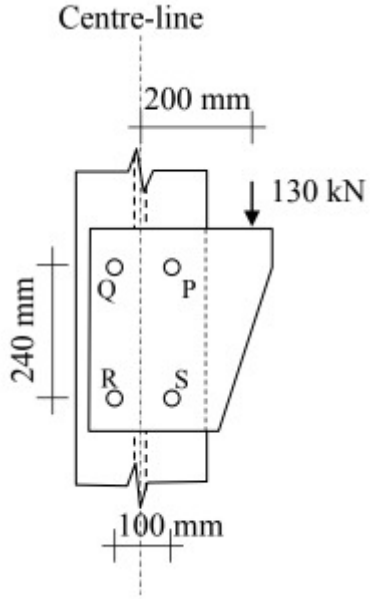
CH: Chemical Engineering

Q.No. 1 Four bolts P, Q, R and S of equal diameter are used for a bracket subjected to a load of 130 kN as



shown in the figure. The force in bolt P is

(A) 32.50 kN

(B) 69.32 kN

(C) 82.50 kN

(D) 119.32 kN

Answer: (B)

Q.No. 2 Group I lists the type of gain or loss of strength in soils. Group II lists the property or responsible for the loss or gain of strength in soils.

Group I	Group II
P. Regain of strength with time	1. Boiling
Q. Loss of strength due to cyclic loading	2. Liquefaction
R. Loss of strength due to upward seepage	3. Thixotropy
S. Loss of strength due to remolding	4. Sensitivity

The correct match between Group I and Group II is

(A) P-4, Q-1, R-2, S-3

(B) P-3, Q-1, R-2, S-4

(C) P-3, Q-2, R-1, S-4

(D) P-4, Q-2, R-1, S-3

Answer: (C)

Q.No. 3 For a broad gauge railway track on a horizontal curve of radius R (in m), the equilibrium cant e required for a train moving at a speed of V (in km per hour) is

(A) e = 1.676 V2/R

(B) e = 1.315 V2/R

(C) e = 0.80 V2/R

(D) e = 0.60 V2/R

Answer: (B)

Q.No. 4 A catchment may be idealised as a rectangle. There are three rain gauges located inside the catchment at arbitrary locations. The average precipitation over the catchment is estimated by two methods: (i) Arithmetic mean P_A, and (ii) Thiessen polygon P_T. Which one of the following statements is correct?

(A) P_A is always smaller than P_T

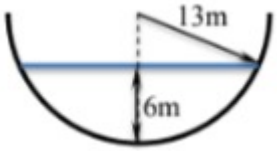
(B) P_A is always greater than P_T

(C) P_A is always equal to P_T

(D) There is no definite relationship between P_A and P_T

Answer: (D)

Q.No. 5 Consider the hemi-spherical tank of radius 13 m as shown in the figure (not drawn to scale). What is



the volume of water (in m3) when the depth of water at the centre of the tank is 6 m?

(A) 78π

(B) 156π

(C) 396π

(D) 468π

Answer: (C)

Q.No. 6 A column of height h with a rectangular cross-section of size a×2a has a buckling load of P . If the cross-section is changed to 0.5a × 3a and its height changed to 1.5h, the buckling load of the redesigned column will be

(A) P/12

(B) P/4

(C) P/2

(D) 3P/4

Answer: (A)

Q.No. 7 A steel column of ISHB 350 @72.4 kg/m is subjected to a factored axial compressive load of 2000 kN. The load is transferred to a concrete pedestal of grade M20 through a square base plate. Consider bearing strength of concrete as $0.45f_{ck}$, where f_{ck} is the characteristic strength of concrete. Using limit state method and neglecting the self weight of base plate and steel column, the length of a side of the base plate to be provided is

(A) 39 cm

(B) 42 cm

(C) 45 cm

(D) 48 cm

Answer: (D)

Q.No. 8 A rectangular open channel has a width of 5 m and a bed slope of 0.001. For a uniform flow of depth 2 m, the velocity is 2 m/s. The Manning's roughness coefficient for the channel is

(A) 0.002

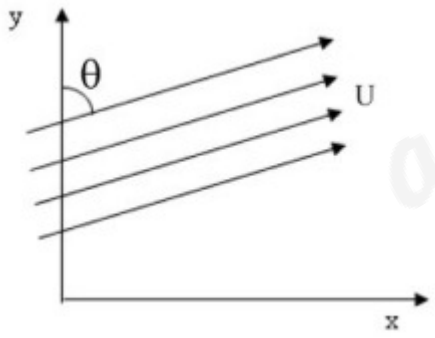
(B) 0.017

(C) 0.033

(D) 0.050

Answer: (B)

Q.No. 9 Uniform flow with velocity U makes an angle θ with the y-axis, as shown in the figure



The velocity potential (Φ), is

(A) ±U(xsinθ + ycosθ)

(B) ±U(ysinθ - xcosθ)

(C) ±U(xsinθ - ycosθ)

(D) ±U(ysinθ + xcosθ)

Answer: (A)

Q.No. 10 A bitumen sample has been graded as VG30 as per IS : 73-2013. The '30' in the grade means that

(A) penetration of bitumen at 25°C is between 20 and 40

(B) viscosity of bitumen at 60°C is between 2400 and 3600 Poise

(C) ductility of bitumen at 27°C is more than 30 cm

(D) elastic recovery of bitumen at 15°C is more than 30%

Answer: (B)

Q.No. 11 Which one of the following matrices is singular?

(A) $\begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix}$

(B) $\begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$

(C) $\begin{bmatrix} 2 & 4 \\ 3 & 6 \end{bmatrix}$

(D) $\begin{bmatrix} 4 & 3 \\ 6 & 2 \end{bmatrix}$

Answer: (C)

Q.No. 12 The number of spectral bands in the Enhanced Thematic Mapper sensor on the remote sensing satellite Landsat-7 is

(A) 64

(B) 10

(C) 8

(D) 15

Answer: (C)

Q.No. 13 As per IS 10500:2012, for drinking water in the absence of alternate source of water, the permissible limits for chloride and sulphate, in mg/L, respectively are

(A) 250 and 200

(B) 1000 and 400

(C) 200 and 250

(D) 500 and 1000

Answer: (B)

Q.No. 14 The Le Chatelier apparatus is used to determine

(A) compressive strength of cement

(B) fineness of cement

(C) setting time of cement

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(D) soundness of cement

Answer: (D)

Q.No. 15 A closed thin-walled tube has thickness, *t*, mean enclosed area within the boundary of the centerline of tube's thickness, A_m , and shear stress, τ. Torsional moment of resistance, T, of the section would be

(A) $0.5\tau A_m t$

(B) $\tau A_m t$

(C) $2\tau A_m t$

(D) $4\tau A_m t$

Answer: (C)

Q.No. 16 Euclidean norm (length) of the vector $\begin{bmatrix}4 & -2 & -6\end{bmatrix}^T$ is

(A) √12

(B) √24

(C) √48

(D) √56

Answer: (D)

Q.No. 17 A triangular direct runoff hydrograph due to a storm has a time base of 90 hours. The peak flow of 60 tn3/s occurs at 20 hours from the start of the storm. The area of catchment is 300 km2. The rainfall excess of the storm (in cm), is

(A) 2.00

(B) 3.24

(C) 5.40

(D) 6.48

Answer: (B)

Q.No. 18 Analysis of a water sample revealed that the sample contains the following species. $CO_3^{2-}, Na^+, H^+, PO_4^3, Al^{3+}, H_2CO_3, Cl^-, Ca^{2+}, Mg^{2+}, HCO_3^-, Fe^{2+}, OH^-$ Concentrations of which of the species will be required to compute alkalinity?

(A) $CO_3^{2-}, H^+, HCO_3^-, OH^-$

(B) $CO_3^{2-}, H^+, H_2CO_3, HCO_3^-$

(C) $CO_3^{2-}, H_2CO_3, HCO_3^-, OH^-$

(D) $H^+, H_2CO_3, HCO_3^-, OH^-$

Answer: (A)

Q.No. 19 Let the characteristic strength be defined as that value, below which not more than 50% of the results are expected to fall. Assuming a standard deviation of 4 MPa, the target mean strength (in MPa) to be considered in the mix design of a M25 concrete would be

(A) 18.42

(B) 21.00

(C) 25.00

(D) 31.58

Answer: (C)

Q.No. 20 The accuracy of an Electronic Distance Measuring Instrument (EDMI) is specified as ± (a mm + b ppm). Which one of the following statements is correct ?

(A) Both a and b remain constant. irrespective of the distance being measured.

(B) a remains constant and b varies in proportion to the distance being measured.

(C) a varies in proportion to the distance being measured and b remains constant.

(D) Both a and b vary in proportion to the distance being measured.

Answer: (B)

Q.No. 21 Which one of the following is NOT a correct statement?

(A) The function $x\sqrt{x}$, (x>0), has the global maxima at $x = e$

(B) The function $x\sqrt{x}$, (x>0), has the global minima at $x = e$

(C) The function x^3 has neither global minima nor global maxima

(D) The function $|x|$ has the global minima at $x = 0$

Answer: (B)

Q.No. 22 Consider the following simultaneous equations (with c_1 and c_2 being constants): $3x_1 + 2x_2 = c_1$ $4x_1 + x_2 = c_2$ The characteristic equation for these simultaneous equations is

(A) $\lambda 2 - 4\lambda - 5 = 0$

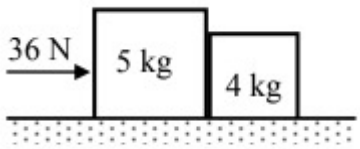
(B) $\lambda 2 - 4\lambda + 5 = 0$

(C) $\lambda 2 + 4\lambda - 5 = 0$

(D) $\lambda 2 + 4\lambda + 5 = 0$

Answer: (A)

Q.No. 23 Two rigid bodies of mass 5 kg and 4 kg are at rest on a frictionless surface until acted upon by a force of 36 N as shown in the figure. The contact force generated between the two bodies is



(A) 4.0 N

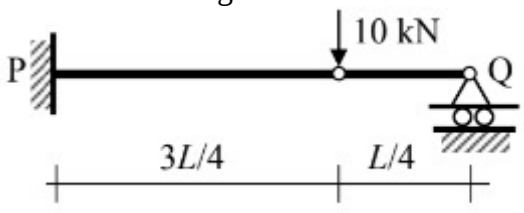
(B) 7.2 N

(C) 9.0 N

(D) 16.0 N

Answer: (D)

Q.No. 24 A vertical load of 10 kN acts on a hinge located at a distance of L/4 from the roller support Q of a beam of length L (see figure).



The vertical reaction at support Q is

(A) 0.0 kN

(B) 2.5 kN

(C) 5 kN

(D) 10.0 kN

Answer: (A)

Q.No. 25 Two rectangular under-reinforced concrete beam sections X and Y are similar in all aspects except that the longitudinal compression reinforcement in section Y is 10% more. Which one of the following is the correct statement?

(A) Section X has less flexural strength and is less ductile than section Y

(B) Section X has less flexural strength but is more ductile than section Y

(C) Sections X and Y have equal flexural strength but different ductility

(D) Sections X and Y have equal flexural strength and ductility

Answer: (A)

Q.No. 26 A flexible pavement has the following class of loads during a particular hour of the day. i. 80 buses with 2-axles (each axle load of 40 kN); ii. 160 trucks with 2-axles (front and rear axle loads of 40 kN and 80 kN, respectively) The equivalent standard axle load repetitions for this vehicle combination as per IRC:37-2012 would be

(A) 180

(B) 240

(C) 250

(D) 320

Answer: (A)

Q.No. 27 The width of a square footing and the diameter of a circular footing are equal. If both the footings are placed on the surface of sandy soil, the ratio of the ultimate bearing capacity of circular footing to that of

square footing will be

(A) 4/3

(B) 1

(C) 3/4

(D) 2/3

Answer: (C)

Q.No. 28 The ratio of the plastic moment capacity of a beam section to its yield moment capacity is termed as

(A) aspect ratio

(B) load factor

(C) shape factor

(D) slenderness ratio

Answer: (C)

Q.No. 29 Velocity of now is proportional to the first power of hydraulic gradient in Darcy's law. This law is applicable to

(A) laminar flow in porous media

(B) transitional flow in porous media

(C) turbulent flow in porous media

(D) laminar as well as turbulent flow in porous media

Answer: (A)

Q.No. 30 For a small value of h, the Taylor series expansion for f(x+ h) is

(A) $f(x) + hf'(x) + \frac{h^2}{2!}f''(x) + \frac{h^3}{3!}f''(x) + \ldots\infty$

(B) $f(x) + hf'(x) + \frac{h^2}{2!}f''(x) - \frac{h^3}{3!}f''(x) + \ldots\infty$

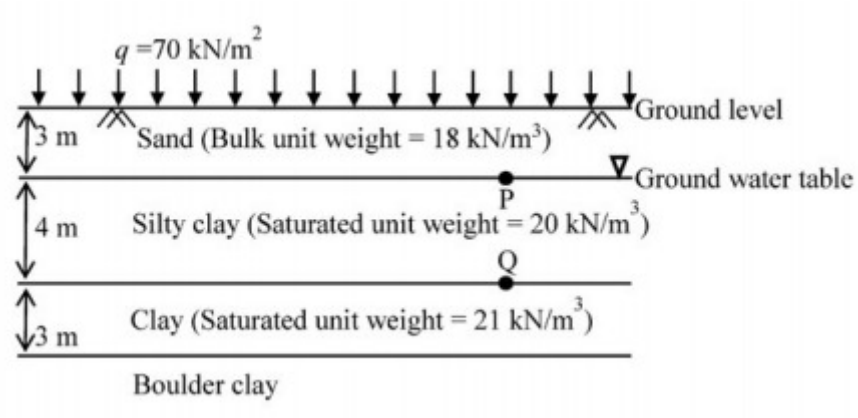
(C) $f(x) - hf'(x) + \frac{h^2}{2}f''(x) + \frac{h^3}{3}f''(x) + \ldots\infty$

(D) $f(x) - hf'(x) + \frac{h^2}{2}f''(x) - \frac{h^3}{3}f''(x) + \ldots\infty$

Answer: (A)

Q.No. 31 The soil profile at a site up to a depth of 10 m is shown in the figure (not drawn to the scale). The soil is preloaded with a uniform surcharge (q) of 70 kN/m2 at the ground level. The water table is at a depth of 3 m below ground level. The soil unit V,eight Of the respective layers are shown in the figure. Consider unit weight Of water as 9.81 kN/m3 and assume that the surcharge (q) is applied instantaneously.Immediately after preloading, the effective stresses (in kPa) at points P and Q,respectively,

are



(A) 124 and 204

(B) 36 and 90

(C) 36 and 126

(D) 54 and 95

Answer: (D)

Q.No. 32 The safety within a roundabout and the efficiency of a roundabout can be increased, respectively, by

(A) increasing the entry radius and increasing the exit radius

(B) increasing the entry radius and decreasing the exit radius

(C) decreasing the entry radius and increasing the exit radius

(D) decreasing the entry radius and decreasing the exit radius

Answer: (C)

Q.No. 33 A retaining wall of height H with smooth vertical backface supports a backfill inclined at an angle β with the horizontal. The backfill consists of cohesionless soil having angle of internal friction ϕ. If the active lateral thrust acting on the wall is P_a, which one of the following statements is TRUE?

(A) P_a acts at a height H/2 from the base of the wall and at an angle β with the horizontal

(B) P_a acts at a height H/2 from the base of the wall and at an angle ϕ with the horizontal

(C) P_a acts at a height H/3 from the base of the wall and at an angle β with the horizontal

(D) P_a acts at a height H/3 from the base of the wall and at an angle ϕ with the horizontal

Answer: (C)

Q.No. 34 The rank of the following matrix is $\begin{pmatrix} 1 & 1 & 0 & -2 \\ 2 & 0 & 2 & 2 \\ 4 & 1 & 3 & 1 \end{pmatrix}$

(A) 1

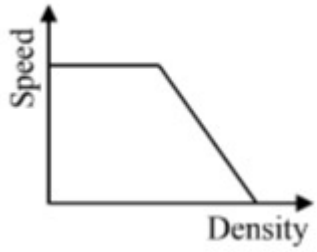
(B) 2

(C) 3

(D) 4

Answer: (B)

Q.No. 35 The speed-density relationship for a road section is shown in the figure. The shape of the flow-



density relationship is

(A) piecewise linear

(B) parabolic

(C) initially linear then parabolic

(D) initially parabolic then linear

Answer: (C)

Triangle	Interior Angles
P	85°, 50°, 45°
Q	100°, 55°, 25°
R	100°, 45°, 35°
S	130°, 30°, 20°

Q.No. 36 The interior angles of four triangles are given below: Which of the triangles are ill-conditioned and should be avoided in Triangulation surveys?

(A) Both P and R

(B) Both Q and R

(C) Both P and S

(D) Both Q and S

Answer: (D)

Q.No. 37 The Laplace transform of sinh (at) is

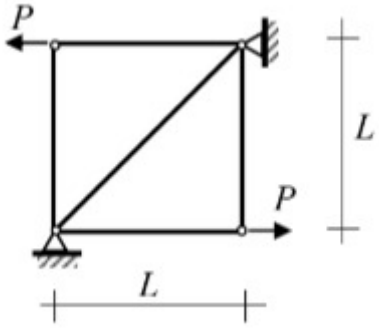
(A) $\frac{a}{s^2-a^2}$

(B) $\frac{a}{s^2+a^2}$

(C) $\frac{s}{s^2-a^2}$

(D) $\frac{s}{s^2+a^2}$

Answer: (A)

Q.No. 38 All the members of the planar truss (see figure), have the same properties in terms of area of cross-section (A) and modulus of elasticity (E). 

For the loads shown on the truss, the statement that correctly represents the nature of forces in the members of the truss is:

(A) There are 3 members in tension, and 2 members in compression

(B) There are 2 members in tension, 2 members in compression, and 1 zero-force member

(C) There are 2 members in tension, 1 member in compression, and 2 zero-force members

(D) There are 2 members in tension, and 3 zero-force members

Answer: (D)

Q.No. 39 According to IS 456 - 2000, which one of the following statements about the depth of neutral axis $X_{u,bal}$ for a balanced reinforced concrete section is correct?

(A) $X_{u,bal}$ depends on the grade of concrete only.

(B) $X_{u,bal}$ depends on the grade of steel only.

(C) $X_{u,bal}$ depends on both the grade of concrete and grade of steel.

(D) $X_{u,bal}$ does not depend on the grade of concrete and grade of steel.

Answer: (B)

Q.No. 40 For the given orthogonal matrix Q, $Q = \begin{bmatrix} 3/7 & 2/7 & 6/7 \\ -6/7 & 3/7 & 2/7 \\ 2/7 & 6/7 & -3/7 \end{bmatrix}$ The inverse is:

(A) $\begin{bmatrix} 3/7 & 2/7 & 6/7 \\ -6/7 & 3/7 & 2/7 \\ 2/7 & 6/7 & -3/7 \end{bmatrix}$

(B) $\begin{bmatrix} -3/7 & -2/7 & -6/7 \\ 6/7 & -3/7 & -2/7 \\ -2/7 & -6/7 & 3/7 \end{bmatrix}$

(C) $\begin{bmatrix} 3/7 & -6/7 & 2/7 \\ 2/7 & 3/7 & 6/7 \\ 6/7 & 2/7 & -3/7 \end{bmatrix}$

$$\begin{bmatrix} -3/7 & 6/7 & -2/7 \\ -2/7 & -3/7 & -6/7 \\ -6/7 & -2/7 & 3/7 \end{bmatrix}$$

(D)

Answer: (C)

Q.No. 41 Sedimentation basin in a water treatment plant is designed for a flow rate of 0.2 m^3/s. The basin is rectangular with a length of 32 m, width of 8 m, and depth of 4 m. Assume that the settling velocity of these particles is governed by the Stokes' law. Given: density of the particles = 2.5 g/cm^3; density of water = 1 g/cm^3; dynamic viscosity of water = 0.01 g/(cm.s); gravitational acceleration = 980 cm/s^2. If the incoming water contains particles of diameter 25 μm (spherical and uniform), the removal efficiency of these particles is

(A) 51%

(B) 65%

(C) 78%

(D) 100%

Answer: (B)

Q.No. 42 Consider a two-dimensional flow through isotropic soil along x direction and z direction. If h is the hydraulic head, the Laplace's equation of continuity is expressed as

(A) $\frac{\partial h}{\partial x} + \frac{\partial h}{\partial z} = 0$

(B) $\frac{\partial h}{\partial x} + \frac{\partial h}{\partial x}\frac{\partial h}{\partial z} + \frac{\partial h}{\partial z} = 0$

(C) $\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial z^2} = 0$

(D) $\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial x \partial z} + \frac{\partial^2 h}{\partial z^2} = 0$

Answer: (C)

Q.No. 43 In the context of provisions relating to durability of concrete, consider the following assertions: Assertion 1): As per IS 456-2000, air entrainment to the extent of 3% to 6% is required for concrete exposed to marine environment. Assertion 2): The equivalent alkali content (in terms of Na2O equivalent) for a cement containing 1% and 0.6% of Na2O and K2O, respectively, is approximately 1.4% (rounded to 1 decimal place). Which one of the following statements is CORRECT?

(A) Assertion 1) is FALSE and Assertion 2) is TRUE

(B) Assertion 1) is TRUE and Assertion 2) is FALSE

(C) Both Assertion 1) and Assertion 2) are FALSE

(D) Both Assertion 1) and Assertion 2) are TRUE

Answer: (A)

Q.No. 44 A solid sphere of radius, r, and made of material with density, ρ_s , is moving through the atmosphere (constant pressure, p) with a velocity, v. The net force ONLY due to atmospheric pressure F_p acting on the sphere at any time, t, is

(A) $\pi r^2 p$

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(B) $4\pi r^2 p$

(C) $4/3\pi r^3 p$

(D) zero

Answer: (D)

Q.No. 45 The matrix P is the inverse of a matrix Q. If I denote the identity matrix. which one of the following options is correct?

(A) $PQ = I$ but $QP \neq I$

(B) $QP = I$ but $PQ \neq I$

(C) $PQ = I$ and $QP = I$

(D) $PQ - QP = I$

Answer: (C)

Q.No. 46 During the process of hydration of cement, due to increase in Dicalcium Silicate (C2S) content in cement clinker, the heat of hydration

(A) increases

(B) decreases

(C) initially decreases and then increases

(D) does not change

Answer: (B)

Q.No. 47 A soil sample is subjected to a hydrostatic pressure σ . The Mohr circle for any point in the soil sample would be

(A) a circle of radius o and center at the origin

(B) a circle Of radius 0 and center at a distance 0 from the origin

(C) a point at a distance o from the origin

(D) a circle of diameter G and center at the ori

Answer: (C)

Q.No. 48 The deformation in concrete due to sustained loading is

(A) creep

(B) hydration

(C) segregation

(D) shrinkage

Answer: (A)

Q.No. 49 As per IRC:37-2012, in order to control subgrade rutting in flexible pavements, the parameter to be considered is

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(A) horizontal tensile strain at the bottom of bituminous layer

(B) vertical compressive strain on top of subgrade

(C) vertical compressive stress on top of granular layer

(D) vertical deflection at the surface of the pavement

Answer: (B)

Q.No. 50 For the following statements: P – The lateral stress in the soil while being tested in an oedometer is always at-rest. Q – For a perfectly rigid strip footing at deeper depths in a sand deposit, the vertical normal contact stress at the footing edge is greater than that at its centre. R – The corrections for overburden pressure and dilatancy are not applied to measured SPT-N values in case of clay deposits. The correct combination of the statements is

(A) P – TRUE; Q – TRUE; R – TRUE

(B) P – FALSE; Q – FALSE; R – TRUE

(C) P – TRUE; Q – TRUE; R – FALSE

(D) P – FALSE; Q – FALSE; R – FALSE

Answer: (A)

Q.No. 51 The ordinary differential equation

(A) linear and homogeneous

(B) linear and nonhomogeneous

(C) nonlinear and homogeneous

(D) nonlinear and nonhomogeneous

Answer: (B)

Q.No. 52 The Laplace transform F(s) of the exponential function, $f(t) = e^{at}$ when $t \geq 0$, where a is a constant and $(s - a) > 0$, is

(A) $\frac{1}{s+a}$

(B) $\frac{1}{s-a}$

(C) $\frac{1}{a-s}$

(D) ∞

Answer: (B)

Q.No. 53 The setting time of cement is determined using

(A) Le Chatelier apparatus

(B) Briquette testing apparatus

(C) Vicat apparatus

(D) Casagrande’s apparatus

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Answer: (C)

Q.No. 54 In a rectangular channel, the ratio of the velocity head to the flow depth for critical flow condition, is

(A) 1/2

(B) 2/3

(C) 3/2

(D) 2

Answer: (A)

Q.No. 55 The coefficient of average rolling friction of a road is f_r and its grade is +G%. If the grade of this road is doubled, what will be the percentage change in the braking distance (for the design vehicle to come to a stop) measured along the horizontal (assume all other parameters are kept unchanged)?

(A) $\frac{0.01G}{f_r+0.02G} \times 100$

(B) $\frac{f_r}{f_r+0.02G} \times 100$

(C) $\frac{0.02G}{f_r+0.01G} \times 100$

(D) $\frac{2f_r}{f_r+0.01G} \times 100$

Answer: (A)

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