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 Select the correct relationship between porosity (n), specific yield (S_y) and specific retention (S_r)

(a) $n = S_y + S_r$ (b) $S_y = n + S_r$
(c) $S_r = n + S_y$ (d) $S_r > (n + S_y)$

Q.3 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.4 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.5 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.6 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.7 Main supply pipes (water mains) are designed for

(a) maximum hourly demand
(b) average hourly demand
(c) average annual demand
(d) maximum daily demand

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 effect of a natural disaster on growth rate curve will be

(a) a steep fall of curve
(b) a steep rise of curve
(c) no significant change
(d) curve will become a straight line

Q.10 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.11 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.12 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.13 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.14 In the equation $P = \frac{P_s}{1 + m\log_e^{-1}(nt)}$ of a logistic curve of population growth, 'n' is

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

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

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

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

Q.15 The present population of a community is 28000 with an average water consumption of 4200 m^3/d. The existing water treatment plant has a design capacity of 6000 m^3/d. It is expected that the population will increase to 44000 during the next 20 years. The number of years from now when the plant will reach its design capacity, assuming an arithmetic rate of population growth, will be

(a) 5.5 years (b) 8.6 years
(c) 15.0 years (d) 16.5 years

Q.16 Assertion (A): The future population is predicted on the basis of knowledge of city and its environment.

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

(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.17 Which one of the following factors has the maximum effect on the figure of per capita demand of water supply of a given town?

(a) Quality of water
(b) Industrial demand
(c) System of supply-intermittent or continuous
(d) Method of charging of consumption

■■■■

Answers Water Demand

1. (a)	2. (a)	3. (d)	4. (b)	5. (c)	6. (b)	7. (d)	8. (c)	9. (a)	10. (d)
11. (d)	12. (d)	13. (c)	14. (b)	15. (c)	16. (a)	17. (b)			

Explanations Water Demand

3. (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

5. (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.

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

10. (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,
$P_s = 60526$

11. (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.

13. (c)
Assumed growth rate,

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

where,
P_2 is final known pouliation = 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.

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

$= 8150 \times 1.14 = 9291$

14. (b)
According to P.F. verhulst, the logistic curve is represented by equation

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

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

$$\text{or, } \frac{P_s - P}{P} \times \frac{P_0}{P_s - P_0} = \log_e^{-1}(-KP_st)$$

$$\text{or, } P = \frac{P_s}{1 + \left(\frac{P_s - P_0}{P_0}\right)\log_n^{-1}(-KP_st)}$$

Assume $m = \frac{P_s - P_0}{P_0}$ where and $n = -KP_s$ 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. (c)
Population increases to 44000 in 20 years
∴ Rate of population growth

$$= \frac{44000 - 28000}{20}$$

$= 800$ per year
Population of community that will have design capacity of 6000 m³/d

$$= \frac{28000 \times 6000}{4200} = 40000$$

Population of 40000 will be reached in
$\Rightarrow \quad P_n = P_0 + n\bar{x}$
$\Rightarrow \quad 40000 = 28000 + n \times 800$
$\Rightarrow \quad n = 15$ years