

National Science Olympiad
Augusta State University, Augusta, GA

May 16, 2009

Environmental Chemistry C

School: _____ **Answer Key** _____ Team #: _____.

Student Names: _____

Instructions: Do NOT open the test until you are instructed to do so. For the chemical tests, **be sure to wear safety glasses and lab coats/aprons**, follow the testing instructions carefully (provided on separate sheet) and do NOT waste materials (strips or activator solution). Do NOT write on the bottle. Leave all materials (bottle, color charts, used strips, etc.) at your workstation. **Part of your grade will be based on how well you follow these instructions!!**

Score	134 possible
Tie Breaker #1	
Tie Breaker #2	

TIE BREAKERS WILL ONLY BE USED IN CASE OF A TIE!

1) (6 points) Soil can be classified by its particle size (diameter). The three main classifications are sand, silt, and clay. **2 pts each part**

- a) Which of these has the largest solid particle size? sand
- b) Which of these has the smallest solid particle size? clay
- c) Through which one would water typically flow the easiest? sand

2) (20 points) Mr. Greenthumb recently moved to the area and has a variety of gardening projects planned. He first wanted to get his soil tested, so he brought it to your laboratory. This soil is in bag "A". Test the soil for the following components, using the testing instructions provided (on a separate page). Fill in your test results in the blanks below. Be sure to also follow the workstation instructions on the test cover.

pH: (accept 5-6.5) **(4 pts each)** mg/L P: (accept 1-4)

mg/L N: 2.5 mg/L K: (accept 15-125)

technique: 1 pt safety glasses, 1 pt. apron or coat, 1 pt. test strip, 1 pt. general technique (4 pts. total)

Use the table below to interpret your results (question 3).

<u>Nutrient</u>	<u>Depleted</u> (Very low concentration. Increase by 2 applications.)	<u>Deficient</u> (Low concentration. Increase by 1 application)	<u>Optimal</u> (Desired value. No addition needed.)	<u>Surplus</u> (More than optimal. No addition needed.)
Phosphorus (P)	1	4	10	25
Nitrogen (N)	0.5	2.5	7	20
Potassium (K)	0	15	55	125
Note: All concentration values are in mg/L				

3) (2 points) Based on the results of the tests of Mr. Greenthumb's soil, what changes should he make if he were planning to put in a successful vegetable garden. Choose the ONE best choice:

- a) Increase P
- b) Increase N **accept either answer, d or g**
- c) Increase K
- d) Increase both P and N**
- e) Increase both N and K
- f) Increase both P and K
- g) Increase P, N, and K**
- h) Change nothing. His soil is fine as it is.

Total possible page points: 28

4) (6 points) Plants are composed primarily of what 3 elements (by weight)? (2 pts. each, any order)

carbon & hyrdogen & oxygen

5) (3 points) Determine the percent water of a soil sample that has a mass of 12.2 grams when wet and 7.1 grams when dried.

% water = 42

TRUE OR FALSE (questions 6-13) (2 points each) (Circle your answer):

- 6) Manganese is important to chlorophyll production **T** or F
- 7) Nitrogen fixation is a process by which plant leaves take up nitrogen gas from the atmosphere T or **F**
- 8) Too much nitrogen can stimulate green leafy growth at the expense of flower production **T** or F
- 9) Micronutrients can be both beneficial and toxic to plants **T** or F
- 10) Moist soils do not warm up as quickly as dry soils **T** or F
- 11) A pH value of 7.0 is ten times more acidic than a pH of 6.0 T or **F**
- 12) Zinc is a type of sugar produced by plant enzymes T or **F**
- 13) Well-established plant growth can help prevent soil erosion **T** or F

14) (12 points) You have a 25-kg bag of 20-15-10 fertilizer. 2 pts. each blank

a) Indicate the amounts, in kg, of each fertilizer (in oxide form, if applicable) contained in the 25-kg bag.

K_2O = 2.5 kg, N = 5 kg, P_2O_5 = 3.75 kg

b) How many kilograms of each fertilizer element (on an elemental basis) are contained in the 25-kg bag?

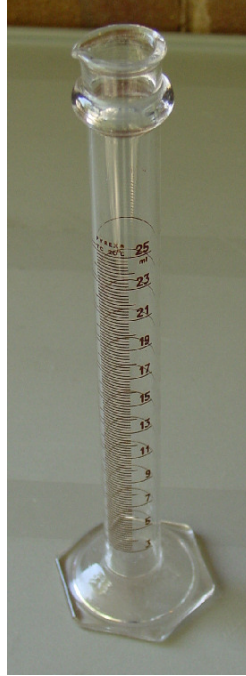
K = 2.075 (accept round, to 2.1) kg, N = 5 kg, P = 1.65 (accept 1.6-1.7) kg

Total possible page points: 37

Questions 15-25 (2 points each): Shown below are pictures of laboratory or field equipment that you might use to collect or analyze soil samples. Choosing from the word bank (on the next page), match the picture to the correct item name. **Put the correct LETTER in the blank provided for each problem. No term will be used more than once.**



15) C



16) L



17) F



18) U



19) P



20) R



21) K

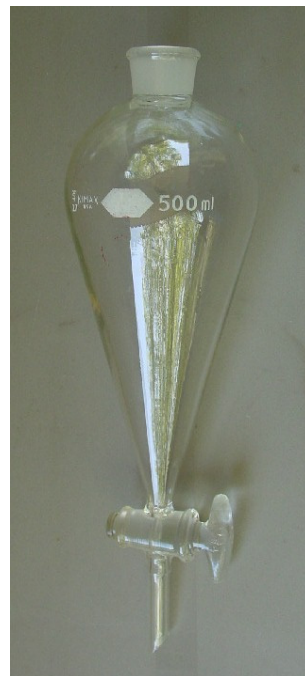
Total possible page points: 14



22) O



23) T



24) B



25) E

Word Bank for questions 15-25:

A: pear-shaped flask

B: separatory funnel

C: Erlenmeyer flask

D: Kjeldahl nitrogen funnel

E: pH electrode

F: auger

G: filtering flask

H: condenser

I: lysimeter

J: buret

K: sieve

L: graduated cylinder

M: Buchner funnel

N: distilling flask

O: pipetter

P: gas-chromatography column

Q: Kuderna Danish flask

R: desiccator

S: beaker

T: soil core sampler

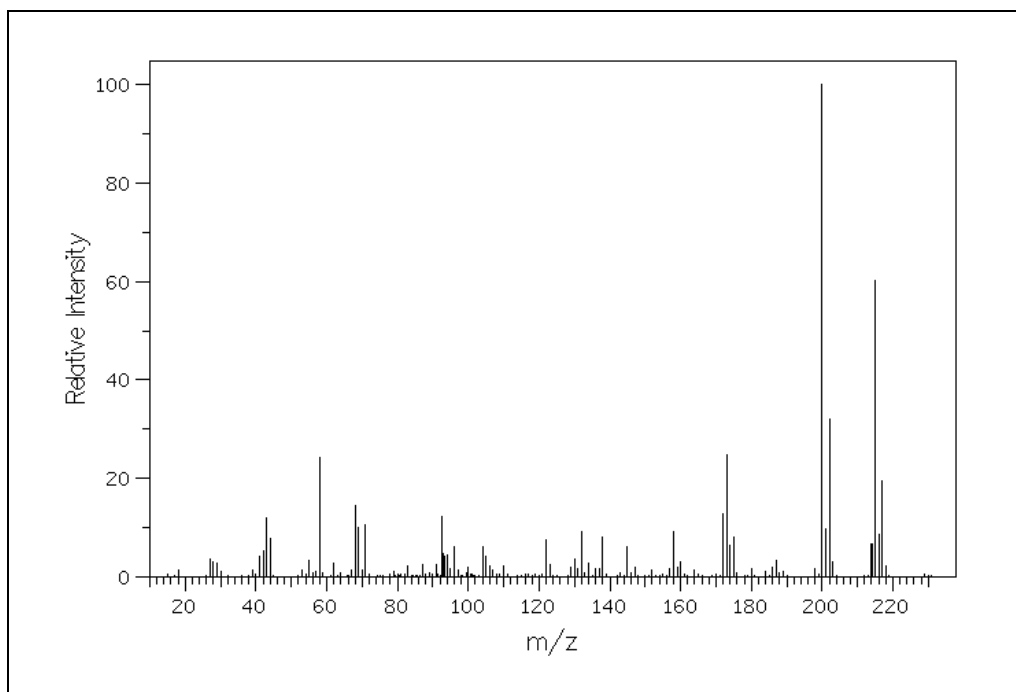
U: volumetric flask

V: centrifugal filter device

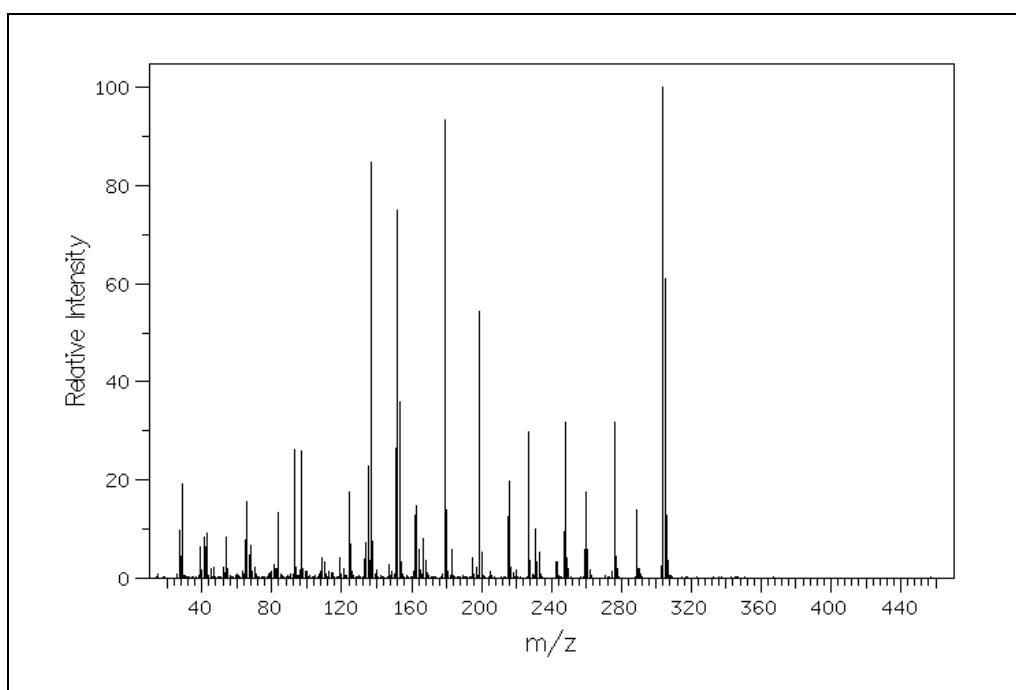
Total possible page points: 8

For question 26 (next page), study the 2 mass spectra below.

Pesticide A (below)



Pesticide B (below)



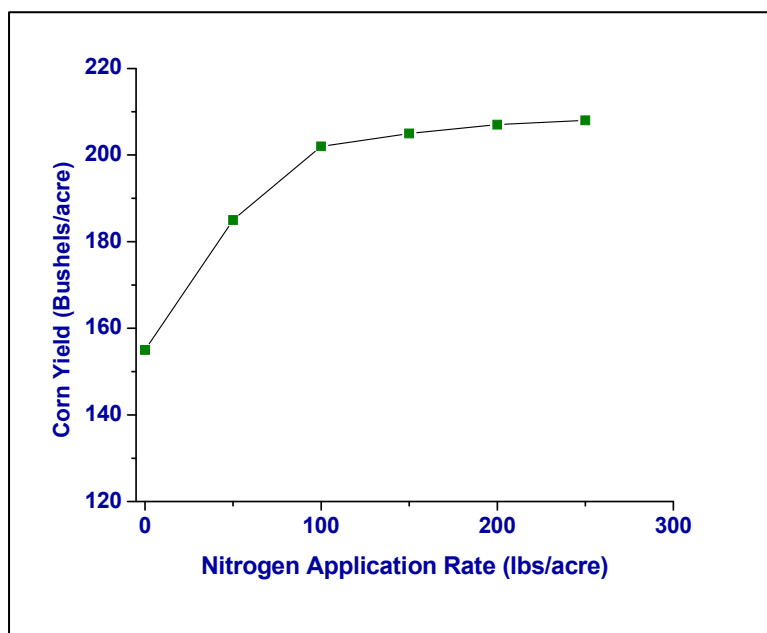
- 26) (6 points) Use the following table of primary mass components for various pesticides, identify Pesticide A and Pesticide B (previous page).

Pesticides and Related Primary Mass Components	
<u>Pesticide Name</u>	<u>Primary Mass Components</u>
simazine	201, 186, 173, 138, 96, 71
atrazine	215, 200, 173, 158, 138, 58
malathion	255, 173, 157, 127, 99, 55
iprodione	314, 243, 187, 124, 85, 70
diazinon	304, 289, 276, 179, 152, 137

a) Pesticide A = atrazine (3 pts.)

b) Pesticide B = diazinon (3 pts.)

- 27) (6 points) Consider the following diagram, which shows the relationship between corn yield and nitrogen application rate:



a) What is the yield of corn, in bushels/acre, with no applied nitrogen? 155 (accept 154-156)

b) Why would the yield not be equal to zero when no fertilizer was applied? soil can support growth without fertilizer; or equivalent

c) What would be the optimum application rate of nitrogen for a farmer who wanted to obtain a high yield with minimal fertilizer use? Pick from the choices below (circle single best choice):

0 or 50 or 100 or 150 or 200 or 250

(2 pts. each part)

Total possible page points: 12

- 28) (8 points) Joe wants to plant a garden with 4 separate crops—lettuce, peppers, tomatoes, and sweetcorn—each in its own section, as shown below (Figure 1). He also wants to apply just the right amount of fertilizer for each crop, using a single mixture for each, and obtaining the optimum yield, but without having any excess fertilizer components left in the soil. He only has 4 choices for fertilizers (shown in table 2).

Using the following tables of nutrient uptake rates and available fertilizer choices, what is the best choice of fertilizer for each section (match the uptake rates with best choice of fertilizer)? Assume that all nutrients come from the fertilizer application. Write in the **LETTER** (from table 2) in each section (in figure 1) on the blank provided.

Table 1: Uptake rates for various crops (tonne/ha)

Crop	N	P ₂ O ₅	K ₂ O
Lettuce	109	12	148
tomato	90	11	106
peppers	51	12	66
sweetcorn	61	13	34

Table 2: Available fertilizers

Available fertilizers (choose from this list)
A: 18-2-25
B: 14-3-8
C: 17-4-22
D: 16-2-19

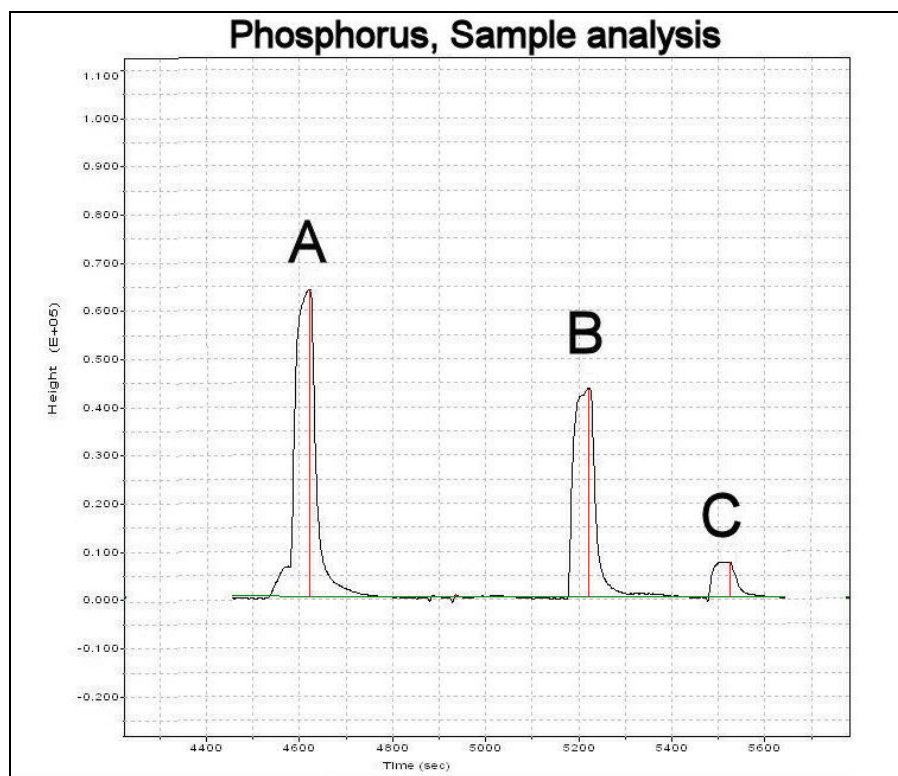
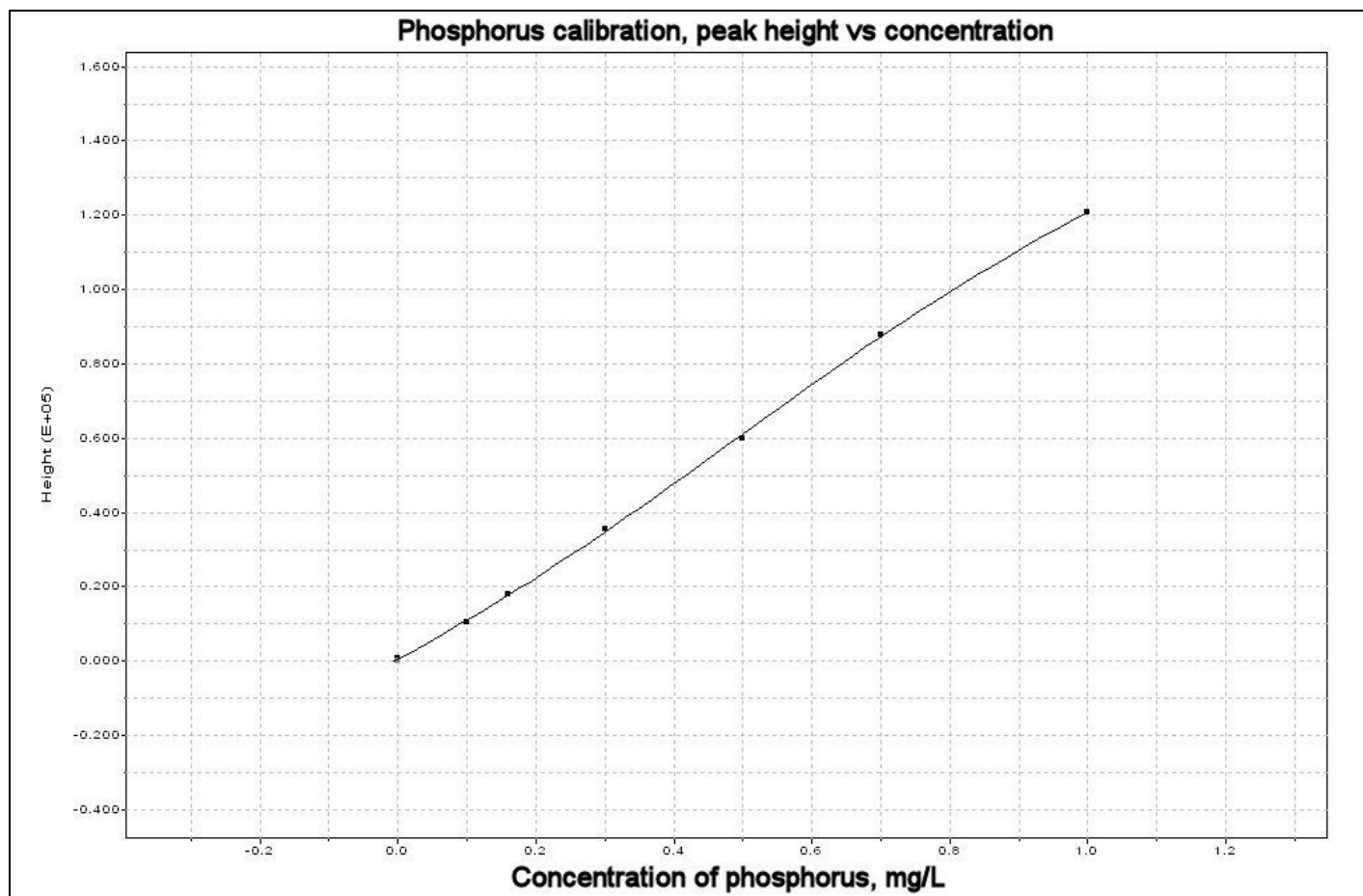
Figure 1: Joe's garden plan

Lettuce Fertilizer choice = <u> A </u>	Peppers Fertilizer choice = <u> C </u>
Tomatoes Fertilizer choice = <u> D </u>	Sweetcorn Fertilizer choice = <u> B </u>

(2 pts. each)

Total possible page points: 8

Study the following 2 diagrams and answer question #29 on the following page.



29) (9 points) The calibration curve on the previous page (top figure) shows a plot of peak height versus phosphorus concentration. The second figure (bottom) shows peaks (labeled A, B, and C) from analyses of three separate soil extracts (each peak represents a single extraction solution).

a) Determine the concentration of phosphorus, to the nearest 0.01 mg/L, in each of the extracts.

A = 0.52 (accept 0.51-0.54) mg/L; B = 0.36 (accept 0.35-0.38) mg/L; C = 0.07 (accept 0.05-0.08) mg/L

b) Assume that the total volume of each extract was 20 ml, and the mass of each soil sample extracted was 0.5 gram. How many grams of phosphorus were there in each kg of soils A, B, and C? You may use the space below for calculations (but be sure final answers are clear)

multiply by $0.02/0.5 = *0.04$

A = <u>0.0208</u> g/kg;	B = <u>0.0144</u> g/kg;	C = <u>0.0028</u> g/kg
(accept 0.020 – 0.022)	(accept 0.014 – 0.0152)	(accept 0.002-0.0032)

MULTIPLE CHOICE (choose ALL correct answers; no partial credit) (2 points each):

30) Loam is:

- ☒ a) composed of sand, silt, and clay
- ☐ b) composed mostly of peat moss and clay, with little sand
- ☐ c) the same as humus
- ☒ d) generally a good choice for a gardening soil

31) A typical productive soil contains:

- ☐ a) very few nutrients
- ☒ b) mineral matter
- ☒ c) organic matter
- ☒ d) water
- ☒ e) air

32) Fertilizers can:

- ☒ a) be made up from organic and inorganic materials
- ☒ b) improve the productivity of a soil
- ☒ c) be both natural and man-made
- ☐ d) have an N-P-K ratio 35-35-35
- ☒ e) release nutrients quickly or slowly, depending on the type

Total possible page points: 15

33) Soil pH:

- a)** is a measure of acidity or alkalinity
- b) has little to do with how a plant takes up nutrients
- c)** is affected by gaseous carbon dioxide levels
- d) is often lowered with the addition of lime
- e)** has an optimal range of 6-7 for most vegetables

34) Calcium:

- a)** is an element in lime
- b) deficiency causes leaf purpling
- c)** aids nutrient uptake
- d)** is an important part of plant cell wall structure
- e) is an essential micronutrient

35) Photosynthesis:

- a) produces carbon dioxide
- b)** requires sunlight
- c)** requires magnesium
- d) utilizes primarily green wavelength light
- e) requires oxygen gas

36) Compost:

- a) does not decay if working properly
- b) can reach temperatures of 120 °C
- c)** can improve soil structure
- d) should be kept completely saturated with water
- e)** contains microorganisms

37) Sulfur:

- a)** can be used to lower the pH of soil
- b)** is an essential component of some amino acids
- c)** is required for the production of chlorophyll
- d)** deficiency can cause yellowing of plants
- e)** often is supplied in “sulfates”

38) Our team thought this test: **(any answer, even none)**

- a) was too easy (Yeah!! We rock!)
- b) was too difficult
- c) was too long
- d) covered interesting subject material
- e) was fun, but we really wanted to make something explode

Total possible page points: 12

TIE BREAKERS (Only used in case of a tie.)

TB#1) What are some environmental effects of too much fertilizer use (list as many as you can)?

many possibilities: contaminated runoff, eutrophication, algal growth, stream pollution,
impurities in fertilizer contaminate environment, soil contamination
air pollution (like ammonia), etc.

TB#2) If you operated your own laboratory, how could you improve the quality of the soil testing results, relative to what you did today for question 2 (test strips)? List as many ideas, differences, or improvements as you can.

Many possibilities: duplicate analyses, use better equipment, run QC check solutions,
calibrate, use different methods, etc.

TIE BREAKERS:

Break ties first by following rule #1 below. If there is still a tie, follow subsequent rules for teams still tied.

- 1) There are 2 tie-breaker questions identified at the end of the test. Break ties by first looking at question #1. Most number of correct answers wins the tie.
- 2) If there is still a tie, go to tie-breaker question #2. Most number of correct answers wins the tie.
- 3) If there is still a tie, start at the beginning of the test and look for wrong answers. The first wrong answer loses the tie. Keep going through the questions (if there are still ties), eliminating teams until all ties are broken. If teams have the same “missed question,” keep going until 1 team is correct and the other(s) has/have missed.
- 4) If there is still a tie (unlikely, but possible), look at question #29 for answer closest to specified true value.