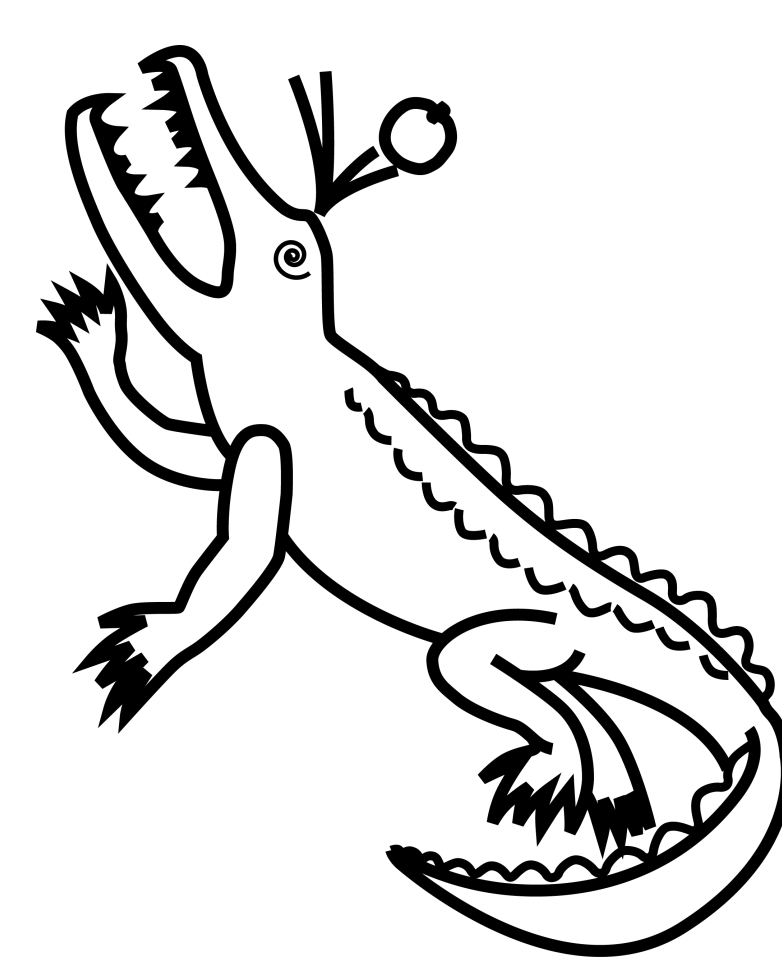


Physics

`\usepackage{physics}`



CAMTEX

Part of the cheat sheet series in partnership with CUPS

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Features of Physics

The physics package is a *convenience package* for the mathematics of physics. In particular, it provides macros for commonly used symbols, and minimises the effort required to optimize the spacing and sizing of elements in your equation. The macros cover vector calculus, Dirac notation, matrices, automatic bracing and more.

Vector Calculus

Vector calculus comes up incredibly often in physics, and using the physics package you will be able to save both time and make your source code more readable. The below examples cover the range of vector calculus commands, like vector quantity, dot/cross products, grad, div, curl, laplacian and unit vectors.

```
\div[ \vb{a} + \frac{1}{2} \curl \vb{E} ]  
\laplacian[ \vb{E} \cp \vb{H} ] = \vu{a} \cdot \grad \phi
```

Vector Calculus Examples

Examples of vector calculus using the physics package. Note how the brackets automatically resize based on their contents.

$$\nabla \cdot \left[\mathbf{a} + \frac{1}{2} \nabla \times \mathbf{E} \right]$$
$$\nabla^2 [\mathbf{E} \times \mathbf{H}] = \hat{\mathbf{a}} \cdot \nabla \phi$$

Dirac Notation

The Dirac notation of Quantum Mechanics can be especially irritating to handle in terms of spacing. Luckily, with the physics package you can simply write an expression as you would say it out loud! Macros include, expected value, matrix elements, bra, ket and their inner and outer products.

```
\ev{A}=\ev{A}{\psi}  
A_{nm}=\mel{n}{A}{m}  
\ket{\psi}=\sum \bra{n}\ket{\psi}\ket{n}  
\delta_{nm}=\bracket{n}{m}  
I=\sum \ketbra{n}{n}
```

Dirac Notation Examples

Examples of Dirac Notation using the physics package.

$$\langle A \rangle = \langle \psi | A | \psi \rangle$$
$$A_{nm} = \langle n | A | m \rangle$$
$$|\psi\rangle = \sum \langle n | \psi \rangle |n\rangle$$
$$\delta_{nm} = \langle n | m \rangle$$
$$I = \sum |n\rangle \langle n|$$

Matrix

Using the standard matrix etc. environments quickly gets very verbose if your equations contain many matrices. The physics package provides very convenient macros to write matrices inline using `\matrixquantity` or more conveniently `\mqty`, followed by the type of braces you would like the matrix to be contained in. As normally `&` changes column, and `\\` changes lines.

```
A=\mqty[ a & b \\ c & d & e ]
```

Matrix Examples

Notice how we do not need to specify the same number of elements in each row, and the missing elements will just be filled with blank elements.

$$A = \begin{bmatrix} a & b \\ c & d & e \end{bmatrix}$$

Derivatives

Finally there is a large collection of commands associated with derivatives. These include differentials, derivatives, partial derivatives, variations and variational derivatives. The main advantage, as always with physics is code readability and the fact that the spacing of components will mostly be handled for you.

```
\dd{x}  
\dv[n]{f}{x}  
\pdv{f}{x}{y}  
\var{x}  
\fdv{f}{x}
```

Derivative Examples

Examples of derivative commands using the physics package.

$$\frac{dx}{dx^n}$$
$$\frac{\partial^2 f}{\partial x \partial y}$$
$$\delta x$$
$$\frac{\delta f}{\delta x}$$

Other resources

Detailed documentation can be found at <https://ctan.org/pkg/physics>