



## Performance Examination - Soils

### Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer<sup>1</sup> (ASTM D854-14) [AASHTO T 100]

Candidate Name: \_\_\_\_\_ NICET ID: \_\_\_\_\_

Apparatus	Trial 1	Trial 2
<b>Pycnometer</b> Stoppered/stoppered iodine/volumetric flask, capacity at least 250-ml		
<b>Balance</b> Class GP1 (readable to 0.01 g), capacity at least 500 g when using a 250-ml pycnometer OR at least 1,000 g when using a 500-ml pycnometer		
<b>Oven</b> Maintains 110 ± 5 °C		
<b>Thermometric Device</b> Readable to the nearest 0.1 °C (0.2 °F) with a maximum permissible error of 0.5 °C (1 °F). Can be read at immersion depth ranging between 25 mm and 80 mm.		
<b>Soil Drying Apparatus</b> Desiccator of suitable size and contains silica gel or anhydrous calcium sulfate tare pan that can be tightly sealed, for drying back the sample.		
<b>Method of Removing Entrapped Air - One of the Following:</b> <b>Vacuum</b> Absolute pressure less than 13.33 kPa (100 mm Hg or 4 inches Hg) <b>Hot Plate or Bunsen Burner</b> Capable of maintaining a temperature adequate to boil water		
<b>Insulated Container</b> Styrofoam cooler with cover or equivalent container, large enough to hold between 3 and six pycnometers plus a beaker, a water bottle, and a thermometer		
<b>Funnel</b> Non-corrosive smooth surface funnel; Stem extends past the calibration mark on the volumetric flask or stoppered seal on the stoppered flasks. Diameter of stem large enough that soil solids will easily pass through.		
<b>Sieve</b> No. 4 (4.75-mm)		
<b>Distilled Water</b>		

Procedures	Trial 1	Trial 2
<b>Calibration of Pycnometer</b>		
1. Mass of clean and dry pycnometer determined to the nearest 0.01 g.		
2. Determination repeated 5 times.		
3. Average and standard deviation recorded.		
4. Standard deviation less than or equal to 0.02 g.		
5. Deaired water added to above or below calibration mark.		
6. Pycnometer placed in covered insulated container, along with thermometer, stopper (if stoppered pycnometer is used), deaired water in a bottle or beaker along with eyedropper or pipette.		
7. Pycnometer allowed to come to thermal equilibrium for at least 3 hours.		
8. Pycnometer placed back in insulated container and water level adjusted in each pycnometer.		

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Procedures (continued)	Trial 1	Trial 2
9. Pycnometer allowed to thermally equilibrate for at least 3 hours.		
10. Steps repeated to obtain 5 measurements for each pycnometer.		
11. Determine volume using the following formula:  $V_p = \frac{(M_{pw,c} - M_p)}{\rho_{w,c}}$ $M_{pw,c}$ = mass of the pycnometer and water at the calibration temperature, g $M_p$ = average mass of the dry pycnometer at calibration, g $\rho_{w,c}$ = mass density of water at the calibration temperature, g/ml (Table 2 in standard)		
12. Average and standard deviation of the five-volume determinations calculated.		
13. Standard deviation (rounded to 2 decimal places) less than or equal to 0.05 ml.		
14. If standard deviation is larger than 0.05 ml, procedure revised until standard deviation is less than or equal to 0.05 ml.		
<b>Sample Preparation:</b>		
1. Passes No. 4 (4.75-mm) sieve.		
2. Mass at least 35 g (No. 4) for 250-ml flask or at least 50 g for a 500-ml flask (depending on soil type and pycnometer size referenced in the table below).		

Soil Type	Specimen Dry Mass (g) When Using 250ml Pycnometer	Specimen Dry Mass (g) When Using 500ml Pycnometer
SP, SP-SM	60 ± 10	100 ± 10
SP-SC, SM, SC	45 ± 10	75 ± 10
Silt or Clay	35 ± 10	50 ± 10

Method A (Moist Specimens)		
1. Mass of pycnometer verified that it is within 0.06 g of the average calibrated mass, using same balance that was used for calibration.		
2. If not, pycnometer re-calibrated.		
3. Water content determined according to D2216.		
4. Using this water content, range of wet masses calculated that will yield enough dry material for the specific gravity specimen according to Section 7.1 of standard.		
5. Specimen obtained within this range and not sampled to obtain exact predetermined mass.		
6. Water amount of 100 ml added to soil.		
7. Soil dispersed using blender or equivalent device.		

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Procedures (continued)	Trial 1	Trial 2
8. Prepared slurry poured into pycnometer, using funnel.		
9. Material remaining on the funnel rinsed into pycnometer.		
<b>Method B (Oven-Dried Specimens)</b>		
1. Mass of pycnometer verified that it is within 0.06 g of the average calibrated mass, using same balance that was used for calibration.		
2. Sample dried to constant mass in oven at 110 ± 5 °C		
3. Soil solids spooned into pycnometer using funnel.		
4. Distilled water added until the water level is between 1/3 and 1/2 of the depth of the main body of the pycnometer.		
5. Water agitated until slurry is formed.		
<b>Entrapped Air Removed by One of the Following</b>		
1. Boiling for at least 2 hours while occasionally agitating the pycnometer.		
2. Vacuum for at least 2 hours (at < 100 mm Hg absolute) while continually agitating the pycnometer.		
3. Boil and vacuum at least 1 hour after initiation of boiling while occasionally rolling pycnometer.		
4. Place in warm water bath (not more than 40 °C) while applying vacuum.		
5. Water level in bath slightly below the water level in the pycnometer.		
6. Deaired water added to above or below calibration mark using small diameter tubing or pycnometer.		
7. Filling tube so that clear water layer develops over top of slurry.		
8. If heat was used, specimen allowed to cool to room temperature.		
9. Pycnometer, thermometer, deaired water (in a bottle or beaker), and an eyedropper or pipette.		
10. Placed in insulated container.		
11. Allowed to achieve thermal equilibrium overnight.		
12. Pycnometer placed on an insulated block (or work performed in container).		
13. Pycnometer: water level adjusted to calibration mark using water from insulated container or stoppered flask		
14. Stoppered Flask: stopper placed in bottle while removing excess water with eyedropper.		
15. Rim dried using paper towel.		
16. Outside of pycnometer (and inside of stem, if volumetric flask is used) cleaned and dried.		
17. Pycnometer and contents weighed to nearest 0.01 g.		

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Procedures (continued)	Trial 1	Trial 2
18. Temperature of contents measured to nearest 0.1 °C using the thermally equilibrated thermometer.		
19. Inserting to appropriate depth of immersion.		
20. Soil slurry transferred to pan, contents dried at 110 ± 5°C and cooled in desiccator.		
21. Pan and contents weighed to nearest 0.01 g.		
22. Specific gravity value calculated based on water at 20 °C (multiply by K) (unless otherwise specified), using the following formula: $G_{20^{\circ}C} = K \cdot G_t$ K = the temperature coefficient given in Table 2 in the standard		

First Attempt: Pass: \_\_\_\_\_ Fail: \_\_\_\_\_ Second Attempt: Pass: \_\_\_\_\_ Fail: \_\_\_\_\_

Exam Administration: Remote \_\_\_\_\_ In-Person \_\_\_\_\_

Comments:

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Examiner Name: \_\_\_\_\_ Examiner Signature: \_\_\_\_\_ Date: \_\_\_\_\_