

# The **mandi** Package

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## Acknowledgements

TO BE COMPLETED

# Change History

v3.0.0c  
General: Initial release. . . . . 6

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# 1 Introduction

This is the documentation for the `mandi`,<sup>1</sup> which is designed primarily for students in introductory physics courses. This document serves to document what commands `mandi` provides and does not necessarily fully demonstrate how students would use them. There is a separate document that serves that purpose.

## 1.1 Loading the Package

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

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

## 1.2 Package Options

N 2021-01-30

N 2021-01-30

`units`=(*type of unit*) (initially unspecified, set to **alternate**)  
`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**.

## 1.3 The `mandisetup` Command

N 2021-02-17

`\mandisetup{<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.

# 2 Intelligent Commands for Physical Quantities and Constants

## 2.1 Physical Quantities

### 2.1.1 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. Here are all the ways to access this quantity and its units in `mandi`.

`\momentum{<magnitude>}`  
`\vectormomentum{<c1, ..., cn>}`

Command for momentum and its vector variant. 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.

---

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

<code>\momentum{5}</code>	<code>\\</code>	5 kg·m/s
<code>\momentumvalue{5}</code>	<code>\\</code>	5
<code>\momentumbaseunits{5}</code>	<code>\\</code>	5 m·kg·s <sup>-1</sup>
<code>\momentumderivedunits{5}</code>	<code>\\</code>	5 N·s
<code>\momentumalternateunits{5}</code>	<code>\\</code>	5 kg·m/s
<code>\momentumonlybaseunits</code>	<code>\\</code>	m·kg·s <sup>-1</sup>
<code>\momentumonlyderivedunits</code>	<code>\\</code>	N·s
<code>\momentumonlyalternateunits</code>	<code>\\</code>	kg·m/s
<code>\vectormomentum{2,3,4}</code>	<code>\\</code>	$\langle 2, 3, 4 \rangle$ kg·m/s
<code>\momentum{\mivector{2,3,4}}</code>		$\langle 2, 3, 4 \rangle$ kg·m/s

### 2.1.2 Checking Physical Quantities

N 2021-02-16

`\checkquantity{<name>}`

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

### 2.1.3 Commands For 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. 30</sup> instead.

`\acceleration{<magnitude>}`

`\vectoracceleration{<c1, ..., cn>}`

name	base	derived	alternate
<code>\acceleration</code>	m·s <sup>-2</sup>	N/kg	m/s <sup>2</sup>

`\amount{<magnitude>}`

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

`\angularacceleration{<magnitude>}`

`\vectorangularacceleration{<c1, ..., cn>}`

name	base	derived	alternate
<code>\angularacceleration</code>	rad·s <sup>-2</sup>	rad/s <sup>2</sup>	rad/s <sup>2</sup>

`\angularfrequency{<magnitude>}`

name	base	derived	alternate
<code>\angularfrequency</code>	rad·s <sup>-1</sup>	rad/s	rad/s

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

name	base	derived	alternate
\charge	$\text{A} \cdot \text{s}$	$\text{C}$	$\text{C}$

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



name <code>\cmagneticfield</code>	base $\text{m}\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-1}$	derived V/m	alternate N/C
<code>\conductance</code> $\{\langle magnitude \rangle\}$			
name <code>\conductance</code>	base $\text{m}^{-2}\cdot\text{kg}^{-1}\cdot\text{s}^3\cdot\text{A}^2$	derived S	alternate A/V
<code>\conductivity</code> $\{\langle magnitude \rangle\}$			
name <code>\conductivity</code>	base $\text{m}^{-3}\cdot\text{kg}^{-1}\cdot\text{s}^3\cdot\text{A}^2$	derived S/m	alternate $(\text{A}/\text{m}^2)/(\text{V}/\text{m})$
<code>\conventionalcurrent</code> $\{\langle magnitude \rangle\}$			
name <code>\conventionalcurrent</code>	base A	derived C/s	alternate A
<code>\current</code> $\{\langle magnitude \rangle\}$			
name <code>\current</code>	base A	derived A	alternate A
<code>\currentdensity</code> $\{\langle magnitude \rangle\}$ <code>\vectorcurrentdensity</code> $\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\currentdensity</code>	base $\text{m}^{-2}\cdot\text{A}$	derived $\text{C}\cdot\text{s}/\text{m}^2$	alternate $\text{A}/\text{m}^2$
<code>\dielectricconstant</code> $\{\langle magnitude \rangle\}$			
name <code>\dielectricconstant</code>	base	derived	alternate
<code>\displacement</code> $\{\langle magnitude \rangle\}$ <code>\vectordisplacement</code> $\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\displacement</code>	base m	derived m	alternate m
<code>\duration</code> $\{\langle magnitude \rangle\}$			
name <code>\duration</code>	base s	derived s	alternate s
<code>\electricdipolemoment</code> $\{\langle magnitude \rangle\}$ <code>\vectorelectricdipolemoment</code> $\{\langle c_1, \dots, c_n \rangle\}$			

name <code>\electricdipolemoment</code>	base $\text{m}\cdot\text{s}\cdot\text{A}$	derived $\text{C}\cdot\text{m}$	alternate $\text{C}\cdot\text{m}$
$\backslash\text{electricfield}\{\langle magnitude \rangle\}$ $\backslash\text{vectorelectricfield}\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\electricfield</code>	base $\text{m}\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-1}$	derived $\text{V}/\text{m}$	alternate $\text{N}/\text{C}$
$\backslash\text{electricflux}\{\langle magnitude \rangle\}$			
name <code>\electricflux</code>	base $\text{m}^3\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-1}$	derived $\text{V}\cdot\text{m}$	alternate $\text{N}\cdot\text{m}^2/\text{C}$
$\backslash\text{electricpotential}\{\langle magnitude \rangle\}$			
name <code>\electricpotential</code>	base $\text{m}^2\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-1}$	derived $\text{V}$	alternate $\text{J}/\text{C}$
$\backslash\text{electroncurrent}\{\langle magnitude \rangle\}$			
name <code>\electroncurrent</code>	base $\text{s}^{-1}$	derived $\text{e}/\text{s}$	alternate $\text{e}/\text{s}$
$\backslash\text{emf}\{\langle magnitude \rangle\}$			
name <code>\emf</code>	base $\text{m}^2\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-1}$	derived $\text{V}$	alternate $\text{J}/\text{C}$
$\backslash\text{energy}\{\langle magnitude \rangle\}$			
name <code>\energy</code>	base $\text{m}^2\cdot\text{kg}\cdot\text{s}^{-2}$	derived $\text{J}$	alternate $\text{J}$
$\backslash\text{energydensity}\{\langle magnitude \rangle\}$			
name <code>\energydensity</code>	base $\text{m}^{-1}\cdot\text{kg}\cdot\text{s}^{-2}$	derived $\text{J}/\text{m}^3$	alternate $\text{J}/\text{m}^3$
$\backslash\text{energyflux}\{\langle magnitude \rangle\}$ $\backslash\text{vectorenergyflux}\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\energyflux</code>	base $\text{kg}\cdot\text{s}^{-3}$	derived $\text{W}/\text{m}^2$	alternate $\text{W}/\text{m}^2$
$\backslash\text{entropy}\{\langle magnitude \rangle\}$			

name <code>\entropy</code>	base $\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{K}^{-1}$	derived J/K	alternate J/K
$\backslash\text{force}\{\langle magnitude \rangle\}$ $\backslash\text{vectorforce}\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\force</code>	base $\text{m} \cdot \text{kg} \cdot \text{s}^{-2}$	derived N	alternate N
$\backslash\text{frequency}\{\langle magnitude \rangle\}$			
name <code>\frequency</code>	base $\text{s}^{-1}$	derived Hz	alternate Hz
$\backslash\text{gravitationalfield}\{\langle magnitude \rangle\}$ $\backslash\text{vectorgravitationalfield}\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\gravitationalfield</code>	base $\text{m} \cdot \text{s}^{-2}$	derived N/kg	alternate N/kg
$\backslash\text{gravitationalpotential}\{\langle magnitude \rangle\}$			
name <code>\gravitationalpotential</code>	base $\text{m}^2 \cdot \text{s}^{-2}$	derived J/kg	alternate J/kg
$\backslash\text{impulse}\{\langle magnitude \rangle\}$ $\backslash\text{vectorimpulse}\{\langle c_1, \dots, c_n \rangle\}$			
name <code>\impulse</code>	base $\text{m} \cdot \text{kg} \cdot \text{s}^{-1}$	derived N·s	alternate N·s
$\backslash\text{indexofrefraction}\{\langle magnitude \rangle\}$			
name <code>\indexofrefraction</code>	base	derived	alternate
$\backslash\text{inductance}\{\langle magnitude \rangle\}$			
name <code>\inductance</code>	base $\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{A}^{-2}$	derived H	alternate V·s/A
$\backslash\text{linearchargedensity}\{\langle magnitude \rangle\}$			
name <code>\linearchargedensity</code>	base $\text{m}^{-1} \cdot \text{s} \cdot \text{A}$	derived C/m	alternate C/m
$\backslash\text{linearmassdensity}\{\langle magnitude \rangle\}$			

name <code>\linearmassdensity</code>	base $\text{m}^{-1} \cdot \text{kg}$	derived kg/m	alternate kg/m
<code>\luminous{\langle magnitude \rangle}</code>			
name <code>\luminous</code>	base cd	derived cd	alternate cd
<code>\magneticcharge{\langle magnitude \rangle}</code>			
name <code>\magneticcharge</code>	base $\text{m} \cdot \text{A}$	derived $\text{m} \cdot \text{A}$	alternate $\text{m} \cdot \text{A}$
<code>\magneticdipolemoment{\langle magnitude \rangle}</code> <code>\vectormagneticdipolemoment{\langle c_1, \dots, c_n \rangle}</code>			
name <code>\magneticdipolemoment</code>	base $\text{m}^2 \cdot \text{A}$	derived $\text{A} \cdot \text{m}^2$	alternate J/T
<code>\magneticfield{\langle magnitude \rangle}</code> <code>\vectormagneticfield{\langle c_1, \dots, c_n \rangle}</code>			
name <code>\magneticfield</code>	base $\text{kg} \cdot \text{s}^{-2} \cdot \text{A}^{-1}$	derived T	alternate $\text{N/C} \cdot (\text{m/s})$
<code>\magneticflux{\langle magnitude \rangle}</code>			
name <code>\magneticflux</code>	base $\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{A}^{-1}$	derived $\text{T} \cdot \text{m}^2$	alternate V·s
<code>\mass{\langle magnitude \rangle}</code>			
name <code>\mass</code>	base kg	derived kg	alternate kg
<code>\mobility{\langle magnitude \rangle}</code>			
name <code>\mobility</code>	base $\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-4} \cdot \text{A}^{-1}$	derived $\text{m}^2/\text{V} \cdot \text{s}$	alternate $(\text{m/s})/(\text{N/C})$
<code>\momentofinertia{\langle magnitude \rangle}</code>			
name <code>\momentofinertia</code>	base $\text{m}^2 \cdot \text{kg}$	derived $\text{J} \cdot \text{s}^2$	alternate $\text{kg} \cdot \text{m}^2$
<code>\momentum{\langle magnitude \rangle}</code> <code>\vectormomentum{\langle c_1, \dots, c_n \rangle}</code>			

name <code>\momentum</code>	base $\text{m}\cdot\text{kg}\cdot\text{s}^{-1}$	derived N·s	alternate kg·m/s
<code>\momentumflux</code> { <i>magnitude</i> } <code>\vectormomentumflux</code> { $\langle c_1, \dots, c_n \rangle$ }			
name <code>\momentumflux</code>	base $\text{m}^{-1}\cdot\text{kg}\cdot\text{s}^{-2}$	derived N/m <sup>2</sup>	alternate N/m <sup>2</sup>
<code>\numberdensity</code> { <i>magnitude</i> }			
name <code>\numberdensity</code>	base $\text{m}^{-3}$	derived /m <sup>3</sup>	alternate /m <sup>3</sup>
<code>\permeability</code> { <i>magnitude</i> }			
name <code>\permeability</code>	base $\text{m}\cdot\text{kg}\cdot\text{s}^{-2}\cdot\text{A}^{-2}$	derived T·m/A	alternate H/m
<code>\permittivity</code> { <i>magnitude</i> }			
name <code>\permittivity</code>	base $\text{m}^{-3}\cdot\text{kg}^{-1}\cdot\text{s}^{-4}\cdot\text{A}^2$	derived F/m	alternate C <sup>2</sup> /N·m <sup>2</sup>
<code>\planeangle</code> { <i>magnitude</i> }			
name <code>\planeangle</code>	base $\text{m}\cdot\text{m}^{-1}$	derived rad	alternate rad
<code>\polarizability</code> { <i>magnitude</i> }			
name <code>\polarizability</code>	base $\text{kg}^{-1}\cdot\text{s}^4\cdot\text{A}^2$	derived C·m <sup>2</sup> /V	alternate C·m/(N/C)
<code>\power</code> { <i>magnitude</i> }			
name <code>\power</code>	base $\text{m}^2\cdot\text{kg}\cdot\text{s}^{-3}$	derived W	alternate J/s
<code>\poynting</code> { <i>magnitude</i> } <code>\vectorpoynting</code> { $\langle c_1, \dots, c_n \rangle$ }			
name <code>\poynting</code>	base $\text{kg}\cdot\text{s}^{-3}$	derived W/m <sup>2</sup>	alternate W/m <sup>2</sup>
<code>\pressure</code> { <i>magnitude</i> }			

name <code>\pressure</code>	base $\text{m}^{-1}\cdot\text{kg}\cdot\text{s}^{-2}$	derived Pa	alternate $\text{N}/\text{m}^2$
<code>\relativepermeability{&lt;magnitude&gt;}</code>			
name <code>\relativepermeability</code>	base	derived	alternate
<code>\relativepermittivity{&lt;magnitude&gt;}</code>			
name <code>\relativepermittivity</code>	base	derived	alternate
<code>\resistance{&lt;magnitude&gt;}</code>			
name <code>\resistance</code>	base $\text{m}^2\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-2}$	derived V/A	alternate $\Omega$
<code>\resistivity{&lt;magnitude&gt;}</code>			
name <code>\resistivity</code>	base $\text{m}^3\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-2}$	derived $\Omega\cdot\text{m}$	alternate $(\text{V}/\text{m})/(\text{A}/\text{m}^2)$
<code>\solidangle{&lt;magnitude&gt;}</code>			
name <code>\solidangle</code>	base $\text{m}^2\cdot\text{m}^{-2}$	derived sr	alternate sr
<code>\specificheatcapacity{&lt;magnitude&gt;}</code>			
name <code>\specificheatcapacity</code>	base $\text{m}^2\cdot\text{s}^{-2}\cdot\text{K}^{-1}$	derived J/K·kg	alternate J/K·kg
<code>\springstiffness{&lt;magnitude&gt;}</code>			
name <code>\springstiffness</code>	base $\text{kg}\cdot\text{s}^{-2}$	derived N/m	alternate N/m
<code>\springstretch{&lt;magnitude&gt;}</code>			
name <code>\springstretch</code>	base m	derived m	alternate m
<code>\stress{&lt;magnitude&gt;}</code>			
name <code>\stress</code>	base $\text{m}^{-1}\cdot\text{kg}\cdot\text{s}^{-2}$	derived Pa	alternate $\text{N}/\text{m}^2$

<b>\strain</b> { <i>\langle magnitude \rangle</i> }			
name \strain	base	derived	alternate
<b>\temperature</b> { <i>\langle magnitude \rangle</i> }			
name \temperature	base K	derived K	alternate K
<b>\torque</b> { <i>\langle magnitude \rangle</i> }			
<b>\vectortorque</b> { <i>\langle c_1, \dots, c_n \rangle</i> }			
name \torque	base $\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2}$	derived N·m	alternate N·m
<b>\velocity</b> { <i>\langle magnitude \rangle</i> }			
<b>\velocityc</b> { <i>\langle magnitude \rangle</i> }			
<b>\vectorvelocity</b> { <i>\langle c_1, \dots, c_n \rangle</i> }			
<b>\vectorvelociyc</b> { <i>\langle c_1, \dots, c_n \rangle</i> }			
name \velocity	base $\text{m} \cdot \text{s}^{-1}$	derived $\text{m} \cdot \text{s}^{-1}$	alternate m/s
name \velocityc	base c	derived	alternate c
<b>\volume</b> { <i>\langle magnitude \rangle</i> }			
name \volume	base $\text{m}^3$	derived $\text{m}^3$	alternate $\text{m}^3$
<b>\volumechargedensity</b> { <i>\langle magnitude \rangle</i> }			
name \volumechargedensity	base $\text{m}^{-3} \cdot \text{s} \cdot \text{A}$	derived C/ $\text{m}^3$	alternate C/ $\text{m}^3$
<b>\volumemassdensity</b> { <i>\langle magnitude \rangle</i> }			
name \volumemassdensity	base $\text{m}^{-3} \cdot \text{kg}$	derived kg/ $\text{m}^3$	alternate kg/ $\text{m}^3$
<b>\wavelength</b> { <i>\langle magnitude \rangle</i> }			
name \wavelength	base m	derived m	alternate m

```
\wavenumber{<magnitude>}
\vectorwavenumber{<c1, ..., cn>}
```

name	base	derived	alternate
\wavenumber	m <sup>-1</sup>	/m	/m

```
\work{<magnitude>}
```

name	base	derived	alternate
\work	m <sup>2</sup> ·kg·s <sup>-2</sup>	J	N·m

```
\youngsm modulus{<magnitude>}
```

name	base	derived	alternate
\youngsm modulus	m <sup>-1</sup> ·kg·s <sup>-2</sup>	Pa	N/m <sup>2</sup>

### 2.1.4 Defining Your Own Physical Quantities

It is important to *not* define a quantity with the same name using *both* `\newscalarquantity` and `\newvectorquantity` because the latter automatically defines both scalar and vector variants. For example in the case of `\momentum`<sup>P.6</sup> both `\momentum` and `\vectormomentum` are defined. The scalar variant is useful for typesetting magnitudes.

N 2021-02-16

```
\newscalarquantity{<name>}{<base units>}[<derived units>][<alternate units>]
```

Command to define a new scalar quantity. If the derived or alternate units are omitted, they are defined to be the same as the base unit.

N 2021-02-16

```
\newvectorquantity{<name>}{<base units>}[<derived units>][<alternate units>]
```

Command to define a new vector quantity. If the derived or alternate units are omitted, they are defined to be the same as the base unit.

### 2.1.5 Setting Global Units

```
\alwaysusebaseunits
\alwaysusederivedunits
\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.

### 2.1.6 Setting Units for a Single Instance

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

### 2.1.7 Setting Units in an Environment

<code>\begin{usebaseunits}</code>	(use base units)
<code>\end{usebaseunits}</code>	
<code>\begin{usederivedunits}</code>	(use derived units)
<code>\end{usederivedunits}</code>	
<code>\begin{usealternateunits}</code>	(use alternate units)
<code>\end{usealternateunits}</code>	

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

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

## 2.2 Physical Constants

### 2.2.1 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>\</code>	$9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
<code>\oofpezapproximatevalue</code>	<code>\</code>	$9 \times 10^9$
<code>\oofpezprecisevalue</code>	<code>\</code>	$8.987551787 \times 10^9$
<code>\oofpezmathsymbol</code>	<code>\</code>	$\frac{1}{4\pi\epsilon_o}$
<code>\oofpezbaseunits</code>	<code>\</code>	$9 \times 10^9 \text{ m}^3\cdot\text{kg}\cdot\text{s}^{-4}\cdot\text{A}^{-2}$
<code>\oofpezderivedunits</code>	<code>\</code>	$9 \times 10^9 \text{ m/F}$
<code>\oofpezalternateunits</code>	<code>\</code>	$9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
<code>\oofpezonlybaseunits</code>	<code>\</code>	$\text{m}^3\cdot\text{kg}\cdot\text{s}^{-4}\cdot\text{A}^{-2}$
<code>\oofpezonlyderivedunits</code>	<code>\</code>	$\text{m/F}$
<code>\oofpezonlyalternateunits</code>	<code>\</code>	$\text{N}\cdot\text{m}^2/\text{C}^2$

## 2.2.2 Checking Physical Constants

N 2021-02-16

`\checkconstant{(name)}`

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

## 2.2.3 Commands For 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 consult the next section for the names that have been used. Here are all the physical constants, with all their units, defined in `mandi`. The constants `\coulombconstant`<sup>P.19</sup> and `\biotsavartconstant` are defined as semantic aliases for, respectively, `\oofpez`<sup>P.21</sup> and `\mzofp`<sup>P.21</sup>.

`\avogadro`

name	base	derived	alternate
<code>\avogadro</code>	$\text{mol}^{-1}$	$\text{mol}^{-1}$	$\text{mol}^{-1}$
symbol	approximate	precise	
$N_A$	$6 \times 10^{23}$	$6.022140857 \times 10^{23}$	

N 2021-02-02

`\biotsavartconstant`

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

`\bohrradius`

name	base	derived	alternate
<code>\bohrradius</code>	$\text{m}$	$\text{m}$	$\text{m}$
symbol	approximate	precise	
$a_0$	$5.3 \times 10^{-11}$	$5.2917721067 \times 10^{-11}$	

### **\boltzmann**

name	base	derived	alternate
<code>\boltzmann</code>	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{K}^{-1}$	J/K	J/K
symbol	approximate	precise	
$k_B$	$1.4 \times 10^{-23}$	$1.38064852 \times 10^{-23}$	

N 2021-02-02

### **\coulombconstant**

name	base	derived	alternate
<code>\coulombconstant</code>	$\text{m}^3 \cdot \text{kg} \cdot \text{s}^{-4} \cdot \text{A}^{-2}$	m/F	$\text{N} \cdot \text{m}^2 / \text{C}^2$
symbol	approximate	precise	
$\frac{1}{4\pi\epsilon_0}$	$9 \times 10^9$	$8.9875517873681764 \times 10^9$	

### **\earthmass**

name	base	derived	alternate
<code>\earthmass</code>	kg	kg	kg
symbol	approximate	precise	
$M_{\text{Earth}}$	$6.0 \times 10^{24}$	$5.97237 \times 10^{24}$	

### **\earthmoondistance**

name	base	derived	alternate
<code>\earthmoondistance</code>	m	m	m
symbol	approximate	precise	
$d_{\text{EM}}$	$3.8 \times 10^8$	$3.81550 \times 10^8$	

### **\earthradius**

name	base	derived	alternate
<code>\earthradius</code>	m	m	m
symbol	approximate	precise	
$R_{\text{Earth}}$	$6.4 \times 10^6$	$6.371 \times 10^6$	

### **\earth sundistance**

name	base	derived	alternate
<code>\earth sundistance</code>	m	m	m
symbol	approximate	precise	
$d_{\text{ES}}$	$1.5 \times 10^{11}$	$1.496 \times 10^{11}$	

### **\electroncharge**

name	base	derived	alternate
<code>\electroncharge</code>	A·s	C	C
symbol	approximate	precise	
$q_e$	$-1.6 \times 10^{-19}$	$-1.6021766208 \times 10^{-19}$	

### **\electronCharge**

name	base	derived	alternate
\electronCharge	A·s	C	C
symbol	approximate	precise	
$Q_e$	$-1.6 \times 10^{-19}$	$-1.6021766208 \times 10^{-19}$	

### **\electronmass**

name	base	derived	alternate
\electronmass	kg	kg	kg
symbol	approximate	precise	
$m_e$	$9.1 \times 10^{-31}$	$9.10938356 \times 10^{-31}$	

### **\elementarycharge**

name	base	derived	alternate
\elementarycharge	A·s	C	C
symbol	approximate	precise	
$e$	$1.6 \times 10^{-19}$	$1.6021766208 \times 10^{-19}$	

### **\finestructure**

name	base	derived	alternate
\finestructure			
symbol	approximate	precise	
$\alpha$	$\frac{1}{137}$	$7.2973525664 \times 10^{-3}$	

### **\hydrogenmass**

name	base	derived	alternate
\hydrogenmass	kg	kg	kg
symbol	approximate	precise	
$m_H$	$1.7 \times 10^{-27}$	$1.6737236 \times 10^{-27}$	

### **\moonearthdistance**

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

### **\moonmass**

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

### \moonradius

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

### \mzofp

name	base	derived	alternate
\mzofp			
symbol	approximate	precise	

### \neutronmass

name	base	derived	alternate
\neutronmass	kg	kg	kg
symbol	approximate	precise	
$m_n$	$1.7 \times 10^{-27}$	$1.674927471 \times 10^{-27}$	

### \oofpez

name	base	derived	alternate
\oofpez	$\text{m}^3 \cdot \text{kg} \cdot \text{s}^{-4} \cdot \text{A}^{-2}$	m/F	$\text{N} \cdot \text{m}^2 / \text{C}^2$
symbol	approximate	precise	
$\frac{1}{4\pi\epsilon_o}$	$9 \times 10^9$	$8.987551787 \times 10^9$	

### \oofpezcs

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

### \planck

name	base	derived	alternate
\planck	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-1}$	J·s	J·s
symbol	approximate	precise	
$h$	$6.6 \times 10^{-34}$	$6.626070040 \times 10^{-34}$	

### \planckbar

name	base	derived	alternate
\planckbar	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-1}$	J·s	J·s
symbol	approximate	precise	
$\hbar$	$1.1 \times 10^{-34}$	$1.054571800 \times 10^{-34}$	

### **\planckc**

name	base	derived	alternate
\planckc	$\text{m}^3\cdot\text{kg}\cdot\text{s}^{-2}$	J·m	J·m
symbol	approximate	precise	
$hc$	$2.0 \times 10^{-25}$	$1.98644568 \times 10^{-25}$	

### **\protoncharge**

name	base	derived	alternate
\protoncharge	A·s	C	C
symbol	approximate	precise	
$q_p$	$+1.6 \times 10^{-19}$	$+1.6021766208 \times 10^{-19}$	

### **\protonCharge**

name	base	derived	alternate
\protonCharge	A·s	C	C
symbol	approximate	precise	
$Q_p$	$+1.6 \times 10^{-19}$	$+1.6021766208 \times 10^{-19}$	

### **\protonmass**

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

### **\rydberg**

name	base	derived	alternate
\rydberg	$\text{m}^{-1}$	$\text{m}^{-1}$	$\text{m}^{-1}$
symbol	approximate	precise	
$R_\infty$	$1.1 \times 10^7$	$1.0973731568508 \times 10^7$	

### **\speedoflight**

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

### **\stefanboltzmann**

name	base	derived	alternate
\stefanboltzmann	$\text{kg}\cdot\text{s}^{-3}\cdot\text{K}^{-4}$	$\text{W}/\text{m}^2\cdot\text{K}^4$	$\text{W}/\text{m}^2\cdot\text{K}^4$
symbol	approximate	precise	
$\sigma$	$5.7 \times 10^{-8}$	$5.670367 \times 10^{-8}$	

### \sunearthdistance

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

### \sunradius

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

### \surfacegravfield

name	base	derived	alternate
\surfacegravfield	m·s <sup>-2</sup>	N/kg	N/kg
symbol	approximate	precise	
$g$	9.8	9.807	

### \vacuumpermeability

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

### \vacuumpermittivity

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

## 2.2.4 Defining Your Own 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]

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

## 2.2.5 Setting Global Precision

N 2021-02-16

**\alwaysuseapproximateconstants**

N 2021-02-16

**\alwaysusepreciseconstants**

Modal commands (switches) for setting the default precision for the entire document. The default with the package is loaded is set by the presence or absence of the **preciseconstants** <sup>P.6</sup> key.

## 2.2.6 Setting Precision for a Single Instance

N 2021-02-16

```
\hereuseapproximateconstants{\content}
```

N 2021-02-16

```
\hereusepreciseconstants{\content}
```

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

```
\hereuseapproximateconstants{\oofpez} \\  
\hereusepreciseconstants{\oofpez}
```

$9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$   
 $8.987551787 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$

## 2.2.7 Setting Precision in an Environment

N 2021-02-16

```
\begin{useapproximateconstants} (use approximate constants)  
  \environment content
```

```
\end{useapproximateconstants}
```

N 2021-02-16

```
\begin{usepreciseconstants} (use precise constants)  
  \environment content
```

```
\end{usepreciseconstants}
```

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

```
\oofpez \\  
\begin{useapproximateconstants}  
  \oofpez \\  
\end{useapproximateconstants}  
\begin{usepreciseconstants}  
  \oofpez \\  
\end{usepreciseconstants}  
\oofpez
```

$9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$   
 $9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$   
 $8.987551787 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$   
 $9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$

# 3 GlowScript and VPython Program Listings

## 3.1 The `glowscripblock` Environment

U 2021-02-11

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

Code placed here is nicely formatted and optionally linked to its source on [GlowScript.org](https://www.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.



```

\begin{glowscripblock}(tinyurl.com/y3lnqyn3){A short \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 short 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 short GlowScript program](#) and is on page 26.

## 3.2 The `vpythonfile` Command

U 2021-02-11

`\vpythonfile` [*options*] {*file*} {*caption*}

Command to load and typeset a `VPython` program. The file is read from {*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.

```
\vpythonfile[hyperurl interior = https://vpython.org]{demo.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 [28](#).

### 3.3 The `glowscriptinline` and `vpythoninline` Commands

`\glowscriptinline{GlowScript code}`

`\vpythoninline{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 Commands for Writing Physics Problem Solutions

### 4.1 Introductory Needs

mandi provides a collection of commands physics students can use for writing problem solutions. This new version focuses on the most frequently needed tools. These commands should always be used in math mode.

#### 4.1.1 Traditional Vector Notation

`\vec{<symbol>}[<labels>]`

(use this variant for boldface notation)

`\vec*{<symbol>}[<labels>]`

(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.

```
\( \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} )
```

**$p$**   
 **$p_{\text{ball}}$**   
 **$p$**   
 **$p_{\text{final}}$**   
 **$p_{\text{final}}$**   
 **$p_{\text{final}}$**   
 **$p_{\text{ball}}$**   
 $\vec{p}$

`\zerovec`

(use this variant for boldface notation)

`\zerovec*`

(use this variant for arrow notation)

Command for typesetting the zero vector. The starred version gives arrow notation whereas without the star you get boldface notation.

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

$\mathbf{0}$   
 $\vec{0}$

`\Dvec{<symbol>}`

(use this variant for boldface notation)

`\Dvec*{<symbol>}`

(use this variant for arrow notation)

Command for typesetting the change in a vector. The starred variant gives arrow notation whereas without the star you get boldface notation. Subscript and superscript labels are not yet supported so if you need the symbol for the change in a subscripted or superscripted vector, just put `\changein` in front of it. This command must be used in math mode.

`\( \Dvec{r} \) \\\`  
`\( \Dvec*{r} \) \\\`

$\Delta \mathbf{r}$   
 $\Delta \vec{r}$

`\dirvec{<symbol>}`

(use this variant for boldface notation)

`\dirvec*{<symbol>}`

(use this variant for arrow notation)

Command for typesetting the direction of a vector. The starred variant gives arrow notation whereas without the star you get boldface notation. Subscript and superscript labels are not yet supported.

`\( \dirvec{r} \) \\\`  
`\( \dirvec*{r} \) \\\`

$\hat{\mathbf{r}}$   
 $\hat{\vec{r}}$

`\magvec{<symbol>}`

(use this variant for boldface notation)

`\magvec*{<symbol>}`

(use this variant for arrow notation)

Command for typesetting the magnitude of a vector. The starred variant gives arrow notation whereas without the star you get boldface notation. Subscript and superscript labels are not yet supported.

`\( \magvec{r} \) \\\`  
`\( \magvec*{r} \) \\\`

$\|\mathbf{r}\|$   
 $\|\vec{r}\|$

`\mivector[<delimiter>]{<c1, ..., cn>}[<units>]`

Typesets a vector as either numeric or symbolic components with an optional unit. 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*.

`\mivector{1,2,3} \\\`  
`\mivector{p_0,p_1,p_2,p_3} \\\`  
`\mivector{-1,0,0}[\meter\per\second] \\\`  
`\velocity{\mivector{-1,0,0}}`

$\langle 1, 2, 3 \rangle$   
 $\langle p_0, p_1, p_2, p_3 \rangle$   
 $\langle -1, 0, 0 \rangle \text{ m/s}$   
 $\langle -1, 0, 0 \rangle \text{ m/s}$

### 4.1.2 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.

<code>\veccomp{symbol}</code>	(use this variant for coordinate-free vector notation)
<code>\veccomp*{symbol}</code>	(use this variant for index vector notation)
<code>\tencomp{symbol}</code>	(use this variant for coordinate-free tensor notation)
<code>\tencomp*{symbol}</code>	(use this variant for index tensor notation)

Conforms to ISO 80000-2 notation.

<code>\( \veccomp{r} \) \\\</code>	$\mathbf{r}$
<code>\( \veccomp*{r} \) \\\</code>	$r$
<code>\( \tencomp{r} \) \\\</code>	$\mathbf{r}$
<code>\( \tencomp*{r} \) \\\</code>	$r$

### 4.1.3 Problems and Annotated Problem Solutions

<code>\begin{physicsproblem}{title}</code> <code>&lt;problem&gt;</code>	(use this variant for vertical lists)
<code>\end{physicsproblem}</code>	
<code>\begin{physicsproblem*}{title}</code> <code>&lt;problem&gt;</code>	(use this variant for in-line lists)
<code>\end{physicsproblem*}</code>	

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.

<pre>\begin{physicsproblem}{Problem 1}   This is a physics problem with no parts. \end{physicsproblem}</pre>	
<hr/>	
<b>Problem 1</b>	
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}
    \problempart This is the first part.
    \problempart This is the second part.
    \problempart 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 2021-02-02

```

\begin{physicssolution}
  <solution steps>

```

(use this variant for numbered steps)

U 2021-02-02

```

\end{physicssolution}
\begin{physicssolution*}
  <solution steps>
\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 2012-02-02

**\reason{(reason)}**

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.32</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}

```

N 2021-02-06

**\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 + (\Delta z)^2 \\
(\Delta s)^2 &= \hilite{-(\Delta t)^2 + (\Delta x)^2}[rounded rectangle] + (\Delta y)^2 + (\Delta z)^2 \\
(\Delta s)^2 &= \hilite{-(\Delta t)^2 + (\Delta x)^2}[rectangle] + (\Delta y)^2 + (\Delta z)^2 \\
(\Delta s)^2 &= \hilite{-(\Delta t)^2 + (\Delta x)^2}[ellipse] + (\Delta y)^2 + (\Delta z)^2 \\
(\Delta s)^2 &= \hilite{2}[circle] \{-(\Delta t)^2 + (\Delta x)^2\} + (\Delta y)^2 + (\Delta z)^2 \\
&\quad + (\Delta x)^2 \{-(\Delta t)^2 + (\Delta y)^2 + (\Delta z)^2\} + (\Delta y)^2 \{-(\Delta t)^2 + (\Delta x)^2 + (\Delta z)^2\} + (\Delta z)^2 \{-(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2\} \\
\end{align*}

```

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

```

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

```

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

$$\Delta \mathbf{p} = \mathbf{F}_{\text{net}} \Delta t$$

`\image[options]{caption}{label}{image}`

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.}{reffi1}
```



Figure 1: Image shown 20 percent actual size.

```
\image[scale=0.20,angle=45]{example-image-1x1}{Image shown 20 percent actual size and }
{rotated.}{reffi1}
```



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

## 4.2 Intermediate and Advanced Needs

`\colvec[delimiter]{c_1, ..., c_n}`  
`\rowvec[delimiter]{c_1, ..., c_n}`

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.

```
\( \colvec{1,2,3} \) \\  
\( \rowvec{1,2,3} \)
```

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

$$(1 \quad 2 \quad 3)$$

```
\valence{<index>}{<index>}  
\valence*{<index>}{<index>}
```

Typesets tensor valence. The starred variant typesets it horizontally.

```
\( \valence{2}{0} \) \\  
\( \valence*{2}{0} \)
```

$$\begin{pmatrix} 2 \\ 0 \end{pmatrix}$$

$$(2, 0)$$

```
\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 slot.

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

$$(\quad)$$

$$(\mathbf{a})$$

$$(\quad)$$

$$(\mathbf{a})$$

### 4.3 Useful Math Commands

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

Commands for powers of ten and scientific notation.

```
\tento{-4} \\  
3\timestento{8} \\  
3\xtento{8}
```

$$10^{-4}$$

$$3 \times 10^8$$

$$3 \times 10^8$$

## `\changein`

Semantic alias for `\Delta`.

<code>\norm[⟨size⟩]{⟨quantity⟩}</code>	(double bars)
<code>\norm*[⟨size⟩]{⟨quantity⟩}</code>	(double bars for fractions)
<code>\absv[⟨size⟩]{⟨quantity⟩}</code>	(single bars)
<code>\absv*[⟨size⟩]{⟨quantity⟩}</code>	(single bars for fractions)
<code>\angs[⟨size⟩]{⟨quantity⟩}</code>	(angle brackets)
<code>\angs*[⟨size⟩]{⟨quantity⟩}</code>	(angle brackets for fractions)
<code>\parentheses[⟨size⟩]{⟨quantity⟩}</code>	(parentheses)
<code>\parentheses*[⟨size⟩]{⟨quantity⟩}</code>	(parentheses for fractions)
<code>\dimensionsof[⟨size⟩]{⟨quantity⟩}</code>	(square brackets)
<code>\dimensionsof*[⟨size⟩]{⟨quantity⟩}</code>	(square brackets for fractions)
<code>\unitsof[⟨size⟩]{⟨quantity⟩}</code>	(curly braces)
<code>\unitsof*[⟨size⟩]{⟨quantity⟩}</code>	(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.

```
\[ \norm{} \]
\[ \norm{\vec{a}} \]
\[ \norm*{\frac{\vec{a}}{3}} \]
\[ \norm[\Bigg]{\frac{\vec{a}}{3}} \]
```

 $\| \cdot \|$ 
 $\| \boldsymbol{a} \|$ 
 $\left\| \frac{\boldsymbol{a}}{3} \right\|$ 
 $\left\| \frac{\boldsymbol{a}}{3} \right\|$ 

```
\[ \absv{} \]
\[ \absv{x} \]
\[ \absv*{\frac{x}{3}} \]
\[ \absv[\Bigg]{\frac{x}{3}} \]
```

 $| \cdot |$ 
 $|x|$ 
 $\left| \frac{x}{3} \right|$ 
 $\left| \frac{x}{3} \right|$ 

```
\[ \angs{} \]
\[ \angs{\vec{a}} \]
\[ \angs*{\frac{\vec{a}}{3}} \]
\[ \angs[\Bigg]{\frac{\vec{a}}{3}} \]
```

 $\langle \cdot \rangle$ 
 $\langle \boldsymbol{a} \rangle$ 
 $\left\langle \frac{\boldsymbol{a}}{3} \right\rangle$ 
 $\left\langle \frac{\boldsymbol{a}}{3} \right\rangle$

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

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

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

`\dim` (defined in amsmath)  
`\abs`  
`\units`

Operators which may be more useful than delimiters.

<code>\( \dim (x) \) \[ \]</code>	$\dim(x)$
<code>\( \abs (x) \) \[ \]</code>	$\abs(x)$
<code>\( \units (x) \) \[ \]</code>	$\units(x)$

## 5 Commands Specific to *Matter & Interactions*

mandi comes with an accessory package `mandiexp` which includes commands specific to *Matter & Interactions*. The commands are primarily for typesetting mathematical expressions used in the text. Use of `mandiexp` is optional and so must be manually loaded by including the line `\usepackage{mandiexp}` in your document's preamble.

### 5.1 The Momentum Principle

<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.

```
\( \LHSmomentumprinciple \)      \\  
\( \RHSmomentumprinciple \)      \\  
\( \LHSmomentumprincipleupdate \) \\  
\( \RHSmomentumprincipleupdate \) \\  
\( \momentumprinciple \)          \\  
\( \momentumprincipleupdate \)    \\  
\( \LHSmomentumprinciple* \)     \\  
\( \RHSmomentumprinciple* \)     \\  
\( \LHSmomentumprincipleupdate* \) \\  
\( \RHSmomentumprincipleupdate* \) \\  
\( \momentumprinciple* \)         \\  
\( \momentumprincipleupdate* \)   \
```

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

### 5.2 The Energy Principle

<code>\LHSEnergyprinciple</code>	(LHS of delta form)
<code>\RHSenergyprinciple[<i>{+process...}</i>]</code>	(RHS of delta form)
<code>\LHSEnergyprincipleupdate</code>	(LHS of update form)
<code>\RHSenergyprincipleupdate[<i>{+process...}</i>]</code>	(RHS of update form)
<code>\energyprinciple[<i>{+process...}</i>]</code>	(delta form)

`\energyprincipleupdate[(<+process...>)]`

(update form)

Variants of command for typesetting the energy principle.

<code>\( \LHSenergyprinciple \)</code>	<code>\)</code>	$\Delta E_{\text{sys}}$
<code>\( \RHSenergyprinciple \)</code>	<code>\)</code>	$W_{\text{ext}}$
<code>\( \RHSenergyprinciple[+Q] \)</code>	<code>\)</code>	$W_{\text{ext}} + Q$
<code>\( \energyprinciple \)</code>	<code>\)</code>	$\Delta E_{\text{sys}} = W_{\text{ext}}$
<code>\( \energyprinciple[+Q] \)</code>	<code>\)</code>	$\Delta E_{\text{sys}} = W_{\text{ext}} + Q$
<code>\( \LHSenergyprincipleupdate \)</code>	<code>\)</code>	$E_{\text{sys,final}}$
<code>\( \RHSenergyprincipleupdate \)</code>	<code>\)</code>	$E_{\text{sys,initial}} + W_{\text{ext}}$
<code>\( \RHSenergyprincipleupdate[+Q] \)</code>	<code>\)</code>	$E_{\text{sys,initial}} + W_{\text{ext}} + Q$
<code>\( \energyprincipleupdate \)</code>	<code>\)</code>	$E_{\text{sys,final}} = E_{\text{sys,initial}} + W_{\text{ext}}$
<code>\( \energyprincipleupdate[+Q] \)</code>	<code>\)</code>	$E_{\text{sys,final}} = E_{\text{sys,initial}} + W_{\text{ext}} + Q$

### 5.3 The Angular Momentum Principle

<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 angularmomentum principle. Use starred variants to get arrow notation for vectors.



<code>\( \LHSangularmomentumprinciple \) \)</code>	$\Delta \mathbf{L}_{A,\text{sys},\text{net}}$
<code>\( \RHSangularmomentumprinciple \) \)</code>	$\tau_{A,\text{sys},\text{net}} \Delta t$
<code>\( \LHSangularmomentumprincipleupdate \) \)</code>	$\mathbf{L}_{A,\text{sys},\text{final}}$
<code>\( \RHSangularmomentumprincipleupdate \) \)</code>	$\mathbf{L}_{A,\text{sys},\text{initial}} + \tau_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprinciple \) \)</code>	$\Delta \mathbf{L}_{A,\text{sys},\text{net}} = \tau_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprincipleupdate \) \)</code>	$\mathbf{L}_{A,\text{sys},\text{final}} = \mathbf{L}_{A,\text{sys},\text{initial}} + \tau_{A,\text{sys},\text{net}} \Delta t$
<code>\( \LHSangularmomentumprinciple* \) \)</code>	$\Delta \vec{\mathbf{L}}_{A,\text{sys},\text{net}}$
<code>\( \RHSangularmomentumprinciple* \) \)</code>	$\vec{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \LHSangularmomentumprincipleupdate* \) \)</code>	$\vec{\mathbf{L}}_{A,\text{sys},\text{final}}$
<code>\( \RHSangularmomentumprincipleupdate* \) \)</code>	$\vec{\mathbf{L}}_{A,\text{sys},\text{initial}} + \vec{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprinciple* \) \)</code>	$\Delta \vec{\mathbf{L}}_{A,\text{sys},\text{net}} = \vec{\tau}_{A,\text{sys},\text{net}} \Delta t$
<code>\( \angularmomentumprincipleupdate* \) \)</code>	$\vec{\mathbf{L}}_{A,\text{sys},\text{final}} = \vec{\mathbf{L}}_{A,\text{sys},\text{initial}} + \vec{\tau}_{A,\text{sys},\text{net}} \Delta t$

## 5.4 Other Expressions

N 2021-02-13

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

Generic symbol for the energy of some entity.

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

N 2021-02-13

`\systemenergy[<label>]`

Symbol for system energy.

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

N 2021-02-13

`\particleenergy[<label>]`

Symbol for particle energy.

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

N 2021-02-13

`\restenergy[<label>]`

Symbol for rest energy.

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

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

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

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[⟨label⟩]`  
`\vibrationalkineticenergy*[⟨label⟩]`

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

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

N 2021-02-13

`\gravitationalpotentialenergy[⟨label⟩]`

Symbol for gravitational potential energy.

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

N 2021-02-13

`\electricpotentialenergy[⟨label⟩]`

Symbol for electric potential energy.

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

N 2021-02-13

`\springpotentialenergy[⟨label⟩]`

Symbol for spring potential energy.

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

## 6 Source Code

We begin by defining the package version and date for global use. We exploit 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{3.0.0c}
2 \def\mandi@Date{2021-02-19}
3 \NeedsTeXFormat{LaTeX2e}[1999/12/01]
4 \providecommand\DeclareRelease[3]{}
5 \providecommand\DeclareCurrentRelease[2]{}
6 \DeclareRelease{v3.0.0c}{2021-02-19}{mandi.sty}
7 \DeclareCurrentRelease{v\mandi@Version}{\mandi@Date}
8 \ProvidesPackage{mandi}[\mandi@Date\space v\mandi@Version\space Macros for introductory physics]
```

We define a convenient package version command.

```
9 \newcommand*{\mandiversion}{v\mandi@Version\space dated \mandi@Date}
```

Next, we 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 L<sup>A</sup>T<sub>E</sub>X kernel. Because `unicode-math` is required, all documents using `mandi` must be compiled with an engine that supports Unicode. We recommend LuaL<sup>A</sup>T<sub>E</sub>X.

```
10 \RequirePackage{unicode-math}
11 \unimathsetup{math-style=ISO}
12 \unimathsetup{warnings-off={mathtools-colon,mathtools-overbracket}}
13 \setmathfont[Scale=MatchLowercase]{TeX Gyre DejaVu Math} % Good g everywhere. Based on Arev.
```

We need to borrow `mathscr` and `mathbfscr` from XITS Math.

See <https://tex.stackexchange.com/a/120073/218142>.

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

Get original and bold `mathcal` fonts.

See <https://tex.stackexchange.com/a/21742/218142>.

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

Now we borrow Greek letters from Latin Modern Math.

```
16 \setmathfont[Scale=MatchLowercase,range= it/{greek,Greek}]{Latin Modern Math}
17 \setmathfont[Scale=MatchLowercase,range= bfit/{greek,Greek}]{Latin Modern Math}
18 \setmathfont[Scale=MatchLowercase,range= up/{greek,Greek}]{Latin Modern Math}
19 \setmathfont[Scale=MatchLowercase,range= bfup/{greek,Greek}]{Latin Modern Math}
20 \setmathfont[Scale=MatchLowercase,range=bfsfup/{greek,Greek}]{Latin Modern Math}
```

Now we load third party packages, documenting why each one is needed.

```
21 \RequirePackage{amsmath} % AMS goodness (don't load amssymb or amsfonts)
22 \RequirePackage[inline]{enumitem} % needed for physicsproblem environment
23 \RequirePackage{eso-pic} % needed for \hilite
24 \RequirePackage[g]{esvect} % needed for nice vector arrow, style g
25 \RequirePackage{pgfplots} % needed for key-value interface
26 \RequirePackage{array} % needed for \checkquantity and \checkconstant
27 \RequirePackage{iftex} % needed for requiring LuaLaTeX
28 \RequirePackage{makebox} % needed for consistent \dirvect; \makebox
29 \RequirePackage{mathtools} % needed for paired delimiters; extends amsmath
30 \RequirePackage{nicematrix} % needed for column and row vectors
31 \RequirePackage{most}[tcolorbox] % needed for program listings
32 \RequirePackage{tensor} % needed for index notation
33 \RequirePackage{tikz} % needed for \hilite
34 \usetikzlibrary{shapes,fit,tikzmark} % needed for \hilite
35 \RequirePackage{hyperref} % load last
36 \RequireLuaTeX % require this engine
```

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

```

37 \DeclareFontFamily{U}{esvect}{}
38 \DeclareFontShape{U}{esvect}{m}{n}{%
39   <-5.5> vect5
40   <5.5-6.5> vect6
41   <6.5-7.5> vect7
42   <7.5-8.5> vect8
43   <8.5-9.5> vect9
44   <9.5-> vect10
45 }{}%

46 \directlua{%
47   luaotfload.add_colorscheme("colordigits",
48     [{"8000FF"}] = {"one","two","three","four","five","six","seven","eight","nine","zero"})
49 }%
50 \newfontfamily{colordigits}{DejaVuSansMono}[RawFeature={color=colordigits}]

```

Now we 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 `tcloborbox`.

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

```

51 \newfontfamily{gsfontfamily}{DejaVuSansMono} % new font for listings
52 \definecolor{gsbggray}{rgb}{0.90,0.90,0.90} % background gray
53 \definecolor{gsgray}{rgb}{0.30,0.30,0.30} % gray
54 \definecolor{gsgreen}{rgb}{0.00,0.60,0.00} % green
55 \definecolor{gsorange}{rgb}{0.80,0.45,0.12} % orange
56 \definecolor{gspeach}{rgb}{1.00,0.90,0.71} % peach
57 \definecolor{gspearl}{rgb}{0.94,0.92,0.84} % pearl
58 \definecolor{gsplum}{rgb}{0.74,0.46,0.70} % plum
59 \lstdefinestyle{vpython}{% % style for listings
60   backgroundcolor=\color{gsbggray},% % background color
61   basicstyle=\colordigits\footnotesize,% % default style
62   breakatwhitespace=true% % break at whitespace
63   breaklines=true,% % break long lines
64   captionpos=b,% % position caption
65   classoffset=1,% % STILL DON'T UNDERSTAND THIS
66   commentstyle=\color{gsgray},% % font for comments
67   deletekeywords={print},% % delete keywords from the given language
68   emph={self,cls,@classmethod,@property},% % words to emphasize
69   emphstyle=\color{gsorange}\itshape,% % font for emphasis
70   escapeinside={(*@){@*}},% % add LaTeX within your code
71   frame=tb,% % frame style
72   framerule=2.0pt,% % frame thickness
73   framexleftmargin=5pt,% % extra frame left margin
74   %identifierstyle=\sffamily,% % style for identifiers
75   keywordstyle=\gsfontfamily\color{gsplum},% % color for keywords
76   language=Python,% % select language
77   linewidth=\linewidth,% % width of listings
78   morekeywords={% % VPython/GlowScript specific keywords
79     __future__,abs,acos,align,ambient,angle,append,append_to_caption,%
80     append_to_title,arange,arrow,asin,astuple,atan,atan2,attach_arrow,%
81     attach_trail,autoscale,axis,background,billboard,bind,black,blue,border,%
82     bounding_box,box,bumpaxis,bumpmap,bumpmaps,camera,canvas,caption,capture,%
83     ceil,center,clear,clear_trail,click,clone,CoffeeScript,coils,color,combin,%
84     comp,compound,cone,convex,cos,cross,curve,cyan,cylinder,data,degrees,del,%
85     delete,depth,descender,diff_angle,digits,division,dot,draw_complete,%
86     ellipsoid,emissive,end_face_color,equal,explog,extrusion,faces,factorial,%
87     False,floor,follow,font,format,forward,fov,frame,gcurve,gdisplay,gdots,%
88     get_library,get_selected,ghbars,global,GlowScript,graph,graphs,green,gvbars,%

```

```

89   hat,headlength,headwidth,height,helix,hsv_to_rgb,index,interval,keydown,%
90   keyup,label,length,lights,line,linecolor,linewidth,logx,logy,lower_left,%
91   lower_right,mag,mag2,magenta,make_trail,marker_color,markers,material,%
92   max,min,mouse,mousedown,mousemove,mouseup,newball,norm,normal,objects,%
93   offset,one,opacity,orange,origin,path,pause,pi,pixel_to_world,pixels,plot,%
94   points,pos,pow,pps,print,print_function,print_options,proj,purple,pyramid,%
95   quad,radians,radius,random,rate,ray,read_local_file,readonly,red,redraw,%
96   retain,rgb_to_hsv,ring,rotate,round,scene,scroll,shaftwidth,shape,shapes,%
97   shininess,show_end_face,show_start_face,sign,sin,size,size_units,sleep,%
98   smooth,space,sphere,sqrt,start,start_face_color,stop,tan,text,textpos,%
99   texture,textures,thickness,title,trail_color,trail_object,trail_radius,%
100  trail_type,triangle,trigger,True,twist,unbind,up,upper_left,upper_right,%
101  userpan,userspin,userzoom,vec,vector,vertex,vertical_spacing,visible,%
102  visual,vpython,VPython,waitfor,white,width,world,xtitle,yellow,yoffset,%
103  ytitle%
104 },%
105 morekeywords={print,None,TypeError},%           % additional keywords
106 morestring=[b]{"",},%                           % treat triple quotes as strings
107 numbers=left,%                                   % where to put line numbers
108 numbersep=10pt,%                                 % how far line numbers are from code
109 numberstyle=\bfseries\tiny,%                     % set to 'none' for no line numbers
110 showstringspaces=false,%                          % show spaces in strings
111 showtabs=false,%                                  % show tabs within strings
112 stringstyle=\gsfontfamily\color{gsgreen},%       % color for strings
113 upquote=true,%                                    % how to typeset quotes
114 }%

```

We introduce a new, more intelligent `glowscripblock` <sup>→ P.24</sup> environment.

```

115 \NewTCBListing[auto counter,list inside=gsprogs]{glowscripblock}{0}{D(){glowscript.org} m }{%
116   breakable,%
117   center,%
118   code = \newpage,%
119   %derivpeach,%
120   enhanced,%
121   hyperurl interior = https://#2,%
122   label = {gs:\thetcbcounter},%
123   left = 8mm,%
124   list entry = \texttt{GlowScript} Program \thetcbcounter: #3,%
125   listing only,%
126   listing style = vpython,%
127   nameref = #3,%
128   title = \texttt{GlowScript} Program \thetcbcounter: #3,%
129   width = 0.9\textwidth,%
130   #1,%
131 }%

```

A command for generating a list of GlowScript programs.

```

132 \NewDocumentCommand{\listofglowscripprograms}{}{\tcblistof[\section*]{gsprogs}
133   {List of \texttt{GlowScript} Programs}}%

```

We introduce a new, more intelligent `\vpythonfile` <sup>→ P.27</sup> command.

```

134 \NewTCBInputListing[auto counter,list inside=vpprogs]{\vpythonfile}{0}{m m }{%
135   breakable,%
136   center,%
137   code = \newpage,%
138   %derivgray,%
139   enhanced,%
140   hyperurl interior = https://,%
141   label = {vp:\thetcbcounter},%

```

```

142 left = 8mm,%
143 list entry = \texttt{VPython} Program \thetcbcounter: #3,%
144 listing file = {#2},%
145 listing only,%
146 listing style = vpython,%
147 nameref = #3,%
148 title = \texttt{VPython} Program \thetcbcounter: #3,%
149 width = 0.9\textwidth,%
150 #1,%
151 }%

```

A command for generating a list of VPython programs.

```

152 \NewDocumentCommand{\listofvpythonprograms}{*}{\tcblistof[\section*]{vpprogs}
153 {List of \texttt{VPython} Programs}}%

```

We introduce a new `\glowscripinline`<sup>P.29</sup> command.

```

154 \DeclareTotalTCBox{\glowscripinline}{ m }{%
155 bottom = 0pt,%
156 bottomrule = 0.0mm,%
157 boxsep = 1.0mm,%
158 colback = gsbgray,%
159 colframe = gsbgray,%
160 left = 0pt,%
161 leftrule = 0.0mm,%
162 nobeforeafter,%
163 right = 0pt,%
164 rightrule = 0.0mm,%
165 sharp corners,%
166 tcbox raise base,%
167 top = 0pt,%
168 toprule = 0.0mm,%
169 }{\lstinline[style = vpython]{#1}}%

```

Here is a semantic alias for VPython in-line listings.

```

170 \NewDocumentCommand{\vpythoninline}{*}{\glowscripinline}%

```

Next, we define units 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 `\symp{...}` from the unicode-math package.

```

171 \NewDocumentCommand{\per}{*}{\ensuremath{/}}
172 \NewDocumentCommand{\usk}{*}{\ensuremath{\cdot}}
173 \NewDocumentCommand{\unit}{ m m }{\ensuremath{{\#1}\;{\#2}}}
174 \NewDocumentCommand{\ampere}{*}{\ensuremath{\symp{A}}}
175 \NewDocumentCommand{\atomicmassunit}{*}{\ensuremath{\symp{u}}}
176 \NewDocumentCommand{\candela}{*}{\ensuremath{\symp{cd}}}
177 \NewDocumentCommand{\coulomb}{*}{\ensuremath{\symp{C}}}
178 \NewDocumentCommand{\degree}{*}{\ensuremath{^\circ}}
179 \NewDocumentCommand{\electronvolt}{*}{\ensuremath{\symp{eV}}}
180 \NewDocumentCommand{\farad}{*}{\ensuremath{\symp{F}}}
181 \NewDocumentCommand{\henry}{*}{\ensuremath{\symp{H}}}
182 \NewDocumentCommand{\hertz}{*}{\ensuremath{\symp{Hz}}}
183 \NewDocumentCommand{\joule}{*}{\ensuremath{\symp{J}}}
184 \NewDocumentCommand{\kelvin}{*}{\ensuremath{\symp{K}}}
185 \NewDocumentCommand{\kilogram}{*}{\ensuremath{\symp{kg}}}
186 \NewDocumentCommand{\lightspeed}{*}{\ensuremath{\symp{c}}}
187 \NewDocumentCommand{\meter}{*}{\ensuremath{\symp{m}}}
188 \NewDocumentCommand{\metre}{*}{\meter}
189 \NewDocumentCommand{\mole}{*}{\ensuremath{\symp{mol}}}
190 \NewDocumentCommand{\newton}{*}{\ensuremath{\symp{N}}}
191 \NewDocumentCommand{\ohm}{*}{\ensuremath{\symp{\Omega}}}

```

```

192 \NewDocumentCommand{\pascal}{-}{\ensuremath{\symup{Pa}}}
193 \NewDocumentCommand{\radian}{-}{\ensuremath{\symup{rad}}}
194 \NewDocumentCommand{\second}{-}{\ensuremath{\symup{s}}}
195 \NewDocumentCommand{\siemens}{-}{\ensuremath{\symup{S}}}
196 \NewDocumentCommand{\steradian}{-}{\ensuremath{\symup{sr}}}
197 \NewDocumentCommand{\tesla}{-}{\ensuremath{\symup{T}}}
198 \NewDocumentCommand{\volt}{-}{\ensuremath{\symup{V}}}
199 \NewDocumentCommand{\watt}{-}{\ensuremath{\symup{W}}}
200 \NewDocumentCommand{\weber}{-}{\ensuremath{\symup{Wb}}}
201 \NewDocumentCommand{\square}{ m }{\ensuremath{\{#1\}^2}} % prefix 2
202 \NewDocumentCommand{\cubic}{ m }{\ensuremath{\{#1\}^3}} % prefix 3
203 \NewDocumentCommand{\quartic}{ m }{\ensuremath{\{#1\}^4}} % prefix 4
204 \NewDocumentCommand{\reciprocal}{ m }{\ensuremath{\{#1\}^{-1}}} % prefix -1
205 \NewDocumentCommand{\reciprocalsquare}{ m }{\ensuremath{\{#1\}^{-2}}} % prefix -2
206 \NewDocumentCommand{\reciprocalcubic}{ m }{\ensuremath{\{#1\}^{-3}}} % prefix -3
207 \NewDocumentCommand{\reciprocalquartic}{ m }{\ensuremath{\{#1\}^{-4}}} % prefix -4
208 \NewDocumentCommand{\squared}{-}{\ensuremath{^2}} % postfix 2
209 \NewDocumentCommand{\cubed}{-}{\ensuremath{^3}} % postfix 3
210 \NewDocumentCommand{\quarted}{-}{\ensuremath{^4}} % postfix 4
211 \NewDocumentCommand{\reciprocaled}{-}{\ensuremath{^{-1}}} % postfix -1
212 \NewDocumentCommand{\reciprocalquared}{-}{\ensuremath{^{-2}}} % postfix -2
213 \NewDocumentCommand{\reciprocalcubed}{-}{\ensuremath{^{-3}}} % postfix -3
214 \NewDocumentCommand{\reciprocalquarted}{-}{\ensuremath{^{-4}}} % postfix -4
215 \NewDocumentCommand{\emptyunit}{-}{\ensuremath{\mathrm{mdlgwhtsquare}}}

```

The core unit engine has been completely rewritten in [expl3](#) for both clarity and power.  
Generic internal selectors.

```

216 \newcommand*{\mandi@selectunits}{-}
217 \newcommand*{\mandi@selectprecision}{-}

```

Specific internal selectors.

```

218 \newcommand*{\mandi@selectapproximate}[2]{#1} % really \@firstoftwo
219 \newcommand*{\mandi@selectprecise}[2]{#2} % really \@secondoftwo
220 \newcommand*{\mandi@selectbaseunits}[3]{#1} % really \@firstofthree
221 \newcommand*{\mandi@selectderivedunits}[3]{#2} % really \@secondofthree
222 \newcommand*{\mandi@selectalternateunits}[3]{#3} % really \@thirdofthree

```

Document level global switches.

```

223 \NewDocumentCommand{\alwaysusebaseunits}{-}
224 {\renewcommand*{\mandi@selectunits}{\mandi@selectbaseunits}}%
225 \NewDocumentCommand{\alwaysusederivedunits}{-}
226 {\renewcommand*{\mandi@selectunits}{\mandi@selectderivedunits}}%
227 \NewDocumentCommand{\alwaysusealternateunits}{-}
228 {\renewcommand*{\mandi@selectunits}{\mandi@selectalternateunits}}%
229 \NewDocumentCommand{\alwaysuseapproximateconstants}{-}
230 {\renewcommand*{\mandi@selectprecision}{\mandi@selectapproximate}}%
231 \NewDocumentCommand{\alwaysusepreciseconstants}{-}
232 {\renewcommand*{\mandi@selectprecision}{\mandi@selectprecise}}%

```

Document level localized variants.

```

233 \NewDocumentCommand{\hereusebaseunits}{ m }{\begingroup\alwaysusebaseunits#1\endgroup}%
234 \NewDocumentCommand{\hereusederivedunits}{ m }{\begingroup\alwaysusederivedunits#1\endgroup}%
235 \NewDocumentCommand{\hereusealternateunits}{ m }{\begingroup\alwaysusealternateunits#1\endgroup}%
236 \NewDocumentCommand{\hereuseapproximateconstants}{ m }{\begingroup\alwaysuseapproximateconstants#1\endgroup}%
237 \NewDocumentCommand{\hereusepreciseconstants}{ m }{\begingroup\alwaysusepreciseconstants#1\endgroup}%

```

Document level environments.

```

238 \NewDocumentEnvironment{usebaseunits}{-}{\alwaysusebaseunits}{-}%
239 \NewDocumentEnvironment{usederivedunits}{-}{\alwaysusederivedunits}{-}%

```



```

240 \NewDocumentEnvironment{usealternateunits}{-}{\alwaysusealternateunits}{-}%
241 \NewDocumentEnvironment{useapproximateconstants}{-}{\alwaysuseapproximateconstants}{-}%
242 \NewDocumentEnvironment{usepreciseconstants}{-}{\alwaysusepreciseconstants}{-}%

```

Defining a new scalar quantity:

```

243 \NewDocumentCommand{\newscalarquantity}{ m m O{#2} O{#2} }{%
244   \expandafter\newcommand\csname #1\endcsname[1]{##1\,\mandi@selectunits{#2}{#3}{#4}}%
245   \expandafter\newcommand\csname #1value\endcsname[1]{##1}%
246   \expandafter\newcommand\csname #1baseunits\endcsname[1]{##1\,\mandi@selectbaseunits{#2}{#3}{#4}}%
247   \expandafter\newcommand\csname #1derivedunits\endcsname[1]{##1\,\mandi@selectderivedunits{#2}{#3}{#4}}%
248   \expandafter\newcommand\csname #1alternateunits\endcsname[1]{##1\,\mandi@selectalternateunits{#2}{#3}{#4}}%
249   \expandafter\newcommand\csname #1onlybaseunits\endcsname{\mandi@selectbaseunits{#2}{#3}{#4}}%
250   \expandafter\newcommand\csname #1onlyderivedunits\endcsname{\mandi@selectderivedunits{#2}{#3}{#4}}%
251   \expandafter\newcommand\csname #1onlyalternateunits\endcsname{\mandi@selectalternateunits{#2}{#3}{#4}}%
252 }%

```

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

```

253 \NewDocumentCommand{\newvectorquantity}{ m m O{#2} O{#2} }{%
254   \newscalarquantity{#1}{#2}{#3}[#4]
255   \expandafter\newcommand\csname vector#1\endcsname[1]{\expandafter\csname #1\endcsname{\mivector{##1}}}%
256 }%

```

Defining a new physical constant:

```

257 \NewDocumentCommand{\newphysicalconstant}{ m m m m m O{#5} O{#5} }{%
258   \expandafter\newcommand\csname #1\endcsname
259     {\mandi@selectprecision{#3}{#4}\,\mandi@selectunits{#5}{#6}{#7}}%
260   \expandafter\newcommand\csname #1mathsymbol\endcsname{\ensuremath{#2}}%
261   \expandafter\newcommand\csname #1approximatevalue\endcsname{\ensuremath{#3}}%
262   \expandafter\newcommand\csname #1precisevalue\endcsname{\ensuremath{#4}}%
263   \expandafter\newcommand\csname #1baseunits\endcsname
264     {\mandi@selectprecision{#3}{#4}\,\mandi@selectbaseunits{#5}{#6}{#7}}%
265   \expandafter\newcommand\csname #1derivedunits\endcsname
266     {\mandi@selectprecision{#3}{#4}\,\mandi@selectderivedunits{#5}{#6}{#7}}%
267   \expandafter\newcommand\csname #1alternateunits\endcsname
268     {\mandi@selectprecision{#3}{#4}\,\mandi@selectalternateunits{#5}{#6}{#7}}%
269   \expandafter\newcommand\csname #1onlybaseunits\endcsname
270     {\mandi@selectbaseunits{#5}{#6}{#7}}%
271   \expandafter\newcommand\csname #1onlyderivedunits\endcsname
272     {\mandi@selectderivedunits{#5}{#6}{#7}}%
273   \expandafter\newcommand\csname #1onlyalternateunits\endcsname
274     {\mandi@selectalternateunits{#5}{#6}{#7}}%
275 }%

```

mandi now has a key-value interface, implemented with `pgfopts` and `pgfkeys`. There are two options: `units` <sup>→P.6</sup>, with values `base`, `derived`, or `alternate` selects the default form of units `preciseconstants` <sup>→P.6</sup>, with values `true` and `false`, selects precise numerical values for constants rather than approximate values.

First, we define the keys. The key handlers require certain commands defined by the unit engine, and thus must be defined and processed after the unit engine code.

```

276 \newif\ifusingpreciseconstants
277 \pgfkeys{%
278   /mandi/options/.cd,
279   initial@setup/.style={%
280     /mandi/options/buffered@units/.initial=alternate,%
281   },%
282   initial@setup,%
283   preciseconstants/.is if=usingpreciseconstants,%
284   units/.is choice,%
285   units/.default=derived,%

```

```

286 units/alternate/.style={/mandi/options/buffered@units=alternate},%
287 units/base/.style={/mandi/options/buffered@units=base},%
288 units/derived/.style={/mandi/options/buffered@units=derived},%
289 }%

```

Process the options.

```

290 \ProcessPgfPackageOptions{/mandi/options}

```

We write a banner to the console showing the options in use. The value of the `units`<sup>P.6</sup> key is used in situ to set the default units.

```

291 \newcommand*{\mandi@linetwo}{\typeout{mandi: Loadtime options...}}
292 \newcommand*{\mandi@do@setup}{%
293   \typeout{}%
294   \typeout{mandi: You are using mandi \mandiversion.}%
295   \mandi@linetwo
296   \csname alwaysuse\pgfkeysvalueof{/mandi/options/buffered@units}units\endcsname%
297   \typeout{mandi: You will get \pgfkeysvalueof{/mandi/options/buffered@units}\space units.}%
298   \ifusingpreciseconstants
299     \alwaysusepreciseconstants
300     \typeout{mandi: You will get precise constants.}%
301   \else
302     \alwaysuseapproximateconstants
303     \typeout{mandi: You will get approximate constants.}%
304   \fi
305   \typeout{}%
306 }%
307 \mandi@do@setup

```

Next, we define a setup command that overrides the loadtime options when called with new options. A new banner is written to the console.

```

308 \NewDocumentCommand{\mandisetup}{ m }{%
309   \IfValueT{#1}{%
310     \pgfkeys{/mandi/options}{#1}
311     \renewcommand*{\mandi@linetwo}{\typeout{mandi: mandisetup options...}}
312     \mandi@do@setup
313   }%
314 }%

```

Now we 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.

```

315 \newvectorquantity{acceleration}%
316   {\meter\usk\second\reciprocalsquared}%
317   [\newton\per\kilogram]%
318   [\meter\per\second\squared]%
319 \newscalarquantity{amount}%
320   {\mole}%
321 \newvectorquantity{angularacceleration}%
322   {\radian\usk\second\reciprocalsquared}%
323   [\radian\per\second\squared]%
324   [\radian\per\second\squared]%
325 \newscalarquantity{angularfrequency}%
326   {\radian\usk\reciprocal\second}%
327   [\radian\per\second]%
328   [\radian\per\second]%
329 %\ifmandi@rotradians
330 %  \newphysicalquantity{angularimpulse}%
331 %    {\meter\squared\usk\kilogram\reciprocal\second\usk\reciprocal\radian}%
332 %    [\joule\usk\second\per\radian]%

```

```

333 %    [\newton\usk\meter\usk\second\per\radian]%
334 % \newphysicalquantity{angularmomentum}%
335 %    {\meter\squared\usk\kilogram\usk\reciprocal\second\usk\reciprocal\radian}%
336 %    [\kilogram\usk\meter\squared\per(\second\usk\radian)]%
337 %    [\newton\usk\meter\usk\second\per\radian]%
338 %\else
339 \newvectorquantity{angularimpulse}%
340     {\meter\squared\usk\kilogram\usk\reciprocal\second}%
341     [\kilogram\usk\meter\squared\per\second]% % also \joule\usk\second
342     [\kilogram\usk\meter\squared\per\second]% % also \newton\usk\meter\usk\second
343 \newvectorquantity{angularmomentum}%
344     {\meter\squared\usk\kilogram\usk\reciprocal\second}%
345     [\kilogram\usk\meter\squared\per\second]% % also \joule\usk\second
346     [\kilogram\usk\meter\squared\per\second]% % also \newton\usk\meter\usk\second
347 %\fi
348 \newvectorquantity{angularvelocity}%
349     {\radian\usk\reciprocal\second}%
350     [\radian\per\second]%
351     [\radian\per\second]%
352 \newscalarquantity{area}%
353     {\meter\squared}%
354 \newscalarquantity{areamassdensity}%
355     {\meter\reciprocal\squared\usk\kilogram}%
356     [\kilogram\per\meter\squared]%
357     [\kilogram\per\meter\squared]%
358 \newscalarquantity{areachargedensity}%
359     {\reciprocal\square\meter\usk\second\usk\ampere}%
360     [\coulomb\per\square\meter]%
361     [\coulomb\per\square\meter]%
362 \newscalarquantity{capacitance}%
363     {\reciprocal\square\meter\usk\reciprocal\kilogram\usk\quartic\second\usk\square\ampere}%
364     [\farad]%
365     [\coulomb\per\volt]% % also \coulomb\squared\per\newton\usk\meter, \second\per\ohm
366 \newscalarquantity{charge}%
367     {\ampere\usk\second}%
368     [\coulomb]%
369     [\coulomb]% % also \farad\usk\volt
370 \newvectorquantity{cmagneticfield}%
371     {\meter\usk\kilogram\usk\second\reciprocalcubed\usk\reciprocal\ampere}%
372     [\volt\per\meter]%
373     [\newton\per\coulomb]%
374 \newscalarquantity{conductance}%
375     {\reciprocal\square\meter\usk\reciprocal\kilogram\usk\cubic\second\usk\square\ampere}%
376     [\siemens]%
377     [\ampere\per\volt]%
378 \newscalarquantity{conductivity}%
379     {\reciprocalcubic\meter\usk\reciprocal\kilogram\usk\cubic\second\usk\square\ampere}%
380     [\siemens\per\meter]%
381     [(\ampere\per\square\meter)\per(\volt\per\meter)]%
382 \newscalarquantity{conventionalcurrent}%
383     {\ampere}%
384     [\coulomb\per\second]%
385     [\ampere]%
386 \newscalarquantity{current}%
387     {\ampere}%
388 \newscalarquantity{currentdensity}%
389     {\reciprocal\square\meter\usk\ampere}%
390     [\coulomb\usk\second\per\square\meter]%
391     [\ampere\per\square\meter]%

```

```

392 \newscalarquantity{dielectricconstant}%
393 {}%
394 \newvectorquantity{displacement}%
395 {\meter}%
396 \newscalarquantity{duration}%
397 {\second}%
398 \newvectorquantity{electricdipolemoment}%
399 {\meter\usk\second\usk\ampere}%
400 [\coulomb\usk\meter]%
401 [\coulomb\usk\meter]%
402 \newvectorquantity{electricfield}%
403 {\meter\usk\kilogram\usk\second\reciprocalcubed\usk\reciprocal\ampere}%
404 [\volt\per\meter]%
405 [\newton\per\coulomb]%
406 \newscalarquantity{electricflux}%
407 {\meter\cubed\usk\kilogram\usk\second\reciprocalcubed\usk\reciprocal\ampere}%
408 [\volt\usk\meter]%
409 [\newton\usk\meter\squared\per\coulomb]%
410 \newscalarquantity{electricpotential}%
411 {\square\meter\usk\kilogram\usk\reciprocalcubic\second\usk\reciprocal\ampere}%
412 [\volt]%
413 [\joule\per\coulomb]%
414 \newscalarquantity{electroncurrent}%
415 {\reciprocal\second}%
416 [\ensuremath{\symup{e}}\per\second]%
417 [\ensuremath{\symup{e}}\per\second]%
418 \newscalarquantity{emf}%
419 {\square\meter\usk\kilogram\usk\reciprocalcubic\second\usk\reciprocal\ampere}%
420 [\volt]%
421 [\joule\per\coulomb]%
422 \newscalarquantity{energy}%
423 {\meter\squared\usk\kilogram\usk\second\reciprocal\squared}%
424 [\joule] % % also \newton\usk\meter
425 [\joule]%
426 \newscalarquantity{energydensity}%
427 {\meter\reciprocaled\usk\kilogram\usk\reciprocal\square\second}%
428 [\joule\per\cubic\meter]%
429 [\joule\per\cubic\meter]%
430 \newscalarquantity{energyflux}%
431 {\kilogram\usk\second\reciprocalcubed}%
432 [\watt\per\meter\squared]%
433 [\watt\per\meter\squared]%
434 \newscalarquantity{entropy}%
435 {\meter\squared\usk\kilogram\usk\second\reciprocal\squared\usk\reciprocal\kelvin}%
436 [\joule\per\kelvin]%
437 [\joule\per\kelvin]%
438 \newvectorquantity{force}%
439 {\meter\usk\kilogram\usk\second\reciprocal\squared}%
440 [\newton]%
441 [\newton] % % also \kilogram\usk\meter\per\second\squared
442 \newscalarquantity{frequency}%
443 {\reciprocal\second}%
444 [\hertz]%
445 [\hertz]%
446 \newvectorquantity{gravitationalfield}%
447 {\meter\usk\second\reciprocal\squared}%
448 [\newton\per\kilogram]%
449 [\newton\per\kilogram]%
450 \newscalarquantity{gravitationalpotential}%

```

451  $\{\text{square}\backslash\text{meter}\backslash\text{usk}\backslash\text{reciprocalsquare}\backslash\text{second}\}\%$   
 452  $[\text{joule}\backslash\text{per}\backslash\text{kilogram}]\%$   
 453  $[\text{joule}\backslash\text{per}\backslash\text{kilogram}]\%$   
 454  $\text{newvectorquantity}\{\text{impulse}\}\%$   
 455  $\{\text{meter}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{second}\}\%$   
 456  $[\text{newton}\backslash\text{usk}\backslash\text{second}]\%$   
 457  $[\text{newton}\backslash\text{usk}\backslash\text{second}]\%$   
 458  $\text{newscalarquantity}\{\text{indexofrefraction}\}\%$   
 459  $\{\}\%$   
 460  $\text{newscalarquantity}\{\text{inductance}\}\%$   
 461  $\{\text{square}\backslash\text{meter}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{usk}\backslash\text{reciprocalsquare}\backslash\text{second}\backslash\text{usk}\backslash\text{reciprocalsquare}\backslash\text{ampere}\}\%$   
 462  $[\text{henry}]\%$   
 463  $[\text{volt}\backslash\text{usk}\backslash\text{second}\backslash\text{per}\backslash\text{ampere}]\%$  % also  $\text{square}\backslash\text{meter}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{per}\backslash\text{coulomb}\backslash\text{squared}, \text{Wb}\backslash\text{per}\backslash\text{ampere}$   
 464  $\text{newscalarquantity}\{\text{linearchargedensity}\}\%$   
 465  $\{\text{reciprocal}\backslash\text{meter}\backslash\text{usk}\backslash\text{second}\backslash\text{usk}\backslash\text{ampere}\}\%$   
 466  $[\text{coulomb}\backslash\text{per}\backslash\text{meter}]\%$   
 467  $[\text{coulomb}\backslash\text{per}\backslash\text{meter}]\%$   
 468  $\text{newscalarquantity}\{\text{linearmassdensity}\}\%$   
 469  $\{\text{reciprocal}\backslash\text{meter}\backslash\text{usk}\backslash\text{kilogram}\}\%$   
 470  $[\text{kilogram}\backslash\text{per}\backslash\text{meter}]\%$   
 471  $[\text{kilogram}\backslash\text{per}\backslash\text{meter}]\%$   
 472  $\text{newscalarquantity}\{\text{luminous}\}\%$   
 473  $\{\text{candela}\}\%$   
 474  $\text{newscalarquantity}\{\text{magneticcharge}\}\%$   
 475  $\{\text{meter}\backslash\text{usk}\backslash\text{ampere}\}\%$   
 476  $\text{newvectorquantity}\{\text{magneticdipolemoment}\}\%$   
 477  $\{\text{square}\backslash\text{meter}\backslash\text{usk}\backslash\text{ampere}\}\%$   
 478  $[\text{ampere}\backslash\text{usk}\backslash\text{square}\backslash\text{meter}]\%$   
 479  $[\text{joule}\backslash\text{per}\backslash\text{tesla}]\%$   
 480  $\text{newvectorquantity}\{\text{magneticfield}\}\%$   
 481  $\{\text{kilogram}\backslash\text{usk}\backslash\text{second}\backslash\text{reciprocalsquared}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{ampere}\}\%$   
 482  $[\text{tesla}]\%$   
 483  $[\text{newton}\backslash\text{per}\backslash\text{coulomb}\backslash\text{usk}\backslash(\text{meter}\backslash\text{per}\backslash\text{second})]\%$  % also  $\text{Wb}\backslash\text{per}\backslash\text{meter}\backslash\text{squared}$   
 484  $\text{newscalarquantity}\{\text{magneticflux}\}\%$   
 485  $\{\text{meter}\backslash\text{squared}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{usk}\backslash\text{second}\backslash\text{reciprocalsquared}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{ampere}\}\%$   
 486  $[\text{tesla}\backslash\text{usk}\backslash\text{meter}\backslash\text{squared}]\%$   
 487  $[\text{volt}\backslash\text{usk}\backslash\text{second}]\%$  % also  $\text{Wb}$  and  $\text{joule}\backslash\text{per}\backslash\text{ampere}$   
 488  $\text{newscalarquantity}\{\text{mass}\}\%$   
 489  $\{\text{kilogram}\}\%$   
 490  $\text{newscalarquantity}\{\text{mobility}\}\%$   
 491  $\{\text{meter}\backslash\text{squared}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{usk}\backslash\text{second}\backslash\text{reciprocalquarted}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{ampere}\}\%$   
 492  $[\text{meter}\backslash\text{squared}\backslash\text{per}\backslash\text{volt}\backslash\text{usk}\backslash\text{second}]\%$   
 493  $[(\text{meter}\backslash\text{per}\backslash\text{second})\backslash\text{per}\backslash(\text{newton}\backslash\text{per}\backslash\text{coulomb})]\%$   
 494  $\text{newscalarquantity}\{\text{momentofinertia}\}\%$   
 495  $\{\text{meter}\backslash\text{squared}\backslash\text{usk}\backslash\text{kilogram}\}\%$   
 496  $[\text{joule}\backslash\text{usk}\backslash\text{second}\backslash\text{squared}]\%$   
 497  $[\text{kilogram}\backslash\text{usk}\backslash\text{meter}\backslash\text{squared}]\%$   
 498  $\text{newvectorquantity}\{\text{momentum}\}\%$   
 499  $\{\text{meter}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{second}\}\%$   
 500  $[\text{newton}\backslash\text{usk}\backslash\text{second}]\%$   
 501  $[\text{kilogram}\backslash\text{usk}\backslash\text{meter}\backslash\text{per}\backslash\text{second}]\%$   
 502  $\text{newvectorquantity}\{\text{momentumflux}\}\%$   
 503  $\{\text{reciprocal}\backslash\text{meter}\backslash\text{usk}\backslash\text{kilogram}\backslash\text{usk}\backslash\text{second}\backslash\text{reciprocalsquared}\}\%$   
 504  $[\text{newton}\backslash\text{per}\backslash\text{meter}\backslash\text{squared}]\%$   
 505  $[\text{newton}\backslash\text{per}\backslash\text{meter}\backslash\text{squared}]\%$   
 506  $\text{newscalarquantity}\{\text{numberdensity}\}\%$   
 507  $\{\text{reciprocalcubic}\backslash\text{meter}\}\%$   
 508  $[\text{per}\backslash\text{cubic}\backslash\text{meter}]\%$   
 509  $[\text{per}\backslash\text{cubic}\backslash\text{meter}]\%$

```

510 \newscalarquantity{permeability}%
511   {\meter\usk\kilogram\usk\second\reciprocal\squared\usk\ampere\reciprocal\squared}%
512   [\tesla\usk\meter\per\ampere]%
513   [\henry\per\meter]%
514 \newscalarquantity{permittivity}%
515   {\meter\reciprocal\cubed\usk\reciprocal\kilogram\usk\second\reciprocal\quarted\usk\ampere\squared}%
516   [\farad\per\meter]%
517   [\coulomb\squared\per\newton\usk\meter\squared]%
518 \newscalarquantity{planeangle}%
519   {\meter\usk\reciprocal\meter}%
520   [\radian]%
521   [\radian]%
522 \newscalarquantity{polarizability}%
523   {\reciprocal\kilogram\usk\second\quarted\usk\square\ampere}%
524   [\coulomb\usk\square\meter\per\volt]%
525   [\coulomb\usk\meter\per(\newton\per\coulomb)]%
526 \newscalarquantity{power}%
527   {\meter\squared\usk\kilogram\usk\second\reciprocal\cubed}%
528   [\watt]%
529   [\joule\per\second]%
530 \newvectorquantity{poynting}%
531   {\kilogram\usk\second\reciprocal\cubed}%
532   [\watt\per\meter\squared]%
533   [\watt\per\meter\squared]%
534 \newscalarquantity{pressure}%
535   {\reciprocal\meter\usk\kilogram\usk\second\reciprocal\squared}%
536   [\pascal]%
537   [\newton\per\meter\squared]%
538 \newscalarquantity{relativepermeability}
539   {}%
540 \newscalarquantity{relativepermittivity}%
541   {}%
542 \newscalarquantity{resistance}%
543   {\square\meter\usk\kilogram\usk\reciprocal\cubic\second\usk\reciprocal\square\ampere}%
544   [\volt\per\ampere]%
545   [\ohm]%
546 \newscalarquantity{resistivity}%
547   {\cubic\meter\usk\kilogram\usk\reciprocal\cubic\second\usk\reciprocal\square\ampere}%
548   [\ohm\usk\meter]%
549   [(\volt\per\meter)\per(\ampere\per\square\meter)]%
550 \newscalarquantity{solidangle}%
551   {\meter\squared\usk\reciprocal\square\meter}%
552   [\steradian]%
553   [\steradian]%
554 \newscalarquantity{specificheatcapacity}%
555   {\meter\squared\usk\second\reciprocal\squared\usk\reciprocal\kelvin}%
556   [\joule\per\kelvin\usk\kilogram]%
557   [\joule\per\kelvin\usk\kilogram]
558 \newscalarquantity{springstiffness}%
559   {\kilogram\usk\second\reciprocal\squared}%
560   [\newton\per\meter]%
561   [\newton\per\meter]%
562 \newscalarquantity{springstretch}% % This is really just a displacement.
563   {\meter}%
564 \newscalarquantity{stress}%
565   {\reciprocal\meter\usk\kilogram\usk\second\reciprocal\squared}%
566   [\pascal]%
567   [\newton\per\meter\squared]%
568 \newscalarquantity{strain}%

```

```

569 {}%
570 \newsclarquantity{temperature}%
571 {\kelvin}%
572 %\ifmandi@rotradians
573 % \newphysicalquantity{torque}%
574 % {\meter\squared\usk\kilogram\usk\second\reciprocal\squared\usk\reciprocal\radian}%
575 % [\newton\usk\meter\per\radian]%
576 % [\newton\usk\meter\per\radian]%
577 %\else
578 \newvectorquantity{torque}%
579 {\meter\squared\usk\kilogram\usk\second\reciprocal\squared}%
580 [\newton\usk\meter]%
581 [\newton\usk\meter]%
582 %\fi
583 \newvectorquantity{velocity}%
584 {\meter\usk\reciprocal\second}%
585 [\meter\usk\reciprocal\second]%
586 [\meter\per\second]%
587 \newvectorquantity{velocityc}%
588 {\lightspeed}%
589 []%
590 [\lightspeed]%
591 \newsclarquantity{volume}%
592 {\cubic\meter}%
593 \newsclarquantity{volumechargedensity}%
594 {\reciprocalcubic\meter\usk\second\usk\ampere}%
595 [\coulomb\per\cubic\meter]%
596 [\coulomb\per\cubic\meter]%
597 \newsclarquantity{volumemassdensity}%
598 {\meter\reciprocalcubed\usk\kilogram}%
599 [\kilogram\per\meter\cubed]%
600 [\kilogram\per\meter\cubed]%
601 \newsclarquantity{wavelength}% % This is really just a displacement.
602 {\meter}%
603 \newvectorquantity{wavenumber}%
604 {\reciprocal\meter}%
605 [\per\meter]%
606 [\per\meter]%
607 \newsclarquantity{work}%
608 {\meter\squared\usk\kilogram\usk\second\reciprocal\squared}%
609 [\joule]%
610 [\newton\usk\meter]%
611 \newsclarquantity{youngsmodulus}% % This is really just a stress.
612 {\reciprocal\meter\usk\kilogram\usk\second\reciprocal\squared}%
613 [\pascal]%
614 [\newton\per\meter\squared]%

```

Similarly, we now define physical constants for introductory physics, again alphabetically for convenience.

```

615 \newphysicalconstant{avogadro}%
616 {N_A}%
617 {6\timestento{23}}{6.022140857\timestento{23}}%
618 {\reciprocal\mole}%
619 \newphysicalconstant{biotsavartconstant}% % alias for \mzopf
620 {\frac{\mu_o}{4\pi}}%
621 {\tento{-7}}{\tento{-7}}%
622 {\meter\usk\kilogram\usk\second\reciprocal\squared\usk\ampere\reciprocal\squared}%
623 [\henry\per\meter]%
624 [\tesla\usk\meter\per\ampere]%
625 \newphysicalconstant{bohrradius}%

```

```

626 {a_0}%
627 {5.3\timestento{-11}}{5.2917721067\timestento{-11}}%
628 {\meter}%
629 \newphysicalconstant{boltzmann}%
630 {k_B}%
631 {1.4\timestento{-23}}{1.38064852\timestento{-23}}%
632 {\meter\squared\usk\kilogram\usk\reciprocalsquare\second\usk\reciprocal\kelvin}%
633 [\joule\per\kelvin]%
634 [\joule\per\kelvin]%
635 \newphysicalconstant{coulombconstant}% % alias for \oofpez
636 {\frac{1}{4\pi\epsilon_0}}%
637 {9\timestento{9}}{8.9875517873681764\timestento{9}}%
638 {\meter\cubed\usk\kilogram\usk\reciprocalquartic\second\usk\ampere\reciprocalsquare}%
639 [\meter\per\farad]%
640 [\newton\usk\meter\squared\per\coulomb\squared]%
641 \newphysicalconstant{earthmass}%
642 {M_{\symup{Earth}}}%
643 {6.0\timestento{24}}{5.97237\timestento{24}}%
644 {\kilogram}%
645 \newphysicalconstant{earthmoondistance}%
646 {d_{\symup{EM}}}%
647 {3.8\timestento{8}}{3.81550\timestento{8}}%
648 {\meter}%
649 \newphysicalconstant{earthradius}%
650 {R_{\symup{Earth}}}%
651 {6.4\timestento{6}}{6.371\timestento{6}}%
652 {\meter}%
653 \newphysicalconstant{earthsundistance}%
654 {d_{\symup{ES}}}%
655 {1.5\timestento{11}}{1.496\timestento{11}}%
656 {\meter}%
657 \newphysicalconstant{electroncharge}%
658 {q_e}%
659 {-\elementarychargeapproximatevalue}{-\elementarychargeprecisevalue}%
660 {\ampere\usk\second}%
661 [\coulomb]%
662 [\coulomb]%
663 \newphysicalconstant{electronCharge}%
664 {Q_e}%
665 {-\elementarychargeapproximatevalue}{-\elementarychargeprecisevalue}%
666 {\ampere\usk\second}%
667 [\coulomb]%
668 [\coulomb]%
669 \newphysicalconstant{electronmass}%
670 {m_e}%
671 {9.1\timestento{-31}}{9.10938356\timestento{-31}}%
672 {\kilogram}%
673 \newphysicalconstant{elementarycharge}%
674 {e}%
675 {1.6\timestento{-19}}{1.6021766208\timestento{-19}}%
676 {\ampere\usk\second}%
677 [\coulomb]%
678 [\coulomb]%
679 \newphysicalconstant{finestructure}%
680 {\alpha}%
681 {\frac{1}{137}}{7.2973525664\timestento{-3}}%
682 {}%
683 \newphysicalconstant{hydrogenmass}%
684 {m_H}%

```



```

685 {1.7\timestento{-27}}{1.6737236\timestento{-27}}%
686 {\kilogram}%
687 \newphysicalconstant{moonearthdistance}%
688 {d_{\symup{ME}}}%
689 {3.8\timestento{8}}{3.81550\timestento{8}}%
690 {\meter}%
691 \newphysicalconstant{moonmass}%
692 {M_{\symup{Moon}}}%
693 {7.3\timestento{22}}{7.342\timestento{22}}%
694 {\kilogram}%
695 \newphysicalconstant{moonradius}%
696 {R_{\symup{Moon}}}%
697 {1.7\timestento{6}}{1.7371\timestento{6}}%
698 {\meter}%
699 \newphysicalconstant{neutronmass}%
700 {m_n}%
701 {1.7\timestento{-27}}{1.674927471\timestento{-27}}%
702 {\kilogram}%
703 \newphysicalconstant{oofpez}%
704 {\frac{1}{4\pi\epsilon_o}}%
705 {9\timestento{9}}{8.987551787\timestento{9}}%
706 {\meter\cubed\usk\kilogram\usk\reciprocalquartic\second\usk\ampere\reciprocalsquared}%
707 [\meter\per\farad]%
708 [\newton\usk\meter\squared\per\coulomb\squared]%
709 \newphysicalconstant{oofpezcs}%
710 {\frac{1}{4\pi\epsilon_o c^2}}%
711 {\tento{-7}}{\tento{-7}}%
712 {\meter\usk\kilogram\usk\second\reciprocalsquared\usk\ampere\reciprocalsquared}%
713 [\tesla\usk\meter\squared]%
714 [\newton\usk\second\squared\per\coulomb\squared]%
715 \newphysicalconstant{planck}%
716 {h}%
717 {6.6\timestento{-34}}{6.626070040\timestento{-34}}%
718 {\meter\squared\usk\kilogram\usk\reciprocal\second}%
719 [\joule\usk\second]%
720 [\joule\usk\second]%
721 \newphysicalconstant{planckbar}%
722 {\hslash}%
723 {1.1\timestento{-34}}{1.054571800\timestento{-34}}%
724 {\meter\squared\usk\kilogram\usk\reciprocal\second}%
725 [\joule\usk\second]%
726 [\joule\usk\second]%
727 \newphysicalconstant{planckc}%
728 {hc}%
729 {2.0\timestento{-25}}{1.98644568\timestento{-25}}%
730 {\meter\cubed\usk\kilogram\usk\reciprocalsquare\second}%
731 [\joule\usk\meter]%
732 [\joule\usk\meter]%
733 \newphysicalconstant{protoncharge}%
734 {q_p}%
735 {+\elementarychargeapproximatevalue}{+\elementarychargeprecisevalue}%
736 {\ampere\usk\second}%
737 [\coulomb]%
738 [\coulomb]%
739 \newphysicalconstant{protonCharge}%
740 {Q_p}%
741 {+\elementarychargeapproximatevalue}{+\elementarychargeprecisevalue}%
742 {\ampere\usk\second}%
743 [\coulomb]%

```

```

744 [\coulomb]%
745 \newphysicalconstant{protonmass}%
746 {m_p}%
747 {1.7\timestento{-27}}{1.672621898\timestento{-27}}%
748 {\kilogram}%
749 \newphysicalconstant{rydberg}%
750 {R_{\infty}}%
751 {1.1\timestento{7}}{1.0973731568508\timestento{7}}%
752 {\reciprocal\meter}%
753 \newphysicalconstant{speedoflight}%
754 {c}%
755 {3\timestento{8}}{2.99792458\timestento{8}}%
756 {\meter\usk\reciprocal\second}%
757 [\meter\per\second]%
758 [\meter\per\second]
759 \newphysicalconstant{stefanboltzmann}%
760 {\sigma}%
761 {5.7\timestento{-8}}{5.670367\timestento{-8}}%
762 {\kilogram\usk\second\reciprocalcubed\usk\kelvin\reciprocalquarted}%
763 [\watt\per\meter\squared\usk\kelvin\quarted]%
764 [\watt\per\meter\squared\usk\kelvin\quarted]
765 \newphysicalconstant{sunearthdistance}%
766 {d_{\symup{SE}}}%
767 {1.5\timestento{11}}{1.496\timestento{11}}%
768 {\meter}%
769 \newphysicalconstant{sunmass}%
770 {M_{\symup{Sun}}}%
771 {2.0\timestento{30}}{1.98855\timestento{30}}%
772 {\kilogram}%
773 \newphysicalconstant{sunradius}%
774 {R_{\symup{Sun}}}%
775 {7.0\timestento{8}}{6.957\timestento{8}}%
776 {\meter}%
777 \newphysicalconstant{surfacegravfield}%
778 {g}%
779 {9.8}{9.807}%
780 {\meter\usk\second\reciprocal squared}%
781 [\newton\per\kilogram]%
782 [\newton\per\kilogram]%
783 \newphysicalconstant{universalgrav}%
784 {G}%
785 {6.7\timestento{-11}}{6.67408\timestento{-11}}%
786 {\meter\cubed\usk\reciprocal\kilogram\usk\second\reciprocal squared}%
787 [\newton\usk\meter\squared\per\kilogram\squared] % also \joule\usk\meter\per\kilogram\squared
788 [\newton\usk\meter\squared\per\kilogram\squared]%
789 \newphysicalconstant{vacuumpermeability}%
790 {\mu_o}%
791 {4\pi\timestento{-7}}{4\pi\timestento{-7}}%
792 {\meter\usk\kilogram\usk\second\reciprocal squared\usk\ampere\reciprocal squared}%
793 [\henry\per\meter]%
794 [\tesla\usk\meter\per\ampere]%
795 \newphysicalconstant{vacuumpermittivity}%
796 {\epsilon_o}%
797 {9\timestento{-12}}{8.854187817\timestento{-12}}%
798 {\meter\reciprocalcubed\usk\reciprocal\kilogram\usk\second\quarted\usk\ampere\squared}%
799 [\farad\per\meter]%
800 [\coulomb\squared\per\newton\usk\meter\squared]%

```

We need a better, intelligent coordinate-free  $\backslash\vec{e}^{\rightarrow}$  [P.29](#) command. Note the use of the  $e_{\_}^{\wedge}$  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>.

```

801 \RenewDocumentCommand{\vec}{ s m e{~} }{%
802   \ensuremath{%
803     % Note the \, used to make superscript look better.
804     \IfBooleanTF {#1}          % check for *
805       {\vv{#2}% % * gives an arrow
806         % Use \sp{} primitive for superscript.
807         % Adjust superscript for the arrow.
808         \sp{\IfValueT{#4}{\, #4}\vphantom{\smash[t]{\big|}}}}
809       }%
810     {\symbfit{#2} % no * gives us bold
811       % Use \sp{} primitive for superscript.
812       % No superscript adjustment needed.
813       \sp{\IfValueT{#4}{#4}\vphantom{\smash[t]{\big|}}}}
814     }%
815     % Use \sb{} primitive for subscript.
816     \sb{\IfValueT{#3}{#3}\vphantom{\smash[b]{|}}}}
817   }%
818 }%
```

Of course we need the zero vector.

```

819 \NewDocumentCommand{\zerovec}{ s }{%
820   \IfBooleanTF {#1}
821     {\vv{0}}%
822     {\symbfup{0}}%
823 }%
```

We need a command for the change in a vector.

```

824 \NewDocumentCommand{\Dvec}{ s m }{%
825   \Delta
826   \IfBooleanTF{#1}
827     {\vec*}%
828     {\vec}%
829   {#2}
830 }%
```

We need a command for the direction of a vector. We use a slight tweak is needed to get uniform hats that requires the [makebox](#) package.

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

```

831 \NewDocumentCommand{\dirvec}{ s m }{%
832   \widehat{\makebox*{\(p\)}}{%
833     \ensuremath{%
834       \IfBooleanTF{#1}%
835         {#2}%
836         {\symbfit{#2}}%
837       }%
838     }%
839   }%
840 }%
```

We need a command for the magnitude of a vector.

```

841 \NewDocumentCommand{\magvec}{ s m }{%
842   \norm{%
843     \IfBooleanTF{#1}
```

```

844     {\vec*}%
845     {\vec}%
846     {#2}
847 }%
848 }%

```

We need 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.

```

849 \NewDocumentCommand{\veccomp}{ s m }{%
850   % Consider renaming this to \vectorsym.
851   \IfBooleanTF{#1}
852   {% We have a *.
853     \ensuremath{\symnormal{#2}}%
854   }%
855   {% We don't have a *.
856     \ensuremath{\symsfit{#2}}%
857   }%
858 }%
859 \NewDocumentCommand{\tencomp}{ s m }{%
860   % Consider renaming this to \tensororsym.
861   \IfBooleanTF{#1}
862   {% We have a *.
863     \ensuremath{\symsfit{#2}}%
864   }%
865   {% We don't have a *.
866     \ensuremath{\symsfsfit{#2}}%
867   }%
868 }%

```

We provide an environment for problem statements. The starred version allows for in-line lists.

```

869 \NewDocumentEnvironment{physicsproblem}{ m }{%
870   \newpage%
871   \section*{#1}%
872   \newlist{parts}{enumerate}{2}%
873   \setlist[parts]{label=\bfseries(\alph*)}%
874   {}%
875 \NewDocumentEnvironment{physicsproblem*}{ m }{%
876   \newpage%
877   \section*{#1}%
878   \newlist{parts}{enumerate*}{2}%
879   \setlist[parts]{label=\bfseries(\alph*)}%
880   {}%
881 \NewDocumentCommand{\problempart}{ }{\item}%

```

We provide an environment for problem solutions.

```

882 \NewDocumentEnvironment{physicssolution}{ +b }{%
883   % Let's make equation numbering consecutive through the document.
884   \begin{align}
885     #1
886   \end{align}
887 }{%
888 \NewDocumentEnvironment{physicssolution*}{ +b }{%
889   % Let's make equation numbering consecutive through the document.
890   \begin{align*}
891     #1
892   \end{align*}
893 }{%

```

We provide a simplified command for important images.

```

894 \NewDocumentCommand{\image}{ O{scale=1} m m m }{%
895   \begin{figure}[ht!]
896     \begin{center}%
897       \includegraphics[#1]{#2}% #4
898     \end{center}%
899     \caption{#3}%           #2
900     \label{#4}%           #3
901   \end{figure}%
902 }%

```

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

```

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

```

We provide notation for column and row vectors. `\mivector`<sup>P.30</sup> is a workhorse command.  
 Original code provided by @egreg.

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

```

904 \ExplSyntaxOn
905 \NewDocumentCommand{\mivector}{ O{,} m o }{%
906   {%
907     \mi_vector:nn { #1 } { #2 }
908     \IfValueT{#3}{\;{#3}}
909   }%
910 \seq_new:N \l__mi_list_seq
911 \cs_new_protected:Npn \mi_vector:nn #1 #2
912   {%
913     \ensuremath{%
914       \seq_set_split:Nnn \l__mi_list_seq { , } { #2 }
915       \int_compare:nF { \seq_count:N \l__mi_list_seq = 1 } { \left\langle }
916       \seq_use:Nnnn \l__mi_list_seq { #1 } { #1 } { #1 }
917       \int_compare:nF { \seq_count:N \l__mi_list_seq = 1 } { \right\rangle }
918     }%
919   }%
920 \NewDocumentCommand{\colvec}{ O{,} m }{%
921   \vector_main:nnnn { p } { \ } { #1 } { #2 }
922 }%
923 \NewDocumentCommand{\rowvec}{ O{,} m }{%
924   \vector_main:nnnn { p } { & } { #1 } { #2 }
925 }%
926 \seq_new:N \l__vector_arg_seq
927 \cs_new_protected:Npn \vector_main:nnnn #1 #2 #3 #4 {%
928   \seq_set_split:Nnn \l__vector_arg_seq { #3 } { #4 }
929   \begin{#1NiceMatrix}[r]
930     \seq_use:Nnnn \l__vector_arg_seq { #2 } { #2 } { #2 }
931   \end{#1NiceMatrix}
932 }%
933 \ExplSyntaxOff

```

Commands for scientific notation.

```

934 \NewDocumentCommand{\tento}{ m }{\ensuremath{10^{#1}}}
935 \NewDocumentCommand{\timestento}{ m }{\ensuremath{\;\;\times\;\;\tento{#1}}}
936 \NewDocumentCommand{\xtento}{ m }{\ensuremath{\;\;\times\;\;\tento{#1}}}
937 \NewDocumentCommand{\changein}{ }{\Delta}

```

We need intelligent delimiters provided via the `mathtools` package. Use the starred versions for fractions. You can supply optional sizes. Note that default placeholders are used when the argument is empty.

```

938 \DeclarePairedDelimiterX{\norm}[1]{\lVert}{\rVert}{\ifblank{#1}{\:\cdot\:{#1}}
939 \DeclarePairedDelimiterX{\absv}[1]{\lvert}{\rvert}{\ifblank{#1}{\:\cdot\:{#1}}
940 \DeclarePairedDelimiterX{\angs}[1]{\langle}{\rangle}{\ifblank{#1}{\:\cdot\:{#1}}

```

```

941 \DeclarePairedDelimiterX{\parentheses}[1]{\{ \}}{\ifblank{#1}{\:\cdot\:{}}{#1}}
942 \DeclarePairedDelimiterX{\dimensionsof}[1]{\lbrack \rbrack}{\ifblank{#1}{\:\cdot\:{}}{#1}}
943 \DeclarePairedDelimiterX{\unitsof}[1]{\lbrace \rbrace}{\ifblank{#1}{\:\cdot\:{}}{#1}}

```

Declare some new math operators. A `\dim` operator is already defined in `amsmath`. These may be more useful than delimiters.

```

944 \DeclareMathOperator{\abs}{abs}
945 \DeclareMathOperator{\units}{units}

```

These versions use `\left...\right` and are rather disfavored by L<sup>A</sup>T<sub>E</sub>X purists. They may eventually be removed from `mandi` so don't rely on them.

```

946 \NewDocumentCommand{\innorm}{ O{\:\cdot\:{}} }{%
947   \left\lVert#1\right\rVert
948 }%
949 \NewDocumentCommand{\inabsv}{ O{\:\cdot\:{}} }{%
950   \left\lvert#1\right\rvert
951 }%
952 \NewDocumentCommand{\inangs}{ O{\:\cdot\:{}} }{%
953   \left\langle#1\right\rangle
954 }%
955 \NewDocumentCommand{\inpens}{ O{\:\cdot\:{}} }{%
956   \left(#1\right)
957 }%
958 \NewDocumentCommand{\indims}{ O{\:\cdot\:{}} }{%
959   \left[#1\right]
960 }%
961 \NewDocumentCommand{\inunts}{ O{\:\cdot\:{}} }{%
962   \left\{#1\right\}
963 }%

```

This command lets you highlight 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>.

```

964 \newcounter{tikzhighlightnode}
965 \NewDocumentCommand{\hilite}{ O{magenta!60} m O{rectangle} }{%
966   \stepcounter{tikzhighlightnode}%
967   \tikzmarknode{highlighted-node-\number\value{tikzhighlightnode}}{#2}%
968   \edef\temp{%
969     \noexpand\AddToShipoutPictureBG{%
970       \noexpand\begin{tikzpicture}[overlay,remember picture]%
971         \noexpand\iftikzmarkconcurrentpage{highlighted-node-\number\value{tikzhighlightnode}}%
972           \noexpand\node[inner sep=1.0pt,fill=#1,#3,fit=(highlighted-node-\number\value{tikzhighlightnode})]{};%
973         \noexpand\fi
974       \noexpand\end{tikzpicture}%
975     }%
976   }%
977   \temp%
978 }%

```

This is an intelligent slot command for coordinate-free tensor notation.

```

979 \NewDocumentCommand{\slot}{ s d[] }{%
980   % d[] must be used because of the way consecutive optional

```

```

981 % arguments are handled. See xparse docs for details.
982 \IfBooleanTF{#1}
983 {% We have a *.
984   \IfValueTF{#2}
985   {% Insert a vector, but don't show the slot.
986     \smash{\makebox[1.5em]{\ensuremath{#2}}}
987   }%
988   {% No vector, no slot.
989     \smash{\makebox[1.5em]{\ensuremath{}}}
990   }%
991 }%
992 {% We don't have a *.
993   \IfValueTF{#2}
994   {% Insert a vector and show the slot.
995     \underline{\smash{\makebox[1.5em]{\ensuremath{#2}}}}
996   }%
997   {% No vector; just show the slot.
998     \underline{\smash{\makebox[1.5em]{\ensuremath{}}}}
999   }%
1000 }%
1001 }%

```

Here is an intelligent notation for contraction on pairs of slots.

```

1002 \NewDocumentCommand{\contraction}{ s m }{%
1003   \IfBooleanTF{#1}
1004   {\mathsf{C}}% We have a *.
1005   {\sybbb{C}}% We don't have a *.
1006   _{#2}
1007 }%

```

There is an intelligent differential (exterior derivative) operator.

```

1008 \NewDocumentCommand{\dd}{ s }{%
1009   \mathop{\!}
1010   \IfBooleanTF{#1}
1011   {\sybfsfup{d}}% We have a *.
1012   {\symsfup{d}}% We don't have a *.
1013 }%

```

We need a command to typeset tensor valence.

```

1014 \NewDocumentCommand{\valence}{ s m m }{%
1015   \IfBooleanTF{#1}
1016   {(#2,#3)}
1017   {\binom{#2}{#3}}
1018 }%

```

We provide these diagnostic commands to provide sanity checks on commands that represent physical quantities and constants.

```

1019 \NewDocumentCommand{\checkquantity}{ m }{%
1020   % Works for both scalar and vector quantities.
1021   \begin{center}
1022     \begin{tabular}{>{\centering}p{4cm} >{\centering}p{3cm} >{\centering}p{4cm} >{\centering}p{3cm}}
1023       name & base & derived & alternate \tabularnewline
1024       \ttfamily\small{\expandafter\string\csname #1\endcsname} &
1025       \small{\csname #1onlybaseunits\endcsname} &
1026       \small{\csname #1onlyderivedunits\endcsname} &
1027       \small{\csname #1onlyalternateunits\endcsname}
1028     \end{tabular}
1029   \end{center}
1030 }%

```

```

1031 \NewDocumentCommand{\checkconstant}{ m }{%
1032   \begin{center}
1033     \begin{tabular}{>{\centering}p{4cm} >{\centering}p{3cm} >{\centering}p{4cm} >{\centering}p{3cm}}
1034       name & base & derived & alternate \tabularnewline
1035       \ttfamily\small{\expandafter\string\csname #1\endcsname} &
1036       \small{\csname #1onlybaseunits\endcsname} &
1037       \small{\csname #1onlyderivedunits\endcsname} &
1038       \small{\csname #1onlyalternateunits\endcsname} \tabularnewline
1039       symbol & approximate & precise \tabularnewline
1040       \small{\csname #1mathsymbol\endcsname} &
1041       \small{\csname #1approximatevalue\endcsname} &
1042       \small{\csname #1precisevalue\endcsname} \tabularnewline
1043     \end{tabular}
1044   \end{center}
1045 }%

```



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