

THERMAL INSULATION STEM INVESTIGATION - KEEP ICE FROM MELTING!

Thermal Insulation STEM Investigation - Keep Ice from Melting!

Purpose

Use an engineering design challenge to teach **heat transfer, insulation, experimental design, data collection, and graphing**. Students will design and build a container that slows melting by reducing heat transfer to an ice cube.

Learning Objectives

- Plan and carry out a controlled investigation with repeated trials
- Design and build a container to reduce heat transfer
- Measure mass change in an ice cube over time
- Collect and analyze quantitative data
- Create and interpret a graph to compare designs
- Use evidence to explain which design best reduced melting

Safety

- Handle scissors and cutting tools carefully
- Dry spills immediately to prevent slipping
- Do not eat ice or materials
- Handle glass beakers with care

Materials

Required

- 1 ice cube (same size for all groups) per trial
- 1 beaker (ice cube sits inside beaker)
- Digital scale (grams)
- Timer or stopwatch
- Thermometer (optional)

Design Materials (Student Choice – Teacher Approved)

- Aluminum foil
- Cotton balls
- Felt or fabric
- Foam sheets
- Bubble wrap
- Paper towels
- ~

Materials with teacher approval.



Print-and-go
STEM lab where
students learn
about thermal
insulation
through a hands-
on activity.

SCROLL
to take a look inside!

NO PREP



HOW THIS LAB WILL HELP YOU



- Print-and-go setup
- Clear Testing Procedure
- Teaches Scientific Method
- Low-cost & common materials

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- Plastic wrap
- Newspaper

Students may propose additional materials with teacher approval.

Keep Ice from Melting! — Thermal Insulation STEM Investigation

Driving Question
How does the design of an insulated container affect how quickly an ice cube melts?

Hypothesis
Write a testable hypothesis predicting which insulation design will keep the most ice from melting after 15 minutes and why.

Variables – List your variables.

Type	Describe for This Experiment
Independent Variable	
Dependent Variable	
Controlled Variables	

Experimental Design

1. Measure and record the **initial mass** of the ice cube (grams).
2. Place the ice cube inside a beaker.
3. Build an insulated container around the beaker using chosen materials.
4. Start the timer for **15 minutes**.
5. After 15 minutes, remove the ice cube, gently remove liquid water, and measure the final mass.
6. Record data and calculate **mass lost**.
7. (Optional) Repeat or compare designs across groups.

Data Table
Ice Mass Data

Group	Insulation Design	Initial Mass (g)	Final Mass (g)	Mass Lost (g)
A				
B				
C				
D				

★ Teacher Guide: setup, safety, pacing, and background science.

★ Student Packet: clear, step-by-step setup and timing instructions with blank data tables.

★ Graphing pages templates and marking rubric.

★ Complete answer key with example data tables.

What you get inside

Rubric Category	4 – Exceeds Expectations	3 – Meets Expectations
Hypothesis	Testable, clearly predicts which design will work best with scientific reasoning.	Testable prediction stated.
Design & Planning	Thoughtful container design based on insulation and heat transfer.	Functional design with insulation.
Variables & Controls	Correctly identifies IV, DV, and multiple controlled variables with explanations.	Variables identified correctly.
Procedure & Build Quality	Container built carefully with minimal gaps; follows procedure consistently.	Container built and used.
Data Collection	Accurate, complete measurements for initial and final mass.	Data recorded accurately.
Graphing	Correct graph type with labeled axes, title, and accurate data.	Graph with title and axes.
Data Analysis & Patterns	Clearly identifies patterns between insulation and mass lost.	Identifies pattern.
Scientific Reasoning	Explains results using heat transfer and insulation concepts accurately.	Basic explanation.
Claim-Evidence-Reasoning (CER)	Strong claim supported by specific data and clear reasoning.	Claim supported.
Sources of Error & Improvements	Identifies realistic errors and meaningful design improvements.	Identifies errors.
Safety & Lab Behavior	Follows all safety rules independently.	Follows safety rules.

Thermal Insulation STEM Investigation - Keep Ice from Melting!

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Materials Required

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- 1 beaker (ice cube sits inside beaker)
- Digital scale (grams)
- Timer or stopwatch
- Thermometer (optional)

Design Materials (Student Choice – Teacher Approved)

- Aluminum foil
- Cotton balls
- Felt or fabric
- Foam sheets
- Bubble wrap
- Paper towels
- Cardboard
- Plastic wrap
- Newspaper

Students may propose additional materials with teacher approval.

After 15 Minutes

Design	Mass of Ice Remaining (grams)
Paper towels only	18
Bubble wrap and aluminum foil	6

... quickly an ice cube melts?

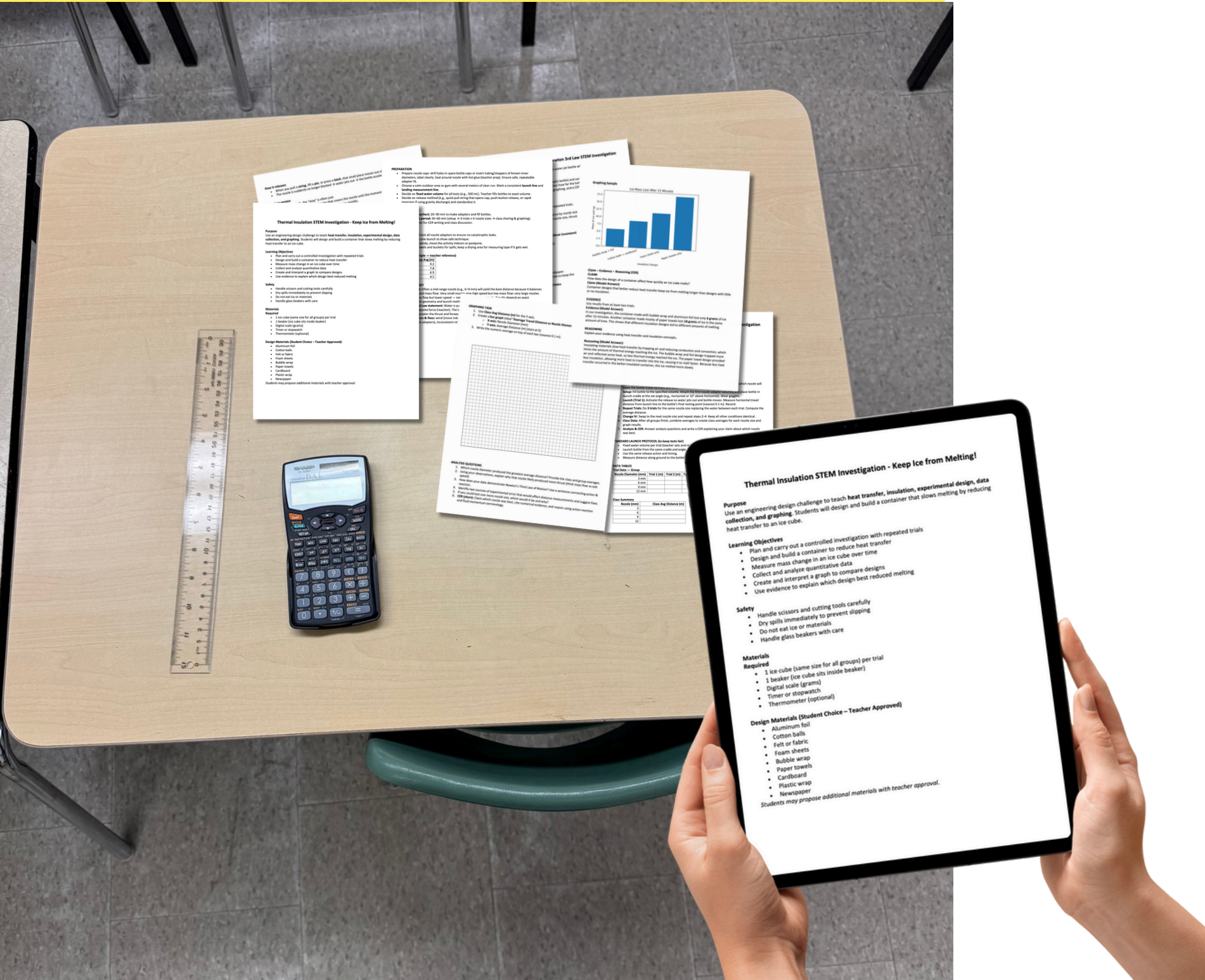
... transfer keep ice from melting longer than designs with little

... bubble wrap and aluminum foil lost only **6 grams** of ice. The paper towels lost **18 grams** of ice in the same amount of time. The paper towel design provided more insulation, leading to different amounts of melting.

... insulation concepts.

... air and reducing conduction and convection, which slowed the melting. The bubble wrap and foil design trapped more air around the ice, causing it to melt faster. Because less heat reached the ice, the ice melted more slowly.

Skills Your Students Will Learn/Improve



- ✓ Carrying out Controlled Experiments
- ✓ Precise Measurement
- ✓ Design and Redesign
- ✓ Graphing Data
- ✓ Claim–Evidence–Reasoning
- ✓ Analyzing Results

Your Lab

Thermal Insulation STEM Investigation - Keep Ice from Melting!

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Materials

Required

- 1 ice cube (same size for all groups) per trial
- 1 beaker (ice cube sits inside beaker)
- Digital scale (grams)
- Timer or stopwatch
- Thermometer (optional)

Design Materials (Student Choice – Teacher Approved)

- Aluminum foil
- Cotton balls
- Felt or fabric
- Foam sheets
- Bubble wrap
- Paper towels
- Cardboard
- Plastic wrap
- Newspaper

Students may propose additional materials with teacher approval.

All steps are clearly
outlined and easy to
follow

Students collect data
in organized charts

Graphing

Students analyze their data
and draw conclusions

Keep Ice from Melting! — Thermal Insulation STEM Investigation

Driving Question

How does the design of an insulated container affect how quickly an ice cube melts?

Hypothesis

Write a testable hypothesis predicting which insulation design will keep the most ice from melting after 15 minutes and why.

Variables – List your variables.

Type	Describe for This Experiment
Independent Variable	
Dependent Variable	
Controlled Variables	

Experimental Design

1. Measure and record the **initial mass** of the ice cube (grams).
2. Place the ice cube inside a beaker.
3. Build an insulated container around the beaker using chosen materials.
4. Start the timer for **15 minutes**.
5. After 15 minutes, remove the ice cube, gently remove liquid water, and measure the final mass.
6. Record data and calculate **mass lost**.
7. (Optional) Repeat or compare designs across groups.

Data Table

Ice Mass Data		
Group	Insulation Design	Initial Mass (g)
A		
B		
C		
D		

Graphing Task

Ice Mass Lost After 15 Minutes for Different Insulation Designs

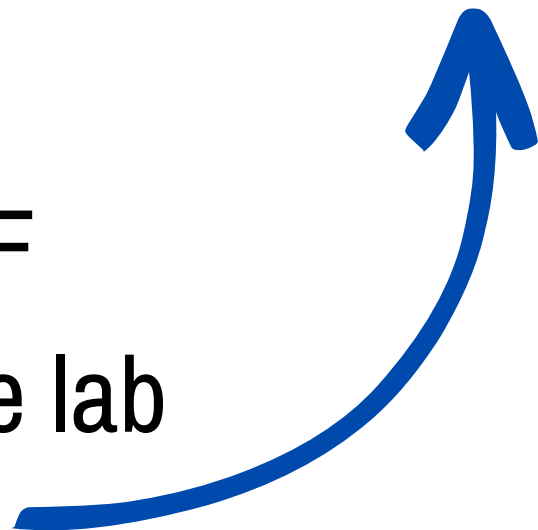
- X-axis: Insulation Design
- Y-axis: Mass of Ice Lost (g)
- Draw a bar graph showing how much ice melted for each design.



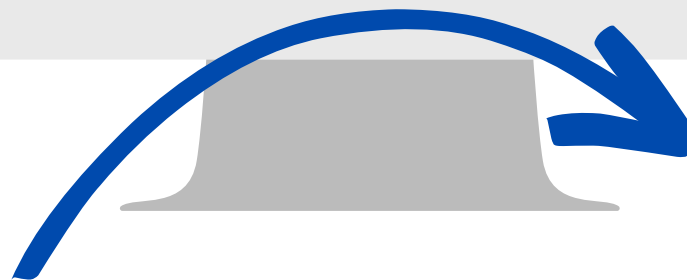
At School or at Home



Word and PDF
versions of the lab



Fully digital and editable - can be
done in class or through distance
education/homeschool



Ways to Use this Resource



Introduce the Scientific Method



Reinforce key ideas



Teach data analysis and graphing



Formative or Summative Assessment

Thermal Insulation STEM Investigat

Purpose
Use an engineering design challenge to teach heat transfer, collection, and graphing. Students will design and build heat transfer to an ice cube.

Learning Objectives

- Plan and carry out a controlled investigation with design and build a container to reduce heat transfer.
- Measure mass change in an ice cube over time.
- Collect and analyze quantitative data.
- Create and interpret a graph to compare design.
- Use evidence to explain which design best reduced heat transfer.

Safety

- Handle scissors and cutting tools carefully.
- Dry spills immediately to prevent slipping.
- Do not eat ice or materials.
- Handle glass beakers with care.

Materials Required

- 1 Ice cube (same size for all groups) per trial
- 1 beaker (ice cube sits inside beaker)
- Digital scale (grams)
- Timer or stopwatch
- Thermometer (optional)

Design Materials (Student Choice – Teacher Approval)

- Aluminum foil
- Cotton balls
- Felt or fabric
- Foam sheets
- Bubble wrap
- Paper towels
- Cardboard
- Plastic wrap
- Newspaper

Students may propose additional materials with teacher approval.

Background Science for the Teacher
Ice melts when thermal energy transfers from the warmer surroundings to the ice. The goal is not to stop melting, but to slow it down by reducing heat transfer.

Insulating materials slow heat transfer by trapping air, reducing convection, reflecting thermal radiation. The goal is not to stop melting, but to slow it down by reducing heat transfer.

Implementation Notes

- Assign roles: Builder, Timer, Measurer, Recorder. Rotate roles for each trial.
- Use the same size ice cube and the same type of beaker for all trials.
- Measure and record mass in grams before and after the 15-minute trial.
- Place the ice cube only inside the beaker, not directly touching the sides or bottom.
- Start timers at the same time for all groups to ensure fair results.
- Seal insulation gaps as best as possible without crushing the ice.
- Remove excess liquid water from the ice cube before measuring mass.
- Run at least one full trial and compare results across different insulation designs.

Teacher Notes on Common Pitfalls and Fixes

Different Ice Sizes
→ All ice cubes should be approximately the same size prior to the investigation. Students measuring water instead of ice.
→ Emphasize removing liquid water before final mass.

Containers touching ice directly
→ Ice must stay inside the beaker only.

Inconsistent timing
→ Start timers at the same time for all groups.

Graphing Sample
Ice Mass Lost After 15 Minutes

Insulation Design	Mass of Ice Lost (g)
Bubble wrap + foil	~6.5
Cotton balls + cardboard	~9.5
Foam sheet only	~12.5
Paper towel	~15.5

Keep Ice from Melting! — Thermal Insulation

Driving Question
How does the design of an insulated container affect how much ice melts?

Hypothesis
Write a testable hypothesis predicting which insulation design will keep the ice from melting the most in 15 minutes and why.

Variables – List your variables.

Type	Description
Independent Variable	
Dependent Variable	
Controlled Variables	

Experimental Design

- Measure and record the initial mass of the ice cube.
- Place the ice cube inside a beaker.
- Build an insulated container around the beaker.
- Start the timer for 15 minutes.
- After 15 minutes, remove the ice cube, gently melt any ice on the beaker, and calculate mass lost.
- Record data and calculate mass lost.
- (Optional) Repeat or compare designs across groups.

Data Table

Group	Insulation Design	Initial Mass (g)	Final Mass (g)
A			
B			
C			
D			

Graphing Task
Ice Mass Lost After 15 Minutes for Different Insulation Designs

- X-axis: Insulation Design
- Y-axis: Mass of Ice Lost (g)
- Create a bar graph showing how much ice melted for each design.

Rubric

Category	4 – Exceeds Expectations	3 – Meets Expectations	2 – Approaches Expectations	1 – Beginning
Hypothesis	Testable, clearly predicts which design will work best with scientific reasoning.	Testable prediction stated.	Vague or weak prediction.	Missing or not testable.
Design & Planning	Thoughtful container design based on insulation and heat transfer.	Functional design with insulation.	Design is weak or poorly planned.	No clear design.
Variables & Controls	Correctly identifies IV, DV, and multiple controlled variables with explanations.	Variables identified correctly.	Some variables incorrect or missing.	Variables not identified.
Procedure & Build Quality	Container built carefully with minimal gaps; procedure follows.	Container built and usable.	Build issues affect results.	Build incomplete or incorrect.
Data Collection	Accurate, complete measurements for initial and final mass.	Data mostly complete and accurate.	Incomplete or inconsistent data.	Data missing or inaccurate.
Graphing	Correct graph type with labeled axes, title, and accurate data.	Graph present with minor errors.	Graph incorrect or unclear.	No graph.
Data Analysis & Patterns	Clearly identifies patterns between insulation and mass lost.	Identifies basic pattern.	Weak or incorrect pattern.	No pattern identified.
Scientific Reasoning	Explains results using heat transfer and insulation concepts accurately.	Basic explanation using science ideas.	Limited or partially incorrect explanation.	No scientific explanation.
Claim-Evidence-Reasoning (CER)	Strong claim supported by specific data and clear reasoning.	Complete CER with evidence.	Weak or incomplete CER.	Missing CER.
Sources of Error & Improvements	Identifies realistic design improvements.	Identifies basic errors or improvements.	Errors or improvements vague.	No reflection.
Safety & Lab Behavior	Follows all safety rules independently.	Minor reminders needed.	Repeated reminders.	Unsafe behavior.

Download my Angle of Attack STEM Lab FREE
CLICK HERE

Paper Airplane Angle of Attack STEM Lab

Scientific Method • Variables • Data & Graphing

✓ Classroom-Ready

✓ Data tables + bar graph templates included



✓ Teacher guide with setup, safety, background science, pacing

✓ Step-by-step procedure for testing

✓ Analysis questions with model answers and Rubric



Paper Airplane: Angle of Attack STEM Investigation: Scientific Method Activity

Teachers Reference:

Angle of Attack Explained - <https://youtu.be/D1J1oUP-aKA?si=vsnb9a72PajoWnZs>



Purpose

Use a high-engagement paper-airplane challenge to teach experimental design, variables and controls, proportional reasoning, data analysis, and communication of results.

Learning Objectives

- Plan and carry out a controlled investigation with clear independent, dependent, and controlled variables.
- Collect sufficient data (replicates) and compare results across angle conditions.
- Graph distance data to analyze trends and construct evidence-based claims.
- Explain the physical principles (lift, drag, stall) that affect flight distance.

only airplanes; no paper clips or sharp nose cones.
a clear launch lane; stand behind the throw line; throw parallel to the floor.
ing area clear; retrieve planes only after all throws in a round are complete.

- Use a standard 8.5x11 in. — identical for all planes
- Use a standard template (optional, one standard design for all teams)
- Use a protractor (or angle guides) to set release angle relative to horizontal
- Tape for a throw line and distance marks; measuring tape or meter tape
- Data sheets (included), clipboards, pencils

Background Science for the Teacher

Lift vs Angle of Attack (AoA): Lift generally increases with AoA up to a point. Beyond a critical AoA, airflow separates (stall), causing lift to drop and drag to rise, shortening distance.

Drag and Energy: Higher AoA increases frontal area and induced drag; too much drag slows the plane quickly. Moderate AoA balances adequate lift with manageable drag for a longer glide.

Consistency: A single plane design, constant throw force/height, and a clear angle-setting method are key to fair comparisons.

Expected Results Pattern

- Distances typically peak at a moderate AoA (around 10°–15° for a simple dart design).
- Very low AoA (0°–5°) may dive or fail to generate a strong glide; very high AoA (20°+) often stalls or climbs then falls rapidly.
- As throw technique becomes consistent, variation decreases and the distance curve vs angle becomes clearer.

Implementation Notes

- Use one standard airplane design per class for consistency (provide a template or model).
- Assign roles: Thrower, Angle Setter/Checker, Measurer, Recorder. Rotate roles between angles.
- Mark the throw line and measure angle at release using a protractor or an angle card taped to the forearm or launcher guide.

Answer Key and Sample Results

Note: Actual class data will vary. The sample below models typical trends and acceptable analysis quality.

Sample Summary Data

Angle (°)	Average Distance (m)
0	7.8
5	10.6
10	12.9
15	12.1
20	8.9

Interpretation

- Greatest average distance at 10° (=12.9 m) with a close second at 15° (=12.1 m).
- Very low angle (0°) underperformed (dives/low lift). Very high angle (20°) lost distance (near-stall and higher drag).
- The trend supports a moderate-angle optimum due to balance of lift and drag.

Model Responses to Analysis Questions

- Best angle: 10° with an average of ~12.9 m (our class graph shows a peak around 10–15°).
- Consistency: Results were reasonably consistent after the practice round; using the same thrower and angle card reduced variation.
- Controls that mattered most: Plane design and paper type, release height and throw force, indoor/no-draft room, and measuring to first contact.
- Follow-up: Test nose mass with paper clips at the best angle. Hypothesis: Adding a small nose mass (1–2 clips) will increase distance by improving stability without greatly increasing drag.

STEM INVESTIGATION BUNDLE

Build a high-engagement, low-prep STEM program.

- This Bundle includes my best STEM investigations—each one built around true engineering design, fair testing, repeated trials, data tables, graphing, and CER writing.
- STEM develops crucial skills like critical thinking and creativity and prepares students for a changing world and future opportunities.



Tell me and I forget. Teach me and I remember. Involve me and I learn. - Benjamin Franklin



STEM Investigation Growing Bundle

Scientific Method • Variables • Data & Graphing

✓ Classroom-Ready

✓ A Variety of Science Topics Included



**Click to
learn more!**

As a special bonus, I want to send you a few resources that you can use in your classroom tomorrow. Completely free and geared towards what you teach!



Just  **and then choose what you teach!**

thanks
**for your interest
in this resource!**

