HOMEWORK 1

Name_____

Due: September 26, 2012, 5:00 PM

1. Assign master soil horizons and suffix symbols to each horizon in the following three profile descriptions (using only those symbols we discussed in lecture):

   a) These soils are on summits of mesas and erosional fan remnants. Slopes are 1 to 3 percent. Mean annual precipitation is about 11 inches and mean annual temperature is about 51 degrees F. (Colors are for dry soil unless otherwise stated. Hint: "duri" refers to pedogenic silica.)

   _____0 to 4 inches; brown (7.5YR 5/3) loam, brown (7.5YR 4/3) moist; moderate thick platy structure parting to weak fine granular; soft, very friable, slightly sticky and nonplastic; few fine and common very fine roots; common very fine vesicular pores; 2 percent gravel; neutral (pH 6.7); clear smooth boundary.

   _____4 to 12 inches; brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to weak coarse subangular blocky; slightly hard, friable, moderately sticky and moderately plastic; few fine and common very fine roots; few fine and common very fine tubular pores; common faint clay films on faces of peds and lining pores; moderately alkaline (pH 8.0); clear wavy boundary.

   _____12 to 17 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; strong medium angular blocky structure; hard, friable, moderately sticky and moderately plastic; few fine and common very fine roots; few fine and common very fine tubular pores; few faint clay films on faces of peds and lining pores; strongly effervescent, secondary calcium carbonate segregated as few fine irregularly shaped coats on faces of peds; moderately alkaline (pH 8.4); clear smooth boundary.

   _____17 to 25 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) moist; moderate coarse subangular blocky structure; slightly hard, very friable, moderately sticky and slightly plastic; few fine and common very fine roots; common very fine tubular pores; common faint clay films on faces of peds and lining pores; strongly effervescent, secondary calcium carbonate segregated as common fine irregularly shaped coats on faces of peds; moderately alkaline (pH 8.4); clear smooth boundary.

   _____25 to 32 inches; light brown (7.5YR 6/4) very fine sandy loam, brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few fine and very fine roots; common very fine tubular pores; 2 percent gravel; strongly effervescent, secondary calcium carbonate segregated as few fine irregularly shaped coats on faces of peds and on rock fragments; strongly alkaline (pH 8.6); clear smooth boundary.

   _____32 to 49 inches; pinkish white (7.5YR 8/2) gravelly sandy loam, pinkish gray (7.5YR 7/2) moist; moderate thick platy structure; very hard, very firm, slightly sticky and nonplastic; few fine and very fine roots; few very fine tubular pores; 25 percent pebble-sized durinodes; 2 percent gravel; violently effervescent, matrix is impregnated with secondary calcium carbonate; strongly alkaline (pH 8.8); abrupt smooth boundary.

_____49 to 54 inches; pink (7.5YR 8/4) duripan, pink (7.5YR 7/4) moist; moderate very thick platy structure; extremely hard and extremely firm; few very fine roots; few very fine irregularly shaped pores; matrix is cemented by secondary silica; 5 percent gravel; violently effervescent, matrix is impregnated and partially cemented with secondary calcium carbonate; strongly alkaline (pH 8.8); clear wavy boundary.

b) These soils consist of very deep, poorly drained, very slowly permeable soils in depressions on the Lower Rio Grande Plains. These nearly level soils are in depressions. Slope ranges from 0 to 1 percent. Mean annual air temperature is about 22.2 degree C (72 degrees F) and mean annual precipitation is about 686 mm (27 in). (Colors are for moist soil unless otherwise stated.)

_____0 to 13 cm (0 to 5 in); very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine and medium angular blocky structure; extremely hard, very firm, very sticky, very plastic; 7 percent fine and medium roots; 5 percent very fine and fine tubular pores; 7 percent fine prominent yellowish brown (10YR 5/6) masses of oxidized iron with sharp boundaries lining pores; 3 percent fine and medium faint dark gray (10YR 4/1) iron depletions with diffuse boundaries in the matrix; noneffervescent; slightly acid, pH 6.1; clear smooth boundary.

_____13 to 43 cm (5 to 17 in); very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine and medium angular blocky structure; extremely hard, very firm, very sticky, very plastic; 5 percent very fine and fine roots; 3 percent very fine and fine pores; 2 percent fine distinct dark yellowish brown (10YR 4/4) masses of oxidized iron with sharp boundaries lining pores; 3 percent fine prominent dark gray (10YR 4/1) and 2 percent fine and medium faint light brownish gray (10YR 6/2) iron depletions with clear boundaries in the matrix; noneffervescent; slightly acid, pH 6.4; clear smooth boundary.

_____43 to 71 cm (17 to 28 in); dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate fine and medium angular blocky structure; extremely hard, very firm, very sticky, very plastic; 3 percent very fine and fine roots; 3 percent very fine and fine pores; 8 percent faint slickensides; 2 percent fine distinct dark yellowish brown (10YR 4/4) masses of oxidized iron with sharp boundaries lining pores; 3 percent fine and medium faint gray (10YR 5/1) iron depletions with diffuse boundaries in the matrix; noneffervescent; neutral, pH 7.3; clear smooth boundary.

_____71 to 94 cm (28 to 37 in); gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate fine and medium angular blocky structure; extremely hard, very firm, very sticky, very plastic; 2 percent very fine and fine roots; 3 percent very fine and fine pores; 20 percent distinct slickensides; 2 percent fine iron-manganese nodules; 1 percent fine prominent light yellowish brown (2.5Y 6/4) masses of oxidized iron with sharp boundaries lining pores; 3 percent fine and medium distinct grayish brown (10YR 5/2) and 5 percent medium faint very dark gray (10YR 3/1) iron depletions with clear boundaries in the matrix; 2 percent fine and medium weakly cemented nodules of calcium carbonate; noneffervescent; moderately alkaline, pH 8.0; clear smooth boundary.

_____94 to 117 cm (37 to 46 in); gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate fine and medium angular blocky structure; extremely hard, very firm, very sticky, very plastic; 1 percent very fine and fine roots; 1 percent very fine and fine pores; 25 percent distinct slickensides; 2 percent fine iron-manganese concretions; 5 percent fine and medium faint very dark gray (10YR 3/1) and 7 percent medium distinct grayish brown (2.5Y 5/2) iron depletions with clear boundaries in the matrix; 2 percent fine weakly cemented nodules of calcium carbonate; noneffervescent; strongly alkaline, pH 8.5; clear smooth boundary.

_____117 to 150 cm (46 to 59 in); light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; moderate fine and medium angular blocky structure; extremely hard, very firm, very sticky, very plastic; 1 percent very fine and fine roots; 1 percent very fine and fine pores; 20 percent distinct slickensides; 3 percent fine iron-manganese concretions; 5 percent medium faint light yellowish brown (2.5Y 6/3) masses of oxidized iron with clear boundaries lining pores; 3 percent fine and medium distinct very dark gray (10YR 3/1) iron depletions with clear boundaries in the matrix; 2 percent fine weakly cemented nodules of calcium carbonate; noneffervescent; moderately alkaline, pH 8.3; clear smooth boundary.

c) These soils consist of very deep, excessively and somewhat excessively drained soils formed in glacial-fluvial or glacio-lacustrine sand. They are on outwash plains, deltas, lake plains, moraines, terraces, and eskers. Saturated hydraulic conductivity is high or very high. Slope ranges from 0 through 70 percent. Mean annual temperature is 6 degrees C. and mean annual precipitation is 970 millimeters. (Colors are for moist soils unless otherwise stated.)

_____0 to 1 cm; very dark brown (7.5YR 2.5/2); slightly decomposed plant material; massive; very friable; many very fine, common fine and few medium roots throughout; extremely acid (pH 4.2); abrupt smooth boundary.

_____1 to 3 cm; black (10YR 2/1); highly decomposed plant material; weak fine and medium granular structure; very friable; many very fine, common fine and few medium roots throughout; extremely acid (pH 4.2); abrupt wavy boundary.

_____3 to 10 cm; 60 percent reddish gray (5YR 5/2) and 40 percent gray (7.5YR 6/1); loamy fine sand; weak fine subangular blocky structure; very friable; common very fine, many fine and few medium and coarse roots throughout; extremely acid (pH 4.0); abrupt wavy boundary.

_____10 to 17 cm; very dusky red (2.5YR 2.5/2); loamy fine sand; weak medium subangular blocky structure; friable; common very fine and few fine, medium and coarse roots throughout; illuvial humus present; extremely acid (pH 4.2); abrupt wavy boundary.

_____17 to 34 cm; dark reddish brown (5YR 3/3); loamy fine sand; weak medium subangular blocky structure; very friable; common very fine and few fine, medium and coarse roots throughout; illuvial humus and sesquioxides present; very strongly acid (pH 5.0); clear wavy boundary.

_____34 to 43 cm; 60 percent strong brown (7.5YR 4/6) and 40 percent brown (7.5YR 4/4); loamy fine sand; weak medium subangular blocky structure; very friable; few very fine and common fine and medium roots throughout; sesquioxides present; 1 percent gravel; strongly acid (pH 5.2); clear wavy boundary.

_____43 to 61 cm; yellowish brown (10YR 5/4) sand; weak medium subangular blocky structure; very friable; common very fine, fine and medium roots throughout; 2 percent gravel; strongly acid (pH 5.2); gradual wavy boundary.

_____61 to 88 cm; brown (10YR 5/3) sand; single grain; loose; few very fine roots throughout; 2 percent gravel; strongly acid (pH 5.2); clear wavy boundary.

2. a) What is the percentage increase in the terminal velocity of a very fine sand particle with an effective diameter of 0.06 mm settling in a column of water at 20°C compared to water at 30°C? (The viscosity of water at 20°C is 0.01002 g s^{-1} cm^{-1} and at 30°C is 0.007977 g s^{-1} cm^{-1}. The density of water at 20°C is 0.9982 g cm^{-3} and at 30°C is 0.9957 g cm^{-3}. Show your work.)

   b) How long would it take for the very fine sand particle in 2a above to settle through a foot of water at 20°C? What about a fine silt particle with an effective diameter of 0.006 mm? (Show your work.)

3. Draw the unit cell structure, calculate (in tabular format) the layer charge (i.e., excluding interlayer cations), and calculate the quantity of a balancing interlayer cation of your choice for the following minerals:

   a) $(Si_{7.7}Al_{0.3})(Al_{3.4}Fe^{2+}_{0.6})O_{20}(OH)_4$

   b) $(Si_{6.3}Al_{1.7})(Mg_{4.2}Fe^{2+}_{1.8})O_{20}(OH)_4$

4. a) Calculate the cation exchange capacity (CEC) in $cmol_c$ kg^{-1} for the mineral in 3a above.

   b) Calculate the CEC ($cmol_c$ kg^{-1}) for a 10 g soil sample that was extracted at pH 5.6 with a neutral salt solution resulting in a volume of 50 mL and containing: 15 mg L^{-1} Al^{3+}, 45 mg L^{-1} Ca^{2+}, 10 mg L^{-1} Mg^{2+}, 20 mg L^{-1} K^+, and 6 mg L^{-1} Na^+.