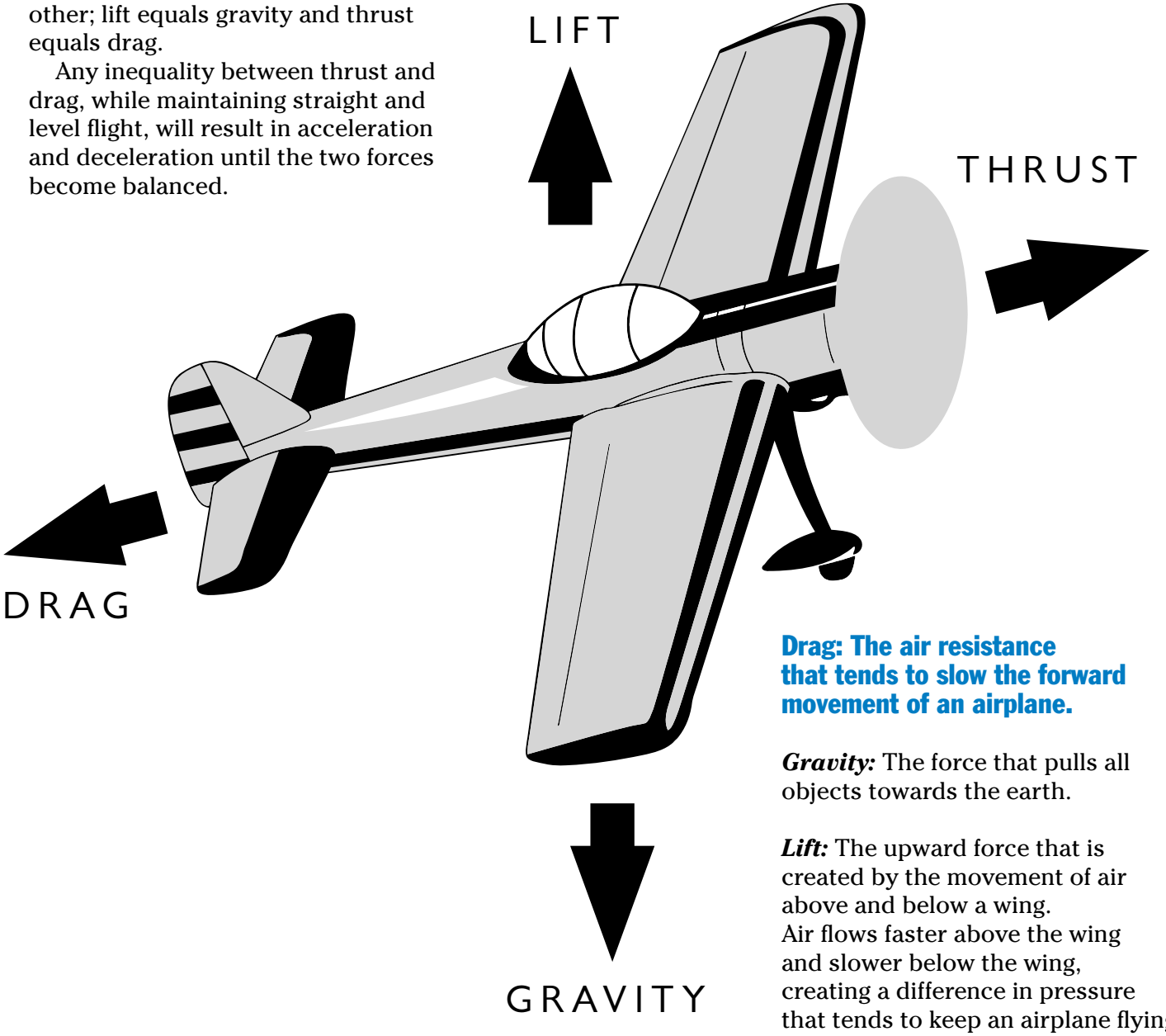
THE FOUR FORCES OF FLIGHT–DRAG

An aircraft in straight and level flight is acted upon by four forces: ***lift, gravity, thrust,*** and ***drag.***

The opposing forces balance each other; lift equals gravity and thrust equals drag.

Any inequality between thrust and drag, while maintaining straight and level flight, will result in acceleration and deceleration until the two forces become balanced.

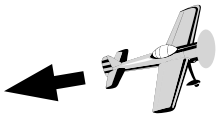


Drag: The air resistance that tends to slow the forward movement of an airplane.

Gravity: The force that pulls all objects towards the earth.

Lift: The upward force that is created by the movement of air above and below a wing. Air flows faster above the wing and slower below the wing, creating a difference in pressure that tends to keep an airplane flying.

Thrust: The force that moves a plane forward through the air. Thrust is created by a propeller or a jet engine.

DRAG 

Paratroopers Away!

OBJECTIVE:

Investigate the principle of drag.

PROBLEM:

How does a parachute create drag for a falling object?

MATERIALS:

Each pair of students needs one plastic grocery bag (with handles), one clothespin (or a large paperclip), and a copy of Blackline 1.

BACKGROUND INFORMATION:

Drag is the force that acts against the forward movement of an airplane and slows It down. All moving objects experience drag.

MANAGEMENT:

1. 30 minutes

2. This activity should be done in pairs.

3. Allow the pairs to take turns dropping the parachutes.

4. Students will get more height if they stand on chairs.

WORD BANK:

drag, parachute, weight, descent, streamline, observation, paratrooper (a soldier trained to jump from an airplane and be lowered slowly to the ground using a parachute), drag chute (a parachute used to slow down an airplane or other object that travels through the air)

Paratroopers Away!

PROCEDURE:

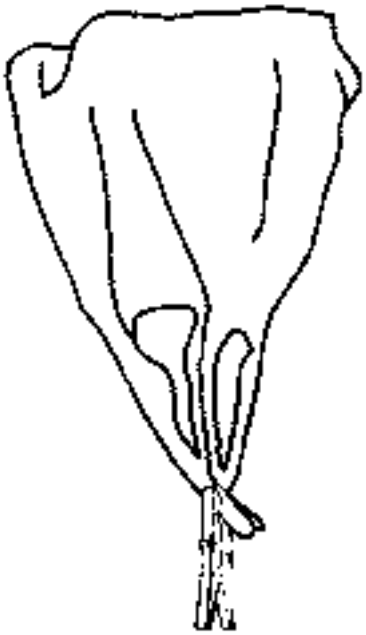
1. Bring the handles of the grocery bag together and secure with a clothespin.

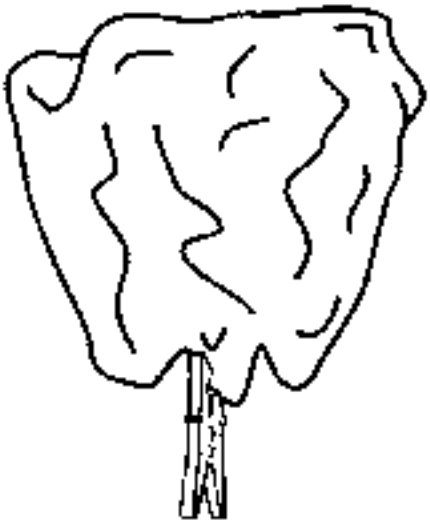
2. First, the students drop the parachute from a chair-standing height. With the grocery bag first crumpled up, observe the decent of the clothespin. Note: make sure the clothespin drops first.

3. Next, students open up the parachute fully and drop it from the same height. Observe the descent of the clothespin.

4. The students should experiment with the two different ways of dropping the clothespin.

5. The students will record their observations on the Paratrooper Data Sheet, Blackline 1.





Paratroopers Away!

DISCUSSION:

1. How does a parachute create drag for falling object?

2. What were the differences they observed between the two drops?

3. How does drag affect the flight of an airplane?

4. Would increased weight require a larger parachute? Why?

EXTENSIONS:

1. Have the students try different sized parachutes.

2. Have the students add different weights.

3. Drop the parachutes from different height.

CULMINATING ACTIVITY:

Paratrooper Target Drop
Students can compete by creating parachute that land accurately on a bullseye target.

Paratroopers Away!

PARATROOPER DATA SHEET

Paratroopers:_____

Diagram and label the two parachute drops.

CLOSED CHUTE	OPEN CHUTE

How does a parachute create drag for a falling object? Write your observations.

_____

_____

_____

_____

Drag Racers

OBJECTIVE:

Investigate the force of drag on a moving object.

PROBLEM:

How does a drag-chute affect the speed of student runners?

MATERIALS:

garbage bags (large, heavyduty bags work best),
tape, stopwatch, and copy of Blackline 1 for each group

BACKGROUND INFORMATION:

This activity lets students to feel the force of drag.
Airplanes are designed to be sleek so that drag is reduced,
allowing easier movement through the air.

MANAGEMENT:

1. 45-60 minutes

2. Students should work in groups of four taking turns running and timing.

3. Construct the drag-chutes in the classroom.
Running will take place outside on a marked 20-30 meter "runway".

4. Garbage bag drag-chutes should be at least one square meter.
(This might require taping bags together. If so, make sure seams are solid—no holes!)

WORD BANK:

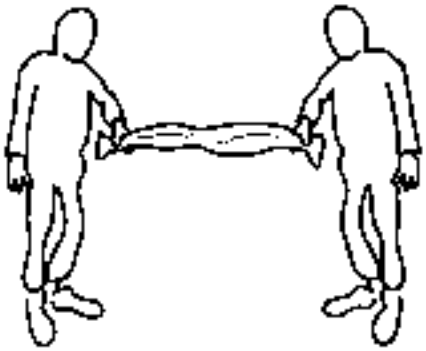
drag, drag-chute, meter, runway, sleek, aerodynamic, speed, resistance, pull

Drag Racers

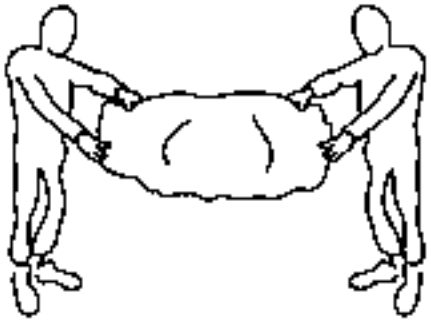
PROCEDURE:

1. Each group will make their garbage bag drag-chute. To do this, cut along one side and the bottom of the bag. This will make one flat sheet. Make sure it is at least one square meter. If it is not, tape another bag to it.

2. Two students run from the starting line, side by side, holding the drag-chute that is rolled up between them. The timers say "Go," the students run to the finish, and the timers stop the watch. Record the time on the record log, Blackline 1.



3. The same two students now repeat the run with the drag-chute unfurled. The timers instruct the students to "Go", then stop the watches at the finish. Record time on the Record Log.



4. The timers should now switch places with the runner. Repeat the procedure.

5. The group then completes the Record Log, Blackline 1.

Drag Racers

DISCUSSION:

1. Explain what it was like running with the drag-chute closed compared to when it was open.

2. What force caused you to slow down?

3. Do you think a larger drag-chute would cause you to run even slower? Why?

4. How are airplanes designed to keep the force of drag in mind?

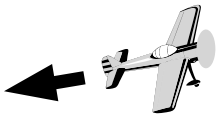
EXTENSION:

1. Complete more trials by running longer distances, using smaller or larger drag-chutes, or using different drag-chute materials

2. Two students with a drag-chute can race two students without drag-chutes.

CULMINATING ACTIVITY:

Allow the students to design original drag-chutes, naming their teams.
Then conduct a class drag race derby!



Drag Racers

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RECORD LOG

Racers:

_____

_____

	TIME WITHOUT DRAG-CHUTE	TIME WITH DRAG-CHUTE
RACERS 1 & 2		
RACERS 3 & 4		

How did the drag-chute affect the speed of your racer?

_____

Why do you think the drag-chute affected your race?

_____

_____

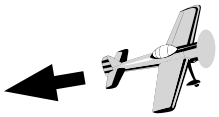
Find the difference in speed between your race without the drag-chute and with the drag-chute:

Racers 1 and 2

_____

Racers 3 and 4

_____



What a Drag!

OBJECTIVE:

Investigate the principle of drag.

PROBLEM:

Does drag affect the flight of an airplane?

MATERIALS:

Balloons (sausage-shaped works best), straws, scotch tape, paper plates (8-1/2" diameter)

BACKGROUND INFORMATION:

This activity is similar to the Balloon Jet activity but emphasizes how drag slows down the jet.

MANAGEMENT:

1. 45-60 minutes

2. This activity works best with small cooperative groups of 3-4 students.

3. Cut pieces of fishing line to the length of the room available.

4. Create one Balloon Jet per group.

5. Each group should have a designated "balloon blower" so that the balloon is always blown up by the same student.

WORD BANK:

thrust, drag, average (mean), launch

What a Drag!

PROCEDURE:

1. Thread the fishing line through the straw and attach the ends of the fishing line securely to a wall or other object.
The line should be taut.

2. Instruct the students to blow up their balloons to the desired size, measure the length, and record it on their Group Data Sheet.
Pinch off the end of the balloon so that no air is released.

3. Tape the balloon to the straw.

4. The students will release the balloon from the designated starting point.

5. Observe and measure the distance the balloon travels and record it on the Group Data Sheet.

6. Repeat the procedure two more times keeping the balloon the same size. (Balloons may be a different size for each group)

7. Repeat procedures 2-6, adding a paper plate to the front of the jet. (Be sure plate does not get caught on line)

8. After all groups have completed the activity and Group Data Sheet, compare the results.

9. Each student will then complete his or her own Class Graph.

What a Drag!

DISCUSSION:

1. Which jet went a shorter distance? Why?

2. Why is it important for an aircraft to have less drag?

3. How are aircrafts designed to overcome drag?

4. Would weight affect the flight of your jet in the same way?

EXTENSIONS:

1. Use different sized plates for drag.

2. Use different shapes for drag.

3. Use different amounts of weight for drag.

CULMINATING ACTIVITY:

Have students share information about their jets, explaining the drags used and their observations.

RECORD LOG

Pilots:

_____

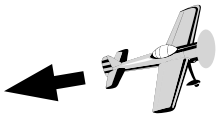
PREDICTION:

We think our Balloon Jet without drag will travel _____cm.

We think our Balloon Jet with drag will travel _____cm.

The name of our Balloon Jet is _____

Diagram and label your Balloon Jet.



What a Drag!

RECORD LOG

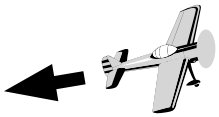
	DISTANCE TRAVELED						
BALLOON LENGTH	TRIAL 1		TRIAL 2		TRIAL 3		AVERAGE DISTANCE
	NO DRAG	DRAG	NO DRAG	DRAG	NO DRAG	DRAG	

CONCLUSION:

Explain how drag affects the flight of an airplane.

_____

_____



What a Drag!

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CLASS GRAPH

Captain:

_____

DISTANCE

NO DRAG	DRAG	NO DRAG	DRAG	NO DRAG	DRAG	NO DRAG	DRAG	NO DRAG	DRAG	NO DRAG	DRAG

GROUP _____ GROUP _____ GROUP _____ GROUP _____ GROUP _____ GROUP _____