1. An undisturbed sample of clay has a wet mass of 100 kg, a dry mass of 93 kg, and a total volume of 0.0491 m³. The solids have a specific gravity of 2.65. The void ratio is most nearly

(A) 0.31
(B) 0.40
(C) 0.61
(D) 1.0
Question 1: A 9.61-cm$^3$ sample of soil weighs 19 g. After being dried in an oven, its weight is 17.5 g. If $G_s = 2.67$, find:

a) Starting unit weight, $\gamma_m$

b) Dry unit weight, $\gamma_d$

c) Water content, $w_c$

d) Void ratio, $e$

e) Porosity, $n$

f) Degree of saturation, $S$
2. A saturated sample of undisturbed clay has a wet mass of 318 kg and a dry mass of 204 kg. The total volume of the sample is 0.193 m$^3$. Most nearly, what is the specific gravity of the soil solids?

(A) 2.4
(B) 2.6
(C) 2.7
(D) 2.9
3. A soil’s grain-size distribution curve is as shown. The effective grain size is 0.19 mm, and $D_{60}$ is 0.49 mm.

The coefficient of gradation is most nearly
(A) 0.17
(B) 0.44
(C) 1.6
(D) 3.0
4. A soil has the following characteristics.

- percentage fines, $F$ 69%
- liquid limit 72
- plastic limit 48

Using the Unified Soil Classification System, what is the classification of the soil?

(A) GW
(B) ML
(C) MH
(D) CH

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5. A sample of soil has the following characteristics.

- % passing no. 40 screen 95
- % passing no. 200 screen 57
- liquid limit 37
- plastic limit 18

What is the AASHTO group index number?

(A) 5
(B) 6
(C) 7
(D) 8
9. The specific gravity of the soil solids in a given sample is 3.11. The porosity of the soil is 27%. What is most nearly the effective unit weight of the soil sample?

(A) 96 lbf/ft³  
(B) 110 lbf/ft³  
(C) 130 lbf/ft³  
(D) 160 lbf/ft³

10. The total unit weight of a given soil is 120 lbf/ft³. The soil has a porosity of 0.26 and is 100% saturated. The dry unit weight of the soil is most nearly

(A) 58 lbf/ft³  
(B) 86 lbf/ft³  
(C) 100 lbf/ft³  
(D) 120 lbf/ft³
11. A 1 L field sample contains soil with an initial weight of 30 N. The soil is dried completely in an oven at 100°C. The weight of the soil after drying is 22 N. The maximum volume of the dry soil sample is 1.5 L, and the minimum volume is 0.60 L. The relative density of the soil is most nearly

(A) 37%
(B) 56%
(C) 62%
(D) 75%

12. An undisturbed 10 cm wide x 10 cm long x 5 cm high sample of clay has a dry weight of 32 kg. The dried soil sample is compacted into a minimum volume, a rectangular prism 8.5 cm wide x 9 cm high x 3.5 cm high. What is most nearly the relative compaction of the soil sample?

(A) 33%
(B) 45%
(C) 49%
(D) 54%
3. A soil sample has the particle size distribution shown.

What is most nearly the coefficient of uniformity of the soil?

(A) 0.4
(B) 0.8
(C) 3
(D) 6
14. A soil has a void ratio of 0.41. The unit weight of the solids is 33 kN/m$^3$. What is most nearly the saturated unit weight of the soil?

(A) 26 kN/m$^3$
(B) 29 kN/m$^3$
(C) 33 kN/m$^3$
(D) 37 kN/m$^3$

15. The water content of a saturated soil sample is 26%, and the void ratio is 0.57. The unit weight of the solids is most nearly

(A) 4.5 kN/m$^3$
(B) 9.8 kN/m$^3$
(C) 22 kN/m$^3$
(D) 28 kN/m$^3$
16. An undisturbed soil sample with a volume of 0.30 ft$^3$ is weighed in a 0.2 lbf pan. The combined weight of the soil sample and the pan is 40.5 lbf. The soil is then completely dried in an oven at 100°C. After drying, the combined weight of the soil and the pan is 35.2 lbf. The unit weight of the soil solids is 194 lbf/ft$^3$. What is most nearly the volume of the air in the original soil sample?

(A) 0.010 ft$^3$
(B) 0.035 ft$^3$
(C) 0.10 ft$^3$
(D) 0.21 ft$^3$

17. A 0.10 m$^3$ saturated soil sample is weighed in a 34 kg pan. The combined weight of the soil and the pan is 450 kg. The soil sample is completely dried in an oven. After drying, the combined weight of the soil sample and the pan is 385 kg. What is most nearly the unit weight of the saturated soil sample?

(A) 27 kN/m$^3$
(B) 34 kN/m$^3$
(C) 41 kN/m$^3$
(D) 44 kN/m$^3$
18. The results of a sieve analysis are shown.

Most nearly, what is the coefficient of curvature of the soil sample?

(A) 0.3
(B) 0.7
(C) 2
(D) 3
For a flow net shown in the following figure, determine head loss at points A, B, and C. The structure is approximately 100 feet long. Determine the flow rate in ft$^3$/min through the permeable layer. Assume hydraulic conductivity, $k = 1.64 \times 10^{-4}$ ft/min.
Find the change in void ratio ($e$) after layer of sand fill is placed normally consolidated clay layer (N.C. clay)

Liquid limit (LL) = 45

Place sand fill on surface. Vertical stress increase of $\sigma = 800$ kPa.

How much will the void ratio ($e$) at point $P$ decrease due to the stress increase?
It is estimated that the total settlement ($s_c$) is 2″.

The coefficient of consolidation ($c_v$) is 0.03 ft$^2$/day.

The time required for 50% consolidation of the total settlement to occur is?
If a two way drainage system was suddenly blocked on one side, how would that affect the drainage time?

- **SAND**
- **SOIL**
- **SAND**

Presented as a two way drainage:

- **SAND**
- **SOIL**

Presented as a one way drainage:

- **SAND**
- **SOIL**

Path blocked
FIND SHEAR STRESS IF ORIENTATION ANGLE IS 35° AND A LOAD OF 200 lb IS PLACED ON A 3m x 3m BOX. FIND SHEAR STRESS AT FAILURE.

GIVEN:

\[ \phi = 35° \]

\[ A = 3m \times 3m = 9 \text{ m}^2 \]

\[ F = 200 \text{ lb} \]
CALCULATE THE ACTIVE EARTH PRESSURE AT THE BASE OF THE WALL.

FIND TOTAL EARTH FORCE.

CALCULATE THE OVERTURNING MOMENT DUE TO THE ACTIVE EARTH PRESSURE.
DETERMINE ULTIMATE BEARING CAPACITY FOR FOOTING.

GIVEN:

- \( D_t = 3 \text{ ft} \)
- \( y' = 125 \text{ kip/ft}^3 \)
- \( c = 1200 \text{ kip/ft}^2 \)
- \( \phi = 0 \)
- \( N_c = 5.14 \)
- \( N_b = 1 \)
- \( N_t = 0 \)

FACTOR OF SAFETY = 3
1. A soil has an angle of internal friction of 25°. What is most nearly the Rankine active earth pressure coefficient?
   (A) 0.34
   (B) 0.41
   (C) 0.52
   (D) 0.58

2. A soil has an angle of internal friction of 25°. What is most nearly the Rankine passive earth pressure coefficient?
   (A) 0.59
   (B) 1.6
   (C) 2.5
   (D) 4.1

3. A retaining wall supports soil with a vertical height of 2 m. The soil has an angle of internal friction of 32° and a specific (unit) weight of 25 kN/m³. Most nearly, what is the active lateral soil resultant?
   (A) 5.0 kN/m
   (B) 15 kN/m
   (C) 46 kN/m
   (D) 92 kN/m
6. An excavation is made in uniform soil. The available shearing resistance along an assumed slip surface is 1350 kN/m. The mobilized shear force along the slip surface is 465 kN/m. The slip surface makes an angle of 45° with respect to the horizontal. What is most nearly the factor of safety against slope instability?

(A) 1.5  
(B) 2.1  
(C) 2.9  
(D) 4.1

7. A retaining wall extends 3 m from the top of bedrock to the ground surface. The soil is cohesionless and has the properties shown.

Using Rankine theory, the total active earth pressure per unit width of retaining wall is most nearly

(A) 15 kN/m  
(B) 22 kN/m  
(C) 44 kN/m  
(D) 82 kN/m
VERTICAL STRESS

Effective stress at B

Pore press. at C

Total stress at C

Effective vertical stress at C

\[ k_w = 9.81 \text{ kN/m}^2 \]

Sand
\[ \gamma = 18 \text{ kN/m}^3 \]

Clay
\[ \gamma = 20 \text{ kN/m}^3 \]
Surcharge = 1000 lb/ft²

\[ \gamma_{sat} = 110 \text{ lb/ft}^3 \]

2 ft

8 ft

Sand

Normally consolidated clay

\[ \gamma_{sat} = 110 \text{ lb/ft}^3 \]

Calculate initial effective stress at center of clay layer
clay layer before application of load

Effective stress at center of clay layer after
application of load:
4. An excavated slope in uniform soil is shown. The specific weight is 14 kN/m$^3$, the cohesion is 15 kPa, and the angle of internal friction is 15°.

[Diagram of an excavated slope with dimensions and angles labeled.]

What is most nearly the available shearing resistance along the assumed failure plane?

(A) 550 kN/m
(B) 600 kN/m
(C) 680 kN/m
(D) 940 kN/m

5. A uniform soil slope has a planar slip surface length of 100 m. The soil’s cohesion is 5 kPa, and the angle of internal friction is 40°. The angle that the assumed failure plane makes with respect to the horizontal is 25°. The weight of the soil mound above the assumed failure plane is 2000 kN/m. What is most nearly the mobilized shear force along the assumed failure plane?

(A) 500 kN/m
(B) 850 kN/m
(C) 1500 kN/m
(D) 2000 kN/m
Find the factor of safety for the instable slope.

- $C = 500 \text{ psf}$
- $\gamma = 120 \text{ pcf}$
- $\alpha = 15 \text{ degrees}$
- $\beta = 30 \text{ degrees}$
- $\theta = 26.6 \text{ degrees}$
A 25’ high slope is designed as part of a highway project as shown below. Assuming a wedge type failure occurs, calculate the factor of safety.

\[ \gamma_c = 128 \text{ pcf} \]
\[ \phi = 32^\circ \]
\[ C \text{ (undrained shear strength)} = 65 \text{ psf} \]