Subject:Physics **Grade Level: 11,12** **Unit Title: Unit 4: Forces** **New 2009 goals are in red**	**Timeframe Needed for Completion:** **Grading Period: 1st 9wks 1 ½ weeks**
Big Idea/Theme: Forces and Newton's Laws **Understandings: Students will understand forces: gravitational, electromagnetic and nuclear forces** **Students will understand Newton's three laws of motion** **Students will understand how to solve force problems by using: net force, applied force, frictional force, and normal Force.**	
Essential Questions: **Why are vehicles equipped with seat belts?** **How does a rocket achieve liftoff?** **What forces are acting on you right now?** **What are forces?** **What is the relationship between forces and vectors?** **What are Newton's Three laws of Motion?** **How does force effect objects?**	**Curriculum Goals/Objectives** (to be assessed at the end of the unit/quarter) **1.2.3 Explain forces using Newton's laws of motion as well as the universal law of gravitation** Conclude that an object will continue in a state of motion (rest or constant velocity) unless acted upon by a net outside force (Newton's first law of motion – the law of inertia). Explain the law of inertia as a cause and effect relationship between an observed change in motion and the presence of an unbalanced or net force. • Conceptually and mathematically describe the acceleration of an object in terms of its mass and the net force applied (Newton's second law- the law of acceleration), • Apply proportional reasoning to determine the effect of changing one quantity while another is held constant – if the force on a mass is doubled, the resulting acceleration would be doubled (direct proportion); if an equal force is applied to an object with double the mass, its acceleration would be half that of the first object (inverse proportion). • Conclude that while Newton's second law describes a single object, forces always come in equal and opposite pairs due to interaction between objects. Give examples of interaction between objects describing Newton's third law – whenever one object exerts a force on another, an equal and opposite force is exerted by the second on the first. The third law can be written mathematically • Explain gravity as a force of attraction between objects due to their mass that decreases with the distance between them; develop the mathematical relationship given by the universal law of gravitation, . **1.2.4 Explain the effects of forces (including weight, normal, tension and friction) on objects.** Construct a cause and effect relationship for interactions between objects that include: • weight as the force of gravity directed toward the Earth, • normal force as a support force when an object is in contact with another stable object (always acts perpendicular to the surface),

	• tension as a force transmitted through and directed along the length of a string, rope, cable or wire due to forces acting at opposite ends, • friction as a force opposing motion of an object due to contact between surfaces (static or kinetic), • air resistance as a frictional force acting on objects traveling through the air.
Essential Skills/Vocabulary: • Observe motion and draw force diagrams for objects moving at constant velocity with very little friction (examples: air track, air puck, balloon puck, dry ice) • Identify that the state of motion must be a constant velocity, including zero velocity, unless acted upon by a net force. Define inertia. • Describe forces as interactions between two objects, including contact and forces at a distance. • Recognize that force is a vector quantity. • Define normal force. • Represent the forces acting on an object using a force diagram. • Analyze force diagrams to calculate the net force on an object. • Determine that the net force acting on an object in static equilibrium is zero. • Design and conduct investigations of force and acceleration. • Experimentally verify the proportional relationships among acceleration, force and mass. • Apply proportional reasoning to the relationship betweenforce and acceleration when mass is constant. • Apply proportional reasoning to the inverse relationship between mass and acceleration when force is constant. • Analyze force diagrams for accelerating objects. (solve for mass, acceleration, various forces) • Calculate the net force on an object: $F_{net} = ma$ • Identify interaction pairs of forces for contact forces and forces at a distance. • Analyze Newton's Third Law as the relationship	**Assessment Tasks:** **Major test, quizzes, homework** **Tug-o-war game (I always start this unit with this activity)** **Lab on Newton's Second Law** **Vernier Lab (ladder experiment)** Enrichment: Discuss how the angle of bank should change along the curve's length for maximum safety **Additional Labs from NCDPI:** **http://www.ncpublicschools.org/curriculum/science/units/high/** **FOR THE BELOW INQUIRY SUPPORT LABS, CLICK ON THIS LINK)** **http://www.ncpublicschools.org/curriculum/science/scos/2004/27physics** **Inquiry Support Lab:** A Minilab --Components of Force Vectors **Inquiry Support Lab:** Newton's Second Law **Inquiry Support Lab:** Newton's Second Law – An Inquiry Approach **Inquiry Support Lab:** Modified Atwood's Machine Lab **Inquiry Support Lab:** Weight vs. Mass

evidenced by

Force $_{\text{of Object A on Object B}}$ = -Force $_{\text{of Object B on Object A}}$

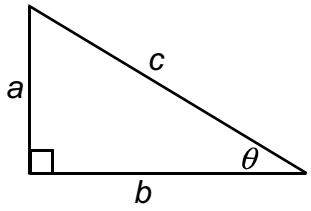
- Observe and experimentally measure equal and opposite forces using pairs of spring scales or force sensors.
  - Resolve forces into components.
  - Apply Newton's Laws of Motion to the perpendicular components of force in the following examples:
    a. objects pulled or pushed along a horizontal surface by a force at an angle to the surface;
    b. objects sliding down an inclined plane;
- three concurrent forces acting on an object in static equilibrium.
- Describe friction as a contact force.
- Distinguish between static friction and kinetic friction.
- Solve quantitative problems with frictional forces. (*coefficient of friction is an enrichment topic*) Calculate gravitational force between any two masses:

$$F = \frac{Gm_1m_2}{d^2}$$

- Apply proportional reasoning to the inverse square relationship between gravitational force and the distance between the centers of two known masses.
- Apply proportional reasoning to the direct relationship between gravitational force and the product of masses.
- Determine the force of gravity (weight) of an object: $F_g = mg$

Design and conduct investigations of objects in static equilibrium. *(Torque and rotational equilibrium are enrichment topics.)*

- 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.
    - Predict and measure the path of the projectile including horizontal range, maximum height, and time in flight (such as a projectile launched horizontally or from the ground at a given angle).
- Recognize that vector components are independent of each other.
- Calculate range, time, angle, etc. for a projectile moving as both a half trajectory and full trajectory
- Understand that centripetal acceleration is a consequence of the changing velocity due to change in direction.
- Design and conduct investigations of circular motion.

Materials Suggestions:
Vernier Equipment
Long rope (tug-0-war-game)

Varying masses: (50 g, 100 g, 200 g, etc)	Ramp (board or two triangle meter sticks)	**Optional:** motion detectors, LabPros or CBL IIs, TI Calculators or computers
Meter sticks	Tape	**Optional:** balsa or basswood, buckets, chain, small blocks of wood, eye bolts, sand
Stopwatches	Electronic or triple beam balances	
Dynamics carts	Matchbox cars or golf balls	
Pulleys mounted on clamps		
string		

http://www.ncpublicschools.org/curriculum/science/scos/2004/27physics **(FOR SUPPLIES NEEDED TO ACCOMPANY THE ABOVE "INQUIRY SUPPORT LABS")**

21st Century Skills	Activity
Communication Skills	
Conveying thought or opinions effectively	• Analysis questions in all labs
When presenting information, distinguishing between relevant and irrelevant information	• Data collection in all Lab Activities
Explaining a concept to others	• Sign Off—Universal Gravitation
Interviewing others or being interviewed	• Sign Off—Universal Gravitation
Computer Knowledge	
Using word-processing and database programs	• Making graphs in labs
Developing visual aides for presentations	• Free Body Diagrams Activities
Using a computer for communication	• Free Body Diagrams Activities
Learning new software programs	• Newton's Second Law • Forces in One Dimension

Employability Skills	
Assuming responsibility for own learning	• Free Body Diagrams • Sign Off –Universal Gravitation
Persisting until job is completed	
Working independently	• Bridge Building Activity
Developing career interest/goals	
Responding to criticism or questions	• Sign Off –Universal Gravitation Team Project
Information-retrieval Skills	
Searching for information via the computer	• Bridge Building Activity
Searching for print information	• Bridge Building Activity
Searching for information using community members	• Newton's Second Law • Forces on an Incline • Forces in One Dimension • Sign Off—Universal Gravitation
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	• Forces on an Incline • Newton's Second Law
Summarizing main points after reading	
Locating and choosing appropriate reference materials	• All lab activities
Reading for personal learning	
Language Skill - Writing	
Using language accurately	
Organizing and relating ideas when writing	• "Explain" and "Evaluate" sections in all lab activities

Proofing and Editing	
Synthesizing information from several sources	• Free Body Activities • Sign Off Activity
Documenting sources	
Developing an outline	
Writing to persuade or justify a position	• Sign Off Activity
Creating memos, letters, other forms of correspondence	
Teamwork	
Taking initiative	• All lab activities • Sign Off Activity
Working on a team	• All lab activities • Sign Off Activity
Thinking/Problem-Solving Skills	
Identifying key problems or questions	• All lab activities • Sign Off Activity
Evaluating results	• All lab activities • Sign Off Activity
Developing strategies to address problems	
Developing an action plan or timeline	