Q. No. 1 – 25 Carry One Mark Each

1. The $\lim_{x\to 0} \frac{\sin\left[\frac{2}{3}x\right]}{X}$ is

(A) $\frac{2}{3}$ (B) 1 (C) $\frac{1}{4}$ (D) $\frac{1}{2}$

2. Two coins are simultaneously tossed. The probability of two heads simultaneously appearing is

(A) $\frac{1}{8}$ (B) $\frac{1}{6}$ (C) $\frac{1}{4}$ (D) $\frac{1}{2}$

3. The order and degree of the differential equation

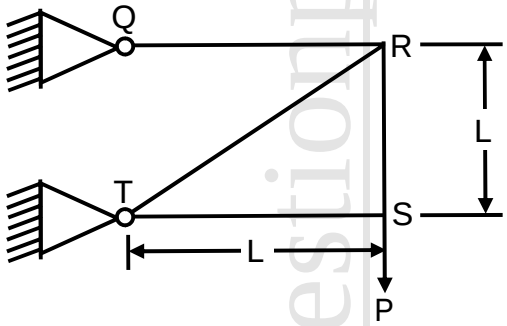
$\frac{d^3y}{dx^3} + 4\sqrt{\left(\frac{dy}{dx}\right)^3 + y^2} = 0$ are respectively

(A) 3 and 2 (B) 2 and 3 (C) 3 and 3 (D) 3 and 1

4. Two people weighing W each are sitting on a plank of length L floating on water at $\frac{L}{4}$ from either end. Neglecting the weight of the plank, the bending moment at the centre of the plank is

(A) $\frac{WL}{8}$ (B) $\frac{WL}{16}$ (C) $\frac{WL}{32}$ (D) zero

5. For the truss shown in the figure, the force in the member QR is



(A) Zero (B) $\frac{p}{\sqrt{2}}$ (C) P (D) 2P2

6. The major and minor principal stresses at a point are 3MPa and -3MPa respectively. The maximum shear stress at the point is

(A) Zero (B) 3MPa (C) 6MPa (D) 9MPa

7. The number of independent elastic constants for a linear elastic isotropic and homogeneous material is

(A) 4 (B) 3 (C) 2 (D) 1

8. The effective length of a column of length L fixed against rotation and translation at one end and free at the other end is

(A) 0.5 L (B) 0.7 L (C) 1.414 L (D) 2L

9. As per India standard code of practice for pre stressed concrete (IS:1343-1980) the minimum grades of concrete to be used for post-tensioned and pre-tensioned structural elements are respectively

(A) M20 for both (B) M40 and M30 (C) M15 and M20 (D) M30 and M40

10. A solid circular shaft of diameter d and length L is fixed at one end and free at the other end. A torque t is applied at the free end. The shear modulus of the material is G. The angle of twist at three free ends is

(A) $\frac{16TL}{\pi d^4 G}$ (B) $\frac{32TL}{\pi d^4 G}$ (C) $\frac{64TL}{\pi d^4 G}$ (D) $\frac{128TL}{\pi d^4 G}$

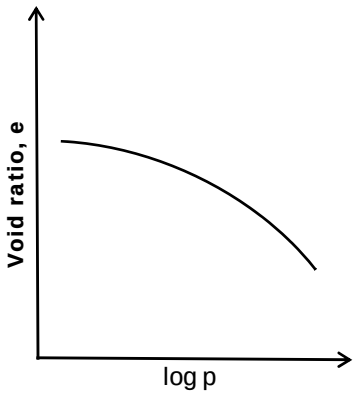
11. In a compaction test, G, w, S and e represent the specific gravity, water content, degree of saturation and void ratio of the soil sample, respectively. If γ_w represents the unit weight of water and γ_w represents the dry unit weight of the soil, the equation for zero air voids line is

(A) $\gamma_d \frac{G\gamma_w}{1+Se}$ (B) $\gamma_d \frac{G\gamma_w}{1+GW}$ (C) $\gamma_d \frac{G\gamma_w}{e+\gamma_w S}$ (D) $\gamma_d \frac{GW}{1+Se}$

12. A fine grained soil has liquid limit of 60 and plastic limit of 20. As per the plasticity chart, according to IS classification, the soil is represented by the letter symbols
(A) CL (B) CI (C) CH (D) CL-ML

13. Quick sand condition occurs when
(A) The void ratio of the soil becomes 1.0
(B) The upward seepage pressure in soil becomes zero
(C) The upward seepage pressure in soil becomes equal to the saturated unit weight of the soil
(D) The upward seepage pressure in soil becomes equal to the submerged unit weight of the soil

14. The e-log p curve shown in the figure is representative of



(A) Normally consolidated clay
(B) Over consolidated clay
(C) Under consolidated clay
(D) Normally consolidated clayey sand

15. If σ_h, σ_v, σ_h, and σ_v represent the total horizontal stress, total vertical stress, effective horizontal stress and effective vertical stress on a soil element, respectively, the coefficient of earth pressure at rest is given by
(A) $\frac{\sigma_h}{\sigma_v}$ (B) $\frac{\sigma_h}{\sigma_v'}$ (C) $\frac{\sigma_v}{\sigma_h}$ (D) $\frac{\sigma_v}{\sigma_h'}$

16. A mild-sloped channel is followed by a steep-sloped channel. The profiles of gradually varied flow in the channel are
(A) M_3, S_2 (B) M_3,S_3 (C) M_2,S_1 (D) M_2,S_2

17. The flow in a rectangular channel is subcritical. If width of the channel is reduced at a certain section, the water surface under no-choke condition will
(A) Drop at a downstream section (B) Rise at a downstream section
(C) Rise at an downstream section (D) Not undergo any change

18. The correct match of **Group-I** with **Group-II** is

Group-II	Group-II
P. Evapotranspiration	1. Penman method
Q. Infiltration	2. Snyder's method
R. Synthetic unit hydrograph	3. Muskingum method
S. Channel Routing	4. Horton's method

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

19. **Group-I** gives a list of devices and **Group-II** gives the list of uses

P. Pitot tube	1. Measuring pressure in a pipe
Q. Manometer	2. Measuring velocity of flow in a pipe
R. Venturimeter	3. Measuring air and gas velocity
S. Anemometer	4. Measuring discharge in a pipe

The correct match of **Group-I** with **Group-II** is
(A) P-1, Q-2, R-4, S-3 (B) P-2, Q-1, R-3, S-4
(C) P-2, Q-1, R-4, S-3 (D) P-4, Q-1, R-3, S-2

20. A coastal city produces municipal solid waste (MSW) with high moisture content, high organic materials, low calorific value and low inorganic materials. The most effective and sustainable option for MSW management in that city is
(A) Composting (B) Dumping in sea (C) Incineration (D) Landfill

21. According to the Noise Pollution (Regulation and control) Rules, 2000, of the Ministry of Environment and Forests, India, the day time and night time noise level limits in ambient air for residential areas expressed in dB(A) Leg are
(A) 50 and 40 (B) 55 and 45 (C) 65 and 55 (D) 75 and 70

22. An air parcel having 40ºC temperature moves from ground level to 500m elevation in dry air following the "adiabatic lapse rate". The resulting temperature of air parcel at 500m elevation will be
(A) 35°C (B) 38°C (C) 41°C (D) 44°C

24. As per IRC: 67-2001, a traffic sign indicating the Speed Limit on a road should be of
(A) Circular Shape with White Background and Red Border
(B) Triangular Shape with White Background and Red Border
(C) Triangular Shape with Red Background and White Border
(D) Circular Shape with Red Background ad White Border

25. The local mean time at a place located in longitude 90º 40'E when the standard time is 6 hours and 30 minutes and the standard meridian is 82º 30'E is
(A) 5 hours, 2 minutes and 40 seconds
(B) 5 hours, 57 minutes and 20 seconds
(C) 6 hours, and 30 minutes
(D) 7 hours, 02 minutes and 40 seconds

Q. No. 26 – 51 Carry Two Marks Each

26. The solution to the ordinary differential equation $\frac{d^2y}{dx^2}+\frac{dy}{dx}-6y=0$ is
(A) $y = c_1e^{3x} + c_2e^{-2x}$ (B) $y = c_1e^{3x} + c_2e^{2x}$
(C) $y = c_1e^{-3x} + c_2e^{-2x}$ (D) $y = c_1e^{-3x} + c_2e^{2x}$

27. The inverse of the matrix is $\begin{bmatrix} 3+2i & -i \\ i & 3-2i \end{bmatrix}$
(A) $\frac{1}{12}\begin{bmatrix} 3+2i & -i \\ i & 3-2i \end{bmatrix}$ (B) $\frac{1}{12}\begin{bmatrix} 3-2i & -i \\ i & 3+2i \end{bmatrix}$
(C) $\frac{1}{14}\begin{bmatrix} 3+2i & -i \\ i & 3-2i \end{bmatrix}$ (D) $\frac{1}{14}\begin{bmatrix} 3-2i & -i \\ i & 3+2i \end{bmatrix}$

28. The table below gives values of a function F(x) obtained for values of x at intervals of 0.25.

X	0	0.25	0.5	0.75	1.0
F(x)	1	0.9412	0.8	0.64	0.50

The value of the integral of the function between the limits 0 to 1 using Simpson's rule is
(A) 0.7854 (B) 2.3562 (C) 3.1416 (D) 7.5000

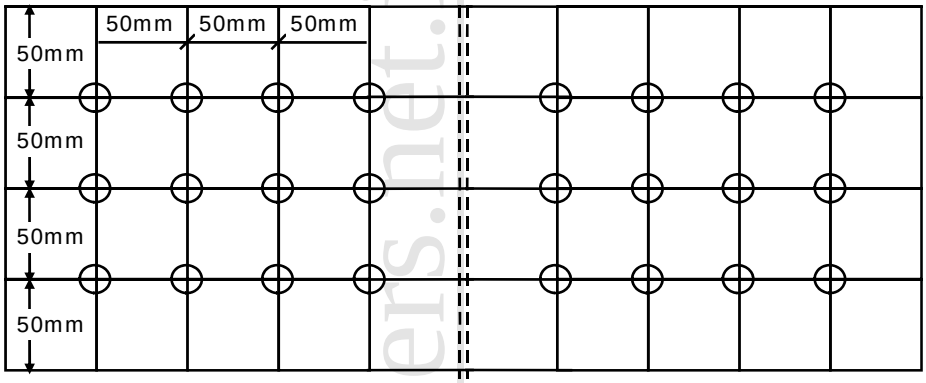
29. The partial differential equation that can be formed from
z = ax + by + ab has the form $\left(\text{with} p=\frac{\partial z}{\partial x} \text{and} q=\frac{\partial z}{\partial y}\right)$
(A) z=px+qy (B) z=px+pq (C) z=px+qy+pq (D) z=qy+pq

30. A parabolic cable is held between two supports at the same level. They horizontal span between the supports is L. The sag at the mid-span is h. The equation of the parabola is $y = 4h\frac{x^2}{L^2}$, where x is the horizontal coordinate and y is the L vertical coordinate with the origin at the centre of the cable. The expression for the total length of the cable is
(A) $\int_0^L \sqrt{1+64\frac{h^2x^2}{L^4}}dx$ (B) $2\int_0^{L/2} \sqrt{1+64\frac{h^3x^2}{L^4}}dx$
(C) $\int_0^{L/2} \sqrt{1+64\frac{h^2x^2}{L^4}}dx$ (D) $2\int_0^{L/2} \sqrt{1+64\frac{h^2x^2}{L^4}}dx$

31. Given a function
$f(x, y) = 4x^2 + 6y^2 - 8x - 4y + 8$

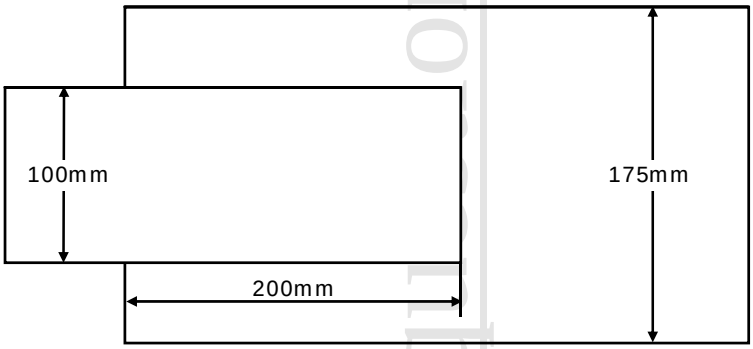
The optimal value of f(x, y)
(A) Is a minimum equal to 10/3 (B) Is a maximum equal to 10/3
(C) Is a minimum equal to 8/3 (D) Is a maximum equal to 8/3

32. A double cover butt riveted joint is used to connect two flat plates of 200mm width and 14mm thickness as show in the figure. There are twelve power driven rivets of 20mm diameter at a pitch of 50mm in both directions on either side of the plate. Two cover plates of 10mm thickness are used. The capacity of the joint in tension considering bearing and shear ONLY, with permissible bearing and shear stresses as 300MPa respectively is



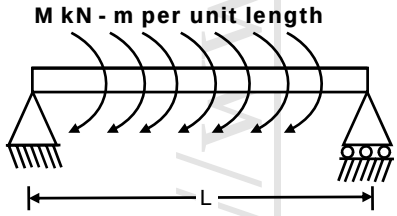
(A) 1083.6kN (B) 871.32kN (C) 541.18kN (D) 433.7kN

33. Two plates, subjected to direct tension, each of 10mm thickness and having widths of 100mm and 175mm, respectively are to be fillet welded with an overlap of 200mm. Given that the permissible weld stress is 110MPa and the permissible stress in steel is 150MPa, then length of the weld required using the maximum permissible weld size as per IS: 800-1984 is



(A) 245.3mm (B) 229.2mm (C) 205.5mm (D) 194.8mm

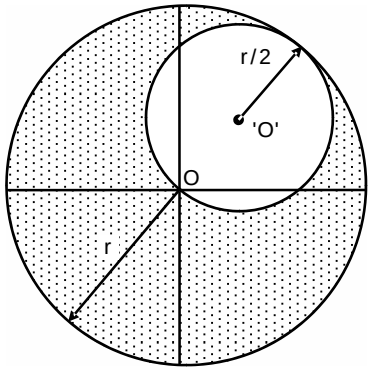
34. For the simply supported beam of length L, subjected to a uniformly distributed moment M kN-m per unit length as shown in the figure, the bending moment (in kN-m) at the mid-span of the beam is



(A) Zero (B) M (C) ML (D) M/L

35. A disc of radius r has a hole of radius $r/2$ cut-out as shown.

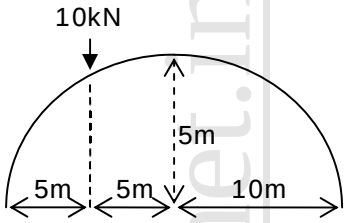
The centroid of the remaining disc (shaded portion) at a radial distance from the centre "O" is



(A) $\frac{r}{2}$ (B) $\frac{r}{3}$

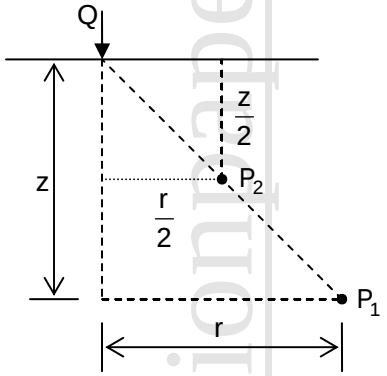
(C) $\frac{r}{6}$ (D) $\frac{r}{8}$

36. A three hinged parabolic arch having a span of 20m and a rise of 5m carries a point load of 10kN at quarter span from the left end as shown in the figure. The resultant reaction at the left support and its inclination with the horizontal are respectively



(A) 9.01kN and 56.31º (B) 9.01kN and 33.69º
(C) 7.50kN and 56.31º (D) 2.50kN and 33.69º

37. The vertical stress at point P_1 due to the point load Q on the ground surface as shown in figure is s_2. According to Boussinesq's equation, the vertical stress at point P_2 shown in figure will be



(A) $\frac{\sigma_z}{2}$ (B) σ_z (C) $2\sigma_z$ (D) $4\sigma_z$

38. An open ended steel barrel of 1m height and 1m diameter is filled with saturated fine sand having coefficient of permeability of 10^{-2} m / s. The barrel stands on a saturated bed of gravel. The time required for the water level in the barrel to drop by 0.75m is
(A) 58.9s (B) 75s (C) 100s (D) 150s

39. The ultimate load capacity of a 10m long concrete pile of square cross section 500mm x 500mm driven into a homogeneous clay layer having undrained cohesion value of 40kPa is 700kN. If the cross section of the pile is reduced to 250mm x 250mm and the length of the pile is increased to 20m, the ultimate load capacity will be
(A) 350kN (B) 632.5kN (C) 722.5kN (D) 1400kN

40. For a rectangular channel section, Group I lists geometrical elements and Group II gives proportions for hydraulically efficient section.

Group I		Group II	
P	Top width	1	$\frac{y_e}{2}$
Q	Perimeter	2	y_e
R	Hydraulic Radius	3	$2y_e$
S	Hydraulic Depth	4	$4y_e$

y_e is the follow depth corresponding to hydraulically efficient section. The correct match of Group I with Group II is
(A) P-2, Q-4, R-1, S-3 (B) P-3,Q-1,R-4,S-2
(C) P-3,Q-4,R-1,S-2 (D) P-3,Q-4,R-2,S-1

41. The Froude number of flown in a rectangular channel is 0.8. If the depth of flow is 1.5m, the critical depth is
(A) 1.80m (B) 1.56m (C) 1.36m (D) 1.29m

42. A wall of diameter 20cm fully penetrates a confined aquifer. After a long period of pumping at a rate of 2720litres per minute, the observations of drawdown taken at 10m and 100m distances from the center of the wall are found to be 3m and 0.5m respectively. The transmissivity of the aquifer is
(A) 676m2/day (B) 576 m2/day (C) 526 m2/day (D) 249 m2/day

43. If the BOD_3 of a wastewater sample is 75mg/L and reaction rate constant k (base e) is 0.345 per day, the amount of BOD remaining in the given sample after 10days is
(A) 3.21 mg/L (B) 3.45 mg/L (C) 3.69 mg/L (D) 3.92 mg/L

44. Consider the following statements in the context of geometric design of roads.
I: A simple parabolic curve is an acceptable shape for summit curves.
II: Comfort to passengers is an important consideration in the design of summit curves.
The correct option evaluating the above statements and their relationship is
(A) I is true, II is false
(B) I is true, II is true, and II is the correct reason for I
(C) I is true, II is true, and II is NOT the correct reason for I
(D) I is false, II is true

45. The design speed for a two-lane road is 80kmph. When a design vehicle with a wheelbase of 6.6m is negotiating a horizontal curve on that road, the off-tracking is measured as 0.096m. The required widening of carriageway of the two-lane road on the curve is approximately
(A) 0.55m (B) 0.65m (C) 0.75m (D) 0.85m

46. Consider the following statements in the context of cement concrete pavements.
I. Warping stresses in cement concrete pavements are caused by the seasonal variation in temperature.
II. Tie bars are generally provided across transverse joints of cement concrete pavements
The correct option evaluating the above statements is
(A) I: True II: False (B) I: False II: True
(C) I: True II: True (D) I: False II: False

47. A bench mark has been established at the soffit of an ornamental arch at the known elevation of 100.0m above sea level. The back sight used to establish height of instrument is an inverted staff reading of 2.105m. A forward sight reading with normally held staff of 1.105m is taken on a recently constructed plinth. The elevation of the plinth is
(A) 103.210m (B) 101.000m (C) 99.000m (D) 96.790m

Common Data Questions: 48 & 49

Ion concentrations obtained for a groundwater sample (having pH=8.1) are given below.

Ion	$Ca2^+$	$Mg2^+$	Na^+	HCO_3^-	$SO4^{2-}$	Cl^-
Ion concentration (mg/L)	100	6	15	250	45	39
Atomic Weight	Ca=40	Mg=24	Na=23	H=1, C=12, O=16	S=32, O=16	Cl=35.5

48. Total hardiness (mg/L as $CaCO_3$) present in the above water sample is
(A) 205 (B) 250 (C) 275 (D) 308

49. Carbonate hardness (mg/L as $CaCO_3$) present in the above water sample is
(A) 205 (B) 250 (C) 275 (D) 289

Common Data Questions: 50 & 51

The moisture holding capacity of the soil in a 100 hectare farm is 18cm/m. the field is to be irrigated when 50 percent of the available moisture in the root zone is depleted. The irrigation water is to be supplied by a pump working for 10hours a day, and water application efficiency is 75%. Details of crops planned for cultivation are as follows:

Crop	Root zone depth (m)	Peak rate of moisture use (mm/day)
X	1.0	5.0
Y	0.8	4.0

50. The capacity of irrigation system required to irrigate crop X in 36 hectares is
(A) 83litres/sec (B) 67 liters/sec (C) 57 liters/sec (D) 53 liters/sec

51. The area of crop Y that can be irrigated when the available capacity of irrigation system is 40 liters / sec is
(A) 40hectares (B) 36 hectares (C) 30 hectares (D) 27 hectares

Linked Answer Questions 52 & 53

A doubly reinforced rectangular concrete beam has a width of 300mm and an effective depth of 500mm. the beam is reinforced with 2200mm^2 of steel in tension and 628mm^2 of steel in compression. The effective cover for compression steel is 50mm. Assume that both tension and compression steel yield. The grades of concrete and steel used are M20 and Fe250 respectively. The stress lock parameters (rounded off to first two decimal places) for concrete shall be as per IS 456:200.

52. The depth of neutral axis is
(A) 205.30mm (B) 184.56mm (C) 160.91mm (D) 145.30mm

53. The moment of resistance of the section is
(A) 206.00kN-m (B) 209.20 kN-m (C) 236.80 kN-m (D) 251.90kN-m,

55. If a square footing of size 4m x 4m is resting on the surface of a deposit of the above clay, the ultimate bearing capacity of the footing (as per Terzaghi's equation) is
(A) 1600kPa (B) 315kPa (C) 27kPa (D) 54kPh

Q. No. 56 – 60 Carry One Mark Each

56. Which of the following options is closest in meaning to the word **Circuitous.**
(A) cyclic (B) indirect (C) confusing (D) crooked

57. The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.
Unemployed: Worker
(A) fallow: land (B) unaware: sleeper
(C) wit: jester (D) renovated: house

58. Choose the most appropriate word from the options given below to complete the following sentence:
If we manage to _____ our natural resources, we would leave a better planet for our children.
(A) uphold (B) restrain (C) cherish (D) conserve

59. Choose the most appropriate word from the options given below to the complete the following sentence:
His rather casual remarks on politics _____ his lack of seriousness about the subject.
(A) masked (B) belied (C) betrayed (D) suppressed

60. 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:
(A) 2 (B) 17 (C) 13 (D) 3

Q. No. 61 – 65 Carry Two Marks Each

61. Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters). All were born on 1st January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts:
i. Hari's age + Gita's age > Irfan's age + Saira's age
ii. The age difference between Gita and Saira is 1 year. However Gita is not the oldest and Saira is not the youngest.
iii. There are no twins. In what order were they born (oldest first)?
(A) HSIG (B) SGHI (C) IGSH (D) IHSG

62. 5 skilled workers can build a wall in 20days: 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?
(A) 20 (B) 18 (C) 16 (D) 15

63. Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause. Which of the following statements best sums up the meaning of the above passage:
(A) Modern warfare has resulted in civil strife.
(B) Chemical agents are useful in modern warfare.
(C) Use of chemical agents in warfare would be undesirable
(D) People in military establishments like to use chemical agents in war.

64. Given digits 2,2,3,3,4,4,4,4 how many distinct 4 digit numbers greater than 3000 can be formed?
(A) 50 (B) 51 (C) 52 (D) 54

65. If 137+276=435 how much is 731+672?
(A) 534 (B) 1403 (C) 1623 (D) 1513

End of Question Paper