

# `problem.sty`: An Infrastructure for formatting Problems\*

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## Abstract

The `problem` package supplies an infrastructure that allows specify problems and to reuse them efficiently in multiple environments.

## Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
<b>2</b>	<b>The User Interface</b>	<b>2</b>
2.1	Package Options . . . . .	2
2.2	Problems and Solutions . . . . .	2
2.3	Multiple Choice Blocks . . . . .	4
2.4	Including Problems . . . . .	4
2.5	Reporting Metadata . . . . .	4
<b>3</b>	<b>Limitations</b>	<b>6</b>
<b>4</b>	<b>The Implementation</b>	<b>7</b>
4.1	Package Options . . . . .	7
4.2	Problems and Solutions . . . . .	8
4.3	Multiple Choice Blocks . . . . .	10
4.4	Including Problems . . . . .	11
4.5	Reporting Metadata . . . . .	11

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# 1 Introduction

The `problem` package supplies an infrastructure that allows specify problem. Problems are text fragments that come with auxiliary functions: hints, notes, and solutions<sup>1</sup>. Furthermore, we can specify how long the solution to a given problem is estimated to take and how many points will be awarded for a perfect solution.

Finally, the `problem` package facilitates the management of problems in small files, so that problems can be re-used in multiple environment.

## 2 The User Interface

### 2.1 Package Options

<code>solutions</code>	The <code>problem</code> package takes the options <code>solutions</code> (should solutions be output?),
<code>notes</code>	<code>notes</code> (should the problem notes be presented?), <code>hints</code> (do we give the hints?),
<code>hints</code>	<code>gnotes</code> (do we show grading notes?), <code>pts</code> (do we display the points awarded for
<code>gnotes</code>	solving the problem?), <code>min</code> (do we display the estimated minutes for problem sol-
<code>pts</code>	ing). If theses are specified, then the corresponding auxiliary parts of the problems
<code>min</code>	are output, otherwise, they remain invisible.
<code>boxed</code>	The <code>boxed</code> option specifies that problems should be formatted in framed boxes
<code>test</code>	so that they are more visible in the text. Finally, the <code>test</code> option signifies that
	we are in a test situation, so this option does not show the solutions (of course),
	but leaves space for the students to solve them.
<code>mh</code>	The <code>mh</code> option turns on MathHub support; see [Koh20a].
<code>showmeta</code>	Finally, if the <code>showmeta</code> is set, then the metadata keys are shown (see [Koh20b]
	for details and customization options).

### 2.2 Problems and Solutions

<code>problem</code>	The main environment provided by the <code>problem</code> package is (surprise surprise) the <code>problem</code> environment. It is used to mark up problems and exercises. The
<code>id</code>	environment takes an optional KeyVal argument with the keys <code>id</code> as an identifier
<code>pts</code>	that can be reference later, <code>pts</code> for the points to be gained from this exercise in
<code>min</code>	homework or quiz situations, <code>min</code> for the estimated minutes needed to solve the
<code>title</code>	problem, and finally <code>title</code> for an informative title of the problem. For an example
	of a marked up problem see Figure 1 and the resulting markup see Figure 2.
<code>solution</code>	The <code>solution</code> environment can be to specify a solution to a problem. If the
<code>solutions</code>	<code>solutions</code> option is set or <code>\solutionstrue</code> is set in the text, then the solution
	will be presented in the output. The <code>solution</code> environment takes an optional
<code>id</code>	KeyVal argument with the keys <code>id</code> for an identifier that can be reference <code>for</code> to
<code>for</code>	specify which problem this is a solution for, and <code>height</code> that allows to specify the
<code>height</code>	amount of space to be left in test situations (i.e. if the <code>test</code> option is set in the
<code>test</code>	<code>\usepackage</code> statement).

---

<sup>1</sup>for the moment multiple choice problems are not supported, but may well be in a future version

```

\usepackage[solutions,hints,pts,min]{problem}
\begin{document}
  \begin{problem}[id=elephants,pts=10,min=2,title=Fitting Elephants]
    How many Elephants can you fit into a Volkswagen beetle?
  \begin{hint}
    Think positively, this is simple!
  \end{hint}
  \begin{exnote}
    Justify your answer
  \end{exnote}
  \begin{solution}[for=elephants,height=3cm]
    Four, two in the front seats, and two in the back.
  \begin{gnote}
    if they do not give the justification deduct 5 pts
  \end{gnote}
  \end{solution}
  \end{problem}
\end{document}

```

**Example 1:** A marked up Problem

**Problem 1 (Fitting Elephants)**

How many Elephants can you fit into a Volkswagen beetle?

---

**Hint:** Think positively, this is simple!

---



---

**Note:** Justify your answer

---



---

**Solution:** Four, two in the front seats, and two in the back.

---

**Example 2:** The Formatted Problem from Figure 1

`hint`        The `hint` and `exnote` environments can be used in a `problem` environment to give hints and to make notes that elaborate certain aspects of the problem.  
`exnote`        The `gnote` (grading notes) environment can be used to document situations that may arise in grading.  
`gnote`        Sometimes we would like to locally override the `solutions` option we have given to the package. To turn on solutions we use the `\startsolutions`, to turn them off, `\stopsolutions`. These two can be used at any point in the documents.  
`\startsolutions`  
`\stopsolutions`  
`\ifsolutions`    Also, sometimes, we want content (e.g. in an exam with master solutions) conditional on whether solutions are shown. This can be done with the `\ifsolutions` conditional.

## 2.3 Multiple Choice Blocks

`mcb`        Multiple choice blocks can be formatted using the `mcb` environment, in which single choices are marked up with `\mcc[⟨keyvals⟩]{⟨text⟩}` macro, which takes an optional key/value argument `⟨keyvals⟩` for choice metadata and a required argument `⟨text⟩` for the proposed answer text. The following keys are supported  
`\mcc`  
`T`        • `T` for true answers, `F` for false ones,  
`F`        • `Ttext` the verdict for true answers, `Ftext` for false ones, and  
`Ttext`        • `feedback` for a short feedback text given to the student.  
`Ftext`  
`feedback`

See Figure ?? for an example

## 2.4 Including Problems

`\includeproblem`    The `\includeproblem` macro can be used to include a problem from another file. It takes an optional `KeyVal` argument and a second argument which is a path to the file containing the problem (the macro assumes that there is only one problem in the include file). The keys `title`, `min`, and `pts` specify the problem title, the estimated minutes for solving the problem and the points to be gained, and their values (if given) overwrite the ones specified in the `problem` environment in the included file.  
`title`  
`min`  
`pts`

## 2.5 Reporting Metadata

The sum of the points and estimated minutes (that we specified in the `pts` and `min` keys to the `problem` environment or the `\includeproblem` macro) to the log file and the screen after each run. This is useful in preparing exams, where we want to make sure that the students can indeed solve the problems in an allotted time period.

The `\min` and `\pts` macros allow to specify (i.e. to print to the margin) the distribution of time and reward to parts of a problem, if the `pts` and `pts` package options are set. This allows to give students hints about the estimated time and the points to be awarded.

```

\begin{problem}[title=Functions]
  What is the keyword to introduce a function definition in python?
  \begin{mcb}
    \mcc[T]{def}
    \mcc[F,feedback=that is for C and C++){function}
    \mcc[F,feedback=that is for Standard ML]{fun}
    \mcc[F,Ftext=Noooooooooooo,feedback=that is for Java]{public static void}
  \end{mcb}
\end{problem}

```

---

### Problem 2 (Functions)

What is the keyword to introduce a function definition in python?

1. def
2. function
3. fun
4. public static void

---

### Problem 3 (Functions)

What is the keyword to introduce a function definition in python?

1. def  
Yes!
2. function  
No, that is for C and C++
3. fun  
No, that is for Standard ML
4. public static void  
Noooooooooooo, that is for Java

**Example 3:** A Problem with a multiple choice block

### 3 Limitations

In this section we document known limitations. If you want to help alleviate them, please feel free to contact the package author. Some of them are currently discussed in the `sTeX` GitHub repository [sTeX].

1. none reported yet

## 4 The Implementation

### 4.1 Package Options

The first step is to declare (a few) package options that handle whether certain information is printed or not. They all come with their own conditionals that are set by the options.

```
1 <*package>
2 \RequirePackage{stex-base}
3 \newif\if@problem@mh@\@problem@mh@false
4 \DeclareOption{mh}{\@problem@mh@true}
5 \newif\ifexnotes\exnotesfalse
6 \DeclareOption{notes}{\exnotestruer}
7 \newif\ifgnotes\gnotesfalse
8 \DeclareOption{gnotes}{\gnotestruer}
9 \newif\ifhints\hintsfalse
10 \DeclareOption{hints}{\hintstruer}
11 \newif\ifsolutions\solutionfalse
12 \DeclareOption{solutions}{\solutionstruer}
13 \newif\ifpts\ptsfalse
14 \DeclareOption{pts}{\ptstruer}
15 \newif\ifmin\minfalse
16 \DeclareOption{min}{\mintruer}
17 \newif\ifboxed\boxedfalse
18 \DeclareOption{boxed}{\boxedtruer}
19 \DeclareOption*{\PassOptionsToPackage{\CurrentOption}{omtext}}
20 \ProcessOptions
```

Then we make sure that the necessary packages are loaded (in the right versions).

```
21 \RequirePackage{omtext}
22 \RequirePackage{comment}
23 \RequirePackage[base]{babel}
24 \if@problem@mh\RequirePackage{problem-mh}\fi
```

The next package relies on the L<sup>A</sup>T<sub>E</sub>X3 kernel, which L<sup>A</sup>T<sub>E</sub>XML only partially supports. As it is purely presentational, we only load it when the `boxed` option is given and we run L<sup>A</sup>T<sub>E</sub>XML.

```
25 \if@latexml\else\ifboxed\RequirePackage{mdframed}\fi\fi
```

`\prob@*@kw` For multilinguality, we define internal macros for keywords that can be specialized in `*.ldf` files.

```
26 \def\prob@problem@kw{Problem}
27 \def\prob@solution@kw{Solution}
28 \def\prob@hint@kw{Hint}
29 \def\prob@note@kw{Note}
30 \def\prob@gnote@kw{Grading}
31 \def\prob@pt@kw{pt}
32 \def\prob@min@kw{min}
```

For the other languages, we set up triggers

```
33 \AfterBabelLanguage{ngerman}{\input{problem-ngerman.ldf}}
34 \AfterBabelLanguage{finnish}{\input{problem-finnish.ldf}}
35 \AfterBabelLanguage{french}{\input{problem-french.ldf}}
36 \AfterBabelLanguage{russian}{\input{problem-russian.ldf}}
```

## 4.2 Problems and Solutions

We now prepare the KeyVal support for problems. The key macros just set appropriate internal macros.

```
37 \srefaddidkey[prefix=prob.]{problem}
38 \addmetakey{problem}{pts}
39 \addmetakey{problem}{min}
40 \addmetakey*{problem}{title}
41 \addmetakey{problem}{refnum}
```

Then we set up a counter for problems.

`\numberproblemsin`

```
42 \newcounter{problem}
43 \newcommand\numberproblemsin[1]{\@addtoreset{problem}{#1}}
```

`\prob@label` We provide the macro `\prob@label` to redefine later to get context involved.

```
44 \newcommand\prob@label[1]{#1}
```

`\prob@number` We consolidate the problem number into a reusable internal macro

```
45 \newcommand\prob@number{%
46 \ifx\inclprob@refnum\@empty% if there is no outside refnum
47 \ifx\problem@refnum\@empty\prob@label\theproblem%
48 \else\prob@label\problem@refnum\fi%
49 \else\prob@label\inclprob@refnum\fi}
```

`\prob@title` We consolidate the problem title into a reusable internal macro as well. `\prob@title` takes three arguments the first is the fallback when no title is given at all, the second and third go around the title, if one is given.

```
50 \newcommand\prob@title[3]{%
51 \ifx\inclprob@title\@empty% if there is no outside title
52 \ifx\problem@title\@empty{#1}\else{#2}\problem@title{#3}\fi
53 \else{#2}\inclprob@title{#3}\fi}% else show the outside title
```

With these the problem header is a one-liner

`\prob@heading` We consolidate the problem header line into a separate internal macro that can be reused in various settings.

```
54 \def\prob@heading{\prob@problem@kw~\prob@number\prob@title{ }{ }{\strut}%
55 \sref@label{id{\prob@problem@kw~\prob@number}{}}%
56 }
```



With this in place, we can now define the `problem` environment. It comes in two shapes, depending on whether we are in boxed mode or not. In both cases we increment the problem number and output the points and minutes (depending) on whether the respective options are set.

```

problem
57 \newenvironment{problem}[1][\metasetkeys{problem}{#1}\sref@target%
58 \@in@omtexttrue% we are in a statement (for inline definitions)
59 \stepcounter{problem}\record@problem%
60 \def\current@section@level{\prob@problem@kw}%
61 \par\noindent\textbf{\prob@heading\show@pts\show@min\\ignorespacesandpars
62 }%
63 {\smallskip}
64 \ifboxed\if@latexml\else\surroundwithmdframed{problem}\fi\fi

\record@problem This macro records information about the problems in the *.aux file.
65 \def\record@problem{\protected@write\@auxout{}%
66 {\string\@problem{\prob@number}%
67 {\ifx\inclprob@pts\@empty\problem@pts\else\inclprob@pts\fi}%
68 {\ifx\inclprob@min\@empty\problem@min\else\inclprob@min\fi}}

\@problem This macro acts on a problem's record in the *.aux file. It does not have any
functionality here, but can be redefined elsewhere (e.g. in the assignment pack-
age).
69 \def\@problem#1#2#3{}

solution The solution environment is similar to the problem environment, only that
it is independent of the boxed mode. It also has it's own keys that we need to
define first.
70 \srefaddidkey{soln}
71 \addmetakey{soln}{for}
72 \addmetakey{soln}{height}
73 \addmetakey{soln}{creators}
74 \addmetakey{soln}{contributors}
75 \addmetakey{soln}{srccite}
76 % \begin{macrocode}
77 % the next step is to define a helper macro that does what is needed to start a solution.
78 % \begin{macrocode}
79 \newcommand\@startsolution[1][\metasetkeys{soln}{#1}%
80 \@in@omtexttrue% we are in a statement.
81 \ifboxed\else\hrule\fi\smallskip\noindent{\textbf{\prob@solution@kw:\enspace}\begin{small}%
82 \def\current@section@level{\prob@solution@kw}%
83 \ignorespacesandpars}

\startsolutions for the \startsolutions macro we use the \specialcomment macro from the
comment package. Note that we use the \@startsolution macro in the start
codes, that parses the optional argument.
84 \newcommand\startsolutions{\specialcomment{solution}{\@startsolution}%

```

```

85 {\ifboxed\else\hrule\medskip\fi\end{small}}%
86 \ifboxed\if@latexml\else\surroundwithmdframed{solution}\fi\fi}

\stopsolutions

87 \newcommand\stopsolutions{\excludecomment{solution}}

    so it only remains to start/stop solutions depending on what option was spec-
    ified.

88 \ifsolutions\startsolutions\else\stopsolutions\fi

exnote
89 \ifexnotes
90 \newenvironment{exnote}[1] []%
91 {\par\smallskip\hrule\smallskip\noindent\textbf{\prob@note@kw: }\small}
92 {\smallskip\hrule}
93 \else%ifexnotes
94 \excludecomment{exnote}
95 \fi%ifexnotes

hint
96 \ifhints
97 \newenvironment{hint}[1] []%
98 {\par\smallskip\hrule\smallskip\noindent\textbf{\prob@hint@kw: }\small}
99 {\smallskip\hrule}
100 \newenvironment{exhint}[1] []%
101 {\par\smallskip\hrule\smallskip\noindent\textbf{\prob@hint@kw: }\small}
102 {\smallskip\hrule}
103 \else%ifhints
104 \excludecomment{hint}
105 \excludecomment{exhint}
106 \fi%ifhints

gnote
107 \ifgnotes
108 \newenvironment{gnote}[1] []%
109 {\par\smallskip\hrule\smallskip\noindent\textbf{\prob@gnote@kw: }\small}
110 {\smallskip\hrule}
111 \else%ifgnotes
112 \excludecomment{gnote}
113 \fi%ifgnotes

```

### 4.3 Multiple Choice Blocks

```

mcb 1
114 \newenvironment{mcb}
115 {\begin{enumerate}}
116 {\end{enumerate}}

```

---

<sup>1</sup>EdNOTE: MK: maybe import something better here from a dedicated MC package

we define the keys for the `mcc` macro

```

117 \srefaddidkey{mcc}
118 \addmetakey{mcc}{feedback}
119 \addmetakey{T}{mcc}{T}
120 \addmetakey[F]{mcc}{F}
121 \addmetakey[Yes]{mcc}{Ttext}
122 \addmetakey[No]{mcc}{Ftext}

\mcc

123 \newcommand\mcc[2][]{\%
124 \metasetkeys{mcc}{#1}%
125 \item #2%
126 \ifsolutions\%
127 \ifcsstring{mcc@T}{T}{\mcc@Ttext}%
128 \ifcsstring{mcc@F}{F}{\mcc@Ftext}%
129 \ifx\mcc@feedback\@empty! \else, \mcc@feedback\fi%
130 \fi} %solutions

```

## 4.4 Including Problems

`\includeproblem` The `\includeproblem` command is essentially a glorified `\input` statement, it sets some internal macros first that overwrite the local points. Importantly, it resets the `inclprob` keys after the input.

```

131 \addmetakey{inclprob}{pts}
132 \addmetakey{inclprob}{min}
133 \addmetakey*{inclprob}{title}
134 \addmetakey{inclprob}{refnum}
135 \clear@inclprob@keys%initially
136 \newcommand\includeproblem[2][]{\metasetkeys{inclprob}{#1}%
137 \edef\temp@path{#2}%
138 \if@iswindows@path@to@windows\temp@path\fi%
139 \input{\temp@path}\clear@inclprob@keys}

```

## 4.5 Reporting Metadata

For messages it is OK to have them in English as the whole documentation is, and we can therefore assume authors can deal with it.

```

140 \AtEndDocument{\ifpts\message{Total: \arabic{pts} points}\fi
141 \ifmin\message{Total: \arabic{min} minutes}\fi}

```

The margin pars are reader-visible, so we need to translate

```

142 \def\pts#1{\ifpts\marginpar{#1 \prob@pt@kw}\fi}
143 \def\min#1{\ifmin\marginpar{#1 \prob@min@kw}\fi}

```

`\show@pts` The `\show@pts` shows the points: if no points are given from the outside and also no points are given locally do nothing, else show and add. If there are outside points then we show them in the margin.

```

144 \newcounter{pts}

```

```

145 \def\show@pts{\ifx\inclprob@pts\@empty%
146 \ifx\problem@pts\@empty\else%
147 \ifpts\marginpar{\problem@pts\;\prob@pt@kw\smallskip}\addtocounter{pts}{\problem@pts}\fi%
148 \fi\else% \inclprob@pts nonempty
149 \ifpts\marginpar{\inclprob@pts\;\prob@pt@kw\smallskip}\addtocounter{pts}{\inclprob@pts}\fi%
150 \fi}

```

and now the same for the minutes

\show@min

```

151 \newcounter{min}
152 \def\show@min{\ifx\inclprob@min\@empty%
153 \ifx\problem@min\@empty\else%
154 \ifmin\marginpar{\problem@min\;min}\addtocounter{min}{\problem@min}\fi%
155 \fi\else%
156 \ifmin\marginpar{\inclprob@min\;min}\addtocounter{min}{\inclprob@min}\fi
157 \fi}
158 \</package>

```

## Change History

v0.9		<code>\start/stopsolution</code> . . . . .	1
General: First Version with		v1.1	
Documentation . . . . .	1	General: adding MathHub support	1
v0.9a		v1.2	
General: Renamed to <code>problem.sty</code>	1	General: moving MathHub support	
v0.9c		out to separate package . . . . .	1
General: based on <code>omd.sty</code> now . .	1	v1.3	
v1.0		General: Addint Multiple Choice	
General: adding		Blocks . . . . .	1