



# The Whirligig Challenge



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# How do things fall?

Demonstration	Predict	Observe	Compare
Book and paper drop			
Seven coffee filters vs. one coffee filter drop			
One coffee filter vs. a flower of seven coffee filters drop			

# How things fall

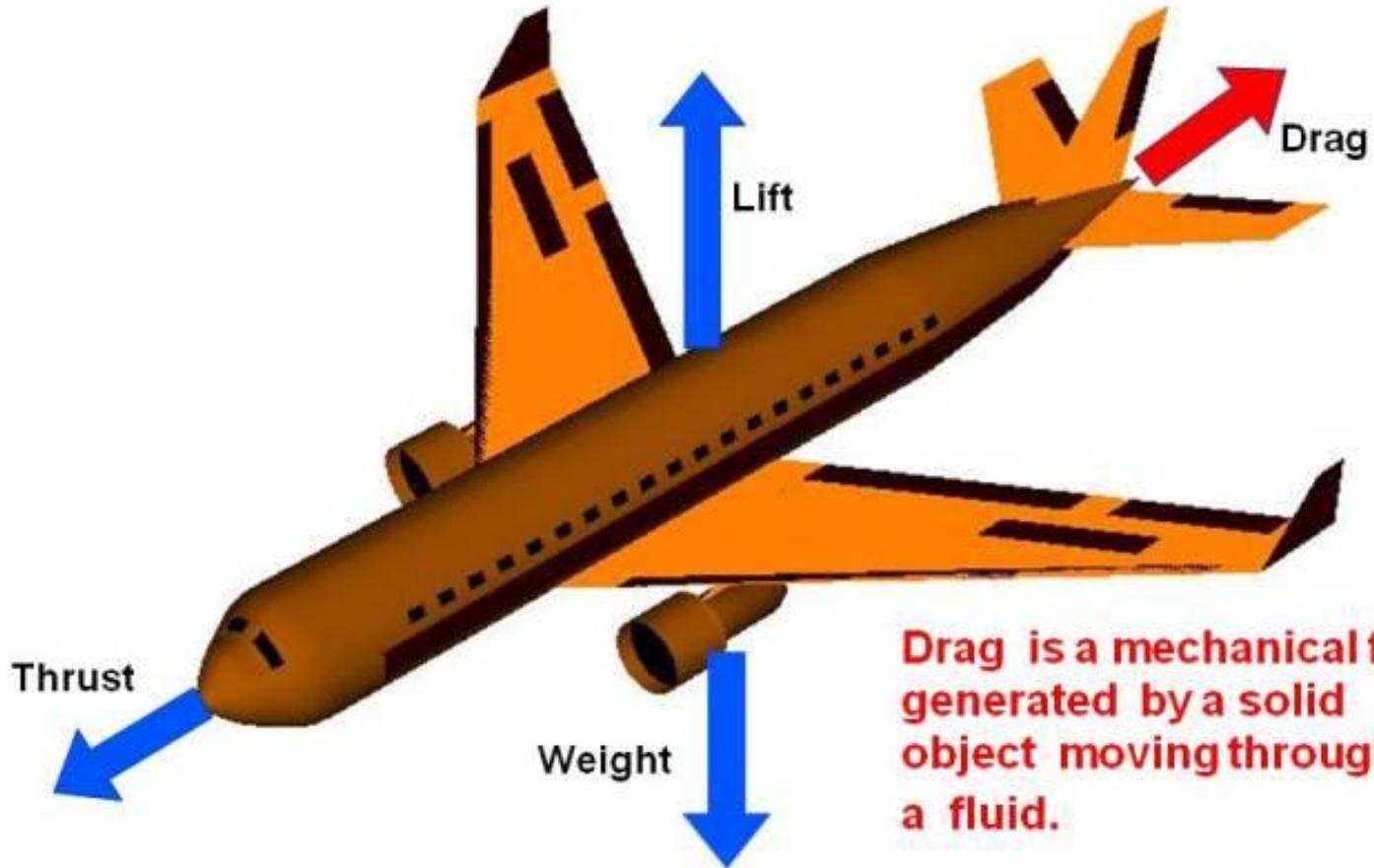
- What happened when you dropped a book and a piece a paper from the same height?
- What happened when you dropped a stack of seven coffee filters and a single coffee filter at the same time and from the same height?
- What happened when you dropped a single coffee filter and a flower of seven coffee filters taped together at the same time and from the same height?

# Air resistance

- Air resistance is also called “drag force”
- This force is a resistive force; opposing the motion of an object
- This force is due to friction between the object and the fluid (gas or liquid) that it travels in
- For objects moving in air, the size of the drag force depends directly on the area of surface going through the air, the density of the air, and the speed of the object.



# What is Drag ?



**Drag is a mechanical force generated by a solid object moving through a fluid.**

# Properties of Air Resistance

Object is released



As it begins to fall



The object will fall toward Earth speeding up until drag force = gravitational force

The object moves with a constant speed and in a constant direction. This speed = terminal speed of the object

# What is a whirligig?

A **whirligig** is an object that spins or whirls, or has at least one member that spins or whirls.

Examples include:

- pinwheels
- comic weathervanes
- spinners



[http://www.youtube.com/watch?v=Lnm\\_16KUF0M](http://www.youtube.com/watch?v=Lnm_16KUF0M)

# Questions to consider

- What do you think happens when a whirligig falls?
- How slowly does it fall?
- When does the whirligig start spinning and how fast?
- Does the whirligig always spin in the same direction?
- Is the path of descent straight or wavy?
- Does the whirligig stay vertical when falling or not?

# What happens when a whirligig falls

- When the whirligig falls, it experiences the force of gravity between it and Earth, and the drag force.
- Depending on which feature of the whirligig you wish to change, will determine how fast or slow the whirligig falls
- The task is to get the whirligig to reach a greater terminal speed so it will fall for a longer time the drag force = gravitational force

# Your job

To determine how to make a whirligig that will fall more slowly than the current one using the materials provided.



# How does a whirligig work?

- How slowly does it fall?
- When does the toy start spinning and how fast?
- Does the toy always spin in the same direction?
- Is the path of descent straight or wavy?
- Does the whirligig stay vertical when falling or not?

# Conduct an experiment

Variables	Settings		
<i>Wing length</i>	Short	Basic	Long
<i># of paper clips</i>	0	1	2
<i>Paper type</i>	Transparency	Basic	Thick

# Results



- What did you observe?
- Did you encounter any problems or challenging when testing?
- How did you address the problem?
- Which type of whirligig fell more slowly than the current one?
- How can explain your findings?

# Take away points

- Things fall because gravity pulls them toward Earth.
- Objects moving through air collide with air molecules, causing a push on the object opposite to the direction it is moving in.
- Adding paper clips to the whirligig results in the whirligig falling more quickly (less time).
- Adding blade length increases the surface area resulting in the object falling more slowly (more time).

# Essential Features of Classroom Inquiry

1. Learner engages in scientifically oriented questions
2. Learner gives priority to evidence in responding to questions
3. Learner formulates explanations from evidence
4. Learner connects explanations to scientific knowledge
5. Learner communicates and justifies explanations

# What is a fair test investigation?

- A fair test investigation involves changing one factor at a time while keeping all other conditions the same.
- Students learn to:
  - observe/question/predict
  - identify variables (independent vs. dependent)
  - conduct an experiment
  - communicate

# Comparison of inquiry and design (NRC, 2012, 2103)

## ***Scientific Inquiry***

- Asking questions
- Generate hypotheses
- Use models/predict
- Conduct experiments
- Construct explanations
- Interpret data/iterate
- Communicate

## ***Engineering Design***

- Defining problems
- Generate ideas
- Use models/build prototypes
- Designing solutions
- Troubleshoot/iterate
- Communicate

## ***Engineering***

- Engineering is the process of designing the human-made world.
- Engineers modify the world to satisfy people's needs and wants.
- Engineers rely on the knowledge of science and math to design solutions.

## ***Science***

- Science is an understanding of the world.
- Scientists ask questions about the world around us.
- Scientific knowledge informs engineering design, and many scientific advances would not be possible without technological tools developed by engineers.