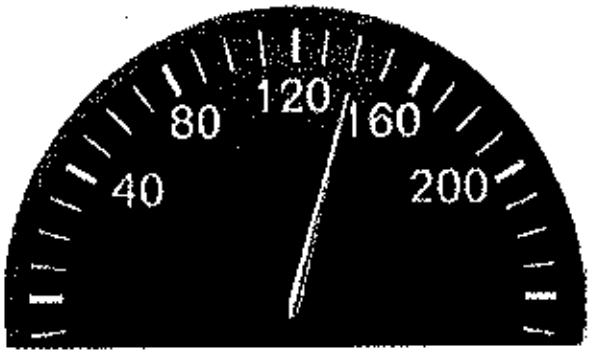
# Science Notebook

## Velocity and Acceleration Unit




NAME:

| Monday | Tuesday | Wednesday | Thursday | Friday |
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## Chapter 4.1 Reading Guide

Read Chapter 4.1 in your textbook and answer the following questions.

1. Define speed.

2. What is the formula for speed?

3. The book lists km/h and mph for the units. What are three other units for speed?

4. What is the difference between average speed and instantaneous speed?

5. Light moves at _____ m/s and would take _____ seconds to travel around the globe.

6. What are three main differences between velocity and speed?

7. Fill in the following table.

| Word Formulas | | Equations |
|---|---|---|
| | | |
| | | |
| | | |

8. Do section review questions 1,2,3,5

**Velocity**

Scalar –

Three Examples of scalar quantities:

Frame of reference –

Position –

Distance –

Vectors –

Instantaneous position –

Instantaneous speed –

Time interval –

Average speed –

Average velocity –

*NOTE: This has a direction associated with it. The equation is the same, but it must include direction.

Constant velocity –

**Steps to solving equations:**

1. **Write the given**
2. **Find what is needed**
3. **Solve the equation**
4. **Plug and chug**

Ex 1: A high school athlete runs 100m in 12.20 s. What is the velocity?

Ex 2: Suppose a car travels at a constant 10 m/s. How far would it move in 90 seconds?

Ex 3: A train leaves the station at the 0.0m marker traveling with a constant velocity of 36.0 m/s. How many seconds later will the train pass the 1620m marker?

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## Velocity Questions One

Directions: answer the following questions. You must **show your work** and make sure everything has a unit. Answers and work without units will not be counted as correct.

$$v = \frac{x}{t} \qquad x = v * t \qquad t = \frac{x}{v}$$

1. A car travels 300 meters in just 5 seconds. What is its velocity?

2. You walk to the corner store that is 3 kilometers away. It takes you 50 minutes. What is your velocity?

3. A car travels at 50 kilometers/hour for 12 hours. How far did the car go?

4. An airplane flies at 500 kilometers/hour for a total distance of 2500 kilometers. How long did the flight take?

5. A go-cart travels a total of 288 centimeters in 12 seconds. What was the go-cart's velocity?

6. You and a friend bike to school. You live 3 kilometers away and it takes you 30 minutes to get to school. Your friend lives 4 kilometers and it takes her 40 minutes to bike to school. Which person had the higher velocity? What is that higher velocity?

7. You decide to visit your grandparents in Oregon and take the train down there. It travels at a velocity of 100 kilometers/hour for 5 hours. How far away do your grandparents live?

8. Picabo Street won the gold medal in the 1998 Winter Olympics for the Super G race. The racetrack was a grand total of 5,000 meters in just 78.02 seconds. How fast did she travel down the mountain?

9. Cee Lo Green needed to travel from Seattle to Portland for his concert, but was running late. He had just 2 hours to travel the 173 miles, but he could not go over the speed limit of 60 miles/hour. How fast will he have to travel in order to make it on time? Does he have to speed?

10. Your family decides to go on vacation and you want to know which car to travel in because one is going to get their first and you want to be in that car. Your parents drive at 50 miles/hour for 750 miles. Your aunt and uncle travel at 60 miles/hour, but take the scenic route and travel for 1200 miles. Which car should your ride with? Which one gets there first?

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# Lab: Velocity

**Question:**
What is the velocity of a Hot Wheel car rolling down a low incline ramp?

**Discussion:**
The velocity of an object is calculated by finding two components; 1. The distance the object travels and 2. How long it takes the object to travel that distance. The following formula can be used to solve for this velocity.

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

Where:
v=velocity
x= distance
t=time
It should be noted that while the car is on the ramp, it is accelerating and will not have a constant velocity, thus you must use the distance and time of the car after it has stopped accelerating and is cruising at a constant velocity on the floor.

**Procedure:**

1. Measure a length of string IN METERS, cut it and tape it to the floor. Record in your data table.
2. Place a ramp at a low height (no more than 40 cm from the floor).
    a. Make sure the end of the ramp lines up with the start of the string.
3. Release the car from the top of the ramp.
4. Time the car for the total distance of your string and record this in your data table.
5. Repeat for a total of 10 trials.
6. Solve for the velocity for each trial.
7. Calculate the average
8. Write a conclusion.

**Results:**

| Trial | Distance (m) | Time (s) | Velocity (m/s) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| Average | | | |

**Conclusion:**

In your conclusion, be sure to:

- Answer the experimental question.
- Include **supporting** data from the data table.
- Explain how these data **support** your conclusion.
- Provide a **scientific** explanation for the trend in the data.

Question: What is the velocity of a Hot Wheel car rolling down a low incline ramp?

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## Chapter 4.2 Reading Guide

Read Chapter 4.2 in your textbook and answer the following questions in complete sentences.

1. Define constant speed.

2. An object moving at a constant speed always creates what kind of line? Draw a sketch of that line.

3. In a strong relationship what kind of changes do large ones make on other variables?

4. In a weak relationship what kind of changes do make on other variables?

5. Sketch a graph where there is no relationship between variables.

6. Define slope.

7. What does a steeper line on a position vs time graph mean in terms of speed? What does a shallower line on a position vs time graph mean in terms of speed?

8. What does the slope of the line on a position vs time graph demonstrate?

9. Sketch a position vs time graph with a constant speed of 3 m/s.

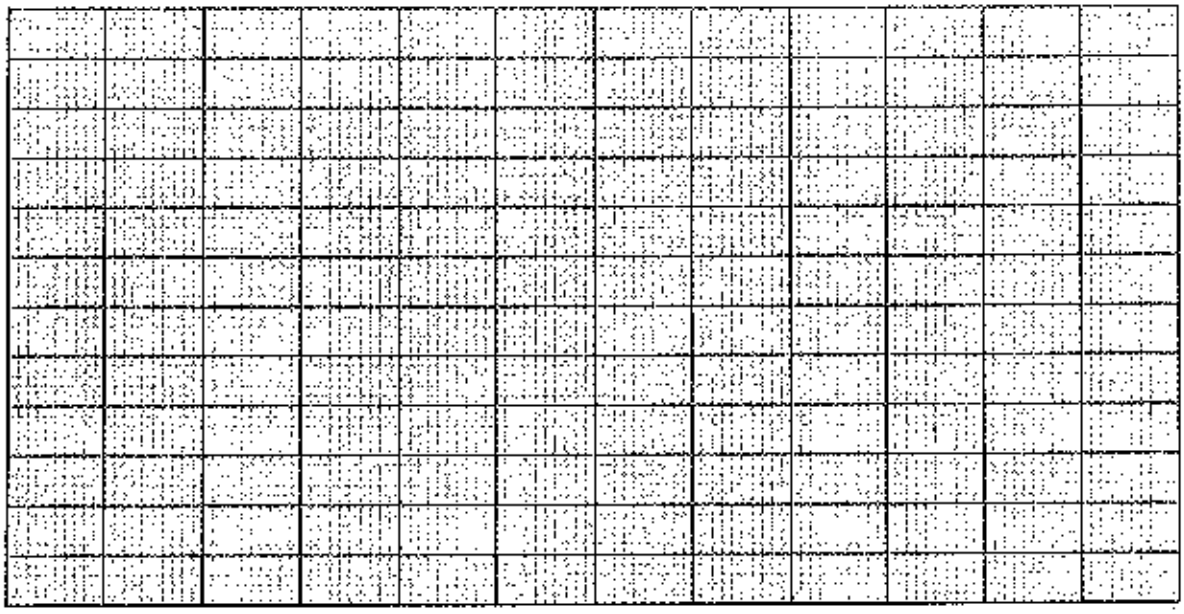
10. Describe the process of finding the distance traveled using a position vs time graph.

11. Answer section 4.2 review questions 1,2,4,5,6,7,8,9.

# Position Time Graphs

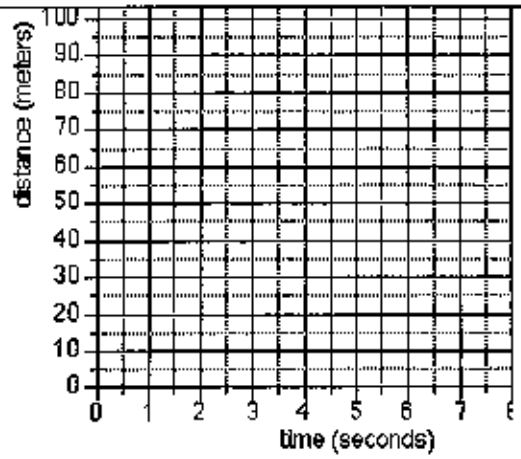
Displacement –

Position Time Graph –

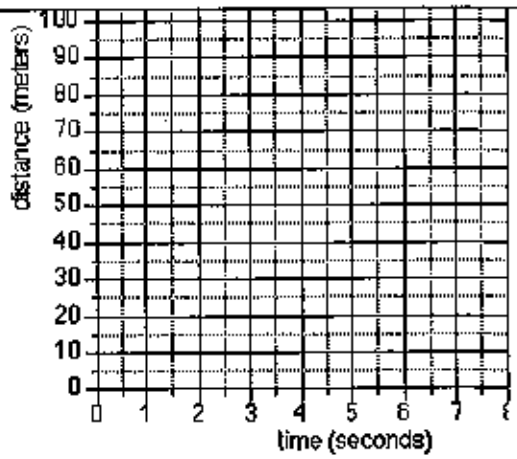



| Position versus Time | | |
|---|---|---|
| Trial | Time (Seconds) | Position (Meters) |
| | | |
| | | |
| | | |
| | | |
| | | |

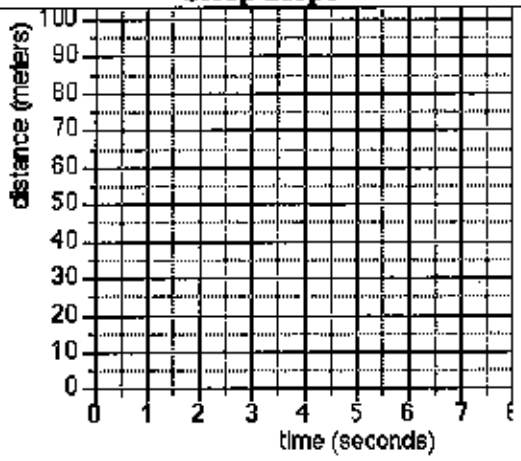
Steps:



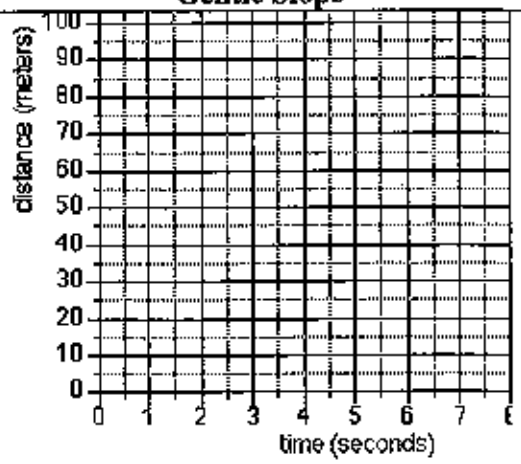

**Steep Slope**




**Gentle Slope**




**No slope**




**Negative slope**

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## Velocity Questions Two

Directions: answer the following questions. You must **show your** work and make sure everything has a unit. Answers and work without units will not be counted as correct.

$v = \frac{x}{t}$ $x = v * t$ $t = \frac{x}{v}$ $m = \frac{y_2 - y_1}{x_2 - x_1}$

1. A car drives for 13 hours at 60 miles/hour. How far did the car travel?

2. You and a friend are walking to the store that is 1500 meters away. It takes you 30 minutes. How fast were you walking?

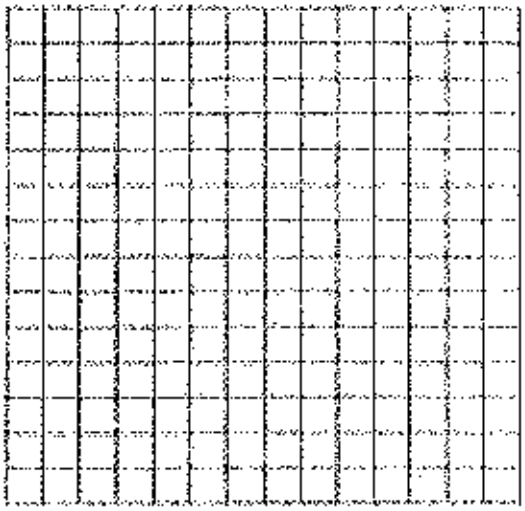
3. A professional skier flies down the mountain at 60 meters/second and completes the course in just 72 seconds. How long is the course?

4. You see your friend down at the end of NMHS hallway and want to greet them. You walk at 2 meters/second for a total distance of 100 meters. How long does it take before you can give your friend a high-five?

5. A train travels for 3300 miles and it takes 3 days. How many miles per day does the train travel?

6. Draw a position time graph using the following table of information.

| Trial | Time (seconds) | Position (meters) |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 2 | 5 |
| 3 | 9 | 7 |
| 4 | 11 | 9 |
| 5 | 15 | 15 |
| 6 | 20 | 6 |
| 7 | 24 | 0 |



For questions 7-10, refer to the figure you drew in question 6.

7. Find the velocity between 0-2 seconds. (Hint: find the slope)

8. Find the velocity between 2-9 seconds. (Hint: find the slope)

9. Describe the difference in motion between 0-2 seconds and 2-9 seconds. Which period of time had the higher velocity? How do you know?

10. What is the velocity between 15-20 seconds? (Hint: find the slope). How does this velocity compare to the velocity between 0-2 seconds? What does that mean for the motion of the object during these two time periods as compared to the frame of reference?

11. While waterskiing on Hood Canal this last summer you were traveling at 20 meters/second and stayed up for 160 seconds. How far did you travel?

12. The earthquake in Japan in early 2011 generated waves in the oceans that traveled at 500 miles/hour. If it is 5,000 miles from Japan to Washington, how long would it take for the waves to get to the Washington coast?

13. A raindrop is 700 meters in the air when it begins falling at 10 meters/second. How long does it take for the raindrop to reach earth?

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# Lab: Position Time Graph

**Purpose:**
To create a position time graph from the speed of a rolling ball.

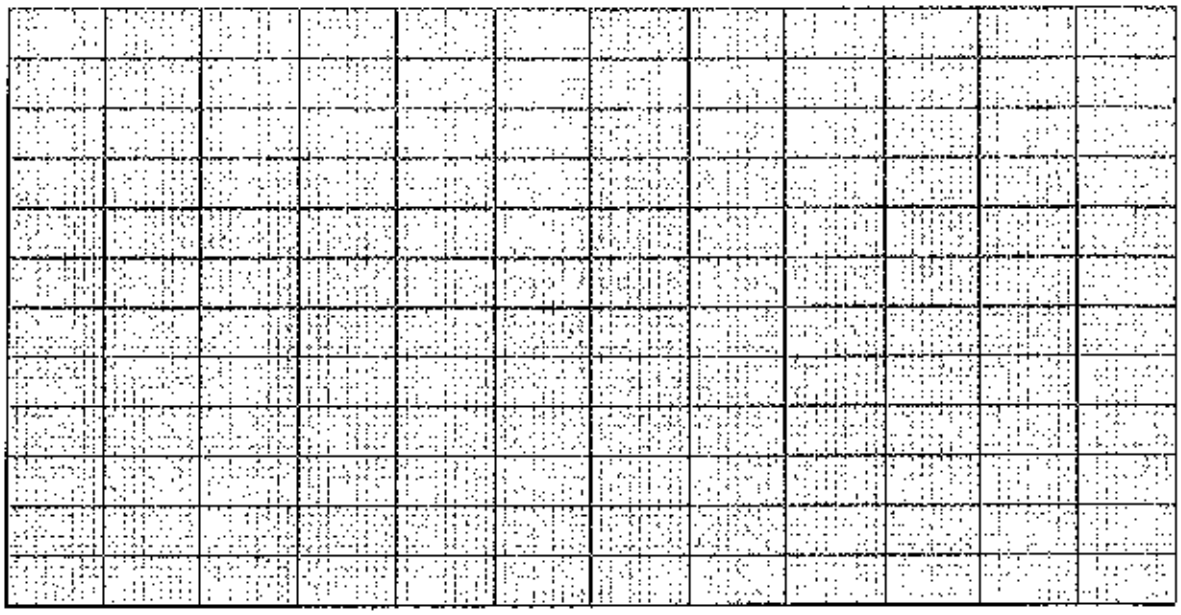
**Discussion:**
We learned that one way to solve for the velocity of an object is to find how far that object travels in a given amount of time. We then use the formula: $v = \frac{x}{t}$ to solve for the speed. Another way to solve for the velocity of an object is to create a position time graph and to solve for the slope of the line between two points on that line. In this lab, you will practice using position time graphs and solving for velocity from them.

**Materials:**
1. String
2. Softball or tennis ball
3. ½ PVC pipe
4. Scissors
5. Tape
6. Stopwatch
7. Meter stick

**Procedure:**
1. Measure an 8 meter length of string, cut it and tape it to the floor.
2. Mark every 2 meters.
3. Place the ½ PVC pipe at 40 cm so the ball will roll along the string length.
4. Roll the ball and get the time it takes for the ball to travel 2 m.
5. Repeat for a total of 4 trials and then find the average.
6. Repeat the whole experiment measuring for the 4 m, the 6 m, and the 8 m mark.
7. Fill in the Position Time Graph using a different color for each trial and the average.
    a. For example, trial one at 2 m, 4 m, 6 m, and 8 m would all be colored yellow.

**Results:**

| Color | Trial | Time at 2m | Time at 4m | Time at 6m | Time at 8m |
|---|---|---|---|---|---|
| Yellow | A | | | | |
| Blue | B | | | | |
| Red | C | | | | |
| Purple | D | | | | |
| Grey | E | | | | |
| Green | Average | | | | |




Questions:

1. Find the velocity (using the data from the average) between 0-2 m using the slope formula.

2. Find the velocity (using the data from the average) between 6-8 m using the slope formula.

3. Compare the speed of the ball between 0-2 m and 6-8 m.

4. Predict the motion of a ball if the slope was negative.

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## Chapter 4.3 Reading Guide

Read Chapter 4.3 in your textbook and answer the following questions in complete sentences.

1. Define acceleration.

2. What are two differences between speed and acceleration?

3. Copy the formula for acceleration below.

4. What is the standard unit that is used for acceleration?

5. What is the difference between acceleration and deceleration?

6. On a position – time graph, when an object is accelerating, what is the slope of the line? Describe and draw it below.

7. Define free fall.

8. Describe the acceleration due to gravity. What is the acceleration due to gravity on Earth?

9. One way to accelerate is to speed up. What is another way to accelerate without changing speeds?

10. What is a projectile?

11. Complete the 4.3 section review questions numbers 2, 5, 7, 8, 11.

# Acceleration Notes

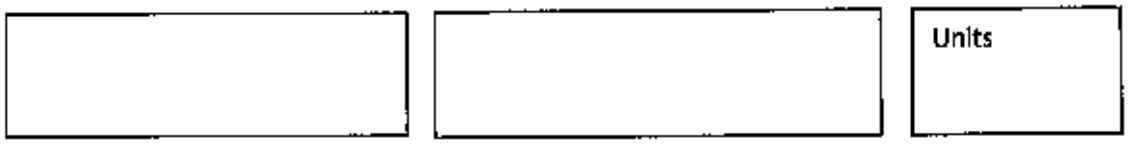
Acceleration –

List three ways in which an object can accelerate

1.
2.
3.

Deceleration –

Uniform acceleration –




EX: A runner starts at 0m/s and reaches 4.5 m/s in just 5 seconds. Assume constant acceleration. What is the acceleration?

EX: A car traveling at 25 meters/second speeds up to 35 meters/second in 50 seconds. Assume constant acceleration. What is the acceleration?

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## Acceleration Questions

Directions: answer the following questions. You must **show your work** and make sure everything has a unit. Answers and work without units will not be counted as correct.

$$a = \frac{(v_2 - v_1)}{t}$$

1. A biker is traveling at 4m/s before she starts down a hill. By the time she has reached the bottom of the hill only 40 seconds later she is traveling at 8 m/s. What is her acceleration?

2. A car is traveling along the road at the speed limit of 40m/s and exits onto a side street reducing speed to 5m/s. It takes the car a grand total of 90 seconds to do this. What is the acceleration?

3. A ball is dropped from the roof to the ground. When the ball reaches the ground it is traveling at 10m/s and it takes only 1 second to fall. What is the acceleration of the ball?

4. You are waterskiing with your uncle and give him the signal to speed up and you go from 3m/s to 6m/s in 30 seconds. At what rate did your uncle accelerate?

5. A train at rest leaves the station at noon and in 240 seconds is traveling at 15 m/s. What is the acceleration of the train?

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# Acceleration Lab

**Purpose**: To find the acceleration due to gravity using the cars and ramps.

**Question:** What effect will _____(MV) have on the acceleration (RV)?

**Hypothesis** (remember If…. Then…. Because……):

_____

_____

_____

**Discussion:**
When an object is in motion at a constant rate, it has a constant velocity. However, most objects in the universe do not have a constant velocity but instead are continually speeding up and slowing down. This process of getting to a faster or slower motion is acceleration. When a person solves for acceleration they use the equation

$$a = \frac{v_2 - v_1}{t}$$

Where:
a= acceleration ($^{m}/_{s}^{2}$)
$v_2$= the second velocity
$v_1$= the first velocity
t= time to speed up or slow down

Thus, when one solves for the acceleration of an object, they need to know 3 things. In part A of the lab you will calculate the $v_2$ of a hot wheels car. Using that velocity, you will then be able to solve for the acceleration of the hot wheels car.

**Procedure Part A:**

1. Set up the ramp at a low angle, 20cm from the ground.
2. Measure 1 meter from the bottom of the ramp out that will follow the path of the car.
3. Roll the car down the ramp and time the car from the bottom of the ramp to 1 meter out.
4. Repeat step 3 for a total of 5 times and fill in Table 1.
5. Move the angle of the ramp to a medium height, 30cm from the ground.
6. Repeat steps 2-4 and fill in Table 2.
7. Move the angle of the ramp to a steep height, 40cm from the ground.
8. Repeat steps 2-4 and fill in Table 3.
9. Calculate the $V_2$ of each trial using the equation $v = \frac{x}{t}$

| Table 1 (20cm) | | | |
|---|---|---|---|
| Trial | Distance (m) | Time (s) | $V_2$ ($^m/_s$) |
| 1 | 1 | | |
| 2 | 1 | | |
| 3 | 1 | | |
| 4 | 1 | | |
| 5 | 1 | | |
| Average | 1 | | |

| Table 2 (30cm) | | | |
|---|---|---|---|
| Trial | Distance (m) | Time (s) | $V_2$ ($^m/_s$) |
| 1 | 1 | | |
| 2 | 1 | | |
| 3 | 1 | | |
| 4 | 1 | | |
| 5 | 1 | | |
| Average | 1 | | |

| Table 3 (40cm) | | | |
|---|---|---|---|
| Trial | Distance (m) | Time (s) | $V_2$ ($^m/_s$) |
| 1 | 1 | | |
| 2 | 1 | | |
| 3 | 1 | | |
| 4 | 1 | | |
| 5 | 1 | | |
| Average | 1 | | |

**Procedure Part B:**

1. Move the ramp back to the low angle.
2. Roll the car down the ramp and time it from start to the end of the ramp.
3. Repeat this for a total of 5 times and fill in Table 4.
4. Move the ramp to the medium angle.
5. Repeat steps 2-3 and fill in Table 5.
6. Move the ramp to the steep angle.
7. Repeat steps 2-3 and fill in Table 6.
8. Calculate the acceleration using the following formula $a = \frac{v_2 - v_1}{t}$ where $v_2$ is the average of the velocities you found in Part A.
9. Answer the questions and write a conclusion.

| Table 4 (20cm) | | | |
|---|---|---|---|
| Trial | Ave V from Part 1 | Time (s) | Acceleration ($^{m}/_{s}^{2}$) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| Average | | | |

| Table 5 (30cm) | | | |
|---|---|---|---|
| Trial | Ave V from part 1 | Time (s) | Acceleration ($^{m}/_{s}^{2}$) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| Average | | | |

| Table 6 (40cm) | | | |
|---|---|---|---|
| Trial | Ave V from part 1 | Time (s) | Acceleration ($^{m}/_{s}^{2}$) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| Average | | | |

**Questions: Answer the following questions and use them to guide you while you write your conclusion**

1. Did the final velocity change when the height of the ramp changed? Why do you think this happened?

2. Did the final acceleration change with the changes in height? Why do you think this happened?

3. Did your hypothesis match the results? Why or why not?

**Conclusion:**

In your conclusion, be sure to:

- Answer the experimental question.
- Include **supporting** data from the data table.
- Explain how these data **support** your conclusion.
- Provide a **scientific** explanation for the trend in the data.

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## Acceleration Questions II

Directions: answer the following questions. You must **show your work** and make sure everything has a unit. Answers and work without units will not be counted as correct.

$$a = \frac{(v_2 - v_1)}{t}$$

1. Find the uniform acceleration that causes a car's velocity to change from 32 m/s to 96 m/s in an 8 second time period.

2. Rocket-powered sleds are used to test the responses of humans to acceleration. Starting from rest, one sled can reach a speed of 444m/s in 1.8 seconds. What is the uniform acceleration?

3. That same sled can slow from 444m/s to stop in 2.15seconds. What is the deceleration?

4. Engineers are developing new types of guns that might someday be used to launch satellites as if they were bullets. One such gun can give a small object a velocity of 3500m/s in just 2 seconds. What is the uniform acceleration?

5. A baseball pitcher throws a fastball at a speed of 44m/s. What is the acceleration of the ball if it takes 0.5 seconds to be thrown?

6. At 1:22PM a plane leaves the runway and at 1:44 the airplane has reached its cruising speed of 520m/s. What is the acceleration?

Name _____

Date _____ Period _____

**Exam Review: Velocity and Acceleration**

Define the following terms

_____Instantaneous Position
_____ Frame of Reference
_____ Vector
_____ Scalar
_____ Deceleration
_____ Distance
_____ Acceleration
_____ Average Speed
_____ Position
_____ Time Interval

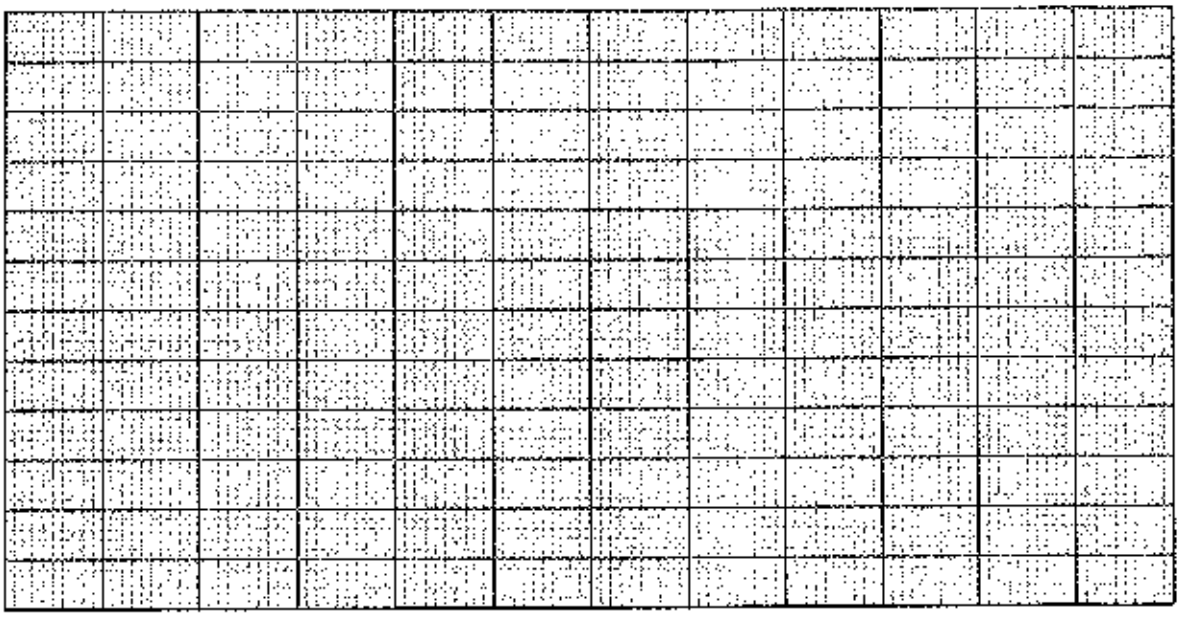
**Part 2: Problems: CHECK TO MAKE SURE THE UNITS MATCH!**

1. A recent earthquake had a shock wave that traveled 6000 m in 12 seconds. How fast did the shock wave travel?
2. Rocket-powered sleds are used to test the responses of humans to acceleration. Starting from rest, one sled can reach a speed of 500m/s in 2 seconds. What is the uniform acceleration?
3. A driver slams on the breaks. The car was traveling at 20m/s and stopped 10 seconds later? What is the uniform deceleration?
4. What is the uniform acceleration of a train from rest to 50m/s over 2000 seconds?
5. You want to meet a friend in Olympia for the weekend. Your friend lives in Tacoma and you live in Belfair. It is 30 miles from Tacoma and your friend can travel at 60 miles/hour. It is 35 miles from Belfair to Olympia and you can only travel at 50 miles/hour. If you wanted to arrive at noon, what time would you and your friend have to leave each location?
6. At 1:30PM a plane leaves the runway and at 1:40 the airplane has reached its cruising speed of 620m/s. What is the acceleration?
7. Construct a position time graph using the following information.

| Time (seconds) | Distance (meters) |
|---|---|
| 0 | 0 |
| 4 | 8 |
| 9 | 12 |
| 10 | 20 |
| 15 | 20 |
| 20 | 14 |

Name _____

Date _____ Period _____



For questions 8-10 use the position time graph you made to answer the questions.

8. Find the velocity between 0-4 seconds and 4-9 seconds. How do these velocities compare? What does that tell you about the motion of the object?
9. What is happening to the motion of the object between 15-20 seconds? How do you know?
10. At which time interval does the velocity become negative? What does that mean about the motion of the object?

**Formulas**

$v = \frac{x}{t}$ $x = v \cdot t$ $t = \frac{x}{v}$ $a = \frac{v_2 - v_1}{t}$ $m = \frac{y_2 - y_1}{x_2 - x_1}$