6
CHAPTER

Hydrographs

Q.1 For a given storm, other factors remaining same
(a) basins having low drainage density give smaller peaks in flood hydrographs
(b) basins with larger drainage densities give smaller flood peaks
(c) low drainage density basins give shorter time bases of hydrographs
(d) the flood peak is independent of the drainage density

Q.2 Base flow separation is performed
(a) on a unit hydrograph to get the direct runoff hydrograph
(b) on a flood hydrograph to obtain the magnitude of effective rainfall
(c) on flood hydrographs to obtain the rainfall hyetograph
(d) on hydrographs of effluent streams only

Q.3 A direct runoff hydrograph due to a storm was found to be triangular in shape with a peak of 150 m^3/s, time from start of effective storm to peak is 24 h and a total time base is 72 h. The duration of the storm in this case was
(a) < 24 h (b) between 24 to 72 h
(c) 72 h (d) > 72 h

Q.4 A unit hydrograph has one unit of
(a) peak discharge
(b) rainfall duration
(c) direct runoff
(d) the time base of direct runoff

Q.5 The basic assumptions of the unit hydrograph theory are
(a) nonlinear response and time invariance
(b) time invariance and linear response
(c) linear response and linear time variance
(d) nonlinear time variance and linear response

Q.6 A storm hydrograph was due to 3 h of effective rainfall. It comprised of 6 cm of direct runoff. The ordinates of DRH of this storm
(a) when divided by 3 give the ordinates of a 6 h unit hydrograph
(b) when divided by 6 give the ordinates of a 3 h unit hydrograph
(c) when divided by 3 give the ordinates of a 3 h unit hydrograph
(d) when divided by 6 give the ordinates of a 6 h unit hydrograph

Q.7 A triangular DRH due to a 6-h storm in a catchment has a time base of 100 h and a peak flow of 40 m^3/s. The catchment area is 180 km^2. The 6-h unit hydrograph of this catchment will have a peak flow (in m^3/s) of
(a) 10 (b) 20
(c) 30 (d) None of these

Q.8 The 12 h unit hydrograph of a catchment is triangular in shape with a base width of 144 hours and a peak discharge value of 23 m^3/s. This unit hydrograph refers to a catchment of area
(a) 756 km^2 (b) 596 km^2
(c) 1000 km^2 (d) None of these

Q.9 The 6 h unit hydrograph of a catchment is triangular in shape with a base width of 64 h and peak ordinate of 20 m^3/s. If a 0.5 cm rainfall excess occurs in 6 h in that catchment, the resulting surface runoff hydrograph will have
(a) a base of 128 h
(b) a base of 32 h
(c) a peak of 40 m^3/s
(d) a peak of 10 m^3/s

Q.10 If U_c is the 6-h unit hydrograph for a basin representing 1 cm of direct runoff and U_m is the direct runoff hydrograph for the same basin due to rainfall excess of 1 mm in a storm of 6 hour duration, then
(a) ordinates of U_m are 1/10 the corresponding ordinates of U_c
(b) base of U_m is 1/10 the base of U_c
(c) ordinates of U_m are 10 times the corresponding ordinates of U_c
(d) base of U_m is 10 times the base of U_c

Q.11 For a catchment of an area, S-curve has been derived by using the D hour unit hydrograph which has a time base T. In this S-curve
(a) the equilibrium discharge is independent of D
(b) the time at which the S-curve attains its maximum value is equal to T
(c) the time at which the S-curve attains its maximum value is equal to D
(d) the equilibrium discharge is independent of A

Q.12 An IUH is a direct runoff hydrograph
(a) of one cm magnitude due to rainfall excess of 1 h duration
(b) that occurs instantaneously due to a rainfall excess of 1 h duration
(c) of unit rainfall excess precipitating instantaneously over the catchment
(d) occurring at any instant in long duration

Q.13 An instantaneous unit hydrograph is a hydrograph of
(a) unit duration and infinitely small rainfall excess
(b) infinitely small duration and of unit rainfall excess
(c) infinitely small duration and of unit rainfall excess of an infinitely small area
(d) unit rainfall excess on infinitely small area

Q.14 If a 4-hour unit hydrograph of certain basin has a peak ordinate of 80 m^3/s, the peak ordinate of a 2-hour unit hydrograph for the same basin will be
(a) equal to 80 m^3/s
(b) greater than 80 m^3/s
(c) less than 80 m^3/s
(d) between 40 m^3/s to 80 m^3/s

Q.15 S-hydrograph is used to obtain unit hydrograph of
(a) shorter duration from longer duration
(b) longer duration from shorter duration
(c) both (a) and (b)
(d) None of the above

Q.16 The word 'unit' in the unit hydrograph refers to
(a) unit depth of direct run off
(b) unit duration of storm
(c) unit area of drainage basin
(d) unit base period of hydrograph

Q.17 The direct run off hydrograph of a basin can be approximated as a triangle with base period of 80 hours and a peak flow of 200 m^3/s occurring at 16th hour. If the area of the basin is 1440 km^2 then the depth of run off indicated by the hydrograph will be
(a) 1 cm (b) 2 cm
(c) 10 cm (d) 20 cm

Q.18 A 6 hour storm had 6 cm of rainfall and the resulting runoff was 3 cm. If the ϕ-index remains at the same level, the run off due to 11 cm of rainfall in 8 hours in the catchment is:
(a) 5.50 cm (b) 6.00 cm
(c) 6.50 cm (d) 7.00 cm

Q.19 The number of peaks in a hydrograph may be:
(a) one only (b) two only
(c) more than two (d) All of the above

Q.20 The average yield from the stream may be determined by
(a) Hydrograph
(b) Flow duration curve
(c) Power duration curve
(d) Mass curve

Q.21 Hydrograph is the graphical representation of
(a) runoff and time
(b) surface runoff and time
(c) ground water flow and time
(d) rainfall and time

Q.22 The direct runoff hydrograph of a storm obtained from a catchment is triangular in shape and has a base period of 80 hours. The peak flow rate is 30 m^3/sec and catchment area is 86.4 km^2. The rainfall excess that has resulted the above hydrograph is
(a) 5 cm (b) 8 cm
(c) 10 cm (d) 16 cm

Q.23 A 6-hour unit hydrograph (UH) of a catchment is triangular in shape with a total time base of 36 hours and a peak discharge of 18 m^3/s. The area of the catchment (in sq. km) is
(a) 233
(b) 117
(c) 1.2
(d) Sufficient information not available

Linked Answer Question Q.24-Q.25
An average rainfall of 16 cm occurs over a catchment during a period of 12 hours with a uniform intensity. The unit hydrograph (unit depth = 1 cm, duration = 6 hours) of the catchment rises linearly from 0 to 30 cumecs in six hours and then falls linearly from 30 to 0 cumecs in the next 12 hours. ϕ index of the catchment is known to be 0.5 cm/hr. Base flow in the river is known to be 5 cumecs.

Q.24 Peak discharge of the resulting direct runoff hydrograph shall be
(a) 150 cumecs (b) 225 cumecs
(c) 230 cumecs (d) 360 cumecs

Q.25 Area of the catchment in hectares is
(a) 97.20 (b) 270
(c) 9720 (d) 27000

Q.26 The average rainfall for a 3 hour duration storm is 2.7 cm and the loss rate is 0.3 cm/hr. The flood hydrograph has a base flow of 20 m^3/s and produces a peak flow of 210 m^3/s. The peak of 3-h unit hydrograph will be
(a) 125.50 m^3/s (b) 105.50 m^3/s
(c) 77.77 m^3/s (d) 70.37 m^3/s

Linked Answer Questions Q.27-Q.28

A four hour unit hydrograph of a catchment is triangular in shape with base of 80 hours. The area of the catchment is 720 km^2. The base flow and ϕ-index are 30 m^3/s and 1 mm/h, respectively. A storm of 4 cm occurs uniformly in 4 hours over the catchment.

Q.27 The peak discharge of four hour unit hydrograph is
(a) 40 m^3/s (b) 50 m^3/s
(c) 60 m^3/s (d) 70 m^3/s

Q.28 The peak flood discharge due to the storm is
(a) 210 m^3/s (b) 230 m^3/s
(c) 260 m^3/s (d) 720 m^3/s

Q.29 If the base period of a 6 hour unit hydrograph of a basin is 84 hours, then a 12 hour unit hydrograph derived from this 6 hour unit hydrograph will have a base period of
(a) 72 hours (b) 78 hours
(c) 84 hours (d) 90 hours

Q.30 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Unit hydrograph
B. Synthetic unit hydrograph
C. Darcy's law
D. Rational method

List-II
1. Design flood
2. Permeability
3. Ungauged basin
4. 1 cm runoff

Codes:

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

Q.31 The peak of a 4 hour flood hydrograph is 240 m^3/sec. If the rainfall excess is 80 mm and base flow which is constant is 40 m^3/sec, then the peak of 4-hour unit hydrograph will be
(a) 20 m^3/sec (b) 25 m^3/sec
(c) 30 m^3/sec (d) 35 m^3/sec

Q.32 A 4-hour direct runoff hydrograph of a catchment is triangular in shape with a time base of 100 hours and peak flow of 50 m^3/sec. The catchment area is 360 km^2. The peak flow of this catchment area for a 4-hour unit hydrograph is
(a) 10 m^3/sec (b) 20 m^3/sec
(c) 25 m^3/sec (d) 50 m^3/sec

Q.33 The 6-hour unit hydrograph of a catchment of area 180 km^2 is triangular in shape. If the peak ordinate of this hydrograph is 10 m^3/sec, then the time base is
(a) 50 hours (b) 75 hours
(c) 100 hours (d) 120 hours

Q.34 The ordinates of a 3-hour unit hydrograph for a small catchment are given below:

Time (hour)	Unit hydrograph ordinate (m^3/s)
0	0
3	1.5
6	4.5
9	18.6
12	12.0
15	9.4
18	4.6
21	2.3
24	0.8
27	0

If the design storm produces net rainfall depths of 4.6 cm and 3.5 cm in successive unit periods, and if the base flow is 20 m^3/s, then the peak flood flow (in m^3/s) will nearly be
(a) 270 (b) 130
(c) 90 (d) 86

Q.35 Match List-I (Name of scientist) with List-II (Contribution to field of hydrology) and select the correct answer using the codes given below the lists:

List-I
A. Dalton
B. Snyder
C. Blaney Criddle
D. Sherman

List-II
1. Unit hydrograph
2. Evaporation
3. Empirial flood formula
4. Synthetic unit hydrograph
5. Consumptive use equation

Codes:

	A	B	C	D
(a)	2	3	5	1
(b)	1	4	3	2
(c)	2	4	5	1
(d)	1	3	4	5

Q.36 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Rainfall simulator
B. Interception loss
C. Urbanisation
D. Soil conservation measures

List-II
1. Increased peak in flood hydrograph
2. Study of infiltration characteristics
3. Not significant in maximum flood computation
4. Reduction in peak in small and medium floods

Codes:

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

Q.37 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

A. Hydrograph due to a continuous effective rainfall at a constant rate for infinite period
B. Hydrograph due to an ERH
C. Unit hydrograph derived from regional empirical relationships
D. Unit hydrograph with ordinate expressed in percent of total direct runoff
E. Unit hydrograph whose duration of effective precipitation is infinitesimally small

List-II

1. Synthetic unit
2. DRH
3. S-curve
4. IUH
5. Distribution graph

Codes:

	A	B	C	D	E
(a)	2	1	3	5	4
(b)	2	1	4	5	3
(c)	4	2	1	3	5
(d)	3	2	1	5	4

Q.38 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

A. Khosla formula
B. Stanford watershed simulation model (SWM-IV)
C. Snyder's method
D. Log-Pearson type -III distribution

List-II

1. Prediction of yield of a catchment
2. Empirical rainfall-seasonal runoff relationship
3. Flood frequency studies
4. Storage computation
5. Synthetic unit hydrograph

Codes:

	A	B	C	D
(a)	2	4	5	1
(b)	2	1	5	3
(c)	1	3	5	2
(d)	2	1	4	3

Q.39 The following hydrological features have to be estimated or taken as inputs before one can compute the flood hydrograph at any catchment outlet

1. Unit hydrograph
2. Rainfall hydrograph
3. Infiltration index
4. Base flow

The correct order in which they have to be employed in the computations, is

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

Q.40 Unit hydrographs are generally used for

1. developing flood hydrographs for extreme rainfall magnitudes for the design of hydraulic structures.
2. extending flood flow records by using the available rainfall records.
3. developing flood forecasting and warning system based on rainfall data.

The correct answer is

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

Directions: The following items consists of two statements; one labelled as 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(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.41 Assertion (A): Instantaneous unit hydrograph (IUH) is used extensively in theoretical analyses of rainfall-excess runoff characteristics of a catchment.

Reason (R): For a given catchment, IUH being independent of rainfall characteristics, is indicative of the catchment storage characteristics.

Q.42 Assertion (A): The recession time of a flood hydrograph is independent of storm characteristics and depends entirely on the basin characteristics.

Reason (R): The starting point of the recession time represents the time of cessation of rainfall.

Q.43 Assertion (A): Given a D_1-hour unit hydrograph. Another D_2-hour hydrograph for the catchment is required to be developed.

Reason (R): The method of superposition is applicable in the use of unit hydrographs.

Q.44 The use of the unit hydrograph for estimating floods is limited to catchments of size less than

(a) 5000 km^2 (b) 500 km^2
(c) 10^6 km^2 (d) no upper limit.

Q.45 In a storm-hydrograph, generally

(a) climatic factors control the recession limb
(b) the rising limb is determined essentially by catchment characteristic
(c) the recession limb is independent of catchment characteristics
(d) the shape of recession limb is independent of storm characteristics and depends entirely on basin

Q.46 Identify the correct statement:

(a) Fan shaped catchments give low-peaked and narrow hydrographs
(b) Nearly semicircular shaped catchments give high-peak and narrow hydrographs
(c) Elongated catchment shapes give highpeak and broad hydrograph
(d) Elongated catchment shapes give highpeak and narrow hydrograph

Q.47 The recession limb of a flood hydrograph can be expressed with positive values of coefficients as Q/Q_0 =

(a) $K\,e^{at}$ (b) $a\,K^{-at}$
(c) e^{-at} (d) e^{-at^2}

Q.48 The peak discharges in 6 h and 12 h unit hydrographs of a catchment occur at t_6 and t_{12} hours from the start. Then

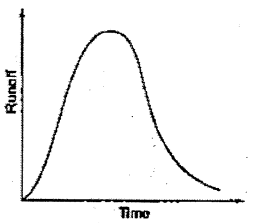
(a) $t_6 > t_{12}$
(b) $t_6 = t_{12}$
(c) $t_6 < t_{12}$
(d) $t_6 = t_{12}$ for triangular UH

Q.49 To determine the reservoir storage capacity for a given uniform demand, one of the following data is most useful:

(a) unit hydrograph of the basin
(b) stage-discharge relation for the stream at the reservoir site
(c) daily flow-duration curve of the stream at the dam site
(d) mass curve of the flow volumes for several consecutive years

Q.50 The given figure shows the curve of a hydrograph. Which of the following would cause the peak of the curve to shift to the right?

1. When the length of the overland flow is more
2. When the slope of the land surface is less
3. When the run-off is more
4. When the rainfall is moderate



Select the correct answer using the codes given below:

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

Q.51 The following steps are involved in arriving at a unit hydrograph:

(i) estimating the surface run off in depth.
(ii) estimating the surface run off in volume.
(iii) separation of base flow.
(iv) dividing surface run off ordinates by depth of run off.

The correct sequence of these steps is
(a) (iii), (ii), (i) and (iv)
(b) (ii), (iii), (iv) and (i)
(c) (iii), (i), (ii) and (iv)
(d) (iv), (iii), (ii) and (i)

Q.52 In an *S*-curve derived by a unit hydrograph *U* of *D*-*h* duration
(a) the equilibrium discharge is independent of *D*
(b) the time base of *UH* represents the time at which the *S*-curve attains its maximum value
(c) the equilibrium discharge of an *S*-curve is independent of the catchment area of the basin
(d) the ordinate is in units of volume

Q.53 The ordinate of the IUH of a catchment at any time t is the
(a) slope of the 1-hour UH at that time
(b) slope of the ERH at that time
(c) slope of the S-curve of intensity 1 cm/h
(d) difference in the slopes of the S-curve and 1-hour UH at that time

Q.54 The point of inflection on the recession limb of a hydrograph represents
(a) the cessation of rainfall
(b) the condition of maximum storage in the catchment
(c) the end of base flow
(d) peak runoff rate

Q.55 A 4 hour unit hydrograph of a basin with area of 1728 km² can be approximated as a triangle with base period of 48 hours. The peak ordinate of hydrograph is
(a) 400 m³/s (b) 300 m³/s
(c) 200 m³/s (d) 100 m³/s

Q.56 If a 4-h unit hydrograph of a catchment has a peak ordinate of 60 m³/s, the peak ordinate of an 8-h unit hydrograph for the same catchment will be
(a) > 60 m³/s (b) = 60 m³/s
(c) < 60 m³/s (d) data inadequate

Q.57 For a catchment area of 36 km², the equilibrium discharge of an S-curve obtained by 2-hour unit hydrograph summation is
(a) 25 m³/sec (b) 50 m³/sec
(c) 100 m³/sec (d) 72 m³/sec

Q.58 If two 4-hour unit hydrographs are staggered by 4-hours and added graphically, the resulting hydrograph will be
(a) 4-hour unit hydrograph
(b) 4-hour hydrograph with 20 mm runoff
(c) 8-hour unit hydrograph
(d) 8-hour hydrograph with 20 mm runoff

Q.59 A 6 hour unit hydrograph is having triangular shape with peak ordinate of 30 m³/sec and base width of 64 hours. The equilibrium discharge of an S-curve obtained by using this 6 hour unit hydrograph is
(a) 140 m³/s (b) 150 m³/sec
(c) 160 m³/sec (d) 180 m³/sec

Q.60 The 6-h unit hydrograph of catchment is in the form of triangle with peak of 100 m³/s occuring at 24 h from the start and the base is 72 hr. The area of the catchment represented by this unit hydrograph is:
(a) 1629 km² (b) 1692 km²
(c) 1962 km² (d) 1296 km²

Q.61 The recession of storage of water in flood hydrograph for a basin can be expressed in form of exponential decay/linear decay as:
(a) $Q_0 e^{(nk)t}$ (b) $Q_0 e^{-(nk)t^2}$
(c) $Q_0 e^{-(nk)t}$ (d) $Q_0 e^{-(nk)t^2}$
where Q_0 = Discharge at $t = 0$, k = recession constant, t = time.

Q.62 A 750 ha catchment has a time of concentration of 90 minutes. The peak discharge for 15-minute unit hydrograph for this watershed. Using SCS triangular unit hydrograph method is:
(a) 10.24 m³/sec (b) 20.48 m³/sec
(c) 15.24 m³/sec (d) 10.48 m³/sec

■■■■

Answers Hydrographs

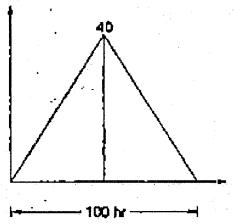
1. (a)	2. (b)	3. (a)	4. (c)	5. (b)	6. (b)	7. (a)	8. (b)	9. (d)	10. (a)
11. (b)	12. (c)	13. (b)	14. (b)	15. (c)	16. (a)	17. (b)	18. (d)	19. (c)	20. (a)
21. (a)	22. (a)	23. (b)	24. (b)	25. (c)	26. (b)	27. (b)	28. (b)	29. (d)	30. (c)
31. (b)	32. (b)	33. (c)	34. (b)	35. (c)	36. (a)	37. (d)	38. (b)	39. (d)	40. (d)
41. (a)	42. (c)	43. (a)	44. (a)	45. (d)	46. (b)	47. (c)	48. (c)	49. (d)	50. (c)
51. (a)	52. (b)	53. (c)	54. (b)	55. (c)	56. (c)	57. (b)	58. (d)	59. (c)	60. (d)
61. (c)	62. (b)								

Explanations Hydrographs

3. (a)
The rising limb of a hydrograph, represents the increase in discharge due to the gradual building up of storage in channels and over the catchment surface. Basin and storm characteristics control the shape of the rising limb of a hydrograph. The recession limb is independent of storm characteristics and depends entirely on basin characteristics. Therefore, the duration of the storm in this case will be less than time from start of effective storm to peak i.e., < 24 hr.

5. (b)
Unit Hydrograph is based on following two basic assumptions:
(i) **Time invariance:** According to this assumption the direct run-off hydrograph for a given effective rain fall is always the same in catchment irrespective of the time when the rain fall or storm takes place.
(ii) **Linear response:** It is the single most important assumption in the theory of unit hydrograph. According to this assumption any variation in the input value is proportionally reflect in the outlet value.
Hence option (b) is correct.

7. (a)



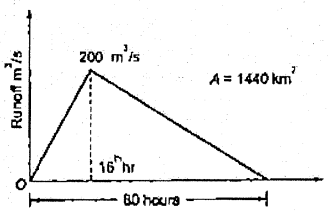
$$V = \frac{1}{2} \times 100 \times 3600 \times 40 \text{ m}^3$$
$$= 50 \times 40 \times 3600 \text{ m}^3$$
Rainfall excess
$$= \frac{V}{A} = \frac{40 \times 50 \times 3600}{180 \times 10^6}$$
$$= 0.04 \text{ m} = 4 \text{ cm}$$
For 1 cm hydrograph peak flow $= \frac{40}{4} = 10 \text{ m}^3/\text{s}$

8. (b)
$$A = \frac{V}{0.01} = \frac{\frac{1}{2} \times 144 \times 3600 \times 23}{0.01}$$
$$= 596.16 \text{ km}^2 \simeq 596 \text{ km}^2$$

14. **(b)**
With the reduction of unit hydrograph duration, 1 cm excess rainfall will occur in reduced period. So peak ordinate of UH will increase and the time base will decrease. Thus the peak ordinate of 2 hr UH will be greater than 80 m^3/s.
Hence option (b) is correct.

16. **(a)**
Direct runoff depth $(n) = \dfrac{0.36\ \Sigma o_i t_i}{A} = 1$ (unit)

17. **(b)**



Direct runoff depth,

$$d = \frac{0.36 \times \text{Area of hydrograph}}{\text{Area of catchment (in km}^2)}$$

$$\Rightarrow \quad d = \frac{0.36 \times \left(\frac{1}{2} \times 80 \times 200\right)}{1440}$$

$$\Rightarrow \quad d = 2 \text{ cm}$$

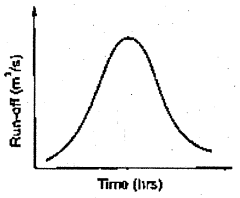
Hence option (b) is correct.

18. **(d)**
Case-1:
Precipitation
P_1 = 6 cm in 6 hour
Runoff O_1 = 3 cm

$$\phi\text{-Index} = \frac{P-Q}{t} = \frac{6-3}{6} = 0.5 \text{ cm/hr}$$

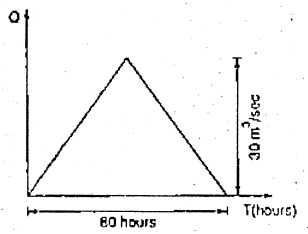
Case-2:
Precipitation
P_2 = 11 cm in 8 hours
Infiltration in 8 hrs = 0.5 × 8 = 4 cm
I = 4 cm
Thus the run-off due to 8 hr storm,
$Q = P - I = 11 - 4 = 7$ cm
Hence option (d) is correct.

21. **(a)**



A hydrograph or a runoff hydrograph is the graphical representation of the discharge flowing in a river at the given location with passage of time.

22. **(a)**



$$\text{Rainfall excess} = \frac{\text{Volume of hydrograph}}{\text{Catchment Area}}$$

$$= \frac{\frac{1}{2} \times 30 \times 80 \times 60 \times 60 \text{ m}}{86.4 \times 10^6}$$

$$= 0.05 \text{ m} = 5 \text{ cm}$$

23. **(b)**
Area of catchment

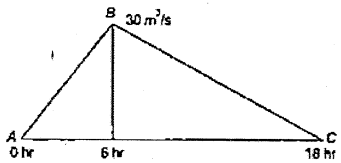
$$= \frac{\text{Volume of hydrograph}}{\text{Rainfall excess of 1 cm}}$$

$$= \frac{\frac{1}{2} \times 18 \times 36 \times 60 \times 60 \text{ m}^2}{0.01}$$

$$= 116.64 \times 10^6 \text{ m}^2 \simeq 117 \times 10^6 \text{ km}^2 = 117 \text{ km}^2$$

24. **(b)**
Total rainfall = 16 cm
and total infiltration = 0.5 × 12 = 6 cm
Net effective rainfall = 16 – 6 = 10 cm
Peak of 12 hr 2 cm DRH = 45 cumec
Peak of 12 hr 10 cm DRH = 225 cumec

25. **(c)**



Area of catchment × 1/100 m = Area under ΔABC

$$\Rightarrow \quad A \times \frac{1}{100} = \frac{1}{2} \times 18 \times 3600 \times 30$$

$$\Rightarrow \quad A = 9720 \text{ hectares}$$

26. **(b)**
Peak of DRH = 210 – 20 = 190 m^3/sec
Effective rainfall = 2.7 – 0.3 × 3 = 1.8 cm
∴ Peak of 3-h unit hydrograph

$$= \frac{190}{1.8} = 105.56 \text{ m}^3/\text{s} = 105.5 \text{ m}^3/\text{s}$$

27. **(b)**

$$Ad = Ol \text{ (= Area of UH)}$$

$$\Rightarrow \quad 720 \times 10^6 \times 10^{-2} = \frac{1}{2}(60)3600O$$

$$\Rightarrow \quad Q = 50 \text{ m}^3/\text{s}$$

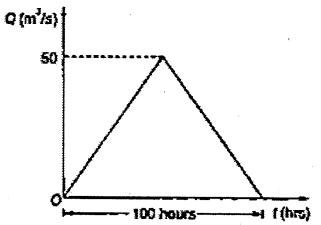
28. **(b)**
Peak flood discharge
= Base flow + flood discharge
$= 30 + (720 \times 10^6 \times 10^{-3})/60 \times 60$
$= 230 \text{ m}^3/\text{sec}$

29. **(d)**
The 12 hour unit hydrograph derived from this 6 hour unit hydrograph will be shifted by 6 hour i.e., it will have a base period of 90 hours.

31. **(b)**
Peak of direct runoff
= 240 – 40 = 200 m^3/sec
Peak of 4-hour unit hydrograph

$$= \frac{200}{8} = 25 \text{ m}^3/\text{sec}$$

32. **(b)**



Peak of DRH = 50 m^3/sec
Rainfall excess of DRH

$$= \frac{\left(\frac{1}{2} \times 50 \times 100 \times 60 \times 60\right)\text{m}}{360 \times 10^6}$$

$$= 0.025 \text{ m} = 2.5 \text{ cm}$$

$$\therefore \text{ Peak of 4-hour UH} = \frac{50}{2.5} = 20 \text{ m}^3/\text{sec}$$

33. **(c)**
Rainfall excess of 6-hour UH = 1 cm
Let the time base = B hours

$$\therefore \frac{\frac{1}{2} \times B \times 60 \times 60 \times 10}{180 \times 10^6} = \frac{1}{100}$$

$$\Rightarrow \quad B = 100 \text{ hours}$$

35. **(c)**
Synder based on the study of a large number of catchments in the United States developed a set of empirical equations for synthetic unit hydrograph.

44. **(a)**
For very large basins, the centre of storm can vary from storm to storm, and each can give different surface run off hydrograph under otherwise identical conditions UH. Therefore, cannot give reliable results for basins exceeding 5000 km^2.

46. (b)
Fan shaped, i.e., nearly semicircular shaped catchments give high peak and narrow hydrographs while elongated catchments gives broad and low peaked hydrographs.

47. (c)
Barnes showed that the recession of a storage can be expressed as

$$Q_t = Q_0 k_r^t$$

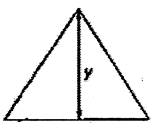
This can also be expressed as

$$Q_t = Q_0 e^{-at}$$

Where $a = -\ln k_r$

54. (b)
The starting point of the recession limb, i.e., the point of inflection represents the condition of maximum storage.

55. (c)



$$\text{Volume} = \frac{1}{2} \times 48 \times y$$

$$\Rightarrow 1728 \times \frac{1}{100} = 24\, y$$

$$\Rightarrow y = \frac{1728 \times 10^6}{100 \times 24 \times 60 \times 60} = 200\ m^3/s$$

57. (b)
Equilibrium discharge of S-curve

$$= \frac{\text{Total discharge}}{\text{Unit hour duration}}$$

$$= \frac{36 \times 10^6 \times 0.01}{2 \times 3600} = 50\ m^3/sec$$

59. (c)

$$\text{Volume of } DR = \frac{1}{2} \times 64 \times 3600 = 3.456 \times 10^6\ m^3$$

If A = area of catchment in km^2, then

$(A \times 10^6) \times 1/100 = 3.456 \times 106$

$A = 345.6\ km^2$

For the unit hydrograph, $D = 6$ hours

Equilibrium discharge of S-curve = Q_s

$= (2.778 \times 345.6)/6$

$= 160\ m^3/sec$

60. (d)
Volume of unit hydrograph

$$= \frac{1}{2} \times 72 \times 3600 \times 100$$

$$= 12.96 \times 10^8\ m^3$$

$(A \times 10^6) \times 1/100 = 12.96 \times 10^6$, hence

Area, $A = 1296\ km^2$

61. (c)
The storage of water in basin exists as (i) surface storage, (ii) Interflow storage, (iii) groundwater storage and can be expressed as exponential decay as:

$$Q_t = Q_0 e^{-at}$$

where, $a = -\ln k$ and k = recession constant and t = time in days

$$\therefore \quad Q_t = Q_0 e^{-(nk)t}$$

62. (b)
$A = 750$ ha $= 7.5\ km^2$; $t_r = 15$ min $= 2.5$ hr;
$t_c = 90$ min $= 1.5$ hr
Lag time $= 0.6\, t_c = t_p = 0.6 \times 1.5 = 0.9$ hr

$$T_p = \left(t_p + \frac{t_r}{2}\right) = 0.9 + \frac{0.25}{2} = 1.025\ hr$$

$$\therefore \quad Q_p = 2.08 \frac{A}{T_p}$$

$$= 2.08 \times \frac{7.5}{1.025} = 20.48\ m^3/sec$$

■■■■