**Rationale**

Physical Science is a high school class designed for incoming freshman that serves as one of the Ohio Core science courses needed for graduation. This course introduces students to new science concepts and builds on the foundation that was taught to them in the elementary and middle school levels. Students will take part in inquiry-based laboratory experiences and learn objectives and concepts that provide a foundation for further study in other sciences and advanced science disciplines. The course is comprised of many different areas of science while intertwining basic scientific inquiry and skills into each unit of study.

This unit will be designed to meet the student’s needs in a Group investigation model design. The unit is designed to allow students to solve a problem derived from the subject area as a small group. This specific unit introduces students to a physics unit based on Newton’s Laws of motion. The students will have previously been introduced to physics concepts such as speed, velocity, acceleration, and the formulas associated with those scientific terms. The students will be confronted with a problem in which they must design a vehicle to support an egg being dropped from a 5 meter height with only selected materials. The students will then have to work together using their problem-solving skills, critical thinking abilities, and background of physics to successfully accomplish the task together. These developed skills will help students not only in science class but also in real-world situations.

The unit was designed in an effort to contextualize the learning for the students. This is a very fun and exciting project for the students to take part in and in directly relates to the science curriculum and everyday problems and critical thinking skills they will encounter and need in the future. I chose to use a constructivist approach based on the Group Investigation Model outlined by Leigh Chiarelott in his book *Curriculum in Context.* According to Chiarelott, (2006) a contextual teaching and learning classroom sometimes utilizes a behaviorist approach and other times a constructivist approach depending upon the best fit of the lesson. A constructivist philosophy would support such teaching models as inquiry based. Constructivist models work best when the content and outcomes allow for a range of possible acceptable responses. (Chiarelott 2006) This unit fits that description perfectly. There are multiple ways for the students to successfully complete the task and hopefully we will end up with many different designs at the end so the students can learn from each other’s ideas. For this specific unit, the post assessment will be the actual project the students create.

**THE GROUP INVESTIGATION MODEL (SIX PHASES)**

Phase One: Students confront a problem situation derived from the subject matter

Phase Two: Students share their reactions to the problem situation.

Phase Three: Students narrow down the situation into a specific problem to be investigated

Phase Four: Students analyze the problem, devise tasks to be undertaken to reach its solution and assign tasks to members.

Phase Five: Students complete their tasks and report finding.

Phase Six: Students evaluate their solution(s) according to the original purposes of the group.

**UNIT INTENDED LEARNING OUTCOMES**

**Subunit One: Forces and Motion**

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams

**Subunit Two: Scientific Inquiry**

* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Pre-Assessment**

**Newton’s Laws/Scientific Inquiry**

**Directions:** Circle the number that best resembles your knowledge of the following.

**1 – no idea 2 – I know a little bit 3 – average 4 – somewhat familiar 5 – very familiar**

1. Mass 1 2 3 4 5

2. Weight 1 2 3 4 5

3. Gravity 1 2 3 4 5

4. Acceleration 1 2 3 4 5

5. Newton’s 1st Law 1 2 3 4 5

6. Newton’s 2nd Law 1 2 3 4 5

7. Newton’s 3rd Law 1 2 3 4 5

8. Scientific Method 1 2 3 4 5

9. Variables 1 2 3 4 5

10. Formula to find Force 1 2 3 4 5

11. Formula to find Velocity 1 2 3 4 5

12. Air resistance 1 2 3 4 5

13. Gravitational pull 1 2 3 4 5

14. Formula for Acceleration 1 2 3 4 5

15. Interpreting force diagrams 1 2 3 4 5

*Answer the following questions to the best of your ability.*

16. What are the steps to solving a scientific problem or conducting an experiment?

17. How are mass and acceleration related to force?

18. Explain everything you know about gravity.

19. What do you know about Newton’s 2nd law?

20. What is the difference between speed and velocity?

**Lesson Plan – Day One**

Unit Outcomes:

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams
* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Time period Objectives:**

* Students will be able to identify Newton’s laws and give an example of each law in nature
* Students will identify questions and concepts that guide science investigations
* Students will be able to define speed, velocity, and acceleration

**Materials**

Student notebooks

Physics notes and formulas

Egg Drop Power point (attached on CMap)

Newton’s 2nd Law worksheet

**Procedures:**

1. Ask the students if they have every cracked in egg to make a meal. Ask the students to describe the amount of force needed to crack the egg. Hand a student an egg inside of a sandwich bag and ask them if they could smash the egg without using their hands as the force. Optional: In my class I always let the students break an egg. Try to steer the students to the idea of dropping the egg. Next you will tell the students that dropping the egg is exactly what you are going to do this week. (10 min)

2. Have the students take out their notebooks. Students will copy Newton’s Laws, Formula for Force, Unit for Force, momentum, weight and Acceleration. Using the Smart board the students will solve 5 example problems that use F = ma and a= F/m, etc. (20-25 min)

3. Give students Newton’s law worksheet to complete. (15-20 min)

**Key Questions:**

How does mass and acceleration affect the force applied to an object?

What force is acting on an egg dropped from 5 meters?

**Assessment:**

1. Complete Calculations worksheet

2. Teacher observation

**Lesson Plan – Day Two & Day Three**

Unit Outcomes:

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams
* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Time period Objectives:**

* Students will be able to identify Newton’s laws and give an example of each law in nature
* Students will identify questions and concepts that guide science investigations
* Students will be able to define speed, velocity, and acceleration
* Students will names types of forces
* Students will design and conduct scientific investigations
* Students will be able to define speed, velocity, and acceleration.

**Materials**

Student notebooks Computer paper

Physics notes and formulas scotch tape

Egg Drop Power point (attached on CMap) meter stick

Newton’s 2nd Law worksheet sandwich bags

eggs

**Procedures:**

1. Begin class with the Egg Drop Power point. Students will write down background notes and procedures for the lab from this power point presentation.

2. Students will be divided up upon ability levels or teacher preferred groups prior to class.

3. Students will be given Pre-Lab checklist and will begin gathering materials needed for this project. In my class I always have the students fill out a post-lab rubric in which they rate group member performance. I also have the students use “inquiry time” 5-10 min to discuss the lab and gather ideas before beginning or touching any supplies or materials from the lab.

4. Students should begin answering Pre-Lab questions and start the design.

5. Students will be given 2 class periods to complete vehicle design with the information that we will be dropping the eggs on Day 4.

**Key Questions:**

How does mass and acceleration affect the force applied to an object?

What force is acting on an egg dropped from 5 meters?

How can we control the force applied to the egg with our materials?

**Assessment:**

1. Teacher observation of group work

2. Pre-Lab Questions

**Lesson Plan – Day Four**

Unit Outcomes:

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams
* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Time period Objectives:**

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams
* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Materials**

Egg Drop Designs Computer paper

Physics notes and formulas scotch tape

Egg Drop Power point (attached on CMap) meter stick

Newton’s 2nd Law worksheet sandwich bags

Eggs Drop area ( bleachers)

stopwatch

**Procedures:**

1. Students will take their designs out to the drop off area (bleachers)

2. Students will need to correctly drop, time, and calculate formulas using Lab-sheet.

**Key Questions:**

How does mass and acceleration affect the force applied to an object?

What force is acting on an egg dropped from 5 meters?

How can we control the force applied to the egg with our materials?

**Assessment:**

1. Successful Egg Drop

2. Teacher observation

3. Lab sheets

**Lesson Plan – Day Five**

Unit Outcomes:

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams
* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Time period Objectives:**

* Students will be able to define speed, velocity, acceleration.
* Students will solve distance, velocity, speed, and time story problems.
* Students will be able to create and interpret speed, velocity, and time graphs
* Students will identify Newton’s laws and give an example of each law in nature
* Students will name types of forces and interpret force diagrams
* Students will design and conduct scientific investigations
* Students will identify questions and concepts that guide science investigations

**Materials**

Egg Drop Post Assessment

**Procedures:**

1. Students complete post egg drop assessment.

**Key Questions:**

How does mass and acceleration affect the force applied to an object?

What force is acting on an egg dropped from 5 meters?

How can we control the force applied to the egg with our materials?

**Assessment:**

1. Egg Drop Post Assessment

Physical Science

Egg Drop

Task: Design an apparatus that prevents an egg from breaking when dropped from the second story.

Materials:

* 7 sheets of computer paper
* Scotch tape
* 1 large egg
* 1 sandwich bag to put the egg in (to contain the egg if the apparatus should fail)

Helpful hints:

* In order to have your egg survive, you should slow down the egg’s fall and/or increase the moment of impact (much like crumple zones in a car).

Good luck and have fun!

\*25 bonus points per group whose egg survives the fall\*

\*10 extra points for each sheet of paper not used, provided that your egg survives.

Additional Information:

1) We will be doing several measurements and calculations of our egg drop.

2) We will be timing our drop to the best of our ability using a stop watch.

3) We will measure the distance of the drop as well.

4) Below is a data table which will be filled in as we conduct our drop.

**Data Table**

|  |  |
| --- | --- |
| Mass of Egg |  |
| Mass of Apparatus |  |
| Height of drop (in meters) |  |
| Time of drop |  |
| Acceleration due to gravity |  |
| Force Calculation |  |
| Avg Speed of Egg |  |

**Post Egg Assessment**

1) Describe the design of your apparatus or draw a diagram.

2) Explain why you chose the design you did? How did you use your knowledge from class in your design? Be SURE to include Newton’s law in your explanation!

3) If your egg broke: if you could change one thing about your apparatus what would it be and how would this help your egg survive?

If your egg didn’t break: what would you change about the egg drop activity and why?

**Calculations**

***Show all of your work.***

4) What was the average speed of your egg and paper?

5) What was the average acceleration of your apparatus? How does this compare to gravity?

6) What was the force of your apparatus?

Newton’s Laws problems

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Show your work. Use the correct unit.

*Possible Formulas*

**F=ma a (for mass) = F/m m= F/a W=mg Momentum = Mass \* Velocity**

**Acceleration (for time) = Vfinal –Vinitial / time**

1. A baseball is throw at a speed of 50 m/s and has a mass of 0.10 kg. What is its momentum?

2. A car takes 10 seconds to go from a standstill to 50 meters. If the car has a mass of 2,000 kg, what is the net force acting on the bicycle? ( HINT: Find the Acceleration first)

3. A 8000 N force accelerates a truck at 4.0 m/s2. What is the mass of the truck?

4. A bundle of shingles that has a mass of 75 kg is rolling down a roof with a net force of 100 N. What is the acceleration of the shingles at that net force?

5. A boy pushes forward a cart of groceries with a total mass of 40 kg. What is the acceleration of the cart if the net force on the cart is 60.0 N?

6. What is the upward acceleration of a helicopter with a mass of 5000 kg if a force of 10,000 N acts on it in an upward direction?

7. A car with a mass of 1200 kg accelerates at a rate of 3.0 m/s2 in a forward direction. What is the net force acting on the car?

8. A 25 N force accelerates a boy in a wheelchair at .5 m/s2. What is the mass of the boy and the wheelchair?

9. A box has a mass of 150 kg. If a net force of 3000 N acts on the box, what is the box’s acceleration?

10. What is the acceleration of a 1000 kg car subject to a 500 N net force?