



## Lesson 2: Building your Drone - Part 1

**Key Concepts:** Weight vs Mass

**Objectives:** Cadets weigh the drone and the drone parts and calculate their mass. Cadets measure resistance of PCB wings. Cadets put together and dismantle a drone with PCB wings.



**Instructor Background:** What is the difference between weight and mass?

### Mass vs. Weight

Weight is the mass of an object multiplied by the force it's being acted upon. Mass is the amount of matter in a body.

### Formulas

$Force = mass * acceleration$

$Mass = \frac{force}{acceleration}$

The acceleration force is applied by the earth's gravity which is  $9.8m/s^2$ . The mass of any object on earth can be found by dividing the weight by the acceleration of gravity. Weight is measured in Newtons.

### Using a scale

There are two types of scales that will be used: a beam scale and a digital scale. A beam scale when used correctly will display the value of mass directly, while a digital scale will show the weight of the objects. Both scales must be zeroed out prior to use. Having the cadets perform this task will be up to the teacher's discretion, but it is recommended, especially if there will be multiple groups using the same scales.

The eight drone parts that will be weighed during the activity are: 2 drone PCB arms, 4 drone motors with motor guards, 1 battery and 1 hub.

### **Activity 1: Total weight of drone**

#### **Materials:**

##### Per Group

- Beam or electronic scale
- Drone builder kit

##### Per Cadet

- Pen
- Flight Academy log with materials



**Time:** 35-40 min.

**Description:** Cadets will practice using scales and record the weight in metric and imperial units of each of the components for the drone in their flight logs. Using the measured results and the formula, find the mass of the drone.

**Plan Ahead:** Before class place a scale and other materials on each of the worktables so that each team has one scale.

#### **Roles:**

1. Engineer - measuring and using the balance.



2. Project Manager - recording data.
3. Pilot - checking out/in drone, organizing materials, and comparing flight log notes.

**Safety:**

- Beam scales have moving parts that can pinch fingers and should be handled with care.
- Make sure drone parts remain on table.
- Remind cadets not to plug in their batteries unless instructed to.

**Step-by-step:**

1. Introduce the concepts of weight and mass and the formula for weight:  $F = ma$ . Include example calculations for mass and weight (force). Explain the SI units for both weight and mass.
2. Demonstrate the proper way to use the scale that the cadets will use by measuring a common object like a pencil.
3. First demonstrate zeroing out the scale.
4. Weigh the pencil 3 times and explain how multiple measurements help improve the accuracy of the result by reducing human error (possible mistakes).
5. Measure the object 3 times and record each measurement in grams in an example flight log.
6. Average the measurements and record the average in an example flight log.
7. Ask cadets to brainstorm and list what parts of the builder kit they should measure and those that they do not need to measure. List out the parts in the table provided. Let them know they should have the whole table filled.
8. Have the cadets follow the instructions on the activity handouts.
9. Each cadet should get a chance to measure all of the drone objects.
10. Have cadets average their measurements and enter it into the data table.
11. Have cadets compare their calculations in the groups.
12. Give the cadets 5 minutes to read and discuss the discussion questions in their groups.
13. Have the cadets write answers to the discussion questions in their flight logs.
14. Have a question and answer session with the whole class where you discuss the questions as a class.

**Class Discussion**

Offer the cadets a question and answer session after the activities. Once all of the cadets' questions are answered, begin to review the discussions as a whole class.