

Parachute STEM Lab - Canopy Diameter vs Descent Time

Scientific Method • Variables • Data & Graphing

- ✓ Classroom-Ready
- ✓ Data tables + bar graph templates included



Parachute STEM Lab - Canopy Diameter vs Descent Time

Purpose

Use an engaging parachute build 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 canopy sizes.
- Graph time data to analyze trends and construct evidence-based claims.
- Explain the physical principles of drag, surface area, and terminal velocity.

Safety

- Use lightweight payloads (washers wrapped in tape or clay, etc.). No sharp edges.
- Drop from safe heights only (step stool with spotter or stair landing with rail).
- Keep a clear drop zone; no one under the drop area during releases.

Materials

- Canopy templates
- Plastic trash bags or coffee filters (identical material for all canopies)
- String (equal length shrouds), tape/hole reinforcements, scissors
- Washers or clay as a standard payload (same mass for all tests)
- Stopwatch or timer app, meter stick or measuring tape for drop height
- Data sheets (included), clipboards, pencils

Background Science for the Teacher

Drag and Area: Air resistance (drag) increases with canopy area and speed. Larger canopies provide more drag, reducing descent speed and increasing fall time.

Terminal Velocity: During descent, gravity is balanced by drag at terminal velocity. A larger canopy lowers terminal velocity, so the parachute falls more slowly.

Diminishing Returns: Very large canopies add mass and instability; beyond a point, added area yields smaller gains or wobble that reduces time consistency.

Expected Results Pattern

- Descent time increases as canopy diameter increases, up to a plateau where returns diminish.
- Medium-to-large canopies often perform best (e.g., 25–30 cm for classroom builds using filters/bags).
- Consistent shroud length (line from canopy to object), drop height, and payload mass.

Implementation Notes

- Keep canopy shape and material constant; vary only diameter. Use a circular template and pre-cut sizes.
- Use equal diameter (e.g., 20–25 cm) and tie to a payload.
- Designate a fixed drop height and a single release technique without push.

Summary Table

Canopy Diameter (cm)	Average Time (s)
10	
15	
20	
25	
30	

Graphing

- Create a bar graph (or line graph) of Average Time (s) on the y-axis vs Canopy Diameter (cm) on the x-axis.
- Start y-axis at 0; include a clear title and axis labels.

Analysis Questions

- Which canopy diameter produced the longest average descent time? Include the mean time and the diameter value.
- Describe how consistent your drops were across trials. What helped keep the test fair?
- Which controlled variables were most critical to keep times comparable?
- If time allowed, what follow-up experiment would you run next (canopy material, shroud length, apex hole)? State a testable hypothesis.

Answer Key and Sample Results

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

Sample Summary Data

Diameter (cm)	Average Time (s)
10	1.6
15	2.2
20	2.9
25	3.4
30	3.5



Interpretation

- Longest average time at 30 cm (~3.5 s) with a close second at 25 cm (~3.4 s).
- Very small canopies (10–15 cm) fell quickly due to low drag; mid-to-large sizes greatly increased drag and time.
- Beyond ~25–30 cm, returns leveled off (diminishing gains).

Model Responses to Analysis Questions

- Best canopy size: 30 cm with an average of ~3.5 s (class graph peaks near 25–30 cm).
- Consistency: Results improved after the practice round; equal shroud length and a fixed drop height reduced variation.
- Controls that mattered most: Canopy material and shape, shroud length, payload mass, still air, identical drop height and release.
- Follow-up: At the best diameter, compare materials (plastic vs coffee filter). Hypothesis: A lighter, less porous material will increase descent time due to higher effective drag.

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Driving Question

How does canopy diameter affect descent time?

Hypothesis

Write a testable hypothesis predicting which canopy size will maximize descent time and why (drag, surface area, terminal velocity).

Variables

Type	Describe for This Experiment
Independent Variable	Canopy diameter (cm)
Dependent Variable	Fall time from a fixed height (seconds)
Controlled Variables	Canopy material and shape; shroud length; payload mass; drop height; indoor still air; release technique; number of drops per condition

Making the parachutes

Part A — Make a full-circle canopy (10, 15, or 20 cm)

- Cut out the circular template along the solid line.
- Place the template on the parachute material and trace around it once.
- Cut out the circle from the material.
- Mark the center: use the small crosshair on the template to mark the canopy's center on the material (light dot).
- Reinforce the edge: place eight small tape tabs evenly around the rim (think clock positions at 12, 1:30, 3, 4:30, 6, 7:30, 9, 10:30).
- Punch eight tiny holes through the tape tabs near the edge.

Part B — Make a large canopy from wedges (25 or 30 cm)

- Trace the wedge on the material four times. Cut out four wedges.
- Align straight edges and tape the four wedges together to form a full circle. Press seams flat.
- Mark the center (where the wedge points meet).
- Add eight tape tabs around the rim and punch holes as in Part A.

Part C — Add shroud lines (same for all sizes)

- Cut eight equal lengths of string (all exactly 20–25 cm; choose one length and keep it for the whole investigation).
- Tie one end of each string through a punched hole around the rim. Use the same knot each time. If using trash bags, wrap once through the hole and tape the knot flat to prevent tearing.
- Gather the free ends of all eight strings and tie them together to a paper clip or a small string loop. This gathering point is the **payload attachment ring**.
- Attach the payload:
 - Washer: open the paper clip slightly and hook the washer or tie the washer to the loop.
 - Clay: press the loop into a small clay ball and smooth it closed around the loop.
- Quality check:
 - Hold the canopy by the center mark and let the shrouds hang. All eight strings should be the same length from canopy edge to the gathering point. If one is longer/shorter, re-tie to match the others.
 - Check that knots are tight and tabs are secure.

Experimental Design

1. Test four canopy diameters: 10 cm, 15 cm, 20 cm, 25 cm, and 30 cm. Use the material tabs created.

Rubric - Parachute STEM Lab - Canopy Diameter vs Descent Time

Category	Exceeds (4)	Meets (3)	Approaches (2)	Beginning (1)
Experimental Design	Variables clearly named; procedure mostly standardizes canopy, shrouds, and drop height; practice round completed; enough drops for fair comparison.	Variables named; procedure mostly consistent; drops completed.	Variables partially named or unclear; inconsistent procedure; fewer drops than planned.	Variables missing; no consistent procedure; very few drops.
Data Quality	All drops recorded neatly; totals match; times to 0.1 s; summary complete.	Almost all drops recorded; minor slips corrected; summary mostly complete.	Several omissions or unclear entries; summary incomplete or mismatched.	Many missing or unreadable entries; summary not usable.
Graphing & Analysis	Correct graph with labeled axes and title; bars/points reflect each diameter; clear takeaway identifying best size with numbers.	Graph present with labels and title; takeaway stated.	Graph present but missing some labels or clarity; takeaway vague.	No graph or incorrect graph; no takeaway.
Claim-Evidence-Reasoning	Clear claim naming best diameter; evidence cites results from this lab; reasoning connects to drag area and	Claim supported with basic evidence and some correct reasoning.	Claim present but weakly supported; reasoning unclear or generic.	Claim absent or unrelated to data; no reasoning.

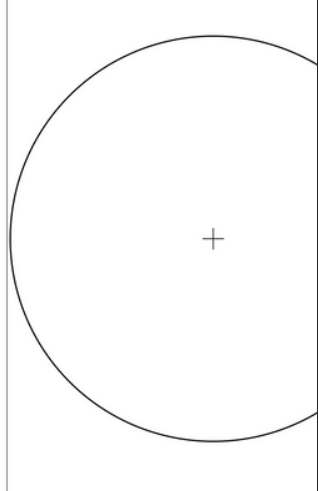
Parachute Canopy Template — 30 cm (quarter circle)

Trace this wedge 4x to make a full circle. Tape pieces together at the straight edges. Print at 100% (no scaling).

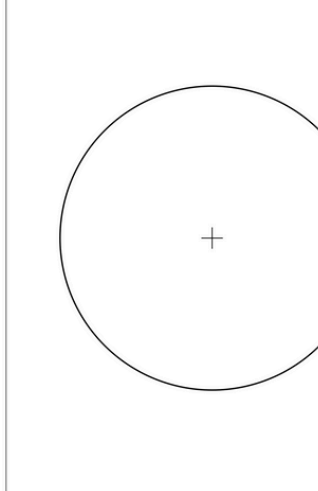
Parachute Canopy Template — 25 cm (quarter circle)

Trace this wedge 4x to make a full circle. Tape pieces together at the straight edges. Print at 100% (no scaling).

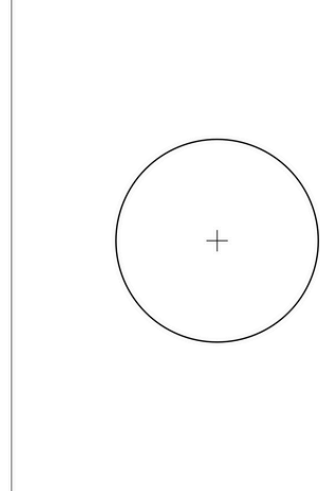
Parachute Canopy Template — 20 cm (full circle)



Parachute Canopy Template — 15 cm (full circle)

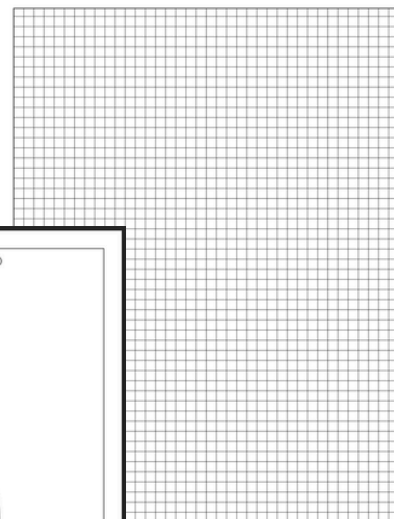


Parachute Canopy Template — 10 cm (full circle)



Data Collection Tables

Canopy Diameter (cm)	Drop #	Time (s)
10	1	
10	2	
10	3	
10	4	
10	5	
10	6	
10	7	
10	8	
10	9	
10	10	
15	1	
15	2	
15	3	
15	4	
15	5	
15	6	
15	7	
15	8	
15	9	
15	10	
20	1	
20	2	
20	3	
20	4	
20	5	
20	6	
20	7	
20	8	
20	9	
20	10	
25	1	
25	2	
25	3	
25	4	
25	5	
25	6	
25	7	
25	8	
25	9	
25	10	
30	1	
30	2	
30	3	
30	4	
30	5	
30	6	
30	7	
30	8	
30	9	
30	10	



What You Get

- **Teacher Guide:** setup, safety, pacing, and background science (drag, surface area, terminal velocity).
- **Student Packet:** clear, step-by-step build instructions and blank data tables for 10 drops per canopy size.
- **Summary & Graphing Pages:** average-by-diameter table and graph template (Average Descent Time vs Canopy Diameter) with included graph paper.
- **Printable Canopy Templates:** full circles (10, 15, 20 cm) and quarter-circle wedges (25, 30 cm) for accurate tracing.
- **Analysis & Model Answers:** four prompts with sample data and exemplar responses.
- **Rubric & Extensions:** simplified rubric for easy grading