# Lesson Plan: What's the Matter?

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Inspired By: StemScopes Matter and Energy in Plants Explore 1 Scientific Investigation activity, Grade 5

**Target Grade:** 5th grade

**Teacher Prep Time:** ~2-2½ hours

**Lesson Time:** 7 hours 25 minutes total. Lesson is broken up over 6 weeks.

- Initial Lesson (Parts 1 & 2): 1 hour 15 minutes
  - Part 1 (How do you think plants grow?): 15 min.
  - Part 2 (Let's conduct an experiment!): 1 hour
- Data Collection (Parts 3 & 7): 5 minutes per day (set to MWF schedule), 1 hour 45 minutes per experiment (2 experiments), 3 hours 30 minutes in total
  - Each experiment will last 21 days. Day 0 MUST be started on a Friday. Data collection will occur on a MWF schedule over the course of the next 3 weeks. It is okay if one of the data collection days is missed due to holiday/other, since the general trend of the data can still be determined.
- Data Analysis and Conclusions (Parts 4, 5, 8, and 9): 1 hour 20 minutes per experiment (2 experiments), 2 hours 40 minutes total
  - Parts 4 & 8 (Data Analysis 1 & 2): 1 hour each
  - Parts 5 & 9 (Conclusions): 20 minutes each

**Lesson Overview:**

In this lesson, a class will conduct 8 experiments total, in two series as guided by the classroom teacher. Each group of students will conduct two experiments, investigating a different variable in each experiment, to determine that plants get the material they need to grow chiefly from air and water. Students use mathematical and computational thinking by collecting data from the height and mass of their plant set ups, plotting the data in a graph, and comparing their data with the rest of the class to make a scientific claim about where plants get their material to grow.

**Learning Objective(s):**

- Students will understand that plants get their material to grow from air and water and that in order to maintain their growth, plants need access to light.
- Students will understand that plants do not need soil to grow.
- Students will be able to predict, using a given growing condition, how a plant's growth will be affected.
- Students will be able to plot a set of data as a scatter plot by hand and on a Google sheet.
- Students will be able to analyze a graph to determine how a variable affects plant growth.

**NGSS:** Performance Expectation 5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water.

- **Science and Engineering Practice**
  - SEP - 5: Using Mathematics and Computational Thinking
    - Organize simple data sets to reveal patterns that suggest relationships.
    - Describe, measure, estimate, and/or graph quantities (e.g. area, volume, weight,

time) to address scientific and engineering questions and problems.

- **Disciplinary Core Idea**
  - DCI – LS1.C: Organization for Matter and Energy Flow in Organisms.
    - Plants acquire their material for growth chiefly from air and water (5-LS5-1)
- **Cross Cutting Concept**
  - CCC - 5: Energy and Matter
    - Students learn matter is made of particles and energy can be transferred in various ways and between objects. Students observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change.
- **Common Core State Standard**
  - 5.NBT.A.3 Number & Operations in Base Ten
    - Understand the place value system.
      - 3. Read, write, and compare decimals to thousandths.
  - 5.NBT.A.4 Number & Operations in Base Ten
    - Understand the place value system.
      - 4. Use place value understanding to round decimals to any place.
  - 5.NBT.B.7 Number & Operations in Base Ten
    - Perform operations with multi-digit whole numbers and with decimals to hundredths.
      - 7. Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value.
  - 5.G.A.2 Geometry insert number and description
    - Graph points on the coordinate plane to solve real-world and mathematical problems
      - 2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

**Where this lesson fits in:**

In science, this lesson should come after the study of matter and its interactions. Students should know and understand the Law of Conservation of Matter. In math, this lesson should come after students have had a chance to work with decimals, as it requires decimal number sense, rounding with decimals, and operations with decimals (i.e add, subtract, divide). The work should be done using calculators.

**Materials Needed** (see start of lessons sequence for suggested groups)**:**

- What's the Matter student notebook (one per student)
- Chart paper & markers, document camera, Smart Notebook file, or Padlet (or similar digital display board) to record/display student responses
- Bean Time Lapse mp4 file link: (see below) https://drive.google.com/file/d/1VbXiLigQscJSJcCwiby-OvWZA0B5gKA-/view?usp=sharing
- Class Data Files in Google sheets for Experiment 1 and Experiment 2 (Two students in each group will need access to this file in order to input their data in Part 4 of the lesson).
- 8 Digital Scales to take mass measurements (i.e. with Tare feature, $16.99 ea. from Amazon.com https://www.amazon.com/s?k=kitchen+scale+amir&hvadid=78271535235228&hvbmt=bp&hvdev=c&hvqmt=p&tag=mh0b-20&ref=pd_sl_925w01fpj9_p
- Small paper plates, bowls, or other containers to distribute radish seeds & pinto beans to each group and to use on the digital scales when making measurements.
- 8 trays or bins to pass out materials to the groups
- 16 sets of tweezers to pick out the plants for the Final Measurements of both experiments (on

p. 2 & 10 of the student notebook)

- 4 small cardboard boxes & one or two large cardboard boxes to store dark plant experiments.
- For Experiment 1:
  - 32 ZipLock gallon size freezer bags (i.e. from Costco)
  - 32 clear plastic 12oz or 20oz. Solo cups from Smart & Final or Costco
  - 32 clear plastic 9oz. Solo cups from Costco or Smart & Final (need to drill ½ inch holes into the bottom center of each cup)
  - terry cloth towel strips *cut into 15cm x 5cm rectangular pieces* (i.e.from Smart & Final)
  - blue painter's tape or masking tape (for labeling cups)
  - 2-4 sharpies (for the teacher to label cups i.e. R1 Light & Water or PB1 Dark & No Water)
  - 3 oz bathroom cups (to measure out the vermiculite) (i.e. from Albertsons)
  - 2 packets of radish seeds (i.e. from Home Depot or Ace Hardware)
  - 1 packet of pinto beans (i.e. from Albertsons)
  - bag of vermiculite (i.e. from Home Depot or Ace Hardware)
  - 8 graduated cylinders to measure and pour water into cups; possibly a dropper for fine tuning measurements
  - 8 trays or bins to pass out materials
- For Experiment 2:
  - 32 ZipLock quart size freezer bags
  - blue painter's tape to secure bags onto the inside of the box and onto the window
  - 2-4 Sharpies (for the teacher to label the bags i.e. R1 Light & Air or PB1 Dark & Little/No Air)
  - radish seeds (i.e. from Home Depot or Ace Hardware)
  - pinto beans (i.e. from Albertsons)
  - folded and stapled paper towels (i.e. from Costco)
  - Eight 60 ml syringe (i.e. from FOSS kit)
  - 8 (pint size) containers (for students to get water)-like those in the FOSS kits
  - duct tape to line the inside of the cardboard box to prevent tearing the cardboard
  - 8 trays or bins to pass out materials

**Teacher Prep: (about 1.5 hrs for Experiment #1 & 1 hr for Experiment #2; 2 hrs total)**

<u>For Experiment 1 (about 1.5 hrs to set up)</u>

- Drill ½ inch hole into the bottom of the center of each of the 32, 9oz clear plastic cups.
- Cut the terry cloth towel into 15cm by 5cm rectangular strips. You will need 32 of these rectangular strips. Then put one strip into the ½ inch hole of the 9 oz. cup making sure that about 11 cm of towel hangs out the bottom of the cup.
- Put the 9 oz. cup into the 20 oz. cup with the towel segment reaching all of the way to the bottom of the larger cup.
- Use blue tape or masking tape & a Sharpie marker to make two sets of radish and pinto bean cups, labeled R1, R2, PB1, PB2. Then write the variables being changed on the cups:
  - <u>*Light & Water*</u>; <u>*Light & No Water*</u>; <u>*Dark & Water*</u>; <u>*Dark & No Water*</u>
- This will be referred to as our *cup set-up* in this lesson plan.

For Experiment 2 (about 1 hr to set up)

- Get two paper towel pieces and fold so that there is a pocket made for the seeds. Staple the paper towel into place to make a *paper towel pocket.*
- Use a Sharpie marker to label 8 bags with each of the 4 sets of variables being changed; there should be 32 labeled bags total:
    - *Light & Air*; *Light & Little to No Air*; *Dark & Air*; *Dark & Little to No Air*
- Load a stapled *paper towel pocket* into each bag.
- Use duct tape to tape the inside of the large box, so that the Dark & Air or the Dark & Little to no air experiments can be removed and replaced without tearing the inside of the bag.
- For ones in the Light, they can just be taped onto the Window, so they are able to get light (indirectly).


**Lesson Sequence:**

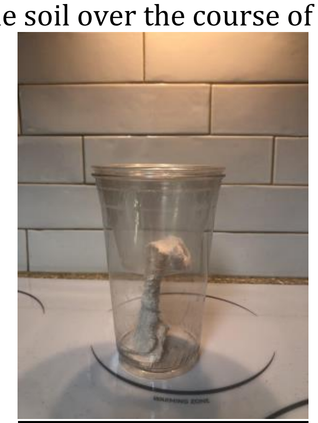
* For this activity we recommend that students work in groups of 4. Each group should be paired with a Partner Group for the experiments

| | |
|---|---|
| **Part 1:** | |
| 15 minutes | **How do you think plants grow?**<br>● Pass out a copy of the What's the Matter student notebook to each student.<br>● Show the Bean Time Lapse video clip [https://drive.google.com/file/d/1VbXiLigQscJSJcCwiby-OvWZA0B5gKA-/view?usp=sharing](https://drive.google.com/file/d/1VbXiLigQscJSJcCwiby-OvWZA0B5gKA-/view?usp=sharing)<br>● Ask students to complete question #1 using what they saw in the video and their prior knowledge as best they can.<br>● Ask students to share out some things that they believe plants need to grow from question 1 and why they think each is important. Use chart paper, a document camera, Smart Notebook file or some other digital display board to document students' responses to this question. Then ask students to record some of these answers from question 2. Expected student response (ESR): *Air, oxygen, carbon dioxide, water, soil, sunlight, light, nutrients or minerals, and/or fertilizer*. |
| **Part 2:** | |
| 60 minutes | **Let's conduct an experiment!**<br>● Tell students, "We have a lot of ideas about where plants get their materials to grow. In order to answer this question, we will be conducting an experiment as a class. We will grow two different types of plants, radishes and pinto beans. We will track their growth and mass over the course of 3 weeks."<br>● Have them write the Class Question on their student notebook (Where do plants get their matter to grow?).<br>● Explain that in order to answer the class question, we will break up into groups to break down our class question into more manageable group experiments. Introduce the four different growing conditions (Light & Water, Dark & Water, Light & No water, Dark & No water) and break students into 8 groups of ~4 students.<br>    ○ Assign each variable to a pair of groups and explain that each pair investigating the same growing condition will be called "partner groups."<br>    ○ If you do not have enough students in your class to split into 8 groups of ~4 students, you can split into 6 or 7 groups and assign yourself (the |

teacher) to be the partner group for the No water experiments.

- Discuss the Controls (variables they will hold constant) with the class and have them copy the information on p. 1 of their student notebook:
  - Soil amount / 1 small cup (show students the 3 oz. cups they will be using)
  - Soil type / vermiculite
  - Water amount/ 100 mL
  - Light amount/ Full light or No light
    - If students are running Dark experiments they will put “No light” and the opposite for the Light experiments.

- Read question 3 to the students and have them predict and write in their own words which growing condition will allow the plants to grow the most. Remind students that because this is a prediction, it’s okay to be wrong, and you are just looking for their thinking.
- Show students an example experimental set-up (shown in picture below) and ask, “What do you think the purpose of this towel is?” Lead students to understand that if they are doing an experiment with water, the towel will carry any excess water up to the soil over the course of 3 weeks.



  - Note: The picture shown above is of 1 cup set.  Each student group will make 2 cup sets for each plant of their given growing condition (2 radish & 2 pinto bean), for a total of 4 cups sets per group . Therefore, 4 cup sets per group x 8 groups = 32 cup sets total needed for this experiment.

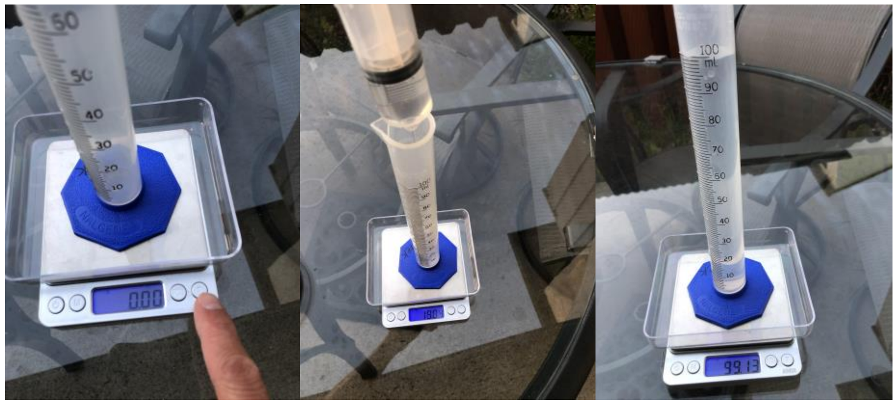
- Distribute the materials to each student group: *4 cup set-ups (each labelled with the experiment info), 3 oz. bathroom cup (for measuring vermiculite), bag of vermiculite, 2 3 oz. bathroom cups with 10 radish seeds, 2 3 oz. bathroom cups with 4 pinto beans, 1 graduated cylinder, 1 small container of water, a 50-60 mL syringe (to load the graduated cylinder with water when measuring its amount on the scale), 1 digital scale (to perform measurements).*
- Walk students through the following steps:
  - Have each group measure the mass of the seeds and record their data on the Initial Measurements table on p. 2

- Next take the mass of cups, towel, & (Ziplock) bag. To get an accurate reading, set a tray onto the scale (each scale comes with a plastic tray), press “tare” to zero its weight, and then place the cup set-up onto the scale. Record the data.

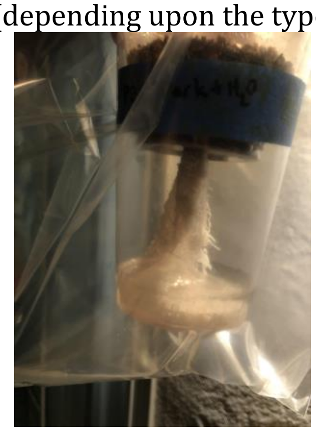
- The cup set-up should still be on the scale. Tare the scale to zero. Fill the cup set-up with 1 small cup of vermiculite using the 3 oz. bathroom cup (filled to the top and levelled off), and then measure this on the scale. Be sure not to tip over the cup set-up. Record the data.

- Take the cup set-up off the scale and put the seeds in the vermiculite.
    - Instruct students to gently push the seeds into the soil and cover them with vermiculite. They should NOT be pushed deep into the soil.

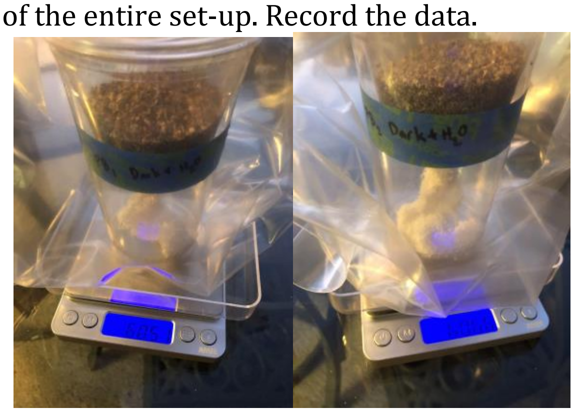
- Place the graduated cylinder onto the scale and tare the scale to zero. Then use the syringe to fill 100 mL of water into the graduated cylinder to determine the mass of water. Record the data.



- Carefully pour the water onto the vermiculite, in a slow and circular motion, making sure to saturate as much of it as possible. The excess water will drain down into the bottom of the larger 12oz or 20oz. Cup (depending upon the type you use for this experiment.



- Zip lock the bag securely and finally take the measurement of the mass of the entire set-up. Record the data.



- Call each group individually by variable to place their cup set-ups in the correct place. All Dark experiments need to go in a box and all Light experiments should go in a well-lit area of your classroom. Make a careful note to place your cups in an area in which you do not expect them to be knocked over or put them into a small box by like variable groups.



- Ask students to turn to page 3 of their student notebooks, while you do the same in an example student notebook under the document camera. Direct their attention to the top right corner where it says, "Our group's growing conditions." Ask students to fill in their growing conditions on that line (Example: Dark and Water).

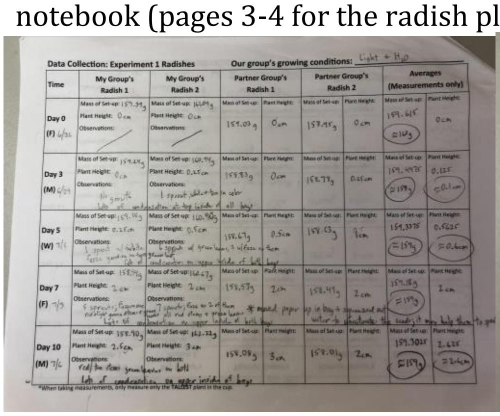
- Next, have students copy the mass of the entire set-up initial measurements for their group & their partner group for Day 0 onto the *Data Collection: Experiment 1 Radishes.* Have them repeat both this step and filling out their growing condition for the *Data Collection: Experiment 1 Pinto Beans* table on page 5*.*
- Ask students, "If we just planted our seeds, what is the height of our plants on this Day 0?" ESR: 0 cm. Have students fill this in for both the radish and pinto bean tables.
- Ask students, "How do we calculate the average mass and height for the radish and for pinto bean experiments for Day 0?" ESR: We add both measurements together and divide by 2. Have students calculate the average mass and plant height for each Day 0 on each table. (This should be done with a calculator. Students should understand that for the plant height, because all measurements are 0 cm, the average is 0 cm.)
  - You will not take any observations on Day 0.

**Part 3:**

5 minutes on MWF for 3 weeks

**Data Collection**

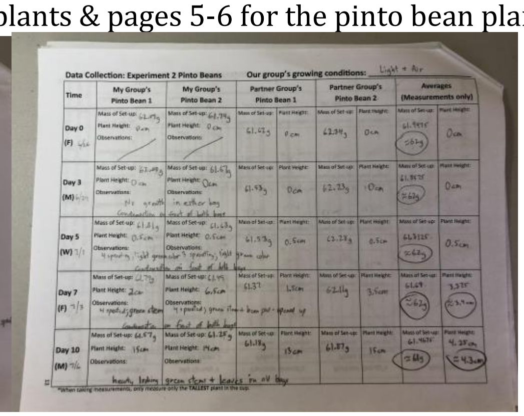
- Three days a week (MWF schedule) students will take measurements of their plants' height (rounded to the nearest tenth of a centimeter) and mass rounded to the nearest whole gram) and record them in the data tables of their student notebook (pages 3-4 for the radish plants & pages 5-6 for the pinto bean plants).



Data Collection: Experiment 1 Radishes    Our group's growing conditions: Light + $H_2O$

| Time | My Group's Radish 1 | My Group's Radish 2 | Partner Group's Radish 1: Mass of Set-up | Partner Group's Radish 1: Plant Height | Partner Group's Radish 2: Mass of Set-up | Partner Group's Radish 2: Plant Height | Averages (Measurements only): Mass of Set-up | Averages (Measurements only): Plant Height |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) 6/26 | Mass of Set-up: 157.39g Plant Height: 0cm Observations: | Mass of Set-up: 161.04g Plant Height: 0cm Observations: | 159.03g | 0cm | 157.95g | 0cm | 159.615 ≈160g | 0cm |
| Day 3 (M) 6/29 | Mass of Set-up: 159.24g Plant Height: 0cm Observations: No growth | Mass of Set-up: 160.94g Plant Height: 0.25cm Observations: 1 sprout, white-brown color | 158.83g | 0cm | 158.77g | 0.25cm | 159.4475 ≈159g | 0.125 ≈0.1cm |
| Day 5 (W) 7/1 | Mass of Set-up: 159.15g Plant Height: 0.25cm Observations: [illegible] | Mass of Set-up: 160.90g Plant Height: 0.5cm Observations: [illegible] | 158.67g | 0.5cm | 158.63g | 1cm | 159.3375 ≈159g | 0.5625 ≈0.6cm |
| Day 7 (F) 7/3 | Mass of Set-up: 158.99g Plant Height: 2cm Observations: [illegible] | Mass of Set-up: 160.67g Plant Height: 2cm Observations: [illegible] | 158.57g | 2cm | 158.41g | 2cm | 159.16g ≈159g | 2cm |
| Day 10 (M) 7/6 | Mass of Set-up: 158.90g Plant Height: 2.5cm Observations: [illegible] | Mass of Set-up: 162.22g Plant Height: 3cm Observations: [illegible] | 158.08g | 3cm | 158.01g | 2cm | 159.3025 ≈159g | 2.625 ≈2.6cm |

*When taking measurements, only measure only the TALLEST plant in the cup.



Data Collection: Experiment 2 Pinto Beans    Our group's growing conditions: Light + Air

| Time | My Group's Pinto Bean 1 | My Group's Pinto Bean 2 | Partner Group's Pinto Bean 1: Mass of Set-up | Partner Group's Pinto Bean 1: Plant Height | Partner Group's Pinto Bean 2: Mass of Set-up | Partner Group's Pinto Bean 2: Plant Height | Averages (Measurements only): Mass of Set-up | Averages (Measurements only): Plant Height |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) 6/26 | Mass of Set-up: 62.19g Plant Height: 0cm Observations: | Mass of Set-up: 62.74g Plant Height: 0cm Observations: | 61.67g | 0cm | 62.34g | 0cm | 61.9975 ≈62g | 0cm |
| Day 3 (M) 6/29 | Mass of Set-up: [illegible] Plant Height: 0cm Observations: No growth in either bag | Mass of Set-up: 61.67g Plant Height: 0cm Observations: | 61.53g | 0cm | 62.23g | 0cm | 61.8525 ≈62g | 0cm |
| Day 5 (W) 7/1 | Mass of Set-up: 61.81g Plant Height: 0.5cm Observations: 4 sprouting, light green color | Mass of Set-up: 61.63g Plant Height: 0.5cm Observations: 3 sprouting, light green color | 61.53g | 0.5cm | 62.28g | 0.5cm | 61.8125 ≈62g | 0.5cm |
| Day 7 (F) 7/3 | Mass of Set-up: 61.79g Plant Height: 2cm Observations: 4 sprouted, green stem | Mass of Set-up: 61.45 Plant Height: 6.5cm Observations: [illegible] | 61.37 | 1.5cm | 62.11g | 3.5cm | 61.69 ≈62g | 3.375 ≈3.4cm |
| Day 10 (M) 7/6 | Mass of Set-up: 61.57g Plant Height: 15cm Observations: healthy looking green stems + leaves in all bags | Mass of Set-up: 61.25g Plant Height: 14cm Observations: | 61.18g | 13cm | 61.87g | 15cm | 61.4675 ≈61g | 4.25cm ≈4.3cm |

*When taking measurements, only measure only the TALLEST plant in the cup.

- **<u>Please note:</u> The ZipLock bags should not be opened at any time during these three weeks of data collection so students should use a piece of string to measure the height of their plant or stand the ruler up next to the plant and estimate its height. The height measure will be for that of the tallest plant.**
  - Do this by placing the string next to the plant to track how tall it is and then place the string down on a ruler to measure the actual height.

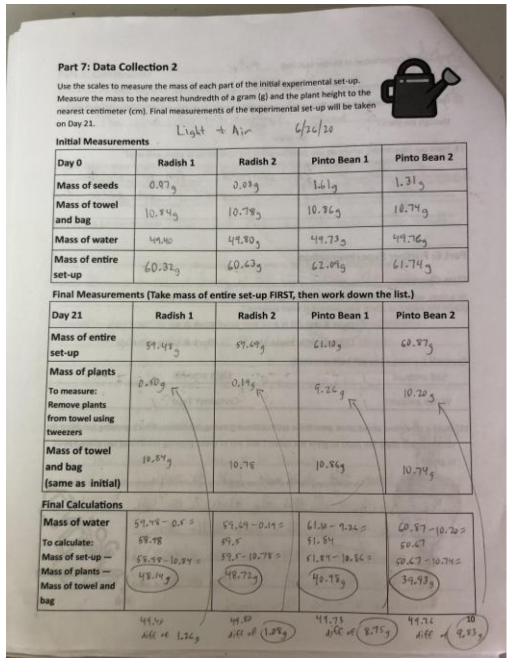
- Instruct students to only measure the height of the <u>tallest</u> plant in their cup.
- After taking their measurements, each group should share their data with their partner group. They do not need to write their partner group's observations.
- Students will then take the average of these four measurements (using a calculator) and write their answer in the appropriate columns on pages 3-6.
  - Note: Students should write both the exact answer appearing on the calculator and the answer rounded to the nearest whole gram. In Part 4, they will input the exact answer into a Google Sheets document, while the rounded answer will be used to plot the points on their notebook graph.

**Part 4:**

60 minutes

**Final Measurements & Data Analysis**

- On Day 21 (the final day of measurements), tell students that we need to take our final measurements and then organize our data by plotting it in a graph so we can compare the height and mass of our experiments for each plant in one place.
- Have students turn to page 2 in their student notebook while you do the same in an example notebook under the document camera. Tell students that first we need to complete our Final Measurements data table.


Part 7: Data Collection 2

Use the scales to measure the mass of each part of the initial experimental set-up. Measure the mass to the nearest hundredth of a gram (g) and the plant height to the nearest centimeter (cm). Final measurements of the experimental set-up will be taken on Day 21.

Light + Air 6/26/20

Initial Measurements

| Day 0 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of seeds | 0.97g | 0.05g | 1.61g | 1.31g |
| Mass of towel and bag | 10.84g | 10.78g | 10.86g | 10.74g |
| Mass of water | 49.40 | 49.80g | 49.73g | 49.76g |
| Mass of entire set-up | 60.32g | 60.63g | 62.09g | 61.74g |

Final Measurements (Take mass of entire set-up FIRST, then work down the list.)

| Day 21 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of entire set-up | 59.48g | 59.69g | 61.10g | 60.87g |
| Mass of plants<br>To measure: Remove plants from towel using tweezers | 0.50g | 0.19g | 9.26g | 10.20g |
| Mass of towel and bag (same as initial) | 10.84g | 10.78 | 10.86g | 10.74g |

Final Calculations

| | | | | |
|---|---|---|---|---|
| Mass of water<br>To calculate: Mass of set-up — Mass of plants — Mass of towel and bag | 59.48 - 0.5 =<br>58.98<br>58.98 - 10.84 =<br>48.14g | 59.69 - 0.19 =<br>59.5<br>59.5 - 10.78 =<br>48.72g | 61.10 - 9.26 =<br>51.84<br>51.84 - 10.86 =<br>40.98g | 60.87 - 10.20 =<br>50.67<br>50.67 - 10.74 =<br>39.93g |

49.40 diff of 1.26g 49.80 diff of 1.08g 49.73 diff of 8.75g 49.76 diff of 9.83g

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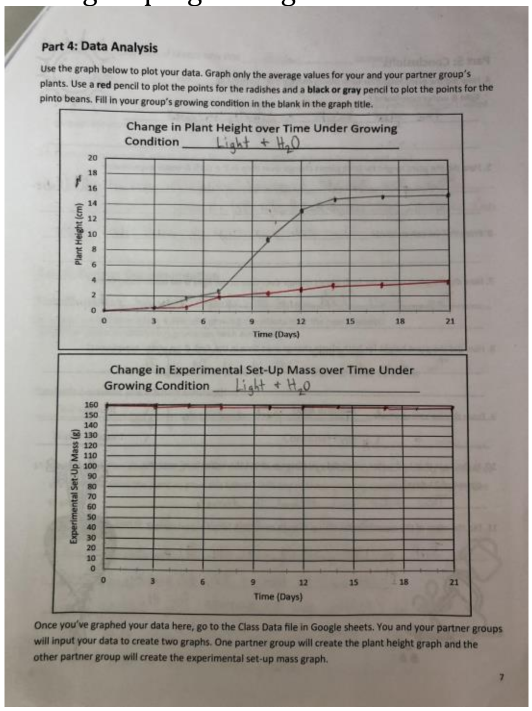
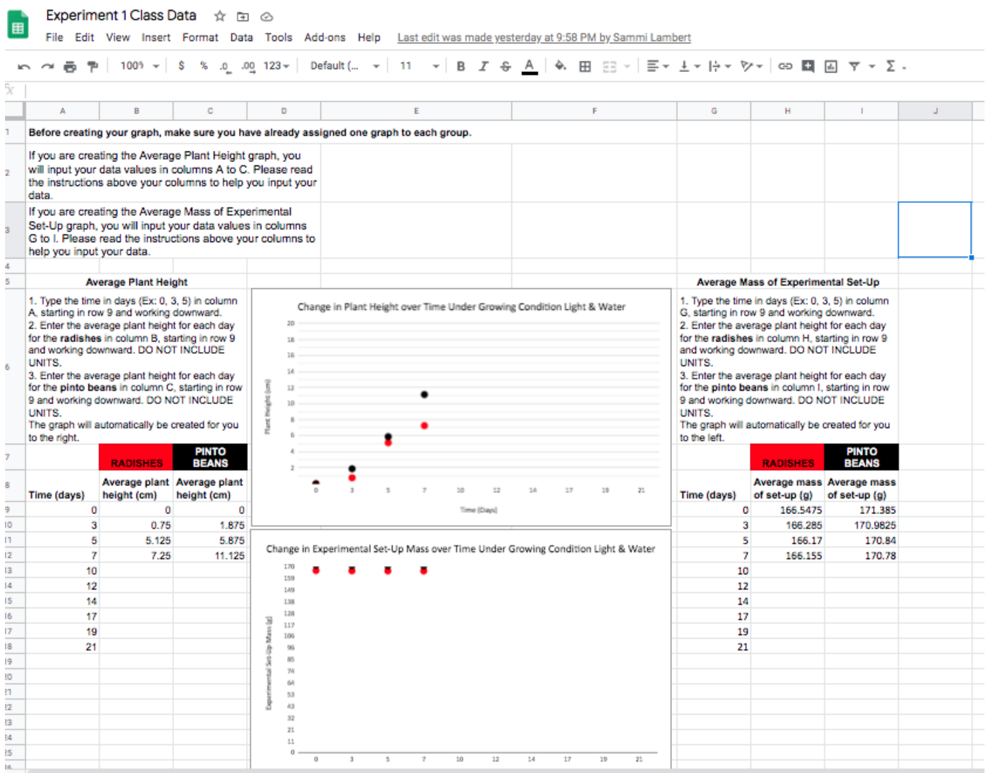
- Tell students that you will complete the final measurements together, then pass out the experimental supplies (scale with tray, tweezers, each group's plants).
- If you (the teacher) were in charge of a group of plants, grab those. If you did not run an experimental set, you should use an example cup set-up with the students. Instruct students to take the mass of the entire set-up first, by placing the cup set-up in the bag on the tared scale, and indicate where to record these measurements on their data table.
- Then work your way down the list of measurements in the table. Make sure to note that when you measure the mass of the plants, you will remove the plants carefully from the soil using tweezers, taking care to brush off excess vermiculite from the base of the plants.
- Finally, to  calculate the mass of the soil and water, have the students use the provided formula (mass of the entire set-up - mass of the plants - mass of the cups, towel, and bag) and write this answer in the Final Calculations section of the data table.
- Since students do not need to re-measure the mass of the cups, towel, and bag, have them keep their cup set-up intact & in the bag. They should return them to the specified location you've determined.
- You will need to select 3 or 4 students' experiment samples to dry out the soil for later use in question 17 on page 16 in about 1 month.
    - Please make note of the students' groups you've collected, as you will need to compare their soil measurements at the beginning of the experiment to the measurement you'll be taking once there has been adequate time for the vermiculite to dry out.
- Instruct students to turn to page 7 in their notebooks as you place an example notebook under the document camera. Tell students that now that we have taken our final measurements, we can graph our results to help us analyze our data. Read the instructions at the top of the page to the students.
    - Make sure students understand that a red pencil/pen should be used for the radish plant data, while a black or gray pencil/pen should be used for the pinto bean data.  (Please note: this color-coding will be the same

in the graphs on the Google Sheets document, so we do not want the students to switch their color key.)
    - Point out the line in the title of each graph so students know where to write their group's growing condition.




- Tell students that once they have finished their graph in their notebook, they should access the Class Data File in Google sheets for Experiment 1. Project the Google sheet file using whatever method accessible to you (projector, Apple TV, etc.).
    - It doesn't matter what platform you use to assign this sheet to the students, but ALL students will have access to the same Google sheet.
- Show students that each growing condition has 1 tab on the Google sheet and each partner group will be responsible for creating 1 graph for their growing condition (either Plant Height or Set-Up Mass). Tell students the instructions for how to correctly fill out the Google sheet are given at the top of each tab's page. An example of a partially filled out sheet is below.




| Time (days) | RADISHES Average plant height (cm) | PINTO BEANS Average plant height (cm) |
|---|---|---|
| 0 | 0 | 0 |
| 3 | 0.75 | 1.875 |
| 5 | 5.125 | 5.875 |
| 7 | 7.25 | 11.125 |
| 10 | | |
| 12 | | |
| 14 | | |
| 17 | | |
| 19 | | |
| 21 | | |

| Time (days) | RADISHES Average mass of set-up (g) | PINTO BEANS Average mass of set-up (g) |
|---|---|---|
| 0 | 166.5475 | 171.385 |
| 3 | 166.285 | 170.9825 |
| 5 | 166.17 | 170.84 |
| 7 | 166.155 | 170.78 |
| 10 | | |
| 12 | | |
| 14 | | |
| 17 | | |
| 19 | | |
| 21 | | |

**Part 5:**

20 minutes

**Conclusions**

- Once students have finished their graphs (on paper and Google sheets), display the Google sheet file by whatever means accessible to you. Tell students that we need to make some scientific claims and conclusions from our experiment by examining our class data.
- Have students open their notebooks to page 8 while you do the same in an
- example notebook.
- Display the Light & Water Google sheet tab and ask students what they notice about the pattern or trend they see in the data. ESR: For both pinto beans and radishes, the plant height consistently increased. Record this for question 4.
- Repeat this process for the Dark & Water experiment. ESR: For both plants, the plant height increased quickly, then decreased as the plant died. Record this for question 5.
- Ask students, "What can we conclude about plant growth from these
- experiments?" ESR: plants need light to sustain their growth. Record this for question 6.
- Display the Light & No Water Google sheet tab and ask students what they notice about the pattern or trend they see in the data. ESR: For both pinto beans and radishes, the plant height did not change because the plant did not grow. Record this for question 7.
- Repeat this process for the Dark & No Water experiment. ESR: For both pinto beans and radishes, the plant height did not change because the plant did not grow. This is the same thing we observed for the light and no water experiment.

| | |
|---|---|
| | Record this for question 8.<br>● Ask students, "What can we conclude about plant growth from these experiments?" ESR: plants need water to grow. Record this for question 9.<br>● Ask students, "In the cups that had water, what did you observe about the water level over the course of 21 days?" ESR: The water level decreased as the soil took in water. Record this for question 10.<br>● Ask students, "Did the mass of the experimental set-up change over time for all experiments?" ESR: No, it relatively stayed the same. Record this for question 11.<br>● Ask students, "What does the Law of Conservation of Matter tell us?" ESR: The Law of Conservation of Matter says that matter cannot be created nor destroyed. Fill in the blanks on question 12.<br>● Read question 13 to students and lead students to understand that no new matter can be created because that would violate the Law of Conservation of Matter.<br>● Ask the students to think back to the changing water level and think about where the matter from the water went, and see if they can account for the changes that have taken place in the experiment over time? Remind students that the mass of the experimental set-up did not change, but they observed new matter appearing. The students should suspect that the water went into making the plant material.<br>○ If students argue that the mass decreased over time, lead them to understand that the changes in mass were very small. Challenge students to think about what could have caused the decrease in mass (i.e. gas escaping through the imperfect seal of the Ziplock plastic bag).<br>● Read question 14 to students (where do you think the plant got its material to grow, and why?) and ask students to fill out their answer on their own. Then have some students share out and compare their thinking.<br>○ From the experiment, students should conclude that the material from plant growth came from the *water* and they will possibly also say the *soil*. That's okay because Experiment 2 will address *soil* being a factor involved in the growth of plants.<br>○ If students argue that plants need light as material to grow, lead them to understand that light does not have mass, but rather is a form of energy. Additionally, the plants in the dark did initially grow. |
| **Part 6:** | |
| 60 minutes | **Further Experimentation**<br>● Ask students, "What did we learn about our first experiment?" Review their findings from question 14, making sure they understand that plants need water to grow.<br>● Tell students, "We are still not sure where plants get *all* of the material they need to grow, so we'll be conducting another experiment to expand our knowledge and confirm and/or refute some of our findings, just as other scientists do."<br>● Have students open to page 9 in their student notebooks while you do the same under the document camera. Have them write the Class Question, Do plants need soil and air to grow?<br>● Introduce the 4 different growing conditions (Light & Air, Dark & Air, Light & |

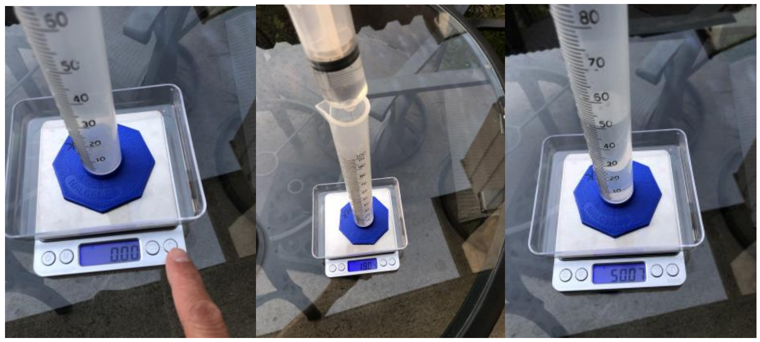
Little to no air, Dark & Little to no air) and explain how we will set-up our experiments to make sure there is little to no air in some of the bags.

- Tell students they will remain in their same groups/partner groups for this experiment and assign each variable to each group.
- Discuss the Controls (variables they will hold constant) with the class and have them copy the information on page 9 of their student notebook:
    - Soil amount / no soil
    - Water amount/ 50 mL
    - Light amount/ Full light or No light
        - If students are running Dark experiments they will put “No light” and the opposite for the Light experiments.
    - Container type / bag (Show students an example bag set-up)
- Read question 15 to the students and have them predict and write in their own words which growing condition will allow the plants to grow the most and if any will not allow the plant to grow. Remind students that because this is a prediction, it’s okay to be wrong, and you are just looking for their thinking.
- Have students get into their groups and distribute the experimental supplies: *4 bag set-ups (each labelled with the experiment info and pre-loaded with paper towel pockets), 2 3 oz. bathroom cups with 10 radish seeds, 2 3 oz. bathroom cups with 4 pinto beans, 1 graduated cylinder, 1 small container of water, a 50-60 mL syringe (to load the graduated cylinder with water when measuring its amount on the scale), 1 digital scale (to perform measurements).*
    - Each group will make 2 bags for each plant of that variable, for a total of 4 bags per group (2 radish & 2 pinto bean). Therefore, 4 bags per group x 8 groups = 32 bags total for this experiment.
- Have each group measure the mass of the seeds and record their data on the Initial Measurements table on page 10.

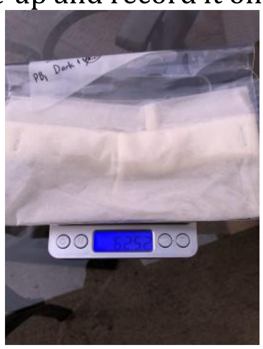

- Set the tray on the scale, press “tare” to zero its weight, and then place the bag set-up onto the scale. Record the data.


- Carefully place the seeds inside the labeled bags. 10 radish seeds in each R1 and R2 bag; 4 pinto beans in each PB1 and PB2 bag.
- Place the graduated cylinder onto the scale and zero the scale by pressing “tare.” Then use the syringe to fill 50 mL of water into the graduated cylinder and

record the data.



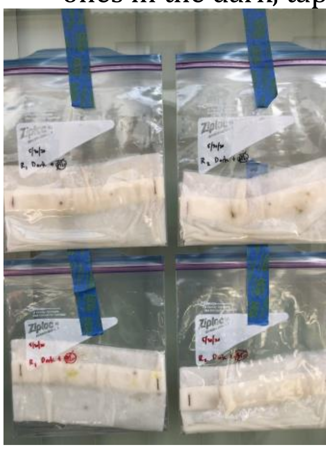
- Carefully pour the water into the Ziplock bags, being sure to keep the radish seeds or pinto beans in the paper towel pocket.
- Zip lock the bag securely and finally take the measurement of the Mass of the entire set-up and record it on p. 2 “Mass of entire set-up”



- **<u>Please note:</u>** If making the experiment with “Little to no air,” be sure to carefully expel as much air out of the bag as possible before closing it and measuring its mass. This is especially difficult with the two pinto bean bags, PB1 & PB2. Students might lose a very small amount of water while laying the bag flat on the table and carefully pushing out the air from the bag. If this is the case, have them record this as an observation.

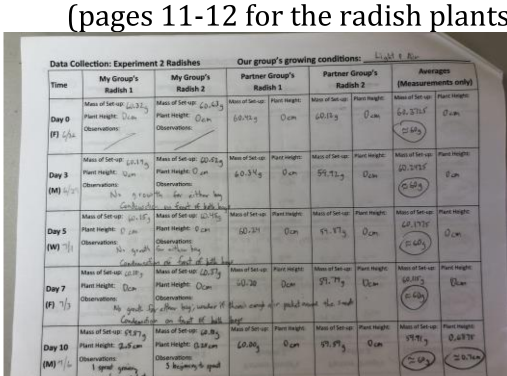
- Have students turn to page 11 in their notebooks and fill out their group’s growing condition in the top right corner.
- Next, have students copy the mass of the entire set-up initial measurements for their group & their partner group for Day 0 onto the *Data Collection: Experiment 2 Radishes* (page 11). Have them repeat both this step and fill out their growing condition for the *Data Collection: Experiment 2 Pinto Beans* table (page 13).
- Ask students, “If we just planted our seeds, what is the height of our plants on this Day 0?” ESR: 0 cm. Have students fill this in for both the radish and pinto bean tables.

| | |
|---|---|
| | • Have students calculate the average mass and plant height for each Day 0 on each table. (This should be done with a calculator. Students should understand that for the plant height, because all measurements are 0 cm, the average is 0 cm.)<br>    ○ They do not need to record observations on this day, unless there was a problem with their experimental set-up.<br>• Call the groups over by growing condition to store their plants.<br>• **Note:** It has been my experience that the plants in the dark will start to emit a strong odor from Day 3 to Day 17, so you may want to put the box outside your classroom, if possible.<br>• For the bags in the light, you may want to tape it onto the window and for the ones in the dark, tape them to the inside of a large box, then close it. |



**Part 7:**

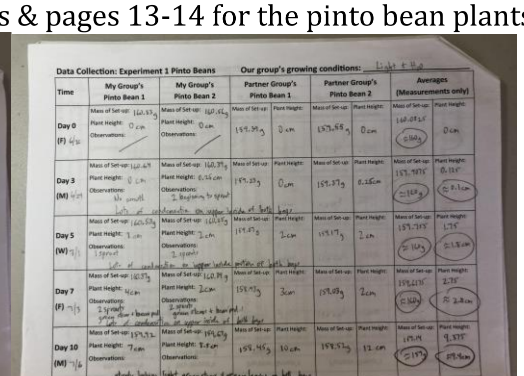
| | |
|---|---|
| 5 minutes on MWF for 3 weeks | **Data Collection**<br>• Three days a week (MWF schedule) students will take measurements of their plants' height (to the nearest tenth of a centimeter) and mass (to the nearest whole gram) and record them in the data tables of their student notebook (pages 11-12 for the radish plants & pages 13-14 for the pinto bean plants). |



Data Collection: Experiment 2 Radishes — Our group's growing conditions: Light + Air

| Time | My Group's Radish 1 | My Group's Radish 2 | Partner Group's Radish 1: Mass of Set-up | Partner Group's Radish 1: Plant Height | Partner Group's Radish 2: Mass of Set-up | Partner Group's Radish 2: Plant Height | Averages (Measurements only): Mass of Set-up | Averages (Measurements only): Plant Height |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) 6/26 | Mass of Set-up: 60.32g<br>Plant Height: 0cm<br>Observations: | Mass of Set-up: 60.63g<br>Plant Height: 0cm<br>Observations: | 60.42g | 0cm | 60.12g | 0cm | 60.3725 ≈60g | 0cm |
| Day 3 (M) 6/29 | Mass of Set-up: 60.19g<br>Plant Height: 0cm<br>Observations: No growth for either bag. Condensation on front of both bags | Mass of Set-up: 60.52g<br>Plant Height: 0 cm<br>Observations: | 60.34g | 0cm | 59.92g | 0cm | 60.2425 ≈60g | 0cm |
| Day 5 (W) 7/1 | Mass of Set-up: 60.15g<br>Plant Height: 0 cm<br>Observations: No growth for either bag. Condensation on front of both bags | Mass of Set-up: 60.45g<br>Plant Height: 0 cm<br>Observations: | 60.24 | 0cm | 59.87g | 0cm | 60.1775 ≈60g | 0cm |
| Day 7 (F) 7/3 | Mass of Set-up: 60.18g<br>Plant Height: 0cm<br>Observations: No growth for either bag; [illegible] Condensation on front of both bags | Mass of Set-up: 60.57g<br>Plant Height: 0cm<br>Observations: | 60.20 | 0cm | 59.79g | 0cm | 60.115g ≈60g | 0cm |
| Day 10 (M) 7/6 | Mass of Set-up: 59.87g<br>Plant Height: 2.5cm<br>Observations: 1 sprout growing, green leaves, red stem | Mass of Set-up: 60.8g<br>Plant Height: 0.25cm<br>Observations: 3 beginning to sprout | 60.00g | 0cm | 59.59g | 0cm | 59.91g ≈60g | 0.6875 ≈0.7cm |

*When taking measurements, only measure only the TALLEST plant in the cup.

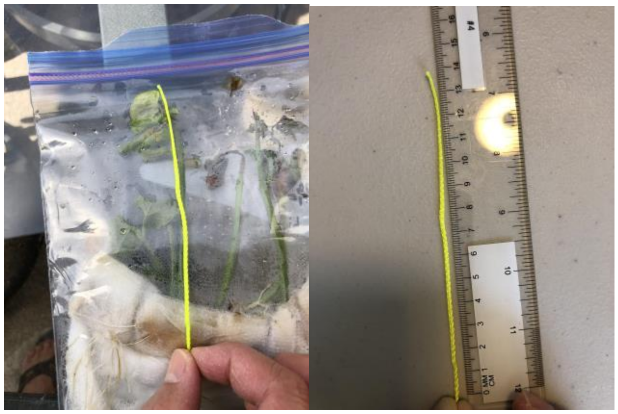


Data Collection: Experiment 1 Pinto Beans — Our group's growing conditions: Light + $H_2O$

| Time | My Group's Pinto Bean 1 | My Group's Pinto Bean 2 | Partner Group's Pinto Bean 1: Mass of Set-up | Partner Group's Pinto Bean 1: Plant Height | Partner Group's Pinto Bean 2: Mass of Set-up | Partner Group's Pinto Bean 2: Plant Height | Averages (Measurements only): Mass of Set-up | Averages (Measurements only): Plant Height |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) 6/26 | Mass of Set-up: 160.53g<br>Plant Height: 0 cm<br>Observations: | Mass of Set-up: 160.56g<br>Plant Height: 0 cm<br>Observations: | 159.39g | 0 cm | 159.65g | 0cm | 160.0325 ≈160g | 0cm |
| Day 3 (M) 6/29 | Mass of Set-up: 160.49<br>Plant Height: 0 cm<br>Observations: No growth. Lots of condensation on upper inside of both bags | Mass of Set-up: 160.39g<br>Plant Height: 0.25cm<br>Observations: 1 beginning to sprout | 159.23g | 0cm | 159.37g | 0.25cm | 159.9975 ≈160g | 0.125 ≈0.1cm |
| Day 5 (W) 7/1 | Mass of Set-up: 160.53g<br>Plant Height: 1 cm<br>Observations: 1 sprout. Lots of condensation on upper inside portion of both bags | Mass of Set-up: 160.25g<br>Plant Height: 2cm<br>Observations: 2 sprouts | 159.07g | 2cm | 159.17g | 2cm | 159.755 ≈160g | 1.75 ≈1.8cm |
| Day 7 (F) 7/3 | Mass of Set-up: 160.57g<br>Plant Height: 4cm<br>Observations: 2 sprouts, green flower + bean pod. Lots of condensation on upper inside of both bags | Mass of Set-up: 160.19g<br>Plant Height: 2cm<br>Observations: 2 sprouts, green flower + bean pod | 158.93g | 3cm | 159.03g | 2cm | 159.675 ≈160g | 2.75 ≈2.8cm |
| Day 10 (M) 7/6 | Mass of Set-up: 159.92<br>Plant Height: 7cm<br>Observations: steady looking light green flower + green leaves on both bags | Mass of Set-up: 159.67g<br>Plant Height: 8.5cm<br>Observations: | 158.45g | 10cm | 158.52g | 12 cm | 159.14 ≈159g | 9.375 ≈9.4cm |

*When taking measurements, only measure only the TALLEST plant in the cup.

• <u>**Please note:**</u> **The ZipLock bags should not be opened, at any time during these three weeks of data collection, so students should use a piece of string and ruler (same process from Experiment 1) to measure the height of their plant.**



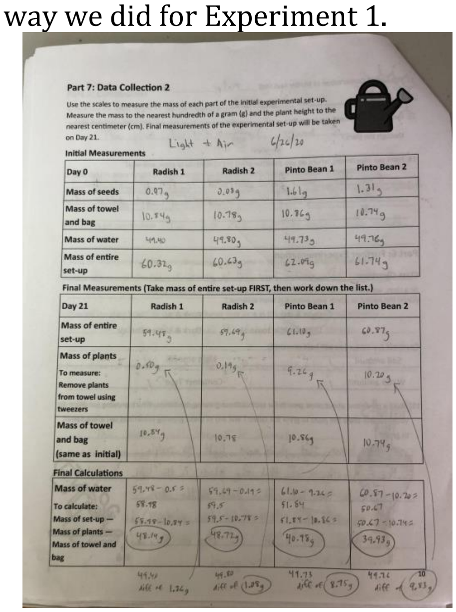

- Instruct students to only measure the height of the <u>tallest</u> plant in their bag.
- After taking their measurements, each group should share their data with their partner group. They do not need to write their partner group's observations.
- Students will then take the average of these four measurements (using a calculator) and write their answer in the appropriate columns on pages 11-14.
    - Note: Students should write both the exact answer appearing on the calculator and the answer rounded to the nearest whole gram. In Part 8, they will input the exact answer into a Google Sheets document, while the rounded answer will be used to plot the points on their notebook graph.

**Part 8:**

60 minutes

**Final Measurements & Data Analysis**

- On Day 21 (the final day of measurements), tell students that we need to take our final measurements and then organize our data by plotting it in a graph so we can compare the height and mass of our experiments for each plant in one place in the same way we did for Experiment 1.



Part 7: Data Collection 2

Use the scales to measure the mass of each part of the initial experimental set-up. Measure the mass to the nearest hundredth of a gram (g) and the plant height to the nearest centimeter (cm). Final measurements of the experimental set-up will be taken on Day 21.

Light + Air 6/26/20

Initial Measurements

| Day 0 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of seeds | 0.97g | 0.08g | 1.61g | 1.31g |
| Mass of towel and bag | 10.84g | 10.78g | 10.86g | 10.74g |
| Mass of water | 49.40 | 49.80g | 49.73g | 49.76g |
| Mass of entire set-up | 60.32g | 60.63g | 62.09g | 61.74g |

Final Measurements (Take mass of entire set-up FIRST, then work down the list.)

| Day 21 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of entire set-up | 59.48g | 59.69g | 61.10g | 60.87g |
| Mass of plants<br>To measure: Remove plants from towel using tweezers | 0.50g | 0.19g | 9.26g | 10.20g |
| Mass of towel and bag (same as initial) | 10.84g | 10.78 | 10.86g | 10.74g |

Final Calculations

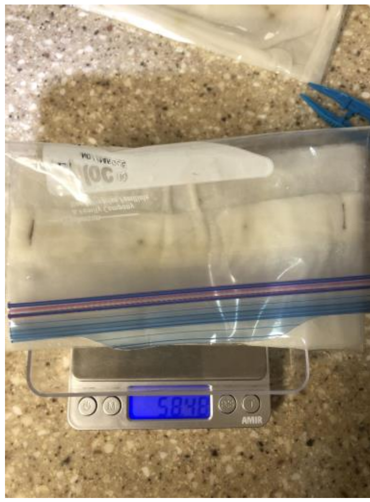
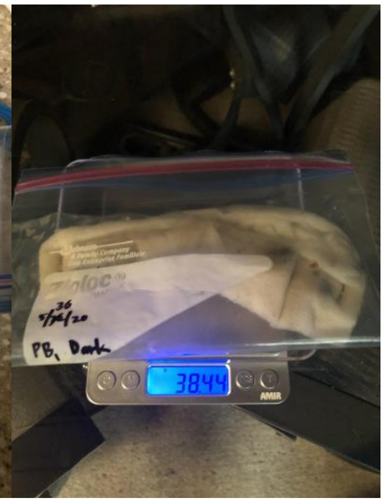
| | | | | |
|---|---|---|---|---|
| Mass of water<br>To calculate: Mass of set-up — Mass of plants — Mass of towel and bag | 59.48 − 0.5 = 58.98<br>58.98 − 10.84 =<br>48.14g | 59.69 − 0.19 = 59.5<br>59.5 − 10.78 =<br>48.72g | 61.10 − 9.26 = 51.84<br>51.84 − 10.86 =<br>40.98g | 60.87 − 10.20 = 50.67<br>50.67 − 10.74 =<br>39.93g |

49.40 diff of 1.26g   49.80 diff of 1.08g   49.73 diff of 8.75g   49.76 diff of 9.83g

10

- Have students turn to page 10 in their student notebook while you do the same in an example notebook under the document camera. Tell students that first we need to complete our Final Measurements data table.

- Tell students that you will complete the final measurements together, then pass out the experimental supplies (scale with tray, tweezers, each group's plants).
- If you (the teacher) were in charge of a group of plants, grab those. If you did not run an experimental set, you should use an example cup set-up with the students. Instruct students to take the mass of the entire set-up first, by placing the bag set-up on the tared scale, and indicate where to record these measurements on their data table.

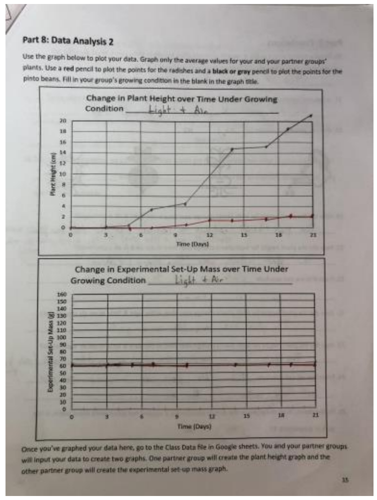




- Then work your way down the list of measurements in the table. Make sure to note that when you measure the mass of the plants, you will remove the plants carefully from the soil using tweezers.



- Finally, to calculate the mass of the water, have the students use the provided formula (mass of the entire set-up - mass of the plants - mass of the towel, and bag) and write this answer in the Final Calculations section of the data table.
- Collect experiment supplies after the measurements are complete to avoid spills.
- Instruct students to turn to page 15 in their notebooks as you place an example notebook under the document camera. Tell students that now that we have taken our final measurements, we can graph our results to help us analyze our data. Read the instructions at the top of the page to the students.
- Tell students that this graphing process will be the same as Experiment 1, so you will let them try to do it on their own instead of walking them through the

process like the first time.



**Part 8: Data Analysis 2**

Use the graph below to plot your data. Graph only the average values for your and your partner groups' plants. Use a **red** pencil to plot the points for the radishes and a **black or gray** pencil to plot the points for the pinto beans. Fill in your group's growing condition in the blank in the graph title.



Once you've graphed your data here, go to the Class Data file in Google sheets. You and your partner groups will input your data to create two graphs. One partner group will create the plant height graph and the other partner group will create the experimental set-up mass graph.

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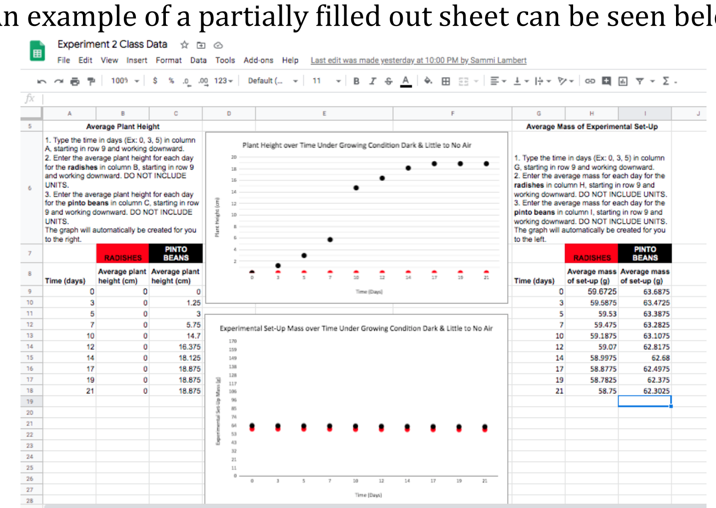
- Tell students that once they have finished their graph in their notebook, they should access the Class Data File in Google Sheets for Experiment 2. Project the Google Sheets file using whatever method accessible to you (projector, Apple TV, etc.) so students can see their graphs being completed in real time.
    - As students are completing their graphs, walk around and help struggling students.
    - Make sure students understand that a red pencil/pen should be used for the radish plant data, while a black or gray pencil/pen should be used for the pinto bean data.  (Please note: this color-coding will be the same in the graphs on the Google Sheets document, so we do not want the students to switch their color key.)
    - Point out the line in the title of each graph so students know where to write their group's growing condition.
    - Remind students that when completing their Google sheet graphs, each partner group will be responsible for one of the graphs (plant height OR set-up mass).
    - An example of a partially filled out sheet can be seen below.





**Average Plant Height**

1. Type the time in days (Ex: 0, 3, 5) in column A, starting in row 9 and working downward.
2. Enter the average plant height for each day for the **radishes** in column B, starting in row 9 and working downward. DO NOT INCLUDE UNITS.
3. Enter the average plant height for each day for the **pinto beans** in column C, starting in row 9 and working downward. DO NOT INCLUDE UNITS.

The graph will automatically be created for you to the right.

| | RADISHES | PINTO BEANS |
|---|---|---|
| Time (days) | Average plant height (cm) | Average plant height (cm) |
| 0 | 0 | 0 |
| 3 | 0 | 1.25 |
| 5 | 0 | 3 |
| 7 | 0 | 5.75 |
| 10 | 0 | 14.7 |
| 12 | 0 | 16.375 |
| 14 | 0 | 18.125 |
| 17 | 0 | 18.875 |
| 19 | 0 | 18.875 |
| 21 | 0 | 18.875 |

**Average Mass of Experimental Set-Up**

1. Type the time in days (Ex: 0, 3, 5) in column G, starting in row 9 and working downward.
2. Enter the average mass for each day for the **radishes** in column H, starting in row 9 and working downward. DO NOT INCLUDE UNITS.
3. Enter the average mass for each day for the **pinto beans** in column I, starting in row 9 and working downward. DO NOT INCLUDE UNITS.

The graph will automatically be created for you to the left.

| | RADISHES | PINTO BEANS |
|---|---|---|
| Time (days) | Average mass of set-up (g) | Average mass of set-up (g) |
| 0 | 59.6725 | 63.6875 |
| 3 | 59.5875 | 63.4725 |
| 5 | 59.53 | 63.3875 |
| 7 | 59.475 | 63.2825 |
| 10 | 59.1875 | 63.1075 |
| 12 | 59.07 | 62.8175 |
| 14 | 58.9975 | 62.68 |
| 17 | 58.8775 | 62.4975 |
| 19 | 58.7825 | 62.375 |
| 21 | 58.75 | 62.3025 |

**Part 9:**

| | |
|---|---|
| 20 minutes | **Conclusions**<br>● Tell students that we need to bring our findings together from both experiments to answer our class questions of "Where do plants get their material to grow?" and "Do plants need soil and air to grow?"<br>● Have students open their notebooks to page 16 while you do the same in an example notebook under the document camera.<br>● Ask students to raise their hands if they saw plant growth in their Experiment 2 plants (you should see hands from at least the light/dark & air groups).<br>● Ask students, "Despite having no soil in these experiments, we still observed plant growth. What does this tell us about where plants get their material to grow?" ESR: Plants do not get their material from soil, since the plants could still<br>● grow without soil. Record this for question 16.<br>● Bring out the cups you saved from experiment 1. Ask students, "We just learned that plants do not use material from the soil to grow. So, if we measure the mass of this dry soil from experiment 1, what should we expect to happen?" ESR: The mass should remain the same since none of it went into making the plant. Record this on question 17.<br>● Place a scale and tray under the document camera and measure the mass of the soil. Ask the group who's soil you are using to compare the mass on the scale to their original mass from their first experiment (initial measurements data table, page 2). You should see that the mass is relatively the same. If it is slightly lower, remind students there may have been soil loss when removing the plants from the experimental set-up.<br>● Ask the students, "Was our prediction correct?" Circle "yes" for question 18.<br>    ○ Repeat this for at least 2 cup set-ups to prove to students that this was not the case for just one group.<br>● Display the class Experiment 2 Google Sheets data by whatever means available to you.<br>● Start with the Light & Air Google Sheets tab and ask students what they notice about the pattern or trend they see in the data. ESR: For both pinto beans and radishes, the plant height consistently increased. Record this for question 19.<br>● Repeat this process for the Dark & Air experiment. ESR: For both plants, the plant height increased quickly, then decreased as the plant died. Record this for question 20.<br>● Ask students, "What can we conclude about plant growth from these experiments?" ESR: plants need light to sustain their growth. This supports what we learned from experiment 1. Record this for question 21.<br>● Display the Light & Little to No Air Google Sheets tab and ask students what they notice about the pattern or trend they see in the data. ESR: For both pinto beans and radishes, the plants did not grow very much/at all, and so the plant heights were very short. Record this for question 22.<br>● Repeat this process for the Dark & Little to no Air experiment. ESR: For both pinto beans and radishes, the plants did not grow very much/at all, and so the plant heights were very short. Record this for question 23.<br>● Ask students, "What can we conclude about plant growth from these experiments?" ESR: plants need air to grow and must get their matter from the air, since in both cases (light and dark) the plants did not grow without air. Record this for question 24.<br>● Ask students, "Do the results from the plants in the dark in experiment 2 support |

| | |
|---|---|
| | our conclusions about plants in the dark in experiment 1? ESR: Yes! Circle this for question 25.<br>● Have students turn back to their experiment 2 initial/final measurements data table. Have them work with their group to determine the average mass of the water that changed from Day 0 to Day 21. (In the example student work, our experiment showed an average mass change of ~13.2 g.)<br>● Have students fill this value in the first blank for question 26. Then, ask students, "If the water mass has changed, but the overall mass of our experimental set-up did not change, where did the water go?" ESR: The water must have gone into making the plants. Record this for question 26.<br>● Ask students, "In the plants grown with little to no air, did we see a small or large mass difference as compared to the plants grown in air?" ESR: small. Circle this for question 27.<br>● Then, ask students, "What does this tell us about plant growth?" ESR: Because the overall mass of the experimental set-up doesn't change, the plants must need air to use as matter to grow. Record this for question 27.<br>● Ask students, "Using all of the information we've obtained for both experiments, from what 2 things do plants get their material to grow?" ESR: *Air* and *water*.<br>● Then ask students, "What did we learn about the role of light in plant growth?" ESR: In order to maintain their growth, plants have to have access to *light*. Fill these in for question 28.<br>● **Note:** The plants growing in little to no air should not see growth or much growth, however, it has been my experience that it's not very easy to rid the pinto bean bag of all air. So if there's even the slightest amount of air, it would be enough to allow for cellular respiration and the bag would expand with air produced from this chemical reaction. **Encourage the students to hypothesize why this might occur, if their pinto bean plant with little or no air ended up growing.** The radish plant, however should exhibit no or little growth in the absence of air or most all the air in the bag since the seeds are so small. *(This is what I experienced with my experiment)*. |

**Example Student Work:**

Name: Sammi Date: ____________

## What's the Matter?

### Part 1: How do you think plants grow?

1. After watching these video clips and drawing upon your own experience, where do you think plants get their material to grow? Explain the reasoning behind your thinking.

I think plants need water, light, and soil to grow. We have a garden at home where our plants are in soil. We water them every day, and they are outside getting plenty of sunlight!

2. From our discussion, what are some things we think plants need to grow?

water    soil    fertilizer
light    air

### Part 2: Let's conduct an experiment!

**Class Question:** Where do plants get their matter to grow?

As a class, we will investigate 4 different growing conditions:
(Circle the option to which your group has been assigned.)

**Light & Water** **Light & No water**

**Dark & Water** **Dark & No water**

**Controls** (variables you will hold constant):

Soil amount / 1 small cup  Light amount / No light

Soil Type / vermiculite  Water Amount / 100 mL

3. We will grow our plants over the course of 3 weeks. Predict which growing conditions will allow the plant to grow the most during this time. Make sure to explain your prediction using the factors you think affect plant growth.

I think "Light and water" as a growing condition will allow the plants to grow tallest because we water our plants in sunlight every day!

1

### Part 3: Data Collection

Use the scales to measure the mass of each part of the initial experimental set-up. Measure the mass to the nearest hundredth of a gram (g) and the plant height to the nearest centimeter (cm). Final measurements of the experimental set-up will be taken on Day 21.

**Initial Measurements**

| Day 0 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of seeds | 0.08g | 0.09g | 4.22g | 4.35g |
| Mass of cups, towel, and bag | 39.68g | 40.76g | 40.43g | 42.76g |
| Mass of soil | 27.14g | 25.91g | 24.28g | 24.43g |
| Mass of water | 100.1g | 100.38g | 100.2g | 100.65g |
| Mass of entire set-up | 166.62g | 167.22g | 169.21g | 172.18g |

**Final Measurements (Take mass of entire set-up FIRST, then work down the list.)**

| Day 21 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of entire set-up | | | | |
| Mass of plants | | | | |
| Mass of cups, towel, and bag (same as initial) | | | | |

**Final Calculations**

| | | | | |
|---|---|---|---|---|
| Mass of soil and water<br>To calculate:<br>Mass of set-up — Mass of plants — Mass of cups, towel and bag | | | | |

2

### Data Collection: Experiment 1 Radishes

Our group's growing conditions: Dark & Water

| Time | My Group's Radish 1 | My Group's Radish 2 | Partner Group's Radish 1 | | Partner Group's Radish 2 | | Averages (Measurements only) | |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 3 (M) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 5 (W) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 7 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 10 (M) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |

*When taking measurements, only measure only the **TALLEST** plant in the cup.

3

### Data Collection continued: Experiment 1 Radishes

| Time | My Group's Radish 1 | My Group's Radish 2 | Partner Group's Radish 1 | | Partner Group's Radish 2 | | Averages (Measurements only) | |
|---|---|---|---|---|---|---|---|---|
| Day 12 (W) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 14 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 17 (M) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 19 (W) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 21 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |

*When taking measurements, only measure only the **TALLEST** plant in the cup.

4

## Data Collection: Experiment 1 Pinto Beans

Our group's growing conditions: Dark 'n Water

| Time | My Group's Pinto Bean 1 | My Group's Pinto Bean 2 | Partner Group's Pinto Bean 1 | | Partner Group's Pinto Bean 2 | | Averages (Measurements only) | |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 3 (M) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 5 (W) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 7 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 10 (M) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |

*When taking measurements, only measure only the **TALLEST** plant in the cup.

5

## Data Collection continued: Experiment 1 Pinto Beans

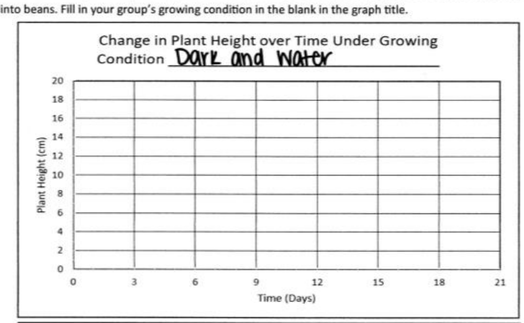
| Time | My Group's Pinto Bean 1 | My Group's Pinto Bean 2 | Partner Group's Pinto Bean 1 | | Partner Group's Pinto Bean 2 | | Averages (Measurements only) | |
|---|---|---|---|---|---|---|---|---|
| Day 12 (W) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 14 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 17 (M) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 19 (W) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |
| Day 21 (F) | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up:<br>Plant Height:<br>Observations: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: | Mass of Set-up: | Plant Height: |

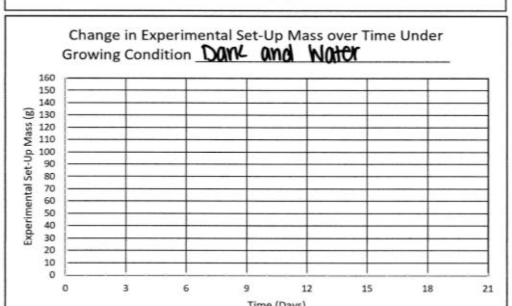
*When taking measurements, only measure only the **TALLEST** plant in the cup.

6

## Part 4: Data Analysis

Use the graph below to plot your data. Graph only the average values for your and your partner group's plants. Use a **red** pencil to plot the points for the radishes and a **black or gray** pencil to plot the points for the pinto beans. Fill in your group's growing condition in the blank in the graph title.




Once you've graphed your data here, go to the Class Data file in Google sheets. You and your partner groups will input your data to create two graphs. One partner group will create the plant height graph and the other partner group will create the experimental set-up mass graph.

7

## Part 5: Conclusions

4. How did the plant height for both plants change over time in the **light & water** experiment?
The plant height consistently increased

5. How did the plant height for both plants change over time in the **dark & water** experiment?
The plant height increased quickly, then decreased as the plant died.

6. From this we can conclude that plants need light to sustain their growth.

7. How did the plant height for both plants change over time in the **light & no water** experiment?
The plant did not grow, thus the plant height did not change.

8. How did the plant height for both plants change over time in the **dark & no water** experiment?
The plant height did not change, because the plant did not grow.

9. From this we can conclude that plants need water to grow.

10. In the cups that had water, what did you observe about the water level over the course of 21 days?
The water level decreased.

11. Did the mass of the experimental set-up change over time for all experiments?
No!

8

12. The Law of Conservation of Matter says that matter cannot be created nor destroyed.

13. From our experiment, we know that in some cases plants grew. Does this mean new matter was created through the plant? YES NO (Circle one)

14. From our experiment, where do you think the plant got its material to grow, and why?

Since the water level decreased, the plant must use water to grow. Maybe the plant also gets nutrients from the soil.

### Part 6: Further Experimentation

Class Question: Do plants need soil and air to grow?

As a class, we will investigate 4 different growing conditions over the next 3 weeks:
(Circle the option to which your group has been assigned.)

Light & Air | Dark & Air
Light & Little to no air | Dark & Little to no air

**Controls (variables you will hold constant):**

Soil amount / No soil | Light amount / No light
Water amount / 50 mL | Container Type / Bag

15. Make a prediction about plant growth for each of these growing conditions. Which growing condition do you think will allow the plant to grow the tallest? Will any of these growing conditions not allow a plant to grow?

We know that plants need light to sustain their growth, so I think the plants in the dark will not grow as well. I think the plants in light and air will grow the tallest because we do not trap the plants in our garden.

9

### Part 7: Data Collection 2

Use the scales to measure the mass of each part of the initial experimental set-up. Measure the mass to the nearest hundredth of a gram (g) and the plant height to the nearest centimeter (cm). Final measurements of the experimental set-up will be taken on Day 21.

**Initial Measurements**

| Day 0 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of seeds | 0.08 g | 0.08 g | 4.25 g | 4.21 g |
| Mass of towel and bag | 10.74 g | 10.69 g | 10.76 g | 10.74 g |
| Mass of water | 48.82 g | 48.91 g | 48.86 g | 48.99 g |
| Mass of entire set-up | 59.64 g | 59.68 g | 63.87 g | 63.94 g |

**Final Measurements (Take mass of entire set-up FIRST, then work down the list.)**

| Day 21 | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of entire set-up | 58.69 g | 58.69 | 62.74 g | 62.68 g |
| Mass of plants<br>To measure: Remove plants from towel using tweezers | 0.06 g | 0.12 | 24.22 g | 20.52 g |
| Mass of towel and bag (same as initial) | 10.74 g | 10.69 | 10.76 g | 10.74 g |

**Final Calculations**

| | Radish 1 | Radish 2 | Pinto Bean 1 | Pinto Bean 2 |
|---|---|---|---|---|
| Mass of water<br>To calculate: Mass of set-up — Mass of plants — Mass of towel and bag | 58.69<br>- 0.06<br>-10.74<br>47.89 g | 58.69<br>0.12<br>-10.69<br>47.88 g | 62.74<br>24.22<br>-10.76<br>27.76 g | 62.68<br>20.52<br>-10.74<br>31.42 g |

10

**Data Collection: Experiment 2 Radishes** Our group's growing conditions: Dark & Little to no air

| Time | My Group's Radish 1 | My Group's Radish 2 | Partner Group's Radish 1 Mass of Set-up | Partner Group's Radish 1 Plant Height | Partner Group's Radish 2 Mass of Set-up | Partner Group's Radish 2 Plant Height | Averages (Measurements only) Mass of Set-up | Averages Plant Height |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) | Mass of Set-up: 59.64 g<br>Plant Height: 0 cm<br>Observations: | Mass of Set-up: 59.68 g<br>Plant Height: 0 cm<br>Observations: | 59.61 g | 0 cm | 59.70 g | 0 cm | 59.6725 ≈ 60 g | 0 cm |
| Day 3 (M) | Mass of Set-up: 59.53 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 59.62 g<br>Plant Height: 0 cm<br>Observations: | 59.58 g | 0 cm | 59.62 g | 0 cm | 59.5875 ≈ 60 g | 0 cm |
| Day 5 (W) | Mass of Set-up: 59.48 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 59.49 g<br>Plant Height: 0 cm<br>Observations: | 59.53 g | 0 cm | 59.62 g | 0 cm | 59.53 ≈ 60 g | 0 cm |
| Day 7 (F) | Mass of Set-up: 59.42 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 59.43 g<br>Plant Height: 0 cm<br>Observations: | 59.52 g | 0 cm | 59.53 g | 0 cm | 59.475 ≈ 59 g | 0 cm |
| Day 10 (M) | Mass of Set-up: 59.03 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 59.18 g<br>Plant Height: 0 cm<br>Observations: | 59.30 g | 0 cm | 59.24 g | 0 cm | 59.1875 ≈ 59 g | 0 cm |

*When taking measurements, only measure only the **TALLEST** plant in the cup.

11

**Data Collection continued: Experiment 2 Radishes**

| Time | My Group's Radish 1 | My Group's Radish 2 | Partner Group's Radish 1 Mass of Set-up | Partner Group's Radish 1 Plant Height | Partner Group's Radish 2 Mass of Set-up | Partner Group's Radish 2 Plant Height | Averages (Measurements only) Mass of Set-up | Averages Plant Height |
|---|---|---|---|---|---|---|---|---|
| Day 12 (W) | Mass of Set-up: 59.01 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 59.02 g<br>Plant Height: 0 cm<br>Observations: | 59.17 g | 0 cm | 59.08 g | 0 cm | 59.07 ≈ 59 g | 0 cm |
| Day 14 (F) | Mass of Set-up: 58.95 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 58.93 g<br>Plant Height: 0 cm<br>Observations: | 59.07 g | 0 cm | 59.04 g | 0 cm | 58.9995 ≈ 59 g | 0 cm |
| Day 17 (M) | Mass of Set-up: 58.77 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 58.80 g<br>Plant Height: 0 cm<br>Observations: | 58.95 g | 0 cm | 58.99 g | 0 cm | 58.8775 ≈ 59 g | 0 cm |
| Day 19 (W) | Mass of Set-up: 58.72 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 58.72 g<br>Plant Height: 0 cm<br>Observations: | 58.88 g | 0 cm | 58.81 g | 0 cm | 58.7825 ≈ 59 g | 0 cm |
| Day 21 (F) | Mass of Set-up: 58.69 g<br>Plant Height: 0 cm<br>Observations: No growth → | Mass of Set-up: 58.69 g<br>Plant Height: 0 cm<br>Observations: | 58.83 g | 0 cm | 58.79 g | 0 cm | 58.75 ≈ 59 | 0 cm |

*When taking measurements, only measure only the **TALLEST** plant in the cup.

*upon removing seeds from towel ~1/4 cm growth measured

12

**Data Collection: Experiment 2 Pinto Beans** Our group's growing conditions: Dark and little to no air

| Time | My Group's Pinto Bean 1 | My Group's Pinto Bean 2 | Partner Group's Pinto Bean 1 Mass of Set-up: | Partner Group's Pinto Bean 1 Plant Height: | Partner Group's Pinto Bean 2 Mass of Set-up: | Partner Group's Pinto Bean 2 Plant Height: | Averages (Measurements only) Mass of Set-up: | Averages (Measurements only) Plant Height: |
|---|---|---|---|---|---|---|---|---|
| Day 0 (F) | Mass of Set-up: 63.87g<br>Plant Height: 0cm<br>Observations: | Mass of Set-up: 63.94g<br>Plant Height: 0cm<br>Observations: | 63.61g | 0cm | 63.33g | 0cm | 63.688 ~64g | 0cm |
| Day 3 (M) | Mass of Set-up: 63.72g<br>Plant Height: ~1cm<br>Observations: 4 seeds began to sprout | Mass of Set-up: 63.78g<br>Plant Height: ~2cm<br>Observations: 6 seeds sprouted | 63.37g | ~1cm | 63.02g | ~1cm | 63.4728 ~63g | ~1cm |
| Day 5 (W) | Mass of Set-up: 63.61g<br>Plant Height: ~3cm<br>Observations: White & yellow plants → odor from bags → | Mass of Set-up: 63.78g<br>Plant Height: ~3cm<br>Observations: | 62.91g | ~3cm | 63.25g | ~3cm | 63.3875 ~63g | ~3cm |
| Day 7 (F) | Mass of Set-up: 63.58g<br>Plant Height: 6cm<br>Observations: some white & yellow color → stronger odor from bags → | Mass of Set-up: 63.61g<br>Plant Height: 5cm<br>Observations: | 62.81g | 6cm | 63.18g | 6cm | 63.2825 ~63g | 5.75 ~6cm |
| Day 10 (M) | Mass of Set-up: 63.31g<br>Plant Height: 14.5<br>Observations: some white & yellow color → odor still smelled → | Mass of Set-up: 63.79g<br>Plant Height: 10cm<br>Observations: | 62.48g | 18cm | 62.85g | 16cm | 63.1075 ~63g | 14.7 ~15cm |

*When taking measurements, only measure only the TALLEST plant in the cup.

13

**Data Collection continued: Experiment 2 Pinto Beans**

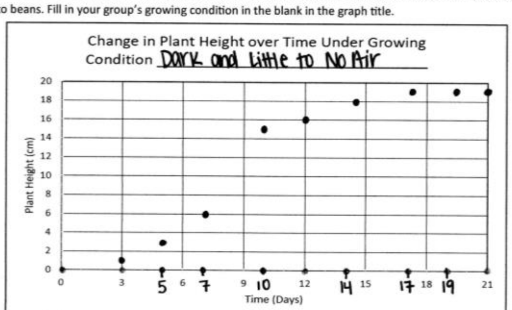
| Time | My Group's Pinto Bean 1 | My Group's Pinto Bean 2 | Partner Group's Pinto Bean 1 Mass of Set-up: | Partner Group's Pinto Bean 1 Plant Height: | Partner Group's Pinto Bean 2 Mass of Set-up: | Partner Group's Pinto Bean 2 Plant Height: | Averages (Measurements only) Mass of Set-up: | Averages (Measurements only) Plant Height: |
|---|---|---|---|---|---|---|---|---|
| Day 12 (W) | Mass of Set-up: 63.19g<br>Plant Height: 17cm<br>Observations: Same color & odor observed | Mass of Set-up: 63.14g<br>Plant Height: 13cm<br>Observations: | 62.31g | 19 cm | 62.63g | 16.5cm | 62.8175 ~63g | 16.375 ~16cm |
| Day 14 (F) | Mass of Set-up: 63.10g<br>Plant Height: 17.5cm<br>Observations: more yellow in color → | Mass of Set-up: 63.06g<br>Plant Height: 16cm<br>Observations: | 62.12g | 19 cm | 62.44g | 20 cm | 62.68 ~63 g | 18.125 ~18cm |
| Day 17 (M) | Mass of Set-up: 62.95g<br>Plant Height: 17.5cm<br>Observations: starting to wilt | Mass of Set-up: 62.88g<br>Plant Height: 17 cm<br>Observations: getting brown | 61.93g | 19 cm | 62.23g | 22cm | 62.4975 ~62g | 18.875 ~19 cm |
| Day 19 (W) | Mass of Set-up: 62.81g<br>Plant Height: 17.5 cm<br>Observations: continuing to wilt / turn brown strong odor still | Mass of Set-up: 62.74g<br>Plant Height: 17 cm<br>Observations: | 61.81g | 19 cm | 62.14g | 22cm | 62.375 ~62g | 18.875 ~19 cm |
| Day 21 (F) | Mass of Set-up: 62.74g<br>Plant Height: 17.5 cm<br>Observations: some stems broke off / sagging looks moldy on some | Mass of Set-up: 62.68g<br>Plant Height: 17 cm<br>Observations: | 61.80g | 19 cm | 62.11g | 22 cm | 62.3325 ~62g | 18.875 ~19 cm |

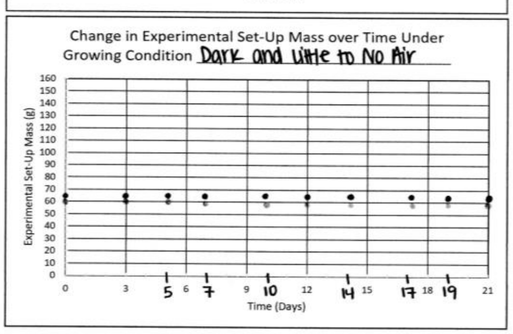
*When taking measurements, only measure only the TALLEST plant in the cup.

14

**Part 8: Data Analysis 2**

Use the graph below to plot your data. Graph only the average values for your and your partner groups' plants. Use a **red** pencil to plot the points for the radishes and a **black or gray** pencil to plot the points for the pinto beans. Fill in your group's growing condition in the blank in the graph title.




Once you've graphed your data here, go to the Class Data file in Google sheets. You and your partner groups will input your data to create two graphs. One partner group will create the plant height graph and the other partner group will create the experimental set-up mass graph.

15

**Part 9: Conclusions**

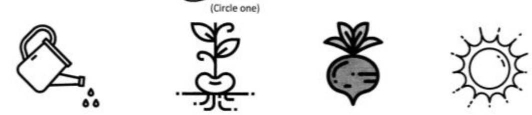
16. Despite having no soil in Exp 2, we still observed plant growth in some cases. What does this tell us about where plants get the material they need to grow?

Plants do not get material to grow from the soil.

17. When we re-measure the mass of the soil from an Exp 1 plant, what should we expect to happen?

We should expect the mass to remain the same.

18. Was our prediction correct? YES NO (Circle one)



19. How did the plant height for both plants change over time in the **light & air** experiment?

The plant height continued to increase

20. How did the plant height for both plants change over time in the **dark & air** experiment?

The plants initially grew, then shrunk.

21. From this we can conclude, Plants need light to continue to grow.

22. How did the plant height for both plants change over time in the **light & little to no air** experiment?

The plants did not grow very much/at all.

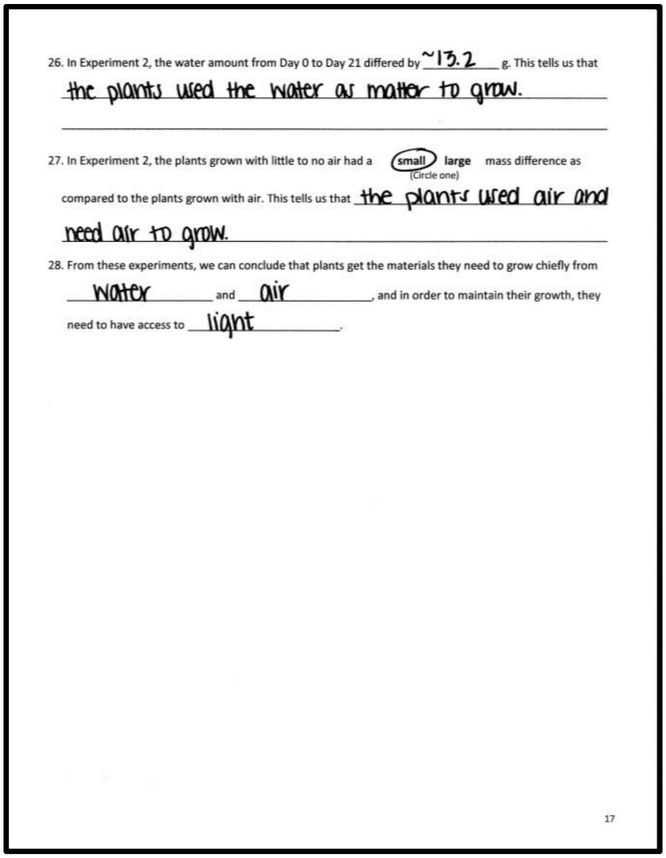
23. How did the plant height for both plants change over time in the **dark & little to no air** experiment?

The plants did not grow very much/at all.

24. From this we can conclude that plants need air to grow, and must get their matter from the air.

25. Do the results from the plants in the dark in experiment 2 support our conclusions about plants in the dark in experiment 1? YES NO (Circle one)

16



26. In Experiment 2, the water amount from Day 0 to Day 21 differed by ~13.2 g. This tells us that the plants used the water as matter to grow.

27. In Experiment 2, the plants grown with little to no air had a small large mass difference as compared to the plants grown with air. This tells us that the plants used air and need air to grow.
(Circle one)

28. From these experiments, we can conclude that plants get the materials they need to grow chiefly from water and air, and in order to maintain their growth, they need to have access to light.

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**Content Notes for Teachers:**

*The chemical reaction for Photosynthesis clearly shows the process by which plants are able to grow, however, an introduction to chemical reactions is not in the 5th grade NGSS standards. Therefore, we cannot use the chemical reaction as evidence for this process in this lesson.*