You can draw here

Physics 111 - Class 3C
Kinematics III

Do not draw in/on this box!

September 24, 2021

You can draw here

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Class Outline

- Logistics / Announcements
- Anonymous Feedback
- HW 3 Reflection
- Worked Problems
- Test Review

Logistics/Announcements

- Lab this week: Lab 1
- HW due this week on Thursday at 6 PM
- Learning Log 3 due on Saturday at 6 PM
- HW and LL deadlines have a 48 hour grace period
- Test/Bonus Test: Test 1 available this week
  - Test Window: Friday 6 PM - Sunday 6 PM

Anonymous Feedback

AnonymousFeedbackBot
Anonymous Feedback: Physics 111
To: Firas Moosvi,
Reply-To: Firas Moosvi

Inbox - Exchange 3:03 PM

Feedback:

Hello Dr. Moosvi, I would like to draw attention to an issue with the homework on PrairieLearn. I believe that at the beginning of the course you said that we had multiple attempts for each homework question so that we could learn from our mistakes when we got a homework question wrong. However, there are some homework questions in which we only get a single attempt to submit the answer, without trying a new variant. For example, in HW3, questions 2, 4, 6, 8, 9, and 10 only had a single attempt without trying a new variant, while questions 1, 3, 5, and 7 had up to 3 attempts without having to try a new variant. I find that it is very annoying to only have a single attempt on some questions, because when I get a new variant I have to do all the calculations all over again because of new initial conditions. This means that if I made a simple calculation error, I have to redo the problem all over again. I am not sure if there is a specific reason why some questions have a single attempt and others have multiple attempts (e.g., up to 3 attempts). If there is a reason, could you please explain it? If there is not a reason, and this is a mistake, could you please make sure that in future homework assignments all the questions have multiple attempts? Thanks for reading this, I appreciate it.

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Adjustment (from HW 4 onwards)

- MCQ will have a limit of 2 attempts
- Other Qs will have a limit of 5 attempts

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Inbox - Exchange Yesterday at 6:48 PM

Anonymous Feedback: Physics 111

To: Firas Moosvi,

Reply-To: Firas Moosvi

Feedback:

I was wondering if you could upload some suggested problems from the textbook. It would be extremely helpful while working through the material if I had some idea of what problems I should be focusing on. Thanks :)

Response:

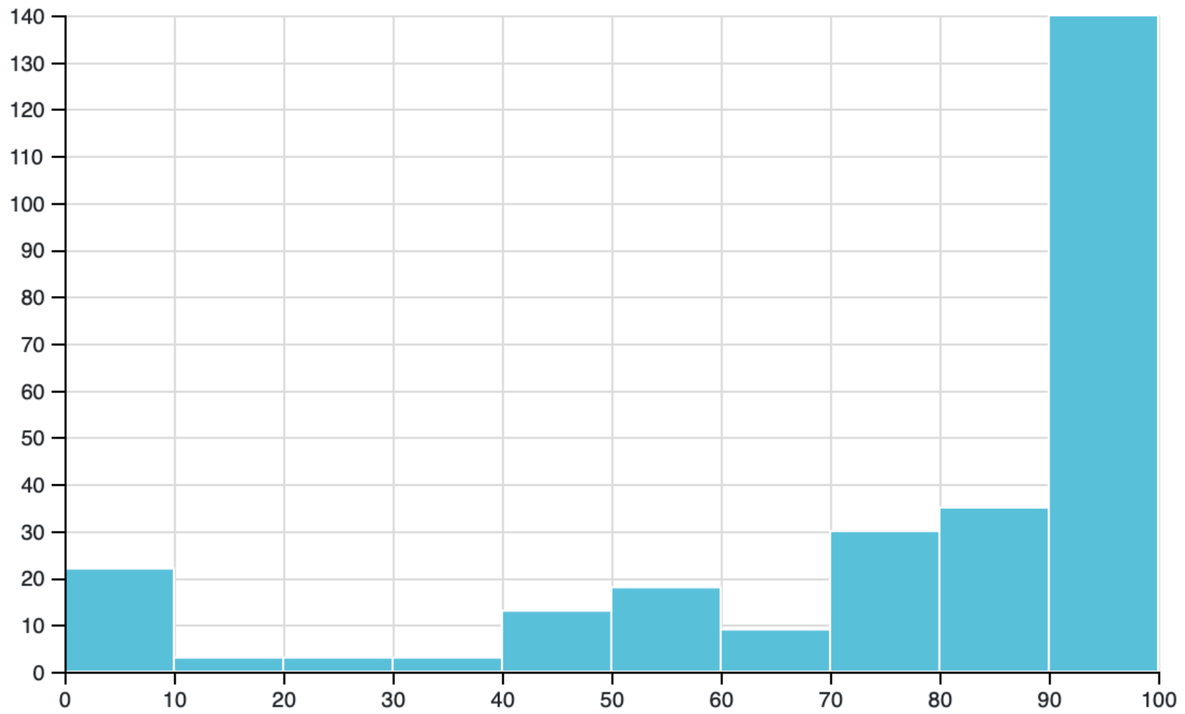
Yes, and I give permission to use your comments as-is.

Adjustment
(from HW 4 onwards)

- Will *TRY* to provide some selected textbook problems pre-HW

HW Reflection

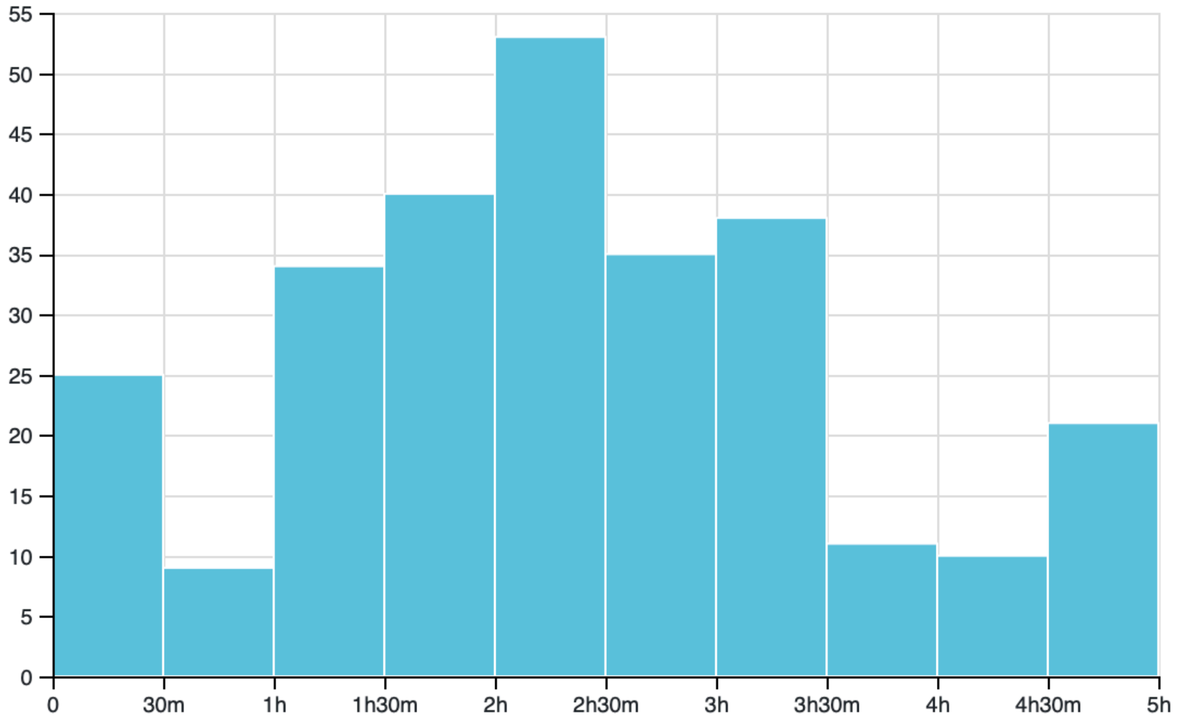
Homework 3: Score statistics



Number of students	276
Mean score	78%

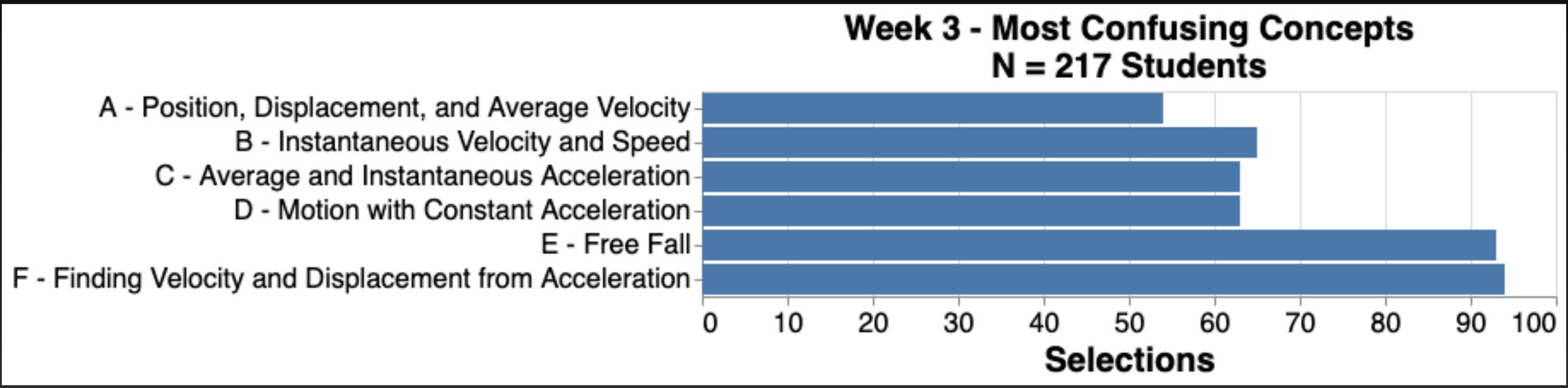
HW Reflection

Homework 3: Duration statistics



Mean duration	2h 21m
Median duration	2h 15m

HW Reflection



HW Reflection

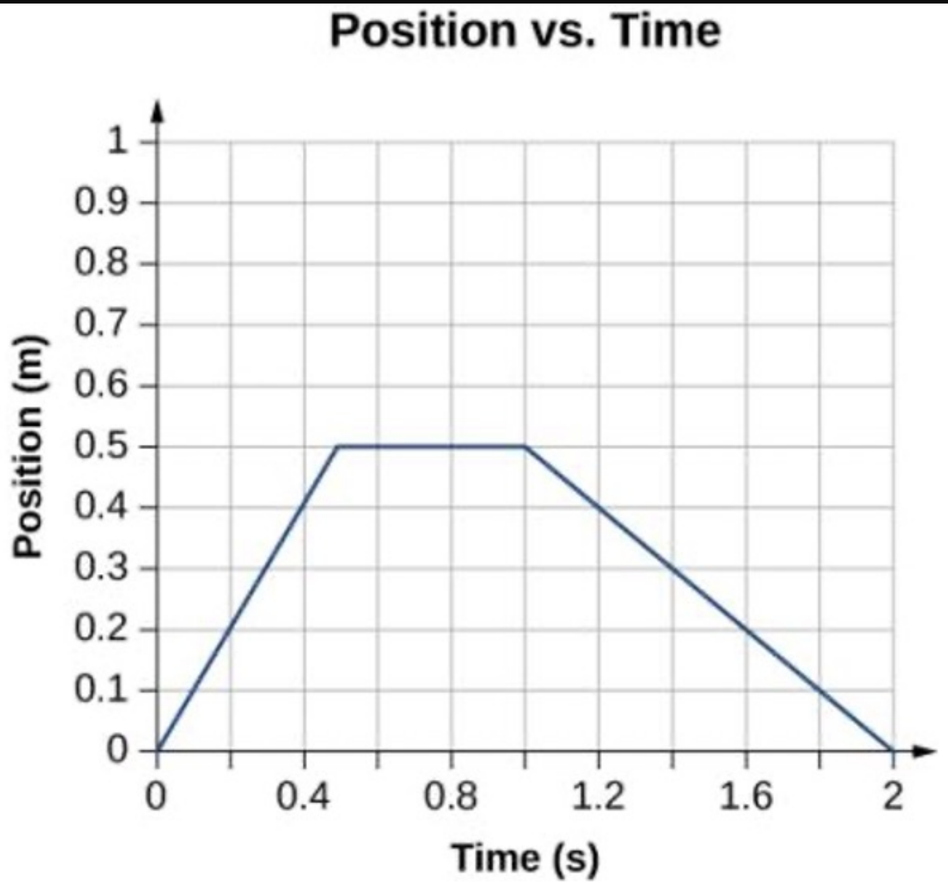
Lots of people said they were “rusty” with physics…
Wording was confusing, not clear what the question was asking…
Concepts related to Free Fall…
Confused about which formula to use when…
Where did momentum come from!?
Trouble with Calculus - derivatives and integrals
Calculating Area under the Curve (Integrals)
Lots of other comments … thank you!

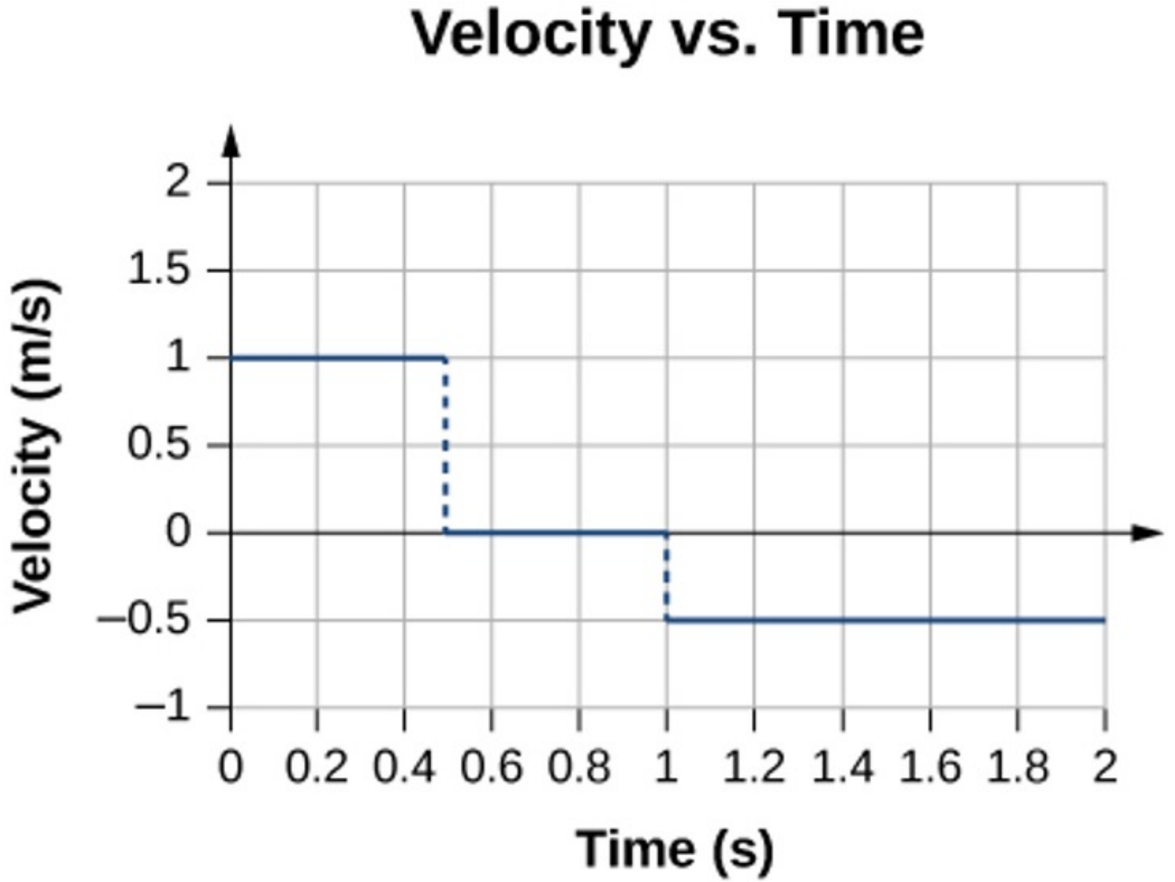
Figure 3.1 A JR Central L0 series five-car maglev (magnetic levitation) train undergoing a test run on the Yamanashi Test Track. The maglev train's motion can be described using kinematics, the subject of this chapter. (credit: modification of work by "Maryland GovPics"/Flickr)

Chapter Outline

Our universe is full of objects in motion. From the stars, planets, and galaxies; to the motion of people and animals; down to the microscopic scale of atoms and molecules—everything in our universe is in motion. We can describe motion using the two disciplines of kinematics and dynamics. We study dynamics, which is concerned with the causes of motion, in Newton's Laws of Motion; but, there is much to be learned about motion without referring to what causes it, and this is the study of kinematics. Kinematics involves describing motion through properties such

Position Graph to Velocity Graph





The object starts out in the positive direction, stops for a short time, and then reverses direction, heading back toward the origin. Notice that the object comes to rest instantaneously, which would require an infinite force. Thus, the graph is an approximation of motion in the real world. (The concept of force is discussed in **Newton's Laws of Motion**.)

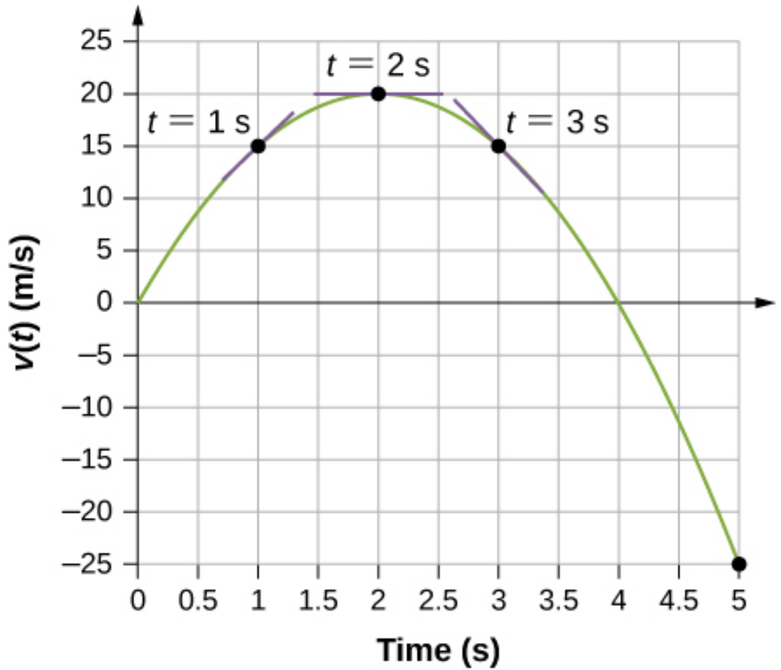
Velocity Graph to Acceleration Graph

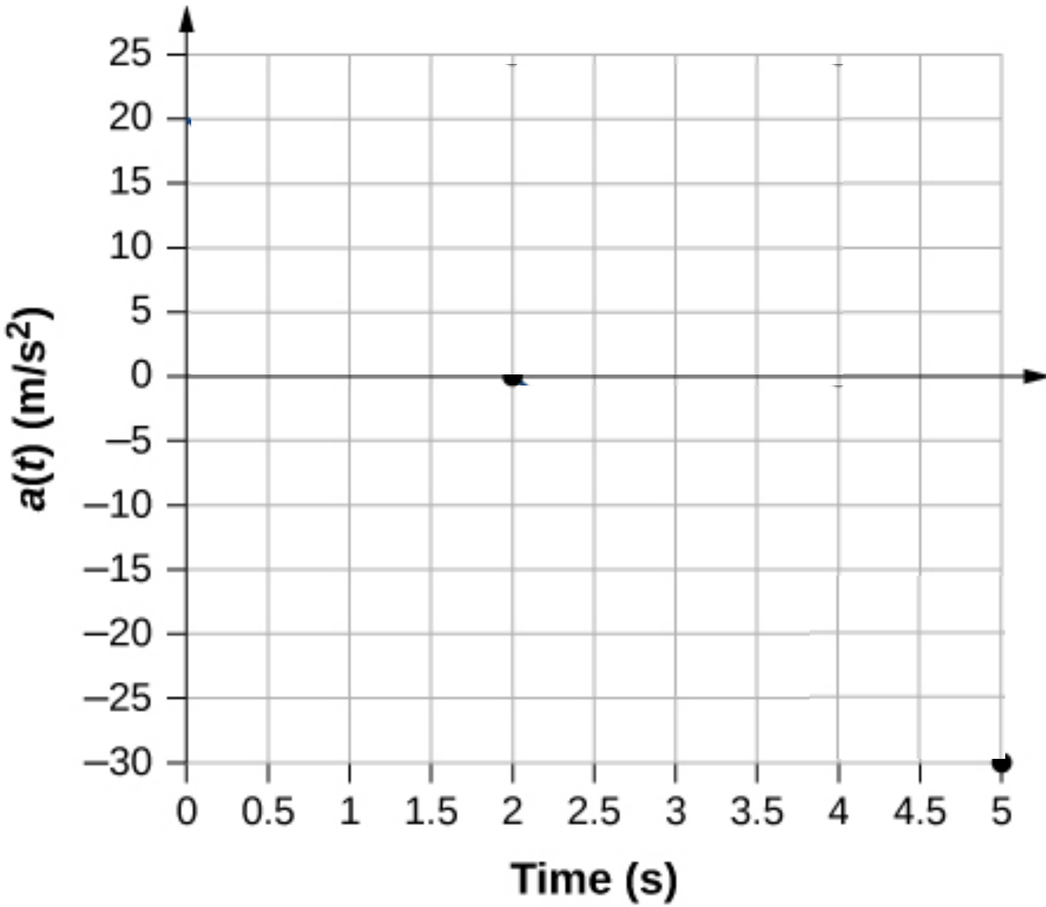
EXAMPLE 3.6

Calculating Instantaneous Acceleration

A particle is in motion and is accelerating. The functional form of the velocity is $v(t) = 20t - 5t^2$ m/s.

a. Find the functional form of the acceleration.
b. Find the instantaneous velocity at t = 1, 2, 3, and 5 s.
c. Find the instantaneous acceleration at t = 1, 2, 3, and 5 s.
d. Interpret the results of (c) in terms of the directions of the acceleration and velocity vectors.





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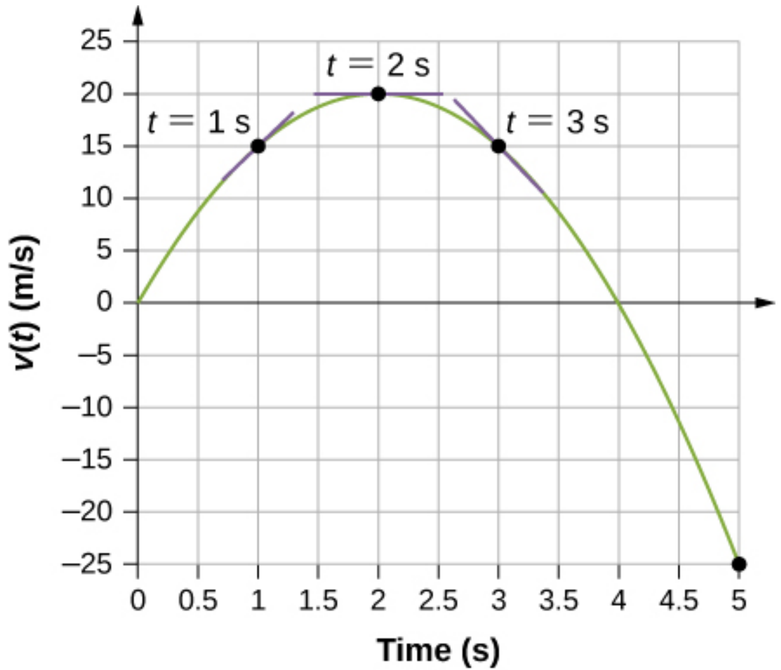

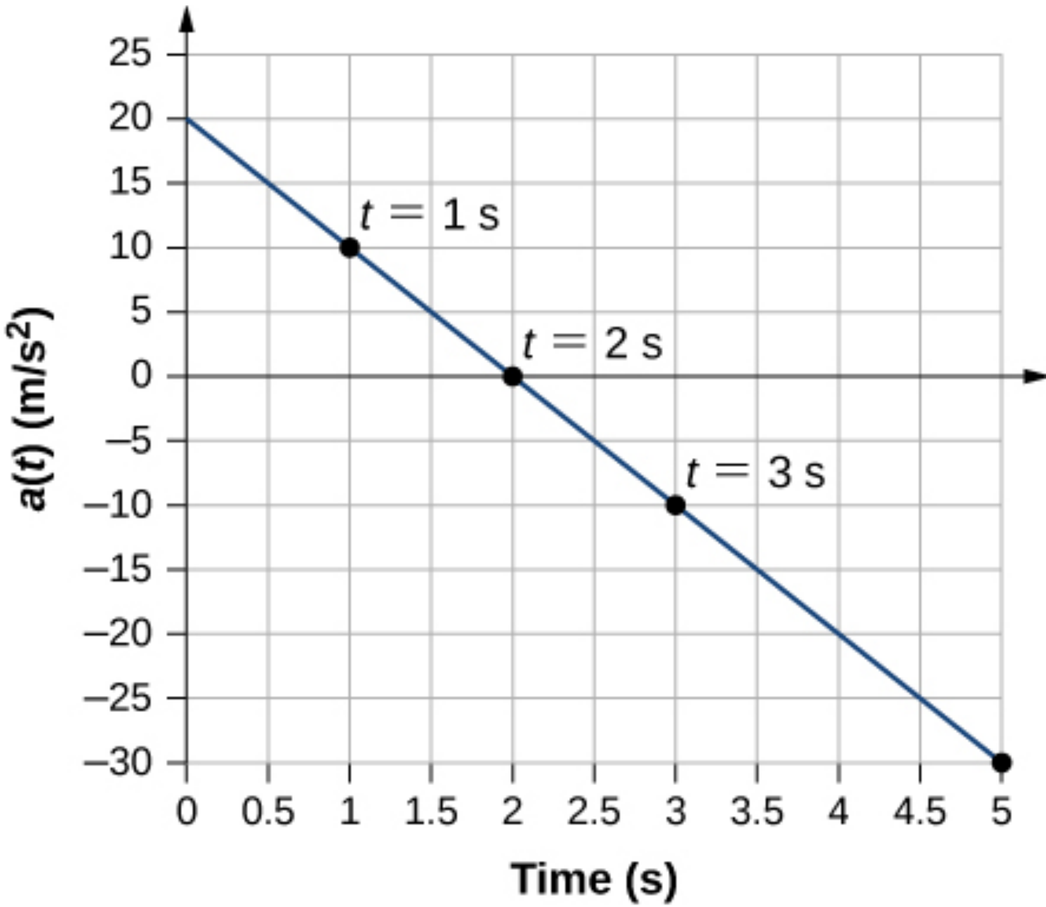

Key Equations

Displacement	$\Delta x = x_{\mathrm{f}} - x_{\mathrm{i}}$
Total displacement	$\Delta x_{\mathrm{Total}} = \sum \Delta x_{\mathrm{i}}$
Average velocity (for constant acceleration)	$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$
Instantaneous velocity	$v(t) = \frac{dx(t)}{dt}$
Average speed	$\text{Average speed} = \overline{s} = \frac{\text{Total distance}}{\text{Elapsed time}}$
Instantaneous speed	$\text{Instantaneous speed} = \lvert v(t) \rvert$
Average acceleration	$\overline{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t_f - t_0}$
Instantaneous acceleration	$a(t) = \frac{dv(t)}{dt}$
Position from average velocity	$x = x_0 + \overline{v}t$

Key Equations

Average velocity	$\overline{v} = \frac{v_0+v}{2}$
Velocity from acceleration	$v = v_0 + at$ (constant a)
Position from velocity and acceleration	$x = x_0 + v_0 t + \frac{1}{2}at^2$ (constant a)
Velocity from distance	$v^2 = v_0^2 + 2a\,(x - x_0)$ (constant a)
Velocity of free fall	$v = v_0 - gt$ (positive upward)
Height of free fall	$y = y_0 + v_0 t - \frac{1}{2}gt^2$
Velocity of free fall from height	$v^2 = v_0^2 - 2g(y - y_0)$
Velocity from acceleration	$v(t) = \int a(t)dt + C_1$
Position from velocity	$x(t) = \int v(t)dt + C_2$

Worked Problems

EXAMPLE 3.15

Vertical Motion of a Baseball

A batter hits a baseball straight upward at home plate and the ball is caught 5.0 s after it is struck Figure 3.28. (a) What is the initial velocity of the ball? (b) What is the maximum height the ball reaches? (c) How long does it take to reach the maximum height? (d) What is the acceleration at the top of its path? (e) What is the velocity of the ball when it is caught? Assume the ball is hit and caught at the same location.

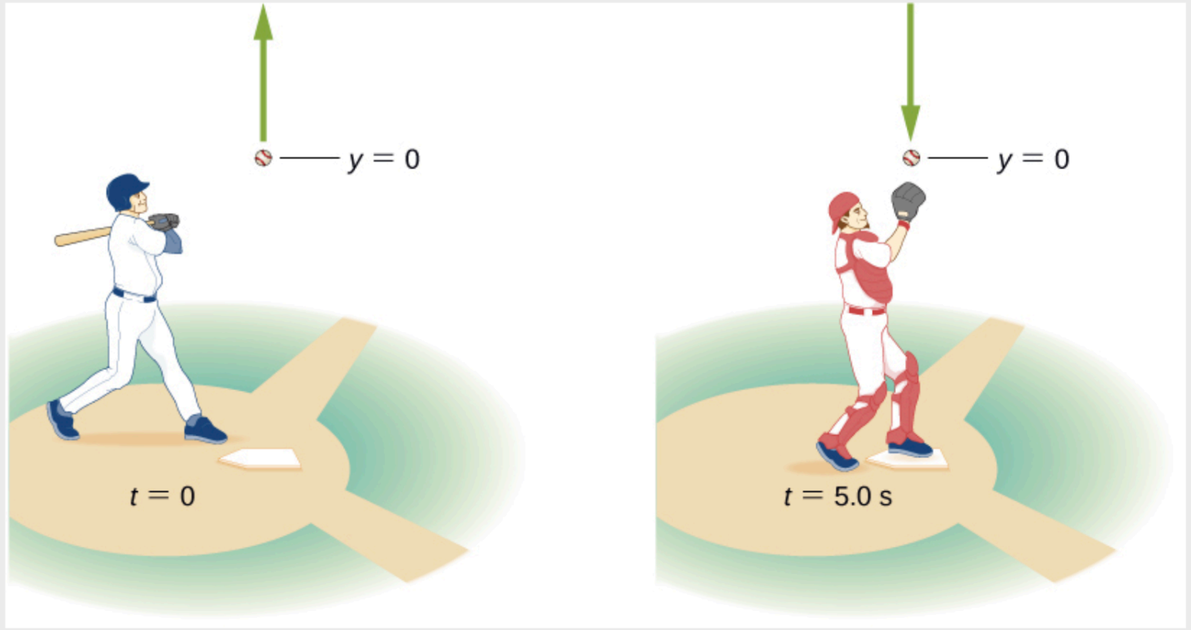

Figure 3.28 A baseball hit straight up is caught by the catcher 5.0 s later.

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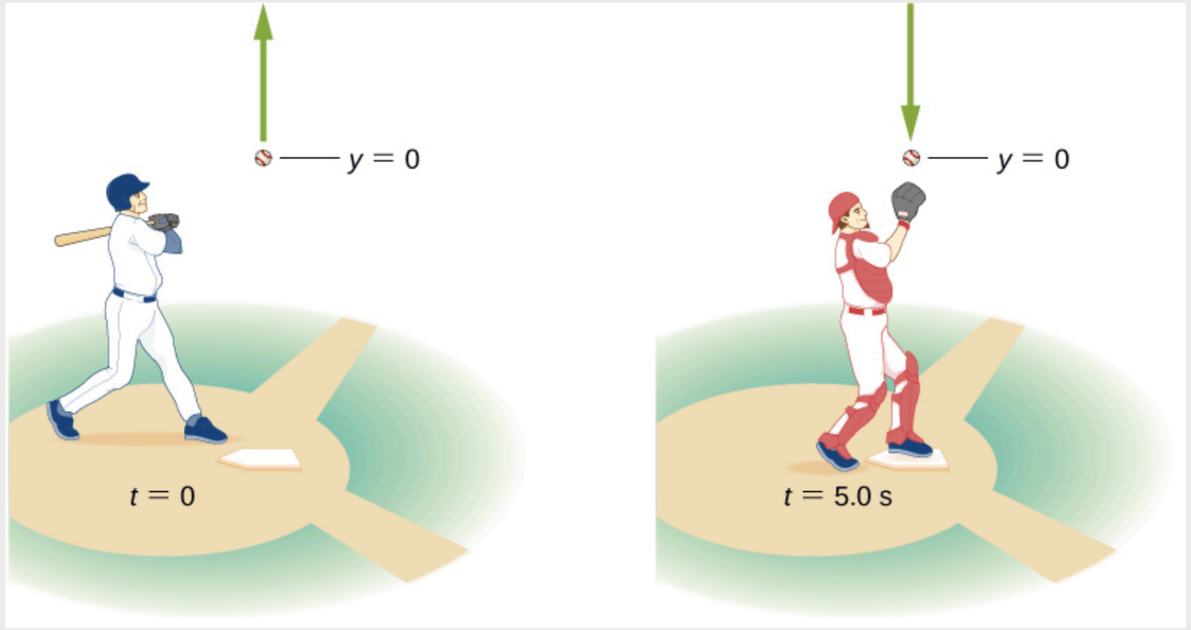

Figure 3.28 A baseball hit straight up is caught by the catcher 5.0 s later.

Solution

a. Equation 3.16 gives

$$y = y_0 + v_0 t - \frac{1}{2} g t^2$$

$$0 = 0 + v_0(5.0\ \text{s}) - \frac{1}{2}\left(9.8\ \text{m/s}^2\right)(5.0\ \text{s})^2,$$

which gives $v_0 = 24.5\ \text{m/s}$.

b. At the maximum height, $v = 0$. With $v_0 = 24.5\ \text{m/s}$, Equation 3.17 gives

$$v^2 = v_0^2 - 2\,g(y - y_0)$$

$$0 = (24.5\ \text{m/s})^2 - 2(9.8\ \text{m/s}^2)(y - 0)$$

or

$$y = 30.6\ \text{m}.$$

c. To find the time when $v = 0$, we use Equation 3.15:

$$v = v_0 - gt$$

$$0 = 24.5\ \text{m/s} - (9.8\ \text{m/s}^2)t.$$

This gives $t = 2.5\ \text{s}$. Since the ball rises for 2.5 s, the time to fall is 2.5 s.

d. The acceleration is 9.8 m/s^2 everywhere, even when the velocity is zero at the top of the path. Although the velocity is zero at the top, it is changing at the rate of 9.8 m/s^2 downward.

e. The velocity at $t = 5.0\text{s}$ can be determined with Equation 3.15:

$$\begin{aligned} v &= v_0 - gt \\ &= 24.5\ \text{m/s} - 9.8\ \text{m/s}^2(5.0\ \text{s}) \\ &= -24.5\ \text{m/s}. \end{aligned}$$

CHECK YOUR UNDERSTANDING 3.7

A chunk of ice breaks off a glacier and falls 30.0 m before it hits the water. Assuming it falls freely (there is no air resistance), how long does it take to hit the water? Which quantity increases faster, the speed of the ice chunk or its distance traveled?

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$$t = 2.47 \text{ s}$$

“Distance travelled” increases faster…

Test 1 Tips

- Total of 18 marks
- 6 questions
  - 1 mark questions: two
  - 2 mark questions: two
  - 6 mark questions: two
- Content Covered:
  - Vectors: Cartesian and Polar Coordinates (2D only)
  - Displacement

Test Rules

Rules for the test

Read them carefully! By clicking START you are agreeing to these conditions:

- You will have **60 minutes to complete the test** (unless you have an accommodation from the DRC).
- You must complete the test **BY YOURSELF** (no friends, no tutors, no classmates, no humans - cats and dogs in the room are fine).
- Any form of communication with other humans, terrestrial or extraterrestrial is not allowed (Discord, Slack, WhatsApp, Terminal, Signal, iMessage, SMS, MMS, etc...)
- The test is **open-book, open-notes, open-web.**
- Copying the question text and googling **IS CHEATING**
- Using google to search for concepts is **NOT cheating.**
- You can use ANY resource **except** CHEGG, Course Hero, SLADER and other similar websites that have Q&A or answer questions.
- If you come across the same or similar question on google, resist the temptation to keep reading, and close your browser tab.
- Do not be anxious about the test! If you don't do well - review the material and try again next week - we will take the better of the two marks!
- You will not be able to ask us questions during the quiz - do your best with your best interpretation.
- Do NOT take pictures of the questions - that **IS CHEATING.**
- Do NOT share test questions with your anyone - that **IS CHEATING.**
- **Overall, do not stress! You will be fine :-)**

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Photo credit: Chibird

See you next class!

Attribution

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—— Original resource license ——