INSTRUCTIONS

The Soil Lab Practical Examination shall be observed by a WACEL Examiner. WACEL is also allowing firms to submit recorded videos of the candidate's performance of the practical component of the WACEL Soils Laboratory Technician Certification. These videos will then be submitted to WACEL and graded by a WACEL examiner. All of the tests included in this set of worksheets must be performed by the technician. Not all of the tests need to be witnessed on the same date. The technician performing the tests should state their name, display ID, and the date at the beginning of each recording. Additional instructions (some repeat for emphasis) are on the following page.

WACEL Soils Laboratory Technician Practical

Name (Technician): _____ Date(s): _____

Office / Location: _____ Final Rating (P or F): _____

Instructions: The testing technician perform the following tests. Rate the performance appropriately and score the overall performance as either pass or fail. A failure of any individual test will result as a failure of the practical exam.

D 421-85 (REAPPROVED 2007): DRY PREPARATION OF SOIL SAMPLES FOR PARTICLE-SIZE ANALYSIS AND DETERMINATION OF SOIL CONSTANTS	**Pass**	**Fail**	**N/A**
1. Field Sample exposed to air at room temperature until thoroughly dried.			
2. Select appropriately-sized air-dried sample and record mass as total test sample uncorrected for hygroscopic moisture. Ultimate representative samples to perform individual tests are: • Particle-size analysis. Material passing a No. 10 (2.0 mm) sieve in amount of 115 grams of sandy soils or 65 grams for silt or clay soils. • Tests for soil constants. 220 grams of soil passing a No. 40 sieve (425 µm).			
3. Separate the sample by sieving with a No. 10 (2.0 mm) sieve.			
4. Break up aggregations of material retained on the No. 10 sieve using a mortar and rubber covered pestle.			
5. Re-sieve with a No. 10 sieve.			
6. Wash, dry, and weigh the material retained on the No. 10 sieve after the second sieving and record the mass as the mass of coarse material.			
7. If appropriate, sieve this same coarse material through a No. 4 (4.75 mm) sieve and record the mass retained.			
8. Thoroughly mix the fractions passing the No. 10 sieve during both sieving operations and by quartering or use of a sampler select a portion weighing approximately 115 grams for sandy soils and 65 grams for silt and clay soils for particle-size analysis.			
9. Separate the remaining portion of the material that passed the No. 10 sieve during both sieving operation using the No. 40 (425 µm) sieve.			
10. Discard the portion retained on the No. 40 sieve and use the fraction passing that sieve for determination of soil constants.			
Signature of examiner observing OVERALL			

ASTM D422-63 (Reapproved 2007) Particle Size Analysis (Hydrometer)	Pass	Fail	N/A
Preparation			
1. Sample prepared in accordance with ASTM D421.			
2. Material separated on a No. 10 sieve.			
Note: Material may be separated on the No. 4 (4.75 mm), No. 40 (425 µm), or No. 200 (75 µm) sieve instead of the No. 10 (2.00 mm) sieve.			
Coarse Portion			
1. Sieve analysis performed on the portion retained on the No. 10 sieve.			
Fine Portion			
1. The portion passing the No. 10 sieve weighs approx. 115 g for sandy soil and 65 g for silt or clay.			
2. 10 to 15 g of this soil used to determine the hygroscopic moisture.			
Dispersing Agent			
1. Solution prepared by dissolving 40 grams of sodium hexametaphosphate in enough distilled or demineralized water to make 1 liter of solution.			
2. Solution is less than a month old or adjusted to pH of 8 or 9 using sodium carbonate.			
3. Date of preparation is marked on bottle containing the solution.			
Composite Correction			
1. Composite correction for hydrometer readings determined in accordance with Section 7.			
Hydrometer Analysis			
1. Determine weight of test sample: approximately 100 g for sandy soil and 50 g for silt and clay.			
2. Sample placed in 250-mL beaker and covered with 125 mL of Sodium Hex. solution.			
3. Stirred until thoroughly wet and allowed to soak for at least 16 hours.			
4. Sample washed from beaker into dispersion cup taking care to transfer all material out of beaker.			
5. Dispersion cup filled to more than half full by addition of distilled or demineralized water.			
6. Material mechanically dispersed for a period of 1 minute.			
7. Test performed in water bath or constant temperature room			
Note: If Apparatus B (air dispersion) is used, refer to ASTM D422.			
8. The soil-water slurry completely transferred immediately into glass sedimentation cylinder.			
9. Volume adjusted to 100 mL by addition of distilled or demineralized water.			
10. End of cylinder covered by either a rubber stopper or open palm.			
11. Cylinder turned upside down and back upright for a period of 1 minute.			
12. This agitation should be approximately 60 turns in 60 seconds.			
Note: Upright to upside down and back to upright constitutes 2 turns.			
13. At the end of agitation, the cylinder set upright and the timing started.			
14. Hydrometer readings taken as follows (at least): 2, 5, 15, 30, 60, 250, and 1440 minutes.			
Note: If water bath is used, cylinder placed in bath between the 2- and 5-minute readings.			
15. Prior to each hydrometer reading, the hydrometer is inserted about 20 to 25 seconds before the reading is due to approximately the depth it will have when the reading is taken.			
16. Readings taken at the top of the meniscus.			
17. Hydrometer removed and placed in graduate of clean distilled or demineralized water with a spinning motion.			
18. Temperature of the suspension is taken after each hydrometer reading.			
Fine Sieve Analysis			
1. After final hydrometer reading, sample washed over No. 200 sieve until water runs clear.			
2. Material retained on No. 200 sieve is transferred to a suitable container and dried at 110 ± 5ºC (230 ± 9ºF).			
3. Sieve analysis performed on this material.			

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Calculations			
1. Proper calculations performed.			
Signature of P.E. observing OVERALL			

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ASTM D698-12 and D1557-12 (Reapproved 2021) Standard and Modified Proctor	Pass	Fail	N/A
D698 – Standard (5.5 lb, 12 inch drop) A: 4-inch mold Minus No. 4 material 3 layers, 25 blows/layer 25% or less plus No. 4 B: 4-inch mold Minus 3/8-inch material 3 layers, 25 blows/layer 25% or less plus 3/8 inch C: 6-inch mold Minus 3/4-inch material 3 layers, 56 blows/layer 30% or less plus 3/4 inch **D1557 – Modified (10 lb, 18 inch drop)** A: 4-inch mold Minus No. 4 material 5 layers, 25 blows/layer 25% or less plus No. 4 B: 4-inch mold Minus 3/8-inch material 5 layers, 25 blows/layer 25% or less plus 3/8 inch C: 6-inch mold Minus 3/4-inch material 5 layers, 56 blows/layer 30% or less plus 3/4 inch			
Test Sample			
1. Enough material to perform the tests (35 lbs [16 kg] for methods A & B; 65 lbs [29 kg] for C)			
Note: Field samples should have wet weights of at least 50 lbs (23 kg) and 100 lbs (45 kg), respectively.			
2. Percentage retained on No. 4, 3/8 in., and ¾ in. sieves determined and proper method selected.			
Moist Preparation (preferred)			
1. Without previously drying, sample processed over the appropriate sieve.			
2. Water content of the processed soil determined.			
Dry Preparation			
1. If too damp to be friable, sample is air-dried or oven-dried at a temperature not exceeding 140ºF (60ºC).			
2. Aggregations broken up and material processed over the appropriate sieve.			
Setting up the Points			
1. At least 4 (preferably 5) subspecimens having water contents bracketing the estimated OMC prepared.			
2. Subspecimen with moisture content close to OMC prepared first. Moisture adjusted by addition of water or by drying, as necessary.			
3. Water contents vary by about 2%.			
Note: Soils with high OMC or flat curves require larger increments but should not exceed 4%.			
4. Enough material prepared for each point (5 lb [2.3 kg] for methods A & B; 13 lb [5.9 kg] for C).			
5. Each specimen thoroughly mixed and allowed to stand in separate covered containers for req. times.			
Classification — **Minimum Time (hours)** GW, GP, SW, SP — No requirement GM, SM — 3 All other soils — 16			
6. For dry preparation only, subspecimens obtained using either mechanical splitting or quartering process			
Compaction			
1. Mass of mold (and base plate, if left attached at end) determined and recorded.			
2. Mold, collar, and base plate assembled, alignment checked, and secured to rigid foundation.			
3. Soil compacted in 3 layers of equal thickness (D698) or 5 layers of equal thickness (D1557).			
4. Soil compacted with 25 blows/layer (4-in. mold) or 56 blows/layer (6-in. mold).			
5. Prior to compaction of each layer, loose soil spread to uniform thickness and lightly tamped with hammer, or similar until it is not in a "fluffy or loose state".			
6. Following compaction of first two layers (D698) or first four layers (D1557), soil clinging to mold walls trimmed with straight edge and discarded.			
7. Third layer (D698) or fifth layer (D1557) entirely fills the mold and does not exceed ¼ inch above top of mold (if so, discard).			

8. Collar and base plate removed, top and **bottom** of mold trimmed with straight edge. If the mold volume was determined with the base plate attached, leave the base plate attached (no need to trim bottom). (Section 10.4.7))			
Note: For very wet or dry soils, the base plate should be left attached.			
9. Any holes in surface filled in with unused or trimmed soil.			
10. Mass of specimen and mold (and base plate if left attached) determined and recorded to nearest 1 g.			
11. Soil removed from mold, water content specimen obtained and tested in accordance with D2216.			
WATER CONTENT SPECIMEN			
• Whole specimen (preferred) used and broken up to facilitate drying.			
• Representative portion of all the compacted layers used. This portion should be sufficient to meet the requirements of D2216, Table 1 (included on page 10 of these worksheets).			
• Water content recorded to nearest 0.1%.			
12. Steps 1 through 11 (**Compaction**) performed for each specimen (point).			
Calculations and Plotting			
1. Water content and dry unit weight calculated for each specimen (point).			
Note: The water-filled volume or linear measurement volume, or average of both may be used when calculating the density.			
2. Values plotted as a smooth compaction curve drawn through the points. Density should be to the nearest 0.1 pcf and the water content to the nearest 0.1%.			
3. Optimum water content and maximum dry density determined from compaction curve.			
Note: If more than 5% oversized material, OMC and max dry density must be corrected.			
4. 100% saturation curve (zero air voids curve) plotted.			
Signature of P.E. observing OVERALL			

ASTM D854-14 Specific Gravity of Soil Solids by Water Pycnometer	Pass	Fail	N/A
Pycnometer Calibration			
1. Mass of clean and dry pycnometer determined to 0.01 g,			
2. Repeated for a total of 5 measurements (using the same balance) and the average and standard deviation calculated.			
3. Standard deviation ≤ 0.02 g.			
4. Pycnometer filled to above or below calibration mark with deaired water .			
5. Pycnometer placed in insulated container with thermometer, beaker of deaired water, and eye dropper or pipette.			
6. Pycnometer allowed to come to thermal equilibrium for at least 3 hours.			
7. After thermal equilibrium is achieved, pycnometer handled by touching rim only.			
8. Pycnometer left in insulated container or placed on Styrofoam block while making water level adjustment.			
9. Water level adjusted using thermally equilibrated water from the insulated container.			
10. Water beads on the pycnometer stem or on the exterior of the flask removed.			
11. Mass of pycnometer and water determined to nearest 0.01 g. and temperature measured to nearest 0.1°C (0.2°F).			
12. Repeated (steps 4 to 11) for a total of 5 measurements, refilling the pycnometer for each measurement.			
13. Average and standard deviation calculated for the 5 volume determinations.			
14. Standard deviation ≤ 0.05 mL.			
Sample Preparation			
1. Test specimen either moist or oven-dry soil passing the No. 4 sieve.			
2. Specimen size conforms to the following: 250 mL Pycnometer / 500 mL Pycnometer Soil Type — Dry Mass (g) / Dry Mass (g) SP, SP-SM — 60 ± 10 / 100 ± 10 SP-SC, SM, SC — 45 ± 10 / 75 ± 10 Silt or Clay — 35 ± 5 / 50 ± 10			
Procedure for Moist Specimens (Method A)			
1. Using the same balance used in calibration, pycnometer mass verified within 0.06 g of the average calibrated mass.			
2. Water content of a portion of the sample determined in accordance with D2216.			
3. Calculate range of wet masses required to conform to above table.			
4. Sample obtained, not taking an exact predetermined mass.			
5. Soil mixed with about 100 mL of water in a blender or equivalent.			
Note: Typically, a 500-mL pycnometer is required to accommodate the minimum volume of slurry that can be prepared by this equipment.			
6. Using a funnel, slurry poured into pycnometer, rinsing all clinging particles into pycnometer.			
Procedure for Oven-Dried Specimens (Method B)			
1. Using the same balance used in calibration, pycnometer mass verified within 0.06 g of the average calibrated mass.			
2. Sample dried to constant mass in oven at 110 ± 5°C (230 ± 9°F).			
3. Clods of soil broken up using mortar and pestle.			
Note: If this changes the soil composition or the specimen will not easily disperse, use Method A.			
4. Sample spooned into pycnometer using funnel extending below the calibration line.			
5. Any soil particles remaining in the funnel rinsed into the pycnometer.			
Remaining Procedure for both Method A and Method B			

1. Water added until water level is between 1/3 to ½ of the depth of the main body of the pycnometer.			
Note: Kerosene may be used with oven-dried samples with high organics (rare). If so, see D854.			
2. Sample agitated until slurry is formed, rinsing any adhering soil into slurry.			
3. Entrapped air removed by boiling, vacuum, or a combination of both:			
• Boiling at least 2 hours, Slurry is agitated as necessary to prevent soil from sticking to or drying onto the glass above the slurry surface.			
• Vacuum (sufficient to bubble at beginning) at least 2 hours while continuously agitating the pycnometer.			
• Combination of heat and vacuum for at least 1 hour after boiling starts, occasionally agitating.			
4. Using small-diameter flexible tubing with its outlet just below the surface of the slurry, pycnometer filled with deaired water so that a clear water level develops on top of the slurry.			
5. Water level brought to just above or just below the calibration mark.			
Note: If added water becomes cloudy, do not add water above the calibration mark. Add the remaining water the next day.			
6. Sample allowed to cool to approximately room temperature if heat was used.			
7. Pycnometer and all other equipment (bottle of deaired water, thermometer, and eyedropper/pipette) placed into a covered, insulated container overnight to achieve thermal equilibrium.			
8. Pycnometer removed from container, only touching the rim of the pycnometer, and placed on an insulated block.			
9. Water level adjusted to calibration mark by adding water from insulated container or removing water from pycnometer using an eyedropper/pipette or a paper towel.			
10. Pycnometer cleaned and dried, then mass determined to 0.01 g (using the same balance).			
11. Temperature determined to 0.1°C (0.2°F) using the thermally equilibrated thermometer.			
Determination of the Dry Mass of Soil			
1. Mass of tare or pan determined to 0.01 g (using the same balance).			
2. Soil slurry transferred to tare or pan, taking care to transfer all soil.			
3. Material dried to constant mass in oven at 110 ± 5°C (230 ± 9°F) and cooled in a desiccator.			
Note: A desiccator is not required if the tare or pan can be sealed.			
4. Dry mass of solids determined (calculated) to 0.01 g.			
5. Specific gravity calculated to 0.01 based on water at 20°C.			
Signature of P.E. observing OVERALL			

ASTM D1883-21 CBR of Laboratory Compacted Soils	Pass	Fail	N/A
Sample			
1. Sample prepared in accordance with Method C of D698 or D1557.			
• If all material passes ¾ inch sieve, the entire gradation is used.			
• If material is retained on ¾ inch sieve, the plus ¾ inch material is removed and replaced with an equal amount of material passing the ¾ inch sieve and retained on the No. 4 sieve.			
Test Specimens			
Bearing Ratio at Optimum Water Content			
1. Optimum water content established for the material (as described above) by one of the following:			
• Control compaction test conducted with a sufficient number of test specimens to establish the optimum moisture content d in accordance with either D698 or D1557.			
• A previously performed compaction test (D698 or D1557) may be used if the material was prepared in accordance with the above **Sample** process.			
2. For CBR at 100% MDD and OMC, sample (within ±0.5% point of OMC) compacted by D698 or D1557.			
3. For CBR at OMC and some percentage of MDD, 3 specimens (within ±0.5% point of OMC) compacted to specified degree of compaction for each specimen (vary the number of blows/layer for each specimen).			
4. Penetration performed on each specimen.			
Bearing Ratio at Range of Water Contents			
1. Procedure same as that for bearing ratio at OMC, except that each specimen used to develop the compaction curve is penetrated.			
2. Complete water content -unit weight relationship for the 25 blows and 10-blows per layer compactions are developed and each test specimen compaction is penetrated.			
3. If specific unit weight is at or near 100% MDD, compactive effort greater than 56-blows per layer is included.			
Compaction procedures			
1. Mold is clamped to base plate and extension collar attached.			
2. Spacer disk is placed over base plate and filter paper placed on spacer disk.			
3. Soil-water mixtures compacted into the molds using the appropriate method.			
4. Moisture content determined using one of the following:			
• If the compaction process is conducted under a controlled temperature range, 65 to 75°F (18 to 24°C), and the processed material is kept sealed during the compaction process, only one representative water content sample is obtained			
• If the compaction process is being conducted in an uncontrolled environment two water content samples taken, one at the beginning of compaction and another sample of the remaining material after compaction.			
• Water content determined using ASTM D2216 and two values are averaged and do not differ by more than 1.5 percentage points.			
5. For unsoaked samples, water content samples taken in accordance with D698 or D1557.			
6. After compaction, the extension collar is removes and the top is trimmed flush with the top of the mold using a straight edge.			
7. Surface voids patched with smaller size materials.			
8. Base plate and spacer disk removed, and the mass of the mold plus compacted soil is determined.			
9. Filter plate is placed on the base plate and mold with compacted soil is inverted and clamped to the base plate.			
Sample Soaking			
10. Surcharge weights (minimum 10 lbf) placed on perforated plate with adjustable stem lowered on the compacted sample.			

11. Mold and weights immersed in water tank, allowing free access of water to top and bottom of the mold.			
12. Initial swell measurements taken, and specimen allowed to soak for 96 ± 2 hours and water level maintained constant during soaking period.			
Note: A shorter immersion period is permissible for soils that take up water readily if tests show that the shorter period does not affect the results.			
13. Final swell measurements taken at end of immersion period and swell calculated.			
14. Free water removed from top specimen surface and specimen allowed to drain downwards for 15 minutes			
15. Weights, perforated plates, and filter paper removed, and mass of specimen determined and recorded.			
Penetration Test			
16. Annular surcharge weight of 5 lbf placed on top of soil surface and penetration piston seating load not exceeding 10 lbf applied on top of specimen.			
17. Remainder of the surcharge weights equal to that used during the soaking period placed on top of specimen.			
18. Penetration and load gauges set to zero or provisions made to subtract initial values from all subsequently collected data.			
19. Penetration gauge connected to penetrating piston, not to the load frame support bars.			
20. Load on penetration piston applied at a rate of approximately 0.05 in/min.			
21. Load readings recorded at following intervals: • 0.025 in, 0.050 in, 0.075 in, 0.100 in, 0.125 in, 0.150 in, 0.175 in, 0.200 in, 0.300 in, 0.400 in, and 0.500 in.			
22. Maximum load and penetration noted if it occurs for a penetration of less than 0.500 in.			
23. Depth of piston penetration into the soil measured with ruler			
24. If measured depth does not closely match the depth of the penetration gauge, cause was determined, and new sample tested.			
25. If specimen was previously soaked, soil removed from mold and moisture content of top 1-inch layer determined in accordance with ASTM D2216.			
26. If specimen was not previously soaked, water content sample taken in accordance with ASTM D698 or D1557.			
27. Penetration stress calculated and plot of stress versus penetration curve generated.			
28. If needed, zero point adjusted in accordance with Figure 2 of ASTM D1883 and stress values at 0.100 in. and 0.200 in. corrected accordingly.			
29. If maximum stress occurs when penetration is less than 0.200 in, bearing ratios for the maximum stress calculated by interpolating the standard stress.			
30. If the ratio at 0.200 in. is greater than the ratio at 0.100 in., test is rerun.			
31. If check test yield similar results, bearing ratio at 0.200 in. penetration is used.			
Signature of P.E. observing OVERALL			

ASTM D4318-17 Liquid Limit, Plastic Limit, and Plasticity Index of Soils	Pass	Fail	N/A
LIQUID LIMIT			
Sample Preparation			
Wet Preparation - Specimen passing No. 40 Sieve:			
1. Specimen prepared by mixing 150 to 200 g of material thoroughly with distilled water on a glass plate or mixing dish using a spatula.			
2. If Method A is used, water content adjusted to 25-35 blows range.			
3. If Method B is used, water content adjusted to 20-30 blows range.			
4. If plus No. 40 materials encountered during mixing, these particles are removed by hand or pressing the sample through a No. 40 sieve using a piece of rubber sheeting, rubber stopper, or convenient device that will not damage the sieve.			
5. Concretions, shells, or other fragile particles removed by hand or by washing.			
6. Sample placed in a covered storage dish and allowed to cure for 16 hours.			
Wet Preparation – Specimen containing particles retained in the No. 40 Sieve:			
1. Specimen placed in a pan or dish and sufficient water added to cover the specimen			
2. Specimen allowed to soak until all lumps have softened and fines no longer adhere to surfaces of coarse particles.			
3. If specimen contains large amounts of particles retained on the No. 40 sieve:			
• No more than 500 g of the soil-water mixture is poured in the No. 40 sieve or a No. 10 sieve nested on top of the No. 40 sieve placed in a clean pan and washed through the sieve(s).			
• Water added to the pan until the water is ½" above the surface of the No. 40 sieve and slurry is agitated until fine materials are washed from the coarser particles.			
• Plus No. 40 particles discarded.			
4. Water content of the minus No. 40 particles is reduced by one of the following methods:			
• Exposing to air currents at room temperature.			
• Exposing to warm air currents from electric hair dryer.			
• Decanting clear water from surface of suspension.			
• Filtering in a Buchner funnel or using filter candles or draining in a colander or plaster of paris dish,			
5. Water content is adjusted by mixing sample with distilled water on a glass plate using a spatula.			
6. If Method A is used, water content adjusted to 25-35 blows range.			
7. If Method B is used, water content adjusted to 20-30 blows range.			
8. Sample placed in a covered storage dish and allowed to cure for 16 hours.			
Dry Preparation Method			
1. Representative sample that will yield 150 to 200 g of material passing the 425-µm (No. 40) sieve obtained.			
2. Sample dried to a temperature not exceeding 60 ºC			
3. Sample placed in covered dish and allowed to stand for at least 16 hours.			
4. Sample pulverized in a mortar using a rubber-tipped pestle.			
5. Concretions, shells, or other fragile particles removed by hand or by washing.			
6. Materials retained on the No. 40 sieve re-pulverized and re-sieved until most of the fine materials has been disaggregated and plus No. 40 materials consist of individual materials.			
7. After final pulverization, plus No. 40 materials soaked in a small amount of water and transferred to a No. 40 sieve, catching the water and any suspended solids.			
8. Plus No. 40 materials discarded, and suspension mixed with minus No. 40 materials.			
9. Water content adjusted by mixing sample with distilled water on a glass plate using a spatula			
10. If Method A is used, water content adjusted to 25-35 blows range.			
11. If Method B is used, water content adjusted to 20-30 blows range			

12. Sample placed in a covered storage dish and allowed to cure for 16 hours.			
Multipoint Liquid Limit – Method A			
1. Device checked for wear and height-of-drop checked/adjusted.			
2. Sample thoroughly mixed and water content adjusted to 25-35 blow range.			
3. Portion of sample placed in cup and spread with spatula to a maximum depth of approximately 10 mm.			
4. Care taken to eliminate air bubbles from soil pat using as few strokes as possible.			
5. Unused soil in dish covered to retain moisture.			
6. Groove formed using the flat grooving tool.			
Note: Several strokes of the grooving tool may be used. Alternatively, a groove (slightly less than the required size) may be cut using the spatula and then the grooving tool used to bring the groove to the final dimensions.			
7. Tearing along the groove and sliding of the soil pat avoided.			
8. Cup dropped at a rate of 2 drops/second until the groove closes a distance of ½ inch.			
Note: This groove closure must occur between 25 to 35 blows.			
9. While the crank is turned, base of machine is not held with the hand.			
10. Both sides of groove observed to verify that an air bubble did not prematurely cause closure.			
11. Number of blows recorded, and moisture sample obtained.			
• Slice of soil, approximately spatula width, extending from edge to edge, at right angles to the groove, including the portion that flowed together.			
12. Moisture sample placed into tared container (0.01 g) and covered.			
13. Soil remaining in cup returned to dish and remixed.			
14. Cup and grooving tool washed and dried.			
15. Steps 3 through 14 repeated two more times, increasing the moisture content each trial.			
16. Each trial results in blow counts of 25-35, 20-30, and 15-25, respectively, with increasing MC%.			
17. Water content of soil from each trial determined in accordance with D2216.			
18. Curve plotted, and liquid limit represented by the moisture content (rounded to nearest whole number) at 25 blows.			
One-Point Liquid Limit – Method B			
1. Device checked for wear and height-of-drop checked/adjusted.			
2. Sample thoroughly mixed and water content adjusted to 20-30 blow range.			
3. Portion of sample placed in cup and spread with spatula to a maximum depth of approximately 10 mm.			
4. Care taken to eliminate air bubbles from soil pat using as few strokes as possible.			
5. Unused soil in dish covered to retain moisture.			
6. Groove formed using the flat grooving tool.			
Note: Several strokes of the grooving tool may be used. Alternatively, a groove (slightly less than the required size) may be cut using the spatula and then the grooving tool used to bring the groove to the final dimensions.			
7. Tearing along the groove and sliding of the soil pat avoided.			
8. Cup dropped at a rate of 2 drops/second until the groove closes a distance of ½ inch.			
Note: If < 20 or > 30 blows are required, adjust the moisture content of the soil and re-perform.			
9. While the crank is turned, base of machine is not held with the hand			
10. Both sides of groove observed to verify that an air bubble did not prematurely cause closure.			
11. Number of blows recorded, and moisture sample obtained.			

• Slice of soil, approximately spatula width, extending from edge to edge, at right angles to the groove, including the portion that flowed together.			
12. Moisture sample placed into tared container (0.01 g) and covered.			
13. Soil reformed in cup, adding a small amount of material to replace the moisture sample.			
14. Groove formed using the flat grooving tool.			
15. Tearing along the groove and sliding of the soil pat avoided.			
16. Cup dropped at a rate of 2 drops/second until the groove closes a distance of ½ inch.			
• If blow count is within 2 drops of first closure, another moisture sample obtained.			
• If blow count is beyond 2 drops of first closure, soil remixed and test repeated.			
17. Water content of soil from each trial determined in accordance with D2216.			
118. Liquid limit for each trial calculated by one of the following equations:			
• $LL^n = W^n \times (N/25)^{0.121}$			
• $LL^n = k \times W^n$			
• Where: LL^n = one point liquid limit for given trial, % N = number of blows causing closure of the groove for given trial W^n = water content for a given trial, % k = factor given in Table 1 (refer to D4318)			
18. Liquid limit calculated as the average of the two trials, rounded to the nearest whole number.			
19. If the difference between the two trials is > 1% point, test repeated.			
Plastic Limit			
Sample			
1. A 20-g (or more) portion of the liquid limit material selected.			
2. Water content reduced to a point where it can be handled without sticking to hands or equipment.			
Procedure			
1. Small portion (1.5 to 2.0 g) of material worked at a time (do not use large portions).			
2. Small portion formed into an ellipsoidal mass and rolled between hand and the ground glass plate.			
Note: A rolling device may be used. Refer to D4318 for this procedure.			
3. Soil rolled down to a uniform diameter of approximately 1/8 inch.			
4. Soil reformed into an ellipsoidal mass and rolled out again on ground glass plate.			
5. Rate of rolling between 80 to 90 strokes per minute			
6. The rolling and reforming process continued until the soil can no longer be rolled out to a thread of 1/8 inch in diameter.			
7. Portions of crumbled thread gathered and placed into a container of known mass (0.01 g) and covered.			
8. Another small portion (1.5 to 2.0 g) worked in the same manner to reduce water content until the soil can no longer be rolled out to a thread of 1/8 inch in diameter.			
9. Portions of crumbled thread gathered and placed into a container of known mass (0.01 g) and covered.			
10. Procedure repeated until the container has at least 6 g of soil (at the plastic limit).			
11. Procedure repeated until a second container has at least 6 g of soil (at the plastic limit).			
12. Water content of containers of soil determined separately.			
13. The average of the two water contents, rounded to nearest whole number, is the plastic limit.			
14. If the difference between the two water contents is > 1.4 percentage points, test repeated.			
Plasticity Index			
1. Plasticity index calculated as follows: PI = LL - PL			
Signature of P.E. observing OVERALL			

WACEL Soils Laboratory Technician Practical

ASTM D2216-19 Water (Moisture) Content of Soil & Rock by Mass					Pass	Fail	N/A
1. Representative portion of sample obtained and conforms to the following:							
	Method A (MC to ±1%)		Method B (MC to ±0.1%)				
Max. Particle Size (100% Passing)	Specimen Mass	Balance Readability	Specimen Mass	Balance Readability			
3-inch	5 kg	10 g	50 kg	10 g			
1 ½ inch	1 kg	10 g	10 kg	10 g			
¾ inch	250 g	1 g	2.5 kg	1 g			
3/8-inch	50 g	0.1 g	500 g	0.1 g			
No. 4	20 g	0.1 g	100 g	0.1 g			
No. 10	20 g	0.1 g	20 g	0.01 g			
2. Mass of clean, dry container (and lid, if used) determined on a balance having the specified readability of the requirements listed above.							
Note: For specimens having a mass < 200 g, the containers must have close fitting lids, unless a desiccator is used. Specimens >200 g do not require lids or use of a desiccator.							
3. Moist specimen placed container (and lid, if used, secured to container) and mass determined on a balance having the specified readability of the requirements listed above.							
Note: Large test specimens should be broken up and placed in large pans having large surface area.							
4. Container with specimen (and if used, lid removed) placed into oven at 230 ± 9°F (110 ± 10°C) and dried to constant mass.							
5. Container removed from oven (replacing the lid, if necessary) and allowed to cool to a temperature at which it can be handled comfortably and will not affect the balance.							
6. If specimen size is < 200 g and a lid is not used, the container with dry specimen allowed to cool in a desiccator.							
7. Water (moisture) content calculated by the following: MC% = (Mass of Water / Mass of Dry Specimen) x 100							
Signature of P.E. observing				OVERALL			