UNIT 1 — KINEMATICS & MOTION

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

AP Physics C/ECE1401 · ECE1201 · Honors Physics

All three pathways study 1D and 2D motion, projectiles, graphing, and identical physical investigations. Calculus activities are completed ONLY by AP Physics C/ECE1401.

Instructions: use the illustrated website notes for explanation; work each problem in the spaces provided. Show diagrams, equations, units, interpretation and uncertainty. Complete each laboratory in the web Lab Studio and print its report.

STRIDES STUDY ROUTINE

S SUBJECT	Name the physical topic and the system.
T TOPIC	State the precise question and assumptions.
R RULES	Record key equations or relationships.
I ILLUSTRATIONS	Draw labeled axes, graphs and vectors.
D DEFINITIONS	Define symbols and scientific language.
E EXAMPLE	Record a modeled example in your own steps.
S STEPS	Solve, check units, and interpret.

Pathway ☐ Honors Physics ☐ ECE1201 ☐ AP Physics C/ECE1401

Student name / period / goal for Unit 1

1.1 • REFERENCE FRAMES

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Vocabulary: position, displacement, distance, speed, velocity, acceleration, reference frame, coordinate origin.

SUBJECT / TOPIC / DEFINITIONS

RULES / EQUATIONS (with units)

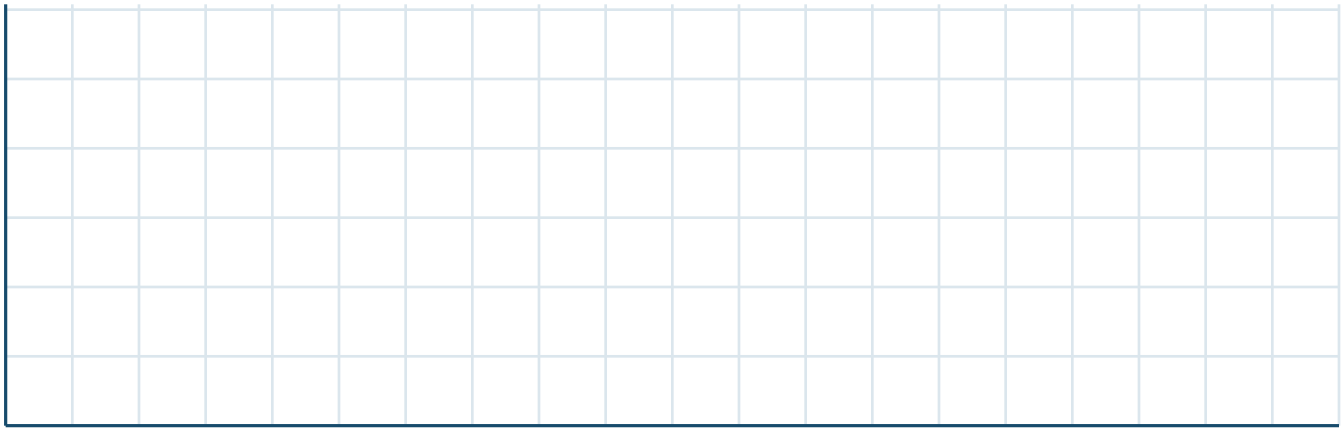
ILLUSTRATIONS: draw motion with a reversal, choose +x

EXAMPLE / STEPS: compare total distance with signed displacement

1.2 • MOTION GRAPHS

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Draw matching x–t, v–t and a–t graphs for an object beginning at x=0, moving with v_0=+2 m/s and constant a=+1 m/s² for 4 s. Label axes, slopes, and graph shapes.



A Explain how slope of x–t relates to velocity and how slope of v–t relates to acceleration.

B A velocity graph rises from −2 m/s to +4 m/s over 3 s. Find acceleration and signed displacement using geometric areas.

1.3 • ONE-DIMENSIONAL MOTION

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Use the constant-acceleration relationships. Sketch an axis and give signs and units for all computed values.

1 A runner starts at $x=-6$ m, moves at $v_0=+4.0$ m/s, and accelerates at -1.0 m/s². Find position and velocity after 5.0 s.

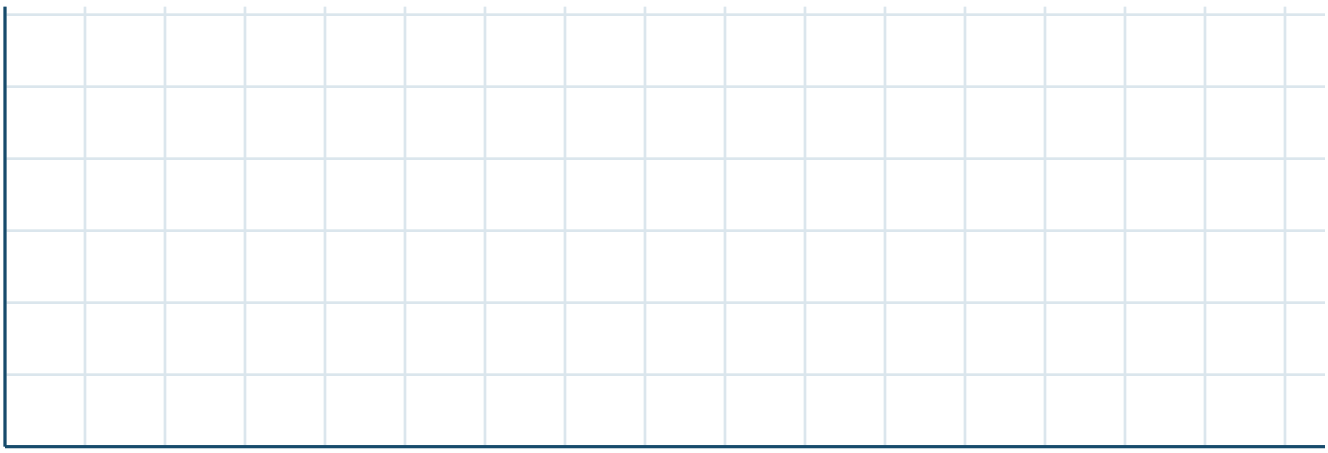
2 A rider traveling +15 m/s brakes steadily at -3.0 m/s². Find stopping time and displacement before rest.

3 A projectile is thrown upward at 12.0 m/s. With +y upward, find time to apex, maximum vertical displacement, and acceleration at apex.

1.4 • VECTOR COMPONENTS

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Draw each vector from an origin; use a right triangle to resolve components.



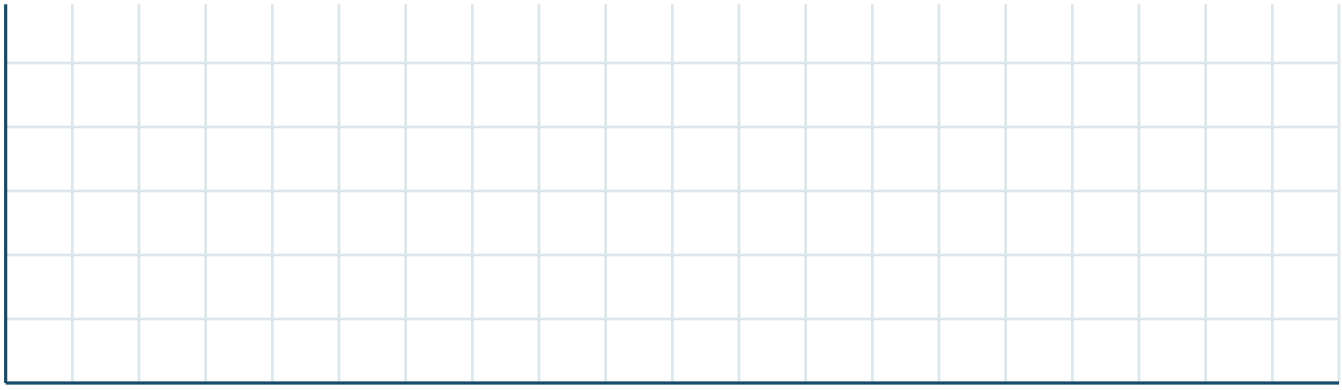
1 A velocity vector is 18.0 m/s at 40° above +x. Resolve into x and y components; express in unit-vector form.

2 A displacement is $(-9\hat{i}+12\hat{j})$ m. Find magnitude and the angle measured counterclockwise from +x.

1.5 • PROJECTILE MOTION

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

For each, draw x and y axes, decompose the initial velocity, and write both position equations before solving. Do not assume launch and landing heights are equal.



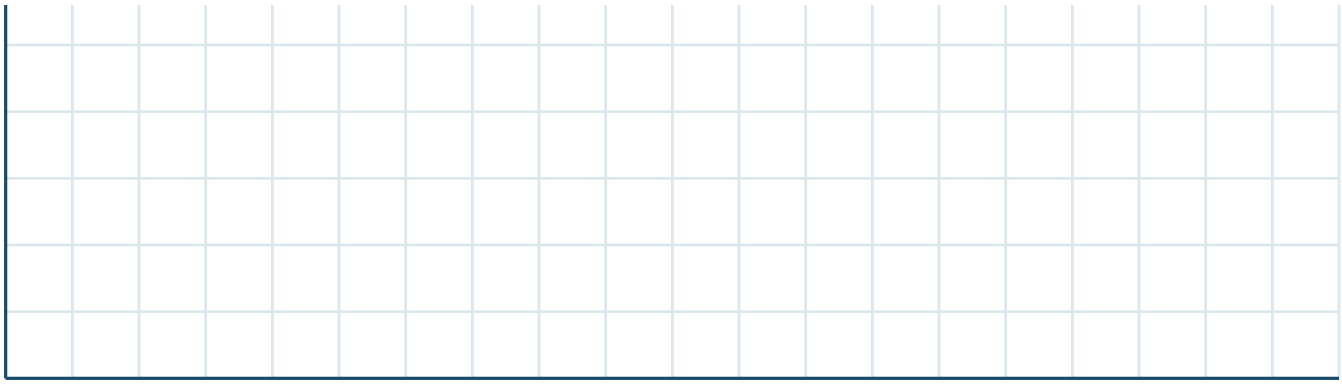
1 A ball leaves a 1.6 m tabletop horizontally at 4.2 m/s. Find time to ground and range. Ignore drag.

2 A ball launches at 14.0 m/s, 32° above horizontal, from a balcony 2.5 m high. Find time to impact and horizontal range.

1.6 • RELATIVE MOTION

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Reference-frame labels must name both the moving object and the observer.



1 A boat moves 4.0 m/s across the river relative to water. Water moves 2.0 m/s downstream. River width is 90 m. Find crossing time, downstream drift, and shore-relative speed.

2 Explain what velocity an observer on the shore measures and which motion components depend on the current.

1.7 • FITTING MOTION DATA

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

For every path, identify the fitted coefficient meanings using algebraic coefficient comparison.

1 Vernier reports $y(t)=0.65+2.80t-4.82t^2$, with y in meters and t in seconds. Identify y_0, initial velocity, acceleration, and percent error in $|g|$ relative to 9.80 m/s^2.

2 Explain which changes to a motion sensor would create random scatter and which might produce systematic bias. How can you detect a poor model fit?

Sketch your chosen experiment: measured position points and fitted curve

1.8 • CALCULUS EXTENSION

AP Physics C/ECE1401 • CALCULUS ONLY

Honors Physics and ECE1201 students skip this page. Show differentiation, integration limits, constants and units.

1 Given $x(t)=1+4t^2-t^3$ (SI), find $v(t)$, $a(t)$ and the time $t>0$ when $a=0$.

2 Given $a(t)=4t-1$ (SI), $v(0)=3$ m/s, $x(0)=-2$ m, derive $v(t)$ and $x(t)$, then find $x(2\ s)$.

3 Use the chain rule $a=v(dv/dx)$. If $a(x)=2x$ and $v(0)=1$ m/s, derive $v^2(x)$ without time.

1.8 • VERNIER ANALYSIS

AP Physics C/ECE1401 • CALCULUS ONLY

With Vernier, obtain a measured velocity–time graph, choose an interval, and use the Integral analysis tool to estimate signed displacement. Compare the result to measured Δx.

Sketch a measured v(t) trace and shade your chosen integral interval

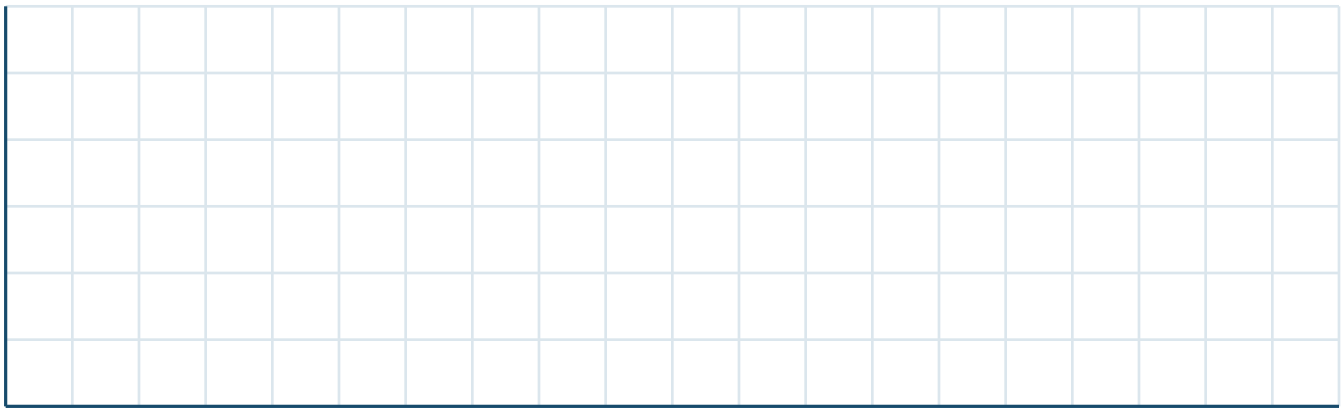
1 For $v(t)=3+2t^2$ (SI), compute displacement from 0 to 2 s using an integral. Report the sign and units.

2 A position fit is $y=A+Bt+Ct^2$. Derive the predicted velocity and acceleration functions from it. Explain why noisy differentiated sensor data may differ.

LAB A • GRAPH MATCHING

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Your task is to walk in front of a physical motion detector to produce a target x–t and v–t trace. Keep the same coordinate convention throughout.



Prediction: how should you move, stop and reverse?

Trial 1 / 2 / 3: measured differences from target

Refinement and comparison to the target

LAB B • MEASURING GRAVITY

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Collect a safe vertical-motion dataset and choose a clean time interval. Record position as function of time. All three pathways fit a quadratic; 1401 additionally differentiates the fit and integrates v(t).

Apparatus, sensor orientation, sign convention, resolution

1	time (s): _____	y (m): _____	v (m/s, optional): _____
2	time (s): _____	y (m): _____	v (m/s, optional): _____
3	time (s): _____	y (m): _____	v (m/s, optional): _____
4	time (s): _____	y (m): _____	v (m/s, optional): _____
5	time (s): _____	y (m): _____	v (m/s, optional): _____
6	time (s): _____	y (m): _____	v (m/s, optional): _____
7	time (s): _____	y (m): _____	v (m/s, optional): _____

Fit coefficients A, B, C; derived a=2C; RMSE / repeatability

LAB B • UNCERTAINTY & SYNTHESIS

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Compare the experimental g from the quadratic fit with 9.80 m/s² and an uncertainty estimate. Identify calibration errors and residual patterns.

1 Show numerical percent difference and uncertainty of the fitted acceleration (if available). State whether the model is consistent with accepted g.

2 Explain how two different fitting intervals could change your result, and how you would improve the data collection.

AP 1401 only: Vernier integral value, physical interval and comparison to Δy

LAB C • PROJECTILE DESIGN

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Design a repeatable physical launch. Define a coordinate origin, measure launch height, angle and initial speed, and predict impact. Unit 1 uses kinematics only.



Sketch apparatus with axes, dimensions and uncertainty labels

Write y(t)=0 landing condition, solve positive t, calculate range

LAB C • TRIAL DATA

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Hold launch conditions constant for at least five releases. Record actual range and report mean, SD and model discrepancy.

Trial 1	Range (m) _____	Notes _____
Trial 2	Range (m) _____	Notes _____
Trial 3	Range (m) _____	Notes _____
Trial 4	Range (m) _____	Notes _____
Trial 5	Range (m) _____	Notes _____
Trial 6	Range (m) _____	Notes _____
Trial 7	Range (m) _____	Notes _____

Mean range, sample SD, SEM and measured − predicted

Sources of measurement uncertainty and control variables

LAB C • CONCLUSION & NEXT STEP

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Propagate measured-input uncertainties into the predicted range (algebraic uncertainty model for all; derivative-based sensitivity optional in 1401). Report both random and systematic sources.

Uncertainty model, units, dominant source and numerical comparison

Claim + at least two numerical evidence statements

Reasoning, limitations, and a specific redesign or refinement

UNIT 1 • READINESS CHECK

SHARED • AP Physics C/ECE1401 | ECE1201 | Honors Physics

Before Unit 2, you should be able to represent the same motion using words, vectors, graphs, equations and real data.

1 Explain the difference between acceleration and velocity, including one case where they have opposite signs.

2 Explain how both directions of a projectile share time but behave differently when drag is neglected.

3 Describe how a fitted graph and measurement uncertainty provide evidence for or against a model.

What do you need to review? Record lesson number and specific skill