Force and Motion Lesson Design

Subject Area: Physics/Algebra 2/ Statistics	**Grade Level:** 10th-12th
Benchmark Period :	**Duration of Lesson:** 50 minutes

Standard(s):
Physics 1C: Student will know how to apply the law F=ma to solve one-dimensional motion problems that involves constant forces (Newton's 2nd Law)

Investigation/Experimentation 1D: Student will formulate explanations by using logic and evidence.

Probability & Statistics 6.0: Students know the definitions of the mean, median, and mode of a distribution of data and can compute each in particular situations.

Probability & Statistics 8.0: Students organize and describe distributions of data by using a number of different methods, including frequency tables, histograms, standard line and bar graphs, stem-and-leaf displays, scatter plots, and box-and-whisker plots.

Big Ideas involved in the lesson:
Applications of Newton's Law of Motion

As a result of this lesson students will:

Know: How to apply Newton's Law of Motion

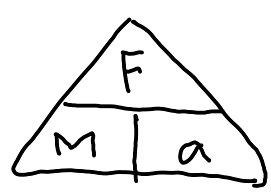
Understand: Net force causes acceleration of an object, and that acceleration is inversely proportional to mass of the object.

Be Able To Do: To describe the relationship between force, mass, and acceleration of objects

Assessments: **What will be evidence of student knowledge, understanding & ability?**	**Formative:** teacher will check for understanding by asking students questions, and walking around the classroom to make sure problems are solved appropriately. **Summative:** Student will complete lab worksheet.	

Lesson Plan

Anticipatory Set: a. T. focuses students b. T. states objectives c. T. establishes purpose of the lesson **d.** T. activates prior	1. State Objectives (explicitly state them; see above) 2. New Airline Fees Commercial (Video) Q: How many of you have been to airplane recently? Why is the airline company charging for everything? Why are they charging for luggage (depending on weight and size)? ($15 each check-in bag. if it's $25 for 2nd luggage)

knowledge	3. Q: What will be the effect of altering the mass of an airplane? 4. Purpose of lesson: by the end of this lesson, you should be able to describe the relationship between force, mass and acceleration. 5. Activate Prior Knowledge: Summa Q: Remember yesterday we've learned that force is a push or pull?
Instruction: **a. Provide information** ▪ Explain concepts ▪ State definitions ▪ Provide exs. ▪ Model **b. Check for Understanding** ▪ Pose key questions ▪ Ask students to explain concepts, definitions, attributes in their own words ▪ Have students discriminate between examples and non-examples ▪ Encourage students generate their own examples ▪ Use participation	**Lab Preparation:** Mass plane = 13.6g, Jumbo Paper Clips = 1.0 g Inquiry Activity: • Students will form group of 3, and each group will determine the time it takes for the model plane to run a distance of 1 meter with various plane mass with constant force (60 windings). • Have the class divided into groups, and have the group doing various mass. Student calculates the acceleration and average time for the data table, and will plot out the data in line graph as homework. Teacher will roughly demonstrate the relationship between mass and acceleration briefly on the board. Graph 1: x = mass y=acceleration ($a=2x/t^2$) • 3 trials per students Teacher discusses the linear relationship demonstrated in the activity, comparing Force and Mass to acceleration • Explain how directly proportional and inversely proportional would like on a math equation • Combine the two relationship to give F=ma Discuss Newton's 2nd law: F= ma with units (by combining the two relationships.) Newton's Pyramid:  Teacher will model problem solving: Ex. 1. Conceptual 1. A constant amount of force is applies to an airplane. If the mass of the airplane is cut in half, what happens to the acceleration?

	Ex2. Computational A 1000 kg plane needs a 5000 N force to accelerate at 5 m/s^2 for 10 seconds. Given: M=1000kg, F=5000N, a=5 m/s^2, *t=10second* $a = \frac{F}{m} = \frac{5000N}{1000Kg} = 5\frac{m}{s^2}$ Now, consider a plane that is 20% lighter. Would it take more force or less force to achieve the same acceleration? Now calculate the solution: How much force would a 800 kg plane (20% lighter) need to accelerate to the same acceleration of 5 m/s^2 in 10 seconds. • Given/Find/Solution: Given: M=800kg, t=10 seconds, a=5 m/s^2 Find: F Solution: $F = ma = (800kg)(5 {}^{m}/_{s^2}) = 4000N$
Guided Practice: a. Initiate practice activities under direct teacher supervision – T. works problem step-by-step along w/students at the same time b. Elicit overt responses from students that demonstrate behavior in objectives c. T. slowly releases student to do more work on their own (semi-independent) d. Check for understanding that students were *correct at each step* e. Provide specific knowledge of results **f.** Provide close monitoring	Provide real-life problem solving: Ex 1: A constant amount of force is applies to an airplane. If the mass of the airplane is cut in half, what happens to the acceleration? Ex 2: A 737 has a mass of 60,000 kg. If the engines provide 213,000N of forward force (thrust) in 20 seconds, what is the acceleration? $a = \frac{F}{m} = \frac{213{,}000N}{60{,}000Kg} = 3.55 {}^{m}/_{s^2}$ Ex 3: If another plane has a mass that is 10,000 kg less and accelerates at the same rate in the same time, how much force is required? $F = ma = (50{,}000kg)(3.55 {}^{m}/_{s^2}) = 177{,}500N$ Compare the two results: Notice that the force needed to move a plane with 15% less mass is (213,000-177,500) = 35,500 less Newtons. Ex. 4: A plane can carry 200 passengers. Each passenger brings an

	extra 20 kg suitcase. How much extra mass is added and what effect will this have on the airplane's acceleration given the same force? Ex. If the mass of the airplane can be reduced to 30% of the original by replacing titanium and aluminum with carbon composite materials while keeping the same acceleration, what would be some possible advantages. Have TA and Teacher walk around to monitor student work Introduce the carbon composite materials: • *Use specific strength chart to compare different materials (?)*
What opportunities will students have to read, write, listen & speak about science and mathematics?	Read: Lab procedure and practice questions Write: Quickwrite exit question summation Listen: Follow verbal directions Speak: Discuss lab procedure with partners
Closure: a. Students prove that they know how to do the work b. T. verifies that students can describe the what and why of the work **c.** Have each student perform behavior	Exit Question (Quick Write) In two minutes, please diagram and explain what happens when you vary the number of windings (force) and/or the mass of the plane. Teacher's Response: from the windings vs. acceleration graph, we see that more windings the plane has, the faster it accelerates. The more mass the plane has, the harder it is to accelerate the plane. So, how fast the plane can change its motion is directly proportional to its net force, and inversely proportional to its mass.
Independent Practice: a. Have students continue to practice on their own b. Students do work by themselves with 80% accuracy **c.** Provide effective, timely feedback	Q1: A Boeing 747 has a thrust of 250,000 N in each of its four engines. With a mass of 400,000 kg, traveling 1000m and disregarding friction, what would the acceleration be? $a = \frac{F}{m} = \frac{4(250{,}000)N}{400{,}000kg} = 2.5 \, m/s^2$ Q2: If one engine fails, what would be the resulting amount of acceleration? $a = \frac{F}{m} = \frac{750{,}000N}{400{,}000Kg} = 1.87 \, m/s^2$

	Q3: Starting from rest, a plane travels a distance of 1000 m in 31.6 seconds, what is the acceleration? $a = \frac{2d}{t^2} = \frac{2(1000m)}{(31.6s)^2} = 2.0 \, m/s^2$ Q4: Using the graph of Mass vs. Acceleration, can you think of a way to use this information to determine the force that was applied?
Resources: materials needed to complete the lesson	- Meter stick - Stopwatch - Masking tape - Airplane - Calculator - Paperclips **Lab Preparation:** • Get one set of equipment next to teacher for ease of explanation and demonstration purpose. • Leave the rest of the materials on storage line. • Pre label the lab areas where students will be working in