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CIVIL ENGINEERING

Objective Practice Sets

Environmental Engineering

1 CHAPTER

Water Demand

Q.1 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

A. Freeman's formula
B. Kuichling's formula
C. Boston's formula
D. National Board of Fire Underwriters formula

List-II

1. $4637\sqrt{P}\left[1-0.01\sqrt{P}\right]$
2. $1136\left[\frac{P}{5}+10\right]$
3. $5663\sqrt{P}$
4. $3182\sqrt{P}$

Codes:

	A	B	C	D
(a)	2	4	3	1
(b)	2	1	3	4
(c)	3	1	2	4
(d)	3	4	2	1

Q.2 The design period for demand reservoir as recommended by the GOI manual on water supply is

(a) 30 years (b) 50 years
(c) 15 years (d) 40 years

Q.3 Which of the following are correctly matched pairs?

1. Arithmetic increase method : Old cities only
2. Geometric increase method : New cities only
3. Incremental increase method: Old cities only

Select the correct option

(a) 1 and 3 (b) 2 and 3
(c) 1 and 2 (d) 1, 2 and 3

Q.4 The total water requirement of a city is generally assessed on the basis of

(a) maximum hourly demand
(b) maximum daily demand + fire demand
(c) average daily demand + fire demand
(d) greater of (a) and (b)

Q.5 The per capita water demand includes

(a) domestic water demand only
(b) domestic and commercial demand
(c) domestic, commercial and industrial demand
(d) domestic, commercial, public, fire and industrial demand

Q.6 Per capita demand for water is affected by which of the following:

1. Size of the city
2. System of supply
3. Cost of water
4. Climatic conditions

Select the correct answer:

(a) 1 and 2 (b) 1, 3 and 4
(c) 1, 2 and 3 (d) 1, 2, 3 and 4

Q.7 If the average weekly consumption of a city is 650000 m^3, the maximum weekly consumption will be

(a) 832000 m^3 (b) 962000 m^3
(c) 1170000 m^3 (d) 1755000 m^3

Q.8 Which of the following factors govern design period of a water supply unit?

(a) Useful life of component structures
(b) Ease and difficulty that is likely to be faced in expansions, if undertaken at future dates
(c) Both (a) and (b)
(d) None of the above

Q.9 The fire demand of a city having a population of 140000 using "National Board of Fire Underwriter's

formula" will be _____ cumecs.

Q.10 In a city with a population of 70,000 water is drawn for domestic purpose from a bell-mouth intake in a canal which runs only for 10 hours a day with flow depth of 1.5 m. If the average consumption per person is 150 lpd, then the intake load is

(a) 0.31 m^3/s (b) 0.29 m^3/s
(c) 0.27 m^3/s (d) 0.25 m^3/s

Q.11 If the population of a growing town in three consecutive decades are 42000, 50000 and 55000, then the saturation value of population of town is

(a) 56233 (b) 70539
(c) 58278 (d) 60526

Q.12 The population of a town in four consecutive year are 5500, 6800, 7500 and 8150 respectively. The population of the town in the fifth consecutive year according to geometrical increase method is

(a) 8321 (b) 8926
(c) 9291 (d) 9829

Q.13 In the equation $P = \dfrac{P_s}{1 + m\log_e^{-1}(nt)}$ of a logistic curve of population growth, 'n' is

(a) $2.3t_1 \log_{10}\left[\dfrac{P_0(P_s - P_1)}{P_1(P_s - P_0)}\right]$

(b) $\dfrac{2.3}{t_1}\log_{10}\left[\dfrac{P_0(P_s - P_1)}{P_1(P_s - P_0)}\right]$

(c) $\dfrac{2.3}{t_1}\log_{10}\left[\dfrac{P_1(P_s - P_0)}{P_0(P_s - P_1)}\right]$

(d) $2.3t_1 \log_{10}\left[\dfrac{P_1(P_s - P_0)}{P_0(P_s - P_1)}\right]$

Q.14 **Statement (I):** The future population is predicted on the basis of knowledge of city and its environment.

Statement (II): The future population depends on the trade and expansion of the city, discovery of mineral deposits, power generation, etc.

(a) Both Statement (I) and Statement (II) are individually true; and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true; but Statement (II) is NOT the correct explanation of Statement (I)
(c) Statement (I) is true; but Statement (II) is false
(d) Statement (I) is false; but Statement (II) is true

Multiple Select Questions (MSQ)

Q.15 In estimating population for assessing water supply demand, using geometric progression method, which of the following statement(s) is/are correct?

(a) This method gives conservative higher values of forecasted population.
(b) In this method percentage growth rate is assumed to be constant.
(c) This method gives correct estimates for a developed city.
(d) In this method, compounding is done every decade.

Q.16 For projecting the population of the town in the year AD 2000 by incremental increase method the following data was available:

Year	Population
1940	25000
1950	27500
1960	34100
1970	41500
1980	54500

Assume the rate of water supply is 200 lpcd in the year 2000. Which of the following option(s) is/are correct?

(a) Expected population at the end of year 2000 is 69250.
(b) Water requirement in year 2000 is 13.85 MLD.
(c) Expected population at the end of year 2000 is 79750.
(d) Water requirement in year 2000 is 15.95 MLD.

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Answers Water Demand

1. (a) 2. (b) 3. (c) 4. (d) 5. (d) 6. (d) 7. (b) 8. (c) 9. 0.806
10. (b) 11. (d) 12. (c) 13. (b) 14. (b) 15. (a, b, d) 16. (c, d)

Explanations Water Demand

2. **(b)**
Design period of demand reservoir in recommended to be of 50 year. Design life of pipe caring raw water as well as treated water in recommended to be 30 years.

3. **(c)**
Geometric increase method gives high results which is suitable for cities growing with fast rate such as new cities whereas arithmetic increase method gives low results which is suitable for cities growing with slow rate such as old cities, however, incremental increase method gives moderate results which can be used for new and old cities both.

4. **(d)**
For general community purposes, the total draft is not taken as the sum of maximum hourly demand and fire demand, but is taken as the sum of maximum daily demand and fire demand, or the maximum hourly demand, whichever is more. The maximum daily demand (i.e. 1.8 times the average daily demand) when added to fire draft for working out total draft, is known as coincident draft.

6. **(d)**
Factors affecting per capita demand for water are:
- Size of city
- Climatic conditions
- Type of gentry and habits of people
- Industrial and commercial activities
- Quality of water supply
- Pressure in the distribution systems
- Development of sewage facilities
- System of supply
- Cost of water
- Policy of metering and method of charging

7. **(b)**
According to Godrich, the ratio of maximum weekly demand to average weekly demand is 1.48.
So, maximum weekly consumption
$= 1.48 \times 650000 = 962000\ m^3$

9. **0.806 (0.750 to 0.850)**
According to National Board of Fire Underwriter's formula,
Fire demand,

$$Q = 4637\sqrt{P}\left(1-0.01\sqrt{P}\right)$$

[Where P in thousand]

$$= 4637\sqrt{140}\left(1-0.01\sqrt{140}\right) l/\text{min}$$

$$= 48374 \text{ litres/min}$$

$$= 0.806 \text{ cumecs}$$

10. **(b)**
Average daily requirement of water
$= 70{,}000 \times 150 = 10500\ m^3/d$
This water shall be withdrawn in 10 hours. So

$$\text{Intake load} = \frac{10500}{60\times10\times60} = \frac{10.5}{36}$$

$$= \frac{3.5}{12} = 0.29\ m^3/s$$

11. **(d)**
Using logistic curve method;
Saturation population is given as,

$$P_s = \frac{2P_0P_1P_2 - P_1^2(P_0+P_2)}{P_0P_2 - P_1^2}$$

where, $P_0 = 42000$
$P_1 = 50000$
$P_2 = 55000$
So we get,
$P_s = 60526$

12. (c)

Assumed growth rate,

$$r = \left(\frac{P_2}{P_1}\right)^{1/t} - 1$$

where,

P_2 is final known population = 8150

P_1 is initial known population = 5500

t is no. of years (period) between P_1 and P_2,

$t = 3$

So, $$r = \left(\frac{8150}{5500}\right)^{1/3} - 1 = 0.14$$

or, $r = 14\%$

Population of town in fifth consecutive year,

$$P_5 = P_4\left(1+\frac{r}{100}\right)^1$$

$$= 8150 \times 1.14 = 9291$$

13. (b)

According to P.F. verhulst, the logistic curve is represented by equation

$$\log_e\left(\frac{P_s - P}{P}\right) - \log_e\left(\frac{P_s - P_0}{P_0}\right) = -K P_s t$$

$$\therefore \quad \log_e\left[\left(\frac{P_s - P}{P_0}\right)\times\left(\frac{P_0}{P_s - P_0}\right)\right] = -K P_s t$$

or, $$\frac{P_s - P}{P}\times\frac{P_0}{P_S - P_0} = \log_e{}^{-1}(-K P_s t)$$

or, $$P = \frac{P_s}{1+\left(\frac{P_s - P_0}{P_0}\right)\log_e{}^{-1}(-K P_s t)}$$

Assume $m = \dfrac{P_s - P_0}{P_0}$ where and $n = -K P_s$ are constant.

If three pairs of characteristic value P_0, P_1 and P_2 at time $t = t_0$, $t = t_1$ and $t_2 = 2t$ are selected, the value of m and n can be found as follows;

$$n = \frac{1}{t_1}\log_e\left[\frac{P_0(P_s - P_1)}{P_1(P_s - P_0)}\right]$$

Option (b) is correct.

15. (a, b, d)

This method is suitable for young cities and rapidly developing cities with a vast scope of expansion.

16. (c, d)

Year	Population	Increase in Population	Increment over the increase
1940	25000		
1950	27500	2500	
1960	34100	6600	4100
1970	41500	7400	800
1980	54500	13000	5600
Total		29500	10500
Average per decade		$\bar{x} = 7375$	$\bar{y} = 3500$

$$\therefore \quad P_{2000} = 54500 + 2 \times 7375 + \frac{2\times3}{2} \times 3500$$

$$= 79750$$

Water requirement @ 200 lpcd

$$= \frac{79750\times200}{10^6}\ \text{MLD} = 15.95\ \text{MLD}$$

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