Water Resource Engineering Test 3

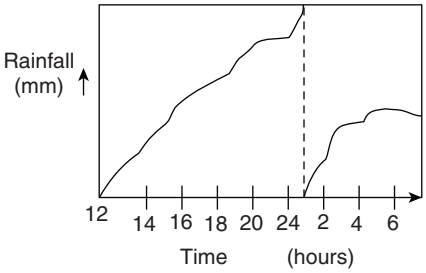
Number of Questions: 30 **Time: 75 min.**

Directions for questions 1 to 30: Select the correct alternative from the given choices.

1. The slope of the rainfall mass curve is zero, when it is horizontal. This happens when the intensity for that period is
(A) constant (B) Increasing
(C) Decreasing (D) Zero

2. Which of the following is not a continuous random variable?
(A) Annual peak flood
(B) Annual runoff
(C) Number of cyclones in a year
(D) Wind velocity

3. The following rainfall chart is from which type of rain gauge.



(A) Weighing bucket type
(B) Float type Raingauge
(C) Tipping bucket type
(D) Both A and B

4. The average pan coefficient of ISI standard pan is
(A) 0.95 (B) 0.8
(C) 0.7 (D) 0.6

5. Storage in the channel is equal to
(A) Prism storage (B) Wedge storage
(C) Largest of A and B (D) (A + B)

6. Which of the following formations does not contain any ground water?
(A) aquifee (B) acquifuge
(C) aquitard (D) aquiclude

7. Moisture equivalent is equal to
(A) Field capacity
(B) Saturation capacity
(C) Available Moisture
(D) Ultimate wilting

8. Indentify the incorrect statement related to the adverse effects of soil salinity or alkalinity, from the following:
(A) Causing low yields of crops
(B) Limiting of the type of crops
(C) Rendering the quality of folder poor
(D) Causing high infiltration, resulting in damage to crops

9. As a result of the construction of a diversion structure across a river, there will be a rise in the flood level on the upstream side of the structure and it is called as
(A) Free board (B) uplift
(C) aggradation (D) afflux

10. Coefficient of discharge of Ogee spillway is
(A) 2 (B) 1.8
(C) 2.2 (D) 2.4

11. A steady groundwater flow is running through an unconfined aquifer of coarse sand under laid by a horizontal impervious formation as shown in figure. The depths of water table below the ground surface in the two observation wells, fixed at a spacing of 300 m along the direction of flow are recorded as 6 m and 6.5m. The sand layer is 30 m thick and its coefficient of permeability is 5×10^{-3} cm/sec. Determine the rate of flow in m^3/day/m width of the quifer.
(A) 0.17 (B) 0.23
(C) 0.38 (D) 0.42

12. Match the parameters in Group - A with Group - B.

	Group – A		Group – B
P.	Isonif	1.	Line joining points having equal rainfall.
Q.	Isohyte	2.	Line joining points having equal snowfall.
R.	Isopleth	3.	A line joining points having equal depths of rainfall of particular duration with particular return period.
S.	Isopluvial	4.	Line joining points having equal depth of evapotranspiration

	P	Q	R	S		P	Q	R	S
(A)	4	3	2	1	(B)	2	1	4	3
(C)	4	1	3	2	(D)	3	1	4	2

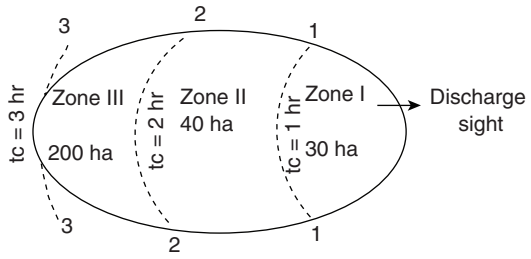
13. Sodium dichromate solution with a concentration of 30mg/cc is introduced into a stream at a rate of 1.7 litres/minute. The samples collected at a downstream section sufficiently far away indicated on equilibrium concentration of 0.001 ppm. Determine the discharge in the stream (Assume no initial concentration of sodium dichromate in the stream)
(A) 424.5 m^3/s (B) 380.6 m^3/s
(C) 298.3 m^3/s (D) 484.1 m^3/s

Common Data for Questions 14 and 15:
Ordinates of 1 hr UGH at 1 hr intervals are 6, 8, 11, 14, 12, 2, 1 m^3/s.

14. Calculate the equilibrium discharge of S-curve in m^3/s.
(A) 53 (B) 54
(C) 55 (D) 56

15. Calculate the maximum ordinate of 3 hr UHG in m^3/s.
(A) 9.33 (B) 8.33
(C) 12.33 (D) 13.33

Common Data for Questions 16 and 17:
A 4 hour rain of average intensity 1.6 cm/hr falls over the catchment as shown below:



The time of concentration from the lines 11, 22, 33 are 1hr, 2hr, and 3hr respectively to the discharge measuring site. The values of run-coefficients are 0.4, 0.5, and 0.6 for 1st, 2nd, 3rd hours of rainfall respectively and there after attains a constant value of 0.65.

16. The discharge at the end of 3 hours period, at the measuring site is
(A) 1.03 m^3/s (B) 1.51 m^3/s
(C) 1.77 m^3/s (D) 2.04 m^3/s

17. The discharge at the end of 5 hours period, at the measuring site, is
(A) 0.58 m^3/s (B) 0.93 m^3/s
(C) 1.21 m^3/s (D) 1.53 m^3/s

18. The isohyets drawn for a storm which occurred over a drainage basin of area 950 km^2 yielded the following information:

Isohyet interval in (mm)	95-85	85-75	75-65	65-55
Area between isohyets in km^2	126	198	224	175

Determine the average depth of rainfall over the basin.
(A) 60.11 mm (B) 68.21 mm
(C) 73.8 mm (D) 80.64 mm

19. Normal annual precipitation of 5 Rain Gauge stations *P*, *Q*, *R*, *S*, *T* are 125, 102, 76, 113 and 137 cm. During a particular storm the precipitation recorded by stations *P*, *Q*, *R*, S are 13.2, 9.2, 6.8 and 10.2 cm. Station *T* was not working. Estimate rainfall during this storm at *T*.
(A) 10.21 cm (B) 12.86 cm
(C) 13.43 cm (D) 7.89 cm

Common Data for Questions 20 and 21:
A 600 sq.km watershed received a 8 hr storm which produced hourly intensities of 4, 10, 16, 20, 11, 2, 13, 4 mm/hr. If the initial abstractions are estimated to be 14 mm and Φ – index is 5 mm/hr.

20. What would be the runoff volume produced by the storm (in hr.m)
(A) 2400 (B) 2000
(C) 3000 (D) 2800

21. What would be the area that can be irrigated, if the above runoff is utilized without wastage to irrigate a land where the depth of irrigation required is 20 cm.
(A) 12000 ha
(B) 10000 ha
(C) 15000 ha
(D) 14000 ha

22. The following data pertains to the healthy growth of a crop. Field capacity of soil = 40%. Permanent witting percentage = 11%. Density of soil = 1400 kg/m^3. Effective depth of root zone = 800 mm. Daily consumptive use of water for the given crop = 15 mm. For healthy growth moisture content must not fall below 25% of the water holding capacity between the field capacity and the permanent witting point. Determine the watering interval in days.
(A) 13 (B) 14
(C) 15 (D) 16

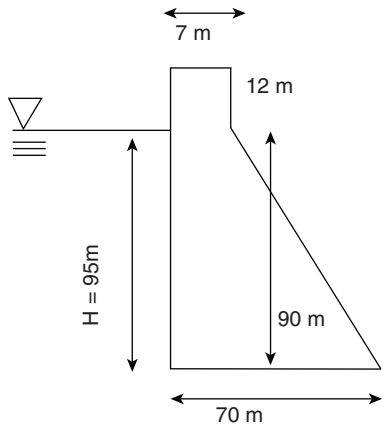
23. Match List - A with List - B

	List – A		**List – B**
P.	CIR	1.	$\frac{C_u + R_e + w}{\eta_a}$
Q.	NIR	2.	$\frac{C_u - R_e + w}{\eta_a . \eta_c}$
R.	FIR	3.	$C_u - R_e$
S.	GIR	4.	$C_u - R_e + w$

CIR – Consumptive Irrigation Requirement
NIR – Net Irrigation Requirement
FIR – Field Irrigation Requirement
GIR – Gross Irrigation Requirement
C_u – Consumptive Use
R_e – Effective Rainfall
w – Water lost in deep percolation
η_a – water application efficiency
η_c – water conveyance efficiency

	P	Q	R	S
(A)	4	3	1	2
(B)	3	4	1	2
(C)	3	4	2	1
(D)	4	3	2	1

24. The given figure gives the profile of a gravity dam with reservoir level as shown. If the coefficient of friction is 0.75, Find the *F.O.S* against sliding and if the dam is safe? (∫concrete = 2.4 tonnes/m^3) (Neglect uplift pressure)



(A) 1.1 and not safe (B) 1.42 and safe
(C) 2.1 and not safe (D) 1.8 and safe

25. A weir across an alluvial river has a horizontal floor of length 70m and retains 7m of water under full pond condition. If the downstream sheet pile is driven to a depth of 6m below the average bed level, calculate the exit gradient if porosity is 30% and the relative density of soil particles as 2.7. Estimate the vertical exit gradient.
(A) $G_E = 0.181$ and $i_C = 1.48$
(B) $G_E = 0.147$ and $i_C = 2.12$
(C) $G_E = 0.147$ and $i_C = 1.19$
(D) $G_E = 0.181$ and $i_C = 2.12$

26. Which of the incorrect statement among the drawbacks in Lacey's theory.
(A) Silt transportation is incorporated in a single factor.
(B) Equations are empirical
(C) Regime conditions are only theoretical
(D) Silt charge and silt grade have not been properly defined.

27. Match the terms of List - A with List - B

	List – A		List – B
P.	Nappe (sheet of water)	1.	Canal regulation work
Q.	Aqueduct	2.	Spillways
R.	Rigid module	3.	Cross drainage work
S.	Canal drop	4.	Canal outlet

	P	Q	R	S		P	Q	R	S
(A)	1	2	3	4	(B)	2	3	1	4
(C)	4	1	3	2	(D)	2	3	4	1

28. Find the discharge over an ogee weir with coefficient of discharge equal to 2.4 at a head of 3m. The length of spillway is 100m. Crest of weir is 10m above the bottom of the approach channel having the same width as that of the spillway
(A) 1247 m^3/s (B) 1276 m^3/s
(C) 1301 m^3/s (D) 1348 m^3/s

Common Data for Questions 29 and 30:
For border strip method of irrigation, discharge in an area from tube well was 0.01 cumecs. The infiltration capacity of the soil may be taken as 6 cm/hour and the average depth of the flow on the field as 10 cm.

29. Determine the time required to irrigate strip of land of 0.05 hectares.
(A) 0.48 hours (B) 48 minutes
(C) 2.98 hours (D) 298 minutes

30. Determine the maximum area that can be irrigated from this tube well.
(A) 0.001 ha (B) 0.02 ha
(C) 0.06 ha (D) 0.2 ha

Answer Keys

1. D	**2.** C	**3.** B	**4.** B	**5.** D	**6.** B	**7.** A	**8.** D	**9.** D	**10.** C
11. A	**12.** B	**13.** A	**14.** B	**15.** C	**16.** D	**17.** A	**18.** C	**19.** B	**20.** A
21. A	**22.** D	**23.** B	**24.** B	**25.** C	**26.** A	**27.** D	**28.** B	**29.** C	**30.** C

Hints and Explanations

11. $Q = k\,I\,A$
$= (5 \times 10^{-3} \times 10^{-2}) \times \left(\frac{6.5-6}{300}\right) \times 1 \times \frac{24+23.5}{2}$
$= 1.979 \times 10^{-6}$ $m^3/s/m$
$= 0.171$ m^3/day/m. Choice (A)

13. $C_o = 0$
$C_T = 30$ mg/cc $= 0.03$ µg/cc
$C = 0.002$ ppm
$= \frac{0.002}{10^6} = 2 \times 10^{-9}$ µg/cc

$Q_T = 1.7$ litres/minute $= \frac{1.7 \times 10^3}{60}$
$= 2.83 \times 10^{-5}$ m^3/s

$C_{min} = \frac{Q_T C_T + Q_R C_R}{Q_T + Q_R}$

$2 \times 10^{-9} = \frac{(2.83 \times 10^{-5} \times 0.03) + 0}{2.83 \times 10^{-5} + Q_R}$

$Q_R = 424.5$ m^3/s. Choice (A)

14.

Time	1 hr UH	S Curve addition	S_A	S_B	$\frac{S_A - S_B}{3} \times 1$ 3 Hr UH
0	0	–	0	–	0
1	6	0	6	–	2
2	8	6	14	–	14/3
3	11	14	25	0	25/3
4	14	25	39	6	11
5	12	39	51	14	37/3
6	2	51	53	25	28/3
7	1	53	**54**	39	5
8	0	54	**54**	51	1
		54	**54**	53	1/3
				54	0

Equilibrium discharge $Q_C = 54$ m³/s. Choice (B)

15. Maximum ordinate = 37/3 = 12.33 m³/s. Choice (C)

16. $Q_{3hr} = \frac{A_1 I_3 R_1}{360} + \frac{A_2 I_2 R_2}{360} + \frac{A_3 I_1 R_3}{360}$

$\frac{1.6 \times 10}{360}$ [(30 × 0.6) + (40 × 0.5) + (20 × 0.4)]

= 2.04 m³/s. Choice (D)

17. $Q_{5hr} = \frac{A_3 I_3 R}{360} = \frac{20 \times 0.65 \times (1.6 \times 10)}{360}$

= 0.58 m³/s. Choice (A)

18. $d = \frac{\Sigma(\text{avg of isohyte}) \times \text{Area}}{\Sigma\text{Area}}$

$= \frac{(90 \times 126) + (80 \times 198) + (70 \times 224) + (60 \times 175)}{(126 + 198 + 224 + 175)}$

= 73.8 mm. Choice (C)

19. $N_x \pm 10\%\ N_x = 137 \pm (10\%\ 137) = 123.3$ to 150.7
Some normal precipations are out of these ranges.
Using Normal ratio method.

$P_x = \frac{N_x}{m}\left[\frac{P_1}{N_1} + \frac{P_2}{N_2} + \ldots \frac{P_m}{N_m}\right]$

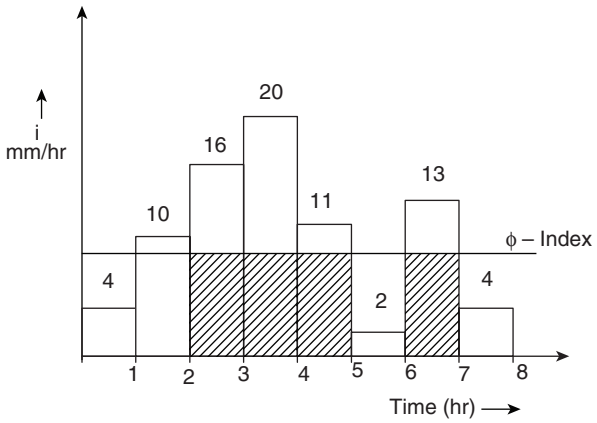
$= \frac{137}{4}\left[\frac{13.2}{125} + \frac{9.2}{102} + \frac{6.8}{76} + \frac{10.2}{113}\right]$

= 12.86 cm. Choice (B)

20. Initial abstractions = losses = 14 mm = 4 + 10
∴ (first 2 hour rainfall not considered)
Φ_{index} = 5 mm/hr

$= \frac{[(16 + 20 + 11 + 13) \times 1 - \text{Runoff}]}{4}$

Runoff = 40 mm = 4 cm



Runoff volume $= \frac{4}{100} \times 600 \times 10^6$

$= 24 \times 10^6$ m³ = 2400 ha.m. Choice (A)

21. Area = $\frac{\text{Volume}}{\text{depth}} = \frac{2400}{0.2}$ = 12000 ha. Choice (A)

22. Water holding capacity above wilting point = $F_C - w_c$ = 40 – 11 = 29%
Optimum moisture
$m_o = 40 - 0.75 \times 29 = 18.25\%$
$d_w = S.d[F_C - m_o]$

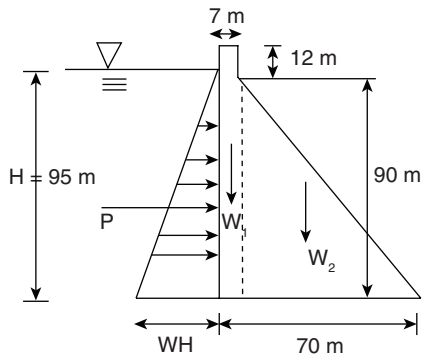
$= \frac{1400}{1000} \times 800[0.4 - 0.1825] = 243.6$ mm

Daily consumptive use C_u = 15 mm

∴ frequency of watering = $\frac{d_w}{C_u} = \frac{243.6}{15}$

= 16.24 ≅ 16 days. Choice (D)

24.



Horizontal water pressure P

$= \frac{wH^2}{2} = \frac{1000}{2} \times (95)^2 \times 10^{-3}$

= 4512.5 tonnes/m

Selfweight $W_1 = 7 \times 102 \times 2.4 = 1713.6$ tonnes/m

$W_2 = \frac{1}{2} \times (70 - 7) \times 90 \times 2.4$

= 6804 tonnes/m

Total self $wt\ W = W_1 + W_2 = 8517.6$ tonnes/m

$$F.O.S \text{ against sliding} = \frac{\mu W}{P} = 0.75 \times \frac{8517.6}{4512.5}$$

$$= 1.416 > 1$$

$\therefore$ safe against sliding. Choice (B)

25. $b = 70$m

$H_s = 7$m

$d = 6$m

$$\therefore \quad = \frac{b}{d} = \frac{70}{6} = \frac{35}{3}$$

$$\lambda = \frac{1\sqrt{1+\propto^2}}{2} = \frac{1+\sqrt{1+\left(\frac{35}{3}\right)^2}}{2} = 6.35$$

Exit hydraulic

Gradient $G_E = \frac{H_s}{d} \times \frac{1}{\pi\sqrt{\lambda}} = \frac{7}{6} \times \frac{1}{\pi\sqrt{6.35}} = 0.147$

Critical hydraulic Gradient

$$i_C = \frac{G-1}{1+e}$$

$$e = \frac{n}{1-n} = \frac{0.3}{1-0.3} = 0.429$$

$$i_C = \frac{2.7-1}{1+0.429} = 1.19.$$ Choice (C)

28. Neglecting approach velocity

$$Q = C_d L H^{\frac{3}{2}} = 2.4 \times 100 (3)^{\frac{3}{2}} = 1247.07 \text{ m}^3/\text{s}$$

Approach velocity

$$V_a = \frac{Q}{\text{Height} \times \text{Width of channel}}$$

$$= \frac{1247.07}{(10+3)\times 100}$$

$$= 0.959 \text{ m/s}$$

$$H_a = \frac{V_a^2}{2g} = \frac{(0.959)^2}{2 \times 9.81} = 0.047 \text{ m}$$

$$H_e = H + h_a = 3 + 0.047 = 3.047 \text{ m}$$

$$Q = 2.4 \times 100 \times (3.047)^{\frac{3}{2}}$$

$= 1276.49$ m^3/s. Choice (B)

29. $Q = 0.01$ cumecs $= 0.01 \times 3600$ m^3/hr

$= 0.0036$ hectare-m/hr

$y = 10$cm $= 0.1$m

$I = 6$cm/hour $= 0.06$ m/hr

$A = 0.05$ hectare

$$t = 2.303 \frac{y}{I} \log_{10}\left(\frac{Q}{Q - IA}\right)$$

$$= \frac{2.303 \times 0.1}{0.06} \log_{10}\left(\frac{0.0036}{0.0036 - 0.06 \times 0.05}\right)$$

$= 2.986$ hours. Choice (C)

30. Maximum area that can be irrigated $= \frac{Q}{I} = \frac{0.0036}{0.06}$

$= 0.06$ ha. Choice (C)