NTTI Media-Rich Lesson

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NAME

"Let's Go to the Races"
LESSON TITLE

9th - 12th Grades
GRADE LEVELS

Two class periods
TIME ALLOTMENT

OVERVIEW

Motion is studied in reference to a stationary object referred to as the frame of reference. A person sitting in the stands at the racetrack see cars moving relatively fast because the background is stationary. One can readily classify the relative speed of the car based on the movement of other cars in the area. Fast cars are moving rapidly compared to slow cars. A car that is not moving is said to have zero speed.

The speed of a car is how fast or how slow the car is moving in a given distance and is a scalar quantity (s = d/t). Velocity on the other hand, is a vector quantity, which refers to the rate of change of a body (v = d/t). Velocity is therefore the rate at which an object change its position or displacement, which is denoted by specifying the direction of the change. A car moving 90 miles/hour is the speed of the car, whereby 90 miles/hour, east is a vector quantity and is velocity. Getting the slope of a graph of velocity vs. time would yield acceleration. Acceleration is a change in velocity over a given period of time [$a = (v_2 - v_1)/t$]. If the value appears to be negative, then it is called deceleration. Deceleration is the slowing down or negative acceleration [$a = (v_2 - v_1)/t$ where v_2 is less than v_1].

The purpose of the lesson is to learn the relationship between distance, time, velocity and acceleration in a real life situation of cars/carts in a race. Students will be given a zip-lock bag with materials needed to make a cart for homework. Instruct them to use

their imagination to make an attractive cart with the materials given or elect to purchase a “hot wheels” car for lesser credit.

Students will review properties of motion (speed, velocity, distance, displacement and acceleration) that are flashed on a PowerPoint presentation to provide for transference of information on motion and its concepts and evaluate these properties in a hands-on activity using homemade cart powered by balloons in a race competition with peers.

Students will be given a zip lock bag with all materials needed to use with their carts to explore activities to analyze the concept of speed. Students will give input in the formation of a rubric to evaluate their work. A video will be used to ensure that students understand the concept of motion before participating in the hands-on activity.

SUBJECT MATTER

Physical Science, Physics, Language Arts and Algebra

LEARNING OBJECTIVES

Students will be able to:

Measure and analyze speed, velocity and acceleration of home made carts in motion by:

- *Explaining the concept of motion in terms of distance, time and acceleration*
- *Show mathematical equations expressing the same*
- *Use the computer to calculate, graph and make a PowerPoint of the same*
- *Make an oral presentation using PowerPoint to class*

NATIONAL STANDARDS

Physical Science

National Science Education Standards from the National Academy of Science for Grades

http://search.nap.edu/readingroom/books/nses/html/6e.html#csb912

Prerequisite for Motions and Forces

Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces of motion on objects…

GEORGIA STANDARDS

Georgia Learning Connections:

Science Skills in Matrices

http://www.glc.k12.ga.us/pandp/science/mx-phy02.htm

Physical Science
http://www.glc.k12.ga.us/passwd/search/srchqcc/Standard.asp?SubjectID=1&Grade=9-12&CSID=13&keywords=Motion&CSType=C&View=SL
14. **Topic:** Interaction of Force and Motion
Standard: Measures and compares relationships among speed, velocity and acceleration.
Physics
http://www.glc.k12.ga.us/passwd/search/srchqcc/Standard.asp?SubjectID=1&Grade=9-12&CSID=9&keywords=Motion&CSType=C&View=SL
Topic: Basic Mechanics
Standard: Collects time and distance data on objects in motion such as toy cars, air track, ball rolling down an incline, etc.

2.1 Distinguishes between vector and scalar quantities.
2.2 Investigates experimentally and solves problems that relate to time, distance, displacement, speed, velocity, and acceleration.
2.5 Explores applications of a microprocessor for the analysis of laboratory data and simulation of mechanical phenomena.
2.6 Constructs and analyzes graphs of various types of motion.

MEDIA COMPONENTS

Video

Motion, Energy and Force Produced by Brian A Jerome, Ph.D.: Episode # 101
This video explains the concept of motion, algebraic expressions to calculation speed and acceleration, graphical analysis of motion and give a quiz to access students' comprehension.

Reinforcement/Enrichment Interactive Activities Web References

http://www.glenbrook.k12.il.us/gbssci/phys/Class/1DKin/1DKinTOC.html
The Physics Classroom - A series of lessons describing motion.

An introduction to the language of kinematics with interactive links to the sections that explain the terms of motion, speed, velocity, acceleration, displacement, etc.

Scalars and Vectors (Vector Diagrams are illustrated in this section)

This site describes the difference between Distance and Displacement. There are illustrations and a quiz to check understanding.

Speed and Velocity are discussed in this section with illustrations, equations, charts and graphs.

Acceleration is explained with equations, charts, and two GIF animations. Positive and negative acceleration are explained.

PREP FOR TEACHERS

Set the PowerPoint for the Introductory Activity on vocabulary to be started with a mouse click. The terms on the PowerPoint include: motion, frame of reference, speed, velocity, time, displacement, acceleration and deceleration. You will need additional speakers connected to the computer to get the volume loud enough for the entire class to hear.

Cue the "Motion" videotape to the beginning of the tape for the Learning Activity. Prepare the hands-on elements of the lesson by copying the following sheets, one per student:

a. **HANDOUT 1 -** Motion sheet
b. **HANDOUT 2 -** Video
c. **HANDOUT 3 -** Activity Procedure
d. **HANDOUT 4 -** Data Table and Extension Questions
e. **HANDOUT 5 -** Culminating Activity - Quiz

INTRODUCTORY ACTIVITY: SETTING THE STAGE (Engage)

Step 1
Show the opening PowerPoint on motion.

Step 2
PASS out **HANDOUT 1.** Ask students to write a brief definition of the terms presented in the PowerPoint on the handout sheet by recalling what they remember about each in 30 seconds or less. Continue to play the PowerPoint at the opening activity. **ADVANCE** by clicking the mouse for each term after 30 seconds.

Step 3
Do not engage or encourage statements! Ask students to reflect on previous experiences. The purpose is to get to recall what they know or remember about concepts of motion. The terms will be explained in the video. There will be a quiz at the end of lesson to make sure that they all understand the concept of motion presented.

LEARNING ACTIVITIES

Step 1

PASS out **HANDOUT 2** to aid in comprehension**.** Ask students to write notes on this sheet to be placed in their notebooks.

Step 2
Video: Motion, Energy and Force

INSTRUCT students that the video will explain the characteristics of motion, forms of motion and mathematical equations to calculate properties of motion. Time will be allowed for Focus of Interaction to answer questions on motion, use equations to calculate properties of motion, and review concepts presented on the video.
START the video on the frame "VLC: The Visual Learning Co." Have the students observe the different characteristics of motion, various forms of motions and use mathematical equations to make calculations about motion.

Position and Motion
Provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING** the question "Is the sun moving or is the earth moving?" Pause the tape immediately after the narrator ask the question on the tape.
Ask students for comments. Press **PLAY** for the correct answer and to continue.
Frame of reference is discussed with examples. Provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING** for some other examples of "Frame of reference," when you see the plane on the video and hear …as in this plane taking off. Press **PLAY** to continue.

What is Motion? When you see the definition "Motion: change in position relative to fixed objects over time," provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING** what units can distance be measured in? Time? What system of measurement do we use in science? Do not correct students. Say **'**Let's see.' Press **PLAY** for the correct answer and to continue. After the mountain scene and the comment ...about the rate your fingernail grows in a year, provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING** "what other term can we use other than motion to describe distance per unit time?" Say, 'Let's see. ' Press **PLAY** for the correct answer and to continue.

What is Speed?
PLAY the video until the definition appears on the screen, "Speed: amount of distance covered in a specific amount of time." Provide students with a **FOCUS FOR INTERACTION BY PAUSING** and asking students to write down the definition. Press **PLAY** to continue. **PAUSE** the video on the frame with the problem, "50 miles in 2 hours," to provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING**, "at what speed would you have to travel to cover 50 miles in 2 hours?" after the frame with the problem. Press **PLAY** for the correct answer and to continue.

Provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING**, "how many of you got the correct answer when the answer of 25 mi./hour is given? Ask are there any questions about how they arrived at 25 miles per hour. Ask a student to explain the procedure. **REWIND TO THE BEGINNING OF THE PROBLEM AND PRESS PLAY** to continue.

Calculating Speed
PAUSE on the frame "Speed = Distance divided/Time" **PLAY** until the next problem frame which has the problem 100m. /11 sec. Provide students with **FOCUS FOR MEDIA INTERACTION BY ASKING** students to calculate the speed of the sprinter. Press **PLAY** for the correct answer of 9.1 m./sec. and to continue. An explanation will be given and other examples of speed. PAUSE on the frame with the wind gauge and provide students with a **FOCUS FOR MEDIA INTERACTION BY PAUSING** after the example and asking students for other examples of speed. Press **PLAY** to continue.

What is Velocity?
PAUSE on the frame "Velocity: speed of an object in a given direction." **PAUSE** on the frame with the problem "15 km. /hr. + 8 km. /hr. = 23 km. /hr," providing students with a **FOCUS FOR MEDIA INTERACTION BY** reminding them that pilots

refer to the speed of a plane or jet as a combined speed when he says what? Answer “tail wind.” Press **PLAY** to continue.

Acceleration
PAUSE for students to write the definition. Press **PLAY** for examples of acceleration. **PAUSE** on the frame with the definition “Acceleration: rate of change in velocity,” providing a **FOCUS FOR MEDIA INTERACTION BY ASKING** students to explain the definition after writing it. Call on a student who hasn’t spoken to tell what the term means. Press **PLAY** for the correct answer (it describes how fast speed increases). The Mathematical Formula “Acceleration = Final velocity – begin. Velocity / time.” will be given next. Provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING** students to solve the with the next problem “2 m./sec. – l.5 m./sec./2.3 sec,” when it appears on the video. **PAUSE** to allow students to work the problem. Ask what should the answer be? **REWIND** to definition and **PLAY** to review the problem and for the answer (.65 m./sec.^{2}) and to continue. **PAUSE** on the frame with the graph and **FOCUS FOR MEDIA INTERACTION BY** asking students to examine the graph and tell us how we can get the unit ‘second squared.’ The answer should be “m./sec./sec. = m./sec x 1/sec.” Ask students to make a sketch of the graph of speed (m/s) vs. time (sec.) on their paper. Reference the point where the slope is smallest (speed is slowest), and the point on the graph where the slope is greatest (speed is greatest).

Press **PLAY** for the next frame, “What is Deceleration?”
Pause the video on the frame where the ball is beginning to roll down the slope. Provide students with a **FOCUS FOR MEDIA INTERACTION ASKING,** “What is happening to the motion at this point? Ask, “What do these things have in common?” Press **PLAY** for the answer, “deceleration” and to continue. **PAUSE** after the definition to give students time to write. Press **PLAY** to continue.
PAUSE the video on the frame with the graph for deceleration. Provide students with a **FOCUS FOR MEDIA INTERACTION BY ASKING** them to sketch this graph in their notebook. Again, ask a student who has not responded orally, “What are the similarities and differences between these the graphs. **STOP THE TAPE.**
ADVANCE the tape to “Summing Up.”

Ask students to give the mathematical symbols and/or equations for summary concepts.

We have learned that:
1. Motion is defined as a change in position of an object over time.

2. *That to calculate the speed of an object by dividing the distance covered by the time it took to cover the distance.*
3. *Velocity is the speed of an object in a specific direction.*
4. *We also discussed the rate of change in velocity or acceleration and how to calculate the acceleration.*

ADVANCE the film to the frame "Video Quiz Follows" and stop. Ask, "Are there any questions or points that need clarity?"

Step 3

Enrichment or Remediation: Tell students about the sites on the Internet that can be used to reinforce the concepts of motion using the Physics Classroom homepage site given.

http://www.glenbrook.k12.il.us/gbssci/phys/Class/1DKin/1DKinTOC.html
The Physics Classroom Click on topics in the left margin for links to the following topics

- Lesson 1 describes motion with words.
- Introduction to the Language of Kinematics with interactive links to the sections that explain the terms of motion, speed, velocity, acceleration, displacement, etc.
- Scalars and Vectors (Vector Diagrams are illustrated in this section)
- This site describes the difference between Distance and Displacement. There are illustrations and a quiz to check understanding.
- Speed and Velocity are discussed in this section with illustrations, equations, charts and graphs.
- Acceleration is explained with equations, charts, and two GIF animations. Positive and negative acceleration are explained
- Motion is described of hot wheels on a track with curves and inclines in terms of velocity and acceleration.

Step 4

Students will now engage in a hands-on activity in groups of four with their homemade carts/hot wheels in "Lets Go to the Races." Give students Handouts 3 (procedures) and 4 (data tables

Extension Practice:

Give students time to experiment with their cart by using a variety of strategies to increase the speed of their carts.

Extension Questions:

- "What happened to the cart when you put the straw on backward?"
- "What happened when you put the straw too far down, extending beyond the cart?"
- "What happened when a weight is added to the carts?"
- "How does the movement of the heavy cart compare to that of the light carts?"
- "What happened when you used too much tape around the mouth of the balloon?"

Evaluation:

Day one: HANDOUT 5 - Video quiz

Day two: Students will go the lab and put all data in a database. Using the appropriate formulas to add, subtract and divide, the students will determine velocity and acceleration. They will then select data in question and click on the graphing icon and follow the directions to graph and analyze their results. Using the data from the graph students will identify and explain the properties of motion as it relates to speed, displacement, velocity, acceleration, and deceleration. The lab write up will be done as a PowerPoint presentation to the class of at least 5 slides.

CROSS-CURRICULAR EXTENSIONS

List cross-curricular activities and interdisciplinary projects that may be generated from the lesson.

1. Physical education – velocity in track, baseball, football, soccer, etc. Using the appropriate playing field, students will mark off a sequence of distances, which will be points where timing will take place. With a known distance, time and direction students can adequately calculate the velocity and acceleration of a player.

2. Mathematics – derivation of equations, graphing properties, etc. Word equations can be converted to algebraic expressions to calculate velocity and acceleration. Graphing distance and time would be an excellent activity to introduce slope of

the line, which in this case is velocity. The flat (horizontal) part of the curve would mean that there is no motion (the body is standing still). Area under the curve can also be determined using a graph of velocity vs. time, and the slope would produce the acceleration. A negative slope would mean deceleration, while a positive slope would mean acceleration. A steep slope would mean, "speeding rapidly," while a slope with a low number would mean, "moving slowly." No slope at all would mean that the body is moving at a constant velocity.

3. Language arts – writing across the curriculum, presentations (written and oral). Students could write narratives, poems, prose, etc to explain the motion seen with the naked eye.

COMMUNITY CONNECTIONS

- Students can interview parents and neighbors about various types of races and how speed is involved. They can also collect pictures of the different types of races and make a portfolio of properties of motion.
- Contact can be made to race establishments, airports, train yards, shipyards etc. to invite the class out to an event.
- NASA has free materials through their Education Department that can be used to enhance and facilitate activities on motion.

STUDENT MATERIALS

Cart (Select 1 per group)

Small balloons (1 per cart)

Flexible straws (1 per cart)

Masking tape (10 cm)

Meter sticks (1 per group)

Butcher paper (0.5 x 10 meters)

Markers (1 per group)

Stopwatch (1 per group)

Balance Scale (1 per group)

Binder clamps (1 per group)

NTTI Media-Rich Lesson Planning Guide

Title __Lets Go to the Races._____

Grade Level(s) _9th-12th_____

Subject Matter _Velocity_____.

Learning Objectives__ Students will measure and compare relationships among speed, velocity and acceleration.

Media Components – Video

1. Motion, Energy and Force – Episode # 101

Time Allotment

Two class periods of_60 minutes each.___

Overview _Motion is defined as the change in position of an object over a period of time. Objects on the earth are used as the frame of reference for determining motion.

Standards_2.2 Investigates experiment-tally and solves problems that relate to time, distance, displacement, speed, velocity, and acceleration._____

2.6 Constructs and analyzes graphs of various types of motion._____

Media Component - Web

The Physics Classroom: http://www.nmt.edu/~mst/554/toycar2.htm Lessons on Scalars and Vectors, Distance and Displacement, Speed and velocity, Acceleration, and Motion using hot wheels.

Prep for Teachers _ Speed is the distance traveled in a given span of time. It can be calculated by dividing distance by time and is a measure of how fast something is moving relative to a reference frame. Distance is the displacement of an object. Distance is also how far an object traveled from its starting point. A distance-time graph can be used to analyze the motion by determining the slope of the line at any given interval. A steep slope indicates fast movement and a low incline indicates slow movement. A zero slope indicates no movement at all. A graph of speed vs. time would give indications of acceleration or deceleration. Again, a steep slope is fast acceleration, while a low incline would indicate slow acceleration and a slope of zero means constant (uniform) velocity.

HANDOUT 1

MOTION_____

_____

SPEED_____

_____

FRAME OF REFERENCE_____

_____

VELOCITY_____

_____

TIME_____

_____

DISPLACEMENT_____

_____

DECELERATION_____

_____

ACCELERATION_____

_____

HANDOUT 2
Video: Motion

Position and Motion _____
Is the sun moving or the earth moving?_____
Another example of frame of reference is _____
What is motion? _____
What units can distance be measured in? _____ Time? _____
What system of measurement do we use in science?_____
What other term can we use to describe distance per unit time? _____
What is speed? _____
At what speed would you have to travel to cover 50 miles in 2 hours? _____

Calculating Speed – formula _____
Problem Given information = distance _____ time _____

Calculate the speed.

Velocity _____
Combined speed _____

Acceleration _____

Formula for acceleration is _____

Problem
Given information = Initial velocity _____ Final velocity _____ time _____

Acceleration =

Graphs one - Complete and label

Graph two – Complete and label

HANDOUT 3

Activity Procedure:

Step 1 Students will work in groups of four and collect required materials (1 cart, 1 small balloon, 15cm. of tape, metric ruler, 1 straw, and a stopwatch).

Step 2 A chart will be given to each student pair.

Step 3 Students will weigh their carts to determine its mass, using balance scale.

Step 4 Set up meter sticks as tracks to measure distance carts travel.

Step 5 Inflate the balloon by blowing throw the straw and clamping it off with a binder clamp.

Step 6 Roll out the paper for a track for the carts and mark off 0.5 meter-distances for up to 2 meters. Have a student stand at intervals of 0.5 meters with a stopwatch to time the cars as they pass a designated point. Start the carts at the zero mark.

Step 7 The person with the carts yells start to the timers so that they all start at the same time and stop when the cart reaches the mark on the paper in front of them.

Step 8 Time the carts from the beginning to the last time.

Step 9 Record data on table provided.

Step 10 Repeat procedures 6, 7, and 9 at least 10 times.

Step 11 Chart – Obtain the interval distance and the total distance by adding all trials distance.

Step 12 Chart – Obtain the interval time and the total time by adding all trials time.

Step 13 Chart – Divide the average distance by the average time to get the average speed.

HANDOUT 4

Data Table for "Off to the Races" with homemade carts

Name:	**GROUP MEMBERS:**
Date:	
Weight of cart:	

TRIAL #	DISTANCE (CM)	TIME (SEC)	SPEED (CM/SEC)	COMMENTS
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
AVERAGE				

Extension Questions:

What happened when you put the straw on backward? _____

What happened when you put the straw too far down? _____

What happened to the heavy carts? _____

What happened to the light carts? _____

What happened when you used too much tape? _____

HANDOUT 5

QUIZ

Name_____ Date _____ Period_____

1. A frame of _____ involves an effect 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 km per _____
6. Velocity is the speed of an object in a given _____.
7. _____ is the rate of change in velocity.
8. Graph (A) or (B) illustrate the process of deceleration of an object.