DETAILED SOLUTIONS

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MPSC 2019 : Main Exam
ASSISTANT ENGINEER

CIVIL ENGINEERING

Test 8

Full Syllabus Test-2 | Paper-II

ANSWER KEY

1.	(a)	18.	(c)	35.	(b)	52.	(b)	69.	(c)
2.	(c)	19.	(b)	36.	(d)	53.	(d)	70.	(d)
3.	(b)	20.	(c)	37.	(a)	54.	(c)	71.	(c)
4.	(a)	21.	(b)	38.	(c)	55.	(c)	72.	(d)
5.	(a)	22.	(a)	39.	(d)	56.	(a)	73.	(c)
6.	(d)	23.	(c)	40.	(c)	57.	(c)	74.	(b)
7.	(d)	24.	(a)	41.	(b)	58.	(b)	75.	(c)
8.	(a)	25.	(a)	42.	(a)	59.	(c)	76.	(c)
9.	(d)	26.	(c)	43.	(a)	60.	(c)	77.	(b)
10.	(a)	27.	(c)	44.	(b)	61.	(b)	78.	(b)
11.	(b)	28.	(a)	45.	(a)	62.	(d)	79.	(b)
12.	(c)	29.	(a)	46.	(b)	63.	(b)	80.	(d)
13.	(c)	30.	(c)	47.	(a)	64.	(d)	81.	(d)
14.	(a)	31.	(d)	48.	(d)	65.	(c)	82.	(c)
15.	(d)	32.	(a)	49.	(c)	66.	(a)	83.	(b)
16.	(b)	33.	(b)	50.	(d)	67.	(a)	84.	(c)
17.	(b)	34.	(c)	51.	(d)	68.	(b)	85.	(a)
								86.	(c)
								87.	(b)
								88.	(b)
								89.	(a)
								90.	(d)
								91.	(d)
								92.	(a)
								93.	(b)
								94.	(a)
								95.	(c)
								96.	(a)
								97.	(c)
								98.	(d)
								99.	(a)
								100.	(c)

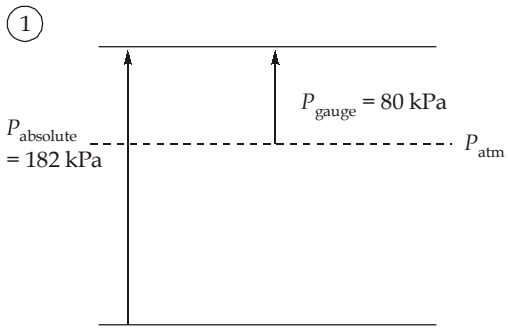
DETAILED EXPLANATIONS

2. (c)

$$\nu = \frac{\mu}{p} = \frac{(1.2/10)\frac{kg}{m\text{-}s}}{(0.8\times1000)\frac{kg}{m^3}} = \frac{12}{8\times10^4} m^2/s$$

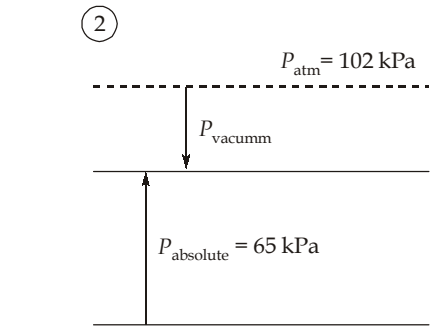
$$= 1.5 \times 10^{-4}\ m^2/s$$

3. (b)



$$P_{abs.} = P_{atm} + P_{gauge}$$

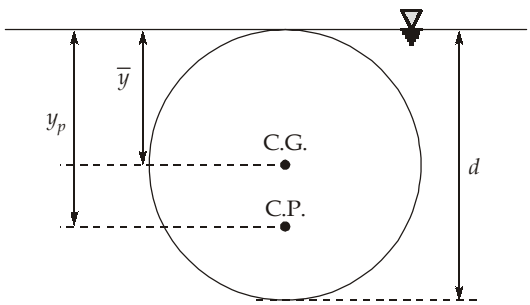
$$P_{atm} = 182 - 80 = 102 \text{ kPa}$$



$$P_{vacuum} = P_{atm} - P_{abs.}$$

$$= 102 - 65 = 37 \text{ kPa}$$

4. (a)



$$y_p = \bar{y} + \frac{I_{GG}}{A\bar{y}} = \frac{d}{2} + \frac{\frac{\pi d^4}{64}}{\frac{\pi}{4}d^2 \times \frac{d}{2}}$$

$$= \frac{d}{2} + \frac{d}{8} = \frac{4d + d}{8} = \frac{5d}{8}$$

5. (a)

A free vortex motion is that in which the fluid mass rotates without any external force being impressed on it. Hence, in a free vortex motion, no expenditure of energy from any external source takes places.

- In free vortex motion since torque applied is zero, angular momentum remain conserved

i.e. $mvr = \text{const}$

$$vr = \text{const}$$

$$\left\{v \propto \frac{1}{r}\right\}$$

6. (d)

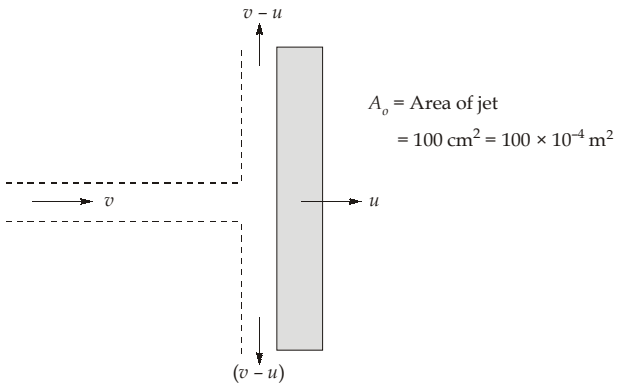
$$\text{Vorticity, } \vec{\xi} = 2\vec{w}$$

∴ Vorticity along z-axis is

$$\xi_z = 2w_z$$

$$= 2\frac{1}{2}\left[\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right] = \left[\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right]$$

7. (d)



The force exerted by the jet in the direction normal to the plate is given by

$$F = \rho A(v - u)^2$$

$$= 1000 \times 100 \times 10^{-4}(20 - 10)^2 = 1000 \text{ N}$$

8. (a)

Meaning of various terms in Bernoulli's equation,

1. $\underset{\left(\frac{\text{Pressure energy}}{\text{mass}}\right)}{\frac{P}{\rho}} + \underset{\left(\frac{\text{Kinetic energy}}{\text{mass}}\right)}{\frac{v^2}{2g}} + \underset{\left(\frac{\text{Potential energy}}{\text{mass}}\right)}{gz} = \text{constant}$

2. $\underset{\left(\frac{\text{Pressure energy}}{\text{weight}}\right)}{\frac{P}{\gamma}} + \underset{\left(\frac{\text{Kinetic energy}}{\text{weight}}\right)}{\frac{v^2}{2g}} + \underset{\left(\frac{\text{Potential energy}}{\text{weight}}\right)}{z} = \text{Constant}$

9. (d)

Discharge over a triangular notch,

$$Q = \frac{8}{15} c_d \sqrt{2g} \cdot \tan\left(\frac{\theta}{2}\right) H^{5/2}$$

$$\Rightarrow \quad Q \propto H^{5/2}$$

Note: Discharge over a rectangular notch,

$$Q = \frac{2}{3} C_d \cdot L\sqrt{2g}\, H^{3/2}$$

$$\Rightarrow \quad Q \propto H^{3/2}$$

10. (a)

As per Froude's model law

$$Q_r = L_r^{5/2} \qquad L_r = 4,\ Q_m = 5\ \text{m}^3/\text{s}$$

$$\frac{Q_p}{Q_m} = (4)^{5/2} = 32$$

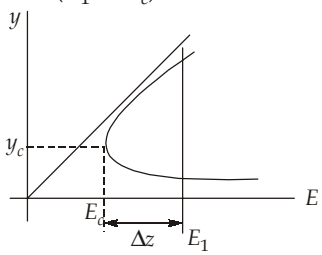
$$Q_p = 32 \times 5 = 160\ \text{m}^3/\text{s}$$

11. (b)

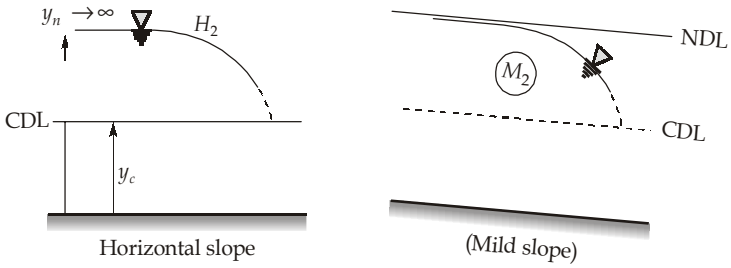
Flow over broad crested weir is critical. Therefore, the hump height Δz above the bed is given by

$$E_1 \geq E_c + \Delta z$$

$$\Delta z \leq (E_1 - E_c)$$



12. (c)



- S_2 does not terminate in the direction of the rather it becomes asymptotic.

14. (a)

A hydraulically equivalent pipe means a pipe which can replace existing compound pipe while carrying same discharge under same losses.

16. (b)

$$C = 1500 \text{ m/s}; L = 3000 \text{ m}$$

$$\text{Critical time of closure } (t_c) = \frac{2L}{c} = \frac{2\times 3000}{1500} = 4''$$

$$\text{Actual time of closure } (t_a) = 4.5''$$

$$t_c < t_a \qquad \text{(Slow closure)}$$

17. (b)

$$N_s = \frac{N\sqrt{Q}}{H^{3/4}}$$

$$N_s \propto \sqrt{Q}$$

$$\frac{(N_s)_1}{(N_s)_2} = \frac{\sqrt{Q}}{\sqrt{Q/2}}$$

$$(N_s)_2 = N_s \cdot \frac{1}{\sqrt{2}}$$

18. (c)

Forebays: It is an enlarged section of a canal spread out to accommodate the required width of intake.

- It is provided with intake structure, to direct water into penstocks.
- It's function is to store temporarily the water rejected by the plant when the electrical load is reduced and also to meet the instantaneous increased demand of water due to sudden increase in load.

19. (b)

Kaplan turbines are axial flow turbines.

20. (c)

$$Q_{th} = \frac{ALN}{60} = \frac{\frac{\pi}{4}\times(0.25)^2\times0.35\times60}{60}$$
$$= 17.18\times10^{-3}\ m^3/sec \simeq 17.2\ Lps$$

21. (b)

Unit weight of soil,

$$\gamma = \left(\frac{G+Se}{1+e}\right)\gamma_w = \left(\frac{G+wG}{1+\frac{wG}{s}}\right)\gamma_w \qquad [Se = wG]$$

$$1+\frac{wG}{S} = G(1+w)\frac{\gamma_w}{\gamma}$$

$$\frac{1}{G}+\frac{w}{S} = (1+w)\frac{\gamma_w}{\gamma}$$

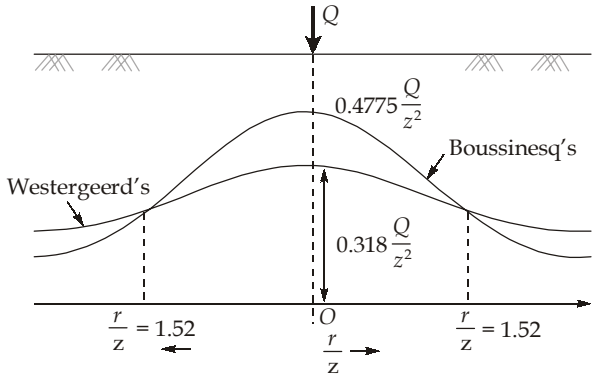
$$\frac{w}{S} = \frac{\gamma_w}{\gamma}(1+w)-\frac{1}{G}$$

$$S = \frac{w}{\frac{\gamma_w}{\gamma}(1+w)-\frac{1}{G}}$$

23. (c)

$$\text{Relative density, } I_D(\%) = \frac{e_{max}-e}{e_{max}-e_{min}}\times100 = \frac{0.6-0.4}{0.6-0.2}\times100 = 50\%$$

24. (a)



25. (a)

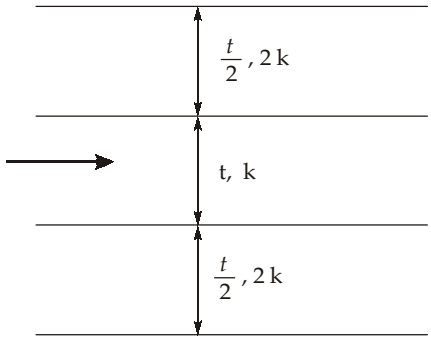
$$n = \frac{e}{1+e} = \frac{0.5}{1+0.5} = \frac{1}{3}$$

$$V_s = \frac{v}{n} = \frac{2.4\times10^{-1}}{1/3} = 7.2\times10^{-1}\ cm/sec$$

27. (c)

$$\text{OCR} = \frac{\bar{\sigma}_c}{\bar{\sigma}} = \frac{125}{75}$$

28. (a)

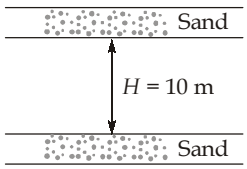


$$k_H = \frac{\Sigma k_i z_i}{\Sigma z_i} = \frac{2k \times (t/2) + k \times t + 2k \times (t/2)}{(t/2) + t + (t/2)} = 1.5\ \text{k}$$

29. (a)

$$\tau_f = c + \sigma_n \cdot \tan\phi$$
$$= 80 + 100 \times \tan(10°)$$
$$= 80 + 100 \times (0.1763) = 97.63\ \text{kPa}$$

30. (c)



$$d = \frac{H}{2} = \frac{10}{2} = 5\ \text{m}$$

$$U = 50\% < 60\%$$

$\therefore$

$$T_v = \frac{\pi}{4}\left(\frac{U}{100}\right)^2 = \frac{\pi}{4}\left(\frac{50}{100}\right)^2 = 0.1963$$

$$C_v = 0.002\ \text{cm}^2/\text{s}$$

$$T_v = \frac{C_v \times t}{d^2}$$

$$0.1963 = \frac{0.002 \times 10^{-4} \times t \times 24 \times 60 \times 60}{(5)^2}$$

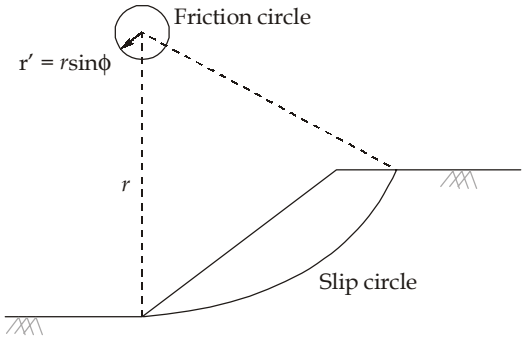
$$t = 284.07\ \text{days} \simeq 284\ \text{days}$$

31. (d)

Coefficient of earth pressure at rest, $(k_o) = \dfrac{\mu}{1-\mu}$

$\therefore \quad \dfrac{1-\mu}{\mu} = \dfrac{1}{k_0}$

32. (a)



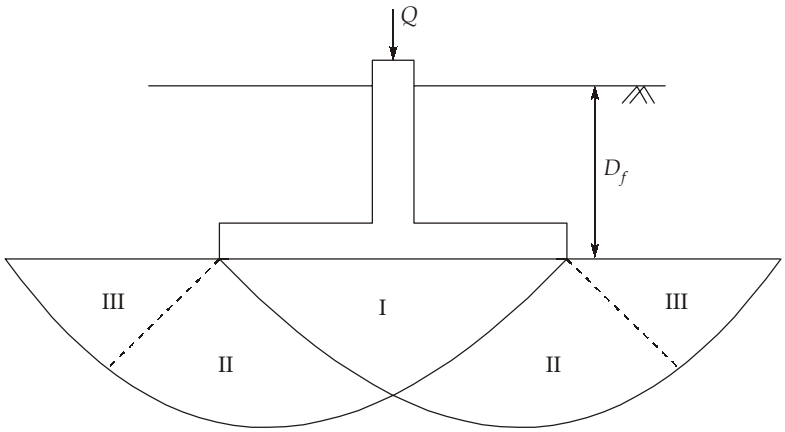
33. (b)

$$k_a = \frac{1-\sin 30°}{1+\sin 30°} = \frac{1}{3}$$

$$P_a = \frac{1}{2}k_a\gamma H^2 = \frac{1}{2}\times\frac{1}{3}\times 2\times(9)^2 = 27 \text{ t/m}$$

34. (c)

As per Terzaghi failure zone in the soil mass is divided into three zones



zone I – zone of elastic equilibrium
zone II – Radial shear zone
zone III – Rankine's passive zone

35. (b)

As per skemption's:

$$q_{nu} = CN_C$$

$$Nc = 6\left(1+0.2\frac{D_f}{B}\right) \text{ for square shape}$$

$\therefore$ $D_f = 0$

$\therefore$ $N_c = 6$

$\therefore$ $q_{nu} = 6\,c$

36. (d)

Engineering news record formula,

$$Q_{allowable} = \frac{wH}{F.O.S(S+C)}$$

Where F.O.S. = 6

W = load(kg)

H = Height of fall (cm)

S = Settlement per blow (cm)

C = Empirical factor

= 2.5 cm – for drop hammer

= 0.25 cm – for single acting steam hammer

39. (d)

Size of shaft is governed by following factors:

i. Amount of muck to be hoisted.

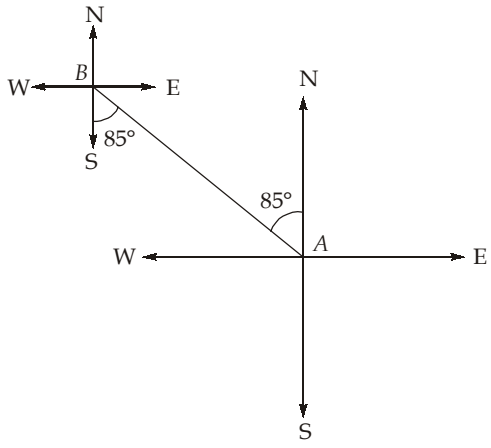
ii. Hoisting system to be adopted.

iii. Size of muck car.

iv. Number of workman.

v. Type of equipment to be used.

40. (c)



B.B of line AB, = S85°E

41. (b)

H.I. = 16 + 1.625 = 17.625 m

R.L. of bottom of roof slab = 17.625 – (– 3.625) = 21.25 m

42. (a)

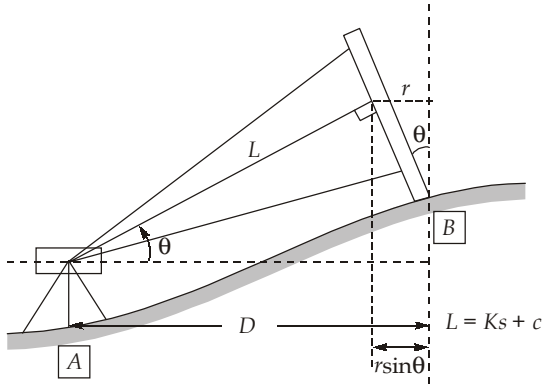
In surveyor's compass, observed bearing are quadrantal bearing which varies from 0° to 90°.

Note: The prismatic compass is used for the determination of the whole circle bearing (W.C.B) of lines which varies from 0° to 360°.

43. (a)

For ordinary work usually single vernier is read, whereas for precise work both the vernier are read and the mean of the two reading is used. This eliminates the error due to eccentricity and imperfection in subdivision which might exists in the circular scale.

45. (a)



$D = L\cos\theta + r\sin\theta$

$= (ks + c)\cos\theta + r\sin\theta$

$C = 0$, Since techeometer is fitted with anallatic lens.

$\therefore \quad D = ks\cos\theta + r\sin\theta$

46. (b)

$$\text{Scale} = \frac{f}{H-h} = \frac{200\,\text{mm}}{(2000-500)\times 1000\,\text{mm}} = \frac{1}{7500}$$

47. (a)

(a) Mid ordinate rule, $A = (h_1 + h_2 + \ldots\ldots\ldots + h_n)d$

(b) Average ordinate rule, $A = \dfrac{(O_1 + O_2 + \ldots\ldots O_{n+1})}{n+1} \times L$

(c) Trapezoidal rule, $A = \left[\dfrac{O_1 + O_n}{2} + O_2 + O_3 + \ldots\ldots + O_{n-1}\right]$

48. (d)

$$\text{Degree of curve, } D° = \frac{1146}{R} \qquad \text{(For 20 m chain length)}$$

$$R = \frac{1146}{2} = 573 \text{ m}$$

52. (b)

Earnest money is taken from all tenders to ensure their interest in tender, this is returned for all unsuccessful tenders.

54. (c)

$$\text{Area of building} = 150 \text{ m}^2$$
$$\text{Courtyard area} = 20 \text{ m}^2$$
$$\text{Plinth area} = 150 - 20 = 130 \text{ m}^2$$
$$\therefore \quad \text{Cost} = 130 \times 1250 = 162,500/-$$

55. (c)

Normally, Earthwork is estimated for 30 m lead (for distance) and 1.5 m for lift (for height or depth) and this distance of 30 m and height of 1.5 m are known as normal lead and lift respectively.

56. (a)

$$\text{Plinth area} = \left(14.7 + \frac{0.3}{2} + \frac{0.3}{2}\right) \times \left(9.7 + \frac{0.3}{2} + \frac{0.3}{2}\right)$$
$$= 15 \times 10 = 150 \text{ m}^2$$

58. (b)

As per 3rd 20 year road plan

$$\text{length of NH} = \frac{\text{Area}(\text{km}^2)}{50} = \frac{13400}{50} = 268 \text{ km}$$

$$\text{Length of SH} = \text{Maximum}\begin{cases} \dfrac{\text{Area}(\text{km}^2)}{25} \\ 62.5 \times \text{No. of towns} - \text{Length of NH} \end{cases}$$

$$= \text{Maximum}\begin{cases} \dfrac{13400}{25} = 536 \text{ km} \\ 62.5 \times 12 - 268 = 482 \text{ km} \end{cases} = 536 \text{ km}$$

59. (c)

$$e = \frac{V^2}{127R}$$

$$= \frac{(40)^2}{127 \times 200} = 0.06299 \simeq 0.063 = 6.3\%$$

60. (c)

$$\text{Longitudinal gradient} = \frac{1}{20} = 5\%$$

$$\text{G.C.} = \frac{30+R}{R} \not> \frac{75}{R} = \frac{75}{76} = 0.986\%$$

$$= \frac{30+76}{76} = 1.394\%$$

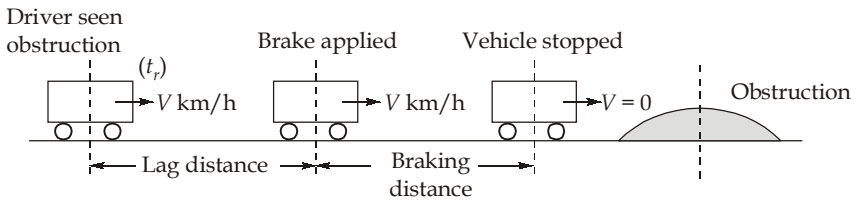
$$\text{G.C.} = 0.986\%$$

Now, compensated gradient,

$$= 5\% - 0.986\% = 4.014\% > 4\%$$

$$\simeq 0.04$$

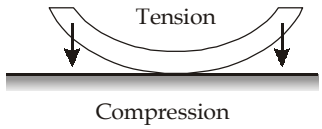
61. (b)



62. (d)

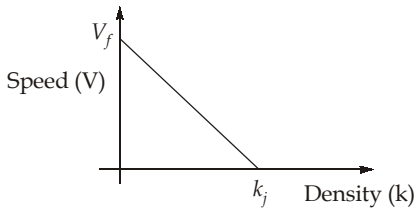
As per IRC, 30th highest hourly volume is considered as design hourly volume.

63. (b)



66. (a)

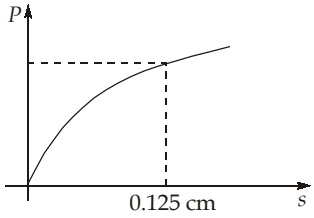
As per green shield, the relation ship between the speed and density should be assumed linear.



$$V = V_f - \frac{k}{k_j} V_f$$

67. (a)

Modulus of subgrade reaction is found out using plate load test (plate bearing test).



Modulus of subgrade reaction is calculated corresponding to the settlement of 0.125 cm.

$$k = \frac{P}{\Delta} = \frac{P\left(\text{kg/cm}^2\right)}{0.125\,\text{cm}}$$

$$k = \frac{P}{0.125}\ \text{kg/cm}^3$$

69. (c)

The CBR method gives the total thickness required of the pavement above a subgrade and the thickness value would remain same irrespective of the quality of materials used in component layers.

74. (b)

The centre line of tunnel on the ground (alignment of tunnel) is located by means of triangulation with the help of micrometer and transit theodolite.

75. (c)

76. (c)

The geometric increase method, gives highest values of forecasted population. This method is suitable for new and younger cities expanding at faster rate. For old cities, the arithmetic method may be better, although incremental method is considered to be the best for any city whether old or new.

77. (b)

Goose-neck is a small curved flexible pipe for making connection between ferrule and service pipe. It is made of lead to provide flexibility. It takes care of to provide flexibility. It takes care of settlement of service pipe and avoid stresses and strains due to temperature change.

78. (b)

In ion exchange method we use zeolites which are hydrated silicates of sodium and aluminium. Which reacts as following:

$$\text{Naz} + \begin{matrix}\text{Ca}\\ \text{Mg}\end{matrix}\left\{\begin{matrix}\text{HCO}_3^-\\ \text{SO}_4^{2-}\\ \text{Cl}^-\end{matrix}\right. \longrightarrow \text{Na}\left\{\begin{matrix}\text{HCO}_3^-\\ \text{SO}_4^{2-}\\ \text{Cl}^-\end{matrix}\right. + \left.\begin{matrix}\text{Ca}\\ \text{Mg}\end{matrix}\right\} \text{Z}$$

- Ion exchange method produces water with zero hardness.

79. (b)

$$\text{Total hardness} = (4 \times 50 + 1 \times 50) = 250 \text{ mg/}l \text{ as } CaCO_3$$
$$\text{Alkalinity} = 3.5 \times 50 = 175 \text{ mg/}l \text{ as } CaCO_3$$

Carbonate hardness

$$\therefore \quad CH = \text{Minimum}\begin{cases} TH \\ \text{Alkalinity} \end{cases} = 175 \text{ mg/}l \text{ as } CaCO_3$$

Also,
$$NCH = TH - CH$$
$$= 250 - 175 = 75 \text{ mg/}l \text{ as } CaCO_3$$

80. (d)

As per IS 10500 : 2012, table

Permissible limit in absence of alternate source,

Turbidity – 5 NTU

Total dissolved solids – 2000 mg/L

81. (d)

The correct sequence for rural water supply is:

Aeration → Plain sedimentation → slow sand Filter → Chlorination

82. (c)

Self cleansing velocity is the minimum velocity at which no solids gets deposited at the bottom of sewer. It must be developed at least once a day and a sewer is commonly designed to attain self cleansing velocity at minimum hourly rate of flow.

83. (b)

$$BOD_5 = (DO)_{\text{Consumed}} \times \text{D.F.}$$
$$= 2 \times \frac{100}{0.5} = 400 \text{ mg/L}$$

84. (c)

Looping plume has a wavy character and occurs in superadiabatic environment which produces highly unstable atmosphere because of rapid mixing.

86. (c)

Sludge with poor settling characteristics is termed as bulking sludge. It occurs due to inadequate air supply resulting in lower pH and septicity. This can be reduced by chlorination of returned activated sludge.

90. (d)

$$\text{Recirculation factor, } F = \frac{1+R}{(1+0.1R)^2} = \frac{1+1}{(1+0.1\times1)^2} = 1.653$$

91. (d)

Aquifer: An aquifer is a saturated formation of earth material which not only stores water but yields it in sufficient quantity relatively easily due to its high permeability.

Ex. Deposits of sand and gravels form good aquifers.

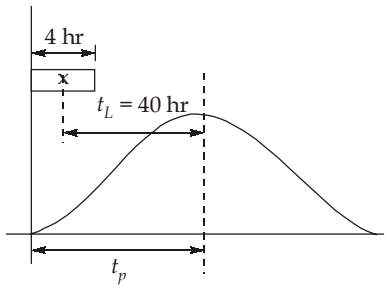
Aquitard: It is a formation through which only seepage is possible and thus the yield is insignificant compared to an aquifer.

Ex. Sandy clay

(Aquiclude): Formations like clay which is highly porous but not permeable due to very small size of pores.

(Aquifuge): It is a geological formations which is neither porous nor permeable.

92. (a)



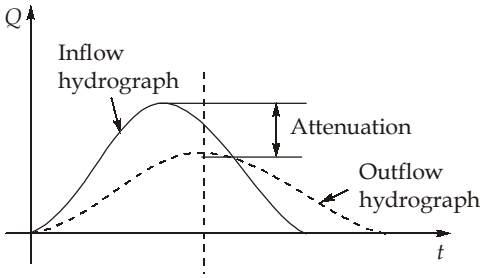
Peak will occur from start at

$$t_p = t_L + \frac{D}{2}$$

$$= 40 + \frac{4}{2} = 42 \text{ hours}$$

93. (b)

Plot of inflow hydrograph and outflow hydrograph (routed hydrograph):



peak of flood hydrograph is lowered and its time base is lengthened.

94. (a)

$$\text{Risk, } R = 1 - \left(1 - \frac{1}{T}\right)^n = 1 - \left(1 - \frac{1}{100}\right)^{20} = 1 - (0.99)^{20}$$

95. (c)

Wind velocity is measured by anemometer humidity is measured by hygrometer evapotranspiration is measured using lysimeter.

Infiltration is measured using:

1. Flooding type infiltrometer
2. Rainfall simulator

96. (a)

During kor watering certain quantity of water is required to be applied in relatively short period hence discharge carrying capacity of the canal has to be maximum during this period.

98. (d)

Net irrigation requirement (NIR) = 15 cm

Water application efficiency, η_a = 80% = 0.8

Water conveyance efficiency, η_c = 60% = 0.6

$$\text{Gross irrigation requirement (GIR)} = \frac{NIR}{\eta_a \eta_c} = \frac{15}{0.8 \times 0.6} = 31.25 \text{ cm}$$

100. (c)

For no tension,
$$B = \frac{H}{\sqrt{S-c}} = \frac{80}{\sqrt{2.4}} = 51.64 \text{ m}$$

For no sliding,
$$B = \frac{H}{\mu(S-c)} = \frac{80}{0.6 \times (2.4)} = 55.56 \text{ m} \simeq 56 \text{ m}$$

Required width will be greater of these two criteria.

$\therefore$ $B = 56$ m

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