Streamflow Measurement

Q.1 The science and practice of water flow measurement is known as
(a) Hypsometry (b) Hydrometeorology
(c) Fluvimetry (d) Hydrometry

Q.2 Which of the following is not a direct stream flow determination technique?
(a) Dilution method
(b) Ultrasonic method
(c) Area-velocity method
(d) Slope-area method

Q.3 A stilling well is required when the stage measurement is made by employing a
(a) bubble gauge
(b) float gauge recorder
(c) vertical staff gauge
(d) inclined staff gauge

Q.4 In the moving boat method of stream flow measurement, the essential measurements are
(a) the velocity recorded by the current motor, the depths and the speed of the boat
(b) the velocity and direction of the current meter, the depths and the time interval between depth readings
(c) the depth, time interval between readings, speed of the boat and velocity of the stream
(d) the velocity and direction of the current meter and the speed of the boat

Q.5 In a triangular channel, the top width and depth of flow were 2.0 m and 0.9 m respectively. Velocity measurements on the centre line at 18 cm and 72 cm below water surface indicated velocities of 0.60 m/s and 0.40 m/s respectively. The discharge in the channel (in m^3/s) is
(a) 0.90 (b) 1.80
(c) 0.45 (d) None of these

Q.6 Which of the following instruments is not connected with stream flow measurement?
(a) Hygrometer
(b) Echo-depth recorder
(c) Electromagnetic flow meter
(d) Sounding weight

Q.7 The surface velocity at any vertical section of a stream is
(a) not of any use in stream flow measurement
(b) smaller than the mean velocity in that vertical
(c) larger than the mean velocity in that vertical section
(d) equal to the velocity in that vertical at 0.6 times the depth

Q.8 If a gauging section has shifting control due to backwater effects, then
(a) a loop rating curve results
(b) the section is useless for stream gauging purposes
(c) the discharge is determined by area velocity methods
(d) a secondary gauge downstream of the section is needed

Q.9 The stage discharge relationship in a river during the passage of a flood wave is measured. If Q_R = discharge at a stage when the water surface was rising and Q_F = discharge at the same stage when the water surface was falling, then
(a) $Q_F = Q_R$
(b) $Q_R > Q_F$
(c) $Q_R < Q_F$
(d) Q_R/Q_F = constant at all stages

Q.10 The dilution method of stream gauging is ideally suited for measuring discharges in
(a) a large alluvial river
(b) flood flow in a mountain terrain
(c) steady flow in a small turbulent stream
(d) a stretch of a river having heavy industrial pollution loads

Q.11 A 400 g/l solution of common salt was discharged into a stream at a constant rate of 45 l/s. At a downstream section where the salt solution is known to have completely mixed with the stream flow the equilibrium concentration was read as 120 ppm. If a background concentration of 20 ppm is applicable, the discharge in the stream can be estimated to be, in m^3/s, as
(a) 150 (b) 180
(c) 117 (d) 889

Q.12 In the gulp method of stream gauging by dilution technique, 60 litres of chemical X with concentration of 250 g/litre is introduced suddenly into the stream at a section. At a downstream monitoring section, the concentration profile of chemical X that crossed the section was found to be a triangle with a base of 10 hours and a peak of 0.10 ppm. The discharge in the stream can be estimated to be about
(a) 83 m^3/s (b) 180 m^3/s
(c) 15000 m^3/s (d) 883 m^3/s

Q.13 For a given stream, the rating curve applicable to a section is available. To determine the discharge in this stream, the following data are needed:
(a) current meter readings at various verticals at the section
(b) slope of the water surface at the section
(c) stage at the section
(d) surface velocity at various sections

Q.14 During a flood in a wide rectangular channel it is found that at a section the depth of flow increases by 50% and at this depth the water surface slope is half its original value in a given interval of time. This marks an approximate change in the discharge of
(a) –33% (b) +39%
(c) +20% (d) no change

Q.15 In a river, the discharge was 173 m^3/s, the water surface slope was 1 in 6000 and the stage at the station X was 10.00 m. If during a flood, the stage at station X was 10.00 and the water surface slope was 1/2000, the flood discharge was approximately
(a) 100 m^3/s (b) 519 m^3/s
(c) 300 m^3/s (d) 371 m^3/s

Q.16 During a flood, the water surface at a section was found to decrease at a rate of 10 cm/h. The slope of the river is 1/3600. Assuming the velocity of the flood wave as 2 m/s, the actual discharge in the stream can be estimated as
(a) 2.5% larger than the normal discharge
(b) 5% smaller than the normal discharge
(c) 2.5% smaller than the normal discharge
(d) Same as the normal discharge
Where normal discharge is the discharge at a given stage under steady, uniform flow.

Q.17 In the radioactive isotope method, the velocity is measured by measuring radioactivity on downstream at a distance of
(a) 1 m (b) 100 m
(c) 10 km (d) 1 km

Q.18 The velocity of flow in a channel is found by
(a) Current meter (b) Float
(c) Pitot tube (d) All of these

Q.19 The stage in a river is 4.8 m, the water surface slope is 1 in 10,000 and the discharge in the stream is 600 m^3/s. If the stage remains the same and the water surface slope is 1 in 40,400, then the discharge in the stream will be
(a) 300 m^3/s (b) 400 m^3/s
(c) 600 m^3/s (d) 500 m^3/s

Q.20 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

A. Streamflow with considerable groundwater flow throughout the year

B. Streamflow that carries water most of the year but ceases to flow occasionally

C. Stream that does not have any base flow contribution

D. A stream that contributes to groundwater due to seepage

List-II

1. Intermittent stream
2. Perennial stream
3. Influent stream
4. Ephemeral stream
5. Effluent stream

Codes:

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

Q.21 A velocity area station essentially possesses
1. a control
2. a gauge
3. a metering section

The correct answer is
(a) both 1 and 2 (b) both 1 and 3
(c) both 2 and 3 (d) 1, 2 and 3

Q.22 Assertion (A): If a shifting control exists at a gauging section, the remedy is to leave frequent update of the rating curve by current meter gauge.
Reason (R): Shifting control due to backwater effect can be remedied by the use of auxiliary gauge.
(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.23 The slope-area method is extensively used in
(a) development of rating curve
(b) estimation of flood discharge based on high-water marks
(c) cases where shifting control exist
(d) cases where backwater effect is present

Q.24 In the single point method of finding the mean velocity in a vertical of depth D in a stream, the velocity measured by a current meter at a depth h below the water surface, is taken as the mean velocity. Here h =
(a) $0.6D$ (b) $0.4D$
(c) $0.2D$ (d) $0.8D$

Q.25 The rating curve in a river during the passage of a flood wave was obtained. If S_R is the stage in the river for a discharge Q when the water surface was rising, and S_f is the stage for the same discharge Q when the stage was falling, then
(a) $S_R < S_f$
(b) $S_R > S_f$
(c) $S_R = S_f$
(d) S_R is less than or greater than S_f depending on the stream roughness

Q.26 If V_s = surface velocity of a stream at a vertical section, the average velocity V in that vertical section will be about
(a) $V_s/0.9$ (b) $0.6\,V_s$
(c) $0.9\,V_s$ (d) V_s

Q.27 A catchment has an area of 150 hectares and a run-off rainfall ratio of 0.40. If due to 10 cm rainfall over the catchment, a stream flow at the catchment outlet lasts for 10 hours, what is the average stream flow in the period?
(a) 60,000 m³/hour (b) 100 m³/minute
(c) 3.5 m³/s (d) 1.33 m³/s

Q.28 When a routine and regular information of the discharge of a stream is desired, it is usually obtained
(a) by directly gauging the stream by dilution technique
(b) indirectly by using the slope-area method
(c) directly by using current meters each time
(d) indirectly by using the stage-discharge relationship

Q.29 In the case of large rivers, a number of equidistant vertical sections of the total width of flow are identified, for the purpose of finding by numerical integration, the total discharge on any day. On each section, the mean velocity is taken as the arithmetic average of two typical depths on that section. Then the mean velocity is worked out for that section. Usually, the mean velocity at any section, corresponds to which one of the following?
(V represents the point velocity at the given section and the depths such as $0.1d$, $0.2d$.... etc.)
(a) $\frac{V_{0.1d}+V_{0.9d}}{2}$ (b) $\frac{V_{0.2d}+V_{0.8d}}{2}$
(c) $\frac{V_{0.3d}+V_{0.7d}}{2}$ (d) $\frac{V_{0.4d}+V_{0.6d}}{2}$

Q.30 Calibration of a current meter for use in channel flow measurement is done in a
(a) wind tunnel (b) water tunnel
(c) towing tank (d) flume

Q.31 As floodwave passes a given section of a river, life time occurrence of the maximum stage and the maximum discharge will be such that
(a) the maximum discharge passes down before the maximum stage is attained
(b) the maximum stage is attained before the maximum discharge passes down
(c) the two events occur simultaneously
(d) no specific sequence would be universally assignable

Q.32 The stage of river carrying a discharge of Q m³/sec at a point is 10 m and slope of water surface is (1/4000). The discharge of a flood at the same point and same stage of 10 m with a water surface slope of (1/1000) will be
(a) $\sqrt{2}\,Q$ m³/sec (b) $0.5\,Q$ m³/sec
(c) $2\,Q$ m³/sec (d) $4\,Q$ m³/sec

Q.33 In a river carrying a discharge of 142 m³/s, the stage at a station A was 3.6 m and the water surface slope was 1 in 6000. If during a flood, the stage at A was 3.6 m and the water surface slope was 1 in 3000, what was the flood approximate discharge?
(a) 284 m³/s (b) 200 m³/s
(c) 164 m³/s (d) 96 m³/s

Q.34 The top width and depth of flow in deep triangular channel are 3 m and 1.8 m respectively. Velocity measurements on centreline at 36 cm, 108 cm and 144 cm below water surface indicated velocities of 0.80 m/s, 0.60 m/s and 0.40 m/s respectively. The discharge in the triangular channel is:
(a) 0.82 m³/sec (b) 1.29 m³/sec
(c) 1.62 m³/sec (d) 0.98 m³/sec

Q.35 A 200 gram/litre solution of common salt was discharged into stream at constant rate of 25 litres/sec. The background concentration of the salt in the stream water was found to be 10 ppm. At a downstream where the solution was believed to have been completely mixed, the salt concentration was found to reach equilibrium value of 45 ppm. The discharge in the stream is:
(a) 124.8 m³/sec (b) 242.8 m³/sec
(c) 214.8 m³/sec (d) 142.8 m³/sec

Q.36 The velocity distribution in a natural stream is given as $\frac{v}{v_a} = \left(\frac{y}{a}\right)^m$ where v and v_a are velocities at height y and a above the bed respectively and m is coefficient. The ratio between the mean velocity and the velocity measured at 0.6 depth from water surface assuming m = 1/6 is:
(a) 1 (b) 1.2
(c) 1.5 (d) 2.0

Q.37 The water surface a particular section of river during flood was found to increase at rate of 11.2 cm/hr. The normal discharge for the river stage obtained from steady flow rating curve was 160 m³/sec and slope of rover is 1/3600. Assuming, the velocity of flood wave as 2.0 m/sec, the actual discharge is:
(a) 124.2 m³/sec (b) 194.2 m³/sec
(c) 142.2 m³/sec (d) 164.4 m³/sec

Answers **Streamflow Measurement**

1. (d)	2. (d)	3. (b)	4. (b)	5. (c)	6. (a)	7. (c)	8. (d)	9. (b)	10. (c)
11. (b)	12. (a)	13. (c)	14. (b)	15. (c)	16. (c)	17. (c)	18. (d)	19. (a)	20. (b)
21. (d)	22. (d)	23. (b)	24. (a)	25. (a)	26. (c)	27. (b)	28. (d)	29. (b)	30. (c)
31. (c)	32. (c)	33. (b)	34. (c)	35. (d)	36. (a)	37. (d)			

Explanations **Streamflow Measurement**

5. (c)

$$V_{avg} = \frac{0.6+0.4}{2} = 0.5 \text{ m/s}$$

$$Q = \frac{1}{2}\times 2\times 0.9\times 0.5 = 0.45 \text{ m}^3/\text{s}$$

6. (a)

Hygrometer is used to measure humidity of air.

11. (b)

$$400\times 45 + 20\times 10^{-3}\times Q = 120\times 10^{-3}(45+Q)$$

$$17994.6 = 100\times 10^{-3} Q$$

$$Q = 179.95 \text{ m}^3/\text{sec} \simeq 180 \text{ m}^3/\text{sec}$$

14. (b)

For very wide channel

$$Q = y^{5/3}\sqrt{S}$$

$$Q' = (1.5y)^{5/3}\sqrt{0.5S}$$

$$= 1.39y^{5/3}\sqrt{S}$$

Percentage change

$$= 0.39\times 100 = 39\%$$

15. (c)

$$\frac{173^2}{Q_1^2} = \frac{2000}{6000}$$

$$Q_1^2 = 3\times 173^2$$

$$Q_1 = 299.6 \text{ m}^3/\text{s} \simeq 300 \text{ m}^3/\text{s}$$

16. (c)

If Q_n is the normal discharge at a given stage under steady uniform flow and Q_M is the measured (actual) unsteady flow, the two are related as

$$\frac{Q_M}{Q_n} = \sqrt{1+\frac{1}{V_w S_0}\frac{dh}{dt}}$$

S_0 = Channel slope

$\frac{dh}{dt}$ = rate of change of stage

V_W = velocity of flood wave

$$\Rightarrow \frac{Q_M}{Q_n} = \sqrt{1+\frac{1\times 3600}{2\times 1}\times\frac{0.10}{60\times 60}},$$

$$\Rightarrow \frac{Q_M}{Q_n} = 1.0246$$

$$\Rightarrow \frac{Q_M - Q_n}{Q_n} = 2.46\% \simeq 2.5\%$$

$$\Rightarrow Q_n < Q_M \text{ by } 2.5\%$$

17. (c)

The mixing length may vary from about 2 km to 100 km. Hence option (c) is correct.

18. (d)

All devices current meter, float and Pitot tube are used to find the velocity of flow in channel. Hence option (d) is correct.

19. (a)

$$Q \propto \sqrt{S}$$

$$\frac{Q}{600} = \sqrt{\frac{1/40400}{1/10000}}$$

$$Q = 298.5 \text{ m}^3/\text{s} \approx 300 \text{ m}^3/\text{s}$$

26. (c)

In rivers having flood flows, only the surface velocity (V_s) is measured within a depth of about 0.5 m below the surface. The average velocity $\bar{V}$ is obtained by

$$\bar{V} = kV_s$$

Where k = reduction factor

$\equiv 0.85 - 0.95$

27. (b)

$$Q = \frac{1}{36}CiA$$

$$i = \frac{10}{10} = 1 \text{ cm/hr}$$

A = 150 hectares

C = 0.4

$$\therefore Q = \frac{1}{36}\times 0.4\times 1\times 150$$

$$= 1.67 \text{ m}^3/\text{sec} = 100 \text{ m}^3/\text{min.}$$

29. (b)

In shallow stream of depth up to about 3.0 m, the average velocity

$$\bar{V} = V_{0.6d}$$

This is called single point observation.

In moderately deep streams the velocity is observed at two points.

$$\therefore \bar{V} = \frac{V_{0.2d}+V_{0.8d}}{2}$$

In rivers having large flood flows, only surface velocity (V_s) is measured within a depth of about 0.5 m from the surface. The average velocity $\bar{V} = kV_s$ where k is in the range of 0.85 to 0.95.

30. (c)

The relation between the stream velocity and revolutions per second of the current meter is called the calibration equation. The calibration equation is unique to each instrument and is determined by towing the instrument in a special tank called towing tank. Towing tank is a long channel containing still water with arrangements for moving a carriage longitudinally over its surface at constant speed. The current meter to be calibrated is mounted on the carriage with the rotating element immersed to a specified depth in the water body in the tank. The carriage is then towed at a predetermined constant speed (v) and the corresponding average value of revolutions per second (N_s) of the instrument determined. This experiment is repeated over the complete range of velocities and a best-fit linear relation in the form of the equation $v = aN_s + b$ where a, b are constants of the current meter.

33. (b)

Discharge is directly proportional to $\sqrt{S}$.

$$\therefore Q_2 = Q_1\times\sqrt{\frac{S_2}{S_1}}$$

$$= 142\times\sqrt{\frac{1}{3000}\times 6000}$$

$$= 200.8 \text{ m}^3/\text{s}$$

34. (c)

$$V_{mean} \text{ (for deep channel)} = \frac{V_{0.2d}+V_{0.8d}}{2}$$

$V_{0.2d}$ = Velocity at 0.2 × 1.8 = 36 cm = 0.80 m/s

$V_{0.8d}$ = Velocity at 0.8 × 1.8 = 144 cm

= 0.40 m/sec

$$\therefore V_{mean} = \frac{0.80+0.40}{2} = 0.60 \text{ m/sec}$$

$$\text{Area of } \Delta \text{ channel} = \frac{1}{2}\times 3\times 1.8 = 2.7 \text{ m}^2$$

$$\therefore Q_{discharge} = A\times V_{mean} = 2.7\times 0.6$$

$$= 16.20 \text{ m}^3/\text{sec}$$

35. (d)

We know, $Q = \frac{Q_t(C_1 - C_2)}{C_2 - C_0}$

$Q_t = 25\times 10^{-3}$ m³/sec; $G = 0.200$; $C_0 = 45\times 10^{-6}$;

$C_0 = 10\times 10^{-6}$

$$Q = \frac{25\times 10^{-3}(0.20 - 45\times 10^{-6})}{(4\times 10^{-6} - 10\times 10^{-6})}$$

$$= 142.8 \text{ m}^3/\text{sec}$$

36. (a)

$$v = ky^m$$

Mean velocity, $\bar{v} = \frac{1}{d}\int_0^d v\,dy = \frac{k}{d}\int_0^d y^m dy = \frac{kd^m}{(m+1)}$

$V_{0.6}$ = Velocity at 0.6 depth that is at $y = 0.4d$

$$\frac{\bar{v}}{v_{0.6}} = \frac{kd^m}{(m+1)} \times \frac{1}{k(0.4)^m} \times \frac{1}{d^m} = \frac{1}{(0.4)^m(m+1)}$$

For $m = \frac{1}{6} = 0.1667 \Rightarrow \frac{\bar{v}}{v_{0.6}} = 1.001 \simeq 1$

37. (d)

Q_n = Normal discharge at a given stage under steady flow.

Q_m = Actual (measured) unsteady flow.

V_w = Velocity of flood wave

For unsteady flow,

$$\frac{Q_m}{Q_n} = \sqrt{1 + \frac{1}{V_w S_0}\frac{dh}{dt}}$$

$$\frac{dh}{dt} = \frac{11.2}{100 \times 60 \times 60} = 3.41 \times 10^{-5} \text{ m/sec}$$

$$S_0 = \frac{1}{3600}$$

Q_n = 160 m^3/sec,

V_w = 2 m/sec

$$\therefore\ Q_m = 160\sqrt{1 + \frac{1}{2 \times (1/3600)} \times 3.111 \times 10^{-5}}$$

$$= 164.4 \text{ m}^3\text{/sec.}$$

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