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Environmental Engineering

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CLASS TEST 2020-2021

CIVIL ENGINEERING

Date of Test : 10/02/2020

ANSWER KEY ➤ Environmental Engineering

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

DETAILED EXPLANATIONS

1. (c)

$$[CaCl_2] \text{ as } CaCO_3 = \frac{[CaCl_2] \text{ in mg}/l}{\text{equivalent wt of } CaCl_2} \times \text{ equivalent wt of } CaCO_3$$

$$= \frac{165}{55} \times 50 = 150 \text{ mg}/l$$

8. (b)

The presence of nitrogen in sewage indicates the presence of organic matter and may occur in the form of free ammonia, albuminoid nitrogen, nitrites and nitrates. The free ammonia indicates the very first stage of decomposition of organic matter (thrust indicating recently staled sewage); albuminoid nitrogen indicates quantity of nitrogen present in sewage before the decomposition of organic matter is started; the nitrites indicate the presence of partly decomposed (not fully oxidized) organic matter; and nitrates indicate the presence of fully oxidized matter.

9. (a)

Rate of filtreration depends on filter area i.e. length × width. So, the new filter area becomes ($4l \times 3b$) i.e. 12 times more than original area. So, amount of filtered water would become 12 times.

12. (a)

During water supply, temperature should be maintained between 10 to 25°C.

13. (a)

In this disinfection process, we have the relationship,

$$tC^n = k$$

where, t = time required to kill all pathogenic organisms

C = concentration of disinfectant

n = dilution coefficient

k = constant

$$\therefore \quad t_1 C_1^n = t_2 C_2^n \quad \text{...(i)}$$

In our case, $n = 1$

$$t = \frac{L}{V}$$

L = length of pipe, V = velocity of flow

$$\therefore \quad t = \frac{L}{Q/A} = \frac{L \times A}{Q}$$

$$C = \frac{W}{Q}$$

where, W = weight of disinfectant per day

Q = discharge per day

Substituting C and t in equation (i),

$$\frac{L \times A}{Q_1} \times \frac{W_1}{Q_1} = \frac{L \times A}{Q_2} \times \frac{W_2}{Q_2}$$

$$\Rightarrow \quad W_2 = \frac{Q_2^2}{Q_1^2} \times W_1 = \left(\frac{28}{22}\right)^2 \times 40 \text{ kg/d} = 64.79 \text{ kg/day}$$

14. (a)

Quantity of ferrous sulphate = $\dfrac{12 \times 16 \times 10^6}{10^6} = 192$ kg

Chemical reaction:

$FeSO_4 \cdot 7H_2O + Ca(OH)_2 \rightarrow Fe(OH)_2 + CaSO_4 + 7H_2O$

and $Ca(OH)_2 \rightarrow CaO + H_2O$

(Molecular weight of $FeSO_4 \cdot 7H_2O$ = 278, Molecular weight of CaO = 56)

∴ 278 kg of ferrous sulphate will react with 56 kg of lime.

Hence quantity of lime corresponding to 192 kg of ferrous sulphate = $\dfrac{56}{278} \times 192 = 38.68$ kg

15. (a)

$$\text{Total hardness} = \left[Mg^{2+}\right] \times \frac{\text{Eq. wt of } CaCO_3}{\text{Eq. wt of } Mg^{2+}} + \left[Ca^{2+}\right] \times \frac{\text{Eq. wt of } CaCO_3}{\text{Eq. wt of } Ca^{2+}}$$

$$= \left(24 \times \frac{50}{12}\right) + \left(80 \times \frac{50}{20}\right) = 100 + 200 = 300 \text{ mg}/l$$

17. (a)

The computation of increase in population per decade and incremental increase is shown below in table.

Year	Population	Increment per decade	Incremental Increase
1940	200000		
		180500	
1950	380500		– 65800
		115000	
1960	495500		– 44800
		70200	
1970	565700		14400
		84600	
1980	650300		
Total		450300	(–) 96200
Average		$\frac{450300}{4} = 112575$	$-\frac{96200}{3} = -32067$

We know that population after *n* decade by incremental increase method will be,

$$P_n = P + nI + \frac{n(n+1)}{2} \times r$$

Here, I = 112575, r = –32067 and n = 2

Expected population in the year 2000 AD (i.e. after 2 decades) is

$$P_{2000} = 650300 + 2(112575) + \frac{2(2+1)}{2} \times (-32067)$$

$$= 779249$$

Hence water requirement in 2000 AD @ 225 litres/head/day

$$= 779249 \times 225$$
$$= 175.33 \times 10^6 \text{ litres/day}$$
$$\simeq 175.3 \text{ MLD}$$

18. (c)

A sedimentation tank will be more efficient when smaller particles are removed which requires low overflow rate and hence large surface area of tank.

19. (a)

Bacterial growth is logarithmic and is described by the equation,

$$N_t = N_0 e^{\mu t}$$

$$\Rightarrow \quad 10^8 = 20 e^{0.02 \times t}$$

$$\Rightarrow \quad t = 771.247 \text{ minute} = \frac{771.247}{60} \text{hrs} = 12.85 \text{hrs}$$

21. (d)

$$\text{Surface loading rate} = \frac{720}{12 \times 1.5} = 40 \text{ m}^3/\text{hr/m}^2$$

$$\text{Detention time} = \frac{V}{Q} = \frac{12 \times 1.5 \times 0.8}{720} \times 60 = 1.2 \text{ minutes}$$

22. (b)

$$\text{Sewage produced} = 1200000 \text{ litres/day}$$
$$\text{5 day BOD of sewage} = 210 \text{ ppm} = 210 \text{ mg/litre}$$
$$\text{BOD of effluent} = 22 \text{ mg/litre}$$
$$\therefore \quad \text{BOD removed by pond} = (210 - 22) = 188 \text{ mg/litre}$$
$$\therefore \quad \text{BOD removed per day} = 1200000 \times 188 = 225.6 \times 10^6 \text{ mg} = 225.6 \text{ kg}$$

It is given that organic loading = 60 kg/ha/day

$$\therefore \quad \text{Required area} = \frac{\text{Sewage consumed}}{\text{Organic loading}} = \frac{225.5}{60} = 3.76 \text{ ha}$$

23. (a)

Stoke's law states that denser and larger particles have a higher settling velocity, thus a higher overflow rate. Hence size and density of particle affects the overflow rate.

When the temperature decreases, the rate of settling becomes slower. When the water is colder, the flow in the plant is at its lowest and the detention time in the plant is increased so the floc has time to settle out in the sedimentation basins.

26. (b)

Sludge solid removal in sedimentation tank = 0.7 × 300 = 210 mg/l

$$\therefore \text{ Mass of total solids removed per 8 million litres} = \frac{210 \times 8 \times 10^6}{1000} = 1.68 \times 10^6 \text{ gm}$$

$\therefore$ Sludge volume $= \dfrac{28 \times 10^6}{1} = 28 \times 10^6 \text{cc}$

$= 28 \times 10^6 \text{ m}l$

$= \dfrac{28 \times 10^6}{1000} \text{litres} = 28000 \text{ litres}$

27. (b)

$$\text{Intensity level} = 10\log\left(\frac{I}{I_0}\right)$$

In first source, $\dfrac{I}{I_0} = 4$

$\therefore$ Thus increased intensity level $= 10\log\left(\dfrac{I}{I_0}\right) = 10\log(4) = 6\text{dB}$

and in second source, $\dfrac{I}{I_0} = 8$

$\therefore$ Thus increased intensity level $= 10\log\left(\dfrac{I}{I_0}\right) = 10\log(8) = 9\text{dB}$

29. (a)

$Q = 4230 \text{ m}^3\text{/d}$

$N_t = N_0 \, e^{-0.156t}$

Let x be the no. of microorganisms present initially.

97% kill of micro-organisms implies that at time 't' 3% of micro-organisms are still surviving.

$\therefore$ Micro-organisms surviving at time 't' $= \dfrac{3}{100}x$

$\therefore \quad \dfrac{3}{100}x = x \,.\, e^{-0.156t}$

$\therefore \quad t = 22.48 \text{ min}$

$t = 0.0156 \text{ days}$

$\therefore$ Volume $= Q.t$

$= 4230 \times 0.0156$

$= 65.99 \text{ m}^3$

30. (c)

$$Q = \frac{2\pi T(s_1 - s_2)}{ln\left(\frac{r_2}{r_1}\right)}$$

$$T = \frac{55 \times 10^{-3} \times 24 \times 60 \times 60 \times \ln\left(\frac{120}{12}\right)}{2 \times \pi \times (3.5 - 0.75)}$$

$$= 633.25 \text{ m}^2/\text{day}$$

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