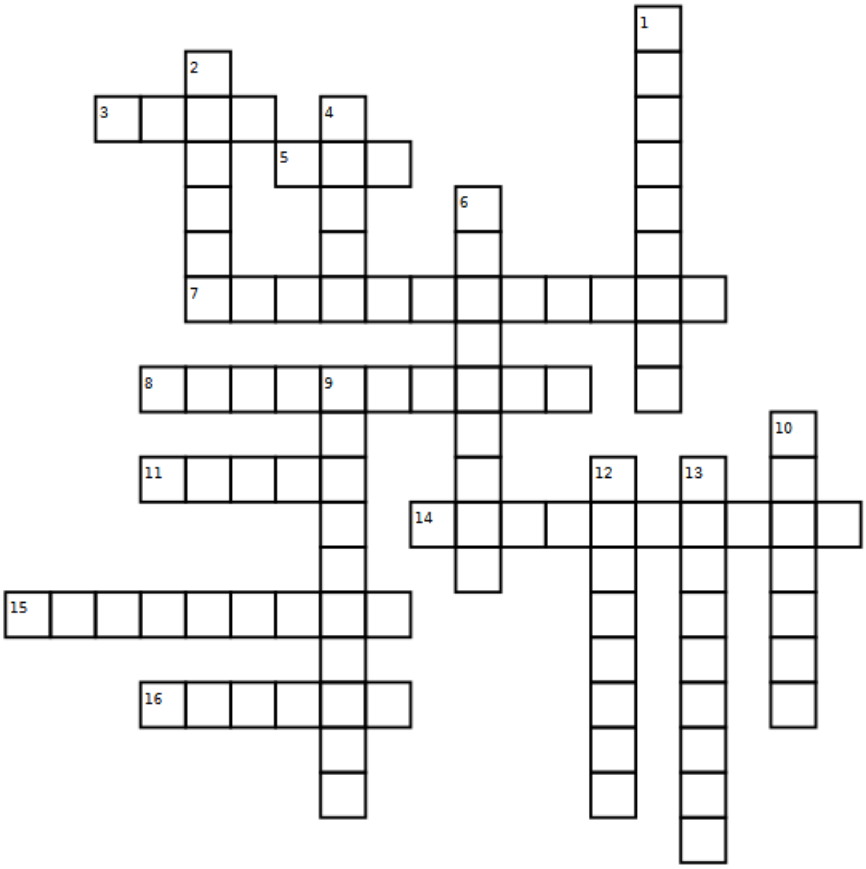
APBI 200 - Problem Set No. 2

Due date: February 14, 2020

1. Soil crossword puzzle



Down:

1. the soil water content when matric potential is equal to zero
2. _____ potential is the result of the attraction of water molecules to soil solids
4. the maximum soil water content which is available to plants is called _____ capacity
6. implies a difference in energy status
9. describes the non-straight nature of soil pores
10. heat flow in response to a temperature gradient is known as _____ conductivity
12. the attraction of water molecules to each other
13. parent material transported downslope by gravity

Across:

3. a soil with 40% sand, 40% silt and 20% clay
5. ____ filled pores do not make a significant contribution to hydraulic conductivity
7. the capability of a soil to transmit water refers to its' hydraulic _____
8. thermal _____ describes how fast or slow surface temperature changes in a soil
11. Darcy's law helps explain how _____ moves in a soil
14. large pores that occur between aggregates or between sand grains in a coarse textured soil
15. solutes move in a direction determined by its own concentration gradient
16. when aeration in a soil is very poor

[8 points]

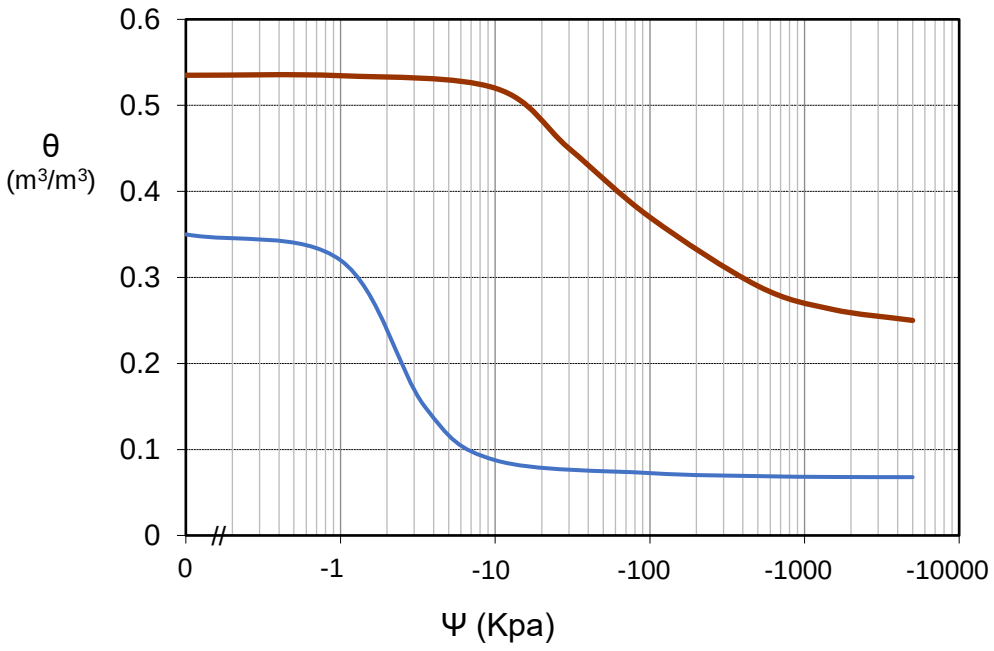
2. Define the paired terms shown below. Identify important similarities and distinctions between the paired terms.

Soil micro-pores & soil macro-pores

[6 points]

**See problem set #1 for a worked example of this type of question*

3. George is looking to buy a property for a Christmas tree farm in the Lower Fraser Valley. Two potential farms are within George's budget. Based on the soil water retention curves shown below, should George buy the red or the blue farm. Explain you answer.
Note: both farms are located on slightly sloping terrain, and George plans to grow Douglas-fir (which have a high water requirement).
Hint: consider pore size distribution, AWSC and potential limitations for each soil.



[5 points]

4. In October, UBC landscape gardeners placed wood chips loosely around the base of trees along the Main Mall. Based on your knowledge of the thermal properties of mineral soil and organic materials, explain how the addition of woodchips on top of the mineral soil (i.e. an organic mulch) would modify the underlying soil temperature in winter.

[3 points]

5. The matric potential of a massive clay soil is -0.5 m, and its hydraulic conductivity is 10^{-8} m/s. Would you expect this soil's hydraulic conductivity to be higher, lower or about the same at a matric potential of -0.01 m? Explain.

[3 points]

6. Multiple choice and multiple answer type of questions that you can expect in midterm & final exams :

a) At permanent wilting point, the highest water content is found in:
   - Clay soils
   - Loamy soils
   - Sandy soils

b) Which parent material has been transported and deposited by water:
   - Loess
   - Colluvium
   - Lacustrine
   - Till

c) Water moves in soil (*select ALL answers that apply*):
   - due to differences in total energy potential
   - from area of low total potential energy to area of high total potential energy
   - from area of high total potential energy to area of low total potential energy
   - due to tortuosity

d) A poorly aerated soil tends to (*select ALL answers that apply*):
   - contain lots of water
   - have large pores
   - have small pores
   - be fine textured
   - be coarse textured

e) Two soil samples A and B, at different soil moisture levels are placed in contact with each other. Water will move from soil A to soil B if their total water potentials (expressed in KPa) are:
   - A = -5 and B = -10
   - A = -5 and B = -5
   - A = -5 and B = +5
   - A = -10 and B = -5

[5 points]

Total for problem set no.2 **[30 points]**

Worked Examples

'Worked examples' are included to provide you example answers to questions similar to those in the problem set. These questions are designed not only to help you learn the content, but also 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:

A soil has the following properties:

volumetric water content (in 1 m^3 of soil) = 0.21 m^3
air intrusion value (AIV) of soil water tension = 0.005 m
pore volume (in 1 m^3 of soil) = 0.62 m^3
field capacity = 0.26 m^3/m^3
permanent wilting point = 0.11 m^3/m^3

a) Calculate the available water storage capacity (AWSC) in 1 m^3 of this soil?
Available water storage capacity (AWSC) = field capacity (FC) – permanent wilting point (PWP) = 0.26 m^3/m^3 – 0.11 m^3/m^3 = 0.15 m^3/m^3

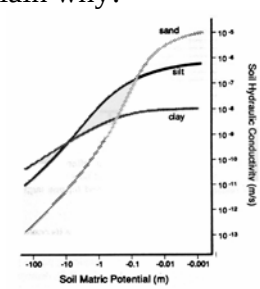
b) Calculate the volume of soil air in 1 m^3 of this soil?
Volume of soil air (Va) is calculated as follows: Va = Vf – Vw = 0.62 m^3 – 0.21 m^3 = 0.41 m^3

c) Calculate the saturated water content of this soil?
Saturated water content θ_{sat} = Vf = 0.62 (m^3_{voids} / m^3_{soil}) or 62%

Worked Example #2:

a) Define soil hydraulic conductivity
Soil hydraulic conductivity is the capability of a soil to transmit water.

b) Which soil texture (sand or clay) has a higher hydraulic conductivity when the soil is saturated? Briefly explain why?



from class notes

The sand curve starts at a higher hydraulic conductivity (around 10^{-5} m/s) than the clay curve (around 10^{-8} m/s). When soils are saturated, water flows more freely through the sand, due to its abundance of macropores (i.e., large well connected pores).

c) The slope of the hydraulic conductivity curve for a sand decreases rapidly (in comparison to a clay soil) as the soil matric potential decreases. Why?

The sandy soil is dominated by macro-pores, thus as the matric potential decreases, water is lost rapidly from the sand. Since air filled pores do not conduct water (only in vapor form), the hydraulic conductivity of the sand is very low even at Ψ near field capacity (e.g. -1 m of water, or -10 KPa).

In contrast, the clay has micropores that hold water more tightly than macropores. Thus at lower matric potentials (e.g. near PWP), the water filled pores of the finer textured soil continue to conduct water.