Regents Physics: Circular Motion and Gravity Unit Plan

Desired Results

Title of Unit

- Circular Motion and Gravity

Enduring Understandings

- An object that has a net force acting on it accelerates in the direction of the net force [Application of previous unit]
- An object that moves in a circle does so because of a net force that points towards the center of a circle. This force is called the centripetal force. [New this unit]
- An object that moves in a circle is moving in a straight line tangent to the circle at any given point in its motion. If the centripetal force is removed, the object will move in a direction tangent to the circular path. [New this unit]
- Gravity is an attractive, non-contact force that is inversely proportional to distance squared (gets weaker with distance) [Old idea built upon during this unit]
- The orbit of planets and other satellites can be approximated as a circular path. [New this unit]
- Additional skills and knowledge listed in the sections below.

Essential Questions

- Do astronauts 'float' when they are in space?

Guiding Questions

- Which direction do you need to hit a bowling ball to make it move in a circle? [Demonstration]
- Which direction does a stopwatch fly when a string is cut? [Demonstration]
- Why will water stay in a bucket when you spin it around your head? [Demonstration]
- What is the mathematical relationship between the speed of an object and the centripetal force? [Lab]
- What is the mathematical relationship between the gravitational force of attraction and the distance between objects? [Virtual Lab]
- How does the force of gravity allow satellites to orbit planets? [Virtual Lab]
- What happens to the orbit of a satellite if the speed is either increased or decreased? [Virtual Lab]

Knowledge

- **Vocabulary**
  - Centripetal Force
  - Centripetal Acceleration
  - Tangential Velocity
  - Newton's Law of Universal Gravitation
  - Gravitational Constant
- **Concepts**
  - See enduring understandings
- **Equations**
  - $a_c=v^2/r$
  - $F_c=ma_c$
  - $F_g=Gm_1m_2/r^2$

Skills

- Proportional Reasoning
  - Determining how many times bigger or smaller a value will get when other variables are changed.

Standards

'Old' Standards:

- 5.1 Students can explain and predict different patterns of motion of objects (e.g., linear and uniform circular motion, velocity and acceleration, momentum and inertia).
  - 5.1j When the net force on a system is zero, the system is in equilibrium.
  - 5.1k According to Newton's Second Law, an unbalanced force causes a mass to accelerate*.
  - 5.1n Centripetal force* is the net force which produces centripetal acceleration.* In uniform circular motion, the centripetal force is perpendicular to the tangential velocity.

'New' Standards:

- HS-PS2-1. Analyze data to support the claim that Newton's Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and

its acceleration.
- HS-PS2-5. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

Assessment Evidence

- Circular Motion Lab [Formative]
- Circular Motion Partner Quiz [Formative]
- Flying Pigs Lab [Formative]
- Universal Gravitation Lab [Formative]
- Universal Gravitation Partner Quiz [Formative]
- Circular Motion and Gravitation Test [Summative in the scope of the unit, Formative in the scope of the year]

Learning Plan

Learning Activities

1) Google Form: Unit Focus Question and Discussion: Do Astronauts 'Float' when they are in space?
2) Demos, Notes, and Practice: Circular Motion Basics
3) Lab: Circular Motion
4) Notes and Practice: Centripetal Acceleration and Centripetal Force Equations
5) Notes and Practice: Math Skill- Proportional Reasoning
6) Notes and Practice: "Youtube Problem Solving"
7) Partner Quiz: Circular Motion Concepts and Problem Solving [Formative Assessment]
8) Discussion and Lab: Banked Curves, Mario Kart and Flying Pigs
9) Virtual Lab: Universal Gravitation
10) Observations, Videos, and Claim: Gravitational Waves, Orbital Motion Sim, Answer Unit Focus Question.
11) Notes and Practice: Universal Gravitation and Gravitational Field
12) Partner Quiz: Universal Gravitation
13) Review Packet
14) Test: Circular Motion and Gravity Summative Assessment

Resources

- Phet Simulations
- Lab Apparatus
- Online Videos