

# The [mandi](#) Bundle

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mandi version v3.0.2 dated 2021-09-20

mandistudent version v3.0.2 dated 2021-09-20

mandiexp version v3.0.2 dated 2021-09-20

**PLEASE DO NOT DISTRIBUTE THIS BUILD.**

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## Acknowledgements

To all of the students who have learned  $\text{\LaTeX}$  in my introductory physics courses over the years, I say a heartfelt thank you. You have contributed directly to the state of this software and to its use in introductory physics courses and to innovating how physics is taught.

I also acknowledge the  $\text{\LaTeX}$  developers who inhabit the [TeX StackExchange](#) site. Entering a new culture is daunting for anyone, especially for newcomers. The  $\text{\LaTeX}$  development culture is no exception. We all share a passion for creating beautiful documents and I have learned much over the past year that improved my ability to do just that. There are too many of you to list individually, and I would surely accidentally omit some were I to try. Collectively, I thank you all for your patience and advice.

# Change History

v3.0.0 (2021-08-22)			
<a href="#">mandiexp</a> <sup>→ P.80</sup>	Initial release	6	
<a href="#">mandi</a> <sup>→ P.8</sup>	Initial release	6	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	Initial release	6	
v3.0.1 (2021-08-24)			
<a href="#">mandiexp</a> <sup>→ P.80</sup>	Minor doc changes	6	
<a href="#">mandi</a> <sup>→ P.8</sup>	Minor doc changes	6	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	Minor doc changes	6	
v3.0.2 (2021-09-19)			
<a href="#">mandiexp</a> <sup>→ P.80</sup>	Version number works	85	
<a href="#">mandiexp</a> <sup>→ P.80</sup>	xparse is loaded for older formats	85	
<a href="#">mandi</a> <sup>→ P.8</sup>	Unknown package options handled		
	safely	39	
<a href="#">mandi</a> <sup>→ P.8</sup>	xparse is loaded for older formats	38	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	URLs fixed in		
<a href="#">glowscriptblock</a> <sup>→ P.64</sup>		78	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	Version number works	70	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	<a href="#">\dirvec</a> <sup>→ P.54</sup> no longer adds		
	<a href="#">\scriptspace</a> when no sub/superscript is		
	given	73	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	<a href="#">\image</a> <sup>→ P.61</sup> slightly		
	modified	75	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	<a href="#">\vec</a> <sup>→ P.54</sup> no longer adds		
	<a href="#">\scriptspace</a> when no sub/superscript is		
	given	73	
<a href="#">mandistudent</a> <sup>→ P.54</sup>	xparse is loaded for older		
	formats	70	

## List of GlowScript Programs

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# 1 Introduction

The `mandi`<sup>1</sup> bundle consists of three packages: `mandi`, `mandistudent`, and `mandiexp`. Package `mandi`<sup>→ P.8</sup> provides the core functionality, namely correctly typesetting physical quantities and constants with their correct SI units as either scalars or vectors, depending on which is appropriate. Package `mandistudent`<sup>→ P.54</sup> provides other typesetting capability appropriate for written problem solutions. Finally, package `mandiexp`<sup>→ P.80</sup> provides commands for typesetting expressions from *Matter & Interactions*<sup>2</sup>.

`mandi` has been completely rewritten from the ground up. It had gotten too large and clumsy to use and maintain. It (unknowingly) used deprecated packages. It had too many arcane “features” that were never used. It did not support Unicode. It was not compatible with modern engines, like Lua $\text{\LaTeX}$ . It did not have a key-value interface. Options could not be changed on the fly within a document. In short, it was a mess. I hope this rewrite addresses all of the bad things and forms a better code base for maintenance, useability, and future improvements.

So many changes have been made that I think the best approach for former, as well as new, users is to treat this as a brand new experience. I think the most important thing to keep in mind is that I assume users, especially new users, will have a relatively recent TeX distribution (like TeX Live) that includes a recently updated  $\text{\LaTeX}$  kernel. If users report that this is a major problem, I can provide some degree of backwards compatibility.

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<sup>1</sup>The bundle name can be pronounced either with two syllables, to rhyme with *candy*, or with three syllables, as *M and I*.

<sup>2</sup>See *Matter & Interactions* and <https://matterandinteractions.org/> for details.

## 2 Student/Instructor Quick Guide

Use `\vec`<sup>P.54</sup> to typeset the symbol for a vector. Use `\magnitude`<sup>P.57</sup> to typeset the symbol for a vector's magnitude. Use `\dirvec`<sup>P.54</sup> to typeset the symbol for a vector's direction. Use `\changein`<sup>P.55</sup> to typeset the symbol for the change in a vector or scalar. Use `\zerovec`<sup>P.55</sup> to typeset the zero vector. Use `\timestento`<sup>P.36</sup> to typeset scientific notation.

<code>\( \vec{p} \)</code> or <code>\( \vec{*p} \)</code>	<code>\)</code>	$p$ or $\vec{p}$
<code>\( \vec{p}_{\text{final}} \)</code> or <code>\( \vec{*p}_{\text{final}} \)</code>	<code>\)</code>	$p_{\text{final}}$ or $\vec{p}_{\text{final}}$
<code>\( \text{magnitude}\vec{p} \)</code> or <code>\( \text{magnitude*}\vec{p}_{\text{final}} \)</code>	<code>\)</code>	$\ p\ $ or $\ p_{\text{final}}\ $
<code>\( \text{dirvec}\{p\} \)</code> or <code>\( \text{dirvec*}\{p\} \)</code>	<code>\)</code>	$\hat{p}$ or $\hat{*p}$
<code>\( \text{changein}\vec{p} \)</code> or <code>\( \text{changein } t \)</code>	<code>\)</code>	$\Delta p$ or $\Delta t$
<code>\( \text{zerovec} \)</code> or <code>\( \text{zerovec*} \)</code>	<code>\)</code>	$\mathbf{0}$ or $\vec{0}$
<code>\( 6.02\text{timestento}\{-19\} \)</code>		$6.02 \times 10^{-19}$

Use a `physical quantity's`<sup>P.9</sup> name to typeset a magnitude and that quantity's units. If the quantity is a vector, you can add `vector` either to the beginning or the end of the quantity's name. For example, if you want momentum, use `\momentum`<sup>P.9</sup> and its variants.

<code>\( \text{momentum}\{7.071\} \)</code>	<code>\)</code>	$7.071 \text{ kg} \cdot \text{m/s}$
<code>\( \text{vectormomentum}\{3,-4,5\} \)</code>	<code>\)</code>	$\langle 3, -4, 5 \rangle \text{ kg} \cdot \text{m/s}$
<code>\( \text{momentumvector}\{3,-4,5\} \)</code>		$\langle 3, -4, 5 \rangle \text{ kg} \cdot \text{m/s}$

Use a `physical constant's`<sup>P.25</sup> name to typeset its numerical value and units. Append `mathsymbol` to the constant's name to get its mathematical symbol. For example, if you want to typeset the vacuum permittivity, use `\vacuumpermittivity`<sup>P.33</sup> and its variant.

<code>\( \text{vacuumpermittivitymathsymbol} = \text{vacuumpermittivity} \)</code>	<code>\)</code>	$\epsilon_0 = 9 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$
--	-----------------	--

Use `\mivector`<sup>P.37</sup> to typeset symbolic vectors with components. Use the aliases `\direction`<sup>P.13</sup> to typeset a direction or unit vector.

<code>\( \text{mivector}\{\text{slot},\text{slot},\text{slot}\} \)</code> or <code>\( \text{mivector}\{p_x,p_y,p_z\} \)</code>	<code>\)</code>	
<code>\( \text{direction}\{\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}}\} \)</code> or		
$\langle \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}} \rangle$ or $\langle p_x, p_y, p_z \rangle$		

Use `physicsproblem`<sup>P.58</sup> and `parts`<sup>P.58</sup> and `\problempart`<sup>P.58</sup> for problems. For step-by-step mathematical solutions use `physicssolution`<sup>P.59</sup>. Use `glowscripblock`<sup>P.64</sup> to typeset **GlowScript** programs. Use `\vpythonfile`<sup>P.67</sup> to typeset **VPython** program files.

### 3 The **mandi** Package

Load **mandi** as you would any package in your preamble.

```
\usepackage[options]{mandi}
```

**\mandiversion**

Typesets the current version and build date.

The version is \mandiversion\ and is a stable build.

The version is v3.0.2 dated 2021-09-20 and is a stable build.

#### 3.1 Package Options

N 2021-01-30

**units**=*<type of unit>* (initially unspecified, set to **alternate**)

N 2021-01-30

**preciseconstants**=*<boolean>* (initially unspecified, set to **false**)

Now **mandi** uses a key-value interface for options. The **units** key can be set to **base**, **derived**, or **alternate**. The **preciseconstants** key is always either **true** or **false**.

#### 3.2 The **mandisetaup** Command

N 2021-02-17

**\mandisetaup**{*<options>*}

Command to set package options on the fly after loadtime. This can be done in the preamble or inside the `\begin{document}... \end{document}` environment.

```
\mandisetaup{units=base}
```

```
\mandisetaup{preciseconstants}
```

```
\mandisetaup{preciseconstants = false}
```

#### 3.3 Lua<sup>A</sup>T<sub>E</sub>X is Required

In order to make use of better fonts and Unicode features, **mandi** now requires the Lua<sup>A</sup>T<sub>E</sub>X engine for processing documents. It will not work with other engines.



## 3.4 Physical Quantities

### 3.4.1 Typesetting Physical Quantities

Typesetting physical quantities and constants using semantically appropriate names, along with the correct [SI units](#), is the core function of `mandi`. Take momentum as the prototypical physical quantity in an introductory physics course.

```
\momentum{\langle magnitude \rangle}
\momentumvector{\langle c_1, \dots, c_n \rangle}
\vectormomentum{\langle c_1, \dots, c_n \rangle}
```

Command for momentum and its vector variants. The default units will depend on the options passed to `mandi` at load time. Alternate units are the default. Other units can be forced as demonstrated. The vector variants can take more than three components. Note the other variants for the quantity's value and units.

<code>\momentum{5}</code>	<code>\momentumvalue{5}</code>	<code>\momentumbaseunits{5}</code>	<code>\momentumderivedunits{5}</code>	<code>\momentumalternateunits{5}</code>	<code>\momentumvector{2,3,4}</code>	<code>\vectormomentum{2,3,4}</code>	<code>\momentum{\mivector{2,3,4}}</code>	<code>\momentumonlybaseunits</code>	<code>\momentumonlyderivedunits</code>	<code>\momentumonlyalternateunits</code>	<code>\momentumvectorvalue{2,3,4}</code>	<code>\vectormomentumvalue{2,3,4}</code>	<code>\momentumvectorbaseunits{2,3,4}</code>	<code>\vectormomentumbaseunits{2,3,4}</code>	<code>\momentumvectorderivedunits{2,3,4}</code>	<code>\vectormomentumderivedunits{2,3,4}</code>	<code>\momentumvectoralternateunits{2,3,4}</code>	<code>\vectormomentumalternateunits{2,3,4}</code>	<code>\momentumvectoronlybaseunits</code>	<code>\vectormomentumonlybaseunits</code>	<code>\momentumvectoronlyderivedunits</code>	<code>\vectormomentumonlyderivedunits</code>	<code>\momentumvectoronlyalternateunits</code>	<code>\vectormomentumonlyalternateunits</code>
<code>\momentum{5}</code>	<code>\momentumvalue{5}</code>	<code>\momentumbaseunits{5}</code>	<code>\momentumderivedunits{5}</code>	<code>\momentumalternateunits{5}</code>	<code>\momentumvector{2,3,4}</code>	<code>\vectormomentum{2,3,4}</code>	<code>\momentum{\mivector{2,3,4}}</code>	<code>\momentumonlybaseunits</code>	<code>\momentumonlyderivedunits</code>	<code>\momentumonlyalternateunits</code>	<code>\momentumvectorvalue{2,3,4}</code>	<code>\vectormomentumvalue{2,3,4}</code>	<code>\momentumvectorbaseunits{2,3,4}</code>	<code>\vectormomentumbaseunits{2,3,4}</code>	<code>\momentumvectorderivedunits{2,3,4}</code>	<code>\vectormomentumderivedunits{2,3,4}</code>	<code>\momentumvectoralternateunits{2,3,4}</code>	<code>\vectormomentumalternateunits{2,3,4}</code>	<code>\momentumvectoronlybaseunits</code>	<code>\vectormomentumonlybaseunits</code>	<code>\momentumvectoronlyderivedunits</code>	<code>\vectormomentumonlyderivedunits</code>	<code>\momentumvectoronlyalternateunits</code>	<code>\vectormomentumonlyalternateunits</code>
$5 \text{ kg} \cdot \text{m/s}$	$5$	$5 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$	$5 \text{ kg} \cdot \text{m/s}$	$5 \text{ kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$	$\text{kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle$	$\langle 2, 3, 4 \rangle$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\langle 2, 3, 4 \rangle \text{ kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$	$\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$	$\text{kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m/s}$

Commands that include the name of a physical quantity typeset units, so they shouldn't be used for algebraic or symbolic values of components. For example, one shouldn't use `\vectormomentum{mv_x,mv_y,mv_z}` but instead the generic `\mivector{mv_x,mv_y,mv_z}` instead.

### 3.4.2 Checking Physical Quantities

N 2021-02-16

**`\checkquantity`** $\{\langle name \rangle\}$

Command to check and typeset the command, base units, derived units, and alternate units of a defined physical quantity.

### 3.4.3 Predefined Physical Quantities

Every other defined physical quantity can be treated similarly. Just replace `momentum` with the quantity's name. Obviously, the variants that begin with `\vector` will not be defined for scalar quantities. Here are all the physical quantities, with all their units, defined in `mandi`. Remember that units are not present with symbolic (algebraic) quantities, so do not use the `\vector` variants of these commands for symbolic components. Use `\mivector`<sup>P.37</sup> instead.

N 2021-02-24

**`\acceleration`** $\{\langle magnitude \rangle\}$   
**`\accelerationvector`** $\{\langle c_1, \dots, c_n \rangle\}$   
**`\vectoracceleration`** $\{\langle c_1, \dots, c_n \rangle\}$

name			
<code>\acceleration</code>			
base	derived	alternate	
$\text{m} \cdot \text{s}^{-2}$	N/kg	$\text{m}/\text{s}^2$	

**`\amount`** $\{\langle magnitude \rangle\}$

name			
<code>\amount</code>			
base	derived	alternate	
mol	mol	mol	

N 2021-02-24

**`\angularacceleration`** $\{\langle magnitude \rangle\}$   
**`\angularaccelerationvector`** $\{\langle c_1, \dots, c_n \rangle\}$   
**`\vectorangularacceleration`** $\{\langle c_1, \dots, c_n \rangle\}$

name			
<code>\angularacceleration</code>			
base	derived	alternate	
$\text{rad} \cdot \text{s}^{-2}$	$\text{rad}/\text{s}^2$	$\text{rad}/\text{s}^2$	

**`\angularfrequency`** $\{\langle magnitude \rangle\}$

name			
<code>\angularfrequency</code>			
base	derived	alternate	
$\text{rad} \cdot \text{s}^{-1}$	rad/s	rad/s	

N 2021-02-24

**\angularimpulse** $\{\langle magnitude \rangle\}$   
**\angularimpulsevector** $\{\langle c_1, \dots, c_n \rangle\}$   
**\vectorangularimpulse** $\{\langle c_1, \dots, c_n \rangle\}$

name		
\angularimpulse		
base	derived	alternate
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-1}$	$\text{kg} \cdot \text{m}^2/\text{s}$	$\text{kg} \cdot \text{m}^2/\text{s}$

N 2021-02-24

**\angularmomentum** $\{\langle magnitude \rangle\}$   
**\angularmomentumvector** $\{\langle c_1, \dots, c_n \rangle\}$   
**\vectorangularmomentum** $\{\langle c_1, \dots, c_n \rangle\}$

name		
\angularmomentum		
base	derived	alternate
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-1}$	$\text{kg} \cdot \text{m}^2/\text{s}$	$\text{kg} \cdot \text{m}^2/\text{s}$

N 2021-02-24

**\angularvelocity** $\{\langle magnitude \rangle\}$   
**\angularvelocityvector** $\{\langle c_1, \dots, c_n \rangle\}$   
**\vectorangularvelocity** $\{\langle c_1, \dots, c_n \rangle\}$

name		
\angularvelocity		
base	derived	alternate
$\text{rad} \cdot \text{s}^{-1}$	$\text{rad}/\text{s}$	$\text{rad}/\text{s}$

**\area** $\{\langle magnitude \rangle\}$

name		
\area		
base	derived	alternate
$\text{m}^2$	$\text{m}^2$	$\text{m}^2$

**\areachargedensity** $\{\langle magnitude \rangle\}$

name		
\areachargedensity		
base	derived	alternate
$\text{A} \cdot \text{s} \cdot \text{m}^{-2}$	$\text{C}/\text{m}^2$	$\text{C}/\text{m}^2$

**\areamassdensity** $\{\langle magnitude \rangle\}$

name		
\areamassdensity		
base	derived	alternate
$\text{kg} \cdot \text{m}^{-2}$	$\text{kg}/\text{m}^2$	$\text{kg}/\text{m}^2$

**\capacitance**{ $\langle magnitude \rangle$ }

name			
\capacitance			
base	derived	alternate	
$A^2 \cdot s^4 \cdot kg^{-1} \cdot m^{-2}$	F	C/V	

**\charge**{ $\langle magnitude \rangle$ }

name			
\charge			
base	derived	alternate	
A · s	C	C	

**\cmagneticfield**{ $\langle magnitude \rangle$ }

**\cmagneticfieldvector**{ $\langle c_1, \dots, c_n \rangle$ }

**\vectorcmagneticfield**{ $\langle c_1, \dots, c_n \rangle$ }

name			
\cmagneticfield			
base	derived	alternate	
$kg \cdot m \cdot A^{-1} \cdot s^{-3}$	N/C	N/C	

**\conductance**{ $\langle magnitude \rangle$ }

name			
\conductance			
base	derived	alternate	
$A^2 \cdot s^3 \cdot kg^{-1} \cdot m^{-2}$	S	A/V	

**\conductivity**{ $\langle magnitude \rangle$ }

name			
\conductivity			
base	derived	alternate	
$A^2 \cdot s^3 \cdot kg^{-1} \cdot m^{-3}$	S/m	A/V · m	

**\conventionalcurrent**{ $\langle magnitude \rangle$ }

name			
\conventionalcurrent			
base	derived	alternate	
A	C/s	A	

**\current**{ $\langle magnitude \rangle$ }

N 2021-02-24

name		
\current		
base	derived	alternate
A	A	A
\currentdensity{\langle magnitude \rangle}		
\currentdensityvector{\langle c_1, \dots, c_n \rangle}		
\vectorcurrentdensity{\langle c_1, \dots, c_n \rangle}		

name		
\currentdensity		
base	derived	alternate
A · m <sup>-2</sup>	C/s · m <sup>2</sup>	A/m <sup>2</sup>
\dielectricconstant{\langle magnitude \rangle}		

N 2021-02-24

name			
\dielectricconstant			
base	derived	alternate	
\direction{\langle magnitude \rangle}			
\directionvector{\langle c_1, \dots, c_n \rangle}			
\vectordirection{\langle c_1, \dots, c_n \rangle}			

N 2021-02-24

name			
\direction			
base	derived	alternate	
\displacement{\langle magnitude \rangle}			
\displacementvector{\langle c_1, \dots, c_n \rangle}			
\vectordisplacement{\langle c_1, \dots, c_n \rangle}			

name		
\displacement		
base	derived	alternate
m	m	m
\duration{\langle magnitude \rangle}		

name			
\duration			
base	derived	alternate	
s	s	s	

N 2021-02-24

**\electricdipolemoment** $\{\langle magnitude \rangle\}$   
**\electricdipolemomentvector** $\{\langle c_1, \dots, c_n \rangle\}$   
**\vectorelectricdipolemoment** $\{\langle c_1, \dots, c_n \rangle\}$

name			
\electricdipolemoment			
base	derived	alternate	
$A \cdot s \cdot m$	$C \cdot m$	$C \cdot m$	

N 2021-02-24

**\electricfield** $\{\langle magnitude \rangle\}$   
**\electricfieldvector** $\{\langle c_1, \dots, c_n \rangle\}$   
**\vectorelectricfield** $\{\langle c_1, \dots, c_n \rangle\}$

name			
\electricfield			
base	derived	alternate	
$kg \cdot m \cdot A^{-1} \cdot s^{-3}$	$V/m$	$N/C$	

**\electricflux** $\{\langle magnitude \rangle\}$

name			
\electricflux			
base	derived	alternate	
$kg \cdot m^3 \cdot A^{-1} \cdot s^{-3}$	$V \cdot m$	$N \cdot m^2/C$	

**\electricpotential** $\{\langle magnitude \rangle\}$

name			
\electricpotential			
base	derived	alternate	
$kg \cdot m^2 \cdot A^{-1} \cdot s^{-3}$	$V$	$V$	

N 2021-05-01

**\electricpotentialdifference** $\{\langle magnitude \rangle\}$

name			
\electricpotentialdifference			
base	derived	alternate	
$kg \cdot m^2 \cdot A^{-1} \cdot s^{-3}$	$V$	$V$	

**\electroncurrent** $\{\langle magnitude \rangle\}$

name			
\electroncurrent			
base	derived	alternate	
$s^{-1}$	$e/s$	$e/s$	

**$\backslash\mathrm{emf}\{\langle magnitude\rangle\}$**

**name**

**$\backslash\mathrm{emf}$**

**base**

$\mathrm{kg} \cdot \mathrm{m}^2 \cdot \mathrm{A}^{-1} \cdot \mathrm{s}^{-3}$

**derived**

V

**alternate**

V

**$\backslash\mathrm{energy}\{\langle magnitude\rangle\}$**

**name**

**$\backslash\mathrm{energy}$**

**base**

$\mathrm{kg} \cdot \mathrm{m}^2 \cdot \mathrm{s}^{-2}$

**derived**

J

**alternate**

J

N 2021-04-15

**$\backslash\mathrm{energyinev}\{\langle magnitude\rangle\}$**

**name**

**$\backslash\mathrm{energyinev}$**

**base**

eV

**derived**

eV

**alternate**

eV

N 2021-04-15

**$\backslash\mathrm{energyinkev}\{\langle magnitude\rangle\}$**

**name**

**$\backslash\mathrm{energyinkev}$**

**base**

keV

**derived**

keV

**alternate**

keV

N 2021-04-15

**$\backslash\mathrm{energyinmev}\{\langle magnitude\rangle\}$**

**name**

**$\backslash\mathrm{energyinmev}$**

**base**

MeV

**derived**

MeV

**alternate**

MeV

**$\backslash\mathrm{energydensity}\{\langle magnitude\rangle\}$**

**name**

**$\backslash\mathrm{energydensity}$**

**base**

$\mathrm{kg} \cdot \mathrm{m}^{-1} \cdot \mathrm{s}^{-2}$

**derived**

$\mathrm{J}/\mathrm{m}^3$

**alternate**

$\mathrm{J}/\mathrm{m}^3$

**$\backslash\mathrm{energyflux}\{\langle magnitude\rangle\}$**

**$\backslash\mathrm{energyfluxvector}\{\langle c_1, \dots, c_n\rangle\}$**

**$\backslash\mathrm{vectorenergyflux}\{\langle c_1, \dots, c_n\rangle\}$**

N 2021-02-24

name			
<code>\energyflux</code>			
base	derived	alternate	
$\text{kg} \cdot \text{s}^{-3}$	$\text{W}/\text{m}^2$	$\text{W}/\text{m}^2$	

`\entropy{\langle magnitude \rangle}`

name			
<code>\entropy</code>			
base	derived	alternate	
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2} \cdot \text{K}^{-1}$	$\text{J}/\text{K}$	$\text{J}/\text{K}$	

`\force{\langle magnitude \rangle}`

`\forcevector{\langle c_1, \dots, c_n \rangle}`

`\vectorforce{\langle c_1, \dots, c_n \rangle}`

name			
<code>\force</code>			
base	derived	alternate	
$\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$	$\text{N}$	$\text{N}$	

`\frequency{\langle magnitude \rangle}`

name			
<code>\frequency</code>			
base	derived	alternate	
$\text{s}^{-1}$	$\text{Hz}$	$\text{Hz}$	

`\gravitationalfield{\langle magnitude \rangle}`

`\gravitationalfieldvector{\langle c_1, \dots, c_n \rangle}`

`\vectorgravitationalfield{\langle c_1, \dots, c_n \rangle}`

name			
<code>\gravitationalfield</code>			
base	derived	alternate	
$\text{m} \cdot \text{s}^{-2}$	$\text{N}/\text{kg}$	$\text{N}/\text{kg}$	

`\gravitationalpotential{\langle magnitude \rangle}`

name			
<code>\gravitationalpotential</code>			
base	derived	alternate	
$\text{m}^2 \cdot \text{s}^{-2}$	$\text{J}/\text{kg}$	$\text{J}/\text{kg}$	

`\gravitationalpotentialdifference{\langle magnitude \rangle}`



name			
\gravitationalpotentialdifference			
base	derived		alternate
$\text{m}^2 \cdot \text{s}^{-2}$	J/kg		J/kg

$\backslash\text{impulse}\{\langle magnitude \rangle\}$   
 $\backslash\text{impulsevector}\{\langle c_1, \dots, c_n \rangle\}$   
 $\backslash\text{vectorimpulse}\{\langle c_1, \dots, c_n \rangle\}$

name			
\impulse			
base	derived		alternate
$\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$	N · s		N · s

$\backslash\text{indexofrefraction}\{\langle magnitude \rangle\}$

name			
\indexofrefraction			
base	derived		alternate

$\backslash\text{inductance}\{\langle magnitude \rangle\}$

name			
\inductance			
base	derived		alternate
$\text{kg} \cdot \text{m}^2 \cdot \text{A}^{-2} \cdot \text{s}^{-2}$	H		V · s/A

$\backslash\text{linearchargedensity}\{\langle magnitude \rangle\}$

name			
\linearchargedensity			
base	derived		alternate
$\text{A} \cdot \text{s} \cdot \text{m}^{-1}$	C/m		C/m

$\backslash\text{linearmassdensity}\{\langle magnitude \rangle\}$

name			
\linearmassdensity			
base	derived		alternate
$\text{kg} \cdot \text{m}^{-1}$	kg/m		kg/m

$\backslash\text{luminousintensity}\{\langle magnitude \rangle\}$

name			
\luminousintensity			
base	derived		alternate
cd	cd		cd

**\magneticcharge** $\{\langle magnitude \rangle\}$

**name**

**\magneticcharge**

**base**

$\text{A} \cdot \text{m}$

**derived**

$\text{A} \cdot \text{m}$

**alternate**

$\text{A} \cdot \text{m}$

**\magneticdipolemoment** $\{\langle magnitude \rangle\}$

**\magneticdipolemomentvector** $\{\langle c_1, \dots, c_n \rangle\}$

**\vectormagneticdipolemoment** $\{\langle c_1, \dots, c_n \rangle\}$

**name**

**\magneticdipolemoment**

**base**

$\text{A} \cdot \text{m}^2$

**derived**

$\text{A} \cdot \text{m}^2$

**alternate**

$\text{J/T}$

**\magneticfield** $\{\langle magnitude \rangle\}$

**\magneticfieldvector** $\{\langle c_1, \dots, c_n \rangle\}$

**\vectormagneticfield** $\{\langle c_1, \dots, c_n \rangle\}$

**name**

**\magneticfield**

**base**

$\text{kg} \cdot \text{A}^{-1} \cdot \text{s}^{-2}$

**derived**

$\text{N/A} \cdot \text{m}$

**alternate**

$\text{T}$

**\magneticflux** $\{\langle magnitude \rangle\}$

**name**

**\magneticflux**

**base**

$\text{kg} \cdot \text{m}^2 \cdot \text{A}^{-1} \cdot \text{s}^{-2}$

**derived**

$\text{T} \cdot \text{m}^2$

**alternate**

$\text{V} \cdot \text{s}$

**\mass** $\{\langle magnitude \rangle\}$

**name**

**\mass**

**base**

$\text{kg}$

**derived**

$\text{kg}$

**alternate**

$\text{kg}$

**\mobility** $\{\langle magnitude \rangle\}$

**name**

**\mobility**

**base**

$\text{kg} \cdot \text{m}^2 \cdot \text{A}^{-1} \cdot \text{s}^{-4}$

**derived**

$\text{m}^2/\text{V} \cdot \text{s}$

**alternate**

$\text{C} \cdot \text{m}/\text{N} \cdot \text{s}$

N 2021-02-24

N 2021-02-24

**\momentofinertia** $\{\langle magnitude \rangle\}$

name			
\momentofinertia			
base	derived	alternate	
$\text{kg} \cdot \text{m}^2$	$\text{J} \cdot \text{s}^2$	$\text{kg} \cdot \text{m}^2$	

**\momentum** $\{\langle magnitude \rangle\}$

**\momentumvector** $\{\langle c_1, \dots, c_n \rangle\}$

**\vectormomentum** $\{\langle c_1, \dots, c_n \rangle\}$

name			
\momentum			
base	derived	alternate	
$\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$	$\text{kg} \cdot \text{m/s}$	$\text{kg} \cdot \text{m/s}$	

**\momentumflux** $\{\langle magnitude \rangle\}$

**\momentumfluxvector** $\{\langle c_1, \dots, c_n \rangle\}$

**\vectormomentumflux** $\{\langle c_1, \dots, c_n \rangle\}$

name			
\momentumflux			
base	derived	alternate	
$\text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$	$\text{N/m}^2$	$\text{N/m}^2$	

**\numberdensity** $\{\langle magnitude \rangle\}$

name			
\numberdensity			
base	derived	alternate	
$\text{m}^{-3}$	$/\text{m}^3$	$/\text{m}^3$	

**\permeability** $\{\langle magnitude \rangle\}$

name			
\permeability			
base	derived	alternate	
$\text{kg} \cdot \text{m} \cdot \text{A}^{-2} \cdot \text{s}^{-2}$	$\text{H/m}$	$\text{T} \cdot \text{m/A}$	

**\permittivity** $\{\langle magnitude \rangle\}$

name			
\permittivity			
base	derived	alternate	
$\text{A}^2 \cdot \text{s}^4 \cdot \text{kg}^{-1} \cdot \text{m}^{-3}$	$\text{F/m}$	$\text{C}^2/\text{N} \cdot \text{m}^2$	

**\planeangle**{ $\langle magnitude \rangle$ }

name			
\planeangle			
base	derived	alternate	
$\text{m} \cdot \text{m}^{-1}$	rad	rad	

**\polarizability**{ $\langle magnitude \rangle$ }

name			
\polarizability			
base	derived	alternate	
$\text{A}^2 \cdot \text{s}^4 \cdot \text{kg}^{-1}$	$\text{C} \cdot \text{m}^2/\text{V}$	$\text{C}^2 \cdot \text{m}/\text{N}$	

**\power**{ $\langle magnitude \rangle$ }

name			
\power			
base	derived	alternate	
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-3}$	W	J/s	

**\poynting**{ $\langle magnitude \rangle$ }

**\poyntingvector**{ $\langle c_1, \dots, c_n \rangle$ }

**\vectorpoynting**{ $\langle c_1, \dots, c_n \rangle$ }

name			
\poynting			
base	derived	alternate	
$\text{kg} \cdot \text{s}^{-3}$	$\text{W}/\text{m}^2$	$\text{W}/\text{m}^2$	

**\pressure**{ $\langle magnitude \rangle$ }

name			
\pressure			
base	derived	alternate	
$\text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$	Pa	$\text{N}/\text{m}^2$	

**\relativepermeability**{ $\langle magnitude \rangle$ }

name			
\relativepermeability			
base	derived	alternate	

**\relativepermittivity**{ $\langle magnitude \rangle$ }

<b>name</b>			
<code>\relativepermittivity</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
<b><code>\resistance</code></b> $\{\langle magnitude \rangle\}$			
<b>name</b>			
<code>\resistance</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
$\text{kg} \cdot \text{m}^2 \cdot \text{A}^{-2} \cdot \text{s}^{-3}$	$\Omega$	$\Omega$	
<b><code>\resistivity</code></b> $\{\langle magnitude \rangle\}$			
<b>name</b>			
<code>\resistivity</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
$\text{kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-3}$	$\Omega \cdot \text{m}$	$\text{V} \cdot \text{m}/\text{A}$	
<b><code>\solidangle</code></b> $\{\langle magnitude \rangle\}$			
<b>name</b>			
<code>\solidangle</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
$\text{m}^2 \cdot \text{m}^{-2}$	sr	sr	
<b><code>\specificheatcapacity</code></b> $\{\langle magnitude \rangle\}$			
<b>name</b>			
<code>\specificheatcapacity</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
$\text{m}^2 \cdot \text{s}^{-2} \cdot \text{K}^{-1}$	$\text{J}/\text{K} \cdot \text{kg}$	$\text{J}/\text{K} \cdot \text{kg}$	
<b><code>\springstiffness</code></b> $\{\langle magnitude \rangle\}$			
<b>name</b>			
<code>\springstiffness</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
$\text{kg} \cdot \text{s}^{-2}$	$\text{N}/\text{m}$	$\text{N}/\text{m}$	
<b><code>\springstretch</code></b> $\{\langle magnitude \rangle\}$			
<b>name</b>			
<code>\springstretch</code>			
<b>base</b>	<b>derived</b>	<b>alternate</b>	
m	m	m	

**`\stress{⟨magnitude⟩}`**

name			
\stress			
base	derived	alternate	
$\text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$	Pa	N/m <sup>2</sup>	

**`\strain{⟨magnitude⟩}`**

name			
\strain			
base	derived	alternate	

**`\temperature{⟨magnitude⟩}`**

name			
\temperature			
base	derived	alternate	
K	K	K	

**`\torque{⟨magnitude⟩}`**

**`\torquevector{⟨c1, ..., cn⟩}`**

**`\vectortorque{⟨c1, ..., cn⟩}`**

name			
\torque			
base	derived	alternate	
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$	N · m	N · m	

**`\velocity{⟨magnitude⟩}`**

**`\velocityvector{⟨c1, ..., cn⟩}`**

**`\vectorvelocity{⟨c1, ..., cn⟩}`**

**`\velocityc{⟨magnitude⟩}`**

**`\velocitycvector{⟨c1, ..., cn⟩}`**

**`\vectorvelocityc{⟨c1, ..., cn⟩}`**

name			
\velocity			
base	derived	alternate	
$\text{m} \cdot \text{s}^{-1}$	m/s	m/s	

name			
\velocityc			
base	derived	alternate	
c	c	c	

**\volume**{ $\langle magnitude \rangle$ }

name			
\volume			
base	derived	alternate	
$\text{m}^3$	$\text{m}^3$	$\text{m}^3$	

**\volumechargedensity**{ $\langle magnitude \rangle$ }

name			
\volumechargedensity			
base	derived	alternate	
$\text{A} \cdot \text{s} / \text{m}^{-3}$	$\text{C} / \text{m}^3$	$\text{C} / \text{m}^3$	

**\volumemassdensity**{ $\langle magnitude \rangle$ }

name			
\volumemassdensity			
base	derived	alternate	
$\text{kg} \cdot \text{m}^{-3}$	$\text{kg} / \text{m}^3$	$\text{kg} / \text{m}^3$	

**\wavelength**{ $\langle magnitude \rangle$ }

name			
\wavelength			
base	derived	alternate	
$\text{m}$	$\text{m}$	$\text{m}$	

**\wavenumber**{ $\langle magnitude \rangle$ }

**\wavenumbervector**{ $\langle c_1, \dots, c_n \rangle$ }

**\vectorwavenumber**{ $\langle c_1, \dots, c_n \rangle$ }

name			
\wavenumber			
base	derived	alternate	
$\text{m}^{-1}$	$/\text{m}$	$/\text{m}$	

**\work**{ $\langle magnitude \rangle$ }

name			
\work			
base	derived	alternate	
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$	$\text{J}$	$\text{J}$	

**\youngsmodulus**{ $\langle magnitude \rangle$ }

name			
\youngsmodulus			
base	derived	alternate	
$\text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$	$\text{Pa}$	$\text{N} / \text{m}^2$	

### 3.4.4 Defining and Redefining Physical Quantities

N 2021-02-16

`\newscalarquantity{⟨name⟩}{⟨base units⟩}[⟨derived units⟩][⟨alternate units⟩]`

N 2021-02-21

`\renewscalarquantity{⟨name⟩}{⟨base units⟩}[⟨derived units⟩][⟨alternate units⟩]`

Command to (re)define a new/existing scalar quantity. If the derived or alternate units are omitted, they are defined to be the same as the base units. Do not use both this command and `\newvectorquantity` or `\renewvectorquantity` to (re)define a quantity.

N 2021-02-16

`\newvectorquantity{⟨name⟩}{⟨base units⟩}[⟨derived units⟩][⟨alternate units⟩]`

N 2021-02-21

`\renewvectorquantity{⟨name⟩}{⟨base units⟩}[⟨derived units⟩][⟨alternate units⟩]`

Command to (re)define a new/existing vector quantity. If the derived or alternate units are omitted, they are defined to be the same as the base units. Do not use both this command and `\newscalarquantity` or `\renewscalarquantity` to (re)define a quantity.

### 3.4.5 Changing Units

Units are set when `mandi` is loaded, but the default setting can be easily overridden in four ways: command variants that are defined when a `physical quantity`<sup>P.9</sup> or `physical constant`<sup>P.25</sup> is defined, a global modal command (switch), a command that sets units for a single instance, and an environment that sets units for its duration. All of these methods work for both physical quantities and physical constants.

U 2021-02-26

`\alwaysusebaseunits`

U 2021-02-26

`\alwaysusederivedunits`

U 2021-02-26

`\alwaysusealternateunits`

Modal commands (switches) for setting the default unit form for the entire document. When `mandi` is loaded, one of these three commands is executed depending on whether the optional `units` key is provided. See the section on loading the package for details. Alternate units are the default because they are the most likely ones to be seen in introductory physics textbooks.

U 2021-02-26

`\hereusebaseunits{⟨content⟩}`

U 2021-02-26

`\hereusederivedunits{⟨content⟩}`

U 2021-02-26

`\hereusedalternateunits{⟨content⟩}`

Commands for setting the unit form on the fly for a single instance. The example uses momentum and the Coulomb constant, but they work for any defined quantity and constant.

<code>\( \hereusebaseunits{\momentum{5}} \)</code>	<code>\)</code>	$5 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$
<code>\( \hereusederivedunits{\momentum{5}} \)</code>	<code>\)</code>	$5 \text{ kg} \cdot \text{m/s}$
<code>\( \hereusealternateunits{\momentum{5}} \)</code>	<code>\)</code>	$5 \text{ kg} \cdot \text{m/s}$
<code>\( \hereusebaseunits{\oofpez} \)</code>	<code>\)</code>	$9 \times 10^9 \text{ kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-4}$
<code>\( \hereusederivedunits{\oofpez} \)</code>	<code>\)</code>	$9 \times 10^9 \text{ m/F}$
<code>\( \hereusealternateunits{\oofpez} \)</code>	<code>\)</code>	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$

U 2021-02-26

`\begin{usebaseunits}` (use base units)  
`⟨environment content⟩`  
`\end{usebaseunits}`



`\begin{usederivedunits}` (use derived units)  
`\end{usederivedunits}`  
`\begin{usealternateunits}` (use alternate units)  
`\end{usealternateunits}`

`\begin{usederivedunits}` (use derived units)  
`\end{usederivedunits}`  
`\begin{usealternateunits}` (use alternate units)  
`\end{usealternateunits}`

Inside these environments units are changed for the duration of the environment regardless of the global default setting.

<code>\( \momentum{5} \)</code>	<code>\( \momentum{5} \)</code>	$5 \text{ kg} \cdot \text{m/s}$
<code>\( \oofpez \)</code>	<code>\( \oofpez \)</code>	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
<code>\begin{usebaseunits}</code>		$5 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$
<code>\( \momentum{5} \)</code>	<code>\( \momentum{5} \)</code>	$9 \times 10^9 \text{ kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-4}$
<code>\( \oofpez \)</code>	<code>\( \oofpez \)</code>	$5 \text{ kg} \cdot \text{m/s}$
<code>\end{usebaseunits}</code>		$9 \times 10^9 \text{ m/F}$
<code>\begin{usederivedunits}</code>		$5 \text{ kg} \cdot \text{m/s}$
<code>\( \momentum{5} \)</code>	<code>\( \momentum{5} \)</code>	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
<code>\( \oofpez \)</code>	<code>\( \oofpez \)</code>	
<code>\end{usederivedunits}</code>		
<code>\begin{usealternateunits}</code>		
<code>\( \momentum{5} \)</code>	<code>\( \momentum{5} \)</code>	
<code>\( \oofpez \)</code>	<code>\( \oofpez \)</code>	
<code>\end{usealternateunits}</code>		

## 3.5 Physical Constants

### 3.5.1 Typesetting Physical Constants

Take the quantity  $\frac{1}{4\pi\epsilon_0}$ , sometimes called the [Coulomb constant](#), as the prototypical [physical constant](#) in an introductory physics course. Here are all the ways to access this quantity in **mandi**. As you can see, these commands are almost identical to the corresponding commands for physical quantities.

#### `\oofpez`

Command for the Coulomb constant. The constant's numerical precision and default units will depend on the options passed to **mandi** at load time. Alternate units and approximate numerical values are the defaults. Other units can be forced as demonstrated.

<code>\( \oofpez \)</code>	<code>\( \oofpez \)</code>	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
<code>\( \oofpezapproximatevalue \)</code>	<code>\( \oofpezapproximatevalue \)</code>	$9 \times 10^9$
<code>\( \oofpezprecisevalue \)</code>	<code>\( \oofpezprecisevalue \)</code>	$8.9875517923 \times 10^9$
<code>\( \oofpezmathsymbol \)</code>	<code>\( \oofpezmathsymbol \)</code>	$\frac{1}{4\pi\epsilon_0}$
<code>\( \oofpezbaseunits \)</code>	<code>\( \oofpezbaseunits \)</code>	$9 \times 10^9 \text{ kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-4}$
<code>\( \oofpezderivedunits \)</code>	<code>\( \oofpezderivedunits \)</code>	$9 \times 10^9 \text{ m/F}$
<code>\( \oofpezalternateunits \)</code>	<code>\( \oofpezalternateunits \)</code>	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
<code>\( \oofpezonlybaseunits \)</code>	<code>\( \oofpezonlybaseunits \)</code>	$\text{kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-4}$
<code>\( \oofpezonlyderivedunits \)</code>	<code>\( \oofpezonlyderivedunits \)</code>	$\text{m/F}$
<code>\( \oofpezonlyalternateunits \)</code>	<code>\( \oofpezonlyalternateunits \)</code>	$\text{N} \cdot \text{m}^2/\text{C}^2$

### 3.5.2 Checking Physical Constants

U 2021-02-26

**`\checkconstant{⟨name⟩}`**

Command to check and typeset the constant's name, base units, derived units, alternate units, mathematical symbol, approximate value, and precise value.

### 3.5.3 Predefined Physical Constants

Every other defined physical constant can be treated similarly. Just replace `oofpez` with the constant's name. Unfortunately, there is no universal agreement on the names of every constant so don't fret if the names used here vary from other sources. Here are all the physical constants, with all their units, defined in `mandi`. The constants `\coulombconstant`<sup>P.27</sup> and `\biotsavartconstant` are defined as semantic aliases for, respectively, `\oofpez`<sup>P.30</sup> and `\mzofp`<sup>P.29</sup>.

**`\avogadro`** (exact)

name			
<code>\avogadro</code>			
symbol	approximate	precise	
$N_A$	$6 \times 10^{23}$	$6.02214076 \times 10^{23}$	
base	derived	alternate	
$\text{mol}^{-1}$	/mol	/mol	

N 2021-02-02

**`\biotsavartconstant`**

name			
<code>\biotsavartconstant</code>			
symbol	approximate	precise	
$\frac{\mu_0}{4\pi}$	$10^{-7}$	$10^{-7}$	
base	derived	alternate	
$\text{kg} \cdot \text{m} \cdot \text{A}^{-2} \cdot \text{s}^{-2}$	H/m	T · m/A	

**`\bohrradius`**

name			
<code>\bohrradius</code>			
symbol	approximate	precise	
$a_o$	$5.3 \times 10^{-11}$	$5.29177210903 \times 10^{-11}$	
base	derived	alternate	
m	m	m	

**`\boltzmann`** (exact)

name			
<code>\boltzmann</code>			
symbol	approximate	precise	
$k_B$	$1.4 \times 10^{-23}$	$1.380649 \times 10^{-23}$	
base	derived	alternate	
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2} \cdot \text{K}^{-1}$	J/K	J/K	

## \coulombconstant

name

\coulombconstant

symbol

$$\frac{1}{4\pi\epsilon_0}$$

base

$$\text{kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-4}$$

approximate

$$9 \times 10^9$$

derived

$$\text{m/F}$$

precise

$$8.9875517923 \times 10^9$$

alternate

$$\text{N} \cdot \text{m}^2/\text{C}^2$$

## \earthmass

name

\earthmass

symbol

$$M_{\text{Earth}}$$

base

$$\text{kg}$$

approximate

$$6.0 \times 10^{24}$$

derived

$$\text{kg}$$

precise

$$5.9722 \times 10^{24}$$

alternate

$$\text{kg}$$

## \earthmoondistance

name

\earthmoondistance

symbol

$$d_{\text{EM}}$$

base

$$\text{m}$$

approximate

$$3.8 \times 10^8$$

derived

$$\text{m}$$

precise

$$3.81550 \times 10^8$$

alternate

$$\text{m}$$

## \earthradius

name

\earthradius

symbol

$$R_{\text{Earth}}$$

base

$$\text{m}$$

approximate

$$6.4 \times 10^6$$

derived

$$\text{m}$$

precise

$$6.3781 \times 10^6$$

alternate

$$\text{m}$$

## \earth sundistance

name

\earth sundistance

symbol

$$d_{\text{ES}}$$

base

$$\text{m}$$

approximate

$$1.5 \times 10^{11}$$

derived

$$\text{m}$$

precise

$$1.496 \times 10^{11}$$

alternate

$$\text{m}$$

## \electroncharge

<b>name</b>			
\electroncharge			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$q_e$		$-1.6 \times 10^{-19}$	$-1.602176634 \times 10^{-19}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
A · s		C	C

### \electronCharge

<b>name</b>			
\electronCharge			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$Q_e$		$-1.6 \times 10^{-19}$	$-1.602176634 \times 10^{-19}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
A · s		C	C

### \electronmass

<b>name</b>			
\electronmass			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$m_e$		$9.1 \times 10^{-31}$	$9.1093837015 \times 10^{-31}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
kg		kg	kg

### \elementarycharge (exact)

<b>name</b>			
\elementarycharge			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
e		$1.6 \times 10^{-19}$	$1.602176634 \times 10^{-19}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
A · s		C	C

### \finestructure

<b>name</b>			
\finestructure			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$\alpha$		$\frac{1}{137}$	$7.2973525693 \times 10^{-3}$
<b>base</b>		<b>derived</b>	<b>alternate</b>

### \hydrogenmass

<b>name</b>			
\hydrogenmass			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$m_{\text{H}}$		$1.7 \times 10^{-27}$	$1.6737236 \times 10^{-27}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
kg		kg	kg

### \moonearthdistance

<b>name</b>			
\moonearthdistance			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$d_{\text{ME}}$		$3.8 \times 10^8$	$3.81550 \times 10^8$
<b>base</b>		<b>derived</b>	<b>alternate</b>
m		m	m

### \moonmass

<b>name</b>			
\moonmass			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$M_{\text{Moon}}$		$7.3 \times 10^{22}$	$7.342 \times 10^{22}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
kg		kg	kg

### \moonradius

<b>name</b>			
\moonradius			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$R_{\text{Moon}}$		$1.7 \times 10^6$	$1.7371 \times 10^6$
<b>base</b>		<b>derived</b>	<b>alternate</b>
m		m	m

### \mzofp

<b>name</b>			
\mzofp			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$\frac{\mu_0}{4\pi}$		$10^{-7}$	$10^{-7}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m} \cdot \text{A}^{-2} \cdot \text{s}^{-2}$		H/m	T · m/A

### \neutronmass

<b>name</b>		
<code>\neutronmass</code>		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$m_n$	$1.7 \times 10^{-27}$	$1.67492749804 \times 10^{-27}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
kg	kg	kg

### `\oofpez`

<b>name</b>		
<code>\oofpez</code>		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$\frac{1}{4\pi\epsilon_0}$	$9 \times 10^9$	$8.9875517923 \times 10^9$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m}^3 \cdot \text{A}^{-2} \cdot \text{s}^{-4}$	m/F	$\text{N} \cdot \text{m}^2 / \text{C}^2$

### `\oofpezcs`

<b>name</b>		
<code>\oofpezcs</code>		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$\frac{1}{4\pi\epsilon_0 c^2}$	$10^{-7}$	$10^{-7}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m} \cdot \text{A}^{-2} \cdot \text{s}^{-2}$	$\text{T} \cdot \text{m}^2$	$\text{N} \cdot \text{s}^2 / \text{C}^2$

### `\planck` (exact)

<b>name</b>		
<code>\planck</code>		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
h	$6.6 \times 10^{-34}$	$6.62607015 \times 10^{-34}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-1}$	$\text{J} \cdot \text{s}$	$\text{J} \cdot \text{s}$

### `\planckbar`

<b>name</b>		
<code>\planckbar</code>		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$\hbar$	$1.1 \times 10^{-34}$	$1.054571817 \times 10^{-34}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-1}$	$\text{J} \cdot \text{s}$	$\text{J} \cdot \text{s}$

### `\planckc`

<b>name</b>		
\planckc		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
hc	$2.0 \times 10^{-25}$	$1.98644586 \times 10^{-25}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m}^3 \cdot \text{s}^{-2}$	$\text{J} \cdot \text{m}$	$\text{J} \cdot \text{m}$

### \protoncharge

<b>name</b>		
\protoncharge		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$q_p$	$+1.6 \times 10^{-19}$	$+1.602176634 \times 10^{-19}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{A} \cdot \text{s}$	$\text{C}$	$\text{C}$

### \protonCharge

<b>name</b>		
\protonCharge		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$Q_p$	$+1.6 \times 10^{-19}$	$+1.602176634 \times 10^{-19}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{A} \cdot \text{s}$	$\text{C}$	$\text{C}$

### \protonmass

<b>name</b>		
\protonmass		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$m_p$	$1.7 \times 10^{-27}$	$1.672621898 \times 10^{-27}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg}$	$\text{kg}$	$\text{kg}$

### \rydberg

<b>name</b>		
\rydberg		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$R_\infty$	$1.1 \times 10^7$	$1.0973731568160 \times 10^7$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{m}^{-1}$	$\text{m}^{-1}$	$\text{m}^{-1}$

### \speedoflight

(exact)

<b>name</b>			
\speedoflight			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
c		$3 \times 10^8$	$2.99792458 \times 10^8$
<b>base</b>		<b>derived</b>	<b>alternate</b>
$\text{m} \cdot \text{s}^{-1}$		m/s	m/s

### \stefanboltzmann

<b>name</b>			
\stefanboltzmann			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$\sigma$		$5.7 \times 10^{-8}$	$5.670374 \times 10^{-8}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{s}^{-3} \cdot \text{K}^{-4}$		$\text{W}/\text{m}^2 \cdot \text{K}^4$	$\text{W}/\text{m}^2 \cdot \text{K}^4$

### \sunearthdistance

<b>name</b>			
\sunearthdistance			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$d_{\text{SE}}$		$1.5 \times 10^{11}$	$1.496 \times 10^{11}$
<b>base</b>		<b>derived</b>	<b>alternate</b>
m		m	m

### \sunradius

<b>name</b>			
\sunradius			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
$R_{\text{Sun}}$		$7.0 \times 10^8$	$6.957 \times 10^8$
<b>base</b>		<b>derived</b>	<b>alternate</b>
m		m	m

### \surfacegravfield

<b>name</b>			
\surfacegravfield			
<b>symbol</b>		<b>approximate</b>	<b>precise</b>
g		9.8	9.807
<b>base</b>		<b>derived</b>	<b>alternate</b>
$\text{m} \cdot \text{s}^{-2}$		N/kg	N/kg

### \universalgrav



<b>name</b>		
\universalgrav		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
G	$6.7 \times 10^{-11}$	$6.67430 \times 10^{-11}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$	$\text{N} \cdot \text{m}^2/\text{kg}^2$	$\text{N} \cdot \text{m}^2/\text{kg}^2$

#### \vacuumpermeability

<b>name</b>		
\vacuumpermeability		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$\mu_0$	$4\pi \times 10^{-7}$	$4\pi \times 10^{-7}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{kg} \cdot \text{m} \cdot \text{A}^{-2} \cdot \text{s}^{-2}$	H/m	T · m/A

#### \vacuumpermittivity

<b>name</b>		
\vacuumpermittivity		
<b>symbol</b>	<b>approximate</b>	<b>precise</b>
$\epsilon_0$	$9 \times 10^{-12}$	$8.854187817 \times 10^{-12}$
<b>base</b>	<b>derived</b>	<b>alternate</b>
$\text{A}^2 \cdot \text{s}^4 \cdot \text{kg}^{-1} \cdot \text{m}^{-3}$	F/m	$\text{C}^2/\text{N} \cdot \text{m}^2$

### 3.5.4 Defining and Redefining Physical Constants

N 2021-02-16

**\newphysicalconstant**  $\{\langle name \rangle\}\{\langle symbol \rangle\}\{\langle approximate value \rangle\}\{\langle precise value \rangle\}\{\langle base units \rangle\}$   
 $[\langle derived units \rangle] [\langle alternate units \rangle]$

N 2021-02-21

**\renewphysicalconstant**  $\{\langle name \rangle\}\{\langle symbol \rangle\}\{\langle approximate value \rangle\}\{\langle precise value \rangle\}\{\langle base units \rangle\}$   
 $[\langle derived units \rangle] [\langle alternate units \rangle]$

Command to define/redefine a new/existing physical constant. If the derived or alternate units are omitted, they are defined to be the same as the base units.

### 3.5.5 Changing Precision

[Changing units](#)<sup>→ P.24</sup> works for physical constants just as it does for physical quantities. A similar mechanism is provided for changing the precision of physical constants' numerical values.

N 2021-02-16

**\alwaysuseapproximateconstants**

N 2021-02-16

**\alwaysusepreciseconstants**

Modal commands (switches) for setting the default precision for the entire document. The default when the package is loaded is set by the presence or absence of the [preciseconstants](#)<sup>→ P.8</sup> key.

N 2021-02-16

**\hereuseapproximateconstants** $\{\langle content \rangle\}$

N 2021-02-16

**\hereusepreciseconstants** $\{\langle content \rangle\}$

Commands for setting the precision on the fly for a single instance.

$\backslash( \backslash\text{hereuseapproximateconstants}\{\backslash\text{oofpez}\} \backslash) \backslash\backslash$ $\backslash( \backslash\text{hereusepreciseconstants}\{\backslash\text{oofpez}\} \backslash)$	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$ $8.9875517923 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
---	---

`\begin{useapproximateconstants}` (use approximate constants)  
 $\langle \text{environment content} \rangle$   
`\end{useapproximateconstants}`  
`\begin{usepreciseconstants}` (use precise constants)  
 $\langle \text{environment content} \rangle$   
`\end{usepreciseconstants}`

Inside these environments precision is changed for the duration of the environment regardless of the global default setting.

$\backslash( \backslash\text{oofpez} \backslash)$ <code>\begin{useapproximateconstants}</code> $\backslash( \backslash\text{oofpez} \backslash)$ <code>\end{useapproximateconstants}</code> <code>\begin{usepreciseconstants}</code> $\backslash( \backslash\text{oofpez} \backslash)$ <code>\end{usepreciseconstants}</code> $\backslash( \backslash\text{oofpez} \backslash)$	$9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$ $9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$ $8.9875517923 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$ $9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
--	---

### 3.6 Predefined Units and Constructs

These commands should be used only in defining or redefining physical quantities or physical constants. One exception is `\emptyunit`, which may be used for explanatory purposes.

`\per`  
`\usk`  
`\unit{\langle magnitude \rangle}\{\langle unit \rangle\}`  
`\emptyunit`  
`\ampere`  
`\atomicmassunit`  
`\candela`  
`\coulomb`  
`\degree`  
`\electronvolt` (not SI but common in introductory physics)  
`\ev` (alias)  
`\farad`  
`\henry`  
`\hertz`  
`\joule`  
`\kelvin`  
`\kev` (alias)  
`\kiloelectronvolt` (not SI but common in introductory physics)  
`\kilogram`  
`\lightspeed` (not SI but common relativity)

N 2021-04-15

\megaelectronvolt (not SI but common in introductory physics)

\meter

\metre (alias)

N 2021-04-15

\mev (alias)

\mole

\newton

\ohm

\pascal

\radian

\second

\siemens

\steradian

\tesla

\volt

\watt

\weber

\tothetwo (postfix)

\tothethree (postfix)

\tothefour (postfix)

\inverse (postfix)

\totheinversetwo (postfix)

\totheinversethree (postfix)

\totheinversefour (postfix)

		/
		.
		3 m/s
		$\square$
<code>\( \perp \)</code>	<code>\)</code>	A
<code>\( \us \)</code>	<code>\)</code>	u
<code>\( \unit{3}{\meter\per\second} \)</code>	<code>\)</code>	cd
<code>\( \emptyunit \)</code>	<code>\)</code>	C
<code>\( \ampere \)</code>	<code>\)</code>	°
<code>\( \atomicmassunit \)</code>	<code>\)</code>	eV
<code>\( \candela \)</code>	<code>\)</code>	F
<code>\( \coulomb \)</code>	<code>\)</code>	H
<code>\( \degree \)</code>	<code>\)</code>	Hz
<code>\( \electronvolt \)</code>	<code>\)</code>	J
<code>\( \farad \)</code>	<code>\)</code>	K
<code>\( \henry \)</code>	<code>\)</code>	keV
<code>\( \hertz \)</code>	<code>\)</code>	kg
<code>\( \joule \)</code>	<code>\)</code>	c
<code>\( \kelvin \)</code>	<code>\)</code>	m
<code>\( \kev \)</code>	<code>\)</code>	m
<code>\( \kilogram \)</code>	<code>\)</code>	MeV
<code>\( \lightspeed \)</code>	<code>\)</code>	mol
<code>\( \meter \)</code>	<code>\)</code>	N
<code>\( \metre \)</code>	<code>\)</code>	$\Omega$
<code>\( \mev \)</code>	<code>\)</code>	Pa
<code>\( \mole \)</code>	<code>\)</code>	rad
<code>\( \newton \)</code>	<code>\)</code>	s
<code>\( \ohm \)</code>	<code>\)</code>	S
<code>\( \pascal \)</code>	<code>\)</code>	sr
<code>\( \radian \)</code>	<code>\)</code>	T
<code>\( \second \)</code>	<code>\)</code>	V
<code>\( \siemens \)</code>	<code>\)</code>	W
<code>\( \steradian \)</code>	<code>\)</code>	Wb
<code>\( \tesla \)</code>	<code>\)</code>	$\square^2$
<code>\( \volt \)</code>	<code>\)</code>	$\square^3$
<code>\( \watt \)</code>	<code>\)</code>	$\square^4$
<code>\( \weber \)</code>	<code>\)</code>	$\square^{-1}$
<code>\( \emptyunit\tothetwo \)</code>	<code>\)</code>	$\square^{-2}$
<code>\( \emptyunit\tothethree \)</code>	<code>\)</code>	$\square^{-3}$
<code>\( \emptyunit\tothefour \)</code>	<code>\)</code>	$\square^{-4}$
<code>\( \emptyunit\inverse \)</code>	<code>\)</code>	
<code>\( \emptyunit\totheinversetwo \)</code>	<code>\)</code>	
<code>\( \emptyunit\totheinversethree \)</code>	<code>\)</code>	
<code>\( \emptyunit\totheinversefour \)</code>	<code>\)</code>	

`\tento{<number>}`  
`\timestento{<number>}`  
`\xtento{<number>}`

Commands for powers of ten and scientific notation.

<code>\( \tento{-4} \)</code>	<code>\)</code>	$10^{-4}$
<code>\( 3\timestento{8} \)</code>	<code>\)</code>	$3 \times 10^8$
<code>\( 3\xtento{8} \)</code>		$3 \times 10^8$

**`\mivector`** $[\langle \textit{delimiter} \rangle]\{c_1, \dots, c_n\}[\langle \textit{units} \rangle]$

Typesets a vector as either numeric or symbolic components with an optional unit (for numerical components only). There can be more than three components. The delimiter used in the list of components can be specified; the default is a comma. The notation mirrors that of *Matter & Interactions*.

<code>\( \mivector{p_0,p_1,p_2,p_3} \)</code>	<code>\)</code>	$\langle p_0, p_1, p_2, p_3 \rangle$
<code>\( \mivector{\gamma m v_x, \gamma m v_y, \gamma m v_z} \)</code>	<code>\)</code>	$\langle \gamma m v_x, \gamma m v_y, \gamma m v_z \rangle$
<code>\( \mivector{\frac{Q_1 Q_2}{x^2}, 0, 0} \)</code>	<code>\)</code>	$\langle \frac{Q_1 Q_2}{x^2}, 0, 0 \rangle$
<code>\( \mivector{-1, 0, 0} \)</code>	<code>\)</code>	$\langle -1, 0, 0 \rangle$
<code>\( \mivector{-1, 0, 0}[\textit{velocityonlyderivedunits}] \)</code>	<code>\)</code>	$\langle -1, 0, 0 \rangle \text{ m/s}$
<code>\( \mivector{-1, 0, 0}[\textit{meter\per\second}] \)</code>	<code>\)</code>	$\langle -1, 0, 0 \rangle \text{ m/s}$
<code>\( \velocity{\mivector{-1, 0, 0}} \)</code>		$\langle -1, 0, 0 \rangle \text{ m/s}$

### 3.7 mandi Source Code

Define the package version and date for global use, exploiting the fact that in a .sty file there is now no need for `\makeatletter` and `\makeatother`. This simplifies defining internal commands (with @ in the name) that are not for the user to know about.

```
1 \def\mandi@version{3.0.2}
2 \def\mandi@date{2021-09-20}
3 \NeedsTeXFormat{LaTeX2e}[2020-02-02]
4 \DeclareRelease{v3.0.2}{2021-09-20}{mandi.sty}
5 \DeclareCurrentRelease{v\mandi@version}{\mandi@date}
6 \ProvidesPackage{mandi}
7 [\mandi@date\space v\mandi@version\space Macros for physical quantities]
```

Define a convenient package version command.

```
8 \newcommand*\mandiversion{\v\mandi@version\space dated \mandi@date}
```

Load third party packages, documenting why each one is needed.

```
9 \RequirePackage{pgfplots}           % needed for key-value interface
10 \RequirePackage{array}              % needed for \checkquantity and \checkconstant
11 \RequirePackage{iftex}              % needed for requiring LuaLaTeX
12 \RequirePackage{unicode-math}       % needed for Unicode support

13 \IfFormatAtLeastTF {2020-10-01} % load xparse if necessary
14 {}%
15 {\RequirePackage{xparse}}%
16 \RequireLuaTeX                    % require this engine
```

Parts of the unit engine have been rewritten with [xparse](#) for both clarity and power. Note that [xparse](#) is now part of the L<sup>A</sup>T<sub>E</sub>X kernel. Other parts have been rewritten in [expl](#) with a look to the future.

Generic internal selectors.

```
17 \newcommand*\mandi@selectunits{}
18 \newcommand*\mandi@selectprecision{}
```

Specific internal selectors.

```
19 \newcommand*\mandi@selectapproximate[2]{#1} % really \@firstoftwo
20 \newcommand*\mandi@selectprecise[2]{#2} % really \@secondoftwo
21 \newcommand*\mandi@selectbaseunits[3]{#1} % really \@firstofthree
22 \newcommand*\mandi@selectderivedunits[3]{#2} % really \@secondofthree
23 \newcommand*\mandi@selectalternateunits[3]{#3} % really \@thirdofthree
```

Document level global switches.

```
24 \NewDocumentCommand{\alwaysusebaseunits}{}
25 {\renewcommand*\mandi@selectunits{\mandi@selectbaseunits}}%
26 \NewDocumentCommand{\alwaysusederivedunits}{}
27 {\renewcommand*\mandi@selectunits{\mandi@selectderivedunits}}%
28 \NewDocumentCommand{\alwaysusealternateunits}{}
29 {\renewcommand*\mandi@selectunits{\mandi@selectalternateunits}}%
30 \NewDocumentCommand{\alwaysuseapproximateconstants}{}
31 {\renewcommand*\mandi@selectprecision{\mandi@selectapproximate}}%
32 \NewDocumentCommand{\alwaysusepreciseconstants}{}
33 {\renewcommand*\mandi@selectprecision{\mandi@selectprecise}}%
```

Document level localized variants.

```
34 \NewDocumentCommand{\hereusebaseunits}{ m }{\begingroup\alwaysusebaseunits#1\endgroup}%
35 \NewDocumentCommand{\hereusederivedunits}{ m }{\begingroup\alwaysusederivedunits#1\endgroup}%
36 \NewDocumentCommand{\hereusealternateunits}{ m }{\begingroup\alwaysusealternateunits#1\endgroup}%
37 \NewDocumentCommand{\hereuseapproximateconstants}{ m }{\begingroup\alwaysuseapproximateconstants#1\endgroup}%
38 \NewDocumentCommand{\hereusepreciseconstants}{ m }{\begingroup\alwaysusepreciseconstants#1\endgroup}%
```

Document level environments.

```

39 \NewDocumentEnvironment{usebaseunits}{}{\alwaysusebaseunits}{}%
40 \NewDocumentEnvironment{usederivedunits}{}{\alwaysusederivedunits}{}%
41 \NewDocumentEnvironment{usealternateunits}{}{\alwaysusealternateunits}{}%
42 \NewDocumentEnvironment{useapproximateconstants}{}{\alwaysuseapproximateconstants}{}%
43 \NewDocumentEnvironment{usepreciseconstants}{}{\alwaysusepreciseconstants}{}%

```

mandi now has a key-value interface, implemented with `pgfopts` and `pgfkeys`. There are two options: `units`<sup>P.8</sup>, with values `base`, `derived`, or `alternate` selects the default form of units `preciseconstants`<sup>P.8</sup>, with values `true` and `false`, selects precise numerical values for constants rather than approximate values.

First, define the keys. The key handlers require certain commands defined by the unit engine.

```

44 \newif\ifusingpreciseconstants
45 \pgfkeys{%
46   /mandi/options/.cd,
47   initial@setup/.style={%
48     /mandi/options/buffered@units/.initial=alternate,%
49   },%
50   initial@setup,%
51   preciseconstants/.is if=usingpreciseconstants,%
52   units/.is choice,%
53   units/.default=derived,%
54   units/alternate/.style={/mandi/options/buffered@units=alternate},%
55   units/base/.style={/mandi/options/buffered@units=base},%
56   units/derived/.style={/mandi/options/buffered@units=derived},%
57   .unknown/.code={%
58     \typeout{}%
59     \typeout{mandi: You used unknown option '\pgfkeyscurrentname'.}%
60   },%
61 }%

```

Process the options.

```

62 \ProcessPgfPackageOptions{/mandi/options}

```

Write a banner to the console showing the options in use.

```

63 \typeout{}%
64 \typeout{mandi: You are using mandi \mandiversion.}%
65 \typeout{mandi: This package requires LuaLaTeX.}%
66 \typeout{mandi: Loadtime options...}

```

Complete the banner by showing currently selected options. The value of the `units`<sup>P.8</sup> key is used in situ to set the default units.

```

67 \newcommand*{\mandi@do@setup}{%
68   \csname alwaysuse\pgfkeysvalueof{/mandi/options/buffered@units}units\endcsname%
69   \typeout{mandi: You will get \pgfkeysvalueof{/mandi/options/buffered@units}\space units.}%
70   \ifusingpreciseconstants
71     \alwaysusepreciseconstants
72     \typeout{mandi: You will get precise constants.}%
73   \else
74     \alwaysuseapproximateconstants
75     \typeout{mandi: You will get approximate constants.}%
76   \fi
77   \typeout{}%
78 }%
79 \mandi@do@setup

```

Define a setup command that overrides the loadtime options when called with new options. A new banner is written to the console.

```

80 \NewDocumentCommand{\mandisetup}{ m }{%
81   \IfValueT{#1}{%
82     \pgfqkeys{/mandi/options}{#1}
83     \typeout{}%
84     \typeout{mandi: mandisetup options...}
85     \mandi@do@setup
86   }%
87 }%

```

Define units and related constructs to be used with the unit engine. All single letter macros are now gone. We basically absorbed and adapted the now outdated [Slunits](#) package. We make use of `\symup{...}` from the `unicode-math` package.

```

88 \NewDocumentCommand{\per}{ }{ / }
89 \NewDocumentCommand{\usk}{ }{ \cdot }
90 \NewDocumentCommand{\unit}{ m m }{ {#1}{\, #2} }
91 \NewDocumentCommand{\ampere}{ }{ \symup{A} }
92 \NewDocumentCommand{\atomicmassunit}{ }{ \symup{u} }
93 \NewDocumentCommand{\candela}{ }{ \symup{cd} }
94 \NewDocumentCommand{\coulomb}{ }{ \symup{C} }
95 \NewDocumentCommand{\degree}{ }{ ^\circ }
96 \NewDocumentCommand{\electronvolt}{ }{ \symup{eV} }
97 \NewDocumentCommand{\ev}{ }{ \electronvolt }
98 \NewDocumentCommand{\farad}{ }{ \symup{F} }
99 \NewDocumentCommand{\henry}{ }{ \symup{H} }
100 \NewDocumentCommand{\hertz}{ }{ \symup{Hz} }
101 \NewDocumentCommand{\joule}{ }{ \symup{J} }
102 \NewDocumentCommand{\kelvin}{ }{ \symup{K} }
103 \NewDocumentCommand{\kev}{ }{ \kilolectronvolt }
104 \NewDocumentCommand{\kilolectronvolt}{ }{ \symup{keV} }
105 \NewDocumentCommand{\kilogram}{ }{ \symup{kg} }
106 \NewDocumentCommand{\lightspeed}{ }{ \symup{c} }
107 \NewDocumentCommand{\megaelectronvolt}{ }{ \symup{MeV} }
108 \NewDocumentCommand{\meter}{ }{ \symup{m} }
109 \NewDocumentCommand{\metre}{ }{ \meter }
110 \NewDocumentCommand{\mev}{ }{ \megaelectronvolt }
111 \NewDocumentCommand{\mole}{ }{ \symup{mol} }
112 \NewDocumentCommand{\newton}{ }{ \symup{N} }
113 \NewDocumentCommand{\ohm}{ }{ \symup{\Omega} }
114 \NewDocumentCommand{\pascal}{ }{ \symup{Pa} }
115 \NewDocumentCommand{\radian}{ }{ \symup{rad} }
116 \NewDocumentCommand{\second}{ }{ \symup{s} }
117 \NewDocumentCommand{\siemens}{ }{ \symup{S} }
118 \NewDocumentCommand{\steradian}{ }{ \symup{sr} }
119 \NewDocumentCommand{\tesla}{ }{ \symup{T} }
120 \NewDocumentCommand{\volt}{ }{ \symup{V} }
121 \NewDocumentCommand{\watt}{ }{ \symup{W} }
122 \NewDocumentCommand{\weber}{ }{ \symup{Wb} }
123 \NewDocumentCommand{\tothetwo}{ }{ ^2 } % postfix 2
124 \NewDocumentCommand{\tothethree}{ }{ ^3 } % postfix 3
125 \NewDocumentCommand{\tothefour}{ }{ ^4 } % postfix 4
126 \NewDocumentCommand{\inverse}{ }{ ^{-1} } % postfix -1
127 \NewDocumentCommand{\totheinversetwo}{ }{ ^{-2} } % postfix -2
128 \NewDocumentCommand{\totheinversethree}{ }{ ^{-3} } % postfix -3
129 \NewDocumentCommand{\totheinversefour}{ }{ ^{-4} } % postfix -4
130 \NewDocumentCommand{\emptyunit}{ }{ \mdlgwhtsquare }
131 \NewDocumentCommand{\tento}{ m }{ 10^{#1} }
132 \NewDocumentCommand{\timestento}{ m }{ \times \tento{#1} }
133 \NewDocumentCommand{\xtento}{ m }{ \times \tento{#1} }
134 \ExplSyntaxOn
135 \cs_new:Npn \mandi_newscalarquantity #1#2#3#4

```



```

136 {%
137 \cs_new:cpn {#1} ##1 {\unit{##1}{\mandi@selectunits{#2}{#3}{#4}}}%
138 \cs_new:cpn {#1value} ##1 {##1}%
139 \cs_new:cpn {#1baseunits} ##1 {\unit{##1}{\mandi@selectbaseunits{#2}{#3}{#4}}}%
140 \cs_new:cpn {#1derivedunits} ##1 {\unit{##1}{\mandi@selectderivedunits{#2}{#3}{#4}}}%
141 \cs_new:cpn {#1alternateunits} ##1 {\unit{##1}{\mandi@selectalternateunits{#2}{#3}{#4}}}%
142 \cs_new:cpn {#1onlybaseunits} {\mandi@selectbaseunits{#2}{#3}{#4}}%
143 \cs_new:cpn {#1onlyderivedunits} {\mandi@selectderivedunits{#2}{#3}{#4}}%
144 \cs_new:cpn {#1onlyalternateunits} {\mandi@selectalternateunits{#2}{#3}{#4}}%
145 }%
146 \NewDocumentCommand{\newscalarquantity}{ m m O{#2} O{#2} }%
147 {%
148 \mandi_newscalarquantity { #1 }{ #2 }{ #3 }{ #4 }%
149 }%
150 \ExplSyntaxOff

```

Redefining an existing scalar quantity.

```

151 \ExplSyntaxOn
152 \cs_new:Npn \mandi_renewscalarquantity #1#2#3#4
153 {%
154 \cs_set:cpn {#1} ##1 {\unit{##1}{\mandi@selectunits{#2}{#3}{#4}}}%
155 \cs_set:cpn {#1value} ##1 {##1}%
156 \cs_set:cpn {#1baseunits} ##1 {\unit{##1}{\mandi@selectbaseunits{#2}{#3}{#4}}}%
157 \cs_set:cpn {#1derivedunits} ##1 {\unit{##1}{\mandi@selectderivedunits{#2}{#3}{#4}}}%
158 \cs_set:cpn {#1alternateunits} ##1 {\unit{##1}{\mandi@selectalternateunits{#2}{#3}{#4}}}%
159 \cs_set:cpn {#1onlybaseunits} {\mandi@selectbaseunits{#2}{#3}{#4}}%
160 \cs_set:cpn {#1onlyderivedunits} {\mandi@selectderivedunits{#2}{#3}{#4}}%
161 \cs_set:cpn {#1onlyalternateunits} {\mandi@selectalternateunits{#2}{#3}{#4}}%
162 }%
163 \NewDocumentCommand{\renewscalarquantity}{ m m O{#2} O{#2} }%
164 {%
165 \mandi_renewscalarquantity { #1 }{ #2 }{ #3 }{ #4 }%
166 }%
167 \ExplSyntaxOff

```

Defining a new vector quantity. Note that a corresponding scalar is also defined.

```

168 \ExplSyntaxOn
169 \cs_new:Npn \mandi_newvectorquantity #1#2#3#4
170 {%
171 \mandi_newscalarquantity { #1 }{ #2 }{ #3 }{ #4 }%
172 \cs_new:cpn {vector#1} ##1 {\unit{\mivector{##1}}{\mandi@selectunits{#2}{#3}{#4}}}%
173 \cs_new:cpn {#1vector} ##1 {\unit{\mivector{##1}}{\mandi@selectunits{#2}{#3}{#4}}}%
174 \cs_new:cpn {vector#1value} ##1 {\mivector{##1}}%
175 \cs_new:cpn {#1vectorvalue} ##1 {\mivector{##1}}%
176 \cs_new:cpn {vector#1baseunits} ##1 {\unit{\mivector{##1}}{\mandi@selectbaseunits{#2}{#3}{#4}}}%
177 \cs_new:cpn {#1vectorbaseunits} ##1 {\unit{\mivector{##1}}{\mandi@selectbaseunits{#2}{#3}{#4}}}%
178 \cs_new:cpn {vector#1derivedunits} ##1 {\unit{\mivector{##1}}{\mandi@selectderivedunits{#2}{#3}{#4}}}%
179 \cs_new:cpn {#1vectorderivedunits} ##1 {\unit{\mivector{##1}}{\mandi@selectderivedunits{#2}{#3}{#4}}}%
180 \cs_new:cpn {vector#1alternateunits} ##1 {\unit{\mivector{##1}}{\mandi@selectalternateunits{#2}{#3}{#4}}}%
181 \cs_new:cpn {#1vectoralternateunits} ##1 {\unit{\mivector{##1}}{\mandi@selectalternateunits{#2}{#3}{#4}}}%
182 \cs_new:cpn {vector#1onlybaseunits} {\mandi@selectbaseunits{#2}{#3}{#4}}%
183 \cs_new:cpn {#1vectoronlybaseunits} {\mandi@selectbaseunits{#2}{#3}{#4}}%
184 \cs_new:cpn {vector#1onlyderivedunits} {\mandi@selectderivedunits{#2}{#3}{#4}}%
185 \cs_new:cpn {#1vectoronlyderivedunits} {\mandi@selectderivedunits{#2}{#3}{#4}}%
186 \cs_new:cpn {vector#1onlyalternateunits} {\mandi@selectalternateunits{#2}{#3}{#4}}%
187 \cs_new:cpn {#1vectoronlyalternateunits} {\mandi@selectalternateunits{#2}{#3}{#4}}%
188 }%
189 \NewDocumentCommand{\newvectorquantity}{ m m O{#2} O{#2} }%
190 {%

```

```

191 \mandi_newvectorquantity { #1 }{ #2 }{ #3 }{ #4 }%
192 }%
193 \ExplSyntaxOff

```

Redefining an existing vector quantity. Note that a corresponding scalar is also redefined.

```

194 \ExplSyntaxOn
195 \cs_new:Npn \mandi_renewvectorquantity #1#2#3#4
196 {%
197   \mandi_renewscalarquantity { #1 }{ #2 }{ #3 }{ #4 }%
198   \cs_set:cpn {vector#1} ##1 {\unit{\mivector{##1}}{\mandi@selectunits{#2}{#3}{#4}}}%
199   \cs_set:cpn {#1vector} ##1 {\unit{\mivector{##1}}{\mandi@selectunits{#2}{#3}{#4}}}%
200   \cs_set:cpn {vector#1value} ##1 {\mivector{##1}}%
201   \cs_set:cpn {#1vectorvalue} ##1 {\mivector{##1}}%
202   \cs_set:cpn {vector#1baseunits} ##1 {\unit{\mivector{##1}}{\mandi@selectbaseunits{#2}{#3}{#4}}}%
203   \cs_set:cpn {#1vectorbaseunits} ##1 {\unit{\mivector{##1}}{\mandi@selectbaseunits{#2}{#3}{#4}}}%
204   \cs_set:cpn {vector#1derivedunits} ##1 {\unit{\mivector{##1}}{\mandi@selectderivedunits{#2}{#3}{#4}}}%
205   \cs_set:cpn {#1vectorderivedunits} ##1 {\unit{\mivector{##1}}{\mandi@selectderivedunits{#2}{#3}{#4}}}%
206   \cs_set:cpn {vector#1alternateunits} ##1 {\unit{\mivector{##1}}{\mandi@selectalternateunits{#2}{#3}{#4}}}%
207   \cs_set:cpn {#1vectoralternateunits} ##1 {\unit{\mivector{##1}}{\mandi@selectalternateunits{#2}{#3}{#4}}}%
208   \cs_set:cpn {vector#1onlybaseunits} {\mandi@selectbaseunits{#2}{#3}{#4}}%
209   \cs_set:cpn {#1vectoronlybaseunits} {\mandi@selectbaseunits{#2}{#3}{#4}}%
210   \cs_set:cpn {vector#1onlyderivedunits} {\mandi@selectderivedunits{#2}{#3}{#4}}%
211   \cs_set:cpn {#1vectoronlyderivedunits} {\mandi@selectderivedunits{#2}{#3}{#4}}%
212   \cs_set:cpn {vector#1onlyalternateunits} {\mandi@selectalternateunits{#2}{#3}{#4}}%
213   \cs_set:cpn {#1vectoronlyalternateunits} {\mandi@selectalternateunits{#2}{#3}{#4}}%
214 }%
215 \NewDocumentCommand{\renewvectorquantity}{ m m O{#2} O{#2} }%
216 {%
217   \mandi_renewvectorquantity { #1 }{ #2 }{ #3 }{ #4 }%
218 }%
219 \ExplSyntaxOff

```

Defining a new physical constant.

```

220 \ExplSyntaxOn
221 \cs_new:Npn \mandi_newphysicalconstant #1#2#3#4#5#6#7
222 {%
223   \cs_new:cpn {#1} {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectunits{#5}{#6}{#7}}}%
224   \cs_new:cpn {#1mathsymbol} {#2}%
225   \cs_new:cpn {#1approximatevalue} {#3}%
226   \cs_new:cpn {#1precisevalue} {#4}%
227   \cs_new:cpn {#1baseunits}
228     {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectbaseunits{#5}{#6}{#7}}}%
229   \cs_new:cpn {#1derivedunits}
230     {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectderivedunits{#5}{#6}{#7}}}%
231   \cs_new:cpn {#1alternateunits}
232     {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectalternateunits{#5}{#6}{#7}}}%
233   \cs_new:cpn {#1onlybaseunits} {\mandi@selectbaseunits{#5}{#6}{#7}}%
234   \cs_new:cpn {#1onlyderivedunits} {\mandi@selectderivedunits{#5}{#6}{#7}}%
235   \cs_new:cpn {#1onlyalternateunits} {\mandi@selectalternateunits{#5}{#6}{#7}}%
236 }%
237 \NewDocumentCommand{\newphysicalconstant}{ m m m m m O{#5} O{#5} }%
238 {%
239   \mandi_newphysicalconstant { #1 }{ #2 }{ #3 }{ #4 }{ #5 }{ #6 }{ #7 }%
240 }%
241 \ExplSyntaxOff

```

Redefining an existing physical constant.

```

242 \ExplSyntaxOn
243 \cs_new:Npn \mandi_renewphysicalconstant #1#2#3#4#5#6#7

```

```

244 {%
245 \cs_set:cpn {#1} {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectunits{#5}{#6}{#7}}}%
246 \cs_set:cpn {#1mathsymbol} {#2}%
247 \cs_set:cpn {#1approximatevalue} {#3}%
248 \cs_set:cpn {#1precisevalue} {#4}%
249 \cs_set:cpn {#1baseunits}
250 {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectbaseunits{#5}{#6}{#7}}}%
251 \cs_set:cpn {#1derivedunits}
252 {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectderivedunits{#5}{#6}{#7}}}%
253 \cs_set:cpn {#1alternateunits}
254 {\unit{\mandi@selectprecision{#3}{#4}}{\mandi@selectalternateunits{#5}{#6}{#7}}}%
255 \cs_set:cpn {#1onlybaseunits} {\mandi@selectbaseunits{#5}{#6}{#7}}%
256 \cs_set:cpn {#1onlyderivedunits} {\mandi@selectderivedunits{#5}{#6}{#7}}%
257 \cs_set:cpn {#1onlyalternateunits} {\mandi@selectalternateunits{#5}{#6}{#7}}%
258 }%
259 \NewDocumentCommand{\renewphysicalconstant}{ m m m m m 0{#5} 0{#5} }%
260 {%
261 \mandi_renewphysicalconstant { #1 }{ #2 }{ #3 }{ #4 }{ #5 }{ #6 }{ #7 }%
262 }%
263 \ExplSyntaxOff

```

Define every quantity we need in introductory physics, alphabetically for convenience. This is really the core feature of `mandi` that no other package offers. There are commands for quantities that have no dimensions or units, and these quantities are defined for semantic completeness.

```

264 \newvectorquantity{acceleration}%
265 {\meter\usk\second\totheinversetwo}%
266 [\newton\per\kilogram]%
267 [\meter\per\second\tothetwo]%
268 \newscalarquantity{amount}%
269 {\mole}%
270 \newvectorquantity{angularacceleration}%
271 {\radian\usk\second\totheinversetwo}%
272 [\radian\per\second\tothetwo]%
273 [\radian\per\second\tothetwo]%
274 \newscalarquantity{angularfrequency}%
275 {\radian\usk\second\inverse}%
276 [\radian\per\second]%
277 [\radian\per\second]%
278 %\ifmandi@rotradians
279 % \newphysicalquantity{angularimpulse}%
280 % {\meter\tothetwo\usk\kilogram\usk\second\inverse\usk\radian\inverse}%
281 % [\joule\usk\second\per\radian]%
282 % [\newton\usk\meter\usk\second\per\radian]%
283 % \newphysicalquantity{angularmomentum}%
284 % {\meter\tothetwo\usk\kilogram\usk\second\inverse\usk\radian\inverse}%
285 % [\kilogram\usk\meter\tothetwo\per(\second\usk\radian)]%
286 % [\newton\usk\meter\usk\second\per\radian]%
287 %\else
288 \newvectorquantity{angularimpulse}%
289 {\kilogram\usk\meter\tothetwo\usk\second\inverse}%
290 [\kilogram\usk\meter\tothetwo\per\second]% % also \joule\usk\second
291 [\kilogram\usk\meter\tothetwo\per\second]% % also \newton\usk\meter\usk\second
292 \newvectorquantity{angularmomentum}%
293 {\kilogram\usk\meter\tothetwo\usk\second\inverse}%
294 [\kilogram\usk\meter\tothetwo\per\second]% % also \joule\usk\second
295 [\kilogram\usk\meter\tothetwo\per\second]% % also \newton\usk\meter\usk\second
296 %\fi
297 \newvectorquantity{angularvelocity}%
298 {\radian\usk\second\inverse}%

```

```

299 [\radian\per\second]%
300 [\radian\per\second]%
301 \newscalarquantity{area}%
302 {\meter\tothetwo}%
303 \newscalarquantity{areachargedensity}%
304 {\ampere\usk\second\usk\meter\totheinversetwo}%
305 [\coulomb\per\meter\tothetwo]%
306 [\coulomb\per\meter\tothetwo]%
307 \newscalarquantity{areamassdensity}%
308 {\kilogram\usk\meter\totheinversetwo}%
309 [\kilogram\per\meter\tothetwo]%
310 [\kilogram\per\meter\tothetwo]%
311 \newscalarquantity{capacitance}%
312 {\ampere\tothetwo\usk\second\tothefour\usk\kilogram\inverse\usk\meter\totheinversetwo}%
313 [\farad]%
314 [\coulomb\per\volt]% % also \coulomb\tothetwo\per\newton\usk\meter, \second\per\ohm
315 \newscalarquantity{charge}%
316 {\ampere\usk\second}%
317 [\coulomb]%
318 [\coulomb]% % also \farad\usk\volt
319 \newvectorquantity{cmagneticfield}%
320 {\kilogram\usk\meter\usk\ampere\inverse\usk\second\totheinversethree}%
321 [\newton\per\coulomb]% % also \volt\per\meter
322 [\newton\per\coulomb]%
323 \newscalarquantity{conductance}%
324 {\ampere\tothetwo\usk\second\tothethree\usk\kilogram\inverse\usk\meter\totheinversetwo}%
325 [\siemens]%
326 [\ampere\per\volt]%
327 \newscalarquantity{conductivity}%
328 {\ampere\tothetwo\usk\second\tothethree\usk\kilogram\inverse\usk\meter\totheinversethree}%
329 [\siemens\per\meter]%
330 [\ampere\per\volt\usk\meter]%
331 \newscalarquantity{conventionalcurrent}%
332 {\ampere}%
333 [\coulomb\per\second]%
334 [\ampere]%
335 \newscalarquantity{current}%
336 {\ampere}%
337 \newscalarquantity{currentdensity}%
338 {\ampere\usk\meter\totheinversetwo}%
339 [\coulomb\per\second\usk\meter\tothetwo]%
340 [\ampere\per\meter\tothetwo]%
341 \newscalarquantity{dielectricconstant}%
342 {}%
343 \newvectorquantity{direction}%
344 {}%
345 \newvectorquantity{displacement}%
346 {\meter}%
347 \newscalarquantity{duration}%
348 {\second}%
349 \newvectorquantity{electricdipolemoment}%
350 {\ampere\usk\second\usk\meter}%
351 [\coulomb\usk\meter]%
352 [\coulomb\usk\meter]%
353 \newvectorquantity{electricfield}%
354 {\kilogram\usk\meter\usk\ampere\inverse\usk\second\totheinversethree}%
355 [\volt\per\meter]%
356 [\newton\per\coulomb]%
357 \newscalarquantity{electricflux}%

```

```

358 {\kilogram\usk\meter\tothethree\usk\ampere\inverse\usk\second\totheinversethree}%
359 [\volt\usk\meter]%
360 [\newton\usk\meter\tothetwo\per\coulomb]%
361 \newscalarquantity{electricpotential}%
362 {\kilogram\usk\meter\tothetwo\usk\ampere\inverse\usk\second\totheinversethree}%
363 [\volt]% % also \joule\per\coulomb
364 [\volt]%
365 \newscalarquantity{electricpotentialdifference}%
366 {\kilogram\usk\meter\tothetwo\usk\ampere\inverse\usk\second\totheinversethree}%
367 [\volt]% % also \joule\per\coulomb
368 [\volt]%
369 \newscalarquantity{electroncurrent}%
370 {\second\inverse}%
371 [\ensuremath{\mathrm{e}}\per\second]%
372 [\ensuremath{\mathrm{e}}\per\second]%
373 \newscalarquantity{emf}%
374 {\kilogram\usk\meter\tothetwo\usk\ampere\inverse\usk\second\totheinversethree}%
375 [\volt]% % also \joule\per\coulomb
376 [\volt]%
377 \newscalarquantity{energy}%
378 {\kilogram\usk\meter\tothetwo\usk\second\totheinversetwo}%
379 [\joule]% % also \newton\usk\meter
380 [\joule]%
381 \newscalarquantity{energyinev}%
382 {\electronvolt}%
383 \newscalarquantity{energyinkev}%
384 {\kiloelectronvolt}%
385 \newscalarquantity{energyinmev}%
386 {\megaelectronvolt}%
387 \newscalarquantity{energydensity}%
388 {\kilogram\usk\meter\inverse\usk\second\totheinversetwo}%
389 [\joule\per\meter\tothethree]%
390 [\joule\per\meter\tothethree]%
391 \newscalarquantity{energyflux}%
392 {\kilogram\usk\second\totheinversethree}%
393 [\watt\per\meter\tothetwo]%
394 [\watt\per\meter\tothetwo]%
395 \newscalarquantity{entropy}%
396 {\kilogram\usk\meter\tothetwo\usk\second\totheinversetwo\usk\kelvin\inverse}%
397 [\joule\per\kelvin]%
398 [\joule\per\kelvin]%
399 \newvectorquantity{force}%
400 {\kilogram\usk\meter\usk\second\totheinversetwo}%
401 [\newton]%
402 [\newton]% % also \kilogram\usk\meter\per\second\tothetwo
403 \newscalarquantity{frequency}%
404 {\second\inverse}%
405 [\hertz]%
406 [\hertz]%
407 \newvectorquantity{gravitationalfield}%
408 {\meter\usk\second\totheinversetwo}%
409 [\newton\per\kilogram]%
410 [\newton\per\kilogram]%
411 \newscalarquantity{gravitationalpotential}%
412 {\meter\tothetwo\usk\second\totheinversetwo}%
413 [\joule\per\kilogram]%
414 [\joule\per\kilogram]%
415 \newscalarquantity{gravitationalpotentialdifference}%
416 {\meter\tothetwo\usk\second\totheinversetwo}%

```

```

417 [\joule\per\kilogram]%
418 [\joule\per\kilogram]%
419 \newvectorquantity{impulse}%
420 {\kilogram\usk\meter\usk\second\inverse}%
421 [\newton\usk\second]%
422 [\newton\usk\second]%
423 \newscalarquantity{indexofrefraction}%
424 {}%
425 \newscalarquantity{inductance}%
426 {\kilogram\usk\meter\tothetwo\usk\ampere\totheinversetwo\usk\second\totheinversetwo}%
427 [\henry]%
428 [\volt\usk\second\per\ampere]% % also \square\meter\usk\kilogram\per\coulomb\tothetwo, \Wb\per\ampere
429 \newscalarquantity{linearchargedensity}%
430 {\ampere\usk\second\usk\meter\inverse}%
431 [\coulomb\per\meter]%
432 [\coulomb\per\meter]%
433 \newscalarquantity{linearmassdensity}%
434 {\kilogram\usk\meter\inverse}%
435 [\kilogram\per\meter]%
436 [\kilogram\per\meter]%
437 \newscalarquantity{luminousintensity}%
438 {\candela}%
439 \newscalarquantity{magneticcharge}%
440 {\ampere\usk\meter}% % There is another convention. Be careful!
441 \newvectorquantity{magneticdipolemoment}%
442 {\ampere\usk\meter\tothetwo}%
443 [\ampere\usk\meter\tothetwo]%
444 [\joule\per\tesla]%
445 \newvectorquantity{magneticfield}%
446 {\kilogram\usk\ampere\inverse\usk\second\totheinversetwo}%
447 [\newton\per\ampere\usk\meter]% % also \Wb\per\meter\tothetwo
448 [\tesla]%
449 \newscalarquantity{magneticflux}%
450 {\kilogram\usk\meter\tothetwo\usk\ampere\inverse\usk\second\totheinversetwo}%
451 [\tesla\usk\meter\tothetwo]%
452 [\volt\usk\second]% % also \Wb and \joule\per\ampere
453 \newscalarquantity{mass}%
454 {\kilogram}%
455 \newscalarquantity{mobility}%
456 {\kilogram\usk\meter\tothetwo\usk\ampere\inverse\usk\second\totheinversefour}%
457 [\meter\tothetwo\per\volt\usk\second]%
458 [\coulomb\usk\meter\per\newton\usk\second]%
459 \newscalarquantity{momentofinertia}%
460 {\kilogram\usk\meter\tothetwo}%
461 [\joule\usk\second\tothetwo]%
462 [\kilogram\usk\meter\tothetwo]%
463 \newvectorquantity{momentum}%
464 {\kilogram\usk\meter\usk\second\inverse}%
465 [\kilogram\usk\meter\per\second]%
466 [\kilogram\usk\meter\per\second]%
467 \newvectorquantity{momentumflux}%
468 {\kilogram\usk\meter\inverse\usk\second\totheinversetwo}%
469 [\newton\per\meter\tothetwo]%
470 [\newton\per\meter\tothetwo]%
471 \newscalarquantity{numberdensity}%
472 {\meter\totheinversethree}%
473 [\per\meter\tothethree]%
474 [\per\meter\tothethree]%
475 \newscalarquantity{permeability}%

```

```

476 {\kilogram\usk\meter\usk\ampere\totheinversetwo\usk\second\totheinversetwo}%
477 [\henry\per\meter]%
478 [\tesla\usk\meter\per\ampere]%
479 \newscalarquantity{permittivity}%
480 {\ampere\tothetwo\usk\second\tothefour\usk\kilogram\inverse\usk\meter\totheinversethree}%
481 [\farad\per\meter]%
482 [\coulomb\tothetwo\per\newton\usk\meter\tothetwo]%
483 \newscalarquantity{planeangle}%
484 {\meter\usk\meter\inverse}%
485 [\radian]%
486 [\radian]%
487 \newscalarquantity{polarizability}%
488 {\ampere\tothetwo\usk\second\tothefour\usk\kilogram\inverse}%
489 [\coulomb\usk\meter\tothetwo\per\volt]%
490 [\coulomb\tothetwo\usk\meter\per\newton]%
491 \newscalarquantity{power}%
492 {\kilogram\usk\meter\tothetwo\usk\second\totheinversethree}%
493 [\watt]%
494 [\joule\per\second]%
495 \newvectorquantity{poynting}%
496 {\kilogram\usk\second\totheinversethree}%
497 [\watt\per\meter\tothetwo]%
498 [\watt\per\meter\tothetwo]%
499 \newscalarquantity{pressure}%
500 {\kilogram\usk\meter\inverse\usk\second\totheinversetwo}%
501 [\pascal]%
502 [\newton\per\meter\tothetwo]%
503 \newscalarquantity{relativepermeability}
504 {}%
505 \newscalarquantity{relativepermittivity}%
506 {}%
507 \newscalarquantity{resistance}%
508 {\kilogram\usk\meter\tothetwo\usk\ampere\totheinversetwo\usk\second\totheinversethree}%
509 [\ohm]% % also \volt\per\ampere
510 [\ohm]%
511 \newscalarquantity{resistivity}%
512 {\kilogram\usk\meter\tothethree\usk\ampere\totheinversetwo\usk\second\totheinversethree}%
513 [\ohm\usk\meter]%
514 [\volt\usk\meter\per\ampere]%
515 \newscalarquantity{solidangle}%
516 {\meter\tothetwo\usk\meter\totheinversetwo}%
517 [\steradian]%
518 [\steradian]%
519 \newscalarquantity{specificheatcapacity}%
520 {\meter\tothetwo\usk\second\totheinversetwo\usk\kelvin\inverse}%
521 [\joule\per\kelvin\usk\kilogram]%
522 [\joule\per\kelvin\usk\kilogram]
523 \newscalarquantity{springstiffness}%
524 {\kilogram\usk\second\totheinversetwo}%
525 [\newton\per\meter]%
526 [\newton\per\meter]%
527 \newscalarquantity{springstretch}% % This is really just a displacement.
528 {\meter}%
529 \newscalarquantity{stress}%
530 {\kilogram\usk\meter\inverse\usk\second\totheinversetwo}%
531 [\pascal]%
532 [\newton\per\meter\tothetwo]%
533 \newscalarquantity{strain}%
534 {}%

```

```

535 \newscalarquantity{temperature}%
536   {\kelvin}%
537 %\ifmandi@rotradians
538 %   \newphysicalquantity{torque}%
539 %   {\kilogram\usk\meter\tothetwo\usk\second\totheinversetwo\usk\radian\inverse}%
540 %   [\newton\usk\meter\per\radian]%
541 %   [\newton\usk\meter\per\radian]%
542 %\else
543 \newvectorquantity{torque}%
544   {\kilogram\usk\meter\tothetwo\usk\second\totheinversetwo}%
545   [\newton\usk\meter]%
546   [\newton\usk\meter]%
547 %\fi
548 \newvectorquantity{velocity}%
549   {\meter\usk\second\inverse}%
550   [\meter\per\second]%
551   [\meter\per\second]%
552 \newvectorquantity{velocityc}%
553   {\lightspeed}%
554   [\lightspeed]%
555   [\lightspeed]%
556 \newscalarquantity{volume}%
557   {\meter\tothethree}%
558 \newscalarquantity{volumechargeddensity}%
559   {\ampere\usk\second\per\meter\totheinversethree}%
560   [\coulomb\per\meter\tothethree]%
561   [\coulomb\per\meter\tothethree]%
562 \newscalarquantity{volumemassdensity}%
563   {\kilogram\usk\meter\totheinversethree}%
564   [\kilogram\per\meter\tothethree]%
565   [\kilogram\per\meter\tothethree]%
566 \newscalarquantity{wavelength}% % This is really just a displacement.
567   {\meter}%
568 \newvectorquantity{wavenumber}%
569   {\meter\inverse}%
570   [\per\meter]%
571   [\per\meter]%
572 \newscalarquantity{work}%
573   {\kilogram\usk\meter\tothetwo\usk\second\totheinversetwo}%
574   [\joule]% % also \newton\usk\meter but discouraged
575   [\joule]%
576 \newscalarquantity{youngsmodulus}% % This is really just a stress.
577   {\kilogram\usk\meter\inverse\usk\second\totheinversetwo}%
578   [\pascal]%
579   [\newton\per\meter\tothetwo]%

```

Define physical constants for introductory physics, again alphabetically for convenience.

```

580 \newphysicalconstant{avogadro}%
581   {\symup{N_A}}%
582   {6\timestento{23}}{6.02214076\timestento{23}}% % exact 2019 value
583   {\mole\inverse}%
584   [\per\mole]%
585   [\per\mole]%
586 \newphysicalconstant{biotsavartconstant}% % alias for \mzofp
587   {\symup{\frac{\mu_o}{4\pi}}}%
588   {\tento{-7}}{\tento{-7}}%
589   {\kilogram\usk\meter\usk\ampere\totheinversetwo\usk\second\totheinversetwo}%
590   [\henry\per\meter]%
591   [\tesla\usk\meter\per\ampere]%

```



```

592 \newphysicalconstant{bohrradius}%
593   {\symup{a_o}}%
594   {5.3\timestento{-11}}{5.29177210903\timestento{-11}}%
595   {\meter}%
596 \newphysicalconstant{boltzmann}%
597   {\symup{k_B}}%
598   {1.4\timestento{-23}}{1.380649\timestento{-23}}% % exact 2019 value
599   {\kilogram\usk\meter\tothetwo\usk\second\totheinversetwo\usk\kelvin\inverse}%
600   [\joule\per\kelvin]%
601   [\joule\per\kelvin]%
602 \newphysicalconstant{coulombconstant}% % alias for \oofpez
603   {\symup{\frac{1}{4\pi\epsilon_o}}}%
604   {9\timestento{9}}{8.9875517923\timestento{9}}%
605   {\kilogram\usk\meter\tothethree\usk\ampere\totheinversetwo\usk\second\totheinversefour}%
606   [\meter\per\farad]%
607   [\newton\usk\meter\tothetwo\per\coulomb\tothetwo]%
608 \newphysicalconstant{earthmass}%
609   {\symup{M_{Earth}}}%
610   {6.0\timestento{24}}{5.9722\timestento{24}}%
611   {\kilogram}%
612 \newphysicalconstant{earthmoondistance}%
613   {\symup{d_{EM}}}%
614   {3.8\timestento{8}}{3.81550\timestento{8}}%
615   {\meter}%
616 \newphysicalconstant{earthradius}%
617   {\symup{R_{Earth}}}%
618   {6.4\timestento{6}}{6.3781\timestento{6}}%
619   {\meter}%
620 \newphysicalconstant{earthsundistance}%
621   {\symup{d_{ES}}}%
622   {1.5\timestento{11}}{1.496\timestento{11}}%
623   {\meter}%
624 \newphysicalconstant{electroncharge}%
625   {\symup{q_e}}%
626   {-\elementarychargeapproximatevalue}{-\elementarychargeprecisevalue}%
627   {\ampere\usk\second}%
628   [\coulomb]%
629   [\coulomb]%
630 \newphysicalconstant{electronCharge}%
631   {\symup{Q_e}}%
632   {-\elementarychargeapproximatevalue}{-\elementarychargeprecisevalue}%
633   {\ampere\usk\second}%
634   [\coulomb]%
635   [\coulomb]%
636 \newphysicalconstant{electronmass}%
637   {\symup{m_e}}%
638   {9.1\timestento{-31}}{9.1093837015\timestento{-31}}%
639   {\kilogram}%
640 \newphysicalconstant{elementarycharge}%
641   {\symup{e}}%
642   {1.6\timestento{-19}}{1.602176634\timestento{-19}}% % exact 2019 value
643   {\ampere\usk\second}%
644   [\coulomb]%
645   [\coulomb]%
646 \newphysicalconstant{finestructure}%
647   {\symup{\alpha}}%
648   {\frac{1}{137}}{7.2973525693\timestento{-3}}%
649   {}%
650 \newphysicalconstant{hydrogenmass}%

```

```

651 {\symup{m_H}}%
652 {1.7\timestento{-27}}{1.6737236\timestento{-27}}%
653 {\kilogram}%
654 \newphysicalconstant{moonearthdistance}%
655 {\symup{d_{ME}}}%
656 {3.8\timestento{8}}{3.81550\timestento{8}}%
657 {\meter}%
658 \newphysicalconstant{moonmass}%
659 {\symup{M_{Moon}}}%
660 {7.3\timestento{22}}{7.342\timestento{22}}%
661 {\kilogram}%
662 \newphysicalconstant{moonradius}%
663 {\symup{R_{Moon}}}%
664 {1.7\timestento{6}}{1.7371\timestento{6}}%
665 {\meter}%
666 \newphysicalconstant{mzofp}%
667 {\symup{\frac{1}{4\pi\epsilon_0}}}%
668 {\tento{-7}}{\tento{-7}}%
669 {\kilogram\usk\meter\usk\ampere\totheinversetwo\usk\second\totheinversetwo}%
670 [\henry\per\meter]%
671 [\tesla\usk\meter\per\ampere]%
672 \newphysicalconstant{neutronmass}%
673 {\symup{m_n}}%
674 {1.7\timestento{-27}}{1.67492749804\timestento{-27}}%
675 {\kilogram}%
676 \newphysicalconstant{oofpez}%
677 {\symup{\frac{1}{4\pi\epsilon_0}}}%
678 {9\timestento{9}}{8.9875517923\timestento{9}}%
679 {\kilogram\usk\meter\tothethree\usk\ampere\totheinversetwo\usk\second\totheinversefour}%
680 [\meter\per\farad]%
681 [\newton\usk\meter\tothetwo\per\coulomb\tothetwo]%
682 \newphysicalconstant{oofpezcs}%
683 {\symup{\frac{1}{4\pi\epsilon_0 c^2}}}%
684 {\tento{-7}}{\tento{-7}}%
685 {\kilogram\usk\meter\usk\ampere\totheinversetwo\usk\second\totheinversetwo}%
686 [\tesla\usk\meter\tothetwo]%
687 [\newton\usk\second\tothetwo\per\coulomb\tothetwo]%
688 \newphysicalconstant{planck}%
689 {\symup{h}}%
690 {6.6\timestento{-34}}{6.62607015\timestento{-34}}% % exact 2019 value
691 {\kilogram\usk\meter\tothetwo\usk\second\inverse}%
692 [\joule\usk\second]%
693 [\joule\usk\second]%

```

See <https://tex.stackexchange.com/a/448565/218142>.

```

694 \newphysicalconstant{planckbar}%
695 {\symup{\lower0.18ex\hbox{\mathchar"AF}\mkern-7mu h}}%
696 {1.1\timestento{-34}}{1.054571817\timestento{-34}}%
697 {\kilogram\usk\meter\tothetwo\usk\second\inverse}%
698 [\joule\usk\second]%
699 [\joule\usk\second]
700 \newphysicalconstant{planckc}%
701 {\symup{hc}}%
702 {2.0\timestento{-25}}{1.98644586\timestento{-25}}%
703 {\kilogram\usk\meter\tothethree\usk\second\totheinversetwo}%
704 [\joule\usk\meter]%
705 [\joule\usk\meter]%
706 \newphysicalconstant{protoncharge}%
707 {\symup{q_p}}%

```

```

708 {+\elementarychargeapproximatevalue}{+\elementarychargeprecisevalue}%
709 {\ampere\usk\second}%
710 [\coulomb]%
711 [\coulomb]%
712 \newphysicalconstant{protonCharge}%
713 {\symup{Q_p}}%
714 {+\elementarychargeapproximatevalue}{+\elementarychargeprecisevalue}%
715 {\ampere\usk\second}%
716 [\coulomb]%
717 [\coulomb]%
718 \newphysicalconstant{protonmass}%
719 {\symup{m_p}}%
720 {1.7\timestento{-27}}{1.672621898\timestento{-27}}%
721 {\kilogram}%
722 \newphysicalconstant{rydberg}%
723 {\symup{R_{\infty}}}%
724 {1.1\timestento{7}}{1.0973731568160\timestento{7}}%
725 {\meter\inverse}%
726 \newphysicalconstant{speedoflight}%
727 {\symup{c}}%
728 {3\timestento{8}}{2.99792458\timestento{8}}% % exact value
729 {\meter\usk\second\inverse}%
730 [\meter\per\second]%
731 [\meter\per\second]
732 \newphysicalconstant{stefanboltzmann}%
733 {\symup{\sigma}}%
734 {5.7\timestento{-8}}{5.670374\timestento{-8}}%
735 {\kilogram\usk\second\totheinversethree\usk\kelvin\totheinversefour}%
736 [\watt\per\meter\tothetwo\usk\kelvin\tothefour]%
737 [\watt\per\meter\tothetwo\usk\kelvin\tothefour]
738 \newphysicalconstant{sunearthdistance}%
739 {\symup{d_{SE}}}%
740 {1.5\timestento{11}}{1.496\timestento{11}}%
741 {\meter}%
742 \newphysicalconstant{sunmass}%
743 {\symup{M_{Sun}}}%
744 {2.0\timestento{30}}{1.98855\timestento{30}}%
745 {\kilogram}%
746 \newphysicalconstant{sunradius}%
747 {\symup{R_{Sun}}}%
748 {7.0\timestento{8}}{6.957\timestento{8}}%
749 {\meter}%
750 \newphysicalconstant{surfacegravfield}%
751 {\symup{g}}%
752 {9.8}{9.807}%
753 {\meter\usk\second\totheinversetwo}%
754 [\newton\per\kilogram]%
755 [\newton\per\kilogram]%
756 \newphysicalconstant{universalgrav}%
757 {\symup{G}}%
758 {6.7\timestento{-11}}{6.67430\timestento{-11}}%
759 {\meter\tothethree\usk\kilogram\inverse\usk\second\totheinversetwo}%
760 [\newton\usk\meter\tothetwo\per\kilogram\tothetwo]% % also \joule\usk\meter\per\kilogram\tothetwo
761 [\newton\usk\meter\tothetwo\per\kilogram\tothetwo]%
762 \newphysicalconstant{vacuumpermeability}%
763 {\symup{\mu_o}}%
764 {4\pi\timestento{-7}}{4\pi\timestento{-7}}% % as of 2018 no longer 4\pi\timestento{-7}
765 {\kilogram\usk\meter\usk\ampere\totheinversetwo\usk\second\totheinversetwo}%
766 [\henry\per\meter]%

```

```

767 [\tesla\usk\meter\per\ampere]%
768 \newphysicalconstant{vacuumpermittivity}%
769 {\symup{\epsilon_o}}%
770 {9\timestento{-12}}{8.854187817\timestento{-12}}%
771 {\ampere\tothetwo\usk\second\tothefour\usk\kilogram\inverse\usk\meter\totheinversethree}%
772 [\farad\per\meter]%
773 [\coulomb\tothetwo\per\newton\usk\meter\tothetwo]%

```

Diagnostic commands to provide sanity checks on commands that represent physical quantities and constants.

```

774 \ExplSyntaxOn
775 \NewDocumentCommand{\checkquantity}{ m }%
776 {%
777 % Works for both scalar and vector quantities (without vector in the name!).
778 \begin{center}
779 \begin{tabular}{%
780 >\bfseries\small}
781 p{0.5\linewidth}
782 p{0.1\linewidth}
783 p{0.1\linewidth}
784 p{0.1\linewidth}
785 }%
786 name & & \tabularnewline
787 \ttfamily\footnotesize{\token_to_str:c {#1}} & & \tabularnewline
788 \end{tabular}~ % This nonbreaking space is important!
789 \begin{tabular}{%
790 >\bfseries\smallp{0.25\linewidth}
791 >\bfseries\smallp{0.25\linewidth}
792 >\bfseries\smallp{0.25\linewidth}
793 }%
794 base & derived & alternate \tabularnewline
795 \footnotesize{\( \use:c {#1onlybaseunits} \)} & &
796 \footnotesize{\( \use:c {#1onlyderivedunits} \)} & &
797 \footnotesize{\( \use:c {#1onlyalternateunits} \)} & &
798 \end{tabular}
799 \end{center}
800 }%
801 \NewDocumentCommand{\checkconstant}{ m }%
802 {%
803 \begin{center}
804 \begin{tabular}{%
805 >\bfseries\small}
806 p{0.5\linewidth}
807 p{0.1\linewidth}
808 p{0.1\linewidth}
809 p{0.1\linewidth}
810 }%
811 name & & \tabularnewline
812 \ttfamily\footnotesize{\token_to_str:c {#1}} & & \tabularnewline
813 \end{tabular}~ % This nonbreaking space is important!
814 \begin{tabular}{%
815 >\bfseries\smallp{0.25\linewidth}
816 >\bfseries\smallp{0.25\linewidth}
817 >\bfseries\smallp{0.25\linewidth}
818 }%
819 symbol & approximate & precise \tabularnewline
820 \footnotesize{\( \use:c {#1mathsymbol} \)} & &
821 \footnotesize{\( \use:c {#1approximatevalue} \)} & &
822 \footnotesize{\( \use:c {#1precisevalue} \)} & &
823 \end{tabular}~ % This nonbreaking space is important!

```

```

824 \begin{tabular}{%
825 >{\bfseries\small}p{0.25\linewidth}
826 >{\bfseries\small}p{0.25\linewidth}
827 >{\bfseries\small}p{0.25\linewidth}
828 }%
829 base & derived & alternate \tabularnewline
830 \footnotesize{(\ \use:c {#1onlybaseunits} \)} &
831 \footnotesize{(\ \use:c {#1onlyderivedunits} \)} &
832 \footnotesize{(\ \use:c {#1onlyalternateunits} \)}
833 \end{tabular}
834 \end{center}
835 }%
836 \ExplSyntaxOff

\mivector→P.37 is a workhorse command. Original code provided by @egreg.
See https://tex.stackexchange.com/a/39054/218142.

837 \ExplSyntaxOn
838 \NewDocumentCommand{\mivector}{ O{,} m o }%
839 {%
840 \mi_vector:nn { #1 } { #2 }%
841 \IfValueT{#3}{\,{#3}}%
842 }%
843 \seq_new:N \l__mi_list_seq
844 \cs_new_protected:Npn \mi_vector:nn #1 #2
845 {%
846 \ensuremath{%
847 \seq_set_split:Nnn \l__mi_list_seq { , } { #2 }
848 \int_compare:nF { \seq_count:N \l__mi_list_seq = 1 } { \left\langle }
849 \seq_use:Nnnn \l__mi_list_seq { #1 } { #1 } { #1 }
850 \int_compare:nF { \seq_count:N \l__mi_list_seq = 1 } { \right\rangle }
851 }%
852 }%
853 \ExplSyntaxOff

```

## 4 The mandistudent Package

mandi comes with an accessory package `mandistudent`, which provides a collection of commands physics students can use for writing problem solutions. This package focuses on the most frequently needed tools. These commands should always be used in math mode. Note that `mandistudent` requires, and loads, `mandi` but `mandi` doesn't require, and doesn't load, `mandistudent`.

Load `mandistudent` as you would any package in your preamble. There are no package options.

```
\usepackage{mandistudent}
```

```
\mandistudentversion
```

Typesets the current version and build date.

```
The version is \mandistudentversion\ and is a stable build.
```

```
The version is v3.0.2 dated 2021-09-20 and is a stable build.
```

### 4.1 Traditional Vector Notation

U 2021-09-18

U 2021-09-18

```
\vec{\langle symbol \rangle} [\langle labels \rangle]
```

(use this variant for boldface notation)

```
\vec*{\langle symbol \rangle} [\langle labels \rangle]
```

(use this variant for arrow notation)

Powerful and intelligent command for symbolic vector notation. The mandatory argument is the symbol for the vector quantity. The optional label(s) consists of superscripts and/or subscripts and can be mathematical or textual in nature. If textual, be sure to wrap them in `\symup{...}` for proper typesetting. The starred variant gives arrow notation whereas without the star you get boldface notation. Subscript and superscript labels can be arbitrarily mixed, and order doesn't matter. This command redefines the default L<sup>A</sup>T<sub>E</sub>X `\vec` command.

```
\( \vec{p} \)          \\\
\(\ \vec{p}_{2} \)      \\\
\(\ \vec{p}^{\symup{ball}} \) \\\
\(\ \vec{p}_{\symup{final}} \) \\\
\(\ \vec{p}^{\symup{ball}}_{\symup{final}} \) \\\
\(\ \vec{p}^{\symup{final}}_{\symup{ball}} \) \\\
\(\ \vec*{p} \)         \\\
```

$p$   
 $p_2$   
 $p_{\text{ball}}$   
 $p_{\text{final}}$   
 $p_{\text{ball}}^{\text{final}}$   
 $p_{\text{final}}^{\text{ball}}$   
 $\vec{p}_{\text{ball}}$

U 2021-09-18

U 2021-09-18

```
\dirvec{\langle symbol \rangle} [\langle labels \rangle]
```

(use this variant for boldface notation)

```
\dirvec*{\langle symbol \rangle} [\langle labels \rangle]
```

(use this variant for arrow notation)

Powerful and intelligent command for typesetting the direction of a vector. The options are the same as those for `\vec`.

```

\(\ \dirvec{p} \)          \\\
\(\ \dirvec{p}_{2} \)      \\\
\(\ \dirvec{p}^{\mathrm{ball}} \) \\\
\(\ \dirvec{p}_{\mathrm{final}} \) \\\
\(\ \dirvec{p}^{\mathrm{ball}}_{\mathrm{final}} \) \\\
\(\ \dirvec{p}^{\mathrm{ball}}_{\mathrm{final}} \) \\\
\(\ \dirvec*{p} \)

```

$$\begin{array}{c} \widehat{p} \\ \widehat{p}_2 \\ \widehat{p}_{\mathrm{ball}} \\ \widehat{p}_{\mathrm{final}} \\ \widehat{p}_{\mathrm{ball}}^{\mathrm{final}} \\ \widehat{p}_{\mathrm{final}}^{\mathrm{ball}} \\ \widehat{p} \end{array}$$

**\zerovec**

(use this variant for boldface notation)

**\zerovec\***

(use this variant for arrow notation)

Command for typesetting the zero vector. The starred variant gives arrow notation. Without the star you get boldface notation.

```

\(\ \zerovec \) \\\
\(\ \zerovec* \)

```

$$\begin{array}{c} \mathbf{0} \\ \vec{0} \end{array}$$

**\changein**

Semantic alias for `\Delta`.

```

\(\ \changein t \) \\\
\(\ \changein \vec{p} \)

```

$$\begin{array}{c} \Delta t \\ \Delta p \end{array}$$

**\doublebars** [*size*] {*quantity*}

(double bars)

**\doublebars\*** [*size*] {*quantity*}

(double bars for fractions)

**\singlebars** [*size*] {*quantity*}

(single bars)

**\singlebars\*** [*size*] {*quantity*}

(single bars for fractions)

**\anglebrackets** [*size*] {*quantity*}

(angle brackets)

**\anglebrackets\*** [*size*] {*quantity*}

(angle brackets for fractions)

**\parentheses** [*size*] {*quantity*}

(parentheses)

**\parentheses\*** [*size*] {*quantity*}

(parentheses for fractions)

**\squarebrackets** [*size*] {*quantity*}

(square brackets)

**\squarebrackets\*** [*size*] {*quantity*}

(square brackets for fractions)

**\curlybraces** [*size*] {*quantity*}

(curly braces)

**\curlybraces\*** [*size*] {*quantity*}

(curly braces for fractions)

If no argument is given, a placeholder is provided. Sizers like `\big`, `\Big`, `\bigg`, and `\Bigg` can be optionally specified. Beginners are encouraged not to use them. See the [mathtools](#) package documentation for details.

$\backslash[ \ \doublebars{} \ \backslash]$ $\backslash[ \ \doublebars{\vec{a}} \ \backslash]$ $\backslash[ \ \doublebars*{\frac{\vec{a}}{3}} \ \backslash]$ $\backslash[ \ \doublebars[\Bigg]{\frac{\vec{a}}{3}} \ \backslash]$	$\ \cdot\ $ $\ \boldsymbol{a}\ $ $\ \frac{\boldsymbol{a}}{3}\ $ $\left\ \frac{\boldsymbol{a}}{3}\right\ $
$\backslash[ \ \singlebars{} \ \backslash]$ $\backslash[ \ \singlebars{x} \ \backslash]$ $\backslash[ \ \singlebars*{\frac{x}{3}} \ \backslash]$ $\backslash[ \ \singlebars[\Bigg]{\frac{x}{3}} \ \backslash]$	$ \cdot $ $ x $ $ \frac{x}{3} $ $\left \frac{x}{3}\right $
$\backslash[ \ \anglebrackets{} \ \backslash]$ $\backslash[ \ \anglebrackets{\vec{a}} \ \backslash]$ $\backslash[ \ \anglebrackets*{\frac{\vec{a}}{3}} \ \backslash]$ $\backslash[ \ \anglebrackets[\Bigg]{\frac{\vec{a}}{3}} \ \backslash]$	$\langle\cdot\rangle$ $\langle\boldsymbol{a}\rangle$ $\langle\frac{\boldsymbol{a}}{3}\rangle$ $\left\langle\frac{\boldsymbol{a}}{3}\right\rangle$
$\backslash[ \ \parentheses{} \ \backslash]$ $\backslash[ \ \parentheses{x} \ \backslash]$ $\backslash[ \ \parentheses*{\frac{x}{3}} \ \backslash]$ $\backslash[ \ \parentheses[\Bigg]{\frac{x}{3}} \ \backslash]$	$(\cdot)$ $(x)$ $\left(\frac{x}{3}\right)$ $\left(\frac{x}{3}\right)$



<code>\[ \squarebrackets{} \]</code>	$[\cdot]$
<code>\[ \squarebrackets{x} \]</code>	$[x]$
<code>\[ \squarebrackets*{\frac{x}{3}} \]</code>	$\left[\frac{x}{3}\right]$
<code>\[ \squarebrackets[\Big]{\frac{x}{3}} \]</code>	$\left[\frac{x}{3}\right]$

<code>\[ \curlybraces{} \]</code>	$\{\cdot\}$
<code>\[ \curlybraces{x} \]</code>	$\{x\}$
<code>\[ \curlybraces*{\frac{x}{3}} \]</code>	$\left\{\frac{x}{3}\right\}$
<code>\[ \curlybraces[\Big]{\frac{x}{3}} \]</code>	$\left\{\frac{x}{3}\right\}$

<code>\magnititude[⟨size⟩]{⟨quantity⟩}</code>	(alias for double bars)
<code>\magnititude*[⟨size⟩]{⟨quantity⟩}</code>	(alias for double bars for fractions)
<code>\norm[⟨size⟩]{⟨quantity⟩}</code>	(alias for double bars)
<code>\norm*[⟨size⟩]{⟨quantity⟩}</code>	(alias for double bars for fractions)
<code>\absolutevalue[⟨size⟩]{⟨quantity⟩}</code>	(alias for single bars)
<code>\absolutevalue*[⟨size⟩]{⟨quantity⟩}</code>	(alias for single bars for fractions)

Semantic aliases. Use `\magnititude` or `\magnititude*` to typeset the magnitude of a vector.

<code>\[ \magnititude{\vec{p}} \]</code>	$\ \boldsymbol{p}\ $
<code>\[ \magnititude{\vec{*p}} \]</code>	$\ \vec{p}\ $
<code>\[ \magnititude*{\vec{p}_{\symup{final}}} \]</code>	$\ \boldsymbol{p}_{\text{final}}\ $
<code>\[ \magnititude*{\vec{*p}_{\symup{final}}} \]</code>	$\ \vec{p}_{\text{final}}\ $

<code>\parallelto</code>
<code>\perpendicularto</code>

Commands for geometric relationships, mainly intended for subscripts.

<code>\( \vec{F}_{\parallelto} + \vec{F}_{\perpendicularto} \)</code>	$\boldsymbol{F}_{\parallel} + \boldsymbol{F}_{\perp}$
---	---

## 4.2 Problems and Annotated Problem Solutions

N 2021-02-03

```
\begin{physicsproblem}{\langle title \rangle}
```

 (use this variant for vertical lists)  

```
\end{physicsproblem}
```

N 2021-02-03

```
\begin{physicsproblem*}{\langle title \rangle}
```

 (use this variant for in-line lists)  

```
\end{physicsproblem*}
```

N 2021-02-03

```
\begin{parts}{\langle title \rangle}
```

 (provides problem parts)  

```
\end{parts}
```

Provides an environment for stating physics problems. Each problem will begin on a new page. See the examples for how to handle single and multiple part problems.

N 2012-02-03

```
\problem part
```

Denotes a part of a problem within a `parts` environment.

```
\begin{physicsproblem}{Problem 1}
  This is a physics problem with no parts.
\end{physicsproblem}
```

### Problem 1

This is a physics problem with no parts.

```
\begin{physicsproblem}{Problem 2}
  This is a physics problem with multiple parts.
  The list is vertical.
  \begin{parts}
    \problem part This is the first part.
    \problem part This is the second part.
    \problem part This is the third part.
  \end{parts}
\end{physicsproblem}
```

### Problem 2

This is a physics problem with multiple parts. The list is vertical.

- (a) This is the first part.
- (b) This is the second part.
- (c) This is the third part.

```

\begin{physicsproblem*}{Problem 3}
  This is a physics problem with multiple parts.
  The list is in-line.
  \begin{parts}
    \problempart This is the first part.
    \problempart This is the second part.
    \problempart This is the third part.
  \end{parts}
\end{physicsproblem*}

```

## Problem 3

This is a physics problem with multiple parts. The list is in-line. **(a)** This is the first part. **(b)** This is the second part. **(c)** This is the third part.

U 2021-02-26

```

\begin{physicssolution}
  \langle solution steps \rangle

```

(use this variant for numbered steps)

U 2021-02-26

```

\end{physicssolution}
\begin{physicssolution*}
  \langle solution steps \rangle
\end{physicssolution*}

```

(use this variant for unnumbered steps)

This environment is only for mathematical solutions. The starred variant omits numbering of steps. See the examples.

```

\begin{physicssolution}
  x &= y + z \\
  z &= x - y \\
  y &= x - z
\end{physicssolution}
\begin{physicssolution*}
  x &= y + z \\
  z &= x - y \\
  y &= x - z
\end{physicssolution*}

```

$$x = y + z \quad (1)$$

$$z = x - y \quad (2)$$

$$y = x - z \quad (3)$$

$$x = y + z$$

$$z = x - y$$

$$y = x - z$$

U 2012-02-26

```

\reason{\langle reason \rangle}

```

Provides an annotation in a step-by-step solution. Keep reasons short and to the point. Wrap mathematical content in math mode.

```

\begin{physicssolution}
  x &= y + z \reason{This is a reason.} \\
  z &= x - y \reason{This is a reason too.} \\
  y &= x - z \reason{final answer}
\end{physicssolution}
\begin{physicssolution*}
  x &= y + z \reason{This is a reason.} \\
  z &= x - y \reason{This is a reason too.} \\
  y &= x - z \reason{final answer}
\end{physicssolution*}

```

$$x = y + z \quad \text{This is a reason.} \quad (4)$$

$$z = x - y \quad \text{This is a reason too.} \quad (5)$$

$$y = x - z \quad \text{final answer} \quad (6)$$

$$x = y + z \quad \text{This is a reason.}$$

$$z = x - y \quad \text{This is a reason too.}$$

$$y = x - z \quad \text{final answer}$$

When writing solutions, remember that the `physicssolution`<sup>P. 59</sup> environment is *only* for mathematical content, not textual content or explanations.

```

\begin{physicsproblem}{Combined Problem and Solution}
  This is an interesting physics problem.
  \begin{physicssolution}
    The solution goes here.
  \end{physicssolution}
\end{physicsproblem}

```

```

\begin{physicsproblem}{Combined Multipart Problem with Solutions}
  This is a physics problem with multiple parts.
  \begin{parts}
    \problempart This is the first part.
    \begin{physicssolution}
      The solution goes here.
    \end{physicssolution}
    \problempart This is the second part.
    \begin{physicssolution}
      The solution goes here.
    \end{physicssolution}
    \problempart This is the third part.
    \begin{physicssolution}
      The solution goes here.
    \end{physicssolution}
  \end{parts}
\end{physicsproblem}

```

`\hilite[color]{target}[shape]`

Hilites the desired target, which can be an entire mathematical expression or a part thereof. The default color is magenta and the default shape is a rectangle.

```
\begin{align*}
(\Delta s)^2 &= -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 + \\
&\quad (\Delta z)^2 \\
(\Delta s)^2 &= \text{\hlite{-(\Delta t)^2 + (\Delta x)^2}[rounded rectangle]} + \\
&\quad (\Delta y)^2 + (\Delta z)^2 \\
(\Delta s)^2 &= \text{\hlite{-(\Delta t)^2 + (\Delta x)^2}[rectangle]} + \\
&\quad (\Delta y)^2 + (\Delta z)^2 \\
(\Delta s)^2 &= \text{\hlite{-(\Delta t)^2 + (\Delta x)^2}[ellipse]} + \\
&\quad (\Delta y)^2 + (\Delta z)^2 \\
(\Delta s)^{\text{\hlite{2}[circle]}} &= \text{\hlite[green]{-}[circle]} \\
&\quad (\Delta t)^{\text{\hlite[cyan]{2}[circle]}} + \\
&\quad (\Delta x)^{\text{\hlite[orange]{2}[circle]}} + \\
&\quad (\Delta y)^{\text{\hlite[blue!50]{2}[circle]}} + \\
&\quad (\Delta z)^{\text{\hlite[violet!45]{2}[circle]}}
\end{align*}
```

$$\begin{aligned}(\Delta s)^2 &= -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 \\(\Delta s)^2 &= -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 \\(\Delta s)^2 &= -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 \\(\Delta s)^2 &= -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 \\(\Delta s)^2 &= -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2\end{aligned}$$

```
\begin{align*}
\Delta\vec{p} &= \vec{F}_{\{\sumup{net}\}}\Delta t \\\
\hिलite[orange]{\Delta\vec{p}}[circle] &= \vec{F}_{\{\symup{net}\}}\Delta t \\\
\Delta\vec{p} &= \hिलite[yellow!50]{\vec{F}_{\{\symup{net}\}}} \\
&\quad [rounded rectangle]\Delta t \\\
\Delta\vec{p} &= \vec{F}_{\{\symup{net}\}}\hिलite[olive!50] \\
&\quad \{\Delta t\}[rectangle] \\\
\Delta\vec{p} &= \hिलite[cyan!50]{\vec{F}_{\{\symup{net}\}}\Delta t} \\
&\quad [ellipse] \\\
&\hिलite{\Delta\vec{p}}[rectangle] &= \vec{F}_{\{\symup{net}\}}\Delta t
\end{align*}
```

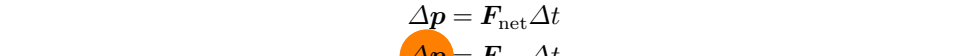


Diagram illustrating the impulse-momentum theorem, showing the relationship between change in momentum ( $\Delta p$ ), net force ( $F_{\text{net}}$ ), and time interval ( $\Delta t$ ).

The equation is shown in six rows, with different parts highlighted in color to indicate which variable is being solved for:

- Row 1:  $\Delta p = F_{\text{net}} \Delta t$  (All terms are black)
- Row 2:  $\Delta p = F_{\text{net}} \Delta t$  (The  $\Delta p$  term is highlighted in orange)
- Row 3:  $\Delta p = F_{\text{net}} \Delta t$  (The  $F_{\text{net}}$  term is highlighted in yellow)
- Row 4:  $\Delta p = F_{\text{net}} \Delta t$  (The  $\Delta t$  term is highlighted in tan)
- Row 5:  $\Delta p = F_{\text{net}} \Delta t$  (The  $F_{\text{net}}$  term is highlighted in light blue)
- Row 6:  $\Delta p = F_{\text{net}} \Delta t$  (The  $\Delta p$  term is highlighted in pink)

Simplified interface for importing an image. The images are treated as floats, so they may not appear at the most logically intuitive place.

```
\image[scale=0.20]{example-image-1x1}
{Image shown 20 percent actual size.}{reffig1}
```



Figure 1: Image shown 20 percent actual size.

Figure \ref{reffig1} is nice.  
It's captioned \nameref{reffig1} and is on page \pageref{reffig1}.

Figure 1 is nice. It's captioned [Image shown 20 percent actual size](#) and is on page [62](#).

```
\image[scale=0.20,angle=45]{example-image-1x1}
{Image shown 20 percent actual size and rotated.}{reffig1}
```

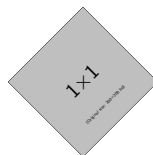


Figure 2: Image shown 20 percent actual size and rotated.

Figure \ref{reffig2} is nice.  
It's captioned \nameref{reffig2} and is on page \pageref{reffig2}.

Figure 2 is nice. It's captioned [Image shown 20 percent actual size and rotated](#) and is on page [62](#).

### 4.3 Coordinate-Free and Index Notation

Beyond the current level of introductory physics, we need intelligent commands for typesetting vector and tensor symbols and components suitable for both coordinate-free and index notations.

```
\colvec[⟨delimiter⟩]{⟨c1, ..., cn⟩}
\rowvec[⟨delimiter⟩]{⟨c1, ..., cn⟩}
```

Typesets column vectors and row vectors as numeric or symbolic components. There can be more than three components. The delimiter used in the list of components can be specified; the default is a comma. Units are not supported, so these are mainly for symbolic work.

```
\[ \colvec{1,2,3} \]
\[ \rowvec{1,2,3} \]
\[ \colvec{x^0,x^1,x^2,x^3} \]
\[ \rowvec{x_0,x_1,x_2,x_3} \]
```

$$\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$$

$$(1 \ 2 \ 3)$$

$$\begin{pmatrix} x^0 \\ x^1 \\ x^2 \\ x^3 \end{pmatrix}$$

$$(x_0 \ x_1 \ x_2 \ x_3)$$

`\veccomp{symbol}`

(use this variant for coordinate-free vector notation)

`\veccomp*{symbol}`

(use this variant for index vector notation)

`\tencomp{symbol}`

(use this variant for coordinate-free tensor notation)

`\tencomp*{symbol}`

(use this variant for index tensor notation)

Conforms to ISO 80000-2 notation.

```
\( \veccomp{r} \) \\\
\(\ \veccomp*{r} \) \\\
\(\ \tencomp{r} \) \\\
\(\ \tencomp*{r} \) \\\
```

$\boldsymbol{r}$

$r$

$\boldsymbol{r}$

$r$

`\valence{index}{index}`

`\valence*{index}{index}`

Typesets tensor valence. The starred variant typesets it horizontally.

```
A vector is a \( \valence{1}{0} \) tensor. \\\
A vector is a \( \valence*{1}{0} \) tensor.
```

A vector is a  $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$  tensor.

A vector is a  $(1,0)$  tensor.

`\contraction{slot,slot}`

`\contraction*{slot,slot}`

Typesets tensor contraction in coordinate-free notation. There is no standard on this so we assert one here.

```
\( \contraction{1,2} \) \\\
\(\ \contraction*{1,2} \)
```

$\mathbb{C}_{1,2}$

$C_{1,2}$

`\slot[vector]`

`\slot*[vector]`

An intelligent slot command for coordinate-free vector and tensor notation. The starred variants suppress the underscore.

```

\(< \slot \) \
\(< \slot[\vec{a}]) \) \
\(< \slot* \) \
\(< \slot*[\vec{a}]) \)

```

$$\begin{array}{c} (\underline{\quad}) \\ (\underline{a}) \\ (\quad) \\ (a) \end{array}$$

N 2021-04-06

**\diff**

Intelligent differential (exterior derivative) operator.

```

\[
\int x\,dx
\]
\[
\int x\,d\diff{x}
\]
\[
\int x\,d\diff{x}
\]

```

$$\begin{array}{c} \int x\,dx \\ \int x\,dx \\ \int x\,dx \end{array}$$

## 4.4 GlowScript and VPython Program Listings

[GlowScript](#)<sup>3</sup> and [VPython](#)<sup>4</sup> are programming environments (both use [Python](#)) frequently used in introductory physics to introduce students for modeling physical systems. `mandi` makes including code listings very simple for students.

## 4.5 The `glowscripblock` Environment

U 2021-09-18

```

\begin{glowscripblock}[\textit{options}](\textit{link}){\textit{caption}}
\textit{GlowScript code}
\end{glowscripblock}

```

Code placed here is nicely formatted and optionally linked to its source on [GlowScript.org](#). Clicking anywhere in the code window will open the link in the default browser. A caption is mandatory, and a label is internally generated. The listing always begins on a new page. A URL shortening utility is recommended to keep the URL from getting unruly. For convenience, `https://` is automatically prepended to the URL and can thus be omitted. The `#` character in a URL should not cause problems. The program must exist in a public, not private, folder.

<sup>3</sup><https://glowsript.org>

<sup>4</sup><https://vpython.org>



```

\begin{glowscripblock}(tinyurl.com/y3lnqyn3){A \texttt{GlowScript} Program}
GlowScript 3.0 vpython

scene.width = 400
scene.height = 760
# constants and data
g = 9.8          # m/s^2
mball = 0.03     # kg
Lo = 0.26        # m
ks = 1.8         # N/m
deltat = 0.01   # s

# objects (origin is at ceiling)
ceiling = box(pos=vector(0,0,0), length=0.2, height=0.01,
              width=0.2)
ball = sphere(pos=vector(0,-0.3,0),radius=0.025,
              color=color.orange)
spring = helix(pos=ceiling.pos, axis=ball.pos-ceiling.pos,
              color=color.cyan,thickness=0.003,coils=40,
              radius=0.010)

# initial values
pball = mball * vector(0,0,0)      # kg m/s
Fgrav = mball * g * vector(0,-1,0) # N
t = 0

# improve the display
scene.autoscale = False           # turn off automatic camera zoom
scene.center = vector(0,-Lo,0)    # move camera down
scene.waitFor('click')           # wait for a mouse click

# initial calculation loop
# calculation loop
while t < 10:
    rate(100)
    # we need the stretch
    s = mag(ball.pos) - Lo
    # we need the spring force
    Fspring = ks * s * -norm(spring.axis)
    Fnet = Fgrav + Fspring
    pball = pball + Fnet * deltat
    ball.pos = ball.pos + (pball / mball) * deltat
    spring.axis = ball.pos - ceiling.pos
    t = t + deltat
\end{glowscripblock}

```

## GlowScript Program 1: A GlowScript Program

```

1  GlowScript 3.0 vpython
2
3  scene.width = 400
4  scene.height = 760
5  # constants and data
6  g = 9.8          # m/s^2
7  mball = 0.03     # kg
8  Lo = 0.26        # m
9  ks = 1.8         # N/m
10 deltatt = 0.01   # s
11
12 # objects (origin is at ceiling)
13 ceiling = box(pos=vector(0,0,0), length=0.2, height=0.01,
14               width=0.2)
15 ball = sphere(pos=vector(0,-0.3,0), radius=0.025,
16               color=color.orange)
17 spring = helix(pos=ceiling.pos, axis=ball.pos-ceiling.pos,
18               color=color.cyan, thickness=0.003, coils=40,
19               radius=0.010)
20
21 # initial values
22 pball = mball * vector(0,0,0)      # kg m/s
23 Fgrav = mball * g * vector(0,-1,0) # N
24 t = 0
25
26 # improve the display
27 scene.autoscale = False            # turn off automatic camera zoom
28 scene.center = vector(0,-Lo,0)     # move camera down
29 scene.waitfor('click')             # wait for a mouse click
30
31 # initial calculation loop
32 # calculation loop
33 while t < 10:
34     rate(100)
35     # we need the stretch
36     s = mag(ball.pos) - Lo
37     # we need the spring force
38     Fspring = ks * s * -norm(spring.axis)
39     Fnet = Fgrav + Fspring
40     pball = pball + Fnet * deltatt
41     ball.pos = ball.pos + (pball / mball) * deltatt
42     spring.axis = ball.pos - ceiling.pos
43     t = t + deltatt

```

\GlowScript\ program \ref{gs:1} is nice.  
 It's called \nameref{gs:1} and is on page \pageref{gs:1}.

GlowScript program 1 is nice. It's called [A GlowScript Program](#) and is on page 66.

## 4.6 The `vpythonfile` Command

U 2021-09-17

```
\vpythonfile [<options>] (<link>){<file>}{<caption>}
```

Command to load and typeset a **VPython** program, read from local file `{<file>}`. Clicking anywhere in the code window can optionally open a link, passed as an option, in the default browser. A caption is mandatory, and a label is internally generated. The listing always begins on a new page. A URL shortening utility is recommended to keep the URL from getting unruly. For convenience, `https://` is automatically prepended to the URL and can thus be omitted. The `#` character in a URL is problematic and should be escaped as `\#`.

```
\vpythonfile{vdemo.py}{A \VPython\ Program}
```

## VPython Program 1: A VPython Program

```

1  from vpython import *
2
3  scene.width = 400
4  scene.height = 760
5  # constants and data
6  g = 9.8      # m/s^2
7  mball = 0.03 # kg
8  Lo = 0.26    # m
9  ks = 1.8     # N/m
10 deltatt = 0.01 # s
11
12 # objects (origin is at ceiling)
13 ceiling = box(pos=vector(0,0,0), length=0.2, height=0.01,
14               width=0.2)
15 ball = sphere(pos=vector(0,-0.3,0), radius=0.025,
16               color=color.orange)
17 spring = helix(pos=ceiling.pos, axis=ball.pos-ceiling.pos,
18               color=color.cyan, thickness=0.003, coils=40,
19               radius=0.010)
20
21 # initial values
22 pball = mball * vector(0,0,0) # kg m/s
23 Fgrav = mball * g * vector(0,-1,0) # N
24 t = 0
25
26 # improve the display
27 scene.autoscale = False      # turn off automatic camera zoom
28 scene.center = vector(0,-Lo,0) # move camera down
29 scene.waitfor('click')      # wait for a mouse click
30
31 # initial calculation loop
32 # calculation loop
33 while t < 10:
34     rate(100)
35     # we need the stretch
36     s = mag(ball.pos) - Lo
37     # we need the spring force
38     Fspring = ks * s * -norm(spring.axis)
39     Fnet = Fgrav + Fspring
40     pball = pball + Fnet * deltatt
41     ball.pos = ball.pos + (pball / mball) * deltatt
42     spring.axis = ball.pos - ceiling.pos
43     t = t + deltatt

```

\VPython\ program \ref{vp:1} is nice.  
 It's called \nameref{vp:1} and is on page \pageref{vp:1}.

VPython program 1 is nice. It's called [A VPython Program](#) and is on page 68.

## 4.7 The `glowscriptinline` and `vpythoninline` Commands

U 2021-02-26

U 2021-02-26

```
\glowscriptinline{\i{GlowScript code}}
```

```
\vpythoninline{\i{VPython code}}
```

Typesets a small, in-line snippet of code. The snippet should be less than one line long.

```
\GlowScript\ programs begin with \glowscriptinline{GlowScript 3.0 VPython}  
and \VPython\ programs begin with \vpythoninline{from vpython import *}.
```

-----

GlowScript programs begin with `GlowScript 3.0 VPython` and VPython programs begin with `from vpython import *`.

## 4.8 mandistudent Source Code

Define the package version and date for global use, exploiting the fact that in a .sty file there is now no need for `\makeatletter` and `\makeatother`. This simplifies defining internal commands, with @ in the name, that are not for the user to know about.

```
1 \def\mandistudent@version{3.0.2}
2 \def\mandistudent@date{2021-09-20}
3 \NeedsTeXFormat{LaTeX2e}[2020-02-02]
4 \DeclareRelease{v3.0.2}{2021-09-20}{mandistudent.sty}
5 \DeclareCurrentRelease{v\mandistudent@version}{\mandistudent@date}
6 \ProvidesPackage{mandistudent}
7 [\mandistudent@date\space v\mandistudent@version\space Macros for introductory physics]
```

Define a convenient package version command.

```
8 \newcommand*{\mandistudentversion}{v\mandistudent@version\space dated \mandistudent@date}
```

Load third party packages, documenting why each one is needed.

```
9 \RequirePackage{amsmath}           % AMS goodness (don't load amssymb or amsfonts)
10 \RequirePackage{inline}{enumitem} % needed for physicsproblem environment
11 \RequirePackage{eso-pic}           % needed for \hilite
12 \RequirePackage{g}{esvect}         % needed for nice vector arrow, style g
13 \RequirePackage{pgfplots}          % needed for key-value interface
14 \RequirePackage{iftex}             % needed for requiring LuaLaTeX
15 \RequirePackage{makebox}           % needed for consistent \direct; \makebox
16 \RequirePackage{mandi}
17 \RequirePackage{mathtools}          % needed for paired delimiters; extends amsmath
18 \RequirePackage{nicematrix}         % needed for column and row vectors
19 \RequirePackage{most}{tcolorbox}    % needed for program listings
20 \RequirePackage{tensor}            % needed for index notation
21 \RequirePackage{tikz}              % needed for \hilite
22 \usetikzlibrary{shapes,fit,tikzmark} % needed for \hilite
23 \RequirePackage{unicode-math}       % needed for Unicode support

24 \IfFormatAtLeastTF {2020-10-01}    % load xparse if necessary
25 {}%
26 {\RequirePackage{xparse}}%
27 \RequirePackage{hyperref}           % load last
28 \RequireLuaTeX                      % require this engine
```

Set up the fonts to be consistent with ISO 80000-2 notation. The `unicode-math` package loads the `fontspec` and `xparse` packages. Note that `xparse` is now part of the  $\text{\LaTeX}$  kernel. Because `unicode-math` is required, all documents using `mandi` must be compiled with an engine that supports Unicode. We recommend `Lua $\text{\LaTeX}$` .

```
29 \unimathsetup{math-style=ISO}
30 \unimathsetup{warnings-off={mathtools-colon,mathtools-overbracket}}
31 %
32 % Use normal math letters from Latin Modern Math for familiarity with
33 % textbooks.
34 %
35 % \begin{macrocode}
36 \setmathfont[Scale=MatchLowercase]
37 {Latin Modern Math} % default math font; better J
```

Borrow from GeX Gyre DejaVu Math for vectors and tensors to get single-storey g.

```
38 \setmathfont[Scale=MatchLowercase,range={sf/it/{latin},bfsf/it/{latin}}]
39 {TeX Gyre DejaVu Math} % single-storey lowercase g
```

Borrow from GeX Gyre DejaVu Math to get single-storey g.

```
40 \setmathfont[Scale=MatchLowercase,range={sfup/{latin},bfsfup/{latin}}]
41 {TeX Gyre DejaVu Math} % single-storey lowercase g
```

Borrow mathscr and mathbfscr from XITS Math.  
See <https://tex.stackexchange.com/a/120073/218142>.

```
42 \setmathfont[Scale=MatchLowercase,range={\mathscr,\mathbfscr}]{XITS Math}
```

Get original and bold mathcal fonts.  
See <https://tex.stackexchange.com/a/21742/218142>.

```
43 \setmathfont[Scale=MatchLowercase,range={\mathcal,\mathbfcal},StylisticSet=1]{XITS Math}
```

Borrow Greek sfup and sfit letters from STIX Two Math. Since this isn't officially supported in unicode-math we have to manually set this up.

```
44 \setmathfont[Scale=MatchLowercase,range={"E17C-"E1F6}]{STIX Two Math}
45 \newfontfamily{\symsfgreek}{STIX Two Math}
46 % I don't understand why \text{...} is necessary.
47 \newcommand{\symsfupalpha}      {\text{\symsfgreek{^^^^e196}}}
48 \newcommand{\symsfupbeta}      {\text{\symsfgreek{^^^^e197}}}
49 \newcommand{\symsfupgamma}     {\text{\symsfgreek{^^^^e198}}}
50 \newcommand{\symsfupdelta}     {\text{\symsfgreek{^^^^e199}}}
51 \newcommand{\symsfupepsilon}   {\text{\symsfgreek{^^^^e1a0}}}
52 \newcommand{\symsfupvarepsilon}{\text{\symsfgreek{^^^^e1a1}}}
53 \newcommand{\symsfupzeta}      {\text{\symsfgreek{^^^^e1a2}}}
54 \newcommand{\symsfupeta}       {\text{\symsfgreek{^^^^e1a3}}}
55 \newcommand{\symsfuptheta}     {\text{\symsfgreek{^^^^e1a4}}}
56 \newcommand{\symsfupvartheta}  {\text{\symsfgreek{^^^^e1a5}}}
57 \newcommand{\symsfupiota}      {\text{\symsfgreek{^^^^e1a6}}}
58 \newcommand{\symsfupkappa}     {\text{\symsfgreek{^^^^e1a7}}}
59 \newcommand{\symsfuplambda}    {\text{\symsfgreek{^^^^e1a8}}}
60 \newcommand{\symsfupmu}        {\text{\symsfgreek{^^^^e1a9}}}
61 \newcommand{\symsfupnu}        {\text{\symsfgreek{^^^^e1aa}}}
62 \newcommand{\symsfupxi}        {\text{\symsfgreek{^^^^e1ab}}}
63 \newcommand{\symsfupomicron}   {\text{\symsfgreek{^^^^e1ac}}}
64 \newcommand{\symsfuppi}        {\text{\symsfgreek{^^^^e1ad}}}
65 \newcommand{\symsfupvarpi}     {\text{\symsfgreek{^^^^e1ae}}}
66 \newcommand{\symsfuprho}       {\text{\symsfgreek{^^^^e1b0}}}
67 \newcommand{\symsfupvarrho}    {\text{\symsfgreek{^^^^e1b1}}}
68 \newcommand{\symsfupsigma}     {\text{\symsfgreek{^^^^e1b2}}}
69 \newcommand{\symsfupvarsigma}  {\text{\symsfgreek{^^^^e1b3}}}
70 \newcommand{\symsfuptau}       {\text{\symsfgreek{^^^^e1b4}}}
71 \newcommand{\symsfupupsilon}   {\text{\symsfgreek{^^^^e1b5}}}
72 \newcommand{\symsfupphi}       {\text{\symsfgreek{^^^^e1b6}}}
73 \newcommand{\symsfupvarphi}    {\text{\symsfgreek{^^^^e1b7}}}
74 \newcommand{\symsfupchi}       {\text{\symsfgreek{^^^^e1b8}}}
75 \newcommand{\symsfuppsi}       {\text{\symsfgreek{^^^^e1b9}}}
76 \newcommand{\symsfupomega}     {\text{\symsfgreek{^^^^e1ba}}}
77 \newcommand{\symsfupDelta}     {\text{\symsfgreek{^^^^e1bb}}}
78 \newcommand{\symsfupGamma}     {\text{\symsfgreek{^^^^e1bc}}}
79 \newcommand{\symsfupTheta}     {\text{\symsfgreek{^^^^e1bd}}}
80 \newcommand{\symsfupLambda}    {\text{\symsfgreek{^^^^e1be}}}
81 \newcommand{\symsfupXi}        {\text{\symsfgreek{^^^^e1bf}}}
82 \newcommand{\symsfupPi}        {\text{\symsfgreek{^^^^e1c0}}}
83 \newcommand{\symsfupSigma}     {\text{\symsfgreek{^^^^e1c1}}}
84 \newcommand{\symsfupUpsilon}   {\text{\symsfgreek{^^^^e1c2}}}
85 \newcommand{\symsfupPhi}       {\text{\symsfgreek{^^^^e1c3}}}
86 \newcommand{\symsfupPsi}       {\text{\symsfgreek{^^^^e1c4}}}
87 \newcommand{\symsfupOmega}     {\text{\symsfgreek{^^^^e1c5}}}
88 \newcommand{\symsfitalpha}     {\text{\symsfgreek{^^^^e1d8}}}
89 \newcommand{\symsfitbeta}      {\text{\symsfgreek{^^^^e1d9}}}
90 \newcommand{\symsfitgamma}     {\text{\symsfgreek{^^^^e1da}}}
91 \newcommand{\symsfitdelta}     {\text{\symsfgreek{^^^^e1db}}}
```

```

92 \newcommand{\symsfitepsilon} {\text{\symsfgreek{~~~~e1f1}}}
93 \newcommand{\symsfitvarepsilon} {\text{\symsfgreek{~~~~e1dc}}}
94 \newcommand{\symsfitzeta} {\text{\symsfgreek{~~~~e1dd}}}
95 \newcommand{\symsfiteta} {\text{\symsfgreek{~~~~e1de}}}
96 \newcommand{\symsfittheta} {\text{\symsfgreek{~~~~e1df}}}
97 \newcommand{\symsfitvartheta} {\text{\symsfgreek{~~~~e1f2}}}
98 \newcommand{\symsfitiota} {\text{\symsfgreek{~~~~e1e0}}}
99 \newcommand{\symsfitkappa} {\text{\symsfgreek{~~~~e1e1}}}
100 \newcommand{\symsfitlambda} {\text{\symsfgreek{~~~~e1e2}}}
101 \newcommand{\symsfitmu} {\text{\symsfgreek{~~~~e1e3}}}
102 \newcommand{\symsfitnu} {\text{\symsfgreek{~~~~e1e4}}}
103 \newcommand{\symsfitxi} {\text{\symsfgreek{~~~~e1e5}}}
104 \newcommand{\symsfitomicron} {\text{\symsfgreek{~~~~e1e6}}}
105 \newcommand{\symsfitpi} {\text{\symsfgreek{~~~~e1e7}}}
106 \newcommand{\symsfitvarpi} {\text{\symsfgreek{~~~~e1f5}}}
107 \newcommand{\symsfitrho} {\text{\symsfgreek{~~~~e1e8}}}
108 \newcommand{\symsfitvarrho} {\text{\symsfgreek{~~~~e1f4}}}
109 \newcommand{\symsfitsigma} {\text{\symsfgreek{~~~~e1ea}}}
110 \newcommand{\symsfitvarsigma} {\text{\symsfgreek{~~~~e1e9}}}
111 \newcommand{\symsfittau} {\text{\symsfgreek{~~~~e1eb}}}
112 \newcommand{\symsfitupsilon} {\text{\symsfgreek{~~~~e1ec}}}
113 \newcommand{\symsfitphi} {\text{\symsfgreek{~~~~e1f3}}}
114 \newcommand{\symsfitvarphi} {\text{\symsfgreek{~~~~e1ed}}}
115 \newcommand{\symsfitchi} {\text{\symsfgreek{~~~~e1ee}}}
116 \newcommand{\symsfitpsi} {\text{\symsfgreek{~~~~e1ef}}}
117 \newcommand{\symsfitomega} {\text{\symsfgreek{~~~~e1f0}}}
118 \newcommand{\symsfitDelta} {\text{\symsfgreek{~~~~e1c2}}}
119 \newcommand{\symsfitGamma} {\text{\symsfgreek{~~~~e1c1}}}
120 \newcommand{\symsfitTheta} {\text{\symsfgreek{~~~~e1d0}}}
121 \newcommand{\symsfitLambda} {\text{\symsfgreek{~~~~e1c9}}}
122 \newcommand{\symsfitXi} {\text{\symsfgreek{~~~~e1cc}}}
123 \newcommand{\symsfitPi} {\text{\symsfgreek{~~~~e1ce}}}
124 \newcommand{\symsfitSigma} {\text{\symsfgreek{~~~~e1d1}}}
125 \newcommand{\symsfitUpsilon} {\text{\symsfgreek{~~~~e1d3}}}
126 \newcommand{\symsfitPhi} {\text{\symsfgreek{~~~~e1d4}}}
127 \newcommand{\symsfitPsi} {\text{\symsfgreek{~~~~e1d6}}}
128 \newcommand{\symsfitOmega} {\text{\symsfgreek{~~~~e1d7}}}

```

Tweak the `esvect` package fonts to get the correct font size. Code provided by @egreg.  
See <https://tex.stackexchange.com/a/566676>.

```

129 \DeclareFontFamily{U}{esvect}{%
130 \DeclareFontShape{U}{esvect}{m}{n}{%
131   <-5.5> vect5
132   <5.5-6.5> vect6
133   <6.5-7.5> vect7
134   <7.5-8.5> vect8
135   <8.5-9.5> vect9
136   <9.5-> vect10
137 }{}}%

```

Write a banner to the console showing the options in use.

```

138 \typeout{}%
139 \typeout{mandistudent: You are using mandistudent \mandistudentversion.}%
140 \typeout{mandistudent: This package requires LuaLaTeX.}%
141 \typeout{mandistudent: This package changes the default math font(s).}%
142 \typeout{mandistudent: This package redefines the \protect\vec\space command.}%
143 \typeout{}%

```

A better, intelligent coordinate-free `\vec`<sup>P.54</sup> command. Note the use of the `e{~}` type of optional argument. This accounts for much of the flexibility and power of this command. Also note the use of the  $\TeX$  primitives `\sb{}` and `\sp{}`.



Why doesn't it work when I put spaces around #3 or #4? Because outside of `\ExplSyntaxOn...\ExplSyntaxOff`, the `_` character has a different catcode and is treated as a mathematical entity.

See <https://tex.stackexchange.com/q/554706/218142>.

See also <https://tex.stackexchange.com/a/531037/218142>.

```

144 \RenewDocumentCommand{\vec}{ s m e_{_} }{%
145   % Note the \, used to make superscript look better.
146   \IfBooleanTF {#1}
147     {\vv{#2}%      % * gives an arrow
148      % Use \sp{} primitive for superscript.
149      % Adjust superscript for the arrow.
150      \IfValueT{#4}{\sp{\,#4\vphantom{\smash[t]{\big|}}}}
151     }%
152     {\symbfit{#2} % no * gives us bold
153      % Use \sp{} primitive for superscript.
154      % No superscript adjustment needed.
155      \IfValueT{#4}{\sp{#4\vphantom{\smash[t]{\big|}}}}
156     }%
157   % Use \sb{} primitive for subscript.
158   \IfValueT{#3}{\sb{#3\vphantom{\smash[b]{\big|}}}}
159 }%

```

A command for the direction of a vector. We use a slight tweak to get uniform hats that requires the [makebox](https://tex.stackexchange.com/a/391204/218142) package.

See <https://tex.stackexchange.com/a/391204/218142>.

```

160 \NewDocumentCommand{\dirvec}{ s m e_{_} }{%
161   \widehat{%
162     \makebox*{\(w\)}{%
163       \ensuremath{%
164         \IfBooleanTF {#1}%
165           {%
166             #2
167           }%
168           {%
169             \symbfit{#2}%
170           }%
171         }%
172       }%
173     }%
174     \IfValueT{#3}{\sb{#3\vphantom{\smash[b]{\big|}}}}%
175     \IfValueT{#4}{\sp{\,#4\vphantom{\smash[t]{\big|}}}}%
176 }%

```

The zero vector.

```

177 \NewDocumentCommand{\zerovec}{ s }{%
178   \IfBooleanTF {#1}
179     {\vv{0}}%
180     {\symbfup{0}}%
181 }%

```

Notation for column and row vectors. Original code provided by @egreg.

See <https://tex.stackexchange.com/a/39054/218142>.

```

182 \ExplSyntaxOn
183 \NewDocumentCommand{\colvec}{ O{,} m }{%
184   \vector_main:nnnn { p } { \ \ } { #1 } { #2 }
185 }%
186 \NewDocumentCommand{\rowvec}{ O{,} m }{%
187   \vector_main:nnnn { p } { & } { #1 } { #2 }
188 }%
189 \seq_new:N \l__vector_arg_seq

```

```

190 \cs_new_protected:Npn \vector_main:nnnn #1 #2 #3 #4 {%
191   \seq_set_split:Nnn \l__vector_arg_seq { #3 } { #4 }
192   \begin{#1NiceMatrix}[r]
193     \seq_use:Nnnn \l__vector_arg_seq { #2 } { #2 } { #2 }
194   \end{#1NiceMatrix}
195 }%
196 \ExplSyntaxOff

```

Students always need this symbol.

```

197 \NewDocumentCommand{\changein}{}{\Delta}

```

Intelligent delimiters provided via the [mathtools](#) package. Use the starred variants for fractions. You can supply optional sizes. Note that default placeholders are used when the argument is empty.

```

198 \DeclarePairedDelimiterX{\doublebars}[1]{\lVert}{\rVert}{\ifblank{#1}{\:\cdot\:{#1}}
199 \DeclarePairedDelimiterX{\singlebars}[1]{\lvert}{\rvert}{\ifblank{#1}{\:\cdot\:{#1}}
200 \DeclarePairedDelimiterX{\anglebrackets}[1]{\langle}{\rangle}{\ifblank{#1}{\:\cdot\:{#1}}
201 \DeclarePairedDelimiterX{\parentheses}[1]{\lparen}{\rparen}{\ifblank{#1}{\:\cdot\:{#1}}
202 \DeclarePairedDelimiterX{\squarebrackets}[1]{\lbrack}{\rbrack}{\ifblank{#1}{\:\cdot\:{#1}}
203 \DeclarePairedDelimiterX{\curlybraces}[1]{\lbrace}{\rbrace}{\ifblank{#1}{\:\cdot\:{#1}}

```

Some semantic aliases. Because of the way [\vec](#)<sup>P.54</sup> and [\dirvec](#)<sup>P.54</sup> are defined, I reluctantly decided not to implement a [\magvec](#) command. It would require accounting for too many options. So [\magnitude](#)<sup>P.57</sup> is the new solution.

```

204 \NewDocumentCommand{\magnitude}{}{\doublebars}
205 \NewDocumentCommand{\norm}{}{\doublebars}
206 \NewDocumentCommand{\absolutevalue}{}{\singlebars}

```

Commands for two important geometric relationships. These are meant mainly to be subscripts.

```

207 \NewDocumentCommand{\parallelto}{}
208   {\mkern3mu\vphantom{\perp}\vrule depth 0pt\mkern2mu\vrule depth 0pt\mkern3mu}
209 \NewDocumentCommand{\perpendicularto}{}{\perp}

```

An environment for problem statements. The starred variant gives in-line lists.

```

210 \NewDocumentEnvironment{physicsproblem}{ m }{%
211   \newpage%
212   \section*{#1}%
213   \newlist{parts}{enumerate}{2}%
214   \setlist[parts]{label=\bfseries(\alph*)}%
215   { }%
216 \NewDocumentEnvironment{physicsproblem*}{ m }{%
217   \newpage%
218   \section*{#1}%
219   \newlist{parts}{enumerate*}{2}%
220   \setlist[parts]{label=\bfseries(\alph*)}%
221   { }%
222 \NewDocumentCommand{\problempart}{}{\item}%

```

An environment for problem solutions.

```

223 \NewDocumentEnvironment{physicssolution}{ +b }{%
224   % Make equation numbering consecutive through the document.
225   \begin{align}
226     #1
227   \end{align}
228 }{%
229 \NewDocumentEnvironment{physicssolution*}{ +b }{%
230   % Make equation numbering consecutive through the document.
231   \begin{align*}
232     #1
233   \end{align*}
234 }{%

```

See <https://tex.stackexchange.com/q/570223/218142>.

```
235 \NewDocumentCommand{\reason}{ O{4cm} m }
236 {&&\begin{minipage}{#1}\raggedright\small #2\end{minipage}}
```

Command for highlighting parts of, or entire, mathematical expressions.

Original code by anonymous user @abcdefg, modified by me.

See <https://texample.net/tikz/examples/beamer-arrows/>.

See also <https://tex.stackexchange.com/a/406084/218142>.

See also <https://tex.stackexchange.com/a/570858/218142>.

See also <https://tex.stackexchange.com/a/570789/218142>.

See also <https://tex.stackexchange.com/a/79659/218142>.

See also <https://tex.stackexchange.com/q/375032/218142>.

See also <https://tex.stackexchange.com/a/571744/218142>

```
237 \newcounter{tikzhightnode}
238 \NewDocumentCommand{\hilite}{ O{magenta!60} m O{rectangle} }{%
239   \stepcounter{tikzhightnode}%
240   \tikzmarknode{highlighted-node-\number\value{tikzhightnode}}{#2}%
241   \edef\temp{%
242     \noexpand\AddToShipoutPictureBG{%
243       \noexpand\begin{tikzpicture}[overlay,remember picture]%
244         \noexpand\iftikzmarkconcurrentpage{highlighted-node-\number\value{tikzhightnode}}%
245         \noexpand\node[inner sep=1.0pt,fill=#1,#3,fit=(highlighted-node-\number\value{tikzhightnode})]{};%
246         \noexpand\fi
247         \noexpand\end{tikzpicture}%
248       }%
249     }%
250   \temp%
251 }%
```

A simplified command for importing images.

See <https://tex.stackexchange.com/a/614478/218142>.

```
252 \NewDocumentCommand{\image}{ O{scale=1} m m m }{%
253   \par
254   \begin{figure}[ht!]
255     \centering%
256     \includegraphics[#1]{#2}%
257     \caption{#3}%
258     \label{#4}%
259   \end{figure}%
260   \par
261 }%
```

Intelligent commands for typesetting vector and tensor symbols and components suitable for use with both coordinate-free and index notations. Use starred form for index notation, unstarred form for coordinate-free.

```
262 \NewDocumentCommand{\veccomp}{ s m }{%
263   % Consider renaming this to \vectorsym.
264   \IfBooleanTF{#1}
265   {%
266     \symnormal{#2}%
267   }%
268   {%
269     \sybfit{#2}%
270   }%
271 }%
272 \NewDocumentCommand{\tencomp}{ s m }{%
273   % Consider renaming this to \tensororsym.
274   \IfBooleanTF{#1}
275   {%
```

```

276 \symsfit{#2}%
277 }%
278 {%
279 \symbfsfit{#2}
280 }%
281 }%

```

Command to typeset tensor valence.

```

282 \NewDocumentCommand{\valence}{ s m m }{%
283 \IfBooleanTF{#1}
284 {(#2,#3)}
285 {\binom{#2}{#3}}
286 }%

```

Intelligent notation for contraction on pairs of slots.

```

287 \NewDocumentCommand{\contraction}{ s m }{%
288 \IfBooleanTF{#1}
289 {\mathsf{C}}%
290 {\sybbb{C}}%
291 _{#2}
292 }%

```

Intelligent slot command for coordinate-free tensor notation.

```

293 \NewDocumentCommand{\slot}{ s d[] }{%
294 % d[] must be used because of the way consecutive optional
295 % arguments are handled. See xparse docs for details.
296 \IfBooleanTF{#1}
297 {%
298 \IfValueTF{#2}
299 {% Insert a vector, but don't show the slot.
300 \smash{\makebox[1.5em]{\ensuremath{#2}}}
301 }%
302 {% No vector, no slot.
303 \smash{\makebox[1.5em]{\ensuremath{}}}
304 }%
305 }%
306 {%
307 \IfValueTF{#2}
308 {% Insert a vector and show the slot.
309 \underline{\smash{\makebox[1.5em]{\ensuremath{#2}}}}
310 }%
311 {% No vector; just show the slot.
312 \underline{\smash{\makebox[1.5em]{\ensuremath{}}}}
313 }%
314 }%
315 }%

```

Intelligent differential (exterior derivative) operator.

```

316 \NewDocumentCommand{\diff}{ s }{%
317 \mathop{\}\!
318 \IfBooleanTF{#1}
319 {\sybfsfup{d}}%
320 {\symsfup{d}}%
321 }%

```

Here is a clever way to color digits in program listings thanks to Ulrike Fischer.

See <https://tex.stackexchange.com/a/570717/218142>.

```

322 \directlua{%
323 luaotfload.add_colorscheme("colordigits",

```

```

324 [{"8000FF"} = {"one","two","three","four","five","six","seven","eight","nine","zero"}})
325 }%
326 \newfontfamily\colordigits{DejaVuSansMono}[RawFeature={color=colordigits}]

```

Set up a color scheme and a new code environment for listings. The new colors are more restful on the eye. All listing commands now use `colorbox`.

See <https://tex.stackexchange.com/a/529421/218142>.

```

327 \newfontfamily{\gfontfamily}{DejaVuSansMono} % new font for listings
328 \definecolor{gsbggray} {rgb}{0.90,0.90,0.90} % background gray
329 \definecolor{gsgray} {rgb}{0.30,0.30,0.30} % gray
330 \definecolor{gsgreen} {rgb}{0.00,0.60,0.00} % green
331 \definecolor{gsorange} {rgb}{0.80,0.45,0.12} % orange
332 \definecolor{gspeach} {rgb}{1.00,0.90,0.71} % peach
333 \definecolor{gspearl} {rgb}{0.94,0.92,0.84} % pearl
334 \definecolor{gsplum} {rgb}{0.74,0.46,0.70} % plum
335 \lstdefinestyle{vpython}{% % style for listings
336 backgroundcolor=\color{gsbggray},% % background color
337 basicstyle=\colordigits\footnotesize,% % default style
338 breakatwhitespace=true% % break at whitespace
339 breaklines=true,% % break long lines
340 captionpos=b,% % position caption
341 classoffset=1,% % STILL DON'T UNDERSTAND THIS
342 commentstyle=\color{gsgray},% % font for comments
343 deletekeywords={print},% % delete keywords from the given language
344 emph={self,cls,@classmethod,@property},% % words to emphasize
345 emphstyle=\color{gsorange}\itshape,% % font for emphasis
346 escapeinside={(*@){@*}},% % add LaTeX within your code
347 frame=tb,% % frame style
348 framerule=2.0pt,% % frame thickness
349 framexleftmargin=5pt,% % extra frame left margin
350 %identifierstyle=sffamily,% % style for identifiers
351 keywordstyle=\gfontfamily\color{gsplum},% % color for keywords
352 language=Python,% % select language
353 linewidth=\linewidth,% % width of listings
354 morekeywords={% % VPython/GlowScript specific keywords
355 __future__,abs,acos,align,ambient,angle,append,append_to_caption,%
356 append_to_title,arange,arrow,asin,astuple,atan,atan2,attach_arrow,%
357 attach_trail,autoscale,axis,background,billboard,bind,black,blue,border,%
358 bounding_box,box,bumpaxis,bumpmap,bumpmaps,camera,canvas,caption,capture,%
359 ceil,center,clear,clear_trail,click,clone,CoffeeScript,coils,color,combin,%
360 comp,compound,cone,convex,cos,cross,curve,cyan,cylinder,data,degrees,del,%
361 delete,depth,descender,diff_angle,digits,division,dot,draw_complete,%
362 ellipsoid,emissive,end_face_color,equals,explog,extrusion,faces,factorial,%
363 False,floor,follow,font,format,forward,fov,frame,gcurve,gdisplay,gdots,%
364 get_library,get_selected,ghbars,global,GlowScript,graph,graphs,green,gvbars,%
365 hat,headlength,headwidth,height,helix,hsv_to_rgb,index,interval,keydown,%
366 keyup,label,length,lights,line,linecolor,linewidth,logx,logy,lower_left,%
367 lower_right,mag,mag2,magenta,make_trail,marker_color,markers,material,%
368 max,min,mouse,mousedown,mousemove,mouseup,newball,norm,normal,objects,%
369 offset,one,opacity,orange,origin,path,pause,pi,pixel_to_world,pixels,plot,%
370 points,pos,pow,pps,print,print_function,print_options,proj,purple,pyramid,%
371 quad,radians,radius,random,rate,ray,read_local_file,readonly,red,redraw,%
372 retain,rgb_to_hsv,ring,rotate,round,scene,scroll,shaftwidth,shape,shapes,%
373 shininess,show_end_face,show_start_face,sign,sin,size,size_units,sleep,%
374 smooth,space,sphere,sqrt,start,start_face_color,stop,tan,text,textpos,%
375 texture,textures,thickness,title,trail_color,trail_object,trail_radius,%
376 trail_type,triangle,trigger,True,twist,unbind,up,upper_left,upper_right,%
377 userpan,userspin,userzoom,vec,vector,vertex,vertical_spacing,visible,%
378 visual,vpython,VPython,waitfor,white,width,world,xtitle,yellow,yoffset,%

```

```

379 ytitle%
380 },%
381 morekeywords={print,None,TypeError},% % additional keywords
382 morestring=[b]{"""},% % treat triple quotes as strings
383 numbers=left,% % where to put line numbers
384 numbersep=10pt,% % how far line numbers are from code
385 numberstyle=\bfseries\tiny,% % set to 'none' for no line numbers
386 showstringspaces=false,% % show spaces in strings
387 showtabs=false,% % show tabs within strings
388 stringstyle=\gssfontfamily\color{gsgreen},% % color for strings
389 upquote=true,% % how to typeset quotes
390 }%

```

Introduce a new, more intelligent [glowscriptblock](#)<sup>→P.64</sup> environment.

See <https://tex.stackexchange.com/a/232208/218142>.

```

391 \NewTCBListing[auto counter,list inside=gsprogs]{glowscriptblock}
392 { 0{ } D(){glowscript.org} m }{%
393 breakable,%
394 center,%
395 code = \newpage,%
396 %derivpeach,%
397 enhanced,%
398 hyperurl interior = https://#2,%
399 label = {gs:\thetcbcounter},%
400 left = 8mm,%
401 list entry = \thetcbcounter~~~~#3,%
402 listing only,%
403 listing style = vpython,%
404 nameref = {#3},%
405 title = \texttt{GlowScript} Program \thetcbcounter: #3,%
406 width = 0.9\textwidth,%
407 {#1},
408 }%
409 \AtBeginEnvironment{glowscriptblock}{\catcode`\#=12}

```

A new command for generating a list of GlowScript programs.

```

410 \NewDocumentCommand{\listofglowscriptprograms}{-}{\tcblistof[\section*]{gsprogs}
411 {List of \texttt{GlowScript} Programs}}%

```

Introduce a new, more intelligent [vpythonfile](#)<sup>→P.67</sup> command. There doesn't seem to be a good way to fix the problem of # in URLs for [vpythonfile](#)<sup>→P.67</sup> so the best advice is to manually escape them as \# when present.

```

412 \NewTCBInputListing[auto counter,list inside=vpprogs]{vpythonfile}
413 { 0{ } D(){vpython.org} m m }{%
414 breakable,%
415 center,%
416 code = \newpage,%
417 %derivgray,%
418 enhanced,%
419 hyperurl interior = https://#2,%
420 label = {vp:\thetcbcounter},%
421 left = 8mm,%
422 list entry = \thetcbcounter~~~~#4,%
423 listing file = {#3},%
424 listing only,%
425 listing style = vpython,%
426 nameref = {#4},%
427 title = \texttt{VPython} Program \thetcbcounter: #4,%
428 width = 0.9\textwidth,%
429 {#1},%

```

430 }%

A new command for generating a list of VPython programs.

```
431 \NewDocumentCommand{\listofvpythonprograms}{*}{\tblistof[\section*]{vpprogs}
432 {List of \texttt{VPython} Programs}}%
```

Introduce a new `\glowscriptinline`<sup>→P.69</sup> command.

```
433 \DeclareTotalTCBox{\glowscriptinline}{m}{%
434   bottom = 0pt,%
435   bottomrule = 0.0mm,%
436   boxsep = 1.0mm,%
437   colback = gsbggray,%
438   colframe = gsbggray,%
439   left = 0pt,%
440   leftrule = 0.0mm,%
441   nobeforeafter,%
442   right = 0pt,%
443   rightrule = 0.0mm,%
444   sharp corners,%
445   tcbox raise base,%
446   top = 0pt,%
447   toprule = 0.0mm,%
448 }{\lstinline[style = vpython]{#1}}%
```

Define `\vpythoninline`<sup>→P.69</sup>, a semantic alias for VPython in-line listings.

```
449 \NewDocumentCommand{\vpythoninline}{*}{\glowscriptinline}%
```

## 5 The `mandiexp` Package

`mandi` comes with an accessory package `mandiexp` which includes commands specific to *Matter & Interactions*.<sup>5</sup> The commands are primarily for typesetting mathematical expressions used in that text. Note that `mandiexp` requires, and loads, `mandi` but `mandi` doesn't require, and doesn't load, `mandiexp`.

Load `mandiexp` as you would any package in your preamble. There are no package options.

```
\usepackage{mandiexp}
```

```
\mandiexpversion
```

Typesets the current version and build date.

```
The version is \mandiexpversion\ and is a stable build.
```

```
The version is v3.0.2 dated 2021-09-20 and is a stable build.
```

### 5.1 The Fundamental Principles

<code>\lhsmomentumprinciple</code>	(LHS of delta form, bold vectors)
<code>\rhsmomentumprinciple</code>	(RHS of delta form, bold vectors)
<code>\lhsmomentumprincipleupdate</code>	(LHS of update form, bold vectors)
<code>\rhsmomentumprincipleupdate</code>	(RHS of update form, bold vectors)
<code>\momentumprinciple</code>	(delta form, bold vectors)
<code>\momentumprincipleupdate</code>	(update form, bold vectors)
<code>\lhsmomentumprinciple*</code>	(LHS of delta form, arrow vectors)
<code>\rhsmomentumprinciple*</code>	(RHS of delta form, arrow vectors)
<code>\lhsmomentumprincipleupdate*</code>	(LHS of update form, arrow vectors)
<code>\rhsmomentumprincipleupdate*</code>	(RHS of update form, arrow vectors)
<code>\momentumprinciple*</code>	(delta form, arrow vectors)
<code>\momentumprincipleupdate*</code>	(update form, arrow vectors)

Variants of command for typesetting the momentum principle. Use starred variants to get arrow notation for vectors.

<sup>5</sup>See *Matter & Interactions* and <https://matterandinteractions.org/> for details.



```

\l \lhsmomentumprinciple \)      \l
\l \rhsmomentumprinciple \)      \l
\l \lhsmomentumprincipleupdate \) \l
\l \rhsmomentumprincipleupdate \) \l
\l \momentumprinciple \)        \l
\l \momentumprincipleupdate \)   \l
\l \lhsmomentumprinciple* \)     \l
\l \rhsmomentumprinciple* \)     \l
\l \lhsmomentumprincipleupdate* \) \l
\l \rhsmomentumprincipleupdate* \) \l
\l \momentumprinciple* \)        \l
\l \momentumprincipleupdate* \)  \l

```

$$\begin{aligned}
&\Delta p_{\text{sys}} \\
&\mathbf{F}_{\text{sys,net}} \Delta t \\
&p_{\text{sys,final}} \\
&p_{\text{sys,initial}} + \mathbf{F}_{\text{sys,net}} \Delta t \\
&\Delta \mathbf{p}_{\text{sys}} = \mathbf{F}_{\text{sys,net}} \Delta t \\
&p_{\text{sys,final}} = p_{\text{sys,initial}} + \mathbf{F}_{\text{sys,net}} \Delta t \\
&\Delta \vec{p}_{\text{sys}} \\
&\vec{F}_{\text{sys,net}} \Delta t \\
&\vec{p}_{\text{sys,final}} \\
&\vec{p}_{\text{sys,initial}} + \vec{F}_{\text{sys,net}} \Delta t \\
&\Delta \vec{p}_{\text{sys}} = \vec{F}_{\text{sys,net}} \Delta t \\
&\vec{p}_{\text{sys,final}} = \vec{p}_{\text{sys,initial}} + \vec{F}_{\text{sys,net}} \Delta t
\end{aligned}$$

<code>\lhsenergyprinciple</code>	(LHS of delta form)
<code>\rhsenergyprinciple[⟨+process...⟩]</code>	(RHS of delta form)
<code>\lhsenergyprincipleupdate</code>	(LHS of update form)
<code>\rhsenergyprincipleupdate[⟨+process...⟩]</code>	(RHS of update form)
<code>\energyprinciple[⟨+process...⟩]</code>	(delta form)
<code>\energyprincipleupdate[⟨+process...⟩]</code>	(update form)

Variants of command for typesetting the energy principle.

```

\l \lhsenergyprinciple \)      \l
\l \rhsenergyprinciple \)      \l
\l \rhsenergyprinciple[+Q] \)   \l
\l \energyprinciple \)        \l
\l \energyprinciple[+Q] \)     \l
\l \lhsenergyprincipleupdate \) \l
\l \rhsenergyprincipleupdate \) \l
\l \rhsenergyprincipleupdate[+Q] \) \l
\l \energyprincipleupdate \)   \l
\l \energyprincipleupdate[+Q] \) \l

```

$$\begin{aligned}
&\Delta E_{\text{sys}} \\
&W_{\text{ext}} \\
&W_{\text{ext}} + Q \\
&\Delta E_{\text{sys}} = W_{\text{ext}} \\
&\Delta E_{\text{sys}} = W_{\text{ext}} + Q \\
&E_{\text{sys,final}} \\
&E_{\text{sys,initial}} + W_{\text{ext}} \\
&E_{\text{sys,initial}} + W_{\text{ext}} + Q \\
&E_{\text{sys,final}} = E_{\text{sys,initial}} + W_{\text{ext}} \\
&E_{\text{sys,final}} = E_{\text{sys,initial}} + W_{\text{ext}} + Q
\end{aligned}$$

<code>\lhsangularmomentumprinciple</code>	(LHS of delta form, bold vectors)
<code>\rhsangularmomentumprinciple</code>	(RHS of delta form, bold vectors)
<code>\lhsangularmomentumprincipleupdate</code>	(LHS of update form, bold vectors)
<code>\rhsangularmomentumprincipleupdate</code>	(RHS of update form, bold vectors)
<code>\angularmomentumprinciple</code>	(delta form, bold vectors)
<code>\angularmomentumprincipleupdate</code>	(update form, bold vectors)
<code>\lhsangularmomentumprinciple*</code>	(LHS of delta form, arrow vectors)
<code>\rhsangularmomentumprinciple*</code>	(RHS of delta form, arrow vectors)
<code>\lhsangularmomentumprincipleupdate*</code>	(LHS of update form, arrow vectors)
<code>\rhsangularmomentumprincipleupdate*</code>	(RHS of update form, arrow vectors)
<code>\angularmomentumprinciple*</code>	(delta form, arrow vectors)
<code>\angularmomentumprincipleupdate*</code>	(update form, arrow vectors)

Variants of command for typesetting the angular momentum principle. Use starred variants to get arrow notation for vectors.

<code>\( \lhsangularmomentumprinciple \)</code>	<code>\)</code>	$\Delta \mathbf{L}_{A,\text{sys},\text{net}}$
<code>\( \rhsangularmomentumprinciple \)</code>	<code>\)</code>	$\boldsymbol{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \lhsangularmomentumprincipleupdate \)</code>	<code>\)</code>	$\mathbf{L}_{A,\text{sys},\text{final}}$
<code>\( \rhsangularmomentumprincipleupdate \)</code>	<code>\)</code>	$\mathbf{L}_{A,\text{sys},\text{initial}} + \boldsymbol{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprinciple \)</code>	<code>\)</code>	$\Delta \mathbf{L}_{A,\text{sys},\text{net}} = \boldsymbol{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprincipleupdate \)</code>	<code>\)</code>	$\mathbf{L}_{A,\text{sys},\text{final}} = \mathbf{L}_{A,\text{sys},\text{initial}} + \boldsymbol{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \lhsangularmomentumprinciple* \)</code>	<code>\)</code>	$\Delta \vec{\mathbf{L}}_{A,\text{sys},\text{net}}$
<code>\( \rhsangularmomentumprinciple* \)</code>	<code>\)</code>	$\vec{\boldsymbol{\tau}}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \lhsangularmomentumprincipleupdate* \)</code>	<code>\)</code>	$\vec{\mathbf{L}}_{A,\text{sys},\text{final}}$
<code>\( \rhsangularmomentumprincipleupdate* \)</code>	<code>\)</code>	$\vec{\mathbf{L}}_{A,\text{sys},\text{initial}} + \vec{\boldsymbol{\tau}}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprinciple* \)</code>	<code>\)</code>	$\Delta \vec{\mathbf{L}}_{A,\text{sys},\text{net}} = \vec{\boldsymbol{\tau}}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprincipleupdate* \)</code>	<code>\)</code>	$\vec{\mathbf{L}}_{A,\text{sys},\text{final}} = \vec{\mathbf{L}}_{A,\text{sys},\text{initial}} + \vec{\boldsymbol{\tau}}_{A,\text{sys},\text{net}} \Delta t$

## 5.2 Other Expressions

N 2021-02-13

`\energyof{<label>}[<label>]`

Generic symbol for the energy of some entity.

<code>\( \energyof{\symup{electron}} \)</code>	<code>\)</code>	$E_{\text{electron}}$
<code>\( \energyof{\symup{electron}}[\symup{final}] \)</code>	<code>\)</code>	$E_{\text{electron},\text{final}}$

N 2021-02-13

`\systemenergy[<label>]`

Symbol for system energy.

<code>\( \systemenergy \)</code>	<code>\)</code>	$E_{\text{sys}}$
<code>\( \systemenergy[\symup{final}] \)</code>	<code>\)</code>	$E_{\text{sys},\text{final}}$

N 2021-02-13

`\particleenergy[<label>]`

Symbol for particle energy.

<code>\( \particleenergy \)</code>	<code>\)</code>	$E_{\text{particle}}$
<code>\( \particleenergy[\symup{final}] \)</code>	<code>\)</code>	$E_{\text{particle},\text{final}}$

N 2021-02-13

`\restenergy[<label>]`

Symbol for rest energy.

<code>\( \restenergy \)</code>	<code>\)</code>	$E_{\text{rest}}$
<code>\( \restenergy[\symup{final}] \)</code>	<code>\)</code>	$E_{\text{rest},\text{final}}$

N 2021-02-13

`\internalenergy[⟨label⟩]`

Symbol for internal energy.

`\( \internalenergy \) \\  
\( \internalenergy[\symup{final}] \)`

$E_{\text{internal}}$   
 $E_{\text{internal,final}}$

N 2021-02-13

`\chemicalenergy[⟨label⟩]`

Symbol for chemical energy.

`\( \chemicalenergy \) \\  
\( \chemicalenergy[\symup{final}] \)`

$E_{\text{chem}}$   
 $E_{\text{chem,final}}$

N 2021-02-13

`\thermalenergy[⟨label⟩]`

Symbol for thermal energy.

`\( \thermalenergy \) \\  
\( \thermalenergy[\symup{final}] \)`

$E_{\text{therm}}$   
 $E_{\text{therm,final}}$

N 2021-02-13

`\photonenergy[⟨label⟩]`

Symbol for photon energy.

`\( \photonenergy \) \\  
\( \photonenergy[\symup{final}] \)`

$E_{\text{photon}}$   
 $E_{\text{photon,final}}$

N 2021-02-13

`\translationalkineticenergy[⟨label⟩]`

N 2021-02-13

`\translationalkineticenergy*[⟨label⟩]`

Symbol for translational kinetic energy. The starred variant gives  $E$  notation.

`\( \translationalkineticenergy \) \\  
\( \translationalkineticenergy[\symup{initial}] \) \\  
\( \translationalkineticenergy* \) \\  
\( \translationalkineticenergy*[\symup{initial}] \)`

$K_{\text{trans}}$   
 $K_{\text{trans,initial}}$   
 $E_K$   
 $E_{K,\text{initial}}$

N 2021-02-13

`\rotationalkineticenergy[⟨label⟩]`

N 2021-02-13

`\rotationalkineticenergy*[⟨label⟩]`

Symbol for rotational kinetic energy. The starred variant gives  $E$  notation.

`\( \rotationalkineticenergy \) \\  
\( \rotationalkineticenergy[\symup{initial}] \) \\  
\( \rotationalkineticenergy* \) \\  
\( \rotationalkineticenergy*[\symup{initial}] \)`

$K_{\text{rot}}$   
 $K_{\text{rot,initial}}$   
 $E_{\text{rot}}$   
 $E_{\text{rot,initial}}$

N 2021-02-13  
N 2021-02-13

**\vibrationalkineticenergy**[\langle label \rangle]  
**\vibrationalkineticenergy\***[\langle label \rangle]

Symbol for vibrational kinetic energy. The starred variant gives  $E$  notation.

<code>\( \vibrationalkineticenergy \)</code>	<code>\)</code>	$K_{\text{vib}}$
<code>\( \vibrationalkineticenergy[\text{symup}{initial}] \)</code>	<code>\)</code>	$K_{\text{vib,initial}}$
<code>\( \vibrationalkineticenergy* \)</code>	<code>\)</code>	$E_{\text{vib}}$
<code>\( \vibrationalkineticenergy*[\text{symup}{initial}] \)</code>	<code>\)</code>	$E_{\text{vib,initial}}$

N 2021-02-13

**\gravitationalpotentialenergy**[\langle label \rangle]

Symbol for gravitational potential energy.

<code>\( \gravitationalpotentialenergy \)</code>	<code>\)</code>	$U_{\text{g}}$
<code>\( \gravitationalpotentialenergy[\text{symup}{final}] \)</code>	<code>\)</code>	$U_{\text{g,final}}$

N 2021-02-13

**\electricpotentialenergy**[\langle label \rangle]

Symbol for electric potential energy.

<code>\( \electricpotentialenergy \)</code>	<code>\)</code>	$U_{\text{e}}$
<code>\( \electricpotentialenergy[\text{symup}{final}] \)</code>	<code>\)</code>	$U_{\text{e,final}}$

N 2021-02-13

**\springpotentialenergy**[\langle label \rangle]

Symbol for spring potential energy.

<code>\( \springpotentialenergy \)</code>	<code>\)</code>	$U_{\text{s}}$
<code>\( \springpotentialenergy[\text{symup}{final}] \)</code>	<code>\)</code>	$U_{\text{s,final}}$

### 5.3 mandiexp Source Code

Define the package version and date for global use, exploiting the fact that in a .sty file there is now no need for `\makeatletter` and `\makeatother`. This simplifies defining internal commands, with @ in the name, that are not for the user to know about.

```

1 \def\mandiexp@version{3.0.2}
2 \def\mandiexp@date{2021-09-20}
3 \NeedsTeXFormat{LaTeX2e}[2020-02-02]
4 \DeclareRelease{v3.0.2}{2021-09-20}{mandiexp.sty}
5 \DeclareCurrentRelease{v\mandiexp@version}{\mandiexp@date}
6 \ProvidesPackage{mandiexp}
7 [\mandiexp@date\space v\mandiexp@version\space Macros for Matter & Interactions]

```

Define a convenient package version command.

```

8 \newcommand*{\mandiexpversion}{v\mandiexp@version\space dated \mandiexp@date}
9 \RequirePackage{mandi}

10 \IfFormatAtLeastTF {2020-10-01} % load xparse if necessary
11 {}%
12 {\RequirePackage{xparse}}%

13 \typeout{}%
14 \typeout{mandiexp: You are using mandiexp \mandiexpversion.}
15 \typeout{mandiexp: This package requires LuaLaTeX.}%
16 \typeout{}%
17 %
18 % Commands specific to Matter & Interactions
19 % The momentum principle
20 \NewDocumentCommand{\lhsmomentumprinciple}{s}{%
21   \Delta
22   \IfBooleanTF{#1}%
23     {\vec*{p}}%
24     {\vec{p}}%
25   _{\symup{sys}}}%
26 }%
27 \NewDocumentCommand{\rhsmomentumprinciple}{s}{%
28   \IfBooleanTF{#1}%
29     {\vec*{F}}%
30     {\vec{F}}%
31   _{\symup{sys,net}}\,\Delta t%
32 }%
33 \NewDocumentCommand{\lhsmomentumprincipleupdate}{s}{%
34   \IfBooleanTF{#1}%
35     {\vec*{p}}%
36     {\vec{p}}%
37   _{\symup{sys,final}}}%
38 }%
39 \NewDocumentCommand{\rhsmomentumprincipleupdate}{s}{%
40   \IfBooleanTF{#1}%
41     {\vec*{p}}%
42     {\vec{p}}%
43   _{\symup{sys,initial}}+}%
44   \IfBooleanTF{#1}%
45     {\vec*{F}}%
46     {\vec{F}}%
47   _{\symup{sys,net}}\,\Delta t%
48 }%
49 \NewDocumentCommand{\momentumprinciple}{s}{%
50   \IfBooleanTF{#1}%

```

```

51    {\lhsmomentumprinciple* = \rhsmomentumprinciple*}%
52    {\lhsmomentumprinciple = \rhsmomentumprinciple}%
53 }%
54 \NewDocumentCommand{\momentumprincipleupdate}{s}{%
55   \IfBooleanTF{#1}%
56     {\lhsmomentumprincipleupdate* = \rhsmomentumprincipleupdate*}%
57     {\lhsmomentumprincipleupdate = \rhsmomentumprincipleupdate}%
58 }%
59 % The momentum principle
60 \NewDocumentCommand{\lhsenergyprinciple}{}{}%
61   \Delta E_{\symup{sys}}%
62 }%
63 \NewDocumentCommand{\rhsenergyprinciple}{O{}}{}%
64   W_{\symup{ext}}#1%
65 }%
66 \NewDocumentCommand{\lhsenergyprincipleupdate}{}{}%
67   E_{\symup{sys,final}}%
68 }%
69 \NewDocumentCommand{\rhsenergyprincipleupdate}{O{}}{}%
70   E_{\symup{sys,initial}}+%
71   W_{\symup{ext}}#1%
72 }%
73 \NewDocumentCommand{\energyprinciple}{}{O{}}{}%
74   \lhsenergyprinciple = \rhsenergyprinciple[#1]%
75 }%
76 \NewDocumentCommand{\energyprincipleupdate}{O{}}{}%
77   \lhsenergyprincipleupdate = \rhsenergyprincipleupdate[#1]%
78 }%
79 % The angular momentum principle
80 \NewDocumentCommand{\lhsangularmomentumprinciple}{s}{%
81   \Delta
82   \IfBooleanTF{#1}%
83     {\vec*{L}}%
84     {\vec{L}}%
85   _{A\symup{,sys,net}}%
86 }%
87 \NewDocumentCommand{\rhsangularmomentumprinciple}{s}{%
88   \IfBooleanTF{#1}%
89     {\vec*{\tau}}%
90     {\vec{\tau}}%
91   _{A\symup{,sys,net}}\,\Delta t%
92 }%
93 \NewDocumentCommand{\lhsangularmomentumprincipleupdate}{s}{%
94   \IfBooleanTF{#1}%
95     {\vec*{L}}%
96     {\vec{L}}%
97   _{A,\symup{sys,final}}%
98 }%
99 \NewDocumentCommand{\rhsangularmomentumprincipleupdate}{s}{%
100   \IfBooleanTF{#1}%
101     {\vec*{L}}%
102     {\vec{L}}%
103   _{A\symup{,sys,initial}}+%
104   \IfBooleanTF{#1}%
105     {\vec*{\tau}}%
106     {\vec{\tau}}%
107   _{A\symup{,sys,net}}\,\Delta t%
108 }%
109 \NewDocumentCommand{\angularmomentumprinciple}{s}{%

```

```

110 \IfBooleanTF{#1}%
111   {\lhsangularmomentumprinciple* = \rhsangularmomentumprinciple*}%
112   {\lhsangularmomentumprinciple = \rhsangularmomentumprinciple}%
113 }%
114 \NewDocumentCommand{\angularmomentumprincipleupdate}{s}{%
115   \IfBooleanTF{#1}%
116   {\lhsangularmomentumprincipleupdate* = \rhsangularmomentumprincipleupdate*}%
117   {\lhsangularmomentumprincipleupdate = \rhsangularmomentumprincipleupdate}%
118 }%
119 \NewDocumentCommand{\energyof}{mo}{%
120   E_{#1\IfValueT{#2}{, #2}}%
121 }%
122 \NewDocumentCommand{\systemenergy}{o}{%
123   E_{\symup{sys}\IfValueT{#1}{, #1}}%
124 }%
125 \NewDocumentCommand{\particleenergy}{o}{%
126   E_{\symup{particle}\IfValueT{#1}{, #1}}%
127 }%
128 \NewDocumentCommand{\restenergy}{o}{%
129   E_{\symup{rest}\IfValueT{#1}{, #1}}%
130 }%
131 \NewDocumentCommand{\internalenergy}{o}{%
132   E_{\symup{internal}\IfValueT{#1}{, #1}}%
133 }%
134 \NewDocumentCommand{\chemicalenergy}{o}{%
135   E_{\symup{chem}\IfValueT{#1}{, #1}}%
136 }%
137 \NewDocumentCommand{\thermalenergy}{o}{%
138   E_{\symup{therm}\IfValueT{#1}{, #1}}%
139 }%
140 \NewDocumentCommand{\photonenergy}{o}{%
141   E_{\symup{photon}\IfValueT{#1}{, #1}}%
142 }%
143 \NewDocumentCommand{\translationalkineticenergy}{sd[]}{%
144 % d[] must be used because of the way consecutive optional
145 % arguments are handled. See xparse docs for details.
146 % See https://tex.stackexchange.com/a/569011/218142
147 \IfBooleanTF{#1}%
148   {E_{\bgroup \symup{K}}}%
149   {K_{\bgroup \symup{trans}}}%
150   \IfValueT{#2}{, #2}%
151   \egroup%
152 }%
153 \NewDocumentCommand{\rotationalkineticenergy}{sd[]}{%
154 % d[] must be used because of the way consecutive optional
155 % arguments are handled. See xparse docs for details.
156 % See https://tex.stackexchange.com/a/569011/218142
157 \IfBooleanTF{#1}%
158   {E_{\bgroup}}%
159   {K_{\bgroup}}%
160   \symup{rot}\IfValueT{#2}{, #2}%
161   \egroup%
162 }%
163 \NewDocumentCommand{\vibrationalkineticenergy}{sd[]}{%
164 % d[] must be used because of the way consecutive optional
165 % arguments are handled. See xparse docs for details.
166 % See https://tex.stackexchange.com/a/569011/218142
167 \IfBooleanTF{#1}%
168   {E_{\bgroup}}%

```

```

169 {K_\bgroup}%
170     \symup{vib}\IfValueT{#2}{, #2}%
171     \egroup%
172 }%
173 \NewDocumentCommand{\gravitationalpotentialenergy}{ o }{%
174     U_{\symup{g}\IfValueT{#1}{, #1}}%
175 }%
176 \NewDocumentCommand{\electricpotentialenergy}{ o }{%
177     U_{\symup{e}\IfValueT{#1}{, #1}}%
178 }%
179 \NewDocumentCommand{\springpotentialenergy}{ o }{%
180     U_{\symup{s}\IfValueT{#1}{, #1}}%
181 }%

```



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