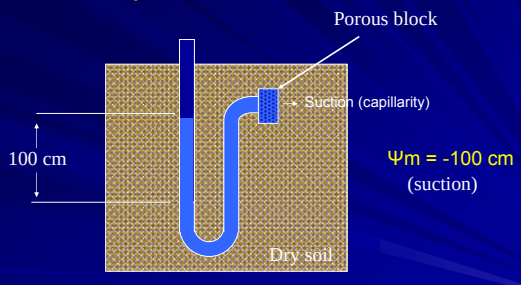
Characterizing Soil Water

Gravitational Potential

1. Gravitational potential energy is due only to the height of an object (water) above some reference point.
2. Gravitational potential energy is independent of soil properties.

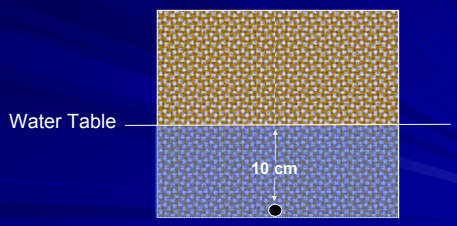
Capillary Potential



Vertical distance between the surface of the water and the porous cup.

Submergence Potential (ψ_s)

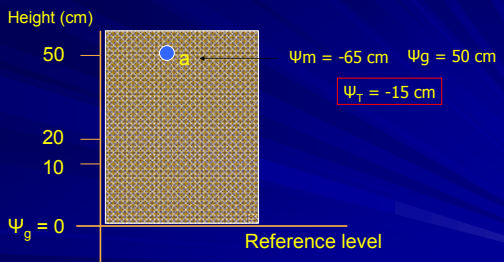
Equal to the distance below a free water surface

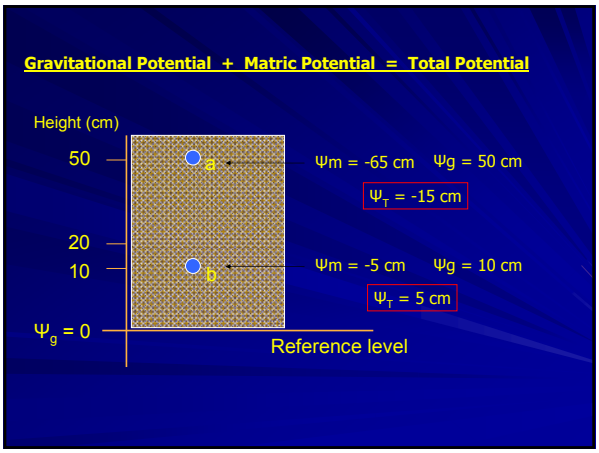


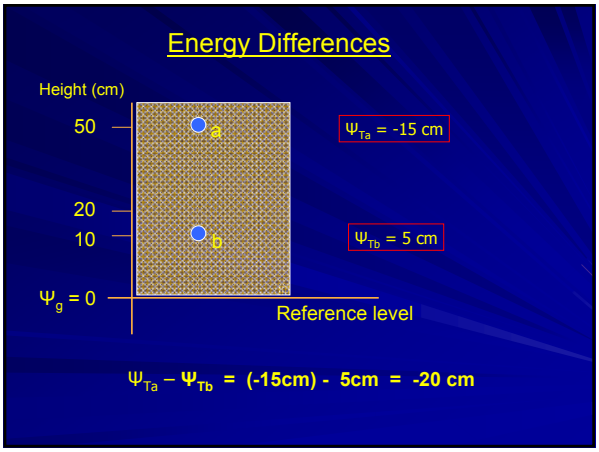
Total Potential Energy is the sum of the gravitational, submergence, and matric potential energies.

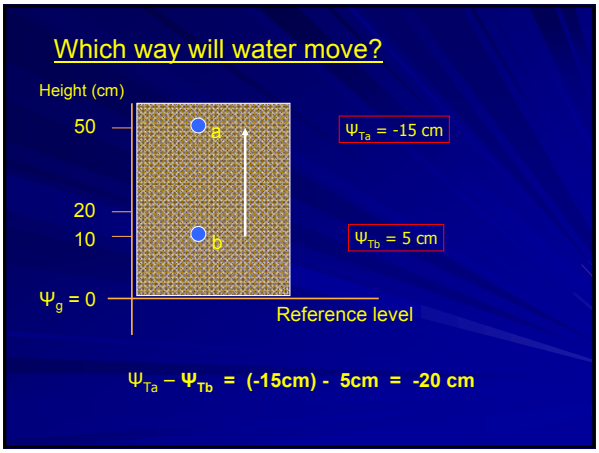
$$\Psi_g + \psi_m + \psi_s = \psi_T$$

Gravitational Potential + Matric Potential = Total Potential




Gravitational Potential + Matric Potential = Total Potential
Height (cm)
50
20
10
Ψg = 0
a
b
Ψm = -65 cm Ψg = 50 cm
ΨT = -15 cm
Ψm = -5 cm Ψg = 10 cm
ΨT = 5 cm
Reference level


Energy Differences
Height (cm)
50
20
10
Ψg = 0
a
b
ΨTa = -15 cm
ΨTb = 5 cm
Reference level
ΨTa – ΨTb = (-15cm) - 5cm = -20 cm


Which way will water move?
Height (cm)
50
20
10
Ψg = 0
a
b
ΨTa = -15 cm
ΨTb = 5 cm
Reference level
ΨTa – ΨTb = (-15cm) - 5cm = -20 cm

Determining the Direction of Water Flow

1. Sum the individual potentials at each point
2. Determine if there is a difference in potential

3. Point A – Point B

4. Water moves from high to low energy
   (look for the higher energy)

Positive → Point **A** to Point **B**

Negative → Point **B** to Point **A**

Characterizing Soil Moisture Status

Water Content Based

Soil Water Content

Water content by weight

$$\frac{\text{Moist weight} - \text{Dry weight}}{\text{Dry weight}} = \frac{\text{Water weight}}{\text{Dry weight}}$$

Multiply by 100 to yield % water by weight

Water content by Volume

$$\frac{\text{Volume Water}}{\text{Volume Soil}}$$

Multiply by 100 to yield % water by volume

Example:

You collect a 200 cm^3 soil sample. Its moist weight is 150 g. After drying, the dry weight is 100 g.

Gravimetric water content:

$$\frac{\text{Moist weight} - \text{Dry weight}}{\text{Dry weight}} = \frac{\text{Water weight}}{\text{Dry weight}}$$

$$\frac{150\text{ g} - 100\text{g}}{100\text{g}} = \frac{50\text{ g}}{100\text{g}} = 0.5 \text{ or } 50\%$$

Example:

You collect a 200 cm^3 soil sample. Its moist weight is 150 g. After drying the dry weight is 100 g.

Volumetric water content:

$$\frac{\text{Volume Water}}{\text{Volume Soil}}$$

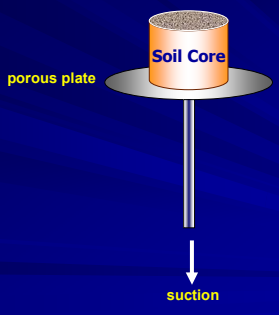
$$\frac{150\text{ g} - 100\text{g}}{200\text{ cm}^3} = \frac{50\text{ g}}{200\text{ cm}^3} = \frac{50\text{ cm}^3\text{ water}}{200\text{ cm}^3\text{ soil}} = 0.25 \text{ or } 25\%$$

Characterizing Soil Moisture Status

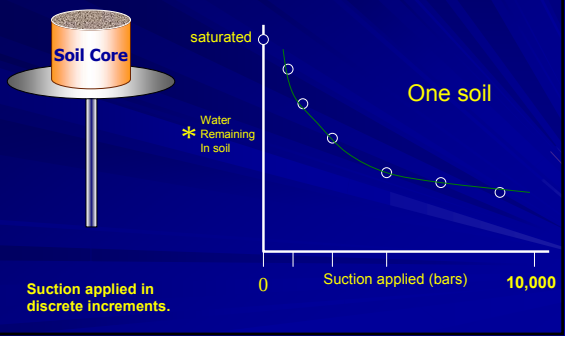
Energy-Based

Relating water content and matric potential (suction)

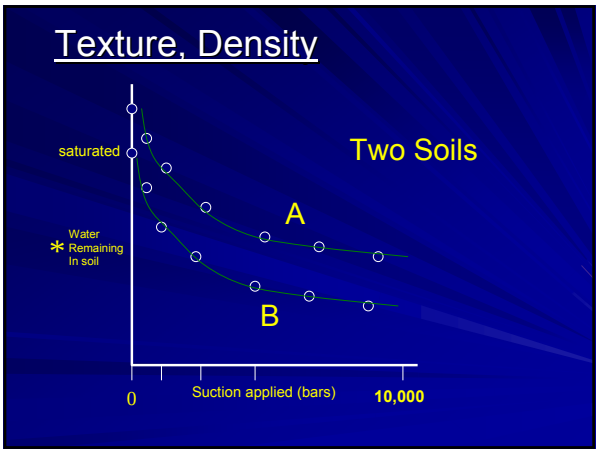
Characterizing Soil Water



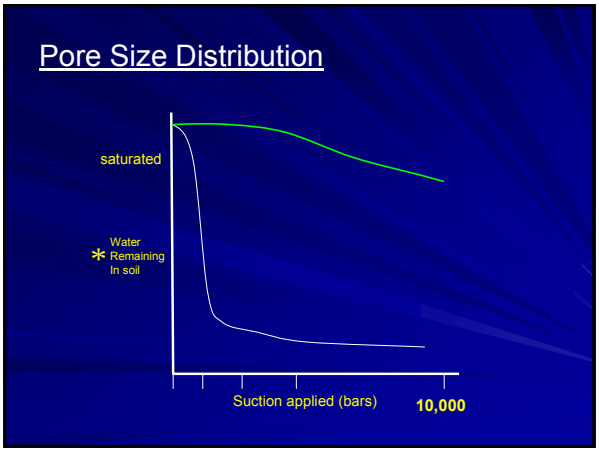
Characterizing Soil Water

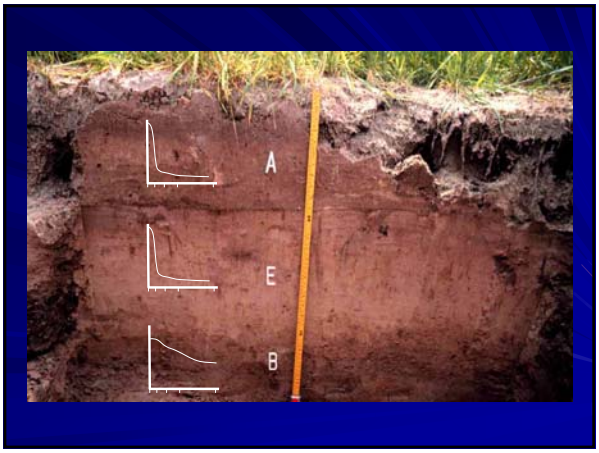


Texture, Density



Pore Size Distribution





Soil Moisture Status

Soil Moisture Status

Saturation: Water content of soil when all pores are filled
Suction equivalent: 0 bars
0 KPa
0 cm water

Field Capacity: Water content of soil after drainage from saturation by gravity
Suction equivalent: -0.33 bars (or –0.10 bars)
- 33 KPa
- 330 cm water

Permanent Wilting point: Water can no longer be accessed by plants
Suction equivalent: -15 bars
-1500 KPa
- 15,000 cm water

Plant Available water: Field Capacity - PWP

Energy and Texture

Smaller particles and pores ↓

Texture	Water Content (%) at Field Capacity	Water Content (%) at Perm. Wilting Point
Sandy Loam	17	9
Loam	24	11
Clay	36	20
Heavy Clay	57	28

Practical Measures