Flow Measurement

Q.1 Consider the following flow measuring structures:
1. Submerged broad-crested weir
2. Free broad-crested weir
3. Free sharp-crested weir
4. Free ogee spillway

The correct sequence in increasing order of the discharge coefficient of these structures is
(a) 1, 2, 4, 3 (b) 2, 1, 3, 4
(c) 2, 1, 4, 3 (d) 1, 2, 3, 4

Q.2 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Rehbock formula
B. Francis formula
C. A special trapezoidal weir
D. Linear proportional weir

List-II
1. Sutro weir
2. Rectangular suppressed weir
3. Rectangular side-contracted weir
4. Cippolletti weir

Codes:

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

Q.3 Due to each end contraction, the discharge of rectangular sharp crested weir is reduced by
(a) 5% (b) 10%
(c) 15% (d) 20%

Q.4 If S is the length of the crest and H the height of water source of a weir whose length if L and discharge is $Q\,m^3/sec$, the velocity of approach V_a is

(a) $\sqrt{2gH}$ (b) $\dfrac{Q}{L(H-L)}$

(c) $\dfrac{Q}{L(H+S)}$ (d) $\dfrac{L(H+S)}{Q}$

Q.5 The empirical formula

$$Q=\left(0.405+\frac{0.003}{H}\right)\sqrt{2gL}\,H^{3/2}$$

for discharge over large rectangular weirs, is known as
(a) Francis formula
(b) Bazin's formula
(c) Rehbook's formula
(d) Kutter's formula

Q.6 With a clinging nappe of a weir, the excess discharge, is
(a) 6% to 7% (b) 8% to 10%
(c) 18% to 20% (d) 25% to 30%

Q.7 Match List-I (Value of exponent n in the equation $Q = KH^n$) with List-II (Weir shape) and select the correct answer using the codes given below the lists:

List-I
A. $n = 1$
B. $n = 1.5$
C. $n = 2.0$
D. $n = 2.5$

List-II
1. Triangular weir
2. Parabolic weir
3. Sutro weir
4. Circular weir
5. Rectangular weir

Codes:

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

Q.8 Assertion (A) : The discharge (Q) through a triangular weir is given by

$$Q = \frac{8}{15} C_d \sqrt{2g} (h^{5/2}) \tan\left(\frac{\theta}{2}\right)$$

where C_d is the coefficient of discharge, h is the head of flow, θ is the apex angle of the weir and g is the acceleration due to gravity.

Reason (R) : The cross-sectional area of flow in a triangular weir is $h^2 \tan(\theta/2)$ and average velocity is $\frac{8}{15} C_d \sqrt{2gh}$.

(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.9 The approximate discharge over a 4 m long rectangular weir (with suppressed end contractions) with head over the crest as 0.36 m is

(a) 4.2 litres/s (b) 2.4 m^3/s
(c) 6.1 litres/s (d) 1.6 m^3/s

Q.10 Consider the following types of weirs:

1. Proportional weir
2. Cipolletti weir
3. Parabolic weir
4. Rectangular weir (without end treatment)

All these weirs have varying values of exponent in the formula $Q = kH^n$. The correct sequence of these weirs in increasing order of the value of 'n' is

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

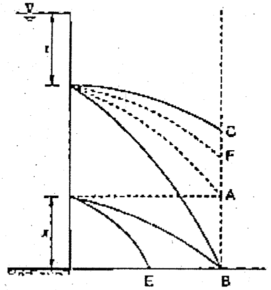
Q.11 Consider the following discharge measurement devices

1. Cylindrical mouthpiece flowing full
2. Sharp edge orifice
3. Convergent divergent mouthpiece
4. Borda's re-entrant mouthpiece flowing free

The correct sequence of increasing order of their discharge coefficients is

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

Q.12 One orifice is located at a distance x from the free surface while another orifice is located at the same distance x from the bottom of the tank as shown in figure.



The water jets through the orifice will

(a) intersect at point A
(b) interesect at point B
(c) strike the plane at points C and B respectively
(d) be striking at E and F only

Q.13 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Coefficient of velocity (C_v)
B. Coefficient of contraction (C_c)
C. Coefficient of discharge (C_d)
D. Kinetic energy correction factor for viscous flow through circular pipe (α)

List-II
1. 0.64 2. 0.62
3. 0.98 4. 2.00

Codes:

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

Q.14 Two small orifice A and B of diameters 1 cm and 2 cm respectively are placed on the sides of a tank at depths of h_1 and h_2 below the open liquid surface. If the discharge through A and B are equal, the ratio of h_1 and h_2 will be (Assume C_d to be same)

(a) 16 : 1 (b) 8 : 1
(c) 4 : 1 (d) 2 : 1

Q.15 The discharge over a broad crested weir is maximum when the depth of flow is

(a) $\frac{H}{3}$ (b) $\frac{H}{2}$
(c) $\frac{2H}{5}$ (d) $\frac{2H}{3}$

Q.16 A submerged weir is one in which the water level on the downstream side of the weir is

(a) below the crest level
(b) just at the crest level
(c) above the crest level
(d) at same elevation as water surface on upstream

Q.17 The percentage error in the measurement of discharge in a V-notch is given by percentage error in angle measurement XZ. Here Z is

(a) $\frac{\theta}{\sin\theta}$ (b) $\frac{\theta}{\cos\theta}$
(c) $\frac{\theta}{\text{cosec}\,\theta}$ (d) $\frac{\theta}{\sec\theta}$

■■■■

Answers Flow Measurement

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

Explanations Flow Measurement

1. (d)

For ogee spillway $C_{d1} = 1.19\, C_{ds}$

C_{ds} is the discharge coefficient for sharp – crested weir. So 4 will come after 3.

The classification of weir is:

$H_1/B_w \le 0.1$ Long crested weir
$0.1 < H_1/B_w < 0.35$ Broad-crested weir
$0.35 \le H_1/B_w < 1.5$ Narrow-crested weir
$H_1/B_w \ge 1.5$ Sharp-crested weir

Further submerged weirs have lesser coefficient of discharge compared to free weirs. So 2 will come after 1.

2. (d)

(i) Rehbock's formula is an empirical formula for calculating discharge in rectangular suppressed weir. It is given by

$$Q = \frac{2}{3}\left(0.605 + 0.08\frac{H}{Z}\right) + \frac{0.001}{H}\sqrt{2g}LH^{\frac{3}{2}}$$

Where L is the length of weir, H is head in meters and Z is the crest height in meters

(ii) Francis formula is one of the commonly used empirical formula for computing the discharge over sharp or narrow crested weirs with or without end contraction. Francis proposed the following formulae for the discharge over rectangular weir.

(a) When the velocity of approach is not considered

$Q = 1.84(L - 0.1\, nH)H^{3/2}$

(b) With the velocity of approach is taken into account $Q = 1.84(L - 0.1\, nH_1)(H_1^{3/2} - h_a^{3/2})$

Where $H_1 = H + h_a = H + \frac{v_a^2}{2g}$, H is height of water surface above the crest of weir, and n is the number of end contractions.

9. (d)

Using Francis formula, $Q = 1.84\, LH^{3/2}$

$= 1.84 \times 4 \times (0.36)^{3/2} = 1.59\ m^3/sec$

14. (a)

$$Q = C_d a\sqrt{2gh}$$
$$Q \propto d^2\sqrt{h}$$
$$\therefore \quad \frac{d_1^2\sqrt{h_1}}{d_2^2\sqrt{h_2}} = 1$$
$$\Rightarrow \quad \frac{h_1}{h_2} = \frac{d_2^4}{d_1^4} = \left(\frac{2}{1}\right)^4 = 16:1$$

■■■■