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PTQ

Prelims Through Questions

for

ESE 2021

Civil Engineering

Day 3 of 11

Q.91 - Q.140

(Out of 500 Questions)

Geotechnical + Environmental Engineering

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Q.91 Consider the following statements:

1. Moisture introduces capillary effect in a sandy soil leading to apparent increase in angle of internal friction.
2. Organic matter increases the permeability of a soil.
3. Permeability of a soil decreases as the effective stress acting on the soil increases.
4. Water is in tension in capillary zone.

Which of the above statements are CORRECT?

(a) 1, 2, 3 and 4 (b) 2 and 3

(c) 1, 3 and 4 (d) 3 and 4

91. (d)

Q.92 Consider the following statements:

I. For soil compacted dry of optimum, generally a flocculated structure is obtained.

II. For soil compacted with a very low compactive effort, a flocculated structure may be obtained even wet of optimum.

III. Shear strength of soil decreases when compacted on wet of optimum as compared to when compacted on dry of optimum.

IV. A swelled soil sample, compacted to the same dry density, once at dry side of optimum and once at wet side of optimum and then soaked in water to have full saturation, may exhibit almost similar shear strength in both cases.

Which of the above statements are CORRECT?

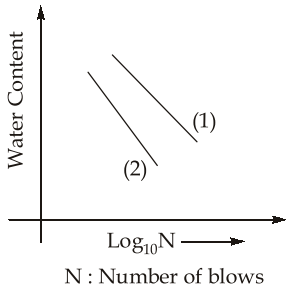
(a) I, II and III (b) II, III and IV

(c) I, III and IV (d) I, II and IV

92. (c)

When a very high compactive effort is applied, even the water content wet of optimum is pretty low. As a flocculated structure is obtained for soils that are compacted dry, in such cases, even a compaction wet of optimum (but pretty dry overall) may result in a flocculated structure.

Q.93 Consider the flow curve as shown in figure below.



(a) Curve 1 has larger shearing strength

(b) Curve 2 has larger shearing strength

(c) Both curve 1 and curve 2 has same strength

(d) None of these

93. **(a)**

$$\text{Slope of curve or Flow index} \propto \frac{1}{\text{Shear Strength}}$$

Q.94 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

A. Laterite soil
B. Talus soil
C. Bentonite soil
D. Marl soil

List-II

1. Formed due to gravitational force in hilly area
2. Residual soil formed from basalt
3. Formed due to the decomposition of bones and cell mass of aquatic life
4. Formed due to chemical weathering of the volcanic ash

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	1	2	4	3
(c)	2	1	3	4
(d)	2	1	4	3

94. **(d)**

Q.95 A pile is driven into the ground with a drop hammer weighing 1200 kg and having a free fall of 2.0 m. If the penetration with the last blow is noted to be 1 cm, the allowable load carrying capacity of this pile, according to Engineering News formula, is

(a) 11.43 tonnes (b) 13.47 tonnes
(c) 15.49 tonnes (d) 18.52 tonnes

95. **(a)**

The allowable load for a pile on the basis of Engineering News formula is calculated with a factor of safety of 6 and is given by equation as

$$Q_a = \frac{WH}{6\,(S + C)}$$ (For drop hammer, $C = 2.5$ cm)

Where,

W = Weight of hammer = 1200 kg
H = Free fall height of hammer in cm = 200 cm
S = Observed penetration in the last blow = 1 cm

$$\therefore \quad Q_a = \frac{1200 \times 200}{6(1 + 2.5)}\ \text{kg} = 11{,}428\ \text{kg} \simeq 11.43\ \text{tonnes}$$

Q.96 A vane 20 cm long and 10 cm in diameter was pressed fully into a soft marine clay at the bottom of a bore hole. Torque was applied gradually and failure occurred at 1000 kg cm. The cohesion of the clay in kg/cm^2 is

(a) $\frac{1}{\pi}\times\frac{6}{7}$ (b) $\frac{1}{\pi}\times\frac{5}{7}$

(c) $\frac{1}{\pi}\times\frac{4}{7}$ (d) $\frac{1}{\pi}\times\frac{3}{7}$

96. (a)

Cohesion of clay, $C_u = \frac{T}{\pi D^2\left(\frac{H}{2}+\frac{D}{6}\right)} = \frac{1000}{\pi\times 10^2\times\left(\frac{20}{2}+\frac{10}{6}\right)}$

$= \frac{1}{\pi\left(1+\frac{1}{6}\right)} = \frac{1}{\pi}\times\frac{6}{7}\text{kg/cm}^2$

Q.97 A line load of inifinite length has an intensity 20 kN/m length. What is the vertical stress at a depth 4 m below the Earth's surface just below the line load?

(a) 50.93 kN/m^2 (b) 3.18 kN/m^2

(c) 203.72 kN/m^2 (d) 0.80 kN/m^2

97. (b)

Stress intensity due to live load,

$$\sigma_z = \frac{2q}{\pi z} = \frac{2\times 20}{\pi\times 4} = 3.18\text{ kN/m}^2$$

Q.98 A stratified soil deposit consists of four layers of equal thickness. The coefficient of permeability of the second, third and fourth layers are respectively $\frac{1}{3}$, $\frac{1}{2}$ and twice of the coefficient of permeability of top layer. The average permeabilities of the deposit in parallel and perpendicular direction respectively, are

(a) $\frac{23}{24}K, \frac{8}{13}K$ (b) $\frac{23}{24}K, \frac{9}{13}K$

(c) $\frac{21}{24}K, \frac{9}{13}K$ (d) $\frac{21}{24}K, \frac{8}{13}K$

98. (a)

$$K_x = \frac{ZK + Z\frac{K}{3} + Z\frac{K}{2} + Z2K}{4Z} = \frac{23}{24}K$$

$$K_Z = \frac{4Z}{\frac{Z}{K}+\frac{3Z}{K}+\frac{2Z}{K}+\frac{Z}{2K}} = \frac{8}{13}K$$

Q.99 A 30 cm square bearing plate settles by 8 mm in the plate load test on cohesionless soil, when the intensity of loading is 180 kN/m^2. The settlement of a shallow foundation of 1.6 m square side under the same intensity of loading is

(a) 2.82 mm (b) 22.7 mm

(c) 28.2 mm (d) 30 mm

99. **(b)**

Settlement of foundation,

$$S_f = S_p\left[\frac{B_p(B_p+0.3)}{B_p(B+0.3)}\right]^2 = 8\times\left[\frac{1.6(0.3+0.3)}{0.3(1.6+0.3)}\right]^2 = 22.7\,\text{mm}$$

Q.100 A soil stratum is 10 m thick with pervious stratum on top and bottom. The time required for 50% consolidation is

(a) 360 days (b) 426 days

(c) 570 days (d) 680 days

Coefficient of permeability = 10^{-7} cm/s

Coefficient of compression = 0.0003 cm^2/gm

Void ratio = 2

Time factor = 0.197

110. **(c)**

$$K = 10^{-7}\ \text{cm/s},\quad a_\gamma = 0.0003\ \text{cm}^2/\text{gm},\quad e_0 = 2,\quad T_v = 0.197$$

$$t_{50} = \frac{(T_v)_{50}\,d^2}{C_v}$$

where, $$d = \frac{10}{2} = 5\ \text{m} = 500\ \text{cm}\quad \gamma_w = 1\ \text{gm/cm}^3$$

$$C_v = \frac{K}{m_v\gamma_w} = K\frac{(1+e)}{a_v\gamma_w} = \frac{10^{-7}(1+2)}{0.0003\times 1} = 10^{-3}\ \text{cm}^2/\text{s}$$

$$\therefore\quad t_{50} = \frac{T_v d^2}{C_v} = \frac{0.197(500)^2}{10^{-3}} = 49250\times 10^3\ \text{sec} \approx 570\ \text{days}$$

Q.101 Choose correct statement(s) from the following with respect to direct shear test.

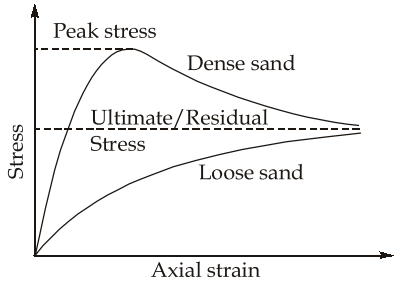
1. Dense sand and stiff clay show a distinct failure stress.
2. Loose sand and soft clay do not show any distinct failure stress.
3. The ultimate stress for both dense sand and loose sand is nearly the same.

The correct answer is

(a) 1 only (b) 1 and 2 only

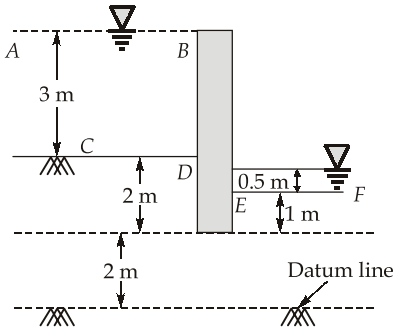
(c) 2 and 3 only (d) 1, 2 and 3

101. **(d)**



From the above graph, it is clear that the ultimate stress for both dense sand and loose sand is nearly the same.

Q.102 A sheet pile wall is driven into a sandy bed as shown in the given figure



The total head along the lines *AB*, *CD* and *EF* respectively, are

(a) 0 m, 3 m and 0.5 m
(b) 7 m, 4 m and 3 m
(c) 7 m, 7 m and 3.5 m
(d) 3 m, 0 m and 0 m

102. (c)

Total head is the summation of pressure head and datum head, thus it can be calculated at respective lines.

$$TH_{AB} = PH + DH = 0 + (3 + 2 + 2) = 7 \text{ m}$$
$$TH_{CD} = PH + DH = -3 + (2 + 2) = 7 \text{ m}$$
$$TH_{EF} = PH + DH = (0.5) + (2 + 1) = 3.5 \text{ m}$$

Q.103 A clay layer of thickness 4.0 m has following properties:

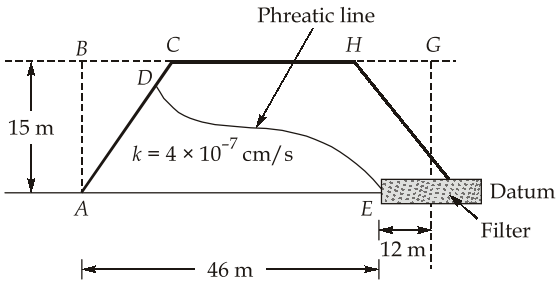
Recompression index, $C_r = 0.1$
Compression index, $C_c = 0.25$
Initial void ratio, $e_0 = 1$
Existing effective stress, $\bar{\sigma}_0 = 100 \text{ kN/m}^2$
Pre-consolidation stress, $\bar{\sigma}_c = 200 \text{ kN/m}^2$
Additional stress applied = 300 kN/m^2
What will be the settlement in the soil layer on the application of additional stress?
[Take log(2) = 0.201 and log(3) = 0.4771]

(a) 210.7 mm
(b) 297.7 mm
(c) 47.7 mm
(d) 60.2 mm

103. (a)

$$\text{Settlement} = \frac{0.1 \times 4000}{1+1} \times \log\left(\frac{200}{100}\right) + \frac{0.25 \times 4000}{1+1} \log\left(\frac{100+300}{200}\right) = 210.72 \text{ mm}$$

Q.104 A homogeneous earthen dam section with filter is given in the figure below:



Which of the following statements are correct regarding this earthen dam?

1. AD is the boundary equipotential line.
2. DE is the top flow line.
3. Flow through dam is 4.8×10^{-8} m^3/s (per metre length of the dam), for a focal distance of 12 m.

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

104. (d)

Flow through dam, $q = KS$
Here, $S = 12$ m and $K = 4 \times 10^{-8}$ m/s
$\therefore$ $q = 4 \times 10^{-9}$ m/s $\times 12 \times 1$ ...[For unit length]
$= 4.8 \times 10^{-8}$ $m^3/s/m$

Q.105 Consider the following statements:

1. Coefficient of consolidation (C_v) incorporates the combined effect of permeability and compressibility of the soil sample
2. Time factor at a particular degree of consolidation is inversely proportional to square of soil layer thickness.
3. Higher is the value of C_v, slower will be the rate of consolidation.
4. Compression index normally increases with increasing liquid limit of clay.

Which of the above statements are CORRECT?

(a) 1 and 2 (b) 2 and 3
(c) 3 and 4 (d) 1 and 4

105. (d)

$$C_V = \frac{K}{m_v \gamma_w}, \qquad T_V = \frac{C_V t}{d^2}$$

$$C_C = 0.009\,(w_L - 10)$$

Q.106 A strip footing was constructed on a pure sand which is 1.5 m wide with its base at a depth of 1 m. Using Terzaghi's method, the ultimate bearing capacity of strip footing will be [Take $\gamma_d = 16$ kN/m^3, $N_\gamma = 75$, Assume general shear failure]

(a) 1876 kN/m^2 (b) 1860 kN/m^2
(c) 1788 kN/m^2 (d) 1792 kN/m^2

106. (b)

$q_u = CN_c + qN_q + 0.5B\gamma N_\gamma$ ($\because$ For sand, $C = 0$)
$= 1 \times 16 \times 60 + 0.5 \times 16 \times 1.5 \times 75$
$= 1860$ kN/m^2

Q.107 A fully saturated clay specimen is placed in a consolidometer and subjected to a loading of 200 kN/m^2. After some of time, it was found that the average pore pressure in the specimen was 70 kN/m^2. The percentage of consolidation reached by then was

(a) 70 (b) 65
(c) 35 (d) 29

107. (b)

Load transferred to clay = Load applied – Pore pressure
$= 200 - 70 = 130\ kN/m^2$

$\therefore$ Percentage of load transferred = Percentage consolidation reached

$$= \frac{130}{200} \times 100 = 65\%$$

Q.108 Consider the following statements:
Criteria for satisfactory performance of footings are that the
1. soil supporting the footing must be safe against shear failure
2. footing must not settle more than a pre-specified value
3. footing must be rigid
4. footing should be above water table.

Which of the above statements are CORRECT?
(a) 3 and 4 (b) 1 and 2
(c) 1 and 3 (d) 2 and 4

108. (b)

Q.109 In a falling-head permeability test, the time taken for the head to fall from 27 cm to 3 cm is 10 minutes. If the test is repeated with the same initial head, i.e., 27 cm, then what time will it take for the head to fall to 9 cm?
(a) 3 minutes (b) 5 minutes
(c) 6 minutes (d) 7.5 minutes

109. (b)

t_1 = 10 min, h_1 = 27 cm, h_2 = 3 cm
t_2 = ? h_3 = 27 cm, h_4 = 9 cm

$$k = \frac{2.303aL}{At}\log_{10}\left(\frac{h_1}{h_2}\right)$$ [Falling-head permeability test]

$$\Rightarrow \frac{1}{t_1}\log\left(\frac{h_1}{h_2}\right) = \frac{1}{t_2}\log\left(\frac{h_3}{h_4}\right)$$ [$\because k$ is constant]

$$\Rightarrow \frac{1}{10}\log\left(\frac{27}{3}\right) = \frac{1}{t_2}\log\left(\frac{27}{9}\right)$$

$$\Rightarrow \frac{1}{10}\log 9 = \frac{1}{t_2}\log 3$$

$$\Rightarrow \frac{2}{10}\log 3 = \frac{1}{t_2}\log 3$$

$$\Rightarrow t_2 = 5 \text{ minutes}$$

Q.110 Consider the following statements in relation to the given table

Component	Volume (cm^3)	Weight (g)
Air	0.1	0.0
Water	0.3	0.3
Solids	0.6	1.50

Which of the following statements are CORRECT?
1. Soil is partially saturated at degree of saturation = 50%
2. Void ratio = 66.7%
3. Water content = 50%
4. Specific gravity of soil = 2.65

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 3 and 4 only

110. (b)

$V_a = 0.1$ cc
$V_w = 0.3$ cc $\quad W_w = 0.3$ g
$V_s = 0.6$ cc $\quad W_s = 1.5$ g

Degree of saturation, $S = \frac{V_w}{V_v} = \frac{0.3}{0.4} = 0.75$ as 75%

Void ratio, $e = \frac{V_v}{V_s} = \frac{0.4}{0.6} = 0.667$ as 66.7%

$\because \quad G = 2.65$

$w = \frac{w_w}{w_{solid}} = \frac{0.3}{0.6} = 0.5$ as 50%

$G = \frac{w_{solid}}{V_{solid} \times \gamma_w} = \frac{1.5}{0.6 \times 1} = 2.5$

Q.111 A 40 cm diameter concrete pile, is driven to a depth of 15 m in a deep deposit of clay having unconfined compressive strength of 80 kN/m^2. The design load carrying capacity of pile will be [Assume $\alpha = 0.8$ and FOS = 3]

(a) 648.42 kN (b) 216.14 kN
(c) 432.28 kN (d) 1296.84 kN

111. (b)

$D = 0.4$ m, $L = 15$ m, $C_u = \frac{80}{2} = 40$ kN/m^2, $\alpha = 0.8$, FOS = 3

$Q_{up} = 9C \times \frac{\pi}{4} D^2 + \alpha\, C\, \pi DL$

$Q_{up} = 9 \times 40 \times \frac{\pi}{4} \times 0.4^2 + 0.8 \times 40 \times \pi \times 0.4 \times 15$

$Q_{up} = 648.42$ kN

$\therefore$ Design load capacity of pile $= = \frac{Q_{up}}{FOS} = \frac{648.42}{3} = 216.14$ kN

Q.112 Elevation and temperature data for places are tabulated below:

Elevation 'm'	temp. °C
4	21.25
444	15.70

based on data, lapse rate can be referred as

(a) super-adiabatic (b) sub-adiabatic
(c) neutral (d) inversion

112. (a)

$$\text{Ambient lapse rate} = \frac{21.25 - 15.70}{(444 - 4)} \times 1000$$

$$= 12.6\ ^\circ\text{C/km} > 9.8^\circ\text{C/km}$$

When the ambient lapse rate exceeds the adiabatic lapse rate, the ambient lapse rate is said to be super adiabatic.

Q.113 The amount of bleaching powder solution required to be added to obtain the chlorine dose of 0.4 mg/l in 300 ml of sample, if the available chlorine in bleaching powder solution is 0.2 mg/ml, will be

(a) 0.15 ml (b) 0.3 ml

(c) 0.45 ml (d) 0.6 ml

113. (d)

$$\text{The chlorine requirement for 300 m}l\text{ of water} = \frac{0.4 \times 300}{1000}\ \text{mg} = 0.12\ \text{mg}$$

$$\text{Amount of bleaching powder solution needed} = \frac{\text{Chlorine demand}}{\text{Available chlorine concentration}}$$

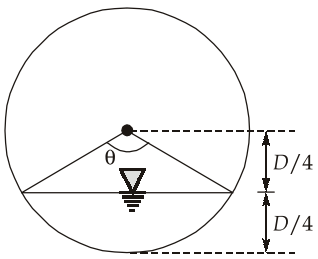
$$= \frac{0.12}{0.2} = 0.6\ \text{m}l$$

Q.114 In a circular sewer of diameter D, if the depth of flow is $D/4$, then what is the wetted perimeter?

(a) $\frac{\pi D}{4}$ (b) $\frac{\pi D}{2}$

(c) $\frac{\pi D}{3}$ (d) $\frac{2\pi D}{3}$

114. (c)



$$\theta = 2\cos^{-1}\left(\frac{\frac{D}{4}}{\frac{D}{2}}\right)$$

$$= 2\cos^{-1} 0.5 = 120^\circ$$

$$\therefore \quad \text{Wetted perimeter} = \frac{\pi D}{360^\circ} \times 120^\circ = \frac{1}{3}\pi D$$

Q.115 The population growth rate (in %) per decade when population in the year 1930 was 62500 and in the year 1970 was 129600 by geometrical increase method, would be

(a) 15% (b) 20%

(c) 23.33% (d) 48.22%

115. (b)

$$r = \sqrt[t]{\frac{P_2}{P_1}} - 1 = \sqrt[4]{\frac{129600}{62500}} - 1 = \frac{60}{50} - 1$$

$$= 1.2 - 1 = 0.2 = 20\%$$

Q.116 If the total hardness and alkalinity of a sample of water are 400 mg/l and 200 mg/l as $CaCO_3$ respectively, then its carbonate and non-carbonate hardness (in units of mg/l) will respectively be

(a) 400 and 200 (b) 200 and 200

(c) 200 and zero (d) 400 and zero

116. (b)

Carbonate hardness = Total hardness or alkalinity whichever is less

So, Carbonate hardness = 200 mg/l

Non-carbonate hardness = Total hardness-carbonate hardness

= 400 – 200 = 200 mg/l

Q.117 Match **List-I** (Treatment units) with **List-II** (Detention period) and select the correct answer using the codes given below the lists:

List-I	**List-II**
A. Grit chamber	**1.** 6 hours
B. Primary sedimentation	**2.** 2 minutes
C. Activated sludge	**3.** 2 hours
D. Sludge digestion	**4.** 20 days

Codes:

	A	**B**	**C**	**D**
(a)	2	3	1	4
(b)	2	3	4	1
(c)	3	2	1	4
(d)	3	2	4	1

117. (a)

Q.118 What is the BOD_5 at 20°C of a waste water sample that yields an oxygen consumption of 2 mg/l from a 0.5% diluted sample?

(a) 40 mg/l (b) 400 mg/l

(c) 200 mg/l (d) 250 mg/l

118. (b)

$$BOD_5 = \frac{2}{\frac{0.5}{100}} = 400 \text{ mg/}l \qquad \left[BOD = \frac{\text{Dissolved oxygen consummed}}{\text{Dilution factor}}\right]$$

Q.119 A power plant treats 10 MLD of boiler feed water by ion exchange method. Total hardness of water is 500 mg/l as $CaCO_3$. If 100 mg/l of hardness is permissible in boiler feed water then by-pass flow rate will be

(a) 2 MLD (b) 4 MLD
(c) 2.5 MLD (d) 1.5 MLD

119. (a)

Since ion exchange method provides water with zero hardness so assuming that x MLD of water is by-passed then

$$100\ \text{mg}/l = \frac{x \times 500\ \text{mg}/l + (10 - x) \times 0}{10}$$

$$\Rightarrow \quad x = 2\ \text{MLD}$$

Q.120 A septic tank of 7 m^3 in volume serves for 5 people. If the rate of accumulation of sludge is 70 litres per capita per year and sludge is removed when it occupies 50% of its volume, what is the cleaning interval of septic tank?

(a) 3 years (b) 5 years
(c) 7.5 years (d) 10 years

120. (d)

The volume of sludge at the time of cleaning = $0.5 \times 7 = 3.5\ m^3 = 3500$ litres

Rate of accumulation of sludge= $5 \times 70 = 350$ litre/year

$$\text{Cleaning interval} = \frac{3500}{350} = 10\ \text{years}$$

Q.121 The BOD_5 of a waste water is determined to be 150 mg/l at 20°C. The k value is known to be 0.1/day (base 10). What would be the ultimate BOD if the test was run at 20°C?

(a) 180 mg/l (b) 200 mg/l
(c) 220 mg/l (d) 250 mg/l

121. (c)

$$BOD_5 = BOD_u\,(1 - 10^{-0.1 \times 5})$$

$$\Rightarrow \quad BOD_u = \frac{150}{\left(1 - \frac{1}{\sqrt{10}}\right)} = 219.37\ \text{mg}/l$$

$$\simeq 220\ \text{mg}/l$$

Q.122 600 m^3/day of water is to be obtained from a proposed infiltration gallery, which is placed at 6 m depth from sub-surface water table. The coefficient of permeability of the soil aquifer is 100 m/day. If the drawdown in the gallery on pumping is not to exceed 4 m, then the length of the gallery will be [Take radius of influence = 100 m]

(a) 28.5 m (b) 30.5 m
(c) 45.5 m (d) 37.5 m

122. **(d)**

Discharge from infiltration gallery,

$$Q = kL\left[\frac{H^2 - h^2}{2R}\right]$$

where, $Q = 600\ m^3/day$, $H = 6$ m, $k = 100$ m/day, $R = 100$ m, drawdown, $S = 4$ m, $h = 6 - 4 = 2$ m

So, $$600 = 100 \times L\left[\frac{6^2 - 2^2}{2 \times 100}\right]$$

$\Rightarrow$ $$L = 37.5 \text{ m}$$

Q.123 A town of two lakh population is getting water at the rate of 150 litres per capita per day from a river. If the pumps are working for 12 hours a day to supply full days demand then maximum capacity of draft required is

(a) 30 MLD (b) 54 MLD

(c) 60 MLD (d) 108 MLD

123. **(d)**

Average quantity of water required

= Population × per capita demand

= $200000 \times 150 = 30 \times 10^6$ litres per day

= 30 MLD

$\therefore$ Maximum demand = 1.8 times the average daily demand

= 1.8×30

= 54 MLD

Since, pumps are working for 12 hours a day to supply full day demand

$\therefore$ Maximum draft required $= 54 \times \frac{24}{12} = 108$ MLD

Q.124 In a sanitary landfill decomposition and chemical changes within organic content of the solid waste is taking place. Consequential changes within landfill can be

1. temperature change within landfill
2. production of gases like H_2S, CO, CO_2 and CH_4
3. destruction of pathogens
4. production of other gases like SO_2 and NO_2

Which of these statements are correct?

(a) 1, 2, 3 and 4 (b) 1, 2 and 3

(c) 1 and 4 (d) 2 and 3

124. **(b)**

Gases found in landfills include air, ammonia, carbon dioxide, carbon monoxide, hydrogen, sulphide, methane, nitrogen and oxygen. Carbon dioxide and methane are the principal gases produced from the anaerobic decomposition of the organic solid waste components.

The landfilling operation is biological method of waste treatment, since the waste is stabilized by aerobic as well as anaerobic processes. During initial phase, aerobic bacteria and fungi use the available oxygen. As a result of aerobic decomposition, the temperature in the fill increases.

Q.125 A conventional activated sludge plant is designed to treat 28000 kiloliters per day at a settled sewage of BOD equal to 220 mg/*l*. The effluent BOD is 15 mg/*l*. F/M ratio is 0.22, MLSS is 3000 mg/*l*. The hydraulic retention time of the sludge will be

(a) 2 h (b) 4 h
(c) 6 h (d) 8 h

125. (d)

$$\frac{F}{M} = \frac{Q\,S_i}{1000\,VX_{SS}}$$

where, Q = 28000 × 10^3 l/d; S_i = influent BOD = 220 mg/l; X_{ss} = MLSS = 3000 mg/l; V = volume (m^3)

$$\Rightarrow \quad 0.22 = \frac{28\times10^6\times220}{1000\times3000\,V}$$

$$\Rightarrow \quad V = 9333.33\ m^3$$

$$\text{Hydraulic Retention time} = \frac{V}{Q}\times 24 \text{ hours} = \frac{9333.33}{28000}\times 24 \quad [\text{Since } 1\ kL = 1\ m^3]$$

$$= 7.99 \approx 8 \text{ hours}$$

Q.126 Which of the following statement regarding wastewater is incorrect?

(a) The biochemical oxygen demand (BOD) is the amount of oxygen required by microbes in the stabilization of organic materials under aerobic conditions.
(b) If the seed microorganisms are acclimated to the waste, then the removal of organic material is a pseudo zero-order reaction.
(c) The COD test does not measure the oxygen required for nitrification
(d) The biodegradable COD equals to the total COD minus the nondegradable COD.

126. (b)

Studies have shown that if the seed microorganisms are acclimated to the waste, then the removal of organic material is a pseudo-first order reaction.

$$-\frac{dc}{dt} = kc$$

Q.127 Match **List-I (Air pollutant)** with **List-II (Impact on human health)** and select the correct answer using the codes given below the lists:

List-I

A. Particulates
B. Carbon monoxide
C. Sulphur oxides
D. Photochemical oxidants

List-II

1. Impairs transport of O_2 in blood stream
2. Irritation of mucous membranes of respiratory tract
3. Causes coughing, shortness of breath, headache, etc.
4. Causes respiratory illness

Codes:

	A	B	C	D
(a)	2	3	4	1
(b)	4	1	2	3
(c)	2	1	4	3
(d)	4	3	2	1

127. (b)

Q.128 The sound level for a jet plane on the ground with sound pressure of 2000 μ bar should be

(a) 60 dB (b) 100 dB
(c) 140 dB (d) 180 dB

128. (c)

$$\text{Source pressure level, SPL (dB)} = 20\log_{10}\left(\frac{P}{P_0}\right)$$

$$P_0 = 2 \times 10^{-5}\ \text{N/m}^2$$
$$P = 2000\ \mu\text{bar} = 200\ \text{N/m}^2$$

$$\text{SPL} = 20\log_{10}\left(\frac{200}{2\times10^{-5}}\right) = 140\ \text{dB}$$

Q.129 In dissolved oxygen sag curve, the sag curve results because

(a) it is a function of rate of addition of oxygen to the stream
(b) it is a function of rate of addition of oxygen from the stream
(c) it is a function of both addition and depletion of oxygen from the stream
(d) the rate of addition of oxygen is linear but the rate of depletion is non-linear

129. (c)

The rate of change of deficit

$$\frac{dD}{dt} = k_D L_t - k_R D$$

k_D, k_R are reaction rate constants for oxygen removal and addition respectively.
L_t is BOD at time t
D is oxygen deficit

Q.130 A water supply of 10 MLD is to be coagulated with Alum where minimum amount of alkalinity required is 9 mg/l as $CaCO_3$ and alkalinity present in water is 6 mg/l. Quantity of Quick Lime required (10^6 mg per year as CaO) shall be

(a) 2500 (b) 3000
(c) 4200 (d) 6132

130. (d)

Natural alkalinity available in water = 6 mg/l
Total alkalinity required to be added in the form of $CaCO_3$ = 9 – 6 = 3 mg/l

$$\underset{56\ \text{gm}}{CaO} + CO_2 \longrightarrow \underset{100\ \text{gm}}{CaCO_3}$$

$\therefore$ 56 gm of CaO (quick lime) is required to produce 100 gm of $CaCO_3$

$\therefore$ Quantity of CaO required $= \frac{56}{100} \times 3 \text{ mg/l} = 1.68 \text{ mg/l}$

Total amount of CaO required $= 10 \times 10^6 \times 1.68 \times 365$

$\simeq 6132 \times 10^6$ mg per year

Q.131 What is population equivalent of a city, if the average sewage from the city is 10^6 l/day and the average 5 day BOD is 300 mg/l? [Take per capita BOD of domestic sewage as 80 gm/day]

(a) 350000 (b) 262000

(c) 3750 (d) 4500

131. (c)

Total BOD in Sewage $= 300 \times 10^6$ mg/day

$$\text{Population equivalent} = \frac{\text{Total 5 day BOD in kg/day}}{0.08} = \frac{300 \times 10^6 \times 10^{-6}}{0.08} = 3750$$

Q.132 A primary sedimentation sludge has a moisture content of 95% and 65% of the dry solids are volatile. The specific gravity of the volatile solids and that of the fixed solids are 1.00 and 2.2 respectively. What is specific gravity of the total dry solids?

(a) 1.18 (b) 1.22

(c) 1.31 (d) 1.42

132. (d)

Dry solids = Volatile solids + Non votalite solids

= 0.65 + 0.35

$\therefore$ Specific gravity of total dry solids $= \frac{0.65 \times 1 + 0.35 \times 2.2}{0.65 + 0.35} = 1.42$

Q.133 An ideal settling basin is designed with surface overflow rate (SOR) of 1 $m^3/m^2/h$. Particles have their discrete settling velocities and concentration as follows:

Particle type	Settling Velocity (m/h)	Initial concentration (mg/L)
1.	1.0	100
2.	0.5	100
3.	0.1	100
4.	0.05	100

Which one of the following gives correct estimate of the overall removal of particles per hour?

(a) 65 mg/l (b) 165 mg/l

(c) 265 mg/l (d) 365 mg/l

133. (b)

Particles with velocity above or equal to SOR will be completely removed and those with settling velocity below SOR are removed in proportion to $\frac{V}{SOR}$, where V is the settling velocity.

$$\text{Thus overall removal} = 100 + \frac{(0.5 \times 100 + 0.1 \times 100 + 0.05 \times 100)}{1} = 165 \text{ mg/l}$$

Direction : The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).

(b) Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

(c) Statement (I) is true but Statement (II) is false.

(d) Statement (I) is false but Statement (II) is true.

Q.134 **Statement (I):** The load carrying capacity of bored cost in-situ pile in a sandy soil is much less than that of a driven pile of similar dimensions.

Statement (II): A driven pile generates much more frictional resistance than a bored pile.

134. (a)

Q.135 **Statement (I):** When a saturated soil mass is subjected to consolidation, its volume at any instant is related to the total stress.

Statement (II): Total stress is equal to the sum of the effective stress and pore water pressure.

135. (d)

Volume of saturated soil sample at any time = (Initial thickness – settlement) × Area of sample. The volume is related to strain directly. The settlement depends on change in effective stress and not on the change in total stress.

Q.136 **Statement (I):** Rankine's earth pressure theory is a simplified form of Coulomb's earth pressure theory.

Statement (II): Coulomb's theory considers the effect of pore pressures.

136. (c)

The active and passive earth pressure coefficients given by Coulomb's theory reduce to those given by Rankine's theory when $\delta = 0$, $\alpha = 90°$ and $\beta = 0$ i.e., for a smooth vertical wall retaining a backfill with horizontal surface.

Q.137 **Statement (I):** In oven drying method, for soils containing significant amount of organic matter, a temperature range of 60°C – 80°C is recommended.

Statement (II): At higher temperature, organic matter in the soil tends to get oxidized.

137. (a)

Q.138 **Statement (I):** The rate of biomass production will be always lower than the rate of food utilization in a biological system having a mixed culture of micro-organisms.

Statement (II): Catabolism converts only a part of the food into waste products.

138. (a)

If all the food were converted to biomass, then the rate of food utilization would equal the rate of biomass production. But, since catabolism convert only a part of the food into waste products, the rate of food utilization will be greater than the rate of biomass production.

Q.139 **Statement (I):** The minimum self cleansing velocity in the sewer, at least once a day, must be generated.
Statement (II): If certain deposition takes place and is not removed subsequently then, it obstructs free flow and causes further deposition leading to complete blocking of sewer.

139. (a)

Q.140 **Statement (I):** Sanitary landfill can no longer be used for the disposal of solid wastes in India.
Statement (II): The leachets from sanitary landfills pollute the ground water.

140. (a)

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