Chapter 1
One Dimensional Kinematics
1.1 Distance vs. Displacement--Speed vs. Velocity Homework # 01

$$\Delta x = x - x_0 \qquad \bar{v} = \frac{d}{t} \qquad \bar{v} = \frac{\Delta x}{\Delta t} = \frac{x-x_0}{t}$$

I

01. A squirrel runs 80.0 m along a fence in 6.00 s. The squirrel stops for 2.00 s, then turns around and runs 35.0 m in 3.00 s in the opposite direction.
    a.) What was the distance traveled by the squirrel for the first part of his journey (from 0 to 6.00 seconds)?
    b.) What was the displacement of the squirrel for the first part of his journey (from 0 to 6.00 seconds)?
    c.) What was the average speed of the squirrel for the first part of his journey (from 0 to 6.00 seconds)?
    d.) What was the average velocity of the squirrel for the first part of his journey (from 0 to 6.00 seconds)?
    e.) What was the distance traveled by the squirrel for the second part of his journey (from 6.00 to 8.00 seconds)?
    f.) What was the displacement of the squirrel for the second part of his journey (from 6.00 to 8.00 seconds)?
    g.) What was the average speed of the squirrel for the second part of his journey (from 6.00 to 8.00 seconds)?
    h.) What was the average velocity of the squirrel for the second part of his journey (from 6.00 to 8.00 seconds)?
    i.) What was the distance traveled by the squirrel for the third part of his journey (from 8.00 to 11.00 seconds)?
    j.) What was the displacement of the squirrel for the third part of his journey (from 8.00 to 11.00 seconds)?
    k.) What was the average speed of the squirrel for the third part of his journey (from 8.00 to 11.00 seconds)?
    l.) What was the average velocity of the squirrel for the third part of his journey (from 8.00 to 11.00 seconds)?
    m.)What was the total distance traveled by the squirrel during the entire trip?
    n.) What was the net displacement for the squirrel for the entire trip?
    o.) What was the average speed of the squirrel for the entire trip?
    p.) What was the average velocity of the squirrel for the entire trip?

02. How long does it take a car to travel 65.0 m if it is moving at 18.5 m/s?

03. A mailman walked in a straight line from one house to another, a distance of 32.5 m, in 12.7 s. What was his average velocity?

04. A plane travels from Newark airport to Orlando Florida in 2.25 hours. If the average velocity of the plane during this trip was 782 km/h, what was the magnitude of the displacement for the trip?

II

05. A runner moving through a 5.00 km course takes 21 minutes and 25 seconds to go 2920 m. He wants to finish the race in 36.0 minutes. What minimum average velocity must he run for the remainder of the course?

III

06. A runner moving through a 1600 m course takes 5 minutes and 25 seconds to go 1230 m. What must his average velocity be for the remainder of the course if his average velocity for the whole race was 3.81 m/s?

ANSWERS: **01.** a.) 80.0 m b.) +80.0 m c.) 13.3 m/s d.) +13.3 m/s e.) 0 m f.) 0 m g.) 0 m/s
01. h.) 0 m/s i.) 35.0 m j.) -35.0 m k.) 11.7 m/s l.) -11.7 m/s m.) 115.0 m n.) +45.0 m
01. o.) 10.5 m/s p.) +4.09 m/s **02.** 3.51 s **03.** 2.56 m/s **04.** 1760 km **05.** 2.38 m/s **06.** 3.89 m/s

Chapter 1
One Dimensional Kinematics
1.2 Uniform Acceleration (Kinematic Equations) Homework # 02

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v\text{-}v_0}{t}, \quad v = v_0 + at, \quad x = x_0 + v_0 t + \tfrac{1}{2}at^2, \quad v^2 = v_0^2 + 2a(x - x_0)$$

I

01. A sprinter, starting from rest, accelerates to 6.42 m/s in 1.35 s. What was his average acceleration?

02. A truck moving 80.0 km/h has the brakes applied causing it to slow down to 60.0 km/h in 6.20 s. What was its average acceleration?

03. A boat accelerates from rest at 1.28 m/s^2 for 9.25 s. How fast will the boat be moving after this time?

04. A skateboarder attains a speed of 16.4 m/s, then begins to coast. Friction results in a deceleration of 0.625 m/s^2. What will be the skateboarder's speed after 12.0 s?

05. Willie Mays hit a baseball in the gap in left-centerfield. He rounds first and is headed to second at 8.56 m/s when he begins to slide into second base. His slide causes him to decelerate at 12.4 m/s^2. How long does it take him to stop?

06. Police investigating an accident measure skidmarks from car A to be 37.6 m before its impact with car B. From the damage to car B, it is estimated that car A was traveling at 20.0 km/h when it impacted car B. Car A is known to have a maximum deceleration of 9.35 m/s^2. How fast must car A have been going before its brakes were applied?

07. On a road with a speed limit of 40 mi/h (64.4 km/h) is a traffic light located at an intersection. A particular truck has a maximum safe deceleration rate of 4.25 m/s^2.
    a.) What is the minimum stopping distance for this truck?
    b.) How long does it take the truck to stop?

II

08. A deranged student throws a physics book down a hallway. When the book lands on the floor, it is traveling at 32.0 km/h and slides down the hallway for 6.45 s before coming to a stop. How far did the book slide?

09. A motorcycle traveling 60.0 mi/h (96.5 km/h) down the parkway accelerates to the posted speed limit of 65.0 mi/h (104.6 km/h) over a distance of 43.4 m. How long did it take the motorcycle to reach the speed limit?

10. An elevator accelerates upward from rest at 0.830 m/s^2. How high has it risen after 3.40 s?

11. A car traveling 28.6 m/s applies the brakes and stops 4.95 s later. How far did the car travel during this time?

ANSWERS: **01.** 4.76 m/s^2 **02.** -0.896 m/s^2 **03.** 11.8 m/s **04.** 8.90 m/s **05.** 0.690 s
06. 97.5 km/h (27.1 m/s) **07.** a.) 37.6 m b.) 4.21 s **08.** 28.7 m **09.** 1.55 s **10.** 4.80 m **11.** 70.8 m

Chapter 1
One Dimensional Kinematics

1.3 Freefall — Homework # 03

Quadratic Equation: $t = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

I

01. A ball is dropped from the top of a 73.0-m tall building.
    a.) How far has the ball fallen after 2.50 s?
    b.) What is the magnitude of the ball's velocity after 2.50 s?
    c.) When will the ball hit the ground below?
    d.) With what velocity will the ball hit the ground below?

02. A paint ball is fired straight up from ground level at 91.8 km/h.
    a.) How high will it be after 2.00 s?
    b.) What is the ball's velocity after 2.00 s?
    c.) How high is the ball's highest point?
    d.) How long will it take the ball to reach the highest point?
    e.) How high will it be after 4.00 s?
    f.) What is the ball's velocity after 4.00 s?
    g.) At what times will the ball be at 25.0 m? (Why are there two correct answers?)
    h.) How long after firing the paint ball will it hit the ground?
    i.) With what velocity will it hit the ground?

03. A stone is thrown straight up from the top of 42.5-m high cliff with a velocity of 18.5 m/s.
    a.) How long will it take to reach the highest point of its trajectory?
    b.) What is the velocity of the stone after 3.00 s?
    c.) How long will it take to hit the ground below?
    d.) With what velocity will the stone hit the ground below?
    e.) How long will it take the stone to return to the level of the cliff?
    f.) What will the velocity of the stone be when it returns to the level of the cliff?
    For parts g.) through i.), assume the stone was thrown straight down at 18.5 m/s from the top of this cliff.
    g.) How long will it take the stone to hit the ground below?
    h.) With what velocity will the stone hit the ground below?
    i.) Why are the answers to parts d.) and h.) the same?

II

04. A super-genius coyote drops a rock from the top of a 160-m high cliff, hoping to hit a roadrunner below. The clumsy coyote loses his balance and falls off the cliff exactly 2.00 s after releasing the rock. How far apart are they after the coyote has been falling for 3.00 s?

05. A baseball player, standing in a foxhole, throws a baseball vertically upward with a speed of 22.0 m/s. Assume the player's hand is level with the ground surrounding the hole upon the release of the ball.
    a.) How high does the ball go?
    b.) How long does it take the ball to return to the ground?

ANSWERS: **01.** a.) 30.6 m b.) -24.5 m/s c.) 3.86 s d.) -37.8 m/s **02.** a.) 31.4 m b.) 5.90 m/s (21.2 km/h) **02.** c.) 33.2 m d.) 2.60 s e.) 23.6 m f.) -13.7 m/s (-49.3 km/h) g.) 1.31 s, 3.89 s h.) 5.20 s **02.** i.) -91.8 km/h (-25.5 m/s) **03.** a.) 1.89 s b.) -10.9 m/s c.) 5.39 s d.) -34.3 m/s e.) 3.78 s **03.** f.) -18.5 m/s g.) 1.61 s h.) -34.3 m/s **04.** 78.4 m **05.** a.) 24.7 m b.) 4.49 s

Chapter 1
One Dimensional Kinematics

1.3 Freefall — Homework # 04

II

06. A kangaroo jumps to a vertical height of 2.6 m. How long was it in the air before returning to earth?

07. A baseball player throws a ball vertically upward and catches it 4.65 s after it left his hand.
    a.) With what speed did he throw it?
    b.) What height did it reach?

08. A helicopter is ascending vertically with a speed of 8.50 m/s. At a height of 120 m above the earth, a grenade is held out a window and released. How much time does it take for the grenade to reach the ground?

09. A baseball is seen to pass vertically upward by a third story window 30 m above the street with a speed of 54.0 km/h.
    a.) What was the initial speed of the ball?
    b.) What altitude does it reach?
    c.) How long after it was thrown does it take to return to it's the ground (or original height)?

10. An arrow is launched vertically upward from a crossbow at 112 m/s.
    a.) What is the arrow's instantaneous speed after 10.0 s?
    b.) What is the arrow's average velocity for the first 10.0 s?
    c.) What is the arrow's instantaneous speed after 15.0 s?
    d.) What is the arrow's average velocity for the first 15.0 s?
    e.) How long does it take for the arrow to return to the ground?
    f.) What is the arrow's average velocity for the trip?

11. A ball is thrown upward from the top of a 42.8-m tall building and lands on an adjacent 96.4-m tall building 4.57 s later. With what velocity will the ball land on the adjacent roof? (Ignore the small horizontal travel of the ball)

III

12. A stone is dropped from the roof of a high building. A second stone is dropped 2.50 s later. How far apart are the stones when the second one has reached a speed of 15.0 m/s?

13. A falling stone takes 0.28 s to travel past a window that is 2.6 m in height. From what height above the **TOP** of the window did the stone fall?

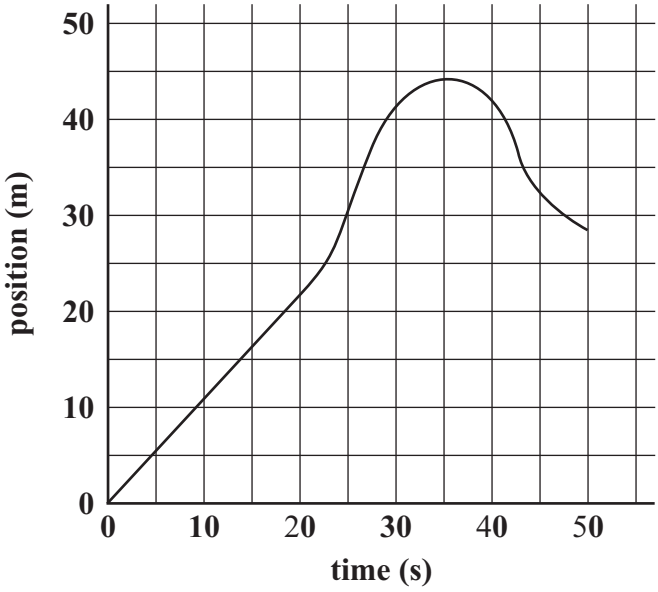
14. A rock is dropped from a bridge and the sound of it striking the water below is heard 3.45 s after its release. If the speed of sound is 343 m/s, how high is the bridge?

15. A garden hose nozzle is pointed vertically upward and held at a height of 1.5 m. When the faucet is turned on the water is heard to hit the ground 2.5 s later. What is the water speed as it leaves the nozzle?

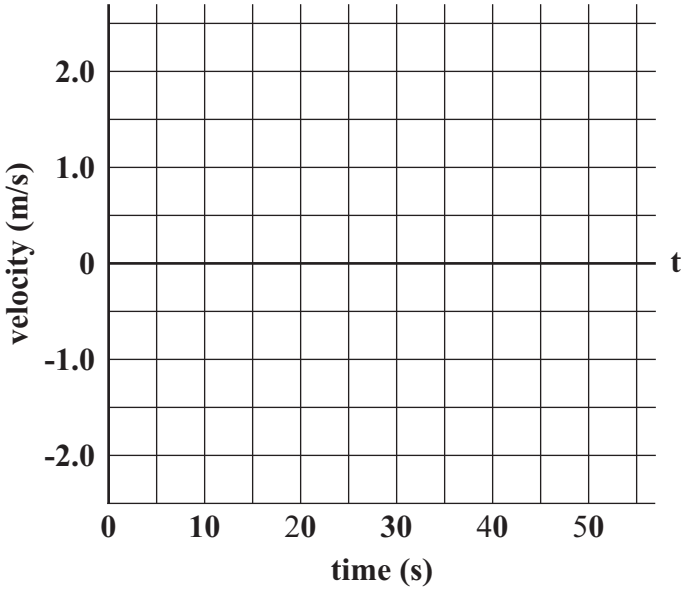
ANSWERS: **06.** 1.46 s **07.** a.) 22.8 m/s b.) 26.5 m **08.** 5.89 s **09.** a.) 28.5 m/s b.) 41.5 m c.) 5.82 s **10.** a.) 14.0 m/s b.) 63.0 m/s c.) -35.0 m/s d.) 38.5 m/s e.) 22.9 s f.) 0 m/s **11.** -10.7 m/s **12.** 68.1 m **13.** 3.20 m **14.** 53.2 m (or 54.9 m) **15.** 11.7 m/s

Chapter 1
One Dimensional Kinematics
1.4 Graphical Analysis-Position vs. Time — Homework # 05

Position vs. Time



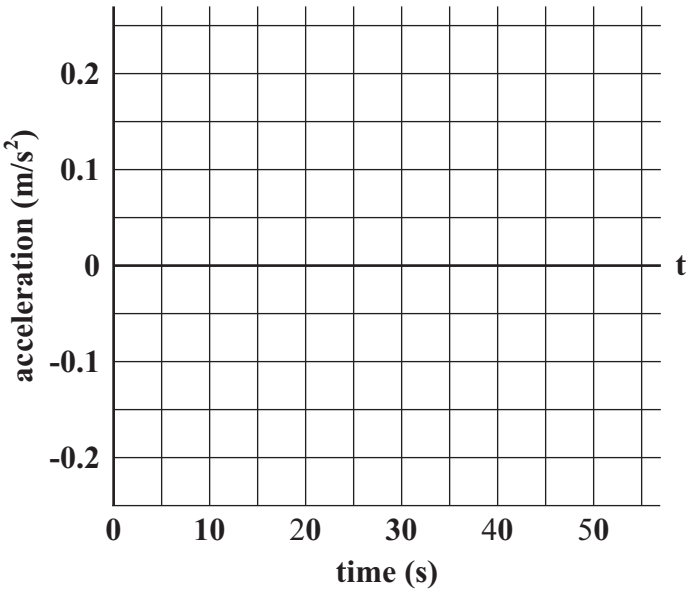
Velocity vs. Time



The top-left graph above is based on data obtained on a rabbit's position as he runs through a pipe.

01. What is the average velocity for the first 20 s?
02. What is the instantaneous velocity at 10 s?
03. What is the average velocity for the 20 s to 30 s time interval?
04. Estimate the instantaneous velocity at 30 s?
05. At what time does the rabbit stop running?
06. What is the average velocity for the time 40 s to 50 s time interval?
07. Estimate the instantaneous velocity at 45 s?
08. Sketch what the velocity vs. time graph would look like for this trip.
09. Sketch what the acceleration vs. time graph would look like for this trip.

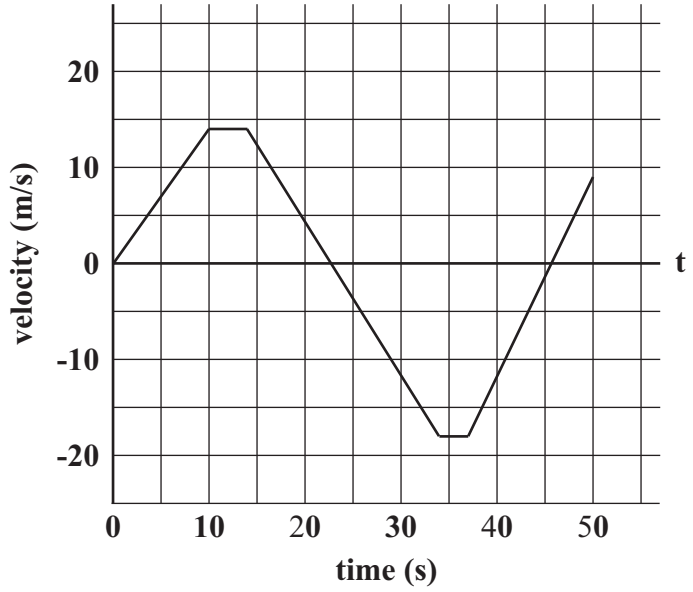
Acceleration vs. Time



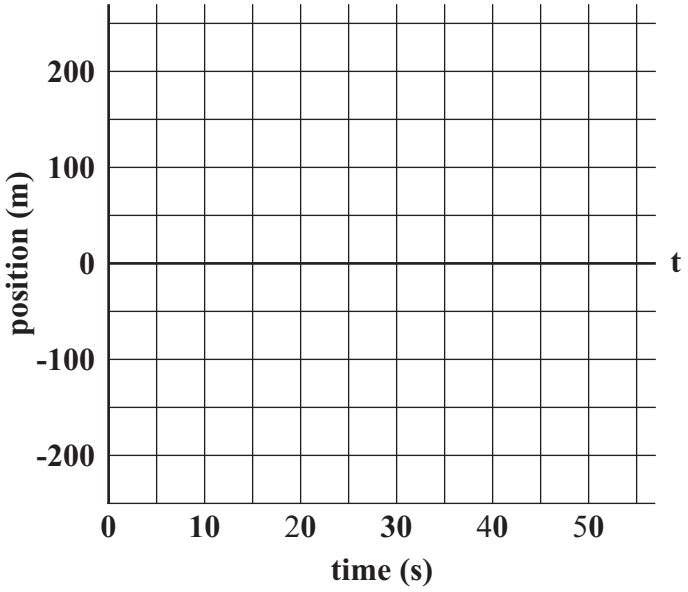
ANSWERS: **01.** 1.1 m/s **02.** 1.1 m/s **03.** 2.0 m/s **04.** 0.9 m/s **05.** 35 s **06.** -1.4 m/s **07.** -1.0 m/s

Chapter 1
One Dimensional Kinematics
1.4 Graphical Analysis-Velocity vs. Time — Homework # 06

Velocity vs. Time



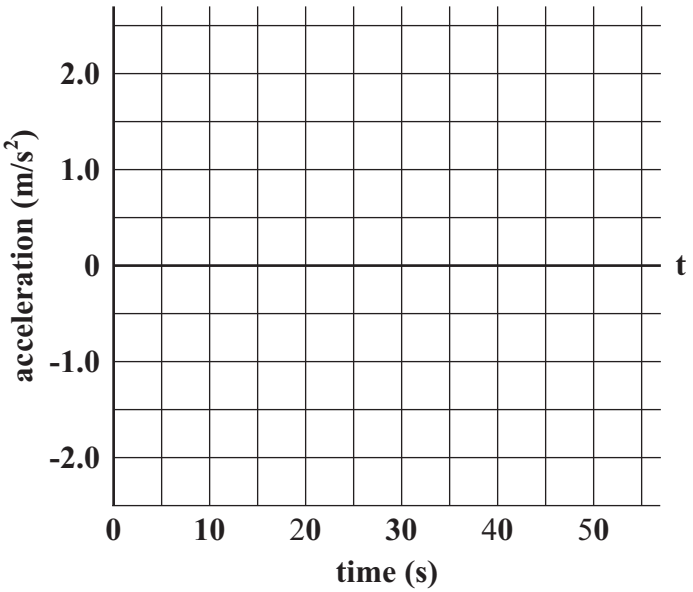
Position vs. Time



The top-left graph above is based on data obtained from observing a rat moving through a long tube.

01. What is the average acceleration for the first 10 s?
02. What is the instantaneous acceleration at 6 s?
03. What is the average acceleration for the 20 s to 30 s time interval?
04. At what times is the rat at rest?
05. At what times is the acceleration rate 0 m/s^2?
06. Estimate the rat's displacement after the first 10 s?
07. Estimate the rat's displacement after the first 30 s?
08. Estimate the rat's displacement at the end of 50 s?
09. Sketch what the position vs. time graph would look like for this trip.
10. Sketch what the acceleration vs. time graph would look like for this trip.

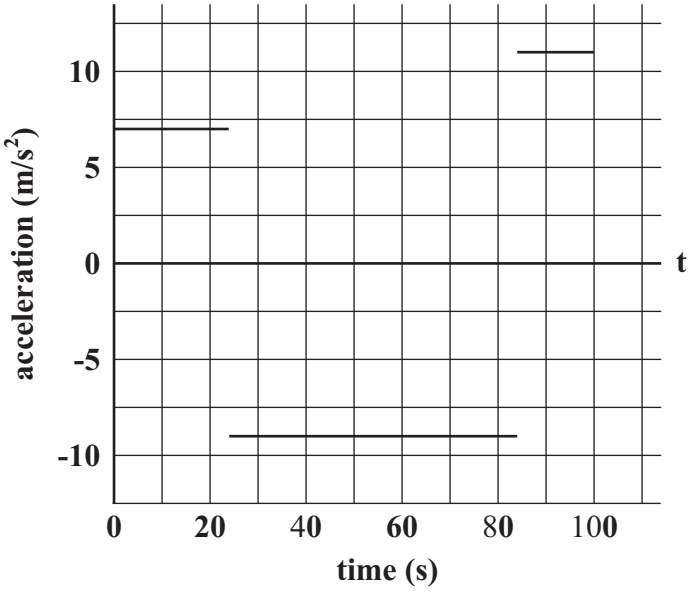
Acceleration vs. Time



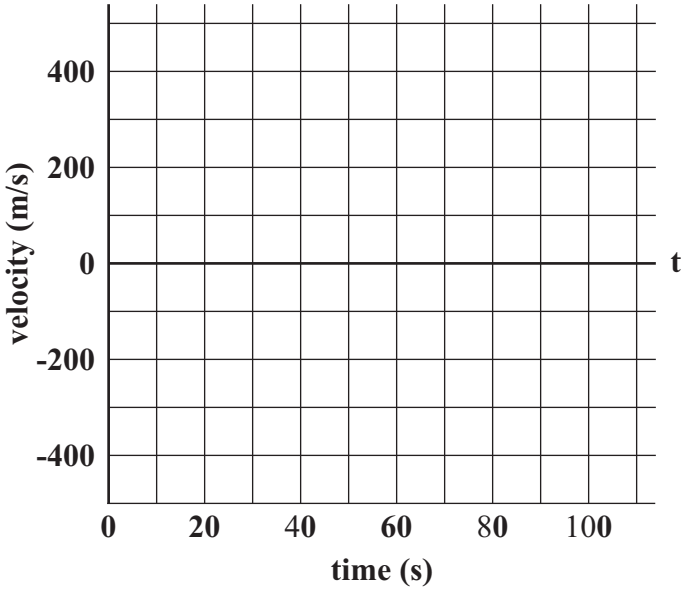
ANSWERS: **01.** 1.4 m/s^2 **02.** 1.4 m/s^2 **03.** -1.6 m/s^2 **04.** 23 s, 46 s **05.** 10 s - 14 s, 33 s - 37 s **06.** 70 m **07.** 147 m **08.** -37 m

Chapter 1
One Dimensional Kinematics
1.4 Graphical Analysis-Acceleration vs. Time Homework # 07

Acceleration vs. Time



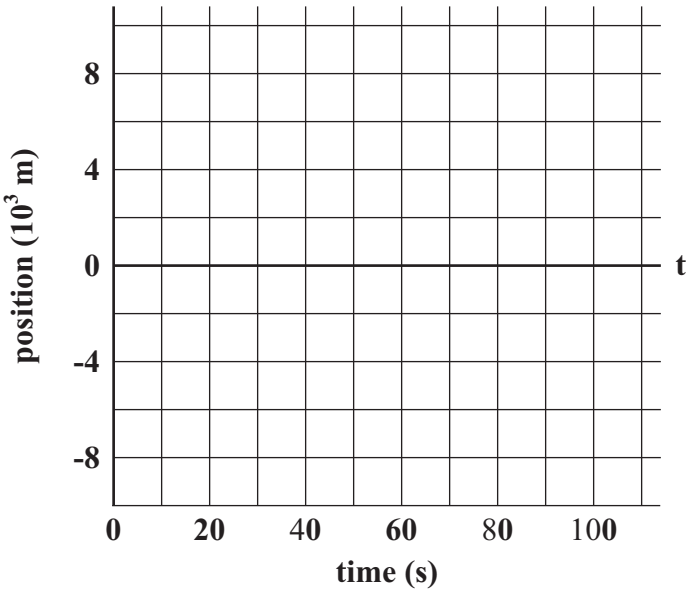
Velocity vs. Time



The top-left graph above is based on data obtained from a unknown lab by a unknown physics student . Assume the object in this lab started from rest.

01. What is the velocity of this object after 20 s?
02. What is the velocity of this object after 30 s?
03. What is the velocity of this object after 80 s?
04. What is the velocity of this object after 100 s?
05. Sketch what the velocity vs. time graph would look like for this trip.
06. Sketch what the position vs. time graph would look like for this trip.

Position vs. Time



ANSWERS: **01.** 140 m/s **02.** 114 m/s **03.** -336 m/s **04.** -196 m/s

Chapter 1
One Dimensional Kinematics

Conceptual Review — Homework # 08

01. Does a car speedometer measure speed, velocity, or both? Explain.
02. If an accurate speedometer registers a constant value for a period of time, can you determine the average velocity over that period of time using only the speedometer? Explain.
03. Can the average velocity of a particle be zero over a given time interval if it is not zero over a shorter time interval? Explain.
04. Can an object have a varying velocity if its speed is constant? If yes, give examples; if no, explain why.
05. Can an object have a varying speed if its velocity is constant? If yes, give examples; if no, explain why.
06. When an object moves with a constant velocity, does its average velocity during any time interval differ from its instantaneous velocity at any instant? Explain.
07. Can the velocity of an object be zero at the same instant its acceleration is not zero? Give an example.
08. If one object (Object A) has a greater speed than another object (Object B) does it (Object A) necessarily have a greater acceleration? Explain, using examples.
09. Compare the acceleration of a motorcycle that accelerates from 80 km/h to 90 km/h with the acceleration of a bicycle that accelerates from rest to 10 km/h in the same time.
10. Can you conclude that a car is not accelerating if its speedometer indicates a steady 60 km/h? Explain.
11. Can an object have a northward velocity and a southward acceleration? Explain.
12. Can the velocity of an object be negative if its acceleration is positive? What about vice versa? Explain.
13. Give an example where both velocity and acceleration are negative.
14. A rock is thrown vertically upward with a speed of v from the edge of a cliff. A second rock is thrown vertically downward with the same initial speed. Which rock has the greater speed when it reaches the bottom of the cliff? Ignore air resistance.
15. A ball, thrown vertically upward, returns to the thrower's hand. Which part of the journey requires the longer time, upward or downward? Answer for (a) no air resistance, and (b) in the presence of air resistance.
16. An object that is thrown vertically upward will return to its original position with the same speed as it had initially, if air resistance is negligible. If air resistance is appreciable, will this result be altered, and if so, how?
17. How do you convert km/h to m/s?
18. How do you convert m/s to km/h?