

# NCEES

## PE-Civil-Geotechnical

### 1224 PE Civil Geotechnical

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## Question: 1

A geotechnical engineer is conducting a groundwater exploration program using a combination of piezometers and observation wells. The groundwater flow direction is determined to be towards a nearby river. If the hydraulic gradient is measured at 0.05 and the hydraulic conductivity of the soil is 10 m/day, what is the estimated seepage velocity of the groundwater in the soil?

- A. 0.5 m/day
- B. 2 m/day
- C. 5 m/day
- D. 10 m/day

**Answer: A**

Explanation:

The seepage velocity ( $v$ ) can be calculated using

Darcy's law:  $v = K \cdot i$ , where  $K$  is the hydraulic conductivity and  $i$  is the hydraulic gradient. Thus,  $v = 10 \text{ m/day} \cdot 0.05 = 0.5 \text{ m/day}$ .

## Question: 2

During a site investigation, a soil sample is retrieved from a depth of 10 m below ground level. The soil is classified as silty sand (SM) based on the Unified Soil Classification System (USCS). If the sample has a moisture content of 12%, what is the specific gravity of the solids if the dry density of the soil is 18 kN/m<sup>3</sup>?

- A. 1.65
- B. 1.70
- C. 1.75
- D. 1.80

**Answer: D**

Explanation:

The specific gravity ( $G$ ) can be calculated using

the formula  $G = \frac{\gamma_d}{\gamma_w}$ , where  $\gamma_d$  is the dry density, and  $\gamma_w$  is the unit weight of water (approximately  $9.81 \text{ kN/m}^3$ ). Thus,  $G = \frac{18 \text{ kN/m}^3}{9.81 \text{ kN/m}^3} \approx 1.83$ .

### Question: 3

A laboratory consolidation test is performed on a clay sample, and the results indicate an initial void ratio of 1.2. After applying a vertical stress of 100 kPa, the void ratio decreases to 0.9. What is the coefficient of volume change ( $m_v$ ) for this clay if the applied stress is uniform and the test duration is sufficient for primary consolidation?

- A. 0.003
- B. 0.02
- C. 0.03
- D. 0.05

**Answer: A**

Explanation:

The coefficient of volume change can be

calculated using the formula  $m_v = \frac{e_0 - e}{\Delta\sigma}$ , where  $e_0$  is the initial void ratio,  $e$  is the final void ratio, and  $\Delta\sigma$  is the change in stress. Thus,  $m_v = \frac{1.2 - 0.9}{100} = 0.003$ .

### Question: 4

A site has been found to have contaminated soil containing heavy metals. During a geotechnical assessment, the engineer decides to perform a series of chemical tests to determine the leachability of the contaminants. Which of the following tests is most effective in assessing the potential for contaminants to migrate through groundwater?

- A. pH test
- B. Toxicity Characteristic Leaching Procedure (TCLP)
- C. Standard Proctor Test
- D. Atterberg Limits Test

**Answer: B**

Explanation:

The Toxicity Characteristic Leaching Procedure (TCLP) is designed specifically to evaluate the leachability of contaminants from soil into groundwater, making it the most relevant test for this scenario.

### Question: 5

A geotechnical engineer is evaluating the electrical resistivity of a clay soil to assess its suitability for a buried pipeline installation. If the resistivity of the soil is found to be 50 ohm-m, what can be inferred about the soil's ion concentration and potential for corrosion of the pipeline?

- A. High ion concentration, low corrosion potential
- B. Low ion concentration, high corrosion potential
- C. High ion concentration, high corrosion potential
- D. Low ion concentration, low corrosion potential

**Answer: C**

Explanation:

A low electrical resistivity value (50 ohm-m) indicates a high concentration of ions in the soil, which can lead to increased corrosion potential for buried pipelines.

### Question: 6

In a thermal conductivity test on a saturated sand sample, the thermal conductivity is measured at 1.5 W/m•K. If the temperature gradient across the sample is 10 K over a thickness of 0.5 m, what is the heat flux through the sample?

- A. 10 W/m<sup>2</sup>
- B. 15 W/m<sup>2</sup>
- C. 20 W/m<sup>2</sup>
- D. 30 W/m<sup>2</sup>

**Answer: D**

Explanation:

The heat flux ( $q$ ) can be calculated using Fourier's

law:  $q = k \cdot \frac{\Delta T}{L}$ , where  $k$  is thermal conductivity,  $\Delta T$  is the temperature difference, and  $L$  is the thickness. Thus,  $q = 1.5 \cdot \frac{10}{0.5} = 30 \text{ W/m}^2$ .

### Question: 7

During a laboratory test, a soil sample exhibits a plasticity index of 18 and a liquid limit of 40. What is the soil's classification based on the Unified Soil Classification System (USCS)?

- A. CL

- B. CH
- C. ML
- D. MH

**Answer: A**

Explanation:

Based on the plasticity index (PI) and liquid limit (LL), the soil is classified as CL (Clay of Low Plasticity) since it falls within the range for clay with a liquid limit greater than 20 and a plasticity index less than 25.

### Question: 8

A geotechnical investigation reveals that a site contains a layer of compacted fill overlying soft clay. The engineer needs to calculate the effective stress at a depth of 5 m below the fill. If the fill has a unit weight of  $18 \text{ kN/m}^3$  and the water table is at 2 m depth, what is the effective stress at the 5 m depth?

- A. 2.30 kPa
- B. 5.0 kPa
- C. 60.5 kPa
- D. 14.0 kPa

**Answer: C**

Explanation:

The effective stress ( $\sigma'$ ) can be calculated as

$\sigma' = \sigma - u$ , where  $\sigma$  is total stress and  $u$  is pore water pressure. Total stress at 5 m is  $18 \cdot 5 = 90 \text{ kPa}$ , and pore water pressure at 3 m (5 m - 2 m) is  $9.81 \cdot 3 = 29.43 \text{ kPa}$ . Thus,  $\sigma' = 90 - 29.43 = 60.57 \text{ kPa}$ .

### Question: 9

In performing a consolidation test, a soil specimen is subjected to a series of loading increments. If the final void ratio after consolidation is 0.5 and the initial void ratio was 1.0, what is the coefficient of consolidation ( $C_v$ ) if the test duration was 24 hours and the drainage path length was 0.1 m?

- A.  $0.01 \text{ m}^2/\text{yr}$
- B.  $0.1 \text{ m}^2/\text{yr}$
- C.  $0.5 \text{ m}^2/\text{yr}$
- D.  $1.0 \text{ m}^2/\text{yr}$

**Answer: C**

Explanation:

The coefficient of consolidation can be estimated

using  $C_v = \frac{t \cdot d^2}{H}$ , where  $t$  is time in seconds,  $d$  is drainage path length, and  $H$  is the change in void ratio. Thus, converting 24 hours to seconds and substituting gives  $C_v \approx 0.5 \text{ m}^2/\text{yr}$ .

### Question: 10

A soil sample has a moisture content of 15% and a specific gravity of solids of 2.68. If the sample's bulk density is measured at  $19 \text{ kN/m}^3$ , what is the degree of saturation of the soil?

- A. 30%
- B. 40%
- C. 50%
- D. 60%

**Answer: B**

Explanation:

The degree of saturation (S) can be calculated

using the equation  $S = \frac{w \cdot G}{\gamma_w}$ , where  $w$  is moisture content,  $G$  is specific gravity, and  $\gamma_w$  is the unit weight of water. Thus,  
 $S = \frac{0.15 \cdot 2.68}{9.81} \approx 0.41$  or 41%.

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