CIVIL ENGINEERING

Q. No. 1 - 25 Carry One Mark Each

1. There is no value of x that can simultaneously satisfy both the given equations. Therefore, find the 'least squares error' solution to the two equations, i.e., find the value of x that minimizes the sum of squares of the errors in the two equations _____.

$$2x = 3$$
$$4x = 1$$

Answer: **(0.5)**

2. What is the minimum number of multiplications involved in computing the matrix product PQR? Matrix P has 4 rows and 2 columns, matrix Q has 2 rows and 4 columns, and matrix R has 4 rows and 1 column.

Answer: **(16)**

3. A 1 hour rainfall of 10 cm has return period of 50 year. The probability that 1 hour of rainfall 10 cm or more will occur in each of two successive years is

(A) 0.04 (B) 0.2 (C) 0.2 (D) 0.0004

Answer: **(D)**

4. Maximum possible value of compaction factor for fresh (green) concrete is

(A) 0.5 (B) 1.0 (C) 1.5 (D) 2.0

Answer: **(B)**

5. As per IS 800: 2007 the cross-section in which extreme fibre can reach the yield stress but cannot develop the plastic moment of resistance due to local buckling is classified as

(A) Plastic section (B) Compact section

(C) Semi compact section (D) Shear section

Answer: **(C)**

6. Creep strain is

(A) caused due to dead load only

(B) caused due to live load only

(C) caused due to cyclic load only

(D) independent of load

Answer: **(A)**

7. As per IS 456 : 2000, bond strength of concrete $\tau_{bd} = 1.2$ for M20. It is increased by 60% for HYSD bar. The development length L_d in terms of ϕ is _____. $(\sigma_{st} = 360\,\text{MPa})$

Answer: **(46.875)**

**8.** The "Plane section remain plane" assumption in bending theory implies

(A) Strain profile is linear

(B) Stress profile is linear

(C) Both profiles are linear

(D) Shear deformation is neglected

Answer: **(A)**

9. Two steel column P (length L and yield strength $(f_y = 250\,\text{MPa})$ and Q (length 2L and yield strength $f_y = 500\,\text{MPa}$) have the same cross-section and end condition. The ratio of buckling load of column P to that of column Q is

(A) 0.5   (B) 1.0   (C) 2.0   (D) 4.0

Answer: **(D)**

10. A pin-jointed 2-D truss is loaded with a horizontal force of 15 kN at joint S and another 15 kN vertical force at joint U as shown in figure.
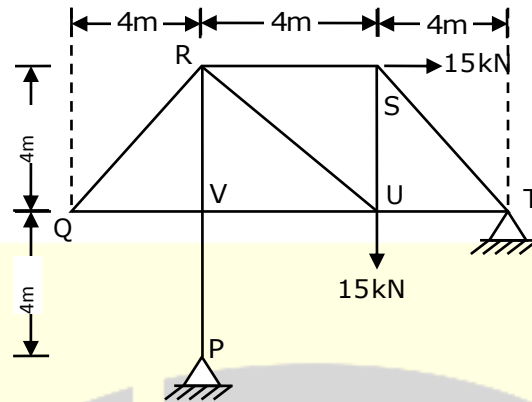
Find the force in member RS (in kN) and report your answer taking tension as +ve and compression as –ve?

Answer: **(0)**

11. A symmetric I-section (with width of each flange = 50 mm, thickness of web = 10 mm) of steel is subjected to a shear force of 100 kN. Find the magnitude of the shear stress (in N/mm^2) in the web at its junction with the top flange

Answer: **(71.12)**

12. In its natural condition a soil sample has a mass of 1.980 kg and a volume of $0.001\,\text{m}^3$. After being completely dried in an oven, the mass of the sample is 1.800 kg. Specific gravity is 2.7. Unit weight of water is $10\,\text{kN}/\text{m}^3$. The degree of saturation of soil is

    (A) 0.65   (B) 0.7   (C) 0.54   (D) 0.61

Answer: **(C)**

13. The ratio N_f / N_d is known as shape-factor where N_f is the number of flow channels and N_d is the equipotential drop. The flownet always drawn with a constant b/ a ratio where b and a are distance between two consecutive flow lines and equipotential lines respectively. Assuming that b/a ratio remains same, the shape factor of a flow net will change if the

(A) Upstream and downstream heads are interchanged

(B) Soil in the flow space is changed

(C) Dimension of the flow space are changed

(D) Head difference causing the flow is changed

Answer: **(C)**

14. Following statement are made on compacted soil, where DS stands for soil compaction on dry side of optimum moisture content and WS stands for soil compacted on Wet side of optimum moisture content. Identify incorrect statement

(A) Soil structure is flocculated on DS and dispersed on WS

(B) Construction of pore water pressure is low on DS and High on WS

(C) Soil on drying, shrinkage is high on DS and Low on WS

(D) On addition to water, swelling is high on DS and low on WS

Answer: **(C)**

15. Four columns of building are to be located within a plot size of $10m \times 10m$. The expected load on each column is 400 kN. Allowable bearing capacity of soil deposit is $100 kN / m^2$. The type of foundation to be used is

(A) Isolated foundation   (B) Raft foundation

(C) Pile foundation   (D) Combined foundation

Answer: **(C)**

16. For subcritical flow in an open channel, the control section for gradually varied flow profile is

(A) at the downstream end   (B) at the upstream end

(C) at the both ends   (D) at any intermediate section

Answer: **(A)**

17. Group-Icontains dimensionless parameter and **Group-II** contains ratio

	Group-I		Group-II
P.	Mach number	1.	Ratio of inertial force and gravity force
Q.	Reynold number	2.	Ratio of fluid velocity and velocity of sound
R.	Weber number	3.	Ratio of inertial force and viscous force
S.	Froude number	4.	Ratio of inertial force and surface tension force

Correct match of the dimensionless parameter in Group-I with Group-II is

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

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

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

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

Answer: **(C)**

18. For a 2-D flow field, the stream function ψ is given as $\psi = \dfrac{3}{2}\left(y^2 - x^2\right)$.

The magnitude of discharge occurring between the stream line passing through points (0, 3) and (3, 4) is

(A) 6 units   (B) 3 units   (C) 1.5 units   (D) 2 units

Answer: **(B)**

19. An isohyet is a line joining points of

(A) Equal temperature

(B) Equal humidity

(C) Equal rainfall depth

(D) Equal evaporation

Answer: **(C)**

20. Match the given water properties in **Group-I** to the given titrants shown in **Group-II**

	Group-I		Group-II
P.	Alkalinity	1.	$N/35.5$ $AgNO_3$
Q.	Hardness	2.	$N/40$ $Na_2S_2O_3$
R.	Chlorine	3.	$N/50$ H_2SO_4
S.	Dissolved oxygen	4.	$N/50$ EDTA

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

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

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

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

Answer: **(B)**

21. A water treatment plant, having discharge $1\,m^3/sec$, has 14 filters to treat the water. Each filter is having $50\,m^2$ area, but due to backwashing activity, 2 filters are non operational. Calculate hydraulic loading rate in $\dfrac{m^3}{day \cdot m^2}$

Answer: **(144)**

22. Select the strength parameter of concrete used in design of plain jointed cement pavement from the following choices:

(A) Tensile strength

(B) Compressive strength

(C) Flexural strength

(D) Shear strength

Answer: **(C)**

23. It was observed that 150 vehicle crossed a particular location of highway in 30 minutes. Assume that vehicle arrival follow a negative exponential distribution. The number of time headways greater than 5 seconds in above observation is _____.

Answer: **(*)**

24. For two major-roads with divided carriage way crossing at right angle, a full clover leaf interchange with four indirect ramps is provided. Following statements are made on turning movement of vehicles to all direction from both roads. Identity the correct statement

(A) Merging from left is not possible, but diverging to left is possible

(B) Merging from left and diverging to left is possible

(C) Merging from left is possible but diverging is not possible

(D) Neither merging from left nor diverging to left is possible

Answer: **(B)**

25. The latitude and departure of a line AB are $+78m$ and $-45.1m$ respectively. The whole circle bearing of the line AB is

(A) 30° (B) 150° (C) 210° (D) 330°

Answer: **(D)**

Q. No. 26 – 55 Carry Two Marks Each

26. 2D stress at a point is given by a matrix, $\begin{bmatrix} \sigma_{xx} & \tau_{xy} \\ \tau_{yx} & \sigma_{yy} \end{bmatrix} = \begin{bmatrix} 100 & 30 \\ 30 & 20 \end{bmatrix} MPa$.

The maximum shear stress in MPa is

(A) 50   (B) 75   (C) 100   (D) 110

Answer: **(A)**

27. The magnitude as the error (correct to two decimal places) in the estimation of integral $\int_{0}^{4}\left(x^4 + 10\right)dx$ using Simpson 1/3 rule is ____. [Take the step length as 1]

Answer: **(0.53)**

28. The value of $\int_{0}^{\pi/6} \cos^4 3\theta \sin^3 6\theta \, d\theta$ is

(A) 0   (B) $\dfrac{1}{15}$ (C) 1   (D) $\dfrac{8}{3}$

Answer: **(B)**

29. Find the value of λ such that function f(x) is valid probability density function?

$$f\left(x\right) = \begin{cases} \lambda\left(x-1\right)\left(2-x\right) & \text{for } 1 \le x \le 2 \\ 0 & \text{otherwise} \end{cases}$$
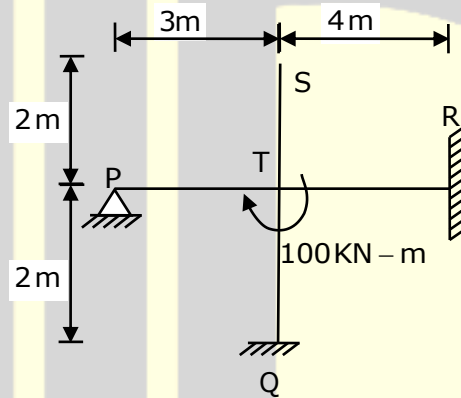
Answer: **(6)**

30. Laplace equation for water flow in soil is given by $\dfrac{\partial^2 H}{\partial x^2} + \dfrac{\partial^2 H}{\partial y^2} + \dfrac{\partial^2 H}{\partial z^2} = 0$

Head H does not vary in y and z-direction. Boundary condition

$x = 0, \; H = 5\,\text{m}, \; \dfrac{dH}{dx} = -1$. What is the value of H at $x = 1.2$?

Answer: **(3.8)**

31. All members in the rigid-jointed frame shown are prismatic and have the same flexural stiffness EI.
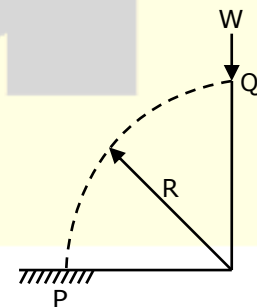

Find the magnitude of the B.M. at Q (in kN-m) due to given loading ?

Answer: **(25)**

32. A uniform beam (EI = constant) PQ in the form of a quarter circle of radius R is fixed at end P and free at the end Q, where a load W is applied as shown.

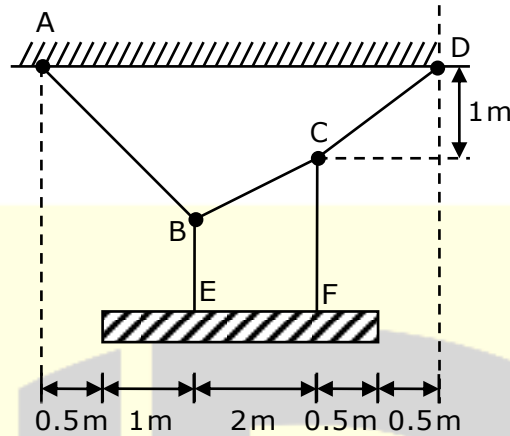The vertical downward displacement δ_Q at the loaded point Q is given by

$\delta_Q = \beta\left(\dfrac{wR^3}{EI}\right)$. Find the value of β correct to 4-decimal place
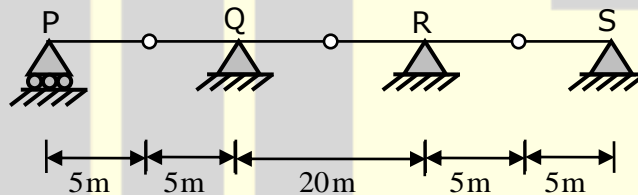

Answer: **(0.7854)**

33. A uniform beam weighing 1800 N is supported at E & F by cable ABCD.

Determine the tension force in segment AB at this cable (correct to 1 decimal place). Assume the cable ABCD, BE and CF are weightless

Answer: **(1272.91)**

34. Beam subjected to moving distributed load of 4 kN/m maximum shear force that can occur just to right of Q is
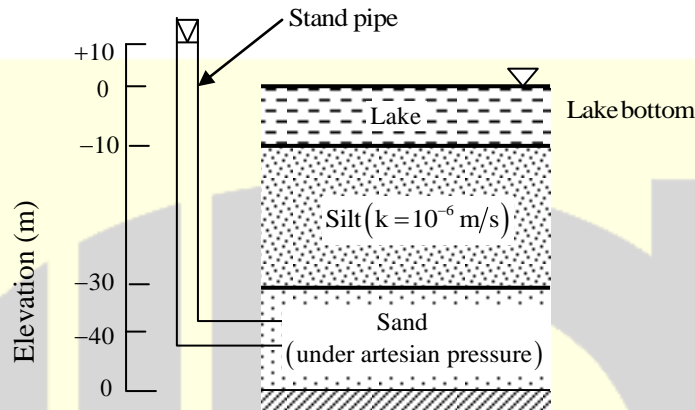

(A) 30 kN   (B) 40 kN   (C) 45 kN   (D) 55 kN

Answer: **(C)**

35. A rectangular concrete beam 250 mm wide and 600 mm deep is prestressed by means of 16 wire of high tensile steel wires, each of 7 mm diameter located at 200 mm from the bottom face of the beam at a given section. If the effective pre-stress in the wires is 700 MPa, what is the maximum sagging B.M (in kN-m) due to live load which this section of the beam can with stand without causing tensile stresses at the bottom face of the beam. Neglect the dead load of the beam.

Answer: **(86.205)**

36. The soil profile below a lake with water level at elevation = 0 m and lake bottom at elevation = −10m is shown in the figure, where k is the permeability coefficient. A piezometer (stand pipe) installed in the sand layer shows a reading of +10m elevation.
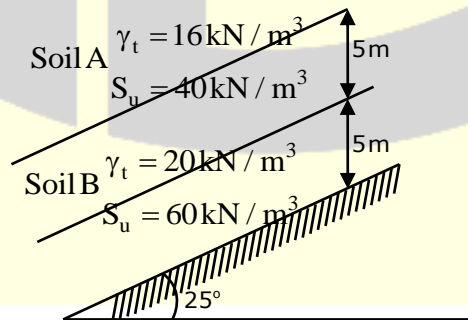
Stand pipe

Elevation (m)

+10, 0, −10, −30, −40, 0

Lake — Lake bottom

$\text{Silt}\left(k = 10^{-6} \text{ m/s}\right)$

Sand (under artesian pressure)

Assume that the piezometric head is uniform in the sand layer. The quantity of water (in m³/s) flowing into the lake from the sand layer through the silt layer per unit area of the lake bed is:

(A) 1.5×10^{-6} (B) 2.0×10^{-6} (C) 1.0×10^{-6} (D) 0.5×10^{-6}

Answer: (D)

37. The soil profile above the rock surface at 25° infinite slope is shown in figure where S_u is undrain shear stress and γ_t is total unit weight.

Soil A $\gamma_t = 16 \text{kN}/\text{m}^3$ 5m
$S_u = 40 \text{kN}/\text{m}^3$

Soil B $\gamma_t = 20 \text{kN}/\text{m}^3$ 5m
$S_u = 60 \text{kN}/\text{m}^3$

25°

The slip will occur at a depth of

(A) 8.83 m   (B) 9.79 m   (C) 7.83 m   (D) 6.53 m

Answer: (A)

38. Two different soil types (Soil 1 and Soil 2) are used as backfill behind a retaining wall as shown in the figure, where γ_t is total unit weight and c' & ϕ' ' are effective shear parameters. Find the resultant active earth pressure in kN/m

$$2m \quad \gamma_1 = 15\,kN/m^3 \quad c'=0,\ \phi'=30°$$

$$2m \quad \gamma_2 = 20\,kN/m^3 \quad c'=0,\ \phi'=40°$$
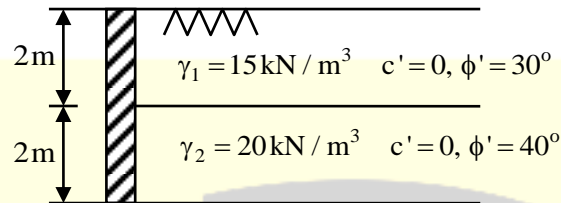
(A) 31.7   (B) 35.2   (C) 57.8   (D) 57

Answer: (A)

39. A 2 km pipe of 0.2 m diameter connects two reservoirs. The difference between the water levels in the reservoir is 8 m. The Darcy Weisbach friction factor of the pipe is 0.04. Accounting for frictional entry and exit losses, the velocity in the pipe in (m/sec) is

(A) 0.63   (B) 0.35   (C) 2.52   (D) 1.25

Answer: (A)

40. The normal depth in a wide rectangular channel is increased by 10%. The percentage increase in discharge in the channel is

(A) 20.1   (B) 15.4   (C) 10.5   (D) 17.2

Answer: (D)

41. The transplantation of rice requires 10 days and total depth of water required during transplantation is 48 cm. During transplantation there is an effective rainfall (useful for irrigation) of 8 cm. The duty of irrigation water in hectare/ cumecs is

(A) 612   (B) 216   (C) 300   (D) 108

Answer: (B)

42. A settling tank is designed for a surface overflow rate of $30\dfrac{m^3}{day\ m^2}$. Assuming specific gravity of sediment particles = 2.65, Density of water, $\gamma_w = 1000\ kg/m^3$, dynamic viscosity of water $m_{water} = 0.001\ Ns/m^2$ and stokes law is valid.

The approximate minimum size of particles which can be completely removed is

(A) 0.01 mm   (B) 0.02 mm   (C) 0.03 mm   (D) 0.04mm

Answer: **(B)**

43. A student began an experiment of 5 day 20^oC BOD on Monday. Since the 5th day fell on Saturday, the final DO reading was taken on Monday. On calculation BOD (i.e. 7 day 20^oC) was found to be 150 mg/L. What would be the 5 day, 20^oC BOD (in mg/L)? Assume value of BOD rate constant (K) at standard temperature of 20^oC as 0.23/day (base e).

Answer: **(128.09)**

44. Elevation and temperature data for places are tabulated below

Elevation 'm'	Temperature ^oC
4	21.25
444	15.70

Based on this data, lapse rate can be referred as

(A) Super-adiabatic   (B) Sub-adiabatic

(C) Neutral   (D) Inversion

Answer: **(A)**

45. The percent voids in mineral aggregate (VMA) and percent air voids (V_v) in a compacted cylindrical bituminous mix specimen are 15 and 4.5 respectively. the percent voids filled with bitumen (VFB) for this specimen is:

(A) 24   (B) 30   (C) 54   (D) 70

Answer: **(D)**

46. Bearing of the given system is shown below:

Line	Fore bearing	Back bearing
AB	$126^\circ45'$	$308^\circ00'$
BC	$45^\circ15'$	$227^\circ30'$
CD	$340^\circ30'$	$161^\circ45'$
DE	$258^\circ30'$	$78^\circ30'$
EA	$216^\circ30'$	$31^\circ45'$

Applying correction due to local attraction, the correct bearing of line BC will be

(A) $48^\circ15'$ (B) $50^\circ15'$ (C) $49^\circ15'$ (D) $48^\circ45'$
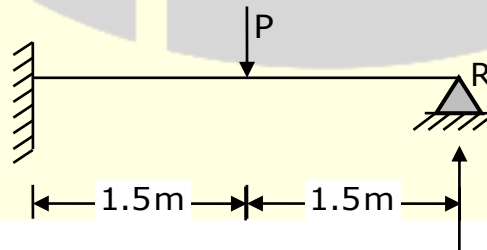
Answer: **(D)**

47. A Theodolite is placed at A and a 3 m long vertical staff is held at B. The depression angle made at reading of 2.5m marking on staff is $6^\circ10'$. The horizontal distance between A and B is 2200 m. The height of instrument at A is 1.2 m and reduced level of point A is 880.88 m. Using curvature correction and refraction correction determine the R.L. of point B (in m).

Answer: **(642.205)**

Statement for Linked Answer Questions: 48&49

The magnitude of load P is increased till collapse and the plastic moment carrying capacity of steel beam section is 90 kNm

48. What is the value of R (in kN) if value of P is 80 kN by elastic theory?

Answer: **(25)**

49. The value of R (in kN), using plastic analysis is (upto 1 decimal place).

Answer: **(60)**

Common Data for Questions: 50&51

For a portion of highway descending gradient 1 in 25 meets an ascending gradient 1 in 20. A valley curve needs to be designed at a velocity of 90 kmph based on

(i) Head light sight distance equal to stopping sight distance of a level terrain.
     Consider length of curve > SSD

(ii) Comfort condition if rate of change of acceleration is $0.5 \, m/s^3$

Reaction time = 2.5 sec, coefficient of longitudinal friction $\mu = 0.35$. Height of head light = 0.75 m, and beam angle $= 1^o$

50. What is the length of valley curve as per headlight sight distance?

**Answer:** **(308.96)**

51. What is the length of valley curve (in meter) based on comfort condition?

Answer: **(106.06)**

Statement for Linked Answer Questions: 52& 53

A multistorey building with a basement is to be constructed. The top 4 m contains loose silt below which dense sand layer is present upto a great depth. Ground water table is at the ground surface. The foundation consists of the basement slab of 6 m width which will rest on the top of dense sand as shown in figure. For dense sand saturated unit weight is $20 \, kN/m^3$ and bearing capacity factor, $N_q = 40$, $N_\gamma = 45$, for loose silt saturated unit weight = $18 kN/m3$, $N_q = 15$, $N_\gamma = 20$. Effective cohesion is 0. Neglect depth factor average elastic modulus E, and Poisson ratio μ of dense sand is $60 \times 10^3 \, kN/m^2$ and 0.3 respectively, using factor of safety = 3. (Take influence factor = 2)

52. The net safe bearing capacity $\left(\text{in kN} / \text{m}^3\right)$ of foundation is
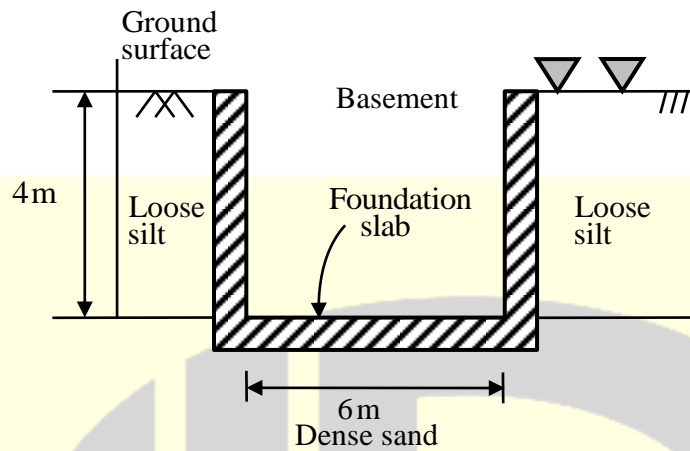
(A) 610　　　　(B) 320　　　　(C) 980　　　　(D) 693

Answer: **(*)**

53. The immediate settlement of foundation is

(A) 58 mm　　　(B) 111 mm　　　(C) 178 mm　　　(D) 126 mm

Answer: **(*)**

Common Data Questions: 54& 55

Storm-I: of duration 5 hours gives a direct run-off of 4 cm and has an average intensity of 2cm / hr

Storm-II: of 8 hour duration gives a run-off of 8.4 cm.

(Assume ϕ-index is same for both the storms.)

54. The value of $\phi-\text{index}$ is

(A) 1.2　　　　(B) 1.6　　　　(C) 1　　　　(D) 1.4

Answer: **(A)**

55. Intensity of storm-II in cm/hr is

(A) 2　　　　(B) 1.5　　　　(C) 1.75　　　　(D) 2.25

Answer: **(D)**

GENERAL APTITUDE

Q. No. 56-60 Carry One Mark Each

56. A number is as much greater than 75 and smaller than 117 is

(A) 91   (B) 93   (C) 89   (D) 96

Answer: **(D)**

57. $\underset{(I)}{\text{The professor}}\ \underset{(II)}{\text{ordered to}}\ \underset{(III)}{\text{the student to go}}\ \underset{(IV)}{\text{out of the class}}$

The incorrect one is

(A) (I)   (B) (II)   (C) (III)   (D) (IV

Answer: **(B)**

58. Which of the following options is closest in meaning to the word given below?

"Primeval"

(A) Modern   (B) Historic   (C) Primitive   (D) Antique

Answer: **(C)**

59. Friendship, No matter how _____ it is, has its limitation

(A) cordial   (B) intimate   (C) secret   (D) pleasant

Answer: **(B)**

60. The pair that best express a relationship similar to that expression in the pair:

Medicine: Health

(A) Science: Experiment   (B) Wealth : Peace

(C) Education: Knowledge   (D) Money: Happiness

Answer: **(C)**

Q. No. 61-65 Carry Two Marks Each

61. x and y are two positive real numbers, such that equation

$2x + y \leq 6;\ x + 2y \leq 8$

For which values of (x, y), the function $f(x, y) = 3x + 6y$ will give maximum value

(A) $(4/3, 10/3)$
(B) $(8/3, 20/3)$
(C) $(8/3, 10/3)$
(D) $(4/3, 20/3)$

Answer: **(A)**

62. If $|4x - 7| = 5$ then the value of $2|x| - |-x|$ is

(A) $2, \dfrac{1}{3}$
(B) $\dfrac{1}{2}, 3$
(C) $\dfrac{2}{3}, \dfrac{1}{3}$
(D) $\dfrac{2}{9}, 3$

Answer: **(B)**

63. Following table provides figures(in rupees) on annual expenditure of a firm for two years -2010 and 2011.

	2010	2011
Raw material	5200	6240
Power & fuel	7000	9450
Salary & wages	9000	12600
Plants & machinery	20000	25000
Advertising	15000	19500
Research & development	22000	26400

Which one of the following increased by same percentage in year 2010-2011?

(A) Raw material and salary and wages

(B) Salary and wages and advertising

(C) Power and fuel and advertising

(D) Raw material and research and development

Answer: **(D)**

64. A firm is selling it product at Rs. 60/unit. The total cost of production is Rs. 100 and firm is earning total profit of Rs. 500. Later, the total cost increased by 30%. By what percentage the price should be increased to maintain the same profit level

(A) 5   (B) 15   (C) 10   (D) 30

Answer: **(A)**

65. Abhishek is elder to Savan, Savan is younger to Anshul. The correct relations is

(A) Abhishek is elder to Anshul

(B) Anshul is elder to Abhishek

(C) Abhishek and Anshul are of same age

(D) No conclusion can be drawn

Answer: **(D)**

★★★ **END OF THE PAPER** ★★★