UNIT: Measurement

“Force Finder” – Newton’s Second Law Lab

OBJECTIVE:

Measure mass and acceleration to apply F = ma.

GOAL:

You’re testing how the mass of a moving object (a mini rover) and its acceleration are related to the net force acting on it. You’ll roll a rover down a ramp, measure time and distance, and calculate acceleration and force using physics formulas.

Materials:

* Ramp (books + board or foam ramp)
* Small “rover” (toy car or weighted container with wheels)
* Stopwatch
* Ruler or measuring tape
* Washers or coins (for adding mass)
* Calculator
* Data sheet or notebook

STUDENT DIRECTIONS:

**Step 1: Set Up the Ramp**

* Place your ramp on a stable surface. Measure the **length of the ramp** (distance the rover will travel from top to bottom).
**Record distance (d):** \_\_\_\_\_\_\_ cm or meters

**Step 2: Test with Starting Mass**

* Put your rover at the top of the ramp.
* Get ready with your **stopwatch**.
* Let it go and **time how long it takes** to reach the bottom.
**Record time (t):** \_\_\_\_\_\_\_ seconds

**Step 3: Repeat with More Mass**

* Add 1–2 washers or coins to your rover to increase mass.
* Repeat the test. Do this **at least 3 times** with different masses.
* Each time, record the time it takes and keep the ramp angle the same.

**Step 4: Calculate Acceleration**



Use the formula:

Where:

* aaa = acceleration
* ddd = distance traveled down the ramp
* ttt = time measured

Use a calculator and show your work!

**Step 5: Calculate Force**



Next, use the formula:

Where:

* FFF = Force
* mmm = Mass of rover (use total mass including added washers—estimate in kg if possible)
* aaa = Acceleration from the last step

**Record in a chart:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trial** | **Mass (kg)** | **Time (s)** | **Acceleration (m/s²)** | **Force (N)** |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

**Discussion Prompt:**

* What happened to the acceleration when the mass increased?

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* Did the net force increase or stay the same? Why do you think that happened?

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* How did using a stopwatch or measuring tools help improve the accuracy of your calculations?

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Standards Alignment

NGSS: HS-PS2-1 STEL: STEL 1E, STEL 4E, STEL 6F, STEL 8F, STEL 11F CCSS: CCSS.MATH.CONTENT.HSN.Q.A.1, CCSS.MATH.CONTENT.HSN.Q.A.2, CCSS.MATH.CONTENT.HSN.Q.A.3, CCSS.MATH.CONTENT.HSA.CED.A.2, CCSS.MATH.PRACTICE.MP4, CCSS.MATH.PRACTICE.MP5