



Nirmaanpro

WBPSA AE Civil Q&A Book — Free Preview

First 12 pages of the full 918-page solved volume

PUBLIC SERVICE COMMISSION · WEST BENGAL

Assistant Engineer (Civil)

Complete Solved Question Bank — Twelve Previous-Year Papers

2016 · 2014 · 2012 · 2007 · 2003 · 2001
1998 — PWD Common · Irrigation · PHE · PWD · CMC
CEA/20 Recruitment Set

1,199 questions, every one worked in full

506 explanatory sketches · complete numerical derivations
distractor analysis on every question

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How to use this volume

This book collects twelve previous-year papers of the West Bengal Public Service Commission Assistant Engineer (Civil) examination — 1,199 questions in all — and works every one of them out in full.

Each paper is a self-contained part. It opens with a divider page, then an answer key you can use to mark a timed attempt, then the questions themselves with the solution printed directly beneath each one. Work the paper first against the clock, mark it from the key, and only then read the solutions for the questions you missed.

The solutions are written to teach the idea, not merely to name the option. Numerical items carry the complete arithmetic, because in a speed exam the fastest route through a calculation is the one you have already rehearsed. Where a drawing settles the matter faster than a paragraph, a sketch is drawn in place — there are 506 of them.

Pay particular attention to the *Why not the others* block under each solution. Every distractor in a well-set paper is built around a specific misconception, and learning to recognise those is worth as much in the hall as learning the correct answers.

ANSWER

The correct option, with the one-line reason it is correct.

Explanation

The concept the examiner is testing, in enough depth to answer a differently-worded version of the same idea.

Working

Step-by-step calculation for numerical questions.

Why not the others

Each wrong option, and the misconception it is designed to catch.

Exam note

Code values, mnemonics and traps worth memorising.

A note on the source: the papers are transcribed from scans of varying quality, and a number of questions reached print with a duplicated option, a truncated line or a mis-set figure. Where that happens the solution gives the answer the engineering supports and shows the working, so you can follow the reasoning rather than take a key on trust.

PART 1 OF 12

Assistant Engineer Examination — 2016 (Civil)

100 questions · 57 sketches
answer key overleaf, then the full solutions

Answer key at a glance

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

1. If the total hardness of water is greater than its total alkalinity, the carbonate hardness will be equal to

- (A) total alkalinity (B) total hardness
(C) noncarbonated hardness (D) total hardness-total alkalinity

ANSWER (A) total alkalinity

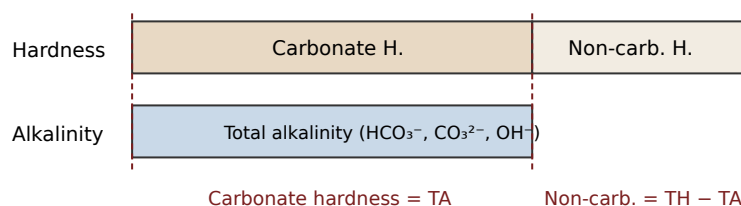
Hardness is caused by Ca^{2+} and Mg^{2+} . Alkalinity is caused by the anions HCO_3^- , CO_3^{2-} and OH^- . *Carbonate* (temporary) hardness is that part of the hardness for which a carbonate or bicarbonate ion is available as the partner — so it can only be as large as whichever of the two quantities runs out first.

The whole topic reduces to a two-line rule:

- If *Total hardness* > *Total alkalinity* → Carbonate hardness = **Total alkalinity**, and Non-carbonate hardness = $\text{TH} - \text{TA}$.
- If *Total hardness* ≤ *Total alkalinity* → Carbonate hardness = **Total hardness**, and Non-carbonate hardness = 0 (the excess alkalinity is then sodium/potassium alkalinity).

The question states $\text{TH} > \text{TA}$, so the first case applies and carbonate hardness equals the total alkalinity.

Case: Total hardness > Total alkalinity



The shorter of the two bars limits how much hardness can be “carbonate” hardness.

Bar diagram: carbonate hardness is limited by whichever of TH or TA is smaller.

WHY NOT THE OTHERS

- (B) Would be true only in the opposite case, $\text{TH} \leq \text{TA}$. Here part of the hardness has no carbonate partner left.
- (C) Non-carbonate hardness is the *remainder*, $\text{TH} - \text{TA}$, not the carbonate part.
- (D) This is precisely the expression for non-carbonate (permanent) hardness — the examiner's intended trap.

EXAM NOTE

Carbonate hardness = lesser of (TH, TA). Memorise it that way and both cases fall out at once.

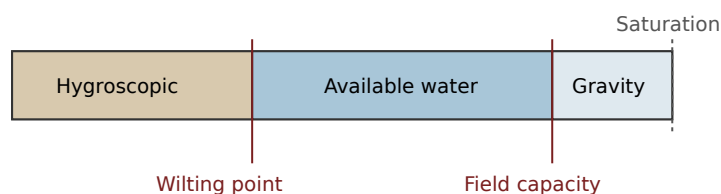
2. Maximum amount of water that a soil can hold by capillary action is called

- (A) wilting point (B) water potential
(C) field capacity (D) osmotic potential

ANSWER (C) field capacity

Field capacity is the moisture content held by a soil against gravity after free drainage from saturation has essentially ceased — usually 2–3 days after irrigation. This water is retained in the capillary pores by surface tension, so it is exactly “the maximum amount of water a soil can hold by capillary action”. It corresponds to a soil suction of roughly 1/3 atmosphere (about 33 kPa).

Field capacity is the upper limit of the water available to a crop; the wilting point is the lower limit. The difference between them is the *available moisture*, and irrigation scheduling is nothing more than refilling the soil from some depletion level back up to field capacity.



Dry → wet. Only the middle band is usable by the crop; irrigation refills up to field capacity.

Soil-moisture bands. Field capacity is the upper limit of capillary-held water.

WHY NOT THE OTHERS

- (A) Wilting point is the *lower* limit — moisture so tightly held that roots cannot extract it and the plant wilts permanently (~15 atm suction).
(B) Water potential is the energy state of soil water (a pressure), not a quantity of water.
(D) Osmotic potential is the component of water potential due to dissolved salts.

EXAM NOTE

FC ≈ 1/3 atm suction; PWP ≈ 15 atm suction. Available moisture = FC – PWP.

3. What is the resultant noise level generated simultaneously from two sources with same intensity of 90 dB respectively?

- (A) 90 dB (B) 95 dB
(C) 93 dB (D) 91 dB

ANSWER (C) 93 dB

Sound levels in decibels are logarithmic, so they cannot simply be added. Intensities add; levels combine as

$$L_{total} = 10 \log_{10} (10^{L_1/10} + 10^{L_2/10})$$

For two *equal* sources the intensity exactly doubles, and $10 \log 2 = 3.01$ dB. So the answer for any pair of equal sources is simply “+3 dB”, regardless of the level.

WORKING

$$L_1 = L_2 = 90 \text{ dB}$$

$$L = 10 \log_{10} (10^9 + 10^9) = 10 \log_{10} (2 \times 10^9) \\ = 10 (\log_{10} 2 + 9) = 10 (0.301 + 9) = 93.01 \text{ dB}$$

$$L \approx 93 \text{ dB}$$

WHY NOT THE OTHERS

- (A) Would require the second source to add nothing at all.
 (B) 95 dB implies about 3.2 times the intensity — this is the “half of 90 + 90” style guess with no basis.
 (D) +1 dB corresponds to an intensity ratio of only 1.26, i.e. adding a much quieter source.

EXAM NOTE

Doubling sound *power* → +3 dB. Doubling sound *pressure* → +6 dB. Ten equal sources → +10 dB.

4. If there is a rain between 8:00 a.m. to 10:30 a.m. and the entire basin just starts contributing water at 8:30 a.m. to the outlet, then the time of concentration will be

- (A) 90 minutes (B) 60 minutes
 (C) 30 minutes (D) 45 minutes

ANSWER (C) 30 minutes

The **time of concentration** (t_c) is the time taken by runoff to travel from the hydraulically most remote point of the catchment to the outlet. The whole basin is contributing to the outlet only after this interval has elapsed from the beginning of rainfall.

Rain begins at 8:00 a.m. The entire basin “just starts contributing” at 8:30 a.m. — that is the instant the most distant droplet's contribution arrives. Hence

$$t_c = 8:30 - 8:00 = 30 \text{ minutes.}$$

The rainfall continuing to 10:30 a.m. is irrelevant to t_c ; the storm duration only matters when you go on to decide whether peak discharge is reached (it is, since duration 150 min > t_c).

WHY NOT THE OTHERS

- (A) 90 minutes is an arbitrary fraction of the storm duration.
 (B) 60 minutes has no event in the problem marking it.
 (D) 45 minutes would be the mid-point of nothing stated.

EXAM NOTE

In the Rational Method $Q = CIA$, the design storm duration is taken equal to t_c , because that is the shortest storm that makes the whole catchment contribute simultaneously.

5. First stage of water treatment is

- (A) plain sedimentation
(B) coagulation
(C) filtration
(D) disinfection

ANSWER (A) plain sedimentation

The conventional order of a surface-water treatment train is:

Screening → Plain sedimentation (grit/plain settling) → Coagulation-flocculation → Clarification → Filtration → Disinfection

Of the four options offered, **plain sedimentation** comes first. It is settling under gravity alone, with no chemicals added, and its job is to strip the coarse, readily-settleable silt so that the later chemical stages are not overloaded. For a very turbid river source this step alone can remove 60–70 % of the suspended load, which is why it is called a “pre-treatment” or “presettling” basin.

WHY NOT THE OTHERS

- (B) Coagulation follows plain sedimentation and treats the colloidal fraction that will not settle on its own.
(C) Filtration is a polishing step, placed after clarification.
(D) Disinfection is always the last unit process before the water enters the clear-water reservoir.

EXAM NOTE

Screening is strictly the first operation of all, but where screening is not offered as an option, plain sedimentation is the intended answer.

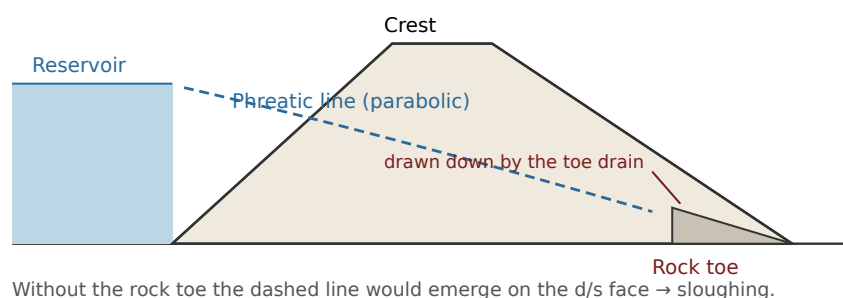
6. To prevent the sloughing of an earthen dam, it is necessary to provide

- (A) riprap
(B) impervious blanket
(C) rock toe
(D) relief wells

ANSWER (C) rock toe

Sloughing is the slipping-away of the downstream face of an earth dam. It happens when the phreatic (seepage) line emerges on the downstream slope: the emerging water raises pore pressure, reduces effective stress, softens the toe, and a shallow slice slides off. The cure is therefore not to armour the face but to *keep the seepage line inside the body of the dam* and give the seepage a controlled exit.

A **rock toe** (with an inverted filter behind it) does exactly this. It intercepts the phreatic line and drops it well below the downstream slope, discharges the seepage safely, and adds weight at the toe where the sliding surface is most critical.



Rock toe intercepts the phreatic line and keeps it clear of the downstream slope.

WHY NOT THE OTHERS

- (A) Riprap is stone armour on the *upstream* face against wave action — it does nothing for internal seepage.
- (B) An impervious blanket extends upstream on the foundation to lengthen the seepage path and cut underseepage; it does not control where the phreatic line emerges downstream.
- (D) Relief wells relieve uplift pressure in a pervious *foundation* stratum, not in the embankment body.

EXAM NOTE

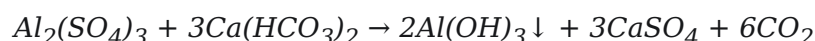
Earth-dam remedies, one line each — Riprap: wave action (u/s). Impervious blanket: underseepage. Rock toe / horizontal filter: sloughing & phreatic control. Relief wells: foundation uplift.

7. Alum acts as

- (A) coagulant
- (B) flocculant
- (C) catalyst
- (D) disinfectant

ANSWER (A) coagulant

Alum, $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$, is the standard **coagulant**. Added to water it hydrolyses and reacts with the natural alkalinity:



The trivalent Al^{3+} ion neutralises the negative surface charge on the colloidal clay particles, destroying the electrostatic repulsion that keeps them dispersed — this charge neutralisation is coagulation. The gelatinous aluminium-hydroxide floc that precipitates then sweeps and enmeshes the destabilised particles.

Note the important consequence: because alum consumes alkalinity, a water of low natural alkalinity needs lime or soda ash added with the alum, or the pH will crash and the floc will not form. Optimum pH for alum is about 6.5–8.5.

WHY NOT THE OTHERS

- (B) Flocculation is the gentle stirring that follows coagulation and grows the pin floc into settleable floc. Alum triggers it but is not itself the flocculant; polyelectrolytes are used as flocculant aids.
- (C) A catalyst by definition is not consumed. Alum is consumed stoichiometrically.
- (D) Alum has no germicidal action. Disinfection is by chlorine, ozone or UV.

EXAM NOTE

Usual alum dose 10–30 mg/l. Rapid mix 30–60 s at high gradient, flocculation 20–40 min at $G \approx 20\text{--}70 \text{ s}^{-1}$.

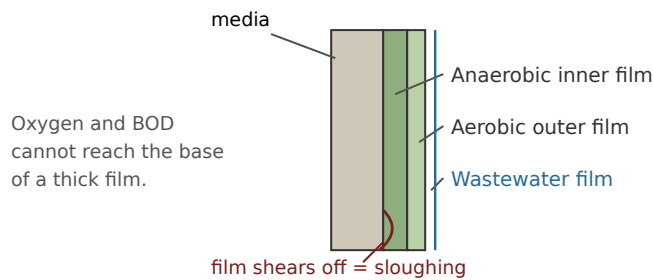
8. Sloughing phenomena is observed in

- (A) oxidation pond
- (B) activated sludge process
- (C) trickling filter
- (D) extended aeration process

ANSWER (C) trickling filter

Sloughing (also called *unloading*) is the periodic shearing-off of the biological slime layer from the media of a **trickling filter**. As the zoogloeal film grows thicker, oxygen and food cannot penetrate to its base; the innermost layer turns anaerobic, loses its grip on the stone, and a sheet of biomass washes off with the effluent. The film then regrows. This is a normal, self-regulating part of

trickling-filter operation, though heavy sloughing shows up as a sudden turbidity spike in the effluent.



Zoogeal film on trickling-filter media; the anaerobic base loses adhesion and sloughs.

WHY NOT THE OTHERS

- (A) An oxidation (stabilisation) pond is a suspended-growth, algal-bacterial system with no fixed film to slough.
- (B) The activated sludge process is suspended-growth; its analogous problems are bulking, foaming and rising sludge.
- (D) Extended aeration is simply a long-SRT variant of activated sludge — again suspended growth.

EXAM NOTE

Sloughing = attached growth (trickling filter, RBC). Bulking = suspended growth (ASP). Don't mix them up.

9. Y-axis of hydrograph indicates

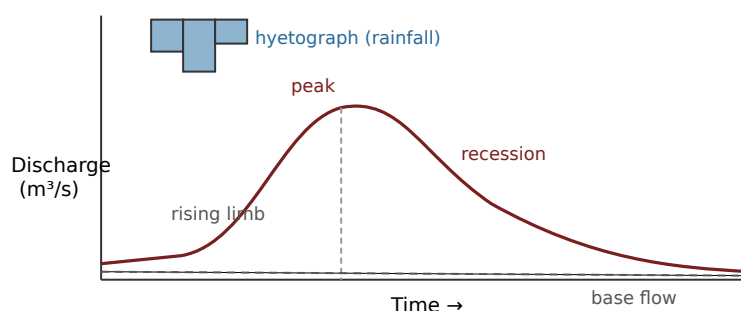
- (A) rainfall
- (B) runoff
- (C) **discharge**
- (D) infiltration

ANSWER (C) discharge

A hydrograph is a plot of **discharge against time** at a specified section of a stream. The ordinate is therefore discharge, normally in m^3/s (cumec), and the abscissa is time.

Keep the family of related plots straight:

- **Hydrograph** — discharge vs time.
- **Hyetograph** — rainfall intensity vs time (usually drawn as a bar chart, inverted at the top of the same sheet).
- **Mass curve** — cumulative rainfall or runoff vs time.
- **Flow-duration curve** — discharge vs percent of time equalled or exceeded.



A flood hydrograph: discharge on the y-axis, time on the x-axis.

WHY NOT THE OTHERS

- (A) Rainfall on the ordinate makes it a hyetograph, not a hydrograph.
(B) Runoff as a *depth or volume* is the area under the hydrograph, not its ordinate. (Careless papers sometimes accept 'runoff', but the precise ordinate is discharge.)
(D) Infiltration vs time is the infiltration capacity curve (Horton's curve).
-

10. Drip irrigation is used in _____ areas.

- (A) marshy (B) flood plain
(C) hilly (D) arid/semi arid

ANSWER (D) arid/semi arid

Drip (trickle) irrigation delivers water drop by drop directly to the root zone through emitters on a low-pressure lateral network. Its whole economic case is **water economy**: field application efficiency reaches 85–95 %, against 60–70 % for surface methods, because there is virtually no conveyance loss, no deep percolation between rows and no evaporation from a wetted soil surface. It is therefore the method of choice in **arid and semi-arid** regions where water is the scarce input, and for widely-spaced high-value row crops — grapes, banana, sugarcane, cotton, orchards and vegetables.

A second benefit matters in exactly those regions: because only a fraction of the soil volume is wetted and the soil is never saturated, salts are pushed to the fringe of the wetted bulb rather than accumulating in the root zone.

WHY NOT THE OTHERS

- (A) Marshy land already has excess water; the problem there is drainage, not irrigation.
(B) Flood plains have shallow groundwater and abundant surface water — cheap surface irrigation suffices.
(C) Hilly areas favour sprinkler irrigation, which handles undulating topography and shallow soils; drip is used there only for specific orchard crops.

EXAM NOTE

Efficiency ranking: Drip (85–95 %) > Sprinkler (70–80 %) > Furrow (60–70 %) > Border/Flooding (50–60 %).

11. In earthen dam the phreatic line is

- (A) linear (B) parabolic
(C) circular (D) elliptical

ANSWER (B) parabolic

The phreatic line (seepage line, or top flow line) is the uppermost streamline of the seepage flow through the body of an earth dam. Along it the pressure is atmospheric. Casagrande showed that this line is very closely a **parabola** — specifically a base parabola with its focus at the downstream toe (or at the upstream end of the horizontal filter, if one is provided), with small corrections at the entry and exit.

The construction is worth remembering:

- Let the water face the upstream slope at point *A*; take *B* on the water surface at the u/s slope and set $AB = 0.3 \times (\text{horizontal projection of the u/s slope})$. Point *B* is the starting point of the



That's the first 12 pages.

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