## MAKE IT FLY

**Performance Standard 12D/11B/13B.E**

Students will apply the processes of scientific inquiry and technological design to explain thrust, weight, lift and drag in flight:

- *Knowledge*: Identify and describe the effects of drag and weight on lift and thrust.
- *Application*: Design an "airplane" to test the 'mechanics' of flight.
- *Communication*: Explain how weight and drag have an effect on lift and thrust.

**Procedures**

1. ***In order to know and apply concepts that describe force and motion and the principles that explain them (12D) and the processes, concepts and principles of scientific inquiry (11B) and technological design 13B,*** students should experience sufficient learning opportunities to develop the following:
   - Formulate inquiry questions associated with flight (thrust, weight, lift and drag).
   - Research sources of scientific information related to posed questions.
   - Brainstorm design dilemma associated with the ordinary circumstances of flight, in terms of testing its scientific principles.
   - Suggest appropriate materials, equipment and data-collection strategies, procedural sequence, success criteria and design options to safely test the technological design dilemma.
   - Sketch design plan and select appropriate graphic display of data according to success criteria variables.
   - Complete assembly of innovation, following classroom rules for preparation, procedures and clean-up.
   - Collect and display data from investigation accurately and honestly.
   - Test prototype of design by conducting multiple trials and record observations.
   - Use scientific technologies to collect, store, retrieve, and communicate data, and incorporate appropriate safety precautions.
   - Recognize the necessity of controlled variables and compare carefully recorded observations and summaries.
   - Identify faulty procedural steps which could cause different results, errors, or distort how variables interact.
   - Communicate an evaluation report to explain the observations and explanations for differences in flights for peer review.
   - Generate further questions for future investigations to evaluate thrust, drag, lift, weight.

   Note to teacher: This activity relates to knowledge associated with the standard 12D, while addressing the performance descriptors for stage D within standard 11A. Applying scientific habits of mind noted in standards 13A are foundational to these activities. Using various technologies to estimate, measure and record data address some performance descriptors in 13B.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Begin contextual inquiry investigation on flight with questions such as this: "How does an airplane stay up in the air?" or "What does it take to get an airplane off the ground?" Allow students to add more questions, such as: What is weight, lift, thrust and drag? How do these four elements enable an airplane to fly? How does the Bernoulli principle affect flight? What difference do construction materials make? How did the first airplane fly? How does weight and drag effect lift and thrust, etc.? Once questions have been listed, students should be divided to find resources that may provide information about their questions. They may choose to investigate single or multiple questions. Instruct students to create large concept maps to visualize the connections between apparently unrelated concepts. They should attach their questions and answers to appropriate links in their concept map and explain their reasoning for each placement. Guide students toward answering their questions and stating their understanding using appropriate scientific vocabulary terms and resources.
4. Introduce the investigation's premise of finding out about the four forces affecting flight, and especially Newton's Laws of Motion. They are to design an Identified Flying Object (IFO) which can go the greatest distance along flight path, using available materials. Students may use different size balloons, a common (uniform) size straw which will fly on a piece of fishing line strung across the room. They should make predictions about their single design element (thrust, drag, etc.) and build an airplane within the design constraints for the classroom: They may choose to have different "classes" for their competition, based on masses, controlled thrust, drag, and lift. For instance, they must predict how the size of the balloon will affect

the length of flight, measure the results and present their information to the whole class. Students should demonstrate/explain why they made each prediction. Allow for additional time to pair, test and compare design parameters, such as weight and drag, etc. Require predictions before testing and recorded observations during testing.

5. Encourage students to generate further questions which could follow from their initial research and presentations. Such questions could include these: Does weather affect the thrust or lift of an airplane? etc. *A curricular unit may incorporate the performance descriptions from 13B which address the interactions of technology in science and societal situations. They may want to study the flight of the Space Shuttle and its design parameters for flight within the atmosphere and beyond.*
6. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge*: The concept mapping provided identification and descriptions for flight concepts, weight, thrust, lift and drag, etc. were complete and correct.
   - *Application*: The data sheet with the predictions and actual measurements of 10-15 flights was complete and well-organized. Predictions, measurements and conclusions for paired design parameters were complete and well-organized.
   - *Communication*: The concept mapping linkages and explanations were complete and accurate. Questions for future studies were pertinent and applicable.

Examples of Student Work not available

**Time Requirements**

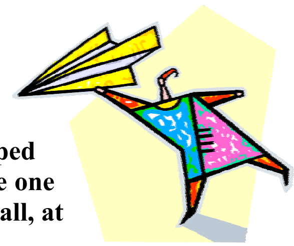
- Initial discussion and introduction to assignment: 25 to 30 minutes sessions, 2-4 days/class periods for research and prototype testing: 1-2 class periods for presentations and new question generation.

**Resources**

- Fishing line, tape, measuring tapes/meter sticks
- Sufficient balloons for testing small, medium, large sizes for group work and retesting
- Science Rubric

# Make It Fly

## Materials:



1. **Common straws**
2. **Balloons: At least 3 different size balloons for each airplane prototype developed**
3. **Fishing line—Suspend a length of at least 4 meters between ring stands where one end can be loosened prior to launch or tape one end securely to a classroom wall, at about student's eye level**
4. **Metric ruler**
5. **Tape: Both scotch and duct tape**

## Procedure:

- **Brain storm and predict how the different size balloons will affect the length the airplane flies down the fishing line.**
- **Determine which size of balloon they will test first.**
- **Create a data table which will record your observations and variables effectively.**
- **Using the duct tape, tape one end of the fishing line either to the classroom wall or a ring stand or something else of similar sturdiness**
- **Inflate the balloon to its full capacity and then attach the balloon to the straw using the scotch tape (make sure the balloon stays inflated).**
- **One student will control launch (holds the end of the balloon); one student will hold the end of the fishing line taunt, while the others prepare to measure the distance.**
- **Let the balloon go.**
- **After flight, measure the distance the balloon flew using metric units.**
- **Students will do 5 trials for the three sizes of balloon chosen.**
- **Chart data.**

**This activity can then be modified for determining weight using pennies attached to the balloon with tape and comparing the distance flown using the same size balloon.**