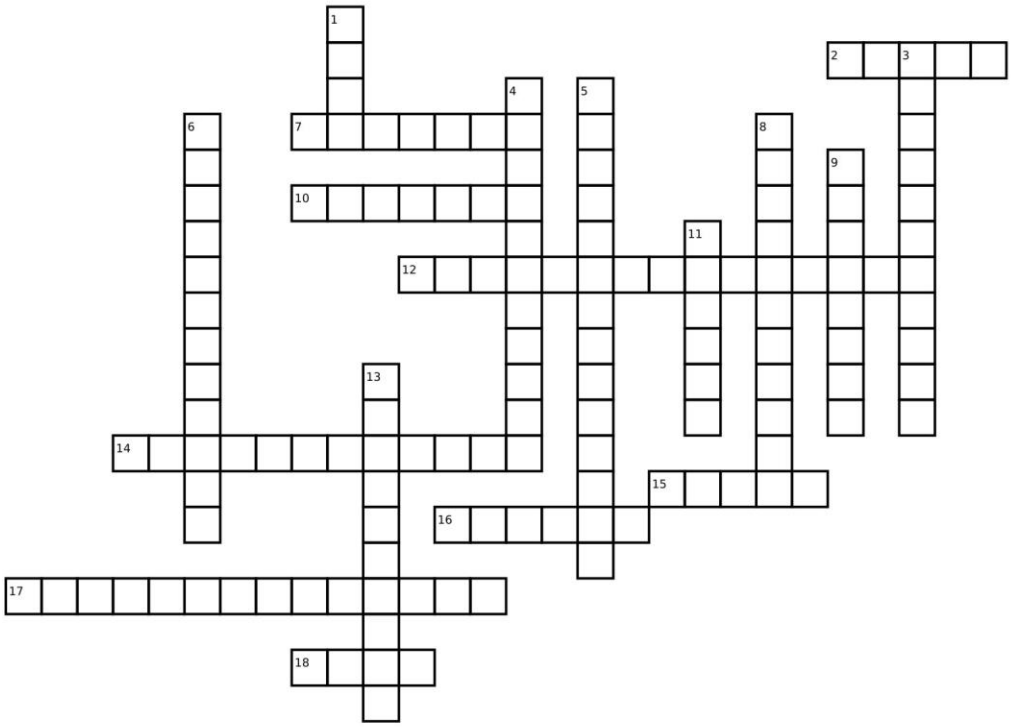
APBI 200 - Problem Set No. 1

Due date: January 18, 2019

1. Soil crossword puzzle



Down:

1. one factor of soil formation
3. a building block of phyllosilicate clay minerals
4. soil aggregates are stabilized by this process
5. a secondary clay mineral with a layered structure
6. attractive force important for retaining water in soils
8. soils integrate the biosphere, hydrosphere, atmosphere and ……
9. layers of soil approximately parallel to the soil surface
11. soil are a medium for the growth of ……
13. the breakdown of rocks and minerals at or near the earth's surface

Across:

2. soil pores are filled with air and …..
7. the proportion of sand, silt and clay in a soil
10. a two dimensional section of the soil
12. a shrink swell 2:1 secondary clay mineral
14. the process by which soil particles clump together due to interactive forces
15. bulk density includes the volume of both soils and …..
16. a primary mineral found largely in the sand size fraction of soils
17. unconsolidated mineral and organic material from which soils are developed
18. has a diameter < 2 mm but > 0.05 mm

[9 points]

2. Define the paired terms shown below. Identify important similarities and distinctions between the paired terms.

   **See back page for a worked example of this question*

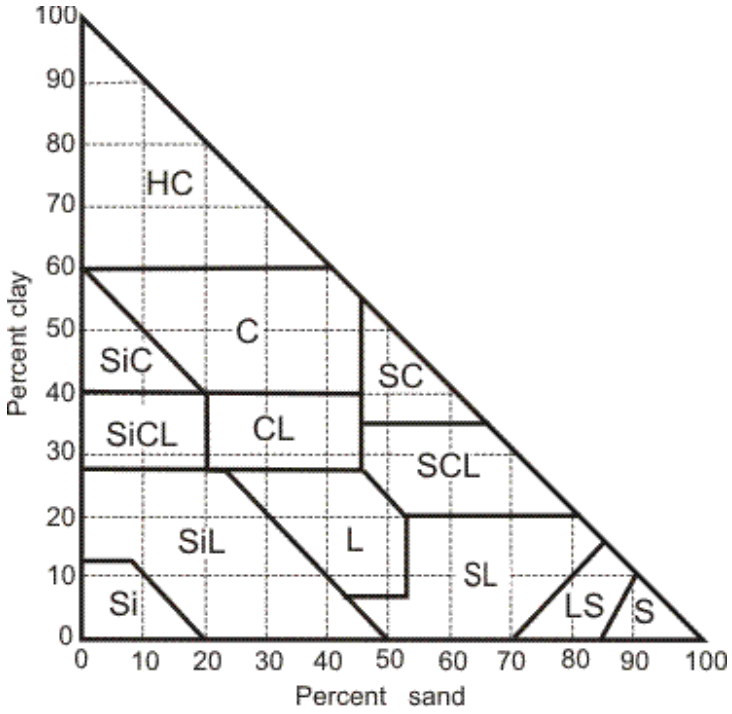
   gravimetric soil water content & volumetric soil water content

   [6 points]

3. You are applying to work part-time for your APBI 200 TA, helping them analyze soil texture for their thesis. As part of your job interview you are asked to do a calculation based on a soil sample, specifically:

   A field-moist soil sample containing 20 grams of water and 5 grams of organic matter, weighs 80 grams. This soil also contains 22% clay and 63% silt.

   (a) Determined the textural class of this soil by using the texture triangle below.



   For the soil sample described above, calculate:

   (b) grams of clay in the sample

   [Hint: you will need to determine the mass of the mineral fraction]

   [2 points]

4. Congratulations on your new job working for TA Tim. While Tim is an eager soil science student, he lacks experience – when sampling the surface soil horizon in two separate fields, he did not properly label his samples, so Tim is unsure which data corresponds to which field. However, one field was compacted by heavy tractor traffic, while the other field was carefully managed.

   Assuming a particle density of 2.65 g cm^{-3}, and given that the density of water is 1g cm^{-3}, fill in the table of soil properties – showing full calculations and units; and help Tim figure out which field is the compacted site.

   a) Calculation of soil properties (showing formulas used, full calculations and units)

	Formula	**Sample 1**	**Sample 2**
Volume of sample (V_t) in cm^3	N/A	300 cm^3	600 cm^3
Field weight	N/A	444 g	1320 g
Oven dry weight	N/A	386 g	1136 g
a) Bulk density (ρ_b) in g cm^{-3}			
b) Porosity (f) in %	f = 1- (P_b /P_s) P_b is bulk density P_s is particle density		
c) Volume of soil pores in sample (V_f) in cm^3			
d) Volume of water in sample (V_w) in cm^3	**V_w= M_w/ ρ_w** V_w is volume of water M_w is mass of water ρ_w is density of water		
e) Water content (θ_v) in cm^3 cm^{-3}	$\theta = V_w / V_t$ V_w is volume of water V_t is total soil volume		

[6 points]

   b) Which one of these samples do you think belongs to the field that was compacted by tractor traffic? Briefly explain why.

[2 points]

5. Identify the factor of soil formation that is influencing soil development in the below statements. No explanation is needed, just provide the factor of soil formation.

   a) Soils with earthworms present tend to have a less distinct boundary between the A and B horizons, due to bioturbation.

   b) Older soils tend to have more distinct horizons than young soils.

   c) Soils formed on historic lake beds tend to be finer in texture.

   d) Soils on the BC coast are typically less fertile, and more acidic due to intense nutrient leaching.

[2 points]

6. Multiple choice, multiple answer, fill in the blank:

a) The particle density of a soil is the:

   i. mass of solids / volume of solids
   ii. mass of solids / total soil volume
   iii. volume of voids (or pores) / total soil volume
   iv. volume of voids (or pores) / volume of solids

b) A soil with a high specific surface area has:

   i. a high soil water retention
   ii. a high reactivity
   iii. a coarse texture
   iv. a fine texture
   v. low soil water drainage

c) Each soil is comprised of following four components: _____, _____, _____, and _____ .

[3 points]

Total for problem set no.1 [30 points]

Worked Examples

Two 'worked examples' will be included per problem set, and will provide example answers to questions similar to those in the problem set. These questions are designed not only help you learn the content, but to help you get an idea for what kind of answers we expect on the problem sets and ultimately the midterm and final exams. This may help you write similar types of answers when doing the practice problems, and when writing your exams.

Worked Example #1:

Define the paired terms shown below. Identify important distinctions between the paired soil properties. Consider how they differently affect soil behavior and/or plant growth. ……[3 points]

Soil bulk density & soil particle density

Soil bulk density is the weight of oven dry soil divided by the total soil volume (i.e. solids plus pores).
Soil particle density is weight of the soil solids divided by the volume of the soil solids.

Distinction between the two: since bulk density includes pore space, and in general the volume of the pores is about 50% in most mineral soils, the bulk density of mineral soils is approximately 1⁄2 the particle density.

Soil particle density reflects the density of the most common minerals in a particular soil. Consequently, particle density is not changed by management practices such as tillage, harvesting or the use of heavy machinery. Soil bulk density on the other hand is affected by these management practices. Soil bulk density affects soil behavior and plant growth by determining the total pore space in a soil, which in turn impacts water infiltration, root growth and microbial activity. Soil particle density on the other hand does not impact plant growth or soil behavior directly.

Worked Example #2:

A loam soil in Lower Fraser Valley, with a typical content of quartz and clay minerals, has a porosity of 41%. What is bulk density of this soil in kg/m^3? Show the formula you use and the full calculation including units. ….. [3 points] **Note: only the highlighted text is necessary for full marks.*

Assuming

a particle density of 2.65 g/cm^3 , and a porosity of 41% (or 0.41), the bulk density is 1.56 g/m^3.

This calculation is done by rearranging and solving the following equation:

Porosity = 1 - (ρ_b /ρ_s), where ρb is soil bulk density and ρs is soil particle density.

Therefore:

$0.41 = 1 – (\rho_b / 2.65\ g/cm^3)$

$\rho_b = 2.65\ (g/cm^3) – (2.65\ g/cm^3 \times 0.41)$

$= 1.56\ g/cm^3$ or

$= 1{,}564\ kg/m^3$