

Chapter 1

Math

1.1 Text over and under symbols

1.1.1 Place text using `overset` & `underset`

```
1 \usepackage{amsmath} % align
2
3 \begin{align}
4   a \overset{why?}{=} b \\
5   a \underset{why?}{=} b
6 \end{align}
```

$$a \overset{why?}{=} b \tag{1.1}$$

$$a \underset{why?}{=} b \tag{1.2}$$

1.1.2 Remove extra spaces with `mathclap`

```
1 \usepackage{amsmath} % align
2 \usepackage{mathtools} % mathclap
3
4 \begin{align}
5   a \overset{
6     \mathclap{why?}
7   }{=} b \\
8   a \underset{
```

```

9      \mathclap{why?}
10     }{=} b
11 \end{align}

```

$$a \overset{why?}{=} b \quad (1.3)$$

$$a = \underset{why?}{b} \quad (1.4)$$

1.1.3 Multiple lines with substack

```

1 \usepackage{amsmath} % align, substack
2 \usepackage{mathtools} % mathclap
3
4 \begin{align}
5   a \overset{
6     \mathclap{
7       \substack{
8         why? \\\
9         how?
10      }
11    }
12 }{=} b \\\
13   a \underset{
14     \mathclap{
15       \substack{
16         why? \\\
17         how?
18      }
19    }
20 }{=} b
21 \end{align}

```

$$a \overset{why?}{\underset{how?}{=}} b \quad (1.5)$$

$$a = \underset{\underset{why?}{how?}}{b} \quad (1.6)$$

1.1.4 Place arrows

```

1 \usepackage{amsmath} % align, substack
2 \usepackage{mathtools} % mathclap

```

```

3
4 \begin{align}
5   a \overset{
6     \mathclap{
7       \substack{
8         why?    \\
9         how?    \\
10        \downarrow
11      }
12    }
13 }{=} b    \\
14   a \underset{
15     \mathclap{
16       \substack{
17         \uparrow \\
18         why?    \\
19         how?
20       }
21     }
22 }{=} b
23 \end{align}

```

$$\begin{array}{c} why? \\ how? \\ a \stackrel{\downarrow}{=} b \end{array} \quad (1.7)$$

$$\begin{array}{c} a = b \\ \uparrow \\ why? \\ how? \end{array} \quad (1.8)$$

1.1.5 Use long arrows with `\big`

```

1 \usepackage{amsmath} % align, substack
2 \usepackage{mathtools} % mathclap
3
4 \begin{align}
5   a \overset{
6     \mathclap{
7       \substack{
8         why?    \\
9         how?    \\
10        \big \downarrow
11      }
12    }
13 }{=} b    \\

```

```

14 a \underset{
15   \mathclap{
16     \substack{
17       \big \uparrow \\
18       why?    \\
19         how?
20     }
21   }
22 }{=} b
23 \end{align}

```

$$\begin{array}{c}
 \textit{why?} \\
 \textit{how?} \\
 \downarrow \\
 a \equiv b
 \end{array}
 \tag{1.9}$$

$$\begin{array}{c}
 a = b \\
 \uparrow \\
 \textit{why?} \\
 \textit{how?}
 \end{array}
 \tag{1.10}$$

1.2 Curly braces over and under equations

```

1 \begin{align}
2   x
3   = \overbrace{a \cdot b \cdot c}^{\textit{explanation}}
4   + \underbrace{d \cdot e \cdot f}_{\textit{explanation}}
5 \end{align}

```

$$x = \overbrace{a \cdot b \cdot c}^{\textit{explanation}} + \underbrace{d \cdot e \cdot f}_{\textit{explanation}}
 \tag{1.11}$$

1.2.1 Inside square root or \left & \right parentheses etc.

```

1 \begin{align}
2   x
3   &= \sqrt{
4     \underbrace{a \cdot b \cdot c}_{\textit{explanation}}
5   }
6   y &= \left[
7     \underbrace{d \cdot e \cdot f}_{\textit{explanation}}

```

```

8 \right]
9 \end{align}

```

$$x = \sqrt{\underbrace{a \cdot b \cdot c}_{\text{explanation}}} \quad (1.12)$$

$$y = \left[\underbrace{d \cdot e \cdot f}_{\text{explanation}} \right] \quad (1.13)$$

1.2.2 Use smash to write explanation outside

```

1 \begin{align}
2   x
3   &= \sqrt{
4     \smash[b]{
5       \underbrace{a \cdot b \cdot c}_{\text{explanation}}
6     }
7   } \\
8   y &= \left[
9     \smash[b]{
10      \underbrace{d \cdot e \cdot f}_{\text{explanation}}
11    }
12   \right]
13 \end{align}

```

$$x = \sqrt{\underbrace{a \cdot b \cdot c}_{\text{explanation}}} \quad (1.14)$$

$$y = \left[\underbrace{\underbrace{d \cdot e \cdot f}_{\text{explanation}}}_{\text{explanation}} \right] \quad (1.15)$$

1.2.3 Add vertical space

```

1 \begin{align}
2   x
3   &= \sqrt{
4     \smash[b]{
5       \underbrace{a \cdot b \cdot c}_{\text{explanation}}
6     }
7   } \\
8   y &= \left[
9     \smash[b]{

```

```

10 \underbrace{d \cdot e \cdot f}_{\text{explanation}}
11 }
12 \right]
13 \end{align}

```

$$x = \sqrt{\underbrace{a \cdot b \cdot c}_{\text{explanation}}} \quad (1.16)$$

$$y = [\underbrace{d \cdot e \cdot f}_{\text{explanation}}] \quad (1.17)$$

1.3 Vector notations

- arrow: \vec{x}
- bold: \mathbf{x}
- bm package: \boldsymbol{x}

1.4 Derivative notations

`\usepackage{derivative}`

1.4.1 Ordinary derivative

```

1 \begin{align}
2 & \quad \& \frac{df}{dx} \quad \backslash\backslash
3 & \quad \& \text{odv}\{f\}\{x\} \quad \backslash\backslash
4 & \quad \& \text{odv*}\{f\}\{x\}
5 \end{align}

```

$$\frac{df}{dx} \quad (1.18)$$

$$\frac{df}{dx} \quad (1.19)$$

$$\frac{d}{dx} f \quad (1.20)$$

1.4.2 Partial derivative

```

1 \begin{align}
2   & \& \frac{\partial}{\partial x} f \\
3   & \& \frac{\partial}{\partial x} f \\
4   & \& \frac{\partial}{\partial x} f \\
5   & \& \frac{\partial}{\partial x} f \\
6   & \& \frac{\partial}{\partial x} f \\
7   & \& \frac{\partial}{\partial x} f \\
8 \end{align}

```

$$\frac{\partial f}{\partial x} \quad (1.21)$$

$$\frac{\partial f}{\partial x} \quad (1.22)$$

$$\frac{\partial}{\partial x} f \quad (1.23)$$

$$\partial_x f \quad (1.24)$$

$$\frac{\partial^2 f}{\partial x \partial y} \quad (1.25)$$

$$\frac{\partial^6 f}{\partial x^2 \partial y^3 \partial z} \quad (1.26)$$

1.4.3 Material derivative

```

1 \begin{align}
2   & \& \frac{Df}{Dx} \\
3   & \& \frac{Df}{Dx} \\
4   & \& \frac{Df}{Dx} \\
5 \end{align}

```

$$\frac{Df}{Dx} \quad (1.27)$$

$$\frac{Df}{Dx} \quad (1.28)$$

$$\frac{D}{Dx} f \quad (1.29)$$

1.4.4 Functional derivative

```

1 \begin{align}
2   & \& \frac{\delta f}{\delta x} \\
3   & \& \frac{\delta f}{\delta x} \\
4   & \& \frac{\delta f}{\delta x} \\
5 \end{align}

```

$$\frac{\delta f}{\delta x} \quad (1.30)$$

$$\frac{\delta f}{\delta x} \quad (1.31)$$

$$\frac{\delta}{\delta x} f \quad (1.32)$$

1.4.5 Average rate of change

```

1 \begin{align}
2   & \& \frac{\Delta f}{\Delta x} \\
3   & \& \frac{\Delta f}{\Delta x} \\
4 \end{align}

```

$$\frac{\Delta f}{\Delta x} \quad (1.33)$$

$$\frac{\Delta f}{\Delta x} \quad (1.34)$$

1.4.6 Jacobian

```

1 \begin{align}
2   & \frac{\partial}{\partial (f, g, h)} \\
3   & \{ \\
4   & \frac{\partial}{\partial (x, y, z)} \\
5   & \} \\
6   & \backslash \\
7   & \frac{\partial (f, g, h)}{\partial (x, y, z)} \\
8 \end{align}
```

$$\frac{\partial (f, g, h)}{\partial (x, y, z)} \quad (1.35)$$

$$\frac{\partial (f, g, h)}{\partial (x, y, z)} \quad (1.36)$$

1.5 Cancel

```
\usepackage{cancel}
```

```

1 \begin{align}
2   a \\
3   = \cancel{b} \\
4   + \bcancel{c} \\
5   + \xcancel{d} \\
6   + \cancelto{x}{e} \\
7 \end{align}
```

$$a = \cancel{b} + \cancel{c} + \cancel{d} + \cancelto{x}{e} \quad (1.37)$$

1.6 Multiline equations

```
\usepackage{amsmath}
```

```
1 \multirow{<nrows>}{<text>}
```

```

1 \begin{align}
2   \begin{split}
3     x \\
4     & = a \cdot b \cdot c \\
5     & + d \cdot e \cdot f \\
6   \end{split} \\
7 \end{align}
```

$$\begin{aligned} x &= a \cdot b \cdot c \\ &+ d \cdot e \cdot f \end{aligned} \quad (1.38)$$