

Hi Everyone,

The second set of notes this week has notes along with equations for the first test, HW 2 and HW 2 answers, and the review for the first test. Your first test is coming up Wednesday, June 17th. You should study HW 1 and HW 2, Notes from Work 1.1 and Work 1.2, and the Test 1 review. I will send the test out by 9:00 AM and it needs to be emailed back by 9:00 PM. If this test were taken in the classroom, it would probably take most of you about 30 minutes, some a little longer. It totally open book but you must do all the work on your own. Put aside some time for the test on Wednesday right now. If you have a major conflict, don't wait until the last minute to inform me!

Enclosed in this packet you will find the following. Just scroll down.

- Notes on straight line motion
- HW 2
- HW 2 Answers
- Metric Conversion Table
- Equations for Test 1
- Test 1 Review (with answers)

Due by midnight, Sunday, June 14, 2020:

- HW 1
- HW 2
- Lab 1

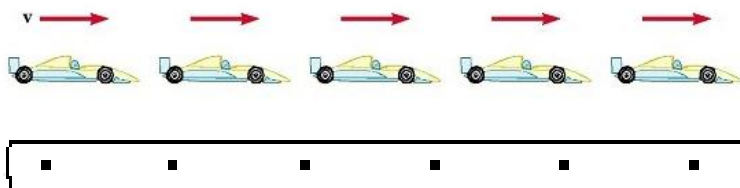
Let me know if you need help or have any questions or concerns.
Mrs. Elliott

I. Describing Motion

Keeping track of the motion of a runner is easier if you disregard the moving arms and legs and concentrate on a single point at the center of his body. In effect, you consider all his mass to be concentrated at that point. This is called the particle model. Below are the motion diagrams for three common types of linear motion. (Velocity is a vector quantity, which means a direction is involved, such as east. Speed is a scalar quantity and no direction is given. In the following problems, we'll use the two terms interchangeably until we study vectors.)

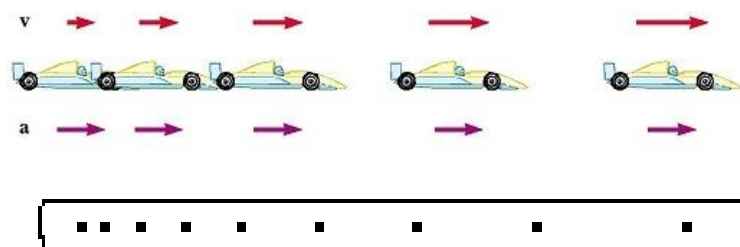
A. Constant Velocity

The first motion diagram, shown below, is for a car moving at a constant speed toward the right. Each car indicates the position of the object at a different time. The cars are separated by equal time intervals. The motion diagram might represent the changing position of a car moving at constant speed along a straight highway. Because the car moves at a constant speed, the distances from one car to the next are of equal lengths. The velocity of the car at each position is represented by an arrow with the symbol " v " under it. The velocity arrows are of equal length because the velocity is constant and in the same direction. **A body traveling at constant velocity must travel in a straight line. If it turns or in any way changes direction, it undergoes acceleration, even if the speed doesn't change.**



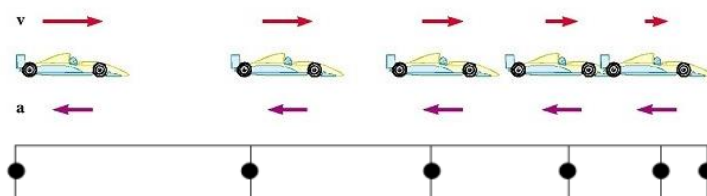
B. Constant Acceleration in the Direction of Motion

The second motion diagram represents a car that undergoes constant acceleration toward the right in the same direction as the initial velocity. This occurs when your car accelerates to pass another car or when a race car accelerates while traveling along the track. Once again, the cars represent the positions of a car at times separated by equal time intervals Δt (the delta symbol, Δ , means change). Because the car accelerates to the right, its velocity arrow increase in length toward the right as time passes, but the acceleration arrow remains the same size, because acceleration is constant. The distance between adjacent positions increases as the car moves right because the car moves faster as it travels right.



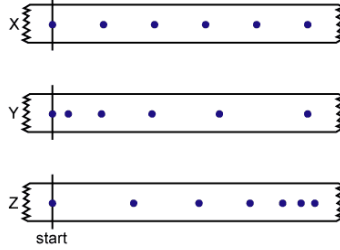
C. Constant Acceleration Opposite in Direction of Motion

The third motion diagram below represents a car that undergoes constant acceleration opposite the direction of the initial velocity (this is commonly called deceleration). For this case, the acceleration arrow points left, opposite the direction of motion. This type of motion occurs when a car skids to a stop. Because the acceleration points to the left opposites the motion, the car's velocity arrows decrease by the same amount from one position to the next.



***Practice Problem 1

What kind of linear motion is being described in the following diagrams?



D. Average Velocity and Instantaneous Velocity

Average velocity is the total distance traveled divided by the total time involved.

$$\text{Average velocity} = \frac{\text{total distance}}{\text{total time}}$$

We use the following equation to determine average velocity:

$$v = \frac{v_f - v_i}{t_f - t_i} = \frac{\Delta v}{\Delta t}$$

Where v_i = initial velocity
 v_f = final velocity

Instantaneous velocity is the speed and direction at an instant in time. Acceleration is changing velocity. If velocity is increasing it is positive, if it is decreasing, acceleration is negative. Negative acceleration is commonly called deceleration.

$$a = \frac{v_f - v_i}{t_f - t_i} = \frac{\Delta v}{\Delta t}$$

Watch the following video for a good introduction to motion in a straight line: <https://youtu.be/ZM8ECpBuQYE>

II. Free Fall

Galileo discovered about 400 years ago that all freely falling objects had the same acceleration. It didn't matter what they were made of, what their masses were, from how high they were dropped.

Try dropping a coin and a baseball or some other similar object at the same time. You will find they hit the ground at the same time, if air resistance is neglected. Everything falls at the same rate and will hit the ground at the same time in a vacuum. Because we don't live in a vacuum, we do see some object fall faster than others. In our world, it's air resistance that makes the difference. The magnitude, or size, of the acceleration of falling objects is given a special symbol, g , equal to 9.8 m/s^2 . We now know that there are small variations in g at different places on Earth, and that 9.8 m/s^2 is the average value. After one second, a falling object will be traveling at 9.8 m/s . After 2 seconds, an object will be traveling 19.6 m/s , after 3 seconds, an object will be traveling 29.4 m/s , and so on. While the velocity of a falling object speeds up as it falls, the acceleration due to gravity is a constant 9.8 m/s^2 .

When a ball is thrown straight up into the air, the ball's velocity begins to slow down as it rises, until it comes to a complete stop. It then begins to fall and gain speed on the way down. If it takes 2 seconds to rise to its highest point where the velocity = 0 m/s , then it will take 2 seconds to fall back to the initial position. Assuming no air resistance, the speed it has when caught will equal the speed it had when it left the hand. This means that $g = -9.8 \text{ m/s}^2$.

***Practice Problem 2 Match the motion diagram with the situation. Hint: Acceleration due to gravity on Mars is less than 9.8 m/s^2 (g on Earth)

A. 0 ●	B. 0 ●	C. 0 ●
1 ●		
2 ●	1 ●	
3 ●	2 ●	1 ●
4 ●	3 ●	2 ●
	4 ●	3 ●
	5 ●	4 ●
		5 ●

(X) Mars explorer making a soft landing

(Y) Ball dropped from a rooftop

(Z) Dust particle settling at constant speed

III. Using Equations

When we work problems in physics (and every other science), we always include the following three elements. If your work is missing any of these three elements, you will NOT get full credit.

- 1) The equation, which is your blueprint for working the problem
- 2) The numbers substituted for the equation (including units)
- 3) The answer with units.

The following video will give a good review on dimensional analysis, which tells us how to handle the units in physics problems. If you have had a previous science class such as chemistry, this concept should be familiar. If you have no experience with dimensional analysis, you will pick it up over time. The main thing to remember is to never omit the units in a problem. <https://youtu.be/OaG1c9FWTsg>

Before trying the following examples and practice problems, find the equations for Test 1 in this packet. You will need them to do the work below.

The following examples will give you practice setting up problems and using your calculator to solve for the answer. If you are unable to solve for the correct answer, go back and look at the videos given in the Math Help notes, or email me for help.

Example 1 A bike travels at a constant speed of 144.0 km/h for 5 s. How many meters does it go?

To solve this problem, we first need to decide what we are given. Constant speed is the same as average speed, $\bar{v}$. We know, then that $\bar{v} = 144.0 \text{ km/h}$ and $t = 5 \text{ s}$. We look for the equation that solves for distance, given both $\bar{v}$ and t . Since the units for distance and time are not what we need, we need to convert them, using the table of metric conversions attached to this packet. In this example, both km and h will cancel.

$$\frac{144.0 \cancel{\text{km}}}{\cancel{\text{h}}} \times \frac{\cancel{\text{h}}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{\cancel{\text{km}}} = 40 \text{ m/s}$$
$$d = \bar{v}t$$
$$\frac{40 \text{ m}}{\text{s}} \times \frac{5 \text{ s}}{1} = 200 \text{ m}$$

If we do this in one step it would look like the following:

$$\frac{144.0 \cancel{\text{km}}}{\cancel{\text{h}}} \times \frac{\cancel{\text{h}}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{\cancel{\text{km}}} \times \frac{5 \text{ s}}{1} = 200 \text{ m}$$

Example 2 A student drops a ball from a window 3.5 m above the sidewalk. The ball accelerates at 9.8 m/s^2 . How fast is it moving when it hits the sidewalk? In this problem, we are given the distance and the acceleration. We are looking for the velocity when the object comes to rest.

$$v = \sqrt{2ad}$$
$$\sqrt{\frac{2}{1} \times \frac{9.8 \text{ m}}{\text{s}^2} \times \frac{3.5 \text{ m}}{1}} = 8.3 \text{ m/s}$$

In this problem, the units are m^2/s^2 , until we take the square root, after which we have m/s left.

Example 3 A car is traveling 20.0 m/s when the driver sees a child standing in the road. He takes 0.80 s to react, then steps on the brakes and slows at 7.0 m/s². How far does the car go before it stops, if it takes 10.2 s to stop after braking?

$$d = v_i t + \frac{1}{2} a t^2$$

$$\frac{20 \text{ m}}{\text{s}} \times \frac{0.8 \text{ s}}{1} + \frac{1}{2} \times \frac{7.0 \text{ m}}{\text{s}^2} \times \left(\frac{10.2 \text{ s}}{1} \right)^2 = 380 \text{ m}$$

Example 4 You throw a ball downward from a window at a speed of 2.0 m/s. The ball accelerates at 9.8 m/s². How fast is it moving when it hits the sidewalk 2.5 m below?

$$v_f^2 = v_i^2 + 2 a d$$

$$\sqrt{\left(\frac{2.0 \text{ m}}{\text{s}} \right)^2 + 2 \times \frac{9.8 \text{ m}}{\text{s}^2} \times \frac{2.5 \text{ m}}{1}} = 7.3 \text{ m/s}$$

Example 5 An Indy 500 race car's velocity increases from +4.0 m/s to +36 m/s over a 4.0-s interval. What is the average acceleration?

$$a = \frac{v_f - v_i}{t}$$

$$\left(\frac{36 \text{ m}}{\text{s}} - \frac{4.0 \text{ m}}{\text{s}} \right) \times \frac{1}{4.0 \text{ s}} = 8 \text{ m/s}^2$$

Example 6 A bus, traveling at 30.0 km/h speeds up at a constant rate of 3.5 m/s². What velocity does it reach 6.8 s later?

$$\frac{30.0 \text{ km}}{\text{h}} \times \frac{\text{h}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{\text{km}} = 8.3 \text{ m/s}$$

$$v_f = v_i + a t$$

$$\frac{8.3 \text{ m}}{\text{s}} + \frac{3.5 \text{ m}}{\text{s}^2} \times \frac{6.8 \text{ s}}{1} = 32 \text{ m/s}$$

Example 7 If a car accelerates from rest at a constant 5.5 m/s², how long will it need to reach a velocity of 28 m/s?

$$t = \frac{v}{a}$$

$$\frac{28 \text{ m}}{\text{s}} \times \frac{\text{s}^2}{5.5 \text{ m}} = 5.1 \text{ s}$$

Example 8 A race car traveling at 44 m/s slows at a constant rate to a velocity of 22 m/s over 11 s. How far does it move during this time?

$$\bar{v} = \frac{v_f + v_i}{2} = \frac{22 \text{ m/s} + 44 \text{ m/s}}{2} = 33 \text{ m/s}$$

$$d = \bar{v} t$$

$$\frac{33 \text{ m}}{\text{s}} \times \frac{11 \text{ s}}{1} = 363 \text{ m}$$

Example 9 An airplane starts from rest and accelerates at a constant 3.00 m/s^2 for 30.0 s before leaving the ground.

- a. How far did it move?

$$d = \frac{1}{2} at^2$$

$$\frac{1}{2} \times \frac{3.00 \text{ m}}{\text{s}^2} \times \left(\frac{30 \text{ s}}{1}\right)^2 = 1350 \text{ m}$$

- b. How fast was it going when it took off?

$$v = at$$

$$\frac{3.00 \text{ m}}{\text{s}} \times \frac{30.0 \text{ s}}{1} = 90 \text{ m/s}$$

*****Practice Problem 3** Convert 855 km/h to m/s

*****Practice Problem 4** If an object falls for 12.8 s , how far did it fall?

*****Practice Problem 5** If a race car, starting from rest, reaches an acceleration of 3.4 m/s^2 in 250 m , what was its final velocity?

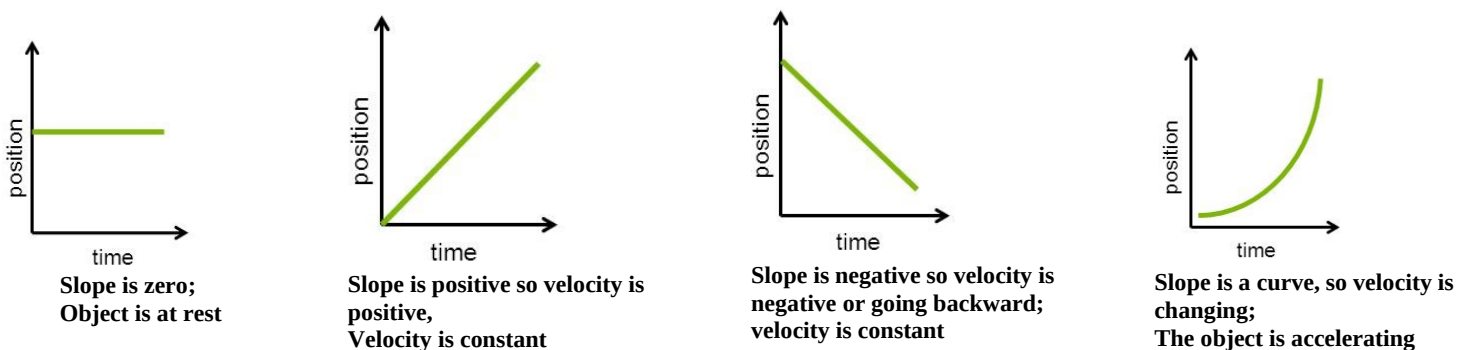
*****Practice Problem 6** If a race car, starting from rest, reaches an acceleration of 3.4 m/s^2 in 5.6 s , how fast was it going when it stopped accelerating?

IV Motion Graphs

Equations are great for many situations, but sometimes they don't give enough information. Motion graphs give a picture of what is going on – descriptions of real events in compact form. Graphs of motion come in several types depending on which of the quantities (time, displacement, velocity, acceleration) are assigned to which axis. We will look at two different types of motion graphs, the position-time graph and the velocity-time graph.

A. Position-Time Graphs

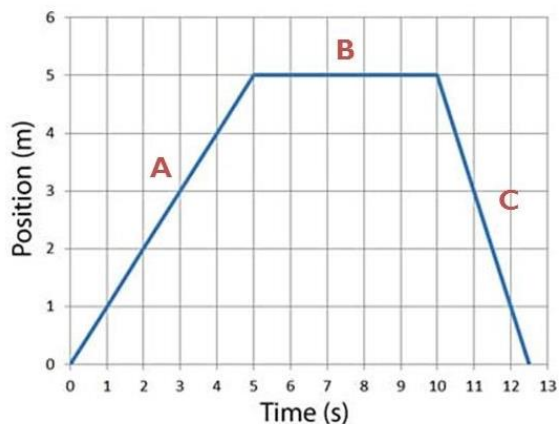
In the diagram below, we see the four ways a line on a position-time graph can give up information. A flat line indicates that there is no motion at all. Time is going forward, but the object is not moving. A positive slope indicates constant positive velocity (going forward) and a negative slope indicates negative velocity (going backward). A curve indicates changing velocity or acceleration.



The slope = the velocity over that time interval. The steeper the slope, faster the velocity.

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{rise}}{\text{run}} = \frac{\text{m}}{\text{s}}$$

The following graph has three sections, A, B, and C. The velocity of each was calculated, by calculating the slope.

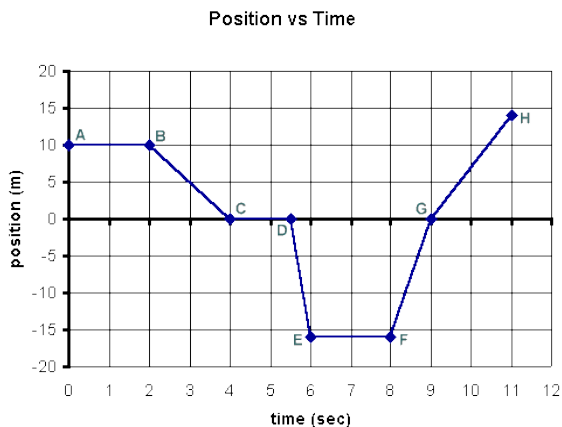


$$\text{Section A: slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 \text{ m} - 0 \text{ m}}{5 \text{ s} - 0 \text{ s}} = 1 \text{ m/s}$$

$$\text{Section B: slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 \text{ m} - 0 \text{ m}}{5 \text{ s} - 0 \text{ s}} = 0 \text{ m/s}$$

$$\text{Section C: slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 \text{ m} - 5 \text{ m}}{12.5 \text{ s} - 10 \text{ s}} = -2 \text{ m/s}$$

Example 10 Given the position-time graph below, answer the following questions.



Questions

1. What is the position at time = 2 s?
2. What is the speed between 9 s and 11 s?
3. What is the speed between 6 s and 8 s?
4. What is the speed between 5.5 s and 6 s?
5. What is the speed between 2 s and 4 s?

Answers

1. 10 m

$$2. \text{ slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{14 \text{ m} - 0 \text{ m}}{11 \text{ s} - 9 \text{ s}} = \frac{14 \text{ m}}{2 \text{ s}} = 7 \text{ m/s}$$

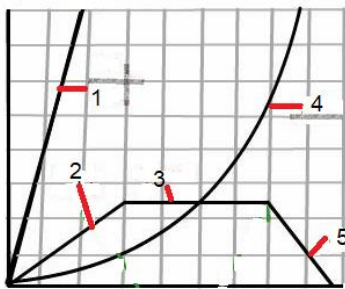
3. 0 m/s

$$4. \text{ slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 \text{ m} - 16 \text{ m}}{6 \text{ s} - 5.5 \text{ s}} = \frac{-16 \text{ m}}{0.5 \text{ s}} = -32 \text{ m/s}$$

$$5. \text{ slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 \text{ m} - 10 \text{ m}}{4 \text{ s} - 2 \text{ s}} = \frac{-10 \text{ m}}{2 \text{ s}} = -5 \text{ m/s}$$

Example 11

Position vs Time



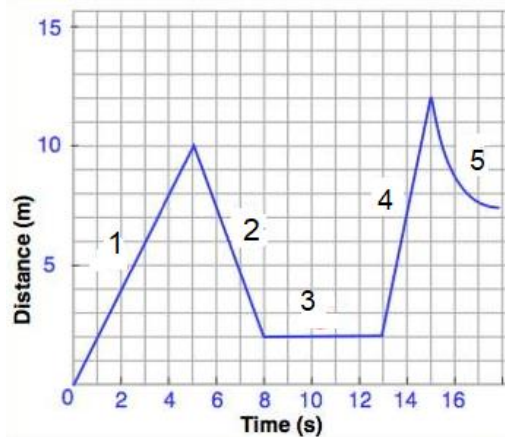
Label what kind of motion is occurring in the graph to the left:

Answers:

1. positive constant velocity
2. positive constant velocity
3. no motion
4. acceleration
5. negative constant velocity

***Practice Problem 7

Position vs Time

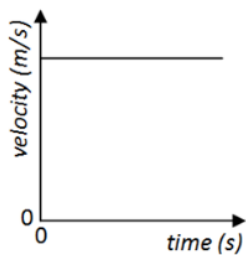


Indicate what type of motion is occurring in each section of the graph.

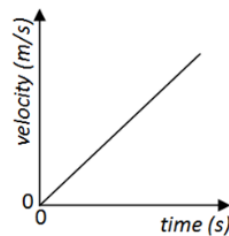
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____ What was the speed in section 1?
7. _____ What was the speed in section 3?
8. _____ Which section has the highest speed?

B. Velocity-Time Graphs

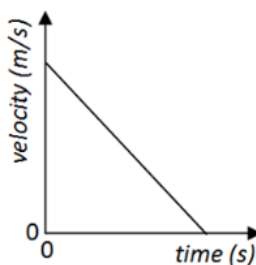
The diagrams below tell us the information that a velocity-time graph can give. In this case a straight line does not indicate no motion, but rather a constant velocity. A positive slope indicates constant acceleration, while a negative slope indicates constant negative acceleration or deceleration. If the negative line were to go below the x-axis, then we have constant acceleration in the opposite direction.



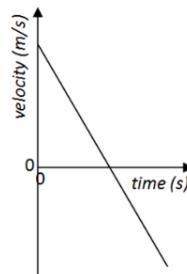
constant velocity



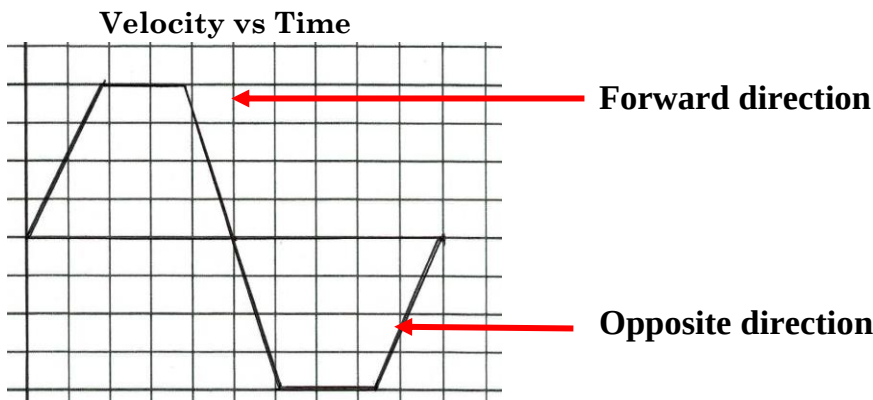
constant acceleration



constant negative acceleration
(deceleration)



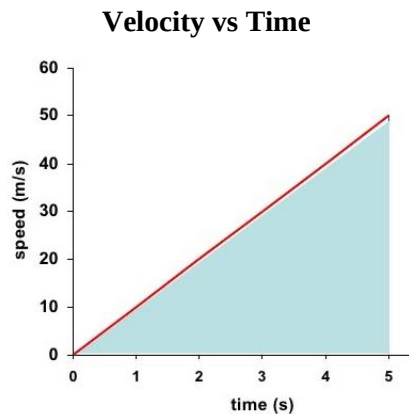
constant deceleration to rest then
acceleration in the opposite direction



The slope of a velocity-time graph gives us the constant acceleration. If we calculate the area under a section of the graph, we find the distance or displacement traveled during that time interval. The area to be calculated will either be a rectangle or square or have a triangular shape. Below are the equations to use.

Area of a square or rectangle = base x height

$$\text{Area of a triangle} = \frac{\text{base} \times \text{height}}{2}$$

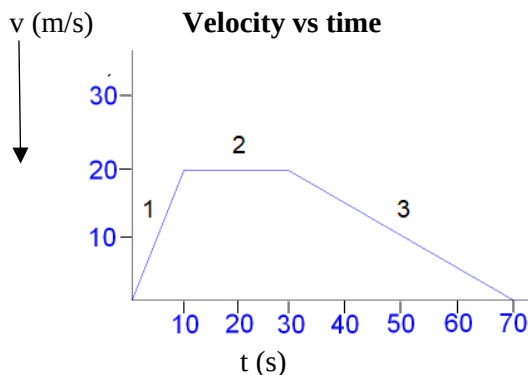


What is the distance traveled in the first 5 s?

$$\text{Area of a triangle} = \frac{\text{base} \times \text{height}}{2} = \frac{5 \times 50}{2} = 125 \text{ m}$$

Example 12

Use the following velocity-time graph to answer the following questions.



Questions

1. What was the speed during section 2?
2. What was the rate of acceleration during section 3?
3. What distance was traveled during the first 10 s?
4. What distance was traveled during the interval between 10 s and 30 s?

Answers

1. 20 m/s

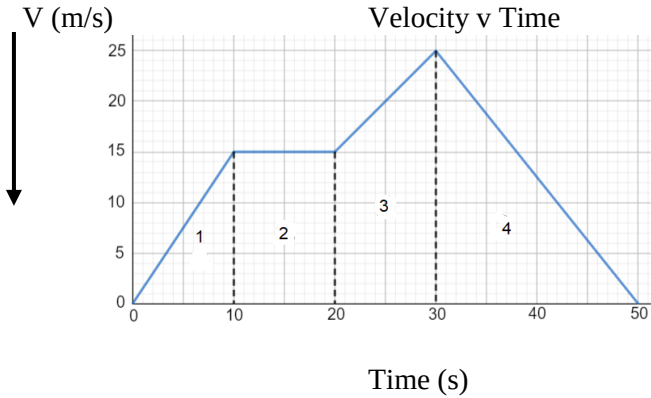
$$\begin{aligned} 2. \text{ slope} &= \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 \text{ m/s} - 20 \text{ m/s}}{70 \text{ s} - 30 \text{ s}} = \frac{-20 \text{ m/s}}{40 \text{ s}} \\ &= -0.5 \text{ m/s}^2 \end{aligned}$$

$$\begin{aligned} 3. \text{ Area of a triangle} &= \frac{\text{base} \times \text{height}}{2} \\ &= \frac{10 \text{ s} \times 20 \text{ m/s}}{2} = 100 \text{ m} \end{aligned}$$

$$\begin{aligned} 4. \text{ Area of a square} &= \text{base} \times \text{height} \\ &= (30 \text{ s} - 10 \text{ s}) \times (20 \text{ m/s}) = 400 \text{ m} \end{aligned}$$

***Practice Problem 8

Use the following velocity-time graph to answer the following questions



Questions

1. What was the acceleration during section A?
2. What was the rate of acceleration during section D?
3. What distance was traveled during the first 10 s?
4. What distance was traveled during section C?
5. What distance was traveled during the section D?

Answers to Practice Problems

1. X = constant velocity
Y = positive acceleration
Z = negative acceleration (deceleration)

3.
$$\frac{855 \text{ km}}{h} \times \frac{h}{3600 \text{ s}} \times \frac{1000 \text{ m}}{\text{km}} = 238 \text{ m/s}$$

5.
$$v = \sqrt{2ad}$$

$$\sqrt{\frac{2}{1} \times \frac{3.4 \text{ m}}{\text{s}^2} \times \frac{250 \text{ m}}{1}} = 41.2 \text{ m/s}$$

7.
 - 1 positive constant velocity
 - 2 negative constant velocity
 - 3 no motion
 - 4 positive constant velocity
 - 5 negative acceleration
 6.
$$\frac{(10 \text{ m} - 0 \text{ m})}{5 \text{ s} - 0 \text{ s}} = 2 \text{ m/s}$$
 7. 0 m/s
 8. section 4 (steepest curve)

2. A = Y (shows a faster acceleration than on Mars)
B = Z (shows constant velocity – equal spacing between dots)
C = X (shows very slow acceleration)

4.
$$d = \frac{1}{2} at^2$$

$$\frac{1}{2} \times \frac{9.8 \text{ m}}{\text{s}^2} \times \left(\frac{12.8 \text{ s}}{1}\right)^2 = 803 \text{ m}$$

6.
$$v = at$$

$$\frac{3.4 \text{ m}}{\text{s}^2} \times \frac{5.6 \text{ s}}{1} = 19 \text{ m/s}$$

8.
 1.
$$\frac{15 \text{ m/s} - 0 \text{ m/s}}{10 \text{ s} - 0 \text{ s}} = \frac{15 \text{ m/s}}{10 \text{ s}} = 1.5 \text{ m/s}^2$$
 2.
$$\frac{0 \text{ m/s} - 25 \text{ m/s}}{50 \text{ s} - 30 \text{ s}} = \frac{-25 \text{ m/s}}{20 \text{ s}} = -1.3 \text{ m/s}^2$$
 3.
$$\frac{\text{base} \times \text{height}}{2} = \frac{10 \text{ s} \times 15 \text{ m/s}}{2} = 75 \text{ m}$$
 4.
$$\frac{\text{base} \times \text{height}}{2} = \frac{10 \text{ s} \times 10 \text{ m/s}}{2} = 50 \text{ m}$$

$$\text{base} \times \text{height} = 10 \text{ s} \times 15 \text{ m/s} = 150 \text{ m}$$

$$\text{Total distance} = 50 \text{ m} + 150 \text{ m} = 200 \text{ m}$$
 5.
$$\frac{\text{base} \times \text{height}}{2} = \frac{20 \text{ s} \times 25 \text{ m/s}}{2} = 250 \text{ m}$$

Name _____

Physics 1100 HW 2

Due: June 14, 2020

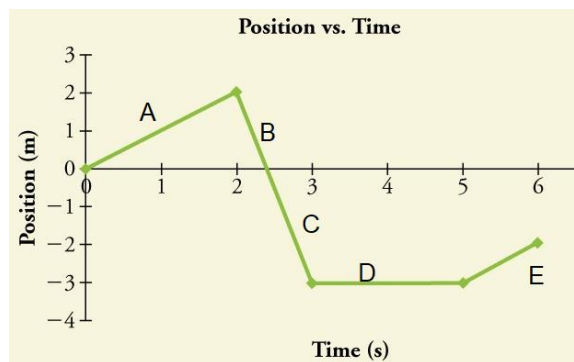
1. Use a motion diagram to illustrate

- a. a runner moving at a constant speed

- b. a runner starting at rest and speeding up

- c. a car that starts from rest, speeds up to a constant speed, and then slows to a stop.

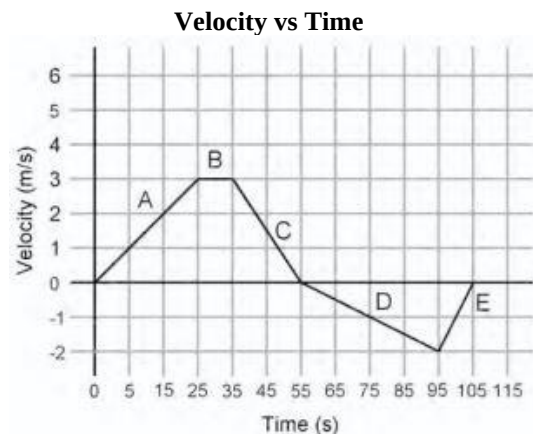
2. Use the following graph to answer the questions. No need to show work.



Questions

- _____ What was the speed in section A?
- _____ What was the speed in section C?
- _____ During which section is there no motion?
- _____ Which sections show positive constant velocity?
- _____ Which sections show negative constant velocity?

3. Use the graph below to answer the questions. No need to show work.



Questions

- _____ What was the acceleration during section C?
- _____ At what time was there no motion?
- _____ What distance was traveled during the first 55 s?
- _____ Which sections show positive acceleration?
- _____ Which sections show motion in the opposite direction?

Directions For each of the following problems, write the equation used, substitute with units and express the final answer with units. The final answer is in brackets.

1. A student is driving down a street at 65 km/h in a school zone when suddenly a cop appears. If it takes the student 0.21 s to react and apply the brakes, how many meters will he have moved before he begins to slow down? [3.8 m]
2. How long does it take to travel 5.6 km if the average speed is 45 m/s? [124 s]
3. In a drag race, a dragster reaches the quarter mile (402 m) marker with a speed of 80 m/s. What is his acceleration? Assume the car starts from rest. [8 m/s²]
4. During the takeoff roll, a Boeing 747 jumbo jet is accelerating at 4 m/s². If it requires 40 s to reach takeoff speed from rest, determine the takeoff speed. [160 m/s]
5. How far does the jet in problem #4 travel on the ground? [3200 m]
6. A car traveling at 30 m/s accelerates uniformly to a speed of 60 m/s in 10 s. What is the car's acceleration? [3 m/s²]
7. A ball is released from rest at a certain height. What is its velocity after falling 200 m? [63 m/s]
8. A rock is dropped from a cliff. If it falls for 3.3 s, how far did it fall? [53 m]

HW 2 Answers

1.

a.



b.



c.



2.

$$1. \quad \frac{2 \text{ m} - 0 \text{ m}}{2 \text{ s} - 0 \text{ s}} = 1 \text{ m/s}$$

$$2. \quad \frac{0 \text{ m} - 3 \text{ m}}{3 \text{ s} - 2.4 \text{ s}} = -5 \text{ m/s}$$

3. D

4. A and E

5. B and C

3.

$$1. \quad \frac{0 \text{ m/s} - 3 \text{ m/s}}{55 \text{ s} - 35 \text{ s}} = -0.15 \text{ m/s}^2$$

2. at 55s

$$3. \quad \left(\frac{25 \text{ s} \times 3 \text{ m/s}}{2} \right) + (5 \text{ s} \times 3 \text{ m/s}) + \left(\frac{20 \text{ s} \times 3 \text{ m/s}}{2} \right) = 82.5 \text{ m}$$

4. A and E

5. D and E

Problems

1.

$$d = v t$$

$$\frac{65 \text{ km}}{\text{h}} \times \frac{\text{h}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{\text{km}} \times \frac{0.21 \text{ s}}{1} = 3.8 \text{ m}$$

3.

$$a = \frac{v^2}{2d}$$

$$\left(\frac{80 \text{ m}}{\text{s}} \right)^2 \times \frac{1}{2 \times 402 \text{ m}} = 8 \text{ m/s}^2$$

5.

$$d = \frac{v_f^2}{2a}$$

$$\left(\frac{160 \text{ m}}{\text{s}} \right)^2 \times \frac{\text{s}^2}{2 \times 4 \text{ m}} = 3200 \text{ m}$$

7.

$$v^2 = 2 a d$$

$$\sqrt{\frac{2}{1} \times \frac{9.8 \text{ m}}{\text{s}^2} \times \frac{200 \text{ m}}{1}} = 63 \text{ m}$$

2.

$$t = \frac{d}{v}$$

$$\frac{5.6 \text{ km}}{1} \times \frac{1000 \text{ m}}{\text{km}} \times \frac{\text{s}}{45 \text{ m}} = 124 \text{ s}$$

4.

$$v_f = at$$

$$\frac{4 \text{ m}}{\text{s}^2} \times \frac{40 \text{ s}}{1} = 160 \text{ m/s}$$

6.

$$a = \frac{v_f - v_i}{t}$$

$$\left(\frac{60 \text{ m}}{\text{s}} - \frac{30 \text{ m}}{\text{s}} \right) \times \frac{1}{10 \text{ s}} = 3 \text{ m/s}^2$$

8.

$$d = \frac{1}{2} a t^2$$

$$\frac{1}{2} \times \frac{9.8 \text{ m}}{\text{s}^2} \times \frac{(3.3 \text{ s})^2}{1} = 53 \text{ m}$$

METRIC EQUIVALENTS

Time

3600 s	=	1 h
365 d	=	1 y
24 h	=	1 d
3.16×10^7 s	=	1 y

Length

1 m	=	39.4 in
1 ft	=	30.5 cm
1 in	=	2.54 cm
6080 ft	=	1.85 km
1 yd	=	91.44 cm
1 mi	=	5280 ft
1 mi	=	1609.3 m
1 ft	=	12 in
1 m	=	1×10^{10} Å
1 LY	=	1×10^{15} m
1000 m	=	km
1×10^6 µm	=	m
100 cm	=	m
1000 mm	=	m
1×10^6 m	=	Mm
1×10^9 nm	=	m
1×10^{12} pm	=	m

Volume

1 dm ³	=	1 L
1 ft ³	=	28.3 L
28.3 L	=	0.0283 m ³
1 cm ³	=	1 mL
1 oz	=	28.4 g
1 qt	=	946.4 mL
1 gal	=	3.8 L
1 gal	=	4 qt
1 gal	=	8 pt
1000 mL	=	L
1 acre-foot	=	4.36×10^4 ft ³
4.7 mL	=	tsp

Energy and Power

1000 cal	=	Cal
1 cal	=	4.184 J
1 MeV	=	1.6022×10^{-13} J
1 J	=	kg m ² /s ²
1 J	=	6.24×10^{18} eV
1000 J	=	kJ
1 Joule (J)	=	1×10^7 ergs
1 hp	=	746 W
1000 W	=	kW
1 kWh	=	3.60×10^6 J

Mass

1 lb	=	453.6 g
1 lb	=	16 oz
1 amu	=	106606×10^{-27} kg
1 mole	=	6.02×10^{23} particles
1 mole	=	1×10^3 mmol
1 kg	=	2.21 lb
1 ton	=	2000 lb
1000 g	=	kg
1×10^6 µg	=	g
100 cg	=	g
1000 mg	=	g
1×10^6 g	=	Mg
1×10^9 ng	=	g
1×10^{12} pg	=	g

Speed

1 m/s	=	3.60 km/h
1 m/s	=	2.24 mph
1 m/s	=	3.28 ft/s
1 mi/h	=	1.609 km/h
1 mi/h	=	0.447 m/s
1 mi/h	=	1.47 ft/s

Force

1 N	=	0.225 lb
1 N	=	1 kg m/s ²
1 N	=	1×10^5 dynes
1 dyne	=	1 g cm/s ²

Pressure

1 atm	=	760 mm Hg
1 atm	=	760 torr
1 atm	=	101.3 kPa
1 atm	=	1.013 bar
1 atm	=	14.7 lb/s ²
1000 Pa	=	kPa
1 Pa	=	1 N/m ²

Temperature Conversions

$$C^{\circ} = (F^{\circ} - 32) \times \frac{5}{9}$$

$$F^{\circ} = \left(\frac{C^{\circ}}{1} \times \frac{9}{5} \right) + 32$$

$$C^{\circ} = K - 273$$

$$K = C^{\circ} + 273$$

Abbreviations

Å	angstrom
amu	atomic mass unit
atm	atmosphere
cal	calorie
d	day
eV	electron volt
ft	feet
g	gram
gal	gallon
h	hour
in	inch
kWh	kilowatt-hour
L	liter

lb	pound
LY	light year
m	meter
mmol	millimole
N	newton
oz	ounce
Pa	Pascal
pt	pint
qt	quart
s	second
W	watt
y	year
yd	yard

Physical Constants

Acceleration due to gravity, g (near the earth's surface)

Average Earth radius

Average Earth-moon distance

Average Earth-sun distance

Avogadro's number, N

Bohr radius, r_{Bohr}

Boltzmann's constant, k_b

Charge on an electron, e

Coulomb's law constant, k

Mass of Earth

Mass of electron

Mass of neutron

Mass of proton

Planck's constant, h

Speed of light in a vacuum, c

Universal constant of gravitation, G

9.80 m/s²

6.38 x 10⁶ m

3.84 x 10⁸ m

1.50 x 10¹¹ m

6.022 x 10²³ particles/mole

5.29 x 10⁻¹¹ m

1.38 x 10⁻²³ J/K

1.60 x 10⁻¹⁹ C

9.00 x 10⁹ N m²/C²

5.98 x 10²⁴ kg

9.11 x 10⁻³¹ kg

1.6750 x 10⁻²⁷ kg

1.6726 x 10⁻²⁷ kg

6.626 x 10⁻³⁴ J s

3.0 x 10⁸ m/s

6.67x 10⁻¹¹ N m²/kg²

SI Prefixes

votta	Y	1 x 10 ²⁴
Zetta	Z	1 x 10 ²¹
exa	E	1 x 10 ¹⁸
peta	P	1 x 10 ¹⁵
tera	T	1 x 10 ¹²
giga	G	1 x 10 ⁹
mega	M	1 x 10 ⁶
kilo	k	1 x 10 ³
hector	h	1 x 10 ²
deka	da	1 x 10 ¹
deci	d	1 x 10 ⁻¹

centi	c	1 x 10 ⁻²
*milli	m	1 x 10 ⁻³
micro	μ	1 x 10 ⁻⁶
nano	n	1 x 10 ⁻⁹
pico	p	1 x 10 ⁻¹²
femto	f	1 x 10 ⁻¹⁵
atto	a	1 x 10 ⁻¹⁸
zepto	z	1 x 10 ⁻²¹
yocto	y	1 x 10 ⁻²⁴

*Examples:

1 mm = 1 x 10⁻³ m

1 m = 1 x 10⁻³ L

1 mg = 1 x 10⁻³ g

Name _____

PHY 1100

Equations for Test 1

Instantaneous velocity = v (m/s)

Average velocity = $\bar{v}$ (m/s)

v_i = initial velocity (m/s)

v_f = final velocity (m/s)

$\Delta v = v_f - v_i$

Distance = d (m or any distance unit)

Acceleration = a (m/s²)

Time = t (s)

$\Delta t = t_f - t_i$

I. Average Velocity Equations

$$\bar{v} = \frac{v_f + v_i}{2}$$

$$\bar{v} = \frac{d}{t}$$

$$d = \bar{v}t$$

$$d = \left(\frac{v_f + v_i}{2} \right) t$$

$$t = \frac{d}{\bar{v}}$$

II. Acceleration Equations with Two Velocities

$$a = \frac{2d}{t^2}$$

$$a = \frac{v_f^2 - v_i^2}{2d}$$

$$\bar{a} = \frac{v_f - v_i}{t} = \frac{\Delta v}{\Delta t}$$

(average acceleration)

III. Acceleration Equations Starting from Rest or Ending at Rest

$$a = \frac{v^2}{2d}$$

$$a = \frac{2d}{t^2}$$

$$a = \frac{v}{t}$$

IV. Distance Equations with Two Velocities

$$d = v_i t + \frac{1}{2} a t^2$$

$$d = \frac{v_f^2 - v_i^2}{2a}$$

V. Distance Equations Starting from Rest or Ending at Rest

$$d = \frac{1}{2} a t^2$$

$$d = \frac{v^2}{2a}$$

VI. Velocity Equations with Two Velocities

$$v_f = v_i + at$$

$$v_f = \sqrt{(v_i)^2 + 2ad}$$

VII. Final Velocity Equations Starting from Rest or Ending at Rest

$$v = at$$

$$v = \sqrt{2ad}$$

VIII. Time Equations with Two Velocities

$$t = \frac{v_f - v_i}{a}$$

$$t = \sqrt{\frac{2d}{a}}$$

IX. Time Equation Starting from Rest or Ending at Rest

$$t = \frac{v}{a}$$

Relationship	Shape of Graph	General Equation for line
Linear	Straight line	$y = mx + b$
Parabolic	parabolic	$y = kx^2$
Inverse	hyperbola	$k = xy$

PHY 1100 Test 1 Review

This review is not for a grade. Do not email it to me! Use it to reinforce what you should know for the first test. The first test will look similar to this but will be somewhat shorter. It will cover ALL the material in the first two attachments.

I. Give the number of significant digits in the following measurements.

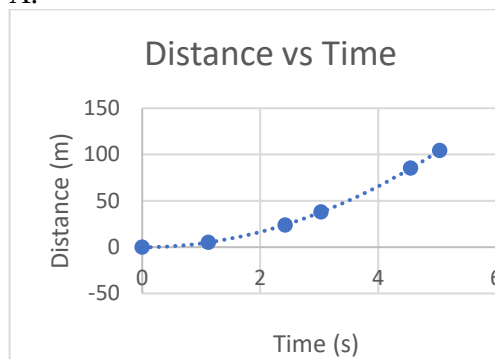
1. _____ 5.101800
2. _____ 0.020
3. _____ 1.70×10^{22}
4. _____ 800
5. _____ 9.30×10^6

Solve the following problems and round the answer using the correct number of significant digits.

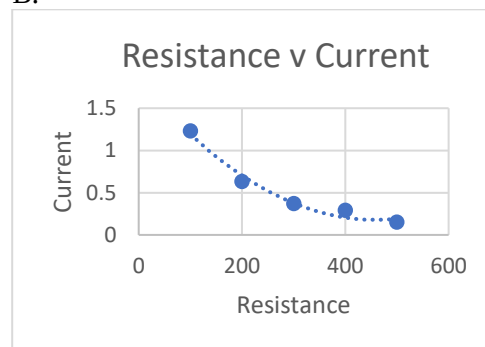
6. _____ $\frac{84 \text{ m}^3}{2.00 \text{ m}^2}$
7. _____ $9.205 \text{ kg} \times 1.30 \text{ kg} \times 0.05 \text{ kg}$
8. _____ $23.00 \text{ m} + 4.6 \text{ m} + 1.44 \text{ m}$
9. _____ $33 \text{ L} - 8.5 \text{ L}$
10. _____ $\frac{(7.3 \times 10^{11} \text{ kg})(3.7 \times 10^{14} \text{ m})}{(1.2 \times 10^{-3} \text{ s})(9.7 \times 10^{-2} \text{ s})}$

II. Answer the questions that refer to the following graphs.

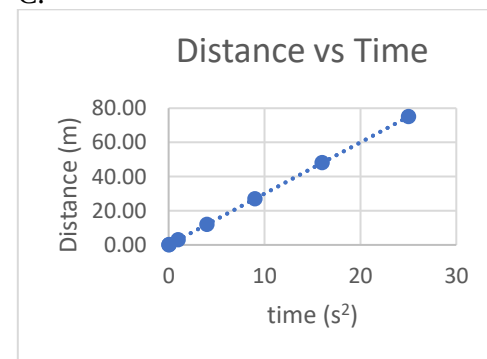
A.



B.

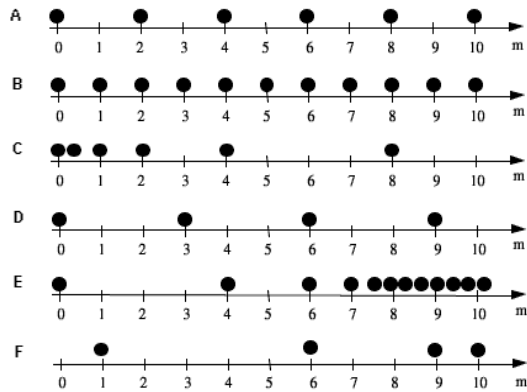


C.



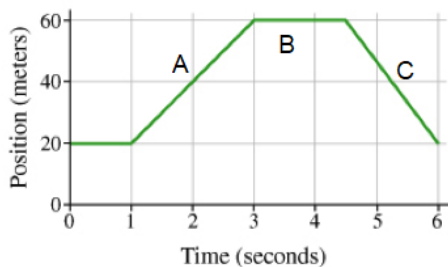
1. _____ Which graph represents an inverse relationship?
2. _____ Which of the graphs could have the equation $y = kx^2$?
3. _____ Write the general equation for graph C.
4. _____ Write the general equation for graph B.
5. _____ Which graph represents a linear relationship?
6. _____ Which graph shows a parabola?
7. _____ Which graph shows a hyperbola?
8. _____ Graphs A and C are both graphs of distance vs time. What was done to the data in graph A to cause the parabola to become a straight line?

III. Label constant velocity, positive acceleration, or negative acceleration in the following motion diagrams.



- A. _____
 B. _____
 C. _____
 D. _____
 E. _____
 F. _____

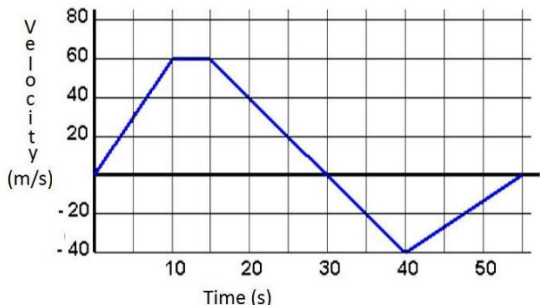
IV. Use the following graph to answer the questions.



1. Questions

- a. _____ What is the velocity in section A
 b. _____ What is the speed in section B?
 c. _____ What is the speed in section C?
 d. _____ Which section show no motion?

Use the following graph to answer the following questions.



2. Questions

- a. _____ What was the acceleration during the first 10 s?
 b. _____ What was the rate of acceleration between 15 s and 40 s?
 c. _____ What distance was traveled during the first 10 s?
 d. _____ What distance was traveled between 40 s and 55 s?
 e. _____ During what time interval was the speed constant?

V. Directions: For each problem 1) Write the equation 2) substitute for the equation using proper units and 3) calculate the answer and express it with correct units (work on a separate sheet of paper).

Study tip: Finding the equation for a problem is usually the most difficult part of working a problem. If this is difficult for you, practice just looking for the right equation, instead of working the whole problem. Read a problem, decide which equation should work, and then check the answer sheet to see if you are right. It's a very quick way to drastically improve your ability to work problems!

1. An athlete runs 200.0 m in 21.20 s. What is the average velocity in km/h? [33.9 km/h]
2. A car's speed increases uniformly from 10.0 m/s, to 51.0 m/s with a rate of acceleration of 3.70 m/s^2 . How long did it take the car to reach its final speed? [11.1 s]
3. What distance did the car in problem # 2 cover during the time that it was accelerating? [334 m]

4. A projectile is shot straight up with a velocity of 63.8 m/s. How high above the ground is the projectile when it comes to a stop and begins to fall? [208 m]
5. A gun is fired, and the bullet is accelerated in the gun barrel, which is 1.1 m long. The bullet leaves the barrel with a velocity of 1230 m/s. Calculate the acceleration of the bullet while it is in the barrel. [$6.9 \times 10^5 \text{ m/s}^2$]
6. A sprinter runs the 200-m dash, accelerating constantly the entire distance at a rate of 0.63 m/s^2 . How fast is the sprinter going when he crosses the finish line? [16 m/s]
7. How long did it take the sprinter in problem #6 to run the 200-m dash? [25 s]
8. A bag is dropped from a hovering helicopter. When the bag has fallen for 2.0 s, what is the bag's velocity? [19.6 m/s]
9. How far has the bag in problem #8 fallen in 2.9 s? [41 m]
10. A plane flying with a speed of 195 m/s accelerates to a speed of 350 m/s in 2.3 km (2300 m). What was the plane's acceleration? [18 m/s^2]
11. An airplane accelerates from a velocity of 31 m/s at the constant rate of 3.0 m/s^2 over 585 m. What is its final velocity? [67 m/s]

Multiple Choice

1. A car traveling at constant speed

A. does not turn	C. can change direction
B. travels more distance in a second the longer the car travels	D. cannot be going uphill
2. A quantity that is a measure of how the velocity of a body changes with time is

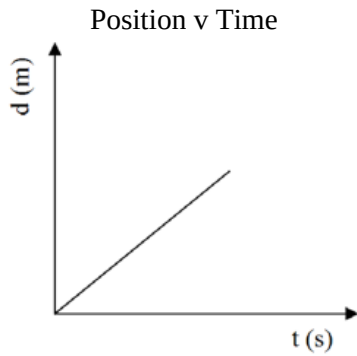
A. distance	C. acceleration
B. speed	D. time
3. A student plots data for the velocity of a body vs the time on a graph. The area under the curve on the graph may be identified as

A. acceleration	C. average speed
B. constant velocity	D. distance
4. A policeman walks on his beat back and forth. His average speed is determined from

A. his velocity divided by the total time	C. his total distance covered divided by the total time
B. total time divided by how far he ends up from the starting point	D. total time divided by his total distance covered
5. Which of the following is not an appropriate unit for measuring acceleration?

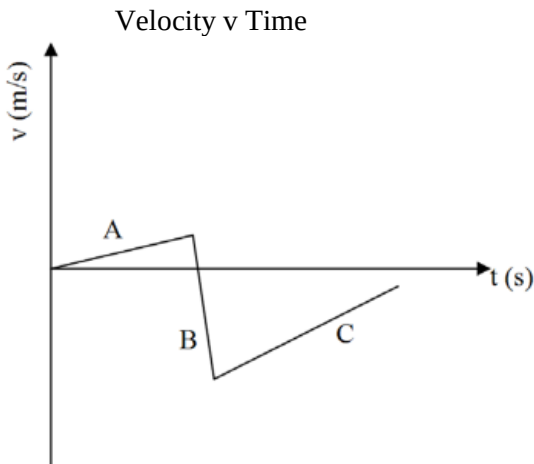
A. mi/h^2	C. m/s
B. ft/s^2	D. m/s^2

6.



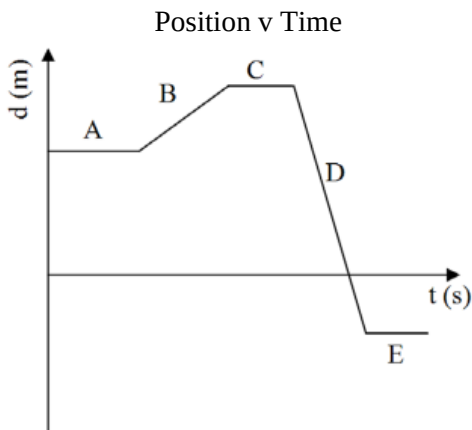
6. An object's distance traveled as a function of time is shown in the graph to the left. The graph shows
- A. an object experiencing an acceleration
 - B. an object with increasing speed
 - C. an object turning in a circle
 - D. An object moving forward at constant speed

7. – 9.



7. Refer to the velocity-time graph to the left. The object moves forward
- A. in region A
 - B. in region B
 - C. in region C
 - D. it always moves forward
8. The acceleration of the object is largest
- A. in region A
 - B. in region B
 - C. in region C
 - D. the object does not accelerate
9. The acceleration of the object is equal to zero
- A. in region A
 - B. in region B
 - C. in region C
 - D. the acceleration is never zero.

10. – 11.



10. The velocity of this object at the start of the motion is
- A. positive
 - B. zero (it is not moving)
 - C. negative
 - D. it is not possible to tell from the graph
11. The speed of the object is greatest
- A. in region A
 - B. in region B
 - C. in region C
 - D. in region D

PHY 1100 Test 1 Review Answers

I. 1. 7

2. 2

3. 3

4. 1

5. 3

6. 42 m

7. 0.6 kg^3

8. 29.0 m

9. 25 L

10. $2.3 \times 10^{30} \text{ kg m/s}^2$

II.

1. B

2. A

3. $y = mx + b$

4. $y = kx$

5. C

6. A

7. B

8. time was squared

III.

A. constant velocity

B. constant velocity

C. positive acceleration

D. constant velocity

E. negative acceleration

F. negative acceleration

IV.

Graph 1

a. $\frac{60 \text{ m} - 20 \text{ m}}{3 \text{ s} - 1 \text{ s}} = \frac{40 \text{ m}}{2 \text{ s}} = 20 \text{ m/s}$

b. 0 m/s

c. $\frac{60 \text{ m} - 20 \text{ m}}{6 \text{ s} - 4.5 \text{ s}} = \frac{40 \text{ m}}{1.5 \text{ s}} = 27 \text{ m/s}$

d. B

Graph 2

a. $\frac{60 \text{ m/s} - 0 \text{ m/s}}{10 \text{ s} - 0 \text{ s}} = 6 \text{ m/s}^2$

b. $\frac{-40 \text{ m/s} - 60 \text{ m/s}}{40 \text{ s} - 15 \text{ s}} = -4 \text{ m/s}^2$

c. $\frac{10 \text{ s} \times 60 \text{ m/s}}{2} = 300 \text{ m}$

d. $\frac{15 \text{ s} \times (-40 \text{ m/s})}{2} = -300 \text{ m}$ (going the opposite direction)

e. Between 10 s and 15 s

V. Problems

1.

$$\bar{v} = \frac{d}{t}$$

$$\frac{200.0 \text{ m}}{21.20 \text{ s}} \times \frac{\text{km}}{1000 \text{ m}} \times \frac{3600 \text{ s}}{\text{h}} = 33.96 \text{ km/h}$$

2.

$$t = \frac{v_f - v_i}{a}$$

$$\frac{51 \text{ m}}{\text{s}} - \frac{10.0 \text{ m}}{\text{s}} \times \frac{\text{s}^2}{3.7 \text{ m}} = 11 \text{ s}$$

3.

$$d = \frac{v_f^2 - v_i^2}{2a}$$

$$\left(\frac{51.0 \text{ m}}{\text{s}} \right)^2 - \left(\frac{10.0 \text{ m}}{\text{s}} \right)^2 \times \frac{\text{s}^2}{2 \times 3.70} = 338 \text{ m}$$

4.

$$d = \frac{v^2}{2a}$$

$$\left(\frac{63.8 \text{ m}}{\text{s}} \right)^2 \times \frac{\text{s}^2}{2 \times 9.8 \text{ m}} = 208 \text{ m}$$

5.

$$a = \frac{v^2}{2d}$$

$$\left(\frac{1230 \text{ m}}{\text{s}} \right)^2 \times \frac{\text{s}^2}{2 \times 1.1 \text{ m}} = 6.9 \times 10^5 \text{ m/s}^2$$

6.

$$v = \sqrt{2ad}$$

$$\sqrt{\frac{2}{1} \times \frac{0.63 \text{ m}}{\text{s}^2} \times \frac{200 \text{ m}}{1}} = 16 \text{ m/s}$$

7.

$$t = \frac{v}{a}$$

$$\frac{16 \text{ m}}{\text{s}} \times \frac{\text{s}^2}{0.63 \text{ m}} = 25 \text{ s}$$

9.

$$d = \frac{1}{2} at^2$$

$$\frac{1}{2} \times \frac{9.8 \text{ m}}{\text{s}^2} \times \frac{(2.9 \text{ s})^2}{1} = 41 \text{ m}$$

11.

$$v_f = \sqrt{(v_i)^2 + 2ad}$$

$$\sqrt{\left(\frac{31 \text{ m}}{\text{s}}\right)^2 + \frac{2}{1} \times \frac{3.0 \text{ m}}{\text{s}^2} \times \frac{585 \text{ m}}{1}} = 67 \text{ m/s}$$

8.

$$v = at$$

$$\frac{9.8 \text{ m}}{\text{s}^2} \times \frac{2.0 \text{ s}}{1} = 19.6 \text{ m/s}$$

10.

$$a = \frac{v_f^2 - v_i^2}{2d}$$

$$\left(\frac{350 \text{ m}}{\text{s}}\right)^2 - \left(\frac{195 \text{ m}}{\text{s}}\right)^2 \times \frac{1}{2 \times 2300 \text{ m}} = 18 \text{ m/s}^2$$

Multiple Choice

1. A

2. C

3. D

4. C

5. C

6. D

7. A

8. B (negative acceleration)

9. D

10. B

11. D