Youngstown City Schools

Science - - PHYSICAL SCIENCE GRADE 9

Unit 6: MOTION (5.5 WEEKS)

SYNOPSIS: Students will learn Newton's laws of motion and their importance in everyday life. In addition, students learn about the concepts of acceleration, speed, velocity, and displacement. Students will calculate speed, acceleration, velocity, displacement as well as graph results of lab work completed in class. At the end of the unit, students will complete a project about Newton's laws.

STANDARDS

III. FORCES AND MOTION

A. Motion

1. "One-dimensional vectors" describe forces and motion acting in one direction.
   a. Moving from qualitative understanding of motion to quantitative including graphing to describe motion phenomena
   b. (In Physical Science) all motion is limited to objects moving in a straight line (e.g., horizontally, vertically, up/down incline), that can be characterized in a single step (e.g., at rest, constant velocity, constant acceleration)
   c. motion of two objects may be compared or addressed simultaneously (e.g., when or where they would meet)
   d. motion depends on the observer's frame of reference; it is described in terms of distance, position, displacement, speed, velocity acceleration, time; there is no motionless frame from which to judge all motion
   e. vector properties (magnitude and direction) impact position, displacement, velocity, and acceleration
2. Displacement, velocity (constant, average, and instantaneous) and acceleration can be measured or calculated.
   a. displacement is calculated by subtracting initial position from final position ($\Delta x = x_f - x_i$)
      (1) can be positive or negative depending on direction of motion
      (2) is not always equal to distance traveled; give examples where distance is not same as displacement
   b. velocity is speed in a given direction [$v_{avg} = (x_f - x_i)/(t_f - t_i)$]
      (1) divide displacement (change in position) by elapsed time
      (2) may be positive or negative depending on direction of motion
      (3) is not always equal to speed; provide examples when average speed is not same as <u>average velocity</u>
      (4) <u>constant velocity</u> = the object has same displacement for each successive time interval
      (5) velocity of object changes continuously while speeding up, slowing down, and/or changing direction
      (6) speed of object at any instant is its <u>instantaneous speed</u>; the object does not travel at this speed for any period of time or cover any distance if the speed is continually changing
   c. acceleration is the rate at which velocity changes
      (1) average acceleration = change in velocity divided by elapsed time; $a_{avg} = (v_f - v_i) / (t_f - t_i)$
      (2) can be positive or negative (but not the specific motions responsible for producing them
      (3) objects with no acceleration can be standing still or moving with constant velocity
      (4) constant acceleration = when change in object's instantaneous velocity is same for equal successive time intervals
3. Position vs. time and velocity vs. time can be interpreted in graphic form.
   a. Interpret graphs to determine specifics about speed, direction and change in motion are limited to positive x-values and show only uniform motion involving constant velocity or constant acceleration
   b. motion is investigated by collecting and analyzing data in lab
      (1) objects that move with constant velocity and have no acceleration form a straight line (not necessarily horizontal) on a position-time graph
      (2) objects at rest form a straight horizontal line on a position-time graph
      (3) objects accelerating show a curved line on a position-time graph
      (4) velocity is calculated by determining slope of position-time graph; positive slopes indicate motion in a positive direction; negative slopes indicate motion in a negative direction
      (5) constant acceleration is represented by a straight line (not necessarily horizontal) on a velocity-time graph
      (6) objects that have no acceleration (at rest or moving at constant velocity) have a straight horizontal line for a velocity-time graph
      (7) average acceleration can be determined by the slope of a velocity-time graph.
   c. technology is used to enhance motion exploration and investigation; e.g., video analysis; motion detectors; and computer graphing programs or graphing calculators can be used for data analysis
   d. make interpretations from motion graph data and develop generalizations

B. Forces

1. Force diagrams are used to determine net force and direction
   b. a force is an interaction between two objects; both objects experience an equal amount of force, but in opposite directions.
      (3) objects involved in an interacting force pair can be identified by using the form " A acts on B so B acts on A." (e.g., truck hits sign therefore the sign hits the truck with an equal force in the opposite direction; Earth pulls book down so the book pulls Earth up with an equal force.
   c. the laws of motion explain and predict changes
2. Types of forces include gravity, normal, and tension; friction is "resistance" to motion [note: the standards document refers to friction as a type of "force"]
   a. force is a vector quantity, having magnitude and direction; a unit of force is a Newton;
      (1) 1 Newton of net force will cause a 1 kg object to experience an acceleration of $1 m/s^2$ or $1 N = kg \cdot m/s^2$

C. Dynamics (how forces affect motion)

1. Objects at rest tend to remain at rest.
   a. an object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced net force acts on it.
   b. when the vector sum of the forces (net force) acting on an object is zero, the object does not accelerate.
   c. an object that is not moving will continue to remain stationary
2. Objects moving with constant velocity tend to move at a constant velocity in the same direction.
   a. when the vector sum of the forces (net force) acting on an object is zero, the object does not accelerate
   b. an object that is moving will remain moving without changing its speed or direction
3. The rate at which an object changes its speed or direction (acceleration) is proportional to the vector sum of the applied forces (net force, F_{net}) and inversely proportional to the mass ($a = F_{net}/m$)

LITERACY STANDARDS: READING (RST) and WRITING (WHST)

RST.10 Read and comprehend science texts independently and proficiently.

VOCABULARY:

Science Technical Words		
Velocity	Distance	Instantaneous
Acceleration	Position	Elapsed Time
One-dimensional vectors	Displacement	Average Velocity
Motion	Speed	Average Acceleration
Constant Velocity	Velocity Acceleration	Position vs Time
Constant Acceleration	Vector Properties: magnitude	Velocity vs Time
Frame of Motion	Vector Properties: direction	Net Force
Frame of Reference	Impact Position	Stationary
Inertia	Inversely Proportional	

Non-Technical Words
Qualitative
Quantitative
Phenomena
Horizontally
Vertically
Incline
Characterize
Simultaneously

VOCABULARY: Post words in room and leave up for the unit. Create a word wall where students know to look for new words.

Address roots and affixes of new words
Use a diagram to show meaning of new words
Relate the new word to a similar and/or familiar word
In the course of teaching, define the word in the context of where if falls in the unit rather than in isolation
Throughout the teaching of the unit, use the word in conversation/discussion
Require students to use the word(s) in: discussion, investigations, and in 2-and 4-point response questions
Use new words in Rubric for the Authentic Assessments

MOTIVATION	TEACHER NOTES
1. Have toy cars, rubber bands, and rulers for students to release a car with the rubber band and watch what happens. Don't do measuring and everything here, but just let them know that this is Newton's Second Law of Motion and we will be working with all three laws in the unit. Let students know that they will move from qualitative to quantitative in terms of how they describe something as part of this unit. The idea here is that the more mass an object has, the more force it takes to move it and the more force you apply to an object, the faster it moves or the greater the distance it moves (e.g., shopping cart empty versus full; a wheel barrow is easy to move empty, but not so when it is full of dirt) (Text, page 275) **(IIIA1a) (RST.10)**	

MOTIVATION	TEACHER NOTES
2. Students establish both academic and personal goals for this unit 3. Teacher previews the Authentic Assessments for the end of the Unit	

TEACHING-LEARNING	TEACHER NOTES
1. **Newton's Laws of Motion**: **(IIIC1a,b,c; IIIC2a,c; IIIC3)** After each law is demonstrated, have students relate its premise to some real-life experience (sports are good reference points) - - have index cards for students to record important information about each law. a. Teacher does demo with cup, card over the cup with a penny on top, and the teacher flicks the card and the penny drops straight down. (Newton's First Law) (page 281) Use Newton's Laws of Motion – Youtube at http://www.youtube.com/wathc?v=PkAO8F-Tm-w from "international Love" by Pitt Bull featuring Chris Brown. (**words to song on pages 6-7**) http://www.youtube.com/watch?v=PkAO8F-Tm-w http://fmzik.com/video_PkAO8F-Tm-w_Newton-s-Laws-of-Motion-Song.html b. Newton's Cradle (Newton's Third Law) - - demo and discuss, or use balloon with string and straw. Stretch a string across the room. Insert one end of the string through a drinking straw. Tape the straw to a balloon. Blow up the balloon and let it go. The balloon will move across the room on the string. The air going out the back of the balloon causes a reaction force and the reaction force causes the balloon to move in the opposite direction. Alternative activity: Use chair with wheels and sit down in it Throw a basketball forward. The chair will move backwards as the ball goes forward. Identify the action and reaction forces. c. Work practice problems, especially for the Second Law! Reference **motion and force** from the previous unit and ask students for a definition and examples for each. Tell students that they will apply what they learned in the previous unit in this unit. Background information for forces and motion: http://www.excellup.com/classnine/sciencenine/worknine.aspx **(RST.10)** d. These activities serve as a frame of reference for the unit: students make a scroll "Hear Ye, Hear Ye…" and set the stage for each Law with notes on real examples and problems. e. Teacher introduces Newton: Students read the articles on Newton and complete the Reading Guide. (**Articles attached with Reading Guide on pages 8-10**) **(RST.10)** 2. **Motion:** Show and discuss examples of motion phenomena (e.g., walking around room, moving an object from the table to above the table; roll marble or car across table) - - the object moved, but the background did not. Next move to having 2 objects moving and have students determine when and where they will meet? Have map and graph paper, and use tile floor in class to show this. **(IIIA1b,c,d)** 3. **Frame of Reference**: www.archive.org\details\framesof_reference Part 1: show only the first 3:10 of the clip; the clip was done in the 60's), but this makes the point. 4. Teacher explains **magnitude and direction** : magnitude is how much, how many, how strong and direction is done in terms of **vectors and graphing**. Graph on page 273 of text shows vectors of distance and time.**(IIIA1e)** 5. **Displacement:** distinguish between **displacement and distance** by having 2 students walk different paths in the class to get from a common start point to a common end point. Calculate distance and displacement for each path. Have students do **Distance and Displacement Lab (attached on pages 11-12)** **include formula:** $(\Delta x = x_f - x_i)$	Frame of Reference Video

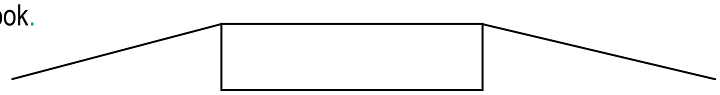
TEACHING-LEARNING	TEACHER NOTES

6. **Speed, Velocity, and Acceleration**. **(IIIA2b1, 2, 3, 4, 5, 6)**

a. **Speed**: (text page 272) students need the formula S = D/T; do sample problems with students, making the problems they would experience. In the discussion ask students what they think **instantaneous speed** means and use a map showing school, mall, and home where they would have to travel in different directions at different speeds as they change directions (e.g., from A to B they go 20 mph; from B to C, they go 40 mph; from C to D, they go 30 mph; and from D to E, they go 50 mph). Which has the greatest instantaneous speed? Next discuss **constant speed**, and **average speed**. Use Ipad maps or maps from the county for this activity.

b. **Velocity**: includes direction with speed. Teacher identifies difference between speed and velocity (may use Speed and velocity video) http://watchknowlearn.org/Video.aspx?VideoID=15703&CategoryID=2515

Difference between speed and velocity (Life is a Box of Marbles attached on page 13-15)
Materials needed: book, 2 grooved rulers, 2 marbles, 2 stopwatches
Procedure: Lay the book on a table. Lay one end of one ruler on the edge of the book and the other end should rest on the table (ramp style). Repeat the procedure with the other ruler on the opposite side of the book.



Release marbles down the ramps (rulers). Have students time the rolling of the marbles down the ramps. Start them at the same time and stop the watches when the marbles reach the table. This may take a few trials to make the timers proficient. Have students calculate the speeds of the marbles using correct units of measurement. Ideally the speeds will be the same. Lead a class discussion to include: Why are the speeds the same? Are the velocities the same, why or why not? Have students calculate the velocities using correct units of measurement.

"Over the river and through the woods" - - you have to go north and east; end up going NE - - use something the kids would know if they don't know that song!

Constant Velocity: describe constant speed with adding direction.
Average Velocity: describe average speed, with adding direction. $v_{avg} = (x_f - x_i)/(t_f - t_i)$

c. **Acceleration**: Students need to see that **acceleration** is not only speed, but could be a change in direction. Acceleration is not only speeding up, it can be slowing down. Use the formula for average acceleration $a_{avg} = (v_f - v_i) / (t_f - t_i)$ and student calculate acceleration and graph. **Do Hot Wheels Lab attached on pages 16-17** do graphing **(IIIA2c1,2,3,4)** **Vectors and Graphing worksheets attached on pages 18-19**

7. **Motion with graphs (IIIA3a,b,1,2,3,4,5,6,7; c, d)** Students look at graph and explain why a graph looks like it does (**attached on page 20**). Include the following in their explanations:
   (1) objects that move with constant velocity and have no acceleration for a straight line (not necessarily horizontal) on a position-time graph
   (2) objects at rest form a straight horizontal line on a position-time graph
   (3) objects accelerating show a curved line on a position-time graph
   (4) velocity is calculated by determining slope of position-time graph; positive slopes indicate motion in a positive direction; negative slopes indicate motion in a negative direction
   (5) constant acceleration is represented by a straight line (not necessarily horizontal) on a velocity-time graph
   (6) objects that have no acceleration (at rest or moving at constant velocity) have a straight horizontal line for a velocity-time graph
   (7) average acceleration can be determined by the slope of a velocity-time graph.

Have students relate what they have learned to real-world situations: The use of graphs is an

TEACHING-LEARNING	TEACHER NOTES
important way to communicate information. At a glance, information can be obtained about acceleration, speed, and velocity. For scientists working on a project in different locations this can be a valuable time saver. It would also be helpful for scientists speaking different languages and working on the same project. Have students cite Newton's Laws and apply why they are important. http://dsc.discovery.com/tv-shows/other-shows/videos/assignment-discovery-shorts-newtons-laws-of-motion.htm Examine careers where this knowledge is used and show some videos for this.	

TRADITIONAL ASSESSMENT	TEACHER NOTES
1. Multiple-Choice **Unit Test**	

TEACHER CLASSROOM ASSESSMENT	TEACHER NOTES
1. Teacher Classroom Assessments	

AUTHENTIC ASSESSMENT	TEACHER NOTES
1. Students evaluate progress on their goals 2. Newton's Laws of Motion Video Project. Create a video showing each of Newton's 3 laws in action. Include an explanation (orally or written) stating why it is an example of Newton's law(s)	

T-L #1a: Words to YouTube Video Song

Objects at rest or ones in motion
Will stay that way
Acceleration depends on mass
And force applied
For every action there's an opposite
Equal reaction
Ohh, Newton's Laws of Motion
Ohh, Newton's Laws of Motion

Objects fall the same acceleration everywhere, everywhere, everywhere
Objects fall to the ground at the same rate from acceleration, gravity
Air resistance makes acceleration slow
And when in freefall gravity's forcing upon it
A centripical force is needed to keep objects up there motion of circular
Gravity acts to keep objects in orbit
And horizontal, vertical, are part of projectile
Spinned all around the world gravity affecting
Vertical motion of projectile motion

Objects at rest or ones in motion
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Ohh, Newton's Laws of Motion
Ohh, Newton's Laws of Motion

Newton's first law states an object in motion
Ain't gonna change if you know what I mean
Unless a force acts on it
And then it will go down if you know what I mean
The second law of Issaic Newton
Acceleration depends on the mass and force on
The equal and opposite reaction to the first action can be seen
In three, forces in pairs
In momentum, velocity and mass will change ya
When objects interact, momentum may exchange
But the total will never change

Objects at rest or ones in motion
Will stay that way
Acceleration depends on mass
And force applied
For every action there's an opposite
Equal reaction
Ohh, Newton's Laws of Motion
Ohh, Newton's Laws of Motion

There's not a place that these laws don't affect all objects
So they never change
I crossed the globe with all kinds of objects
Ayy
Woah-oh

Objects at rest or ones in motion
Will stay that way
Acceleration depends on mass
And force applied
For every action there's an opposite
Equal reaction
Ohh, Newton's Laws of Motion
Ohh, Newton's Laws of Motion

Objects at rest or ones in motion
Will stay that way
Acceleration depends on mass
And force applied
For every action there's an opposite
Equal reaction
Ohh, Newton's Laws of Motion
Ohh, Newton's Laws of Motion

Laws of Motion, Newton's Laws of Motion
Laws of Motion, Newton's Laws of Motion
Laws of Motion, Newton's Laws of Motion

Wawawa, wawawa, Newton's Laws of Motion
Wawawa, wawawa, Newton's Laws of Motion

T-L #1e <u>SIR ISAAC NEWTON BIOGRAPHY - -</u> Dr. Gulden Akinci / Article Source: http://EzineArticles.com/1732831

Sir Isaac Newton was not only one of the best physicists ever lived but he was also one of those scientists that contributed a lot to mathematics. He made most of his mathematical contributions while he was first a student then a professor at Trinity College, Cambridge between the years 1661 and 1696. Our world would not be the same today without the important discoveries of the son of this yeoman farmer.

The years 1665-66 were one of the worst for England when the Bubonic Plague devastated all big cities. 1665 is also the year when Newton got his B.A. When the school was shut down to fight the plague, Newton retreated to the family farm at Woolsthorpe. During those two years that he spent in seclusion doing nothing but devoting all his time to physics and mathematics, Newton discovered the law of gravity and made important advances in mathematics.

Here is a list of the 23 year old Newton's achievements during those two crucial years: He discovered the law of universal gravitation, invented calculus (at the same time as but independently of Leibnitz in Germany), further developed the binomial theorem, and started his life-long studies in optics and the theory of colors.

There, during his two year stay at the farm, Newton discovered and proved that the same force that pulls a rock towards the earth (i.e., gravity) is one and the same force that pulls the moon towards the earth and keeps it in orbit. He later on developed this into a "Principle of Universal Gravitation" which said any two objects in the universe attracted one another in direct ratio to the product of their masses, and in inverse ratio to the square of the distance between them."

Newton is best known for his **3 Laws of Motion**:

Law 1 (Law of Inertia): If an object is at rest and there is no net force acting on it, it will remain at rest. If it is moving at a constant speed and no net force is acting on it, it will continue to move at that constant speed.

Law 2: F = ma, or: the net force acting on an object is its mass multiplied by the acceleration of the object. Thus if an object is moving at a constant speed, that is, if its acceleration is zero, then there is zero net force acting on it.

Law 3: To every action there is an equal and opposite reaction. If A is pushing B with a force of F, B is also pushing A in the opposite direction with a force of F. Sun attracts the Earth, and Earth attracts the Sun with the same force!

During 1668 and 1669, Newton worked on optics at the Cambridge University.

1669 is another important year in Newton's life since that's when Prof. Isaac Barrow resigned from the famous "Lucasian Chair" at Cambridge and offered it to Newton as its second occupant. Having the security of a good tenured position, Newton pressed on with his studies into the nature of light and optics with a renewed vigor.

Here is a summary of Newton's various contributions to the science of optics, some of which later on culminated in his 1704 book also titled "Optics."

Newton developed instruments to grind lenses into shapes other than spheres. He is the first in human history to discover that, when passed through a prism, the sun light is split into a bundle of different colored rays. On the basis of that observation he developed the first successful explanation of rainbows.

The great physicist has also discovered the telescope that is still known today by his name; invented a reflecting microscope in 1672, as well as a sextant which was independently discovered in 1731 by J. Hadley.

However, for all his daring discoveries in optics and the theory of colors, Newton was attacked vehemently during the 1670s. Sometimes it takes minds lesser than a genius a little lag time to catch up with the greatest discoveries of human history.

Even if Newton had died in his mid-twenties his place in the world of mathematics and science would've been secure enough. But he lived about 60 more years and pushed the frontiers of human reason and science even further - thanks to his extraordinary gifts as physicist and a mathematician.

SIR ISAAC NEWTON (1642-1727) - - By Abhijit Naik

Sir Isaac Newton was a renowned English physicist and mathematician, who was considered by many as one of the most influential scientists in history. Owing to his numerous discoveries, Newton is quite often referred to as the Father of Modern Science. Some of his prominent accomplishments include defining the laws of gravity and planetary motion and explaining the laws of light and color.

Newton was born on January 4, 1643, in Woolsthorpe - a hamlet in Lincolnshire county in England. Some sources also refer to Newton's date of birth as December 25, 1642, which is mainly due to the confusion prevailing between the Old Style and New Style dates. However, there is a consensus among the historians that he was actually born on January 4, 1643.

Early Childhood and Schooling. Newton's father died three months before he was born. When Newton was 3 years old, his mother remarried, and left him with his grandmother who raised him. At the age of 12, he was sent to the King's School in Grantham. While schooling, he lived with an apothecary name Clarke. During his stay here, Newton showed keen interest in Clarke's laboratory. He quite often built some mechanical devices, such as floating lanterns or sundials, in a bid to impress people around him.

Education and Fundamental Thinking. In 1661, at the age of 19, Newton joined the Trinity College in Cambridge University. Here he showed keen interest in various subjects, especially in mathematics, physics, astronomy and optics. He went on to complete his Bachelor's degree by 1665, and decided to stay back at Cambridge and complete his Masters. However an epidemic outbreak in the same year forced the University to shut, thus leaving Newton with no other option but to return to Woolsthorpe. He spent around 2 years at home, during which he emphasized on some of the basic experiments. It was during this period that Newton initiated fundamental thinking for his various works pertaining to gravitation and optics.

Return to Cambridge. In 1667, Newton returned to Cambridge University and became a fellow of the Trinity College. At the same time, he decided to elaborate his work which he had begun in Woolsthorpe. In 1669, at the age of 27, he was appointed the second Lucasian professor of mathematics at the Trinity College. He continued on this post for the next 27 years of his life. In the meanwhile, the reflecting telescope made by Newton in 1668 became quite popular and earned him fame in the scientific community. He received wide appreciation for this invention. Subsequently, he was made a fellow of the Royal Society, an honorary society through which the British government supported science, in 1672.

Isaac Newton's Accomplishments. By the age of 30, Newton had earned a great repute in the field of science, but that didn't mean he didn't venture into other fields. He was also well versed with various other subjects, including theology and astronomy. Through his series of experiments about the composition of light, he discovered that the white light is made up of same colors which are found in the rainbow and established the modern study of optics. With some help from the astronomer Edmond Halley, of Halley's Comet fame, Newton produced the 'Philosophiae Naturalis Principia Mathematica' Mathematical Principles of Natural Philosophy, in 1687. This was followed by publishing of his yet another acclaimed work related to the behavior of light and color - The Opticks, in 1704.

Prominent Positions Held by Isaac Newton. In his life spanning over 84 years, Newton made it to some of the most prestigious posts in various organizations. He was elected as the member of parliament for Cambridge University, a post he held for two terms - first in 1689-90 and then in 1701-02. He was appointed the warden of the Royal Mint, the organization in charge of manufacturing coins in the United Kingdom, in 1696. He was also elected the president of the Royal Society in 1703, a position he held until his death. In 1705, he was conferred the knighthood, and thus he became Sir Isaac Newton. He became one of the most dominant figures of the European scientific community in the first quarter of the 18th century.

He died on March 31, 1727, and was cremated in Westminster Abbey. Newton is often remembered for the incident wherein an apple fell on his head and inspired him to think about the laws of gravity. Although the apple hitting his head was not quite true, his assistant, John Conduitt later confirmed that it was indeed witnessing a falling apple in his garden that inspired Newton to think about gravity.

COMPARISON OF NEWTON TO NEWTON: READING GUIDE

1. Why don't both articles report the same information about Newton?

2. Which of the two articles do you believe is best in giving a clear picture of Newton? Explain your answer.

3. What information do you think is not important about Newton and should be removed from each of the articles?

4. Newton once said about himself, "If I have seen further than others, it is because I have stood on the shoulders of giants." What do you think he meant by this statement; cite evidence from the text of the articles to support your answer.

Distance and Displacement Lab

Note! In this lab when you measure, round all measurements to the nearest meter!

1. Place a piece of tape where you will begin your walk outside. This tape marks the **origin**.

2. Walk 10 steps forward and stop. Using the meter stick, have your partner measure the distance you walked. Write that distance here: _______________ (don't forget units!)

3. Now turn 180 degrees and walk 5 steps and stop. Using the meter stick, have your partner measure the distance you walked. Write that distance here: _______________ (don't forget units!)

4. Now turn 180 degrees and walk 20 steps and stop. Using the meter stick, have your partner measure the distance you walked. Write that distance here: _______________ (don't forget units!)

5. Finally, have your partner measure how far you are from the origin. Write that measurement here: _______________. This is your **measured displacement**.

6. Figure out the **distance** and **calculated displacement** you walked.
   Add all measurements to find the **distance**: _________________

   Add all *forward* measurements and subtract all *backwards* measurements to find the **calculated displacement**: ________________

   Did your **measured displacement** match your **calculated displacement**? ________

7. Find your piece of tape again, and walk 10 steps forward and measure how far you walked. Write it here: _________ (don't forget your units!)

8. Turn 90° left, walk 15 steps and measure how far you walked. Write it here: _______

9. Turn 90° left, walk 10 steps and measure how far you walked. Write it here: _______

10. Turn 90° left, walk 20 steps and measure how far you walked. Write it here: _______

11. Have your partner measure how far you are form the origin. Write it here: ________
    This is your **measured displacement**.

12. Now figure out your **distance** and write it below. Show your work. Add up the measurements you wrote in numbers 7 through 10. Distance = __________

    Now figure out your **calculated displacement** and write it below. Show your work. Add number 7 and number 8, then subtract number 9 and number 10.

    Calculated Displacement = ________

    Does your **calculated displacement** match your **measured displacement**? ______

13. Find your piece of tape again, and walk 20 steps forward. Measure how far you walked and write it here: ___________

14. Turn 90° right and walk 20 steps. Measure how far you walked and write it here: __

15. Have your partner measure how far you are from the origin, your **measured displacement**, and write it here: ______ (Turn this page over and continue.)

16. Now figure out your **distance** and write it below. Show your work.
Add number 14 and 15. Distance = ______________

Here's a way to figure out your **calculated displacement**. You can use Pythagoras' Theorem! Add the square of number 13 and the square of number 14. Write it here:____________ .

Now square the distance you measured in number 15 (your measured displacement).
Write it here: ____________The two numbers should be equal or nearly so.
If you have a calculator, find the square root of the value you found for the **sum of the square of #13 and square of #14**.
This value is your calculated displacement. Does it match your measured displacement (or nearly so)?

17. Now diagram the last walk and indicate displacement with a vector arrow. Show all your measured distances and displacements on the diagram.

18. Show with the same diagram how you used Pythagoras' theorem to find your calculated displacement. Label the square of each leg of your triangle on the diagram.

19. Can you explain why Pythagoras' Theorem can be used to find the calculated displacement in your last walk? Hint: you made a 90 degree turn on your walk.

20. Explain why displacement is a vector quantity.

TL#6

Activity:

Title: "Life is like a Box of Marbles"

Prepared By: Rowland Webb and Vic Boddie

DCPS Standards:

8.1.12, 8.7.7

Calculate the acceleration of an object rolling down two ramps on different slopes.

Determine how the slope of the ramp affects the acceleration of the object.

Goals:

1) The students will calculate acceleration using distance and time.
2) The students will learn by first-hand account how the steepness of an incline can affect acceleration of a marble rolling down that incline.
3) The students will refresh knowledge of taking averages.
4) The students will gain knowledge of jobs in this same field of science.

Objectives:

With data the Scholars get from this experiment they will create and record data on a table.

The scholars will answer questions based on information they receive from the lab experiment.

Prerequisite Knowledge/Background:

Acceleration can be calculated from velocity and time. If one knows the starting velocity of an object, the final velocity, and the time interval during which the object changed velocity one can calculate the acceleration of an object. Previously the students have learned that velocity is a speed in a specific direction. Also, the students should have a good background in calculating averages. This will be very important in calculating acceleration. The background knowledge that the scholars have learned, will help them understand concepts such as calculating acceleration when there is an average time and an initial and final velocity.

Essential Questions:

1) How does one calculate final velocity?
2) How does one calculate acceleration when they have final velocity and initial velocity when average time from release of marble from bottom of ramp?

Laboratory Materials:

1) 3 rulers
2) marble
3) 2 books (for slope)
4) stopwatch
5) masking tape
6) calculator

Differentiating Instruction:

N/A

Rationale:

The activity is designed to help the students gain knowledge of calculating acceleration using a final velocity and an initial velocity. This activity also allows students to refresh their knowledge of taking averages of numbers.

Research Activity:

Make data table like the one shown on worksheet given out

Make a ramp by laying two meter sticks side by side. Leave a small gap between the meter sticks.

Use masking tape as shown in the photograph to join the meter sticks. The marble should be able to roll freely along the groove.

Set up your ramp on a smooth, even surface, such as a tabletop. Raise one end of the ramp on top of one of the books. The other end of the ramp should remain on the table.

Make a finish line by putting a piece of tape on the tabletop 30cm from the bottom of the ramp. Place a ruler just beyond the finish line to keep your marble from rolling beyond your work area.

Test your ramp by releasing the marble from the top of the ramp. Make sure that the marble rolls freely. Do not push the marble down the incline.

Release the marble and measure the time it takes for it to roll from the release point to the end of the ramp. Record this time under Column A for trial 1.

Release the marble again from the same point, and record the time it takes the marble to roll from the end of the ramp to the finish line. Record this time in Column B for trial 1. Repeat and record three more trials.

Raise the height of the ramp by propping it up with both paperback books. Repeat steps 7 and 8.

<u>Evaluation and Assessment</u>:

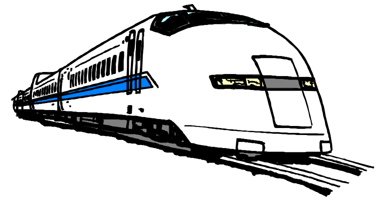
Ask students to calculate average time it took for the marble to travel from the end of the ramp to the finish line for both ramps 1 and 2.

Ask the students to calculate the final velocity for both ramps 1 and 2 using the formula,

V (final) = distance from end of ramp to finish line/ Avg distance from end of ramp to finish line.

Ask students to calculate acceleration for ramps 1 and 2 using formula,

A = V(final) – V(initial)/Avg. time from release to bottom of ramp.



Hot Wheels Lab

Purpose – To calculate the average speed and average acceleration of an object that has been rolled down an inclined track.

Problem Statement – How does the height of an object affect its speed and acceleration?

Hypothesis – State what you think will happen to the speed and acceleration of an object as you increase the height of the incline ramp.

Procedure – Read the following procedure steps and sketch a diagram of your lab set up in your science journal (include labels).

Set up an inclined plane using two meter sticks, prop one end of the track with science books (approx. 5 cm thick)

Create a data table in your lab write-up to collect all of the required information. Your data table should include **4 different incline heights** with the following categories:

Three time trials (for each ramp height)
Average time
Distance traveled
Average speed
Average acceleration

Record the height of the incline.

Set the object at the top of the track and let it roll down the track and along the side of the meter stick.

Record the time it takes the object to travel from the top of the track to the 1-meter mark on the meter stick.

Repeat this process, obtaining a total of four time trails.

Calculate the average time for the four runs.

Calculate the object's average speed.

Calculate the objects average acceleration (starting with initial velocity = 0 m/s)
Repeat the above steps for four different incline heights. To change the height of the incline, simply add another book.

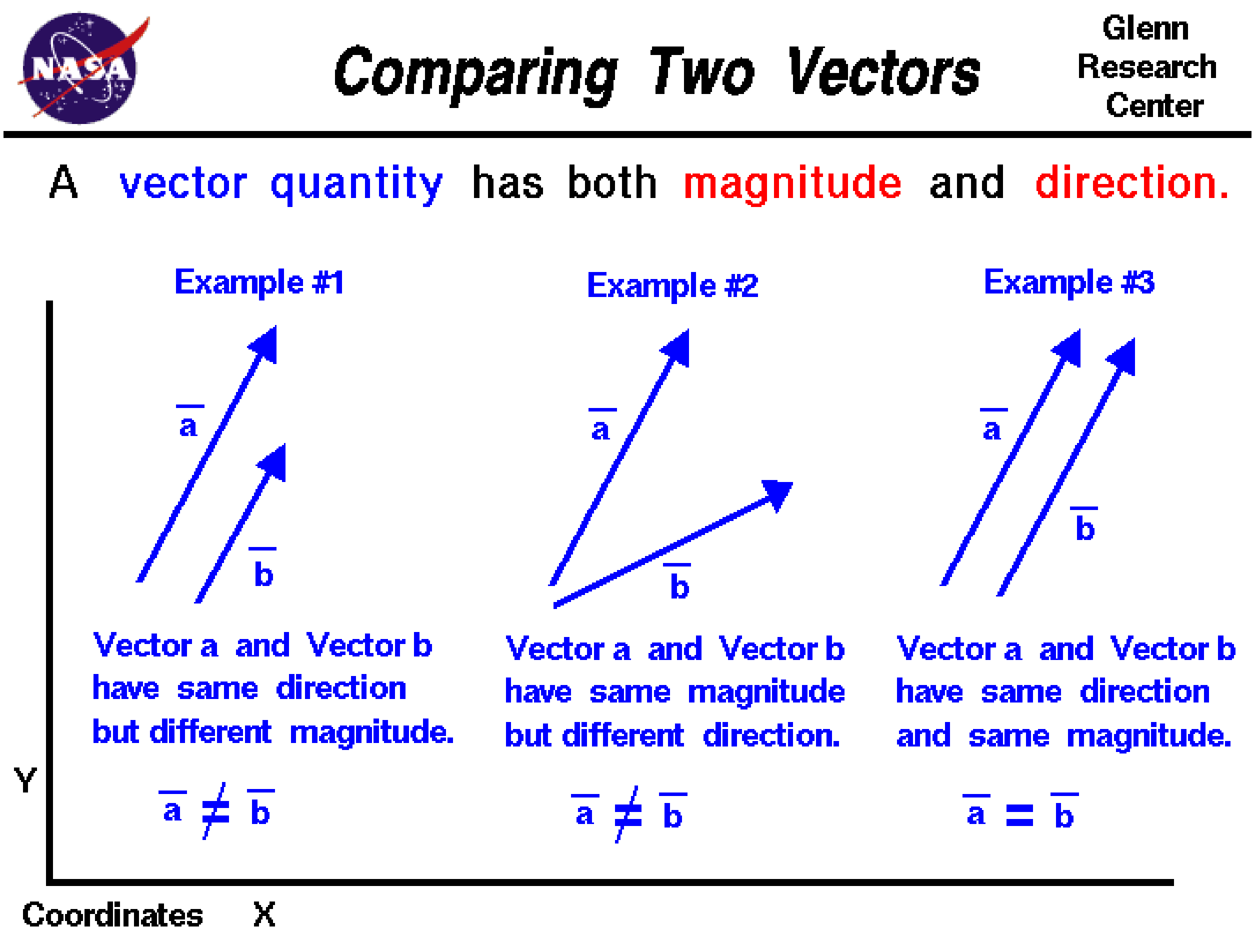
Record all observations and calculations in your data table.

Graphs – Create the following LINE graphs on graph paper to include in your lab write-up. *(be careful which units you put on the x or the y axis! Independent variable is on the X axis, Dependent variable is on the Y axis)*

- Speed vs. Incline Height.
- Acceleration vs. Incline Height.

Conclusion – RECALL format (3 paragraphs).

- Be sure to incorporate the following questions into your conclusion:
- How does the objects average speed change as the incline height changes?
- How does the object's average acceleration change as the incline height changes?
- How can you tell the difference between the graphs for constant speed and acceleration? How do they look different?



Math and science were invented by humans to describe and understand the world around us. We observe that there are some quantities and processes in our world that depend on the **direction** in which they occur, and there are some quantities that do not depend on direction. Mathematicians and scientists call a quantity which depends on direction a **vector quantity**. A quantity which does not depend on direction is called a **scalar quantity**.
A vector quantity has two characteristics, a **magnitude** and a **direction**. When comparing two vector quantities of the same type, you have to compare both the magnitude and the direction.

On this slide we show three examples in which two vectors are being compared. Vectors are usually denoted on figures by an arrow. The length of the arrow indicates the magnitude and the tip of the arrow indicates the direction. The vector is labeled with an alphabetical letter with a line over the top to distinguish it from a scalar. Our web print fonts don't allow for this notation, so we will use a bold letter for a vector. We will be comparing two vectors, **a** and **b**. They could be forces, or velocities, or accelerations; it doesn't really matter.

Example #1: We have two vectors with the same direction, but the magnitudes (or length of the vectors) are different. Vector**a** does not equal vector **b** in this example. This example seems pretty simple, because the same rule applies for scalars; if the magnitude is different, the quantities are not equal. An object weighing 50 pounds is not equal to an object weighing 25 pounds.

Example #2: This example is a little more complex. In this case, we have two vectors with equal magnitude, but the directions are different. Vector **a** does not equal vector **b** in this example. If the vector was a velocity, this tells us that a car traveling 45 mph to the northeast will end up in a different place than another car also traveling 45 mph due east. In one hour, they will both move 45 miles, but the locations will be different. In two hours, they will be even farther apart.

Example #3: In this example, we have two vectors with equal length and equal direction. Vector is equal to vector **b**. For two vectors to be equal, they must have both the magnitude and the directions equal.

MATCH EACH D-T graph TO THE Proper V-T and A-T graph.