**Unit Overview**

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**MAIN IDEA: Interactions between systems affect their motion OR "Forces alter the motion of objects"**

**Number Label (#) on the left corner of the textbook indicates the Lesson number.**

Summative Assessment Grid

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Topic | Remembering(20%) | Understanding(20%) | Applying (30%) | Analyzing(30%) | Total |
| Forces (15%) | 3 | 3 | 4.5 (?) | 4.5 | 15 |
| Vectors (20%) | 4 | 4 | 6 | 6 | 20 |
| Newton’s 1st Law (20%) | 4 | 4 | 6 | 6 | 20 |
| Newton’s 2nd Law (30%) | 6 | 6 | 9 | 9 | 30 |
| Newton’s 3rd Law (15%) | 3 | 3 | 4.5 | 4.5 | 15 |
| Subtotals | 20 | 20 | 30 | 30 | \*100\* |

**Unit Objectives:**

**By the end of this unit, the student will be able to:**

* **Define a force**
* **Identify types of forces acting on an object and their direction**
* **Distinguish weight from mass**
* **Calculate the weight of an object based on its mass.**
* **Calculate the net force acting on the object**
* **State Newton's 1st Law**
* **Create a graphical representation of the forces acting on an object**
* **Add vectors in 2-dimensions**
* **Decompose a 2-dimensional vector**
* **Identify the condition for translational equilibrium**
* **Apply Newton's 1st Law to solve for an unknown quantity (force, θ, mass) in a scenario of translational equilibrium**
* **State Newton's 2nd Law**
* **Apply Newton's 2nd Law to solve for an unknown quantity (force, θ, acceleration, velocity (initial/final), time, mass) in a scenario of where a net force is acting on the object.**
* **Predict the motion of an object that is acted upon by a net force.**
* **State Newton's 3rd law**
* **Identify pairs of interaction forces**
* **Distinguish the effect of Newton's 3rd Law in the motion of Individual objects within the interaction pair.**

**DAILY LESSON PLAN TEMPLATE**

**Date: Day 5 Subject: Applications of Newton's 1st Law**

**Title: The Moving Company**

For an object to remain at rest, all forces acting on it must be in equilibrium.

**Grade Level**

High School

**Virginia Standards of Learning**

**Standard PH.2 a & e**

The student will investigate and understand how to analyze and interpret data. Key concepts include:

a) a description of a physical problem is translated into a mathematical statement in order to find

a solution; and

e) analysis of systems employs vector quantities utilizing trigonometric and graphical methods.

**Standard PH.4 a**

The student will investigate and understand how applications of physics affect the world. Key concepts include:

1. examples from the real world.

**Standard PH.5 d**

The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include

d) Newton’s laws of motion;

**Objectives:**

***Science Content Objectives***

A student will be able to:

* **Identify the condition for translational equilibrium**
* **Apply Newton's 1st Law to solve for an unknown quantity (force, θ, mass) in a scenario of translational equilibrium**

***Nature of Science Objectives:***

A student will be able to:

* Recognize that scientific laws are generalizations or universal relationships related to the way that some aspect of the natural world behaves under certain conditions.

**Materials and Setup**

List all materials needed to teach the lesson including:

* **Stands and connectors**
* **Pulleys**
* **Protractors**
* **Hangers and calibrated masses**
* **String or fishing line**
* **Spring Scales**

**Safety**

No special safety precautions are needed for this lesson.

**Requisite Knowledge/skills for students**

Students will need to recognize that the forces are vector quantities and that apply the rules of direction for friction, tension and normal forces. Students should also be familiar with vector decomposition.

**Procedure:**

Engage:The group will be presented with a slideshow with samples of force (free-body) diagrams. Using the stand, connectors and calibrated masses, they will be asked to build a model using a combination of forces, (i.e., tension, weight, normal force) that results in the object remaining at rest. The group will review Newton’s First Law and discuss how multiple forces are combined. They will visit the computer lab to explore further.

Explore:

PHET simulation: Forces & Motion / Forces & Motion with Ramp

Students will simulate applying a force to an object on a surface with/without friction to compare the resulting net force and change in the motion. The will make observations of the conditions for moving at constant velocity.

Students will receive different worksheets depending on their level of content. Students that need reinforcement of types of forces will be working on scenarios without a ramp, and displaying only 2 forces in each direction. Students that have demonstrated understanding of the types of forces and vector decomposition will be working with scenarios that build up into adding a ramp and change the mass of the object to test the effect of increasing the friction.

Explain: The group will discuss patterns in the motion of the object, such as which forces act against each other, which are tied to a specific object, which require a person to interact with the object, etc. The goal is for them to explore as many combinations of forces as possible.

Elaborate (Apply, Extend):

Based on their observations, the students will make predictions for the motion resulting on the force acting on objects of different masses. They will trade prediction slips with a partner and test each other’s predictions.

Evaluate: The student will create a free body diagram for 2 situations where the object remains at rest, solving for the unknown force, and free body diagrams for 2 situations where the object travels at constant velocity, solving for the unknown force. Forces must be labeled to show the type of force, along with its magnitude and direction of the force vector.

**References**

Simulation accessed on February 29 at: <http://phet.colorado.edu/en/simulation/ramp-forces-and-motion>

Free body diagram presentation accessed on February 29 at: <http://www.wisc-online.com/Objects/ViewObject.aspx?ID=TP1502>

Placeholder (Lesson Plans 5-10)

Save for later:

Using graphs to explain motion: <http://www.wisc-online.com/Objects/ViewObject.aspx?ID=TP1101>