SAMPLE PAPERS

JEE Mains

Time: 3 Hours **Maximum Marks: 360**

Topics Covered:

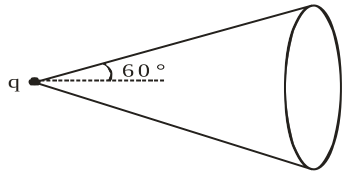
Physics	:	*Units & Measurements, Kinematics (1 & 2-D Motion), NLM (Including Friction), Electrostatics, Capacitance*
Chemistry	:	*Atomic Structure, Redox Reaction, Periodic Properties, General Organic Chemistry, Solutions, p-Block Elements*
Mathematics	:	*Sets, Relation & Functions, Binomial Theorem, Matrices & Determinants, Relations, Functions, Inverse Trigonometry*

Important Instructions :

1. *The test is of* ***3 hours*** *duration.*
2. *The Test consists of 90 questions. The maximum marks are* ***360****.*
3. *There are three parts in the question paper A, B, C consisting of* ***Physics, Chemistry*** *and* ***Mathematics*** *having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for each correct response.*
4. *Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. ¼ (one-fourth) marks of the total marks allotted to the question (i.e. 1 mark) will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.*
5. *There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 4 above.*
6. *For writing particulars/marking responses on Answer Sheet use* ***only Black/Blue Ball Point Pen*** *provided in the examination hall.*
7. *No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination hall/room.*

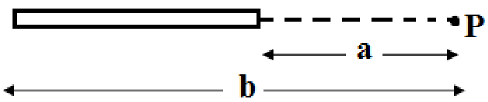
PART-A : PHYSICS

1. A point charge q is placed at the apex of a cone as shown in figure. Find the flux linked through the base of the cone.



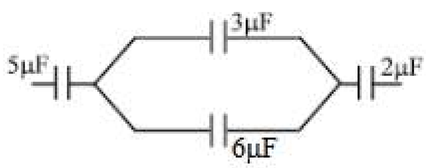
(A) 0 (B) $\frac{q}{8\in_0}$ (C) $\frac{q}{\in_0}$ (D) $\frac{q}{4\in_0}$

2. A uniformly charged linear rod is placed as shown in the figure. Find the electric field intensity at point P. Given that charge density is λ C/m.



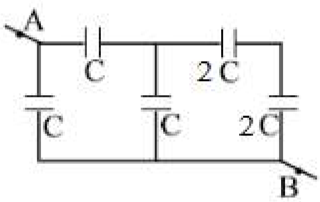
(A) $\frac{\lambda(b-a)}{4\pi\in_0 ab}$ (B) $\frac{\lambda(b^2-a^2)}{4\pi\in_0 ab}$ (C) $\frac{\lambda}{2\pi\in_0}\frac{(b-a)}{ab}$ (D) $\frac{\lambda}{4\pi\in_0}\ell n\left(\frac{b}{a}\right)$

3. If charge on left of the 5μF capacitor in the circuit segment shown in the figure is –18μC. The charge on the right plate of 3μF capacitor is



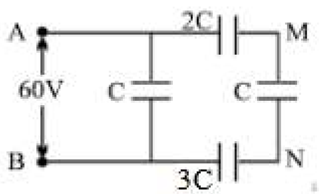
(A) –6μC (B) –12 μC (C) –18 μC (D) +6 μC

4. What is the equivalent capacitance of the system of capacitors between A and B?



(A) $\frac{7}{6}$C (B) $\frac{5}{3}$C (C) C (D) None of these

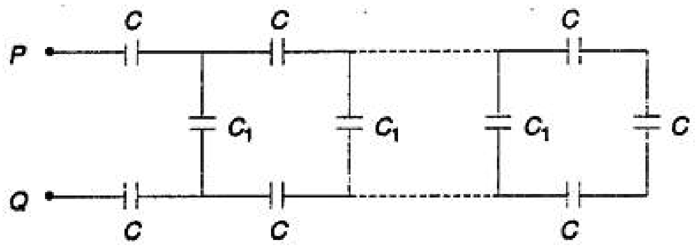
5. In the circuit shown, a potential difference of 60V is applied across AB. The potential difference between the point M and N is



(A) $\frac{300}{11}$ V (B) $\frac{450}{11}$ V (C) 20V (D) $\frac{360}{11}$ V

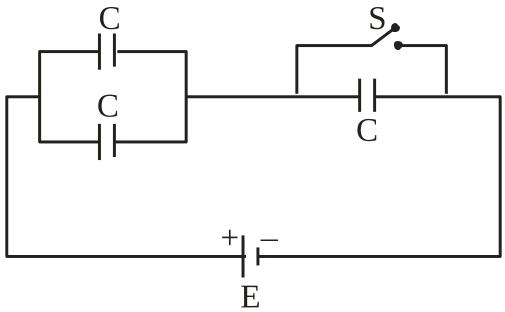
Space for Rough Work

6. In the finite network shown in the figure, C_1= 8μF and C = 12μF. The equivalent capacitance between points P and Q is:



(A) 4μF (B) 6μF (C) 8μF (D) 12μF

7. In the circuit shown, each capacitor has a capacitance C. The emf of the cell is E. If the switch S is closed, the amount heat loss is



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

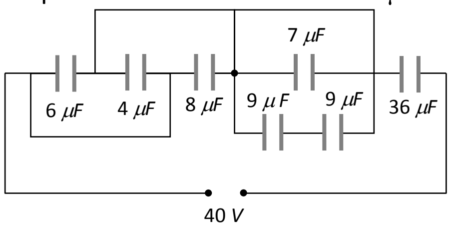
8. In a parallel plate capacitor the separation between the plates is 3mm with air between them. Now a 1mm thick layer of a material of dielectric constant 2 is introduced between the plates due to which the capacity increases. In order to bring its capacity to the original value the separation between the plates must be made

(A) 1.5 mm (B) 2.5 mm (C) 3.5 mm (D) 4.5 mm

9. The radii of the inner and outer spheres of a condenser are 9 cm and 10 cm respectively. If the dielectric constant of the medium between the two spheres is 6 and charge on the inner sphere is 18×10^{-9} coulomb, then the potential of inner sphere will be, if the outer sphere is earthed

(A) 180 volts (B) 30 volts (C)18 volts (D) 90 volts

10. In the following diagram, the charge and potential difference across 8 μF capacitance will be respectively



(A) 320 μ C, 40 V (B) 420 μ C, 50 V (C) 214 μ C, 27 V (D) 360 μ C, 45 V

Space for Rough Work

11. A projectile projected from the ground has its direction of motion making an angle $\frac{\pi}{4}$ with the horizontal at a height 40m. If initial velocity of projection is 50 m/s, the angle of projection is

(A) $\frac{1}{2}\cos^{-1}\left(-\frac{8}{25}\right)$ (B) $\frac{1}{2}\cos^{-1}\left(\frac{8}{25}\right)$ (C) $\frac{1}{2}\cos^{-1}\left(-\frac{4}{5}\right)$ (D) $\frac{1}{2}\cos^{-1}\left(-\frac{1}{4}\right)$

12. A particle moves along the parabolic path $y = 2x - x^2 + 2$, in such a way that the x-component of velocity vector remains constant(5m/s). Find the magnitude of acceleration of the particle.

(A) $-10\ m/s^2$ (B) $-20\ m/s^2$ (C) $-50\ m/s^2$ (D) $-100\ m/s^2$

13. Two ships are 10 km apart on a line joining south to north. The one farther north is steaming west at 20 km h^{-1}. The other is steaming north at 20 km h^{-1}. What is their distance of closest approach?

(A) $10\sqrt{2}$ km (B) $5\sqrt{2}$ km (C) $20\sqrt{2}$ km (D) 10 km

14. The external and internal diameters of a hollow cylinder are measured to be (4.23 ± 0.01) cm and (3.89 ± 0.01)cm. The thickness of the wall of the cylinder is

(A) (0.34 ± 0.02) cm (B) (0.17 ± 0.02) cm (C) (0.17 ± 0.01) cm (D) (0.34 ± 0.01) cm

15. The smallest division on the main scale of a vernier callipers is 1mm and 10 vernier divisions coincide with 9 main scale divisions. While measuring the diameter of a sphere, the zero mark of the vernier scale lies between 20 and 21 mm and the fifth division of the vernier scale coincide with a main scale division. Then diameter of the sphere is

(A) 20.5 mm (B) 21.5 mm (C) 21.50 mm (D) 20.50 mm

16. The velocity of water waves may depend on their wavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensions gives the relation between these quantities as

(A) $v^2 \propto \lambda^{-1} g^{-1} \rho^{-1}$ (B) $v^2 \propto g\lambda$ (C) $v^2 \propto g\lambda\rho$ (D) $v^2 \propto \lambda^3 g^{-1} \rho^{-1}$

17. Mark incorrect statement

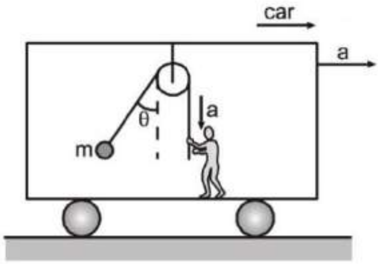
(A) A vector can't be divided by another vector.
(B) Angular displacement can either be a scalar or a vector quantity.
(C) Since addition of vectors is commutative therefore vector subtraction is also commutative.
(D) The resultant of two equal forces of magnitude F acting at a point is F, if the angle between the two forces is 120°.

18. A motor boat going down stream overcomes a float at a point A. 60 minutes later it turns and after some time passes the float at a distance of 12 km from the point A. The velocity of the stream is(assuming constant velocity for the boat in still water)

(A) 6 km/h (B) 3 km/h (C) 4 km/h (D) 2 km/h

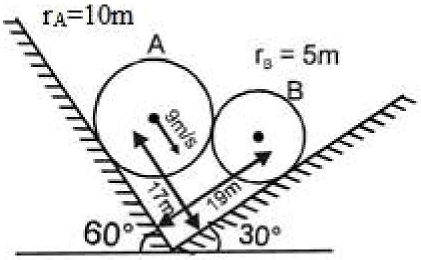
Space for Rough Work

19. A bob is hanging over a pulley inside a car through a string. The second end of the string is in the hand of a person standing in the car. The car is moving with constant acceleration 'a' directed horizontally as shown in figure. Other end of the string is pulled with constant acceleration 'a' (relative to car) vertically. The tension in the string is equal to



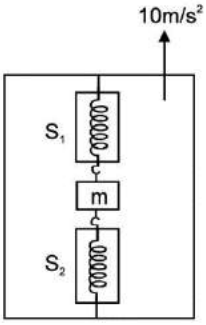
(A) $m\sqrt{g^2 + a^2}$ (B) $m\sqrt{g^2 + a^2} - ma$ (C) $m\sqrt{g^2 + a^2} + ma$ (D) m(g + a)

20. System is shown in the figure. Velocity of sphere A is 9 m/s. Then speed of sphere B will be



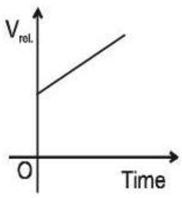
(A) 9 m/s (B) 12 m/s (C) $9 \times \frac{5}{4}$ m/s (D) None of these

21. Reading shown in two spring balances S_1 and S_2 is 90 kg and 30 kg respectively when lift is accelerating upwards with acceleration 10 m/s^2. The mass is stationary with respect to lift. Then the mass of the block will be



(A) 60 kg (B) 30 kg (C) 120 kg (D) None of these

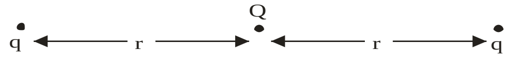
22. A particle is observed from two frames S_1 and S_2. The graph of relative velocity of S_1 with respect to S_2 is shown in figure. Let F_1 and F_2 be the pseudo forces on the particle when seen from S_1 and S_2 respectively. Which one of the following is not possible?



(A) $F_1 = 0, F_2 \neq 0$ (B) $F_1 \neq 0, F_2 = 0$ (C) $F_1 \neq 0, F_2 \neq 0$ (D) $F_1 = 0, F_2 = 0$

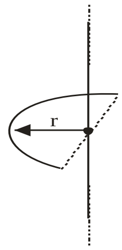
Space for Rough Work

23. Two positive charges of equal magnitude q are placed as shown in the figure. A negative charge of magnitude Q is placed at the centre of line joining them. The value of Q for the whole system to be in equilibrium.



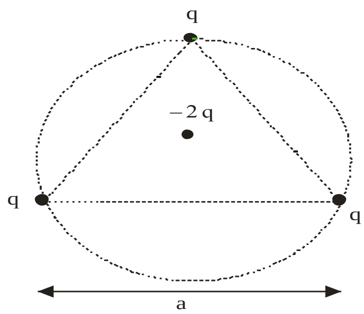
(A) $\frac{q}{2}$ (B) $\frac{q}{4}$ (C) $\frac{q}{\sqrt{2}}$ (D) $\frac{q}{2\sqrt{2}}$

24. A semicircular arc of radius r with charge density λ, having a uniformly charged infinitely long straight wire (with charge density λ) passing through its centre and perpendicular to its plane. Find electrostatic force between them.



(A) $\frac{\lambda^2}{\pi \in_0}$ (B) $\frac{2\lambda^2}{\pi \in_0}$ (C) $\frac{\lambda^2}{2\pi \in_0}$ (D) $\frac{\lambda^2}{4\pi \in_0}$

25. Consider a system of 4 charged particles each of mass m placed at the vertices and centre of an equilateral triangle of side a as shown in figure. Under mutually electrostatic interaction charges at vertices of the triangle are revolving in a circle. Find speed of charges. [$k = \frac{1}{4\pi \in_0}$ and neglect gravitational effect]



(A) $q\sqrt{\frac{k}{a}(6 - 2\sqrt{3})}$ (B) $q\sqrt{\frac{k}{a}(2 - \sqrt{3})}$ (C) $q\sqrt{\frac{k}{a}(2\sqrt{3} - 1)}$ (D) $q\sqrt{\frac{3k}{a}(2\sqrt{3} - 1)}$

26. Consider two concentric spherical shells of radius R and 2R; with same surface charge density. If total charge on them is Q, then find electric potential at their centre.

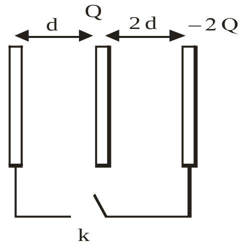
(A) $\frac{kQ}{R}$ (B) $\frac{kQ}{2R}$ (C) $\frac{2kQ}{R}$ (D) $\frac{3kQ}{5R}$

27. The electric potential V in a space (in metre) is given by V= $(x^2 - 2y + yz^2)$ volt. Find electric field at (0, 1, 0)

(A) $-\hat{j}$ N/C (B) $+2\hat{j}$ N/C (C) $(-\hat{i} + \hat{k})$ N/C (D) $(-\hat{j} + 2\hat{k})$ N/C

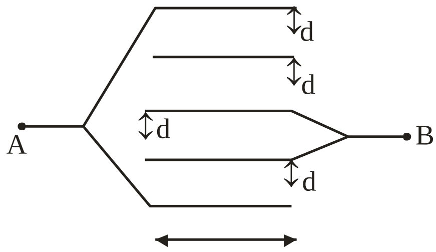
Space for Rough Work

28. Three large plates are arranged as shown. How much charge will flow through the key k if it is closed?



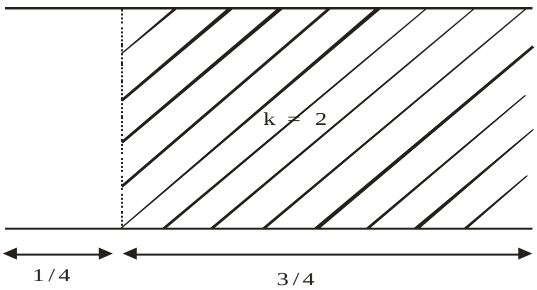
(A) $\frac{5Q}{6}$ (B) $\frac{7Q}{6}$ (C) $\frac{6Q}{5}$ (D) $\frac{6Q}{7}$

29. Find equivalent capacitance between A and B.



(A) $\frac{2A\in_0}{3d}$ (B) $\frac{3A\in_0}{2d}$ (C) $\frac{A\in_0}{d}$ (D) $\frac{4A\in_0}{d}$

30. A parallel plate capacitor has capacitance C. When its $3/4th$ area filled with a dielectric of dielectric constant k = 2, as shown in figure



(A) $\frac{7C}{4}$ (B) $\frac{3C}{2}$ (C) $\frac{7C}{5}$ (D) $\frac{9C}{4}$

Space for Rough Work

PART-B : CHEMISTRY

31. Vapour pressure of a solvent is 17.5 mm Hg while that of its dilute solution is 17.45mm Hg. The mole fraction of the solvent is
(A) 0.997 (B) 0.075 (C) 17.98 (D) 1.05

32. Which of the following aqueous solution has osmotic pressure nearest to that of an equimolar solution of $K_4[Fe(CN)_6]$?
(A) Na_2SO_4 (B) $BaCl_2$ (C) $Al_2(SO_4)_3$ (D) $C_{12}H_{22}O_{11}$

33. A 0.01m aqueous solution of $K_3[Fe(CN)_6]$ was found to get freezed at –0.062°C. If K_f for water is 1.86°C/molal then the apparent percentage of dissociation is:
(A) 60% (B) 78% (C) 100% (D) 50%

34. The weight of water in 1 litre of 2M NaCl solution of density 1.117 g/mL is
(A) 1117 g (B) 1000 g (C) 117 g (D) 883 g

35. Which of the following solutes will produce the largest total molality of solute particles upon addition of 1 kg of water?
(A) 1.0 mole $Co(NO_3)_2$ (B) 2.0 mole KCl (C) 3.0 mole C_2H_5OH (D) 3.0 mole of sugar

36. Among the boron halides, which is the strongest lewis acid?
(A) BBr_3 (B) BCl_3 (C) BI_3 (D) BF_3

37. Carbon-60 contains
(A) 20 pentagons and 12 hexagons (B) 12 pentagons and 20 hexagons
(C) 30 pentagons and 30 hexagons (D) 24 pentagons and 36 hexagons

38. Which of the following molecules have zero dipole moment?
(A) CS_2 (B) H_2O (C) CCl_2 (D) CH_2Cl_2

39. Nitrogen is prepared by heating
(A) a mixture of CuO and NH_3 (B) Barium azide
(C) a mixture of NH_4Cl and $NaNO_3$ (D) Hydrolysis of aqueous NCl_3 solution

40. On descending the group of which lead is a member, the
(A) Stability of the +4 oxidation state decreases
(B) Stability of the +2 oxidation state decreases
(C) Tendency of inert-pair effect decrease
(D) Tendency of the inter-pair effect increases up to Ge and then decreases.

41. The number of d-electrons in Fe^{2+} (Z = 26) is not equal to that of:
(A) p-electrons in Ne (Z = 10) (B) s-electrons in Mg (Z = 12)
(C) d-electrons in Fe (Z = 26) (D) p-electrons in Cl (Z = 17)

42. The orbital angular momentum of an electron in 2s orbital is:
(A) $\frac{h}{4\pi}$ (B) 0 (C) $\frac{h}{2\pi}$ (D) $\sqrt{2}\frac{h}{2\pi}$

Space for Rough Work

43. Which of the following orbital is nearest to the nucleus?
(A) 4f (B) 5d (C) 4s (D) 7p

44. If the radius of first Bohr orbit is x, then de-Broglie wavelength of electron in 3rd orbit is nearly:
(A) $2\pi x$ (B) $6\pi x$ (C) 9x (D) $\frac{x}{3}$

45. A near UV photon of 300 nm is absorbed by a gas and then re-emitted as 2 photons. One photon is red with wavelength 760 nm. Hence wavelength of the second photon is:
(A) 460 nm (B) 1060 nm (C) 496 nm (D) 300 nm

46. Which of the following acts as a reducing agent?
(A) HNO_3 (B) $KMnO_4$ (C) H_2SO_4 (D) Oxalic acid

47. When H_2SO_3 is converted into H_2SO_4 the change in the oxidation state of sulphur is from:
(A) 0 to +2 (B) +2 to +4 (C) +4 to +2 (D) +4 to +6

48. The equivalent mass of $KMnO_4$ in acidic medium is (molar mass of $KMnO_4$ = 158 g/mol)
(A) 158 (B) 15.8 (C) 31.6 (D) 3.16

49. In the given reaction
$5H_2O_2 + xClO_2 + 2OH^- \longrightarrow yCl^- + zO_2 + 6H_2O$
The values of x, y and z are:
(A) x = 5, y = 5, z = 2 (B) x = 2, y = 2, z = 5 (C) x = 4, y = 4, z = 10 (D) x = 5, y = 5, z = 5

50. 0.3 g of an oxalate salt was dissolved in 100 mL solution. The solution required 90 mLof $\frac{N}{20}$ $KMnO_4$ for complete oxidation. The percentage of oxalate ion in the salt is:
(A) 33% (B) 66% (C) 70% (D) 40%

51. The electronegativity order of O, F, Cl and Br is:
(A) F > O > Cl > Br (B) F > Cl < Br > O (C) Br > Cl > F > O (D) F < Cl < Br < O

52. The electron affinity for inert gases is likely to be:
(A) High (B) Small (C) Zero (D) Positive

53. The general electronic configuration of d-block elements is:
(A) $ns^2(n-1)d^{1-10}$ (B) $ns^{1-2}(n-1)d^{1-10}$ (C) $ns^{0-2}(n-1)d^{1-10}$ (D) $ns^{0-2}(n-1)d^{0-10}$

54. The basic character of MgO, SrO, K_2O and NiO increases in the order:
(A) K_2O < SrO < MgO < NiO (B) NiO < MgO < SrO < K_2O
(C) MgO < NiO < SrO < K_2O (D) K_2O < MgO < NiO < SrO

Space for Rough Work

55. Which of the following is arranged in increasing order of hydration energy?

(A) $Cu^{2+} < Fe^{3+} < Fe^{2+} < Al^{3+}$
(B) $Fe^{2+} < Cu^{2+} < Al^{3+} < Fe^{3+}$
(C) $Al^{3+} < Fe^{3+} < Fe^{2+} < Cu^{2+}$
(D) $Fe^{3+} < Al^{3+} < Cu^{2+} < Fe^{2+}$

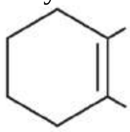
56. Arrange in the order of decreasing pK_b.

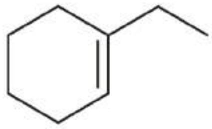
(P) $F-CH_2CH_2COOH$
(Q) $Cl-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_2-COOH$
(R) $F-CH_2-COOH$
(S) $Br-CH_2-CH_2-COOH$

(A)Q > S > P > R
(B) P > R > S > Q
(C) R > Q > P > S
(D) S > Q > P > R

57. Arrange the following in increasing order of stability.

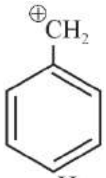

(I)


(II)

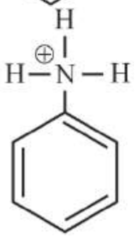

(III)

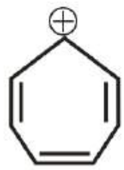
(A) I < II < III
(B) II < I < III
(C) I < III < II
(D) II < III < I

58. Which of the following compounds will not show resonance?

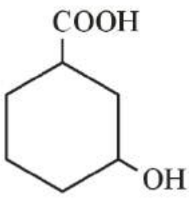
(A) 

(B) $CH_2=CH-CH=CH-\overset{\oplus}{C}H_2$

(C) 

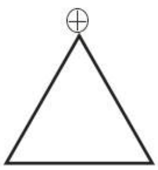
(D) 

59. The IUPAC name of the following compound is:

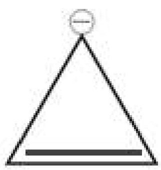


(A) 3-Oxyhexanoic acid
(B) 3-Carboxycyclohexanol
(C) 3-Hydroxycyclohexanoic acid
(D) 3-Hydroxycyclohexcarboxylic acid

60. Which of the following compound is non-aromatic?

(A) 

(B) 

(C) 

(D) 

PART-C : MATHEMATICS

61. Suppose $A_1, A_2, A_3, ..., A_{30}$ are thirty sets each having 5 elements and B_1, B_2, ..., B_n are n sets each with 3 elements. Let $\bigcup_{i=1}^{30} A_i = \bigcup_{j=1}^{n} B_j$ = S and each elements of S belongs to exactly 10 of the $A_i's$ and exactly 9 of the $B_j's$. Then n is equal to

(A) 15 (B) 3 (C) 45 (D) None of these

62. If [2 sin x] + [cos x] = – 3 then the range of the function f(x) = sinx + $\sqrt{3}$ cosx in [0, 2π] is (where [·] denotes greatest integer function)

(A) [–2, – 1] (B) (–2, –1) (C) (–1, –1/2) (D) None of these

63. The value of $\frac{C_0}{1.3} - \frac{C_1}{2.3} + \frac{C_2}{3.3} - \frac{C_3}{4.3} + ... + (-1)^n \frac{C_n}{(n+1).3}$ is

(A) $\frac{3}{n+1}$ (B) $\frac{n+1}{3}$ (C) $\frac{1}{3(n+1)}$ (D) none of these

64. Let E = (2n + 1) (2n + 3) (2n + 5)…(4n – 3) (4n – 1) where n > 1, then 2^n E is divisible by

(A) ${}^{2n}C_n$ (B) ${}^{4n}C_{2n}$ (C) ${}^{2n}C_{n/2}$ (D) ${}^{4n}C_{n/2}$

65. The number of terms in $\left(x^3 + 1 + \frac{1}{x^3}\right)^{100}$ is

(A) 300 (B) 200 (C) 100 (D) 201

66. Coefficient of x^{1007} in
$(1 + x)^{2006} + x(1 + x)^{2005} + x^2(1 + x)^{2004} + ……+ x^{2006}$ is

(A) ${}^{2006}C_{1007}$ (B) ${}^{2006}C_{1008}$ (C) ${}^{2007}C_{1007}$ (D) ${}^{2007}C_{1008}$

67. The value of $2({}^nC_0) + \frac{3}{2}({}^nC_1) + \frac{4}{3}({}^nC_2) + \frac{5}{4}({}^nC_3) +…..$ is

(A) $\frac{2^n(1-n)-1}{n+1}$ (B) $\frac{2^n(n+3)-1}{n+1}$ (C) $\frac{2^n-1}{n+1}$ (D) $\frac{2^n+2}{n-1}$

68. Coefficient of x^n in $(x + {}^nC_0)(x + 3\,{}^nC_1)(x + 5\,{}^nC_2)………(x + (2n + 1)\,{}^nC_n)$ is

(A) $2^n n$ (B) $2^n(n + 1)$ (C) $2^n(n + 2)$ (D) $2^n(n – 1)$

69. If $\sum_{r=0}^{n}\left(\frac{r+2}{r+1}\right){}^nC_r = \frac{2^8-1}{6}$ then n is

(A) 8 (B) 4 (C) 6 (D) 5

70. The function $f(x) = (\tan x^{11})e^{x^5}\,\mathrm{sgn}(x^{11})\left[\frac{1}{3x^2+2}\right]$, where [.] denotes greatest integer function, is:

(A) even function (B) odd function
(C) even as well as odd function (D) neither even nor odd function

Space for Rough Work

71. Domain of $f(x) = \sin^{-1}\left(\frac{2x-[x]}{[x]}\right)$, where [.] denotes the greatest integer function, is

(A) $(-\infty, 1) - \{0\}$ (B) $\left[-\frac{4}{3}, 0\right) \cup \{0\}$ (C) $(-\infty, 0) \cup I^+$ (D) $(-\infty, \infty) - [0, 1)$

72. If f(x) is continuous and increasing function such that domain of $g(x) = \sqrt{f(x) - x}$ be R and $h(x) = \frac{1}{1-x}$, then the domain of $\phi(x) = \sqrt{f(f(f(x))) - h(h(h(x)))}$ is

(A) R (B) $\{0, 1\}$ (C) $R - \{0, 1\}$ (D) $R - (0, 1)$

73. If A > 0, c, d, u, v are non-zero constants, and the graphs of $f(x) = |Ax + c| + d$ and $g(x) = -|Ax + u| + v$ intersect exactly at 2 points (1, 4) and (3, 1) then the value of $\frac{u+c}{A}$ equals to

(A) 4 (B) –4 (C) 2 (D) –2

74. Let $I_1 = \left(\frac{\pi}{4}\right)^2 + \sqrt{2}$, $I_2 = \left(\tan^{-1}\left(\frac{1}{e}\right)\right)^2 + \frac{2e}{\sqrt{e^2+1}}$, $I_3 = (\tan^{-1} e)^2 + \frac{2}{\sqrt{e^2+1}}$, then which of the following is true

(A) $I_1 < I_2 < I_3$ (B) $I_2 < I_1 < I_3$ (C) $I_1 < I_3 < I_2$ (D) $I_3 < I_2 < I_1$

75. Let $f : R \to R$ be a function satisfying $f(x + y) = f(x) + 2y^2 + kxy$ for all $x, y \in R$. If f(1) = 2 and f(2) = 8, then f(x) is equal to

(A) $2x^2$ (B) $6x - 4$ (C) $x^2 + 3x - 2$ (D) $-x^2 + 9x - 6$

76. If $z = \sec^{-1}\left(x + \frac{1}{x}\right) + \sec^{-1}\left(y + \frac{1}{y}\right)$, where xy > 0, then the value of z (among the given values) which is not possible is

(A) $\frac{5\pi}{6}$ (B) $\frac{7\pi}{10}$ (C) $\frac{9\pi}{10}$ (D) $\frac{5\pi}{3}$

77. The number of solutions of equation $\pi \cot^{-1}(x-1) + (\pi-1)\cot^{-1}x = 2\pi - 1$ is

(A) 0 (B) 1 (C) 2 (D) 3

78. If $1 < x < \sqrt{2}$, then number of solutions of the equation $\tan^{-1}(x-1) + \tan^{-1} x + \tan^{-1}(x+1) = \tan^{-1} 3x$, is

(A) 0 (B) 1 (C) 2 (D) 3

79. If $(\cot^{-1} x)^2 - 3(\cot^{-1} x) + 2 > 0$, then x lies in

(A) (cot 2, cot 1) (B) $(-\infty, \cot 2) \cup (\cot 1, \infty)$
(C) $(\cot 1, \infty)$ (D) $(-\infty, \cot 1) \cup (\cot 2, \infty)$

80. Which of the following is negative

(A) $\cos(\tan^{-1}(\tan 4))$ (B) $\sin(\cot^{-1}(\cot 4))$ (C) $\tan(\cos^{-1}(\cos 5))$ (D) $\cot(\sin^{-1}(\sin 4))$

81. If x_1, x_2, x_3, x_4 are roots of the equation $x^4 - x^3 \sin 2\beta + x^2 \cos 2\beta - x\cos\beta - \sin\beta = 0$ then $\sum_{i=1}^{4} \tan^{-1} x_i$ is equal to

(A) $\pi - \beta$ (B) $\pi - 2\beta$ (C) $\pi/2 - \beta$ (D) $\pi/2 - 2\beta$

Space for Rough Work

82. The inequality $\log_2(x) < \sin^{-1}(\sin(5))$ holds true if $x \in$
(A) $(0, 2^{5-2\pi})$ (B) $(2^{5-2\pi}, \infty)$ (C) $(2^{2\pi-5}, \infty)$ (D) $(0, 2^{2\pi-5})$

83. If $A = 2\tan^{-1}(2\sqrt{2} - 1)$ and $B = 3\sin^{-1}\left(\frac{1}{3}\right) + \sin^{-1}\left(\frac{3}{5}\right)$, then
(A) A = B (B) A < B (C) A > B (D) None of these

84. If $A = \begin{bmatrix} 0 & \alpha & \alpha \\ 2\beta & \beta & -\beta \\ \gamma & -\gamma & \gamma \end{bmatrix}$ is an orthogonal matrix, then the number of possible triplets (α, β, γ)
(A) 8 (B) 6 (C) 4 (D) 2

85. The number of solutions of the matrix equation $A^2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ is
(A) 2 (B) 4 (C) 8 (D) infinitely many

86. If $\sum_{n=1}^{n} \alpha_n = an^2 + bn$, where a, b are constants and $\alpha_1, \alpha_2, \alpha_3 \in \{1, 2, 3, \ldots\ldots, 9\}$ and $25\alpha_1, 37\alpha_2, 49\alpha_3$ be three digit numbers, then $\begin{vmatrix} \alpha_1 & \alpha_2 & \alpha_3 \\ 5 & 7 & 9 \\ 25\alpha_1 & 37\alpha_2 & 49\alpha_3 \end{vmatrix} =$
(A) $\alpha_1 + \alpha_2 + \alpha_3$ (B) $\alpha_1 - \alpha_2 + \alpha_3$ (C) 7 (D) 0

87. If $\Delta = \begin{vmatrix} e^x & \sin x & 1 \\ \cos x & \ell n(1 + x^2) & 1 \\ x & x^2 & 1 \end{vmatrix} = a + bx + cx^2$ then the value of b is
(A) 0 (B) –1 (C) –2 (D) None of these

88. In a quadrilateral ABCD,
Let $\Delta = \begin{vmatrix} \cos A & \sin A & \cos(A + D) \\ \cos B & \sin B & \cos(B + D) \\ \cos C & \sin C & \cos(C + D) \end{vmatrix}$, then Δ is
(A) independent of A and B only (B) independent of B and C only
(C) independent of A, B and C only (D) independent of all A, B, C and D

89. The system of equations $\alpha x + y + z = \alpha - 1$, $x + \alpha y + z = \alpha - 1$, $x + y + \alpha z = \alpha - 1$ has one solution, if α is
(A) –2 (B) either –2 or 1 (C) not –2 (D) 1

90. The determinant $\begin{vmatrix} xp + y & x & y \\ yp + z & y & z \\ 0 & xp + y & yp + z \end{vmatrix} = 0$, if
(A) x, y, z are in A.P. (B) x, y, z are in G.P. (C) x, y, z are in H.P. (D) xy, yz, zx are in A.P.

Space for Rough Work