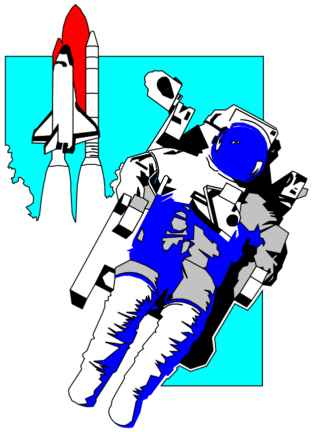
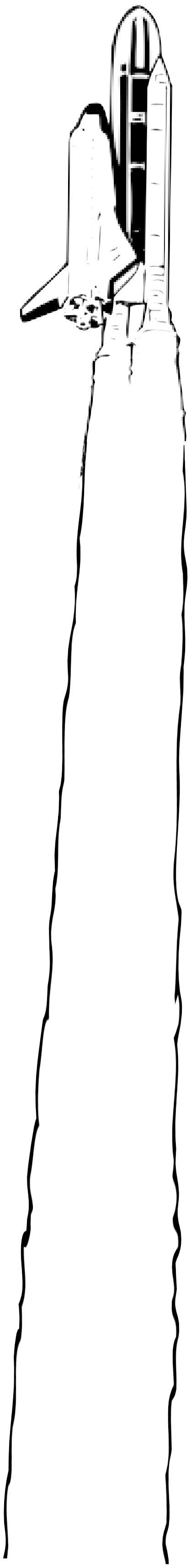


Student Science Activity: Everything's Under Control

Student Science Activity: Everything's Under Control



Overview

This activity is designed to allow students to explore the basic control surfaces of the orbiter and the motions they affect by having the students perform a hands-on experiment that will demonstrate the orbiter's movement during flight. This 2 – 3 session activity is designed for students in grades 4 – 8. It is primarily a hands-on experiment complemented by a student informational reading, comprehension worksheet, experiment guidesheet and a series of photos displaying the experiment's set-up. Students will construct pre-fabricated space shuttle orbiters with movable control surfaces that will be used to demonstrate the motions of roll, pitch and yaw. The students will manipulate each control surface (rudder, elevons: elevators/ailerons) on the glider and determine which motion each affects. They will observe, and record their findings. From this data they will determine that the rudder affects yaw, the outer elevons (acting as ailerons) affect roll, and the inside elevons (acting as elevators) affect pitch. They will also demonstrate that the outer elevons (ailerons) act in opposition (one in the up position and the other in the down position). While the inner elevons (elevators) act in tandem (both in the up position or both in the down position).

Grade Levels

Grades 4 – 8

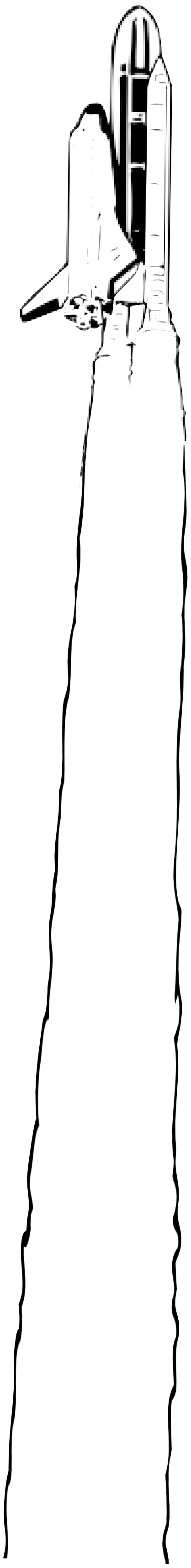
Time Frame

2 – 3 class sessions of 45 – 60 minutes

Key Questions

1. What are the motions of the orbiter?
2. How is the orbiter controlled?
3. What control surfaces are used on the orbiter?
4. What motions are affected by each control surface?

Student Science Activity: Everything's Under Control (continued)



Materials

1. Control Surface Experiment Data Sheets #1, #2, #3
2. Student Informational Reading: Orbiter Control
3. Student Comprehension Worksheet: Orbiter Control
4. Pre-fabricated Space Shuttle Glider (recommended commercially-made glider with movable control surfaces: *White Wings Space Shuttle*™.

Getting Ready

1. Run multiple copies of student handouts:
2. Decide where the "fly zone" will be located.
3. Purchase pre-fabricated gliders (Recommended *White Wings Space Shuttle™)*

Teacher Background *See Student Informational Reading: Orbiter Control*

Vocabulary

1. **aileron**: Control surfaces on the trailing edge of each wing that affect the motion of roll.

2. **axis**: A straight line through the center of gravity around which an aircraft rotates.

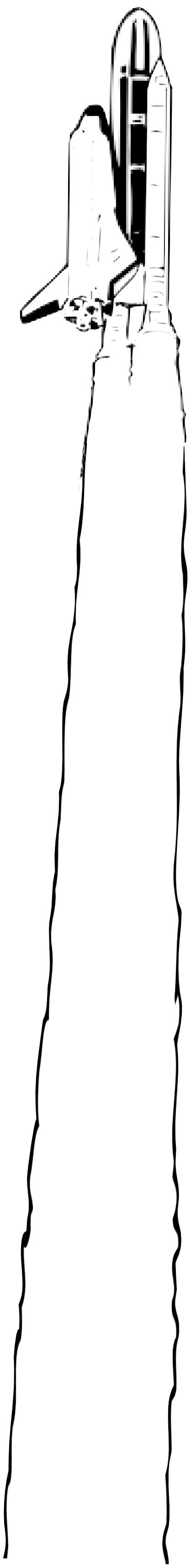
3. **center of gravity**:
A point on an airplane at which the entire weight of the airplane is considered concentrated so that if the airplane is supported at this point the airplane would remain in equilibrium (or balance).

4. **drag**: The force that resists the motion of the aircraft through the air.

5. **elevator**: Control surfaces on the horizontal part of the tail section (horizontal stabilizer) that affects the motion of pitch.

6. **elevon**: Control surfaces located on the trailing edge of a delta wing airplane that control the motion of pitch and roll.

7. **force**: A push or pull in a certain direction that can be measured.



Vocabulary - Continued

8. **lift**: Upward force produced by air passing over and under the wing of an airplane.

9. **lateral axis:** The axis extending through the center of gravity of an airplane and parallel to a line connecting the tips of the wings.

10. **longitudinal axis:** The axis extending through the center of the fuselage from the nose to the tail.

11. **pitch**: A rotational motion in which the aircraft turns around its lateral axis by raising or lowering the nose of the airplane.

12. **roll**: A rotational motion in which the aircraft turns around its longitudinal axis by raising one wing higher as the other wing dips lower.

13. **rudder**: A control surface on the trailing edge of the vertical part of the tail section (vertical stabilizer) that affects the motion of yaw.

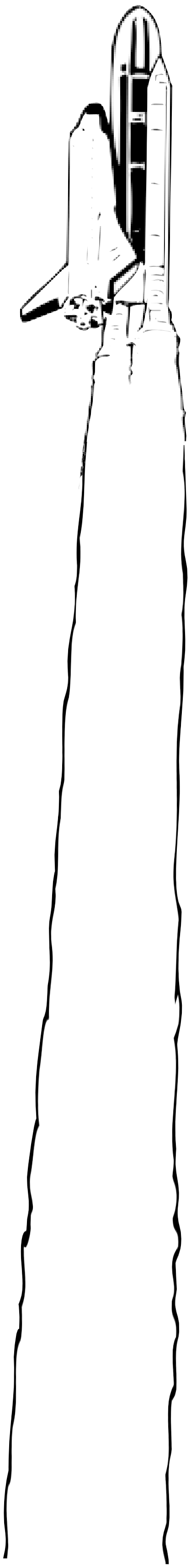
14. **thrust**: A force created by the engines that pushes an aircraft through the air.

15. **weight**: A force of gravity acting on an object.

16. **vertical axis**: The axis extending straight up and down through the center of gravity of an aircraft.

17. **yaw**: A rotational motion in which the aircraft turns around its vertical axis by moving the nose of the aircraft to the pilot's left or right.

Student Science Activity: Everything's Under Control (continued)



Prerequisite Knowledge

1. Familiarity with the motions of an airplane: roll, pitch, yaw.
2. Familiarity with the 3 axes: lateral, longitudinal and vertical.

Skills

1. Reading for meaning
2. Observation of flight
3. Data collection

Concepts

1. Rudder affects the motion of yaw (horizontal axis).

2. Elevon is a control surface located along the trailing edge of a delta wing and is actually a combination of an elevator and an aileron.

3. The elevator (inner elevon on the orbiter's delta wings) affects the motion of pitch (vertical axis).

4. The aileron (outer elevon on the orbiter's delta wings) affects the motion of roll (lateral axis).

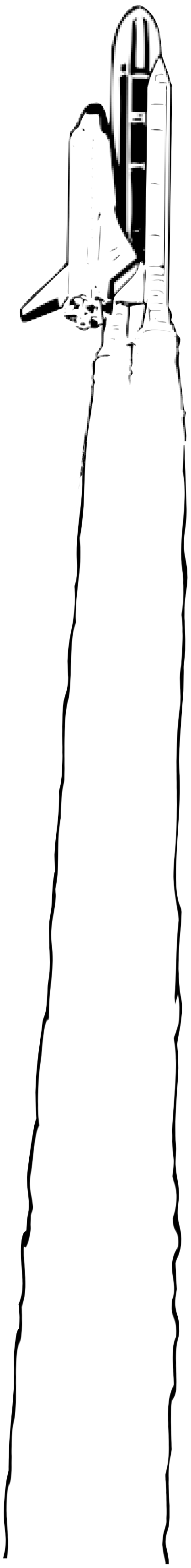
5. Ailerons (outer elevons) work in opposition.

6. Elevators (inner elevons) work in tandem.

Processes

1. Use the scientific method to answer a question.
2. Perform research to gather additional information.
3. Making models.

Student Science Activity: Everything's Under Control (continued)



Session 1

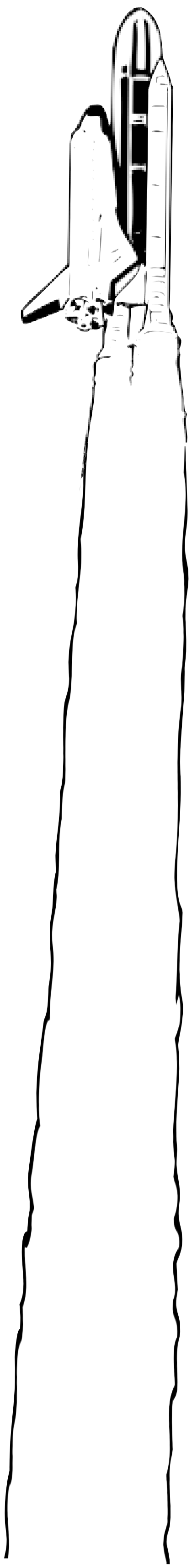
- Show videotape footage (or use the animation from the Female Frontiers Web site) of the space shuttle (orbiter) landing. Discuss with the students the path the orbiter flies during descent along with an explanation as to why it flies such a descent route. Point out the different motions the orbiter uses as it descends to land. (See “Student Informational Reading: Orbiter Control”)

- Using a model of the orbiter demonstrate and review the 3 motions of an airplane (glider): roll, pitch, yaw. (See overhead transparencies of “Axes and Orbiter Motions”.) At this point, the teacher can choose to introduce control surfaces providing for or reviewing with the students what they are, what motions they affect, and how they work OR merely point out on the glider model that there appears to be some hinged surfaces on the model. If taking the latter approach, then query the students as for what each of the hinged surfaces might be used.
- Pose and discuss the questions below:
  1. What are the 3 basic motions of an airplane?
  2. Can you describe each motion or demonstrate how each motion moves?
  3. How does the commander and pilot of the orbiter control these motions?
  4. Where on the orbiter are these control surfaces located?
  5. What motion does each control surface control?
  6. How can we find out answers to some of these questions?

- Lead the students towards defining an experiment which would use the glider model to test or demonstrate the control surfaces of the orbiter. The experiment should include manipulating the hinged surfaces, flying the glider, observing its flight motion and recording their observations. Have students in small groups or pairs develop a set of procedures for such an experiment (or simply review the procedure and template already provided).

- Have students record their set of procedures on chart paper, post and present their steps to the class. From the different sets of procedures have the class develop one definitive procedure list detailing how each team will perform the experiment. Record the final set of procedures on chart paper and post.

Student Science Activity: Everything’s Under Control (continued)



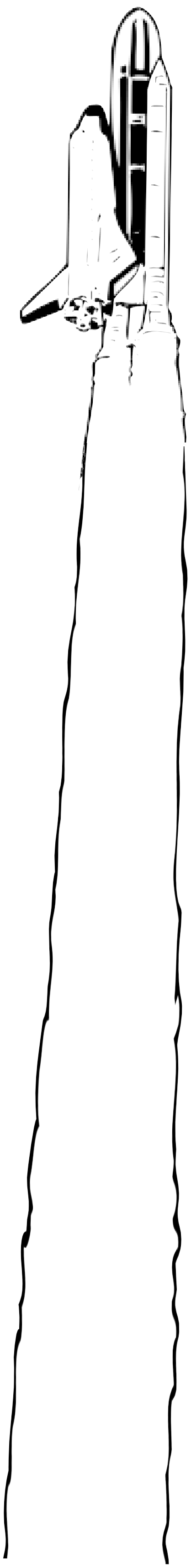
Session 2

- Review the motions of roll, pitch and yaw using the overhead transparencies, animation found on the Web site and orbiter glider.
- Review the posted set of procedures for the class to follow for the experiment.
- Distribute “Experiment Data Sheets #1, #2, #3” and space shuttle gliders.
- Have students assemble space shuttle gliders.
- Review safety considerations.
- Allow 30 minutes for experiment.
- Have teams or partners meet in small groups of 4 – 6 students and consolidate findings using the “Experiment Conclusion Report”. Have them then transfer the information from that sheet onto a large sheet of chart or butcher paper for posting.
- Collect and post for the next session’s discussion.

Session 3

- Review and discuss each group’s “Experiment Conclusion Report” that was posted from previous assignment.
- If any disagreement results from the posted information. Clarify by having you or a student re-test the glider with the disputed control surface/motion in each position, and flying it in front of the class.
- Distribute the “Descent Control” assessment and have students using the posted information, answer each question.
- Collect the “Descent Control” for evaluation.
- Review the answer key for “Descent Control” for wrap-up.
- Have students complete their “Self-Evaluation Check-Up” regarding their work on the activity.

Student Science Activity: Everything's Under Control (continued)



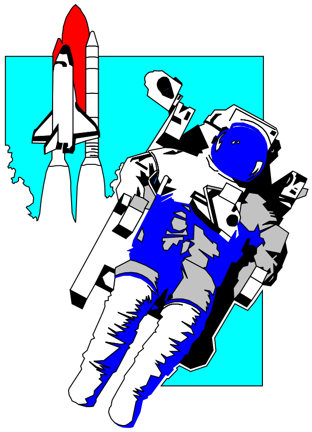
Teacher Section

- Overhead Transparencies
    - Axes and Orbiter Motion
    - Orbiter Control Surfaces with Descriptions
    - Orbiter Control Surfaces Experiment Procedure List
    - Orbiter Control Surfaces Experiment
    - Experiment Procedure: Experiment #1
    - Experiment Procedure: Experiment #2
    - Experiment Procedure: Experiment #3

- Answer Keys
    - Control Surface Experiment Data Sheet #1 - Key
    - Control Surface Experiment Data Sheet #2 - Key
    - Control Surface Experiment Data Sheet #3 - Key
    - Experiment Conclusion Report - Key
    - Student Worksheet: Orbiter Control - Key
    - Student Worksheet: Descent Control - Key

Student Handouts

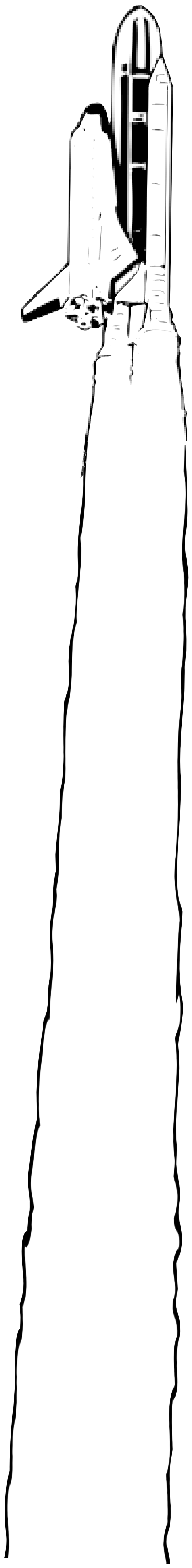
- Control Surface Experiment Data Sheet #1
- Control Surface Experiment Data Sheet #2
- Control Surface Experiment Data Sheet #3
- Experiment Conclusion Report
- Student Informational Reading: Orbiter Control
- Student Worksheet: Orbiter Control
- Student Worksheet: Descent Control
- Self-Evaluation Check-Up

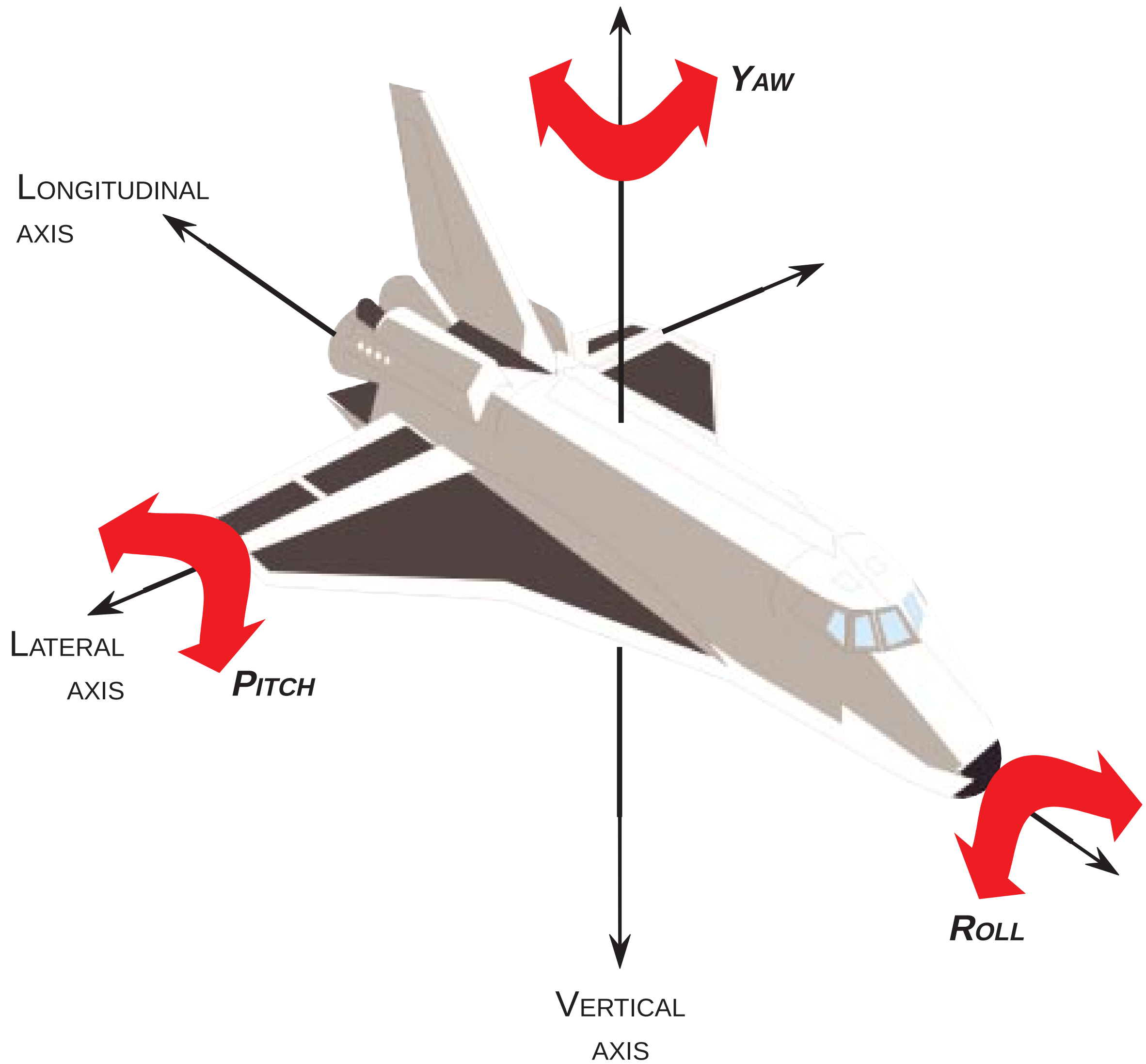


Student Science Activity: Everything's Under Control

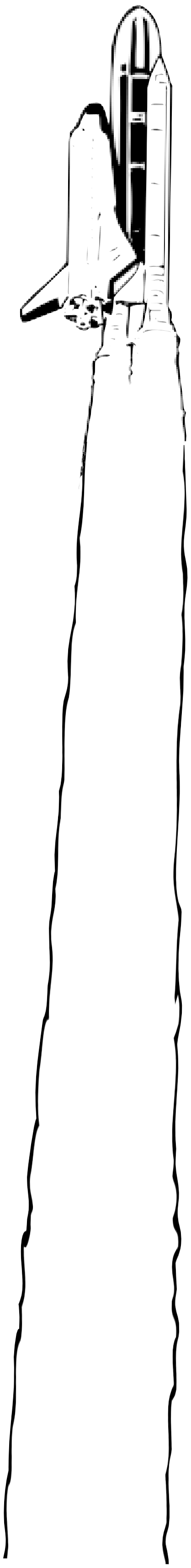
Teacher Section

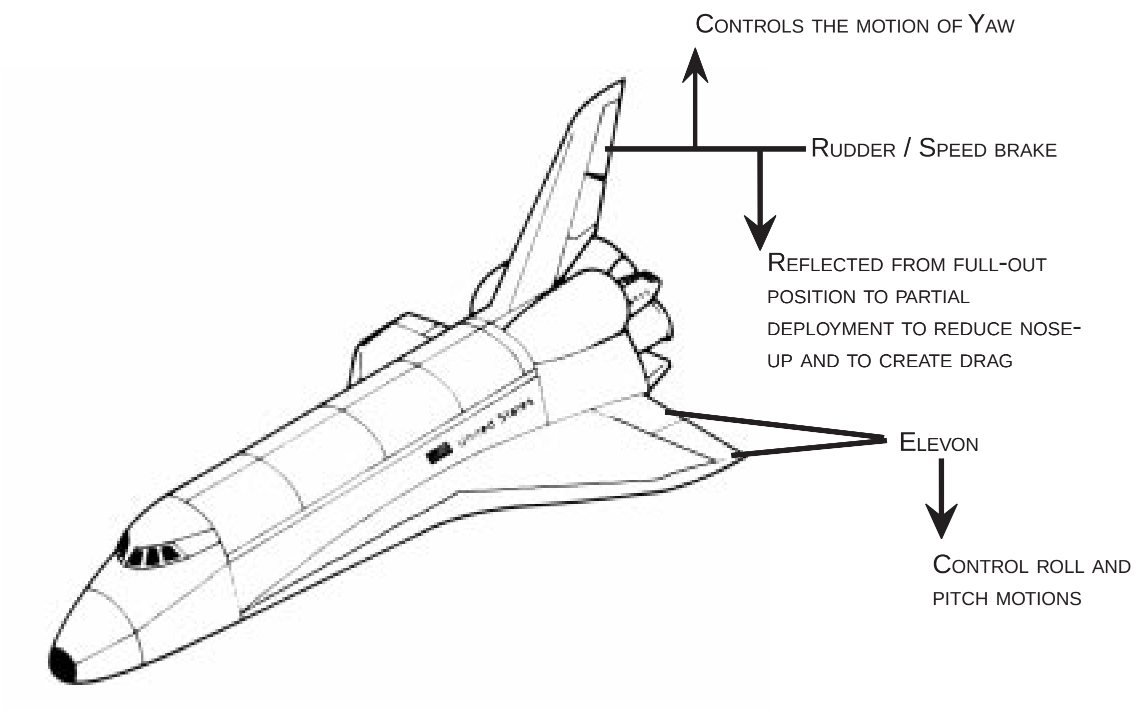
Axes and Orbiter Motion

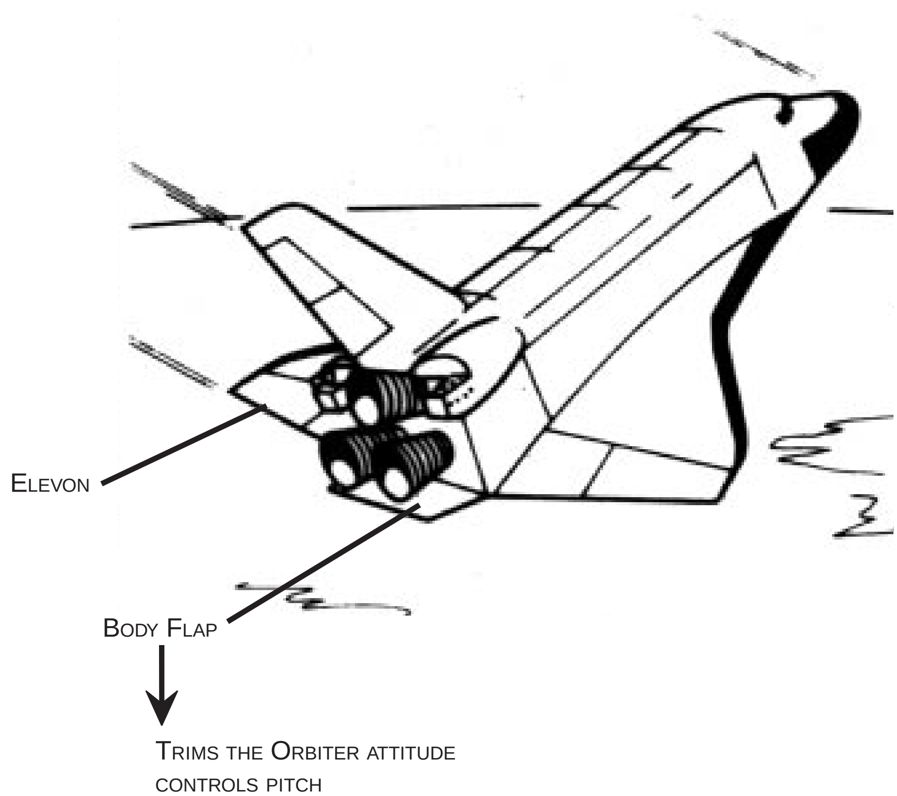




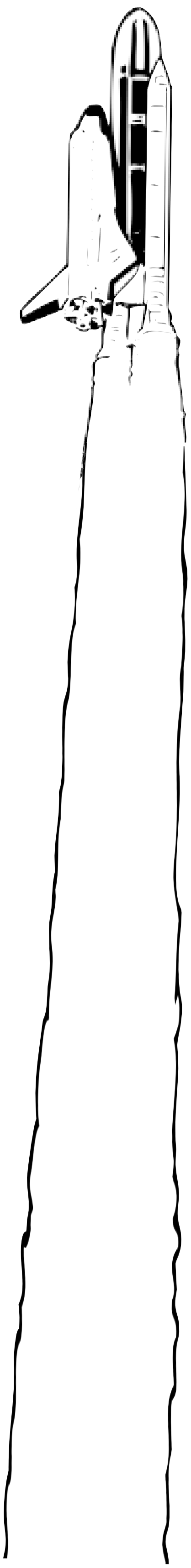
Orbiter Control Surfaces With Descriptions







Orbiter Control Surfaces Experiment Procedure List



Experiment #1

1. Bend left inner elevon up and right inner elevon down.
2. Launch glider.
3. Observe flight.
4. Record observations.
5. Bend left inner elevon down and right inner elevon up.
6. Repeat steps #2 - #4.
7. Bend left inner elevon up and right inner elevon up.
8. Repeat steps #2 - #4.
9. Bend left inner elevon down and right inner elevon down.
10. Repeat steps #2 - #4.

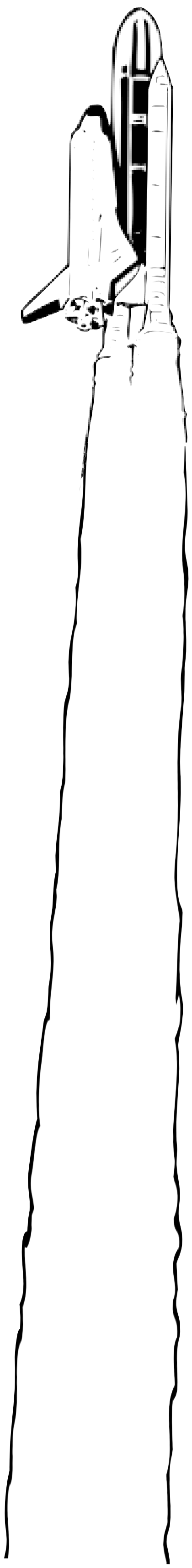
Experiment #2

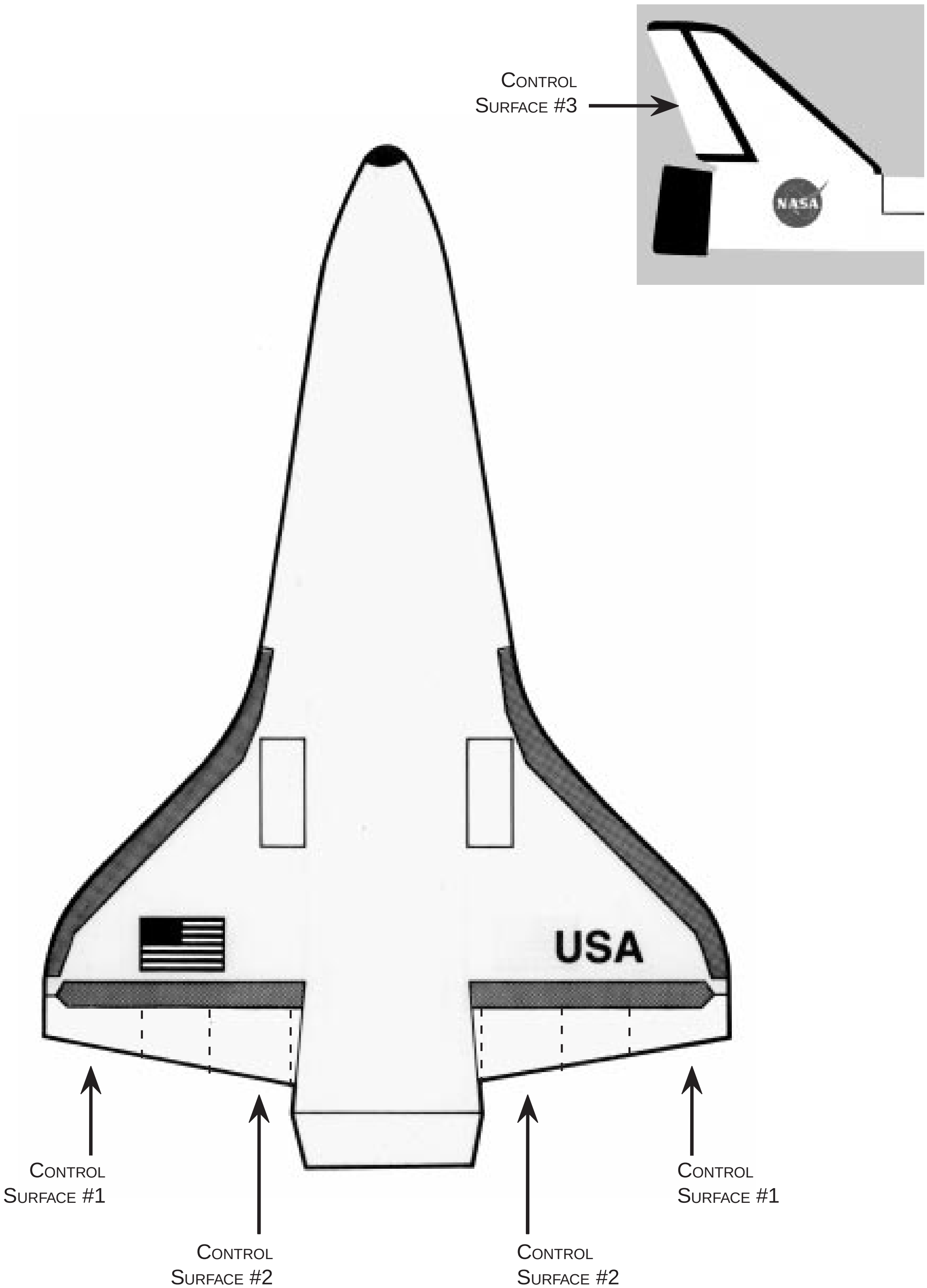
1. Bend left outer elevon up and right outer elevon down.
2. Launch glider.
3. Observe flight.
4. Record observations.
5. Bend left outer elevon down and right outer elevon up.
6. Repeat steps #2 - #4.
7. Bend left outer elevon up and right outer elevon up.
8. Repeat steps #2 - #4.
9. Bend left outer elevon down and right outer elevon down.
10. Repeat steps #2 - #4.

Experiment #3

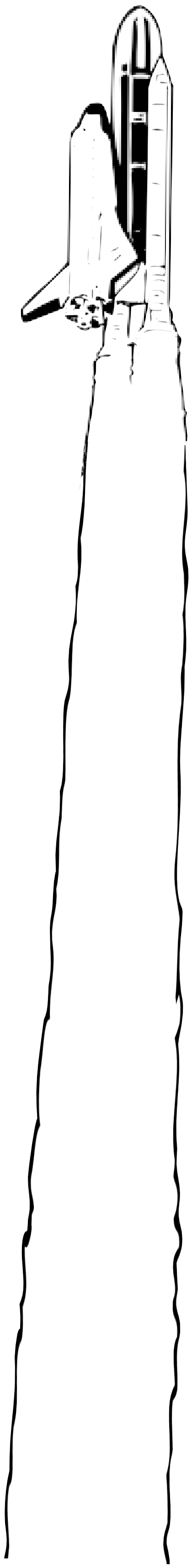
1. Bend rudder right.
2. Launch glider.
3. Observe flight.
4. Record observations.
5. Bend rudder left.
6. Repeat steps #2 - #4.

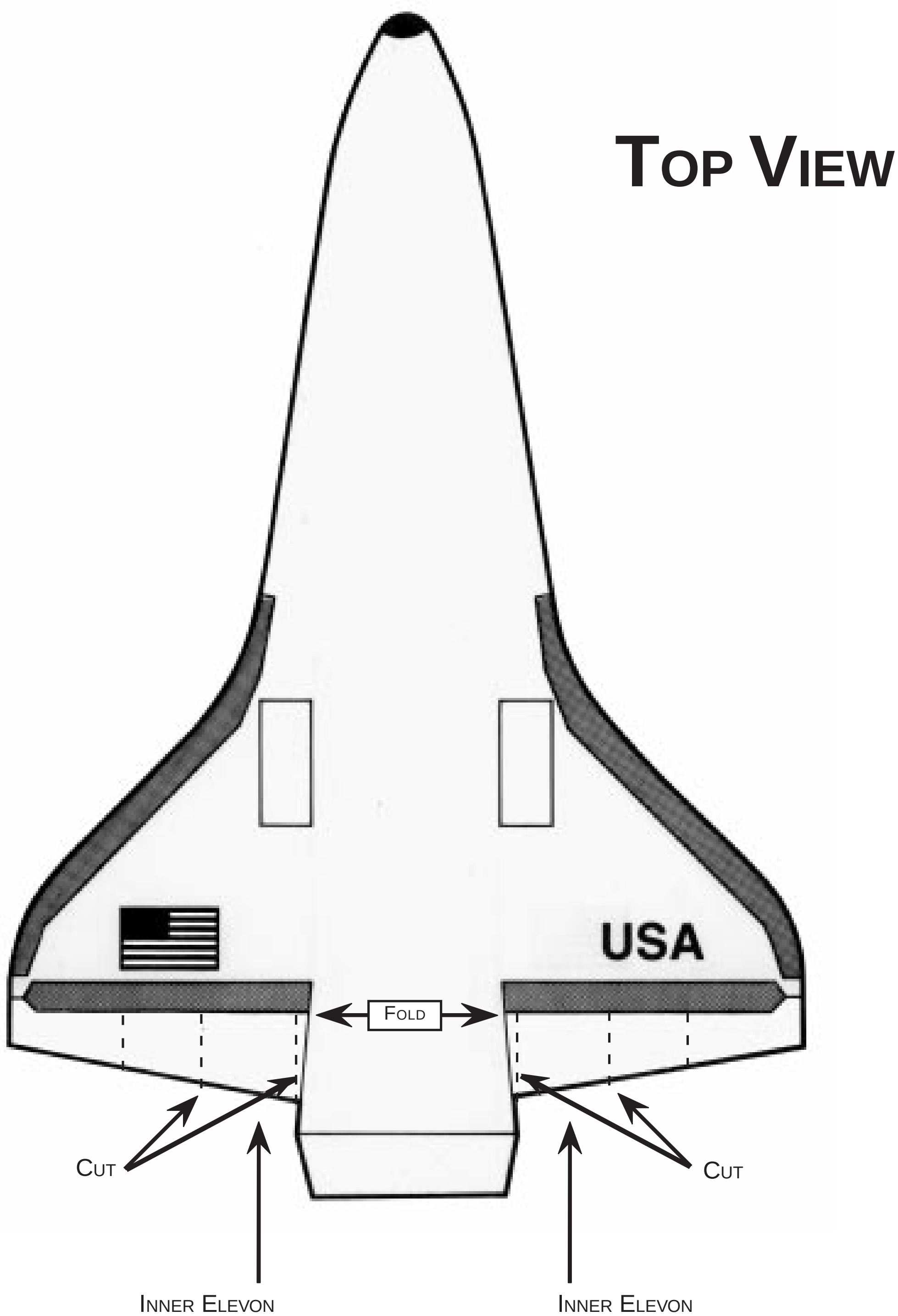
Orbiter Control Surfaces Experiment





Experiment Procedure Experiment #1





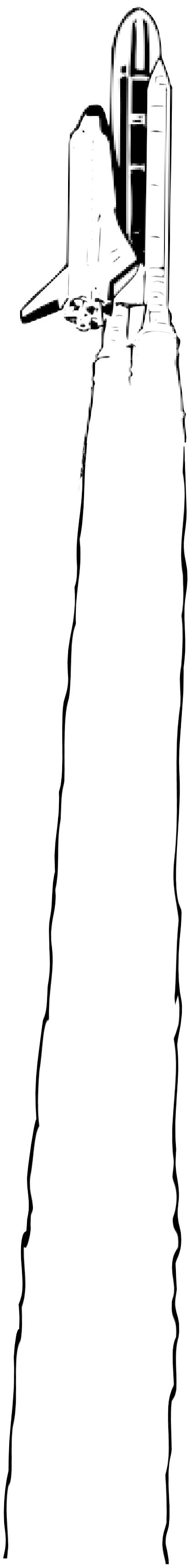
Inner Elevon (left):

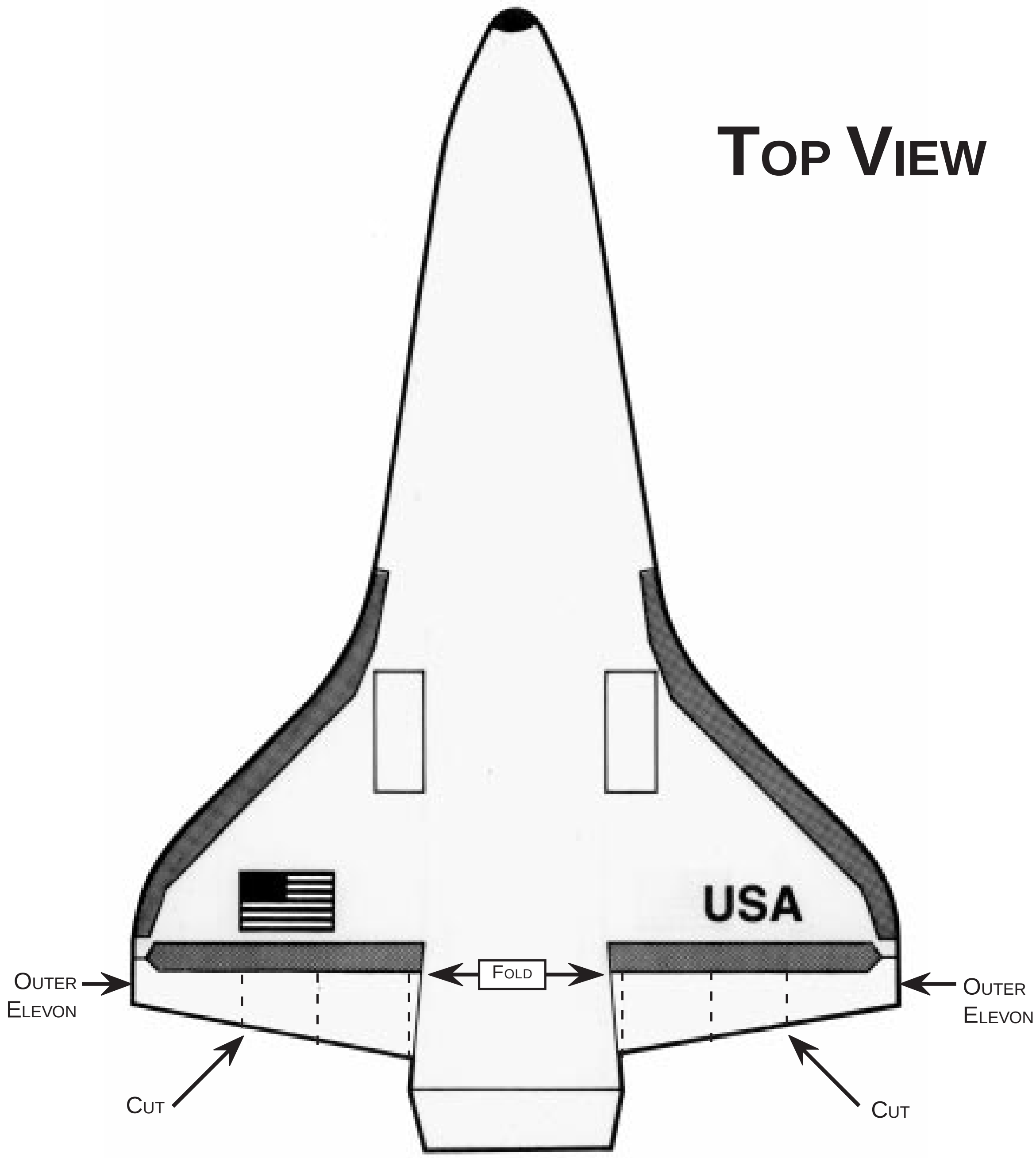
1. Left-Up
   then
2. Left -Down
   then
3. Left-Up
   then
4. Left-Down

Inner Elevon (right):

1. Right-Up
   then
2. Right -Down
   then
3. Right-Down
   then
4. Right-Up

Experiment Procedure Experiment #2



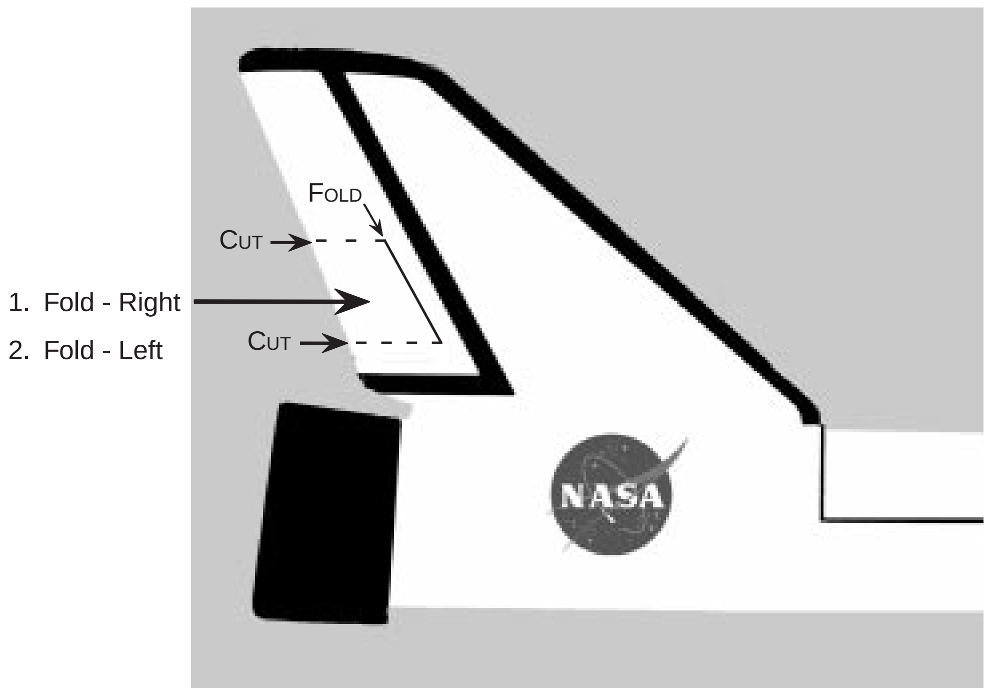


1. Left-Up
   then
2. Left-Down
   then
3. Left-Up
   then
4. Left-Down

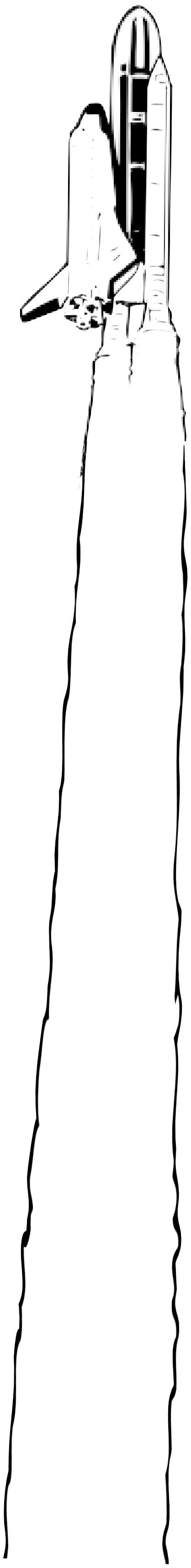
1. Right-Up
   then
2. Right-Down
   then
3. Right-Down
   then
4. Right-Up

Experiment Procedure Experiment #3

SIDE VIEW

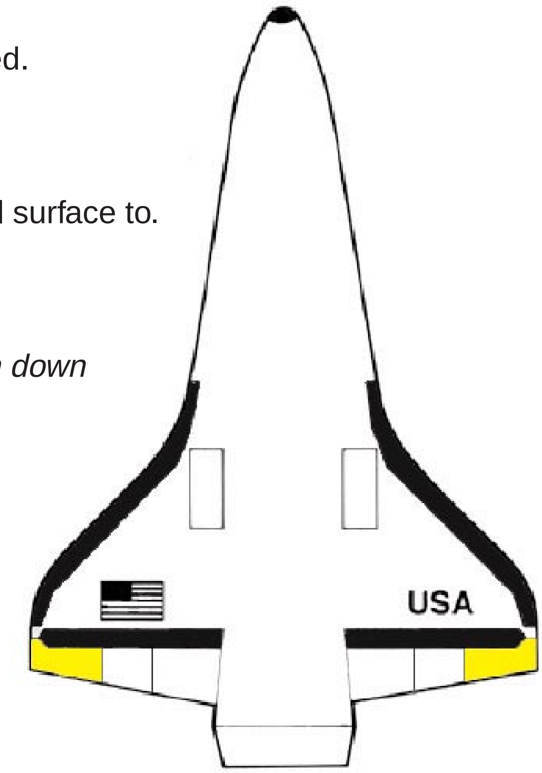


Control Surface Experiment Data Sheet #1 - Key



Directions: Follow the steps from your class procedure for Control Surface Experiment #1. As you test control surface #1 with your glider, complete this data sheet.

1. On the diagram shade the part of the plane you are testing.



2. Name the control surface you just shaded.

   outer elevon

3. Tell what position you moved that control surface to. (up, down, left, right, etc.)

   left outer elevon up, right outer elevon down

   or

   left outer elevon down, right outer elevon up

4. Briefly describe the glider's flight.

   the glider rolled left
   or
   the glider rolled right

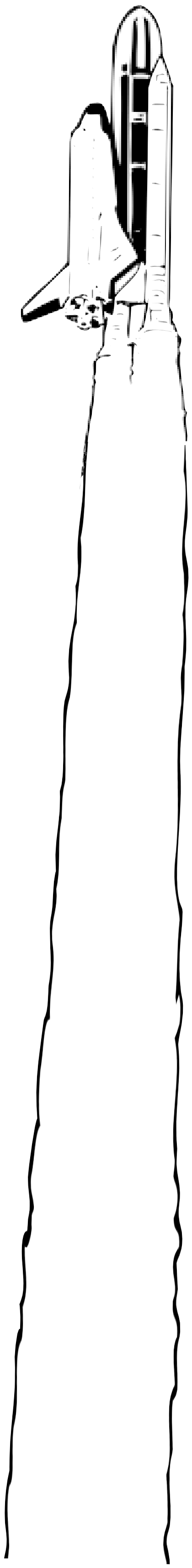
5. Draw the glider's flight path.

6. Circle the type of motion that this control surface controls.

   pitch yaw roll

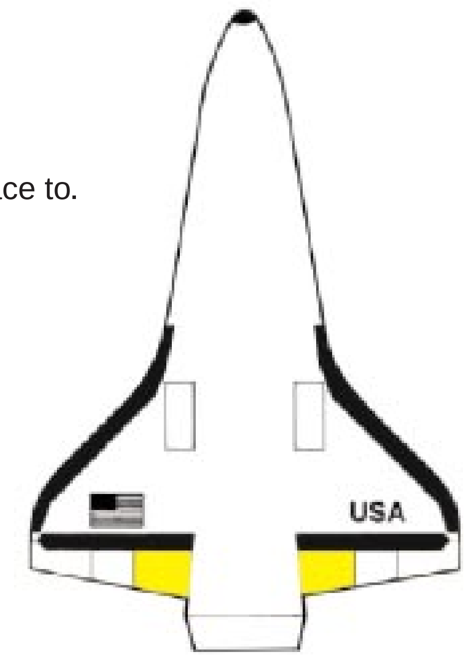
7. Use this space for any other observations you might have.

Control Surface Experiment Data Sheet #2 - Key



Directions: Follow the steps from your class procedure for Control Surface Experiment #2. As you test control surface #2 with your glider, complete this data sheet.

1. On the diagram shade the part of the plane you are testing.



2. Name the control surface you just shaded.

   inner elevon

3. Tell what position you moved that control surface to. (up, down, left, right, etc.)

   both inner elevon bent up

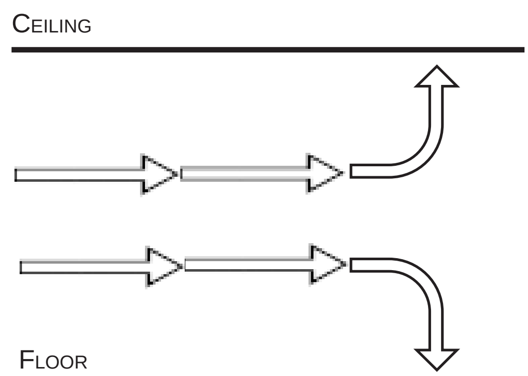
   or

   both inner elevon bent down

4. Briefly describe the glider's flight.

   the glider's nose pitched up
   or
   the glider's nose pitched down

5. Draw the glider's flight path.

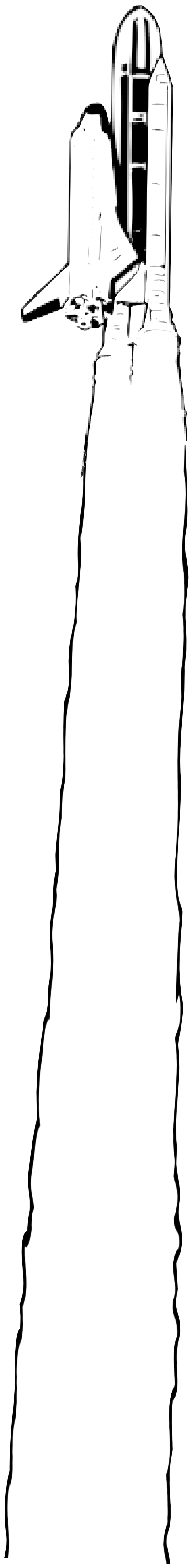


6. Circle the type of motion that this control surface controls.

pitch yaw roll

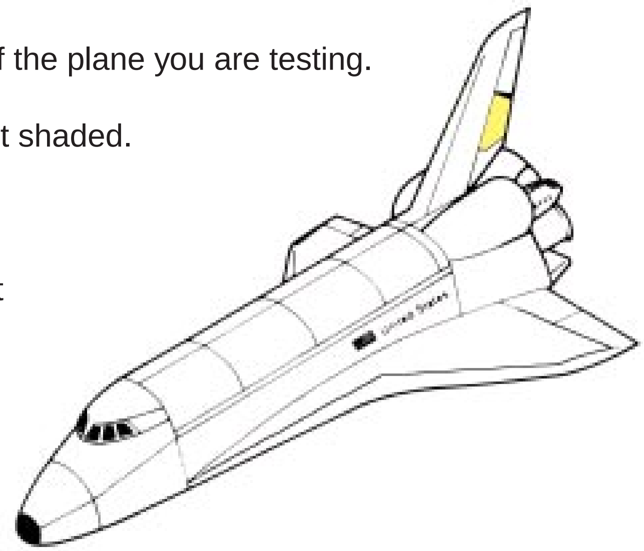
7. Use this space for any other observations you might have.

Control Surface Experiment Data Sheet #3 - Key



Directions: Follow the steps from your class procedure for Control Surface Experiment #3. As you test control surface #3 with your glider, complete this data sheet.

1. On the diagram shade the part of the plane you are testing.



2. Name the control surface you just shaded.

   rudder

3. Tell what position you moved that control surface to (up, down, left, right, etc.)

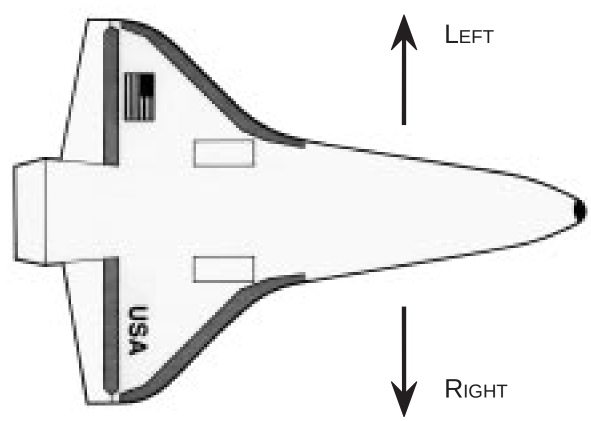
   to the left

   or

   to the right

4. Briefly describe the glider's flight.

   the glider's nose yawed left
   or
   the glider's nose yawed right



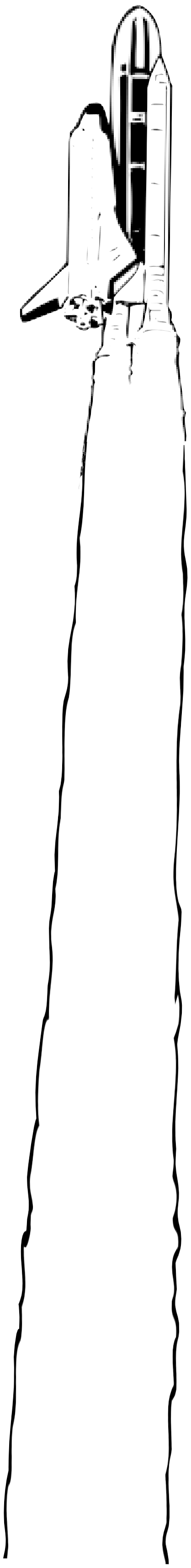
5. Draw the glider's flight path.

6. Circle the type of motion that this control surface controls.

   pitch yaw roll

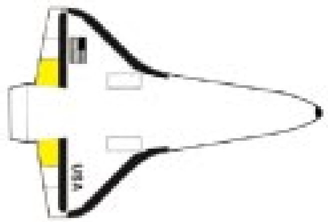
7. Use this space for any other observations you might have.

Experiment Conclusion Report - Key



Data

Control Surface
#1



control surface:

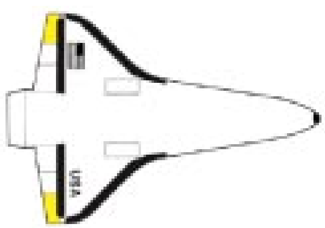
____

Position
(in tandem, opposite)
(up, down, right, left)

Motion
(roll, pitch, yaw)
Direction
(up, down, left, right)

left - up right - down	roll left (pronounced)
left - down right - up	roll right (pronounced)
both - down	pitch down
both - up	pitch up

Control Surface
#2



control surface:

____

Position
(in tandem, opposite)

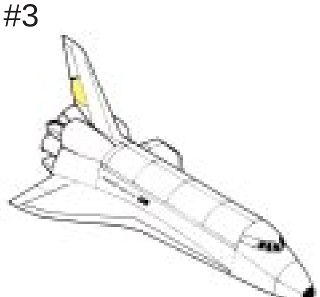
(up, down, right, left)

Motion
(roll, pitch, yaw)
Direction
(up, down, left, right)

left - up / right - down left - down / right - up	roll - left roll - right
both - down both - up	pitch - down flies straight & level longer with slight nose up

---

Control Surface
#3



control surface:

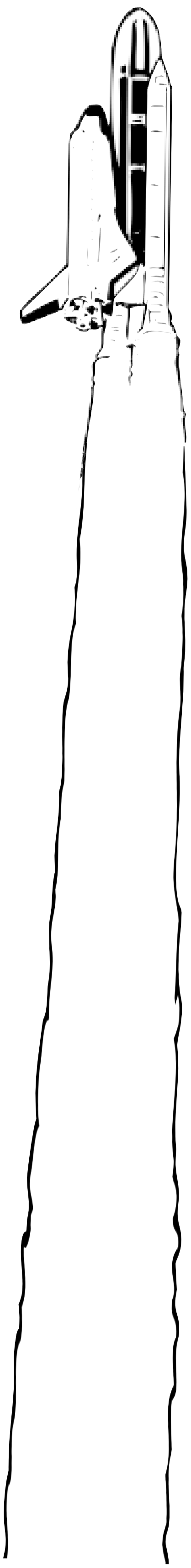
____

Position
(in tandem, opposite)
(up, down, right, left)

Motion
(roll, pitch, yaw)
Direction
(up, down, left, right)

right	yaw right
left	yaw left

Student Worksheet: Orbiter Control - Key



Directions: After reading “Orbiter Control”, answer each question below.

1. Explain in your own words why the orbiter is a “true aerospace vehicle”.

   An aerospace vehicle is a craft that cannot only fly “in the air” (or atmosphere), but also in space without having to change its form. The orbiter can do this.

2. Complete the chart below by naming the four basic control surfaces and what motions each one controls.

Control Surface	Motion Controlled
Elevons	roll, pitch
Rudder	yaw
Speed brake	forward motion
Body flap	pitch

3. Why does the orbiter have wide S-turns as part of its descent flight path?

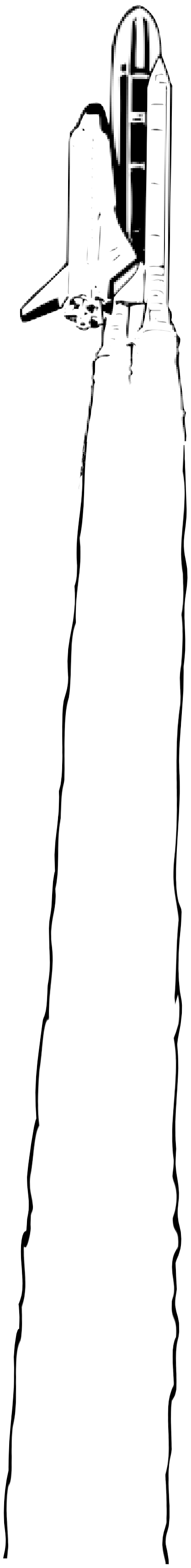
   The wide S-turns help to slow its speed during descent by generating more drag with its positive pitch (nose up entry) and longer flight path.

4. Give the orbiter’s fastest speed and slowest speed that it flies during its landing.

   Fastest speed: 28,000 km/h or 17,100 mph
   Slowest speed: 350 km/h or 210 mph

5. Why is the orbiter’s nose pitched positively (up) during most of its landing flight?

   This exposes the widest part of the orbiter to the oncoming airflow and generates more drag that slows its speed. It also concentrates the heat encountered during the descent onto the heat shields located on its underbelly. This protects the orbiter from burning up upon reentry.



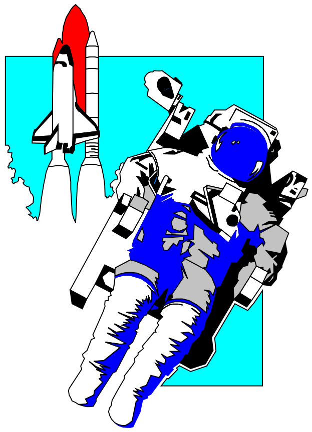
Student Worksheet: Descent Control - Key

Directions: Using what you have learned about control surfaces on the orbiter and motions; give flying advice to the commander. At each numbered orbiter on the descent profile in the diagram (see next page), recommend to the commander the following flight instructions:

- motion(s) to be flown
- control surfaces to be used
- position of each control surface used

Complete the chart below with your information.

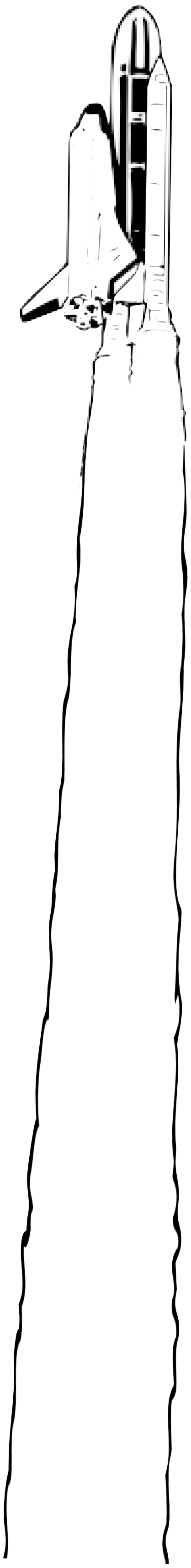
Orbiter	Motions	Control Surface(s)	Position of control surface
1	roll left slight yaw left	inner elevon outer elevon rudder	left - up / right down left - up / right down left
2	roll right slight yaw right	inner elevon outer elevon rudder	left - down / right up right
3	roll right slight yaw right	inner elevon outer elevon rudder	left - down / right up right
4	pitch - up	inner or outer elevon	both up



Student Science Activity: Everything's Under Control

Student Handouts

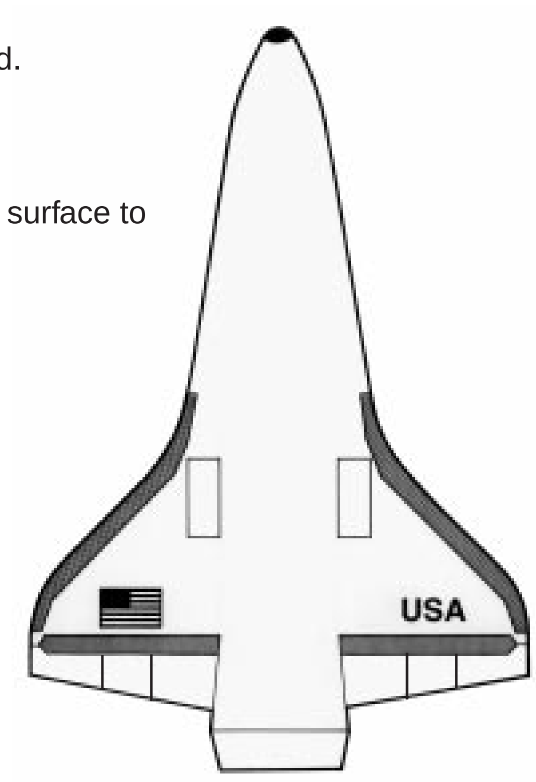
Control Surface Experiment Data Sheet #1



Directions: Follow the steps from your class procedure for Control Surface Experiment #1. As you test control surface #1 with your glider, complete this data sheet.

1. On the diagram shade the part of the plane you are testing.

2. Name the control surface you just shaded.



3. Tell what position you moved that control surface to (up, down, left, right, etc.)

4. Briefly describe the glider's flight.

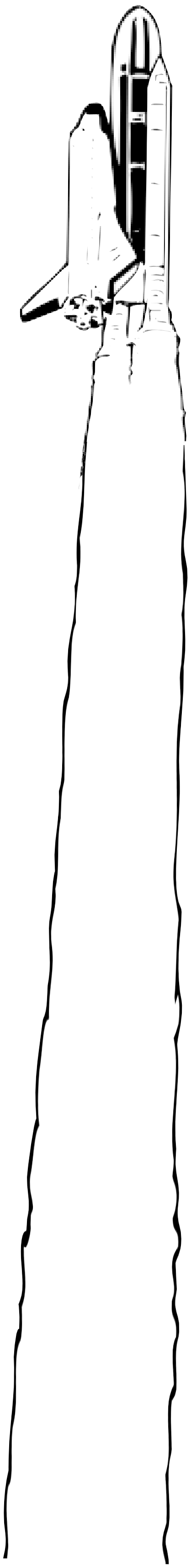
5. Draw the glider's flight path.

6. Circle the type of motion that this control surface controls.

   pitch yaw roll

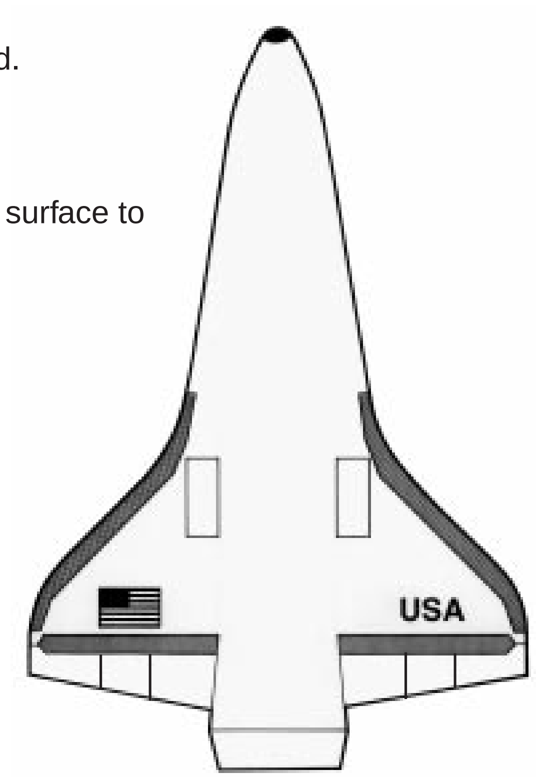
7. Use this space for any other observations you might have.

Control Surface Experiment Data Sheet #2



Directions: Follow the steps from your class procedure for Control Surface Experiment #2. As you test control surface #2 with your glider, complete this data sheet.

1. On the diagram shade the part of the plane you are testing.



2. Name the control surface you just shaded.

3. Tell what position you moved that control surface to (up, down, left, right, etc.)

4. Briefly describe the glider's flight.

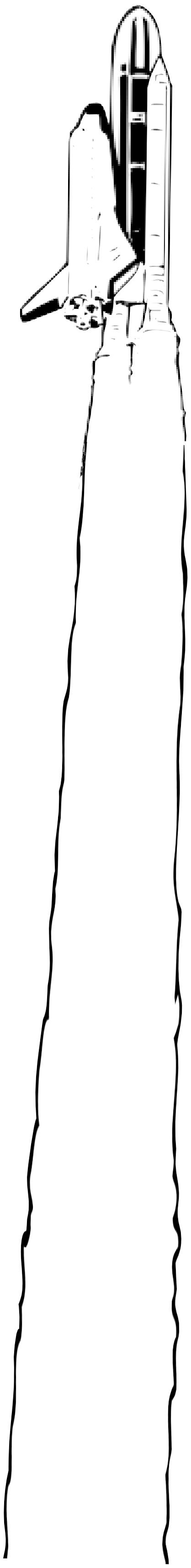
5. Draw the glider's flight path.

6. Circle the type of motion that this control surface controls.

   pitch yaw roll

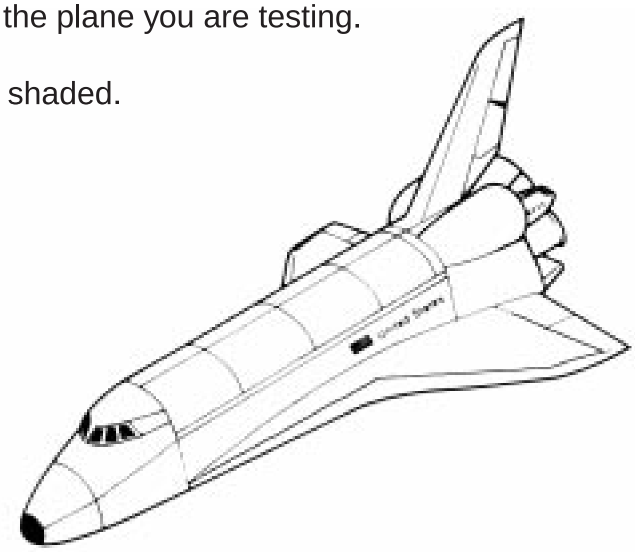
7. Use this space for any other observations you might have.

Control Surface Experiment Data Sheet #3



Directions: Follow the steps from your class procedure for Control Surface Experiment #3. As you test control surface #3 with your glider, complete this data sheet.

1. On the diagram shade the part of the plane you are testing.



2. Name the control surface you just shaded.

3. Tell what position you moved that control surface to.
(up, down, left, right, etc.)

4. Briefly describe the glider's flight.

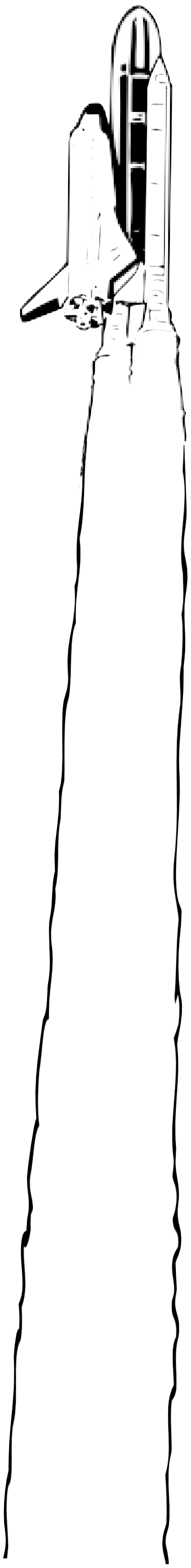
5. Draw the glider's flight path.

6. Circle the type of motion that this control surface controls.

   pitch yaw roll

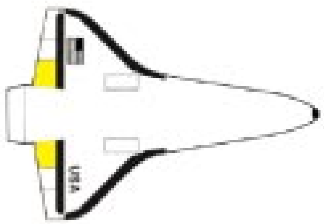
7. Use this space for any other observations you might have.

Experiment Conclusion Report



Data

Control Surface
#1

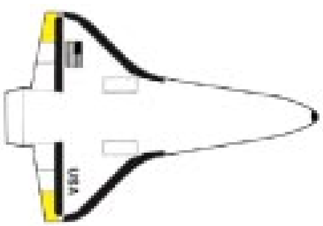


control surface:

____

Position (in tandem, opposite) (up, down, right, left)	Motion (roll, pitch, yaw) Direction (up, down, left, right)

Control Surface
#2



control surface:

____

Position (in tandem, opposite) (up, down, right, left)	Motion (roll, pitch, yaw) Direction (up, down, left, right)

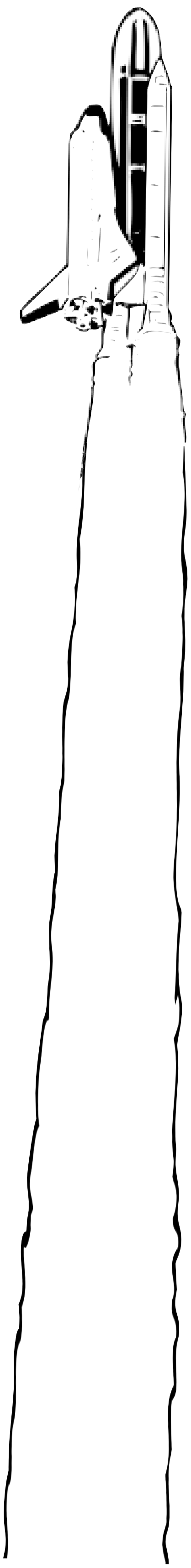
Control Surface
#3

control surface:

____

Position (in tandem, opposite) (up, down, right, left)	Motion (roll, pitch, yaw) Direction (up, down, left, right)

Student Informational Reading: Orbiter Control

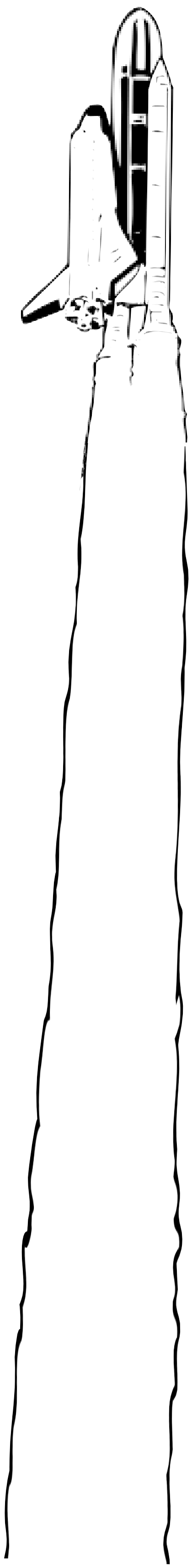


The space shuttle orbiter is truly an aerospace vehicle. It takes off using rockets, it orbits the earth as a spacecraft, and glides to the earth's surface as an airplane. During launch and its orbit of the earth, the orbiter does not make use of its airplane control surfaces at all. Because space is a vacuum, there is no air and therefore no air molecules through which the orbiter could fly. Remember that in order for there to be a difference in air pressure between the air flowing over a wing and the air flowing under a wing, there has to be air! No air, no air pressure, no lift! So the orbiter's wings and control surfaces are useless in space, but once below an altitude of about 96.9 km (60 miles), they can be used just like the control surfaces on an airplane.

The orbiter has 4 basic control surfaces. They are the split rudder, elevons, speed brake and the body flap. The split rudder is located on the tail section of the orbiter which is called the vertical stabilizer. It is used to move the nose of the orbiter to the pilot's right or left. This side-to-side motion of the nose is called yaw. Because of the orbiter's delta wing configuration, it does not have elevators or ailerons. It has a combination of these two airplane control surfaces: elevons. The orbiter has two sets of these elevons. It has an inner set and an outer set located on the delta wings. The inner elevons control the motions of pitch and roll. The outer elevons also control the motions of pitch and roll. The difference between the inner and outer elevons is that the outer elevon is used primarily at higher (faster) speeds, while the inner elevon is used primarily at the lower (slower) speeds.

The split rudder is a control surface unique to the orbiter. The split rudder has two hinged surfaces which can move together to the left and right (functioning as a rudder). It can also split apart or open (functioning as a speed brake). When deflected (or opened) it changes the way the air flows around the tail section of the orbiter. In doing this, it creates drag that slows the orbiter's speed. Because of the orbiter's need to be able to glide through the atmosphere at speeds from hypersonic to subsonic, the speed brake is used along with the wide S-turns to slow the orbiter's speed as it descends. The body flap (located just underneath the engines) is also a control surface unique to the orbiter. It is used to help trim the orbiter's attitude. That means that the body flap is used to keep the orbiter in its proper flight position to maintain its course. These four basic control surfaces (rudder, elevons, speed brake and body flap) work together to keep everything under control as the orbiter rushes towards its runway.

Student Informational Reading: Orbiter Control (continued)

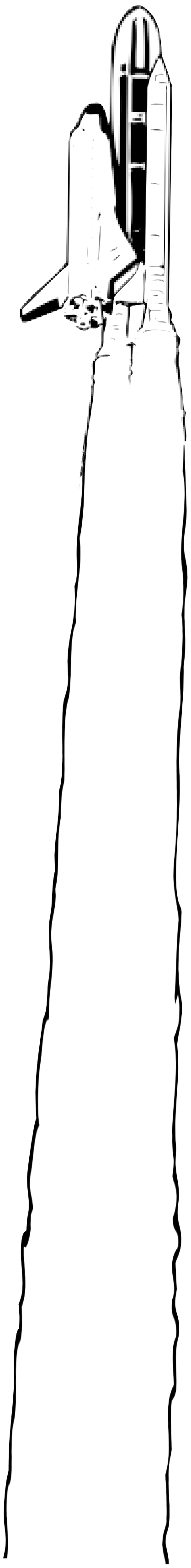


Let's follow closely a typical landing of the orbiter and see how and when each control surface is used during this phase of the flight. At about an altitude of 96.6 km (60 miles), the orbiter encounters the fringes of the earth's atmosphere moving at a speed of 28,500 km/h (17,100 mph) with its nose pitched to a 30 degree angle. Less than 8 minutes later, the orbiter has already descended to an altitude of 77 km (46.2 miles) and is maintaining a speed of 28,000 km/h (16,800 mph). At approximately this altitude the air is dense enough for the control surfaces on the orbiter to operate. The body flap, elevons, split rudder and speed brake are put into use.

The orbiter begins its series of S-turns by making a broad sweeping roll to the right which is done to slow its speed as it descends dramatically from an altitude of 70 km (42 miles) to 33 km (19.8 miles). During this descent it also slows its speed from 28,000 km/h (17,100 mph) to 4,800 km/h (2,880 mph). During speeds above 8,180 mph the elevons and the body flap are in the up position. At a speed of 8,720 km/h (5,450 mph) the speed brake is deflected to a full-out position. This causes the nose to pitch up and allows the elevons to be put in the down position while the orbiter continues to slow its speed while descending. At a speed of 3,272 km/h (2,045 mph) the elevons are returned to an up position and the speed brake is moved to a smaller deflection (or closed slightly) to reduce the positive pitch angle (upward pitch) of the nose.

At an altitude of 21 km (12.6 miles) flying at a speed of 1,700 km/h (1,020 mph), the orbiter enters the Terminal Area Energy Management (TAEM) phase of its flight. During this phase of its landing, its energy (lift versus drag) is balanced for the final approach. Since the orbiter does not use engine power to land, it has only one opportunity to land. It cannot abort and fly around the runway for another try because it has no engine power to propel it upward again. It is important that during the TAEM phase the commander achieves a balance between lift and drag to ensure the best possible landing. At 15 km (9 miles) above the earth's surface, the orbiter slows as it passes through the sound barrier. At 3 km (1.8 miles) in altitude, the orbiter has entered its final approach phase with a 10 degree angle of attack as it maintains a steep glide slope of 21 to 24 degrees. To compare, a jetliner on its final approach phase approaches a runway at a glideslope of 2 to 3 degrees. While flying at subsonic speed, the speed brake is slightly deflected to continue to slow the

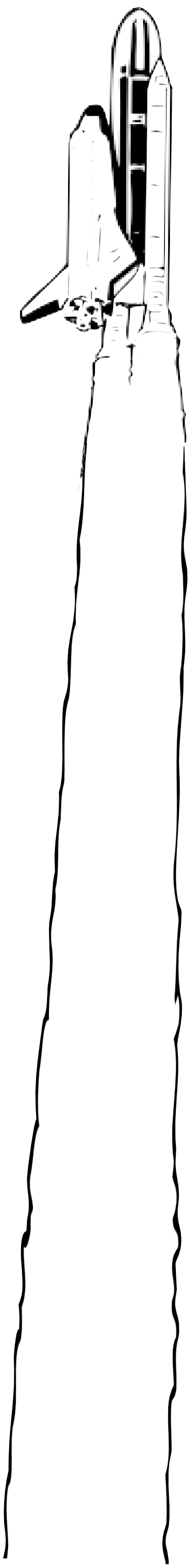
Student Informational Reading: Orbiter Control (continued)



orbiter's speed. The body flap is used to assist in trimming the orbiter's attitude. As the orbiter descends to about 550 meters (about 1,650 feet) above the ground, the orbiter's angle of attack is slowly lowered to 3 degrees and the glideslope is flattened from 24 degrees to 3 degrees. During this part of the landing the orbiter's onboard computers are assisted by a landing system that uses a microwave scanning beam. About 2 km (1.2 miles) from the touchdown point, the main landing gear is lowered and the flare maneuver is used which pitches the nose up 10 degrees. The orbiter's speed slows to about 350 km/h (210 mph) as it touches down on the runway. The parachute is deployed and the orbiter rolls to a stop about 2.5 km (1.5 miles) down the runway.

So we see how this unique aerospace vehicle travels from the outer reaches of the atmosphere to landing on a runway far below. We see how the control surfaces work together to guide the delta-winged glider from hypersonic speeds to subsonic speed, bringing it to a halt with the deployment of its parachute at its final destination. It is the orbiter's remarkable aerospace glider design that has made it a dependable part of the space transportation system linking the earth with space.

Student Worksheet: Orbiter Control



Directions: After reading “Orbiter Control”, answer each question below.

1. Explain in your own words why the orbiter is a “true aerospace vehicle”.

2. Complete the chart below by naming the four basic control surfaces and what motions each one controls.

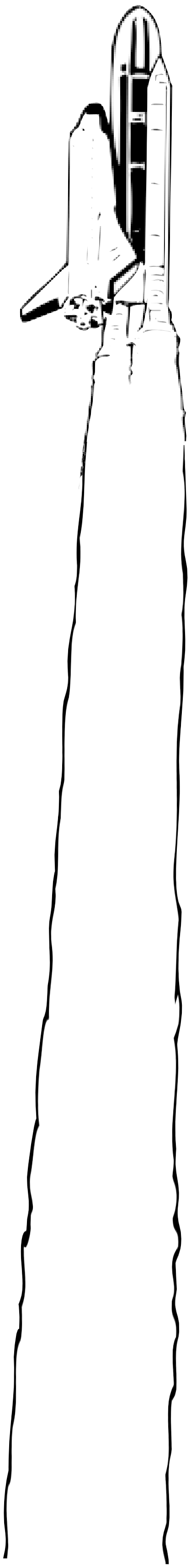
Control Surface	Motion Controlled

3. Why does the orbiter have wide S-turns as part of its descent flight path?

4. Give the orbiter’s fastest speed and slowest speed that it flies during its landing.

5. Why is the orbiter’s nose pitched positively (up) during most of its landing flight?

Student Worksheet: Descent Control



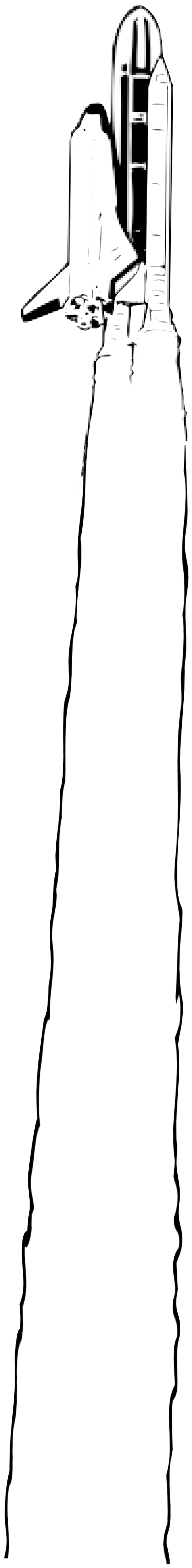
Directions: Using what you have learned about control surfaces on the orbiter and motions; give flying advice to the commander. At each numbered orbiter on the descent profile in the diagram (see next page), recommend to the commander the following flight instructions:

- motion(s) to be flown
- control surfaces to be used
- position of each control surface used

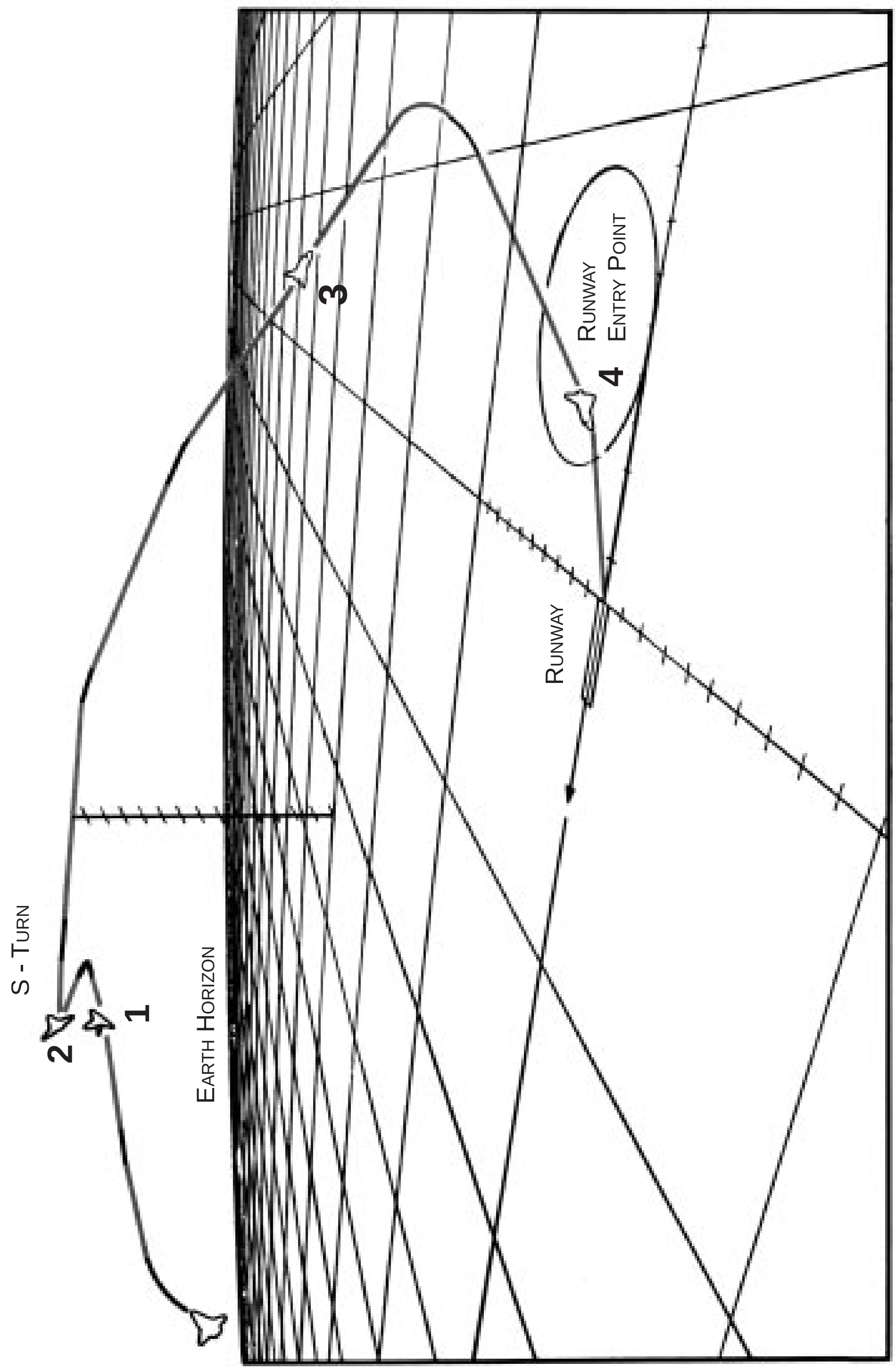
Complete the chart below with your information.

Orbiter	Motions	Control Surface(s)	Position of control surface
1			
2			
3			
4			

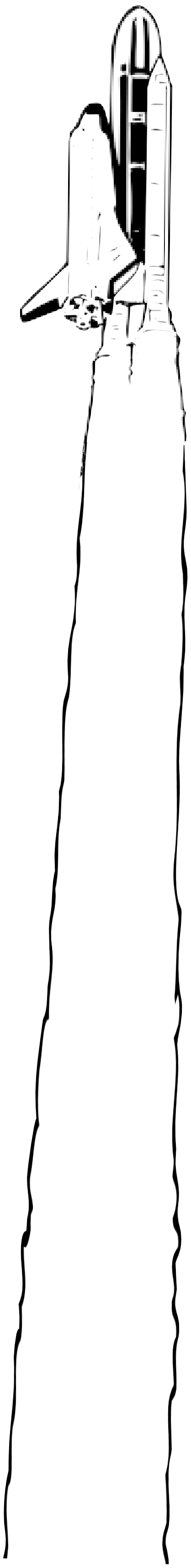
Student Worksheet: Descent Control (continued)



Flight Profile



Self - Evaluation Check-up



Directions: Rate yourself and your work. On a scale of one (low) to ten (high), tell how well did you do on each part of this activity.

Name of Activity: **Everything's Under Control**

A) Following Directions

I skipped around a lot because I did not follow directions.

I closely followed the directions and did the steps in proper order.

1 5 10

B) Using Time Wisely

I misspent a lot of time.

I stayed on task the whole time.

1 5 10

C) Recording Observations / Information

I did not write much.

I wrote a lot and included everything I observed.

1 5 10

D) Working Well With Others

I got along only part of the time.

I got along most of the time.

1 5 10

E) Discussing Ideas / Results with Others

I did not add much to the discussion.

I contributed lots of ideas to the discussion.

1 5 10

F) List two things you learned about flight from this activity.