Motion

Teacher's Guide
High/Middle School

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Viewing Clearances

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National Standards Correlations

National Science Education Standards

(Content Standards: 5-8, National Academy of Sciences, c. 1996)

Science as Inquiry - Content Standard A:

As a result of activities in grades 5-8, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science - Content Standard B:

As a result of their activities in grades 5-8, all students should develop an understanding of:

- Motions and Forces

Benchmarks for Science Literacy

(Project 2061 - AAAS, c. 1993)

The Physical Setting - Motion (4F)

By the end of the eighth grade, students should know that:

- In the absence of retarding forces such as friction, an object will keep its direction of motion and its speed. Whenever an object is seen to speed up, slow down, or change direction, it can be assumed that an unbalanced force is acting on it.

By the end of the 12th grade, students should know that:

- The change in motion of an object is proportional to the applied force and inversely proportional to the mass.
- All motion is relative to whatever frame of reference is chosen.

Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students should be able to do the following:

- Define motion relative to frame of reference;
- Define speed and describe the units in which speed is measured;
- Calculate the speed of objects using the formula for speed;
- Define velocity and differentiate between speed and velocity;
- Calculate the combined velocity of moving objects;
- Define acceleration and deceleration;
- Calculate the acceleration of an object, using the formula for acceleration;
- Define momentum and describe how mass and velocity affect the momentum of objects;
- Calculate the momentum of objects, using the formula for momentum; and
- Explain the Law of the Conservation of Momentum and describe how it is applied to specific situations.

Assessment

Preliminary Test:

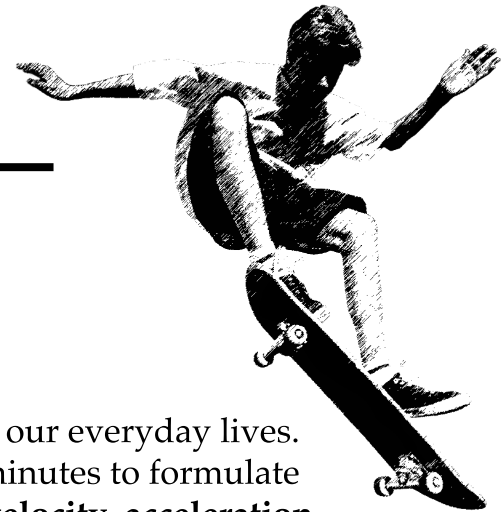
The Preliminary Test, provided in the Student Master section, is an assessment tool designed to gain an understanding of student preexisting knowledge. It can also be used as a benchmark upon which to assess student progress on the objectives stated on the previous pages.

Video Review:

The Video Review, provided in the Student Masters section, can be used as an assessment tool or as a student activity. There are two main parts. The first part contains questions titled "You Decide" that can be answered during the video. The second series of ten questions consists of video review questions to be answered at the conclusion of the video.

Post-Test:

The Post-Test, provided in the Student Masters section, can be utilized as an assessment tool following student completion of the video and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.



Introducing the Video

Begin by discussing the ways in which physics affects our everyday lives. Divide the class into groups. Allow each group five minutes to formulate general definitions for physical terms such as **speed**, **velocity**, **acceleration**, and **momentum**. Have each group write their definitions on the board and discuss them as a class. Next, ask each group to compile a list of everyday activities which involve the vocabulary terms previously discussed. Remind students that their list may include examples as simple as running or driving. Add these lists to those on the board and discuss the examples as a class. Allow the lists to remain on the board. At the conclusion of the program, ask students to discuss new examples of physics in our everyday lives that they learned from the video.

Video Viewing Suggestions

The Student Master "Video Review" is provided for distribution to students. You may choose to have your students complete this Master while viewing the program or to do so upon its conclusion.

The program is approximately 20-minutes in length and includes a ten-question video quiz. Answers are not provided to the Video Quiz on the video, but are included in this teacher's guide. You may decide to grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.

Student Assessments and Activities

Assessment Masters:

- Preliminary Test
- Video Review
- Post-Test

Student Activity Masters:

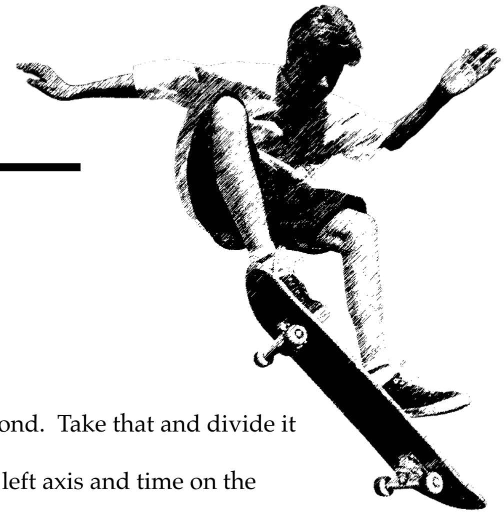
- Calculating Speed and Velocity
- Graphing Speed
- Speed in Action
- Momentum of Objects
- Vocabulary of *Motion*

Video Script: *Motion*

1. These birds defy gravity by flapping their wings.
2. These ice boats sailing across the lake are exceeding speeds of 100 kilometers per hour.
3. These young ski racers are flying down the slope at over 30 kilometers per hour.
4. And these fish propel themselves swiftly through the water with their fins.
5. The leaves on this tree are tossed in the air by wind.
6. And these pieces of wood splinter when smashed by an ax.
7. As you can see, all these objects are in motion. During the next few minutes we are going to discuss the different characteristics of motion...
8. ...and the various forms motion can take.
9. We'll also learn how to use mathematical equations to make calculations about motion.
10. The Earth on which we live, walk and move is a huge object which appears motionless.
11. But it's spinning on its axis at an amazing rate of over 1600 kilometers per hour.
12. **You Decide**: In this image of a setting sun, is the sun moving or is the Earth moving?
13. If you answered that the Earth is actually moving even though it looks as if the sun is moving, then you are correct!
14. We do not feel the Earth's motion, but we can catch a glimpse of its effects by seeing the sun set over the horizon.
15. Why can't we feel the Earth spinning? It has something to do with our frame of reference.
16. For example, we know that this truck is moving because the objects behind it are stationary, or standing still.
17. The stationary background, consisting of buildings and trees, is called the frame of reference.
18. In most cases, our frame of reference for objects in motion are objects on earth, as in this plane taking off.
20. This skier is speeding down this race course. He covered a distance of about 40 meters.
21. It took about seven seconds for him to cover the distance.
22. This skier was in motion. **Motion** is defined as a change in position relative to fixed objects over time.
23. Time can be measured in units of seconds, minutes, hours or days.
24. And distance can be measured in English units of feet, yards or miles.
25. In the metric system, units of centimeters, meters, or kilometers are used to describe distance. The metric system is the preferred system of measurement in science.
26. Some objects have a very quick motion,...
27. ...while other objects have a slow motion. These mountains, for example, are rising at a rate of one centimeter per year - about the rate your fingernail grows in a year.
29. This car was speeding and now the driver is paying the price.
30. The speed limit on this street is 25 miles per hour.
31. But what is speed? And how did this police woman know that this car was speeding?
32. **Speed** is defined as the amount of distance covered in a specific amount of time.
33. The term 25 miles per hour is an expression of speed.
34. It means that a car traveling at this rate would cover a distance of 25 miles in one hour.
35. You Decide: The distance between the town and the lake where you want to go swimming is 50 miles. At what speed would you have to travel if you want to get there in two hours?
36. The answer is 25 miles per hour.
37. A car traveling at 25 miles per hour travels 50 miles in 2 hours.
39. As we have already stated, speed is the rate at which an object moves.
40. But how do we calculate the rate of speed?
41. This car, for example, is going 28 miles per hour.
42. While some high-tech tools, such as the radar gun used by police to calculate speed of moving cars can be used,...
43. ...there is yet a simpler method.

Script

44. If we know the distance an object traveled and the time it took for the object to travel the distance, we can calculate speed.
45. This can be written as a formula where the average Speed equals Distance divided by Time.
46. Let's put this formula to use by calculating the speed of this sprinter.
47. The distance this sprinter is covering is 100 meters.
48. She covered this distance in 11 seconds. How would you calculate her speed?
49. Let's go back to our formula, Speed equals Distance divided by Time. All we need to do is plug the numbers into the formula. The distance is 100 meters...
50. ... and the time is 11 seconds. By dividing the distance by the time, we arrive at an answer of 9.09 meters per second.
51. Speed is expressed as a rate - a unit of distance per unit of time.
52. For example, the speed of this train is expressed in miles per hour or kilometers per hour.
53. And the wind recorded by this wind gauge is recorded in kilometers per hour or miles per hour.
54. If we were going to take a bicycle trip, it is not only important to do the trip at a good speed,...
55. ...but it is also important to travel in the right direction.
56. **Velocity** is the speed of an object in a given direction.
57. Velocity is very important when flying an airplane.
58. Velocity not only states the amount of distance covered per unit of time, or its speed, but it also states the compass direction in which the plane needs to travel.
59. The velocity of large storms is also very important in helping meteorologists predict when and where an offshore hurricane will reach the land.
60. Their prediction can mean life or death for people who need to evacuate from the path of the hurricane.
61. In some cases, velocities combine to create a greater velocity.
62. For example, this plane can travel up to 200 miles per hour. But when it is pushed by a 50 mile per hour wind, its combined velocity increases to 250 miles per hour.
63. This river is flowing at a rate of 15 kilometers per hour.
64. The person paddling this kayak is going at a rate of 8 kilometers per hour.
65. The river's velocity of 15 kilometers per hour, combined with the velocity of the kayaker of 8 kilometers per hour, creates a combined velocity of 23 kilometers per hour.
66. This sports car can go from zero to 60 miles per hour in 8 seconds - a pretty quick change in velocity.
67. Other machines with powerful engines, such as this motorcycle, can also create rapid changes in velocity.
68. **Acceleration** is the rate of change in velocity or it describes how fast speed increases.
69. An object like this sports car is speeding up or accelerating.
70. Just how is acceleration calculated? As in computing speed or velocity, we can use a mathematical formula.
71. The formula for acceleration is:
72. Acceleration equals Final Velocity minus Beginning Velocity divided by Time.
73. Let's look at an example of this snowboarder riding in this half-pipe.
74. At the top of the half-pipe, the snowboarder's speed is relatively slow at about .5 meters per second.
75. But after going downhill and arriving at the bottom of the half-pipe, the snowboarder's velocity is about 2 meters per second.
76. The time this took was about 2.3 seconds.
77. To compute the snowboarder's acceleration we will plug the numbers into the formula for acceleration.
78. Placing the numbers into the formula, we had 2 meters per second for the final velocity and .5 meters per second for the initial velocity. Divide that by 2.3 seconds.



Script

79. 2 meters per second minus .5 meters per second equals 1.5 meters per second. Take that and divide it by 2.3 seconds and it equals .65 meters per second squared.
80. We can also graph the acceleration of the snowboarder with speed on the left axis and time on the bottom axis. Notice how the line rises.
81. **You Decide**: What do these following things have in common: This car coming to a screeching halt,...
82. ...this skier gradually coming to a stop,...
83. ...and this soccer ball losing speed?
84. If you said that all these are losing speed or velocity, then you are correct.
85. **Deceleration** is a decrease in velocity. Deceleration can be thought of as negative acceleration.
86. When the snowboarder climbs the uphill side of the half-pipe, his acceleration decreases.
87. While acceleration can be graphed like this, with a rising line, deceleration can be graphed like this, with a downward line.
89. This glass window is hard and solid.
90. So is this rock.
91. **You Decide**: What will happen to the path of the rock when it comes in contact with the glass?
92. As you can see the rock continues right through the glass - shattering it. While it is slowed down slightly by the glass, it continues its path of motion past it.
93. A similar phenomena occurs when this toy race car flies off this curve in the track.
94. The reason these things occur is due to something called momentum. **Momentum** is a property of moving objects.
95. The momentum of a moving object depends on two things, the mass of the object and the velocity with which it travels.
97. It is possible to calculate the momentum of moving objects using a fairly simple formula.
98. The formula for momentum is: Momentum equals Mass times Velocity.
99. Let's take a look at the momentum of this softball thrown by this pitcher.
100. The softball has a mass of about .3 kilograms.
101. The young pitcher can throw a fast ball at about 100 kilometers per hour.
102. To calculate the momentum, we multiply the mass of .3 kilograms by the velocity of 100 kilometers per hour to get a momentum of 30 kilogram kilometers per hour.
105. The moving pool ball collided with the red ball and transferred its momentum, causing the red ball to move.
106. This demonstrates the Law of Conservation of Momentum, which states that the momentum of an object remains the same unless outside forces act on it.
107. The momentum gained by the red ball is equal to the momentum lost by the cue ball. No momentum is lost -- it is conserved.
108. A similar phenomena occurs in tennis when the moving racket transfers its momentum to the tennis ball.
109. The moving racket loses some of its momentum, but the momentum is gained by the ball - sending it in the opposite direction.
111. During the past few minutes we have explored many different aspects of motion.
112. We have learned that motion is defined as the change in position of an object over time.
113. And we have learned to calculate the speed of an object by dividing the amount of distance covered by the time it took to cover the distance.
114. We have also learned that velocity is the speed of an object in a specific direction.
115. We also studied the rate of change in velocity, or acceleration of an object...
116. ... and how to calculate the acceleration of an object.
117. Finally, we explored the momentum of objects,...
118. ... by studying the relationship between mass and velocity.
119. Next time you see objects in motion, try to remember some of the principles of motion we have discussed. You just might look at moving things a little differently.

Script

Video Review: Fill in the correct word when you hear this tone. Good luck and let's get started.

1. A frame of ___________ involves an object that is standing still.
2. _______________ is defined as a change in position of an object over time.
3. The __________ System is the preferred system of measurement in science.
4. Speed is the amount of ___________ covered over time.
5. The speed of this train can be expressed in units of kilometers per _________.
6. Velocity is the speed of an object given ____________.
7. ______________ is the rate of change in velocity.
8. Graph ___ illustrates the process of deceleration of an object.
9. The momentum of a moving object depends on the _________ of the object and the velocity with which it travels.
10. In this picture, the white ball _____________ its momentum to the red ball.

Answers to Student Assessments

Preliminary Test

1. time
2. speed
3. velocity
4. acceleration
5. decelerate
6. momentum
7. position
8. distance
9. mass
10. frame of reference
11. True
12. True
13. False
14. True
15. False
16. False
17. True
18. True
19. True
20. False

Video Review

You Decide:

A. The Earth
B. 25 miles per hour
C. They are decelerating.
D. Due to momentum, the rock slows slightly, but continues through the glass.

Video Quiz:

1. reference
2. motion
3. metric
4. distance
5. hour
6. direction
7. acceleration
8. graph B
9. mass
10. transfers

Post Test

1. True
2. True
3. True
4. True
5. False
6. True
7. False
8. False
9. True
10. False
11. speed
12. decelerate
13. position
14. frame of reference
15. velocity
16. time
17. mass
18. distance
19. momentum
20. acceleration

Answers to Student Activities

Calculating Speed and Velocity
1) 80 feet/second
2) 180 kph
3) 4 meters/second
4) 300 miles per hour east

Graphing Speed
Student graphs should also be checked.
1) .8 meters per second
2) .73 meters per second;
Juanita's speed is greater.
3) Their speed decreases. Perhaps the cyclists are riding up a hill.
4) Their speed increases again. Perhaps the cyclists reached the top of the hill and are now going down the other side.
5) Henry passed Juanita at 120 seconds into the ride.

Speed in Action
Answers will vary from student to student or group to group. Check that the correct formula has been used and timing has been done as accurately as equipment allows. Discuss the results of this activity in class.

Momentum of Objects
1) a. 13846.5 kg
b. 2376 km/h
2) 32,899,284 kg*km/h
3) a. 49,500 kg
b. 920 km/h
4) 45,540,000 kg*km/h
5) B
6) The F-4 has a greater speed. The greater the mass of an object, the greater its momentum will be.

Extra Credit: Answers will vary.

Vocabulary of Motion
1) speed, b
2) motion, a
3) acceleration, d
4) momentum, f
5) velocity, c
6) conservation of momentum, g
7) deceleration, e
8) metric, i
9) frame of reference, h

Assessment and Student Activity Masters

Name________________

Preliminary Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

1. ______________ is measured in units of seconds, minutes, hours, or days.

2. To calculate the rate of ______________ , you divide distance by time.

3. ______________ is the speed of an object in a given direction.

4. An increase in velocity is called ______________.

5. A bicyclist riding uphill will ______________.

6. An object that continues its motion past an obstacle is carried by ______________ .

7. Motion is a change in ______________ relative to fixed objects over time.

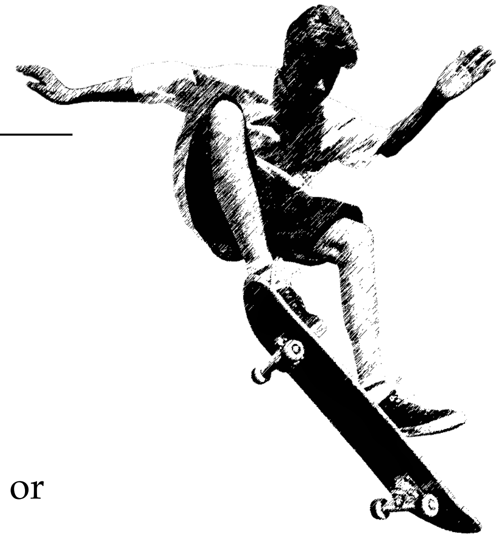
8. Centimeters, meters, or kilometers are the metric units for measuring ______________.

9. To calculate momentum, we need to know the ______________ and velocity of the object.

10. A ______________________ is an object or place that is fixed or is standing still.

mass	Law of Conservation
acceleration	velocity
position	decelerate
distance	momentum
frame of reference	speed
time	weight

Name________________



Preliminary Test

Directions: Decide whether the answer is True (T) or False (F)

11. There are various forms of motion. T F

12. Mathematical equations can be used to calculate velocity. T F

13. Acceleration is the constant speed of an object. T F

14. Acceleration and deceleration are two rates of change in velocity. T F

15. Road signs are not good frames of reference for determining motion. T F

16. Velocities do not combine to create a greater velocity. T F

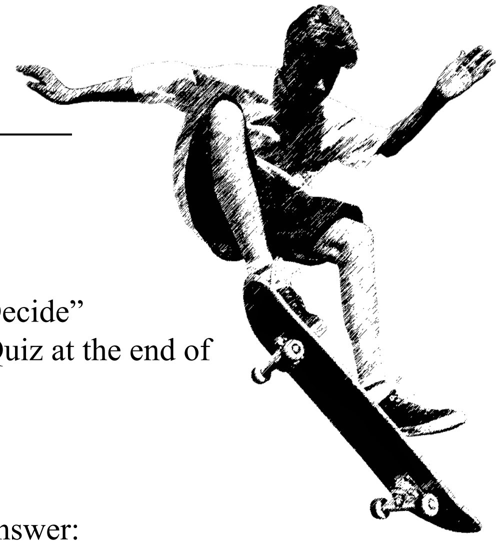
17. Strong winds can increase an object's current velocity. T F

18. Speed is expressed as a rate - a unit of distance per unit of time. T F

19. A falling leaf is an example of an object in motion. T F

20. The preferred system of measurement in science is the English system. T F

Name________________



Video Review

Directions: During the course of the program answer the "You Decide" questions as they are presented in the video. Answer the Video Quiz at the end of the video.

You Decide

A. In this image of a setting sun, is the sun moving or is the Earth moving? Answer: ____________

B. The distance between the town and the lake where you want to go swimming is 50 miles. At what speed would you have to travel if you want to get there in two hours? Answer: ___________

C. What do these following things have in common: this car coming to a screeching halt, this skier gradually coming to a stop, and this soccer ball losing speed? Answer: ____________

D. What will happen to the path of the rock when it comes in contact with the glass? Answer: ____________

Video Quiz

1. A frame of ___________ involves an object that is standing still.

2. _______________ is defined as a change in position of an object over time.

3. The __________ System is the preferred system of measurement in science.

4. Speed is the amount of ___________ covered over time.

5. The speed of this train can be expressed in units of kilometers per _________.

6. Velocity is the speed of an object in a given ____________.

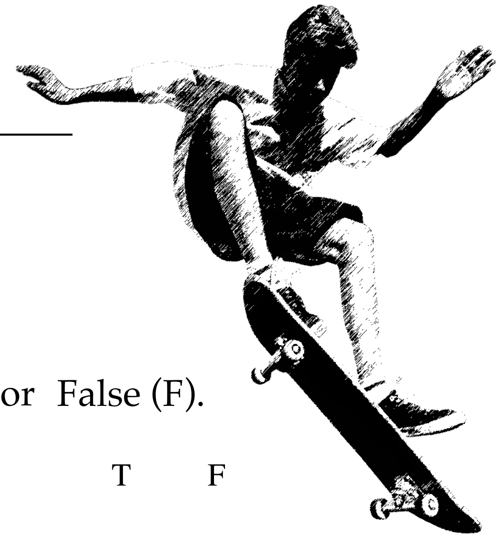
7. ______________ is the rate of change in velocity.

8. Graph __ illustrates the process of deceleration of an object.

9. The momentum of a moving object depends on the _________ of the object and the velocity with which it travels.

10. In this picture, the white ball _____________ its momentum to the red ball.

Name_______________



Post Test

Directions: Decide whether the answer is True (T) or False (F).

1. There are various forms of motion. T F

2. A falling leaf is an example of an object in motion. T F

3. Mathematical equations can be used to calculate velocity T F

4. Acceleration and deceleration are two rates of change in velocity. T F

5. Velocities do not combine to create a greater velocity. T F

6. Speed is expressed as a rate - a unit of distance per unit of time. T F

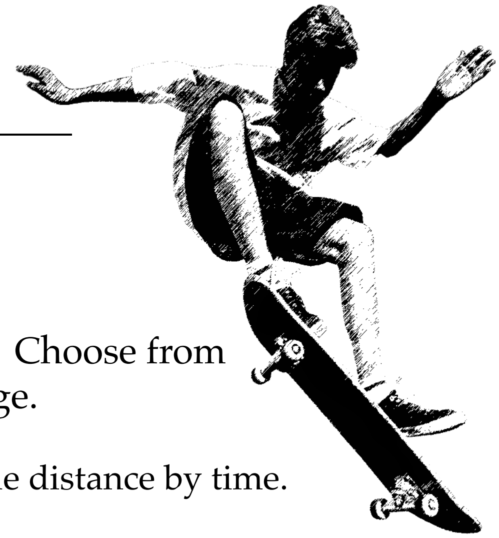
7. Road signs are not good frames of reference for determining motion. T F

8. Acceleration is the constant speed of an object. T F

9. Strong winds can increase an object's current velocity. T F

10. The preferred system of measurement in science is the English system. T F

Name________________



Post Test

Directions: Fill in the blank with the correct word. Choose from the list of possible answers at the bottom of the page.

11. To calculate the rate of ______________ , you divide distance by time.

12. A bicyclist riding uphill will ______________.

13. Motion is a change in ______________ relative to fixed objects over time.

14. A ____________________ is an object or place that is fixed or is standing still.

15. ______________ is the speed of an object in a given direction.

16. ______________ is measured in units of seconds, minutes, hours, or days.

17. To calculate momentum we need to know the _____________ and velocity of the object.

18. Centimeters, meters, or kilometers are the metric units for measuring ______________.

19. An object that continues its motion past an obstacle is carried by ______________ .

20. An increase in velocity is called ______________.

mass	Law of Conservation
acceleration	velocity
position	decelerate
distance	momentum
frame of reference	speed
time	weight

Name________________

Calculating Speed and Velocity

Objective: In this lab you will calculate the speed or velocity of moving objects.

Background:
Recall from the video that speed is defined as the distance covered per unit of time. The formula for speed is: Speed = Distance / Time

Velocity is similar to speed and is even computed with the same formula. But velocity is speed in a given direction. For example, a car's velocity could be described as 50 kilometers per hour east. This means that the car is traveling in an easterly direction at 50 kilometers per hour.

Directions: Use the information provided above to answer the following questions.

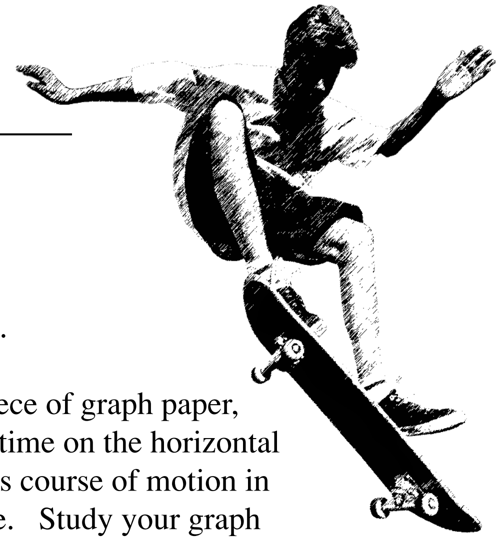
Questions:
1) A softball pitcher has the ability to throw a softball at a high speed to the catcher at home plate. The distance from the pitcher to the catcher is 40 feet. The ball travels the distance in 0.5 seconds. Calculate the speed of the ball.

2) A certain race track is four and a half kilometers long. The winning driver in the race drove his car around the track TWICE in three minutes. What was his average speed over those two laps? Please answer in kilometers per hour.

3) Jane has a kitten named Fluff-ball. Fluff-ball usually sleeps in a cat bed 20 meters from the kitchen and hardly ever moves. But whenever Jane opens a can of cat food, the kitten comes running into the kitchen as fast as he can. If Fluff-ball takes 5 seconds to reach the kitchen, how fast can he run? Please answer in meters per second.

4) An air traffic controller locates an airplane on her radar display. The plane is moving in a diagonal direction. According to the radar, the plane moves 5 miles east and 1 mile north over the course of a minute. There are no other planes to the north of the plane on the controller's display, but there is an airport to the east of it. The air traffic controller is not concerned with the plane's northerly velocity, but she quickly calculates the plane's easterly velocity. What does she find the easterly velocity of the airplane to be? Please answer in miles per hour.

Name________________



Graphing Speed

Objective: In this lab you will learn to calculate and graph speed.

Directions: Review the information provided below. Using a piece of graph paper, graph the motion of the two bicyclists, Juanita and Henry. Place time on the horizontal axis of your graph and distance on the vertical axis. Plot Juanita's course of motion in red, then plot Henry's course of motion on the same graph in blue. Study your graph after plotting the data. Use your graph to answer the following questions.

Data:
It is possible to graph the motion of an object if we know the distance covered by the object and the time it took to cover that distance. The table below contains data for the motion of Juanita and Henry.

	Juanita	**Henry**
Time in seconds	Distance in meters	Distance in meters
20 sec.	15 m	14 m
40 sec.	32 m	29 m
60 sec.	48 m	44 m
80 sec.	67 m	62 m
100 sec.	88 m	83 m
120 sec.	94 m	98 m
150 sec.	102 m	108 m
180 sec.	180 m	138 m

Name________________

Graphing Speed (cont.)

Questions:

1) What is Juanita's overall speed after 60 seconds of cycling?

2) What is Henry's overall speed after 60 seconds of cycling? Whose overall speed is greater?

3) What happened to the cyclists' speed between 100 and 150 seconds? What may have caused this?

4) What happened to the cyclists' speed between 150 and 180 seconds? What may have caused this?

5) At what point did Henry pass Juanita?

Name________________

Speed in Action

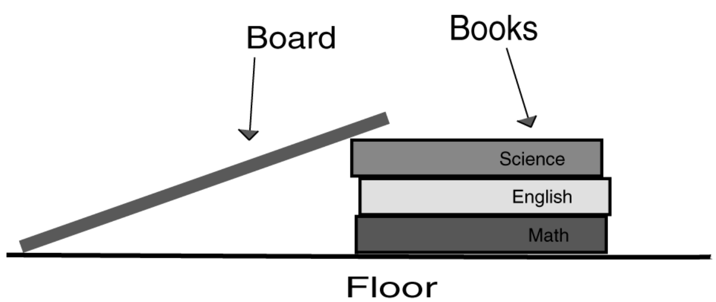
Objective:
In this activity you will calculate the speed of moving objects.

Materials:

Several books	70-100 cm board
Tape measure	Stopwatch or digital wristwatch
Tennis or rubber ball	Meter stick

Various types and sizes of balls (soccer ball, ping-pong ball, etc.)

Procedure:
1) Build a ramp similar to the one below. Stack a few books on top of each other. Place one end of the board on the books and the other end on the floor.



2) Using the meter stick, measure three meters from the bottom of the ramp. Mark the spot by placing a piece of tape on the floor.

3) Place the ball at the top of the ramp. Make sure the timer is ready! Release the ball and start timing.

4) The timer should stop the clock when the ball crosses the 3 meter marker on the floor. Repeat this three times and record the data in the table on the following page. Calculate the speed of the ball using the formula *speed = distance/time* and record.

Name________________

Speed in Action (cont.)

	Distance (in meters)	**Time** (in seconds)	**Speed** (meters/second)
Trial 1			
Trial 2			
Trial 3			

5) Add or remove a book to see how altering the slope of the ramp affects the speed of the ball. Also try different types of balls to see how size and texture affects speed. Is a soccer ball faster than a basketball? Does a hard, smooth ball go faster than a fuzzy or rough ball? Try it and see!

Conclusion:

Discuss with class members any differences in data that may have occurred and the factors that might have contributed to these differences. Discuss how changing the angle of the ramp altered your results, or how different types of balls affect speed. Brainstorm possible reasons for these differences and methods to test your theories.

Name________________

Momentum of Objects: Importance of Speed and Mass

Background:
This activity may require the use of a calculator. If you do not have your own, you can use the one built into most computers or borrow one from your teacher.

This activity may also require you to convert English units of measurement to Metric units. Use these conversion formulas:

Miles x 1.6 = Kilometers

Pounds x 0.45 = Kilograms

Airplanes are very fast and can have a large mass. They are an excellent example of how both speed and mass affect an object's momentum. Below is a table of technical information on two airplanes: the McDonnel F-4 and the Boeing 737-100.

Airplane	Length	Wingspan	Weight	Speed
McDonnel F-4	58 ft 3.75 in.	38 ft 4.75 in	30,770 lbs	1,485 mph
Boeing 737-100	97 ft 9 in	87 ft	110,000 lbs	575 mph

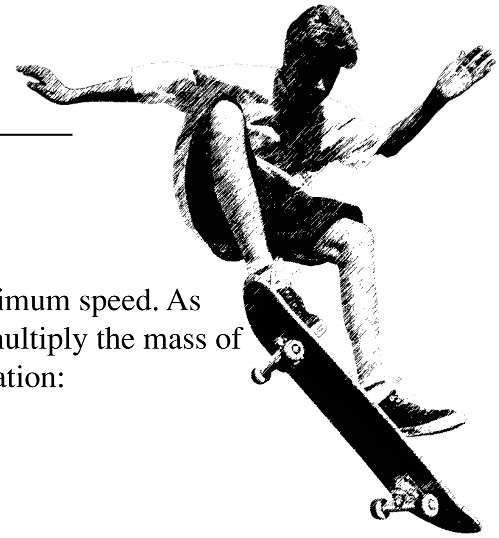
Directions:
1) The McDonnel Douglas F-4 Phantom II is the Navy's first Mach 2 carrier-based aircraft. To learn more about the McDonnel F-4, visit the website for the National Air and Space Museum in Washington, DC.

Use the information provided in the table to fill in the blanks. Make sure to convert to metric units.

Weight in kilograms :______________________

Speed in kilometers per hour:____________________

Name________________



Momentum (cont.)

2) Now calculate the momentum of the McDonnel F-4 at its maximum speed. As you may remember, the formula for momentum is simple - just multiply the mass of the object by its speed. Use the space below to write out the equation:

Momentum:_____________________

3) WOW! That is a big number, isn't it? Let's see how the momentum of the McDonnel F-4 compares to the momentum of a Boeing 737-100, a popular small airliner on which you or a friend may have flown. To learn more about the Boeing 737-100, visit the Boeing company webpage.

Find the information on the maximum takeoff weight and cruise speed of the 737-100. Convert to metric units and record this information below.

Weight:___________________

Speed:____________________

4) Let's calculate the momentum of the Boeing 737-100 at its cruising speed. The formula, remember, is speed multiplied by mass. Use the space below to write out the formula and your answer:

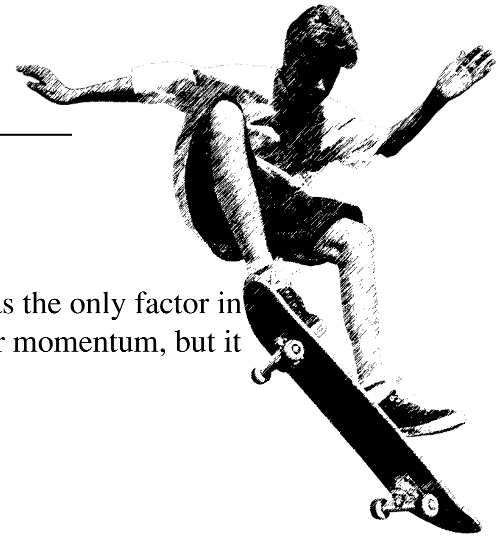
Momentum:______________________

5) Look at the results you computed. Which airplane has a greater momentum?

A) McDonnell Douglas F-4S-44 Phantom II

B) Boeing 737-100 airliner

Name________________



Momentum (cont.)

6) Now look at which airplane has the greater speed. If speed was the only factor in calculating momentum, the faster airplane would have the greater momentum, but it does not. What does this tell us?

Extra Credit: Weigh yourself on a scale and write your weight below (convert to metric units if necessary):

Your Weight:____________

Assume you are moving at a speed of 12 kilometers per hour. Calculate your momentum. Use the space below to write out the equation and your answer:

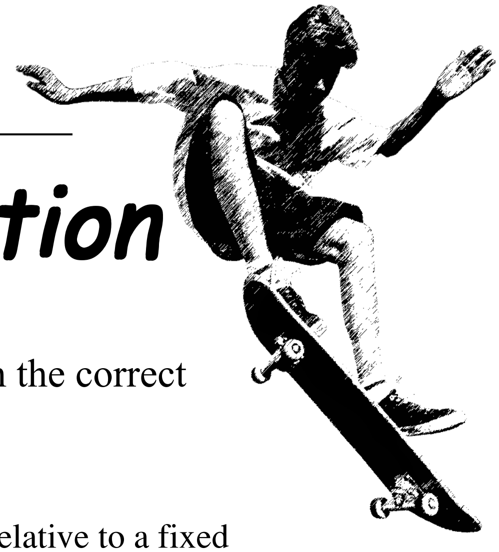
Your Momentum:______________

Your momentum is much smaller than that of the two airplanes we looked at, isn't it? For fun, let's see how many people of your size, moving at 12 kilometers per hour, it takes to equal the momentum of the McDonnell Douglas F-4S-44 Phantom II. To do this you need to divide the momentum of the airplane by your own momentum.

Number of people:___________________

Think about how many people live in your city or town and compare it to this number. Objects moving at a high speed have a very large momentum!

Name________________



Vocabulary of *Motion*

Directions: Unscramble the word and match it with the correct definition.

___ 1. epsed

___ 2. nomoti

___ 3. celetacarnoi

___ 4. tenmomum

___ 5. elovitcy

___ 6. notsonervaic of tenmomum

___ 7. lerniotedeca

___ 8. rtemic

___ 9. earfm fo efrrnceee

a. a change in position relative to a fixed object over time

b. the amount of distance covered in a given time

c. the speed of an object in a given direction

d. a positive rate of change in velocity

e. a negative rate of change in velocity

f. a property of moving objects that is determined by an object's mass and velocity

g. law that states momentum is never lost, only transferred

h. a stationary object by which motion can be determined

i. the preferred system of measurement in science