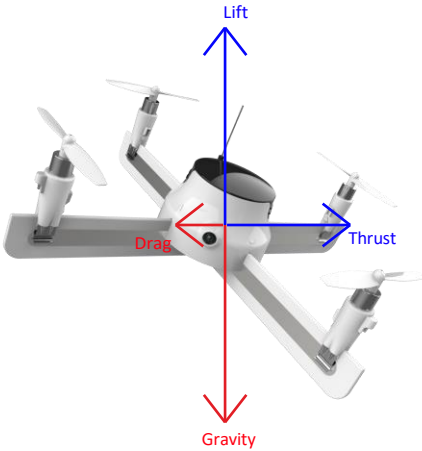


Lesson 1 Worksheet

Name _____



A free body diagram is a tool used in physics to show the relative magnitude and direction of forces acting on an object. A flying drone typically has 4 forces acting on it:

- Lift - the upwards force created by the motors.
- Gravity - the downwards force that opposes lift.
- Thrust - the forwards force created by an unbalance in motor speeds.
- Drag - the backwards force caused by wind resistance.

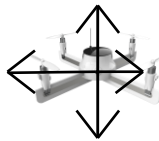
Longer arrows represent larger forces. In the example to the left, the arrows representing lift and gravity are the same length. This means the forces are equal to each other. When lift and gravity are equal, the drone is vertically stationary, meaning it isn't moving up or down. The arrow representing thrust is longer than the arrow representing drag, this means the force of thrust is greater than the force of drag and the drone is moving to the right.

Exercise 1

Determine what direction the drone is moving in each of the examples below, based on the free body diagram.



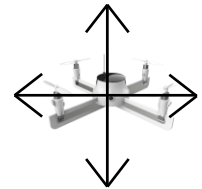
1. up



2. left



3. down



4. stationary (not moving)

Exercise 2

Fill in the blanks below with words from the word box.

Word bank:		
greater	opposite	equal and opposite
adjacent	clockwise	angular momentum

- As Newton's third law states, for every action, there is an equal and opposite reaction.
- To make a drone go up, the force of lift needs to be greater than the force of gravity.
- A Circuit Scribe Drone has two sets of propellers rotating in opposite directions.
- When the drone is stationary in the air, the propellers are all going at the same speed, so the net angular momentum is equal to zero.
- To rotate the drone clockwise, increase the speed of the motors going clockwise and decrease the speed of the motors going counterclockwise.
- Drones move by reducing the speed of two adjacent motors, and increasing the speed of the other two

motors by the same factor.