LaTeX: A Guide for the Curious Physicist

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Contents

Chapter 1

Why LaTeX for Physics?

1.1 Physics Needs Precision: Why LaTeX?

Physics is inherently mathematical, symbolic, and visual. LaTeX is built for this world — allowing you to:

- Write precise equations like Maxwell's or Schrödinger's
- Label vectors, units, and derivatives cleanly
- Create professional plots, diagrams, and models
- Reference figures and formulas with accuracy

1.2 Why Word Processors Fail for Physics

Word processors are designed for prose, not precision. They struggle with:

- Alignment and labeling of multi-line equations
- Complex symbols like ∇, $\hat{x}$, or $\sum_{n=1}^{\infty}$
- Drawing force diagrams or Feynman diagrams cleanly
- Consistent formatting for units, references, or citations

LaTeX wins because it is a language of structure, not style.

1.3 What You'll Learn in This Book

This book shows you how to:

- Typeset equations and derivations
- Draw physics diagrams: free body, vector fields, Feynman diagrams
- Use color and overlays to explain motion and forces
- Format reports and presentations professionally
- Cite physics sources from arXiv, journals, and conferences

Each chapter ends with tips and LaTeX code you can copy, modify, and deploy.

1.4 Getting Started: Overleaf and Offline Tools

Option A: Overleaf (Recommended)

- Free, browser-based LaTeX editor
- Auto-compiles and supports collaboration
- Supports ‘tikz-feynman‘, ‘physics‘, ‘pgfplots‘, etc.

`https://overleaf.com`

Option B: Offline Installation

- Install a TeX distribution (TeX Live, MiKTeX, MacTeX)
- Use an editor: TeXstudio, VSCode + LaTeX Workshop, etc.

1.5 Your First Physics Document

Try this in Overleaf:

```
\documentclass{article}
\usepackage{amsmath}
\usepackage{physics}
\begin{document}
```

```
Newton's Second Law:

\[
\vb{F} = m\vb{a}
\]

\end{document}
```

$$F = ma$$

Try This!

- Change the equation to $p = mv$
- Add a title and your name
- Use ‘`\physics`‘ for derivatives and vectors

What's Next

Now that you know why LaTeX is powerful for physics, Chapter 2 will show you how to write clean, professional equations — from classical mechanics to quantum theory.

Chapter 2

Writing Equations and Formulas in Physics

2.1 Math Mode Review for Physicists

Use dollar signs `$...$` or `\[...\]` to enter math mode.

- Inline: `$E = mc^2$` $\to E = mc^2$
- Display: `\[ E = mc^2 \]` $\to$

$$E = mc^2$$

Use `\text` inside equations for units and labels: `$F = 10\ \text{N}$` $\to F = 10\ \text{N}$

2.2 Kinematic Equations, Energy, Momentum

$$\begin{aligned}
v &= v_0 + at \\
x &= x_0 + v_0 t + \frac{1}{2}at^2 \\
F &= ma \\
K &= \frac{1}{2}mv^2 \\
p &= mv
\end{aligned}$$

Use `amsmath`'s `align` or `equation` for clean formatting.

2.3 Vectors, Greek Letters, and Operators

Load the `physics` package:

```
\usepackage{physics}
```

- Vectors: `\vb{F}` $\to F$
- Unit vectors: `\vu{x}` $\to x$
- Derivatives: `\dv{y}{x}` $\to yx$
- Partial derivatives: `\pdv{f}{x}` $\to fx$, `\pdv[2]{f}{x}` $\to [2]fx$
- Greek: `\theta` $\to \theta$, `\psi` $\to \psi$

2.4 Gradient, Divergence, and Curl

$$\begin{aligned} \phi &= \nabla\phi \\ \div F &= \nabla \cdot F \\ F &= \nabla \times F \end{aligned}$$

Symbols and commands:

- `\nabla` $\to \nabla$
- `\div{}` $\to \div F$
- `\curl{}` $\to F$
- `\grad{}` $\to \phi$

2.5 Dot and Cross Products

- Dot: `\vb{A} \cdot \vb{B}` $\to A \cdot B$
- Cross: `\vb{A} \times \vb{B}` $\to A \times B$

Example (Lorentz Force):

$$F = qE + qv \times B$$

2.6 Summation, Limits, and Integrals

- Summation: `\sum_{n=1}^\infty a_n` → $\sum_{n=1}^{\infty} a_n$
- Limit: `\lim_{x \to 0} \frac{\sin x}{x}` → $\lim_{x\to 0} \frac{\sin x}{x}$
- Integral: `\int_0^L \vb{F} \cdot d\vb{x}` → $\int_0^L F \cdot dx$
- Double integral: `\iint`, Triple: `\iiint`

$$\int_0^\infty e^{-x^2} x = \frac{\sqrt{\pi}}{2}$$

2.7 Display Equations with Numbering

Use ‘equation‘ for numbering:

```
\begin{equation}
    \nabla \cdot \vb{E} = \frac{\rho}{\varepsilon_0}
\end{equation}
```

$$\nabla \cdot E = \frac{\rho}{\varepsilon_0} \tag{2.1}$$

Try This!

- Write Gauss’s Law, Ampère’s Law, and Faraday’s Law
- Use ‘align‘ to list the four Maxwell equations
- Try partial derivatives for the Lagrangian $\mathcal{L}(q, \dot{q}, t)$

Lab Tip

Use `physics` macros consistently — they reduce errors and improve readability. Use `\si{}` for all physical units and label equations with `\label{eq:}` for referencing.

What’s Next

In Chapter 3, we’ll model real physical systems — projectiles, pendulums, oscillators — and learn how to align derivations in structured formats.

Chapter 3

Modeling Physical Systems

3.1 Projectile Motion and Trajectories

Use ‘align‘ to display kinematic equations:

$$\begin{aligned} x(t) &= v_0 \cos\theta \cdot t \\ y(t) &= v_0 \sin\theta \cdot t - \frac{1}{2} g t^2 \end{aligned}$$

To draw a simple path:

```
\usepackage{tikz}
\begin{tikzpicture}[scale=0.8]
\draw[->] (0,0) -- (5,0) node[right] {$x$};
\draw[->] (0,0) -- (0,3) node[above] {$y$};
\draw[domain=0:4, smooth, variable=\x, thick]
    plot ({\x}, {2*\x - 0.5*9.8*(\x/2)^2});
\end{tikzpicture}
```

3.2 The Bullet-and-Block Problem

Use ‘cases‘ for piecewise outcomes:

$$v_f = \begin{cases} \dfrac{mv}{m+M} & \text{(perfectly inelastic)} \\ \text{solve from conservation} & \text{(elastic)} \end{cases} \tag{3.1}$$

3.3 Spring-Mass and Pendulum Systems

Hooke's Law and Newton's 2nd Law:

$$m\ddot{x} + kx = 0$$

Solution:

$$x(t) = A\cos(\omega t + \phi), \quad \omega = \sqrt{\frac{k}{m}}$$

Pendulum (small-angle approximation):

$$\theta(t) = \theta_0 \cos\left(\sqrt{\frac{g}{\ell}}t\right)$$

3.4 Damped Oscillators and Driven Systems

Damped oscillator:

$$m\ddot{x} + b\dot{x} + kx = 0$$

Driven oscillator:

$$m\ddot{x} + b\dot{x} + kx = F_0\cos(\omega t)$$

Use ‘xt‘ or “ from `physics` for clarity.

3.5 Aligning and Annotating Derivations with `align`

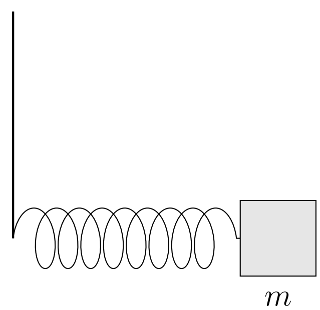
Use ‘align‘ to show step-by-step reasoning:

$$
\begin{aligned}
F_{\text{net}} &= T - mg \qquad (3.2)\\
ma &= T - mg \qquad (3.3)\\
T &= m(a+g) \qquad (3.4)
\end{aligned}
$$

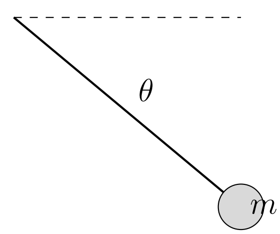
Use ‘‘ for in-line annotations.

Diagrams for Physical Models

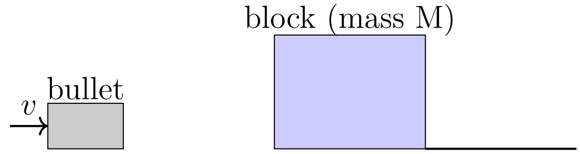
Simple Harmonic Oscillator (Mass on Spring)



Simple Pendulum



Bullet and Block



Try This!

- Derive time of flight, max height, and range of a projectile

- Use ‘align‘ to show a step-by-step derivation for SHM
- Sketch a damped oscillator response and label amplitude decay

Lab Tip

Use ‘‘ to keep all reported values with consistent units. Use TikZ to sketch experimental setups and help communicate your assumptions and models clearly.

What’s Next

In Chapter 4, we’ll transition from equations to illustrations — learning to draw free-body diagrams, coordinate systems, and vector fields using ‘tikz‘.

Chapter 4

Diagrams and Visual Models in Physics

4.1 Using `tikz` for Physics Figures

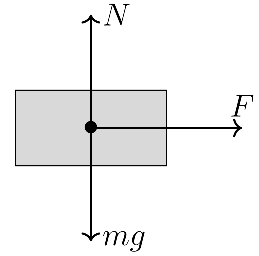
Add TikZ to your preamble:

```
\usepackage{tikz}
\usetikzlibrary{arrows.meta, decorations.pathreplacing, calc}
```

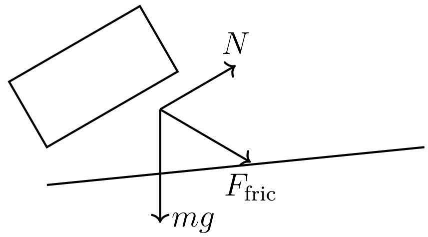
Start any drawing with:

```
\begin{tikzpicture}
  % your drawing
\end{tikzpicture}
```

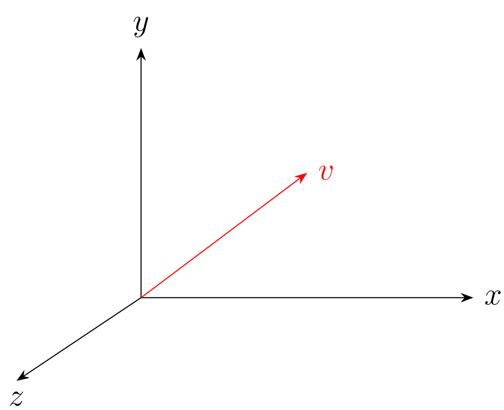
4.2 Drawing Free Body Diagrams



4.3 Inclined Planes, Tension, and Pulley Systems



4.4 2D/3D Coordinate Systems and Vector Fields



4.5 Highlighting with `xcolor` and Overlays

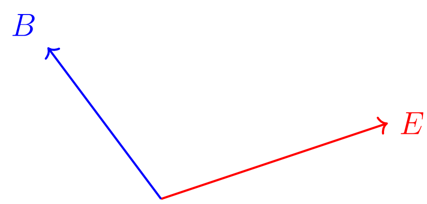
Add:

```
\usepackage{xcolor}
```

To color elements:

- `\textcolor{blue}{force}` → force
- `\draw[red,->]` for arrows

Example:



Try This!

- Draw a 2-block pulley system
- Add friction arrows to an inclined block
- Create a field map with arrows using a ‘for‘ loop in TikZ

Lab Tip

Use ‘node‘ labels for clean vector naming. Align force vectors from the object’s center, and use consistent angle conventions.

What’s Next

In Chapter 5, we’ll dive into drawing quantum field theory visuals with ‘tikz-feynman‘, including real Feynman diagrams for QED.

Chapter 5

Feynman Diagrams and Quantum Field Visuals

5.1 Introduction to Feynman Diagrams

Feynman diagrams visually represent particle interactions in QFT. LaTeX offers a clean and professional way to render them using ‘tikz-feynman‘.

5.2 Installing and Using `tikz-feynman`

Add to your preamble:

```
\usepackage{tikz-feynman}
\tikzfeynmanset{compat=1.1.0}
```

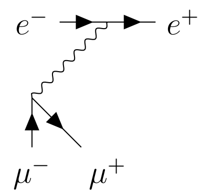
You may also need:

```
\usepackage{tikz}
\usepackage[compat=1.0.0]{tikz-feynman}
```

5.3 Fermion and Boson Lines: Syntax and Styles

```
\feynmandiagram [horizontal=a to b] {
  i1 [particle=\(e^-\)] -- [fermion] a -- [fermion] i2 [particle=\(e^+\)],
  a -- [photon] b,
  f1 [particle=\(\mu^-\)] -- [fermion] b -- [fermion] f2 [particle=\(\mu^+\)],
```

```
};
```



5.4 Basic QED Scattering: $e^+e^- \to \mu^+\mu^-$

This represents electron–positron annihilation into a muon–antimuon pair.

5.5 Loops, Vertices, and Complex Interactions

Example with a loop:

```
\feynmandiagram [layered layout, horizontal=a to b] {
  a -- [fermion] b -- [fermion] c -- [fermion] a,
  b -- [photon, out=45, in=135, loop, min distance=2cm] b,
};
```

5.6 Labeling Particles, Momenta, and Time Direction

- Use `particle=\(e^-\)` to label lines
- Arrows indicate time direction
- Use ‘momentum=p‘ to annotate lines

5.7 Advanced Styling: Curves, Loops, Momentum Arrows

```
\feynmandiagram [horizontal=a to b] {
  a -- [fermion, momentum=\(p\)] b -- [photon, edge label=\(\gamma\)] c,
};
```

You can customize:

- `out` and `in` angles for curved lines
- Use ‘edge label‘, ‘momentum’‘, and color for clarity

Try This!

- Create a t-channel diagram
- Add a loop with a virtual photon
- Label all external particles and include momenta

Lab Tip

For journal-quality diagrams, export TikZ pictures standalone and compile them into figures. Always use ‘compat‘ with your Overleaf version.

What’s Next

In Chapter 6, we return to classical vector tools — exploring coordinate systems, vector diagrams, and component notation.

Chapter 6

Vectors and Coordinate Systems

6.1 Vectors in Component Form

Use “ to denote vectors and ‘$\left[...\right]$‘ for component layout:

$$A = A_x i + A_y j + A_z k$$
$$r = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

In 2D:

$$v = \begin{bmatrix} 3 \\ 4 \end{bmatrix}, \quad |v| = \sqrt{3^2 + 4^2} = 5$$

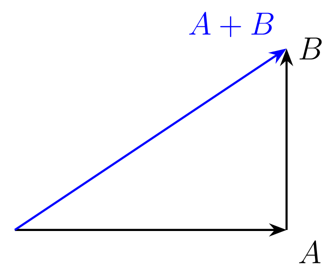
6.2 Using the `physics` Package for Vectors

The ‘physics‘ package simplifies derivatives, vector arrows, and unit vectors:

- `\vb{v}` $\to v$
- `\vu{x}` $\to x$
- `\grad{f}` $\to f$
- `\div{\vb{E}}` $\to \div E$

- `\curl{\vb{B}}` $\to B$

6.3 Drawing Vector Addition and Resolution



Use vector triangles or parallelograms to show composition.

6.4 Polar and Spherical Coordinates

Polar:

$$x = r\cos\theta, \quad y = r\sin\theta$$

Spherical:

$$x = r\sin\theta\cos\phi, \quad y = r\sin\theta\sin\phi, \quad z = r\cos\theta$$

Vector in Spherical Form:

$$E = E_r r + E_\theta \theta + E_\phi \phi$$

Use r, θ to denote directional unit vectors.

Try This!

- Break a vector into components on an incline
- Draw a 3D coordinate system with labeled axes
- Convert between Cartesian and spherical vector representations

Lab Tip

Use ‘tikz‘ to visually verify directionality and component breakdowns. Highlight angles and axes using ‘[dashed]‘ and node labels.

What’s Next

In Chapter 7, we’ll explore how to visualize physical quantities dynamically — from motion graphs to potential wells and multicolor field plots.

Chapter 7

Visualizing Motion and Change

7.1 Graphing Motion with `pgfplots`

Load the package in your preamble:

```
\usepackage{pgfplots}
\pgfplotsset{compat=1.18}
```

Example: Position vs. Time

```
\begin{tikzpicture}
\begin{axis}[
    axis lines=middle,
    xlabel={$t$ (s)},
    ylabel={$x(t)$ (m)},
    domain=0:5,
    samples=100,
]
\addplot[blue, thick] {3*x + 0.5*x^2};
\end{axis}
\end{tikzpicture}
```

7.2 Visualizing Trajectories Over Time

Use parametric plots for curved paths:

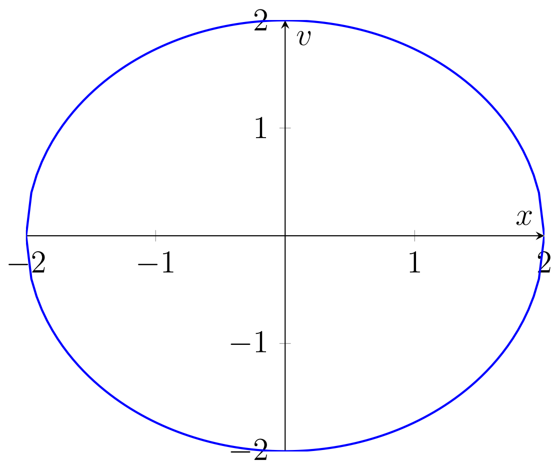
```
\begin{tikzpicture}
\begin{axis}[axis lines=middle, xlabel=$x$, ylabel=$y$]
\addplot[domain=0:5, samples=100, thick]
    ({x}, {2*x - 0.5*9.8*(x/2)^2});
\end{axis}
\end{tikzpicture}
```

This simulates projectile motion.

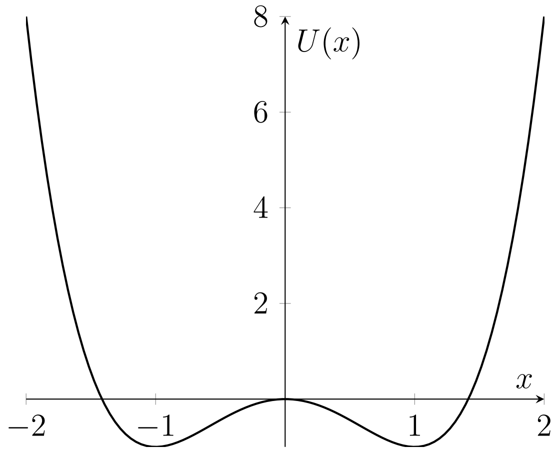
7.3 Phase Diagrams and Potential Energy Wells

SHM Phase Diagram:

$$\frac{1}{2}mv^2 + \frac{1}{2}kx^2 = E$$



Potential Energy Well:



7.4 Multicolor Paths and Overlays

You can split plots with color stages:

```
\addplot[red, domain=0:2] {f(x)};
\addplot[blue, domain=2:4] {f(x)};
```

Or use ‘nodes near coords‘ to annotate turning points.

Try This!

- Plot a pendulum's angle over time
- Create a multistage graph showing motion segments
- Visualize escape velocity as a potential graph

Lab Tip

Use ‘axis lines=middle‘ and gridlines for clarity. Normalize units if plotting across different physical domains (e.g., energy vs. position).

What's Next

In Chapter 8, we'll refine visual design using ‘xcolor‘, themes, and styles — to create professional documents and presentations.

Chapter 8

Using Colors and Styles in Physics Documents

8.1 The `xcolor` Package and Color Design

Add the package to your preamble:

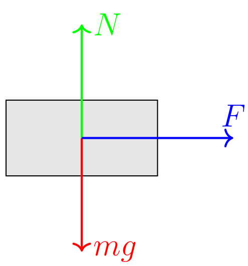
```
\usepackage{xcolor}
```

Example Usage:

- `\textcolor{red}{energy}` $\rightarrow$ energy
- `\color{blue} F = ma` $\rightarrow$ $F = ma$
- Custom color: `\definecolor{mygray}{gray}{0.7}`

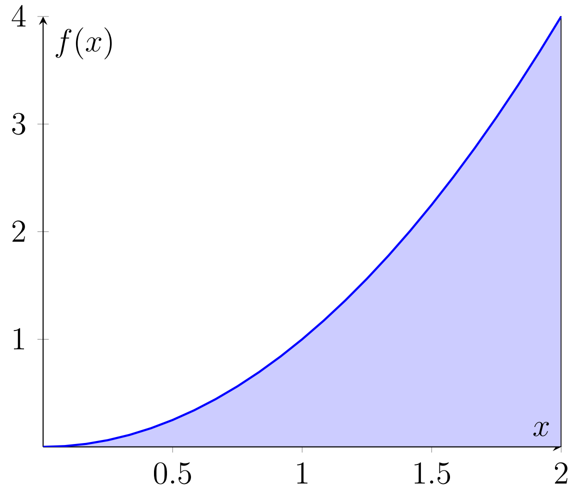
8.2 Coloring Forces and Highlighting Arrows

Color-coded force diagrams improve legibility:



8.3 Shading Areas Under Curves

Using ‘fill‘ in TikZ:



This visually emphasizes the integral or work done.

8.4 Presentation-ready Aesthetics

Use consistent color themes:

- Titles and headings in ‘blue!70!black‘
- Vectors in ‘red‘, fields in ‘blue‘
- Shaded potentials with ‘gray!30‘

You can also define reusable styles:

```
\tikzset{force/.style={->, thick, color=red}}
\tikzset{vector/.style={->, thick, blue}}
```

Try This!

- Shade a velocity-time graph area (displacement)
- Color electric field lines differently than magnetic ones
- Apply custom styles to plot segments

Lab Tip

Avoid overusing bright colors — use desaturated tones (e.g., ‘blue!40!white‘) for diagrams. Use color primarily to distinguish concepts or forces.

What’s Next

In Chapter 9, you’ll learn how to format physics lab reports and research papers with proper structure, equations, and citations.

Chapter 9

Writing Lab Reports and Scientific Papers

9.1 Physics Report Structure

A good report includes:

- Title and Abstract
- Introduction and Theory
- Experimental Method
- Data and Analysis
- Conclusion and References

9.2 Basic Document Setup

```
\documentclass[12pt]{article}
\usepackage{amsmath, siunitx, graphicx, physics}
\usepackage{caption}
\title{Conservation of Energy in a Pendulum}
\author{Nishtha Tikalal}
\date{\today}
```

Use ‘

9.3

‘ and ‘

9.3.1

‘ to structure content.

9.4 Tables, Units, and Error Propagation

Use ‘siunitx‘ to present measurements and uncertainties:

```
\begin{tabular}{|c|c|}
\hline
Mass (g) & Time (s) \\
\hline
\SI{100.0 \pm 0.5}{\gram} & \SI{2.34 \pm 0.03}{\second} \\
\hline
\end{tabular}
```

For error propagation:

$$\Delta T = \sqrt{\left(\frac{\partial T}{\partial x}\Delta x\right)^2 + \left(\frac{\partial T}{\partial y}\Delta y\right)^2}$$

9.5 Incorporating Experimental Diagrams

Insert figures:

```
\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{pendulum_setup.png}
\caption{Experimental setup for the simple pendulum}
\label{fig:pendulum}
\end{figure}
```

Refer with: `As seen in Figure~\ref{fig:pendulum}...`

9.6 Referencing Figures and Equations

- Use `\label{}` and `\ref{}` to refer back
- Numbered equations: `\begin{equation}...\end{equation}`
- Add references to published results or constants using ‘biblatex‘

Try This!

- Write a full lab report on projectile motion
- Include one table, one graph, one error analysis, and one diagram
- Use ‘align‘ to derive an energy equation

Lab Tip

Use separate ‘.tex‘ files for sections (e.g., ‘intro.tex‘, ‘data.tex‘) and ‘ ‘ them. Maintain a shared ‘.bib‘ file for citations.

What’s Next

In Chapter 10, you’ll learn how to present physics visually using ‘beamer‘ — ideal for slides, lectures, and defense presentations.

Chapter 10

Presenting Physics with Beamer

10.1 Physics Slide Templates

Basic slide setup:

```
\documentclass{beamer}
\usepackage{amsmath, physics, tikz}
\usetheme{CambridgeUS}
\title{Quantum Tunneling}
\author{Nishtha Tikalal}
\date{\today}
```

Start slides with:

```
\begin{document}
\frame{\titlepage}
```

Use ‘□□□‘ or ‘□..‘ for each slide.

10.2 Animating Steps with \pause and \onslide

Show derivations in steps:

```
\begin{frame}{Energy Derivation}
\begin{align*}
T &= \frac{1}{2}mv^2 \pause \\
  &= \frac{1}{2}m\left(\frac{dx}{dt}\right)^2
```

```
\end{align*}
\end{frame}
```

Use ‘<2->‘ to control visibility precisely.

10.3 Diagrams in Presentations

You can use ‘tikz‘, ‘pgfplots‘, or ‘tikz-feynman‘ inside frames:

```
\begin{frame}{Free Body Diagram}
\begin{tikzpicture}
  \draw[fill=gray!20] (0,0) rectangle (2,1);
  \draw[->, thick] (1,0.5) -- (1,-1) node[right] {$mg$};
\end{tikzpicture}
\end{frame}
```

10.4 Overlaying Concepts and Graphs

Beamer supports multi-stage visual explanation:

```
\begin{frame}{Projectile Motion}
\begin{tikzpicture}
  \draw[->] (0,0) -- (5,0) node[right] {$x$};
  \onslide<2->{\draw[->, thick, blue] (0,0) parabola (4,2);}
  \onslide<3->{\node at (2,1) {trajectory};}
\end{tikzpicture}
\end{frame}
```

Try This!

- Create a 3-slide derivation of the work-energy theorem
- Use “ to reveal one equation at a time
- Animate a diagram of circular motion

Lab Tip

Avoid overloading slides — one idea per frame. Use colors for emphasis, not decoration. Keep fonts readable (minimum 11pt) and equations centered.

What's Next

In Chapter 11, we'll learn how to cite physics literature from journals, arXiv, and databases using BibTeX and 'biblatex'.

Chapter 11

Citing Physics Literature

11.1 Using biblatex with biber

Add to your preamble:

```
\usepackage[style=numeric, backend=biber]{biblatex}
\addbibresource{refs.bib}
```

In your document:

```
As shown in \cite{einstein1905}, the mass-energy relation is...
```

11.2 Adding arXiv, DOI, and Journal References

Example entry from arXiv:

```
@article{hawking1975,
  author = {S. W. Hawking},
  title = {Particle Creation by Black Holes},
  journal = {Commun. Math. Phys.},
  volume = {43},
  pages = {199--220},
  year = {1975},
  doi = {10.1007/BF02345020}
}
```

From arXiv.org:

```
@article{weinberg1967,
  author = {Steven Weinberg},
  title = {A Model of Leptons},
  journal = {Phys. Rev. Lett.},
  volume = {19},
  year = {1967},
  pages = {1264--1266},
  doi = {10.1103/PhysRevLett.19.1264},
  eprint = {arXiv:hep-ph/9601357}
}
```

11.3 Bibliography Styles for Physicists

- **numeric** — [1], [2], etc.
- **authoryear** — Author (Year)
- **ieee**, **apsrev4-2**, **aip**

Use in preamble:

```
\usepackage[style=ieee]{biblatex}
```

11.4 Inline Citations and Hyperlinks

Use:

```
\usepackage[colorlinks=true,linkcolor=blue,citecolor=purple]{hyperref}
```

- `\cite{}` → numbered or name-based reference
- `\textcite{}` → inline citation: Author (Year)

Try This!

- Add 3 references: 1 from arXiv, 1 textbook, 1 peer-reviewed journal
- Apply IEEE or AIP bibliography style
- Insert a hyperlink to a DOI

Lab Tip

Use Zotero or JabRef to export BibTeX entries. Always verify DOIs and page ranges — especially with arXiv preprints and physics journals.

What's Next

In Chapter 12, we'll compile a physics LaTeX cheat sheet — your go-to reference for equations, packages, and diagrams.

Chapter 12

Physics LaTeX Cheat Sheet

Essential Math Symbols and Environments

`\frac{a}{b}`	$\frac{a}{b}$
`\sqrt{x}`	$\sqrt{x}$
`\sum_{n=1}^{\infty} a_n`	$\sum_{n=1}^{\infty} a_n$
`\int_0^L f(x)\dd{x}`	$\int_0^L f(x)x$
`\dv{f}{x}, \pdv{f}{x}`	fx, fx
`\nabla, \grad{}, \div{}, \curl{}`	$\nabla, , \div,$

Physics Package Commands

`physics`:

- `\vb{F}` $\rightarrow F$ (vectors)
- `\vu{i}` $\rightarrow i$ (unit vectors)
- `\dd{x}` $\rightarrow x$ (differentials)
- `\abs{x}` $\rightarrow x$ (absolute value)

`siunitx`:

- `\SI{9.81}{\meter\per\square\second}` $\rightarrow$ 9.81□`\num{1.602e-19}`ß1.602$e - 19$

Diagram Packages and Styles

`tikz`:

- `\draw[->] (0,0) -- (1,1);` $\to$ arrow
- `\node at (x,y) {label};`
- Coordinate systems, field lines, mechanics setups

`pgfplots`:

- `\begin{axis}...\addplot{...};`
- Graphing functions, motion curves, energy wells

`tikz-feynman`:

- `\feynmandiagram [horizontal=a to b] {...};`
- Fermion lines, boson loops, QED scatterings

Common Physical Equations in LaTeX

$$\begin{aligned} E &= mc^2 \\ F &= ma \\ F &= qE + qv \times B \\ p &= mv \\ \mathcal{L} &= T - V \quad \text{(Lagrangian)} \\ pt &= -V \end{aligned}$$

Constants and Units

`\SI{6.626e-34}{\joule\second}`	Planck's constant (h)
`\SI{1.602e-19}{\coulomb}`	Elementary charge (e)
`\SI{8.854e-12}{\farad\per\meter}`	Vacuum permittivity (ε_0)
`\SI{9.81}{\meter\per\square\second}`	Acceleration due to gravity

Best Practices Summary

- Use ‘`physics`‘, ‘`tikz`‘, and ‘`siunitx`‘ consistently
- Label all figures and equations
- Reference figures using ‘**??**‘ and cross-labels
- Use display math for key derivations

Lab Tip

Keep this cheat sheet near your Overleaf or TeXStudio window as you write. You’ll internalize commands by typing them often.

What’s Next

In the final chapter, we share full physics LaTeX templates for lab reports, problem sets, presentations, and theoretical notes.

Chapter 13

Physics Templates

13.1 Lab Report Template

```
\documentclass[12pt]{article}
\usepackage{amsmath, physics, siunitx, graphicx}
\title{Conservation of Energy in a Pendulum}
\author{Nishtha Tikalal}
\date{\today}

\begin{document}
\maketitle

\begin{abstract}
This experiment verifies conservation of mechanical energy using a simple pendulum.
\end{abstract}

\section{Theory}
\[
E = K + U = \frac{1}{2}mv^2 + mgh = \text{const}
\]

\section{Method}
\begin{itemize}
  \item Measure pendulum height and time period
```

```
  \item Compute velocity and potential energy
\end{itemize}

\section{Results}
\begin{tabular}{|c|c|}
\hline
Height (m) & Speed (m/s) \\
\hline
0.50 & 3.13 \\
\hline
\end{tabular}

\section{Conclusion}
Mechanical energy is conserved within experimental uncertainty.

\end{document}
```

13.2 Beamer Slide Template

```
\documentclass{beamer}
\usepackage{physics, tikz}
\usetheme{Madrid}

\title{Work-Energy Theorem}
\author{Nishtha Tikalal}
\date{}

\begin{document}
\frame{\titlepage}

\begin{frame}{Statement}
\[
W = \Delta K = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2
\]
\end{frame}
```

```
\begin{frame}{Free Body Diagram}
\begin{tikzpicture}
  \draw[fill=gray!20] (0,0) rectangle (2,1);
  \draw[->, thick] (1,0.5) -- (1,-1) node[right] {$mg$};
\end{tikzpicture}
\end{frame}

\end{document}
```

13.3 Quantum Field Theory Notes Template

```
\documentclass[12pt]{article}
\usepackage{amsmath, physics, tikz-feynman}
\tikzfeynmanset{compat=1.1.0}

\title{Intro to QFT: Scattering Amplitudes}
\author{Nishtha Tikalal}

\begin{document}
\maketitle

\section{Feynman Diagrams}
\[
\feynmandiagram [horizontal=a to b] {
  i1 [particle=\(e^-\)] -- [fermion] a -- [fermion] i2 [particle=\(e^+\)],
  a -- [photon] b,
  f1 [particle=\(\mu^-\)] -- [fermion] b -- [fermion] f2 [particle=\(\mu^+\)],
};
\]

\section{Amplitude}
\[
\mathcal{M} \sim \frac{e^2}{q^2}
\]

\end{document}
```

Try This!

- Customize each template with your title, name, and topic
- Add one figure and one equation per section
- Compile on Overleaf to preview and export

What's Next

In our final chapter, we'll point you toward excellent LaTeX resources, physics TeX communities, and advanced package documentation.

Chapter 14

Further Resources

14.1 TikZ, PGFPLOTS, and Physics Drawing Tools

- **TikZ** — Core drawing library `https://tikz.dev`
- **PGFPLOTS** — 2D/3D graph plotting `https://ctan.org/pkg/pgfplots`
- **TikZ-Feynman** — Feynman diagram toolkit `https://jpellis.me/projects/tikz-feynman/`

14.2 Physics Writing Templates

- Overleaf Physics Report Template `https://www.overleaf.com/latex/templates/physics-lab-report/zxvcpksvkfnt`
- APS and AIP Manuscript Templates `https://journals.aps.org/revtex`, `https://publishing.aip.org/resources/templates/`
- arXiv Submission Help `https://arxiv.org/help/submit_tex`

14.3 TeX Communities and Forums

- **TeX StackExchange** (Physics-specific tags): `https://tex.stackexchange.com/questions/tagged/physics`
- **LaTeX Reddit**: `https://reddit.com/r/LaTeX`
- **Overleaf Learn**: `https://www.overleaf.com/learn`

- **TikZ Gallery**: `https://www.texample.net/tikz/`

14.4 Reference Management

- **Zotero + Better BibTeX Plugin**
- **JabRef** — Open-source BibTeX GUI `https://www.jabref.org`
- **BibGuru** — Online BibTeX generator `https://www.bibguru.com/latex/`

14.5 Final Advice and Acknowledgments

> *LaTeX is not just about formatting — it's about communicating physics clearly, rigorously, and beautifully.*

With Thanks To:

- TeX developers and the physics LaTeX community
- Open-source authors of packages featured in this book
- Students and educators who inspired this guide

License

Final Challenge

- Recreate your favorite problem set or derivation using LaTeX
- Submit your notes or poster using Overleaf
- Teach a fellow physicist to use LaTeX!