Lesson Outline--Day 1

Forces of Flight (25 minutes)

Unit Introduction:

Begin with a **demonstration** of a flyer that you have constructed prior to the first day of class. Ask the students: How long do you think this flyer can stay in the air?" Record guesses on the board or on chart paper. Ask a student volunteer to be timekeeper. Fly your plane several times. Compare the time it stays in the air to the student guesses. Discuss.

Introduce the essential question:

Can I make my plane fly for at least six seconds? Prove it. Explain that students will work in pairs to build planes that can fly for at least six seconds. They will build two planes. After building the first plane, they will test it, observe problems and strengths, and then build a second plane that addresses the problems. The second plane will be used during the culminating activity, a competition at the Science Olympiad.

Checking prior knowledge:

In table groups, students will complete a **KWL** chart that shares what they already KNOW about flight, and what they WANT TO KNOW about flight. Their chart should have a third column for what they will LEARN during the unit. The last column will remain empty today but will be revisited at the end of the unit. After five minutes, ask groups to share what they have in their KNOW columns. Use their responses to fill in a large KWL chart on butcher paper in the front of the class. Repeat the procedure for the WANT to know column.

What I KNOW	What I WANT TO KNOW	What I LEARNED

Vocabulary Terms:

Start by displaying the first vocabulary section, Part 1 Real Flyers (see master):

Bernouilli's Principle

and surfaces. In journals, have students sketch wing shapes, design ideas and possible innovations they may want to try.

Closure (10 minutes)

- Let volunteers demonstrate their paper airplanes for the class. (If extra time, they could first make revisions, based on observations and drawings from the airport trip.) You could also time the flights.
- Journals: Students can list the forces of flight and draw explanations of lift and thrust.
- If time, and just for fun, have students form a large circle, facing in, and launch all their planes at once.

Lesson Outline--Day 2

Glass Blowing (20 minutes)

- Prior to class, read "Glass Blowing (F2.1)," and try this activity several times before you do it in front of students.
- Demonstrate "Glass Blowing" three times.
- In pairs, students discuss and record possible reasons why blowing on the glass causes the candle directly behind the glass to be blown out. Ask two or three groups to share their ideas with the class. (This is a good time to stress sharing and teamwork.)
- After discussion, check students' understanding of lift, thrust, gravity and drag by having groups complete Part 2 of their vocabulary posters, again using drawings to clarify.
- Connect these concepts to yesterday's paper airplane activity.

Building a PB & J (40 minutes)

This messy activity emphasizes communication and the importance of attention to detail. For complete directions, see "Make a PB & J," (F2.3).

Flyer Introduction and Building Session #1 (60 minutes)

Note: It is important that students follow directions precisely during Flyer construction. The first day of building requires as much patience and guidance as possible. Individual attention is important since students will grasp the concepts and construction processes at different rates.

- Handout: student sheet, "Build a Flyer: Construction Session 1," and a plane kit to each pair of students.
- Following directions on the sheet, students should first inventory their materials.
- Next, you need to demonstrate how to cut and glue wood. Lead them through the process of pinning down the schematic, cutting gluing wood for the wings, tail and stabilizers. Emphasize the importance of following directions accurately and paying attention to detail. They must go slowly to cut and match joints flush to each other.
- Circulate continually through the room as they begin the construction process. Make sure the students know they are expected to get through these steps during this class session.
- As they build, you can discuss the positive and negative effects of construction and the importance of following directions and taking their time.

Extension: The investigation, "How far can you throw a piece of paper?" (F2.4), may be used for students who complete the first stage of plane construction early.

Closure (10 minutes)

- Journals: Use the "So What?" question on student work sheet to guide journal entries.
- Tell students how and where to store their planes while the glue dries. No one should be near or touch a plane that is not theirs.

Lesson Outline--Day 3

Bernoulli's Principle

The first two activities are designed to help students gain an understanding of Bernoulli's Principle: pressure decreases as velocity increases.

Bernoulli's Cans (25 minutes)

Refer to "Bernoulli's Cans," sheet F3.1, for complete background and demonstration instructions. Although this activity is fairly simple, it affords several opportunities to model prediction and analytical thinking. Setting up several stations around the room will allow students to experiment themselves.

Demonstrate the experiment three times and ask students to hypothesize why the cans roll together instead of apart; they can use the *Pairs Compare** strategy and record ideas in their journals. Let them try the experiment themselves as they work to discover answers.

After five to ten minutes, ask groups to share and demonstrate their hypotheses.

Bubble-ology (25 minutes)

Refer to "Bubble-ology," sheet F3.2 for complete directions. This activity is best conducted in an open area that is free from wind gusts. There should be ample space for exploration and experimentation. The challenge is for students to devise ways to keep bubbles from hitting the ground. Have a mop and bucket on hand as well as towels for mopping the floor!

- Begin by handing each pair of students directions (F3.2) and an index card. Using the *Partners** strategy, have them record observations and adjustments on the cards. The bubbleology sheets need to be rewritten--one for teacher and one for students. Use the student handout format.
- *Extension:* Each team can present to the class a method for keeping a bubble airborne.

Vocabulary (10 minutes)

Student groups work to fill in part 3 of their vocabulary posters. Science terms:

Control
Variable
Qualitative observation
Quantitative observation

Connect these terms to the morning experiments. Students can add drawings to their definitions to help them explain and remember the terms.

Flyers Building Session #2 (60 minutes)

- Before students continue with construction, model the process of cutting out and assembling the wings, tail and stabilizers. This is fairly simple, but students will be much more successful if you model it first.
- Hand out "Build a Flyer, Construction Session #2."
- Work with students who are behind as partners begin work. Students should follow the directions for the Super Delta Dart, steps ____ through ___, as they cut out and assemble the wings, tail and stabilizers. Remind students of the importance of following directions and taking their time.

  Questions: "What effect will messy construction have on the flight of your plane?
- Stress that the planes should not be touched after glue has been applied.
- Use the *rotating feedback** strategy for pairs to give feedback on plane construction of other groups.

Closure (10 minutes)

Clean up!

Journals: Use the "So What?" on student sheet to guide entries.

Lesson Outline--Day 4

Final Plane Assembly--Plane A

Warm up (20 minutes)

- Share the following list of questions with students (or create your own!):

  Need a list!! How about this one?

  What made the cans in our experiment yesterday roll together?
  What do cans rolling together have to do with flight?
  What does air pressure have to do with bubble movement?
  What's Bernoulli's Principle and what does that have to do with flight?
  Show what drag looks like.
  What part of a plane is affected by thrust?
  What helps keep an object up in the air?
- Partners can use *Paired Heads Together** strategy to answer questions. Rotate through room, giving each pair a chance to answer at least one question.
- Ask one student from each table group to reteach "Bernoulli's Cans," using the *Circle the Sage** strategy. Four student "expert" volunteers go the four corners of the room as the other students gather round to listen to an explanation.

Vocabulary (10 minutes)

Complete the vocabulary posters, Part 4, Fly Away:

Trimming
Find and rudder
Stabilizer
Flight pattern

Use the words as often as possible and encourage students to use them as well!

Wing Design (25 minutes)

This is a good spot to discuss the similarities between bird wings and airplane wings. Refer to "Raven's Light" and "Raven Gliders" in the Teacher Resource section. These are NOT in the resource section.

- Use the discussion as a lead-in to a review of flight terms, which will lead to the introduction of dihedral and polyhedral wing construction. (See "Teaching with Model Airplanes," page 6) **Need visuals provided here--overheads, or???**

  Dihedral is the angle at which the wings are inclined upwards when the airplane is viewed head on.
- Brainstorm: advantages and disadvantages of straight dihedral, tip dihedral and polyhedral wings.
- In table groups ask students to compare/contrast full size planes and bird wings.

- Using the *Thinkpad Brainstorming** strategy, pairs or table groups can devise a method for building dihedral or polyhedral wings. Remind them to take into account drying time and how they will keep the wings still while drying. **This whole section (wing design), could use a student worksheet, with examples of the different wings and a place to sketch their ideas, etc.)**
- Demonstrate with your flyer how to make the wings dihedral.

Gary--I haven't seen anything in the unit about the terms saddle, propeller mount, fuselage, all of which they need to construct the planes and for the COG activity.

Flyers Final Building Session (60-75 minutes or as needed)

- Pairs will finish construction of their first planes today. Emphasize to the students that their planes need to be ready to test tomorrow, but that they also must work slowly as they cut and match joints, making sure they are flush to each other. Remind them not to touch the planes after applying glue.
- When planes are completed, use the *Rotating Feedback** strategy for pairs to observe and provide feedback on each other's planes. Make sure they do not touch each other's planes, and that the feedback is not derogatory.

Center of Gravity (COG) **Gary--How can they do this activity today when their planes are not dry???**

This activity demonstrates the results of manipulating a variable. Students will adjust the center of gravity on their planes by moving the wing section, or saddle, forward and backward on the fuselage.

- Hand out the worksheet "Testing Planes, Center of Gravity," F4.1 and read through the directions together.
- Pairs of students complete the data table. They need to record observations (qualitative and quantitative) for the best results.
- A final mark on the fuselage that indicates the center of gravity will help them fine tune their planes later.
- Use the *Pairs Compare** strategy to critique each other's planes as they attempt to fly them.
- Remind the students that the planes may not fly the first time, but recording observations and adjusting variables gently will help them achieve flight. Patience is important! Don't let them give up!

Closure (10 minutes)

Journals: Try to draw what it will look like if you use Bernoulli's Principle in the construction of your next flyer.

Lesson Outline--Day 5

Mystery Architecture Challenge Extension Activity

I'm having a hard time with seeing how this activity fits here and why. I see the extension of the cooperative skills, but it seems misplaced in the middle of all the airplane stuff. Is it to give the planes a day to dry? If so, we should say that. If not, it just seems out of place. Perhaps the center of gravity day should be here?

Lesson Outline--Day 6

Flyer Testing

Experiments with Air (20 minutes)

Handout "Experiments with Air," sheet F5.1. Using *Partners** strategy, have students discover the vacuum effect and kite effect as they work through the sheet. As you discuss results with the class, ask questions that connect these experiments with Bernoulli's Principle.

Trouble Shooting (30 minutes)

This isn't clear to me, when you say they must complete the cog before moving on. Why is it on this day and also day 4? Also, it's not clear to me if students are using their motors for this activity, or if they use the troubleshooting sheet before they try the other two activities.

- Model how to wind, hold, launch and carry a completed plane in order to consistently get the best performance. Remind students that not handling planes gently results in damage. Even slightly damaged parts may result in negative effects on each flight and provide incorrect test results.
- Hand out the "Trouble Shooting" sheet, F5.3. Demonstrate how to adjust different variables on the plane to control flight. Refer to "Coaching Tips" in the Teacher Resource Section. **I don't see this in the Teacher Resource Section**
- Spread students across an open area and let them troubleshoot! Stress that they can test only one variable at a time.

Glide Test and What a Drag (75-90 minutes)

Both of these investigations need large open spaces.

Glide Test:

- Demonstrate how to attach motors, then have students attach motors to planes, but not wind them. Has this already been done above?

- Measure the mass of the plane and record it in the workbook. This is the first mention of a workbook--is it their journal? And why record the mass? Do you need scales ready? These are not listed in the materials list.
- Pairs will practice launching their airplanes to test glide. The goal is to achieve a smooth, straight glide with a consistent release and landing. They should fill in the Flight Log (F5.4) as they go. The flight log looks like it is part of the drag experiment? Do they use it for both? Or is this step actually part of the troubleshooting stage above? I'm confused!
- Remind students that gliding is gentle! Also remind them that using the troubleshooting handout is essential to success.

What a Drag: I'm having a hard time figuring out how students will use both the worksheet, "Flying Tests," and the Testing Planes--What a drag. Can they be incorporated into one sheet? You never say to handout either one. Also, the students sheets that you added need to be numbered to fit into the rest of the handouts.

The purpose of this test is to show students how changing a variable effects the outcome and how drag effects flight.. Students will complete five experiments, taping a paper flag or triangle to a piece of string, which is taped to the plane each time.

- Handout "Testing Planes--What a Drag," F5.2.
- After students have completed the activity, use *Pairs Compare** strategy to look at each other's charts and compare and discuss results.

Extension: Use the activity described in "Flight Time," F5.5 and/or "Experimental Design, extensions 1 and 1a." These activities ask students to create their own experiments to test their planes. These need to be placed after Day 6 in the unit. I had to really look for them.

Closure (10 minutes)

- Review: Using the *Think-Pair-Share** strategy, ask partners to share results and conclusions from "What a Drag."
- Make sure students know where to store planes and that they should not touch a plane that is not theirs.

Lesson Outline--Day 7

Flyer Construction--Plane B

Getting Ready (30 minutes)

Before beginning construction of the second flyer, it is important to examine the strengths and weaknesses of the first planes, and what students have learned from building and flying them.

- Demonstrate your flyer again and discuss flight patterns. Ask students how to control turns, ascent and descent. Volunteers can try to demonstrate with their first flyers.
- Using *Paired Heads Together** strategy, students can brainstorm the strengths and weaknesses and problems of their first flyers. What worked well? What did not work? Students can record these lists in their journals, creating columns for each category.
- For each weakness, ask students, in groups, (use *ThinkPad Brainstorming** strategy) to discuss solutions. Have them add a third column in their journal to record the most promising solutions.

Review (45-50 minutes)

- Review the four forces of flight (lift, thrust, drag, and gravity), by handing each table group a slip of paper with one of the forces written on it. Each group will demonstrate, using their first flyers or by acting, their assigned force. The rest of the class will guess which force is being demonstrated.
- Gary--you have here that they should finish vocab. posters, but those were finished on a previous day, weren't they?
- Discuss possible dihedral and polyhedral adjustments. (What might these proposals be? I wouldn't know--can we list some?) For each proposal, ask pairs to discuss why they should or shouldn't try those adjustments. Ask pairs to share and defend their answers.
- Review what students have learned about proper cutting, gluing and other construction techniques by using peer modeling. You can do this in groups, or by having one student model to the entire class. By this point in the unit, an atmosphere of personal safety should have been established and peer modeling is a good first step for shy students.
- Demonstrate one more time how to make the wings dihedral, or ask a student to demonstrate.

Flyer B Building Session #1 (60 minutes)

As the students move into building their second planes, the process will go much faster as they apply knowledge gained from building and testing their first planes.

- Handout "Build a Flyer--Flyer B Construction Session #1" worksheet and the plane kits.

- Have students inventory materials.
- Before students start actual construction, ask these questions:

  What effect will large amounts of glue have on the mass of the plane?

  How will this effect the flight of the plane?

  What can you do to minimize mass?

  Gary--I haven't seen enough on mass before this. I think that whole concept needs to be addressed more and earlier in the unit.
- Allow students to work independently on constructing this flyer. Circulate and assist where necessary, but guide them to use their own discoveries as they build.
- Remind them to go slowly, especially when cutting and matching end joints.
- Encourage the students to be creative and to use whatever materials from their first planes they see as necessary.

Extension: Because the construction process will go faster this time around, be sure to have extension activities ready for those who finish early. See "Paper Helicopters," F6.1.

Closure (10 minutes)

- Have students use a Venn diagram (F6.2) to sort similarities and differences of Plane A and Plane B. Combine pairs and compare their charts. Did they make similar changes?
- Make sure students know where to store planes.

Lesson Outline--Day 8

Flyer Construction--Plane B

Vocabulary Review (15 minutes)

Assign each table group 2 of the words on their vocabulary lists. Each group writes "Jeopardy" style answers which match one of their assigned words. When the "answers" are ready, each group selects an "M.C." who presents the answer to the rest of the class. Groups use *Numbered Heads Together** strategy to come up with the correct "question."

Flyer B Final Building Session (75 minutes)

Gary--it sounded like lots of kids might finish the building the day before this?

Final construction should come to an end today. Make sure that each pair has a plane ready for testing tomorrow. Again, much of this work should be student driven and independent, although the teacher needs to circulate and keep students on task.

- Students begin where they left off yesterday. Some will be behind; work with them to get caught up.
- Have the students assemble the parts following the kit directions, unless they want to add dihedral to the wings. This will take more time but is well worth the effort.
- Remind them to go slowly when cutting and matching joints. Discuss the importance of quality craftsmanship: "What effect will messy construction have on the flight of the plane?"
- Encourage them to use the knowledge gained from building and testing their first planes, and to use their journal notes.
- Be sure they know they must finish their planes today.
- When planes are completed, use *Rotating Feedback** strategy for pairs to provide feedback to each other regarding construction and design.

Extension: Gary--you suggest Paper Helicopters, but you used that yesterday. Do you have another option?

Closure (10 minutes)

Journals: reflect on how they feel about their second plane as compared to their first plane. What changes did they make and why? What differences in flight patterns do they expect to see as a result?

Lesson Outline--Day 9

Flyer B Testing

Revisiting KWL (15 minutes)

- Ask students to revisit the KWL charts they made the first day. Have them, in their original table groups, review the first two categories. What did they know, what did they want to know? Then have them complete the third category--the L column. What have they learned about flight through this unit? Also, have them consider whether what they thought they knew about flight at the beginning of the unit was correct information.
- Have each table group share their completed L columns. How did the information in the L columns vary from group to group?

Flyer B Testing (90-100 minutes)

These activities need a wide-open space. They are basically the same activities completed on Day 5 and students should be able to work through them fairly independently as they apply newly acquired knowledge.

Glide Test and COG:

- Hand out "Build a Flyer--Fine Adjustments and Flight for Competition," along with copies of the C.O.G. sheet from Day 5.
- The students will go through the process of finding the center of gravity and determining the best glide adjustments. This should go rather quickly.
- They should fill out the investigation sheets to guide their actiivity.
- Explain to students that upon completing these tests, they should have good testable flyers.
- Stress that no further adjustments should be made, as these could change the results of their flights.

Flight Time

Gary--there is no sheet for this. Do they use one from earlier in the unit? If so, put copies with this lesson. Do the same for the COG lesson above.

The purpose of this investigation, which will take longer than the glide test and COG, is to observe the experiment results after changing a variable. The students will observe the effect of adjusting the number of winds of the rubber motor on flight time.

- Remind students of the importance of precision with this test.
- Have them record results on ??????
- Use *PairsCompare** strategy to critique planes.

Extension: Students can design their own investigations for lift, gravity, drag or thrust with their new flyers. Use "Experimental Design, Extension 1 and 1a." Gary--put a copy of that with this day's lesson.

Lesson Outline--Day 10

Flyer B Testing

Fish Bone (15 minutes)

Partners use "Fish Bone Graphic Organizer," F9.3 (Gary--I don't see this anyplace! This needs a bit more explaining. Maybe it will be clear if the page is there, but it's not now. Also, can you connect this to the competition preparation? It seems like it's all part of the same thing.) to explore cause and effect of testing done during previous class. This will help analyze flight problems so solutions can be hypothesized and investigated.

Flight Concepts Review (15 minutes)

- Have table groups review flight concepts (Forces of flight and Fly Away sections). Tell them to select one word from each list and be ready to draw a picture that shows what the word means. Also have them choose an "artist" who will come to the front of the room to draw what the group has decided. The other groups will see how quickly they can guess what word is being illustrated through the drawing.
- Peer modeling: Have a volunteer at each table demonstrate how to hold, wind and launch their plane to get the best performance on a consistent basis.

Competition Preparation (90-115 minutes)

This lesson should be completed in an open space.

Set up two stations.

Station 1:

- This is an open space for pairs to fly and observe their planes. Have some materials (glue, tape, etc.) and equipment on hand for adjustments. Students should use "Flight Time," F9.2 (I can't find this!) and "Comp Prep--Day 10." They can also use any of the activities from earlier in the unit to help them fine-tune their planes.
- Remind students that too much adjustment usually leads to negative results. Once they believe they have achieved optimal flight performance, they should stop testing.
- Once students complete testing and fine-tuning on their own, use *Pairs Compare** strategy to critique planes within groups and to achieve the best planes possible through cooperative and collaborative efforts.

Station 2:

This station, which is for students who are behind and need to catch up, should be in the classroom.

- Use the "Project Checklist," F9.3 (This needs to be placed with this day's lesson)to keep students focused. As students finish testing and fine-tuning their planes, be

prepared with extension activities. Gary--you need more extensions. You can't keep offering the same ones! How about adding an activity where they practice role playing being judges and ask each other questions about plane construction, etc. You could formalize it so it really is a rehearsal. If there's something I'm missing about this, sorry!

- All planes should be stored and not adjusted further until the culminating activity. Remind students not to touch each other's planes.

Closure (10 minutes)

Ask each pair to share results and conclusions from testing their new planes.

Other questions:

I'm wondering about the write-up of the competition itself. It seems to be missing. Is that day 11 or 12?

The student worksheets that you've added at the back need to be worked into the unit itself, in terms of physical placement and your numbering system (F3.1, etc.). It feels to me like some days have repetitive sheets--your original sheet (i.e.-bubble-ology) and then the one you created later. Do we need to use one or the other?

I also think we need to (I guess you need to ☺), create some visuals to go with the unit. The days where you reference the flight manual sometimes don't seem to really give teachers a clear visual to use. Will teachers use overhead projectors at camp? Or can we make large posters to go with the unit that have larger versions of the illustrations in the manual? Like for the four forces of aerodynamics?

Okay--hope I'm not driving you nuts!

I haven't done anything with those two days where you include the other Olympiad activities because I wanted to talk with you first. Thanks for explaining that to me!

Lesson Outline--Day 1

Forces of Flight (25 minutes)

Unit Introduction:

Begin with a **demonstration** of a flyer that you have constructed prior to the first day of class. Ask the students: How long do you think this flyer can stay in the air?" Record guesses on the board or on chart paper. Ask a student volunteer to be timekeeper. Fly your plane several times. Compare the time it stays in the air to the student guesses. Discuss.

Introduce the essential question:

Can I make my plane fly for at least six seconds? Prove it. Explain that students will work in pairs to build planes that can fly for at least six seconds. They will build two planes. After building the first plane, they will test it, observe problems and strengths, and then build a second plane that addresses the problems. The second plane will be used during the culminating activity, a competition at the Science Olympiad.

Checking prior knowledge:

In table groups, students will complete a **KWL** chart that shares what they already KNOW about flight, and what they WANT TO KNOW about flight. Their chart should have a third column for what they will LEARN during the unit. The last column will remain empty today but will be revisited at the end of the unit. After five minutes, ask groups to share what they have in their KNOW columns. Use their responses to fill in a large KWL chart on butcher paper in the front of the class. Repeat the procedure for the WANT to know column.

What I KNOW	What I WANT TO KNOW	What I LEARNED

Vocabulary Terms:

Start by displaying the first vocabulary section, Part 1 Real Flyers (see master):

Bernouilli's Principle
Otto Lilienthal
Leonardo DaVinci
Wright Brothers

Briefly share the history of flight with students, using and explaining the vocabulary words. Refer to the *Teaching with model Airplanes* booklet for information and visual aids. Need overheads prepared??

Four Forces of Aerodynamics (25 minutes)

Use the information in "Teaching with Model Airplanes," page 5, to describe and discuss **lift, thrust, drag,** and **gravity**. Animate the drawing so the students can see the forces at work during flight. **What does it mean to animate drawing? How??? No reference to this on page 5.**

- Using the *Think-Pair-Share** strategy, have students brainstorm other objects that have a similar shape and purpose to airplanes (i.e., racecars, snow machines, etc.) In their groups, students develop and record definitions for Vocabulary Part 2 (lift and thrust only) on their posters. Encourage the use of drawings to help explain their definitions.

- Demonstrate **drag**: Ask for a student volunteer. Tell him/her to walk away from you, but hold the back of the student's shirt as he/she tries to move away.

Build a Paper Airplane (60 minutes):

This activity, which focuses on lift and thrust, should be done in a large open area. Handout the "Build a Paper Airplane" activity sheet (F1.2)**this sheet refers to Shultz design--I see no other reference or explanation of what that is???** .

- Review the directions before having students complete the investigation with a partner or cooperative table group. Each student should record observations (flight patterns) and adjustments (**variables and controls**) on the flight log (F1.3).
- Students can mark and measure distances by starting from a consistent spot on the floor and marking the distance with an object (a partner's foot or a piece of tape will work).
- After recording observations, students complete "Testing Paper Airplane Designs, Parts 1 and 2 (F1.2).
- Finally, use *"Think-Pair-Share** to discuss answers to numbers 5 and 6.

Airport Field Trip (60 minutes)

Before the trip, arrange for a local pilot to meet with the class for a question and answer discussion. At the airport, ask students to observe the shapes used on full size planes. Discuss similarities and difference to paper airplanes. Focus attention of the wing shape and surfaces. In journals, have students sketch wing shapes, design ideas and possible innovations they may want to try.

Closure (10 minutes)

- Let volunteers demonstrate their paper airplanes for the class. (If extra time, they could first make revisions, based on observations and drawings from the airport trip.) You could also time the flights.
- Journals: Students can list the forces of flight and draw explanations of lift and thrust.
- If time, and just for fun, have students form a large circle, facing in, and launch all their planes at once.

Lesson Outline--Day 2

Glass Blowing (20 minutes)

- Prior to class, read "Glass Blowing (F2.1)," and try this activity several times before you do it in front of students.
- Demonstrate "Glass Blowing" three times.
- In pairs, students discuss and record possible reasons why blowing on the glass causes the candle directly behind the glass to be blown out. Ask two or three groups to share their ideas with the class. (This is a good time to stress sharing and teamwork.)
- After discussion, check students' understanding of lift, thrust, gravity and drag by having groups complete Part 2 of their vocabulary posters, again using drawings to clarify.
- Connect these concepts to yesterday's paper airplane activity.

Building a PB & J (40 minutes)

This messy activity emphasizes communication and the importance of attention to detail. For complete directions, see "Make a PB & J," (F2.3).

Flyer Introduction and Building Session #1 (60 minutes)

Note: It is important that students follow directions precisely during Flyer construction. The first day of building requires as much patience and guidance as possible. Individual attention is important since students will grasp the concepts and construction processes at different rates.

- Handout: student sheet, "Build a Flyer: Construction Session 1," and a plane kit to each pair of students.
- Following directions on the sheet, students should first inventory their materials.
- Next, you need to demonstrate how to cut and glue wood. Lead them through the process of pinning down the schematic, cutting/gluing wood for the wings, tail and stabilizers. Emphasize the importance of following directions accurately and paying attention to detail. They must go slowly to cut and match joints flush to each other.
- Circulate continually through the room as they begin the construction process. Make sure the students know they are expected to get through these steps during this class session.
- As they build, you can discuss the positive and negative effects of construction and the importance of following directions and taking their time.

Extension: The investigation, "How far can you throw a piece of paper?" (F2.4), may be used for students who complete the first stage of plane construction early.

Closure (10 minutes)

- Journals: Use the "So What?" question on student work sheet to guide journal entries.
- Tell students how and where to store their planes while the glue dries. No one should be near or touch a plane that is not theirs.