CLASS TEST

S.No. : 01JP_CE_22072024

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CIVIL ENGINEERING

ENVIRONMENT ENGINEERING

Duration : 1:00 hr. **Maximum Marks : 50**

Read the following instructions carefully

1. This question paper contains **30** objective questions. **Q.1-10** carry one mark each and **Q.11-30** carry two marks each.
2. Answer all the questions.
3. Questions must be answered on Objective Response Sheet (**ORS**) by darkening the appropriate bubble (marked **A**, **B**, **C**, **D**) using HB pencil against the question number. Each question has only one correct answer. In case you wish to change an answer, erase the old answer completely using a good soft eraser.
4. There will be **NEGATIVE** marking. For each wrong answer **1/3rd** of the full marks of the question will be deducted. More than one answer marked against a question will be deemed as an incorrect response and will be negatively marked.
5. Write your name & Roll No. at the specified locations on the right half of the **ORS**.
6. No charts or tables will be provided in the examination hall.
7. Choose the **Closest** numerical answer among the choices given.
8. If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that questions.
9. If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

Q.No. 1 to Q.No. 10 carry 1 mark each

Q.1 The population of a city in the year 2000 was 80000. If average percent increase in population per decade is 40%, the population of the city in the year 2020 estimated by geometrical increase method will be
(a) 155700 (b) 156500
(c) 158200 (d) 156800

Q.2 The acceptable limit of calcium in domestic water supply is
(a) 75 mg/l (b) 200 mg/l
(c) 45 mg/l (d) 100 mg/l

Q.3 Effluent from a wastewater treatment plant (flow rate = 8640 m^3/day, temperature = 25°C) is discharged to a surface stream (flow rate = 1.5 m^3/s, temperature = 18°C). What is the temperature of stream after mixing?
(a) 10°C (b) 18.44°C
(c) 17.47°C (d) 19.23°C

Q.4 The atmosphere extends upto a height of 10000 km. It is divided into the following four thermal layers :
1. Mesosphere 2. Stratosphere
3. Thermosphere 4. Troposphere
The correct sequence of these layers starting from the surface of the earth upwards is
(a) 2, 4, 1 and 3 (b) 4, 2, 3 and 1
(c) 4, 2, 1 and 3 (d) 2, 4, 3 and 1

Q.5 Which one of the following is considered as the mesophilic range of sludge digestion?
(a) 50°C to 57°C (b) 20°C to 45°C
(c) 0° to 20°C (d) 40°C to 70°C

Q.6 For a rapid sand filter, the depth of filter bed is 0.6 m. The porosity before and after the initiating backwashing is 0.5 and 0.6. What will be the head loss through the expended medium? Given, G = 2.5.
(a) 0.75 m (b) 0.45 m
(c) 0.35 m (d) 0.5 m

Q.7 The sound pressure level for a jet plane on the ground with sound pressure of 20000 μbar should be
(a) 60 decibel
(b) 140 decibel
(c) 160 decibel
(d) 180 decibel

Q.8 The capacity of a service reservoir in a campus should cater to
(a) Sum total of balancing storage, breakdown storage and fire reserve.
(b) Balancing storage only.
(c) Sum total of breakdown storage and fire.
(d) Sum total of balancing storage and fire reserve.

Q.9 The pH of water admitted into a treatment plant was 7 in the morning. Consequent to inflow of raw water from a different source, it changed to 9 in the next 24 hours. Assuming linear variation in time of the hydrogen ion concentration, the time mean pH value of the water over this 24 hours period will approx be
(a) 8
(b) 8.30
(c) 8.70
(d) 7.30

Q.10 Which one of the following chemicals is employed for dechlorination of water?
(a) Sodium bicarbonate
(b) Calcium carbonate
(c) Hydrogen peroxide
(d) Sodium sulphite

Q. No. 11 to Q. No. 30 carry 2 marks each

Q.11 The moisture content of a certain municipal solid waste with the following composition will be

	Wet, %weight	Dry, %weight
Food waste	8	2
Paper	37	30
Yard waste	17	12
Others	38	18

(a) 100%
(b) 64%
(c) 37%
(d) 38%

Q.12 An ideal horizontal flow settling basin is 3 m deep and is having surface area of 900 m^2. Water flows at the rate of 8000 m^3/day, at temperature of 20°C ($\mu = 10^{-3}$ kg/m-s and ρ = 1000 kg/m^3). Assuming Stoke's law to be valid, the proportion (percentage) of spherical sand particles (0.01 mm in diameter with specific gravity 2.65), that will be removed is
(a) 67.52 (b) 33.53
(c) 95.51 (d) 87.41

Q.13 A fabric filter is to be constructed using bags that are 0.3 m in diameter and 5 m long. The baghouse is to be receive 10 m^3/s of air, and the appropriate filtering velocity has been determined to be 1.5 m/min. The number of bags required for a continuously cleared operation will be
(a) 65 (b) 19
(c) 85 (d) 104

Q.14 Before entering an underground utility vault to do repairs, a work crew analyzed the gas in the vault and found that it contained 29 mg/m^3 of hydrogen sulphide. Because the allowable exposure level is 14 mg/m^3, the work crew began ventilating the vault with a blower. If the volume of the vault is 160 m^3 and the flow rate of contaminate-free air is 10 m^3/min, how long will it take to lower the hydrogen sulphide level to a level that will allow the work crew to enter?
[Take reaction rate constant k = 1/16 min^{-1}]
(a) 8 min (b) 10 min
(c) 16 min (d) 12 min

Q.15 The coagulant ferric sulphate and ferric chloride is most effective in the pH values of respectively.
(a) 3 and 5.5 (b) 5 and 4.5
(c) 5 and 8.5 (d) 3 and 8.5

Q.16 An aerobic reactor receives wastewater at a flow rate of 400 m^3/d having a COD of 1800 mg/l. The effluent COD is 300 mg/l. Assuming that wastewater contains 75% biodegradable waste, the daily volume of methane produced by the reactor is
(a) 195.4 m^3 (b) 182.2 m^3
(c) 168.7 m^3 (d) 157.5 m^3

Q.17 The 2-day and 4-day BOD values of a sewage sample are 100 mg/l and 175 mg/l, respectively. The value of BOD rate constant at base e (expressed in per day) is
(a) 0.123 (b) 0.132
(c) 0.143 (d) 0.158

Q.18 The maximum velocity in sewer is _____ % times more than full flow velocity.
(a) 17.5 (b) 10.5
(c) 12.5 (d) 120.5

Q.19 A township is to treat 735000 litres of sewage per day which has a 5 day BOD of 190 mg/litre. An oxidation pond is used for the purpose. The effluent can have a BOD of 28 mg/litre. The loading is to be 65 kg of 5 day BOD per hectare per day. The required area (in ha) of the pond is
(a) 2.21 (b) 1.83
(c) 1.765 (d) 3.21

Q.20 A 300 ml control sample bottle containing seeded dilution water only has a drop of 2 mg/l in its DO over 5 days incubation. The BOD bottle (300 ml with 20 ml of waste water and the remaining seeded water) has a drop of 6.8 mg/l. The BOD_5 of the sample is
(a) 64 mg/l (b) 74 mg/l
(c) 84 mg/l (d) 94 mg/l

Q.21 In a high rate trickling filter plant for sewage treatment, the total volume is 4 MLD and recirculation ratio is 1. The incoming BOD is 180 mg/l and organic loading rate is 10000 kg/ha-m/d (excluding recirculate sewage). The efficiency (in %) of this filter is _____.
(a) 66.4% (b) 74.5%
(c) 79.8% (d) 82.7%

Q.22 The population of a city in previous consecutive census years was 500000, 610000, 735000 and 1147000. The anticipated population after four consecutive census from now (or hence) to the nearest 10000 will be _____× 10^4. [Use incremental increase method]
(a) 352 (b) 377
(c) 364 (d) 346

Q.23 Following data pertaining to ASP is given :
Flow, $Q_0 = 0.0796\ m^3/s$
MLSS, $X = 2100\ mg/l$
MLVSS, $X' = 1500\ mg/l$
Return sludge concentration, $X_u = 9100\ mg/l$
The return sludge rate will be
(a) 13.9 l/s (b) 29.5 l/s
(c) 21.4 l/s (d) 23.8 l/s

Q.24 Following chemical species were reported water sample from a well:

Species	Concentration (meq/l)
Chloride (Cl^-)	20
Sulphate (SO_4^{2-})	20
Carbonate (CO_3^{2-})	6
Bicarbonate (HCO_3^-)	25
Calcium (Ca^{2+})	18
Magnesium (Mg^{2+})	20
pH	8.5

Total hardness of water sample in mg/l as $CaCO_3$ is
(a) 2750 (b) 1900
(c) 3150 (d) 2000

Q.25 The gases evolved in sludge digestion process are mainly
(a) CH_4 and H_2S (b) CH_4 and CO_2
(c) H_2S and CO_2 (d) CH_4, H_2S and CO_2

Q.26 A town has an existing horizontal flow sedimentation tank with an overflow rate of 18 $m^3/day/m^2$, and it is desirable to remove particles that have settling velocity of 0.1 mm/s. Assuming that the tank is an ideal sedimentation tank, the percentage of particles removed is approximately equal to
(a) 48% (b) 25%
(c) 41% (d) 36%

Q.27 A city supply of 20000 cubic meters of water per day is treated with a chlorine dosage of 0.75 ppm. For this purposes, the requirement (in kg) of 25% bleaching powder per day would be
(a) 30 (b) 45
(c) 60 (d) 120

Q.28 Two electrostatic precipitators (ESPs) are in series having fractional efficiencies for particle size 'd' as 76% and 69% respectively. The overall efficiency of the system for the same particle size 'd' will be
(a) 74.40% (b) 97.34%
(c) 88.42% (d) 92.56%

Q.29 The equivalent CO concentration of a sample of air is 20 µg/m^3, when analyzed at 0°C and 1 atm pressure. The parts per million of CO concentration is _____.
(a) 0.023 (b) 0.012
(c) 0.016 (d) 0.021

Q.30 Which of the statements is(are) CORRECT?
1. The higher value of pH means higher hydrogen ion concentration.
2. If an acid is added to the neutral water then the number of hydrogen ions will increase.
3. The lower values of pH of water may cause incrustation and higher value of pH of water may cause tuberculation and corrosion of water supply pipes.

(a) 1 and 2
(b) 2 and 3
(c) Only 2
(d) All of the above

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Environment Engineering

CIVIL ENGINEERING

Date of Test : 22/07/2024

ANSWER KEY ➤

1.	(d)	7.	(c)	13.	(c)	19.	(b)	25.	(b)
2.	(a)	8.	(a)	14.	(d)	20.	(b)	26.	(a)
3.	(b)	9.	(d)	15.	(b)	21.	(b)	27.	(c)
4.	(c)	10.	(d)	16.	(d)	22.	(a)	28.	(d)
5.	(b)	11.	(d)	17.	(c)	23.	(d)	29.	(c)
6.	(b)	12.	(d)	18.	(c)	24.	(b)	30.	(c)

DETAILED EXPLANATIONS

1. (d)

$$\because \quad P = P_0\left(1+\frac{r}{100}\right)^n$$

$$\therefore \quad P_{2020} = P_{2000}\left(1+\frac{40}{100}\right)^2$$

Where, $P_0 = P_{2000} = 80000$

$$\therefore \quad P_{2020} = 80000\left(1+\frac{40}{100}\right)^2 = 156800$$

2. (a)

Refer Table 2 of **IS 10500 : 2012**

3. (b)

$$\text{Temperature mix, } T = \frac{Q_w T_w + Q_s T_s}{Q_w + Q_s}$$

$$= \frac{\frac{8640}{24\times 60\times 60}\times 25 + 1.5\times 18}{\frac{8640}{24\times 60\times 60}+1.5} = 18.4375°C \simeq 18.44°C$$

4. (c)

5. (b)

The optimum mesophilic temperature is about 29°C. Thus (b) is correct.

6. (b)

$$D_e(1 - n_e) = D \times (1 - n)$$
$$D_e(1 - 0.6) = 0.6 \times (1 - 0.5)$$
$$D_e = 0.75 \text{ m}$$

Head loss through expanded medium

$$h_e = D_e\,(1 - n_1) \times (G - 1)$$
$$= 0.75 \times (1 - 0.6) \times (2.5 - 1)$$
$$= 0.45 \text{ m}$$

7. (c)

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

where P is sound pressure in N/m^2

P_0 is reference sound pressure 20 μPa = 2×10^{-5} N/m^2

$\because$ P = 20000 μbar

$$= 2 \times 10^4 \times 10^{-6} \times 10^5 \text{ N/m}^2$$
$$= 2000 \text{ N/m}^2$$

$\therefore$ Sound pressure level $= 20 \log_{10}\left(\frac{2000}{2 \times 10^{-5}}\right) = 160$ dB

8. (a)

9. (d)

$\because$ $\text{pH} = -\log_{10}[H^+]$

Initially $\text{pH} = 7$

$\Rightarrow$ $[H^+]_1 = 10^{-7}$ mol/l

After 24 hours

$\text{pH} = 9$

$\Rightarrow$ $[H^+]_2 = 10^{-9}$ mol/l

$\therefore$ H^+ ion average concentration $= \frac{10^{-7} + 10^{-9}}{2} = 5.05 \times 10^{-8}$

$\therefore$ $\text{pH} = -\log_{10}(5.05 \times 10^{-8})$
$= 8 - \log_{10} 5.05 = 7.30$

10. (d)

Some common dechlorinating agents are sodium sulphite (Na_2SO_3), activated carbon, sodium this sulphate ($Na_2S_2O_3$), sodium bisulphite (Na_2SO_3).

11. (d)

Let, total weight of municipal solid waste be 100 kg.

(1)	Wet weight (2)	Dry weight (3)	Moisture (kg) (4) = (2) – (3)
Food waste	8	2	6
Paper	37	30	7
Yard waste	17	12	5
Others	38	18	20
			Total moisture = 38 kg

$\therefore$ Moisture content $= \frac{\text{Weight of water}}{\text{Total weight}} \times 100$

$= \frac{38}{100} \times 100 = 38\%$

12. (d)

Velocity of sand particles,

$$V_s' = \frac{g}{18}(G-1)\cdot\frac{d^2}{\nu}$$

$\Rightarrow$ $$V_s' = \frac{9.81}{18} \times (2.65-1) \times \frac{\left(0.01 \times 10^{-3}\right)^2}{10^{-3}/1000}$$

$$\Rightarrow \quad V_s' = \frac{9.81}{18} \times 1.65 \times 10^{-4}$$

$$\Rightarrow \quad V_s' = 8.9925 \times 10^{-5} \text{ m/s}$$

$$\text{Setting time} = \frac{\text{Volume of tank}}{\text{Water flow rate}}$$

$$= \frac{900 \times 3}{8000} \text{ days} = \frac{2700}{8000} \times 24 = 8.1 \text{ hours}$$

$$\text{Settling velocity, } V_s = \frac{\text{Depth of tank}}{\text{Settling time}}$$

$$= \frac{3}{8.1 \times 3600} = 1.0288 \times 10^{-4} \text{ m/s}$$

$$\therefore \quad \text{Removal efficiency} = \frac{V_s'}{V_s} \times 100$$

$$= \frac{8.9925 \times 10^{-5}}{1.0288 \times 10^{-4}} \times 100 = 87.41\%$$

13. (c)

$$\text{Required cloth area} = 10 \text{ m}^3/\text{s} \times \frac{60s}{\text{min}} = 600 \text{ m}^3/\text{min}$$

$$= \frac{600 \text{ m}^3/\text{min}}{1.5 \text{ m/min}} = 400 \text{ m}^2$$

$$\text{Surface area of one bag} = \pi DH = \pi \times 0.3 \times 5$$

$$= 4.712 \text{ m}^2$$

$$\text{Total number of bags required} = \frac{400}{4.712} = 84.89 \simeq 85$$

14. (d)

The theoretical detention time is $t = \frac{V}{Q} = \frac{160 \text{ m}^3}{10 \text{ m}^3/\text{min}} = 16 \text{ min}$

By using relation, $\frac{C_t}{C_0} = e^{-kt}$

$$\frac{14 \text{ mg/m}^3}{29 \text{ mg/m}^3} = e^{-\frac{t}{16}} \qquad \left[\because k = \frac{1}{16 \text{ min}}\right]$$

$$-0.7282 = -\frac{t}{16 \text{ min}}$$

$t = 11.7 \simeq 12$ min to lower the concentration of hydrogen sulphide to the allowable level.

15. (b)

The coagulant ferric sulphate is effective for pH-value 4 to 9 and ferric chloride is effective for pH-value 3.5 to 6.5.

16. (d)

Organic matter stabilized per day = $Q\,[S_i - S_0] \times \eta$

$$= 400 \times 10^3\,[1800 - 300] \times 0.75$$

$= 450$ kg

$\because$ 1 kg BOD generates 0.35 m^3 methane

$\therefore$ 450 kg BOD generates $= 0.35 \times 450 = 157.5\ m^3$

17. (c)

$y_2 = 100$ mg/l ; $t_2 = 2$ days

$y_4 = 175$ mg/l ; $t_4 = 4$ days

$k = ?$

$$y_2 = y_0\left(1 - e^{-kt_2}\right)$$

$$y_4 = y_0\left(1 - e^{-kt_4}\right)$$

$$\frac{y_2}{y_4} = \frac{1 - e^{-k2}}{1 - e^{-k4}}$$

$$\frac{100}{175} = \frac{1 - e^{-2k}}{1 - e^{-4k}}$$

$1.75 - 1.75x = 1 - x^2$ where, $x = e^{-2k}$

$x^2 - 1.75x + 0.75 = 0$

$x = 1, 0.75$

when $x = 1$

$e^{-2k} = 1$

$\Rightarrow$ $k = 0$

when, $x = 0.75$

$e^{-2k} = 0.75$

$k = 0.1438\ day^{-1}$

18. (c)

The maximum flow velocity in sewer occurs when depth of flow, $d = 0.81D$ and is 12.5% more than velocity at full flow condition.

19. (b)

Sewage produced = 735000 litres/day

5 day BOD of sewage = 190 mg/litres

BOD of effluent = 28 mg/litres

$\therefore$ BOD removed by pond = (190 – 28) = 162 mg/litres

$\therefore$ Sewage solids removed per day = $735000 \times 162 = 119.07$ kg

It is given that organic loading rate = 65 kg/ha/day

$$\therefore \text{Area required for pond} = \frac{119.07}{65} = 1.832\ \text{ha} \simeq 1.83\ \text{ha}$$

20. (b)

$$\text{BOD}_5\ (\text{at } 20°\text{C}) = \frac{(D_1 - D_2) - (B_1 - B_2)(1 - P)}{P}$$

$$= \frac{6.8 - 2.0\left(1 - \frac{20}{300}\right)}{\frac{20}{300}} = 74\ \text{mg/}l$$

21. (b)

BOD to be removed by filter

$$W = 4 \times 180 = 720 \text{ kg/day}$$

Volume of filter media, $V = \dfrac{720}{10000} = 0.072$ ha-m

Re-circulation ratio, $F = \dfrac{1+\dfrac{R}{I}}{\left(1+0.1\dfrac{R}{I}\right)^2} = \dfrac{1+1}{(1+0.1)^2} = 1.65$

$$\eta = \frac{100}{1+0.0044\sqrt{\dfrac{W}{VF}}}$$

$$= \frac{100}{1+0.0044\sqrt{\dfrac{720}{0.072\times 1.65}}} = 74.5\%$$

22. (a)

Census year	Population	Population increment	Incremental increase
1.	500000	110000	15000
2.	610000	125000	287000
3.	735000	412000	
4.	1147000		
		$\bar{x} = \dfrac{647000}{3} = 215666.67$	$\bar{y} = \dfrac{302000}{2} = 151000$

$$P_n = P_0 + n\bar{x} + \frac{n(n+1)}{2}.\bar{y}$$

$\therefore$ $$P_4 = P_0 + 4\bar{x} + \frac{4(4+1)}{2}\times\bar{y}$$

$$= 1147000 + 4 \times 215666.67 + 10 \times 151000$$

$$= 3519666.7 = 3519667 = 351.9667 \times 10^4$$

$$\simeq 352 \times 10^4$$

23. (d)

For ASP, we know that

$\because$ $$\frac{Q_R}{Q_0} = \frac{X}{X_u - X}$$

$$Q_R = \left(\frac{2100}{9100-2100}\right)\times Q_0$$

$$= 0.3 \times 0.0796$$

$$= 0.02388 \text{ m}^3/\text{s}$$

$$Q_R = 23.88 \text{ l/s}$$

24. (b)

Total hardness (due to multivalent metallic cations) = Milliequivalents of $\left(Ca^{2+} \text{ and } Mg^{2+}\right)$

$= 18 + 20$

$= 38$ milliequivalent/l

$= (38 \times 50)$ mg/l $\quad [\because$ Eq. weight of $CaCO_3 = \frac{100}{2} = 50$ mg/meq$]$

$= 1900$ mg/l as $CaCO_3$

25. (b)

In sludge digestion process gases like CH_4 (65 to 70%), CO_2 (30%) and traces of other gases is inert gases like hydrogen sulphide etc. are evolved.

26. (a)

Overflow rate $= 18\ m^3/day/m^2$

$= 18$ m/day

$= \frac{18 \times 1000}{24 \times 60 \times 60} = 0.2083$ mm/sec

Percentage particle removal $= \frac{V_S}{V_0} \times 100 = \frac{0.1}{0.2083} \times 100 = 48\%$

27. (c)

Amount of chlorine required daily $= \frac{0.75 \times 20000 \times 10^3}{10^6} = 15$ kg

Amount of beaching powder required daily $= \frac{15 \times 100}{25} = 60$ kg

28. (d)

The overall efficiency will be η

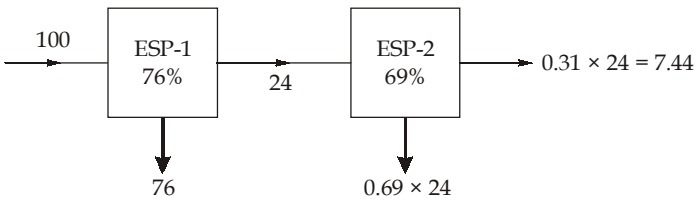
$= 100 \times [1 - (1 - \eta_I)(1 - \eta_{II})]$

where, $\eta_I = 76\%$, $\eta_{II} = 69\%$

$= 100\ [1 - (1 - 0.76)(1 - 0.69)]$

$= 92.56\%$

Alternatively,



$\therefore \quad \eta_{overall} = \frac{(100 - 7.44)}{100} \times 100 = 92.56\%$

29. (c)

$$1\frac{\mu g}{m^3} = \frac{1\text{ppm} \times \text{molecular mass of gas} \times 10^3\, l/\text{m}^3}{l/\text{mole of gas at the given temperature and pressure}}$$

Gram molecular mass of CO = 12 + 16 = 28 gm/mole

At 0°C and 1 atm of pressure (760 mm Hg), the volume of one mole of gas is 22.4*l*,

So, $$\frac{20\ \mu g}{m^3} = \frac{x\ \text{ppm} \times \frac{28g}{mole} \times \frac{10^3 l}{m^3} \times 10^6\ \frac{\mu g}{g}}{\frac{22.4\,l}{mole}}$$

$$\Rightarrow \quad x = \frac{20 \times 22.4}{28 \times 10^9} = 16 \times 10^{-9} = 0.016\ \text{ppm}$$

30. (c)

The higher values of pH means lower hydrogen ions concentration.

Lower value of pH of water may cause tuberculation and corrosion whereas higher values of pH may cause incrustation of water supply pipes.

■■■■