

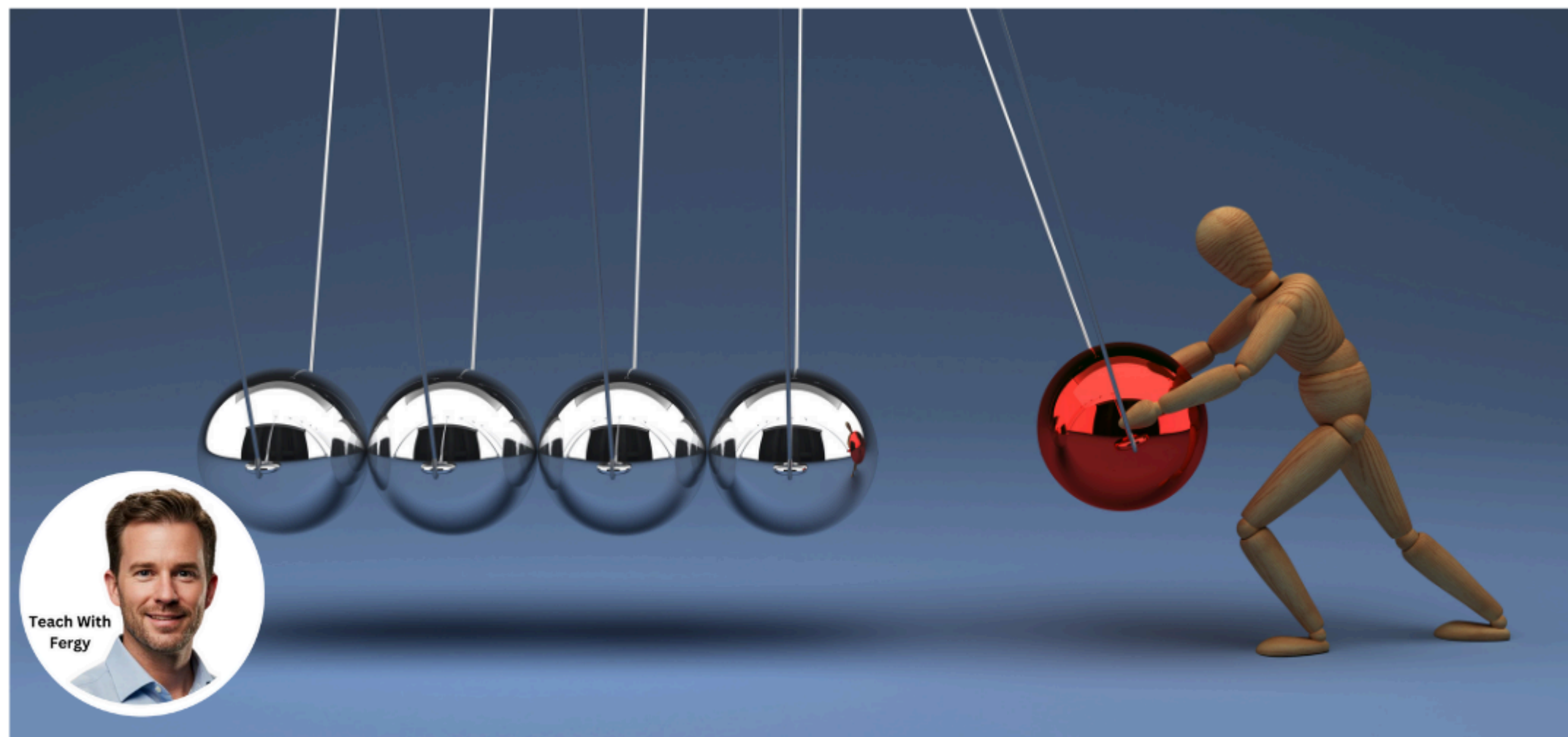
Newton's 3 Laws of Motion

STEM Investigation Bundle

Scientific Method • Variables • Data & Graphing

✓ THREE, Classroom-Ready STEM Investigations

✓ Covers Newton's 1st, 2nd, and 3rd Law of Motion



Print and go
STEM
Investigation
Bundle

SCROLL
to take a look inside!



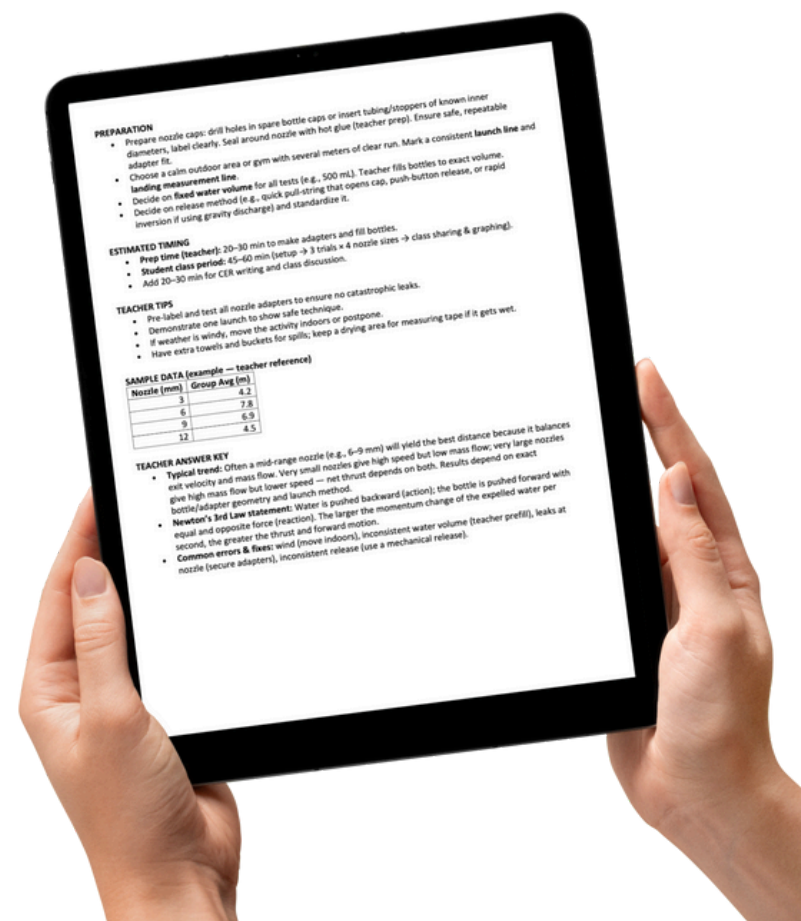
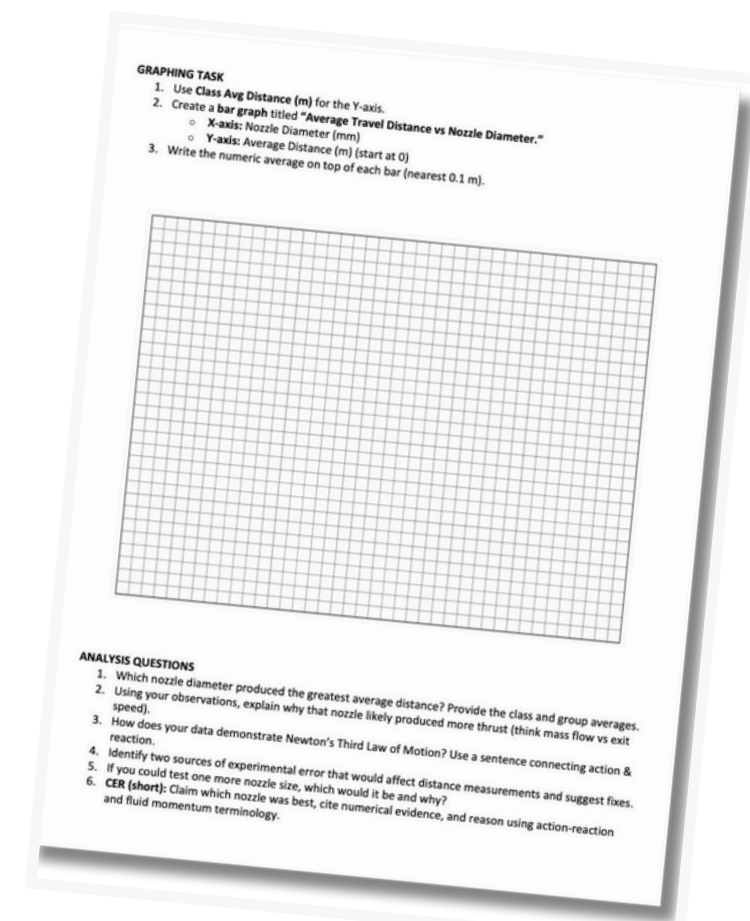
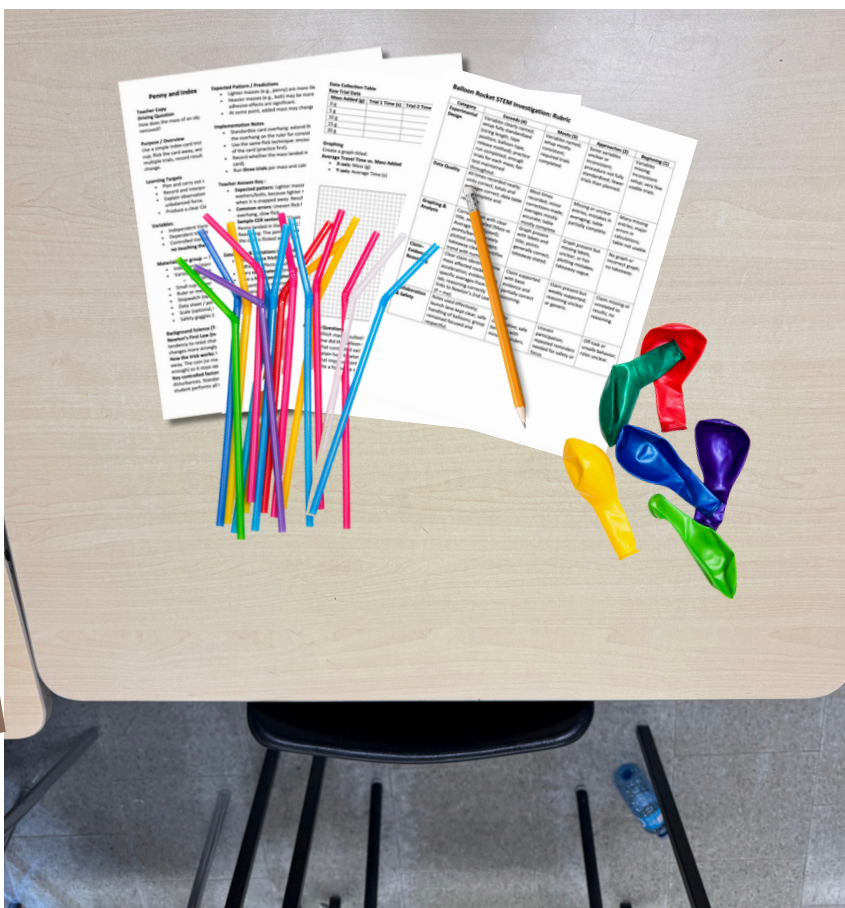
Ways to Use this Resource

★ Introduce the Scientific Method and Graphing

★ Teach STEM Concepts

★ Engineering Lessons/Activities

★ STEM and/or Engineering Clubs



HOW THESE CHALLENGES WILL HELP YOU



- Prep-FREE and fully editable Lab Investigations - just print/upload and assign with almost no materials.
- Engages every learner through hands-on, high-interest lab investigations that boost motivation and participation.
- Strengthens instruction by aligning directly with NGSS.
- Builds essential skills such as problem-solving, teamwork, creativity, and communication—core competencies for high school STEM.

What's Inside Each Challenge



Teacher Guide

Setup diagrams, safety notes, background concepts, and tips for managing materials, variables, and testing procedures.



Student Packet

Hypothesis prompt, variables chart, investigation steps, multi-trial data tables, calculations, graphing tasks, and CER response.



Class Data & Graphing Pages

Class data charts, graph templates, and caption prompts requiring evidence-based conclusions.



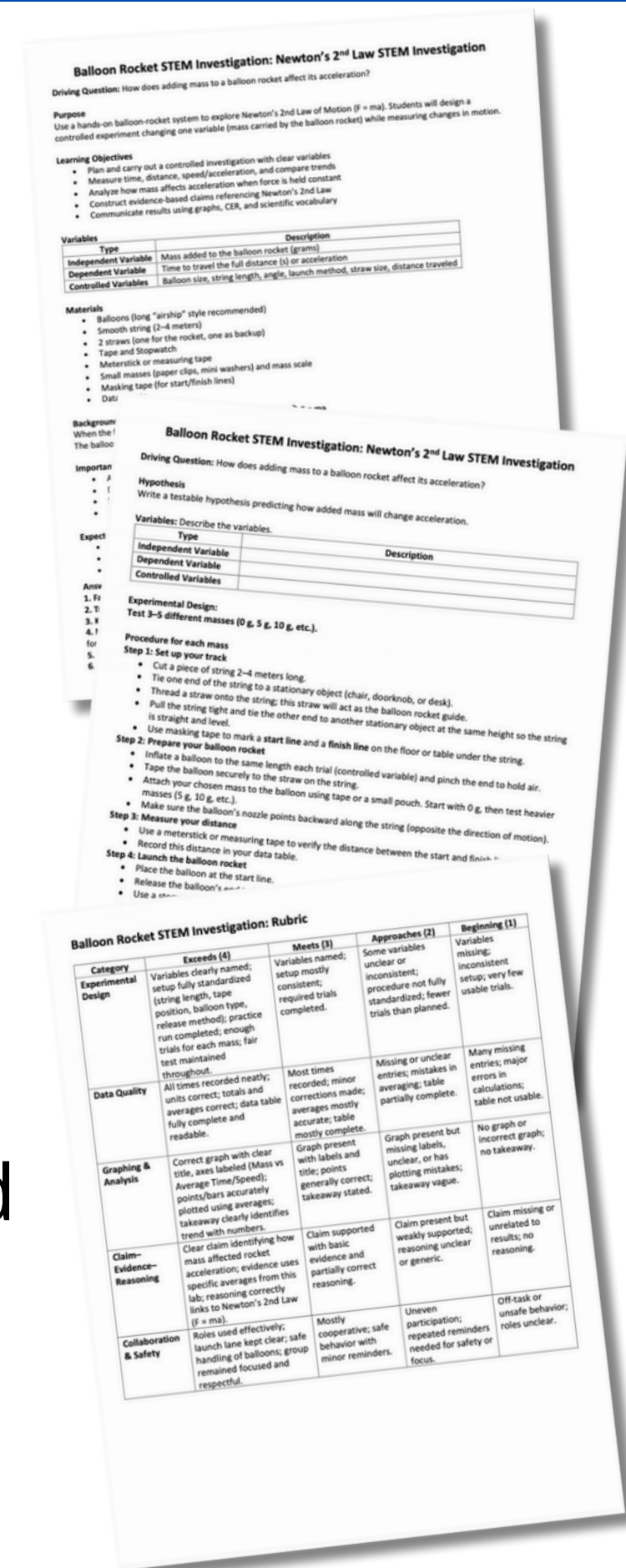
Analysis & Answer Key

Expected results, sample calculations, reasoning examples, error sources, and a model CER.

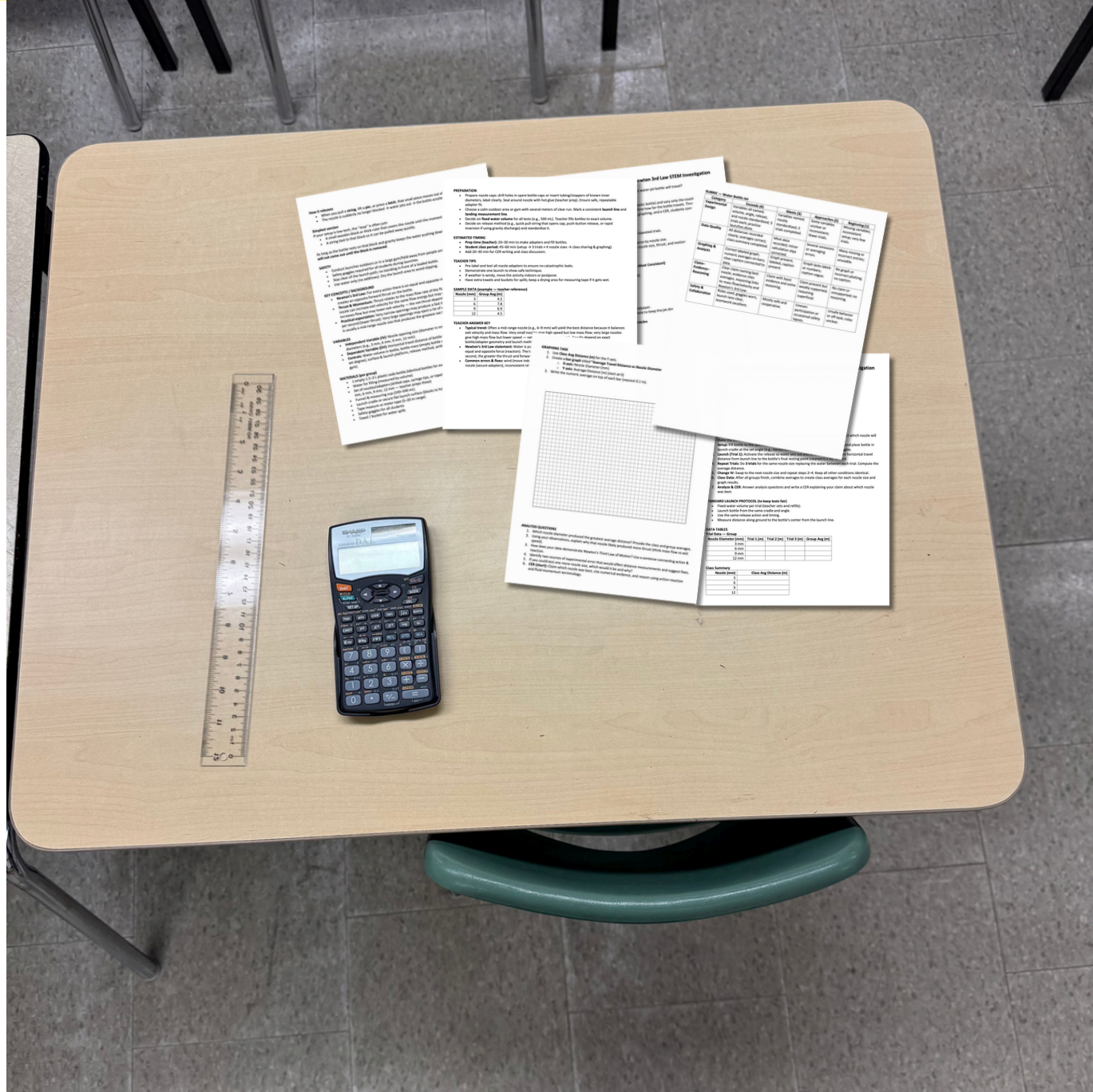


Rubric

Assesses design, data accuracy, graphs, CER quality, and teamwork/safety.



Skills Your Students Will Learn/Improve



- ✓ Problem-Solving and Critical Thinking & Innovation
- ✓ Collaboration & Communication
- ✓ Engineering Design Process
- ✓ Data Collection & Analysis
- ✓ Resilience & Perseverance
- ✓ STEM Content Knowledge
- ✓ Time Management & Organization

Includes

NEWTON 1ST LAW OF MOTION STEM INVESTIGATION

Penny and Index Card Inertia Test: Newton's 1st Law STEM Investigation

Teacher Copy
Driving Question
How does the mass of an object affect its tendency to remain at rest when the support beneath it is quickly removed?

Purpose / Overview
Use a simple index-card trick to investigate Newton's First Law (inertia): place a coin on an index card over a cup, flick the card away, and observe whether the coin drops into the cup. Students change the coin/mass, run multiple trials, record results, graph class data, and use a CER to explain how mass affects resistance to motion change.

Learning Targets

- Plan and carry out a controlled investigation with repeated trials.
- Record and interpret data about motion and inertia.
- Explain observations using Newton's First Law: objects at rest remain at rest unless acted on by an unbalanced force.
- Produce a clear Claim-Evidence-Reasoning (CER) statement linking mass and inertia.

Variables:

- Independent Variable: mass of the object (Identify by name and mass)
- Dependent Variable: drop outcome (Yes/No) for each trial; percent success
- Controlled Variables: same card type, same overhang distance, same flicking motion

Materials (per group — 3-4 students)

- Index cards (standard 3 x 5 in or similar) — 6-10 per group
- Various small masses: pennies, nickels, washers, small bolts (label mass)
- You can also have the students find the mass using a balance as:
- Small cup (paper or plastic) per group
- Ruler or meterstick (for consistent card overhang)
- Stopwatch (optional)
- Data sheet / pencil
- Scale (optional, to measure mass precisely)
- Safety goggles (optional, recommended)



PENNY AND THE INDEX CARD INERTIA TEST

NEWTON 3RD LAW OF MOTION STEM INVESTIGATION

Water Bottle Jet - Thrust vs Nozzle Size - Newton 3rd Law STEM Investigation

Driving Question: How does nozzle diameter affect how far a water-jet bottle will travel?

PURPOSE / OVERVIEW
Students build a simple water-jet rocket (a partially filled plastic bottle) and vary only the nozzle opening size to measure how nozzle diameter changes thrust and therefore how far the bottle travels. Through repeated launches, controlled tests, data recording, class averaging, graphing, and a CER, students connect action-reaction forces and fluid momentum to real motion.

LEARNING TARGETS

- Plan and carry out a controlled investigation with repeated trials.
- Measure travel distance and compute averages.
- Graph class averages to compare thrust performance by nozzle size.
- Write a CER explaining the relationship between nozzle size, thrust, and motion using Newton's 3rd Law.

PREPARATION

Option 1 — Drill Holes in Spare Bottle Caps (Easiest & Most Consistent)

Materials:

- Extra plastic bottle caps (same brand + same fit)
- Drill + drill bits (1 mm, 6 mm, 9 mm, 12 mm)
- Hot glue (optional)

How to make them:

- Drill a centered hole using each drill-bit size.
- Label each cap (e.g., "3 mm," "6 mm," "9 mm").
- If the hole has rough edges, smooth with sandpaper.
- Optional: Glue a short straw piece into the hole to keep the jet direction straight.

Option 2 — Use Rubber Stoppers with Pre-Drilled Holes

Materials:

- Rubber stoppers (RS, RS) with 1 hole
- Hot glue or wax to seal

How to make them:

- Insert stopper into bottle mouth (fits tightly).
- Swap stopper to change nozzle diameter.

The bottle is placed in the launch cradle then released. How the bottle stays in the cradle

Revised design: The new design is a simple water-jet rocket that uses a plastic bottle with a small hole in the bottom. The hole is made by using a small hole punch or a sharp object to make a hole in the bottom of the bottle. The hole is made in the bottom of the bottle, not the side. The hole is made in the bottom of the bottle, not the side. The hole is made in the bottom of the bottle, not the side.

How the bottle stays in the launch cradle then released. How the bottle stays in the cradle

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THRUST VS NOZZLE SIZE

NEWTON 2ND LAW OF MOTION STEM INVESTIGATION

Balloon Rocket STEM Investigation: Newton's 2nd Law STEM Investigation

Driving Question: How does adding mass to a balloon rocket affect its acceleration?

Purpose: Use a hands-on balloon-rocket system to explore Newton's 2nd Law of Motion ($F = ma$). Students will design a controlled experiment changing one variable (mass carried by the balloon rocket) while measuring changes in motion.

Learning Objectives

- Plan and carry out a controlled investigation with clear variables.
- Measure time, distance, speed/acceleration, and compare trends.
- Analyze how mass affects acceleration when force is held constant.
- Construct evidence-based claims referencing Newton's 2nd Law.
- Communicate results using graphs, CER, and scientific vocabulary.

Variables:

Independent Variable:

Dependent Variable:

Controlled Variables:

Materials:

- Balloons (long "dining" style recommended)
- Smooth string (2-4 meters)
- 2 straw (one for the rocket, one as backup)
- Tape and Stopwatch
- Meterstick or measuring tape
- Small masses (paper clips, mini washers) and mass scale
- Masking tape (for start/finish lines)
- Data sheets

Background Science for the Teacher: Newton's 2nd Law $F = ma$

When the force is the same, adding mass decreases acceleration.

The balloon provides similar thrust force each time, but heavier rockets accelerate more slowly.

Important Controlled Variables

- Amount of air in balloon (inflate to same length)
- Distance of the test track
- Same string, angle, and straw design
- Same launch method and starting alignment

Expected Results Pattern

- The balloon rocket travels fastest with low mass attached.
- More mass $\rightarrow$ longer time, slower acceleration.
- If too much mass is added, the balloon may not move at all.

Review Key Concepts: Newton's 2nd Law states that the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass ($a = F/m$). In this investigation, the net force (thrust from the escaping air) is kept constant, and the mass is varied to observe its effect on acceleration.

Key Vocabulary: Acceleration, Force, Mass, Newton's 2nd Law, Thrust, Velocity.

Safety: Use caution with the string and balloons. Do not throw balloons at people or pets.

Extension: Investigate how launch angle affects the horizontal distance traveled.

Challenge: Design a rocket that can carry a small payload (like a paper clip) and still move.

Reflection: How did changing the mass affect the acceleration? Did your results match your predictions?

Conclusion: Summarize your findings and the relationship between mass and acceleration.

Share: Present your findings to the class and discuss any discrepancies.

Assessment: Use the CER and graph to evaluate student understanding.

Exit Ticket: Write a short paragraph explaining Newton's 2nd Law using the balloon rocket.

Homework: Research the applications of Newton's 2nd Law in real-world scenarios.

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