```

Aire du rectangle :

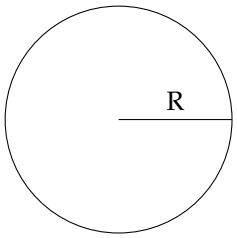
$\boxed{S = L \cdot \ell}$



Aire du cercle :

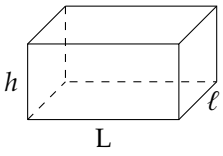
$\boxed{S = \pi \cdot R^2}$

$\pi = 3{,}14$

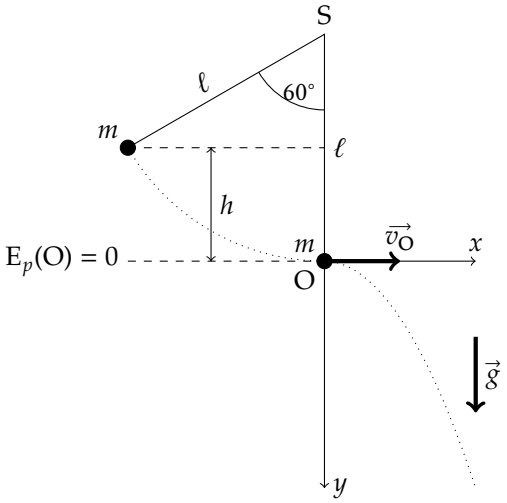


Volume du pavé :

$\boxed{V = L \cdot \ell \cdot h}$

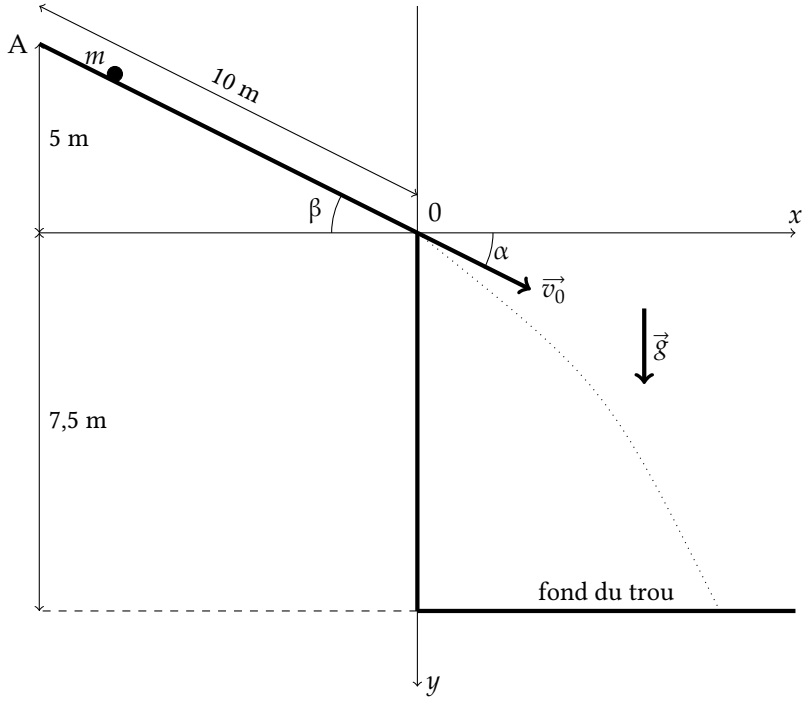



```
\begin{tikzpicture}
\draw[->](0,0)node[below left ] { $O$}--(2,0)node[above ] { $x$};
\draw[->](0,0)--(0,-3)node[ right] { $y$};
\draw(0,0)--(0,3)node[midway, right] { $\ell$}node[above] { $S$}--(-2.6,1.5)
node[midway, above left,sloped] { $\ell$};
%\draw[ultra thick](-5,2.5)node[left] { $A$}--(0,0)node[above right] { $0$};
\draw[<->](-1.5,0)--(-1.5,1.5)node[midway, right] { $h$};
\draw[ultra thick,->](0,0)--(1,0)node[above] { $\overrightarrow{v_O}$};
\draw[ultra thick,->](2,-1)--(2,-2)node[ midway,right] { $\overrightarrow{g}$};
\draw[dotted](0,0)parabola(2,-3);
\draw[dashed](-2.6,1.5)--(0,1.5);
\draw[dashed](-2.6,0)node[ left ] { $E_p(O)=0$}--(0,0);
\filldraw(0,0)circle(.1)node[above left] { $m$};
\filldraw(-2.6,1.5)circle(.1)node[above left] { $m$};
\draw[dotted](-2.6,1.5)arc(-150:-90:3);
\draw(-0.87,2.5)arc(-150:-90:1)node[above left] { 60\degres};
\end{tikzpicture}
```

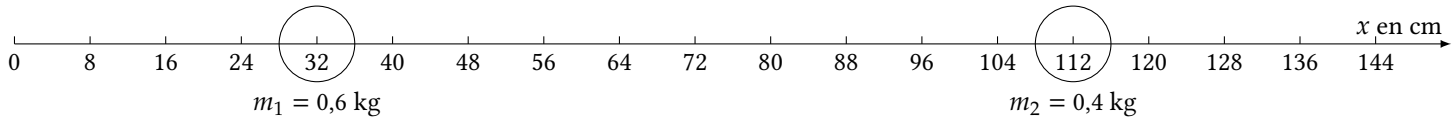



```
\begin{tikzpicture}
\draw[->](-5,0)--(5,0)node[above ] { $x$};
\draw[->](0,3)--(0,-6)node[ right] { $y$};
\draw[ultra thick](0,0)--(0,-5);
\draw[ultra thick](-5,2.5)node[left] { $A$}--(0,0)node[above right] { $0$};
\draw[<->](-5,3)--(0,0.5)node[midway, sloped,above] { 10~m};
\draw[ultra thick,->](0,0)--(1.5,-.75)node[right] { $\overrightarrow{v_0}$};
```

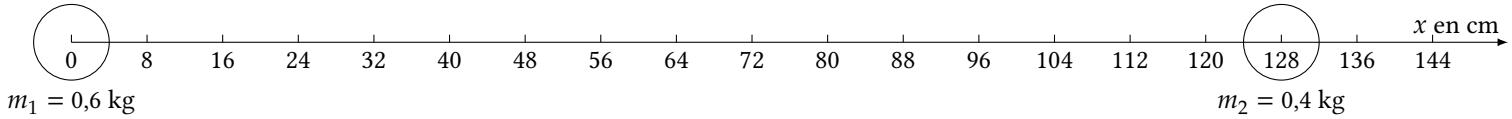
```
\draw[ultra thick,->](3,-1)--(3,-2)node[ midway,right] { $\overrightarrow{g}$};
\draw[ultra thick](0,-5)--(5,-5)node[ midway,above] {fond du trou};;
\draw[<->](-5,0)--(-5,2.5)node[ midway,right] { 5~m};
\draw[<->](-5,0)--(-5,-5)node[ midway,right] { 7,5~m};
\draw[dotted](0,0)..controls(2.5,-2)..(4,-5);
\draw[dashed](0,-5)--(-5,-5);
\filldraw(-4,2.1)circle(.1)node[above left] { $m$};
\draw(1,0)arc(0:-28:1)node[above right] { $\alpha$};
\draw(-1,.5)arc(150:180:1)node[above left] { $\beta$};
\end{tikzpicture}
```




```
\hspace{1cm}\begin{tikzpicture}
\draw[-latex](0,0)--(19,0)node[above left]{$x$ en cm};
\foreach \x in {0,8,...,144} \draw(\x/8,1mm)--(\x/8,0)node[below]{\x};
\draw(4,0)circle(.5)node[below=5mm]{$m_1=$ 0,6~kg};
\draw(14,0)circle(.5)node[below=5mm]{$m_2=$ 0,4~kg};
\end{tikzpicture}
```

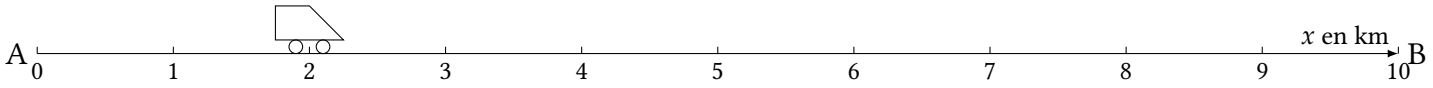



```
\begin{tikzpicture}
\draw[-latex](0,0)--(19,0)node[above left]{$x$ en cm};
\foreach \x in {0,8,...,144} \draw(\x/8,1mm)--(\x/8,0)node[below]{\x};
\draw(0,0)circle(.5)node[below=5mm]{$m_1=$ 0,6~kg};
\draw(16,0)circle(.5)node[below=5mm]{$m_2=$ 0,4~kg};
\end{tikzpicture}
```

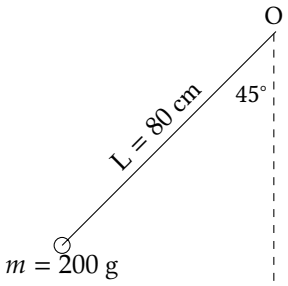



```
\begin{tikzpicture}[scale=.9]
\draw[-latex](0,0)node[ left]{{\large A}}--(20,0)node[above left]{$x$ en km}
node[right]{{\large B}};
\foreach \x in {0,1,...,10} \draw(\x*2,1mm)--(\x*2,0)node[below]{\x};
\draw(3.8,0.1)circle(.1);
\draw(4.2,0.1)circle(.1);
\draw(3.5,0.2)--++(1,0)--++(-.5,.5)--++(-.5,0)--cycle;
%\draw(16,0)circle(.5)node[below=5mm]{$m_2=$ 0,4~kg};
```

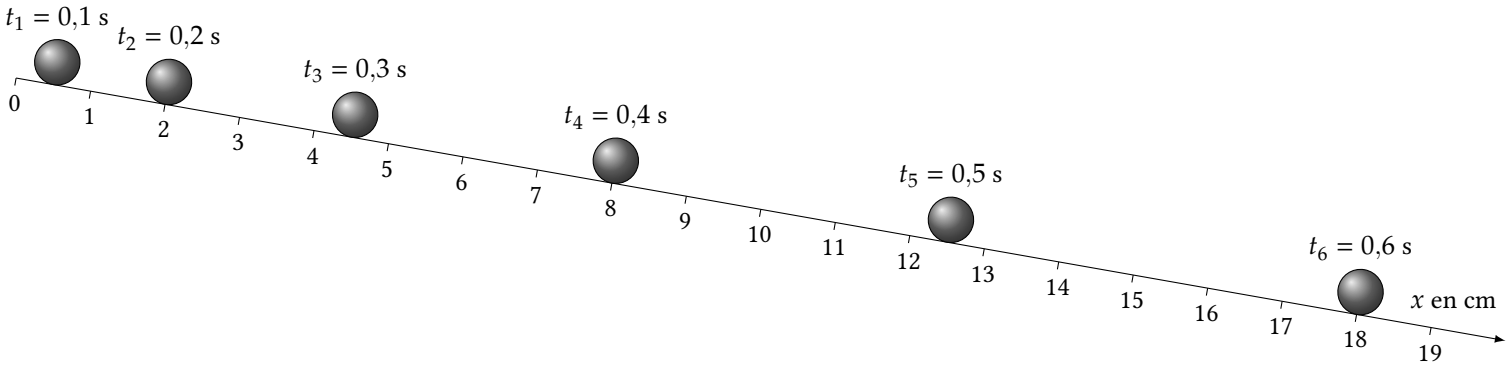
```
\end{tikzpicture}
```



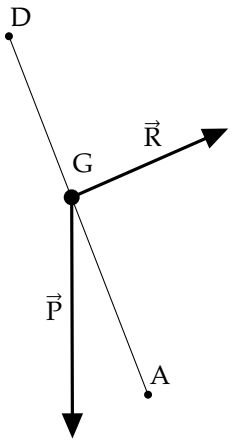

```
\begin{tikzpicture}
\draw (0,0)circle(3pt)node[below]{$m=200$~g}--(45:4)node[midway,above,sloped]{$L=80$~cm};
\draw[dashed](2.8,2.8)node[above]{O}--(2.8,-.5);
\node at (2.5,2){45\degres};
\end{tikzpicture}
```



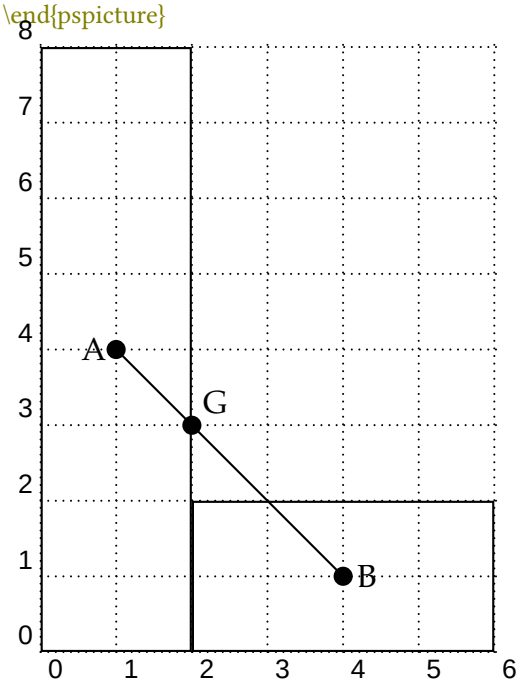

```
\begin{tikzpicture}[rotate=-10]
\foreach  \x in {0,...,19}
\draw (\x,-1mm) node[below]{\x}-- (\x,0);
\draw[-latex] (0,0) -- (20,0)node[yshift=3mm,above left]{$x$ en cm};
\foreach \x/\t in {1/0\symbol{44}1,2/0\symbol{44}2,3/0\symbol{44}3,4/0\symbol{44}4,5/0\symbol{44}5,6/0\symbol{44}6}
\draw[ball color=gray] (.5*\x*\x,.3) circle (.3)node[above=3mm]{$t_{\x}=\t$~s};
\end{tikzpicture}
```



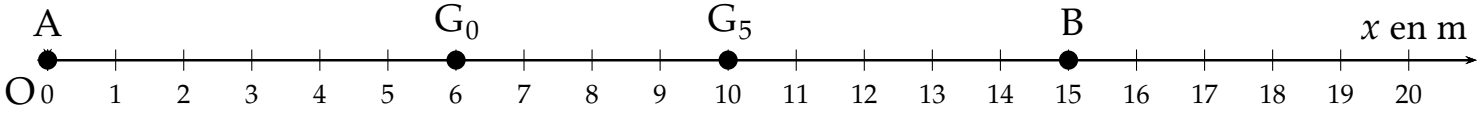

```
\begin{tikzpicture}[line cap=round,line join=round,>=triangle 45,x=1.0cm,y=1.0cm]
\clip(-2,-1) rectangle (4,6);
\draw (-0.2,5.28)-- (1.64,0.54);
\draw [->,line width=1.2pt] (0.63,3.15) -- (0.64,-0.04);
\draw [->,line width=1.2pt] (0.63,3.15) -- (2.7,4.06);

\fill (-0.2,5.28) circle (1.5pt);
\draw (-0.04,5.54) node {$D$};
\fill (1.64,0.54) circle (1.5pt);
\draw (1.8,0.8) node {$A$};
\fill (0.63,3.15) circle (3pt);
\draw (0.78,3.6) node {$G$};
\draw[color=black] (0.4,1.7) node {$\vec{P}$};
\draw[color=black] (1.7,4) node {$\vec{R}$};

\end{tikzpicture}
```




```
\null\begin{pspicture}(0,0)(6,8)
\psgrid[subgriddiv=1,griddots=10]
\psframe(2,8)
\psdots[dotscale=2](1,4)(4,1)(2,3)
\psline(1,4)(4,1)
\psframe(2,0)(6,2)
\rput(.7,4){\large $A$}
\rput(4.3,1){\large $B$}
\rput(2.3,3.3){\large $G$}
\end{pspicture}
```

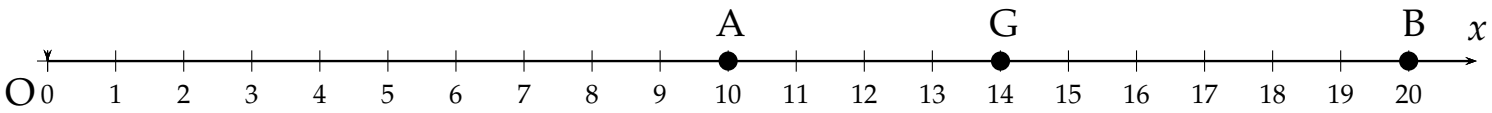



```
\psset{xunit=9mm}
\begin{pspicture}(0,-1)(21,.6)
\psaxes{->}(0,0)(0,0)(21,0)
\psdots[dotscale=2](0,0)(15,0)(6,0)(10,0)
\rput(0,0.5){\Large $A$}
\rput(15,0.5){\Large $B$}
\rput(-0.4,-0.4){\Large $O$}
\rput(20,0.4){\Large $x$ en m}
\rput(6,0.5){\Large $G_0$}
\rput(10,0.5){\Large $G_5$}
\end{pspicture}
```

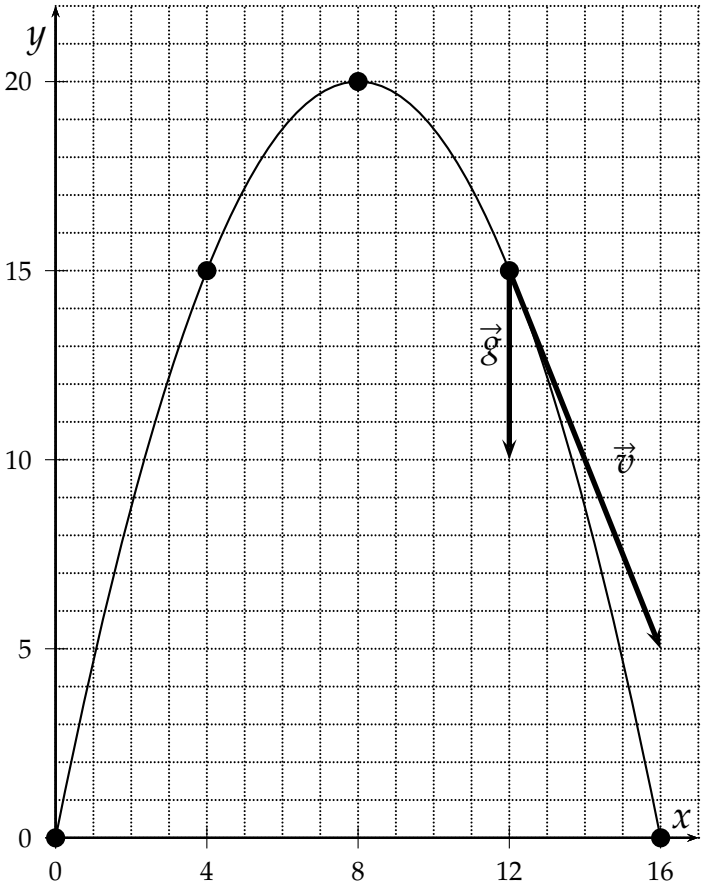



```
\begin{pspicture}(0,-1)(21,.6)
```

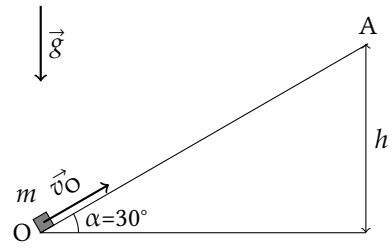
```
\psaxes{->}(0,0)(0,0)(21,0)
\psdots[dotscale=2](20,0)(10,0)(14,0)
\rput(20,0.5){\Large $B$}
\rput(-0.4,-0.4){\Large $O$}
\rput(21,0.4){\Large $x$ }
\rput(10,0.5){\Large $A$}
\rput(14,0.5){\Large $G$}
\end{pspicture}
```




```
\psset{unit=5mm}
\begin{pspicture}(17,22)
\psgrid[subgriddiv=1,griddots=10,gridlabels=0pt]
\psaxes[Dx=4,Dy=5]{->}(0,0)(0,0)(17,22)
\psdots[dotscale=2](0,0)(4,15)(8,20)(12,15)(16,0)
\psline[linewidth=2pt]{->}(12,15)(12,10)
\rput(11.5,13){\Large $\overrightarrow{g}$}
\psline[linewidth=2pt]{->}(12,15)(16,5)
\rput(15,10){\Large $\overrightarrow{v}$}
\psparabola(0,0)(8,20)
\rput(-.5,21){\Large $y$}
\rput(16.5,0.5){\Large $x$}
\end{pspicture}
```



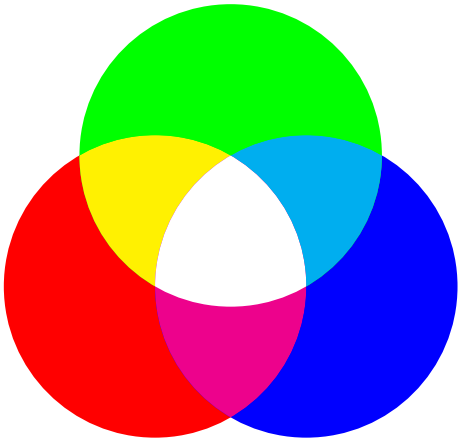

```
\begin{tikzpicture}
\draw[fill=gray,rotate=30](0,0)rectangle(.2,.2)node[above left]{$m$};
\draw[thick,->,rotate=30](0.1,0.1)--++(1,0)node[above, midway,rotate=30]{$\vec{v_O}$};
\draw(4.3,0)--(0,0)node[left]{O}--(30:5)node[above]{A};
\draw(.5,0)arc(0:30:.5);
\node at(1,.2){$\alpha$=30\degres};
\draw[thick,->] (0,3)--++(0,-1)node[right, midway]{$\vec{g}$};
\draw[<->](4.3,0)--(4.3,2.5)node[right, midway]{$h$};
\end{tikzpicture}
```



4.5–Dessins d'Optique

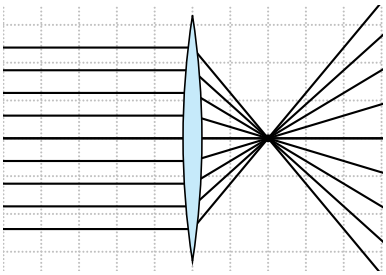
```
\begin{tikzpicture}
\foreach \y in {363,...,814}
\definecolor{c}{wave}{\y}%nombre compris entre 363 et 814
\draw[c,thick] (\y/50-2*3.63,0) -- (\y/50-2*3.63,1);
\end{tikzpicture}
```

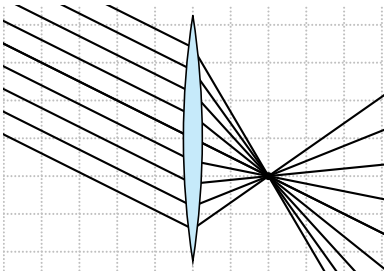
```
\begin{tikzpicture}
\fill[red](0,0)circle (2);
\fill[blue](2,0)circle (2);
\fill[green](60:2)circle (2);
\begin{scope}
\clip(0,0)circle (2);
\clip(60:2)circle (2);
\fill[yellow](0,0)circle (2);
\end{scope}
\begin{scope}
\clip(2,0)circle (2);
\clip(60:2)circle (2);
\fill[cyan](2,0)circle (2);
\end{scope}
\begin{scope}
\clip(2,0)circle (2);
\clip(0,0)circle (2);
\fill[magenta](0,0)circle (2);
\end{scope}
\begin{scope}
\clip(2,0)circle (2);
\clip(0,0)circle (2);
\clip(60:2)circle (2);
\fill[white](0,0)circle (2);
\end{scope}
\end{tikzpicture}
```



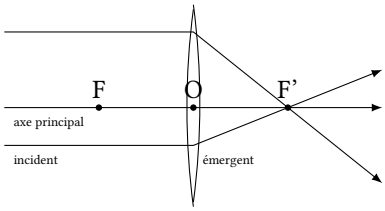
```
\psset{unit=5mm}
\hfill
```

```
\begin{pspicture*}[showgrid=true](-5,-3.5)(5,3.5)
 \pnode(2,0){FF}\qdisk(FF){1.5pt} \pnode(-100,0){A} \pnode(0,0){O}
 \multido{\nCountA=-2.4+0.6}{9}{%
 \Parallel[length=9](O)(A)(0,\nCountA){P1}
 \psline[](0,\nCountA)(FF)
 \psOutLine[length=9](0,\nCountA)(FF){P2}}
 \psline[](A)(FF)
 \psOutLine[length=5](A)(FF){END1}
 \rput(0,0){\lens[yBottom=-3.5,yTop=3.5,lensGlass=true,lensHeight=6.5,drawing=false,
 spotFi=315,lensWidth=0.5]
 \psline[linewidth=1pt](xLeft)(xRight)
 \psline[length=2,linewidth=2pt,arrows=->](F')(FF)}
 \end{pspicture*}
 \hfill
 \begin{pspicture*}[showgrid=true](-5,-3.5)(5,3.5)
 \pnode(2,-1){FF}\qdisk(FF){1.5pt} \pnode(-100,50){A} \pnode(0,0){O}
 \multido{\nCountA=-2.4+0.6}{9}{%
 \Parallel[length=9](O)(A)(0,\nCountA){P1}
 \psline[](0,\nCountA)(FF)
 \psOutLine[length=9](0,\nCountA)(FF){P2}}
 \psline[](A)(FF)
 \psOutLine[length=5](A)(FF){END1}
 \rput(0,0){\lens[yBottom=-3.5,yTop=3.5,lensGlass=true,lensHeight=6.5,drawing=false,
 spotFi=315,lensWidth=0.5]
 \psline[linewidth=1pt](xLeft)(xRight)
 \psline[length=2,linewidth=2pt,arrows=->](F')(FF)}
 \end{pspicture*}
 \hfill{}
```



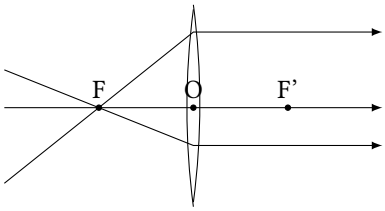


```
\begin{tikzpicture}[scale=.5]
\draw [-latex](0,0)node[below right] {{\tiny axe principal}}--(10,0);
\draw (5,-2.5)arc(-7.5:7.5:20);
\draw (5,2.6)arc(172.5:187.5:20);
\filldraw (2.5,0)circle(2pt)node[above]{F};
\filldraw (7.5,0)circle(2pt)node[above]{F'};
\filldraw (5,0)circle(2pt)node[above]{O};
\draw [-latex](0,2)--(5,2)--(10,-2);
\draw [-latex] (0,-1)node[below right] {{\tiny incident}}--(5,-1)
node[ below right] {{\tiny émergent}}--(10,1);
\end{tikzpicture}
```

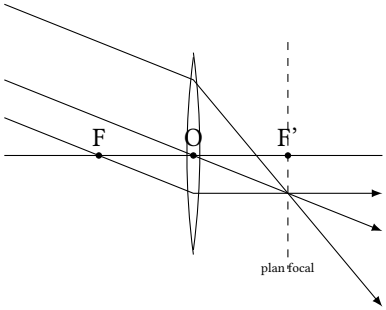



```
\begin{tikzpicture}[scale=.5]
\draw [-latex](0,0)--(10,0);
\draw (5,-2.5)arc(-7.5:7.5:20);
\draw (5,2.6)arc(172.5:187.5:20);
\filldraw (2.5,0)circle(2pt)node[above]{F};
\filldraw (7.5,0)circle(2pt)node[above]{F'};
\filldraw (5,0)circle(2pt)node[above]{O};
\draw [-latex](0,-2)--(5,2)--(10,2);
```

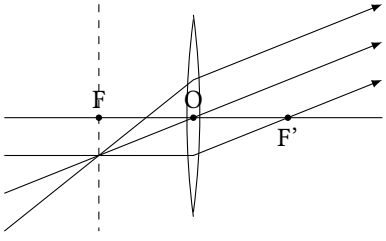
```
\draw [-latex] (0,1)--(5,-1)--(10,-1);
\end{tikzpicture}
```




```
\begin{tikzpicture}[scale=.5]
\draw (0,0)--(10,0);
\draw [-latex](0,2)--(10,-2);
\draw (5,-2.5)arc(-7.5:7.5:20);
\draw (5,2.6)arc(172.5:187.5:20);
\filldraw (2.5,0)circle(2pt)node[above]{F};
\filldraw (7.5,0)circle(2pt)node[above]{F'};
\filldraw (5,0)circle(2pt)node[above]{O};
\draw [-latex](0,4)--(5,2)--(10,-4);
\draw [-latex] (0,1)--(5,-1)--(10,-1);
\draw[dashed](7.5,3)--(7.5,-3)node[]{{\tiny plan focal}};
\end{tikzpicture}
```

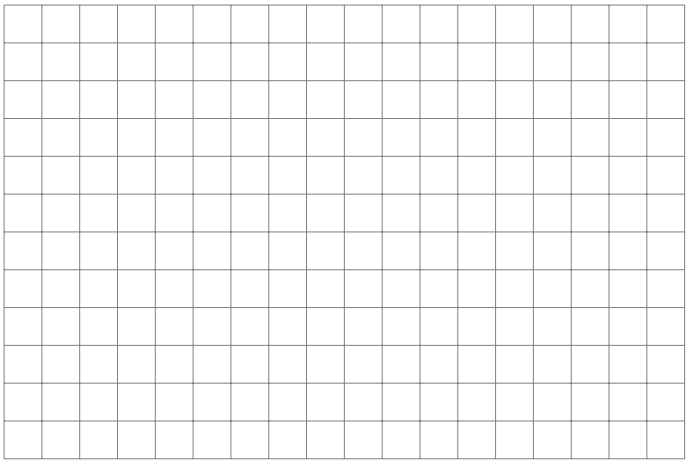



```
\begin{tikzpicture}[scale=.5]
\draw (0,0)--(10,0);
\draw (5,-2.5)arc(-7.5:7.5:20);
\draw (5,2.6)arc(172.5:187.5:20);
\filldraw (2.5,0)circle(2pt)node[above]{F};
\filldraw (7.5,0)circle(2pt)node[below]{F'};
\filldraw (5,0)circle(2pt)node[above]{O};
\draw [-latex](0,-2)--(5,0)--(10,2);
\draw [-latex] (0,-1)--(5,-1)--(10,1);
\draw [-latex] (0,-3)--(5,1)--(10,3);
\draw[dashed](2.5,3)--(2.5,-3);
\end{tikzpicture}
```

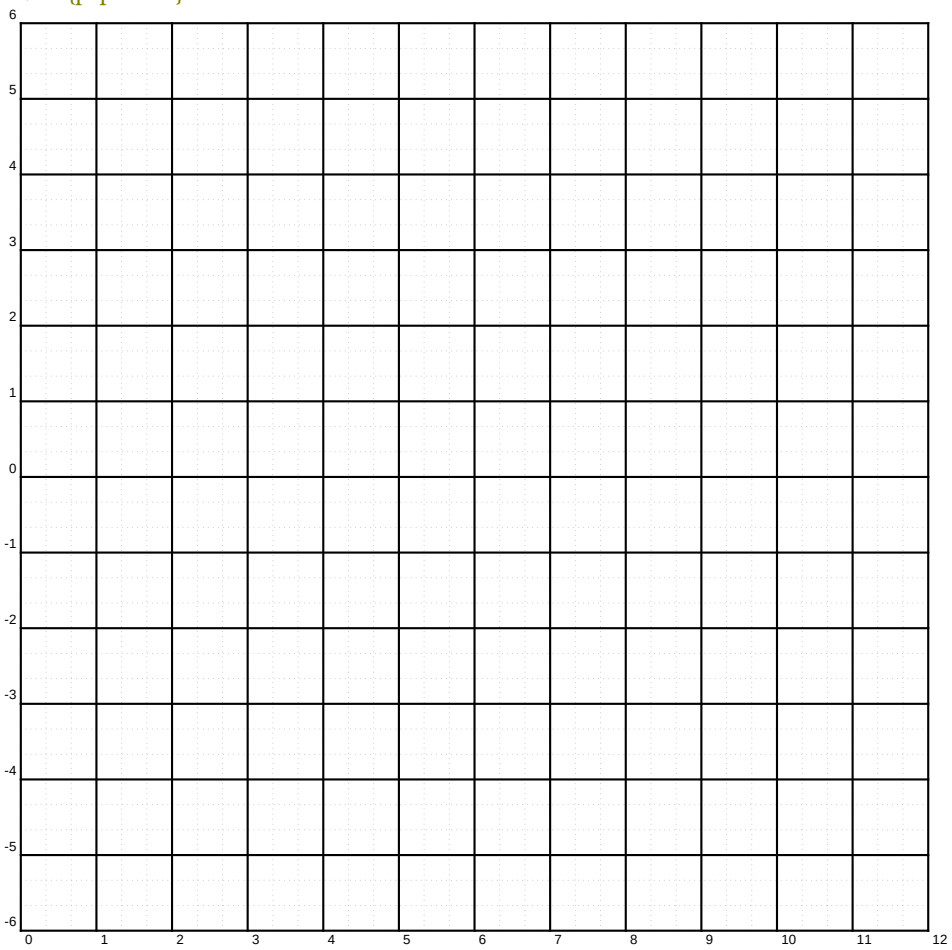


4.6–Graphes

```
\begin{tikzpicture}
\draw [help lines,step=5mm](0,0) grid (9,6) ;
\end{tikzpicture}
```

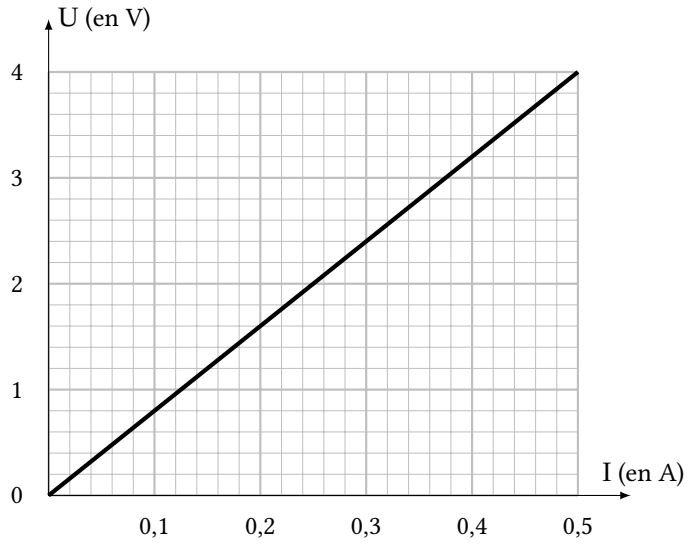


```
\psset{unit=1cm}
\begin{pspicture}(0,-6)(12,6)
\psgrid[gridlabels=5pt,subgriddiv=3,subgriddots=5,subgridcolor=lightgray]
\end{pspicture}
```

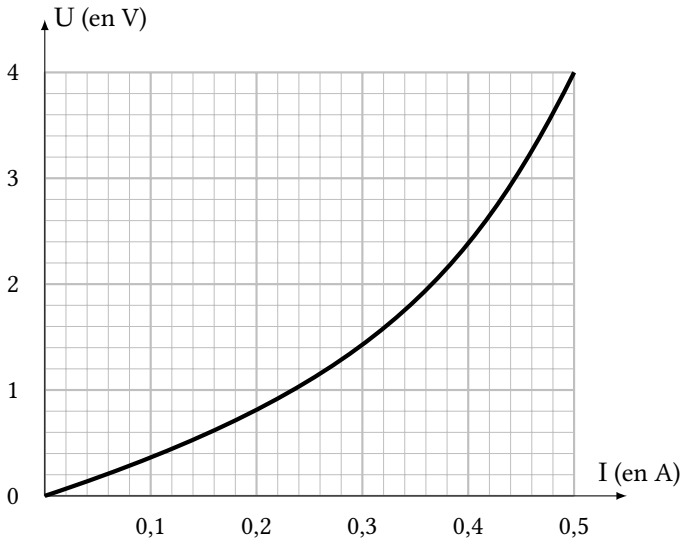



```
\begin{tikzpicture}[scale=1.4]
\draw[thick,lightgray](0,0)grid(5,4) ;
\draw[ultra thin,step=2mm,lightgray](0,0)grid(5,4) ;
\draw[latex-latex](0,4.5)node[right]{$U$ (en V)}|-(5.5,0)
node[xshift=-5mm,above right]{$I$ (en A)};
\foreach \x in {1,...,5} \node at (\x,-.3){0,\x};
\foreach \y in {0,...,4} \node at (-.3,\y){\y};
\draw [ultra thick](0,0) -- (5,4);
\node at(2.5,-1){Résistor (résistance)};
\end{tikzpicture}
\begin{tikzpicture}[scale=1.4]
\draw[thick,lightgray](0,0)grid(5,4) ;
\draw[ultra thin,step=2mm,lightgray](0,0)grid(5,4) ;
\draw[latex-latex](0,4.5)node[right]{$U$ (en V)}|-(5.5,0)
node[xshift=-5mm,above right]{$I$ (en A)};
\foreach \x in {1,...,5} \node at (\x,-.3){0,\x};
```

```
\foreach \y in {0,...,4} \node at (-.3,\y){\y};
\draw [ultra thick](0,0)..controls(3,1)and(4,2).. (5,4);
\node at(2.5,-1){Lampe};
\end{tikzpicture}
```

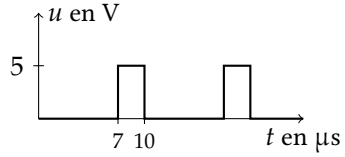


Résistor (résistance)



Lampe

```
\begin{tikzpicture}[scale=.7]
\draw[->](0,0)--(5,0)node[below]{$t$ en $\mu$s};
\draw(-.1,1)node[left]{$5$}--(.1,1);
\draw(1.5,.1)--(1.5,-.1)node[below ]{{\footnotesize $7$}};
\draw(2,.1)--(2,-.1)node[below]{{\footnotesize $10$}};
\draw[->](0,0)--(0,2)node[right]{$u$ en V};
\draw[thick](0,0)--(1.5,0)--(1.5,1)--(2,1)--(2,0)--(3.5,0)--(3.5,1)--(4,1)--(4,0)--(5,0);
\end{tikzpicture}
```



5–Exemples en CHIMIE

5.1–Subtilités avec du texte

```
\textbf{Exemple:} Une lame de zinc plongée dans une solution (bleue) de sulfate de cuivre
 se couvre de cuivre (rouge) et la solution pâlit.
 \[Zn+\underbrace{Cu^{2+}+SO_4^{2-}}_{\text{solution bleue}}\longrightarrow \underbrace{Cu}_{\text{rouge}}+Zn^{2+}+SO_4^{2-}\]

C'est une équation-bilan. On remarque que l'ion sulfate est présent des deux côtés,
 il n'est pas obligatoire de l'écrire:\[Zn+Cu^{2+}\longrightarrow Cu+Zn^{2+}\]

Cette équation-bilan simplifiée est la somme de 2 \emph{demi-équations électroniques}:
\[\underbrace{Zn}_{\text{réducteur}}\longrightarrow Zn^{2+}+ 2~e^-\]
\[\underbrace{Cu^{2+}}_{\text{oxydant}}+ 2~e^-\longrightarrow Cu\]
La première demi-équation est relative au couple $Zn^{2+}/Zn$: le réducteur est toujours écrit à droite.
\\La deuxième demi-équation est relative au couple $Cu^{2+}/Cu$: l'oxydant est toujours écrit à gauche.

\textbf{Première demi-équation:}\\
On commence par équilibrer tout sauf O et H:\\
$H_2C_2O_4\longrightarrow 2~CO_2$ \\
On équilibre  O avec $H_2O$:\\
sans objet ici\\
On équilibre  H avec $H^+$:\\
$H_2C_2O_4\longrightarrow 2~CO_2+ 2~H^+$ \\
On équilibre  la charge avec des $e^-$:\\
```

$H_2C_2O_4\longrightarrow 2~CO_2+ 2~H^++ 2~e^-$ \\
Le réducteur est donc $H_2C_2O_4$

Exemple : Une lame de zinc plongée dans une solution (bleue) de sulfate de cuivre se couvre de cuivre (rouge) et la solution pâlit.

$$\underbrace{Zn + Cu^{2+} + SO_4^{2-}}_{\text{solution bleue}} \longrightarrow \underbrace{Cu}_{\text{rouge}} + Zn^{2+} + SO_4^{2-}$$

C'est une équation-bilan. On remarque que l'ion sulfate est présent des deux côtés, il n'est pas obligatoire de l'écrire :

$$Zn + Cu^{2+} \longrightarrow Cu + Zn^{2+}$$

Cette équation-bilan simplifiée est la somme de 2 *demi-équations électroniques* :

$$\underbrace{Zn}_{\text{réducteur}} \longrightarrow Zn^{2+} + 2\,e^-$$

$$\underbrace{Cu^{2+}}_{\text{oxydant}} + 2\,e^- \longrightarrow Cu$$

La première demi-équation est relative au couple Zn^{2+}/Zn : le réducteur est toujours écrit à droite.
La deuxième demi-équation est relative au couple Cu^{2+}/Cu : l'oxydant est toujours écrit à gauche.

Première demi-équation :
On commence par équilibrer tout sauf O et H :
$H_2C_2O_4 \longrightarrow 2\,CO_2$
On équilibre O avec H_2O :
sans objet ici
On équilibre H avec H^+ :
$H_2C_2O_4 \longrightarrow 2\,CO_2 + 2\,H^+$
On équilibre la charge avec des e^- :
$H_2C_2O_4 \longrightarrow 2\,CO_2 + 2\,H^+ + 2\,e^-$
Le réducteur est donc $H_2C_2O_4$

5.2–Tableaux

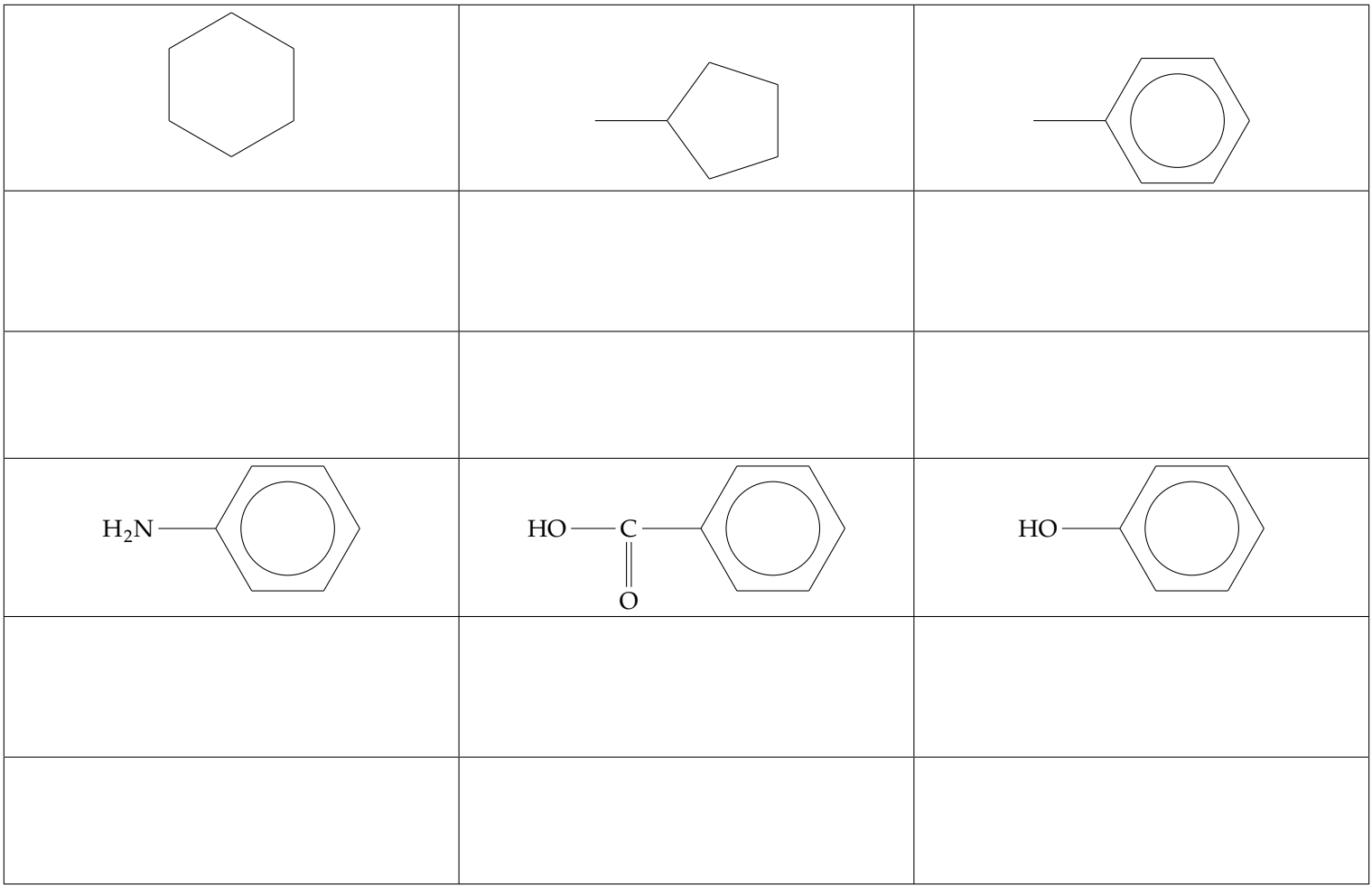
\begin{tabular}{lllll}
NO_3^-/NO&Na^+/Na&$Cr_2O_7^{2-}/Cr^{3+}$&H^+/H_2&Al^{3+}/Al\\
MnO_4^-/Mn^{2+}&O_2/H_2O_2&H_2O_2/H_2O&$S_2O_8^{2-}/SO_4^{2-}$&$S_2O_3^{2-}/S$\\
$SO_2/S_2O_3^{2-}$&Fe^{3+}/Fe^{2+}&I_2/I^-&$CO_2/H_2C_2O_4$&Cu^{2+}/Cu\\
\end{tabular}

NO_3^-/NO	Na^+/Na	$Cr_2O_7^{2-}/Cr^{3+}$	H^+/H_2	Al^{3+}/Al
MnO_4^-/Mn^{2+}	O_2/H_2O_2	H_2O_2/H_2O	$S_2O_8^{2-}/SO_4^{2-}$	$S_2O_3^{2-}/S$
$SO_2/S_2O_3^{2-}$	Fe^{3+}/Fe^{2+}	I_2/I^-	$CO_2/H_2C_2O_4$	Cu^{2+}/Cu

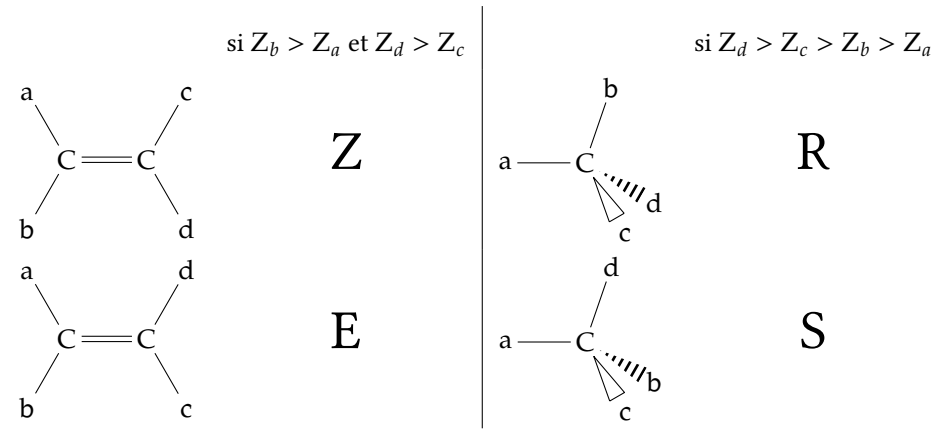
\begin{tabularx}{\linewidth}{|*4{>{\centering\arraybackslash}X|}}
\hline
CH_3CH_2OH&CH_3CHO&CH_3COOH&CH_3COCH_3\\
\hline
&&&\\[1cm]
\hline
&&&\\[.8cm]
\hline
CH_3COOCH_3&$CH_3CH_2NH_2$&CH_3CONH_2&$CH_3CH(NH_2)COOH$\\
\hline
&&&\\[1cm]
\hline
&&&\\[.8cm]
\hline
\end{tabularx}

CH_3CH_2OH	CH_3CHO	CH_3COOH	CH_3COCH_3
CH_3COOCH_3	$CH_3CH_2NH_2$	CH_3CONH_2	$CH_3CH(NH_2)COOH$

```
\setcellgapes{1mm}
\makegapedcells
\begin{tabularx}{\linewidth}{|*3{>{\centering\arraybackslash}X|}}

\hline
\chemfig{*6(------)}&\chemfig{-*5(-----)}&\chemfig{-**6(------)}\\
\hline
&&\\[1cm]
\hline
&&\\[.8cm]
\hline
\chemfig{H_2N-**6(------)}&\chemfig{HO-C(=[6]O)-**6(------)}&\chemfig{HO-**6(------)}\\
\hline
&&\\[1cm]
\hline
&&\\[.8cm]
\hline
\end{tabularx}
```



```
\begin{tabularx}{\linewidth}{cc|cc}
&si $Z_b>Z_a$  et $Z_d>Z_c$&&si $Z_d>Z_c>Z_b>Z_a$\\
\chemfig{C(-[:-120]b)(-[:120]a)=C(-[:-60]d)-[:60]c} &\huge Z
&\chemfig{a-C(<|[:-60]c)(<:[:-30]d)-[:71]b}&\huge R\\
\chemfig{C(-[:-120]b)(-[:120]a)=C(-[:-60]c)-[:60]d} &\huge E
&\chemfig{a-C(<|[:-60]c)(<:[:-30]b)-[:71]d}&\huge S\\
\end{tabularx}
```




```
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\multicolumn{1}{c}{1A}&\multicolumn{1}{c}{2A}&\multicolumn{1}{c}{3A}
&\multicolumn{1}{c}{4A}&\multicolumn{1}{c}{5A}&\multicolumn{1}{c}{6A}
&\multicolumn{1}{c}{7A}&\multicolumn{1}{c}{8A}\\\cline{1-1}\cline{8-8}
$_1H$&\multicolumn{6}{c|}{}&$_2He$\\\hline
$_3Li$&$\textcolor{gray}{_4Be}$&$\textcolor{gray}{_5B}$&$_6C$&$_7N$&$_8O$&$_9F$&$_{10}Ne$\\\hline
$_{11}Na$&$_{12}Mg$&$_{13}A\ell$&$_{14}Si$&$_{15}P$&$_{16}S$&$_{17}C\ell$&$_{18}Ar$\\\hline
$_{19}K$&$_{20}Ca$&&&&&$_{35}Br$&$_{36}Kr$\\\hline
&&&&&&$_{53}I$&$_{54}Xe$\\\hline
\end{tabular}
```

1A	2A	3A	4A	5A	6A	7A	8A
$_{1}$H							$_{2}$He
$_{3}$Li	$_{4}$Be	$_{5}$B	$_{6}$C	$_{7}$N	$_{8}$O	$_{9}$F	$_{10}$Ne
$_{11}$Na	$_{12}$Mg	$_{13}$Al	$_{14}$Si	$_{15}$P	$_{16}$S	$_{17}$Cl	$_{18}$Ar
$_{19}$K	$_{20}$Ca					$_{35}$Br	$_{36}$Kr
						$_{53}$I	$_{54}$Xe

```
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\multicolumn{1}{c}{1A}&\multicolumn{1}{c}{2A}&\multicolumn{1}{c}{3A}&\multicolumn{1}{c}{4A}
&\multicolumn{1}{c}{5A}&\multicolumn{1}{c}{6A}&\multicolumn{1}{c}{7A}&\multicolumn{1}{c}{8A}\\\cline{1-1}\cline{8-8}
\lewis{0.,H}&\multicolumn{6}{c|}{}&\lewis{2:,He}\quad ou\quad \lewis{2,He}\\\hline
\lewis{0.,Li}&\lewis{0.4.,Be}&\lewis{0.4.6.,B}&\lewis{0.4.6.2.,C}&\lewis{0.4.6.2:,N}\quad ou\quad \lewis{0.4.6.2,N} &\lewis{0.4.6:2:,O}\quad ou\quad
\lewis{0.4.62,O}&\lewis{0.4:6:2:,F}\quad ou\quad \lewis{0.462,F}&\lewis{0:4:6:2:,Ne}\quad ou\quad \lewis{0462,Ne}\\\hline
\lewis{0.,Na}&\lewis{0.4.,Mg}&\lewis{0.4.6.,A\ell}&\lewis{0.4.6.2.,Si}&\lewis{0.4.6.2:,P}\quad ou\quad \lewis{0.4.6.2,P} &\lewis{0.4.6:2:,S}\quad ou\qu
\lewis{0.4.62,S} &\lewis{0.4:6:2:,C\ell}\quad ou\quad \lewis{0.462,C\ell}&\lewis{0:4:6:2:,Ar}\quad ou\quad \lewis{0462,Ar}\\\hline
\lewis{0.,K}&\lewis{0.4.,Ca}&&&&&\lewis{0.4:6:2:,Br}\quad ou\quad \lewis{0.462,Br}&\lewis{0:4:6:2:,Kr}\quad ou\quad \lewis{0462,Kr}\\\hline
&&&&&&\lewis{0.4:6:2:,I}\quad ou\quad \lewis{0.462,I}&\lewis{0:4:6:2:,Xe}\quad ou\quad \lewis{0462,Xe}\\\hline
\end{tabular}
```

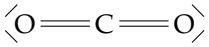
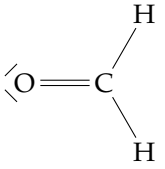
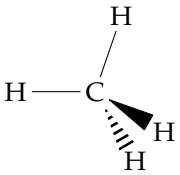
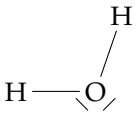
1A	2A	3A	4A	5A	6A	7A	8A
H·							He ou He
Li·	·Be·	·B·	·C·	·N· ou ·N·	·O· ou ·O·	:F· ou |F·	:Ne: ou |Ne|
Na·	·Mg·	·Al·	·Si·	·P· ou ·P·	·S· ou ·S·	:Cl· ou |Cl·	:Ar: ou |Ar|
K·	·Ca·					:Br· ou |Br·	:Kr: ou |Kr|
						:I· ou |I·	:Xe: ou |Xe|

```
\begin{tabular}{cccc}
atomes à assembler: & molécule développée obtenue & formule compacte ou brute:&nom:\\
\lewis{0.,H}\quad\lewis{0.4.62,O}&\chemfig{H-\lewis{26,O}-H}&$H_2O$&eau\\
\lewis{0.4.6.2.,C}\quad\lewis{0.4.62,O}&\chemfig{\lewis{35,O}=C=\lewis{17,O}}&$CO_2$&gaz carbonique\\
\lewis{0.4.6.2,N}&\chemfig{\lewis{2,N}~\lewis{2,N}}&$N_2$&diazote\\
%\chemfig{H-\lewis{26,O}-S(=[2]\lewis{13,O})(=[6]\lewis{57,O})-\lewis{26,O}-H}
\end{tabular}
```

atomes à assembler :	molécule développée obtenue	formule compacte ou brute :	nom :
H· ·O·	H—O—H	H_2O	eau
·C· ·O·	O=C=O	CO_2	gaz carbonique
·N·	N≡N	N_2	diazote

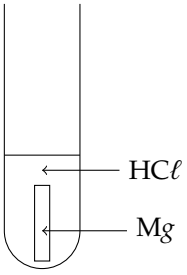
```
\begin{tabularx}{18cm}{*{7}{>{\centering\arraybackslash}X}}
Exemples:&\parbox{2cm}{atome\\central}&$\stackrel{\text{\normalsize nombre de}}{\text{ liaisons:}}$ &$\stackrel{\text{\normalsize nombre de}}{\te
&total:&angle:&représentation:\\
\rule[0pt]{0pt}{2.5cm}$CO_2$&C&2&0&2 (digonal)~$\rightarrow$&180\degres
&\chemfig{\lewis{35,O}=C=\lewis{17,O}}\\
\rule[0pt]{0pt}{2.5cm}$H_2CO$&C&3&0&3 (trigonal)~$\rightarrow$&120\degres&\chemfig{\lewis{35,O}=C(-[:-60]H)-[:60]H}\\
\rule[0pt]{0pt}{2.5cm}$CH_4$&C&4&0&4 (tétragonal)~$\rightarrow$&109\degres
&\chemfig{H-C(<[:-30]H)(<:[:-60]H)-[:71]H}\\
\rule[0pt]{0pt}{2.5cm}$H_2O$&O&2&2&4 (tétragonal)~$\rightarrow$&109\degres
&\chemfig{H-\lewis{57,O}-[:71]H}\\
```

```
\end{tabularx}
```

Exemples :	atome central	nombre de liaisons :	nombre de doublets :	total :	angle :	représentation :
CO_2	C	2	0	2 (digonal) →	180°	
H_2CO	C	3	0	3 (trigonal) →	120°	
CH_4	C	4	0	4 (tétragonal) →	109°	
H_2O	O	2	2	4 (tétragonal) →	109°	

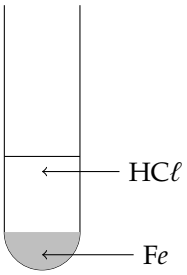
5.3–Dessins de Chimie

```
\begin{tikzpicture}
\draw (0,0) -- (0,-3)arc(180:360:.5)--++(up:3);
\draw(.4,-3.4)rectangle  (.6,-2.4);
\node(mg) at(2,-3){$Mg$};
\node(hcl) at(2,-2.2){$HC\ell$};
\coordinate(rect) at (.5,-3);
\coordinate(sol) at (.5,-2.2);
\draw[->](mg)--(rect);
\draw[->] (hcl) -- (sol);
\draw(0,-2)--++(1,0);
\end{tikzpicture}
```

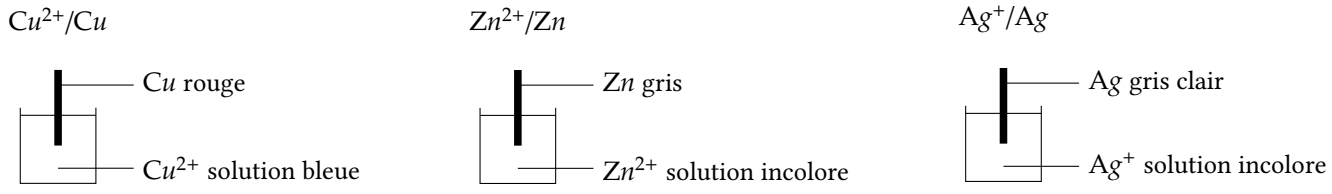



```
%\clip (0,0) -- (0,-3)arc(180:360:.5)--++(up:3);
\draw (0,0) -- (0,-3)arc(180:360:.5)--++(up:3);
\fill[lightgray](0,-3)arc(180:360:.5);
%\draw(.4,-3.4)rectangle  (.6,-2.4);
```

```
\node(mg) at(2,-3.3){$Fe$};
\node(hcl) at(2,-2.2){$HC\ell$};
\coordinate(rect) at (.5,-3.3);
\coordinate(sol) at (.5,-2.2);
\draw[->](mg)--(rect);
\draw[->] (hcl) -- (sol);
\draw(0,-2)--++(1,0);
\end{tikzpicture}
```

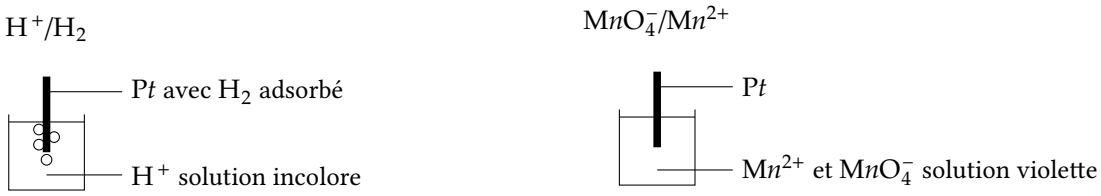



```
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=3mm]{$Cu^{2+}/Cu$}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Cu$~rouge};
\draw(.5,-.8)--++(1,0)node[right]{$Cu^{2+}$~solution bleue};
\end{tikzpicture}
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=3mm]{$Zn^{2+}/Zn$}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Zn$~gris};
\draw(.5,-.8)--++(1,0)node[right]{$Zn^{2+}$~solution incolore};
\end{tikzpicture}
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=3mm]{$Ag^{+}/Ag$}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Ag$~gris clair};
\draw(.5,-.8)--++(1,0)node[right]{$Ag^{+}$~solution incolore};
\end{tikzpicture}
\hfill{\strut}
```

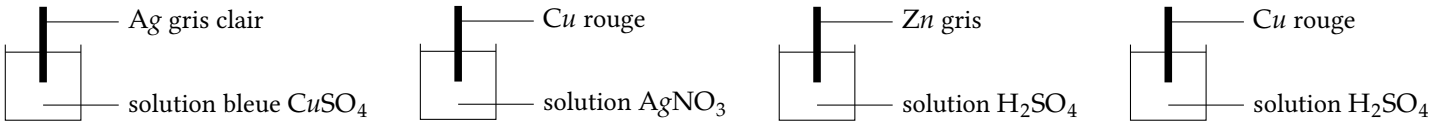



```
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=3mm]{$H^{+}/H_2$}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Pt$ avec $H_2$ adsorbé};
\draw(.5,-.8)--++(1,0)node[right]{$H^{+}$~solution incolore};
\draw(.5,-.6)circle(2pt);
\draw(.4,-.4)circle(2pt);
\draw(.4,-.2)circle(2pt);
\draw(.6,-.3)circle(2pt);
\end{tikzpicture}
\hfill
\begin{tikzpicture}
```

```
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)node[above=3mm]{$MnO_4^{-}/Mn^{2+}$}--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Pt$};
\draw(.5,-.8)--++(1,0)node[right]{$Mn^{2+}$ et $MnO_4^-$~solution violette};
\end{tikzpicture}
\hfill{\strut}
```



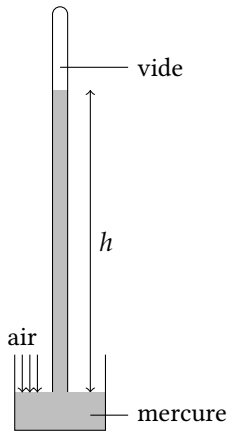

```
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Ag$~gris clair};%{$Cu$~rouge};
\draw(.5,-.8)--++(1,0)node[right]{solution bleue $CuSO_4$};
\end{tikzpicture}
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Cu$~rouge};
\draw(.5,-.8)--++(1,0)node[right]{solution $AgNO_3$};%{$Cu^{2+}$~solution bleue};
\end{tikzpicture}
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Zn$~gris};
\draw(.5,-.8)--++(1,0)node[right]{solution $H_2SO_4$};
\end{tikzpicture}
\hfill
\begin{tikzpicture}
\draw(0,0)--++(0,-1)--++(1,0)--++(0,1);
\draw[line width=1mm](.5,.5)--++(0,-1);
\draw(0,-.1)--++(1,0);
\draw(.5,.3)--++(1,0)node[right]{$Cu$~rouge};
\draw(.5,-.8)--++(1,0)node[right]{solution $H_2SO_4$};
\end{tikzpicture}
\hfill{\strut}
```



6–Divers

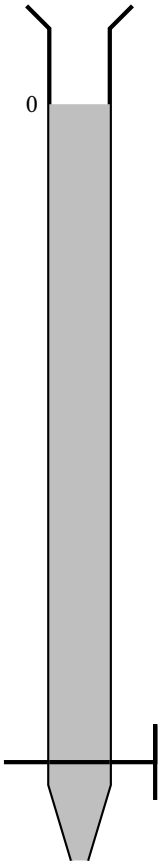
```
\begin{tikzpicture}
\fill[lightgray](0,0)--(0,4)--(.2,4)--(.2,0);
\draw(0,0)--(0,5)arc(180:0:.1)--(.2,0);
\draw[<->](.5,0)--(.5,4)node[midway,right]{$h$};
\fill[lightgray](-.5,-.5)rectangle++(1.2,.5);
\draw(-.5,.5)--++(0,-1)--++(1.2,0)--++(0,1);
\draw(0.1,4.3)--(1,4.3)node[right]{vide};
\draw(0.5,-0.3)--(1,-0.3)node[right]{mercure};
\draw [->](-.4,.5)node[above]{air} -- (-.4,0);
\draw [->](-.3,.5) -- (-.3,0);
```

```
\draw [->](-.2,.5) -- (-.2,0);
\end{tikzpicture}
```



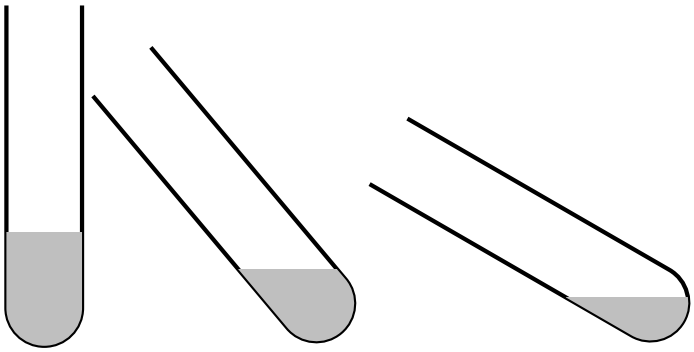
6.1–Burette

```
\begin{tikzpicture}[ultra thick]
\draw (-.3,-10) --++ (2,0) -- ++(0,.5) --++(0,-1);
\begin{scope}
\draw (0,0) --++ (.3,-.3) --++ (0,-1)coordinate(a)node[left]{0} --++
(0,-9)coordinate(b)--++(.3,-1)coordinate(c);
\end{scope}
\begin{scope}[xshift=1.4cm,xscale=-1]
\draw (0,0) --++ (.3,-.3) --++ (0,-1)coordinate(a') --++ (0,-9)coordinate(b')--++(.3,-1)coordinate(c');
\end{scope}
\clip(a)--(b)--(c)--(c')--(b')--(a')--cycle;
\fill[lightgray] (0,0)rectangle++(2,-13);
\draw(-.3,-10) --++ (2,0) -- ++(0,.5) --++(0,-1);
\end{tikzpicture}
```



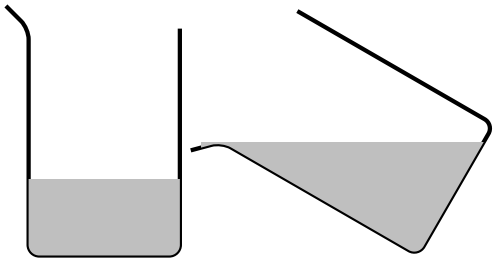
6.2–Tube à essai

```
\begin{tikzpicture}[ultra thick]
\draw(0,0)--++(0,-3)coordinate(a)--++(0,-1)arc(-180:0:.5)--++(0,4);
\clip(0,0)--++(0,-3)coordinate(a)--++(0,-1)arc(-180:0:.5)--++(0,4);
\fill[lightgray](a) rectangle++ (2,-2);
\end{tikzpicture}
\begin{tikzpicture}[ultra thick]
\draw[rotate=40](0,0)--++(0,-3)coordinate(a)--++(0,-1)arc(-180:0:.5)--++(0
\clip[rotate=40](0,0)--++(0,-3)coordinate(a)--++(0,-1)arc(-180:0:.5)--++(0,4
\fill[lightgray](a) rectangle++ (2,-2);
\end{tikzpicture}
\begin{tikzpicture}[ultra thick]
\draw[rotate=60](0,0)--++(0,-3)coordinate(a)--++(0,-1)arc(-180:0:.5)--++(0
\clip[rotate=60](0,0)--++(0,-3)coordinate(a)--++(0,-1)arc(-180:0:.5)--++(0,4
\fill[lightgray](a) rectangle++ (2,-2);
\end{tikzpicture}
```



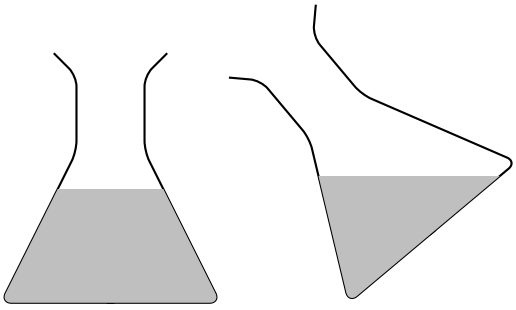
6.3–Bécher

```
\begin{tikzpicture}
\draw [ultra thick,rounded corners](0,0) -- ++(.3,-.3) --++
(0,-2)coordinate(a) --++ (0,-1)-- ++(2,0) -- ++(0,3);
\clip[rounded corners](0,0) -- ++(.3,-.3) --++ (0,-2)--++ (0,-1)-- ++(2,0)
-- ++(0,3);
\fill[lightgray](a) rectangle++ (2,-2);
\end{tikzpicture}
\begin{tikzpicture}
\draw [ultra thick,rounded corners,rotate=60](0,0) -- ++(.3,-.3) --++
(0,-2)coordinate(a) --++ (0,-1)-- ++(2,0) -- ++(0,3);
\clip[rounded corners,rotate=60](0,0) -- ++(.3,-.3) --++ (0,-2)--++
(0,-1)-- ++(2,0) -- ++(0,3);
\fill[lightgray](a) [xshift=-2cm,yshift=1cm]rectangle++ (4,-2);
\end{tikzpicture}
```



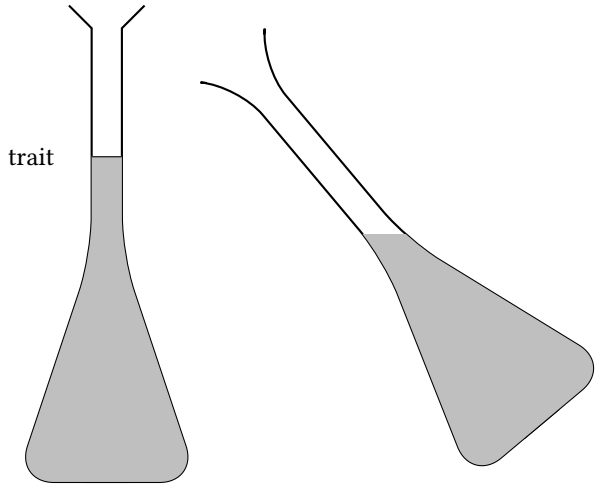
6.4–Erlenmeyer

```
\begin{tikzpicture}[ultra thick]
\draw[thick,rounded corners] (0,0) --++ (.3,-.3) --++ (0,-1)coordinate(a)
-- ++(-1,-2)coordinate(b)--++(1.5,0)coordinate(c);
\begin{scope}[xshift=1.5cm,xscale=-1]
\draw[thick,rounded corners] (0,0) --++ (.3,-.3) --++ (0,-1)coordinate(a')
-- ++(-1,-2)coordinate(b')--++(1.5,0)coordinate(c');
\end{scope}
\clip[rounded corners] (a) -- (b) --(c) -- (c')--(b')--(a');
\begin{scope}[xshift=1.5cm,xscale=-1]
\clip[rounded corners] (0,0) --++ (.3,-.3) --++ (0,-1) --
++(-1,-2)--++(1.5,0);
\end{scope}
\fill[lightgray](a) [xshift=-2cm,yshift=-.5cm]rectangle++ (4,-2);
\end{tikzpicture}
\begin{tikzpicture}[ultra thick]
%\begin{scope}[]
\draw[rotate=40,thick,rounded corners] (0,0) --++ (.3,-.3) --++
(0,-1)coordinate(a) -- ++(-1,-2)coordinate(b)--++(1.5,0)coordinate(c);
\begin{scope}[rotate=40,xshift=1.5cm,xscale=-1]
\draw[thick,rounded corners] (0,0) --++ (.3,-.3) --++ (0,-1)coordinate(a')
-- ++(-1,-2)coordinate(b')--++(1.5,0)coordinate(c');
\end{scope}
\clip[rounded corners] (a) -- (b) --(c) -- (c')--(b')--(a');
\begin{scope}[xshift=1.5cm,xscale=-1]
\clip[rounded corners] (0,0) --++ (.3,-.3) --++ (0,-1) --
++(-1,-2)--++(1.5,0);
\end{scope}
\fill[lightgray](a) [xshift=-2cm,yshift=-.5cm]rectangle++ (6,-2);

%\end{scope}


\end{tikzpicture}
```



6.5–Fiole jaugée

```
\begin{tikzpicture}
\node at (-0.5,-2){trait};
\draw [thick](0,0) -- (.3,-.3)[rounded corners=5mm]coordinate(a) --++
(0,-3)coordinate(b) --++ (-1,-3)coordinate(c)--++(1.5,0)coordinate(d);
\begin{scope}[xshift=1cm,xscale=-1]
\draw [thick](0,0) -- (.3,-.3)[rounded corners=5mm]coordinate(a')
--++ (0,-3)coordinate(b') --++ (-1,-3)coordinate(c')--++(1.5,0)coordinate(d');
\end{scope}
\clip[rounded corners=5mm] (a) -- (b) --(c) --(d)--(d')-- (c')--(b')--(a');

\fill[lightgray](-2,-2)rectangle++(5,-5);
\draw (0,-2) -- ++(2,0);
\end{tikzpicture}
\begin{tikzpicture}

\draw [rotate=40,thick,rounded corners=5mm](0,0) -- (.3,-.3)coordinate(a)
--++ (0,-3)coordinate(b) --++ (-1,-3)coordinate(c)--++(1.5,0)coordinate(d);
\begin{scope}[rotate=40,xshift=1cm,xscale=-1]
\draw [thick,rounded corners=5mm](0,0) -- (.3,-.3)coordinate(a') --++
(0,-3)coordinate(b') --++ (-1,-3)coordinate(c')--++(1.5,0)coordinate(d');
\end{scope}
\clip[rounded corners=5mm] (a) -- (b) --(c) --(d)--(d')-- (c')--(b')--(a');

\fill[lightgray](-2,-2)rectangle++(10,-5);
\draw (0,-2) -- ++(2,0);
\end{tikzpicture}
```



6.6–Pipette

```
\begin{tikzpicture}
\draw [ultra thick,rounded corners](0,0) --++ (0,-1)coordinate(a)--++
(0,-1) -| ++(-.5,-2) -|++ (.5,-2)--++ (0,-1)coordinate(b)--++
(0,-1)--++(.1,-.1) ;
\begin{scope}[xshift=3mm,xscale=-1]
\draw [ultra thick,rounded corners](0,0) --++ (0,-1)coordinate(a')--++
(0,-1) -| ++(-.5,-2) -|++ (.5,-2)--++ (0,-1)coordinate(b')--++
(0,-1)--++(.1,-.1) ;
\end{scope}
\draw(a)--(a');
\draw(b)--(b');
\end{tikzpicture}
```