

# Newton's 2nd Law of Motion in Space

Grade Level: 8th Grade

Duration: 2 x 45 min lesson

Objectives:

- Understand how changing mass affect on velocity.
- Develop logical argument on how mass and acceleration are related.
- Demonstrate the difference between Mass and Weight by integrating classroom activities with video filmed by astronauts in the microgravity environment on the International Space Station (ISS)
- Demonstrate the difference between mass and weight.

Next Generation Science Standards (NGSS)

- MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Common Core State Standards (CCSS)

- CCSS.Math.Content.HSF.IF.B.6 -Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
- CCSS.Math.Content.HSS.IC.B.6- Evaluate reports based on data.
- CCSS.ELA-Literacy.RST.6-8.9- Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Materials Needed:

- Meter stick
- Triple Beam Balance
- Hotwheels cars
- Toy car launcher
- Timer
- Masking tape
- 2 Water bottles
- Meter tape
- Ping-pong ball, tennis ball, baseball
- Plastic ruler

5E Lesson Plan	
<p><b>Engage</b></p>	<p><b>Demonstration:</b> Movement (the speed) of a ping-pong ball, a tennis ball and a baseball flipped by a plastic ruler. Students will first predict, observe and write down their justification on their notebook followed by a class discussion. 10 min.</p> <p><b>Probing Questions:</b>            What feature of the object do you think accounted for the different speed of the objects?            What do you expect to happen if we try this in space, in a microgravity environment?</p>
<p><b>Explore</b></p>	<p><b>Activity 1:</b> Working in groups of two, each team will be provided Hot wheels cars (with different masses), and spring powered car launchers. Students will measure the mass of the each car, and using the launcher, record their travel time (repeat the procedure three times, and calculate the average time). Using collected data, students will create a bar graph, and analyze and compare results with other teams.</p> <p><b>Probing Questions:</b>            What would you happen if we try this experiment at International Space Station(ISS)? Why?            Error analysis: What might be some factors that have affected our data? (wheel alignment of cars can result more/less friction, reaction speed of the person that keeps time).            Why did we repeat the procedure three times?</p>
<p><b>Explain</b></p>	<p>After sharing their data, students will make correlation with the mass and speed of car. Using same force, cars with less mass will travel faster. Connections with Newton’s Second Law of Motion (mass and acceleration are indirectly proportional to each other.)</p> <p><b>Probing Question:</b>            Instead of mass can we take weight of the car accounted to the difference in travel time?            Recalling mass vs weight. How we measure weight and mass. Triple beam balance vs scale. What is the relationship between gravity, mass and weight?</p>
<p><b>Elaborate/Extend</b></p>	<p><b>Activity 2:</b>            Students explore Newton’s Second Law of Motion by attaching an empty (air-inflated) foil drink pouch to a spring release tape measure, and measure the time it takes the pouch to travel one meter as the tape is automatically retracted. The same process will be repeated using a full (fluid-filled) pouch. Which drink pouch will accelerate the fastest - the full one with the greater</p>

	<p>mass or the empty one with the lesser mass? Once this experiment is completed, students will discuss their data and compare it to the video results of a similar experiment done on the International Space Station. <a href="https://youtu.be/aw2VEJ5UDeU">https://youtu.be/aw2VEJ5UDeU</a></p>
<b>Evaluate</b>	<p><b>Formative Assessment:</b></p> <ul style="list-style-type: none"> <li>● Response given to probing questions in class.</li> <li>● Data Collection of students during activities.</li> <li>● Graphing the collected data and analyzing the results.</li> </ul> <p><b>Summative Assessment Questions: (to be submitted on Canvas(OLS))</b></p> <ol style="list-style-type: none"> <li>1) What are the units of acceleration, force? and mass?</li> <li>2) If you use the same force to push an SUV and push a compact car which one will have more acceleration and why?</li> <li>3) Mike's car, which weighs 1,000 kg, is out of gas. Mike is trying to push the car to a gas station, and he makes the car go 0.05 m/s/s. Using Newton's Second Law, you can compute how much force Mike is applying to the car.</li> <li>4) A 7.3 kg bowling ball sliding down a smooth ramp has a net force of 20 N exerted on it. What is its acceleration?</li> </ol>

#### References

Mass vs Weight - Part 4 - Accelerating Mass. (2017, June 26). Retrieved from

<https://www.youtube.com/watch?v=aw2VEJ5UDeU>

Mass vs. Weight Educator Guide. (2011, October 13). Retrieved from

[https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Mass\\_vs\\_Weight.html](https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Mass_vs_Weight.html)

Quiz - Quizizz. (n.d.). Retrieved from

<https://quizizz.com/admin/quiz/5803e3a1ab98727c4ff8751d>

**Name:**

**Period:**

**Date:**

### Activity 1: Which car is faster?

You are given two toy cars with different masses. Using the spring loaded launcher, you will find the speed of given cars.

- 1) State your hypothesis, with your reasoning. (When applied with the same force, which car will travel faster (Car 1: heavier/more mass, Car 2: lighter/less mass))
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- 2) Set up your launcher on your lab table.
- 3) Find the masses of each car using a triple beam balance, and record on the data table.
- 4) Using a meter stick and a masking tape, mark finish point (100cm away from start line).
- 5) Test each car's travel time and record the time. (repeat this three times).

	Mass (g)	Travel time (s) (Trial 1)	Travel time (s) (Trial 2)	Travel time (s) (Trial 3)	Average Travel Time (s)
Car 1					
Car 2					

- 6) Draw a bar graph using average travel time of each car.  
(Show your graph on the next page)
  - 7) Conclusion: Which car travelled faster? Why?
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- 8) Error analysis: List the possible error points for this experiment.
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**Graph:**

Make sure your graph is approved by SULTAN! (scale, units, label, title, accurate, neat)

