Class: Grade 6 Science

Lesson Title: Flight and the Four Forces Kinulation

Class Size: **24**
Time: **60 mins**

Curriculum Outcomes:
301-18 Describe and demonstrate methods for altering drag in flying devices
303-32 Describe the role of lift in overcoming gravity and enabling devices or living things to fly
300-22 Describe and justify the differences in design between aircraft and spacecraft

Learning Objectives:
1. Students will learn the four forces acting on a flying object (gravity, lift, thrust and drag)
2. Students will have a concrete understanding of what these four forces do and how a flying object moves if the forces are altered

Materials:
- A visual of an airplane (a 3D cardboard model)
- 4 force arrows labeled gravity, lift, thrust and drag to place around the airplane visual
- Chairs to act as the students' flying objects (or another object they can pick up and move around)
- Lift/drag/thrust nametags for students (groups of 4 students, one nametag for thrust, one for drag, and two lift nametags)
- Gravity labels to attach to the bottom of the chair/flying object
- Desks, books, other objects that can act as obstacles (depending on the room size and what is available to you)
- (optional) Ask students to bring in a "passenger" for their flying object (a teddy bear, toy, etc.)

Preparation beforehand:
- Be sure to have all force arrows, nametags and labels ready for your class size
- Have obstacles set up in the classroom before the lesson starts

Introduction:
1. Introduce the topic. Possible prompt questions include:
    a. If I take a baseball and throw it through the air, is it flying? Why?
    b. What about birds and planes? What is the difference between those things and a ball?
    c. What is it that makes things fly?
    d. As soon as I let go of the ball what forces are acting on it? (gravity, friction)

2. Introduce "drag" and ask students how they'd describe what a drag force is
    a. Does it slow objects down? Is it the same as friction?
    b. Give an example of sliding a chair across the floor or a hand across a desk. Is this drag or friction? What about swimmers? Why do they try to be as smooth as possible? Drag racers? Sky divers? (Drag is a type of friction that only happens when an object is travelling through fluids)
    c. What is a fluid? Is air a fluid?

3. Bring out the 3D airplane and ask students what forces are acting on the airplane?
    a. As they name a force, have them come up and hold that force arrow around the plane, showing the direction. As they do this they can explain what the force is doing to the plane.
    b. Have students critique the placement of the arrows and the explanations. (Do you agree or disagree? How is this force controlled?)

Gravity: Can the pilot control gravity? Does the force of gravity stay the same throughout the whole flight? How does that work?
Lift: What creates the lift in an airplane? How does the design or shape cause lift to occur? What does the word "aerodynamic" mean? Do the wings play a role in lift? How do you create more lift?
Drag: Where is the drag coming from? Is all drag a type of friction?
Thrust: Where is the thrust coming from? If I have drag pulling one way and thrust pulling the other way, which way is the plane moving?

Note that figure 1 shows a correct representation of the free body diagram for the forces acting on a flying

object. To avoid confusion, it is important students understand that the thrust is a force pushing an object forward and drag is a force pushing against the object and slowing it down (see figure 2). For this reason, simply move the thrust force behind the airplane and move the drag force to the front of the airplane.

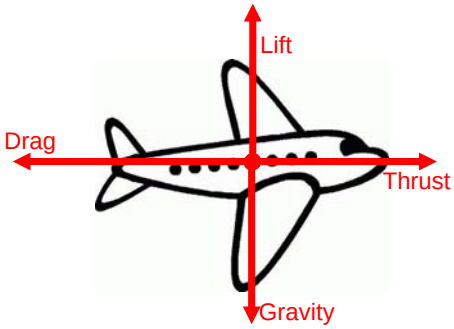

Figure 1

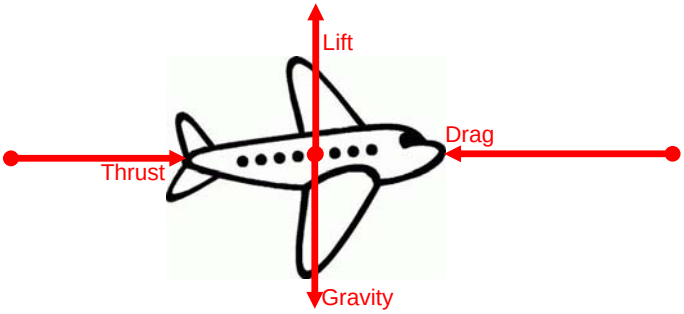

Figure 2

4. Explain what a kinulation is (broken up into kinesthetic and simulation). Tell them that these are used to help students learn difficult concepts that are otherwise difficult to picture. It allows students to become part of the demonstration, and therefore easier to remember and learn. Ask students if they would like to try one.

Activity #1 :

1. Have students divide into groups of 3 or 4. They will need one chair per group with a gravity label underneath their chair (the chair is their airplane). You can use one group as a demo to start.
    a. Leave extra chairs, desks, etc. in the room to act as obstacles that they must fly around.

2. Each student will be given a force. If it is a group of 3 there will be one lift, one drag and one thrust. If it is a group of 4 there will be two lift forces. They are going to exert the force they are given onto the airplane.

3. Have the demo group stand around their airplane and strap in their passenger (if they brought in a toy/teddy bear). Students can discuss where they should stand and try out different strategies to get their airplane in the air.
    a. Have this demo group "fly" around the classroom and then have the rest of the class critique or evaluate what they just saw. What did the students-forces do? Why is there drag? How could we get rid of some drag?

4. Now have all groups strategize where they will stand and how they will exert their force on the chair.
    a. Suggest to students where they should stand.
        i. The thrust force can stand behind the chair pushing forward or in front of the chair facing forward and pulling (hands behind them)
        ii. The drag force can stand in front of the chair facing forward adding some resistance, or behind the chair pulling back a bit **(as long as it is opposite of thrust and both students can see where they are going)**
        iii. The lift forces should be on the left and right of the chair

5. Explain that the groups need to be their own air traffic controllers and make sure they do not collide with any other planes.

6. Have groups "take off" one at a time and travel around the room for their flight
    a. Let them fly for a few minutes

7. Students will most like lose passengers as the flight goes on
    a. Discuss this and ask them why this is occurring (plane is tilting, lift isn't even)
    b. Have them modify their model to try and keep passengers in the plane

8. Give the students a challenge of making two left turns, two right turns, one increase in height and one decrease in height during their next flight
    a. The forces must adjust accordingly to do these commands

Conclusion – Possible wrap-up questions:

1. What did it feel like being the drag force? The lift force? The friction force? What were your roles?