2C - Simple Acceleration

Write down what these quantities are:

Quantity	Formula	Units	What it is called
v			
a			

Example: A car goes from 0 to 27 m/s in 9.0 seconds, what is its acceleration?

Super Confusing Example: A rocket accelerates at 4.5 "g" s. What time will it take to reach the speed of sound (Mach I = 343 m/s) from rest?

Try these example problems. Don't freak out if you can't immediately get the answer.   They are solved in the linked videos that follow the main one, so if you get stuck, just watch the video.

1. A car speeds up from 0 to 21 m/s in 5.3 seconds. What is their acceleration? (4.0 m/s/s)	2. A train can accelerate at 0.15 m/s/s. What time will it take to reach its top speed of 24 m/s from rest? (160 s)
3. What is the final speed if a person accelerates from rest at 32 f/s/s for 2.7 seconds? (86 f/s)	4. What is your acceleration if your velocity goes from 35 m/s to 20. m/s in 4.7 seconds? (-3.2 m/s/s - hint - what is the change in velocity?)

5. What is your final velocity if you are going 12 m/s and you accelerate at 0.48 m/s/s for the next 16 seconds? (19.68 m/s ≈ 20. m/s - hint - you are already going 12 m/s - figure out the change in velocity with the formula, and add it to 12 m/s)

2E - Kinematics

$v_f = v_i + at$	x - displacement (m)
$x = \frac{1}{2}(v_i + v_f)t$	v_i - initial velocity (m/s)
$v_f^2 = v_i^2 + 2ax$	v_f - final velocity (m/s)
$x = v_i t + \frac{1}{2}at^2$	a - acceleration (m/s/s)
	t - time (s)

(write down the names I give them, like "No X", "No a" etc.)

Example 1: A car goes from 14 m/s to 26 m/s in 300. m.
- What is the acceleration, and
- What time does it take?

Example 2: A rocket going 3130 m/s accelerates at 0.00135 m/s/s for a distance of 5.50 x 10^9 m.
- What time does it take, and
- What is the final velocity?

Try these example problems.

1. A cart stops in a distance of 3.81 m in a time of 4.51 s. What was its initial velocity? (1.69 m/s)	2. A car going 12 m/s accelerates at 1.2 m/s/s for 5.0 seconds. What is its displacement during this time? (75 m)
3. Another car with a velocity of 27 m/s stops in a distance of 36.74 m. What was its acceleration? (-9.9 m/s/s)	4. A car's brakes slow it at 9.5 m/s/s. If it stops in 47.3 m, how fast was it going to start with? (30. m/s)

5. What time will it take a car going 23 m/s to start with, and accelerating at 3.5 m/s/s, to go 450 m?
(10.7585 ≈ 11 s   Hint - it is quadratic with "No V$_f$" but you can use "No t" to find V$_f$, and then use "No X" to find t without using the quadratic equation)

Videos 2F-Free Fall Problems   **Name**_____

Problem solving tips:

1

2

3

4

5

Example 1 - An object is launched straight up with a velocity of 33.0 m/s, and strikes the ground at the same elevation from which it is launched. Use the acceleration of gravity to be -9.80 m/s/s, and neglect air friction

    1. What time did it take to reach the top
    2. How high does it go at the highest?
    3. What total time is it in the air?

Example 2 – An air rocket leaves reaches a height of 31.0 m before falling back to the ground.

    1. What was the initial velocity
    2. What time did it take to reach the top
    3. What total time is it in the air?

Example 3 – Red Elk drops from a cliff that is 11.2 m tall
    1. With what velocity does he strike the water?
    2. What time does it take to hit the water?

Example 4 – Black Elk drops from a cliff and strikes the water at a velocity of 34.0 m/s.
    1. What time did it take him to hit the water?
    2. How high is the cliff?

Try these example problems. Don't freak out if you can't immediately get the answer. We will work on these as a group in class. They are solved in the linked videos that follow the main one

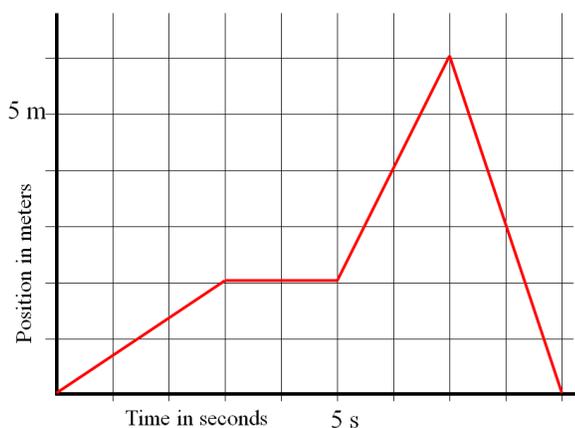| 1. An air rocket goes straight up, and then falls back to earth, remaining in the air for a total of 6.32 s
   1. What time did it take to reach the top
   2. What was the initial velocity (3.16 s, 31.0 m/s) | 2. It takes a rock 1.52 s to fall from rest from a bridge and strike the water below.
   1. How high is the bridge?
   2. With what velocity does the rock strike the water? (11.3 m, -14.9 m/s) |

Noteguide for Displacement Graphs - Videos 2G   Name_____

Position in meters (vertical axis, marked 4 m)
Time in seconds   5 s
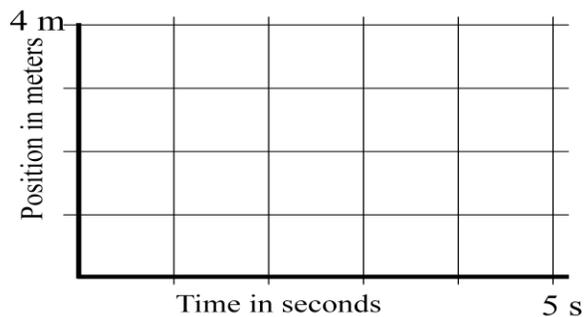
Slope on a position time graph:

Whiteboards:

Position in meters (vertical axis, marked 5 m)
Time in seconds   5 s

Keep in mind that when you find the slope, you should use the entire line segment. (i.e. 2.0 seconds, use the entire line from t = 0 to t = 3.0 s, and find the rise/run for that entire segment.)
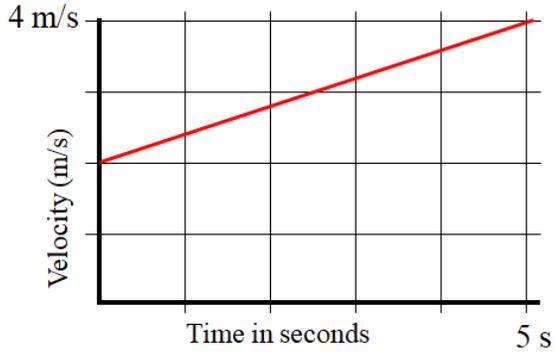
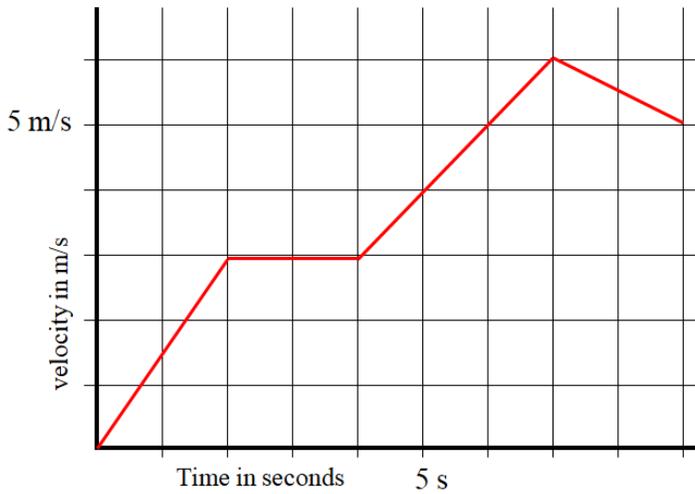| 1. What is the velocity at 2.0 s? (0.67 m/s)	2. What is the velocity at 4.0 s? (0 m/s)
3. What is the velocity at 6.2 s? (2.0 m/s)	4. What is the velocity at 8.15 s? (-3.0 m/s)

Noteguide for Velocity Graphs - Videos 2H

Name_____

Slope of velocity graphs:

What does the slope on a velocity graph mean?
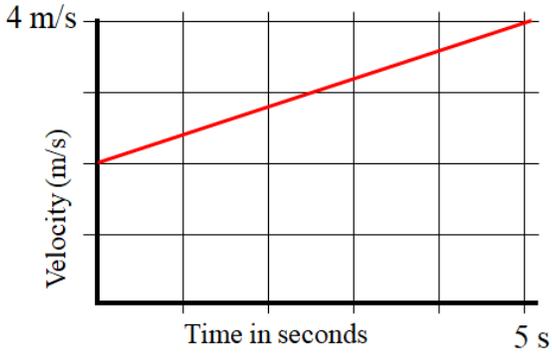
Whiteboards:

Keep in mind that when you find the slope, you should use the entire line segment.

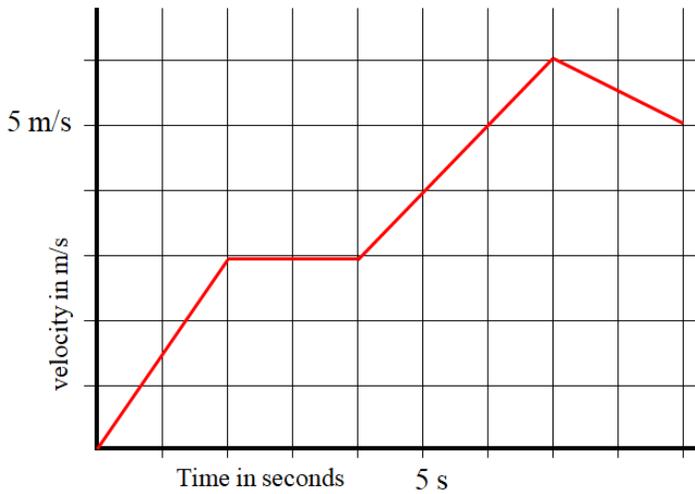| 1. What is the Acceleration at 1.15887 seconds? (1.5 m/s/s)	2. What is the Acceleration at 8.1 s? (-0.50 m/s/s)

(In calculus the slope is the derivative)

Area under velocity graphs:

What does the area under a velocity graph mean?

Whiteboards:

"Area under" means the area between the graph and the x-axis. The units of this "area" are meters in this case, so it's not area in a strict sense. Graph areas can have all kinds of different units.

1. What displacement between 2 and 4 seconds? (6.0 m)	2. What displacement between 4 and 7 seconds? (13.5 m)

(In calculus the area under is the integral)

Practice for 2.1 - Speed and unit conversions
(Do the work for these on a separate sheet of paper.)

12.8 m/s	1. A car in front of the school goes 30.0 m in 2.35 seconds. What is its **speed**?
0.15 s	2. What **time** will it take a car going 88 f/s to go 13 feet?
68 f/s	3. My Tercel can go 92 f in about 1.35 seconds. What is its **speed**?
78 feet	4. A glacier moves at a rate of 5.6 feet/day. What **distance** does it go in two weeks?
49 mph	5. A trucker goes 345 miles in 7.0 hours. What is her **speed**?
0.36 s	6. A car moving 44 feet/second takes what **time** to travel 16 feet?
93 km/h	7. What **speed** must you average to go 280 km in 3.0 hours?
66 f/s	8. Convert 45 miles/hour to Feet/second
17 m/s	9. Convert 60 km/hour to m/s
24 m/s	10. Convert 80 feet/second to m/s
68 mph	11. Convert 110 km/hr to mph
96.6 km/hr	12. Convert 88.0 feet/sec to km/hr
9.6 s	13. A river current moves at 3.2 miles/hour. How many **seconds** will it take you to drift 45 feet? (Convert to feet/second first)
12 m/s	14. A car in front of the school travels 15 feet in 0.38 seconds. What is its speed in m/s?
6075 mph	15. A satellite travels at 5.4 miles in 3.2 seconds. What is its speed in miles/hour?
12240 mi 6.5×10^7 f	16. A space shuttle moves at 3.4 miles/second. What **distance** does it go in one hour? How many feet?

Practice for 2.2 - Acceleration
(Do the work for these on a separate sheet of paper.)

$a = \dfrac{\Delta v}{t}$:

1. A car's brakes can make it slow at a rate of -6.70 m/s/s. What time will it take the car to stop if it is going 28.1 m/s? (4.19 s)
2. A drag racer reaches a speed from rest of 54.2 m/s in 1.83 seconds. What was its acceleration? (29.6 m/s/s)
3. A javelin is accelerated at 15.6 m/s/s for 1.30 seconds. What is its change in velocity? (20.3 m/s)
4. A runner accelerates at 4.80 m/s/s for 1.39 seconds. What is their change in velocity? (6.67 m/s)
5. What time will it take a rock accelerating at 32.0 f/s/s to reach 44.0 f/s? (1.375 s)
6. A car reaches a speed of 22.5 m/s in 2.70 seconds from rest. What is its acceleration? (8.33 m/s/s)
7. A giant lizard goes from rest to 4.50 m/s in 2.54 seconds. What is its acceleration? (1.77 m/s/s)
8. A rocket can accelerate at 6.97 m/s/s. What time will it take to change the velocity of the rocket by 1200 m/s? (172 s)
9. What is the change in velocity of a baseball if a pitcher accelerates it at 85.1 m/s/s for 0.320 seconds? (27.2 m/s)
10. What time will it take a baseball accelerated by a pitching machine at 92.0 m/s/s to reach 41.5 m/s from rest? (0.451 s)
11. A car at a stoplight accelerates from rest to 21.0 m/s in 4.81 seconds. What is its acceleration? (4.37 m/s/s)
12. A rocket accelerates at 45.0 m/s/s for 2.30 seconds. What is its change in velocity? (103.5 m/s)
13. A runner goes from rest to 8.10 m/s in 2.70 seconds. What is their acceleration? (3.00 m/s/s)
14. A tennis ball is accelerated at 160. m/s/s from rest to 78.0 m/s. What time does it take? (0.4875 s)
15. A train can accelerate at 0.382 m/s/s. What is its change in velocity if it accelerates at this rate for 120. seconds? (45.8 m/s)

$v_f = v_i + at$:
16. A car accelerates at 3.54 m/s/s from 22.0 m/s to 35.0 m/s. What time does it take? (3.67 s)
17. A car accelerates from 17.4 m/s to 36.1 m/s in 6.00 seconds. What is its acceleration? (3.12 m/s/s)
18. A car coasts along the road, slowing from 23.0 m/s to 12.0 m/s in 18.2 seconds. What is its acceleration? (-0.604 m/s/s)
19. A train going 34.8 m/s decelerates at a rate of -1.40 m/s/s for 18.2 seconds. What is its final velocity? (9.32 m/s)
20. An oil tanker accelerates from 4.30 m/s to 14.8 m/s at a rate of 0.172 m/s/s. What time does it take? (61.0 s)
21. A bullet going 816 m/s decelerates at -151 m/s/s for 1.20 s. What is its final velocity? (634.8 m/s)
22. A car accelerates at 5.75 m/s/s for 2.68 seconds. At the end, it is going 28.0 m/s, so what was its initial velocity? (12.6 m/s)
23. A car going 15.7 m/s accelerates at 4.35 m/s/s for 9.00 seconds. What is its final velocity? (54.85 m/s)
24. A car going 27.2 m/s is slowed at -5.30 m/s/s to 12.9 m/s. What time does it take? (2.70 s)
25. A car is decelerating at -7.46 m/s/s, and is still going 11.5 m/s after 2.60 seconds. What was its initial velocity? (30.9 m/s)

How Far for A2.3

	Regular one step or two step problems:
11.2 m	1. A Pirate Ship accelerates uniformly from 1.80 m/s to 5.60 m/s with an acceleration of 1.25 m/s/s. What was its displacement?
8.28 m/s	2. A lemur going 3.45 m/s accelerates at 1.52 m/s/s for 3.18 s. What is its final velocity?
-8.85 m/s/s	3. A giant lizard stops in 5.85 m in 1.15 s. What was its acceleration?
12.4 s	4. A tuna going 2.35 m/s accelerates at 0.208 m/s/s covering a distance of 45.0 m. What time did it take?
7.27 m	5. A lemming speeds up from rest to 5.19 m/s in 2.80 s. What is its displacement during this time?
21.6 m/s	6. An accident scene detective knows that a car with a deceleration of -7.14 m/s/s was brought to rest in 32.8 m. What was the initial velocity?
-1.22 m/s/s	7. What is the acceleration of an ATV that goes from 12.0 m/s to 7.50 m/s in 3.68 s?
41.9 m	8. A XC runner accelerates uniformly for 8.20 s at 0.540 m/s/s having a final velocity of 7.32 m/s. What is their displacement during this time?
22.8 m/s	9. A racecar accelerates at 5.13 m/s/s for 3.35 s covering a distance of 105 m. What was its initial velocity?
21.9 m/s	10. A car avoiding an accident is brought to rest over a distance of 56.0 m in 5.12 s. What was its initial velocity?
-4690 m/s/s	11. A baseball going 38.0 m/s decelerates to rest over a distance of 0.154 m. What was its deceleration? (It's big)
-2.01 m/s/s	12. A car goes from 27.2 m/s to 14.7 m/s in 6.23 s. What is its acceleration?
458 m	13. A train going 45.0 m/s decelerates at -2.17 m/s/s for 17.9 s. What is its displacement during this time?
4.36 m/s	14. A hamster going 2.7 m/s accelerates uniformly for 6.52 s, covering a distance of 23.0 m. What was its final velocity? (it's riding a hamster scooter)
2.33 s	15. A car is going 15.0 m/s after having decelerated at -6.25 m/s/s over a distance of 52.0 m. What time did it take?
-25.1 m/s	16. A hot pocket accelerating at -9.81 m/s/s from rest falls downward -32.1 m. What is the final velocity?
18.2 m/s	17. A car accelerates uniformly for 8.70 s with a final velocity of 31.5 m/s over a distance of 216 m. What was its initial velocity?
2.39 s	18. A car that can brake at -8.92 m/s/s will take what time to decelerate from 33.1 m/s to 11.8 m/s?
81.6 m	19. A rollercoaster car going 8.60 m/s decelerates at -0.215 m/s/s for 11.0 s. What was its displacement during this time?
47.1 s	20. A space probe is going 615 m/s after having decelerated at -0.147 m/s/s over a distance of 29,100 m. What time did it take?
	Two-Part Kinematics:
39.2 m	21. A dragon accelerates from 1.13 m/s to 3.60 m/s in 4.13 seconds. Over what distance could it accelerate from rest to 6.85 m/s if it had the same acceleration?
4.98 s	22. A car accelerates uniformly from rest, covering 65.0 m in 5.62 seconds. What time would it take the same car to go from 8.90 m/s to 29.4 m/s if it had the same acceleration?
7.73 m/s	23. A runner covers 21.5 m accelerating uniformly from rest to 9.94 m/s. What was their speed when they had covered only 13.0 m?
2.84 s	24. A train decelerates from 35.0 m/s to 22.0 m/s in 42.0 seconds. What time did it take it to cover 98.0 meters from the beginning?
17.5 s	25. A car accelerates from rest to 23.0 m/s over a distance of 231 m. What time would it take it to accelerate from rest to 20.0 m/s if it accelerated at the same rate?

Physics
Free Fall Practice Problems for A2.4
Ignore air friction and use the convention that **down is negative.** g = 9.8 m/s/s

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1.

a-b: A baseball is popped straight up in the air at a velocity of 42.0 m/s
a. What is the greatest height it reaches? (90.0 m)
b. What time does it spend in the air before reaching the same elevation from which it was popped up? (8.57 s)
c-d: A rock is dropped from rest from the top of a cliff and strikes the ground after 2.10 seconds.
c. What is its velocity of impact with the ground? (-20.6 m/s)
d. What is the height of the cliff? (21.6 m)
e. An air rocket is launched from the ground straight up, and on the way down is strikes a light tower that is 16.0 m tall with a downward velocity of 12.0 m/s. What was its initial upward velocity? (+21.4 m/s)

2.

a-b: A soccer ball is kicked straight up from the ground, and reaches a height of 23.0 m before coming back down.
a. What time does it spend in the air (total)? (4.33 s)
b. What was its initial upward velocity leaving the ground? (+21.2 m/s)
c-d: A golf ball is dropped from a cliff and strikes the ground with a downward velocity of 34.0 m/s.
c. How high is the cliff? (59.0 m)
d. What time did it take the ball to strike the ground? (3.47 s)
e. An air rocket is launched straight up at 36.0 m/s. What time elapses between the launch, and the point on the way down where it has a downward velocity of 21.0 m/s? (5.82 s)

3.

a-b: A steel marble is launched straight up from the ground at some velocity, and stays in the air for a total time of 8.20 s before striking the ground again.
a. What was its initial launch velocity? (+40.2 m/s)
b. To what height does the marble rise before going back down again? (82.4 m)
c-d: A hot pocket is dropped from the top of a 52.0 m tall building in Manhattan.
c. What time does it take to reach the sidewalk below? (3.26 s)
d. What is the velocity of impact with the sidewalk? (-31.9 m/s)
e. An air rocket is launched straight upwards at 27.0 m/s. What is its velocity at a time of 4.80 s? (-20.0 m/s)

4.

a-b: A giant lizard jumps straight upwards from the ground at 4.30 m/s.
a. To what height does the lizard rise before going back down again? (0.943 m)
b. What total time does the lizard spend in the air? (0.878 s)
c-d: A frozen blueberry falls from a counter top and strikes the floor with a downward velocity of 4.50 m/s.
c. What is the height of the counter top? (1.03 m)
d. What time does it take the blueberry to strike the ground? (0.459 s)
e. An air rocket is launched straight up with a speed of 31.0 m/s and strikes a 12.0 m tall light tower on the way down. What is the velocity of impact with the light tower? (-26.9 m/s)

5.

a-b: A bowling ball is launched using black powder from a well casing and goes straight up 320. m before coming back down again.
a. For what time does the bowling ball stay in the air? (16.2 s)
b. What was its initial upward velocity of launch? (+79.2 m/s)
c-d: A person falls from a bridge that is 18.0 m above the water.
c. What time does it take them to reach the water? (1.92 s)
d. What is the velocity of impact with the water? (-18.8 m/s)
e. An air rocket is launched straight up and lands on the roof of a building 3.80 s later with a downward velocity of 8.60 m/s. What was its initial velocity of launch from the ground? (+28.6 m/s)