



AI First Engineering

FUNDAMENTALS OF AI-AUGMENTED ENGINEERING

Chapter 1/Part 1 Lab Extension Challenge Report

Four Balls — One Height

LAB EXTENSION CHALLENGE — INDIVIDUAL SUBMISSION

Individual submission: The main Chapter 1-Part 1 laboratory is performed collaboratively. This Extension Challenge is completed and submitted individually so that every student independently practices the experimental, computational, AI-assisted, and engineering-judgment skills developed during the team lab. You may discuss concepts with classmates and may use an AI teammate as directed in the assignment, but you must independently analyze the provided videos, perform the quantitative analysis, evaluate the evidence and AI suggestions, and make your own engineering judgment. You may begin this challenge during the laboratory period or complete it outside the laboratory. Suggested Assessment: **10 points** (rubric on the last page).

Student Information

Student name	
Student ID (if applicable)	
Date	
Lab section (if applicable)	

How to use this template: replace every gray italic guide with your own evidence and reasoning, and delete nothing else. Concise evidence + engineering reasoning beats pages of polished prose. This is a compact challenge — not another full laboratory report. The final section is where you take responsibility for your work.

1. Committed Prediction

Record **BEFORE** any quantitative analysis of the slow-motion videos. Do you expect all four balls to reach the ground at essentially the same time, or measurably different times? If one arrives first, which one — and what is the physical reasoning behind your prediction?

2. Ideal Model Prediction

The simple free-fall model — the same model you computed with earlier in this lab.

$$t = \sqrt{(2h/g)}$$

with $h = 1.854 \text{ m}$ and $g = 9.81 \text{ m/s}^2$

Notice: mass and diameter do not appear anywhere in this model — it predicts the same fall time for all four balls.

Calculated ideal fall time: $t_{\text{ideal}} =$ _____ s

3. Experimental Evidence

Measure one fall time per ball from the provided slow-motion videos, using the same video-analysis method you used earlier in this lab (frame trimming or Tracker). Record how you extracted each value.

$$\% \text{ diff} = (t_{\text{measured}} - t_{\text{ideal}}) / t_{\text{ideal}} \times 100$$

Ball	Mass (g)	Diameter (mm)	Measured Fall Time (s)	Ideal Fall Time (s)	Difference (s)	Percent Difference
SBB	15	29				
SSB	67	29				
LBB	90	57				
STB	57	66				

Video frame rate used: _____ fps Method: (trim method / Tracker)

4. Can We Actually Distinguish the Cases?

Estimate the timing resolution of your video measurement (roughly one frame $\approx 1 / \text{frame rate}$, in seconds). Then answer the key question — quantitatively, but without advanced uncertainty analysis:

Are the measured differences among the four balls larger than the measurement / video-resolution uncertainty — or could some differences simply be within it?

5. What Do Mass and Diameter Tell You?

SBB and SSB have the same diameter (29 mm) but substantially different masses (15 g versus 67 g). What does your experimental evidence suggest from this comparison? Then consider all four balls collectively: does mass, diameter, or some combination appear related to the observed discrepancies? Use your measured evidence — not what you expected to see.

6. AI Teammate — Generate Hypotheses

Give any capable AI assistant (your Engineering Companion) the following challenge prompt:

“Four balls of different masses and diameters were dropped individually from the same height. The simple free-fall model predicts the same fall time for all four. What physical effects could cause small differences in their measured fall times?”

Record a concise summary of the most relevant AI-generated hypotheses. Do NOT paste the entire AI conversation.

7. Human Validation — Challenge the AI

Distinguish **PHYSICALLY POSSIBLE** from **LARGE ENOUGH TO MATTER**. Critique the AI-generated explanations against your experimental evidence: which are plausible for this experiment, which are actually supported by your measurements, which are real but probably too small, and which you cannot verify at all?

A physically possible explanation is not necessarily an explanation large enough to account for the measured discrepancy.

8. ENGINEER DECIDES — Final Judgment

Based on your measurements AND the measurement / video-resolution uncertainty, is the simple free-fall model $t = \sqrt{(2h/g)}$ adequate for all four balls? Support your answer with quantitative evidence. Either conclusion is acceptable if supported by quantitative evidence and defensible engineering reasoning.

If your evidence suggests that the physical model should be improved: what physical effect would you consider adding? Conceptually, how would improving the physical model change the computer program used earlier in the lab? (You are NOT expected to derive or program an air-drag model.)

Better physical model → different computational model → different computer program

9. Suggested Assessment Rubric — 10 Points

Criterion	Points
Prediction and physical reasoning	1
Quantitative analysis / results table	3
Measurement resolution / uncertainty reasoning	2
Mass / diameter comparison	1
AI use AND critical evaluation	2
Final engineering judgment / model improvement	1
TOTAL	10

10. Human Review & Approval

"I have reviewed my measurements, calculations, AI-assisted analysis, and engineering conclusions. I accept responsibility for the submitted engineering work."

Human reviewed and approved.

Would you confidently put your name on this result? Sign only when the answer is yes.

Name · Signature · Date

AI assists. Humans observe. Humans verify. Humans decide. Humans approve.