CLASS TEST

S.No.:01_CE_ABC_29042024

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Environment Engineering

CIVIL ENGINEERING

Date of Test : 29/04/2024

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)

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

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

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

$\because \quad$ 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 $= 20\log_{10}\left(\frac{2000}{2\times10^{-5}}\right) = 160$ 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 $= \frac{10^{-7}+10^{-9}}{2} = 5.05\times10^{-8}$

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

$= 8 - \log_{10} 5.05 = 7.30$

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,

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

$\Rightarrow$ $$V_s' = \frac{9.81}{18}\times(2.65-1)\times\frac{(0.01\times10^{-3})^2}{10^{-3}/1000}$$

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

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

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

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

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

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

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

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

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)

$$y_2 = 100 \text{ mg}/l; \quad t_2 = 2 \text{ days}$$
$$y_4 = 175 \text{ mg}/l; \quad t_4 = 4 \text{ days}$$
$$k = ?$$
$$y_2 = y_0\left(1 - e^{-kt_2}\right)$$
$$y_4 = y_0\left(1 - e^{-kt_4}\right)$$
$$\frac{y_2}{y_4} = \frac{1 - e^{-k2}}{1 - e^{-k4}}$$
$$\frac{100}{175} = \frac{1 - e^{-2k}}{1 - e^{-4k}}$$
$$1.75 - 1.75x = 1 - x^2 \qquad \text{where, } x = e^{-2k}$$
$$x^2 - 1.75x + 0.75 = 0$$
$$x = 1, 0.75$$

when $x = 1$

$$e^{-2k} = 1$$

$\Rightarrow$ $k = 0$

when, $x = 0.75$

$$e^{-2k} = 0.75$$
$$k = 0.1438 \text{ day}^{-1}$$

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 × 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)

$$\text{BOD}_5 \text{ (at 20°C)} = \frac{(D_1 - D_2) - (B_1 - B_2)(1 - P)}{P}$$
$$= \frac{6.8 - 2.0\left(1 - \frac{20}{300}\right)}{\frac{20}{300}} = 74 \text{ mg}/l$$

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

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

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

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

22. (a)

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

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

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

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

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

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

23. (d)

For ASP, we know that

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

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

$$= 0.3 \times 0.0796$$

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

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

24. (b)

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

$$= 18 + 20$$
$$= 38 \text{ milliequivalent}/l$$
$$= (38 \times 50) \text{ mg}/l \quad [\because \text{ Eq. weight of } CaCO_3 = \frac{100}{2} = 50 \text{ mg/meq}]$$
$$= 1900 \text{ mg}/l \text{ as } CaCO_3$$

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)

$$\text{Overflow rate} = 18 \text{ m}^3/\text{day}/\text{m}^2$$
$$= 18 \text{ m/day}$$
$$= \frac{18 \times 1000}{24 \times 60 \times 60} = 0.2083 \text{ mm/sec}$$

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

27. (c)

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

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

28. (d)

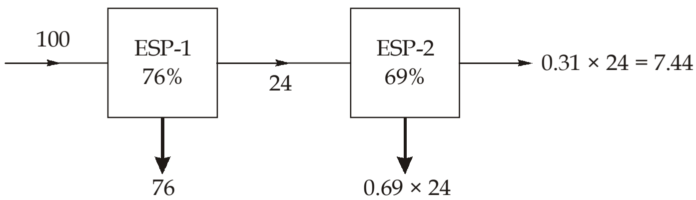
The overall efficiency will be η

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

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 22.4l,

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.

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