1 Delimiters

See how the delimiters are of reasonable size in these examples

\[(a + b) \left[1 - \frac{b}{a + b}\right] = a,
\]
$$\sqrt{|xy|} \leq \left| \frac{x + y}{2} \right|,$$
even when there is no matching delimiter
\[
\int_a^b u \frac{d^2v}{dx^2} dx = u \frac{dv}{dx} \bigg|_a^b - \int_a^b \frac{du}{dx} \frac{dv}{dx} dx.
\]

2 Spacing

Differentials often need a bit of help with their spacing as in
\[
\iint xy^2 \, dx \, dy = \frac{1}{6} x^2 y^3,
\]
whereas vector problems often lead to statements such as
\[
u = \frac{-y}{x^2 + y^2}, \quad v = \frac{x}{x^2 + y^2}, \quad \text{and} \quad w = 0.
\]
Occasionally one gets horrible line breaks when using a list in mathematics such as listing the first twelve primes 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37.
In such cases, perhaps include \texttt{mathcode}'. In-line maths environment so that the list breaks: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37. Be discerning about when to do this as the spacing is different.

3 Arrays

Arrays of mathematics are typeset using one of the matrix environments as in
\[
\begin{bmatrix}
1 & x & 0 \\
0 & 1 & -1
\end{bmatrix}
\begin{bmatrix}
1 \\
y \\
1
\end{bmatrix} = \begin{bmatrix}
1 + xy \\
y - 1
\end{bmatrix}.
\]
Case statements use cases:

\[ |x| = \begin{cases} 
  x, & \text{if } x \geq 0, \\
  -x, & \text{if } x < 0. 
\end{cases} \]

Many arrays have lots of dots all over the place as in

\[
\begin{array}{ccccccc}
-2 & 1 & 0 & 0 & \cdots & 0 \\
1 & -2 & 1 & 0 & \cdots & 0 \\
0 & 1 & -2 & 1 & \cdots & 0 \\
0 & 0 & 1 & -2 & \cdots & 1 \\
\vdots & \vdots & \vdots & \vdots & \ddots & \vdots & 1 \\
0 & 0 & 0 & \cdots & 1 & -2 \\
\end{array}
\]

4 Equation arrays

In the flow of a fluid film we may report

\[
\begin{aligned}
  u_\alpha &= \epsilon^2 \kappa_{xxx} \left( y - \frac{1}{2} y^2 \right), \\
  v &= \epsilon^3 \kappa_{xxx} y, \\
  p &= \epsilon \kappa_{xx}.
\end{aligned}
\]

Alternatively, the curl of a vector field \((u, v, w)\) may be written with only one equation number:

\[
\begin{aligned}
  \omega_1 &= \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}, \\
  \omega_2 &= \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}, \\
  \omega_3 &= \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}.
\end{aligned}
\]
Whereas a derivation may look like
\[(p \land q) \lor (p \land \neg q) = p \land (q \lor \neg q)\] by distributive law
\[= p \land T\] by excluded middle
\[= p\] by identity

5 Functions

Observe that trigonometric and other elementary functions are typeset properly, even to the extent of providing a thin space if followed by a single letter argument:

\[\exp(i\theta) = \cos \theta + i \sin \theta,\quad \sinh(\log x) = \frac{1}{2} \left(x - \frac{1}{x}\right).\]

With sub- and super-scripts placed properly on more complicated functions,

\[\lim_{q \to \infty} \|f(x)\|_q = \max_x |f(x)|,\]

and large operators, such as integrals and

\[e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \quad \text{where } n! = \prod_{i=1}^{n} i,\]

\[\overline{U_\alpha} = \bigcap_\alpha U_\alpha.\]

In inline mathematics the scripts are correctly placed to the side in order to conserve vertical space, as in \(1/(1 - x) = \sum_{n=0}^{\infty} x^n.\)

6 Accents

Mathematical accents are performed by a short command with one argument, such as

\[\tilde{f}(\omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} f(x)e^{-i\omega x} \, dx,\]
or
\[ \dot{\omega} = \vec{r} \times \vec{l}. \]

### 7 Command definition

The Airy function, \( \text{Ai}(x) \), may be incorrectly defined as this integral

\[ \text{Ai}(x) = \int \exp(s^3 + isx) \, ds. \]

This vector identity serves nicely to illustrate two of the new commands:

\[ \nabla \times \vec{q} = i \left( \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} \right) + j \left( \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x} \right) + k \left( \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right). \]

### 8 Theorems et al.

**Definition 1 (right-angled triangles)** A right-angled triangle is a triangle whose sides of length \( a, b \) and \( c \), in some permutation of order, satisfies \( a^2 + b^2 = c^2 \).

**Lemma 2** The triangle with sides of length 3, 4 and 5 is right-angled.

This lemma follows from the Definition 1 as \( 3^2 + 4^2 = 9 + 16 = 25 = 5^2 \).

**Theorem 3 (Pythagorean triplets)** Triangles with sides of length \( a = p^2 - q^2 \), \( b = 2pq \) and \( c = p^2 + q^2 \) are right-angled triangles.

Prove this Theorem by the algebra
\[ a^2 + b^2 = (p^2 - q^2)^2 + (2pq)^2 = p^4 - 2p^2q^2 + q^4 + 4p^2q^2 = p^4 + 2p^2q^2 + q^4 = (p^2 + q^2)^2 = c^2. \]