Subject:Physics **Grade Level: 11,12** **Unit Title: Unit 3: Motion in Two Dimensions** **New 2009 objectives are in red**	**Timeframe Needed for Completion: 2 Weeks** **Grading Period: 1st 9wks**

Big Idea/Theme: Motion in two dimensions: projectile, centripetal
Understandings: Students will understand how to solve mathematical problems for half and full trajectories.
Students will understand centripetal force and how it related to circular motion.

Projectile Motion

- Identify a frame of reference for measurement of position for projectile motion.
- Analyze and evaluate the position, velocity and acceleration in horizontal and vertical frames of reference for projectile motion.
- Apply the concepts of position, velocity and acceleration developed in Unit One to solve conceptual and quantitative problems for projectile motion in both horizontal and vertical reference frames.
- Describe the path of a projectile as parabolic.
- Describe the effects of changing launch speed and launch angle on the path of a trajectory.
- Clarify (for horizontal component of projectile motion) that velocity is constant. $v_x = (v_{launch})(\cos \theta_{launch})$ $a_x = 0\ m/s^2$ $x_f = x_i + v\Delta t$ (note that θ is measured from the x axis)
- Clarify (for vertical component of projectile motion) that velocity changes and acceleration is that of gravity. $a_y = g = -9.8\ m/s^2$ $v_i = (v_{launch})(\sin \theta_{launch})$ $v_f = v_i + gt$ $y_f = y_i + v_i\Delta t + \frac{1}{2} g\ \Delta t^2$ $v_f^2 = v_i^2 + 2g\Delta y$ (note that θ is measured from the x axis)

Uniform Circular Motion

- Define *uniform circular motion*, incorporating magnitude and direction.
- Apply the concept of vectors to observe acceleration for an object traveling at constant speed in a circular path.
- Distinguish between speed and velocity for an object in uniform circular motion.

Application of Graphical and Mathematical Tools

Projectile Motion—Horizontal Motion:

- Measure horizontal position versus time of an object moving in a trajectory.
- Sketch a position versus time graph of the projectile path for both horizontal motion of a projectile.
- Recognize that the relationship is linear for horizontal motion.
- Identify the slope of the line as the change in position over time (velocity) and the y-intercept as the initial position for the given time interval. Note that the slope of position, time for horizontal motion is constant and thus velocity is constant.
- Recognize that a constant velocity means that acceleration for horizontal motion is zero!

Projectile Motion—Vertical Motion:

- Measure vertical position versus time of an object moving in a trajectory.
- Sketch a position versus time graph of the projectile path for vertical motion of a projectile.
- Recognize that the relationship for position versus time is parabolic for vertical motion.

- Identify the slope of the line as the change in position over time (velocity) and the y-intercept as the initial position for the given time interval. Note that the slope of position, time for horizontal motion is not constant and thus velocity is not constant.
- Recognize that a parabolic position versus time graph means that acceleration is constant for vertical motion!

$$x_f = x_i + v_i t + \frac{1}{2} a t^2 \qquad a = \frac{\Delta v}{\Delta t}$$

$$v_f^2 = v_i^2 + 2a\Delta x \quad \text{where a = g}$$

Essential Questions:

1. Compare and contrast the processes of vector resolution and vector addition.
2. How do the vertical and horizontal components of a projectile's velocity change?
3. How can the trajectory of a projectile be predicted?
4. How do linear and projectile motion relate to each other? How are they different?
5. How can an object moving at constant speed experience an acceleration?
6. How do you evaluate the centripetal acceleration of an object?
7. How is a force applied to create circular motion?
8. How do mass, velocity, and radius relate to centripetal force?
9. Why is centrifugal force a fictitious quantity in physics?
10. How would you design a lab to measure the relationships between mass, velocity, radius, and centripetal force?
11. How does our military use projectile motion?
12. How could you use dot diagrams to show the motion of a diver

Curriculum Goals/Objectives (to be assessed at the end of the unit/quarter)

1.1.3 Analyze motion in two dimensions using angle of trajectory, time, distance, displacement, velocity, and acceleration.

• Analyze projectile motion to:

- determine that horizontal and vertical components are independent of each other;
  - determine that the horizontal component of velocity does not change (neglecting air resistance) and the vertical component of velocity changes due to gravity;
  - determine that for a projectile launched from the ground at an angle, the vertical component of velocity at the maximum height has a value of zero while the horizontal component remains constant;
  - resolve vectors into vertical and horizontal components using trigonometric relationships.
  - apply conceptual and mathematical relationships for uniform velocity for the horizontal component of velocity and range (horizontal displacement);
  - apply conceptual and mathematical relationships for uniform acceleration with the vertical component of velocity and height (vertical displacement).

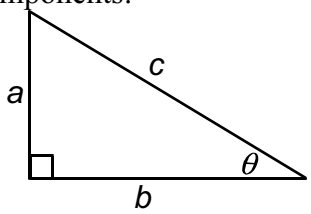
• Analyze circular motion to:

- determine that an object may move with constant speed but changing velocity;
- determine that the directions of velocity and acceleration vectors are perpendicular to each other;
- determine the relationship between acceleration and velocity (squared), and between acceleration and radius of curvature (inverse),

• Solve problems involving motion of planes and boats due to winds or river currents using vector addition.

1.2.5 Analyze basic forces related to rotation in a circular path (centripetal force).

• Recognize the cause and effect relationship between centripetal force and the change in

competing in the Olympics? 13. What physics is involved when a football player kicks a football down field? 14. How is your body affected when riding a roller coaster?	velocity due to change in direction (centripetal acceleration) of an object as an example of Newton's second law, ; • Recognize that a centripetal force is ***not*** the result of circular motion but is provided by interaction with another object
Essential Skills/Vocabulary: • Resolve vectors into vertical and horizontal components:  $a^2 + b^2 = c^2$ $\sin\theta = \frac{a}{c}$ $\cos\theta = \frac{b}{c}$ $\tan\theta = \frac{a}{b}$ • Evaluate the motion of a projectile both horizontally and vertically. ○ Recognize that the horizontal component of velocity does not change (neglecting air resistance). Recognize that the vertical component of velocity does change due to gravity at the rate of $9.8 m/s^2$ downward • Recognize that vector components are independent of each other. • Relate height, time in air and initial vertical velocity (such as a projectile launched horizontally or from the ground at a given angle).	**Assessment Tasks:** **http://www.ncpublicschools.org/docs/curriculum/science/units/high/physics/unit2.doc** **Major Test, Quizzes, homework** **Lab on projectile motion: (competition activity to land ball in cup)** **Lab on Centripetal Force** **Computer Activity on Forces**

• Relate range of projectile, time and initial horizontal velocity (such as a projectile launched horizontally or from the ground at a given angle). • Understand that for uniform circular motion the net force is called the centripetal force. • Understand that the centripetal force is not the result of circular motion but must be provided by an interaction with an external source. • Apply the formula for centripetal force as mass times centripetal acceleration using the following equations: $a_c = \frac{v^2}{r}$ • $F_c = \frac{mv^2}{r}$	

Materials Suggestions: http://www.ncpublicschools.org/docs/curriculum/science/units/high/physics/unit2.doc
CHECK THIS FOR ADDITIONAL RESOURCES)

Vernier Equipment
Large marbles, weights
Meter sticks
String
Compasses
Rulers
Blank paper
Protractors
Measuring tape
Golf balls/marbles
Rulers with troughs (to be used as ramps
Stopwatches
Small boxes or soup cans
Toy dart guns
Small blocks of wood
Masking tape
Duct tape

Photogates and LabPros (optional)
Soccer balls
Rubber stoppers
Small hollow tubes (6-10 cm)
Dental floss (or other strong string)
washers

21st Century Skills	Activity
Communication Skills	
Conveying thought or opinions effectively	• Questions in all Laboratory Activities
When presenting information, distinguishing between relevant and irrelevant information	• Data collection in all Lab Activities
Explaining a concept to others	• Projectiles at an Angle
Interviewing others or being interviewed	
Computer Knowledge	
Using word-processing and database programs	• Circular Motion
Developing visual aides for presentations	• Circular Motion
Using a computer for communication	• Investigation of Projectile Motion
Learning new software programs	• Investigation of Projectile Motion
Employability Skills	
Assuming responsibility for own learning	• Circular Motion
Persisting until job is completed	• Exploring Projectiles
Working independently	• Vector Treasure Hunt
Developing career interest/goals	

Responding to criticism or questions	• Questions in all Lab Activities
Information-retrieval Skills	
Searching for information via the computer	• Investigation of Projectile Motion
Searching for print information	
Searching for information using community members	
Language Skills - Reading	
Following written directions	Most of the activities can be presented as opportunities for students to follow written directions. The teacher will have to work with most students to develop this skill over time.
Identifying cause and effect relationships	• “Explain” and “Evaluate” in all lab activities
Summarizing main points after reading	• Exploring Projectiles
Locating and choosing appropriate reference materials	• Investigation of Projectile Motion
Reading for personal learning	
Language Skill - Writing	
Using language accurately	
Organizing and relating ideas when writing	• “Explain” and “Evaluate” in all lab activities
Proofing and Editing	• “Evaluate” in all lab activities
Synthesizing information from several sources	• “Explain” and “Evaluate” in all lab activities
Documenting sources	
Developing an outline	
Writing to persuade or justify a position	• “Evaluate” in all lab activities
Creating memos, letters, other forms of correspondence	
Teamwork	

Taking initiative	• All Lab Activities
Working on a team	• All Lab Activities
Thinking/Problem-Solving Skills	
Identifying key problems or questions	• All Lab Activities
Evaluating results	• All Lab Activities