Q1. A soil has bulk density of 17.6 KN/m³ and water content 10%. if void ratio remains constant then the bulk density for water content of 20% will be
(a) 16.13 KN/m³
(b) 19.20 KN/m³
(c) 19.36 KN/m³
(d) 17.6 KN/m³

Q2. A fully saturated soil has a water content of 200 percent. If G = 2.6, the void ratio is:
(a) 1.3
(b) 2.6
(c) 5.2
(d) None of these above

Q3. A sand deposit has a porosity of 1/3 and its specific gravity is 2.5. The critical hydraulic gradient to cause sand boiling in the stratum will be
(a) 1.5
(b) 1.25
(c) 1.0
(d) 0.75

Q4. Void ratio of an undisturbed sample of soil is 0.6. the values of maximum and minimum possible void ratio are found as 0.8 and 0.4, respectively. The relative density in percentage, for this soil sample will be
(a) 25
(b) 50
(c) 75
(d) 90

Q5. The total unit weight of soil is 22 kN/m³. the specific gravity of soil particles is 2.67 and the water content of the soil is 10%. The dry unit weight would be
(a) 20 kN/m³
(b) 2 kN/m³
(c) 0.02 kN/m³
(d) 200 kN/m³

Q6. Relationship between dry density $\gamma_d{}'$ percentage air voids $n_a{}'$ water content w and specific gravity G of any soil is
(a) $\gamma_d = \frac{(1+b_a)G\gamma_w}{1+wG}$
(b) $\gamma_d = \frac{(1+n_a)G\gamma_w}{1-wG}$
(c) $\gamma_d = \frac{(1-n_a)G\gamma_w}{1+wG}$
(d) $\gamma_d = \frac{(1-n_a)G\gamma_w}{1-wG}$

Q7. Relative density of a compacted dense sand is approximately equal to
(a) 0.4

(b) 0.6
(c) 0.95
(d) 1.20

Q8. A fully saturated soil is said to be
(a) One phase system
(b) Two phase system with soil and air
(c) Two phase system with soil and water
(d) Three phase system with soil, water and air

Q9. In situ density of a soil deposit was determined by core cutter method. Weight of empty core cutter is 1286 gm. Weight of core cutter filled with soil is 3196 gm and volume of core cutter is 1000 cc. water content of soil is 12%, G=2.70. and g= 9.8 m/sec^2.
The bulk unit weight of soil is
(a) 19.10 kN/m^3
(b) 18.72 kN/m^3
(c) 17.83 kN/m^3
(d) 21.20 kN/m^3

Q10. Select the correct range of density index
(a) $0 \leq ID \leq 1$
(b) $0 < ID < 1$
(c) $ID > 0$
(d) $ID \geq 0$

Q11. To determine the liquid limit, in the flow curve the water content is plotted on:
(a) X-axis
(b) Y-axis
(c) on any axis
(d) one of the above

Q12. The plastic limit and liquid limit of a soil sample are 35% and 70% respectively. The percentage of soil fraction with grain size finer than 0.002mm is 25. The activity ratio of the sample is:
(a) 0.6
(b) 1.0
(c) 1.4
(d) 1.8

Q13. Which one in the following list does not possess plasticity?

(a) Bentonite
(b) Kaolinite
(c) Rock flour
(d) Fat clay

Q14. The smallest water content below which soil sample will not reduce its volume any further is known as _________.
(a) plasticity limit
(b) plasticity index
(c) drying limit
(d) shrinkage limit

Q15. Consistency index for a clayey soil is ________.
Where LL = liquid limit, PL = plastic limit, PI = plasticity index, w=natural moisture content
(a) $0.5w$
(b) $\frac{LL-w}{PI}$
(c) $\frac{w-LL}{PI}$
(d) $LL - PL$

Q16. If the liquid limit of a soil is 35%, then according to the skempton's empirical index equation for unsaturated clays, the estimated value of compression index would be:
(a) 0.150
(b) 0.200
(c) 0.225
(d) 0.250

Q17. If the plasticity index of a soil is 45%, then the soil will be:
(a) with medium plasticity
(b) with high plasticity
(c) non-plastic
(d) with low plasticity

Q18. Which of the following soils has more plasticity index
(a) Sand
(b) Silt
(c) Clay
(d) Gravel

Q19. What will be the liquid limit of soil of number of blows 30 in soils? (hint : cosagrande liquid limit device)
(a) 16.5
(b) 15.6
(c) 21.3

(d) 18.5

Q20. The relationship between water content (w%) and number of blows (N) in soils, as obtained from Casagrande's liquid limit device is given by:
W=20 – $\log_{10} N$
The liquid limit of the soil is
(a) 1.5%
(b) 16.6%
(c) 17.6%
(d) 18.6%

Q21. Toughness index is defined as the ratio of
(a) Plasticity index to consistency index
(b) Liquidity index to flow index
(c) Consistency index to liquidity index
(d) Plasticity index to flow index

Q22. If a soil sample is dried beyond its limit, this sample will show –
(a) No volume change
(b) Moderate volume change
(c) Low volume change
(d) large volume change

Q23. The flow index in soils indicates:
(a) Shear strength variation with water content
(b) Rate of flow of water through the soil
(c) Variation of liquid limit
(d) Ratio of the liquid limit to the plastic

Q24. When a water content in a soil is reduced beyond the shrinkage limit the soil will be in a?
(a) Solid state
(b) Liquid state
(c) Semi – solid state
(d) Plastic sate

Q25. According to Atterberg, the soil is said to be of medium plasticity, if the plasticity index PI is
(a) 0 < PI < 7
(b) $7 \leq PI \leq 107$
(c) $17 < PI < 27$
(d) $PI \geq 27$

Q26. As per the Indian soil classification system. 'MI' is the symbol for
(a) Inorganic silt of high plasticity

(b) Inorganic silt of high compressibility
(c) Inorganic silt of medium compressibility
(d) None of the above

Q27. As per the Indian soil classification system inorganic silts of high compressibility defined by the symbol:
(a) MH
(b) CH
(c) OH
(d) OI

Q28. A given soil sample has the following given size analysis

<2.00mm-80%	<0.66mm-60%
<0.075mm-30%	<0.002mm-2%
<0.005mm-10%	

(a) skip graded
(b) uniformly graded
(c) well graded
(d) average graded

Q29. The uniformity coefficient of soil with usual notation is defined as:

(a) $\frac{D_{30}}{D_{40}}$
(b) $\frac{D_{40}}{D_{50}}$
(c) $\frac{D_{50}}{D_{60}}$
(d) $\frac{D_{60}}{D_{10}}$

Q30. In which type of soils more than half the total material by weight is larger than 75 micron IS sieve size?
(a) Coarse grained soils
(b) Fine grained soils
(c) Highly organic soils
(d) Silts soils

Q31. Consistency limit measured by the instrument, is known as:
(a) Plate load test
(b) Oedometer
(c) Casagrande's apparatus
(d) Hydrometer

Q32. In a soil specimen, 60% of soil passing through 4.75 mm IS sieve and 40% of particle are passing through 75 micron IS sieve. Its uniformity coefficient is 5 and coefficient of curvature is 4. As per IS classification, this soil is classified as:

(a) SP
(b) GP
(c) SW
(d) GW

Q33. If the value of uniformity coefficient of a soil sample is nearly equal to one. This sample will be designated as –
(a) Well graded soil
(b) Uniformly graded soil
(c) Poorly graded soil
(d) None of the above

Q34. If the coefficient of uniformity of a soil is 25 and the coefficient of curvature is unity, then the ratio (D_{30} / D_{10}) is:
(a) 2
(b) 3
(c) 4
(d) 5

Q35. The effective size of particles of soil is denoted by –
(a) D_{60}
(b) D_{30}
(c) D_{20}
(d) D_{10}

Q36. A soil having particles of approximately the same size is known as
(a) Well graded
(b) Poorly graded
(c) Uniformly graded
(d) Gap graded

Q37. How much is the effective diameter of a particle for the Stoke's law to be applicable?
(a) less than 0.0002 mm
(b) less than 0.002 mm
(c) more than 0.02 mm
(d) less than 0.2 mm

Q38. In a shear test on cohesionless soils, if the initial void ratio is less than the critical void ratio, the sample will:
(a) Increase in volume
(b) Initially increase in volume and then remain constant
(c) Decrease in volume
(d) Initially decrease and then increase in volume

Q39. Coulomb's equation for shear strength can be represented by (symbols have their usual meanings)

(a) $c = s + \sigma \tan \phi$
(b) $s = c - \sigma \tan \phi$
(c) $c = \sigma + c \tan \phi$
(d) $s = c + \sigma \tan \phi$

Q40. Laboratory vane shear test can also be used to determine
(a) Shear parameters of silty sand
(b) Shears parameters of sandy clay
(c) Liquid limit of silty clay
(d) Plastic limit of clayey silt

Q41. Drainage conditions are best controlled during
(a) Direct shear box test
(b) Vane shear test
(c) Unconfined compression test
(d) Triaxial test

Q42. Un-confined compression test is generally applicable to
(a) Non-cohesive soil
(b) Saturated clays
(c) Silt
(d) Sandy soil

Q43. In-situ vane shear test is conducted to determine the shear strength of:
(a) cohesive soil
(b) non-cohesive soil
(c) silty soil
(d) sandy soil

Q44. In the triaxial test the major principal stress is:
(a) deviator stress
(b) cell pressure
(c) deviator stress + cell pressure
(d) none of the above

Q45. The unconfined compression test is generally applicable to saturated clays for which the apparent angle of shearing resistance is
(a) 0°
(b) 30°
(c) 60°
(d) 22.5°

Q46. The appropriate triaxial test to assess the immediate stability of an unloading problem, such as excavation of a clay slope, would be the
(a) Unconsolidated – undrained test
(b) Consolidated – undrained test

(c) Consolidated – drained test
(d) Unconsolidated – drained test

Q47. The effective stress strength parameters of a soil are c= 10kPa and ϕ = 30°, then shear strength on a plane within the saturated soil mass at a point where total normal stress is 300 kPa and pore water pressure is 150 kPa, will be
(a) 90.5 kPa
(b) 96.6 kPa
(c) 101.5 kPa
(d) 105.5 kPa

Q48. When a soil, whoes present effective overburden pressure is the maximum pressure that it was subjected to in the past, then it is:
(a) Unconsolidated
(b) Normally consolidated
(c) Over consolidated
(d) Pre-consolidated

Q49. The expansion of soil due to shear at a constant value of pressure is called:-
(a) Apparent cohesion
(b) True cohesion
(c) Dilatancy
(d) Consistency

Q50. The spring – cylinder analogy is used in soil mechanics to explain
(a) Air removal from clayey soils
(b) Relative density of cohesionless soils
(c) Compaction of clays
(d) Time-dependent deformation of saturated clayey soils

S1. Ans.(b)
Sol. $r_{bulk_1} = 17.6 \frac{kN}{m^3}$
$W_1 = 10\%$
$Void\ ratio\ (e) = constant$
$r_{bulk2} = ?>$
$w_2 = 20\%$
$$dry\ density\ (r_d) = \frac{r_b}{1+w}$$

$r_b \ \alpha \ (1 + w)$

$\frac{r_{b_1}}{r_{b_2}} = \frac{(1 + w_1)}{(1 + w_2)}$

$\frac{17.6}{r_{b_2}} = \frac{(1 + 0.1)}{(1 + 0.2)}$

$\boxed{r_{b_2} = 19.2}$

S2. Ans.(c)

Sol. water content (w) = 200%

G= 2.6

Void Ratio (e) = ?

→ soil is fully saturated (S = 1)

Se = WG

1×e = 2×2.6

$\boxed{e = 5.2}$

S3. Ans.(c)

Sol. porosity (n) = $\frac{1}{3}$

G = 2.5

Critical hydraulic gradient (ic) = ?

e = $\frac{n}{1-n} = \frac{1/3}{2/3} = 0.5$

$\boxed{e = 0.5}$

$i_c = \frac{G - 1}{1 + e} = \frac{2.5 - 1}{1 + 0.5} = \frac{1.5}{1.5}$

$\boxed{i_c = 1}$

S4. Ans.(b)

Sol. $e_{max} = 0.8$

$e_{min} = 0.4$

$e = 0.6$

Relative density = $\frac{e_{max} - e}{e_{max} - e_{min}} \times 100$

$\frac{0.8 - 0.6}{0.8 - 0.4} \times 100$

$\frac{0.2}{0.4} \times 100$

$= 50\%$

S5. Ans.(a)

Sol. total unit weight = (r_b) = 22 kN/m³

Specific gravity (G) = 2.67

Water content (w) = 10%

Dry unit weight $(r_d) = ?$

$$r_d = \frac{r_d}{1 + w} = \frac{22}{1 + 0.1}$$

$$\boxed{r_d = 20kN/m^s}$$

S6. Ans.(c)

Sol. $r_d = \frac{(1-\eta_a)Gr_\omega}{(1+e)}$

r_d → dry density

η_a → percentage air void

G → Specific gravity

e → void ratio

$$\boxed{Se = W.G}$$

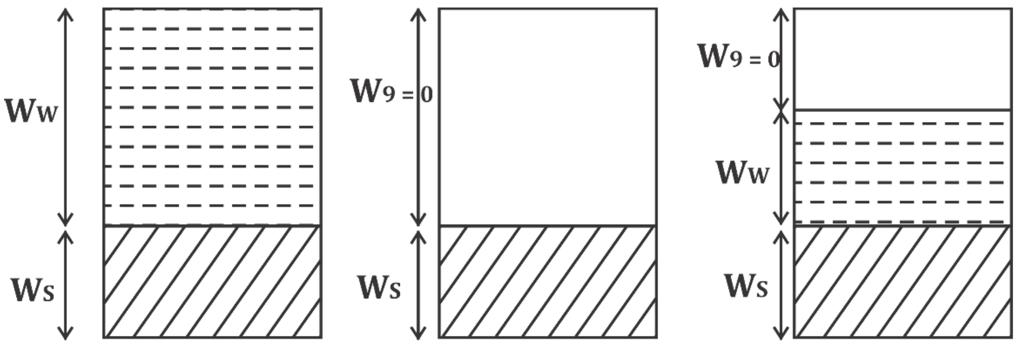
$$\boxed{r_d = \frac{(1-\eta_a)Gr_\omega}{1+WG}}$$

S7. Ans.(c)

Sol. relative density of compacted dense sand equal to 0.95.

S8. Ans.(c)

Sol. Fully saturated soil have two phase system with soil & water.



2 - Phase 2-phase 3 - phase e

S9. Ans.(b)

Sol. Weight of empty core cutter = 1286 gm

Weight of core cutter filled with soil = 3196 gm.

Volume of curve cutter = 1000 c.c.

Water content (w) = 12%

G = 2.70

g = 9.8 m/sec²

Bulk unit weight (r_b) = ?

Weight of soil = 3196-1286

= 1910

$$r_b = \frac{weight}{Volume} = \frac{1910\ gm}{1000\ cm^3}$$

= 1.910 gm/cm³

$$= \frac{1.910 \times 9.81 \times 100 \times 100 \times 100}{1000 \times 1000}$$

$$= 18.74\ kN/m^3$$

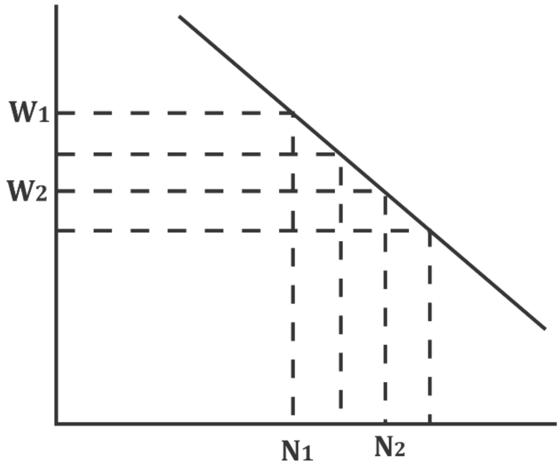
S10. Ans.(a)

Sol. Density index (ID) = $\frac{e_{max} - e}{e_{max} - e_{min}}$

$limit - 0 \le ID \le 1$

S11. Ans.(b)

Sol.



Log10 (N) →

(Flow Curve)

N → Number of blow

$$\boxed{Flow\ index\ = tan\theta = \frac{dy}{dx} = I_f}$$

$$\boxed{I_f = \frac{W_1 - W_2}{log\frac{N_2}{N_1}}}$$

→ Flow index of soil indicates shear strength variation with water content.

S12. Ans.(c)

Sol. plastic limit (W_P) = 35%

Liquid limit (W_L) = 70%

% of soil fraction finer then 2μ = 25

Activity $(A_t) = \frac{I_P}{C}$

C → % of clay size particle

$$A_t = \frac{70 - 35}{25}$$

$$\boxed{A_t = 1.4}$$

Activity	Disruption
< 0.75 0.75 to 1.25 > 1.25	Non active Normal soil Active

S13. Ans.(c)
Sol. Rock flour is not posses any plasticity.

S14. Ans.(d)
Sol. the shrinkage limit of soil is when the water is just sufficient to fill all the pores of the soil. The volume of the soil does not decrease when the water content is reduced below the shrinkage limit.

S15. Ans.(b)
Sol. consistency index (I_c) = $\frac{liquid\ limit - Natural\ water\ content}{liquid\ limit - plastic\ limit}$

$$\boxed{I_C = \frac{W_L - W}{W_L - W_P}}$$

S16. Ans.(c)
Sol. liquid limit (W_L) = 35%
Compression index (Cc) = 0.009 $(W_L - 10)$
= 0.009 (35-10)
= 0.009 × 25
= 0.225

S17. Ans.(b)
Sol.

Plasticity index (I_P)	Consistency
0	Non Plastic
<7	Low plastic
7 – 17	Medium plastic
> 17	Highly plastic

S18. Ans.(c)
Sol.

Soil	Plasticity index (I_P)
Sand	0
Silt	10-15
Clay	15-100

S19. Ans.(d)
Sol. number of blows = 30
<u>According to Casagrande</u>

$$W_L = 20 - log_{10}N$$
$$W_L = 20 - log_{10}30$$

$$\boxed{W_L = 18.52}$$

S20. Ans.(d)

Sol. W = 20 – $\log_{10}$ N

Put $\boxed{N = 25}$

W = 20 – $\log_{10}$ 25

$$\boxed{W = 18.60}$$

S21. Ans.(d)

Sol. $\boxed{Toughness\ index = \frac{Plasticity\ index}{flow\ index}}$

S22. Ans.(a)

Sol. if soil sample dried beyond its limit then no volume change in soil because water is replaced by air & volume of soil same

S23. Ans.(a)

Sol. Refer the solution of question number (11)

S24. Ans.(a)

Sol. when water content in a soil is reduced beyond the shrinkage limit the soil will be in solid state.

S25. Ans.(b)

Sol. Refer the solution of question number (17)

S26. Ans.(c)

Sol. ML → low compressible silt

MI → Medium compressible silt

MH→ high compressible silt

S27. Ans.(a)

Sol. Refer the solution of question No. 1

S28. Ans.(c)

Sol. $C_u = \frac{D_{60}}{D_{10}} = \frac{0.66}{0.005} = 132$

$$Cc = \frac{(D_{30})^2}{D_{60}\,D_{10}} = \frac{(0.075)^2}{(0.66)(0.005)} = 1.70$$

$C_u > 6 \rightarrow$ Weld graded sand

For well graded Cc is lies between 1 to 3.

S29. Ans.(d)

Sol. uniformity coefficient (Cu) = $\frac{D_{60}}{D_{10}}$

If $C_u \simeq 1 \rightarrow$ uniformly graded soil

$C_u > 6 \rightarrow$ well graded sand

$C_u > 4 \rightarrow$ well graded gravel

S30. Ans.(a)
Sol. if more than 50% of soil grains are retained over 75 micron sieve then its termed as coarse grained soils.

S31. Ans.(c)
Sol. Consistency limit measured by casa Grande's apparatus –

S32. Ans.(d) more than 50% of soil grains are retained over 75 micron sieve then its coarse grained soil.

→ **Coefficient of uniformity = (Cu) = 5**

→ **Coefficient of curvature (Cc) = 4**

→ if Cu > 4 than well graded gravel other

S33. Ans.(b)
Sol. coefficient of uniformity (Cu) = $\frac{D_{60}}{D_{10}}$

If - Cu ≃ 1 (uniformly graded)
Cu > 4 (well graded gravel)
Cu > 6 (well graded sand)

S34. Ans.(d)
Sol. coefficient of uniformity (Cu) = $\frac{D_{60}}{D_{10}}$

Coefficient of curvature (Cc) = $\frac{(D_{30})^2}{D_{60}\,D_{10}}$

$$\frac{D_{60}}{D_{10}} = 25$$

$$\frac{(D_{30})^2}{D_{60}D_{10}} = 1$$

$$Cu \times Cc = 25 \times 1$$

$$\frac{D_{60}}{D_{10}} \times \frac{(D_{30})^2}{D_{60} \times D_{10}} = 25$$

$$\left(\frac{D_{30}}{D_{10}}\right)^2 = 25$$

$$\boxed{\frac{D_{30}}{D_{10}} = 5}$$

S35. Ans.(d)
Sol. D_{10} is termed as the effective particle size it means that 10 percent of the particle are finer and the 90% of the particles are coarser than that particular particle size D_{10}.

S36. Ans.(c)
Sol. Uniformly graded – if soil consist of excess one size of particle.
Gap graded – certain size of particles are missing from soil.
Well graded – the soil may be termed as well graded if soil has good representation of all the size of particles present in it.

S37. Ans.(d)
Sol. stokes law valid between 0.0002 mm to 0.2 mm particle size.

S38. Ans.(d)
Sol. in a shear test on cohesionless soils, if the initial void ratio is less then the critical void ratio, the sample will initially decrease and then increase in volume.

S39. Ans.(d)
Sol. coulombs equation for shear strength.

$$\boxed{\tau = C + \sigma_n tan\phi}$$

τ → shear strength
c → cohesion
σ_n → Normal stress
ϕ → friction Angle.

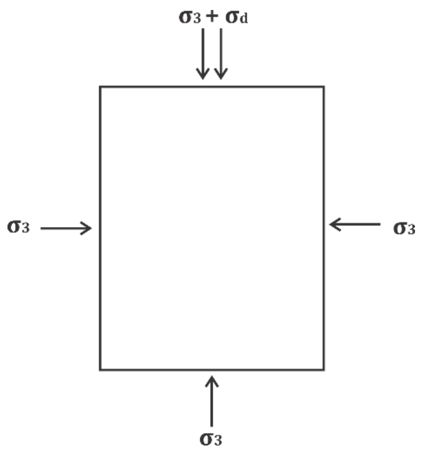
S40. Ans.(a)
Sol uses of vane shear test.
(i) Shear parameter of silty sand
(ii) Sensitivity of clay.

S41. Ans.(d)
Sol. Drainage conditions are best controlled in triaxial test.

S42. Ans.(b)
Sol. in unconfined compression test rubber membrane not used without rubber membrane dry soil can not be held position hence this test can be conducted in saturated silt & clay but more suitable for clay.

S43. Ans.(a)
Vane shear test is conducted to determine shear strength of cohesive soil.

S44. Ans.(c)
Sol.



$\sigma_1 = (\sigma_3 + \sigma_d) =$ Major principal stress
σ_3 = minor principal stress

S45. Ans.(a)

S46. Ans.(a)
Sol. in saturated clay for short term analysis consolidated – undrained test in used. This test takes only 5 to 7 minutes.

S47. Ans.(b)
Sol. C' = 10 kPa
Φ' = 30°
σ_n = 300 kPa
U = 150 kPa
Shear strength (τ) =?
Effective normal stress $(\bar{\sigma}_n) = \sigma_n - U$
= 300 – 150
= 150 kPa
$\tau' = C' + \bar{\sigma}_n tan\phi$
=10+150tan30
=96.60

S48. Ans.(b)
Sol. when present effective overburden pressure is the maximum pressure that it was subjected to in the past then it is normally consolidated soil.

S49. Ans.(c)
Sol. Expansion of soil due to shear at a constant value of pressure is called dilatancy.

S50. Ans.(d)
Sol. soil spring analogy is used to explain the mechanism of consolidation i.e. time dependent deformation of fine soil