Example Calculations

Mechanical Analysis

The below data are for a mechanical analysis by the pipette method in which a 40.80 g of air-dry soil were dispersed in 1000 mL of water and two 50 mL aliquots taken. The air-dry moisture content of the soil was 2 % (0.02). What are the percents sand, silt and clay of the sample?

Mass Dish 1	= 50.00 g
Mass Dish 1 + Soil Residue 1	= 51.20 g
Mass Dish 2	= 52.00 g
Mass Dish 2 + Soil Residue 2	= 52.40 g

How to do it

The oven-dry mass equivalent of the air-dry soil was

$m_{oven\text{-}dry}$ = 40.80 / (1 + 0.02) = 40.00 g

The total mass of silt + clay was

$m_{silt+clay}$ = 1.20 g x (1000 mL / 50 mL) = 24.00 g

The total mass of clay was

m_{clay} = 0.40 g x (1000 mL / 50 mL) = 8.00 g

Therefore,

% clay = [8.00 g / 40.00 g] x 100 % = 20 %

% silt + clay = [24.00 g / 40.00 g] x 100 % = 60 %

% silt = 60 % - 20 % = 40 %

% sand = 100 % - 60 % = 40 %

Particle Density

The below data are for determination of particle density. Calculate the particle density.

Mass of picnometer	20.00 g
Mass of picnometer + air-dry soil	40.80
Gravimetric water content of the air-dry soil	0.04
Mass of picnometer + soil + water (picnometer filled with soil + water)	52.42 g
Mass of picnometer + water (picnometer filled with water)	40.00 g

How to do it

The oven-dry mass equivalent of the air-dry soil was

$m_{oven\text{-}dry}$ = 20.80 / (1 + 0.04) = 20.00 g

The volume of the picnometer filled with water when it also contained soil was

V_{water} = [52.42 g_{total} – 20.00 g_{solids} – 20.00 $g_{picnometer}$] / 1.00 g mL^{-1} = 12.42 mL

The total volume of the picnometer was

V_{total} = [40.00 g – 20.00 g] / 1.00 g mL^{-1} = 20.00 mL

Therefore, the volume of soil solids was

V_{solids} = 20.00 mL – 12.42 mL = 7.58 mL

Accordingly, the particle density of the soil was

ρ_S = 20.00 g / 7.58 mL = 2.64 g mL^{-1} or 2.64 g cm^{-3}

Bulk Density

A 100 cm^3 sample of field-moist soil weighed 180 g. After drying at 105 ^oC for 24 h, it weighed 150 g.

What was the bulk density of the soil?

How to do it

ρ_B = 150 g / 100 cm^3 = 1.50 g cm^{-3}

What were the gravimetric and volumetric water contents of the field-moist soil?

How to do it

GW = [180 g – 150g] / 150 g = 0.20

VW = {[180 g – 150 g] / 1.00 g cm^{-3}} / 100 cm^3 = 0.30

Assuming a particle density of 2.60 g, what was the porosity of the soil? Also, what fraction of the pore space was air-filled?

How to do it

Porosity = 1 – 1.50 g cm^{-3} / 2.60 g cm^{-3} = 0.42

Air-filled porosity = total porosity – VW = 0.42 – 0.30 = 0.12

Thus, the fraction of the total pore space filled with air was 0.12 / 0.42 = 0.29

Hydraulic Conductivity

You determine the saturated hydraulic conductivity of two soils, X and Y, under the different conditions given below.

	X	Y
Cross sectional area, A	10 cm^2	80 cm^2
Depth of soil, L	10 cm	5 cm
Constant depth of water, D	10 cm	15 cm
Average discharge rate, Q	10 cm^3 h^{-1}	16 cm^3 h^{-1}

What are the saturated hydraulic conductivities, K, of soils A and B? Also, if one soil is a silt loam and the other is a clay loam, which is which?

How to do it

From Darcy's Law, $Q = KA\{[D + L] / L\}$,

$K = Q / (A\{[D + L] / L\})$

$K_{soilX} = 10\ cm^3\ h^{-1} / (10\ cm^2\ \{[10\ cm + 10\ cm] / 10\ cm\}) = 0.50\ cm\ h^{-1}$

$K_{soilY} = 16\ cm^3\ h^{-1} / (80\ cm^2\ \{[15\ cm + 5\ cm] / 5\ cm\}) = 0.05\ cm\ h^{-1}$

Thus, based on conductivities, soil X would be the silt loam and soil Y, the clay loam.

Air- and Water-Filled Pore Space (Degree of Water Saturation)

Continuing with the above, if 133.32 g of air-dry soil X were used, the gravimetric water content of the air-dry soil is 1 %, its particle density is 2.64 g cm^{-3}, and the total wet mass of the soil was 177.00 g, what fraction of the pore space was filled with water?

How to do it

There were 177.00 g – [133.32 g / (1 + 0.01)] = 177.00 g – 132.00 g = 45.00 g_{water} (or 45.00 cm^3) in the wet soil.

The maximum volume of water that the sample could have contained is the total pore space, i.e., porosity x total volume,

$(1 - \rho_B / \rho_S) \times V_T = [1 - (132.00 / 264.00)] \times 100.00\ cm^3 = 50.00\ cm^3$ water.

So, only 45.00 / 50.00 = 0.90 of the total pore space was filled with water.