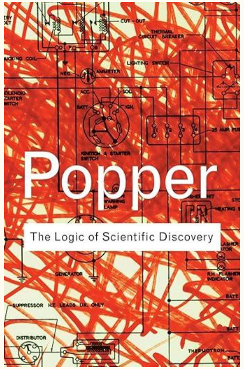
LECTURE III

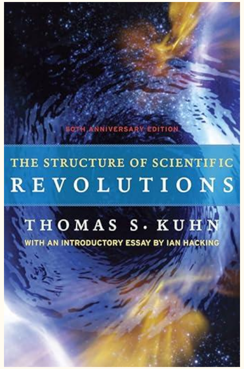
ORAL EXAM PRACTICE SESSION

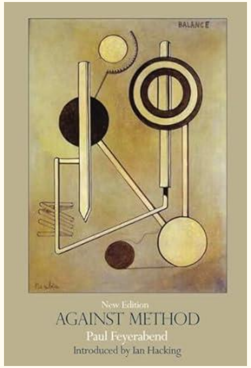
CLASSICAL MECHANICS

Foundations of Science I
Prof. Overbey
4/8/25

CHOOSE 2 FOR READING WEEK



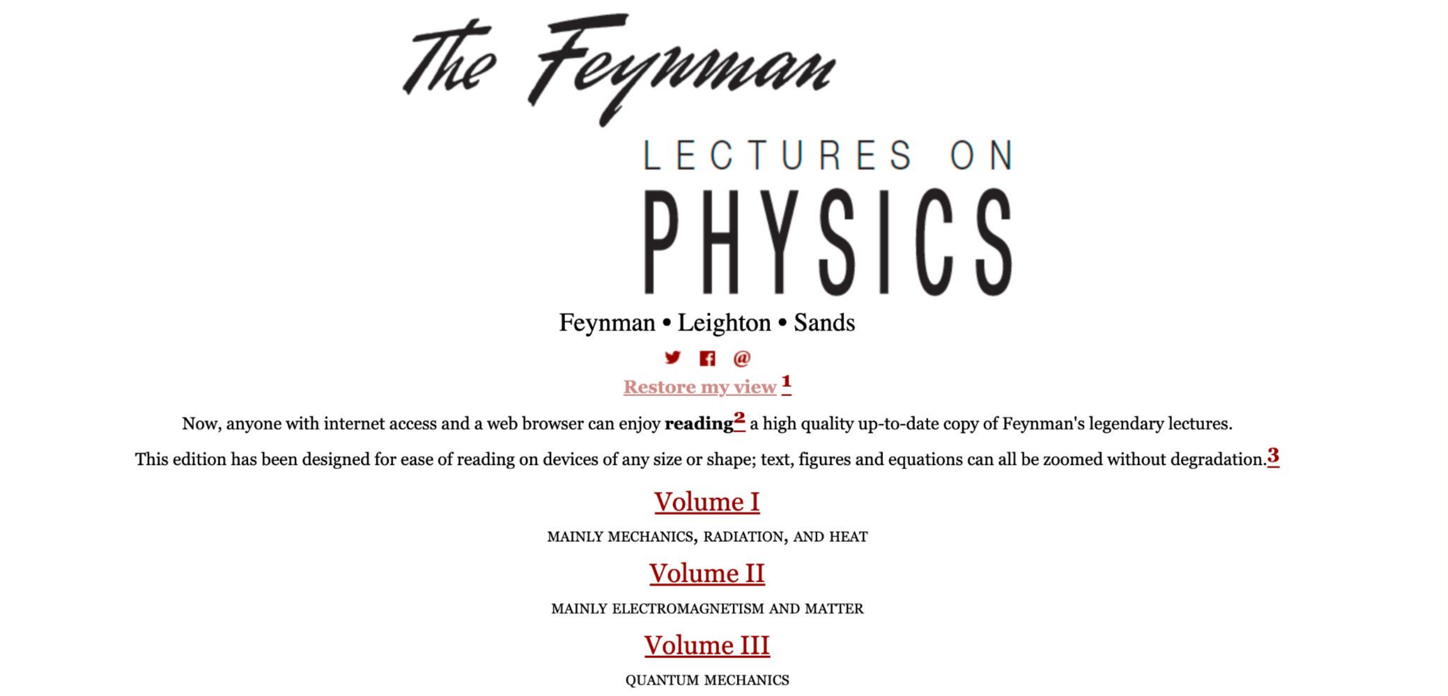




TECHNICAL LECTURE REFLECTIONS

[Assignment Link]

FEYNMAN LECTURES



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LECTURES ON
PHYSICS

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Restore my view [1]

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This edition has been designed for ease of reading on devices of any size or shape; text, figures and equations can all be zoomed without degradation.[3]

Volume I

MAINLY MECHANICS, RADIATION, AND HEAT

Volume II

MAINLY ELECTROMAGNETISM AND MATTER

Volume III

QUANTUM MECHANICS

TYPES OF READING

EXPLORATORY READING
VS
GOAL-ORIENTED READING

TYPES OF READING

Dimension	Exploratory Reading	Goal-Driven Reading
Primary Goal	Build understanding, curiosity, and conceptual depth	
Approach	Open-ended, broad, inquisitive	
Common Contexts	Studying new topics, reviewing literature, ideation	
Reading Style	Linear or meandering, open to tangents	
Strategies Used	- Previewing structure - Annotating ideas - Asking 'What is this about?' and 'How does this fit in?' - Making connections to other knowledge	
Cognitive Emphasis	Comprehension, synthesis, curiosity	
Outcome	Deeper understanding, broad mental models	

TYPES OF READING

Dimension	Exploratory Reading	Goal-Driven Reading
Primary Goal	Build understanding, curiosity, and conceptual depth	Find specific information or achieve a task
Approach	Open-ended, broad, inquisitive	Focused, selective, purposeful
Common Contexts	Studying new topics, reviewing literature, ideation	Solving a case, answering a question, doing research
Reading Style	Linear or meandering, open to tangents	Non-linear, skips to relevant parts
Strategies Used	- Previewing structure - Annotating ideas - Asking 'What is this about?' and 'How does this fit in?' - Making connections to other knowledge	- Skimming for keywords - Asking 'Does this help answer my question?' - Extracting relevant details - Applying content to a specific case
Cognitive Emphasis	Comprehension, synthesis, curiosity	Analysis, evaluation, decision-making
Outcome	Deeper understanding, broad mental models	Problem resolution, task completion, actionable insight

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Reading Week Essay **Oral Exam Prep**

ORAL EXAM

PRACTICE SESSION I

QUESTIONS

1. Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

2. Why do we feel "thrown outward" on a turning carousel, even though there’s no outward force?

3. How does a ball bounce differently from a piece of clay?

ANSWERING A QUESTION

Blueprint

1) Restate the Question
2) State the Key Concept(s)
3) Present the Relevant Equation(s)
4) Interpret the Result
5) Conclude your answer

EXAMPLE

Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

ANSWERING A QUESTION

Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

1) Restate the Question

   Start with a quick paraphrase to anchor the discussion.

   > “The question is about why all objects — including a feather — fall at the same rate in a vacuum, and what causes the difference in behavior in air?”

ANSWERING A QUESTION

Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

2) State the Key Concept(s)

Identify and explain the central idea in clear language.

> "This involves **Newton's Second Law of Motion** and the concept of **air resistance**. In a vacuum, gravity is the only force acting on a falling object. In air, the object also experiences a resistive force — **drag** — which opposes motion. This explains the difference in how objects fall in different environments."

ANSWERING A QUESTION

Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

3) Present the Relevant Equation(s)

> Starting with Newton's Second Law:
>
> $$F = ma$$
>
> In a vacuum, the only force is gravity:
>
> $$F_{\text{gravity}} = mg$$
>
> So we substitute into Newton's law: $ma = mg \Rightarrow a = g$

In air, we must account for **air resistance**. Feynman presents two common models:

Linear drag (for small objects or low speeds): $F_{\text{drag}} = -kv$

Quadratic drag (for larger objects or higher speeds): $F_{\text{drag}} = -cv^2$

- k and c are constants depending on air density, object shape, and cross-sectional area
- v is velocity
- The negative sign shows the drag force opposes motion

At **terminal velocity**, drag balances gravity:

Linear case: $mg = kv$

Quadratic case: $mg = cv^2$

These equations explain why the feather slows down in air but not in a vacuum.

ANSWERING A QUESTION

Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

4) Interpret the Result

> "A feather has a small mass and a large surface area, so the drag force becomes significant very quickly as it falls. In air, the net force becomes small as air resistance nearly balances gravity, so the feather falls slowly. Eventually, the feather reaches **terminal velocity**, where:
>
> $$mg = cv^2 \quad \text{or} \quad mg = kv$$
>
> meaning it stops accelerating and continues falling at a constant slow speed.
>
> In a vacuum, however, there's no drag force. The feather experiences only gravity, so it accelerates just like any other object and its velocity increases indefinitely (no terminal velocity)"

ANSWERING A QUESTION

Why does a feather drift down slowly through air but fall at the same rate as a hammer in a vacuum?

5) Conclude your answer

> "In summary, all objects fall at the same rate in a vacuum because mass cancels out in F=ma when only gravity is present. A feather falls more slowly in air because of air resistance, modeled by $-kv$ or $-cv^2$, which reduces its acceleration. But in a vacuum, with no air resistance, the feather falls just as fast as a rock."

WHAT WAS WRONG WITH THE ANSWER?