CHAPTER 2

Motion: Speed & Acceleration

PHYSICAL SCIENCE NOTEBOOK TABLE OF CONTENTS

Chapter 2 – "Motion: Speed & Acceleration"

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Physical Science Vocabulary

Vocabulary for Chapter 2 - Motion

No.#	Term	Page #	Definition
1.	Acceleration		
2.	Average Speed		
3.	Balanced Force		
4.	Displacement		
5.	Distance		
6.	Force		
7.	Inertia		
8.	Instantaneous Speed		
9.	Net force		
10	Speed		
11	Velocity		
12	Net Force		
13	Negative Acceleration		
14	Positive Acceleration		
15	Unbalanced Force		

Speed, Velocity, & Acceleration

Speed: a measure of distance divided by time.

Velocity: refers to both speed of an object and the direction of its motion.

Acceleration: change of an object's velocity over time.

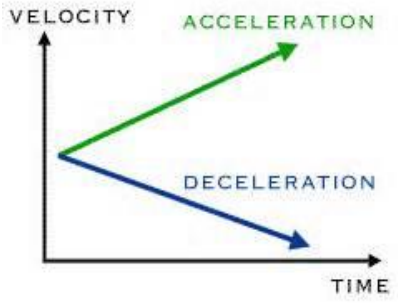
Speed

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

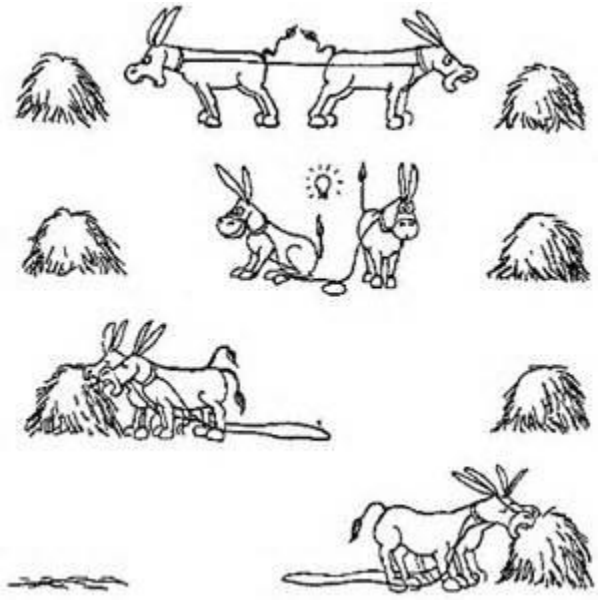
Velocity

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

Acceleration



$$\text{Acceleration (a)} = \frac{\text{change in velocity (v)}}{\text{time (t)}}$$



DETERMINING SPEED (VELOCITY)

Name _____

Speed is a measure of how fast an object is moving or traveling. Velocity is a measure of how fast an object is traveling in a certain direction. Both speed and velocity include the distance traveled compared to the amount of time taken to cover this distance.

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{velocity} = \frac{\text{distance}}{\text{time}} \text{ in a specific direction}$$

Answer the following questions.

1. What is the velocity of a car that traveled a total of 75 kilometers north in 1.5 hours?

   _____

2. What is the velocity of a plane that traveled 3,000 miles from New York to California in 5.0 hours? _____

3. John took 45 minutes to bicycle to his grandmother's house, a total of four kilometers. What was his velocity in km/hr? _____

4. It took 3.5 hours for a train to travel the distance between two cities at a velocity of 120 miles/hr. How many miles lie between the two cities? _____

5. How long would it take for a car to travel a distance of 200 kilometers if it is traveling at a velocity of 55 km/hr? _____

6. A car is traveling at 100 km/hr. How many hours will it take to cover a distance of 750 km? _____

7. A plane traveled for about 2.5 hours at a velocity of 1200 km/hr. What distance did it travel? _____

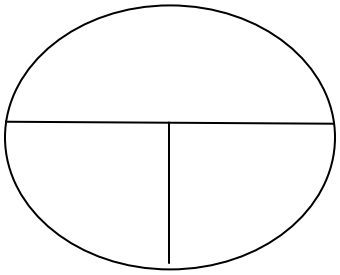
8. A girl is pedaling her bicycle at a velocity of 0.10 km/min. How far will she travel in two hours? _____

9. An ant carries food at a speed of 1 cm/s. How long will it take the ant to carry a cookie crumb from the kitchen table to the ant hill, a distance of 50 m? Express your answer in seconds, minutes and hours. _____

10. The water in the Buffalo River flows at an average speed of 5 km/hr. If you and a friend decide to canoe down the river a distance of 16 kilometers, how many hours and minutes will it take? _____

SPEED PROBLEMS I

Complete the following memory circle **AND** the chart below.



	Letter stands for	Units
S		
D		
T		

1. Calculate the speed of a car that travels 120 km in 2 hours.

Formula	Set Up & Solve	Answer

2. A horse travels 225 meters in 3 seconds. What is the horse's speed?

Formula	Set Up & Solve	Answer

3. The sound of thunder moves at about 330 meters per second. Calculate the time required for the sound to travel 1320 meters.

Formula	Set Up & Solve	Answer

4. Using the speed in problem #3, calculate the distance the sound of thunder can travel in 5 seconds.

Formula	Set Up & Solve	Answer

SPEED PROBLEMS I

5. A quarterback throws a football at 27 m/sec. If the receiver runs out 54 meters, how much time will it take for the football to reach him?

Formula	Set Up & Solve	Answer

6. A receiver can run 9.0 m/sec. How much time does it take him to run 54 meters?

Formula	Set Up & Solve	Answer

7. An ostrich runs 15 kilometers in 2.5 hours. What is the bird's speed?

Formula	Set Up & Solve	Answer

8. A flock of geese flies at a speed of 20 km/hr. for 3 hours. How far have the flock flown?

Formula	Set Up & Solve	Answer

9. A student walks 10 meters in 8.2 seconds. What is the walking speed?

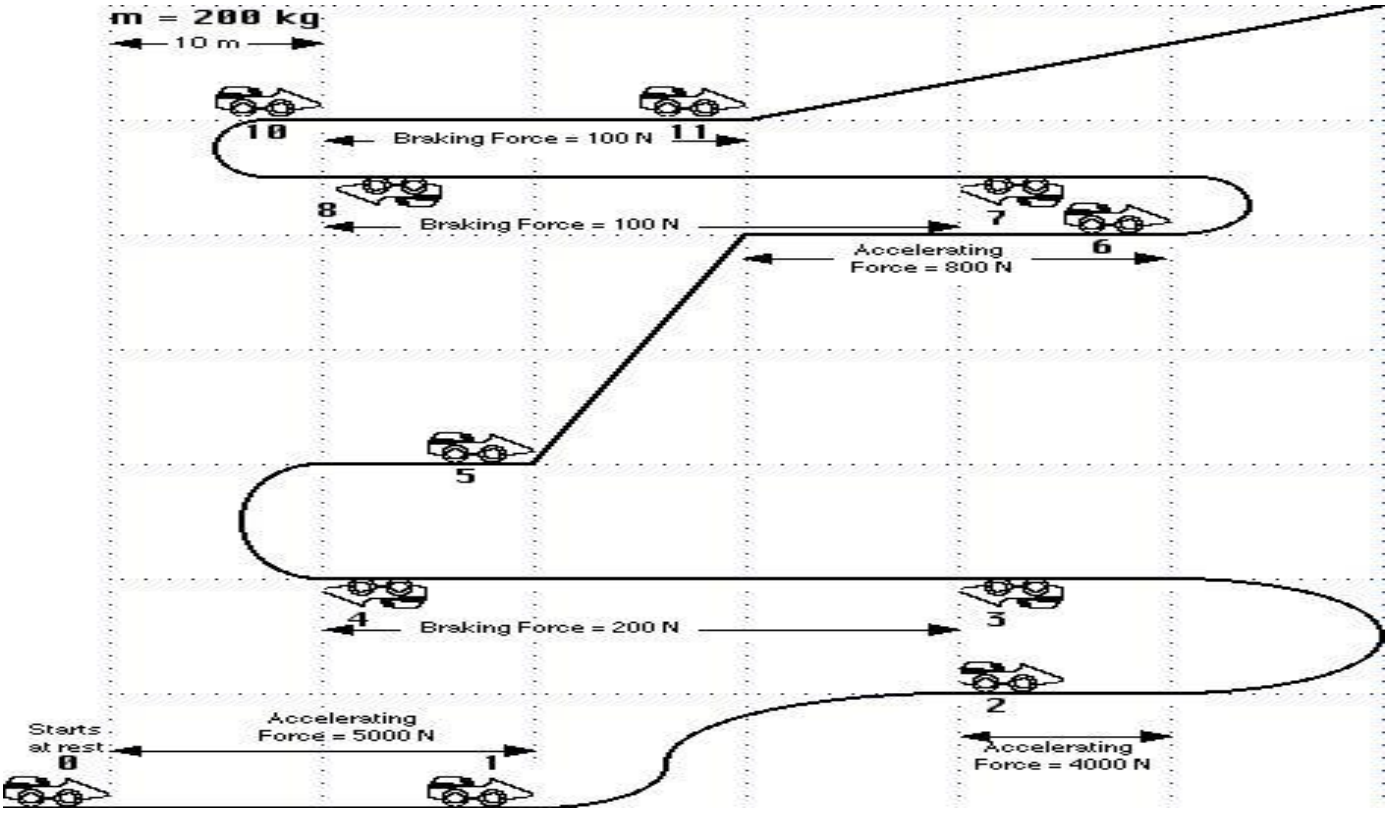
Formula	Set Up & Solve	Answer

10. Using the speed of the student in problem #9, calculate how far the student will walk if she walks at that speed for 30 seconds?

Formula	Set Up & Solve	Answer

Velocity & Speed Worksheet

Directions: Determne the acceleration of the car at each location?



Directions: Solve the following siutation problems using equations for speed.

1. What is the speed of a jet plane that travels 528 meters in 4 seconds?

Formula	Set Up & Solve	Answer

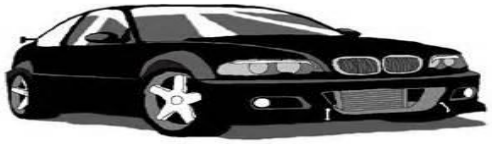
2. After an impact involving a non-functioning satellite, a paint chip leaves the surface of the satellite at a speed of 96 m/s. After 17 seconds, how far has the chip landed?

Formula	Set Up & Solve	Answer

3. What is the speed of rocket that travels 9,000 meters in 12.45 seconds?

Formula	Set Up & Solve	Answer

SPEED PROBLEMS II



1. An ant travels 75cm in 5 seconds. What was the ant's speed?

Formula	Set Up & Solve	Answer

2. It took you 6.5 hours to drive 550 km. What was your speed?

Formula	Set Up & Solve	Answer

3. A bus leaves at 9:00 am with a group of tourists. They Travel 350km before they stop for lunch. Then they travel an additional 250km until the end of their trip at 3:00 pm. What was the average speed of the bus?

Formula	Set Up & Solve	Answer

4. You are traveling an average speed of 60km/hr. The total trip is 240km. How long does the trip take?

Formula	Set Up & Solve	Answer

5. You are riding in a train that is traveling at a speed of 120km/hr. How long will it take to travel 950km?

Formula	Set Up & Solve	Answer

SPEED PROBLEMS II

6. A car traveling at a constant speed covers a distance of 750m in 25 seconds. What is the car's speed?

Formula	Set Up & Solve	Answer

7. A motorcyclist travels an average speed of 20km/hr. If the cyclist is going to a friend's house 5km away, how long does it take the cyclist to make the trip?

Formula	Set Up & Solve	Answer

8. A passenger elevator operates at an average speed or 8m/s. If the 6oth floor is 219m above the first floor, how long does it take the elevator to go from the first floor to the 60^{th} floor?

Formula	Set Up & Solve	Answer

9. Mike walked distance of 1.60km in 30 min. Find his average speed in m/s.

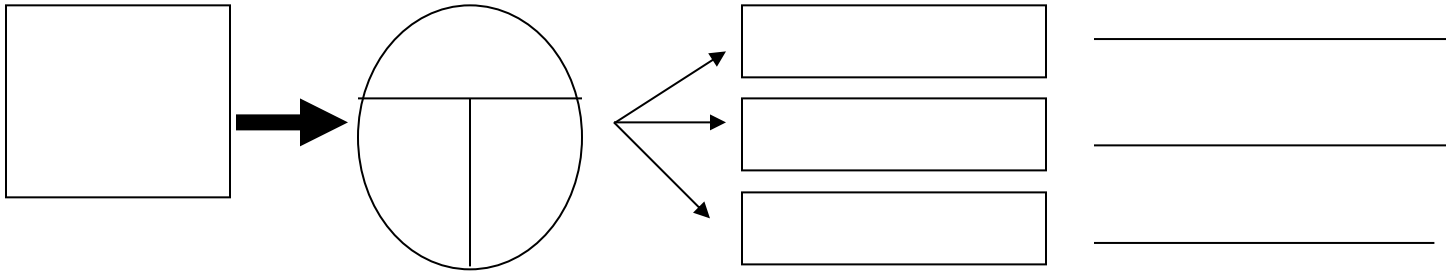
Formula	Set Up & Solve	Answer

10. A car travels at a constant speed of 30m/s for 0.8hr. Find the total distance traveled in km.

Formula	Set Up & Solve	Answer

SPEED, DISTANCE, & TIME PROBLEMS I

Formula **Manipulations** **Solve For:**



Directions: (Solve all problems in the 3 step method. Round off answers to 2 decimal places.)

1. How long will it take to travel 150 kilometers running at a speed of 30km/hr.?

Formula	Set Up & Solve	Answer

2. Driving at an average speed of 58 mph, how long will it take to get to a city 220 miles away?

Formula	Set Up & Solve	Answer

3. In dry air, sound travels 1992 meters in 6 seconds. What is the speed of sound in dry air?

Formula	Set Up & Solve	Answer

4. How far will sound in problem #3 travel in half a minute?

Formula	Set Up & Solve	Answer

SPEED, DISTANCE, & TIME PROBLEMS I

5. In water, sound travels 26,172 meters in only 18 seconds. What is the speed of sound in water?

Formula	Set Up & Solve	Answer

6. Jogging at a speed of 3m/sec, how far will John travel in 4 minutes?

Formula	Set Up & Solve	Answer

7. How far will a bus go in 90 minutes is its speed is 60 km/hr.?

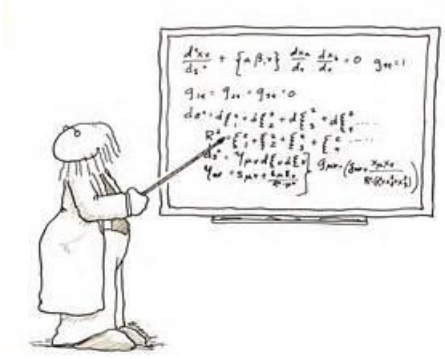
Formula	Set Up & Solve	Answer

8. How long will it take John to travel 1000 meters at a speed of 3 m/sec?

Formula	Set Up & Solve	Answer

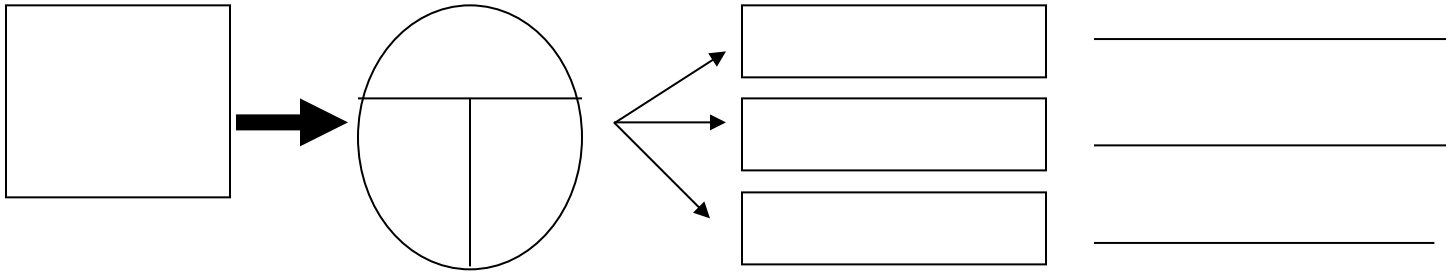
9. It takes a sound just 15 seconds to travel through a mountain that is 1,492.75 meters wide. What is the speed of sound in the mountain?

Formula	Set Up & Solve	Answer



SPEED, DISTANCE, & TIME PROBLEMS II

Formula **Manipulations** **Solve For:**



Directions: (Solve all problems in the 3 step method. Round off answers to 2 decimal places.)

1. How long will it take to travel 50 kilometers running at a speed of 8km/minute?

Formula	Set Up & Solve	Answer

2. Walking at an average speed of 2 mph, how long will it take to get to a city 34 miles away?

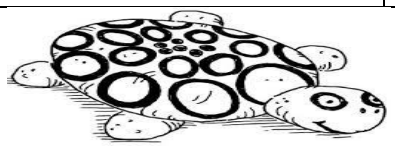
Formula	Set Up & Solve	Answer

3. How far will a bus go in 30 minutes if its speed is 88 km/hr.?

Formula	Set Up & Solve	Answer

4. How long will it take a turtle to travel 62 kilometers traveling 130 km/hr.?

Formula	Set Up & Solve	Answer



SPEED, DISTANCE, & TIME PROBLEMS II

5. What is the speed of an ant that travels 250 centimeters in 125 seconds?

Formula	Set Up & Solve	Answer

6. What is the speed of a wheel that turns 2,000 millimeters in 60 seconds?

Formula	Set Up & Solve	Answer

7. The speed of a plane is 270 mph. How far will it travel in 3.5 hours?

Formula	Set Up & Solve	Answer

8. What is the average speed of a car that travels 170 miles in 3.25 hours?

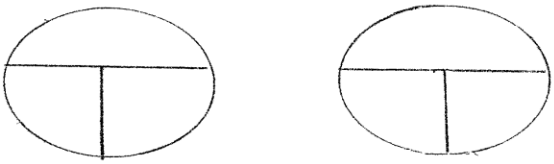
Formula	Set Up & Solve	Answer

Quick Review A

Vocabulary Matching:

_____	1. Acceleration	a. forces on an object that combine to give a zero net force and do not change the motion of the object
___	2. Inertia	b. distance an object travels per unit of time
_____	3. Distance	c. the speed and direction of a moving object
_____	4. Balanced Forces	d. forces on an object that combine to give a non-zero net force and result in acceleration, or a change in the motion of the object
_____	5. Displacement	e. resistance of an object to a change in its motion
_____	6. Frame of Reference	f. rate of change of velocity; can be calculated by dividing the change in the velocity by the time it takes to occur
_____	7. Unbalanced Forces	g. the sum of the forces acting on an object
_____	8. Speed	h. a coordinate system in which the position of an object is measured
_____	9. Net Force	i. how far an object moves
_____	10. Velocity	j. distance and direction of an object's change in position from its starting point

Memory Circle Practice:

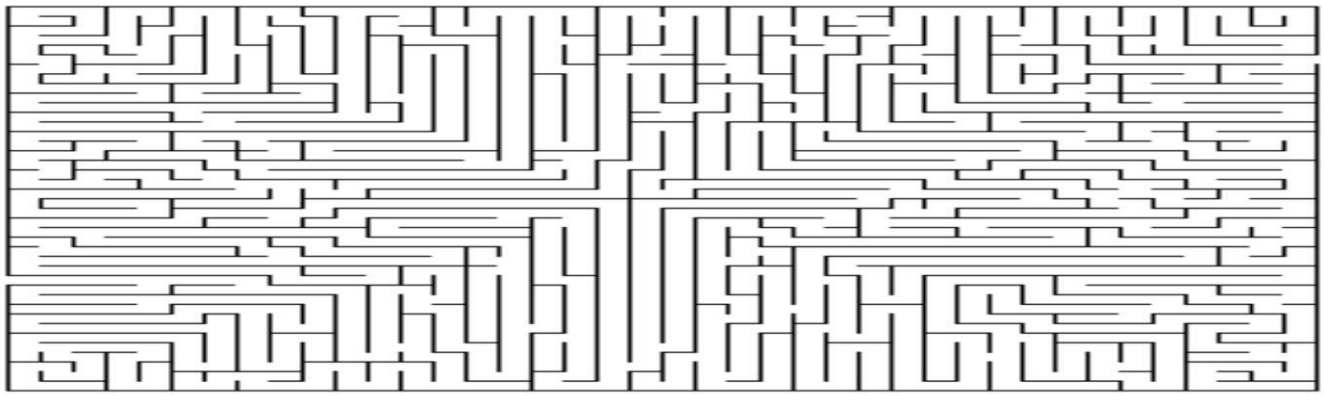


1. A raft is floating down a river with a constant speed of 15 m/s. If the current carries the raft at this speed for 1 hour, how far has is traveled?

2. A ball is rolling down a hill with an acceleration of 3.5 m/s^2. If the ball starts rolling at 2 m/s, how long will it be until it has achieved a speed of 12 m/s?

3. A dog on roller skates moves a distance of 20 m in 5 seconds. How fast is the dog skating?

4. If a book is thrown off a cliff with a speed of 5 m/s and experiences an acceleration of 10 m/s^2, how fast is it moving when it hits the ground 10 s later?



Labyrinth

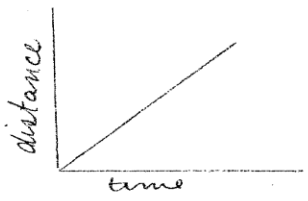
Quick Review B

5. How long would it take a snail to move five meters at the pace of 0.25 m/s?

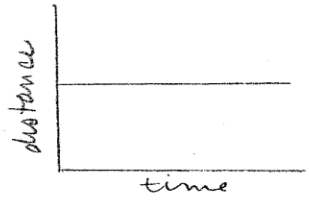
6. What is the acceleration of a car that goes from 0 to 50 m/s in 35 s?

7. If a wagon is rolling down a hill with an acceleration of 2 m/s^2 and it reaches the bottom of the hill 5 s later with a speed of 20 m/s^2, what was the initial speed of the wagon?

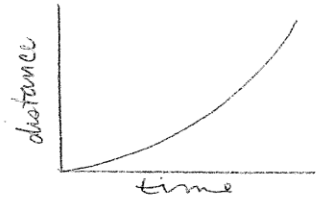
8. Shown below and three different **distance vs. time** graphs. One graph represents an object at rest, another shows an object moving at constant speed and the third represents an object speeding up. Under each graph, write the kind of motion being represented.



Motion: _____

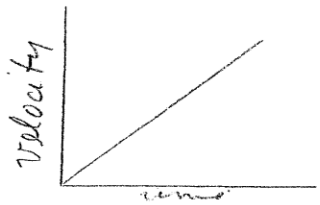


Motion: _____

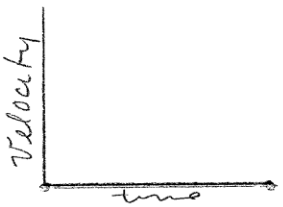


Motion: _____

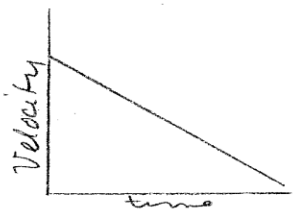
9. Shown below and three different **velocity vs. time** graphs. One graph represents an object slowing down, another shows an object moving at constant speed, one represents an object speeding up, and the fourth shows an object at rest. Under each graph, write the kind of motion being represented.



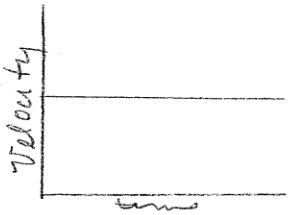
Motion: _____



Motion: _____



Motion: _____



Motion: _____

What hidden pictures can you find?

Describing Motion Review

Directions: For each of the following, write the letter of the term or phrase that best completes the sentence.

1. A sprinter runs 200 meters west and 100 meters east. Her displacement is _____.
_____ **a**. 300 meters **b**. 100 meters west

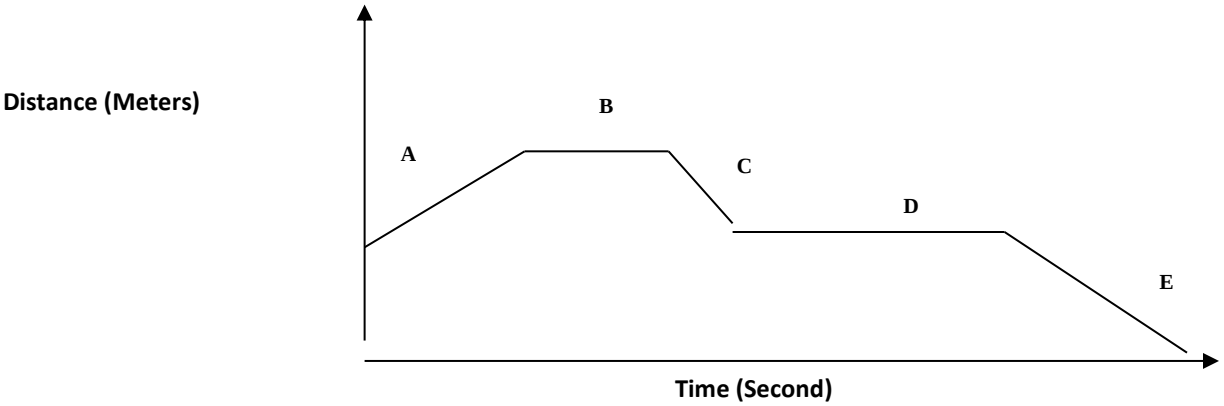
2. Speed can be calculated by diving distance by _____.
_____ **a**. time **b**. displacement

3. The speed of a motorcycle at a particular moment is its _____ speed.
_____ **a**. average **b**. instantaneous

4. Earth's plates move only a few _____ per year.
_____ **a**. centimeters **b**. meters

5. Two cars are each traveling at 72 km/h. One car is traveling northeast and the other is traveling south. The two cars have different _____.
_____ **a**. velocities **b**. speeds

Directions: The distance-time graph above shows the motion of a student walking to a convenience store for a loaf of bread and returning home. Use the graph to answer questions 6 through 10.



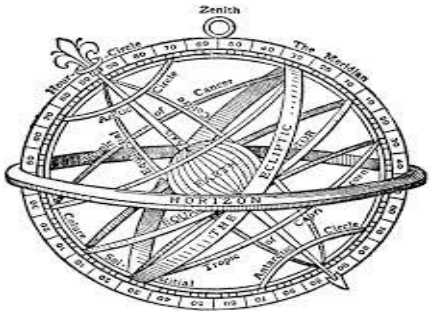
6. In which segment was the student moving at the slowest rate of speed? _____.
7. Which segment indicates that the student might be stopped at the convenience store? _____.
8. In which two segments was the student moving at the fastest rate of speed? _____.
9. In which segment might the student be waiting for a traffic light? _____.
10. Which took longer, walking to the store or walking home? _____.

Directions: Look at the graph. Match the letters in the graph to the sentences below.

_____ 11. Ruth stops for 10 minutes to speak to a friend.

_____ 12. She walks at a constant speed of 80 m/min.

_____ 13. She jogs 600 m in 5 minutes.



Uniform Motion Worksheet #1 (answers at the bottom of the page)

Solve each problem algebraically.

1. Two buses leave Houston at the same time and travel in opposite directions. One bus averages 50 mi/hour and the other bus averages 45 mi/hour. In how many hours will they be 570 miles apart?

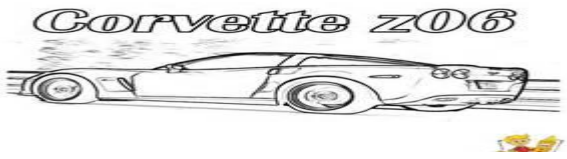
2. A passenger plane and a cargo plane leave at the same time from the same airport but travel in opposite directions. The passenger plane travels at twice the speed of the cargo plane. Find the speed of each plane if they are 2400 miles apart in 4 hours.

3. An express train and a freight train leave at the same time from two cities 270 miles apart and travel toward each other on parallel tracks. The rate of the express train is 50 mi/hour and the rate of the freight train is 40 mi/hour. In how many hours will the trains meet?

4. Jim and Joe started on trips from San Francisco and traveled in opposite directions. Jim traveled 15 km/hour faster than Joe. After 4 hours, they were 420 km apart. How fast was each person traveling?

5. Nan and Peg started on trips from New York City and traveled in opposite directions. Nan traveled 10 mi/hour faster than Peg. fIf they were 450 miles apart after 5 hours, how fast was each person traveling?

Answers: 1. 6 hrs 2. 200 mph, 400 mph 3. 3 hrs 4. Joe 45 km/h, Jim 60 km/h 5. Nan 50 mph, Peg 40 mph

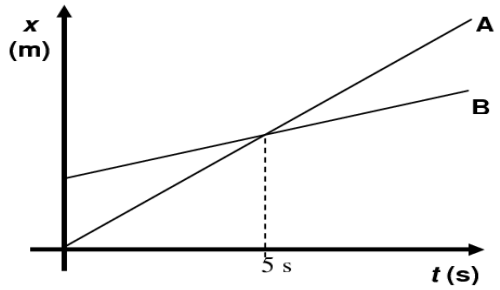


Unit 1: Uniform Motion
Worksheet 1.2

Name_____

Date_____Period_____

1. Consider the position vs. time graph below for cyclists A and B.



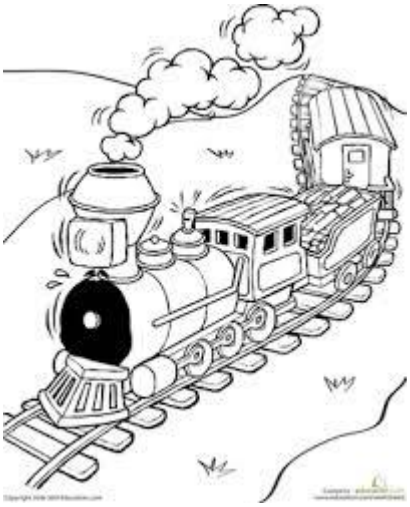
a. Do the cyclists start at the same point? How do you know? If not, which is ahead?

b. At t= 7s, which cyclist is ahead? How do you know?

c. Which cyclist is travelling faster at t = 3s? How do you know?

d. Are their velocities equal at any time? How do you know?

e. What is happening at the intersection of lines A and B?



Olympic Events (Speed and Acceleration problems)

1) The Usain Bolt has had phenomenal times for the 100 meter track event. Calculate his speed in **each** case.

Here are some of his times for this event:

a) In the 2008 Beijing Olympics he ran the 100 m in 9.69 seconds

Speed =

b) In Berlin he ran an amazing 9.58 seconds for the 100 meters.

Speed =

c) Another Beijing time was 9.72 sec. in the 100 meters.

Speed =

2) The Usain Bolt also ran the 200m race in 19.30 seconds. What was his average speed for this race?

Speed =

3) When Cathy Turner qualified for the Olympic team in speed skating, she broke two American records in the 1000 meter and 500 meter races.

a) Her time in the 1000 m was 1 minute and 35.7 seconds. What was her speed in m/s?

Speed =

b) Cathy skated the 500 m race in 47.53 seconds. What was her speed in m/s?

Speed =

c) Cathy's old record for the 500 m was 46.86 seconds. What was her speed for the "old" record?

Speed =

4) La 'Shawn Merritt ran the 400m event in 43.75 seconds. Calculate his speed in m/s.

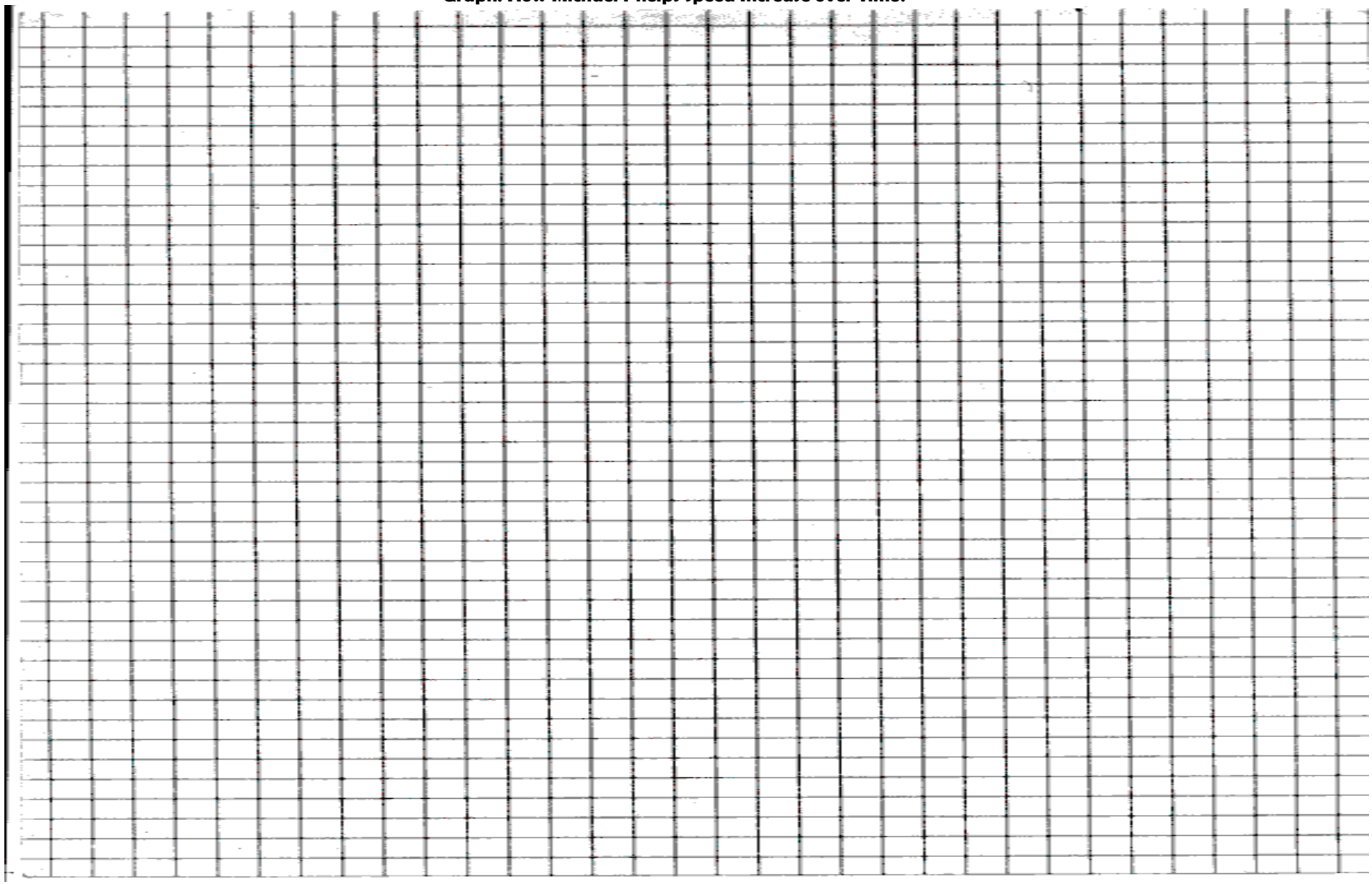
Speed =

Michael Phelps is an American who is generally considered the greatest swimmer of all time as well as one of the greatest Olympians of all time. He has won 14 career Olympic gold medals, the most by any Olympian. As of August 2, 2009, Phelps has broken thirty-seven world records in swimming.

Here are some of Phelps' butterfly times:

Location	Event	Time	Time in seconds	Speed in m/s
2000 Sydney Olympics	200 m butterfly	1 minute 56.50 seconds	_____sec	_____ m/s
July 2001 in Japan	200 m fly	1 minute 54.58 seconds	_____sec	_____ m/s
2003 Barcelona	200 m fly	1 minute 53.93 seconds	_____sec	_____ m/s
2006 in Canada	200 m fly	1 minute 53.80 seconds	_____sec	_____ m/s
2007 World Championship	200 m fly	1 minute 52.09 seconds	_____sec	_____ m/s
2008 Beijing Olympics	200 m butterfly	1 minute 52.03 seconds	_____sec	_____ m/s
2009 World Championships	200 m butterfly	1 minute 51.51 seconds	_____sec	_____ m/s

Graph: How Michael Phelps Speed Increase over Time?



A Quick Motion Review

1. Define the following terms and include any important formulas:
a. Distance
b. Displacement
c. Speed
d. Velocity
e. Acceleration

2. Describe the difference between constant, instantaneous, and average speed.

3. NASCAR driver, Jeff Gordon, has a car that is one of the fastest on the circuit. If it travels 600 miles in 4 hours, what is his cruising speed?

4. The fastest car on Earth, a German-made *Thrust SSC*, would win every NASCAR race in America. If it takes 0.5 hours (30 minutes) to travel 380 miles, what is its speed?

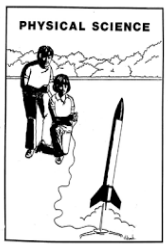
5. The fastest train on Earth, the *TGV* from France, can travel at faster speeds than trains in the United States. During a speed test, the train traveled 800 miles in 2.5 hours. What is its speed?

6. An airplane accelerates down a runway at 3.20 m/s^2 for 32.8 s until it finally lifts off the ground. Determine the distance traveled before takeoff.

7. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

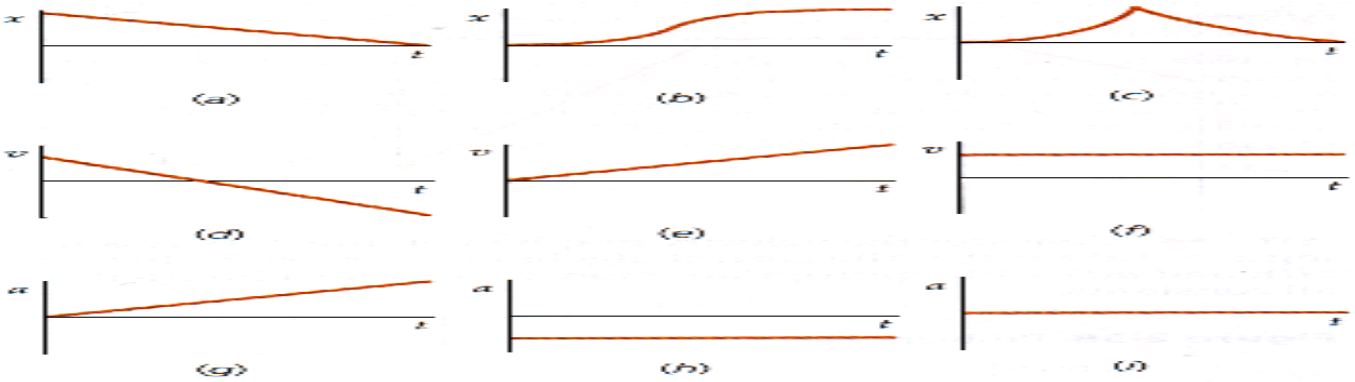
8. A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 m/s^2. Determine the velocity for the feather after it has been falling for 5s. How fast would the feather be traveling if it were dropped from the same height on Earth (acceleration of gravity on Earth is 9.8 m/s^2).

9. Rocket-powered sleds are used to test the human response to acceleration. If a rocket-powered sled is accelerated to a speed of 444 m/s in 1.8 seconds, then what is the acceleration?



A Quick Motion Review

10. Indicate the graphs that meet the following conditions



(a) Velocity is constant.

- ☐ Graph (*a*)
- ☐ Graph (*b*)
- ☐ Graph (*c*)
- ☐ Graph (*d*)
- ☐ Graph (*e*)
- ☐ Graph (*f*)
- ☐ Graph (*g*)
- ☐ Graph (*h*)
- ☐ Graph (*i*)

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(b) Acceleration is constant.

- ☐ Graph (*a*)
- ☐ Graph (*b*)
- ☐ Graph (*c*)
- ☐ Graph (*d*)
- ☐ Graph (*e*)
- ☐ Graph (*f*)
- ☐ Graph (*g*)
- ☐ Graph (*h*)
- ☐ Graph (*i*)

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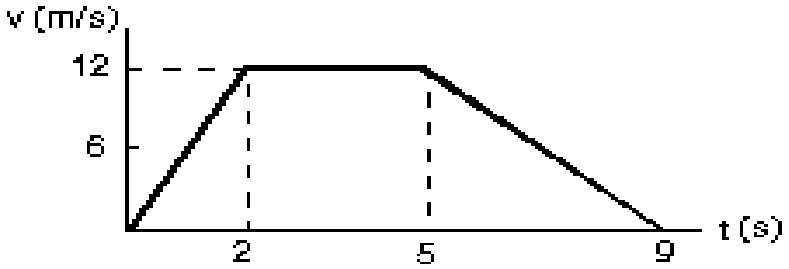
11. Explain the difference between positive and negative velocity.

12. Explain the difference between positive and negative acceleration.

13. The diagram represents the straight line motion of a car. Circle the letter for each of the following statements that is true.



A) The car accelerates, stops, and reverses for 4s.
B) The car accelerates at a rate of 6 m/s2 for the first 2 seconds.
C) The car is moving for a total time of 9 s.
D) The car decelerates at 12 m/s2 for the last 4 seconds.
E) The car returns to its starting point.
F) The car starts at rest and stops at rest after 9 seconds.
G) The car maintains a constant velocity from 2-5 seconds.