

The mandi package

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Change History

v2.0.0		<code>mandi</code>	1
General: First public release	1	Coexists with <code>siunitx</code>	1
v2.1.0		Improved vector operators.	1
General: Added more predefined quantities. . .	1	No longer needs <code>SIunits</code> . It's deprecated . .	1
Coexists with <code>physymb</code> . Load <code>physymb</code> before			

Possible Future Enhancements

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1 Introduction

This package provides a collection of commands useful in introductory physics and astronomy. The underlying philosophy is that the user, potentially an introductory student, should just type the name of a physical quantity, with a numerical value if needed, without having to think about the units. `mandi` will typeset everything correctly. For symbolic quantities, the user should type only what is necessary to get the desired result. What one types should correspond as closely as possible to what one thinks when writing. The package name derives from *Matter & Interactions*¹ by Ruth Chabay and Bruce Sherwood. The package certainly is rather tightly tied to that textbook but can be used for typesetting any document that requires consistent physics notation. With `mandi` many complicated expressions can be typeset with just a single command. Great thought has been given to command names and I hope users find the conventions logical and easy to remember.

There are other underlying philosophies and goals embedded within `mandi`, all of which are summarized here. They are

- to employ a *type what you think* model for remembering commands
- to relieve the user of having to explicitly worry about typesetting SI units
- to enforce certain concepts that are too frequently merged, which causes confusion, such as the distinction between a vector quantity and its magnitude (e.g. we often use the same name for both)
- to enforce consistent terminology in the naming of quantities, with names that are both meaningful to introductory students and accurate (e.g. *duration* vs. *time*)
- to enforce consistent notation, especially for vector quantities

I hope that using `mandi` will cause users to form good habits that benefit physics students.

2 Building From Source

I am assuming the user will use pdfL^AT_EX, which creates PDF files as output, to build the documentation. I have not tested the build with standard L^AT_EX, which creates DVI files.

¹See the *Matter & Interactions* home page at <http://www.matterandinteractions.org/> for more information about this innovative introductory calculus-based physics curriculum.

3 Loading the Package

To load the `mandi` package, simply put the line

```
\usepackage{mandi}
```

in your document's preamble to load `mandi` with its default options. To use the package's available options, write

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

There are five available options, with one option being based on the absence of two of the others.

- **italicvectors** gives italic letters for the kernels of vector names. Otherwise, the letters are in Roman.
- **doubleabsbars** gives double bars in symbols for vector magnitudes. Otherwise, single bars are used. Double bars may be more familiar to students from their calculus courses.
- **baseunits** causes all units to be displayed in *baseunits* form, with SI base units. No solidi (slashes) are used. Positive and negative exponents are used to denote powers of various base units.
- **drvdunits** causes all units to be displayed, when possible, in *drvdunits* form, with SI derived units. Students may already be familiar with many of these derived units.
- If neither **baseunits** nor **drvdunits** is specified (the default), units are displayed in what I call *tradunits* form, which is typically the way they would traditionally appear in textbooks. Units in this form frequently hide the underlying physical meaning and are probably not best pedagogically but are familiar to students and teachers. In this document, the default is to use traditional units. As you will see later, there are ways to override these options either temporarily or permanently.

4 Usage

So what does `mandi` allow you to do? Suppose you want to typeset a calculation of a particle's kinetic energy (assume the magnitude of the particle's velocity is much less than the magnitude of light's velocity). You could use

```
K \approx \frac{1}{2}\left(\unit{2}{\kg}\right)\left(\unit{2}{\m\per\s}\right)^2
```

but it is more logical and more readable to use

```
K \approx \onehalf (\mass{2})(\velocity{2})^2
```

given that they produce the same output. The second way is what `mandi` lets you do.

$$K \approx \frac{1}{2} (2 \text{ kg}) (2 \text{ m/s})^2$$

The second way is more readable if you come back to the document, perhaps having not looked at the source code for a while. Suppose you want to use vectors quantities. That's no problem because `mandi` handles vector quantities.

```
Calculate the magnitude of \momentum{\mivector{3,2,5}}.
```

produces

Calculate the magnitude of $\langle 3, 2, 5 \rangle \text{ kg} \cdot \text{m/s}$.

The underlying strategy is to *think about how you would say what you want to write and then write it the way you would say it*. With a few exceptions, this is how `mandi` works. You need not worry about units because `mandi` knows what SI units go with which physical quantities. You can define new quantities so that `mandi` knows about them and in doing so, you give the new quantities the same names they would normally have.

If you want to save time in writing out the energy principle, just use

```
\energyprinciple
```

which gives

$$E_{\text{sys},f} = E_{\text{sys},i} + W_{\text{ext}} + Q$$

with fewer keystrokes, and it's easier to remember.

This barely scratches the surface in describing `mandi` so continue reading this document to see everything this package can do.

5 Features and Commands

5.1 Autosized Parentheses

An experimental feature of `mandi` is autosized parentheses in math mode. This means you need never use `\left(` or `\right)`. Just use unadorned parentheses and they will size correctly. Note that this only works in math mode, only works for parentheses and not for other delimiters.

To illustrate, `(\oofpezmathsymbol)` gives $(\frac{1}{4\pi\epsilon_0})$ but `\((\oofpezmathsymbol)\)` gives $\left(\frac{1}{4\pi\epsilon_0}\right)$.

5.2 SI Base Units

This is not a tutorial on SI units and the user is assumed to be familiar with SI rules and usage. Begin by defining shortcuts for the units for the seven SI base quantities: *spatial displacement* (what others call *length*), *mass*, *temporal displacement* (what others call *time*, but we will call it *duration* in most cases), *electric current*, *thermodynamic temperature*, *amount*, and *luminous intensity*. These shortcuts are used internally and need not explicitly be invoked by the user.

`\m`

metre or SI unit of spatial displacement (length)

`\m`

m

`\kg`

kilogram or SI unit of mass

`\kg`

kg

`\s`

second or SI unit of temporal displacement (duration)

`\s`

s

`\A`

ampere or SI unit of electric current

`\A`

A

`\K`

kelvin or SI unit of thermodynamic temperature

`\K`

K

`\mol`

mole or SI unit of amount

`\mol`

mol

`\cd`

candela or SI unit of luminous intensity

`\cd`

cd

If `mandi` was invoked with **baseunits**, then every physical quantity will have a unit that is some product of powers of these seven base SI units. Exceptions are angular quantities, which will include either degrees or radians depending upon the application. Again, this is what we mean by *baseunits* form.

Certain combinations of the SI base units have nicknames and each such combination and nickname constitutes a *derived unit*. Derived units are no more physically meaningful than the base units, they are merely nicknames for particular combinations of base units. An example of a derived unit is the newton, for which the symbol (it is not an abbreviation) is N. However, the symbol N is merely a nickname for a particular combination of base units. It is not the case that every unique combination of base units has a nickname, but those that do are usually named in honor of a scientist. Incidentally, in such cases, the symbol is capitalized but the *name* of the unit is **never** capitalized. Thus we would write the name of the derived unit of force as newton and not Newton. Again, using these select nicknames for certain combinations of base units is what we mean by *drvdunits* form.

5.3 Defining Physics Quantities

`\newphysicsquantity`

define a physics quantity

```
\newphysicsquantity{<newname>}{<baseunits>}[<drvdunits>][<tradunits>]
```

Here is how spatial displacement is defined internally.

```
\newphysicsconstant{displacement}{\m}{\m}{\m}
```

Using this command causes several things to happen.

- A command `\newname{<magnitude>}`, where **newname** is the first argument passed to `\newphysicsquantity`, is created that takes one mandatory argument, a numerical magnitude. Subsequent use of your defined scalar quantity can be invoked by typing `\newname{<magnitude>}` and the units will be typeset according to the options given when **mandi** was loaded. Note that if the *drvdunits* and *tradunits* forms are not specified, they will be populated with the *baseunits* form.
- A command `\newnamebaseunit{<magnitude>}` is created that expresses the quantity and its units in *baseunits* form.
- A command `\newnamedrvdunit{<magnitude>}` is created that expresses the quantity and its units in *drvdunits* form. This command is created whether or not the first optional argument is provided.
- A command `\newnametradunit{<magnitude>}` is created that expresses the quantity and its units in *tradunits* form. This command is created whether or not the first optional argument is provided.
- A command `\newnameonlybaseunit{<magnitude>}` is created that expresses **only** the quantity's units in *baseunits* form.
- A command `\newnameonlydrvdunit{<magnitude>}` is created that expresses **only** the quantity's units in *drvdunits* form.
- A command `\newnameonlytradunit{<magnitude>}` is created that expresses **only** the quantity's units in *tradunits* form.
- A command `\newnamevalue{<magnitude>}` is created that expresses **only** the quantity's numerical value.

To typeset a numerical displacement, you would merely type `\displacement{3}` to get 3 m in a calculation.

5.3.1 Defining Vector Quantities

Nothing special is necessary for defining vector quantities, but a formatted vector is used when invoking the value of that quantity. Thus, typing `\displacement{\mivector{3,2,-1}}` gives $\langle 3, 2, -1 \rangle$ m precisely as expected.

5.4 First Semester Physics

The first semester of *Matter & Interactions* focuses on mechanics, dynamics, and statistical mechanics.

5.4.1 Predefined Quantities

The seven fundamental quantities are similarly defined and examples of their usage is given in the following table.

<code>\displacement{3.14}</code>	3.14 m
<code>\mass{2.81}</code>	2.81 kg
<code>\duration{4.32}</code>	4.32 s
<code>\current{5.19}</code>	5.19 A
<code>\temperature{273}</code>	273 K
<code>\amount{2.87}</code>	2.87 mol
<code>\luminous{5.64}</code>	5.64 cd

Okay, so much for the base quantities. While we're at it, let's also go ahead and define plane angle, solid angle, and a few non-SI units of angular measure, energy, and distance.

<code>\planeangle{2.88}</code>	2.88 rad
<code>\solidangle{4\pi}</code>	4π sr
<code>\indegrees{30.1}</code>	30.1 °
<code>\inarcminutes{30.1}</code>	30.1 '
<code>\inarcseconds{30.1}</code>	30.1 ''
<code>\ineV{10.2}</code>	10.2 eV
<code>\inAU{5.2}</code>	5.2 AU

Angles are confusing in introductory physics because sometimes we write the unit and sometimes we do not. Some concepts, such as flux, are simplified by introducing solid angle.

Now let us move on into first semester physics, defining quantities in the approximate order in which they appear in *Matter & Interactions*. Use `\scin[]{}{}` to get scientific notation, with the mantissa as the optional first argument and the exponent as the required second argument. An optional third argument specifies a unit, but that is not needed in the following examples.

<code>\velocity{0.24}</code>	0.24c
<code>\velocity{2.99}</code>	2.99 m/s
<code>\gamman{4.32}</code>	4.32
<code>\momentum{\scin[2.44]{4}}</code>	$2.44 \times 10^4 \text{ kg} \cdot \text{m/s}$
<code>\acceleration{9.81}</code>	9.81 m/s^2
<code>\impulse{3.56}</code>	$3.56 \text{ kg} \cdot \text{m/s}$
<code>\force{2.84}</code>	2.84 N
<code>\springstiffness{6.92}</code>	6.92 N/m
<code>\springstretch{0.212}</code>	0.212 m
<code>\area{0.125}</code>	0.125 m^2
<code>\volume{5.33}</code>	5.33 m^3
<code>\linearmassdensity{2.33}</code>	2.33 kg/m
<code>\areamassdensity{3.60}</code>	3.60 kg/m^2
<code>\volumemassdensity{27.4}</code>	27.4 kg/m^3
<code>\youngsmodulus{\scin[2.12]{9}}</code>	$2.12 \times 10^9 \text{ Pa}$
<code>\work{4.04}</code>	4.04 N · m
<code>\energy{4.40}</code>	4.40 N · m
<code>\power{100.2}</code>	100.2 J/s
<code>\angularvelocity{3.02}</code>	3.02 rad/s
<code>\angularacceleration{5.32}</code>	5.32 rad/s^2
<code>\angularmomentum{6.81}</code>	$6.81 \text{ kg} \cdot \text{m}^2/\text{s}$
<code>\momentofinertia{4.59}</code>	$4.59 \text{ kg} \cdot \text{m}^2$
<code>\torque{3.40}</code>	3.40 N · m
<code>\entropy{5.95}</code>	5.95 J/K
<code>\wavelength{\scin[4.00]{-7}}</code>	$4.00 \times 10^{-7} \text{ m}$
<code>\wavenumber{\scin[2.50]{6}}</code>	$2.50 \times 10^6 / \text{m}$
<code>\frequency{\scin[7.50]{14}}</code>	$7.50 \times 10^{14} \text{ Hz}$
<code>\angularfrequency{\scin[4.70]{15}}</code>	$4.70 \times 10^{15} \text{ rad/s}$

Two quick thoughts here. First, work and energy are similar to momentum and impulse in that they come from two different concepts. Work comes from force acting through a spatial displacement and energy is a fundamental property of matter. It is a coincidence that they have the same dimensions and thus the same unit. Second, notice that I didn't define speed. Velocity is the only quantity I can think of for which we have different names for the vector and the magnitude of the vector. I decided to put it on the same footing as momentum, acceleration, and force.

5.5 Second Semester Physics

The second semester of *Matter & Interactions* focuses on electromagnetic theory, and there are many primary and secondary quantities.

5.5.1 Predefined Quantities

<code>\charge{\scin[2]{-9}}</code>	$2 \times 10^{-9} \text{ C}$
<code>\permittivity{\scin[9]{-12}}</code>	$9 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$
<code>\electricfield{\scin[2]{5}}</code>	$2 \times 10^5 \text{ N/C}$
<code>\electricdipolemoment{\scin[3]{-22}}</code>	$3 \times 10^{-22} \text{ C} \cdot \text{m}$
<code>\permeability{\scin[4\pi]{-7}}</code>	$4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$
<code>\magneticfield{1.25}</code>	$1.25 \text{ N/C} \cdot (\text{m/s})$
<code>\cmagneticfield{1.25}</code>	1.25 N/C
<code>\linearchargedensity{1.25}</code>	1.25 C/m
<code>\areachargedensity{1.25}</code>	1.25 C/m^2
<code>\volumechargedensity{1.25}</code>	1.25 C/m^3
<code>\mobility{\scin[4.5]{-3}}</code>	$4.5 \times 10^{-3} (\text{m/s}) / (\text{N/C})$
<code>\numberdensity{\scin[2]{18}}</code>	$2 \times 10^{18} / \text{m}^3$
<code>\polarizability{\scin[1.96]{-40}}</code>	$1.96 \times 10^{-40} \text{ C} \cdot \text{m} / (\text{N/C})$
<code>\electricpotential{1.5}</code>	1.5 V
<code>\emf{1.5}</code>	1.5 V
<code>\dielectricconstant{1.5}</code>	1.5
<code>\indexofrefraction{1.5}</code>	1.5
<code>\relativepermittivity{0.9}</code>	0.9
<code>\relativepermeability{0.9}</code>	0.9
<code>\energydensity{1.25}</code>	1.25 J/m^3
<code>\electroncurrent{\scin[2]{18}}</code>	$2 \times 10^{18} \text{ e/s}$
<code>\conventionalcurrent{0.003}</code>	0.003 A
<code>\magneticdipolemoment{1.25}</code>	$1.25 \text{ A} \cdot \text{m}^2$
<code>\currentdensity{1.25}</code>	1.25 A/m^2
<code>\capacitance{1.00}</code>	1.00 F
<code>\conductivity{1.25}</code>	$1.25 \text{ A/V} \cdot \text{m}$
<code>\resistivity{1.25}</code>	$1.25 \Omega \cdot \text{m}$
<code>\resistance{\scin[1]{6}}</code>	$1 \times 10^6 \Omega$
<code>\conductance{1.25}</code>	1.25 S

5.6 Further Words on Units

As you recall, when a new scalar or vector is defined, a host of other commands is also automatically defined. Consider momentum. The following commands are defined:

<code>\momentum{3}</code>	$3 \text{ kg} \cdot \text{m/s}$	unit determined by global options
<code>\momentumbaseunit{3}</code>	$3 \text{ m} \cdot \text{kg} \cdot \text{s}^{-1}$	quantity with base unit
<code>\momentumdrvdunit{3}</code>	$3 \text{ N} \cdot \text{s}$	quantity with derived unit
<code>\momentumtradunit{3}</code>	$3 \text{ kg} \cdot \text{m/s}$	quantity with traditional unit
<code>\momentumvalue{3}</code>	3	numerical value of quantity
<code>\momentumonlybaseunit</code>	$\text{m} \cdot \text{kg} \cdot \text{s}^{-1}$	selects only base unit
<code>\momentumonlydrvdunit</code>	$\text{N} \cdot \text{s}$	selects only derived unit
<code>\momentumonlytradunit</code>	$\text{kg} \cdot \text{m/s}$	selects only traditional unit

The form of a quantity's unit can be changed on the fly regardless of the global format determined by **baseunits** and **drvdunits**. One way, as illustrated in the table above, is to append **baseunit**, **drvdunit**, **tradunit** to the quantity's name, and this will override the global options for that instance.

`\hereusebaseunit` A second way is to use the commands `\hereusebaseunit{}`, `\hereusedrvdunit{}`, or `\hereusetradunit{}` with the quantity as the argument.

<code>\hereusedrvdunit</code>	<code>\hereusebaseunit{\momentum{3}}</code>	$3 \text{ m} \cdot \text{kg} \cdot \text{s}^{-1}$
<code>\hereusetradunit</code>	<code>\hereusedrvdunit{\momentum{3}}</code>	$3 \text{ N} \cdot \text{s}$
	<code>\hereusetradunit{\momentum{3}}</code>	$3 \text{ kg} \cdot \text{m/s}$

`usebaseunit` A third way is to use the `usebaseunit`, `usedrvdunit`, `usetradunit` environments.

<code>usedrvdunit</code>		
<code>usetradunit</code>	<code>\begin{usebaseunit}</code>	
	<code>\momentum{3}</code>	$3 \text{ m} \cdot \text{kg} \cdot \text{s}^{-1}$
	<code>\end{usebaseunit}</code>	
	<code>\begin{usedrvdunit}</code>	
	<code>\momentum{3}</code>	$3 \text{ N} \cdot \text{s}$
	<code>\end{usedrvdunit}</code>	
	<code>\begin{usetradunit}</code>	
	<code>\momentum{3}</code>	$3 \text{ kg} \cdot \text{m/s}$
	<code>\end{usetradunit}</code>	

`\perpusebaseunit` A fourth way is to use the global switches `\perpusebaseunit`, `\perpusedrvdunit`, and `\perpusetradunit` (think *perpetually use...*). **It's important to remember that these switches override the global options for the rest of the document or until overridden by one of the other two switches.**

5.7 Expressions with Vectors

5.7.1 Basic Vectors

`\vect`

symbol for a vector quantity

`\vect{<kernel>}`

`\vect{p}`

\vec{p}

`\magvect`

symbol for a vector quantity's magnitude

`\magvect{<kernel>}`

`\magvect{p}`

$|\vec{p}|$

`\dirvect`

symbol for a vector quantity's direction

`\dirvect{<kernel>}`

`\dirvect{p}`

\hat{p}

`\ncompszerovect`

symbol for the zero vector expressed in components

Deprecated. Use `\mivector` instead.

`\ncompszerovect`

`\ncompszerovect`

$\langle 0, 0, 0 \rangle$

`\symvect`

symbol for vector with expressions as components
 Deprecated. Use `\mivector` instead.
`\symvect{\langle listofcomps \rangle}`

`\symvect{\magvect{E}\cos\theta,\magvect{E}\sin\theta,0}`

$$\left\langle \left| \vec{E} \right| \cos \theta, \left| \vec{E} \right| \sin \theta, 0 \right\rangle$$

`\ncompsvect`

vector with numerical components and an optional unit
 Deprecated. Use `\mivector` instead.
`\ncompsvect{\langle listofcomps \rangle}[\langle unit \rangle]`

`\ncompsvect{3,4,6}[\text{m}\text{per}\text{s}]`

$$\langle 3, 4, 6 \rangle \text{ m/s}$$

`\magvectncomps`

expression for a vector's magnitude with numerical components and an optional unit
`\magvectncomps{\langle listofcomps \rangle}[\langle unit \rangle]`

`\magvectncomps{3.12,4.04,6.73}[\text{m}\text{per}\text{s}]`

$$\sqrt{(3.12 \text{ m/s})^2 + (4.04 \text{ m/s})^2 + (6.73 \text{ m/s})^2}$$

`\scompsvect`

symbolic components of a vector
`\scompsvect{\langle kernel \rangle}`

`\scompsvect{E}`

$$\left\langle E_x, E_y, E_z \right\rangle$$

`\compvect`

symbolic component of a vector
`\compvect{⟨kernel⟩}{⟨comp⟩}`

`\compvect{E}{y}`

E_y

`\magvectscomps`

expression for a vector's magnitude in terms of its symbolic components
`\magvectscomps{⟨kernel⟩}`

`\magvectscomps{B}`

$\sqrt{B_x^2 + B_y^2 + B_z^2}$

5.7.2 Position Vectors

`\scompospos`

symbolic components of a position vector
`\scompospos`

`\scompospos`

$\langle x, y, z \rangle$

`\compospos`

one component of a position vector
`\compospos{⟨comp⟩}`

`\compospos{y}`

y

5.7.3 Differentials and Derivatives of Vectors

$\backslash\text{dvect}$ $\backslash\text{Dvect}$	<p>symbol for the differential of a vector $\backslash\text{dvect}\{\langle kernel \rangle\}$ or $\backslash\text{Dvect}\{\langle kernel \rangle\}$</p> <p>$\backslash\text{dvect}\{E\}$ or $\backslash\text{Dvect}\{E\}$</p> <hr/> <p>$d\vec{E}$ or $\Delta\vec{E}$</p>
$\backslash\text{dirdvect}$ $\backslash\text{dirDvect}$	<p>symbol for the direction of the differential of a vector $\backslash\text{dirdvect}\{\langle kernel \rangle\}$ or $\backslash\text{dirDvect}\{\langle kernel \rangle\}$</p> <p>$\backslash\text{dirdvect}\{E\}$ or $\backslash\text{dirDvect}\{E\}$</p> <hr/> <p>$\widehat{d\vec{E}}$ or $\widehat{\Delta\vec{E}}$</p>
$\backslash\text{ddirvect}$ $\backslash\text{Ddirvect}$	<p>symbol for the differential of a vector's direction $\backslash\text{ddirvect}\{\langle kernel \rangle\}$ or $\backslash\text{Ddirvect}\{\langle kernel \rangle\}$</p> <p>$\backslash\text{ddirvect}\{E\}$ or $\backslash\text{Ddirvect}\{E\}$</p> <hr/> <p>$d\hat{E}$ or $\Delta\hat{E}$</p>
$\backslash\text{magdvect}$ $\backslash\text{magDvect}$	<p>magnitude of the differential of a vector $\backslash\text{magdvect}\{\langle kernel \rangle\}$ or $\backslash\text{magDvect}\{\langle kernel \rangle\}$</p> <p>$\backslash\text{magdvect}\{E\}$ or $\backslash\text{magDvect}\{E\}$</p> <hr/> <p>$d\vec{E}$ or $\Delta\vec{E}$</p>
$\backslash\text{dmagvect}$ $\backslash\text{Dmagvect}$	<p>differential of the magnitude of a vector $\backslash\text{dmagvect}\{\langle kernel \rangle\}$ or $\backslash\text{Dmagvect}\{\langle kernel \rangle\}$</p> <p>$\backslash\text{dmagvect}\{E\}$ or $\backslash\text{Dmagvect}\{E\}$</p> <hr/> <p>$d \vec{E}$ or $\Delta \vec{E}$</p>

`\scompsdvect`
`\scompsDvect`

symbolic components of the differential of a vector
`\scompsdvect{<kernel>}` or `\scompsDvect{<kernel>}`

`\scompsdvect{E}` or `\scompsDvect{E}`

$\langle dE_x, dE_y, dE_z \rangle$ or $\langle \Delta E_x, \Delta E_y, \Delta E_z \rangle$

`\compdvect`
`\compDvect`

one symbolic component of the differential of a vector
`\compdvect{<kernel>}{<comp>}` or `\compDvect{<kernel>}{<comp>}`

`\compdvect{E}{z}` or `\compDvect{E}{y}`

dE_z or ΔE_y

`\scompsdpos`
`\scompsDpos`

symbolic components of the differential of a position vector
`\scompsdpos` or `\scompsDpos`

`\scompsdpos\` or `\scompsDpos`

$\langle dx, dy, dz \rangle$ or $\langle \Delta x, \Delta y, \Delta z \rangle$

`\compdpos`
`\compDpos`

one component of the differential of a position vector
`\compdpos{<comp>}` or `\compDpos{<comp>}`

`\compdpos{z}` or `\compDpos{y}`

dz or Δy

`\dervect`
`\Dervect`

symbol for the derivative of a vector
`\dervect{<kernel>}{<indvar>}` or `\Dervect{<kernel>}{<indvar>}`

`\dervect{E}{t}` or `\Dervect{E}{t}`

$\frac{d\vec{E}}{dt}$ or $\frac{\Delta\vec{E}}{\Delta t}$

`\dermagvect`
`\Dermagvect`

symbol for the derivative of the magnitude of a vector
`\dermagvect{<kernel>}{<indvar>}` or `\Dermagvect{<kernel>}{<indvar>}`

`\dermagvect{E}{t}` or `\Dermagvect{E}{t}`

$$\frac{d|\vec{E}|}{dt} \text{ or } \frac{\Delta|\vec{E}|}{\Delta t}$$

`\scompsderivect`
`\scompsDervect`

symbolic components of the derivative of a vector
`\scompsderivect{<kernel>}{<indvar>}` or
`\scompsDervect{<kernel>}{<indvar>}`

`\scompsderivect{E}{t}` or `\scompsDervect{E}{t}`

$$\left\langle \frac{dE_x}{dt}, \frac{dE_y}{dt}, \frac{dE_z}{dt} \right\rangle \text{ or } \left\langle \frac{\Delta E_x}{\Delta t}, \frac{\Delta E_y}{\Delta t}, \frac{\Delta E_z}{\Delta t} \right\rangle$$

`\compderivect`
`\compDervect`

one component of the derivative of a vector
`\compderivect{<kernel>}{<indvar>}{<comp>}` or
`\compDervect{<kernel>}{<indvar>}{<comp>}`

`\compderivect{E}{t}{y}` or `\compDervect{E}{t}{y}`

$$\frac{dE_y}{dt} \text{ or } \frac{\Delta E_y}{\Delta t}$$

`\magderivect`
`\magDervect`

magnitude of the derivative of a vector
`\magderivect{<kernel>}{<indvar>}` or `\magDervect{<kernel>}{<indvar>}`

`\magderivect{E}{t}` or `\magDervect{E}{t}`

$$\left| \frac{d\vec{E}}{dt} \right| \text{ or } \left| \frac{\Delta \vec{E}}{\Delta t} \right|$$

`\scompsderpos`
`\scompsDerpos`

symbolic components of the derivative of a position vector
`\scompsderpos{<indvar>}` or `\scompsDerpos{<indvar>}`

`\scompsderpos{t}` or `\scompsDerpos{t}`

$$\left\langle \frac{dx}{dt}, \frac{dy}{dt}, \frac{dz}{dt} \right\rangle \text{ or } \left\langle \frac{\Delta x}{\Delta t}, \frac{\Delta y}{\Delta t}, \frac{\Delta z}{\Delta t} \right\rangle$$

`\compderpos`
`\compDerpos`

one component of the derivative of a position vector
`\compderpos{<comp>}{<indvar>}` or
`\compDerpos{<comp>}{<indvar>}`

`\compderpos{z}{t}` or `\compDerpos{z}{t}`

$$\frac{dz}{dt} \text{ or } \frac{\Delta z}{\Delta t}$$

5.7.4 Naming Conventions You Have Seen

By now you probably understand that commands are named as closely as possible to the way you would say or write what you want. Every time you see `comp` you should think of a single component. Every time you see `scomps` you should think of a set of symbolic components. Every time you see `der` you should think derivative. Every time you see `dir` you should think direction. I have tried to make the names simple both logically and lexically.

5.7.5 Subscripted Vectors

Now we have commands for vectors that carry subscripts, usually to identify an object or something similar. Basically, `vect` becomes `vectsub` and `pos` becomes `possub`. Ideally, a subscript should not contain mathematical symbols. However, if you wish to do so, just wrap the symbol with `\(...\)` as you normally would. All of the commands for non-subscripted vectors are available for subscripted vectors.

`\vectsub`
`\magvectsub`
`\dirvectsub`

name magnitude and direction of a subscripted vector

`\vectsub{\langle kernel \rangle}{\langle sub \rangle}`
`\dirvectsub{\langle kernel \rangle}{\langle sub \rangle}`
`\magvectsub{\langle kernel \rangle}{\langle sub \rangle}`

`\vectsub{p}{ball}` and `\magvectsub{p}{ball}` and `\dirvectsub{p}{ball}`

\vec{p}_{ball} and $|\vec{p}_{\text{ball}}|$ and \hat{p}_{ball}

`\scompsvectsub`

symbolic components of a subscripted vector

`\scompsvectsub{\langle kernel \rangle}{\langle sub \rangle}`

`\scompsvectsub{p}{ball}`

$\langle p_{\text{ball},x}, p_{\text{ball},y}, p_{\text{ball},z} \rangle$

`\compvectsub`

one component of a subscripted vector

`\compvectsub{\langle kernel \rangle}{\langle sub \rangle}{\langle comp \rangle}`

`\compvectsub{p}{ball}{z}`

$p_{\text{ball},z}$

`\magvectsubcomps`

magnitude of a subscripted vector in terms of its symbolic components
`\magvectsubcomps{<kernel>}{<sub>}`

`\magvectsubcomps{p}{ball}`

$$\sqrt{p_{\text{ball},x}^2 + p_{\text{ball},y}^2 + p_{\text{ball},z}^2}$$

`\scompspossub`

symbolic components of a subscripted position vector

`\scompspossub{<sub>}`

`\scompspossub{ball}`

$$\langle x_{\text{ball}}, y_{\text{ball}}, z_{\text{ball}} \rangle$$

`\comppossub`

one component of a subscripted position vector

`\comppossub{<sub>}{<comp>}`

`\comppossub{ball}{x}`

$$x_{\text{ball}}$$

`\dvectsub`

`\Dvectsub`

differential of a subscripted vector

`\dvectsub{<kernel>}{<sub>}` or `\Dvectsub{<kernel>}{<sub>}`

`\dvectsub{p}{ball}` or `\Dvectsub{p}{ball}`

$$d\vec{p}_{\text{ball}} \text{ or } \Delta\vec{p}_{\text{ball}}$$

`\scompsdvectsub`

`\scompsDvectsub`

symbolic components the differential of a subscripted vector

`\scompsdvectsub{<kernel>}{<sub>}` or

`\scompsDvectsub{<kernel>}{<sub>}`

`\scompsdvectsub{p}{ball}` or `\scompsDvectsub{p}{ball}`

$$\langle dp_{\text{ball},x}, dp_{\text{ball},y}, dp_{\text{ball},z} \rangle \text{ or } \langle \Delta p_{\text{ball},x}, \Delta p_{\text{ball},y}, \Delta p_{\text{ball},z} \rangle$$

`\compdvectsub`
`\compDvectsub`

one component of the differential of a subscripted vector
`\compdvectsub{<kernel>}{<sub>}{<comp>}` or
`\compDvectsub{<kernel>}{<sub>}{<comp>}`

`\compdvectsub{p}{ball}{y}` or `\compDvectsub{p}{ball}{y}`

$dp_{\text{ball},y}$ or $\Delta p_{\text{ball},y}$

`\scompsdpossub`
`\scompsDpossub`

symbolic components of the differential of a subscripted position vector
`\scompsdpossub{<sub>}` or
`\scompsDpossub{<sub>}`

`\scompsdpossub{ball}` or `\scompsDpossub{ball}`

$\langle dx_{\text{ball}}, dy_{\text{ball}}, dz_{\text{ball}} \rangle$ or $\langle \Delta x_{\text{ball}}, \Delta y_{\text{ball}}, \Delta z_{\text{ball}} \rangle$

`\compdpossub`
`\compDpossub`

one component of the differential of a subscripted position vector
`\compdpossub{<sub>}{<comp>}` or
`\compDpossub{<sub>}{<comp>}`

`\compdpossub{ball}{x}` or `\compDpossub{ball}{x}`

dx_{ball} or Δx_{ball}

`\derivectsub`
`\Dervectsub`

derivative of a subscripted vector
`\derivectsub{<kernel>}{<sub>}{<indvar>}` or
`\Dervectsub{<kernel>}{<sub>}{<indvar>}`

`\derivectsub{p}{ball}{t}` or `\Dervectsub{p}{ball}{t}`

$\frac{d\vec{p}_{\text{ball}}}{dt}$ or $\frac{\Delta\vec{p}_{\text{ball}}}{\Delta t}$

`\dermagvectsub`
`\Dermagvectsub`

symbol for the derivative of the magnitude of a subscripted vector
`\dermagvectsub{<kernel>}{<sub>}{<indvar>}` or
`\Dermagvectsub{<kernel>}{<sub>}{<indvar>}`

`\dermagvectsub{E}{ball}{t}` or `\Dermagvectsub{E}{ball}{t}`

$$\frac{d|\vec{E}_{\text{ball}}|}{dt} \text{ or } \frac{\Delta|\vec{E}_{\text{ball}}|}{\Delta t}$$

`\scompsdervectsub`
`\scompsDervectsub`

symbolic components of the derivative of a subscripted vector
`\scompsdervectsub{<kernel>}{<sub>}{<indvar>}` or
`\scompsDervectsub{<kernel>}{<sub>}{<indvar>}`

`\scompsdervectsub{p}{ball}{t}` or `\scompsDervectsub{p}{ball}{t}`

$$\left\langle \frac{dp_{\text{ball},x}}{dt}, \frac{dp_{\text{ball},y}}{dt}, \frac{dp_{\text{ball},z}}{dt} \right\rangle \text{ or } \left\langle \frac{\Delta p_{\text{ball},x}}{\Delta t}, \frac{\Delta p_{\text{ball},y}}{\Delta t}, \frac{\Delta p_{\text{ball},z}}{\Delta t} \right\rangle$$

`\compdervectsub`
`\compDervectsub`

one component of the derivative of a subscripted vector
`\compdervectsub{<kernel>}{<sub>}{<indvar>}{<comp>}` or
`\compDervectsub{<kernel>}{<sub>}{<indvar>}{<comp>}`

`\compdervectsub{p}{ball}{t}{y}` or `\compDervectsub{p}{ball}{t}{y}`

$$\frac{dp_{\text{ball},y}}{dt} \text{ or } \frac{\Delta p_{\text{ball},y}}{\Delta t}$$

`\magdervectsub`
`\magDervectsub`

magnitude of the derivative of a subscripted vector
`\magdervectsub{<kernel>}{<sub>}{<indvar>}` or
`\magDervectsub{<kernel>}{<sub>}{<indvar>}`

`\magdervectsub{p}{ball}{t}` or `\magDervectsub{p}{ball}{t}`

$$\left| \frac{d\vec{p}_{\text{ball}}}{dt} \right| \text{ or } \left| \frac{\Delta\vec{p}_{\text{ball}}}{\Delta t} \right|$$

`\scompsderpossb`
`\scompsDerpossb`

symbolic components of the derivative of an indexed position vector
`\scompsderpossb{}{<indvar>}` or
`\scompsDerpossb{}{<indvar>}`

`\scompsderpossb{ball}{t}` or `\scompsDerpossb{ball}{t}`

$$\left\langle \frac{dx_{\text{ball}}}{dt}, \frac{dy_{\text{ball}}}{dt}, \frac{dz_{\text{ball}}}{dt} \right\rangle \text{ or } \left\langle \frac{\Delta x_{\text{ball}}}{\Delta t}, \frac{\Delta y_{\text{ball}}}{\Delta t}, \frac{\Delta z_{\text{ball}}}{\Delta t} \right\rangle$$

`\compderpossb`
`\compDerpossb`

one component of the derivative of a subscripted position vector
`\compderpossb{}{<indvar>}{<comp>}` or
`\compDerpossb{}{<indvar>}{<comp>}`

`\compderpossb{ball}{t}{z}` or `\compDerpossb{ball}{t}{z}`

$$\frac{dz_{\text{ball}}}{dt} \text{ or } \frac{\Delta z_{\text{ball}}}{\Delta t}$$

5.7.6 Relative Vectors

Sometimes we need the position, velocity, momentum, or force of/on one thing relative to/due to another thing.

`\relpos`
`\relvel`
`\relmom`
`\relfor`

relative position or velocity or momentum or force vectors for two objects
`\relpos{}` and `\relvel{}` and `\relmom{}`
and `\relfor{}`

`\relpos{12}` and `\relvel{12}` and `\relmom{12}` and `\relfor{12}`

$$\vec{r}_{12} \text{ and } \vec{v}_{12} \text{ and } \vec{p}_{12} \text{ and } \vec{F}_{12}$$

5.7.7 Expressions Containing Dot Products

Now we get to commands that will save you many, many keystrokes. All of the naming conventions documented in earlier commands still apply. There are some new ones though. Every time you see `dot` you should think *dot product*. When you see `dots` you should think *dot product in terms of symbolic components*. When you see `dote` you should think *dot product expanded as a sum*. These, along with the previous naming conventions, handle many dot product expressions.

`\vectdotvect`
`\vectdotsvect`
`\vectdotevect`

dot product of two vectors as a single symbol or with symbolic components or as an expanded sum

`\vectdotvect{<vector1>}{<vector2>}`
`\vectdotsvect{<kernel1>}{<kernel2>}`
`\vectdotevect{<kernel1>}{<kernel2>}`

`\vectdotvect{\vect{F}}{\vect{v}}` `\`
`\vectdotsvect{F}{v}` `\`
`\vectdotevect{F}{v}`

$$\begin{aligned} & \vec{F} \bullet \vec{v} \\ & \left\langle F_x, F_y, F_z \right\rangle \bullet \left\langle v_x, v_y, v_z \right\rangle \\ & F_x v_x + F_y v_y + F_z v_z \end{aligned}$$

`\vectdotspos`
`\vectdotepos`

dot product of a vector and a position vector with symbolic components or as an expanded sum

`\vectdotspos{<kernel>}` or `\vectdotepos{<kernel>}`

`\vectdotspos{F}` `\`
`\vectdotepos{F}`

$$\begin{aligned} & \left\langle F_x, F_y, F_z \right\rangle \bullet \left\langle x, y, z \right\rangle \\ & F_x x + F_y y + F_z z \end{aligned}$$

`\vectdotsdvect`
`\vectdotsDvect`
`\vectdotedvect`
`\vectdoteDvect`

dot product of a vector and the differential of a vector with symbolic components or expanded as a sum

`\vectdotsdvect{<kernel1>}{<kernel2>}`
`\vectdotsDvect{<kernel1>}{<kernel2>}`
`\vectdotedvect{<kernel1>}{<kernel2>}`
`\vectdoteDvect{<kernel1>}{<kernel2>}`

`\vectdotsdvect{F}{r}` or `\vectdotsDvect{F}{r}` `\`
`\vectdotedvect{F}{r}` or `\vectdoteDvect{F}{r}` `\`

$$\begin{aligned} & \left\langle F_x, F_y, F_z \right\rangle \bullet \left\langle dr_x, dr_y, dr_z \right\rangle \text{ or } \left\langle F_x, F_y, F_z \right\rangle \bullet \left\langle \Delta r_x, \Delta r_y, \Delta r_z \right\rangle \\ & F_x dr_x + F_y dr_y + F_z dr_z \text{ or } F_x \Delta r_x + F_y \Delta r_y + F_z \Delta r_z \end{aligned}$$

`\vectdotsdpos`
`\vectdotsDpos`
`\vectdotedpos`
`\vectdoteDpos`

dot product of a vector and the differential position vector with symbolic components or expanded as a sum

`\vectdotsdpos{<kernel>}` or `\vectdotsDpos{<kernel>}`
`\vectdotedpos{<kernel>}` or `\vectdoteDpos{<kernel>}`

`\vectdotsdpos{F}` or `\vectdotsDpos{F}` `\`
`\vectdotedpos{F}` or `\vectdoteDpos{F}`

$$\left\langle F_x, F_y, F_z \right\rangle \bullet \langle dx, dy, dz \rangle \text{ or } \left\langle F_x, F_y, F_z \right\rangle \bullet \langle \Delta x, \Delta y, \Delta z \rangle$$

$$F_x dx + F_y dy + F_z dz \text{ or } F_x \Delta x + F_y \Delta y + F_z \Delta z$$

`\vectsubdotsvectsub`
`\vectsubdotevectsub`

dot product of two subscripted vectors with symbolic components or expanded as a sum

`\vectsubdotsvectsub{<kernel1>}{<sub1>}{<kernel2>}{<sub2>}`
`\vectsubdotevectsub{<kernel1>}{<sub1>}{<kernel2>}{<sub2>}`

`\vectsubdotsvectsub{F}{grav}{r}{ball}` `\`
`\vectsubdotevectsub{F}{grav}{r}{ball}`

$$\left\langle F_{\text{grav},x}, F_{\text{grav},y}, F_{\text{grav},z} \right\rangle \bullet \left\langle r_{\text{ball},x}, r_{\text{ball},y}, r_{\text{ball},z} \right\rangle$$

$$F_{\text{grav},x} r_{\text{ball},x} + F_{\text{grav},y} r_{\text{ball},y} + F_{\text{grav},z} r_{\text{ball},z}$$

`\vectsubdotsdvectsub`
`\vectsubdotsDvectsub`
`\vectsubdotedvectsub`
`\vectsubdoteDvectsub`

dot product of a subscripted vector and the differential of a subscripted vector with symbolic components or expanded as a sum

`\vectsubdotsdvectsub{<kernel1>}{<sub1>}{<kernel2>}{<sub2>}`
`\vectsubdotsDvectsub{<kernel1>}{<sub1>}{<kernel2>}{<sub2>}`
`\vectsubdotedvectsub{<kernel1>}{<sub1>}{<kernel2>}{<sub2>}`
`\vectsubdoteDvectsub{<kernel1>}{<sub1>}{<kernel2>}{<sub2>}`

`\vectsubdotsdvectsub{A}{ball}{B}{car}` `\`
`\vectsubdotsDvectsub{A}{ball}{B}{car}` `\`
`\vectsubdotedvectsub{A}{ball}{B}{car}` `\`
`\vectsubdoteDvectsub{A}{ball}{B}{car}`

$$\left\langle A_{\text{ball},x}, A_{\text{ball},y}, A_{\text{ball},z} \right\rangle \bullet \left\langle dB_{\text{car},x}, dB_{\text{car},y}, dB_{\text{car},z} \right\rangle$$

$$\left\langle A_{\text{ball},x}, A_{\text{ball},y}, A_{\text{ball},z} \right\rangle \bullet \left\langle \Delta B_{\text{car},x}, \Delta B_{\text{car},y}, \Delta B_{\text{car},z} \right\rangle$$

$$A_{\text{ball},x} dB_{\text{car},x} + A_{\text{ball},y} dB_{\text{car},y} + A_{\text{ball},z} dB_{\text{car},z}$$

$$A_{\text{ball},x} \Delta B_{\text{car},x} + A_{\text{ball},y} \Delta B_{\text{car},y} + A_{\text{ball},z} \Delta B_{\text{car},z}$$

`\vectsubdotsdvect`
`\vectsubdotsDvect`
`\vectsubdotedvect`
`\vectsubdoteDvect`

dot product of a subscripted vector and the differential of a vector with symbolic components or expanded as a sum

`\vectsubdotsdvect{<kernel1>}{<sub1>}{<kernel2>}`
`\vectsubdotsDvect{<kernel1>}{<sub1>}{<kernel2>}`
`\vectsubdotedvect{<kernel1>}{<sub1>}{<kernel2>}`
`\vectsubdoteDvect{<kernel1>}{<sub1>}{<kernel2>}`

`\vectsubdotsdvect{A}{ball}{B} \\`
`\vectsubdotsDvect{A}{ball}{B} \\`
`\vectsubdotedvect{A}{ball}{B} \\`
`\vectsubdoteDvect{A}{ball}{B}`

$$\begin{aligned}
 &\left\langle A_{\text{ball},x}, A_{\text{ball},y}, A_{\text{ball},z} \right\rangle \bullet \left\langle dB_x, dB_y, dB_z \right\rangle \\
 &\left\langle A_{\text{ball},x}, A_{\text{ball},y}, A_{\text{ball},z} \right\rangle \bullet \left\langle \Delta B_x, \Delta B_y, \Delta B_z \right\rangle \\
 &A_{\text{ball},x} dB_x + A_{\text{ball},y} dB_y + A_{\text{ball},z} dB_z \\
 &A_{\text{ball},x} \Delta B_x + A_{\text{ball},y} \Delta B_y + A_{\text{ball},z} \Delta B_z
 \end{aligned}$$

`\vectsubdotsdpos`
`\vectsubdotsDpos`
`\vectsubdotedpos`
`\vectsubdoteDpos`

dot product of a subscripted vector and a differential position vector with symbolic components or expanded as a sum

`\vectsubdotsdpos{<kernel>}{<sub>}`
`\vectsubdotsDpos{<kernel>}{<sub>}`
`\vectsubdotedpos{<kernel>}{<sub>}`
`\vectsubdoteDpos{<kernel>}{<sub>}`

`\vectsubdotsdpos{A}{ball} \\`
`\vectsubdotsDpos{A}{ball} \\`
`\vectsubdotedpos{A}{ball} \\`
`\vectsubdoteDpos{A}{ball}`

$$\begin{aligned}
 &\left\langle A_{\text{ball},x}, A_{\text{ball},y}, A_{\text{ball},z} \right\rangle \bullet \langle dx, dy, dz \rangle \\
 &\left\langle A_{\text{ball},x}, A_{\text{ball},y}, A_{\text{ball},z} \right\rangle \bullet \langle \Delta x, \Delta y, \Delta z \rangle \\
 &A_{\text{ball},x} dx + A_{\text{ball},y} dy + A_{\text{ball},z} dz \\
 &A_{\text{ball},x} \Delta x + A_{\text{ball},y} \Delta y + A_{\text{ball},z} \Delta z
 \end{aligned}$$

`\dervectdotsvect`
`\Dervectdotsvect`
`\dervectdotevect`
`\Dervectdotevect`

dot product of the derivative of a vector and a vector with symbolic components or expanded as a sum

`\dervectdotsvect{<kernel1>}{<indvar>}{<kernel2>}`
`\Dervectdotsvect{<kernel1>}{<indvar>}{<kernel2>}`
`\dervectdotevect{<kernel1>}{<indvar>}{<kernel2>}`
`\Dervectdotevect{<kernel1>}{<indvar>}{<kernel2>}`

`\dervectdotsvect{A}{t}{B} \\\`
`\Dervectdotsvect{A}{t}{B} \\\`
`\dervectdotevect{A}{t}{B} \\\`
`\Dervectdotevect{A}{t}{B}`

$$\begin{aligned}
 &\left\langle \frac{dA_x}{dt}, \frac{dA_y}{dt}, \frac{dA_z}{dt} \right\rangle \bullet \langle B_x, B_y, B_z \rangle \\
 &\left\langle \frac{\Delta A_x}{\Delta t}, \frac{\Delta A_y}{\Delta t}, \frac{\Delta A_z}{\Delta t} \right\rangle \bullet \langle B_x, B_y, B_z \rangle \\
 &\frac{dA_x}{dt} B_x + \frac{dA_y}{dt} B_y + \frac{dA_z}{dt} B_z \\
 &\frac{\Delta A_x}{\Delta t} B_x + \frac{\Delta A_y}{\Delta t} B_y + \frac{\Delta A_z}{\Delta t} B_z
 \end{aligned}$$

`\vectdotsdervect`
`\vectdotsDervect`
`\vectdotedervect`
`\vectdoteDervect`

dot product of a vector and the derivative of a vector with symbolic components or expanded as a sum

`\vectdotsdervect{<kernel1>}{<kernel2>}{<indvar>}`
`\vectdotsDervect{<kernel1>}{<kernel2>}{<indvar>}`
`\vectdotedervect{<kernel1>}{<kernel2>}{<indvar>}`
`\vectdoteDervect{<kernel1>}{<kernel2>}{<indvar>}`

`\vectdotsdervect{A}{B}{t} \\\`
`\vectdotsDervect{A}{B}{t} \\\`
`\vectdotedervect{A}{B}{t} \\\`
`\vectdoteDervect{A}{B}{t}`

$$\begin{aligned}
 &\langle A_x, A_y, A_z \rangle \bullet \left\langle \frac{dB_x}{dt}, \frac{dB_y}{dt}, \frac{dB_z}{dt} \right\rangle \\
 &\langle A_x, A_y, A_z \rangle \bullet \left\langle \frac{\Delta B_x}{\Delta t}, \frac{\Delta B_y}{\Delta t}, \frac{\Delta B_z}{\Delta t} \right\rangle \\
 &A_x \frac{dB_x}{dt} + A_y \frac{dB_y}{dt} + A_z \frac{dB_z}{dt} \\
 &A_x \frac{\Delta B_x}{\Delta t} + A_y \frac{\Delta B_y}{\Delta t} + A_z \frac{\Delta B_z}{\Delta t}
 \end{aligned}$$

`\derivectdotspos`
`\Derivectdotspos`
`\derivectdotepos`
`\Derivectdotepos`

dot product of the derivative of a vector and a position vector using symbolic components or expanded as a sum

`\derivectdotspos{<kernel>}{<indvar>}`
`\Derivectdotspos{<kernel>}{<indvar>}`
`\derivectdotepos{<kernel>}{<indvar>}`
`\Derivectdotepos{<kernel>}{<indvar>}`

`\derivectdotspos{A}{t} \\`
`\Derivectdotspos{A}{t} \\`
`\derivectdotepos{A}{t} \\`
`\Derivectdotepos{A}{t}`

$$\begin{aligned}
 &\left\langle \frac{dA_x}{dt}, \frac{dA_y}{dt}, \frac{dA_z}{dt} \right\rangle \bullet \langle x, y, z \rangle \\
 &\left\langle \frac{\Delta A_x}{\Delta t}, \frac{\Delta A_y}{\Delta t}, \frac{\Delta A_z}{\Delta t} \right\rangle \bullet \langle x, y, z \rangle \\
 &\frac{dA_x}{dt}x + \frac{dA_y}{dt}y + \frac{dA_z}{dt}z \\
 &\frac{\Delta A_x}{\Delta t}x + \frac{\Delta A_y}{\Delta t}y + \frac{\Delta A_z}{\Delta t}z
 \end{aligned}$$

`\derivectdotsvect`
`\Derivectdotsvect`
`\derivectdotedvect`
`\Derivectdotedvect`

dot product of the derivative of a vector and the differential of a vector using symbolic components or expanded as a sum

`\derivectdotsvect{<kernel1>}{<indvar>}{<kernel2>}`
`\Derivectdotsvect{<kernel1>}{<indvar>}{<kernel2>}`
`\derivectdotedvect{<kernel1>}{<indvar>}{<kernel2>}`
`\Derivectdotedvect{<kernel1>}{<indvar>}{<kernel2>}`

`\derivectdotsvect{A}{t}{B} \\`
`\Derivectdotsvect{A}{t}{B} \\`
`\derivectdotedvect{A}{t}{B} \\`
`\Derivectdotedvect{A}{t}{B}`

$$\begin{aligned}
 &\left\langle \frac{dA_x}{dt}, \frac{dA_y}{dt}, \frac{dA_z}{dt} \right\rangle \bullet \left\langle dB_x, dB_y, dB_z \right\rangle \\
 &\left\langle \frac{\Delta A_x}{\Delta t}, \frac{\Delta A_y}{\Delta t}, \frac{\Delta A_z}{\Delta t} \right\rangle \bullet \left\langle \Delta B_x, \Delta B_y, \Delta B_z \right\rangle \\
 &\frac{dA_x}{dt}dB_x + \frac{dA_y}{dt}dB_y + \frac{dA_z}{dt}dB_z \\
 &\frac{\Delta A_x}{\Delta t}\Delta B_x + \frac{\Delta A_y}{\Delta t}\Delta B_y + \frac{\Delta A_z}{\Delta t}\Delta B_z
 \end{aligned}$$

`\dervectdotsdpos`
`\DervectdotsDpos`
`\dervectdotedpos`
`\DervectdoteDpos`

dot product of the derivative of a vector and the differential of a position vector using symbolic components or expanded as a sum

`\dervectdotsdpos{\langle kernel \rangle}{\langle indvar \rangle}`
`\DervectdotsDpos{\langle kernel \rangle}{\langle indvar \rangle}`
`\dervectdotedpos{\langle kernel \rangle}{\langle indvar \rangle}`
`\DervectdoteDpos{\langle kernel \rangle}{\langle indvar \rangle}`

`\dervectdotsdpos{A}{t} \\\`
`\DervectdotsDpos{A}{t} \\\`
`\dervectdotedpos{A}{t} \\\`
`\DervectdoteDpos{A}{t}`

$$\begin{aligned}
 &\left\langle \frac{dA_x}{dt}, \frac{dA_y}{dt}, \frac{dA_z}{dt} \right\rangle \bullet \langle dx, dy, dz \rangle \\
 &\left\langle \frac{\Delta A_x}{\Delta t}, \frac{\Delta A_y}{\Delta t}, \frac{\Delta A_z}{\Delta t} \right\rangle \bullet \langle \Delta x, \Delta y, \Delta z \rangle \\
 &\frac{dA_x}{dt} dx + \frac{dA_y}{dt} dy + \frac{dA_z}{dt} dz \\
 &\frac{\Delta A_x}{\Delta t} \Delta x + \frac{\Delta A_y}{\Delta t} \Delta y + \frac{\Delta A_z}{\Delta t} \Delta z
 \end{aligned}$$

5.7.8 Basis Vectors and Bivectors

If you use geometric algebra or tensors, eventually you will need symbols for basis vectors and basis bivectors.

`\ezero`

basis vectors with lower indices 0 to 4 (use `\ek` or `\e` for indices > 4)
`\ezero`

`\ezero \(\cdots\) \efour`

$$\mathbf{e}_0 \cdots \mathbf{e}_4$$

`\uezero`

normalized basis vectors with lower indices 0 to 4 (use `\uek` or `\ue` for indices > 4)
`\uezero`

`\uezero \(\cdots\) \uefour`

$$\hat{\mathbf{e}}_0 \cdots \hat{\mathbf{e}}_4$$

`\ezerozero`

basis bivectors with lower indices (use `\ek` or `\e` for indices > 4)

`\ezerozero`

`\ezerozero \(\cdots\) \efourfour`

$$e_{00} \cdots e_{44}$$

`\euzero`

basis vectors with upper indices 0 to 4 (use `\euk` or `\eu` for indices > 4)

`\euzero`

`\euzero \(\cdots\) \eufour`

$$e^0 \cdots e^4$$

`\euzerozero`

basis bivectors with upper indices (use `\euk` or `\eu` for indices > 4)

`\euzerozero`

`\euzerozero \(\cdots\) \eufourfour`

$$e^{00} \cdots e^{44}$$

`\gzero`

`\guzero`

basis vectors with γ as the kernel (use `\guk` or `\gu` for indices > 4)

`\gzero` or `\guzero`

`\gzero \(\cdots\) \gfour \(\cdots\) \gufour`

`\guzero \(\cdots\) \gufour`

$$\gamma_0 \cdots \gamma_4$$

$$\gamma \cdots \gamma$$

`\gzerozero`
`\guzerozero`

basis bivectors with γ as the kernel (use `\guk` or `\gu` for indices > 4)
`\gzerozero` or `\guzerozero`

`\gzerozero \(\cdots\) \gfourfour \\\`
`\guzerozero \(\cdots\) \gufourfour`

$$\begin{matrix} \gamma & \cdots & \gamma \\ 00 & & 44 \\ \gamma & \cdots & \gamma \end{matrix}$$

`\mivector`

generic command for vectors formatted as in *Matter & Interactions*
`\mivector[\langle printed delimiter \rangle]{\langle commadelimitedlist of comps \rangle}[\langle unit \rangle]`

`\begin{align*}`
`\msub{u}{\mu} &= \mivector{\ezero,\eone,\etwo,\ethree} \\\`
`\vect{v} &= \mivector{1,3,5}[\mper\s] \\\`
`\vect{E} &= \mivector{\oofpezmathsymbol \frac{Q}{\msup{x}{2}},0,0}`
`\end{align*}`

$$\begin{aligned} u_{\mu} &= \langle \mathbf{e}_0, \mathbf{e}_1, \mathbf{e}_2, \mathbf{e}_3 \rangle \\ \vec{v} &= \langle 1, 3, 5 \rangle \text{ m/s} \\ \vec{E} &= \left\langle \frac{1}{4\pi\epsilon_0} \frac{Q}{x^2}, 0, 0 \right\rangle \end{aligned}$$

`\colvector`

typesets column vectors
`\colvect{\langle commadelimitedlist of comps \rangle}`

`\colvector{\msup{x}{0},\msup{x}{1},\msup{x}{2},\msup{x}{3}}`

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

`\rowvector`

typesets row vectors

`\rowvect{\langle commadelimitedlistofcomps \rangle}`

`\rowvector{\msup{x}{0},\msup{x}{1},\msup{x}{2},\msup{x}{3}}`

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

`\scompsvect`

Allow for superscripts.

typesets symbolic components of column 3- or 4-vectors (use any nonzero value for the optional argument to typeset a 4-vector

`\scompsvect[\langle anynonzero \rangle]{\langle kernel \rangle}`

`\begin{align*}`

`\vect{p} \&= \scompsvect{p} \\\`

`\vect{p} \&= \scompsvect[4]{p}`

`\end{align*}`

$$\vec{p} = \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix}$$

$$\vec{p} = \begin{pmatrix} p_0 \\ p_1 \\ p_2 \\ p_3 \end{pmatrix}$$

`\scompsrvect`

Allow for superscripts.

typesets symbolic components of row 3- or 4-vectors (use any nonzero value for the optional argument to typeset a 4-vector

`\scompsrvect[\langle anynonzero \rangle]{\langle kernel \rangle}`

`\begin{align*}`

`\vect{p} \&= \scompsrvect{p} \\\`

`\vect{p} \&= \scompsrvect[4]{p}`

`\end{align*}`

$$\vec{p} = \begin{pmatrix} p_1 & p_2 & p_3 \end{pmatrix}$$

$$\vec{p} = \begin{pmatrix} p_0 & p_1 & p_2 & p_3 \end{pmatrix}$$

5.8 Physical Constants

5.8.1 Defining Physical Constants

`\newphysicsconstant`

define a physical constant

```
\newphysicsconstant{<newname>}{<symbol>}{<value>}{<baseunits>}  
[<drvdunits>][<tradunits>]
```

Here is how `\oofpez` (the Coulomb constant) is defined internally.

```
\newphysicsconstant{oofpez}  
{\ensuremath{\frac{1}{\phantom{_{o}}4\pi\ssub{\epsilon}{o}}}}  
{\scin[9]{9}}  
{\ensuremath{\m\cubed\usk\kg\usk\s^{-4}\usk\A\rpsquared}}  
[\m\per\farad]  
[\newton\usk\m\squared\per\coulomb\squared]
```

Using this command causes several things to happen.

- A command `\newname` is created and contains the constant and units typeset according to the options given when `mandi` was loaded.
- A command `\newnamemathsymbol` is created that expresses **only** the constant's mathematical symbol.
- A command `\newnamevalue` is created that expresses **only** the constant's numerical value.
- A command `\newnamebaseunit` is created that expresses the constant and its units in *baseunits* form.
- A command `\newnamedrvdunit` is created that expresses the constant and its units in *drvdunits* form.
- A command `\newnametradunit` is created that expresses the constant and its units in *tradunits* form.
- A command `\newnameonlybaseunit` is created that expresses **only** the constant's units in *baseunits* form.
- A command `\newnameonlydrvunit` is created that expresses **only** the constant's units in *drvdunits* form.
- A command `\newnameonlytradunit` is created that expresses **only** the constant's units in *tradunits* form.

None of these commands takes any arguments.

5.8.2 Predefined Physical Constants

`\oofpez`

Coulomb constant

`\oofpez`

`\(\oofpezmathsymbol \approx \oofpez\)`

$$\frac{1}{4\pi\epsilon_0} \approx 9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

`\oofpezcs`

alternate form for Coulomb constant

`\oofpezcs`

`\(\oofpezcsmathsymbol = \oofpezcs\)`

$$\frac{1}{4\pi\epsilon_0 c^2} = 10^{-7} \text{ N} \cdot \text{s}^2/\text{C}^2$$

`\epsz`

vacuum permittivity

`\epsz`

`\(\epszmathsymbol = \epsz\)`

$$\epsilon_0 = 9 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$$

`\mzofp`

Biot-Savart constant

`\mzofp`

`\(\mzofpmathsymbol = \mzofp\)`

$$\frac{\mu_0}{4\pi} = 10^{-7} \text{ T} \cdot \text{m}/\text{A}$$

`\muz`

vacuum permeability

`\muz`

`\(\muzmathsymbol = \muz\)`

$$\mu_o = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$$

`\kboltz`

Boltzmann constant

`\kboltz`

`\(\kboltzmathsymbol \approx \kboltz\)`

$$k_B \approx 1.38 \times 10^{-23} \text{ J/K}$$

`\kboltznev`

anternate Boltzmann constant

`\kboltznev`

`\(\kboltzmathsymbol \approx \kboltznev\)`

$$k_B \approx 8.62 \times 10^{-5} \text{ eV/K}$$

`\stefan`

Stefan-Boltzmann constant

`\stefan`

`\(\stefanmathsymbol \approx \stefan\)`

$$\sigma \approx 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$$

`\planck`

Planck constant

`\planck`

`\(\planckmathsymbol \approx \planck\)`

$$h \approx 6.62 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}$$

`\plancknev`

alternate Planck constant
`\plancknev`

`\(\planckmathsymbol \approx \plancknev\)`

$$h \approx 4.136 \times 10^{-15} \text{ eV} \cdot \text{s}$$

`\planckbar`

reduced Planck constant (Dirac constant)
`\planckbar`

`\(\planckbarmathsymbol \approx \planckbar\)`

$$\hbar \approx 1.05 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}$$

`\planckbarnev`

alternate reduced Planck constant (Dirac constant)
`\planckbarnev`

`\(\planckbarmathsymbol \approx \planckbarnev\)`

$$\hbar \approx 4.136 \times 10^{-15} \text{ eV} \cdot \text{s}$$

`\Navogadro`

Avogadro constant
`\Navogadro`

`\(\planckbarmathsymbol \approx \Navogadro\)`

$$\hbar \approx 6.022 \times 10^{23} \text{ mol}^{-1}$$

`\bigG`

gravitational constant
`\bigG`

`\(\bigGmathsymbol \approx \bigG\)`

$$G \approx 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$$

`\littleg`

Earth's surface gravitational field strength
`\littleg`

`\(\littlegmathsymbol \approx \littleg\)`

$$g \approx 9.80 \text{ m/s}^2$$

`\clight`

magnitude of light's velocity
`\clight`

`\(\clightmathsymbol \approx \clight\)`

$$c \approx 3.00 \times 10^8 \text{ m/s}$$

`\clightnfn`

magnitude of light's velocity (alternate)
`\clightnfn`

`\(\clightnfn\)`

$$1 \text{ ft/ns}$$

`\Ratom`

approximate atomic radius
`\Ratom`

`\(\Ratommathsymbol \approx \Ratom\)`

$$r_{\text{atom}} \approx 10^{-10} \text{ m}$$

`\Mproton`

proton's mass
`\Mproton`

`\(\Mprotonmathsymbol \approx \Mproton\)`

$$m_{\text{proton}} \approx 1.673 \times 10^{-27} \text{ kg}$$

`\Mneutron`

neutron's mass

`\Mneutron`

`\(\Mneutronmathsymbol \approx \Mneutron\)`

$$m_{\text{neutron}} \approx 1.675 \times 10^{-27} \text{ kg}$$

`\Mhydrogen`

hydrogen atom's mass

`\Mhydrogen`

`\(\Mhydrogenmathsymbol \approx \Mhydrogen\)`

$$m_{\text{hydrogen}} \approx 1.673 \times 10^{-27} \text{ kg}$$

`\Melectron`

electron's mass

`\Melectron`

`\(\Melectronmathsymbol \approx \Melectron\)`

$$m_{\text{electron}} \approx 9.109 \times 10^{-31} \text{ kg}$$

`\echarge`

elementary charge quantum

`\echarge`

`\(\echargemathsymbol \approx \echarge\)`

$$e \approx 1.602 \times 10^{-19} \text{ C}$$

`\Qelectron`

`\qelectron`

electron's charge

`\Qelectron` or `\qelectron`

`\(\qelectronmathsymbol \approx \qelectron\)`

$$q_{\text{electron}} \approx -1.602 \times 10^{-19} \text{ C}$$

`\Qproton`
`\qproton`

proton's charge
`\Qproton` or `\qproton`

`\(\qprotonmathsymbol \approx \qproton\)`

$$q_{\text{proton}} \approx +1.602 \times 10^{-19} \text{ C}$$

`\MEarth`

Earth's mass
`\MEarth`

`\(\MEarthmathsymbol \approx \MEarth\)`

$$M_{\text{Earth}} \approx 6 \times 10^{24} \text{ kg}$$

`\MMoon`

Moon's mass
`\MMoon`

`\(\MMoonmathsymbol \approx \MMoon\)`

$$M_{\text{Moon}} \approx 7 \times 10^{22} \text{ kg}$$

`\MSun`

Sun's mass
`\MSun`

`\(\MSunmathsymbol \approx \MSun\)`

$$M_{\text{Sun}} \approx 2 \times 10^{30} \text{ kg}$$

`\REarth`

Earth's radius
`\REarth`

`\(\REarthmathsymbol \approx \REarth\)`

$$R_{\text{Earth}} \approx 6.4 \times 10^6 \text{ m}$$

`\RMoon`

Moon's radius

`\RMoon`

`\(\RMoonmathsymbol \approx \RMoon\)`

$$R_{\text{Moon}} \approx 1.75 \times 10^6 \text{ m}$$

`\RSun`

Sun's radius

`\RSun`

`\(\RSunmathsymbol \approx \RSun\)`

$$R_{\text{Sun}} \approx 7 \times 10^8 \text{ m}$$

`\ESdist`

Sun-Earth distance or Earth-Sun distance

`\ESdist` or `\SEdist`

`\(\ESdistmathsymbol \approx \SEdist\)`

$$\left| \vec{r}_{\text{ES}} \right| \approx 1.5 \times 10^{11} \text{ m}$$

`\EMdist`

Earth-Moon distance or Moon-Earth distance

`\EMdist` or `\MEDist`

`\(\EMdistmathsymbol \approx \EMdist\)`

$$\left| \vec{r}_{\text{EM}} \right| \approx 4 \times 10^8 \text{ m}$$

5.9 Astronomical Constants and Quantities

`\lightyear`

various ways of denoting light years and years and parsecs as units

`\lightyear\` or `\Lightyear\` or `\cyear\` or `\cyr\` or `\yyear\` or `\yr \`
`\parsec`

ly or LY or $c \cdot \text{year}$ or $c \cdot \text{yr}$ or year or yr
pc

`\LSun`

Sun's luminosity
`\LSun`

`\(\LSunmathsymbol \approx \LSun\)`

$$L_{\text{Sun}} \approx 4 \times 10^{26} \text{ J/s}$$

`\TSun`

Sun's effective temperature
`\TSun`

`\(\TSunmathsymbol \approx \TSun\)`

$$T_{\text{Sun}} \approx 5800 \text{ K}$$

`\MagSun`

Sun's absolute magnitude
`\MagSun`

`\(\MagSunmathsymbol \approx \MagSun\)`

$$M_{\text{Sun}} \approx +4.83$$

`\magSun`

Sun's apparent magnitude
`\magSun`

`\(\magSunmathsymbol \approx \magSun\)`

$$m_{\text{Sun}} \approx -26.74$$

`\Lstar`

stellar luminosity
`\Lstar[⟨object⟩]`

`\Lstar` or `\Lstar[Sirius]` or `\Lsolar`

L_{\star} or L_{Sirius} or L_{\odot}

`\Tstar`

stellar and solar temperature
`\Tstar[⟨object⟩]`

`\Tstar` or `\Tstar[Sirius]` or `\Tsolar`

T_{\star} or T_{Sirius} or T_{\odot}

`\Rstar`

stellar and solar radius
`\Rstar[⟨object⟩]`

`\Rstar` or `\Rstar[Sirius]` or `\Rsolar`

R_{\star} or R_{Sirius} or R_{\odot}

`\Mstar`

stellar and solar mass
`\Mstar[⟨object⟩]`

`\Mstar` or `\Mstar[Sirius]` or `\Msolar`

M_{\star} or M_{Sirius} or M_{\odot}

`\Fstar`

`\fstar`

stellar and solar flux
`\Fstar[⟨object⟩]` or `\fstar[⟨object⟩]`

`\Fstar` or `\Fstar[Sirius]` or `\FSun` or `\Fsolar` or `\fstar` or
`\fstar[Sirius]` or `\fSun` or `\fsolar`

F_{\star} or F_{Sirius} or F_{Sun} or F_{\odot} or f_{\star} or f_{Sirius} or f_{Sun} or f_{\odot}

`\Magstar`
`\magstar`

stellar and solar magnitude
`\Magstar[⟨object⟩]` or `\magstar[⟨object⟩]`

`\Magstar` or `\Magstar[Sirius]` or `\magstar` or `\magstar[Sirius]` or
`\Magsolar` or `\magsolar`

M_{\star} or M_{Sirius} or m_{\star} or m_{Sirius} or M_{\odot} or m_{\odot}

`\Dstar`
`\dstar`

stellar and solar distance (or diameter)
`\Dstar[⟨object⟩]` or `\dstar[⟨object⟩]`

`\Dstar` or `\Dstar[Sirius]` or `\Dsolar` or `\dstar` or `\dstar[Sirius]` or
`\dsolar`

D_{\star} or D_{Sirius} or D_{\odot} or d_{\star} or d_{Sirius} or d_{\odot}

5.10 Frequently Used Fractions

`\onehalf`

small fractions with numerator 1
`\onehalf`

`\(\onehalf \cdots \onetenth\)`

$\frac{1}{2} \cdots \frac{1}{10}$

`\twothirds`

small fractions with numerator 2
`\twothirds`

`\(\twothirds \cdots \twoninths\)`

$\frac{2}{3} \cdots \frac{2}{9}$

`\threehalves`

small fractions with numerator 3

`\threehalves`

`\(\threehalves \cdots \threetenths\)`

$$\frac{3}{2} \cdots \frac{3}{10}$$

`\fourthirds`

small fractions with numerator 4

`\fourthirds`

`\fourthirds`

$$\frac{4}{3}$$

5.11 Calculus

`\dx`

properly typesets variables of integration (the d should not be in italics and should be properly spaced relative to the integrand)

`\dx{<integrationvariable>}`

`\[\int y^2 \dx{y} \]`

$$\int y^2 \, dy$$

`\evalfromto`

properly typesets evaluation of definite integrals

`\evalfromto{<antiderivative>}{<lowerlimit>}{<upperlimit>}`

`\[\evalfromto{\frac{1}{3} y^3}{0}{3} \]`

$$\left. \frac{1}{3} y^3 \right|_0^3$$

`\evalat`

Combine with `\evaluatedat`?

properly typesets quantities evaluated at a particular point or value

`\evalat{<expression>}{<evaluationpoint>}`

`\[\evalat{\dbydt{x}}{t=1} \]`

$$\left. \frac{dx}{dt} \right|_{t=1}$$

`\evaluatedat`

properly indicates evaluation at a particular point or value without specifying the quantity

`\evaluatedat{<evaluationpoint>}`

`\[\mbox{LMST} \evaluatedat{\longitude{0}} \]`

$$\text{LMST} \Big|_{0^\circ}$$

`\integral`
`\Integral`

typesets indefinite and definite integrals

`\integral[\langle lowerlimit \rangle][\langle upperlimit \rangle]{\langle integrand \rangle}{\langle variable \rangle}`
`\Integral[\langle lowerlimit \rangle][\langle upperlimit \rangle]{\langle integrand \rangle}{\langle variable \rangle}`

`\[\integral{y^2}{y} \]`
`\[\integral[0][3]{y^2}{y} \]`
`\[\Integral{y^2}{y} \]`
`\[\Integral[0][3]{y^2}{y} \]`

$$\int y^2 \, dy$$

$$\int_{y=0}^{y=3} y^2 \, dy$$

$$\int y^2 \, dy$$

$$\int_{y=0}^{y=3} y^2 \, dy$$

`\opensurfintegral`
`\opensurfIntegral`

integral over an open surface of the normal component of a vector field
`\opensurfintegral{<surfacename>}{<vectorname>}`
`\opensurfIntegral{<surfacename>}{<vectorname>}`

`\[\opensurfintegral{S}{E} \]`
`\[\opensurfIntegral{S}{E} \]`

$$\int_S \vec{E} \cdot \hat{n} dA$$

$$\int_S \vec{E} \cdot \hat{n} dA$$

`\closedsurfintegral`
`\closedsurfIntegral`

integral over a closed surface of the normal component of a vector field
`\closedsurfintegral{<surfacename>}{<vectorname>}`
`\closedsurfIntegral{<surfacename>}{<vectorname>}`

`\[\closedsurfintegral{S}{E} \]`
`\[\closedsurfIntegral{S}{E} \]`

$$\oint_S \vec{E} \cdot \hat{n} dA$$

$$\oint_S \vec{E} \cdot \hat{n} dA$$

`\openlineintegral`
`\openlineIntegral`

integral over an open path of the tangential component of a vector field
`\openlineintegral{\langle pathname \rangle}{\langle vectorname \rangle}`
`\openlineIntegral{\langle pathname \rangle}{\langle vectorname \rangle}`

`\[\openlineintegral{C}{E} \]`
`\[\openlineIntegral{C}{E} \]`

$$\int_C \vec{E} \cdot \hat{t} d\ell$$

$$\int_C \vec{E} \cdot \hat{t} d\ell$$

`\closedlineintegral`
`\closedlineIntegral`

integral over a closed path of the tangential component of a vector field
`\closedlineintegral{\langle pathname \rangle}{\langle vectorname \rangle}`
`\closedlineIntegral{\langle pathname \rangle}{\langle vectorname \rangle}`

`\[\closedlineintegral{C}{E} \]`
`\[\closedlineIntegral{C}{E} \]`

$$\oint_C \vec{E} \cdot \hat{t} d\ell$$

$$\oint_C \vec{E} \cdot \hat{t} d\ell$$

For line integrals, I have not employed the common $d\vec{\ell}$ symbol. Instead, I use $\hat{t} d\ell$ for two main reason. The first is that line integrals require the component of a vector that is tangent to a curve, and I use \hat{t} to denote a unit tangent. The second is that the new notation looks more like that for surface integrals.

`\dbydt`
`\DbyDt`

first time derivative operator with optional operand
`\dbydt[⟨operand⟩]` or `\DbyDt[⟨operand⟩]`

`\[\dbydt \]`
`\[\dbydt x \]`
`\[\dbydt[x] \]`
`\[\DbyDt \]`
`\[\DbyDt x \]`
`\[\DbyDt[x] \]`

$$\frac{d}{dt}$$

$$\frac{d}{dt}x$$

$$\frac{dx}{dt}$$

$$\frac{\Delta}{\Delta t}$$

$$\frac{\Delta}{\Delta t}x$$

$$\frac{\Delta x}{\Delta t}$$

`\ddbydt`
`\DDbyDt`

second time derivative operator with optional operand
`\ddbydt[⟨operand⟩]` or `\DDbyDt[⟨operand⟩]`

`\[\ddbydt \]`
`\[\ddbydt x \]`
`\[\ddbydt [x] \]`
`\[\DDbyDt \]`
`\[\DDbyDt x \]`
`\[\DDbyDt [x] \]`

$$\frac{d^2}{dt^2}$$

$$\frac{d^2}{dt^2}x$$

$$\frac{d^2x}{dt^2}$$

$$\frac{\Delta^2}{\Delta t^2}$$

$$\frac{\Delta^2}{\Delta t^2}x$$

$$\frac{\Delta^2x}{\Delta t^2}$$

`\pbypt`

first time partial derivative operator with optional operand
`\pbypt[⟨operand⟩]`

`\[\pbypt \]`
`\[\pbypt x \]`
`\[\pbypt [x] \]`

$$\frac{\partial}{\partial t}$$

$$\frac{\partial}{\partial t}x$$

$$\frac{\partial x}{\partial t}$$

`\ppbypt`

second time partial derivative operator with optional operand
`\ppbypt[⟨operand⟩]`

`\[\ppbypt \]`
`\[\ppbypt x \]`
`\[\ppbypt [x] \]`

$$\frac{\partial^2}{\partial t^2}$$

$$\frac{\partial^2}{\partial t^2} x$$

$$\frac{\partial^2 x}{\partial t^2}$$

`\dbyd`

`\DbyD`

generic first derivative operator
`\dbyd{⟨dependentvariable⟩}{⟨indvar⟩}` or `\dbyd{⟨dependentvariable⟩} {⟨indvar⟩}`

`\[\dbyd{f}{y} \]`
`\[\DbyD{f}{y} \]`

$$\frac{df}{dy}$$

$$\frac{\Delta f}{\Delta y}$$

`\ddbyd`

`\DDbyD`

generic second derivative operator
`\ddbyd{⟨dependentvariable⟩}{⟨indvar⟩}` or `\ddbyd{⟨dependentvariable⟩} {⟨indvar⟩}`

`\[\ddbyd{f}{y} \]`
`\[\DDbyD{f}{y} \]`

$$\frac{d^2 f}{dy^2}$$

$$\frac{\Delta^2 f}{\Delta y^2}$$

`\pbyp`

generic first partial derivative operator
`\pbyp{⟨dependentvariable⟩}{⟨indvar⟩}`

`\[\pbyp{f}{y} \]`

$$\frac{\partial f}{\partial y}$$

`\ppbyp`

generic second partial derivative operator
`\ppbyp{⟨dependentvariable⟩}{⟨indvar⟩}`

`\[\ppbyp{f}{y} \]`

$$\frac{\partial^2 f}{\partial y^2}$$

`\gradient`
`\divergence`
`\curl`
`\laplacian`
`\dalembertian`

vector operators
`\gradient` and `\divergence` and `\curl` and `\laplacian` and `\dalembertian`

`\gradient{⟨f⟩}` and `\divergence{vect{E}}` and `\curl{vect{E}}` and `\laplacian{⟨f⟩}`
and `\dalembertian{⟨F⟩}`

$$\nabla f \text{ and } \nabla \bullet \vec{E} \text{ and } \nabla \times \vec{E} \text{ and } \nabla^2 f \text{ and } \square F$$

`\seriesfofx`

series expansion of $f(x)$
`\seriesfofx`

`\seriesfofx`

$$f(x) \approx f(a) + \frac{f'(a)}{1!} (x-a) + \frac{f''(a)}{2!} (x-a)^2 + \frac{f'''(a)}{3!} (x-a)^3 + \dots$$

`\seriesexp`

series expansion of e^x
`\seriesexp`

`\seriesexp`

$$e^x \approx 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots$$

`\seriesin`

series expansion of $\sin x$
`\seriesin`

`\seriesin`

$$\sin x \approx x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots$$

`\seriescos`

series expansion of $\cos x$
`\seriescos`

`\seriescos`

$$\cos x \approx 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \dots$$

`\seriesan`

series expansion of $\tan x$
`\seriesan`

`\seriesan`

$$\tan x \approx x + \frac{x^3}{3} + \frac{2x^5}{15} + \dots$$

`\seriesat`

series expansion of a^x
`\seriesatox`

`\seriesatox`

$$a^x \approx 1 + x \ln a + \frac{(x \ln a)^2}{2!} + \frac{(x \ln a)^3}{3!} + \dots$$

`\serieslnoneplusx`

series expansion of $\ln(1+x)$
`\serieslnoneplusx`

`\serieslnoneplusx`

$$\ln(1 \pm x) \approx \pm x - \frac{x^2}{2} \pm \frac{x^3}{3} - \frac{x^4}{4} \pm \dots$$

`\binomialseries`

series expansion of $(1+x)^n$
`\binomialseries`

`\binomialseries`

$$(1+x)^n \approx 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots$$

`\diracdelta`

Dirac delta function
`\diracdelta{arg}`

`\diracdelta{x}`

$\delta(x)$

5.12 Other Useful Commands

`\asin`
`\acos`
`\atan`
`\asec`
`\acsc`
`\acot`

trigonometric and inverse trigonometric functions not defined in \LaTeX
`\asin` and `\acos` and `\atan` and `\asec` and `\acsc` and `\acot`

`\(\asin\)` and `\(\acos\)` and `\(\atan\)` and `\(\asec\)` and `\(\acsc\)` and
`\(\acot\)`

\sin^{-1} and \cos^{-1} and \tan^{-1} and \sec^{-1} and \csc^{-1} and \cot^{-1}

`\sech`
`\csch`
`\asinh`
`\acosh`
`\atanh`
`\asech`
`\acsch`
`\acoth`

hyperbolic and inverse hyperbolic functions not defined in \LaTeX
`\sech` and `\csch` and `\asinh` and `\acosh`
`\atanh` and `\asech` and `\acsch` and `\acoth`

`\(\sech\)` and `\(\csch\)` and `\(\asinh\)` and `\(\acosh\)` `\(\`
`\(\atanh\)` and `\(\asech\)` and `\(\acsch\)` and `\(\acoth\)`

sech and csch and \sinh^{-1} and \cosh^{-1}
 \tanh^{-1} and sech^{-1} and csch^{-1} and coth^{-1}

`\sgn`

signum function

`\sgn`

`\(\sgn\)`

sgn

`\dex`

decimal exponentiation function (used in astrophysics)

`\dex`

`\(\dex\)`

dex

`\eV`
`\ev`

shortcuts for `\electronvolt`
`\eV` or `\ev`

`\eV\` or `\eV`

eV or eV

`\logb`

logarithms to arbitrary bases
`\logb[<base>]`

`\logb 8` or `\logb[2] 8`

$\log 8$ or $\log_2 8$

`\cB`

alternate symbol for magnetic field inspired by Tom Moore
`\cB`

`\cB\` or `\vect{\cB}`

dB or $\vec{\text{B}}$

`\newpi`

Bob Palais' symbol for 2π
`\newpi`

`\newpi`

π

`\scripty`

use to get fonts in Griffith's electrodynamics textbook
`\scripty{<kernel>}`

`\scripty{r}`

\mathcal{z}

`\flux`

symbol for flux of a vector field
`\flux[<label>]`

`\flux` or `\flux[E]`

Φ or Φ_{E}

`\abs`

absolute value function

`\abs{⟨arg⟩}`

`\abs{-4}`

$|-4|$

`\magof`

magnitude of a quantity (lets you selectively use double bars without setting the **doubleabsbars** option)

`\magof{⟨arg⟩}`

`\magof{\vect{E}}`

$\|\vec{E}\|$

`\dimsof`

notation for showing the dimensions of a quantity

`\dimsof{⟨arg⟩}`

`\(\dimsof{\vect{v}} = L \cdot T^{-1}\)`

$[\vec{v}] = L \cdot T^{-1}$

`\unitsof`

notation for showing the units of a quantity (I propose this notation and hope to propagate it because I could not find any standard notation for this same idea in other sources)

`\unitsof{⟨arg⟩}`

`\unitsof{\vect{v}} = \m\per\s`

$[\vec{v}]_u = \text{m/s}$

`\quant`
`\bquant`

surrounds the argument with variable sized parentheses (use `\bquant` to get square brackets)

`\quant{⟨arg⟩}` or `\bquant{⟨arg⟩}`

`\quant{\oofpez}` or `\bquant{\oofpez}`

$\left(9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2\right)$ or $\left[9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2\right]$

`\Changein`
`\changein`

notation for *the change in a quantity*

`\Changein{⟨quantity⟩}` or `\changein{⟨quantity⟩}`

`\Changein{\vect{E}}` or `\changein{\vect{E}}`

$\Delta \vec{E}$ or $\delta \vec{E}$

`\scin`
`\ee`
`\EE`

scientific notation (use `\ee` or `\EE` for computer code)

`\scin[⟨mantissa⟩]{⟨exponent⟩}[⟨unit⟩]`

`\ee{⟨mantissa⟩}{⟨exponent⟩}`

`\EE{⟨mantissa⟩}{⟨exponent⟩}`

`\scin[2.99]{8}[\text{m}\text{per}\text{s}] \text{\\}`

`\ee{2.99}{8} \text{\\}`

`\EE{2.99}{8}`

$2.99 \times 10^8 \text{ m/s}$

2.99e8

2.99E8

`\dms`
`\hms`
`\clockreading`

formatted angles and times

`\dms{<deg>}{<min>}{<sec>}`
`\hms{<hour>}{<min>}{<sec>}`

`\clock reading{<hour>}{<minute>}{<second>}`

`\dms{23}{34}{10.27} \\\`

`\hms{23}{34}{10.27} \\\`

`\clockreading{23}{34}{10.27}`

$23^{\circ}34'10.27''$

$23^{\text{h}}34^{\text{m}}10.27^{\text{s}}$

$23^{\text{h}}34^{\text{m}}10.27^{\text{s}}$

`\latitude`
`\latitudeN`
`\latitudeS`
`\longitude`
`\longitudeE`
`\longitudeW`

formatted latitude and longitude

`\latitude{+35}` or `\latitudeN{35}` or `\latitudeS{35} \\\`

`\longitude{-81}` or `\longitudeE{81}` or `\longitudeW{81}`

$+35^{\circ}$ or $35^{\circ} N$ or $35^{\circ} S$

-81° or $81^{\circ} E$ or $81^{\circ} W$

`\ssub`

text subscripts

`\ssub{<kernel>}{<sub>}`

`\ssub{N}{AB}`

N_{AB}

`\ssup`

text superscripts

`\ssup{<kernel>}{<sup>}`

`\ssup{N}{contact}`

N^{contact}

`\ssud`

text superscripts and subscripts
`\ssud{<kernel>}{<sup>}{<sub>}`

`\ssud{N}{<contact>}{AB}`

$$N_{AB}^{\text{contact}}$$

`\msub`

mathematical subscripts
`\msub{<kernel>}{<sub>}`

`\msub{R}{\alpha\beta}`

$$R_{\alpha\beta}$$

`\msup`

mathematical superscripts
`\msup{<kernel>}{<sup>}`

`\msup{R}{\gamma}`

$$R^{\gamma}$$

`\msud`

mathematical superscripts and subscripts
`\msud{<kernel>}{<sup>}{<sub>}`

`\msud{\Gamma}{\gamma}{\alpha\beta}`

$$\Gamma_{\alpha\beta}^{\gamma}$$

`\levicivita`

Levi-Civita symbol
`\levicivita{<indices>}`

`\levicivita{ijk}`

$$\varepsilon_{ijk}$$

`\xaxis`
`\yaxis`
`\zaxis`
`\naxis`

shortcuts for coordinate axes
`\xaxis` or `\yaxis` or `\zaxis` or `\naxis{<axis>}`

`\xaxis` or `\yaxis` or `\zaxis` or `\naxis{t}`

x-axis or *y*-axis or *z*-axis or *t*-axis

`\xyplane`
`\yzplane`
`\zxplane`
`\yxplane`
`\zyplane`
`\xzplane`

shortcuts for coordinate planes
`\xyplane` or `\yzplane` or `\zxplane` or `\yzplane` or `\zyplane` or `\xzplane`

`\xyplane` or `\yzplane` or `\zxplane` or `\yxplane` or `\zyplane` or `\xzplane`

xy-plane or *yz*-plane or *zx*-plane or *yx*-plane or *zy*-plane or *xz*-plane

`\cuberoot`
`\fourthroot`
`\fifthroot`
`\fsqrt`
`\fcuberoot`
`\ffourthroot`
`\ffifthroot`

frequently used roots as radicals
`\cuberoot{<arg>}` or `\fourthroot{<arg>}` or `\fifthroot{<arg>}` or `\fsqrt{<arg>}`
or `\fcuberoot{<arg>}` or `\ffourthroot{<arg>}` or `\ffifthroot{<arg>}`

`\cuberoot{x}` or `\fourthroot{x}` or `\fifthroot{x}` or `\fsqrt{x}`
or `\fcuberoot{x}` or `\ffourthroot{x}` or `\ffifthroot{x}`

$\sqrt[3]{x}$ or $\sqrt[4]{x}$ or $\sqrt[5]{x}$ or $x^{\frac{1}{2}}$ or $x^{\frac{1}{3}}$ or $x^{\frac{1}{4}}$ or $x^{\frac{1}{5}}$

`\relgamma`
`\frelgamma`

expressions for relativistic gamma factor
`\relgamma{<arg>}` or `\frelgamma{<arg>}`

`\relgamma{\magvect{v}}` or `\relgamma{(0.5c)}` \\
`\frelgamma{\magvect{v}}` or `\frelgamma{(0.5c)}`

$$\frac{1}{\sqrt{1 - \left(\frac{|\vec{v}|}{c}\right)^2}} \text{ or } \frac{1}{\sqrt{1 - \left(\frac{(0.5c)}{c}\right)^2}}$$

$$\left(1 - \frac{|\vec{v}|^2}{c^2}\right)^{-\frac{1}{2}} \text{ or } \left(1 - \frac{(0.5c)^2}{c^2}\right)^{-\frac{1}{2}}$$

`\oosqrtomxs`
`\oosqrtomx`
`\oomx`
`\oopx`

expressions convenient for numerically evaluating γ
`\oosqrtomxs{<arg>}` (*one over square root of one minus x squared*)
`\oosqrtomx{<arg>}` (*one over square root of one minus x*)
`\oomx{<arg>}` (*one over one minus x*)
`\oopx{<arg>}` (*one over one plus x*)

`\oosqrtomxs{0.22} \\`
`\oosqrtomx{0.22} \\`
`\oomx{0.22} \\`
`\oopx{0.11}`

$$\frac{1}{\sqrt{1 - 0.22^2}}$$

$$\frac{1}{\sqrt{1 - 0.22}}$$

$$\frac{1 - 0.22}{1}$$

$$\frac{1}{1 + 0.11}$$

5.13 Custom Operators

`\isequals`

typesets *test-for-equality* operator
`\isequals`

`5 \isequals 3`

$5 \stackrel{?}{=} 3$

`\wordoperator`
`\pwordoperator`

typesets two lines of tiny text to be use as an operator without using mathematical symbols

`\wordoperator{<firstline>}{<secondline>}`
`\pwordoperator{<firstline>}{<secondline>}`

`\wordoperator{added}{to} \\`
`\pwordoperator{added}{to}`

added
to
(added
to)

`\definedas`
`\associated`
`\adjustedby`
`\earliertan`
`\laterthan`
`\forevery`

frequently used word operators

`\definedas` or `\associated` or `\adjustedby` or `\earliertan` or `\laterthan` or `\forevery`

`\definedas` or `\associated` or `\adjustedby` `\`
`\earliertan` or `\laterthan` or `\forevery`

$\begin{array}{ccccc} \text{defined} & & \text{associated} & & \text{adjusted} \\ \text{as} & \text{OR} & \text{with} & \text{OR} & \text{by} \\ \text{earlier} & & \text{later} & & \text{for} \\ \text{than} & \text{OR} & \text{than} & \text{OR} & \text{every} \end{array}$

`\pdefinedas`
`\passociated`
`\padjustedby`
`\pearliertan`
`\platerthan`
`\pforevery`

frequently used word operators with parentheses

`\pdefinedas` or `\passociated` or `\padjustedby` or `\pearliertan` or `\platerthan` or `\pforevery`

`\pdefinedas` or `\passociated` or `\padjustedby` `\`
`\pearliertan` or `\platerthan` or `\pforevery`

$\begin{array}{ccccc} \left(\begin{array}{c} \text{defined} \\ \text{as} \end{array}\right) & \text{OR} & \left(\begin{array}{c} \text{associated} \\ \text{with} \end{array}\right) & \text{OR} & \left(\begin{array}{c} \text{adjusted} \\ \text{by} \end{array}\right) \\ \left(\begin{array}{c} \text{earlier} \\ \text{than} \end{array}\right) & \text{OR} & \left(\begin{array}{c} \text{later} \\ \text{than} \end{array}\right) & \text{OR} & \left(\begin{array}{c} \text{for} \\ \text{every} \end{array}\right) \end{array}$

`\defines`

defines or *defined by* operator

`\defines`

`\vect{p}` `\defines` `\(\gamma m\)\vect{v}`

$$\vec{p} \stackrel{\text{def}}{=} \gamma m \vec{v}$$

`\inframe`

Make the arrow's length fixed.

operator for indicating the coordinate representation of a vector in a particular reference frame denoted by a capital letter

`\inframe[⟨frame⟩]`

`\vect{p}` `\inframe[S]` `\momentum{\mivector{1,2,3}}` `\`
`\vect{p}` `\inframe[S']` `\momentum{\mivector{\sqrt{14},0,0}}`

$$\vec{p} \xrightarrow{S} \langle 1, 2, 3 \rangle \text{ kg} \cdot \text{m/s}$$

$$\vec{p} \xrightarrow{S'} \langle \sqrt{14}, 0, 0 \rangle \text{ kg} \cdot \text{m/s}$$

`\associates`

associated with or *associates with* operator (for verbal concepts)

`\associates`

kinetic energy `\associates` velocity

kinetic energy $\xrightarrow{\text{assoc}}$ velocity

`\becomes`

becomes operator

`\becomes`

`\(\gamma m\)\vect{v}` `\becomes` `\(m\)\vect{v}`

$\gamma m\vec{v} \xrightarrow{\text{becomes}} m\vec{v}$

`\rrelatedto`

`\lrelatedto`

`\brelatedto`

operators for directional mathematical relationships without mathematical notation

`\rrelatedto{<operation>}`

`\lrelatedto{<operation>}`

`\brelatedto{<operation>}{<operation>}`

`(flux ratio) \rrelatedto{taking logarithm} (mag diff) \\\`

`(flux ratio) \lrelatedto{exponentiation} (mag diff) \\\`

`(mag diff) \brelatedto{taking logarithm}{exponentiation}(flux ratio)`

$(\text{flux ratio}) \xrightarrow{\text{taking logarithm}} (\text{mag diff})$

$(\text{flux ratio}) \xleftarrow{\text{exponentiation}} (\text{mag diff})$

$(\text{mag diff}) \xleftarrow[\text{taking logarithm}]{\text{exponentiation}} (\text{flux ratio})$

5.14 Commands Specific to *Matter & Interactions*

`\momprinciple`

momentum principle
`\LHSmomprinciple` or `\RHSmomprinciple` or `\momprinciple`

`\LHSmomprinciple` `\`
`\RHSmomprinciple` `\`
`\momprinciple`

$$\begin{aligned} \vec{p}_{\text{sys},f} \\ \vec{p}_{\text{sys},i} + \vec{F}_{\text{net,sys}} \Delta t \\ \vec{p}_{\text{sys},f} = \vec{p}_{\text{sys},i} + \vec{F}_{\text{net,sys}} \Delta t \end{aligned}$$

`\energyprinciple`

energy principle
`\LHSEnergyprinciple` or `\RHSenergyprinciple` or `\energyprinciple`

`\LHSEnergyprinciple` `\`
`\RHSenergyprinciple` `\`
`\energyprinciple`

$$\begin{aligned} E_{\text{sys},f} \\ E_{\text{sys},i} + W_{\text{ext}} + Q \\ E_{\text{sys},f} = E_{\text{sys},i} + W_{\text{ext}} + Q \end{aligned}$$

`\angularmomprinciple`

angular momentum principle
`\LHSangularmomprinciple` or `\RHSangularmomprinciple` or
`\angularmomprinciple`

`\LHSangularmomprinciple` `\`
`\RHSangularmomprinciple` `\`
`\angularmomprinciple`

$$\begin{aligned} \vec{L}_{\text{sys,A},f} \\ \vec{L}_{\text{sys,A},i} + \vec{T}_{\text{net,sys}} \Delta t \\ \vec{L}_{\text{sys,A},f} = \vec{L}_{\text{sys,A},i} + \vec{T}_{\text{net,sys}} \Delta t \end{aligned}$$

`\gravinteraction`

expression for gravitational interaction
`\gravinteraction`

`\gravinteraction`

$$G \frac{M_1 M_2}{|\vec{r}_{12}|^2} (-\hat{r}_{12})$$

`\elecinteraction`

expression for electric interaction
`\elecinteraction`

`\elecinteraction`

$$\frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{|\vec{r}_{12}|^2} \hat{r}_{12}$$

`\Efieldofparticle`

expression for electric field of a particle
`\Efieldofparticle`

`\Efieldofparticle`

$$\frac{1}{4\pi\epsilon_0} \frac{Q}{|\vec{r}|^2} \hat{r}$$

`\Bfieldofparticle`

expression for magnetic field of a particle
`\Bfieldofparticle`

`\Bfieldofparticle`

$$\frac{\mu_0}{4\pi} \frac{Q |\vec{v}|}{|\vec{r}|^2} \hat{v} \times \hat{r}$$

`\Esys`

symbol for energy of system

`\Esys`

E_{sys}

`\Us`

symbol for spring potential energy

`\Us`

`\Us`

U_{s}

`\Ug`

symbol for gravitational potential energy

`\Ug`

`\Ug`

U_{g}

`\Ue`

symbol for electric potential energy

`\Ue`

`\Ue`

U_{e}

`\Ktrans`

symbol for translational kinetic energy

`\Ktrans`

`\Ktrans`

K_{trans}

`\Krot`

symbol for rotational kinetic energy
`\Krot`

`\Krot`

K_{rot}

`\Eparticle`

symbol for particle energy
`\Eparticle`

`\Eparticle`

E_{particle}

`\Einternal`

symbol for internal energy
`\Einternal`

`\Einternal`

E_{internal}

`\Erest`

symbol for rest energy
`\Erest`

`\Erest`

E_{rest}

`\Echem`

symbol for chemical energy
`\Echem`

`\Echem`

E_{chem}

`\Etherm`

symbol for thermal energy

`\Etherm`

`\Etherm`

E_{therm}

`\Evib`

symbol for vibrational energy

`\Evib`

`\Evib`

E_{vib}

`\Ephoton`

symbol for photon energy

`\Ephoton`

`\Ephoton`

E_{photon}

`\DU_s`

symbol for change in spring potential energy

`\DU_s`

`\DU_s`

ΔU_{s}

`\DU_g`

symbol for change in gravitational potential energy

`\DU_g`

`\DU_g`

ΔU_{g}

`\DUe`

symbol for change in electric potential energy

`\DUe`

`\DUe`

ΔU_e

`\DKtrans`

symbol for change in translational kinetic energy

`\DKtrans`

`\DKtrans`

ΔK_{trans}

`\DKrot`

symbol for change in rotational kinetic energy

`\DKrot`

`\DKrot`

ΔK_{rot}

`\DEparticle`

symbol for change in particle energy

`\DEparticle`

`\DEparticle`

$\Delta E_{\text{particle}}$

`\DEinternal`

symbol for change in internal energy

`\DEinternal`

`\DEinternal`

$\Delta E_{\text{internal}}$

`\DErest`

symbol for change in rest energy
`\DErest`

`\DErest`

$$\Delta E_{\text{rest}}$$

`\DEchem`

symbol for change in chemical energy
`\DEchem`

`\DEchem`

$$\Delta E_{\text{chem}}$$

`\DEtherm`

symbol for change in thermal energy
`\DEtherm`

`\DEtherm`

$$\Delta E_{\text{therm}}$$

`\DEvib`

symbol for change in vibrational energy
`\DEvib`

`\DEvib`

$$\Delta E_{\text{vib}}$$

`\DEphoton`

symbol for change in photon energy
`\DEphoton`

`\DEphoton`

$$\Delta E_{\text{photon}}$$

`\Usfinal`

expression for final spring potential energy

`\Usfinal`

`\Usfinal`

$$\left(\frac{1}{2}k_s s^2\right)_f$$

`\Usinitial`

expression for initial spring potential energy

`\Usinitial`

`\Usfinal`

$$\left(\frac{1}{2}k_s s^2\right)_f$$

`\Ugfinal`

expression for final gravitational potential energy

`\Ugfinal`

`\Ugfinal`

$$\left(-G\frac{M_1 M_2}{|\vec{r}_{12}|}\right)_f$$

`\Uginitial`

expression for initial gravitational potential energy

`\Uginitial`

`\Ugfinal`

$$\left(-G\frac{M_1 M_2}{|\vec{r}_{12}|}\right)_f$$

`\Uefinal`

expression for final electric potential energy
`\Uefinal`

`\Uefinal`

$$\left(\frac{1}{4\pi\epsilon_o} \frac{Q_1 Q_2}{|\vec{r}_{12}|} \right)_f$$

`\Ueinitial`

expression for initial electric potential energy
`\Ueinitial`

`\Uefinal`

$$\left(\frac{1}{4\pi\epsilon_o} \frac{Q_1 Q_2}{|\vec{r}_{12}|} \right)_f$$

`\ks`

symbol for spring stiffness
`\ks`

`\ks`

$$k_s$$

`\Fnet`

`\Fnettext`

`\Fnetsys`

`\Fsub`

various symbols for net force
`\Fnet` or `\Fnettext` or `\Fnetsys` or `\Fsub{label}`

`\Fnet` or `\Fnettext` or `\Fnetsys` or `\Fsub{ball,bat}`

$$\vec{F}_{\text{net}} \text{ or } \vec{F}_{\text{net,ext}} \text{ or } \vec{F}_{\text{net,sys}} \text{ or } \vec{F}_{\text{ball,bat}}$$

`\Tnet`

`\Tnettext`

`\Tnetsys`

`\Tsub`

various symbols for net torque

`\Tnet` or `\Tnettext` or `\Tnetsys` or `\Tsub{\label}`

`\Tnet` or `\Tnettext` or `\Tnetsys` or `\Tsub{ball,bat}`

\vec{T}_{net} or $\vec{T}_{\text{net,ext}}$ or $\vec{T}_{\text{net,sys}}$ or $\vec{T}_{\text{ball,bat}}$

`\vpythonline`

single line of VPython code used inline

`\vpythonline{\vpythoncode}`

`\vpythonline{from visual import *}`

from visual import *

`vpythonblock`

environment for a block of VPython code

`\begin{vpythonblock}`

`\vpythoncode`

`\end{vpythonblock}`

`\begin{vpythonblock}`

`from visual import *`

`sphere(center=pos(1,2,3),color=color.green)`

`MyArrow=arrow(pos=earth.pos, axis=fscale*Fnet, color=color.green)`

`print ("arrow.pos = "), arrow.pos`

`\end{vpythonblock}`

```
1  from visual import *
2  sphere( center=pos(1,2,3) , color=color.green)
3  MyArrow=arrow( pos=earth.pos , axis=fscale*Fnet , color=color
4  print  ("arrow.pos = ") , arrow.pos
```

\vpythonfile

file in the current directory containing VPython code

\vpythonfile{filename}

\vpythonfile{vdemo.py}

```
1 from __future__ import print_function, division
2 from visual import *
3
4 giant = sphere(pos=vector(-1e11,0,0),radius=2e10,mass=2e30,
5               color=color.red)
6 giant.p = vector(0, 0, -1e4) * giant.mass
7
8 dwarf = sphere(pos=vector(1.5e11,0,0),radius=1e10,mass=1e30,
9               color=color.yellow)
10 dwarf.p = -giant.p
11
12 for a in [giant, dwarf]:
13     a.orbit = curve(color=a.color, radius=2e9)
14
15 dt = 86400
16 while 1:
17     rate(100)
18     dist = dwarf.pos - giant.pos
19     force = 6.7e-11 * giant.mass * dwarf.mass * dist / mag(
20         dist)**3
21     giant.p = giant.p + force*dt
22     dwarf.p = dwarf.p - force*dt
23     for a in [giant, dwarf]:
24         a.pos = a.pos + a.p/a.mass * dt
25         a.orbit.append(pos=a.pos)
```

5.15 Boxes and Environments

`\emptyanswer`

empty space for filling answer boxes so there is nothing to see
`\emptyanswer[$\langle width \rangle$][$\langle hght \rangle$]`

`\emptyanswer[0.75][0.2]`

`activityanswer`

main environment for typesetting boxed answers
`\begin{activityanswer}[$\langle bgclr \rangle$][$\langle frmclr \rangle$][$\langle txtclr \rangle$][$\langle width \rangle$][$\langle hght \rangle$]`
 `$\langle content \rangle$`
`\end{activityanswer}`

`\begin{activityanswer}`
 Lorem ipsum dolor sit amet, consectetur adipiscing elit.
 Morbi commodo, ipsum sed pharetra gravida, orci magna
 rhoncus neque, id pulvinar odio lorem non turpis. Nullam
 sit amet enim.
`\end{activityanswer}`

 Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo,
 ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio
 lorem non turpis. Nullam sit amet enim.

adjactivityanswer

```
like \activityanswer but adjusts vertically to tightly surround text
\begin{adjactivityanswer} [<bgclr>] [<frmclr>] [<txtclr>] [<wdth>] [<hght>]
<content>
\end{adjactivityanswer}
```

```
\begin{adjactivityanswer}
  Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi
  commodo, ipsum sed pharetra gravida, orci magna rhoncus neque,
  id pulvinar odio lorem non turpis. Nullam sit amet enim.
  Suspendisse id velit vitae ligula volutpat condimentum. Aliquam
  erat volutpat. Sed quis velit. Nulla facilisi. Nulla libero.
  Vivamus pharetra posuere sapien. Nam consectetur. Sed aliquam,
  nunc eget euismod ullamcorper, lectus nunc ullamcorper orci,
  fermentum bibendum enim nibh eget ipsum. Donec porttitor ligula
  eu dolor. Maecenas vitae nulla consequat libero cursus venenatis.
  Nam magna enim, accumsan eu, blandit sed, blandit a, eros.
\end{adjactivityanswer}
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim. Suspendisse id velit vitae ligula volutpat condimentum. Aliquam erat volutpat. Sed quis velit. Nulla facilisi. Nulla libero. Vivamus pharetra posuere sapien. Nam consectetur. Sed aliquam, nunc eget euismod ullamcorper, lectus nunc ullamcorper orci, fermentum bibendum enim nibh eget ipsum. Donec porttitor ligula eu dolor. Maecenas vitae nulla consequat libero cursus venenatis. Nam magna enim, accumsan eu, blandit sed, blandit a, eros.

\emptybox

```
provides a fixed-size box with optional text
\emptybox[<txt>] [<bgclr>] [<frmclr>] [<txtclr>] [<wdth>] [<hght>]
```

```
\emptybox[Lorem ipsum dolor sit amet, consectetur adipiscing elit.
Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque,
id pulvinar odio lorem non turpis. Nullam sit amet enim.]
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.

`\adjemptybox`

like `\emptybox` but adjusts vertically to tightly surround text
`\adjemptybox[$\langle txt \rangle$][$\langle bgclr \rangle$][$\langle frmclr \rangle$][$\langle txtclr \rangle$][$\langle width \rangle$][$\langle hght \rangle$]`

```
\adjemptybox[Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.]
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.

`\answerbox`

wrapper for `\emptybox`
`\answerbox[$\langle txt \rangle$][$\langle bgclr \rangle$][$\langle frmclr \rangle$][$\langle txtclr \rangle$][$\langle width \rangle$][$\langle hght \rangle$]`

```
\answerbox[Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.]
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.

`\adjanswerbox`

wrapper for `\adjemptybox`
`\adjanswerbox[$\langle txt \rangle$][$\langle bgclr \rangle$][$\langle frmclr \rangle$][$\langle txtclr \rangle$][$\langle width \rangle$][$\langle hght \rangle$]`

```
\adjanswerbox[Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.]
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi commodo, ipsum sed pharetra gravida, orci magna rhoncus neque, id pulvinar odio lorem non turpis. Nullam sit amet enim.

`\smallanswerbox`

answer box with height 0.10 that of current `\textheight` and width 0.90 that of current `\linewidth`
`\smallanswerbox[⟨txt⟩][⟨bgclr⟩]`

`\smallanswerbox[] [red]`



`\mediumanswerbox`

answer box with height 0.20 that of current `\textheight` and width 0.90 that of current `\linewidth`
`\mediumanswerbox[⟨txt⟩][⟨bgclr⟩]`

`\mediumanswerbox[] [lightgray]`



`\largeanswerbox`

answer box with height 0.25 that of current `\textheight` and width 0.90 that of current `\linewidth` (too large to show here)
`\largeanswerbox[⟨txt⟩][⟨bgclr⟩]`

`\largeanswerbox[] [lightgray]`

`\largeranswerbox`

answer box with height 0.33 that of current `\textheight` and width 0.90 that of current `\linewidth` (too large to show here)
`\largreanswerbox[$\langle txt \rangle$][$\langle bgclr \rangle$]`

`\largreanswerbox[] [lightgray]`

`\hugeanswerbox`

answer box with height 0.50 that of current `\textheight` and width 0.90 that of current `\linewidth` (too large to show here)
`\hugeanswerbox[$\langle txt \rangle$][$\langle bgclr \rangle$]`

`\hugeanswerbox[] [lightgray]`

`\hugeranswerbox`

answer box with height 0.75 that of current `\textheight` and width 0.90 that of current `\linewidth` (too large to show here)
`\hugeranswerbox[$\langle txt \rangle$][$\langle bgclr \rangle$]`

`\hugeranswerbox[] [lightgray]`

`\fullpageanswerbox`

answer box with height 1.00 that of current `\textheight` and width 0.90 that of current `\linewidth` (too large to show here)
`\fullpageanswerbox[$\langle txt \rangle$][$\langle bgclr \rangle$]`

`\fullpageanswerbox[] [lightgray]`

miinstructornote

environment for highlighting notes to instructors

```
\begin{miinstructornote}
```

```
<content>
```

```
\end{miinstructornote}
```

```
\begin{miinstructornote}
```

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

```
\end{miinstructornote}
```

INSTRUCTOR NOTE

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

mistudentnote

environment for highlighting notes to students

```
\begin{studentnote}
```

```
<content>
```

```
\end{studentnote}
```

```
\begin{mistudentnote}
```

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

```
\end{mistudentnote}
```

STUDENT NOTE

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

miderivation

fancy environment for mathematical derivations based on `align` environment
`\begin{miderivation}`
`\end{miderivation}`

```
\begin{miderivation}
  \gamma &= \relgamma{\magvect{v}}
  && \text{given} \\
  \msup{\gamma}{2} &= \oomx{\msup{(\frac{\magvect{v}}{c})}{2}}
  && \text{square both sides} \\
  \frac{1}{\msup{\gamma}{2}} &= 1 - \msup{(\frac{\magvect{v}}{c})}{2}
  && \text{reciprocal of} \\
  && \text{both sides} \\
  \msup{(\frac{\magvect{v}}{c})}{2} &= 1 - \frac{1}{\msup{\gamma}{2}}
  && \text{rearrange} \\
  \frac{\magvect{v}}{c} &= \sqrt{1 - \frac{1}{\msup{\gamma}{2}}}
  && \text{square root of both sides} \\
\end{miderivation}
```

DERIVATION

$$\gamma = \frac{1}{\sqrt{1 - \left(\frac{|\vec{v}|}{c}\right)^2}} \quad \text{given} \quad (1)$$

$$\gamma^2 = \frac{1}{1 - \left(\frac{|\vec{v}|}{c}\right)^2} \quad \text{square both sides} \quad (2)$$

$$\frac{1}{\gamma^2} = 1 - \left(\frac{|\vec{v}|}{c}\right)^2 \quad \text{reciprocal of both sides} \quad (3)$$

$$\left(\frac{|\vec{v}|}{c}\right)^2 = 1 - \frac{1}{\gamma^2} \quad \text{rearrange} \quad (4)$$

$$\frac{|\vec{v}|}{c} = \sqrt{1 - \frac{1}{\gamma^2}} \quad \text{square root of both sides} \quad (5)$$

bwinstructornote

environment for highlighting notes to instructors

```
\begin{bwinstructornote}
```

```
<content>
```

```
\end{bwinstructornote}
```

```
\begin{bwinstructornote}
```

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

```
\end{bwinstructornote}
```

INSTRUCTOR NOTE

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

bwstudentnote

environment for highlighting notes to students

```
\begin{bwstudentnote}
```

```
<content>
```

```
\end{bwstudentnote}
```

```
\begin{bwstudentnote}
```

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

```
\end{bwstudentnote}
```

STUDENT NOTE

Nunc auctor bibendum eros. Maecenas porta accumsan mauris. Etiam enim enim, elementum sed, bibendum quis, rhoncus non, metus. Fusce neque dolor, adipiscing sed, consectetur et, lacinia sit amet, quam. Suspendisse wisi quam, consectetur in, blandit sed, suscipit eu, eros. Etiam ligula enim, tempor ut, blandit nec, mollis eu, lectus. Nam cursus. Vivamus iaculis. Aenean risus purus, pharetra in, blandit quis, gravida a, turpis. Donec nisl. Aenean eget mi. Fusce mattis est id diam. Phasellus faucibus interdum sapien.

bwderivation

fancy environment for mathematical derivations based on `align` environment
`\begin{bwderivation}`
`<content>`
`\end{bwderivation}`

```
\begin{bwderivation}
  \gamma &= \relgamma{\magvect{v}}
  && \text{given} \\
  \msup{\gamma}{2} &= \oomx{\msup{(\frac{\magvect{v}}{c})}{2}}
  && \text{square both sides} \\
  \frac{1}{\msup{\gamma}{2}} &= 1 - \msup{(\frac{\magvect{v}}{c})}{2}
  && \text{reciprocal of} \\
  && \text{both sides} \\
  \msup{(\frac{\magvect{v}}{c})}{2} &= 1 - \frac{1}{\msup{\gamma}{2}}
  && \text{rearrange} \\
  \frac{\magvect{v}}{c} &= \sqrt{1 - \frac{1}{\msup{\gamma}{2}}}
  && \text{square root of both sides}
\end{bwderivation}
```

DERIVATION

$$\gamma = \frac{1}{\sqrt{1 - \left(\frac{|\vec{v}|}{c}\right)^2}} \quad \text{given} \quad (1)$$

$$\gamma^2 = \frac{1}{1 - \left(\frac{|\vec{v}|}{c}\right)^2} \quad \text{square both sides} \quad (2)$$

$$\frac{1}{\gamma^2} = 1 - \left(\frac{|\vec{v}|}{c}\right)^2 \quad \text{reciprocal of both sides} \quad (3)$$

$$\left(\frac{|\vec{v}|}{c}\right)^2 = 1 - \frac{1}{\gamma^2} \quad \text{rearrange} \quad (4)$$

$$\frac{|\vec{v}|}{c} = \sqrt{1 - \frac{1}{\gamma^2}} \quad \text{square root of both sides} \quad (5)$$

5.16 Miscellaneous Commands

`\checkpoint`

centered checkpoint for student discussion
`\checkpoint`

`\checkpoint`

|——— CHECKPOINT ———|

`\image`

centered figure displayed actual size with caption
`\image{\langle imagefilename \rangle}{\langle caption \rangle}`

`\image{satellite.pdf}{Photograph of satellite}`

`\sneakyone`

shows factors dividing to a sneaky one
`\sneakyone{\langle thing \rangle}`

`\sneakyone{\m}`

$$\frac{m}{m} \nearrow 1$$

5.17 Experimental Commands

Commands defined in this section are not guaranteed to work consistently and are included for experimental uses only. They may or may not exist in future releases. Most are an attempt to simplify existing commands for subscripted vectors.

Should the subscript or component come first?

Experimental Syntax		Existing Syntax
<code>\vecto{E}</code>	\vec{E}	<code>\vect{E}</code>
<code>\vecto{E}[ball]</code>	\vec{E}_{ball}	<code>\vectsub{E}{ball}</code>
<code>\compvecto{E}{y}</code>	E_y	<code>\compvect{E}{y}</code>
<code>\compvecto{E}[ball]{x}</code>	$E_{\text{ball},x}$	<code>\compvectsub{E}{ball}{x}</code>
<code>\scompsvecto{E}</code>	$\langle E_x, E_y, E_z \rangle$	<code>\scompsvect{E}</code>
<code>\scompsvecto{E}[ball]</code>	$\langle E_{\text{ball},x}, E_{\text{ball},y}, E_{\text{ball},z} \rangle$	<code>\scompsvectsub{E}{ball}</code>
<code>\compposo{y}</code>	y	<code>\comppos{y}</code>
<code>\compposo[ball]{y}</code>	y_{ball}	<code>\comppossub{ball}{y}</code>
<code>\scompsposo</code>	$\langle x, y, z \rangle$	<code>\scompspos</code>
<code>\scompsposo[ball]</code>	$\langle x_{\text{ball}}, y_{\text{ball}}, z_{\text{ball}} \rangle$	<code>\scompspossub{ball}</code>

6 Source Code

Note the packages that must be present.

```
\RequirePackage{amsmath}
\RequirePackage{amssymb}
\RequirePackage{bigints}
\RequirePackage{cancel}
\RequirePackage[leftbars,color]{changebar}
\RequirePackage[dvipsnames]{xcolor}
\RequirePackage{environ}
\RequirePackage{etoolbox}
\RequirePackage{filehook}
\RequirePackage{extarrows}
\RequirePackage[T1]{fontenc}
\RequirePackage{graphicx}
\RequirePackage{epstopdf}
\RequirePackage{textcomp}
\RequirePackage{letltxmacro}
\RequirePackage{listings}
\RequirePackage[framemethod=TikZ]{mdframed}
\RequirePackage{suffix}
\RequirePackage{xargs}
\RequirePackage{xparse}
\RequirePackage{xspace}
\RequirePackage{ifthen}
\RequirePackage{calligra}
\DeclareMathAlphabet{\mathcalligra}{T1}{calligra}{m}{n}
\DeclareFontShape{T1}{calligra}{m}{n}{<->s*[2.2]callig15}{}
\DeclareGraphicsRule{.tif}{png}{.png}{\convert #1 'basename #1 .tif'.png}
\DeclareMathAlphabet{\mathpzc}{OT1}{pzc}{m}{it}
\usetikzlibrary{shadows}
\definecolor{vpythoncolor}{rgb}{0.95,0.95,0.95}
\newcommand{\lstvpython}{\lstset{language=Python,numbers=left,numberstyle=\tiny,
    backgroundcolor=\color{vpythoncolor},upquote=true,breaklines}}
\newboolean{@optitalicvectors}
\newboolean{@optdoubleabsbars}
\newboolean{@optbaseunits}
\newboolean{@optdrvdunits}
\setboolean{@optitalicvectors}{false}
\setboolean{@optdoubleabsbars}{false}
\setboolean{@optbaseunits}{false}
\setboolean{@optdrvdunits}{false}
\DeclareOption{italicvectors}{\setboolean{@optitalicvectors}{true}}
\DeclareOption{doubleabsbars}{\setboolean{@optdoubleabsbars}{true}}
\DeclareOption{baseunits}{\setboolean{@optbaseunits}{true}}
\DeclareOption{drvdunits}{\setboolean{@optdrvdunits}{true}}
\ProcessOptions\relax
```

This block of code fixes a conflict with the amssymb package.

```
\@ifpackageloaded{amssymb}{%
  \csundef{square}
  \typeout{mandi: Package amssymb detected. Its \protect\square\space has been redefined.}
}%
\typeout{mandi: Package amssymb not detected.}
}%
```

This block of code defines unit names and symbols.

```
\newcommand{\per}{\ensuremath{/}}
\newcommand{\usk}{\ensuremath{\cdot}}
\newcommand{\unit}[2]{\ensuremath{\{#1\},\{#2\}}}
\newcommand{\ampere}{\ensuremath{\mathrm{A}}}
\newcommand{\arcminute}{\ensuremath{'}}
\newcommand{\arcsecond}{\ensuremath{''}}
\newcommand{\atomicmassunit}{\ensuremath{\mathrm{u}}}
\newcommand{\candela}{\ensuremath{\mathrm{cd}}}
\newcommand{\coulomb}{\ensuremath{\mathrm{C}}}
\newcommand{\degree}{\ensuremath{^{\circ}}}
\newcommand{\electronvolt}{\ensuremath{\mathrm{eV}}}
\newcommand{\farad}{\ensuremath{\mathrm{F}}}
\newcommand{\henry}{\ensuremath{\mathrm{H}}}
\newcommand{\hertz}{\ensuremath{\mathrm{Hz}}}
\newcommand{\hour}{\ensuremath{\mathrm{h}}}
\newcommand{\joule}{\ensuremath{\mathrm{J}}}
\newcommand{\kelvin}{\ensuremath{\mathrm{K}}}
\newcommand{\kilogram}{\ensuremath{\mathrm{kg}}}
\newcommand{\metre}{\ensuremath{\mathrm{m}}}
\newcommand{\minute}{\ensuremath{\mathrm{min}}}
\newcommand{\mole}{\ensuremath{\mathrm{mol}}}
\newcommand{\newton}{\ensuremath{\mathrm{N}}}
\newcommand{\ohm}{\ensuremath{\Omega}}
\newcommand{\pascal}{\ensuremath{\mathrm{Pa}}}
\newcommand{\radian}{\ensuremath{\mathrm{rad}}}
\newcommand{\second}{\ensuremath{\mathrm{s}}}
\newcommand{\siemens}{\ensuremath{\mathrm{S}}}
\newcommand{\steradian}{\ensuremath{\mathrm{sr}}}
\newcommand{\tesla}{\ensuremath{\mathrm{T}}}
\newcommand{\volt}{\ensuremath{\mathrm{V}}}
\newcommand{\watt}{\ensuremath{\mathrm{W}}}
\newcommand{\weber}{\ensuremath{\mathrm{Wb}}}
\newcommand{\C}{\coulomb}
\newcommand{\F}{\farad}
%\H is already defined as a LaTeX accent
\newcommand{\J}{\joule}
\newcommand{\N}{\newton}
\newcommand{\Pa}{\pascal}
\newcommand{\rad}{\radian}
\newcommand{\sr}{\steradian}
%\S is already defined as a LaTeX symbol
\newcommand{\T}{\tesla}
```

```

\newcommand{\V}{\volt}
\newcommand{\W}{\watt}
\newcommand{\square}[1]{\ensuremath{\mathrm{\#1}^{\{2\}}}} % prefix 2
\newcommand*\{cubic}[1]{\ensuremath{\mathrm{\#1}^{\{3\}}}} % prefix 3
\newcommand*\{quartic}[1]{\ensuremath{\mathrm{\#1}^{\{4\}}}} % prefix 4
\newcommand*\{reciprocal}[1]{\ensuremath{\mathrm{\#1}^{\{-1\}}}} % prefix -1
\newcommand*\{reciprocalsquare}[1]{\ensuremath{\mathrm{\#1}^{\{-2\}}}} % prefix -2
\newcommand*\{reciprocalcubic}[1]{\ensuremath{\mathrm{\#1}^{\{-3\}}}} % prefix -3
\newcommand*\{reciprocalquartic}[1]{\ensuremath{\mathrm{\#1}^{\{-4\}}}} % prefix -4
\newcommand*\{squared}{\ensuremath{\mathrm{2}}} % postfix 2
\newcommand*\{cubed}{\ensuremath{\mathrm{3}}} % postfix 3
\newcommand*\{quarted}{\ensuremath{\mathrm{4}}} % postfix 4
\newcommand*\{reciprocaled}{\ensuremath{\mathrm{-1}}} % postfix -1
\newcommand*\{reciprocalquared}{\ensuremath{\mathrm{-2}}} % postfix -2
\newcommand*\{reciprocalcubed}{\ensuremath{\mathrm{-3}}} % postfix -3
\newcommand*\{reciprocalquarted}{\ensuremath{\mathrm{-4}}} % postfix -4

```

\newphysicsquantity Define a new named physics quantity or physical constant and commands for selecting units. My thanks to Ulrich Diez for contributing this code.

```

\newphysicsconstant
\hereusebaseunit \newcommand\mi@exchangeargs[2]{\#2\#1}%
\hereusedrvdunit \newcommand\mi@name{%
\hereusetradunit \long\def\mi@name#1{\romannumeral0\mi@innername{\#1}}%
\usebaseunit \newcommand\mi@innername[2]{%
\usedrvdunit \expandafter\mi@exchangeargs\expandafter{\csname#2\endcsname}{\#1}}%
\usetradunit \begin{group}
\perpusebaseunit \@firstofone{%
\endgroup
\perpusedrvdunit \newcommand\mi@forkifnull[3]{%
\perpusetradunit \romannumeral\iffalse\fi\expandafter\@secondoftwo\expandafter
{\expandafter\string\#1}\expandafter\@secondoftwo\string}%
\expandafter\@firstoftwo\expandafter{\iffalse}\fi0 #3}{0 #2}}}%
\newcommand\selectbaseunit[3]{\#1}
\newcommand\selectdrvunit[3]{\#2}
\newcommand\selecttradunit[3]{\#3}
\newcommand\selectunit{}
\newcommand\perpusebaseunit{\let\selectunit=\selectbaseunit}
\newcommand\perpusedrvunit{\let\selectunit=\selectdrvunit}
\newcommand\perpusetradunit{\let\selectunit=\selecttradunit}
\newcommand\hereusebaseunit[1]{%
\begin{group}\perpusebaseunit\#1\end{group}}%
\newcommand\hereusedrvunit[1]{%
\begin{group}\perpusedrvunit\#1\end{group}}%
\newcommand\hereusetradunit[1]{%
\begin{group}\perpusetradunit\#1\end{group}}%
\newenvironment{usebaseunit}{\perpusebaseunit}{}%
\newenvironment{usedrvunit}{\perpusedrvunit}{}%
\newenvironment{usetradunit}{\perpusetradunit}{}%
\newcommand*\newphysicsquantity{\definephysicsquantity{\newcommand}}
\newcommand*\redefinephysicsquantity{\definephysicsquantity{\renewcommand}}
\newcommandx\definephysicsquantity[5][4=,5=]{%

```

```

\innerdefinewhatsoeverquantityfork{#3}{#4}{#5}{#1}{#2}{\{[1]{#1}\}}%
\newcommand*\newphysicsconstant{\definephysicsconstant{\newcommand}}
\newcommand*\redefinephysicsconstant{\definephysicsconstant{\renewcommand}}
\newcommandx\definephysicsconstant[7][6=,7=]{%
\innerdefinewhatsoeverquantityfork{#5}{#6}{#7}{#1}{#2}{#3}{\{#4\}}%
\newcommand\innerdefinewhatsoeverquantityfork[3]{%
\expandafter\innerdefinewhatsoeverquantity\romannumeral0%
\mi@forkifnull{#3}{\mi@forkifnull{#2}{\{#1\}}{\{#2\}}{#1}}%
{\mi@forkifnull{#2}{\{#1\}}{\{#2\}}{#3}}{#1}}%
\newcommand\innerdefinewhatsoeverquantity[8]{%
\mi@name4{#5}#7{\ensuremath{\unit{#8}{\selectunit{#3}{#1}{#2}}}}%
\mi@name4{#5baseunit}#7{\ensuremath{\unit{#8}{#3}}}%
\mi@name4{#5drvdunit}#7{\ensuremath{\unit{#8}{#1}}}%
\mi@name4{#5tradunit}#7{\ensuremath{\unit{#8}{#2}}}%
\mi@name4{#5onlyunit}{\ensuremath{\selectunit{#3}{#1}{#2}}}%
\mi@name4{#5onlybaseunit}{\ensuremath{#3}}%
\mi@name4{#5onlydrvdunit}{\ensuremath{#1}}%
\mi@name4{#5onlytradunit}{\ensuremath{#2}}%
\mi@name4{#5value}#7{\ensuremath{#8}}%
\mi@forkifnull{#7}{%
\ifx#4\renewcommand\mi@name\let{#5mathsymbol}=\relax\fi
\mi@name\newcommand{#5mathsymbol}{\ensuremath{#6}}}{}}%

```

This block of code processes the options.

```

\ifthenelse{\boolean{@optitalicvectors}}
{\typeout{mandi: You'll get italic vector kernels.}}
{\typeout{mandi: You'll get Roman vector kernels.}}
\ifthenelse{\boolean{@optdoubleabsbars}}
{\typeout{mandi: You'll get double absolute value bars.}}
{\typeout{mandi: You'll get single absolute value bars.}}
\ifthenelse{\boolean{@optbaseunits}}
{\perpusebaseunit %
\typeout{mandi: You'll get base units.}}
{\ifthenelse{\boolean{@optdrvdunits}}
{\perpusedrvdunit %
\typeout{mandi: You'll get derived units.}}
{\perpusetradunit %
\typeout{mandi: You'll get traditional units.}}}

```

This block of code makes parentheses adjustable.

```

\def\resetMathstrut@{%
\setbox\z@\hbox{%
\mathchardef\@tempa\mathcode'\[\relax
\def\@tempb##1"##2##3{\the\textfont"##3\char"%
\expandafter\@tempb\meaning\@tempa \relax
}%
\ht\Mathstrutbox@\ht\z@ \dp\Mathstrutbox@\dp\z@}
\begingroup
\catcode'\active \xdef{\left\string{
\catcode'}\active \xdef{\right\string{
\endgroup

```

```
\mathcode'("8000 \mathcode')="8000
\typeout{mandi: parentheses made adjustable in math mode.}
```

This block of code fixes square root symbol.

```
\let\oldr@@t\r@@t
\def\r@@t#1#2{%
\setbox0=\hbox{\(\oldr@@t#1{#2\,}\)}\dimen0=\ht0
\advance\dimen0-0.2\ht0
\setbox2=\hbox{\vrule height\ht0 depth -\dimen0}%
{\box0\lower0.4pt\box2}}
\letLtxMacro{\oldsqrt}{\sqrt}
\renewcommand*\sqrt[2][\relax]{\oldsqrt[#1]{#2}}
\typeout{mandi: square root symbol fixed.}
```

```
\m SI base unit of length or spatial displacement
\newcommand{\m}{\metre}
```

```
\kg SI base unit of mass
\newcommand{\kg}{\kilogram}
```

```
\s SI base unit of time or temporal displacement
\newcommand{\s}{\second}
```

```
\A SI base unit of electric current
\newcommand{\A}{\ampere}
```

```
\K SI base unit of thermodynamic temperature
\newcommand{\K}{\kelvin}
```

```
\mol SI base unit of amount
\newcommand{\mol}{\mole}
```

```
\cd SI base unit of luminous intensity
\newcommand{\cd}{\candela}
```

```
\displacement
\newphysicsquantity{displacement}{\m}{\m} [\m]
```

```
\mass
\newphysicsquantity{mass}{\kg}{\kg} [\kg]
```

```
\duration
\newphysicsquantity{duration}{\s}{\s} [\s]
```

```
\current
\newphysicsquantity{current}{\A}{\A} [\A]
```

```
\temperature
\newphysicsquantity{temperature}{\K}{\K} [\K]
```


$\backslash amount$
 $\backslash newphysicsquantity\{amount\}\{\backslash mol\}[\backslash mol][\backslash mol]$

$\backslash luminous$
 $\backslash newphysicsquantity\{luminous\}\{\backslash cd\}[\backslash cd][\backslash cd]$

$\backslash planeangle$
 $\backslash newphysicsquantity\{planeangle\}\{\backslash m\backslash usk\backslash reciprocal\backslash m\}[\backslash rad][\backslash rad]$

$\backslash solidangle$
 $\backslash newphysicsquantity\{solidangle\}\{\backslash m\backslash squared\backslash usk\backslash reciprocalsquare\backslash m\}[\backslash sr][\backslash sr]$

$\backslash indegrees$
 $\backslash newcommand\{\backslash indegrees\}[1]\{\backslash ensuremath\{\backslash unit\{#1\}\{\backslash degree\}\}\}$

$\backslash inarcminutes$
 $\backslash newcommand\{\backslash inarcminutes\}[1]\{\backslash ensuremath\{\backslash unit\{#1\}\{\backslash arcminute\}\}\}$

$\backslash inarcseconds$
 $\backslash newcommand\{\backslash inarcseconds\}[1]\{\backslash ensuremath\{\backslash unit\{#1\}\{\backslash arcsecond\}\}\}$

$\backslash ineV$
 $\backslash newcommand\{\backslash ineV\}[1]\{\backslash ensuremath\{\backslash unit\{#1\}\{\backslash electronvolt\}\}\}$

$\backslash inAU$
 $\backslash newcommand\{\backslash inAU\}[1]\{\backslash ensuremath\{\backslash unit\{#1\}\{\backslash mathrm\{AU\}\}\}\}$

$\backslash velocityc$
 $\backslash newcommand\{\backslash velocityc\}[1]\{\backslash ensuremath\{#1c\}\}$

$\backslash velocity$
 $\backslash newphysicsquantity\{velocity\}\{\backslash m\backslash usk\backslash reciprocal\backslash s\}[\backslash m\backslash usk\backslash reciprocal\backslash s][\backslash m\backslash per\backslash s]$

$\backslash acceleration$
 $\backslash newphysicsquantity\{acceleration\}\{\backslash m\backslash usk\backslash s\backslash reciprocalsquared\}[\backslash N\backslash per\backslash kg][\backslash m\backslash per\backslash s\backslash squared]$

$\backslash gamman$
 $\backslash newcommand\{\backslash gamman\}[1]\{\backslash ensuremath\{#1\}\}$

$\backslash momentum$
 $\backslash newphysicsquantity\{momentum\}\{\backslash m\backslash usk\backslash kg\backslash usk\backslash reciprocal\backslash s\}[\backslash N\backslash usk\backslash s][\backslash kg\backslash usk\backslash m\backslash per\backslash s]$

$\backslash impulse$
 $\backslash newphysicsquantity\{impulse\}\{\backslash m\backslash usk\backslash kg\backslash usk\backslash reciprocal\backslash s\}[\backslash N\backslash usk\backslash s][\backslash kg\backslash usk\backslash m\backslash per\backslash s]$

$\backslash force$
 $\backslash newphysicsquantity\{force\}\{\backslash m\backslash usk\backslash kg\backslash usk\backslash s\backslash reciprocalsquared\}[\backslash N][\backslash N]$

$\backslash\text{springstiffness}$
 $\backslash\text{newphysicsquantity}\{\text{springstiffness}\}\{\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\backslash\text{squared}\}\backslash\text{N}\backslash\text{per}\backslash\text{m}\backslash\text{N}\backslash\text{per}\backslash\text{m}$

$\backslash\text{springstretch}$
 $\backslash\text{newphysicsquantity}\{\text{springstretch}\}\{\text{m}\}$

$\backslash\text{area}$
 $\backslash\text{newphysicsquantity}\{\text{area}\}\{\text{m}\backslash\text{squared}\}$

$\backslash\text{volume}$
 $\backslash\text{newphysicsquantity}\{\text{volume}\}\{\backslash\text{cubic}\backslash\text{m}\}$

$\backslash\text{linearmassdensity}$
 $\backslash\text{newphysicsquantity}\{\text{linearmassdensity}\}\{\backslash\text{reciprocal}\backslash\text{m}\backslash\text{usk}\backslash\text{kg}\}\backslash\text{kg}\backslash\text{per}\backslash\text{m}\backslash\text{kg}\backslash\text{per}\backslash\text{m}$

$\backslash\text{areamassdensity}$
 $\backslash\text{newphysicsquantity}\{\text{areamassdensity}\}\{\text{m}\backslash\text{reciprocal}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\}\backslash\text{kg}\backslash\text{per}\backslash\text{m}\backslash\text{squared}\backslash\text{kg}\backslash\text{per}\backslash\text{m}\backslash\text{squared}$

$\backslash\text{volumemassdensity}$
 $\backslash\text{newphysicsquantity}\{\text{volumemassdensity}\}\{\text{m}\backslash\text{reciprocal}\backslash\text{cubed}\backslash\text{usk}\backslash\text{kg}\}\backslash\text{kg}\backslash\text{per}\backslash\text{m}\backslash\text{cubed}\backslash\text{kg}\backslash\text{per}\backslash\text{m}\backslash\text{cubed}$

$\backslash\text{youngsmodulus}$
 $\backslash\text{newphysicsquantity}\{\text{youngsmodulus}\}\{\backslash\text{reciprocal}\backslash\text{m}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\backslash\text{squared}\}\backslash\text{N}\backslash\text{per}\backslash\text{m}\backslash\text{squared}\backslash\text{Pa}$

$\backslash\text{work}$
 $\backslash\text{newphysicsquantity}\{\text{work}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\backslash\text{squared}\}\backslash\text{J}\backslash\text{N}\backslash\text{usk}\backslash\text{m}$

$\backslash\text{energy}$
 $\backslash\text{newphysicsquantity}\{\text{energy}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\backslash\text{squared}\}\backslash\text{J}\backslash\text{N}\backslash\text{usk}\backslash\text{m}$

$\backslash\text{power}$
 $\backslash\text{newphysicsquantity}\{\text{power}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\backslash\text{cubed}\}\backslash\text{W}\backslash\text{J}\backslash\text{per}\backslash\text{s}$

$\backslash\text{angularvelocity}$
 $\backslash\text{newphysicsquantity}\{\text{angularvelocity}\}\{\text{rad}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{s}\}\backslash\text{rad}\backslash\text{per}\backslash\text{s}\backslash\text{rad}\backslash\text{per}\backslash\text{s}$

$\backslash\text{angularacceleration}$
 $\backslash\text{newphysicsquantity}\{\text{angularacceleration}\}\{\text{rad}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\backslash\text{squared}\}\backslash\text{rad}\backslash\text{per}\backslash\text{s}\backslash\text{squared}\backslash\text{rad}\backslash\text{per}\backslash\text{s}\backslash\text{squared}$

$\backslash\text{angularmomentum}$
 $\backslash\text{newphysicsquantity}\{\text{angularmomentum}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{s}\}\backslash\text{J}\backslash\text{usk}\backslash\text{s}\backslash\text{kg}\backslash\text{usk}\backslash\text{m}\backslash\text{squared}\backslash\text{per}\backslash\text{s}$

$\backslash\text{momentofinertia}$
 $\backslash\text{newphysicsquantity}\{\text{momentofinertia}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\}\backslash\text{J}\backslash\text{usk}\backslash\text{s}\backslash\text{squared}\backslash\text{kg}\backslash\text{usk}\backslash\text{m}\backslash\text{squared}$

$\backslash\text{torque}$
 $\backslash\text{newphysicsquantity}\{\text{torque}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{squared}\}\backslash\text{J}\backslash\text{per}\backslash\text{rad}\backslash\text{N}\backslash\text{usk}\backslash\text{m}$

$\backslash\text{entropy}$
 $\backslash\text{newphysicsquantity}\{\text{entropy}\}\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{squared}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{K}\}\backslash\text{J}\backslash\text{per}\backslash\text{K}\backslash\text{J}\backslash\text{per}\backslash\text{K}$

$\backslash\text{wavelength}$
 $\backslash\text{newphysicsquantity}\{\text{wavelength}\}\{\text{m}\}\backslash\text{m}\backslash\text{m}$

$\backslash\text{wavenumber}$
 $\backslash\text{newphysicsquantity}\{\text{wavenumber}\}\{\text{reciprocal}\backslash\text{m}\}\backslash\text{per}\backslash\text{m}\backslash\text{per}\backslash\text{m}$

$\backslash\text{frequency}$
 $\backslash\text{newphysicsquantity}\{\text{frequency}\}\{\text{reciprocal}\backslash\text{s}\}\backslash\text{hertz}\backslash\text{hertz}$

$\backslash\text{angularfrequency}$
 $\backslash\text{newphysicsquantity}\{\text{angularfrequency}\}\{\text{rad}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{s}\}\backslash\text{rad}\backslash\text{per}\backslash\text{s}\backslash\text{rad}\backslash\text{per}\backslash\text{s}$

$\backslash\text{charge}$
 $\backslash\text{newphysicsquantity}\{\text{charge}\}\{\text{A}\backslash\text{usk}\backslash\text{s}\}\backslash\text{C}\backslash\text{C}$

$\backslash\text{permittivity}$
 $\backslash\text{newphysicsquantity}\{\text{permittivity}\}\{\text{m}\backslash\text{reciprocal}\text{cubed}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{quarted}\backslash\text{usk}\backslash\text{A}\backslash\text{squared}\}\backslash\text{F}\backslash\text{per}\backslash\text{m}\backslash\text{C}\backslash\text{squared}\backslash\text{per}\backslash\text{N}\backslash\text{usk}\backslash\text{m}\backslash\text{squared}$

$\backslash\text{permeability}$
 $\backslash\text{newphysicsquantity}\{\text{permeability}\}\{\text{m}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{squared}\backslash\text{usk}\backslash\text{A}\backslash\text{reciprocal}\text{squared}\}\backslash\text{henry}\backslash\text{per}\backslash\text{m}\backslash\text{T}\backslash\text{usk}\backslash\text{m}\backslash\text{per}\backslash\text{A}$

$\backslash\text{electricfield}$
 $\backslash\text{newphysicsquantity}\{\text{electricfield}\}\{\text{m}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{cubed}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{A}\}\backslash\text{V}\backslash\text{per}\backslash\text{m}\backslash\text{N}\backslash\text{per}\backslash\text{C}$

$\backslash\text{electricdipolemoment}$
 $\backslash\text{newphysicsquantity}\{\text{electricdipolemoment}\}\{\text{m}\backslash\text{usk}\backslash\text{s}\backslash\text{usk}\backslash\text{A}\}\backslash\text{C}\backslash\text{usk}\backslash\text{m}\backslash\text{C}\backslash\text{usk}\backslash\text{m}$

$\backslash\text{magneticfield}$
 $\backslash\text{newphysicsquantity}\{\text{magneticfield}\}\{\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{squared}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{A}\}\backslash\text{T}\backslash\text{N}\backslash\text{per}\backslash\text{C}\backslash\text{usk}\backslash\text{m}\backslash\text{per}\backslash\text{s}$

$\backslash\text{cmagneticfield}$
 $\backslash\text{newphysicsquantity}\{\text{cmagneticfield}\}\{\text{m}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{cubed}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{A}\}\backslash\text{V}\backslash\text{per}\backslash\text{m}\backslash\text{N}\backslash\text{per}\backslash\text{C}$

$\backslash\text{linearchargedensity}$
 $\backslash\text{newphysicsquantity}\{\text{linearchargedensity}\}\{\backslash\text{reciprocal}\backslash\text{m}\backslash\text{usk}\backslash\text{s}\backslash\text{usk}\backslash\text{A}\}[\backslash\text{C}\backslash\text{per}\backslash\text{m}][\backslash\text{C}\backslash\text{per}\backslash\text{m}]$

$\backslash\text{areachargedensity}$
 $\backslash\text{newphysicsquantity}\{\text{areachargedensity}\}\{\backslash\text{reciprocal}\text{square}\backslash\text{m}\backslash\text{usk}\backslash\text{s}\backslash\text{usk}\backslash\text{A}\}[\backslash\text{C}\backslash\text{per}\backslash\text{square}\backslash\text{m}][\backslash\text{C}\backslash\text{per}\backslash\text{square}\backslash\text{m}]$

$\backslash\text{volumechargedensity}$
 $\backslash\text{newphysicsquantity}\{\text{volumechargedensity}\}\{\backslash\text{reciprocal}\text{cubic}\backslash\text{m}\backslash\text{usk}\backslash\text{s}\backslash\text{usk}\backslash\text{A}\}[\backslash\text{C}\backslash\text{per}\backslash\text{cubic}\backslash\text{m}][\backslash\text{C}\backslash\text{per}\backslash\text{cubic}\backslash\text{m}]$

$\backslash\text{mobility}$
 $\backslash\text{newphysicsquantity}\{\text{mobility}\}\{\backslash\text{m}\backslash\text{quared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocal}\text{quarted}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{A}\}[\backslash\text{m}\backslash\text{quared}\backslash\text{per}\backslash\text{volt}\backslash\text{usk}\backslash\text{s}][(\backslash\text{m}\backslash\text{per}\backslash\text{s})\backslash\text{per}(\backslash\text{N}\backslash\text{per}\backslash\text{C})]$

$\backslash\text{numberdensity}$
 $\backslash\text{newphysicsquantity}\{\text{numberdensity}\}\{\backslash\text{reciprocal}\text{cubic}\backslash\text{m}\}[\backslash\text{per}\backslash\text{cubic}\backslash\text{m}][\backslash\text{per}\backslash\text{cubic}\backslash\text{m}]$

$\backslash\text{polarizability}$
 $\backslash\text{newphysicsquantity}\{\text{polarizability}\}\{\backslash\text{reciprocal}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{quarted}\backslash\text{usk}\backslash\text{square}\backslash\text{A}\}[\backslash\text{C}\backslash\text{usk}\backslash\text{square}\backslash\text{m}\backslash\text{per}\backslash\text{V}][\backslash\text{C}\backslash\text{usk}\backslash\text{m}\backslash\text{per}(\backslash\text{N}\backslash\text{per}\backslash\text{C})]$

$\backslash\text{electricpotential}$
 $\backslash\text{newphysicsquantity}\{\text{electricpotential}\}\{\text{square}\backslash\text{m}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{reciprocal}\text{cubic}\backslash\text{s}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{A}\}[\backslash\text{J}\backslash\text{per}\backslash\text{C}][\backslash\text{V}]$

$\backslash\text{emf}$
 $\backslash\text{newphysicsquantity}\{\text{emf}\}\{\text{square}\backslash\text{m}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{reciprocal}\text{cubic}\backslash\text{s}\backslash\text{usk}\backslash\text{reciprocal}\backslash\text{A}\}[\backslash\text{J}\backslash\text{per}\backslash\text{C}][\backslash\text{V}]$

$\backslash\text{dielectricconstant}$
 $\backslash\text{newphysicsquantity}\{\text{dielectricconstant}\}\{\}[\][\]$

$\backslash\text{indexofrefraction}$
 $\backslash\text{newphysicsquantity}\{\text{indexofrefraction}\}\{\}[\][\]$

$\backslash\text{relativepermittivity}$
 $\backslash\text{newphysicsquantity}\{\text{relativepermittivity}\}\{\}[\][\]$

$\backslash\text{relativepermeability}$
 $\backslash\text{newphysicsquantity}\{\text{relativepermeability}\}\{\}[\][\]$

$\backslash\text{energydensity}$
 $\backslash\text{newphysicsquantity}\{\text{energydensity}\}\{\backslash\text{m}\backslash\text{reciprocal}\text{ed}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{reciprocal}\text{square}\backslash\text{s}\}[\backslash\text{J}\backslash\text{per}\backslash\text{cubic}\backslash\text{m}][\backslash\text{J}\backslash\text{per}\backslash\text{cubic}\backslash\text{m}]$

`\electroncurrent`

$$\frac{1}{\mathrm{e} \cdot \mathrm{s}}$$

`\conventionalcurrent`

$$\frac{\mathrm{A}}{\mathrm{C} \cdot \mathrm{s}}$$

`\magneticdipolemoment`

$$\frac{\mathrm{J}}{\mathrm{T}} \cdot \mathrm{m}^2$$

`\currentdensity`

$$\frac{1}{\mathrm{m}^2 \cdot \mathrm{s}} \cdot \frac{\mathrm{C}}{\mathrm{s} \cdot \mathrm{m}^2}$$

`\capacitance`

$$\frac{1}{\mathrm{m}^2 \cdot \frac{1}{\mathrm{kg} \cdot \mathrm{s}^4 \cdot \mathrm{A}^2} \cdot \frac{\mathrm{C}}{\mathrm{V}}} \cdot \mathrm{F}$$

`\conductivity`

$$\frac{1}{\mathrm{m}^3 \cdot \frac{1}{\mathrm{kg} \cdot \mathrm{s}^4 \cdot \mathrm{A}^2}} \cdot \frac{\mathrm{siemens}}{\mathrm{m} \cdot \mathrm{V}}$$

`\resistivity`

$$\frac{1}{\mathrm{m}^3 \cdot \frac{1}{\mathrm{kg} \cdot \frac{1}{\mathrm{s}^4 \cdot \frac{1}{\mathrm{A}^2}}}} \cdot \frac{\mathrm{m}}{\mathrm{siemens}} \cdot \mathrm{ohm}$$

`\resistance`

$$\frac{1}{\mathrm{m}^2 \cdot \frac{1}{\mathrm{kg} \cdot \frac{1}{\mathrm{s}^4 \cdot \frac{1}{\mathrm{A}^2}}}} \cdot \frac{\mathrm{V}}{\mathrm{A}} \cdot \mathrm{ohm}$$

`\conductance`

$$\frac{1}{\mathrm{m}^2 \cdot \frac{1}{\mathrm{kg} \cdot \mathrm{s}^4 \cdot \mathrm{A}^2}} \cdot \frac{\mathrm{A}}{\mathrm{V}} \cdot \mathrm{siemens}$$

`\lv`

`\rv`

$$\left\langle \right\rangle$$

`\symvect`

$$\vec{}$$

`\ncompsvect`

$$\vec{}$$

```

\magvectncomps Written in LaTeX3
\ExplSyntaxOn
\NewDocumentCommand{\magvectncomps}{ m 0{} }
{
  \sum_of_squares:nn { #1 }{ #2 }
}%

\cs_new:Npn \sum_of_squares:nn #1 #2
{
  \tl_if_empty:nTF { #2 }
  {
    \clist_set:Nn \l_tmpa_clist { #1 }
    \ensuremath{%
      \sqrt{(\clist_use:Nnnn \l_tmpa_clist { } )^2+( { } { } )^2+( { } { } )^2+( { } )^2 }
    }%
  }%
  {
    \clist_set:Nn \l_tmpa_clist { #1 }
    \ensuremath{%
      \sqrt{(\clist_use:Nnnn \l_tmpa_clist {\;{ #2 }})^2+( { } {\;{ #2 }})^2+( { } {\;{ #2 }})^2+( { } {\;{ #2 }})^2}
    }%
  }%
}%
\ExplSyntaxOff

\zerovect
\ncompszerovect \newcommand{\zerovect}{\vect{0}}
\newcommand{\ncompszerovect}{\mivector{0,0,0}}

\vect
\ifthenelse{\boolean{@optitalicvectors}}
{
  \newcommand{\vect}[1]{\ensuremath{\vec{#1}}}
  \newcommand{\vect}[1]{\ensuremath{\vec{\mathrm{#1}}}}
}

\magvect
\ifthenelse{\boolean{@optdoubleabsbars}}
{
  \newcommand{\magvect}[1]{\ensuremath{\magof{\vect{#1}}}}
  \newcommand{\magvect}[1]{\ensuremath{\abs{\vect{#1}}}}
}

\dmagvect
\Dmagvect \newcommand{\dmagvect}[1]{\ensuremath{dx{\magvect{#1}}}}
\newcommand{\Dmagvect}[1]{\ensuremath{\Delta!\magvect{#1}}}

\dirvect
\ifthenelse{\boolean{@optitalicvectors}}
{
  \newcommand{\dirvect}[1]{\ensuremath{\widehat{#1}}}
  \newcommand{\dirvect}[1]{\ensuremath{\widehat{\mathrm{#1}}}}
}

```

```

\compvect
\ifthenelse{\boolean{@optitalicvectors}}
{\newcommand{\compvect}[2]{\ensuremath{\ssub{#1}{\(#2\)}}}}
{\newcommand{\compvect}[2]{\ensuremath{\ssub{\mathrm{#1}}{\(#2\)}}}}

\scompsvect
\newcommand{\scompsvect}[1]{\ensuremath{\lv
\compvect{#1}{x},
\compvect{#1}{y},
\compvect{#1}{z}\rv}}

\magvectscomps
\newcommand{\magvectscomps}[1]{\ensuremath{\sqrt{
\msup{\compvect{#1}{x}}{2}+
\msup{\compvect{#1}{y}}{2}+
\msup{\compvect{#1}{z}}{2}}}}

\dvect
\Dvect
\newcommand{\dvect}[1]{\ensuremath{\mathrm{d}\vect{#1}}}
\newcommand{\Dvect}[1]{\ensuremath{\Delta\vect{#1}}}

\dirvect
\dirDvect
\newcommand{\dirvect}[1]{\ensuremath{\widehat{\dvect{#1}}}}
\newcommand{\dirDvect}[1]{\ensuremath{\widehat{\Dvect{#1}}}}

\ddirvect
\Ddirvect
\newcommand{\ddirvect}[1]{\ensuremath{\mathrm{d}\dirvect{E}}}
\newcommand{\Ddirvect}[1]{\ensuremath{\Delta\dirvect{E}}}

\magdvect
\magDvect
\ifthenelse{\boolean{@optdoubleabsbars}}
{\newcommand{\magdvect}[1]{\ensuremath{\magof{\dvect{#1}}}}}
{\newcommand{\magDvect}[1]{\ensuremath{\magof{\Dvect{#1}}}}}
{\newcommand{\magdvect}[1]{\ensuremath{\abs{\dvect{#1}}}}}
{\newcommand{\magDvect}[1]{\ensuremath{\abs{\Dvect{#1}}}}}

\compdvect
\compDvect
\newcommand{\compdvect}[2]{\ensuremath{\mathrm{d}\compvect{#1}{#2}}}
\newcommand{\compDvect}[2]{\ensuremath{\Delta\compvect{#1}{#2}}}

\scompsdvect
\scompsDvect
\newcommand{\scompsdvect}[1]{\ensuremath{\lv
\compdvect{#1}{x},
\compdvect{#1}{y},
\compdvect{#1}{z}\rv}}
\newcommand{\scompsDvect}[1]{\ensuremath{\lv
\compDvect{#1}{x},
\compDvect{#1}{y},
\compDvect{#1}{z}\rv}}

```

```

\derivect
\Dervect      \newcommand{\derivect}[2]{\ensuremath{\frac{\mathrm{d}\mathrm{vect}\{#1\}}{\mathrm{d}\{#2\}}}}
               \newcommand{\Dervect}[2]{\ensuremath{\frac{\mathrm{D}\mathrm{vect}\{#1\}}{\Delta\{#2\}}}}

\compderivect
\compDervect  \newcommand{\compderivect}[3]{\ensuremath{\mathrm{d}\mathrm{byd}\{\mathrm{compvect}\{#1\}\{#3\}\{#2\}}}}
               \newcommand{\compDervect}[3]{\ensuremath{\mathrm{D}\mathrm{byD}\{\mathrm{compvect}\{#1\}\{#3\}\{#2\}}}}

\scompsderivect
\scompsDervect \newcommand{\scompsderivect}[2]{\ensuremath{\mathrm{lv}
               \mathrm{compderivect}\{#1\}\{#2\}\{x\},
               \mathrm{compderivect}\{#1\}\{#2\}\{y\},
               \mathrm{compderivect}\{#1\}\{#2\}\{z\}\mathrm{rv}\}}
               \newcommand{\scompsDervect}[2]{\ensuremath{\mathrm{lv}
               \mathrm{compDervect}\{#1\}\{#2\}\{x\},
               \mathrm{compDervect}\{#1\}\{#2\}\{y\},
               \mathrm{compDervect}\{#1\}\{#2\}\{z\}\mathrm{rv}\}}

\magderivect
\magDervect    \ifthenelse{\boolean{@optdoubleabsbars}}{
               {\newcommand{\magderivect}[2]{\ensuremath{\mathrm{magof}\{\mathrm{derivect}\{#1\}\{#2\}\}}}
               \newcommand{\magDervect}[2]{\ensuremath{\mathrm{magof}\{\mathrm{Dervect}\{#1\}\{#2\}\}}}
               {\newcommand{\magderivect}[2]{\ensuremath{\mathrm{abs}\{\mathrm{derivect}\{#1\}\{#2\}\}}}
               \newcommand{\magDervect}[2]{\ensuremath{\mathrm{abs}\{\mathrm{Dervect}\{#1\}\{#2\}\}}}

\dermagvect
\Dermagvect    \newcommand{\dermagvect}[2]{\ensuremath{\mathrm{d}\mathrm{byd}\{\mathrm{magvect}\{#1\}\{#2\}\}}}
               \newcommand{\Dermagvect}[2]{\ensuremath{\mathrm{D}\mathrm{byD}\{\mathrm{magvect}\{#1\}\{#2\}\}}}

\scompspos
               \newcommand{\scompspos}{\mathrm{mivector}\{x,y,z\}}

\compos
               \newcommand{\compos}[1]{\ensuremath{\{#1\}}}

\scompsdpos
\scompsDpos    \newcommand{\scompsdpos}{\mathrm{mivector}\{\mathrm{d}x,\mathrm{d}y,\mathrm{d}z\}}
               \newcommand{\scompsDpos}{\mathrm{mivector}\{\Delta x,\Delta y,\Delta z\}}

\compdpos
\compDpos      \newcommand{\compdpos}[1]{\ensuremath{\mathrm{d}\{#1\}}}
               \newcommand{\compDpos}[1]{\ensuremath{\Delta\{#1\}}}

\scompsderpos
\scompsDerpos  \newcommand{\scompsderpos}[1]{\ensuremath{\mathrm{lv}
               \frac{\mathrm{d}x}{\mathrm{d}\{#1\}},\frac{\mathrm{d}y}{\mathrm{d}\{#1\}},
               \frac{\mathrm{d}z}{\mathrm{d}\{#1\}}\mathrm{rv}\}}
               \newcommand{\scompsDerpos}[1]{\ensuremath{\mathrm{lv}
               \frac{\Delta x}{\Delta\{#1\}},\frac{\Delta y}{\Delta\{#1\}},
               \frac{\Delta z}{\Delta\{#1\}}\mathrm{rv}\}}

```



```

\compderpos
\compDerpos    \newcommand{\compderpos}[2]{\ensuremath{\frac{\mathrm{d}\{#1\}}{\mathrm{d}\{#2\}}}}
               \newcommand{\compDerpos}[2]{\ensuremath{\frac{\Delta\{#1\}}{\Delta\{#2\}}}}

\vectsub
               \newcommand{\vectsub}[2]{\ensuremath{\ssub{\vect{#1}}{#2}}}

\compvectsub
               \ifthenelse{\boolean{@optitalicvectors}}
               {\newcommand{\compvectsub}[3]{\ensuremath{\ssub{#1}{#2},\langle\#3\rangle}}}
               {\newcommand{\compvectsub}[3]{\ensuremath{\ssub{\mathrm{#1}}{#2},\langle\#3\rangle}}}

\scompsvectsub
               \newcommand{\scompsvectsub}[2]{\ensuremath{\lv
               \compvectsub{#1}{#2}\{x\},
               \compvectsub{#1}{#2}\{y\},
               \compvectsub{#1}{#2}\{z\}\rv}}}

\magvectsub
               \ifthenelse{\boolean{@optdoubleabsbars}}
               {\newcommand{\magvectsub}[2]{\ensuremath{\magof{\vectsub{#1}{#2}}}}}
               {\newcommand{\magvectsub}[2]{\ensuremath{\abs{\vectsub{#1}{#2}}}}}

\magvectsubscmps
               \newcommand{\magvectsubscmps}[2]{\ensuremath{\sqrt{
               \msup{\compvectsub{#1}{#2}\{x\}}{2}+
               \msup{\compvectsub{#1}{#2}\{y\}}{2}+
               \msup{\compvectsub{#1}{#2}\{z\}}{2}}}}}

\dirvectsub
               \ifthenelse{\boolean{@optitalicvectors}}
               {\newcommand{\dirvectsub}[2]{\ensuremath{\ssub{\widehat{#1}}{#2}}}}
               {\newcommand{\dirvectsub}[2]{\ensuremath{\ssub{\widehat{\mathrm{#1}}}{#2}}}}

\dvectsub
\Dvectsub      \newcommand{\dvectsub}[2]{\ensuremath{\mathrm{d}\vectsub{#1}{#2}}}
               \newcommand{\Dvectsub}[2]{\ensuremath{\Delta\vectsub{#1}{#2}}}

\compdvectsub
\compDvectsub  \newcommand{\compdvectsub}[3]{\ensuremath{\mathrm{d}\compvectsub{#1}{#2}{#3}}}
               \newcommand{\compDvectsub}[3]{\ensuremath{\Delta\compvectsub{#1}{#2}{#3}}}

\scompsdvectsub
\scompsDvectsub \newcommand{\scompsdvectsub}[2]{\ensuremath{\lv
               \compdvectsub{#1}{#2}\{x\},
               \compdvectsub{#1}{#2}\{y\},
               \compdvectsub{#1}{#2}\{z\}\rv}}
               \newcommand{\scompsDvectsub}[2]{\ensuremath{\lv
               \compDvectsub{#1}{#2}\{x\},
               \compDvectsub{#1}{#2}\{y\},
               \compDvectsub{#1}{#2}\{z\},\rv}}}

```

```

\dermagvectsub
\Dermagvectsub    \newcommand{\dermagvectsub}[3]{\ensuremath{\dbyd{\magvectsub{#1}{#2}}{#3}}}
                  \newcommand{\Dermagvectsub}[3]{\ensuremath{\DbyD{\magvectsub{#1}{#2}}{#3}}}

\dervectsub
\Dervectsub       \newcommand{\dervectsub}[3]{\ensuremath{\dbyd{\vectsub{#1}{#2}}{#3}}}
                  \newcommand{\Dervectsub}[3]{\ensuremath{\DbyD{\vectsub{#1}{#2}}{#3}}}

\magdervectsub
\magDervectsub    \ifthenelse{\boolean{@optdoubleabsbars}}{
                  {\newcommand{\magdervectsub}[3]{\ensuremath{\magof{\dervectsub{#1}{#2}}{#3}}}}
                  {\newcommand{\magDervectsub}[3]{\ensuremath{\magof{\Dervectsub{#1}{#2}}{#3}}}}
                  {\newcommand{\magdervectsub}[3]{\ensuremath{\abs{\dervectsub{#1}{#2}}{#3}}}}
                  {\newcommand{\magDervectsub}[3]{\ensuremath{\abs{\Dervectsub{#1}{#2}}{#3}}}}

\compdervectsub
\compDervectsub   \newcommand{\compdervectsub}[4]{\ensuremath{\dbyd{\compvectsub{#1}{#2}{#4}}{#3}}}
                  \newcommand{\compDervectsub}[4]{\ensuremath{\DbyD{\compvectsub{#1}{#2}{#4}}{#3}}}

\scompsdervectsub
\scompsDervectsub \newcommand{\scompsdervectsub}[3]{\ensuremath{\lv
                  \compdervectsub{#1}{#2}{#3}{x},
                  \compdervectsub{#1}{#2}{#3}{y},
                  \compdervectsub{#1}{#2}{#3}{z}\rv}}
                  \newcommand{\scompsDervectsub}[3]{\ensuremath{\lv
                  \compDervectsub{#1}{#2}{#3}{x},
                  \compDervectsub{#1}{#2}{#3}{y},
                  \compDervectsub{#1}{#2}{#3}{z}\rv}}

\comppossb
\compDpossb       \newcommand{\comppossb}[2]{\ensuremath{\ssub{#2}{#1}}}

\scompspossb
\scompsDpossb     \newcommand{\scompspossb}[1]{\ensuremath{\lv
                  \comppossb{#1}{x},
                  \comppossb{#1}{y},
                  \comppossb{#1}{z}\rv}}

\compdpossb
\compDpossb       \newcommand{\compdpossb}[2]{\ensuremath{\mathrm{d}\comppossb{#1}{#2}}}
                  \newcommand{\compDpossb}[2]{\ensuremath{\Delta\comppossb{#1}{#2}}}

\scompsdpossb
\scompsDpossb     \newcommand{\scompsdpossb}[1]{\ensuremath{\lv
                  \compdpossb{#1}{x},
                  \compdpossb{#1}{y},
                  \compdpossb{#1}{z}\rv}}
                  \newcommand{\scompsDpossb}[1]{\ensuremath{\lv
                  \compDpossb{#1}{x},
                  \compDpossb{#1}{y},
                  \compDpossb{#1}{z}\rv}}

```

```

\compderpossub
\compDerpossub    \newcommand{\compderpossub}[3]{\ensuremath{\dbyd{\comppossub{#1}{#3}}{#2}}}
                  \newcommand{\compDerpossub}[3]{\ensuremath{\DbyD{\comppossub{#1}{#3}}{#2}}}

\scompsderpossub
\scompsDerpossub  \newcommand{\scompsderpossub}[2]{\ensuremath{\lv
                  \compderpossub{#1}{#2}{x},
                  \compderpossub{#1}{#2}{y},
                  \compderpossub{#1}{#2}{z}\rv}}
                  \newcommand{\scompsDerpossub}[2]{\ensuremath{\lv
                  \compDerpossub{#1}{#2}{x},
                  \compDerpossub{#1}{#2}{y},
                  \compDerpossub{#1}{#2}{z}\rv}}

\relpos
                  \newcommand{\relpos}[1]{\ensuremath{\vectsub{r}{#1}}}

\relvel
                  \newcommand{\relvel}[1]{\ensuremath{\vectsub{v}{#1}}}

\relmom
                  \newcommand{\relmom}[1]{\ensuremath{\vectsub{p}{#1}}}

\relfor
                  \newcommand{\relfor}[1]{\ensuremath{\vectsub{F}{#1}}}

\vectdotvect
                  \newcommand{\vectdotvect}[2]{\ensuremath{{#1}\bullet{#2}}}

\vectdotsvect
                  \newcommand{\vectdotsvect}[2]{\ensuremath{\scompsvect{#1}\bullet\scompsvect{#2}}}

\vectdotevect
                  \newcommand{\vectdotevect}[2]{\ensuremath{
                  \compvect{#1}{x}\compvect{#2}{x}+
                  \compvect{#1}{y}\compvect{#2}{y}+
                  \compvect{#1}{z}\compvect{#2}{z}}}

\vectdotspos
                  \newcommand{\vectdotspos}[1]{\ensuremath{\scompsvect{#1}\bullet\scompspos}}

\vectdotepos
                  \newcommand{\vectdotepos}[1]{\ensuremath{
                  \compvect{#1}{x}\comppos{x}+
                  \compvect{#1}{y}\comppos{y}+
                  \compvect{#1}{z}\comppos{z}}}

\vectdotsdvect
\vectdotsDvect    \newcommand{\vectdotsdvect}[2]{\ensuremath{\scompsvect{#1}\bullet\scompsdvect{#2}}}
                  \newcommand{\vectdotsDvect}[2]{\ensuremath{\scompsvect{#1}\bullet\scompsDvect{#2}}}

```

```

\vectdotedvect
\vectdoteDvect \newcommand{\vectdotedvect}[2]{\ensuremath{
  \compvect{#1}{x}\compdvect{#2}{x}+
  \compvect{#1}{y}\compdvect{#2}{y}+
  \compvect{#1}{z}\compdvect{#2}{z}}}
\newcommand{\vectdoteDvect}[2]{\ensuremath{
  \compvect{#1}{x}\compDvect{#2}{x}+
  \compvect{#1}{y}\compDvect{#2}{y}+
  \compvect{#1}{z}\compDvect{#2}{z}}}

\vectdotsdpos
\vectdotsDpos \newcommand{\vectdotsdpos}[1]{\ensuremath{\scompsvect{#1}\bullet\scompsdpos}}
\newcommand{\vectdotsDpos}[1]{\ensuremath{\scompsvect{#1}\bullet\scompsDpos}}

\vectdotedpos
\vectdoteDpos \newcommand{\vectdotedpos}[1]{\ensuremath{
  \compvect{#1}{x}\compdpos{x}+
  \compvect{#1}{y}\compdpos{y}+
  \compvect{#1}{z}\compdpos{z}}}
\newcommand{\vectdoteDpos}[1]{\ensuremath{
  \compvect{#1}{x}\compDpos{x}+
  \compvect{#1}{y}\compDpos{y}+
  \compvect{#1}{z}\compDpos{z}}}

\vectsubdotsvectsub
\newcommand{\vectsubdotsvectsub}[4]{\ensuremath{
  \scompsvectsub{#1}{#2}\bullet\scompsvectsub{#3}{#4}}}

\vectsubdotevectsub
\newcommand{\vectsubdotevectsub}[4]{\ensuremath{
  \compvectsub{#1}{#2}{x}\compvectsub{#3}{#4}{x}+
  \compvectsub{#1}{#2}{y}\compvectsub{#3}{#4}{y}+
  \compvectsub{#1}{#2}{z}\compvectsub{#3}{#4}{z}}}

\vectsubdotsdvectsub
\vectsubdotsDvectsub \newcommand{\vectsubdotsdvectsub}[4]{\ensuremath{
  \scompsvectsub{#1}{#2}\bullet\scompsdvectsub{#3}{#4}}}
\newcommand{\vectsubdotsDvectsub}[4]{\ensuremath{
  \scompsvectsub{#1}{#2}\bullet\scompsDvectsub{#3}{#4}}}

\vectsubdotedvectsub
\vectsubdoteDvectsub \newcommand{\vectsubdotedvectsub}[4]{\ensuremath{
  \compvectsub{#1}{#2}{x}\compdvectsub{#3}{#4}{x}+
  \compvectsub{#1}{#2}{y}\compdvectsub{#3}{#4}{y}+
  \compvectsub{#1}{#2}{z}\compdvectsub{#3}{#4}{z}}}
\newcommand{\vectsubdoteDvectsub}[4]{\ensuremath{
  \compvectsub{#1}{#2}{x}\compDvectsub{#3}{#4}{x}+
  \compvectsub{#1}{#2}{y}\compDvectsub{#3}{#4}{y}+
  \compvectsub{#1}{#2}{z}\compDvectsub{#3}{#4}{z}}}

```

```

\vecsbdotsdvect
\vecsbdotsDvect    \newcommand{\vecsbdotsdvect}[3]{\ensuremath{
                    \scompsvectsub{#1}{#2}\bullet\scompsdvect{#3}}}
                    \newcommand{\vecsbdotsDvect}[3]{\ensuremath{
                    \scompsvectsub{#1}{#2}\bullet\scompsDvect{#3}}}

\vecsbdotedvect
\vecsbdoteDvect    \newcommand{\vecsbdotedvect}[3]{\ensuremath{
                    \compvectsub{#1}{#2}{x}\compdvect{#3}{x}+
                    \compvectsub{#1}{#2}{y}\compdvect{#3}{y}+
                    \compvectsub{#1}{#2}{z}\compdvect{#3}{z}}}
                    \newcommand{\vecsbdoteDvect}[3]{\ensuremath{
                    \compvectsub{#1}{#2}{x}\compDvect{#3}{x}+
                    \compvectsub{#1}{#2}{y}\compDvect{#3}{y}+
                    \compvectsub{#1}{#2}{z}\compDvect{#3}{z}}}

\vecsbdotsdpos
\vecsbdotsDpos    \newcommand{\vecsbdotsdpos}[2]{\ensuremath{
                    \scompsvectsub{#1}{#2}\bullet\scompsdpos}}
                    \newcommand{\vecsbdotsDpos}[2]{\ensuremath{
                    \scompsvectsub{#1}{#2}\bullet\scompsDpos}}

\vecsbdotedpos
\vecsbdoteDpos    \newcommand{\vecsbdotedpos}[2]{\ensuremath{
                    \compvectsub{#1}{#2}{x}\compdpos{x}+
                    \compvectsub{#1}{#2}{y}\compdpos{y}+
                    \compvectsub{#1}{#2}{z}\compdpos{z}}}
                    \newcommand{\vecsbdoteDpos}[2]{\ensuremath{
                    \compvectsub{#1}{#2}{x}\compDpos{x}+
                    \compvectsub{#1}{#2}{y}\compDpos{y}+
                    \compvectsub{#1}{#2}{z}\compDpos{z}}}

\dervectdotsvect
\Dervectdotsvect    \newcommand{\dervectdotsvect}[3]{\ensuremath{
                    \scompsdervect{#1}{#2}\bullet\scompsvect{#3}}}
                    \newcommand{\Dervectdotsvect}[3]{\ensuremath{
                    \scompsDervect{#1}{#2}\bullet\scompsvect{#3}}}

\dervectdotevect
\Dervectdotevect    \newcommand{\dervectdotevect}[3]{\ensuremath{
                    \compdervect{#1}{#2}{x}\compvect{#3}{x}+
                    \compdervect{#1}{#2}{y}\compvect{#3}{y}+
                    \compdervect{#1}{#2}{z}\compvect{#3}{z}}}
                    \newcommand{\Dervectdotevect}[3]{\ensuremath{
                    \compDervect{#1}{#2}{x}\compvect{#3}{x}+
                    \compDervect{#1}{#2}{y}\compvect{#3}{y}+
                    \compDervect{#1}{#2}{z}\compvect{#3}{z}}}

```

```

\vectdotsdervect
\vectdotsDervect    \newcommand{\vectdotsdervect}[3]{\ensuremath{
                     \scompsvect{#1}\bullet\scompsdervect{#2}{#3}}}
                     \newcommand{\vectdotsDervect}[3]{\ensuremath{
                     \scompsvect{#1}\bullet\scompsDervect{#2}{#3}}}

\vectdotedervect
\vectdoteDervect    \newcommand{\vectdotedervect}[3]{\ensuremath{
                     \compvect{#1}{x}\compdervect{#2}{#3}{x}+
                     \compvect{#1}{y}\compdervect{#2}{#3}{y}+
                     \compvect{#1}{z}\compdervect{#2}{#3}{z}}}
                     \newcommand{\vectdoteDervect}[3]{\ensuremath{
                     \compvect{#1}{x}\compDervect{#2}{#3}{x}+
                     \compvect{#1}{y}\compDervect{#2}{#3}{y}+
                     \compvect{#1}{z}\compDervect{#2}{#3}{z}}}

\dervectdotspos
\Dervectdotspos    \newcommand{\dervectdotspos}[2]{\ensuremath{
                     \scompsdervect{#1}{#2}\bullet\scompspos{}}}
                     \newcommand{\Dervectdotspos}[2]{\ensuremath{
                     \scompsDervect{#1}{#2}\bullet\scompspos{}}}

\dervectdotepos
\Dervectdotepos    \newcommand{\dervectdotepos}[2]{\ensuremath{
                     \compdervect{#1}{#2}{x}\comppos{x}+
                     \compdervect{#1}{#2}{y}\comppos{y}+
                     \compdervect{#1}{#2}{z}\comppos{z}}}
                     \newcommand{\Dervectdotepos}[2]{\ensuremath{
                     \compDervect{#1}{#2}{x}\comppos{x}+
                     \compDervect{#1}{#2}{y}\comppos{y}+
                     \compDervect{#1}{#2}{z}\comppos{z}}}

\dervectdotsdvect
\DervectdotsDvect    \newcommand{\dervectdotsdvect}[3]{\ensuremath{
                     \scompsdervect{#1}{#2}\bullet\scompsdvect{#3}}}
                     \newcommand{\DervectdotsDvect}[3]{\ensuremath{
                     \scompsDervect{#1}{#2}\bullet\scompsDvect{#3}}}

\dervectdotedvect
\DervectdoteDvect    \newcommand{\dervectdotedvect}[3]{\ensuremath{
                     \compdervect{#1}{#2}{x}\compdvect{#3}{x}+
                     \compdervect{#1}{#2}{y}\compdvect{#3}{y}+
                     \compdervect{#1}{#2}{z}\compdvect{#3}{z}}}
                     \newcommand{\DervectdoteDvect}[3]{\ensuremath{
                     \compDervect{#1}{#2}{x}\compDvect{#3}{x}+
                     \compDervect{#1}{#2}{y}\compDvect{#3}{y}+
                     \compDervect{#1}{#2}{z}\compDvect{#3}{z}}}

```

```

\dervectdotsdpos
\DervectdotsDpos    \newcommand{\dervectdotsdpos}[2]{\ensuremath{
                     \scompsdervect{#1}{#2}\bullet\scompsdpos}}
                     \newcommand{\DervectdotsDpos}[2]{\ensuremath{
                     \scompsDervect{#1}{#2}\bullet\scompsDpos}}

\dervectdotedpos
\DervectdoteDpos    \newcommand{\dervectdotedpos}[2]{\ensuremath{
                     \compdervect{#1}{#2}{x}\compdpos{x}+
                     \compdervect{#1}{#2}{y}\compdpos{y}+
                     \compdervect{#1}{#2}{z}\compdpos{z}}}
                     \newcommand{\DervectdoteDpos}[2]{\ensuremath{
                     \compDervect{#1}{#2}{x}\compDpos{x}+
                     \compDervect{#1}{#2}{y}\compDpos{y}+
                     \compDervect{#1}{#2}{z}\compDpos{z}}}

\ezero
\eone    \newcommand{\ezero}{\ensuremath{\msub{\mathbf{e}}{0}}}
\etwo    \newcommand{\eone}{\ensuremath{\msub{\mathbf{e}}{1}}}
\ethree  \newcommand{\etwo}{\ensuremath{\msub{\mathbf{e}}{2}}}
\efour   \newcommand{\ethree}{\ensuremath{\msub{\mathbf{e}}{3}}}
\ek      \newcommand{\efour}{\ensuremath{\msub{\mathbf{e}}{4}}}
\ek      \newcommand{\ek}[1]{\ensuremath{\msub{\mathbf{e}}{#1}}}
\ek      \newcommand{\ek}{\ek}

\uezero
\ueone   \newcommand{\uezero}{\ensuremath{\msub{\widehat{\mathbf{e}}}{0}}}
\uetwo   \newcommand{\ueone}{\ensuremath{\msub{\widehat{\mathbf{e}}}{1}}}
\uetthree \newcommand{\uetwo}{\ensuremath{\msub{\widehat{\mathbf{e}}}{2}}}
\uefour  \newcommand{\uetthree}{\ensuremath{\msub{\widehat{\mathbf{e}}}{3}}}
\uek     \newcommand{\uefour}{\ensuremath{\msub{\widehat{\mathbf{e}}}{4}}}
\uek     \newcommand{\uek}[1]{\ensuremath{\msub{\widehat{\mathbf{e}}}{#1}}}
\ue      \newcommand{\ue}{\uek}

\ezerozero
\eoneone \newcommand{\ezerozero}{\ek{00}}
\eonetwo \newcommand{\eoneone}{\ek{11}}
\eonethree \newcommand{\eonetwo}{\ek{12}}
\eonefour \newcommand{\eonethree}{\ek{13}}
\etwoone  \newcommand{\eonefour}{\ek{14}}
\etwotwo  \newcommand{\etwoone}{\ek{21}}
\etwothree \newcommand{\etwotwo}{\ek{22}}
\etwofour \newcommand{\etwothree}{\ek{23}}
\ethreeone \newcommand{\etwofour}{\ek{24}}
\ethreetwo \newcommand{\ethreeone}{\ek{31}}
\ethreethree \newcommand{\ethreetwo}{\ek{32}}
\ethreefour \newcommand{\ethreethree}{\ek{33}}
\efourone  \newcommand{\ethreefour}{\ek{34}}
\efourtwo  \newcommand{\efourone}{\ek{41}}
\efourthree \newcommand{\efourtwo}{\ek{42}}
\efourfour

```

```

\newcommand{\efourthree}{\ek{43}}
\newcommand{\efourfour}{\ek{44}}

\euzero
\euone \newcommand{\euzero}{\ensuremath{\msup{\mathbf{e}}{0}}}
\eutwo \newcommand{\euone}{\ensuremath{\msup{\mathbf{e}}{1}}}
\eutree \newcommand{\eutwo}{\ensuremath{\msup{\mathbf{e}}{2}}}
\eufour \newcommand{\eutree}{\ensuremath{\msup{\mathbf{e}}{3}}}
\euk \newcommand{\eufour}{\ensuremath{\msup{\mathbf{e}}{4}}}
\eu \newcommand{\euk}[1]{\ensuremath{\msup{\mathbf{e}}{#1}}}
\newcommand{\eu}{\euk}

```



```

\euzerozero
\euoneone \newcommand{\euzerozero}{\euk{00}}
\euonetwo \newcommand{\euoneone}{\euk{11}}
\euonethree \newcommand{\euonetwo}{\euk{12}}
\euonefour \newcommand{\euonethree}{\euk{13}}
\eutwoone \newcommand{\euonefour}{\euk{14}}
\eutwotwo \newcommand{\eutwoone}{\euk{21}}
\eutwothree \newcommand{\eutwotwo}{\euk{22}}
\eutwofour \newcommand{\eutwothree}{\euk{23}}
\euthreeone \newcommand{\eutwofour}{\euk{24}}
\euthreetwo \newcommand{\euthreeone}{\euk{31}}
\euthreethree \newcommand{\euthreetwo}{\euk{32}}
\euthreefour \newcommand{\euthreethree}{\euk{33}}
\eufourone \newcommand{\euthreefour}{\euk{34}}
\eufourtwo \newcommand{\eufourone}{\euk{41}}
\eufourthree \newcommand{\eufourtwo}{\euk{42}}
\eufourfour \newcommand{\eufourthree}{\euk{43}}
\eufourfour \newcommand{\eufourfour}{\euk{44}}

\gzero
\gone \newcommand{\gzero}{\ensuremath{\msub{\mathbf{\gamma}}{0}}}
\gtwo \newcommand{\gone}{\ensuremath{\msub{\mathbf{\gamma}}{1}}}
\gthree \newcommand{\gtwo}{\ensuremath{\msub{\mathbf{\gamma}}{2}}}
\gfour \newcommand{\gthree}{\ensuremath{\msub{\mathbf{\gamma}}{3}}}
\gk \newcommand{\gfour}{\ensuremath{\msub{\mathbf{\gamma}}{4}}}
\g \newcommand{\gk}[1]{\ensuremath{\msub{\mathbf{\gamma}}{#1}}}
\gk

\gzerozero
\goneone \newcommand{\gzerozero}{\gk{00}}
\gonetwo \newcommand{\goneone}{\gk{11}}
\gonethree \newcommand{\gonetwo}{\gk{12}}
\gonefour \newcommand{\gonethree}{\gk{13}}
\gtwoone \newcommand{\gonefour}{\gk{14}}
\gtwotwo \newcommand{\gtwoone}{\gk{21}}
\gtwothree \newcommand{\gtwotwo}{\gk{22}}
\gtwofour \newcommand{\gtwothree}{\gk{23}}
\gthreeone \newcommand{\gtwofour}{\gk{24}}
\gthreetwo \newcommand{\gthreeone}{\gk{31}}
\gthreethree \newcommand{\gthreetwo}{\gk{32}}
\gthreefour \newcommand{\gthreethree}{\gk{33}}
\gfourone \newcommand{\gthreefour}{\gk{34}}
\gfourtwo \newcommand{\gfourone}{\gk{41}}
\gfourthree \newcommand{\gfourtwo}{\gk{42}}
\gfourfour \newcommand{\gfourthree}{\gk{43}}
\gfourfour \newcommand{\gfourfour}{\gk{44}}

```

```

\guzero
\guone \newcommand{\guzero}{\ensuremath{\msup{\mathbf{\gamma}}{0}}}
\gutwo \newcommand{\guone}{\ensuremath{\msup{\mathbf{\gamma}}{1}}}
\guthree \newcommand{\gutwo}{\ensuremath{\msup{\mathbf{\gamma}}{2}}}
\gufour \newcommand{\guthree}{\ensuremath{\msup{\mathbf{\gamma}}{3}}}
\guk \newcommand{\gufour}{\ensuremath{\msup{\mathbf{\gamma}}{4}}}
\gu \newcommand{\guk}[1]{\ensuremath{\msup{\mathbf{\gamma}}{#1}}}
\newcommand{\gu}{\guk}

\guzerozero
\guoneone \newcommand{\guzerozero}{\guk{00}}
\guonetwo \newcommand{\guoneone}{\guk{11}}
\guonethree \newcommand{\guonetwo}{\guk{12}}
\guonefour \newcommand{\guonethree}{\guk{13}}
\gutwoone \newcommand{\guonefour}{\guk{14}}
\gutwotwo \newcommand{\gutwoone}{\guk{21}}
\gutwothree \newcommand{\gutwotwo}{\guk{22}}
\gutwofour \newcommand{\gutwothree}{\guk{23}}
\guthreeone \newcommand{\gutwofour}{\guk{24}}
\guthreetwo \newcommand{\guthreeone}{\guk{31}}
\guthreethree \newcommand{\guthreetwo}{\guk{32}}
\guthreethree \newcommand{\guthreethree}{\guk{33}}
\guthreefour \newcommand{\guthreethree}{\guk{34}}
\gufourone \newcommand{\guthreefour}{\guk{34}}
\gufourtwo \newcommand{\gufourone}{\guk{41}}
\gufourthree \newcommand{\gufourtwo}{\guk{42}}
\gufourfour \newcommand{\gufourthree}{\guk{43}}
\newcommand{\gufourfour}{\guk{44}}

\mivector Vectors formatted as in M&I, written in LaTeX3
\ExplSyntaxOn
\NewDocumentCommand{\mivector}{ O{,} m o }%
{%
\mi_vector:nn { #1 } { #2 }
\IfValueT{#3}{\;{#3}}
}%
\seq_new:N \l__mi_list_seq
\cs_new_protected:Npn \mi_vector:nn #1 #2
{%
\ensuremath{%
\seq_set_split:Nnn \l__mi_list_seq { , } { #2 }
\int_compare:nF { \seq_count:N \l__mi_list_seq = 1 } { \left\langle }
\seq_use:Nnnn \l__mi_list_seq { #1 } { #1 } { #1 }
\int_compare:nF { \seq_count:N \l__mi_list_seq = 1 } { \right\rangle }
}%
}%
\ExplSyntaxOff

\colvector Column and row vectors, written in LaTeX3
\rowvector \ExplSyntaxOn
\seq_new:N \l__vector_arg_seq

```

```

\cs_new_protected:Npn \vector_main:nnnn #1 #2 #3 #4
{
  \seq_set_split:Nnn \l__vector_arg_seq { #3 } { #4 }
  \begin{#1matrix}
    \seq_use:Nnnn \l__vector_arg_seq { #2 } { #2 } { #2 }
  \end{#1matrix}
}%
\NewDocumentCommand{\rowvector}{ 0{,} m }
{
  \ensuremath{
    \vector_main:nnnn { p } { \,,\,, } { #1 } { #2 }
  }
}%
\NewDocumentCommand{\colvector}{ 0{,} m }
{
  \ensuremath{
    \vector_main:nnnn { p } { \,\, } { #1 } { #2 }
  }
}%
\ExplSyntaxOff

```

\scompscvect

```

\newcommandx{\scompscvect}[2][1,usedefault]{
  \ifthenelse{\equal{#1}{}}{
    {
      \colvector{\msub{#2}{1},\msub{#2}{2},\msub{#2}{3}}
    }
  }{
    \colvector{\msub{#2}{0},\msub{#2}{1},\msub{#2}{2},\msub{#2}{3}}
  }
}%

```

\scompsrvect

```

\newcommandx{\scompsrvect}[2][1,usedefault]{
  \ifthenelse{\equal{#1}{}}{
    {
      \rowvector[,]{\msub{#2}{1},\msub{#2}{2},\msub{#2}{3}}
    }
  }{
    \rowvector[,]{\msub{#2}{0},\msub{#2}{1},\msub{#2}{2},\msub{#2}{3}}
  }
}%

```

\oofpez Coulomb constant

```

\newphysicsconstant{oofpez}{\ensuremath{\frac{1}{\phantom{o}4\pi\ssub{\epsilon}{o}}}}
{\scin[9]{9}}{\ensuremath{\m\cubed\usk\kg\usk\reciprocalquartic\s\usk\reciprocalssquared}}
[\m\per\farad][\newton\usk\m\squared\per\coulomb\squared]

```

\oofpezcs Coulomb constant (alternate)

```

\newphysicsconstant{oofpezcs}{\ensuremath{\frac{1}{\phantom{o}4\pi\ssub{\epsilon}{o}}}}

```

$c^2 \frac{1}{\text{phantom}\{_{\text{oo}}\} \text{scin}[-7] \frac{\text{m} \cdot \text{kg}}{\text{us} \cdot \text{s}} \frac{1}{\text{reciprocal}^2 \text{us} \cdot \text{A}} \frac{1}{\text{reciprocal}^2 \text{us}}}$
 $[\text{T} \frac{\text{us}}{\text{m}} \frac{1}{\text{squared}}] [\text{N} \frac{\text{us}}{\text{s}} \frac{1}{\text{squared}} \text{per} \text{C} \frac{1}{\text{squared}}]$

$\backslash\text{epsz}$ vacuum permittivity
 $\backslash\text{newphysicsconstant}\{\text{epsz}\} \{ \backslash\text{ensuremath}\{ \text{ssub}\{\epsilon\}\}\{ \text{scin}[9] \{-12\}\} \frac{\text{m}}{\text{reciprocal}^3 \text{us}} \frac{1}{\text{reciprocal} \text{kg} \cdot \text{us} \cdot \text{s}^4} \frac{1}{\text{us} \cdot \text{A} \cdot \text{squared}} [\text{F} \text{per} \text{m}] [\text{C} \frac{1}{\text{squared}} \text{per} \text{N} \frac{\text{us}}{\text{m}} \frac{1}{\text{squared}}]$

$\backslash\text{mzofp}$ Biot-Savart constant
 $\backslash\text{newphysicsconstant}\{\text{mzofp}\} \{ \backslash\text{ensuremath}\{ \frac{\text{phantom}\{_{\text{oo}}\} \text{ssub}\{\mu\}\{_{\text{oo}}\} \text{phantom}\{_{\text{oo}}\} \{4\pi\}\}\{ \text{scin}[-7]\} \frac{\text{m} \cdot \text{kg}}{\text{us} \cdot \text{s}} \frac{1}{\text{reciprocal}^2 \text{us} \cdot \text{A}} \frac{1}{\text{reciprocal}^2 \text{us}} [\text{henry} \text{per} \text{m}] [\text{tesla} \frac{\text{us}}{\text{m}} \text{per} \text{A}] \}$

$\backslash\text{muz}$ vacuum permeability
 $\backslash\text{newphysicsconstant}\{\text{muz}\} \{ \backslash\text{ensuremath}\{ \text{ssub}\{\mu\}\}\{ \text{scin}[4\pi] \{-7\}\} \frac{\text{m} \cdot \text{kg}}{\text{us} \cdot \text{s}} \frac{1}{\text{reciprocal}^2 \text{us} \cdot \text{A}} \frac{1}{\text{reciprocal}^2 \text{us}} [\text{henry} \text{per} \text{m}] [\text{T} \frac{\text{us}}{\text{m}} \text{per} \text{A}] \}$

$\backslash\text{kboltz}$ Boltzmann constant
 $\backslash\text{newphysicsconstant}\{\text{kboltz}\} \{ \backslash\text{ensuremath}\{ \text{ssub}\{k\}\{B\}\}\{ \text{scin}[1.38] \{-23\}\} \frac{\text{kg}}{\text{us} \cdot \text{m} \cdot \text{squared}} \frac{1}{\text{us} \cdot \text{reciprocal}^2 \text{us}} \frac{1}{\text{us} \cdot \text{reciprocal} \text{K}} [\text{joule} \text{per} \text{K}] [\text{J} \text{per} \text{K}] \}$

$\backslash\text{kboltznev}$ Boltzmann constant (alternate)
 $\backslash\text{newcommand}\{\text{kboltznev}\} \{ \backslash\text{ensuremath}\{ \text{scin}[8.62] \{-5\}\} \frac{\text{eV}}{\text{per} \text{K}} \}$

$\backslash\text{stefan}$ Stefan-Boltzmann constant
 $\backslash\text{newphysicsconstant}\{\text{stefan}\} \{ \backslash\text{ensuremath}\{ \sigma \}\{ \text{scin}[5.67] \{-8\}\} \frac{\text{kg}}{\text{us} \cdot \text{s}} \frac{1}{\text{reciprocal}^3 \text{us} \cdot \text{K}} \frac{1}{\text{reciprocal}^4 \text{us}} [\text{W} \text{per} \text{m} \cdot \text{squared} \text{us} \cdot \text{K}^4] [\text{W} \text{per} \text{m} \cdot \text{squared} \text{us} \cdot \text{K}^4] \}$

$\backslash\text{planck}$ Planck constant
 $\backslash\text{newphysicsconstant}\{\text{planck}\} \{ \backslash\text{ensuremath}\{ h \}\{ \text{scin}[6.62] \{-34\}\} \frac{\text{m} \cdot \text{squared}}{\text{us} \cdot \text{kg} \cdot \text{us}} \frac{1}{\text{reciprocal} \text{s}} [\text{J} \text{us} \cdot \text{s}] [\text{kg} \frac{\text{us}}{\text{m} \cdot \text{squared}} \text{per} \text{s}] \}$

$\backslash\text{plancknev}$ Planck constant (alternate)
 $\backslash\text{newcommand}\{\text{plancknev}\} \{ \backslash\text{ensuremath}\{ \text{scin}[4.136] \{-15\}\} \frac{\text{eV}}{\text{us} \cdot \text{s}} \}$

$\backslash\text{planckbar}$ reduced Planck constant (Dirac constant)
 $\backslash\text{newphysicsconstant}\{\text{planckbar}\} \{ \backslash\text{ensuremath}\{ \hbar \}\{ \text{scin}[1.05] \{-34\}\} \frac{\text{m} \cdot \text{squared}}{\text{us} \cdot \text{kg} \cdot \text{us}} \frac{1}{\text{reciprocal} \text{s}} [\text{joule} \text{us} \cdot \text{s}] [\text{kg} \frac{\text{us}}{\text{m} \cdot \text{squared}} \text{per} \text{s}] \}$

$\backslash\text{planckbarnev}$ reduced Planck constant (alternate)
 $\backslash\text{newcommand}\{\text{planckbarnev}\} \{ \backslash\text{ensuremath}\{ \text{scin}[4.136] \{-15\}\} \frac{\text{eV}}{\text{us} \cdot \text{s}} \}$

$\backslash\text{Navogadro}$ Avogadro constant
 $\backslash\text{newphysicsconstant}\{\text{Navogadro}\} \{ \backslash\text{ensuremath}\{ \text{ssub}\{N\}\{A\}\}\{ \text{scin}[6.022] \{23\}\} \frac{1}{\text{reciprocal} \text{mol}} [\text{reciprocal} \text{mol}] [\text{reciprocal} \text{mol}] \}$

`\bigG` universal gravitational constant

$$\frac{\text{newphysicsconstant}\{\text{bigG}\}\{\text{ensuremath}\{G\}\}\{\text{scin}[6.67]\{-11\}\}}{\text{m}\text{cubed}\text{usk}\text{reciprocal}\text{kg}\text{usk}\text{s}\text{reciprocalssquared}}[\text{J}\text{usk}\text{m}\text{per}\text{kg}\text{quared}][\text{N}\text{usk}\text{m}\text{quared}\text{per}\text{kg}\text{quared}]$$

`\littleg` gravitational field strength at Earth's surface

$$\frac{\text{newphysicsconstant}\{\text{littleg}\}\{\text{ensuremath}\{g\}\}\{9.80\}\{\text{m}\text{usk}\text{s}\text{reciprocalssquared}\}}{[\text{N}\text{per}\text{kg}][\text{m}\text{per}\text{s}\text{quared}]}$$

`\clight` light's speed

$$\frac{\text{newphysicsconstant}\{\text{clight}\}\{\text{ensuremath}\{c\}\}\{\text{scin}[3.00]\{8\}\}\{\text{m}\text{usk}\text{reciprocal}\text{s}\}}{[\text{m}\text{usk}\text{reciprocal}\text{s}][\text{m}\text{per}\text{s}]}$$

`\clightnfn` light's speed (alternate)

$$\text{newcommand}\{\text{clightnfn}\}\{\text{ensuremath}\{\text{unit}\{1\}\{\text{mathrm}\{\text{ft}\}\text{per}\text{mathrm}\{\text{n}\}\text{s}\}\}\}$$

`\Ratom` approximate atomic radius

$$\text{newphysicsconstant}\{\text{Ratom}\}\{\text{ensuremath}\{\text{ssub}\{r\}\{\text{atom}\}\}\}\{\text{scin}\{-10\}\}\{\text{m}\}[\text{m}][\text{m}]$$

`\Mproton` proton's mass

$$\frac{\text{newphysicsconstant}\{\text{Mproton}\}\{\text{ensuremath}\{\text{ssub}\{m\}\{\text{proton}\}\}\}\{\text{scin}[1.673]\{-27\}\}}{\{\text{kg}\}[\text{kg}][\text{kg}]}$$

`\Mneutron` neutron's mass

$$\frac{\text{newphysicsconstant}\{\text{Mneutron}\}\{\text{ensuremath}\{\text{ssub}\{m\}\{\text{neutron}\}\}\}\{\text{scin}[1.675]\{-27\}\}}{\{\text{kg}\}[\text{kg}][\text{kg}]}$$

`\Mhydrogen` hydrogen atom's mass

$$\frac{\text{newphysicsconstant}\{\text{Mhydrogen}\}\{\text{ensuremath}\{\text{ssub}\{m\}\{\text{hydrogen}\}\}\}\{\text{scin}[1.673]\{-27\}\}}{\{\text{kg}\}[\text{kg}][\text{kg}]}$$

`\Melectron` electron's mass

$$\frac{\text{newphysicsconstant}\{\text{Melectron}\}\{\text{ensuremath}\{\text{ssub}\{m\}\{\text{electron}\}\}\}\{\text{scin}[9.109]\{-31\}\}}{\{\text{kg}\}[\text{kg}][\text{kg}]}$$

`\echarge` charge quantum

$$\text{newphysicsconstant}\{\text{echarge}\}\{\text{ensuremath}\{e\}\}\{\text{scin}[1.602]\{-19\}\}\{\text{A}\text{usk}\text{s}\}[\text{C}][\text{C}]$$

`\Qelectron` electron's charge
`\qelectron`
$$\frac{\text{newphysicsconstant}\{\text{Qelectron}\}\{\text{ensuremath}\{\text{ssub}\{Q\}\{\text{electron}\}\}\}\{-\text{echargevalue}\}}{\{\text{A}\text{usk}\text{s}\}[\text{C}][\text{C}]}$$

$$\frac{\text{newphysicsconstant}\{\text{qelectron}\}\{\text{ensuremath}\{\text{ssub}\{q\}\{\text{electron}\}\}\}\{-\text{echargevalue}\}}{\{\text{A}\text{usk}\text{s}\}[\text{C}][\text{C}]}$$

`\Qproton` proton's charge
`\qproton`
$$\frac{\text{newphysicsconstant}\{\text{Qproton}\}\{\text{ensuremath}\{\text{ssub}\{Q\}\{\text{proton}\}\}\}\{+\text{echargevalue}\}}{\{\text{A}\text{usk}\text{s}\}[\text{C}][\text{C}]}$$

$$\frac{\text{newphysicsconstant}\{\text{qproton}\}\{\text{ensuremath}\{\text{ssub}\{q\}\{\text{proton}\}\}\}\{+\text{echargevalue}\}}{\{\text{A}\text{usk}\text{s}\}[\text{C}][\text{C}]}$$

$\backslash\text{MEarth}$ Earth's mass
 $\backslash\text{newphysicsconstant}\{\text{MEarth}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{M}\}\{\text{Earth}\}\}\}\{\text{scin}[6]\{24\}\}\{\text{kg}\}\{\text{kg}\}\{\text{kg}\}$

$\backslash\text{MMoon}$ Moon's mass
 $\backslash\text{newphysicsconstant}\{\text{MMoon}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{M}\}\{\text{Moon}\}\}\}\{\text{scin}[7]\{22\}\}\{\text{kg}\}\{\text{kg}\}\{\text{kg}\}$

$\backslash\text{MSun}$ Sun's mass
 $\backslash\text{newphysicsconstant}\{\text{MSun}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{M}\}\{\text{Sun}\}\}\}\{\text{scin}[2]\{30\}\}\{\text{kg}\}\{\text{kg}\}\{\text{kg}\}$

$\backslash\text{REarth}$ Earth's radius
 $\backslash\text{newphysicsconstant}\{\text{REarth}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{R}\}\{\text{Earth}\}\}\}\{\text{scin}[6.4]\{6\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$

$\backslash\text{RMoon}$ Moon's radius
 $\backslash\text{newphysicsconstant}\{\text{RMoon}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{R}\}\{\text{Moon}\}\}\}\{\text{scin}[1.75]\{6\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$

$\backslash\text{RSun}$ Sun's radius
 $\backslash\text{newphysicsconstant}\{\text{RSun}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{R}\}\{\text{Sun}\}\}\}\{\text{scin}[7]\{8\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$

$\backslash\text{ESdist}$ Earth-Sun distance (Sun-Earth distance)
 $\backslash\text{SEdist}$ $\backslash\text{newphysicsconstant}\{\text{ESdist}\}\{\backslash\text{magvectsub}\{\text{r}\}\{\text{ES}\}\}\{\text{scin}[1.5]\{11\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$
 $\backslash\text{newphysicsconstant}\{\text{SEdist}\}\{\backslash\text{magvectsub}\{\text{r}\}\{\text{SE}\}\}\{\text{scin}[1.5]\{11\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$

$\backslash\text{EMdist}$ Earth-Moon distance (Moon-Earth distance)
 $\backslash\text{MEDist}$ $\backslash\text{newphysicsconstant}\{\text{EMdist}\}\{\backslash\text{magvectsub}\{\text{r}\}\{\text{EM}\}\}\{\text{scin}[4]\{8\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$
 $\backslash\text{newphysicsconstant}\{\text{MEDist}\}\{\backslash\text{magvectsub}\{\text{r}\}\{\text{ME}\}\}\{\text{scin}[4]\{8\}\}\{\text{m}\}\{\text{m}\}\{\text{m}\}$

$\backslash\text{lightyear}$ light year, year, and parsec
 $\backslash\text{Lightyear}$ $\backslash\text{newcommand}\{\backslash\text{lightyear}\}\{\backslash\text{ensuremath}\{\text{mathrm}\{\text{ly}\}\}\}$
 $\backslash\text{cyear}$ $\backslash\text{newcommand}\{\backslash\text{Lightyear}\}\{\backslash\text{ensuremath}\{\text{mathrm}\{\text{LY}\}\}\}$
 $\backslash\text{cyr}$ $\backslash\text{newcommand}\{\backslash\text{cyear}\}\{\backslash\text{ensuremath}\{\text{c}\backslash\text{usk}\backslash\text{mathrm}\{\text{year}\}\}\}$
 $\backslash\text{yyear}$ $\backslash\text{newcommand}\{\backslash\text{cyr}\}\{\backslash\text{ensuremath}\{\text{c}\backslash\text{usk}\backslash\text{mathrm}\{\text{yr}\}\}\}$
 $\backslash\text{yr}$ $\backslash\text{newcommand}\{\backslash\text{yyear}\}\{\backslash\text{ensuremath}\{\text{mathrm}\{\text{year}\}\}\}$
 $\backslash\text{parsec}$ $\backslash\text{newcommand}\{\backslash\text{yr}\}\{\backslash\text{ensuremath}\{\text{mathrm}\{\text{yr}\}\}\}$
 $\backslash\text{newcommand}\{\backslash\text{parsec}\}\{\backslash\text{ensuremath}\{\text{mathrm}\{\text{pc}\}\}\}$

$\backslash\text{LSun}$ Sun's luminosity
 $\backslash\text{newphysicsconstant}\{\text{LSun}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{L}\}\{\text{Sun}\}\}\}\{\text{scin}[4]\{26\}\}$
 $\{\text{m}\backslash\text{squared}\backslash\text{usk}\backslash\text{kg}\backslash\text{usk}\backslash\text{s}\backslash\text{reciprocalcubed}\}\{\text{W}\}\{\text{J}\backslash\text{per}\backslash\text{s}\}$

$\backslash\text{TSun}$ Sun's effective temperature
 $\backslash\text{newphysicsconstant}\{\text{TSun}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{T}\}\{\text{Sun}\}\}\}\{5800\}\{\text{K}\}\{\text{K}\}\{\text{K}\}$

$\backslash\text{MagSun}$ Sun's absolute magnitude
 $\backslash\text{newphysicsconstant}\{\text{MagSun}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{M}\}\{\text{Sun}\}\}\}\{+4.83\}\{\}\{\}$

$\backslash\text{magSun}$ Sun's apparent magnitude
 $\backslash\text{newphysicsconstant}\{\text{magSun}\}\{\backslash\text{ensuremath}\{\text{ssub}\{\text{m}\}\{\text{Sun}\}\}\}\{-26.74\}\{\}\{\}$

$\backslash\text{Lstar}$ stellar and solar luminosity
 $\backslash\text{Lsolar}$ $\backslash\newcommand{\text{Lstar}}[1][\backslash(\text{star})]{\ensuremath{\text{L}_{\text{#1}}}}$
 $\backslash\newcommand{\text{Lsolar}}{\ensuremath{\text{Lstar}[\backslash(\odot)]}}$

 $\backslash\text{Tstar}$ stellar and solar temperature
 $\backslash\text{Tsolar}$ $\backslash\newcommand{\text{Tstar}}[1][\backslash(\text{star})]{\ensuremath{\text{T}_{\text{#1}}}}$
 $\backslash\newcommand{\text{Tsolar}}{\ensuremath{\text{Tstar}[\backslash(\odot)]}}$

 $\backslash\text{Rstar}$ stellar and solar radius
 $\backslash\text{Rsolar}$ $\backslash\newcommand{\text{Rstar}}[1][\backslash(\text{star})]{\ensuremath{\text{R}_{\text{#1}}}}$
 $\backslash\newcommand{\text{Rsolar}}{\ensuremath{\text{Rstar}[\backslash(\odot)]}}$

 $\backslash\text{Mstar}$ stellar and solar mass
 $\backslash\text{Msolar}$ $\backslash\newcommand{\text{Mstar}}[1][\backslash(\text{star})]{\ensuremath{\text{M}_{\text{#1}}}}$
 $\backslash\newcommand{\text{Msolar}}{\ensuremath{\text{Mstar}[\backslash(\odot)]}}$

 $\backslash\text{Fstar}$ stellar and solar fluxes
 $\backslash\text{fstar}$ $\backslash\newcommand{\text{Fstar}}[1][\backslash(\text{star})]{\ensuremath{\text{F}_{\text{#1}}}}$
 $\backslash\text{FSun}$ $\backslash\newcommand{\text{fstar}}[1][\backslash(\text{star})]{\ensuremath{\text{f}_{\text{#1}}}}$
 $\backslash\text{fSun}$ $\backslash\newcommand{\text{FSun}}{\ensuremath{\text{Fstar}[\text{Sun}]}}$
 $\backslash\text{Fsolar}$ $\backslash\newcommand{\text{fSun}}{\ensuremath{\text{fstar}[\text{Sun}]}}$
 $\backslash\text{fsolar}$ $\backslash\newcommand{\text{Fsolar}}{\ensuremath{\text{Fstar}[\backslash(\odot)]}}$
 $\backslash\newcommand{\text{fsolar}}{\ensuremath{\text{fstar}[\backslash(\odot)]}}$

 $\backslash\text{Magstar}$ stellar and solar magnitudes
 $\backslash\text{magstar}$ $\backslash\newcommand{\text{Magstar}}[1][\backslash(\text{star})]{\ensuremath{\text{M}_{\text{#1}}}}$
 $\backslash\text{Magsolar}$ $\backslash\newcommand{\text{magstar}}[1][\backslash(\text{star})]{\ensuremath{\text{m}_{\text{#1}}}}$
 $\backslash\text{magsolar}$ $\backslash\newcommand{\text{Magsolar}}{\ensuremath{\text{Magstar}[\backslash(\odot)]}}$
 $\backslash\newcommand{\text{magsolar}}{\ensuremath{\text{magstar}[\backslash(\odot)]}}$

 $\backslash\text{Dstar}$ stellar and solar distance
 $\backslash\text{dstar}$ $\backslash\newcommand{\text{Dstar}}[1][\backslash(\text{star})]{\ensuremath{\text{D}_{\text{#1}}}}$
 $\backslash\text{Dsolar}$ $\backslash\newcommand{\text{dstar}}[1][\backslash(\text{star})]{\ensuremath{\text{d}_{\text{#1}}}}$
 $\backslash\text{dsolar}$ $\backslash\newcommand{\text{Dsolar}}{\ensuremath{\text{Dstar}[\backslash(\odot)]}}$
 $\backslash\newcommand{\text{dsolar}}{\ensuremath{\text{dstar}[\backslash(\odot)]}}$

 $\backslash\text{onehalf}$ frequently used fractions
 $\backslash\text{onethird}$ $\backslash\newcommand{\text{onehalf}}{\ensuremath{\frac{1}{2}}\xspace}$
 $\backslash\text{onefourth}$ $\backslash\newcommand{\text{onethird}}{\ensuremath{\frac{1}{3}}\xspace}$
 $\backslash\text{onefifth}$ $\backslash\newcommand{\text{onefourth}}{\ensuremath{\frac{1}{4}}\xspace}$
 $\backslash\text{onesixth}$ $\backslash\newcommand{\text{onefifth}}{\ensuremath{\frac{1}{5}}\xspace}$
 $\backslash\text{oneseventh}$ $\backslash\newcommand{\text{onesixth}}{\ensuremath{\frac{1}{6}}\xspace}$
 $\backslash\text{oneeighth}$ $\backslash\newcommand{\text{oneseventh}}{\ensuremath{\frac{1}{7}}\xspace}$
 $\backslash\text{oneninth}$ $\backslash\newcommand{\text{oneeighth}}{\ensuremath{\frac{1}{8}}\xspace}$
 $\backslash\text{onetenth}$ $\backslash\newcommand{\text{oneninth}}{\ensuremath{\frac{1}{9}}\xspace}$
 $\backslash\text{twothirds}$ $\backslash\newcommand{\text{onetenth}}{\ensuremath{\frac{1}{10}}\xspace}$
 $\backslash\text{twofifths}$ $\backslash\newcommand{\text{twothirds}}{\ensuremath{\frac{2}{3}}\xspace}$
 $\backslash\text{twosevenths}$ $\backslash\newcommand{\text{twofifths}}{\ensuremath{\frac{2}{5}}\xspace}$
 $\backslash\text{two ninths}$ $\backslash\newcommand{\text{twosevenths}}{\ensuremath{\frac{2}{7}}\xspace}$
 $\backslash\text{threehalves}$
 $\backslash\text{threefourths}$
 $\backslash\text{threefifths}$
 $\backslash\text{threesevenths}$
 $\backslash\text{threeeighths}$
 $\backslash\text{threetenths}$
 $\backslash\text{fourthirds}$

```

\newcommand{\twoninths}{\ensuremath{\frac{2}{9}}\xspace}
\newcommand{\threehalves}{\ensuremath{\frac{3}{2}}\xspace}
\newcommand{\threefourths}{\ensuremath{\frac{3}{4}}\xspace}
\newcommand{\threefifths}{\ensuremath{\frac{3}{5}}\xspace}
\newcommand{\threesevenths}{\ensuremath{\frac{3}{7}}\xspace}
\newcommand{\threeeighths}{\ensuremath{\frac{3}{8}}\xspace}
\newcommand{\threetenths}{\ensuremath{\frac{3}{10}}\xspace}
\newcommand{\fourthirds}{\ensuremath{\frac{4}{3}}\xspace}

\dx variable of integration
\newcommand{\dx}[1]{\ensuremath{\,\mathrm{d}\,}{\scriptstyle #1}}

\evalfromto
\newcommand{\evalfromto}[3]{\ensuremath{\mathrm{Bigg}.{\scriptstyle #1}\mathrm{Bigg}\mathrm{rvert}_{\scriptstyle #2}^{\scriptstyle #3}}}

\evalat
\@ifpackageloaded{physymb}{%
  \typeout{mandi: Package physymb detected. Its commands will be used.}
}{%
  \newcommand{\evalat}[2]{\ensuremath{\mathrm{Bigg}.{\scriptstyle #1}\mathrm{Bigg}\mathrm{rvert}_{\scriptstyle #2}}}
}%

\evaluatedat
\newcommand{\evaluatedat}[1]{\ensuremath{\mathrm{Bigg}.\mathrm{Bigg}\mathrm{rvert}_{\scriptstyle #1}}}

\integral
\Integral
\newcommandx{\integral}[4][1,2,usedefault]{\ensuremath{
  \int_{\ifthenelse{\equal{\scriptstyle #1}{}}{\scriptstyle #4=\scriptstyle #1}}{\ifthenelse{\equal{\scriptstyle #2}{}}{\scriptstyle #4=\scriptstyle #2}}
  {\scriptstyle #3}\mathrm{d}\scriptstyle #4}}
\newcommandx{\Integral}[4][1,2,usedefault]{\ensuremath{
  \bigint_{\ifthenelse{\equal{\scriptstyle #1}{}}{\scriptstyle #4=\scriptstyle #1}}{\ifthenelse{\equal{\scriptstyle #2}{}}{\scriptstyle #4=\scriptstyle #2}}
  {\scriptstyle #3}\mathrm{d}\scriptstyle #4}}

\opensurfintegral
\opensurfIntegral
\newcommand{\opensurfintegral}[2]{\ensuremath{
  \int\limits_{\scriptstyle #1}\mathrm{vctdotvect}\{\mathrm{vect}\scriptstyle #2\}\{\mathrm{dirvect}\scriptstyle n\}\mathrm{d}\scriptstyle A}}
\newcommand{\opensurfIntegral}[2]{\ensuremath{
  \bigint\limits_{\mskip -25.00mu\displaystyle\mathbf{\scriptstyle #1}}
  \mathrm{vctdotvect}\{\mathrm{vect}\scriptstyle #2\}\{\mathrm{dirvect}\scriptstyle n\}
  \mathrm{d}\scriptstyle A}}

\closedsurfintegral
\closedsurfIntegral
\newcommand{\closedsurfintegral}[2]{\ensuremath{
  \oint\limits_{\scriptstyle #1}\mathrm{vctdotvect}\{\mathrm{vect}\scriptstyle #2\}\{\mathrm{dirvect}\scriptstyle n\}\mathrm{d}\scriptstyle A}}
\newcommand{\closedsurfIntegral}[2]{\ensuremath{
  \bigoint\limits_{\mskip -25.00mu\displaystyle\mathbf{\scriptstyle #1}}\backslash;
  \mathrm{vctdotvect}\{\mathrm{vect}\scriptstyle #2\}\{\mathrm{dirvect}\scriptstyle n\}\mathrm{d}\scriptstyle A}}

```



```

\openlineintegral
\openlineIntegral \newcommand{\openlineintegral}[2]{\ensuremath{
\int\limits_{\#1}\vecdotvect{\vect{\#2}}{\dirvect{t}}
dx{\ell}}}
\newcommand{\openlineIntegral}[2]{\ensuremath{
\bigint\limits_{\mskip -25.00mu\displaystyle\mathbf{\#1}}
\vecdotvect{\vect{\#2}}{\dirvect{t}}dx{\ell}}}

\closedlineintegral
\closedlineIntegral \newcommand{\closedlineintegral}[2]{\ensuremath{
\oint\limits_{\#1}\vecdotvect{\vect{\#2}}{\dirvect{t}}dx{\ell}}}
\newcommand{\closedlineIntegral}[2]{\ensuremath{
\bigoint\limits_{\mskip -25.00mu\displaystyle\mathbf{\#1}}\;;\;
\vecdotvect{\vect{\#2}}{\dirvect{t}}dx{\ell}}}

\dbdyt
\DbyDt \newcommandx{\dbdyt}[1][1]{\ensuremath{\frac{\mathrm{d}\{\#1\}}{\mathrm{d}t}}}
\newcommandx{\DbyDt}[1][1]{\ensuremath{\frac{\Delta\{\#1\}}{\Delta t}}}

\ddbdt
\DDbyDt \newcommandx{\ddbdt}[1][1]{\ensuremath{\frac{\mathrm{d}^2\{\#1\}}{\mathrm{d}t^2}}}
\newcommandx{\DDbyDt}[1][1]{\ensuremath{\frac{\Delta^2\{\#1\}}{\Delta t^2}}}

\pbpyt
\newcommandx{\pbpyt}[1][1]{\ensuremath{\frac{\partial\{\#1\}}{\partial t}}}

\ppbpyt
\newcommandx{\ppbpyt}[1][1]{\ensuremath{\frac{\partial^2\{\#1\}}{\partial t^2}}}

\dbyd
\DbyD \newcommand{\dbyd}[2]{\ensuremath{\frac{\mathrm{d}\{\#1\}}{\mathrm{d}\{\#2\}}}}
\newcommand{\DbyD}[2]{\ensuremath{\frac{\Delta\{\#1\}}{\Delta\{\#2\}}}}

\ddbzd
\DDbyD \newcommand{\ddbzd}[2]{\ensuremath{\frac{\mathrm{d}^2\{\#1\}}{\mathrm{d}\{\#2\}^2}}}
\newcommand{\DDbyD}[2]{\ensuremath{\frac{\Delta^2\{\#1\}}{\Delta\{\#2\}^2}}}

\pbyp
\newcommand{\pbyp}[2]{\ensuremath{\frac{\partial\{\#1\}}{\partial\{\#2\}}}}

\ppbyp
\newcommand{\ppbyp}[2]{\ensuremath{\frac{\partial^2\{\#1\}}{\partial\{\#2\}^2}}}

\seriesfofx
\seriesexp \newcommand{\seriesfofx}{\ensuremath{
f(x) \approx f(a) + \frac{f^{\prime}(a)}{1!}(x-a) + \frac{f^{\prime\prime}(a)}{2!}(x-a)^2
+ \frac{f^{\prime\prime\prime}(a)}{3!}(x-a)^3 + \ldots}\xspace}
\seriescosx
\seriesstanx \newcommand{\seriesexp}{\ensuremath{
e^x \approx 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots}\xspace}
\serieslnoneplusx
\binomialseries

```

```

\newcommand{\seriesinx}{\ensuremath{%
\sin x \approx x - \frac{x^3}{3!} + \frac{x^5}{5!} - \ldots}\xspace}
\newcommand{\seriescosx}{\ensuremath{%
\cos x \approx 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \ldots}\xspace}
\newcommand{\seriesstanx}{\ensuremath{%
\tan x \approx x + \frac{x^3}{3} + \frac{2x^5}{15} + \ldots}\xspace}
\newcommand{\seriesatox}{\ensuremath{%
a^x \approx 1 + x \ln a + \frac{(x \ln a)^2}{2!} + \frac{(x \ln a)^3}{3!} + \ldots}
\xspace}
\newcommand{\serieslnoneplusx}{\ensuremath{%
\ln(1 \pm x) \approx \pm x - \frac{x^2}{2} \pm \frac{x^3}{3} - \frac{x^4}{4} \pm \ldots}
\xspace}
\newcommand{\binomialseries}{\ensuremath{%
(1 + x)^n \approx 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots}\xspace}

\gradient user must specify \vect{} around the argument to get arrows
\divergence \@ifpackageloaded{physymb}{%
\curl \typeout{mandi: Package physymb detected. Its commands will be used.}
\laplacian }{%
\dalembertian \newcommand{\gradient}{\ensuremath{\nabla}}
\newcommand{\divergence}{\ensuremath{\nabla\bullet}}
\newcommand{\curl}{\ensuremath{\nabla\times}}
\newcommand{\laplacian}{\ensuremath{\msup{\nabla}{2}}}
\newcommand{\dalembertian}{\ensuremath{\Box}}
}%

\diracdelta \newcommand{\diracdelta}[1]{\ensuremath{\boldsymbol{\delta}\quant{#1}}}

\asin
\acos \@ifpackageloaded{physymb}{%
\atan \typeout{mandi: Package physymb detected. Its commands will be used.}
\asec }{%
\acsc \DeclareMathOperator{\asin}{\sin^{-1}}
\acot \DeclareMathOperator{\acos}{\cos^{-1}}
\sech \DeclareMathOperator{\atan}{\tan^{-1}}
\csch \DeclareMathOperator{\asec}{\sec^{-1}}
\asinh \DeclareMathOperator{\acsc}{\csc^{-1}}
\acosh \DeclareMathOperator{\acot}{\cot^{-1}}
\atanh \DeclareMathOperator{\sech}{sech}
\asech \DeclareMathOperator{\csch}{csch}
\acsch \DeclareMathOperator{\asinh}{\sinh^{-1}}
\acoth \DeclareMathOperator{\acosh}{\cosh^{-1}}
\sgn \DeclareMathOperator{\atanh}{\tanh^{-1}}
\DeclareMathOperator{\asech}{\sech^{-1}}
\DeclareMathOperator{\acsch}{\csch^{-1}}
\DeclareMathOperator{\acoth}{\coth^{-1}}
\DeclareMathOperator{\sgn}{sgn}
}%

```

```

\ded
\DeclareMathOperator{\dex}{dex}

\ev
\ev \newcommand{\ev}{\electronvolt}
\ev \newcommand{\ev}{\electronvolt}

\logb
\newcommand{\logb}[1][\relax]{\ensuremath{\log_{\_{{#1}}}}}

\cB
\ifthenelse{\boolean{@optitalicvectors}}
{\newcommand{\cB}{\ensuremath{c\mskip -5.00mu B}}}
{\newcommand{\cB}{\ensuremath{\textsf{c}\mskip -3.00mu\mathrm{B}}}}

\newpi
\newcommand{\newpi}{\ensuremath{\pi\mskip -7.8mu\pi}}

\scripty
\newcommand{\scripty}[1]{\ensuremath{\mathcalligra{#1}}}

\flux
\newcommand{\flux}[1][1]{\ensuremath{\ssub{\Phi}{#1}}}

\abs
\@ifpackageloaded{physymb}{%
\typeout{mandi: Package physymb detected. Its commands will be used.}
}%
\newcommand{\abs}[1]{\ensuremath{\left\lvert{#1}\right\rvert}}
}%

\magof
\newcommand{\magof}[1]{\ensuremath{\left\lVert{#1}\right\rVert}}

\dimsof
\newcommand{\dimsof}[1]{\ensuremath{\left[ {#1} \right]}}

\unitsof
\newcommand{\unitsof}[1]{\ensuremath{\left[ {#1} \right]_{\text{u}}}}

\quant
\bquant \newcommand{\quant}[1]{\ensuremath{\left( {#1} \right)}}
\newcommand{\bquant}[1]{\ensuremath{\left[ {#1} \right]}}

\changein
\Changein \newcommand{\changein}[1]{\ensuremath{\delta{#1}}}
\newcommand{\Changein}[1]{\ensuremath{\Delta{#1}}}

```

```

\scin
\ee \newcommandx{\scin}[3][1,3=\!\!,usedefault]{\ensuremath{
\EE \ifthenelse{\equal{#1}{}}
    {\unit{\msup{10}{#2}}{#3}}
    {\unit{\msup{{#1}\times 10}{#2}}{#3}}}
\newcommand{\ee}[2]{\texttt{{#1}e{#2}}}
\newcommand{\EE}[2]{\texttt{{#1}E{#2}}}

\dms
\hms \newcommand{\dms}[3]{\ensuremath{\indegrees{#1}\inarcminutes{#2}\inarcseconds{#3}}}
\clockreading \newcommand{\hms}[3]{\ensuremath{{#1}^{\mathrm{hour}}{#2}^{\mathrm{m}}{#3}^{\mathrm{s}}}}
\newcommand{\clockreading}{\hms}

\latitude
\latitudeN \newcommand{\latitude}[1]{\ensuremath{\unit{#1}{\degree}}}
\latitudeS \newcommand{\latitudeN}[1]{\ensuremath{\unit{#1}{\degree}; N}}
\longitude \newcommand{\latitudeS}[1]{\ensuremath{\unit{#1}{\degree}; S}}
\longitudeE \newcommand{\longitude}[1]{\ensuremath{\unit{#1}{\degree}}}
\longitudeW \newcommand{\longitudeE}[1]{\ensuremath{\unit{#1}{\degree}; E}}
\newcommand{\longitudeW}[1]{\ensuremath{\unit{#1}{\degree}; W}}

\ssub I have never liked LATEX's default subscript positioning, so I have this command instead. There may be a
better way of doing this.
\newcommand{\ssub}[2]{\ensuremath{{#1}_{_{\mbox{\tiny{#2}}}}}}}

\ssup I have never liked LATEX's default superscript positioning, so I have this command instead. There may be
a better way of doing this.
\newcommand{\ssup}[2]{\ensuremath{{#1}^{\tiny{#2}}}}}

\ssud
\newcommand{\ssud}[3]{\ensuremath{{#1}^{\tiny{#2}}}_{_{\mbox{\tiny{#3}}}}}}}

\msub I have never liked LATEX's default subscript positioning, so I have this command instead. There may be a
better way of doing this.
\newcommand{\msub}[2]{\ensuremath{{#1}^{\scriptstyle{}}}_{_{\scriptstyle{#2}}}}}

\msup I have never liked LATEX's default superscript positioning, so I have this command instead. There may be
a better way of doing this.
\newcommand{\msup}[2]{\ensuremath{{#1}^{\scriptstyle{#2}}}}}

\msud
\newcommand{\msud}[3]{\ensuremath{{#1}^{\scriptstyle{}}}_{_{\scriptstyle{#3}}}}}}}

\levicivita
\newcommand{\levicivita}[1]{\ensuremath{\msub{\varepsilon}{#1}}}

```

`\xaxis` Coordinate axes.
`\yaxis` `\newcommand{\xaxis}{\ensuremath{x\mbox{-axis}}}`
`\zaxis` `\newcommand{\yaxis}{\ensuremath{y\mbox{-axis}}}`
`\naxis` `\newcommand{\zaxis}{\ensuremath{z\mbox{-axis}}}`
`\newcommand{\naxis}[1]{\ensuremath{\{#1\}\mbox{-axis}}}`

`\xyplane` All permutations of planes formed by cartesian axes.
`\yzplane` `\newcommand{\xyplane}{\ensuremath{xy\mbox{-plane}}}`
`\zxplane` `\newcommand{\yzplane}{\ensuremath{yz\mbox{-plane}}}`
`\yxplane` `\newcommand{\zxplane}{\ensuremath{zx\mbox{-plane}}}`
`\zyplane` `\newcommand{\yxplane}{\ensuremath{yx\mbox{-plane}}}`
`\xzplane` `\newcommand{\zyplane}{\ensuremath{zy\mbox{-plane}}}`
`\newcommand{\xzplane}{\ensuremath{xz\mbox{-plane}}}`

`\cuberoot` Frequently used roots. Prepend `f` for fractional exponents.
`\fourthroot` `\newcommand{\cuberoot}[1]{\ensuremath{\sqrt[3]{#1}}}`
`\fifthroot` `\newcommand{\fourthroot}[1]{\ensuremath{\sqrt[4]{#1}}}`
`\fsqrt` `\newcommand{\fifthroot}[1]{\ensuremath{\sqrt[5]{#1}}}`
`\fcuberoot` `\newcommand{\fsqrt}[1]{\ensuremath{\msup{#1}{\onehalf}}}`
`\ffourthroot` `\newcommand{\fcuberoot}[1]{\ensuremath{\msup{#1}{\onethird}}}`
`\ffifthroot` `\newcommand{\ffourthroot}[1]{\ensuremath{\msup{#1}{\onefourth}}}`
`\newcommand{\ffifthroot}[1]{\ensuremath{\msup{#1}{\onefifth}}}`

`\relgamma`
`\frelgamma` `\newcommand{\relgamma}[1]{\ensuremath{\frac{1}{\sqrt{1-\msup{\quant{\frac{#1}{c}}{2}}}}}}`
`\newcommand{\frelgamma}[1]{\ensuremath{\msup{\quant{1-\frac{\msup{#1}{2}}{\msup{c}{2}}}}{-\onehalf}}}`

`\oosqrtomxs`
`\newcommand{\oosqrtomxs}[1]{\ensuremath{\frac{1}{\sqrt{1-\msup{#1}{2}}}}}`

`\oosqrtomx`
`\newcommand{\oosqrtomx}[1]{\ensuremath{\frac{1}{\sqrt{1-#1}}}}`

`\oomx`
`\newcommand{\oomx}[1]{\ensuremath{\frac{1}{1-#1}}}`

`\oopx`
`\newcommand{\oopx}[1]{\ensuremath{\frac{1}{1+#1}}}`

`\isequals`
`\newcommand{\isequals}{\wordoperator{?}{=}\xspace}`

`\wordoperator`
`\newcommand{\wordoperator}[2]{\ensuremath{\%`
`\mathrel{\vcenter{\offinterlineskip`
`\halign{\hfil\tiny\upshape##\hfil\cr\noalign{\vskip-.5ex}`
`{#1}\cr\noalign{\vskip.5ex}{#2}\cr}}}`

```

\definedas
\associated      \newcommand{\definedas}{\wordoperator{defined}{as}\xspace}
\adjustedby     \newcommand{\associated}{\wordoperator{associated}{with}\xspace}
\earlierthan    \newcommand{\adjustedby}{\wordoperator{adjusted}{by}\xspace}
\laterthan      \newcommand{\earlierthan}{\wordoperator{earlier}{than}\xspace}
\forevery       \newcommand{\laterthan}{\wordoperator{later}{than}\xspace}
                \newcommand{\forevery}{\wordoperator{for}{every}\xspace}

\pwordoperator

\newcommand{\pwordoperator}[2]{\ensuremath{\left(
\mathrel{\vcenter{\offinterlineskip
\halign{\hfil\tiny\upshape##\hfil\cr\noalign{\vskip-.5ex}
{#1}\cr\noalign{\vskip.5ex}{#2}\cr}}\right)}}%

\pdefinedas
\passociated    \newcommand{\pdefinedas}{\pwordoperator{defined}{as}\xspace}
\padjustedby    \newcommand{\passociated}{\pwordoperator{associated}{with}\xspace}
\pearlierthan   \newcommand{\padjustedby}{\pwordoperator{adjusted}{by}\xspace}
\platerthan     \newcommand{\pearlierthan}{\pwordoperator{earlier}{than}\xspace}
\pforevery      \newcommand{\platerthan}{\pwordoperator{later}{than}\xspace}
                \newcommand{\pforevery}{\pwordoperator{for}{every}\xspace}

\defines
\newcommand{\defines}{\ensuremath{\stackrel{\text{\tiny{def}}}{=}}\xspace}

\inframe
\newcommand{\inframe}[1][\relax]{\ensuremath{\xrightarrow{\text{\tiny{\mathcal{#1}}}}}\xspace}

\associates
\newcommand{\associates}{\ensuremath{\xrightarrow{\text{\tiny{assoc}}}}\xspace}

\becomes
\newcommand{\becomes}{\ensuremath{\xrightarrow{\text{\tiny{becomes}}}}\xspace}

\lrelatedto
\rrelatedto
\brelatedto
\newcommand{\rrelatedto}[1]{\ensuremath{\xrightarrow{\text{\tiny{#1}}}}}
\newcommand{\lrelatedto}[1]{\ensuremath{\xleftarrow{\text{\tiny{#1}}}}}
\newcommand{\brelatedto}[2]{\ensuremath{\xleftrightarrow{\text{\tiny{#1}}}\text{\tiny{#2}}}}

\momprinciple
\LHSmomprinciple
\RHSmomprinciple
\newcommand{\momprinciple}{\ensuremath{\vecsub{p}{sys,f}=\vecsub{p}{sys,i}+\Fnetsys\Delta t}}
\newcommand{\LHSmomprinciple}{\ensuremath{\vecsub{p}{sys,f}}}
\newcommand{\RHSmomprinciple}{\ensuremath{\vecsub{p}{sys,i}+\Fnetsys\Delta t}}

```

```

\energyprinciple
\LHSenergyprinciple \newcommand{\energyprinciple}{\ensuremath{\ssub{E}{sys,f}=\ssub{E}{sys,i}+
\RHSenergyprinciple \ssub{W}{ext}+Q}}
\newcommand{\LHSenergyprinciple}{\ensuremath{\ssub{E}{sys,f}}}
\newcommand{\RHSenergyprinciple}{\ensuremath{\ssub{E}{sys,i}+\ssub{W}{ext}+Q}}

\angularmomprinciple
\LHSangularmomprinciple \newcommand{\angularmomprinciple}{\ensuremath{\vectsub{L}{sys,A,f}=\vectsub{L}{sys,A,i}+
\RHSangularmomprinciple \Tnetsys\Delta t}}
\newcommand{\LHSangularmomprinciple}{\ensuremath{\vectsub{L}{sys,A,f}}}
\newcommand{\RHSangularmomprinciple}{\ensuremath{\vectsub{L}{sys,A,i}+\Tnetsys\Delta t}}

\gravinteraction
\newcommand{\gravinteraction}{\ensuremath{
\bigGmathsymbol{\frac{\msub{M}{1}\msub{M}{2}}{\msup{\magvectsub{r}{12}}{2}}
\quant{-\dirvectsub{r}{12}}}}

\elecinteraction
\newcommand{\elecinteraction}{\ensuremath{
\oofpezmathsymbol{\frac{\msub{Q}{1}\msub{Q}{2}}{\msup{\magvectsub{r}{12}}{2}}
\dirvectsub{r}{12}}}

\Bfieldofparticle
\newcommand{\Bfieldofparticle}{\ensuremath{
\mzofpmathsymbol{\frac{Q\magvect{v}}{\msup{\magvect{r}}{2}}\dirvect{v}\times\dirvect{r}}}

\Efieldofparticle
\newcommand{\Efieldofparticle}{\ensuremath{
\oofpezmathsymbol{\frac{Q}{\msup{\magvect{r}}{2}}\dirvect{r}}}

\Esys
\newcommand{\Esys}{\ssub{E}{sys}}

\Us
\newcommandx{\Us}[1][1]{\ssub{\ssub{U}{s}}{\#1}}

\Ug
\newcommandx{\Ug}[1][1]{\ssub{\ssub{U}{g}}{\#1}}

\Ue
\newcommandx{\Ue}[1][1]{\ssub{\ssub{U}{e}}{\#1}}

\Ktrans
\newcommandx{\Ktrans}[1][1]{\ssub{\ssub{K}{trans}}{\#1}}

\Krot
\newcommandx{\Krot}[1][1]{\ssub{\ssub{K}{rot}}{\#1}}

```

```

\Eparticle
\newcommandx{\Eparticle}[1][1]{\ssub{\ssub{E}{particle}}{#1}}

\Einternal
\newcommandx{\Einternal}[1][1]{\ssub{\ssub{E}{internal}}{#1}}

\Erest
\newcommandx{\Erest}[1][1]{\ssub{\ssub{E}{rest}}{#1}}

\Echem
\newcommandx{\Echem}[1][1]{\ssub{\ssub{E}{chem}}{#1}}

\Etherm
\newcommandx{\Etherm}[1][1]{\ssub{\ssub{E}{therm}}{#1}}

\Evib
\newcommandx{\Evib}[1][1]{\ssub{\ssub{E}{vib}}{#1}}

\Ephoton
\newcommandx{\Ephoton}[1][1]{\ssub{\ssub{E}{photon}}{#1}}

\DEsys
\newcommand{\DEsys}{\Changein\Esys}

\DUus
\newcommand{\DUus}{\Changein\Us}

\DUg
\newcommand{\DUg}{\Changein\Ug}

\DUe
\newcommand{\DUe}{\Changein\Ue}

\DKtrans
\newcommand{\DKtrans}{\Changein\Ktrans}

\DKrot
\newcommand{\DKrot}{\Changein\Krot}

\DEparticle
\newcommand{\DEparticle}{\Changein\Eparticle}

\DEinternal
\newcommand{\DEinternal}{\Changein\Einternal}

\DERest
\newcommand{\DERest}{\Changein\Erest}

```



```

\DEchem
\newcommand{\DEchem}{\Changein\Echem}

\DEtherm
\newcommand{\DEtherm}{\Changein\Etherm}

\DEvib
\newcommand{\DEvib}{\Changein\Evib}

\DEphoton
\newcommand{\DEphoton}{\Changein\Ephoton}

\Usfinal
\newcommand{\Usfinal}{\ssub{\left(\onehalf\ks \msup{s}{2}\right)}{f}}

\Usinitial
\newcommand{\Usinitial}{\ssub{\left(\onehalf\ks \msup{s}{2}\right)}{i}}

\Ugfinal
\newcommand{\Ugfinal}{\ssub{\left(-G\frac{\msub{M}{1}\msub{M}{2}}{\magvectsub{r}{12}}\right)}{f}}

\Uginitial
\newcommand{\Uginitial}{\ssub{\left(-G\frac{\msub{M}{1}\msub{M}{2}}{\magvectsub{r}{12}}\right)}{i}}

\Uefinal
\newcommand{\Uefinal}{\ssub{\left(\oofpezmathsymbol\frac{\ssub{Q}{1}\ssub{Q}{2}}{\magvectsub{r}{12}}\right)}{f}}

\Ueinitial
\newcommand{\Ueinitial}{\ssub{\left(\oofpezmathsymbol\frac{\ssub{Q}{1}\ssub{Q}{2}}{\magvectsub{r}{12}}\right)}{i}}

\ks
\newcommand{\ks}{\ssub{k}{s}}

\Fnet
\Fnetext \newcommand{\Fnet}{\ensuremath{\vectsub{F}{net}}}
\Fnetsys \newcommand{\Fnetext}{\ensuremath{\vectsub{F}{net,ext}}}
\Fsub \newcommand{\Fnetsys}{\ensuremath{\vectsub{F}{net,sys}}}
\newcommand{\Fsub}[1]{\ensuremath{\vectsub{F}{#1}}}

\Tnet
\Tnetext \newcommand{\Tnet}{\ensuremath{\vectsub{T}{net}}}
\Tnetsys \newcommand{\Tnetext}{\ensuremath{\vectsub{T}{net,ext}}}
\Tsub \newcommand{\Tnetsys}{\ensuremath{\vectsub{T}{net,sys}}}
\newcommand{\Tsub}[1]{\ensuremath{\vectsub{T}{#1}}}

```

```

\vpypythonline
\newcommand{\vpypythonline}{\lstinline[language=Python,numbers=left,numberstyle=\tiny,
upquote=true,breaklines]}

vpypythonblock
\lstnewenvironment{vpypythonblock}{\lstvpypython}{}

\vpypythonfile
\newcommand{\vpypythonfile}{\lstinputlisting[language=Python,numbers=left,
numberstyle=\tiny,upquote=true,breaklines]}

\emptyanswer
\newcommandx{\emptyanswer}[2][1=0.80,2=0.1,usedefault]
{\begin{minipage}{#1\textwidth}\hfill\vspace{#2\textheight}\end{minipage}}

activityanswer
\newenvironmentx{activityanswer}[5][1=white,2=black,3=black,4=0.90,5=0.10,usedefault]{%
\def\skipper{#5}%
\def\response@fbox{\fcolorbox{#2}{#1}}%
\begin{center}%
\begin{lrbox}{\@tempboxa}%
\begin{minipage}[c]{#5\textheight}[c]{#4\textwidth}\color{#3}%
\vspace{#5\textheight}}{%
\vspace{\skipper\textheight}%
\end{minipage}%
\end{lrbox}%
\response@fbox{\usebox{\@tempboxa}}}%
\end{center}%
}%

adjactivityanswer
\newenvironmentx{adjactivityanswer}[5][1=white,2=black,3=black,4=0.90,5=0.00,
usedefault]{%
\def\skipper{#5}%
\def\response@fbox{\fcolorbox{#2}{#1}}%
\begin{center}%
\begin{lrbox}{\@tempboxa}%
\begin{minipage}[c]{#4\textwidth}\color{#3}%
\vspace{#5\textheight}}{%
\vspace{\skipper\textheight}%
\end{minipage}%
\end{lrbox}%
\response@fbox{\usebox{\@tempboxa}}}%
\end{center}%
}%

\emptybox
\newcommandx{\emptybox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.10,usedefault]
{\begin{center}

```

```

\colorbox{#3}{#2}{%
\begin{minipage}[c][#6\textheight][c]{#5\textwidth}\color{#4}%
{#1}%
\end{minipage}}%
\vspace{\baselineskip}%
\end{center}%
}%

```

`\adjemptybox`

```

\newcommand{\adjemptybox}[7][1=\hfill,2=white,3=black,4=black,5=0.90,6=,7=0.0,usedefault]
{\begin{center}
\colorbox{#3}{#2}{%
\begin{minipage}[c]{#5\textwidth}\color{#4}%
\vspace{#7\textheight}%
{#1}%
\vspace{#7\textheight}%
\end{minipage}}%
\vspace{\baselineskip}%
\end{center}%
}%

```

`\answerbox`

```

\newcommand{\answerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.1,usedefault]
{\ifthenelse{\equal{#1}{}}
{\begin{center}%
\colorbox{#3}{#2}{%
\emptyanswer[#5][#6]}%
\vspace{\baselineskip}%
\end{center}}%
{\emptybox[#1][#2][#3][#4][#5][#6]}%
}%

```

`\adjanswerbox`

```

\newcommand{\adjanswerbox}[7][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.1,7=0.0,
usedefault]
{\ifthenelse{\equal{#1}{}}%
{\begin{center}%
\colorbox{#3}{#2}{%
\emptyanswer[#5][#6]}%
\vspace{\baselineskip}%
\end{center}}%
{\adjemptybox[#1][#2][#3][#4][#5][#6][#7]}%
}%

```

`\smallanswerbox` box that takes up ten percent of text height

```

\newcommand{\smallanswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.10,
usedefault]
{\ifthenelse{\equal{#1}{}}
{\begin{center}%
\colorbox{#3}{#2}{%

```

```

        \emptyanswer[#5][#6]]%
        \vspace{\baselineskip}%
        \end{center}}%
    {\emptybox[#1][#2][#3][#4][#5][#6]]%
}%

\mediumanswerbox box that takes up twenty percent of text height
\newcommand{\mediumanswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.20,
usedefault]{%
\ifthenelse{\equal{#1}{}}{
{\begin{center}%
\fcolorbox{#3}{#2}{%
\emptyanswer[#5][#6]%
}%
\vspace{\baselineskip}%
\end{center}%
}%
{\emptybox[#1][#2][#3][#4][#5][#6]
}%
}%

\largeanswerbox box that takes up twenty-five percent of text height
\newcommand{\largeanswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.25,
usedefault]{%
\ifthenelse{\equal{#1}{}}{
{\begin{center}%
\fcolorbox{#3}{#2}{%
\emptyanswer[#5][#6]%
}%
\vspace{\baselineskip}%
\end{center}%
}%
{\emptybox[#1][#2][#3][#4][#5][#6]
}%
}%

\largeranswerbox box that takes up thirty-three percent of text height
\newcommand{\largeranswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.33,
usedefault]{%
\ifthenelse{\equal{#1}{}}{
{\begin{center}%
\fcolorbox{#3}{#2}{%
\emptyanswer[#5][#6]%
}%
\vspace{\baselineskip}%
\end{center}%
}%
{\emptybox[#1][#2][#3][#4][#5][#6]
}%
}%

```

```

\hugeanswerbox box that takes up fifty percent of text height
\newcommandx{\hugeanswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.50,
  usedefault]{%
  \ifthenelse{\equal{#1}{}}{
    {\begin{center}%
      \fcolorbox{#3}{#2}{%
        \emptyanswer[#5][#6]%
      }%
      \vspace{\baselineskip}%
    \end{center}%
  }%
  {\emptybox[#1][#2][#3][#4][#5][#6]
  }%
}%

\hugeranswerbox box that takes up seventy-five percent of text height
\newcommandx{\hugeranswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=0.75,
  usedefault]{%
  \ifthenelse{\equal{#1}{}}{
    {\begin{center}%
      \fcolorbox{#3}{#2}{%
        \emptyanswer[#5][#6]%
      }%
      \vspace{\baselineskip}%
    \end{center}%
  }%
  {\emptybox[#1][#2][#3][#4][#5][#6]
  }%
}%

\fullpageanswerbox box that takes up one hundred percent of text height
\newcommandx{\fullpageanswerbox}[6][1=\hfill,2=white,3=black,4=black,5=0.90,6=1.00,
  usedefault]{%
  \ifthenelse{\equal{#1}{}}{
    {\begin{center}%
      \fcolorbox{#3}{#2}{%
        \emptyanswer[#5][#6]}%
      \vspace{\baselineskip}%
    \end{center}}%
  {\emptybox[#1][#2][#3][#4][#5][#6]}%
}%

miinstructornote
\mdfdefinestyle{miinstructornotestyle}{%
  hidealllines=false, skipbelow=\baselineskip, skipabove=\baselineskip,
  leftmargin=40pt, rightmargin=40pt, linewidth=1, roundcorner=10,
  frametitle={INSTRUCTOR NOTE},
  frametitlebackgroundcolor=cyan!60, frametitlerule=true, frametitlerulewidth=1,
  backgroundcolor=cyan!25,
  linecolor=black, fontcolor=black, shadow=true}

```

```

\NewEnviron{miinstructornote}{%
  \begin{mdframed}[style=miinstructornotestyle]
    \begin{adjactivityanswer}[cyan!25][cyan!25][black]
      \BODY
    \end{adjactivityanswer}
  \end{mdframed}
}%

```

mistudentnote

```

\mdfdefinestyle{mistudentnotestyle}{%
  hidealllines=false, skipbelow=\baselineskip, skipabove=\baselineskip,
  leftmargin=40pt, rightmargin=40pt, linewidth=1, roundcorner=10,
  frametitle={STUDENT NOTE},
  frametitlebackgroundcolor=cyan!60, frametitlerule=true, frametitlerulewidth=1,
  backgroundcolor=cyan!25,
  linecolor=black, fontcolor=black, shadow=true}
\NewEnviron{mistudentnote}{%
  \begin{mdframed}[style=mistudentnotestyle]
    \begin{adjactivityanswer}[cyan!25][cyan!25][black]
      \BODY
    \end{adjactivityanswer}
  \end{mdframed}
}%

```

miderivation This definition requires the mdframed package.

```

\mdfdefinestyle{miderivationstyle}{%
  hidealllines=false, skipbelow=\baselineskip, skipabove=\baselineskip,
  leftmargin=0pt, rightmargin=0pt, linewidth=1, roundcorner=10,
  frametitle={DERIVATION},
  frametitlebackgroundcolor=orange!60, frametitlerule=true, frametitlerulewidth=1,
  backgroundcolor=orange!25,
  linecolor=black, fontcolor=black, shadow=true}
\NewEnviron{miderivation}{%
  \begin{mdframed}[style=miderivationstyle]
    \setcounter{equation}{0}
    \begin{align}
      \BODY
    \end{align}
  \end{mdframed}
}%

```

bwinstructornote

```

\mdfdefinestyle{bwinstructornotestyle}{%
  hidealllines=false, skipbelow=\baselineskip, skipabove=\baselineskip,
  leftmargin=40pt, rightmargin=40pt, linewidth=1, roundcorner=10,
  frametitle={INSTRUCTOR NOTE},
  frametitlebackgroundcolor=gray!50, frametitlerule=true, frametitlerulewidth=1,
  backgroundcolor=gray!20,
  linecolor=black, fontcolor=black, shadow=true}
\NewEnviron{bwinstructornote}{%

```

```

\begin{mdframed}[style=bwinstructornotestyle]
\begin{adjactivityanswer}[gray!20][gray!20][black]
\BODY
\end{adjactivityanswer}
\end{mdframed}
}%

```

bwstudentnote

```

\mdfdefinestyle{bwstudentnotestyle}{%
hidealllines=false, skipbelow=\baselineskip, skipabove=\baselineskip,
leftmargin=40pt, rightmargin=40pt, linewidth=1, roundcorner=10,
frametitle={STUDENT NOTE},
frametitlebackgroundcolor=gray!50, frametitlerule=true, frametitlerulewidth=1,
backgroundcolor=gray!20,
linecolor=black, fontcolor=black, shadow=true}
\NewEnviron{bwstudentnote}{%
\begin{mdframed}[style=bwstudentnotestyle]
\begin{adjactivityanswer}[gray!20][gray!20][black]
\BODY
\end{adjactivityanswer}
\end{mdframed}
}%

```

bwderivation This definition requires the mdframed package.

```

\mdfdefinestyle{bwderivationstyle}{%
hidealllines=false, skipbelow=\baselineskip, skipabove=\baselineskip,
leftmargin=0pt, rightmargin=0pt, linewidth=1, roundcorner=10,
frametitle={DERIVATION},
frametitlebackgroundcolor=gray!50, frametitlerule=true, frametitlerulewidth=1,
backgroundcolor=gray!20,
linecolor=black, fontcolor=black, shadow=true}
\NewEnviron{bwderivation}{%
\begin{mdframed}[style=bwderivationstyle]
\setcounter{equation}{0}
\begin{align}
\BODY
\end{align}
\end{mdframed}
}%

```

\checkpoint

```

\newcommand{\checkpoint}{%
\vspace{1cm}\begin{center}|----- CHECKPOINT -----|\end{center}}%

```

\image

```

\newcommand{\image}[2]{%
\begin{figure}[h!]
\begin{center}%
\includegraphics[scale=1]{#1}%
\caption{#2}%
\end{center}
\end{figure}

```

```

        \label{#1}%
    \end{center}%
\end{figure}}

\sneakyone
    \newcommand{\sneakyone}[1]{\ensuremath{\cancelto{1}{\frac{#1}{#1}}}}

\chkphysicsquantity undocumented diagnostic command
    \newcommand{\chkphysicsquantity}[1]{%
        \cs{#1}
    }%

\vecto new \vect that allows for subscripts
    \newcommandx{\vect}[2][2,usedefault]{\ensuremath{%
        \ifthenelse{\equal{#2}{}}{%
            {\vec{\mathrm{#1}}}%
            {\ssub{\vec{\mathrm{#1}}}{#2}}}%
    }}%

\compvecto new \compvect that allows for subscripts
    \newcommandx{\compvecto}[3][2,usedefault]{\ensuremath{%
        \ifthenelse{\equal{#2}{}}{%
            {\ssub{\mathrm{#1}}{\scriptstyle{#3}}}%
            {\ssub{\mathrm{#1}}{#2,\scriptstyle{#3}}}}%
    }}%

\scompsvecto new \scompsvect that allows for subscripts
    \newcommandx{\scompsvecto}[2][2,usedefault]{\ensuremath{%
        \ifthenelse{\equal{#2}{}}{%
            {\lv\compvecto{#1}{x},\compvecto{#1}{y},\compvecto{#1}{z}\rv}%
            {\lv\compvecto{#1}[#2]{x},\compvecto{#1}[#2]{y},\compvecto{#1}[#2]{z}\rv}}%
    }}%

\compposo new \comppos that allows for subscripts
    \newcommandx{\compposo}[2][1,usedefault]{\ensuremath{%
        \ifthenelse{\equal{#1}{}}{%
            {#2}%
            {\ssub{#2}{#1}}}%
    }}%

\scompsposo new \scompspos that allows for subscripts
    \newcommandx{\scompsposo}[1][1,usedefault]{\ensuremath{%
        \ifthenelse{\equal{#1}{}}{%
            {\lv\compposo{x},\compposo{y},\compposo{z}\rv}%
            {\lv\compposo[#1]{x},\compposo[#1]{y},\compposo[#1]{z}\rv}}%
    }}%

```


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