One Dimensional Kinematics

Guided Notes

[Distance and Displacement]

One-Dimension:

Kinematics:

Scalar:

Vector:

Example #1: Scalars & Vectors

Which of the following are scalars and which are vectors?

(A) 5 meters _____

(B) 30 meters/second East _____

(C) 20 degrees Celsius _____

(D) 4000 calories _____

(E) -10 centimeters _____

Distance:

Displacement:

Example #2: Distance & Displacement

Jim travels 60 meters east to go to Cindy's house. However, Cindy is not home so he decides to head 40 meters west to hang out with Harry.

A) What distance did Jim travel?

B) What is Jim's displacement?

Example #3: Distance & Displacement

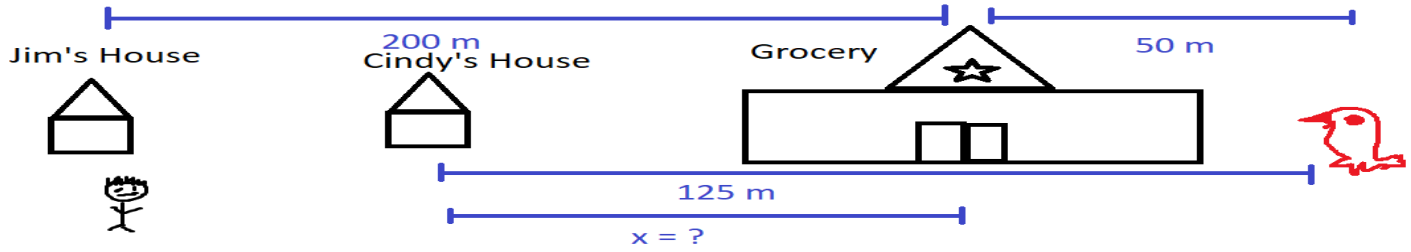
Cindy notices Jim coming to her house and decides to run out the door 150 meters to the east. Afterward, Cindy goes to Harry's house which is 40 meters to the west of Cindy's house.

A) What distance did Cindy travel?

B) What is Cindy's displacement?

Example #4: Distance & Displacement

Jim's mom tells Jim to go buy some eggs at the grocery. On his way Jim sees and walks up to a RED PENGUIN 50 meters to the right of the grocery store. He's so excited he forgets about the eggs and runs to Cindy's house to tell her about this. Then Jim gets a call from his mom asking about the eggs. He rushes to the grocery store before it closes, but as soon as he gets there he passes out.



A) What is Jim's displacement?

B) What is x?

C) What is the total distance Jim traveled?

D) How far does Cindy live from Jim?

Conceptual Example #1

Can you drive your car in such a way that the distance it covers is (a) greater than (b) equal to, or (c) less than the magnitude of its displacement?

If your answer is yes, give an example for each case. If your answer is no, explain why for each case.

(A) _____
(B) _____
(C) _____

[Speed and Velocity]

Speed:

_____
_____

Velocity:

_____
_____

Interactive Example #1: Speed

Example #5: Speed and Velocity *1609 meters = 1 mile*

Cindy sees an ice cream truck and charges toward it to the right. She runs 60 meters in 8.2 seconds.

A) What is her average velocity in m/s and mi/hr?

B) What is her average speed in m/s and mi/hr?

Example #6: Speed and Velocity

Jim sees a spider and lets out a loud scream! Then, he starts running away as fast as he can to the left. He travels 20 meters in 10.2 seconds.

A) What is his average velocity in m/s and mi/hr?

B) What is his average speed in m/s and mi/hr?

Example #7: Speed and Velocity

Jim and Harry are walking to the bus stop which is 0.5 miles to the left of Jim's house. It takes them 20 minutes to arrive. As soon as they get to the bus stop, Jim realizes he forgot his lunch and runs back home, taking 10 minutes. He then rushes back, which takes him another 12 minutes.

A) What was Jim's average velocity in m/s for the entire trip?

B) What was Jim's average speed in m/s for the entire trip?

Example #8: Speed and Velocity

Cindy is running a 5k (5000 meters) loop for her first cross-country meet. Jim wants to make sure he is at the finish line when she finishes, but he also wants to get a hotdog. Cindy usually runs with a speed of 4.3 meters/second.

A) How long does Jim have to get his hotdog?

B) What is Cindy's average velocity when she finishes the race?

C) Explain shy Cindy's average velocity differs from her average speed when she finishes the race.

Conceptual Example #2

If someone is moving at a constant speed of 10 m/s, this means that the person:

A) Increases her speed by 10m every second

B) Decreases her speed by 10m every second

C) Moves with an acceleration of 10 m/s every second

D) Moves 10m every second

Example #9: Speed and Velocity

Jim noticed how much Cindy liked him being at the cross-country meet. He decides to train so that he can join the team. He sprints 100 meters in 13.2 seconds. Then, he takes 50 seconds to walk back to the starting line. If his "sprint direction" is positive, what is:

A) The average sprint velocity?

B) The average walking velocity?

C) The average velocity for the complete trip?

Example #10: Speed and Velocity

Jim and Harry are having a race to get to Cindy's house. Cindy's house is 600 meters away. Jim runs as hard as he can with a speed of 5.3 m/s and Harry jogs with a speed of 8.2 m/s.

How long will Harry have to wait for Jim when he gets to Cindy's house?

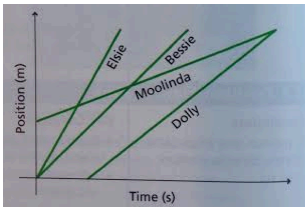
Example #11: Speed and Velocity

Cindy, Harry, Kiki, and Jim are participating in a 4 x 100 meter relay race. Cindy burns everyone and runs the first 100 meters with a speed of 8.7 m/s. Harry gets the baton and runs his 100 meters in 12.8 seconds. Kiki runs her 100 meters with a speed of 7.2 m/s. Jim almost fumbles the baton pass, but is able to hold onto it. With only one person in front of him, Jim runs as fast he can and finishes the last 100 meters in 12.4 seconds.

A) Who ran the slowest on the team?

B) What was the average speed for the entire team?

[Kinematic Motion and Graphs]



Conceptual Example #3:

Cindy decides to go to a cow racing competition with Jim. Rank the cows from fastest to slowest.

Conceptual Example #4

Harry and Jim decide to go kayaking together during their Thanksgiving break.

A) At what time(s) are Harry and Jim in the same place?

B) How much time does Harry spend on the river before he passes Jim?

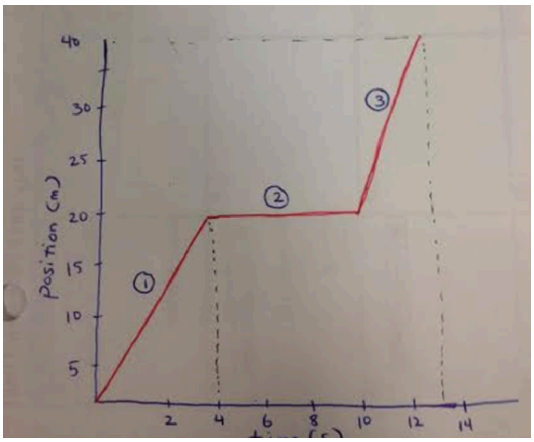
C) Where on the river does it appear that there might be a swift current?

Example #12: Graphs

Jim is training for another race, and decides to use an app to track his runs.

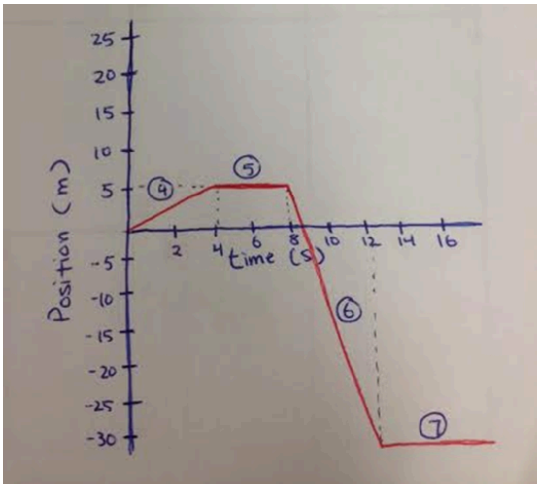
A) How fast did Jim run each interval?

B) What was his average velocity?



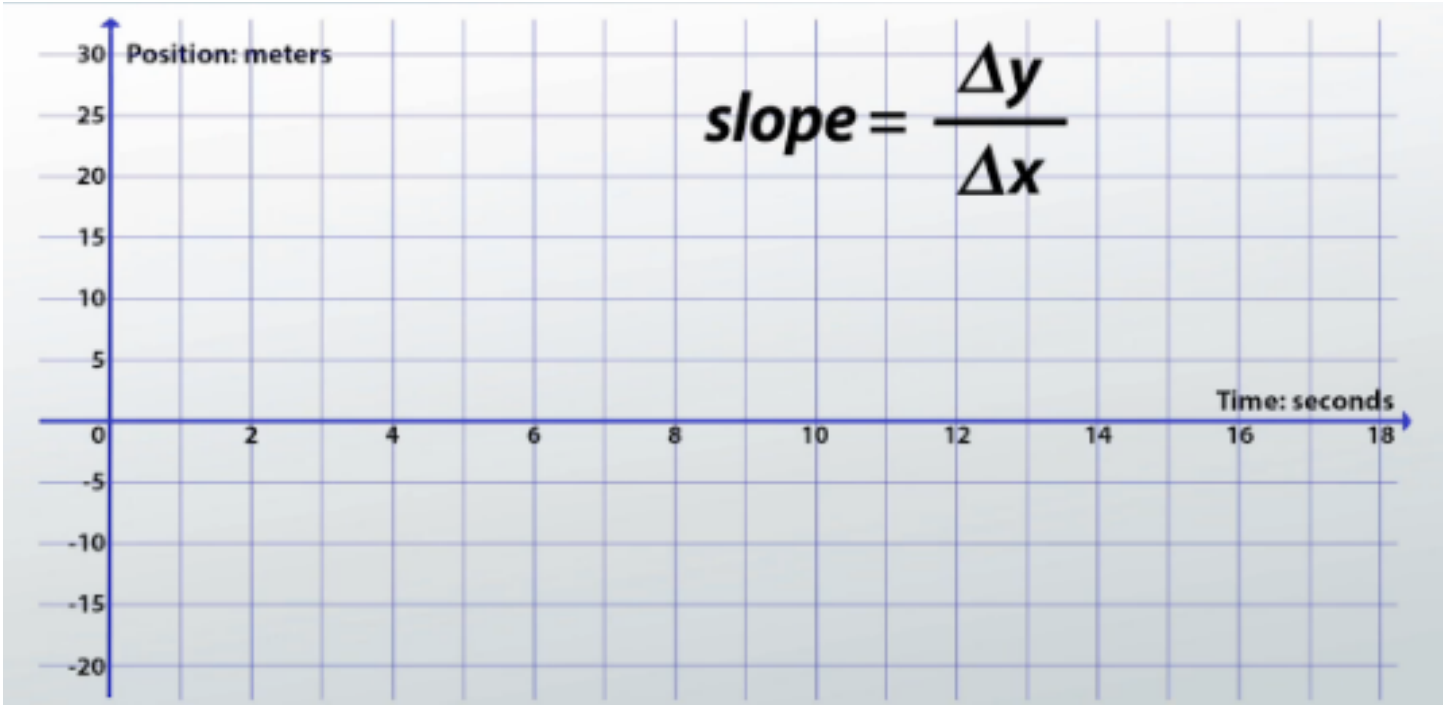
Example #13: Graphs

Jim continues his workout. Continue to find his average velocity for each segment.



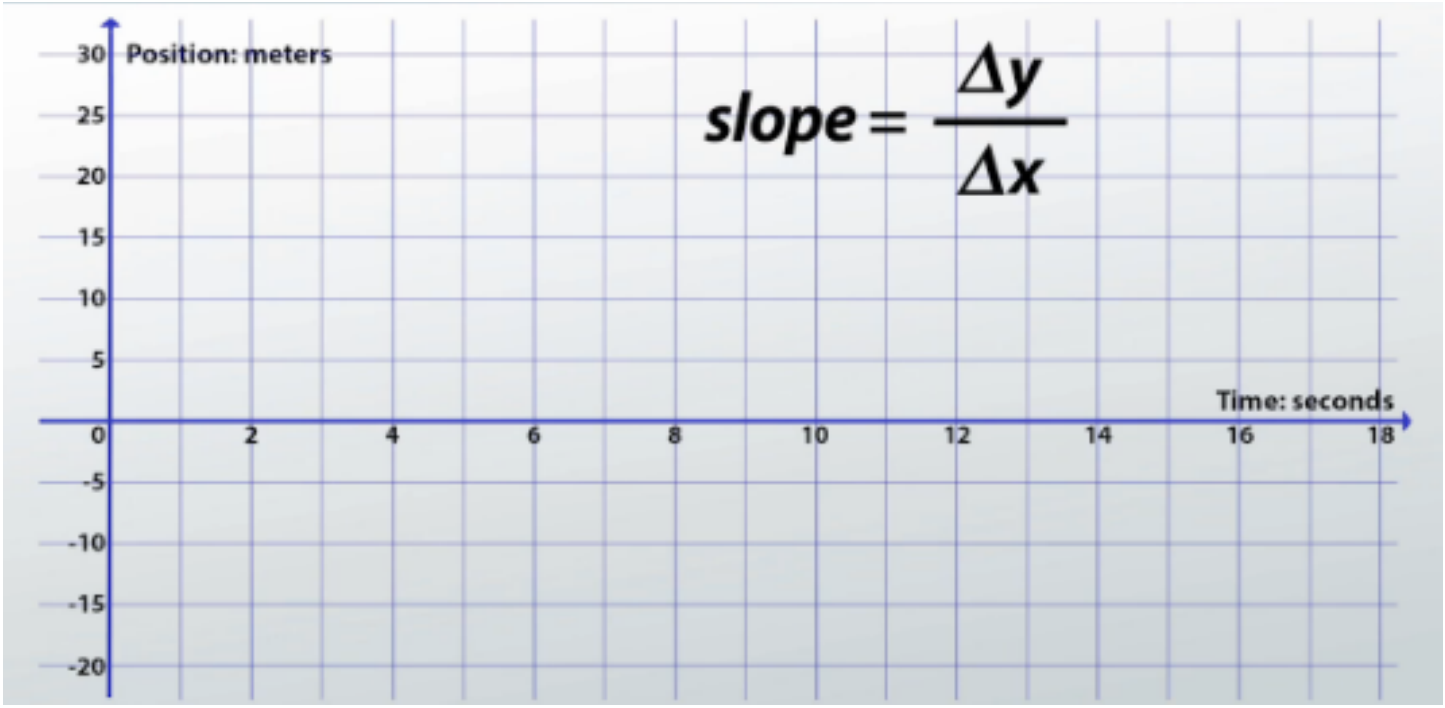
Example #14: Graphs

Draw on the following graph



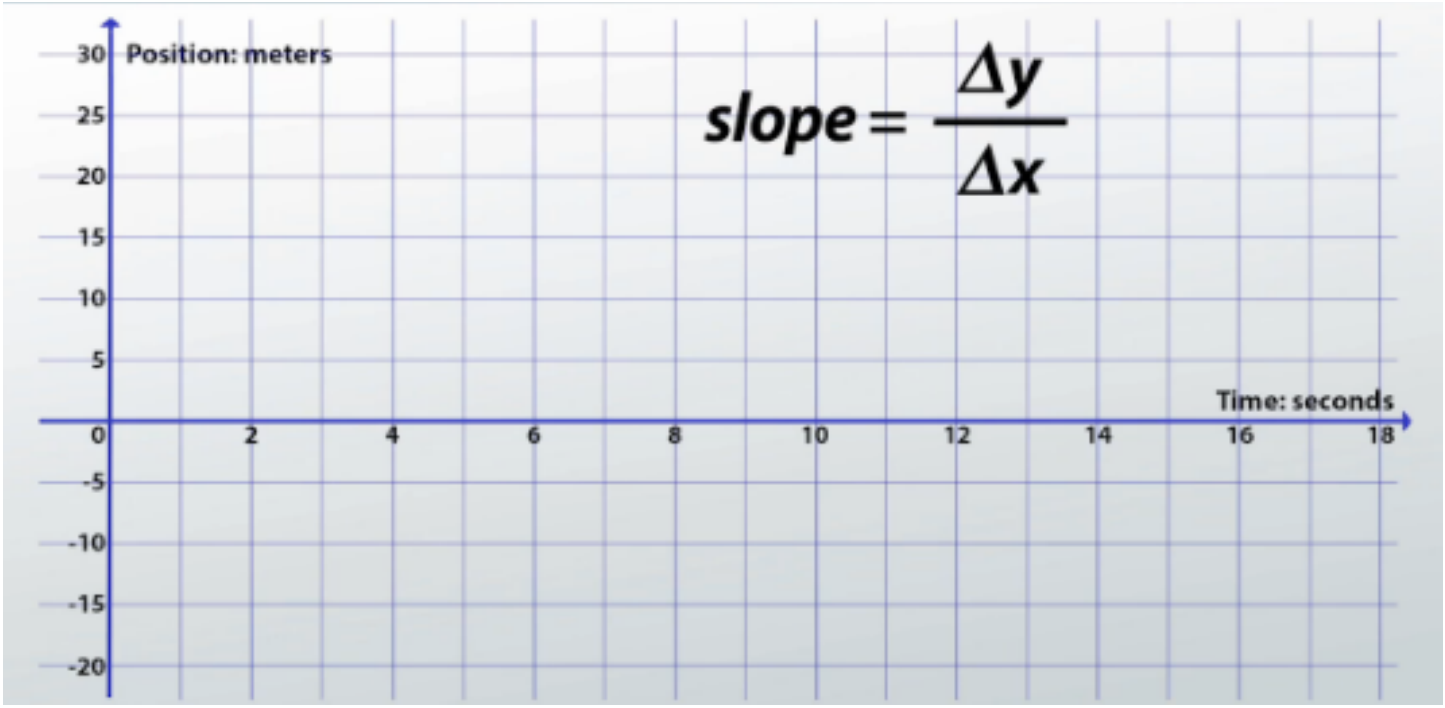
Example #15: Graphs

Draw on the following graph



Interactive Example #2: Graphs

1) _____
2) _____
3) _____
4) _____
5) _____



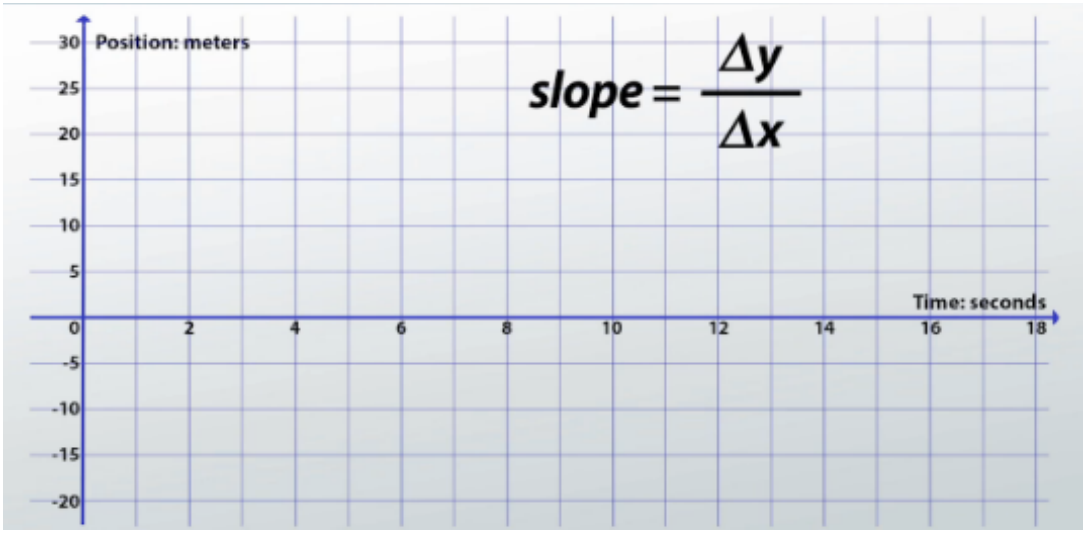
Example #16: Graphs

Jim walked 10 m down the school hallway, from the cafeteria to the band room. Cindy, who has developed an interest in Jim, records his position every 2 s and notes that he moved 2.6 m every 2 s. At what time was Jim in the following positions:

A) 3 m from the cafeteria?

B) 3 m from the band room?

C) Create a graph showing Jim's motion.



Instantaneous Velocity:

Average Velocity:

[Acceleration]

Formulas

Conceptual Example #5

A horse gallops with a constant acceleration of 3 m/s^2. Which statement below is true?

A) The horse's velocity does not change.

B) The horse moves 3m every second.

C) The horse's velocity increases 3m every second.

D) The horse's velocity increases 3m/s every second.

Example #17: Acceleration

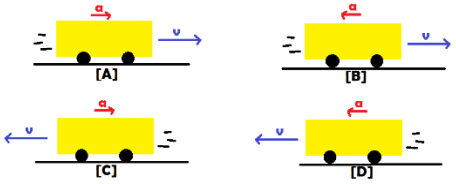
Cindy is about to get her permit and starts to shop around to look for cars. The salesman lets her know that the Audi R8 that she is looking at can go from 0 to 60 mph in 3.3 seconds.
(A) What is the acceleration in miles per hour per second?

(B) What is the acceleration in meters per $second^2$?

(C) Explain how something that starts with a speed of 0 m/s, but accelerates at a rate of $1m/s^2$ can eventually go faster than 100 m/s

Conceptual Example #6:

(A) In which scenario does the car's speed increase? Decrease?



(B) In which scenario does the car have a negative acceleration?

Example #18: Acceleration

Jim and Cindy decide to go on a ferry ride together as "friends." The ferry makes a short run between two docks; one in NJ, the other in NY. As the ferry approaches NY (traveling in the positive x direction), its speed is 7.4 m/s.
(A) If the ferry slows to a stop in 12.3s, what is its average acceleration?

(B) As the ferry returns to the NJ dock its speed is 7.3 m/s. If it comes to rest in 13.1s, what is its average acceleration?

The 5 Steps to Solving a Physics Problem

1.

2.

3.

4.

5.

Example #19: Acceleration

Cindy just got her provisional driver's license and is driving with Jim, cruising at 20 m/s. After a while Cindy decides to show off and steps on the gas, accelerating at 2.4 m/s^2.

(A) How fast are they moving after accelerating for 5s?

(B) How far have they traveled at this time?

(C) If the ferry took a longer time to come to a stop, would that mean that there was more acceleration or less acceleration? Explain.

Example #20: Acceleration

Jim and Cindy decide to enter an engineering competition. They need to build a toy plane that will be able to accelerate fast enough to take off the runway. The plane starts from rest and drives the length of the 15m runway. It needs to lift off at a speed of 20 km/hr.

How fast must the engine be able to accelerate, in m/s^2?

Example #21: Acceleration

Jim, who was left at the competition, gets on his bicycle and starts heading home. He coasts due west at 8 m/s. At one point he encounters a sandy patch of road that is 7.2m across. By the time he leaves the sandy patch, his speed has been reduced to 6.5 m/s. Assuming the bicycle slows with constant acceleration, what is his acceleration?

[Free Fall]

Free Fall:

Conceptual Question #7

A ball is thrown straight up.

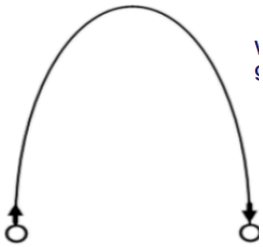
A) At what point is it moving the fastest?

B) At what point is it moving the slowest?

Conceptual Question #8

A ball is thrown straight up. Does it take more time to go up or come down (or is it the same)?

Example of Ball Going Up and Down



Conceptual Questions #9:

A) If I throw a ball downward, would the acceleration be greater than 9.8 m/s^2 or less than 9.8 m/s^2?

B) If I throw a ball up while the ball is initially traveling up, is the acceleration + or -?

C) At the very top of the ball's motion, is the ball's acceleration +, -, or 0?

Example #22: Free Fall

Harry and Cindy decide to go to NY together. They decide to visit the Empire State Building and climb to the top (380m). When they get to the top, Cindy decides to drop a penny to make a wish.

A) How long does the penny take to reach the ground?

B) How fast is the penny going when it reaches the ground?

Example #23: Free Fall

Harry is on top of the Empire State Building (380m) and decides to throw his penny down with a velocity of 5 m/s. He makes a wish too.

A) What is the velocity of the penny 2 seconds later?

B) How much has it fallen in those 2 seconds?

Conceptual Question #10

You drop a penny. After it travels 4m, you drop another penny. As the pennies fall, does their distance away from each other increase, decrease, or stay the same?

A) Decrease
B) Stay the same
C) Increase

Example #24: Free Fall

Jim realizes that he screwed up at the last Engineering Competition so he decides to build a rocket to impress Cindy. The rocket is fired into the air and reaches its highest point 4 seconds later.

A) With what velocity was the rocket fired?

B) How high did the rocket go up?

Interactive Example #3

Example #25: Free Fall

In an effort to get Cindy's attention, Jim decides to climb the roof of Cindy's house in the middle of the night. On the way, he stumbles and falls. He gets back up again and makes it to the top. Once there, he calls Cindy to let her know that he is above her window. When Cindy opens her window, Jim tosses her a bouquet of flowers with an upward speed of 15 m/s. Find
(A) The bouquet's displacement and velocity after 4 seconds.

(B) The maximum height reached (distance from the point it was thrown).

(C) The bouquet's acceleration when it is at its maximum height.

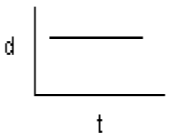
Example #26: Free Fall

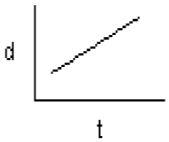
Meanwhile, an owl flies upward right above Jim, who is unconscious. When the bird (traveling with a velocity of 5 m/s) is 10m away from Jim, it releases a small branch that it is carrying. The branch lands right next to Jim.
A) How fast will the branch be traveling right before it hits the ground?

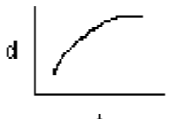
B) What is the max height that the branch reaches while in the air?

[Kinematic Motion and Graphs]

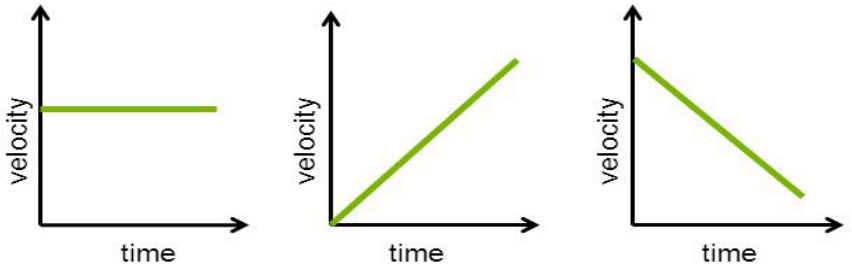
Position vs Time Graphs



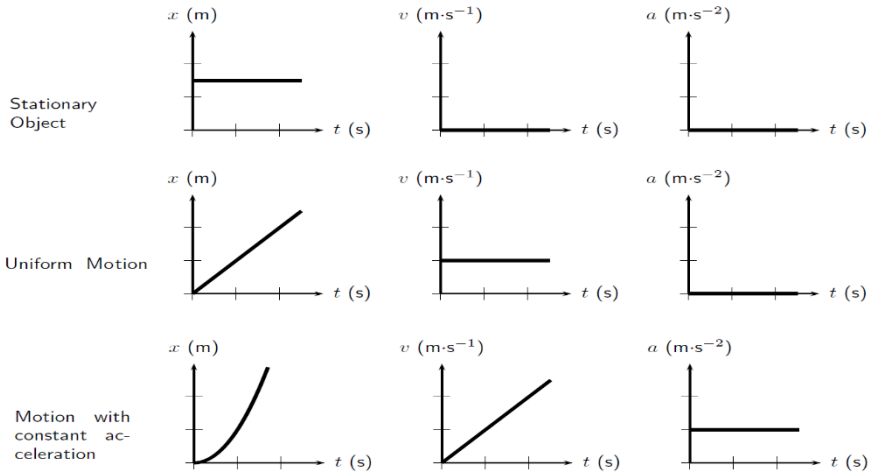


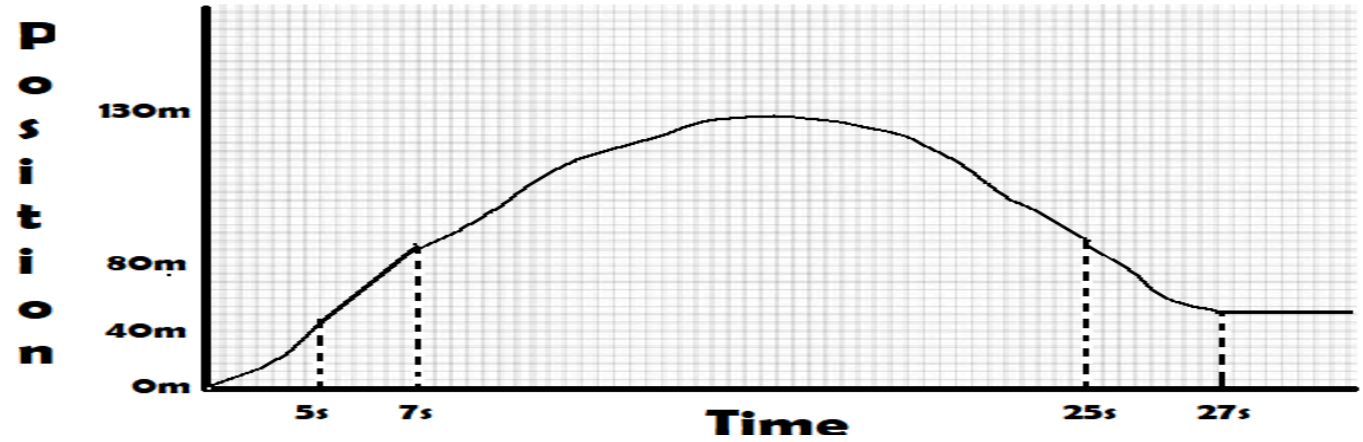


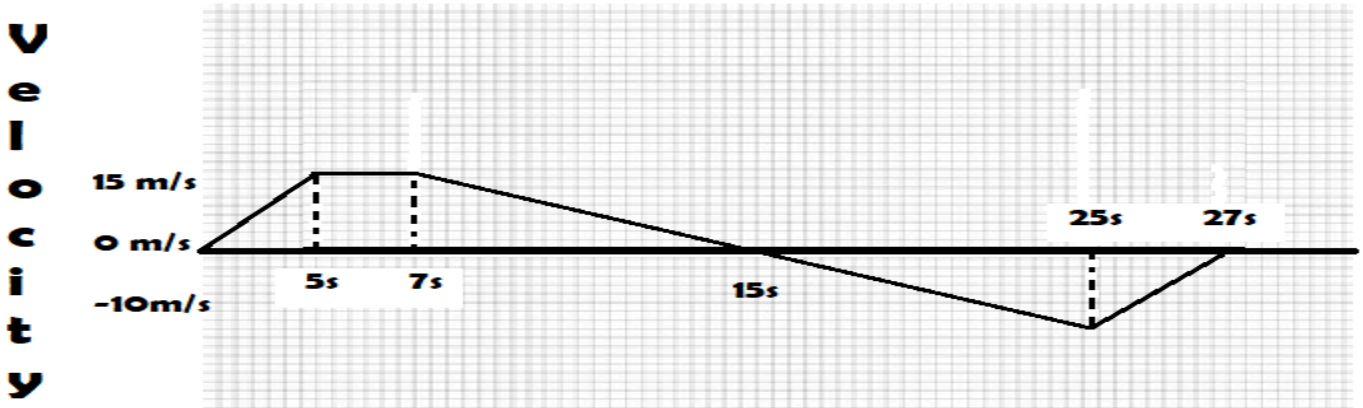
Velocity vs Time Graphs



of how motion looks with 3 Different Graphs



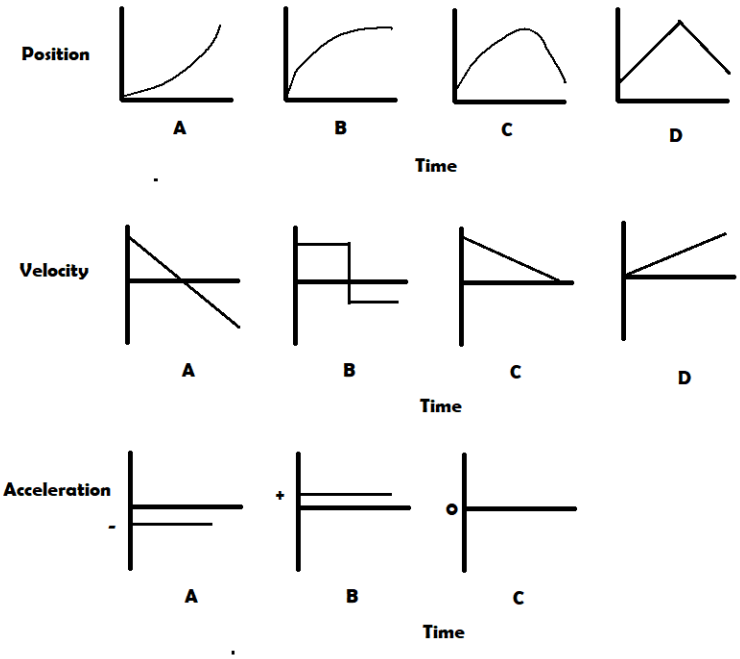




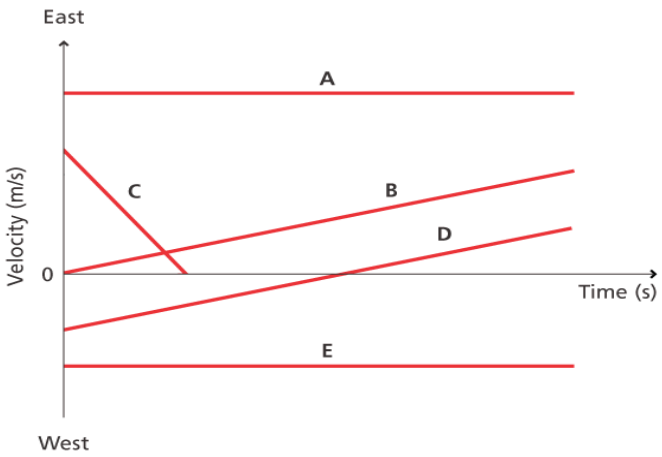
Example #27: Graphs

Written description	Motion diagram	Position vs. time	Velocity vs. time	Acceleration vs. time
Pos. direction, speeding up	T=0			
Neg direction, speeding up	T=0			
Pos direction, slowing down	T=0			
Neg direction slowing down	T=0			
Turning around	T=0			

Example #28: Graphs



Example #29: Graphs



A)

B)

C)

D)

E)

Example #30: Graphs

From the following graph…

A) Find the acceleration of the motion

B) Find the displacement of the motion

Example #31: Graphs

Using the graph at the right, determine the average acceleration of the car.

Example #32: Graphs

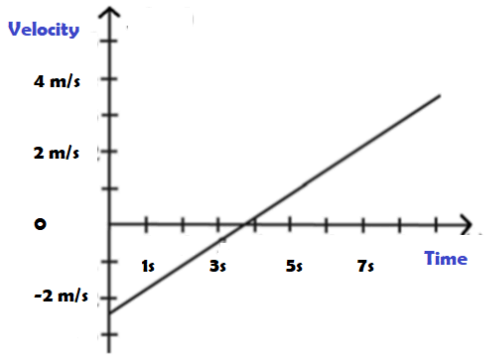
Find the acceleration and displacement for each segment.

Example #33: Graphs

Find the acceleration and displacement for each segment.

Example #34: Graphs

What can we say about the speed in the following graph?



Bonus Problems

Conceptual Example #1 (BONUS)

You drive 4 miles at 30 mi/h and then another 4 miles at 50 mi/h. Is your average speed for the 8 mile trip…

(A) Greater than 40 mi/h
(B) Equal to 40 mi/h
(C) Less than 40 mi/h

Example #1: Speed and Velocity (BONUS)

After the race, Jim starts to ride his bicycle back to his house, which is one mile away. After he travels 0.5 miles, he gets a flat tire and starts to walk his bicycle home with a speed of 2.1 m/s. If it takes Jim a total of 8 minutes to get home:

A) How fast was Jim riding his bicycle, in m/s, before he got his flat?

B) What was Jim's average speed (in m/s) during the 8-minute trip?

Example #2: Acceleration (BONUS)

Cindy is frustrated and leaves the competition without Jim. She is driving on a road going 11.4 m/s and suddenly sees a deer. Cindy immediately applies the brakes to slow down with an acceleration of 3.8 m/s^2.

- If the deer is 10m from Cindy when she applies the brakes, does she hit the deer? If not, by how much does she miss it?

- If she did hit the deer, at what speed did she hit it?

Example #3: Acceleration (BONUS)

Harry leaves his house and starts to sprint to Cindy. If Cindy is 400m away and Harry is running out the door at 2 m/s with an acceleration of 0.2 m/s^2, how long will it take him to get to the bus stop?

Example #4: Acceleration (BONUS)

A speeder who is doing 40 mi/hr (17.9 m/s) in a 25 mi/hr zone approaches a parked police car. The instant the speeder passes the police car, the police begin their pursuit. If the speeder maintains a constant velocity and the police car accelerates with a constant acceleration of 4.5 m/s^2,

(A) How long does it take for the police car to catch the speeder?

(B) How far will the two cars have traveled by this time?

(C) What is the velocity of the police car when it catches the speeder?

Conceptual Question #2 (BONUS)

Assume that the brakes in your car create a constant deceleration, regardless of how fast you are going. If you double your driving speed, how does this affect (A) the time required to come to a stop, and (B) the distance required to come to a stop?

Example #5: Free Fall (BONUS)

Cindy and Jim decide to go out for a little walk onto the George Washington Bridge. They both laugh and talk until they stumble upon two glowing rocks. Jim picks up the blue glowing rock and drops it over the bridge. It takes 3 seconds to reach the river below. Cindy takes the red glowing rock and throws it vertically. It takes this rock 2 seconds to hit the water.

A) With what velocity was the red glowing rock thrown?

B) If the scenario was the same, but it happened on the moon, where there is less gravity, would the rock have taken more, less, or the same amount of time to hit the water? Explain.

Example #6 (BONUS)

To determine the height of a building, Jessica throws a ball straight up. She sees that the ball reaches the top of the building after 0.5s. The ball continues traveling upward before falling back down again. As it falls, it reaches the top of the building the second time after a total elapsed time of 4.1 seconds. How high is the building (ignore Jessica's height)?