**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_**

**Net Primary Productivity**

**Introduction**

The primary productivity of plants can be measured by an increase in dry weight over a specified period of time. This increase in mass comes from the carbon which plants fix and convert to carbohydrates. See your text for more information on productivity. In this lab you will determine the mass of grass seed, plant it, let it grow, clip it, let the grass grow again (after clipping), and determine the biomass produced during that time. You will use this data to calculate net primary productivity.

**Procedure**

1. Choose a 11” x 21 3/8” plastic seed flat and label it with your name.
2. Fill plastic seed flat with potting soil to a level about ¼ inch from the top.
3. Plant 50g of grass seed in the potting soil by spreading it evenly and covering it gently with .5 cm of potting soil.
4. Water the seeds.
5. Wait 12 days.
6. Clip the grass blades of each plant down to the level of the top of the plastic seed flat. Discard the clippings. This process is to allow the grass plants to get established and these clippings will not be measured.
7. Allow the grass to continue growing for an additional 8 days.
8. Clip the grass again and dry it in the drying oven.
9. Keep the grass from each flat in a separate pre-weighed drying container.

**Data Collection**

Mass of grass seed planted\_\_\_\_\_\_\_\_\_\_\_\_

Date planted\_\_\_\_\_\_\_\_\_\_\_\_

Date clipped first time\_\_\_\_\_\_\_\_\_\_

Date clipped second time\_\_\_\_\_\_\_\_\_\_

Dimensions of plastic flat (in cm)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of drying container\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of drying container + grass clippings after drying\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Biomass of grass clippings\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Productivity Calculations:** Show your work and keep the correct # of significant figures throughout. Use scientific notation.

|  |  |
| --- | --- |
| Biomass of grass clippings |  |
| Time period (days) |  |
| Average biomass gained per day |  |
| Kcal gained per day\* |  |
| Area of plastic flat in cm2 |  |
| Area of plastic flat in m2\*\* |  |
| Area of plastic flat in km2 |  |
| Net productivity (kcal/day/square meter) |  |
| Class average for net productivity |  |

\*There are 3.6 kcal/gram dry weight

\*\*Hint: Use unit analysis to do conversions!

**Discussion/Conclusion**

1. Define net productivity.
2. Define gross productivity.
3. Taking your own productivity, use it to calculate the net productivity for a grassland composed of your grass plants over a 12-week summer period. Assume the grassland is one square kilometer. (Hint: apply your knowledge of dimensional analysis to keep track of your units.) Show your work.
4. Repeat your calculations for the average biomass of clippings for the entire class.
5. Compare your calculations to the data in your textbook for grassland productivity. What is the % difference between your data and the data in your textbook. Show your work.

(accepted value –your value)

% difference= --------------------------------------- X 100

accepted value

**Significant Figures**

Significant figures are critical when reporting scientific data because they give the reader an idea of how well you could actually measure/report your data. Before looking at a few examples, let's summarize the rules for significant figures.

1) ALL non-zero numbers (1,2,3,4,5,6,7,8,9) are ALWAYS significant.

2) ALL zeroes between non-zero numbers are ALWAYS significant.

3) ALL zeroes which are SIMULTANEOUSLY to the right of the decimal point AND at the

end of the number are ALWAYS significant.

4) ALL zeroes which are to the left of a written decimal point and are in a number >= 10 are ALWAYS significant.

A helpful way to check rules 3 and 4 is to write the number in scientific notation. If you can/must get rid of the zeroes, then they are NOT significant.

Examples: How many significant figures are present in the following numbers?

|  |  |  |
| --- | --- | --- |
| Number | # Significant Figures | Rule(s) |
| 48,923 | 5 | 1 |
| 3.967 | 4 | 1 |
| 900.06 | 5 | 1,2,4 |
| 0.0004 (= 4 E-4) | 1 | 1,4 |
| 8.1000 | 5 | 1,3 |
| 501.040 | 6 | 1,2,3,4 |
| 3,000,000 (= 3 E+6) | 1 | 1 |
| 10.0 (= 1.00 E+1) | 3 | 1,3,4 |

**Scientific Notation**

Scientific notation is the way that scientists easily handle very large numbers or very small numbers. For example, instead of writing 0.0000000056, we write 5.6 x 10**-**9. So, how does this work?

We can think of 5.6 x 10**-**9 as the product of two numbers: 5.6 (the digit term) and 10**-**9 (the exponential term).

Here are some examples of scientific notation.

|  |  |
| --- | --- |
| 10000 = 1 x 104 | 24327 = 2.4327 x 104 |
| 1000 = 1 x 103 | 7354 = 7.354 x 103 |
| 100 = 1 x 102 | 482 = 4.82 x 102 |
| 10 = 1 x 101 | 89 = 8.9 x 101 (not usually done) |
| 1 = 100 |  |
| 1/10 = 0.1 = 1 x 10**-**1 | 0.32 = 3.2 x 10**-**1 (not usually done) |
| 1/100 = 0.01 = 1 x 10**-**2 | 0.053 = 5.3 x 10**-**2 |
| 1/1000 = 0.001 = 1 x 10**-**3 | 0.0078 = 7.8 x 10**-**3 |
| 1/10000 = 0.0001 = 1 x 10**-**4 | 0.00044 = 4.4 x 10**-**4 |

As you can see, the exponent of 10 is the number of places the decimal point must be shifted to give the number in long form. A **positive** exponent shows that the decimal point is shifted that number of places to the right. A **negative** exponent shows that the decimal point is shifted that number of places to the left.

In scientific notation, the digit term indicates the number of significant figures in the number. The exponential term only places the decimal point. As an example,

46600000 = 4.66 x 107

This number only has 3 significant figures. The zeros are not significant; they are only holding a place. As another example,

0.00053 = 5.3 x 10**-**4

This number has 2 significant figures. The zeros are only place holders.

**How to do calculations:**

**On your scientific calculator:**

Make sure that the number in scientific notation is put into your calculator correctly.   
Read the directions for your particular calculator. For inexpensive scientific calculators:

1. Punch the number (the digit number) into your calculator.
2. Push the EE or EXP button. Do **NOT**use the x (times) button!!
3. Enter the exponent number. Use the +/- button to change its sign.
4. Voila! Treat this number normally in all subsequent calculations.

To check yourself, multiply 6.0 x 105 times 4.0 x 103 on your calculator. Your answer should be 2.4 x 109.

**On a non-scientific calculator:**

You will need to be familiar with exponents since your calculator cannot take care of them for you. For an introduction to rules concerning exponents, see the section on Manipulation of Exponents.

**Addition and Subtraction:**

* All numbers are converted to the same power of 10, and the digit terms are added or subtracted.
* Example: (4.215 x 10**-**2) + (3.2 x 10**-**4) = (4.215 x 10**-**2) + (0.032 x 10**-**2) = 4.247 x 10**-**2
* Example: (8.97 x 104) - (2.62 x 103) = (8.97 x 104) - (0.262 x 104) = 8.71 x 104

**Multiplication:**

* The digit terms are multiplied in the normal way and the exponents are added. The end result is changed so that there is only one nonzero digit to the left of the decimal.
* Example: (3.4 x 106)(4.2 x 103) = (3.4)(4.2) x 10(6+3) = 14.28 x 109 = 1.4 x 1010  
  (to 2 significant figures)
* Example: (6.73 x 10**-**5)(2.91 x 102) = (6.73)(2.91) x 10(**-**5+2) = 19.58 x 10**-**3 = 1.96 x 10**-**2  
  (to 3 significant figures)

**Division:**

* The digit terms are divided in the normal way and the exponents are subtracted. The quotient is changed (if necessary) so that there is only one nonzero digit to the left of the decimal.
* Example: (6.4 x 106)/(8.9 x 102) = (6.4)/(8.9) x 10(6-2) = 0.719 x 104 = 7.2 x 103  
  (to 2 significant figures)
* Example: (3.2 x 103)/(5.7 x 10**-**2) = (3.2)/(5.7) x 103**-**(**-**2) = 0.561 x 105 = 5.6 x 104  
  (to 2 significant figures)