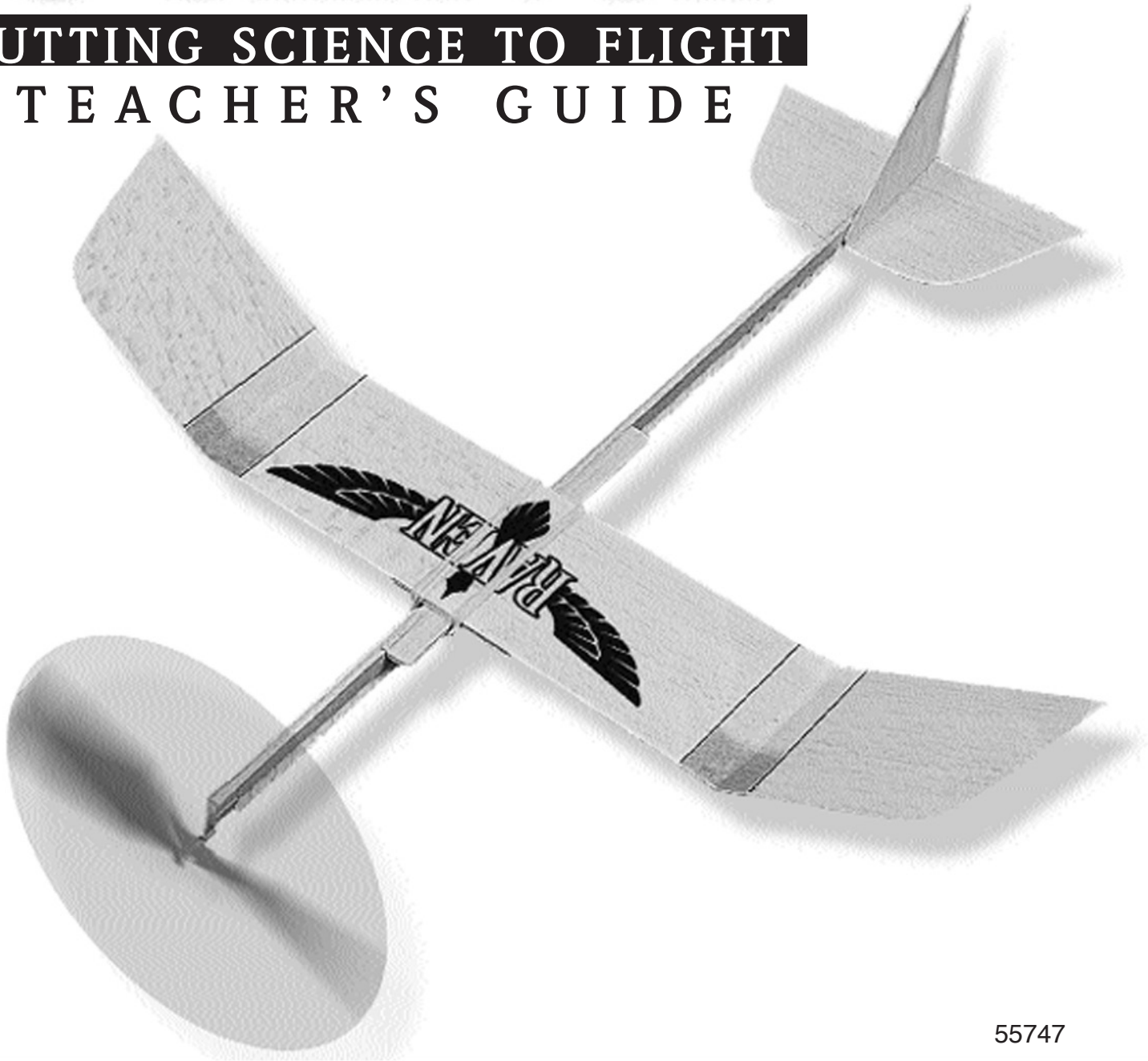
"MODEL" SCIENCE

PUTTING SCIENCE TO FLIGHT

TEACHER'S GUIDE



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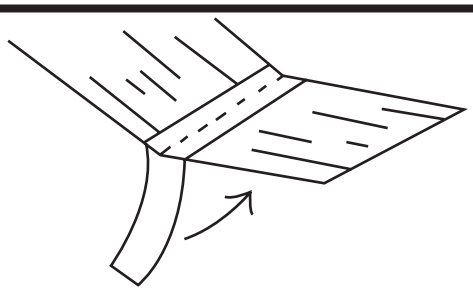
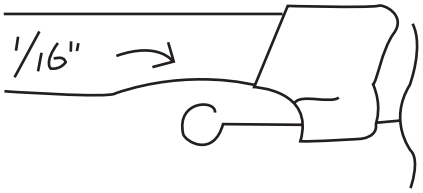
TECH TIPS
Building Tips for the Raven

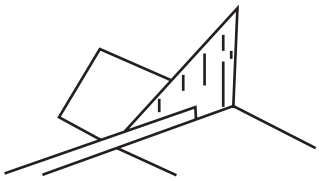
Broken wings are a bummer. Unless the dihedral joint is glued just right, the wing tips may break during a hard landing. To keep this from happening, glue a strip of tissue across the top of the joint and underneath the wing. Use a thin layer of white glue, and smooth it down with your finger.

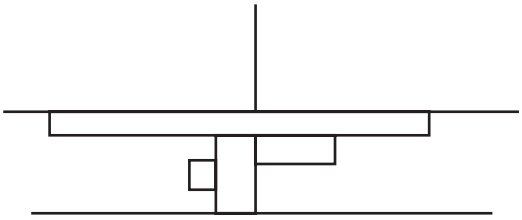




The 1/4" rubber motors used on the *Raven* provide a fast climb but are a bit large for the prop hanger. With a razor blade, trim the front of the fuselage as shown to give the motor a little room as it is being wound.

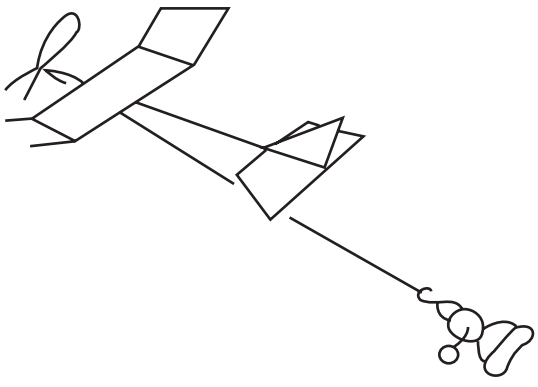
As you're putting the tail assembly together, make sure the grain on the fin is going up and down, and that it is glued firmly to the top of the stabilizer.





Make sure the wing saddle is at a right angle to the fuselage, and that it's level with the top. The wing should be flat and level with the stabilizer when viewed from the front. If it's still a little crooked after being rubber banded, use the sanding block to plane the saddle to the correct angle.

Use a winder to stretch wind the rubber band motor to give longer flight times. An old hand drill with a bent nail for a hook works well. Take the rubber band from the back of the plane, and hook it to the winder. Stretch the motor to twice its length, making note of the tension you feel in the rubber band. Wind the motor while slowly moving toward the plane, keeping that same amount of tension. When even with the back pin, remove the rubber band from the winder and hook it onto the plane.



POWER PARAGRAPHS
Putting Writing to Flight

The following topic sentences are a great way to infuse some powerful writing into your *Raven* project.

Where appropriate, put three of these sentences on the front board, and ask your students to pick the two they would like to use. Review the basics of what a proper paragraph should look like, and you've got an instant homework assignment.

1) I still can't believe that the same forces that keep a 747 flying, also keep my *Raven* up and going.

2) Why does my plane seem to fly so much (better, worse) than my partners? They all look the same.

3) The *Raven* flies alright, but I would like to see some changes made in its design.

4) This *Raven* project is the best thing we've done all year!

5) This *Raven* project is the dumbest thing we've done all year, and I can't believe we're being asked to do it!

6) I really enjoy projects like this because they help make science so realistic to me.

7) Even though I've been reading that little chart, I still can't seem to get my *Raven* flying right.

8) Working in small groups is my favorite way to learn new things.

9) Working in small groups has always been tough for me, and I wish I had the chance to work alone.

10) Now that we're almost done with the *Raven*, I've got some great ideas for our next project.

These are just a few examples of how flying *Raven's* can result in some challenging student writings. Keeping a journal during the project could easily accomplish the same thing.

LAB REPORT
"Doing Science the Right Way"

Problem: _____

Manipulated Variable: _____

Responding Variable: _____

Control Variables: _____

Experimental Procedure: _____

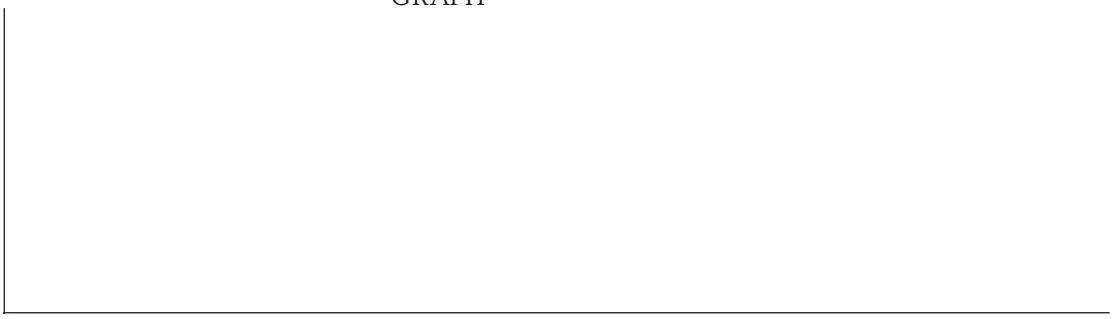
_____

_____

_____

DATA TABLE

GRAPH



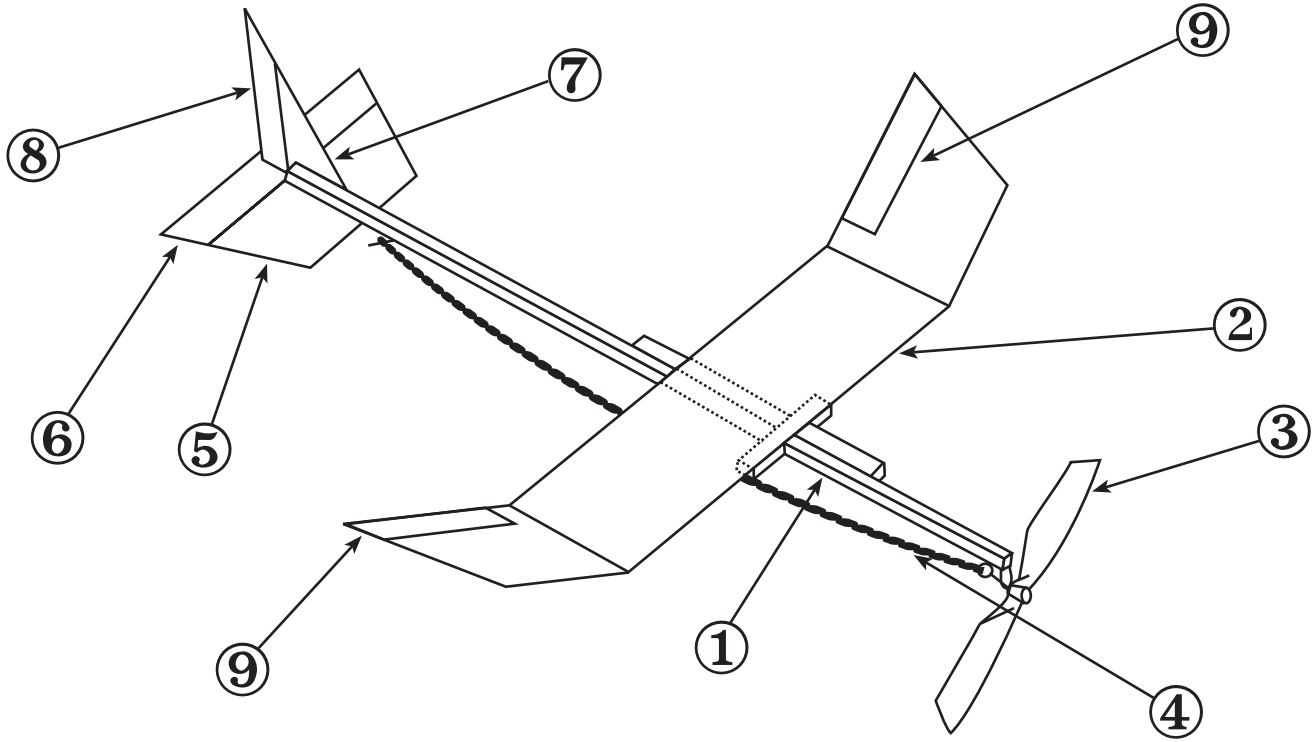
Conclusion: _____

_____

_____

_____

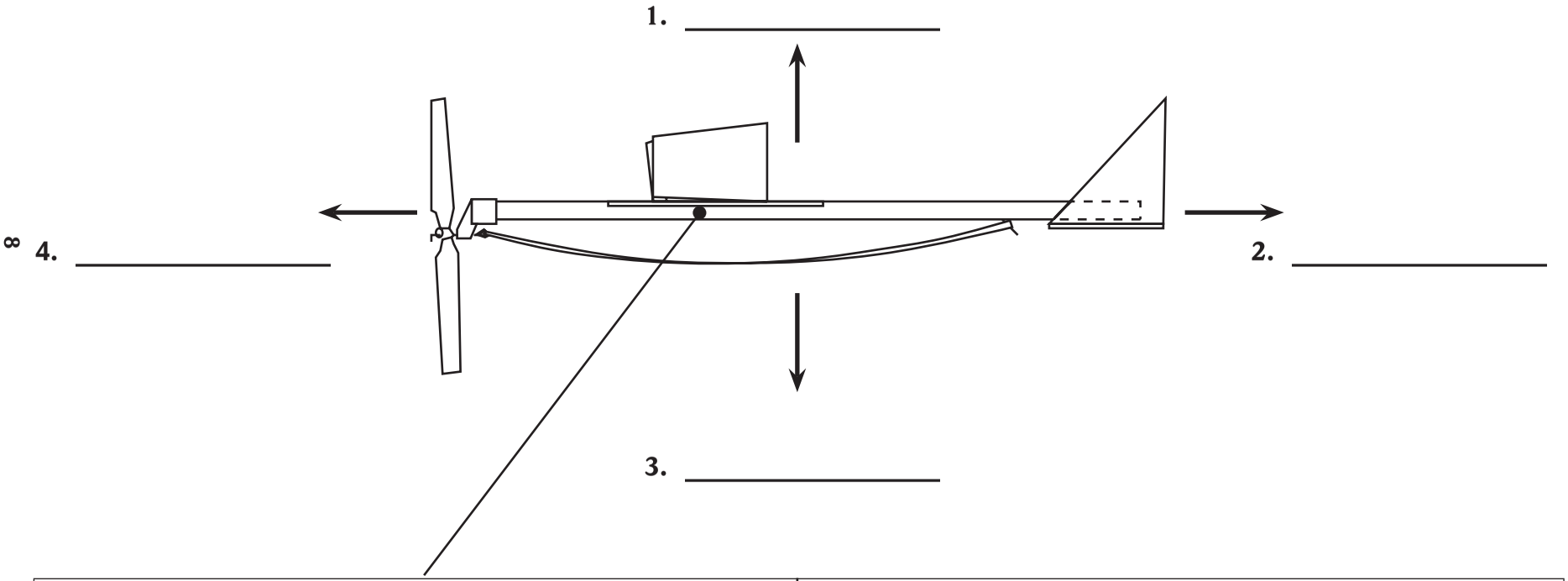
AIRPLANE PARTS
Raven



PART	FUNCTION	PART	FUNCTION
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.			

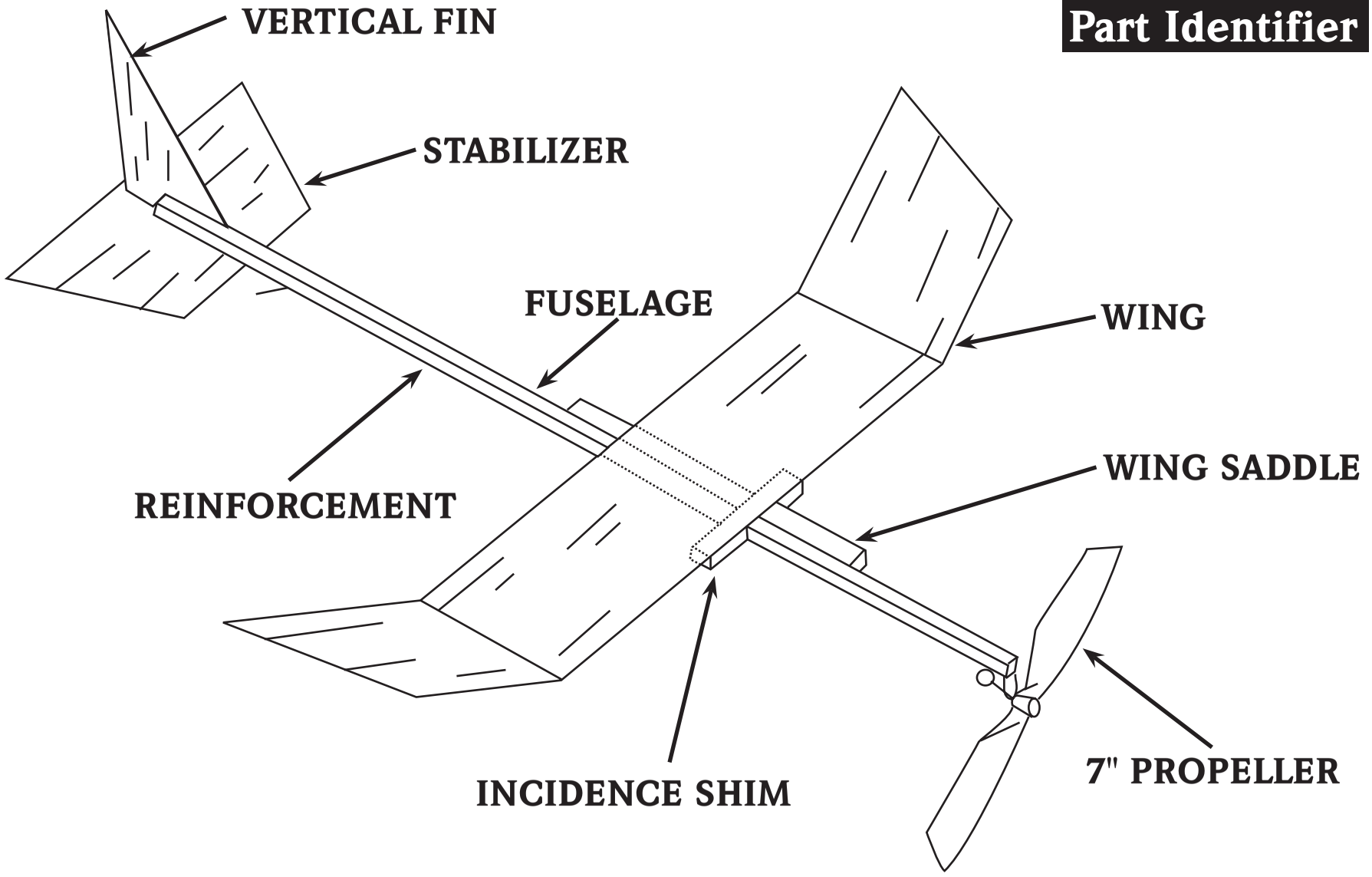
FORCES OF FLIGHT
Raven

FORCE: _____



CENTER OF GRAVITY	
	1.
	2.
	3.
	4.

RAVEN
Part Identifier



FLIGHT DYNAMICS
And the Analysis of Change

❶ Describe in detail how each of the following changes to your *Raven* would change the forces of flight acting on the airplane.

❷ Predict what impact these changes would have on the plane's flight performance.

For Example:
Use a wing that is only half the size of the original wing.
Forces: Having half the wing would result in a plane that is lighter with less drag, but the lift would be much less. The thrust would stay the same.
Flight: I think this plane would fly a lot faster and maybe even climb a bit higher, but with much less lift, I don't think it would fly any longer.

Using the above example as a model, analyze the following changes.

1. Tape 10 pennies to the wing at the center of gravity.
Forces: _____
_____
_____
Flight: _____
_____
_____

2. Add a second wing above the first to create a biplane.
Forces: _____
_____
_____
Flight: _____
_____
_____

3. Give the entire plane a slick glossy coat of paint.
Forces: _____
_____
_____
Flight: _____
_____
_____

These are just a few possible changes. Can you think of any others?

LAB REPORT
"Doing Science the Right Way"

SAMPLE

Problem: How does the # of turns on the motor change flight times?

Manipulated Variable: # of turns on the rubber motor

Responding Variable: Flight time in seconds

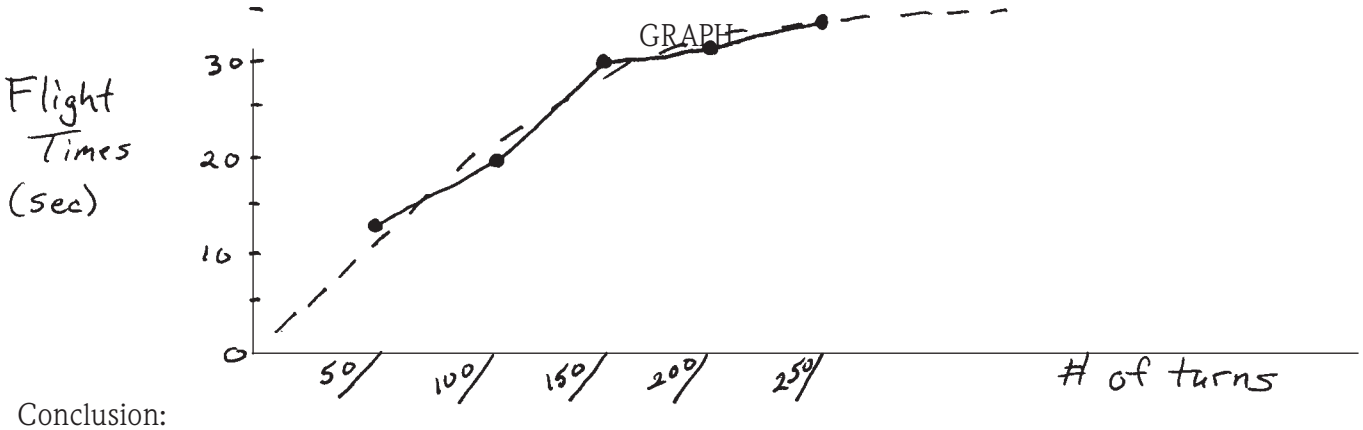
Control Variables: Same plane, same launch conditions

Experimental Procedure: Wind the rubber motor with a different # of turns; 50, 100, 150, 200, 250 and time the resultant flight endurance.

DATA TABLE

# of turns on motor	Flight time in seconds
50	12 sec.
100	20 sec.
150	30 sec.
200	31 sec.
250	33 sec.

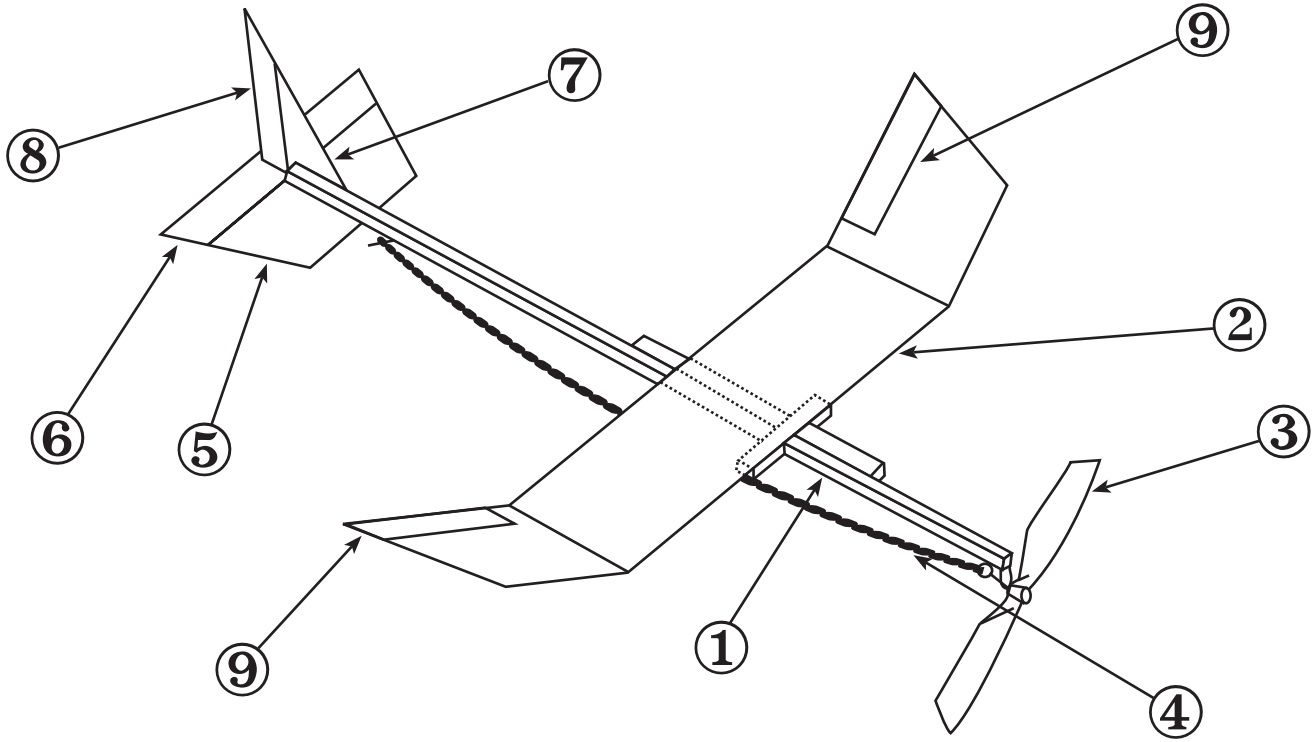
GRAPH



Conclusion: Between 50-150 turns, there is a large increase in flight times. Around 200 turns, flight times start to level off.

AIRPLANE PARTS
Raven

KEY

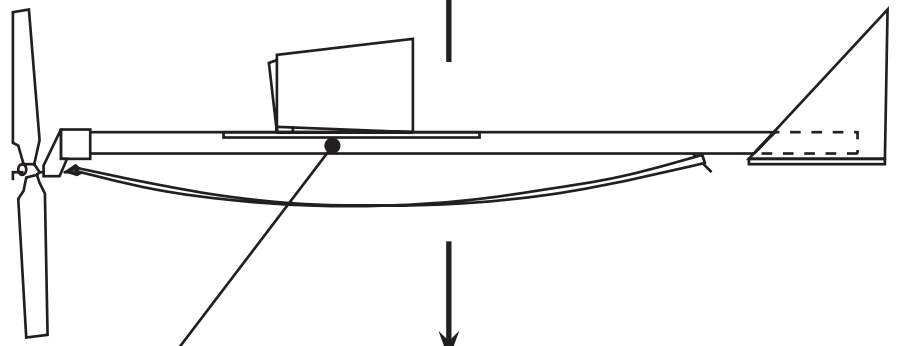


PART	FUNCTION	PART	FUNCTION
1. Fuselage	Body: Holds everything	6. Elevator	Control surface "up down"
2. Wing	Lift	7. Fin	"Left-right" stability
3. Prop	Thrust	8. Rudder	Control surface LR
4. Motor	Potential Energy	9. Aileron	Control surface banking
5. Stabilizer	"up-down" stability		

FORCES OF FLIGHT
Raven

KEY

FORCE: Any Push or Pull



1. Lift
2. Drag
3. Gravity
4. Thrust

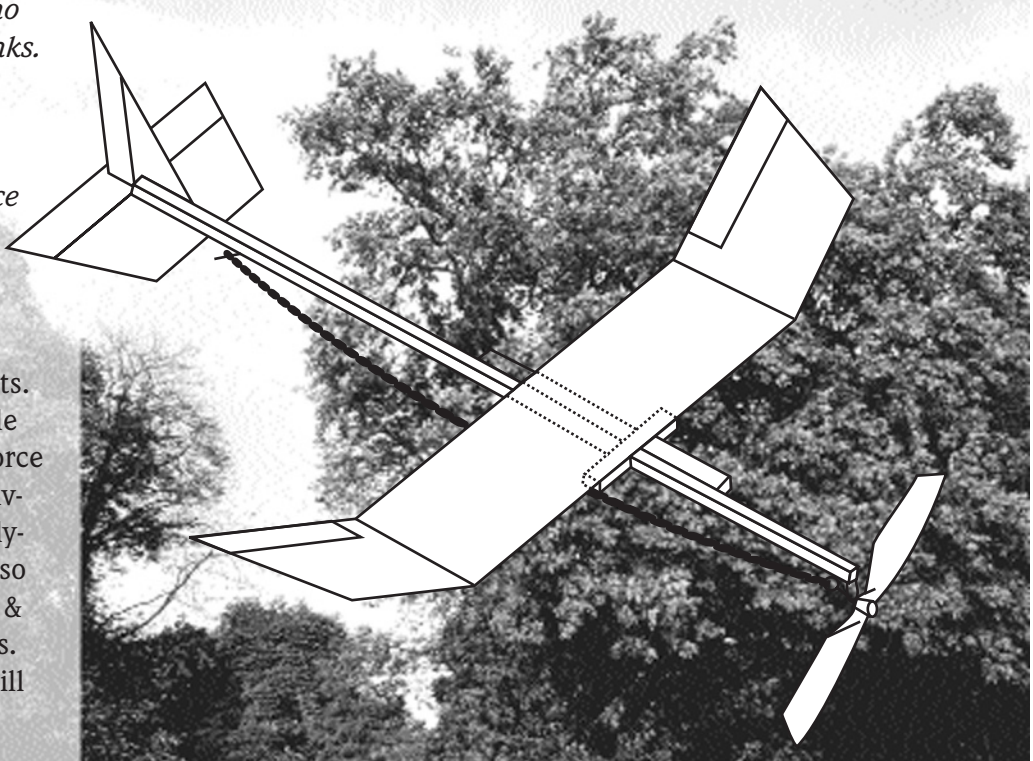
CENTER OF GRAVITY	
	1. Push upward from the wing
Point at which the plane	2. Friction with the air
is balanced in every	3. Pull downward
direction	4. Action – Reaction: The prop pushes
	air back, air pushed plane forward.

In the grassy field next to the school, Johnny stands in the warm sun. Gently clutched in his right hand is his completed Raven model airplane. He thinks to himself, "I hope this flies like Mr. Ferrario says it will. Well, here goes. . ." He releases the plane. The rubber band immediately begins to unwind, rapidly spinning the propeller. The plane soars upward, curving in a graceful, gentle arc. It spirals steadily upward into the bright blue sky, till it's almost out of sight.

Johnny stands there, gazing upward, amazed. After all, he built the model with his own hands in only three class periods. "Mr. Ferrario talked about all those forces of flight and how they would make my plane fly, but I had no idea it would work this well," he thinks.

Johnny watches his plane slowly glide down and come to rest on the grassy earth. He smiles.

He just became hooked on science and doesn't even know it.



Building and flying the Raven is a dynamic hands-on activity that will inspire even hard-to-motivate students.

The Model Science Teacher Guide sheds light on how to teach or reinforce science concepts with the Raven activity–forces of flight, mechanics, aerodynamics, to name a few. The Guide also includes ideas for great labs, control & variable testing, and writing activities. Let your students experience the thrill of the Raven project, and they'll be hooked too.