The listeq package*

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DISCLAIMER: I DID NOT WRITE THIS CODE! Credit goes to Philippe Goutet on TEX Stack Exchange.

Contents

1 Usage

So let's say your math teacher assigned you to do some algebra problems. And boy oh boy do you get constantly *annoyed* how crappy the math equations made in Word look:

4. Evaluate
   $\sin 75^\circ$
   $tan\frac{\pi}{12}$
   $\cos\left(\cos^{-1}\frac{1}{2}\right)$
   $\sin^{-1}(\sin\frac{\pi}{7})$
   ...

(Yes, this is just about how bad it looked. It's ironic how I have to go the extra mile to make things look *bad* here in LATEX lol)

Let's just say, if you got the chance to, you would want to write your homework in something... better-looking. If you decide to just write on paper then you've probably gone to the wrong place. *But*... if you decide to write with LATEX, well... for starters you might think of writing something like this.

*This document corresponds to hmk v0.1, dated 2021/04/22.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
\begin{enumerate}
  % 3 lines \item omitted...
  \item % 4.
  \begin{enumerate}
    \item % (a)
      \begin{align*}
        ...
      \end{align*}
    \item % (b)
      \begin{align*}
        ...
      \end{align*}
  \end{enumerate}
\end{enumerate}
\end{document}
```

But what you get is, well... this:

4. (a)

$$\begin{aligned}\sin 75^\circ &= \sin(30^\circ + 45^\circ) = \sin 30^\circ \cos 45^\circ + \cos 30^\circ \sin 45^\circ \\ &= \left(\frac{1}{2}\right)\left(\frac{\sqrt{2}}{2}\right) + \left(\frac{\sqrt{3}}{2}\right)\left(\frac{\sqrt{2}}{2}\right) = \frac{\sqrt{2}+\sqrt{6}}{4}.\end{aligned}$$

(b)

$$\begin{aligned}\tan\frac{\pi}{12} &= \tan\left(\frac{4\pi}{12} - \frac{3\pi}{12}\right) = \tan\left(\frac{\pi}{3} - \frac{\pi}{4}\right) = \frac{\tan(\pi/3) - \tan(\pi/4)}{1 + \tan(\pi/3)\tan(\pi/4)} \\ &= \frac{\sqrt{3}-1}{1+\sqrt{3}\cdot 1} = \frac{\sqrt{3}-1}{1+\sqrt{3}} = \frac{3-\sqrt{3}}{\sqrt{3}+3} = \frac{(\sqrt{3}-1)(\sqrt{3}-1)}{(\sqrt{3}+1)(\sqrt{3}-1)} \\ &= \frac{4-2\sqrt{3}}{2} = 2 - \sqrt{3}.\end{aligned}$$

which doesn't look very nice...

Well, one simple solution would be to use the inline version of these environments (`aligned`, `gathered`) with the `[t]` option and put `\hfill` around them, like this:

```
\hfill \begin{aligned}[t] ...
  \end{aligned}\hfill \null \par
```

But that means you'll lose the ability to split equations across pages; that is, you want to keep using environments like align and gather, but with some magical way of offsetting it the right amount...

`listeq` Well that's what this package does! Directly based on code contributed by Philippe Goutet, the `listeq` environment takes the name of your equation environment and adjusts it so that the baseline aligns.

The above code can be replaced as follows:

```
% XXX: i don't know if this does anything to remove the extra spaces O-O;
\makeatletter \def\nodisplayskip{%
  \abovedisplayskip\z@
  \abovedisplayshortskip\z@
  \belowdisplayshortskip\z@
  \belowdisplayshortskip\z@
}\makeatother
\begin{enumerate}
  % 3 \item lines omitted...
  \item
  \begin{enumerate}
    \item
      \begin{listeq}{align*}
        ...
      \end{listeq}
    \item % (b)
      \begin{listeq}{align*}
        ...
      \end{listeq}
  \end{enumerate}
\end{enumerate}
```

which produces this:

4. (a) $$\begin{aligned}\sin 75^\circ &= \sin(30^\circ + 45^\circ) = \sin 30^\circ \cos 45^\circ + \cos 30^\circ \sin 45^\circ \\ &= \left(\frac{1}{2}\right)\left(\frac{\sqrt{2}}{2}\right) + \left(\frac{\sqrt{3}}{2}\right)\left(\frac{\sqrt{2}}{2}\right) = \frac{\sqrt{2}+\sqrt{6}}{4}.\end{aligned}$$

   (b) $$\begin{aligned}\tan\frac{\pi}{12} &= \tan\left(\frac{4\pi}{12} - \frac{3\pi}{12}\right) = \tan\left(\frac{\pi}{3} - \frac{\pi}{4}\right) = \frac{\tan(\pi/3) - \tan(\pi/4)}{1 + \tan(\pi/3)\tan(\pi/4)} \\ &= \frac{\sqrt{3}-1}{1+\sqrt{3}\cdot 1} = \frac{\sqrt{3}-1}{1+\sqrt{3}} = \frac{3-\sqrt{3}}{\sqrt{3}+3} = \frac{(\sqrt{3}-1)(\sqrt{3}-1)}{(\sqrt{3}+1)(\sqrt{3}-1)} \\ &= \frac{4-2\sqrt{3}}{2} = 2-\sqrt{3}.\end{aligned}$$

Just like how table of contents and indices need multiple passes, you'll have to compile two, three, or even *four* times to get the position right! And every time your document layout changes you'll need to recompile about the same number of times to get things right.

Also keep in mind this only works if placed directly after `\item`. If you place it anywhere else, well… let's just say, I don't know.

2 Implementation

```
⟨*package⟩
\ProvidesFile{listeq.sty}[2021/04/22 v0.1 Display equation in lists]
\RequirePackage{amsmath}
\RequirePackage[savepos]{zref}

%% This ingenious solution comes directly from Philippe Goutet on
%% TeX Stack Exchange: https://tex.stackexchange.com/a/9640

\newcounter{le@count}
\setcounter{le@count}{0}
%% The name of the position before the start of equation, which will be
%% passed to \zsaveref and \zposy and such commands.
\def\le@top{le@pos@top@\number\value{le@count}}
%% Similar to \le@bottom but right after the start of equation.
\def\le@bottom{le@pos@bottom@\number\value{le@count}}
%% The macro name that stores vertical space to shift the equation by, as
%% recorded in the aux file.  For it to be used as a control sequence,
%% \csname ... \endcsname has to be inserted around it.
\def\le@vspacename{le@vspacevalue\romannumeral\value{le@count}}

\def\le@markitemstart{%
  \stepcounter{le@count}%
  %% \le@vspacename is kinda like the "final" determined vertical space.
  %% It is only defined when we know that the top position (before start
  %% of equation) and bottom position (after the start of equation) coincide.
  \@ifundefined{\le@vspacename}%
    %% Let \le@vspace@value 0pt so that later on the \vspace* would have
    %% no effects, and later the saved top and bottom positions will accurately
    %% be the length between the text and display equation.
    {\edef\le@vspace@value{\z@}}%
    %% Since \le@vspacename is defined, we will set \le@vspace@value equal
    %% to it.
    {\edef\le@vspace@value{\csname \le@vspacename \endcsname}}
  %% When the top and bottom position coincide, there are two possible cases.
  \ifnum\zposy{\le@bottom}=\zposy{\le@top}
    \@ifundefined{\le@vspacename}%
      %% \le@vspace is not even defined... so why are these two equal?
      %% Well... on the first run, \zposy returns 0 for a name it's never saved,
      %% so that should be the case.
      {%
        %% Advance the imperfect alignment counter, globally.
        \xdef\le@badcount{\the\numexpr\le@badcount+1\relax}%
      }%
      %% I'm not sure what this does... it just writes the same thing back
      %% to the aux file, the same definition of \le@vspacename back.
      %% Maybe it's just to be sure that, "Yes, this works, so we write it
      %% in the aux file."
      {\immediate\write\@mainaux{%
        \gdef\expandafter\noexpand\csname \le@vspacename\endcsname
          {\csname \le@vspacename \endcsname}
        }%
```

```
    }%
  \else
    %% If they don't coincide, we need to do some adjustments...
    %% First, if the length from bottom to top (it's a negative length indeed
    %% since zsavepos saves position measured from the bottom of the page)
    %% is equal to \le@vspace@value, then...
    \ifdim\dimexpr\zposy{\le@bottom}sp-\zposy{\le@top}sp\relax=\le@vspace@value
      %% ... it means that we have the correct length, so we can get the
      %% alignment right on this run.
    \else
      %% The space \le@vspace@value doesn't work anymore, so set it to 0pt
      %% first... (Again, just so that the following \vspace* commands don't
      %% produce space and that we can save accurate positions.)
      \edef\le@vspace@value{\z@}%
      %% Advance the imperfect alignment counter, globally.
      \xdef\le@badcount{\the\numexpr\le@badcount+1\relax}%
    \fi
    %% Either way, we somehow have to write to the aux file about the
    %% vertical space?
    \immediate\write\@mainaux{%
      \gdef\expandafter\noexpand\csname \le@vspacename\endcsname
        {\the\dimexpr\zposy{\le@bottom}sp-\zposy{\le@top}sp\relax}}%
  \fi
  %% Recall that \le@vspacename is a negative space... so this is a positive
  %% space that would nudge the text down.
  \vspace*{-\le@vspace@value}%
  %% They said \leavevmode is like starting a new paragraph, so
  %% i guess...
  \leavevmode
  %% The position is right after the length has been nudged.
  \zsavepos{\le@top}%
  %% I don't know how the internal works... but as i've tested this, this
  %% space pushes the equation up (since \le@vspacename is a negative space)
  \vspace*{\le@vspace@value}%
}
\def\le@markdisplaystart{\zsavepos{\le@bottom}}
\AtBeginDocument{\gdef\le@badcount{0}}
\AtEndDocument{%
  \ifnum\le@badcount=0\else
    \PackageWarningNoLine{listeq}
     {\le@badcount\space imperfect alignment(s).
      Rerun LaTeX to get them right}%
  \fi
}

%% Originally an adaptation of https://tex.stackexchange.com/a/312131,
%% but now...
\DeclareDocumentEnvironment{listeq}{ m }
  {%
    \gdef\le@environ{#1}%
    \le@markitemstart
    \@nameuse{\le@environ}%
    \le@markdisplaystart
```

```
  }{%
    \@nameuse{end\le@environ}%
    \ignorespacesafterend
  }

%% The same as listeq but with extra arguments appended to the environment
\DeclareDocumentEnvironment{listeq*}{ m m }
  {%
    \gdef\le@environ{#1}%
    \le@markitemstart
    \@nameuse{\le@environ}#2\relax
    \le@markdisplaystart
  }{\endlisteq}

\endinput
```

3 Old quirky version

An adaptation of https://tex.stackexchange.com/a/312131

```
\DeclareDocumentEnvironment{listequation}{ s }
  {%
    \setlength{\abovedisplayskip}{0pt}%
    \setlength{\abovedisplayshortskip}{0pt}%
    \vspace{\baselineskip}\leavevmode\vspace*{-\baselineskip}%
    \IfBooleanTF{#1}%
      {\csname equation*\endcsname}{\equation}%
  }
  {\endequation \ignorespacesafterend}
\DeclareDocumentEnvironment{listalign}{ s }
  {%
    \setlength{\abovedisplayskip}{0pt}%
    \setlength{\abovedisplayshortskip}{0pt}%
    \leavevmode\vspace*{-\baselineskip}%
    \IfBooleanTF{#1}%
      {\csname align*\endcsname}{\align}%
  }
  {\endalign \ignorespacesafterend}
\DeclareDocumentEnvironment{listgather}{ s }
  {%
    \setlength{\abovedisplayskip}{0pt}%
    \setlength{\abovedisplayshortskip}{0pt}%
    \leavevmode\vspace*{-\baselineskip}%
    \IfBooleanTF{#1}%
      {\csname gather*\endcsname}{\gather}%
  }
  {\endgather \ignorespacesafterend}
\DeclareDocumentEnvironment{listalignat}{ s }
  {%
    \setlength{\abovedisplayskip}{0pt}%
    \setlength{\abovedisplayshortskip}{0pt}%
    \leavevmode\vspace*{-\baselineskip}%
    \IfBooleanTF{#1}%
      {\csname alignat*\endcsname}{\alignat}%
```

```
  }
  {\endalignat \ignorespacesafterend}

\expandafter\def\csname listequation*\endcsname{\listequation*}
\expandafter\def\csname endlistequation*\endcsname{\endlistequation}
\expandafter\def\csname listalign*\endcsname{\listalign*}
\expandafter\def\csname endlistalign*\endcsname{\endlistalign}
\expandafter\def\csname listgather*\endcsname{\listgather*}
\expandafter\def\csname endlistgather*\endcsname{\endlistgather}
\expandafter\def\csname listalignat*\endcsname{\listalignat*}
\expandafter\def\csname endlistalignat*\endcsname{\endlistalignat}
⟨/package⟩
```

Index

Numbers written in italic refer to the page where the corresponding entry is described; numbers underlined refer to the code line of the definition; numbers in roman refer to the code lines where the entry is used.