

AP Physics C: Mechanics 2026-27

Summer Assignment



ASSIGNMENT OVERVIEW

1. Introduction
2. Motion Basics and Concept Checks
3. Motion Strategies
4. Practice Problems with Answers
5. Practice Problems with Submission QR Code

1. Introduction

AP Physics C: Mechanics is a calculus-based, college-level physics course that incorporates algebraic principles. The applicable calculus for this course includes integrals, derivatives, and differential equations. AP Physics C Mechanics covers kinematics, Newton's laws of motion, work, energy, systems, linear momentum, circular motion, rotation, oscillations, and gravitation. If time allows, we will finish the year with content from the calculus-based Electricity and Magnetism course. Physics is learned through measurement, experimentation, critical thinking, and problem solving. This course is a strong foundation for further study in the physical sciences and engineering as well as a proving ground for critical thinking and problem solving.

This assignment will be turned in at the beginning of the first class on Tuesday August 11th. The following items will need to be submitted for full credit:

- This completed document (10%)
- Attached, fully worked out solutions that include appropriate unit analysis for ALL practice problems (78%)
- Answers submitted online for the second set of practice problems (12% based on accuracy)

*If you would like a paper copy of any linked documents, come to room 111 before 5/19. I will check my email periodically this summer. You are welcome to contact me with any questions and I will do my best to answer them via email: mclarkston@rcps.info

Good luck, enjoy your summer, and I look forward to seeing you all August 11th.

Mr. Clarkston

2. Motion Basics and Concept Checks

Physics begins with a study of motion and builds from there. Often, math classes use motion while teaching to provide real life examples. This is meant to be a review of common applications of skills you learned in precalculus and calculus AB. This material was also covered in the first-year physics course to a lesser extent.

Directions: Use the QR code to access chapter 3 of University Physics and complete the unit outline and concept checkers (optional) throughout the summer assignment. The blanks are not "word for word" answers from the reading. You should digest the information and fill in blanks appropriately.



Position

Position is _____ and is normally referenced to _____ because it is a convenient _____. Objects can be moving or not depending on the reference frame used.

Displacement

Displacement (Δx) is always a _____ and is calculated by using _____. Standard units in physics for any measurement of length are meters (m).

Displacement is the first **vector quantity** in physics. This means that it requires a direction. This can be a + or – sign, cardinal directions, polar coordinates, etc.

Net displacement is calculated by _____.

Distance is different from displacement in that it is a scalar quantity. Calculating the total distance traveled differs from calculating total displacement by _____.

Average Velocity

The rest of kinematics (motion) requires the use of the quantity time (standard unit of seconds). Time is another _____ (vector/scalar) quantity. This is because _____.

Average velocity is determined mathematically by _____.

Concept Check: Delivering Flyers

Jill sets out from her home to deliver flyers for her yard sale, traveling due east along her street lined with houses. At 0.5 km and 9 minutes later, she runs out of flyers and has to retrace her steps back to her house to get more. This takes an additional 9 minutes. After picking up more flyers, she sets out again on the same path, continuing where she left off, and ends up 1.0 km from her house. This third leg of her trip takes 15 minutes. At this point she turns back toward her house, heading west. After 1.75 km and 25 minutes she stops to rest.

- What is Jill's total displacement to the point where she stops to rest?
- What is the magnitude of the total displacement?
- What is the average velocity during her entire trip?
- What is the total distance traveled?
- Make a graph of position versus time.

Instantaneous Velocity

Instantaneous velocity tells us _____. In physics this is normally referred to simply as *velocity* (note: average velocity is usually explicitly stated).

Instantaneous velocity is used more often in physics, but average velocity is useful for objects with zero or constant acceleration. This will be revisited later.

Speed

Speed is like velocity except that it does NOT include _____. This makes it a _____ quantity. When calculating speed _____ is substituted for displacement.

Concept Check: Instantaneous Velocity Versus Average Velocity

The position of a particle is given by $x(t) = \left(3.0 \frac{m}{s}\right)t + (0.50 \frac{m}{s^3})t^3$

- Find the instantaneous velocity at $t = 2.0$ s.
- Calculate the average velocity between 1.0 s and 3.0 s.

Standard units in physics for ALL rates of change of lengths are in meters per second (m/s).

Acceleration

Acceleration is another _____ (vector/scalar) quantity that is formally defined as _____.

_____. This means that acceleration can occur due to either a change in _____ or a change in _____.

Instantaneous Acceleration

Instantaneous acceleration is almost always determined by using _____ (calculus/algebra). Since acceleration is directly tied to forces it becomes an incredibly important concept in almost every mechanics topic.

3. Motion Strategies

IMPORTANT: Physics revolves around applying fundamental principles that fall into two different scenarios:

- Constant conditions
- Variable conditions

It is useful to start classifying scenarios early in learning physics. **Constant condition** problems will involve algebraic based solutions. They can become more complex by introducing an IMMEDIATE change during the scenario but still rely on algebra-based solutions. Variable conditions REQUIRE the use of calculus (mainly integrals and derivatives). Sometimes an equation for the change is known, other times a substitution for the changing quantity must be determined. The next two sections will briefly go over main ideas for these scenarios based on types of motion. There are significantly more examples in the provided chapter that can be reviewed if needed. **THE FOLLOWING STRATEGIES AND EQUATIONS SHOULD BE USED WHEN COMPLETING THE PRACTICE PROBLEMS.**

Constant Conditions

Constant motion means that acceleration is either zero or some known value (either positive or negative). Thus, we can use some known derived equations to solve a litany of problems.

Position from Velocity with ZERO Acceleration

With zero acceleration an object's velocity will be constant. In this case average velocity will always be equal to the instantaneous velocity.

The following two equations are NOT listed on the official Equation Sheet but are useful to remember.

Position can be determined by

$$x = x_0 + \bar{v}t$$

where the average velocity is

$$\bar{v} = \frac{v_0 + v}{2}$$

Position and Velocity with Constant Acceleration

The following equations are all derived based on motion graphs (position vs. time and velocity vs. time). Understanding the derivation is not necessary. The following equations are all GIVEN on the class formula sheet.

Finding velocity

$$v = v_0 + at$$

Finding position

$$x = x_0 + v_0t + \frac{1}{2}at^2$$

A combination of the previous two equations is useful in situations where time is unknown.

$$v^2 = v_0^2 + 2a(x - x_0)$$

Free fall

Free fall is a common type of constant acceleration problem. Students are required to think vertically rather than horizontally and remember that acceleration due to gravity is a known constant close to earth. An object is considered in free fall IF only the force due to gravity is acting on the object. Until we go over air resistance in Unit 2 assume air resistance to be negligible unless otherwise stated.

The known value for the acceleration due to gravity on earth is:

$$g = 9.81 \text{ m/s}^2 \text{ (or } 32.2 \text{ ft/s}^2\text{)}$$

Unless otherwise stated you may use 10 m/s² for all calculations in AP Physics C.

Variable Conditions

Position from Velocity with NONZERO AND NONCONSTANT Acceleration

To repeat, any changing conditions will require the use of calculus. For motion we will involve integral calculus. Known integrals for motion include the following and are listed on the AP Physics C reference sheet.

Acceleration from the velocity function

$$v(t) = \int a(t)dt + C_1$$

Velocity from the position function

$$x(t) = \int v(t)dt + C_2$$

4. Practice Problems

Follow the QR code to view the practice problems. The first 15 will have answers posted following them. The last 10 problems will not. Answer to the last 10 questions will need to be submitted via the QR code found in part 5. WRITTEN WORK MUST BE SUBMITTED FOR ALL PROBLEMS ON August 11th.



5. Answer Submission

Use the QR code to submit answers to questions 1-10 that appear without a key. These will be graded for accuracy and will make up 12% of the grade for the summer assignment.

Submissions will close on August 11th at 8:30AM.

