FIITJEE

Solutions to JEE(Main)-2020

Test Date: 4th September 2020 (Second Shift)

PHYSICS, CHEMISTRY & MATHEMATICS

Paper - 1

Time Allotted: 3 Hours | **Maximum Marks: 300**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

Important Instructions:

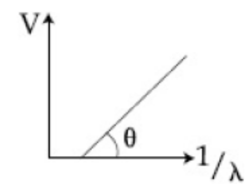
1. The test is of **3 hours** duration.
2. This **Test Paper** consists of **75** questions. The maximum marks are **300**.
3. There are ***three*** parts in the question paper A, B, C consisting of **Physics, Chemistry** and **Mathematics** having 25 questions in each part of equal weightage out of which 20 questions are MCQs and 5 questions are numerical value based. Each question is allotted **4 (four)** marks for correct response.
4. **(Q. No. 01 – 20, 26 – 45, 51 – 70)** contains 60 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.
5. **(Q. No. 21 – 25, 46 – 50, 71 – 75)** contains 15 Numerical based questions with answer as numerical value. Each question carries **+4 marks** for correct answer. There is no negative marking.
6. Candidates will be awarded marks as stated above in **instruction No.3** for correct response of each question. One 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 box.
7. There is only one correct response for each question. Marked up more than one response in any question will be treated as wrong response and marked up for wrong response will be deducted accordingly as per **instruction 6** above.

PART –A (PHYSICS)

1. A capacitor C is fully charged with voltage V_0. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance. $\frac{C}{2}$. The energy loss in the process after the charge is distributed between the two capacitor is:

(A) $\frac{1}{6}CV_0^2$ (B) $\frac{1}{2}CV_0^2$
(C) $\frac{1}{4}CV_0^2$ (D) $\frac{1}{3}CV_0^2$

2. In photoelectric effect experiment, the graph of stopping potential V versus reciprocal of wavelength obtained is shown in the figure. As the intensity of incident radiation is increased:



(A) Slope of the straight line get more steep
(B) Straight line shifts to left
(C) Straight line shifts to right
(D) Graph does not change

3. Consider two uniform discs of the same thickness and different radii $R_1 = R$ and $R_2 = \alpha R$ made of the same material. If the ratio of their moments of inertia I_1 and I_2, respectively, about their axes is $I_1 : I_2 = 1 : 16$ then the value of α is:

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

4. A circular coil has moment of inertia 0.8 kg m^2 around any diameter and is carrying current to produce a magnetic moment of 20 Am^2. The coil is kept initially in a vertical position and it can rotate freely around a horizontal diameter. When a uniform magnetic field of 4 T is applied along the vertical, it starts rotating around its horizontal diameter. The angular speed the coil acquires after rotating by 60° will be:

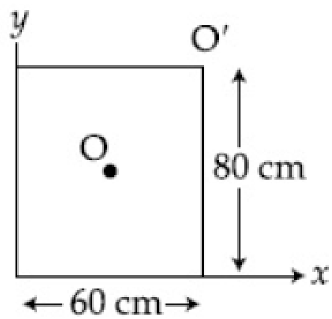
(A) 10 π rad s^{-1} (B) 20 π rad s^{-1}
(C) 20 rad s^{-1} (D) 10 rad s^{-1}

5. Find the binding energy per neucleon for ${}^{120}_{50}Sn$. Mass of proton m_p = (A) 1.00783 U, mass of neutron m_n = (A) 1.00867 U and mass of tin nucleus m_{Sn} = 119.902199 U. (take 1U = 931 MeV)

(A) 8.5 MeV (B) 9.0 MeV
(C) 7.5 MeV (D) 8.0 MeV

6. A quantity X is given by $(IF\upsilon^2/WL^4)$ in terms of moment of inertia I, force F, velocity υ, work W and Length L. The dimensional formula for x is same as that of:

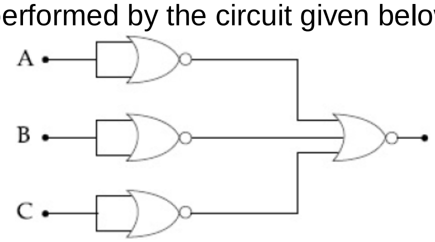
(A) coefficient of viscosity (B) planck's constant
(C) energy density (D) force constant

7. 

For a uniform rectangular sheet shown in the figure, the ratio of moments of inertia about the axes perpendicular to the sheet and passing through O (the centre of mass) and O′ (corner point) is:

(A) 1/2 (B) 2/3
(C) 1/4 (D) 1/8

8. Identify the operation performed by the circuit given below:

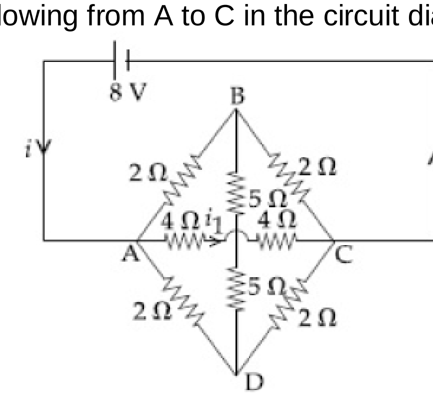


(A) AND (B) NOT
(C) NAND (D) OR

9. A particle of charge q and mass m is subjected to an electric field $E = E_0(1 - ax^2)$ in the x-direction, where a and E_0 are constants. Initially the particle was at rest at x = 0. Other then the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is:

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

10. The value of current i_1 flowing from A to C in the circuit diagram is:



(A) 4 (B) 2
(C) 5 (D) 1

11. Two identical cylindrical vessels are kept on the ground and each contain the same liquid of density d. The area of the base of both vessels is S but the height of liquid in one vessel is x1 and in the other, x2. When both cylinders are connected through a pipe of negligible volume very close to the bottom, the liquid flows from one vessel to the other until it comes to equilibrium at a new height. The change in energy of the system in the process is :

(A) $\frac{3}{4}gdS(x_2 - x_1)^2$ (B) $gdS(x_2 + x_1)^2$

(C) $\frac{1}{4}gdS(x_2 - x_1)^2$ (D) $gdS(x_2^2 + x_1^2)$

12. The driver of bus approaching a big wall notices that the frequency of his bus's horn changes from 420 Hz to 490 Hz when he hears it after it gets reflected from the wall. Find the speed of the bus if speed of the sound is 330 ms^{-1} :

(A) 90 kmh^{-1} (B) 80 kmh^{-1}

(C) 61 kmh^{-1} (D) 71 kmh^{-1}

13. A series L-R circuit is connected to a battery of emf V. If the circuit is switched on at t = 0, then the time at which the energy stored in the inductor reaches (1/n) times of its maximum value, is :

(A) $\frac{L}{R}\ln\left(\frac{\sqrt{n}}{\sqrt{n}+1}\right)$ (B) $\frac{L}{R}\ln\left(\frac{\sqrt{n}+1}{\sqrt{n}-1}\right)$

(C) $\frac{L}{R}\ln\left(\frac{\sqrt{n}-1}{\sqrt{n}}\right)$ (D) $\frac{L}{R}\ln\left(\frac{\sqrt{n}}{\sqrt{n}-1}\right)$

14. The electric field of a plane electromagnetic wave is given by $\vec{E} = E_0(\hat{x} + \hat{y})\sin(kz - \omega t)$

Its magnetic field will be given by:

(A) $\frac{E_0}{c}(\hat{x} - \hat{y})\sin(kz - \omega t)$ (B) $\frac{E_0}{c}(\hat{x} - \hat{y})\cos(kz - \omega t)$

(C) $\frac{E_0}{c}(-\hat{x} + \hat{y})\sin(kz - \omega t)$ (D) $\frac{E_0}{c}(\hat{x} + \hat{y})\sin(kz - \omega t)$

15. A person pushes a box on a rough horizontal platform surface. He applies a force of 200 N over a distance of 15m. Thereafter, he gets progressively tired and his applied force reduces linearly with distance to 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box?

(A) 5250 J (B) 5690 J

(C) 3280 J (D) 2780 J

16. A paramagnetic sample shows a net magnetisation of 6A/m when it is placed in an external magnetic field of 0.4 T at a temperature of 4K. When the sample is placed in an external magnetic field of 0.3T at a temperature of 24K, then the magnetisation will be :

(A) 1 A/m (B) 0.75 A/m

(C) 2.25 A/m (D) 4 A/m

17. A body is moving in a low circular orbit about a planet of mass M and radius R. The radius of the orbit can be taken to be R itself. Then the ratio of the speed of this body in the orbit to the escape velocity from the planet is :
(A) 2
(B) 1
(C) $\sqrt{2}$
(D) $\frac{1}{\sqrt{2}}$

18. A small ball of mass m is thrown upward with velocity u from the ground. The ball experiences a resistive force mkv^2 where v is it speed. The maximum height attained by the ball is:
(A) $\frac{1}{k}\ln\left(1+\frac{ku^2}{2g}\right)$
(B) $\frac{1}{2k}\tan^{-1}\frac{ku^2}{g}$
(C) $\frac{1}{k}\tan^{-1}\frac{ku^2}{2g}$
(D) $\frac{1}{2k}\ln\left(1+\frac{ku^2}{g}\right)$

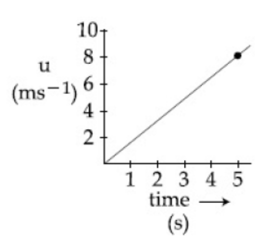
19. Match the thermodynamics processes taking place in a system with the correct conditions. In the table: ΔQ is the heat supplied, ΔW is the work done and ΔU is change in internal energy of the system. Match the following:

	Process		Condition
(I)	Aidabatic	(A)	$\Delta W = 0$
(II)	Isothermal	(B)	$\Delta Q = 0$
(III)	Isochoric	(C)	$\Delta U \neq 0, \Delta W \neq 0, \Delta Q \neq 0$
(IV)	Isobaric	(D)	$\Delta U = 0$

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

20. A cube of metal is subjected to a hydrostatic pressure 4GPa. The percentage change in the length of the side of the cube is close to: (Given bulk modulus of metal, $B = 8 \times 10^{10}$ Pa)
(A) 0.6
(B) 5
(C) 1.67
(D) 20

21. The speed verses time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval t = 0 to t = 5 s will be …..

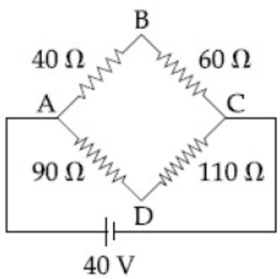


22. The distance between an object and a screen is 100 cm. A lens can produce real image of the object on the screen for two different positions between the screen and the object.

The distance between these two positions is 40 cm. If the power of the lens is close to $\left(\frac{N}{100}\right)$D where N is an integer, the value of N is ……….

23. The change in the magnitude of the volume of an ideal gas when a small additional pressure ΔP is applied at a constant temperature, is the same as the change when the temperature is reduced by a small quantity ΔT at constant pressure. The initial temperature and pressure of the gas were 300 K and 2 atm. respectively. If $|\Delta T| = C|\Delta P|$ then value of C in (K/atm) is ….

24.



Four resistance 40 Ω, 60 Ω, 90 Ω, and 110 Ω make the arms of a quadrilateral ABCD. Across AC is a battery of emf 40V and internal resistance negligible. The potential difference across BD in V is ……

25. Orange light of wavelength 6000×10^{-10} m illuminates a single slit of width 0.6×10^{-4} m. the maximum possible number of diffraction minima produced on both sides of the central maximum is ……..

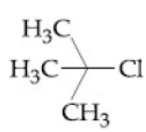
PART –B (CHEMISTRY)

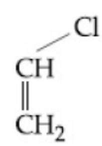
26. The Crystal Field Stabilization Energy (CFSE) of $[CoF_3(H_2O)_3]$ ($\Delta_0 < P$) is :
(A) $-0.8\ \Delta_0$
(B) $-0.4\ \Delta_0 + P$
(C) $-0.8\ \Delta_0 + 2P$
(D) $-0.4\ \Delta_0$

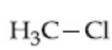
27. The processes of calcination and roasting in metallurgical industries, respectively, can lead to:
(A) Photochemical smog and global warming
(B) Global warming and photochemical smog
(C) Global warming and acid rain
(D) Photochemical smog and ozone layer depletion

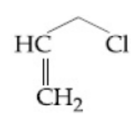
28. 250 mL of a waste solution obtained from the workshop of a goldsmith contains 0.1 M $AgNO_3$ and 0.1 M AuCl. The solution was electrolyzed at 2 V by passing a current of 1 A for 15 minutes. The metal/metals electrodeposited will be : $\left(E^o_{Ag^+/Ag} = 0.8\,V, E^o_{Au^+/Au} = 1.69\,V\right)$
(A) silver and gold in equal mass proportion
(B) only silver
(C) only gold
(D) silver and gold in proportion to their atomic weights

29. Among the following compounds, which one has the shortest C – Cl bond?

(A) 

(B) 

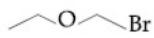
(C) 

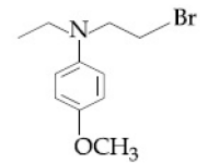
(D) 

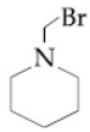
30. The process that is NOT endothermic in nature is:
(A) $H_{(g)} + e^- \rightarrow H^-_{(g)}$
(B) $O^-_{(g)} + e^- \rightarrow O^{2-}_{(g)}$
(C) $Na_{(g)} \rightarrow Na^+_{(g)} + e^-$
(D) $Ar_{(g)} + e^- \rightarrow Ar^-_{(g)}$

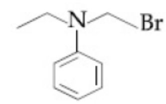
31. If the equilibrium constant for $A \rightleftharpoons B + C$ is $K^{(1)}_{(eq)}$ and that of $B + C \rightleftharpoons P$ is $K^{(2)}_{(eq)}$, the equilibrium constant for $A \rightleftharpoons P$ is:
(A) $K^{(1)}_{(eq)} K^{(2)}_{(eq)}$
(B) $K^{(1)}_{(eq)} / K^{(1)}_{(eq)}$
(C) $K^{(1)}_{(eq)} + K^{(2)}_{(eq)}$
(D) $K^{(2)}_{(eq)} - K^{(1)}_{(eq)}$

32. Which of the following compounds will form the precipitate with aq. $AgNO_3$ solution most readily ?

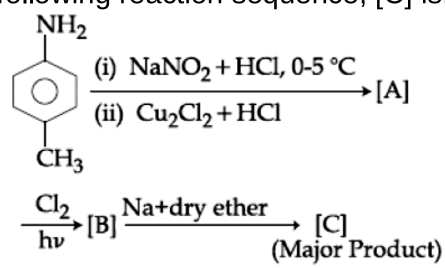
(A) 

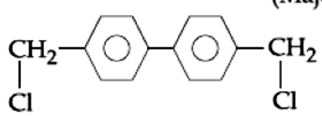
(B) 

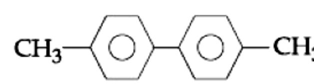
(C) 

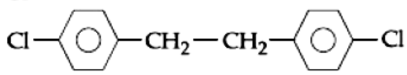
(D) 

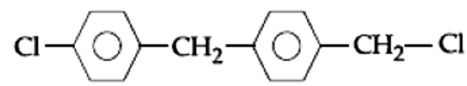
33. In the following reaction sequence, [C] is:



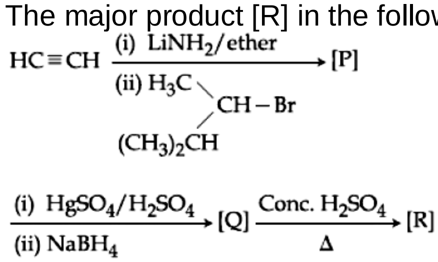
(A) 

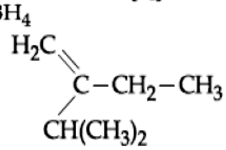
(B) 

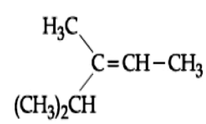
(C) 

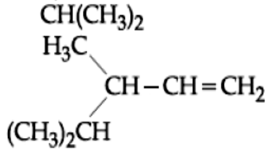
(D) 

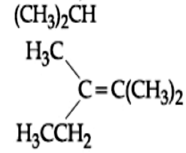
34. The major product [R] in the following sequence of reactions is:



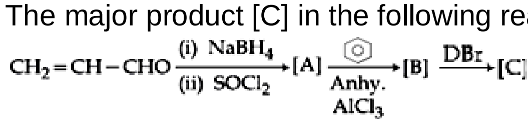
(A) 

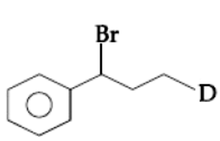
(B) 

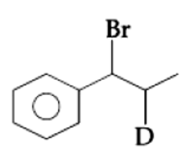
(C) 

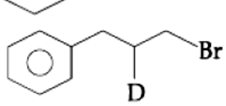
(D) 

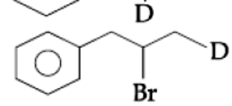
35. The major product [C] in the following reaction sequence will be:



(A) 

(B) 

(C) 

(D) 

36. A sample of red ink (a colloidal suspension) is prepared by mixing eosine dye, egg white, HCHO and water. The component which ensures stability of the ink sample is :
(A) Egg white
(B) HCHO
(C) Water
(D) Eosin dye

37. The one that can exhibit highest paramagnetic behaviour among the following is:
gly = glycinato ; bpy = 2, 2'-bipyridine
(A) $[Fe(en)(bpy)(NH_3)_2]^{2+}$
(B) $[Co(OX)_2(OH)_2]^{-}$ ($\Delta_0 > P$)
(C) $[Pd(gly)_2]$
(D) $[Ti(NH_3)_6]^{3+}$

38. The major product [B] in the following reactions is:

$$CH_3-CH_2-\overset{\overset{\large CH_3}{|}}{C}H-CH_2-OCH_2-CH_3$$

$$\xrightarrow[\text{Heat}]{\text{HI}} [A]\text{ alcohol} \xrightarrow[\Delta]{H_2SO_4} [B]$$

(A) $CH_3-CH_2-CH=CH-CH_3$
(B) $CH_3-CH=\overset{\overset{\large CH_3}{|}}{C}-CH_3$
(C) $CH_3-CH_2-\overset{\overset{\large CH_3}{|}}{C}=CH_2$
(D) $CH_2=CH_2$

39. The mechanism of action of "Terfenadine" (Seldane) is :
(A) Inhibits the action of histamine receptor
(B) Inhibits the secretion of histamine
(C) Helps in the secretion of histamine
(D) Activates the histamine receptor

40. An alkaline earth metal 'M' readily forms water soluble sulphate and water insoluble hydroxide. Its oxide MO is very stable to heat and does not have rock-salt structure. M is:
(A) Sr
(B) Be
(C) Mg
(D) Ca

41. The incorrect statement(s) among (a) - (c) is (are):
(a) W(VI) is more stable than Cr(VI).
(b) in the presence of HCl, permanganate titrations provide satisfactory results.
(c) some lanthanoid oxides can be used as phosphors.
(A) (b) and (c) only
(B) (a) only
(C) (b) only
(D) (a) and (b) only

42. The molecule in which hybrid MOs involve only one d-orbital of the central atom is :
(A) XeF_4
(B) $[CrF_6]^{3-}$
(C) $[Ni(CN)_4]^{2-}$
(D) BrF_5

43. The reaction in which hybridization of the underlined atom is affected is:
(A) $\underline{Xe}F_4 + SbF_5 \rightarrow$
(B) $H_2\underline{S}O_4 + NaCl \xrightarrow{420\text{ K}}$
(C) $H_3\underline{P}O_2 \xrightarrow{\text{Disproportionation}}$
(D) $\underline{N}H_3 \xrightarrow{H^+}$

44. The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer Series of H^+ is:

(A) $\frac{5\lambda_1}{9}$ (B) $\frac{36\lambda_1}{5}$

(C) $\frac{9\lambda_1}{5}$ (D) $\frac{27\lambda_1}{5}$

45. Five moles of an ideal gas at 1 bar and 298 K is expanded into vacuum to double the volume. The work done is :

(A) $C_V(T_2 - T_1)$ (B) $-RT \ln V_2/V_1$

(C) zero (D) $-RT\ V_2/V_1$

46. The number of molecules with energy greater than the threshold energy for a reaction increases five fold by a rise of temperature from 27º C to 42º C. Its energy of activation in J/mol is ………….. (Take in 5 = 1.6094; R = 8.314 J $mol^{-1}K^{-1}$)

47. Consider the following equations :

$2Fe^{2+} + H_2O_2 \rightarrow x\ A + y\ B$ (in basic medium)

(in acidic medium)

$2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow x'C + y'D + z'E$

(in acidic medium)

The sum of the stoichiometric coefficients x, y, x', y' and z' for products A, B, C, D and E, respectively, is ………..

48. The number of chiral centres present in threonine is _______.

49. A 100 mL solution was made by adding 1.43 g of $Na_2CO_3.xH_2O$. The normality of the solution is 0.1 N. The value of x is ………..

(The atomic mass of Na is 23 g/mol)

50. The osmotic pressure of a solution of NaCl is 0.10 atm and that of a glucose solution is 0.20 atm. The osmotic pressure of a solution formed by mixing 1 L of the sodium chloride solution with 2 L of the glucose solution is $x \times 10^{-3}$ atm. x is ………….. (nearest integer)

PART–C (MATHEMATICS)

51. If a and b are real numbers such that $(2 + \alpha)^4 = a + b\alpha$, where $\alpha = \frac{-1+i\sqrt{3}}{2}$, then a + b is equal to:
(A) 9 (B) 33
(C) 57 (D) 24

52. Contrapositive of the statement:
'If a function f is differentiable at a, then it is also continuous at a', is:
(A) If a function f is not continuous at a, then it is not differentiable at a.
(B) If a function f is continuous at a, then it is differentiable at a.
(C) If a function f is not continuous at a. then it is differentiable at a.
(D) If a function f is continuous at a, then it is not differentiable at a.

53. If for some positive integer n, the coefficients of three consecutive terms in the binomial expansion of $(1 + x)^{N+5}$ are in the ratio 5 : 10 : 14, then the largest coefficient in the expansion is:
(A) 252 (B) 330
(C) 792 (D) 462

54. The function $f(x) = \begin{cases} \frac{\pi}{4} + \tan^{-1} x, & |x| \le 1 \\ \frac{1}{2}(|x| - 1), & |x| > 1 \end{cases}$ is:
(A) both continuous and differentiable on R – {1}.
(B) both continuous and differentiable on R – {–1}.
(C) continuous on R – {1} and differentiable on R – {–1, 1}.
(D) continuous on R – {–1} and differentiable on R – {–1, 1}.

55. If the system of equations
$x + y + z = 2$
$2x + 4y - z = 6$
$3x + 2y + \lambda z = \mu$
has infinitely many solutions, then:
(A) $\lambda + 2\mu = 14$ (B) $2\lambda + \mu = 14$
(C) $2\lambda - \mu = 5$ (D) $\lambda - 2\mu = -5$

56. Let $\lambda \neq 0$ be in R. If α and β are the roots of the equation, $x^2 - x + 2\lambda = 0$ and α and γ are the roots of the equation, $3x^2 - 10x + 27\lambda = 0$, then $\frac{\beta\gamma}{\lambda}$ is equal to:
(A) 18 (B) 36
(C) 9 (D) 27

57. The circle passing through the intersection of the circles, $x^2 + y^2 - 6x = 0$ and $x^2 + y^2 - 4y = 0$, having its centre on the line, $2x - 3y + 12 = 0$, also passes through the point:
(A) (–1, 3) (B) (–3, 6)
(C) (–3, 1) (D) (1, –3)

58. The integral $\int_{\pi/6}^{\pi/3} \tan^3 x \cdot \sin^2 3x \left(2\sec^2 x \cdot \sin^2 3x + 3\tan x \cdot \sin 6x\right) dx$ is

(A) $-\frac{1}{18}$ (B) $-\frac{1}{9}$

(C) $\frac{9}{2}$ (D) $\frac{7}{18}$

59. The area (in sq. units) of the largest rectangle ABCD whose vertices A and B lie on the x-axis and vertices C and D lie on the parabola, $y = x^2 - 1$ below the x-axis, is:

(A) $\frac{4}{3\sqrt{3}}$ (B) $\frac{1}{3\sqrt{3}}$

(C) $\frac{4}{3}$ (D) $\frac{2}{3\sqrt{3}}$

60. Suppose the vectors x_1, x_2 and x_3 are the solutions of the system of linear equations, Ax = b when the vector b on the right side is equal to b_1, b_2 and b_3 respectively. If $x_1 = \begin{bmatrix}1\\1\\1\end{bmatrix}, x_2 = \begin{bmatrix}0\\2\\1\end{bmatrix}, x_3 = \begin{bmatrix}0\\0\\1\end{bmatrix}, b_1 = \begin{bmatrix}1\\0\\0\end{bmatrix}, b_2 = \begin{bmatrix}0\\2\\0\end{bmatrix}$ and $b_3 = \begin{bmatrix}0\\0\\2\end{bmatrix}$, then the determinant of A is equal of A is equal to :

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

(C) 2 (D) $\frac{3}{2}$

61. The solution of differential equation $\frac{dy}{dx} - \frac{y+3x}{\log_e(y+3x)} + 3 = 0$ is:

(where C is a constant of integration.)

(A) $y + 3x - \frac{1}{2}(\log_e x)^2 = C$ (B) $x - \frac{1}{2}(\log_e(y+3x))^2 = C$

(C) $x - 2\log_e(y+3x) = C$ (D) $x - \log_e(y+3x) = C$

62. The minimum value of $2^{\sin x} + 2^{\cos x}$ is:

(A) $2^{1-\frac{1}{\sqrt{2}}}$ (B) $2^{1-\sqrt{2}}$

(C) $2^{-1+\sqrt{2}}$ (D) $2^{-1+\frac{1}{\sqrt{2}}}$

63. Let $f : (0, \infty) \to (0, \infty)$ be a differentiable function such that f(1) = e and $\lim\limits_{t\to x} \frac{t^2 f^2(x) - x^2 f^2(t)}{t - x} = 0$. If f(x) = 1, then x is equal to:

(A) e (B) $\frac{1}{e}$

(C) $\frac{1}{2e}$ (D) 2e

64. The distance of the point (1, –2, 3) from the plane x – y + z = 5 measured parallel to the line $\frac{x}{2}=\frac{y}{3}=\frac{z}{-6}$ is:
(A) $\frac{1}{7}$ (B) 7
(C) $\frac{7}{5}$ (D) 1

65. In a game two players A and B take turns in throwing a pair of fair dice starting with player A and total of scores on the two dice, in each throw is noted. A wins the game if he throws a total of 6 before B throws a total of 7 and B wins the game if he throws a total of 7 before A throws a total of six. The game stops as soon as either of the players wins. The probability of A winning the game is:
(A) $\frac{5}{6}$ (B) $\frac{31}{61}$
(C) $\frac{30}{61}$ (D) $\frac{5}{31}$

66. The angle of elevation of a cloud C from a point P, 200 m above a still take is 30°. If the angle of depression of the image of C in the lake from the point P is 60°, then PC (in m) is equal to
(A) $200\sqrt{3}$ (B) 100
(C) 400 (D) $400\sqrt{3}$

67. Let x = 4 be a directrix to an ellipse whose centre is at the origin and its eccentricity is $\frac{1}{2}$.
If P(1, β), β > 0 is a point on this ellipse, then the equation of the normal to it at P is:
(A) 4x – 2y = 1 (B) 4x – 3y = 2
(C) 7x – 4y = 1 (D) 8x – 2y = 5

68. Let $\bigcup_{i=1}^{50} X_i = \bigcup_{i=1}^{n} Y_i = T$, where each X_i contains 10 elements and each Yi contains 5 elements. If each element of the set T is an element of exactly 20 of sets X_i's and exactly 6 of sets Y_i's then n is equal to:
(A) 15 (B) 30
(C) 45 (D) 50

69. If the perpendicular bisector of the line segment joining the points P(1, 4) and Q(k, 3) has y-intercept equal to –4, then a value of k is:
(A) $\sqrt{14}$ (B) $\sqrt{15}$
(C) – 4 (D) – 2

70. Let $a_1, a_2, \ldots. a_n$ be a given A.P. whose common difference is an integer and $S_n = a_1 + a_2 + \ldots + a_n$. If $a_1 = 1$, $a_1 = 300$ and $15 \le n \le 50$, then the ordered pair (S_{n-4}, a_{n-4}) is equal to:
(A) (2490, 248) (B) (2480, 248)
(C) (2490, 249) (D) (2480, 249)

71. If $\vec{a} = 2\hat{i} + \hat{j} + 2\hat{k}$, then the value of $\left|\hat{i} \times \left(\vec{a} \times \hat{i}\right)\right|^2 + \left|\hat{j} \times \left(\vec{a} \times \hat{j}\right)\right|^2 + \left|\hat{k} \times \left(\vec{a} \times \hat{k}\right)\right|^2$ is equal to:

72. A test consists of 6 multiple choice questions, each having 4 alternative answers of which only one is correct. The number of ways, in which a candidate answers all six questions such that exactly four of the answers are correct, is ……

73. Let PQ be a diameter of the circle $x^2 + y^2 = 9$. If α and β are the lengths of the perpendiculars from P and Q on the straight line, $x + y = 2$ respectively, then the maximum value of $\alpha\beta$ is……

74. If the variance of the following frequency distribution :

Class	:	10 – 20	20 – 30	30 – 40
Frequency	:	2	x	2

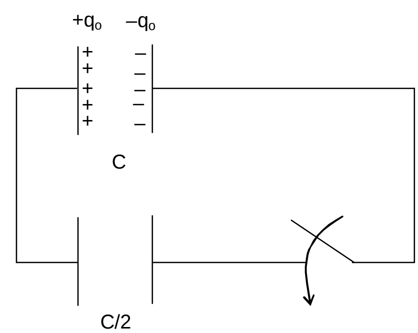
is 50, then x is equal to:

75. Let {x} and [x] denote the fractional part of x and the greatest integer $\leq$x respectively of a real number x. if $\int_0^n \{x\}dx, \int_0^n [x]dx$ and $10(n^2 - n)$, $(n \in N, n > 1)$ are three consecutive terms of a G.P. then n is equal to ……

FIITJEE
Solutions to JEE (Main)-2020
PART –A (PHYSICS)

1. **A**

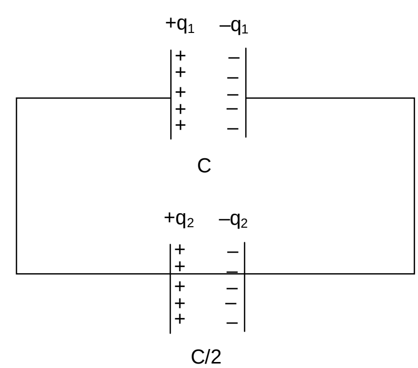
Sol. $Q_o = CV_o$



$U_i = \frac{1}{2}CV_0^2$

$q_1 = \frac{q_o C}{C + \frac{C}{2}} = \frac{2q_o}{3}$

$q_2 = \frac{q_o \frac{C}{2}}{C + \frac{C}{2}} = \frac{q_o}{3}$; $U_f = \frac{q_1^2}{2c} + \frac{q_2^2}{\frac{2c}{2}}$



$= \frac{4q_0^2}{9 \times 2c} + \frac{q_0^2}{9c}$

$= \frac{6q_0^2}{18c} = \frac{q_0^2}{3c} = \frac{cv_0^2}{3}$

Energy loss in the process = $U_i - U_f$

$= \frac{1}{2}CV_0^2 - \frac{CV_0^2}{3}$

$= \frac{CV_0^2}{6}$

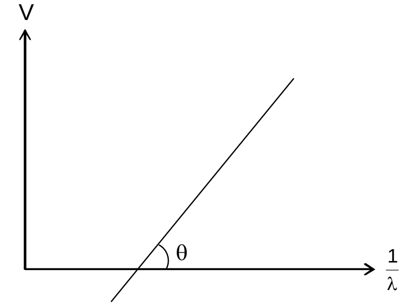
2. **D**

Sol. $eV_{slop} = \frac{hc}{\lambda} - \phi$

Slope of curve

$\tan\theta = \frac{hc}{e} = \text{constant}$

as intensity of incident radiation is increased, there will be no effect on graph



3. **A**

Sol. $I_1 \propto R_1^2$ & $I_2 \propto R_2^2$

$$\frac{I_1}{I_2} = \left(\frac{R_1}{R_2}\right)^2 = \frac{1}{\alpha^2} = \frac{1}{16}$$

$\alpha = 4$

4. **None of the options**

Sol. I = 0.8 kg M^2, $\left|\vec{\mu}\right|$ = 20 Am^2

$U_i = -\vec{\mu} \cdot \vec{B} = 0$

$U_f = -\mu B \cos(30°) = -20 \times 4 \times \frac{\sqrt{3}}{2}$

$U_i - U_f = 40\sqrt{3} = \frac{1}{2}I\omega^2 = 0.4\,\omega^2$

$\omega^2 = 100\sqrt{3}$; $\omega = 10\,(3^{1/4})$

5. **A**

Sol. Binding energy = $(50\,M_p + 70\,M_n - M_{sn})C^2$

= $(50.3915 + 70.6069 - 119.902199)UC^2$

= $(1.0962\ U)C^2$

= 931×1.0962 MeV

Binding energy per neucleon

$= \frac{931 \times 1.0962}{120}$ MeV

= 8.5 MeV

6. **C**

Sol. $x = \frac{IFV^2}{WL^4}$

$I = [ML^2]$

$F = [MLT^{-2}]$

$V^2 = [L^2T^{-2}]$

$W = [M\,L^2T^{-2}]$

$Q^4 = [L^4]$

$X = [M\,L^{-1}\,T^{-2}]$

7. **C**

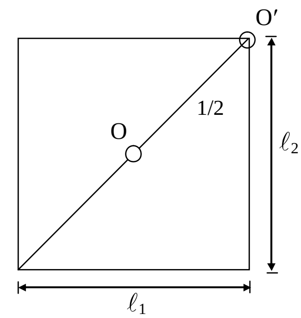
Sol. $\ell_1 = 0.6$ M

$\ell_2 = 0.8$ M

$\sqrt{\ell_1^2 + \ell_2^2} = 1$

MI about 0 = $\frac{M}{12}\left(\ell_1^2 + \ell_2^2\right)$

$I_1 = \frac{M}{12}$



MI about O' = $\frac{M}{12}\left(\ell_1^2 + \ell_2^2\right) + \frac{M\left(\ell_1^2 + \ell_2^2\right)}{4}$

$I_2 = \frac{M}{12} + \frac{M}{4} = \frac{4m}{12}$; $\frac{I_1}{I_2} = \frac{1}{4}$

8. **A**

9. **A**

Sol. $E = E_o\,(1 - ax^2)$

$F = qE_o$

$\text{acceleration} = \frac{F}{m} = \frac{qE_o}{m}(1 - ax^2) = v\frac{dv}{dx}$

$\frac{qE_o}{m}\int_0^x (1 - ax^2)dx = \int_0^0 vdv$; $\frac{qE_0}{M}\left(x - \frac{ax^3}{3}\right) = 0$

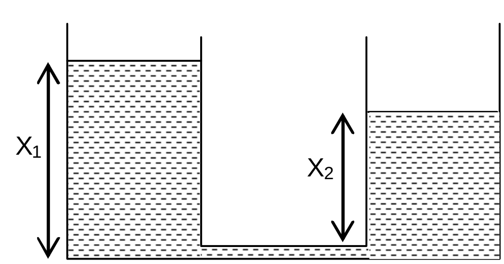
$x\left(1 - \frac{ax^3}{3}\right) = 0$; $x = 0$ & $x = \sqrt{\frac{3}{a}}$

10. **D**

Sol. $i_1 = \frac{8}{8} = 1$ A

11. **C**

Sol. $U_i = sx_1dg\frac{x_1}{2} + sx_2dg\frac{x_2}{2}$



$U_f = \frac{S(x_1 + x_2)gd}{2}\left(\frac{x_1 + x_2}{4}\right)x2$

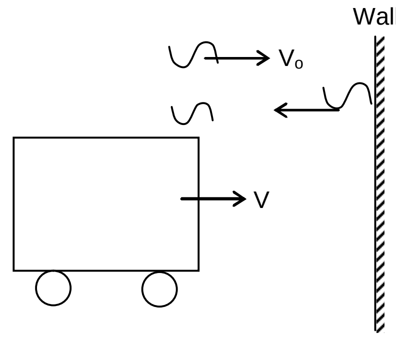
$= \frac{s(x_1 + x_2)^2 gd}{4}$

$U_i - U_f = \frac{5gd}{4}\left\{2x_1^2 + 2x_2^2 - (x_1 + x_2)^2\right\}$

$= \frac{5gd}{4}(x_1 - x_2)^2$

12. **A**

Sol. $f_1 = 420$ Hz



$$f_2 = \left(\frac{V_o + V}{V_o - V}\right) f_1 = 490$$

$$\left(\frac{330 + V}{300 - V}\right) 420 = 490$$

(330 + V) 6 = 7 (330 – V)

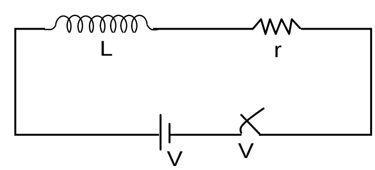
13 V = 330

$$V = \frac{33}{13}(m/s)$$

= 91 (km/hr)

13. **4**

Sol.



$$i = \frac{V}{r}\left\{1 - e^{\frac{-t}{L}}\right\}$$

$$i_{max} = \frac{V}{r}$$

$$U = \frac{1}{2}Li^2$$

$$= \frac{1}{2}L\frac{V^2}{r^2}\left\{1 - e^{-rt/L}\right\} = \frac{1}{n} \times \frac{L}{2}\frac{V^2}{r^2}$$

$$1 - e^{-rt/L} = \frac{1}{\sqrt{n}} \quad ; \quad e^{-rt/L} = 1 - \frac{1}{\sqrt{n}} = \frac{\sqrt{n} - 1}{\sqrt{n}}$$

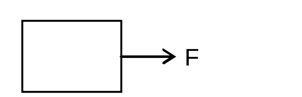
$$e^{rt/L} = \ln\frac{\sqrt{n}}{\sqrt{n} - 1} \quad ; \quad \frac{rt}{L} = \ln\frac{\sqrt{n}}{\sqrt{n - 1}}$$

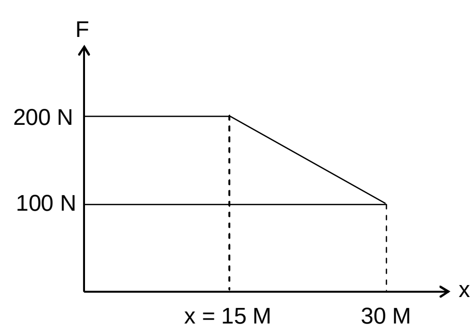
$$T = \frac{L}{r}\ \ln\left(\frac{\sqrt{n}}{\sqrt{n - 1}}\right)$$

14. **C**

15. **A**

Sol.





Network done is equal to area under F-x curve

$= 200 \times 15 + \frac{1}{2} \times 100 \times 15 + 100 \text{x} 15$
$= 4500 + 750$
$= 5250$

16. **B**

Sol. From aerie's law $x = \frac{c}{T}$

$I = x\,H$
$I_1 = x_1\,H_1$
$I_2 = x_2\,H_2$

$$\frac{I_2}{I_1} = \frac{\chi_2 H_2}{\chi_1 H_1}$$

$$\frac{I_2}{I_1} = \frac{\chi_2 H_2}{\chi_1 H_1}$$

$$\frac{I_2}{I_1} = \frac{T_1 H_2}{T_2 H_1} = \frac{4 \times 0.3}{24 \times 0.4} = \frac{1}{8}$$

$$I_2 = \frac{T_1}{8} = \frac{6}{8} = 0.75$$

17. **D**

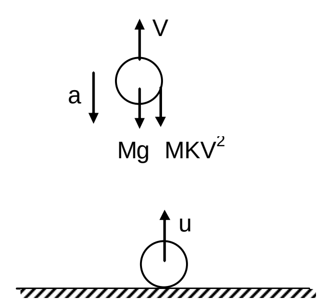
Sol. Escape velocity = $\sqrt{\frac{2GM}{R}} = V_{esf}$

Orbital speed = $\sqrt{\frac{GM}{R}} = V_o$

$$\frac{V_o}{V_{esp}} = \frac{1}{\sqrt{2}}$$

18. **D**

Sol.



$\text{Mg} + \text{MkV}^2 = \text{ma} = -\text{mv}\frac{dV}{dx}$

$\text{Vdv} = (-)\,(g + k\,V^2)\text{dx}$

$$\int_a^0 \frac{Vdv}{g + kv^2} = \int_0^x -dx$$

$$\frac{\ln (g + kV^2)\big|_u^0}{2k} = -x$$

$$\ln\left(\frac{2}{g + ku^2}\right) = -2kx$$

$$X = \frac{1}{2k}\ln\left(1 + \frac{ku^2}{g}\right)$$

19. **A**

Sol. ΔQ = heat supplied

ΔW = work done
ΔU = change in internal energy

(i) adiabatic	(B) $\Delta\theta = 0$
(ii) isothermal	(D) $\Delta U = 0$
(iii) isochoric	(A) $\Delta W = 0$
(iv) isobaric	(C) $\Delta U \neq 0$, $\Delta W \neq = 0$, $\Delta Q \neq 0$

20. **C**

Sol. $B\dfrac{\Delta V}{V} = \Delta P$

$$\frac{\Delta V}{V} = \frac{\Delta P}{B} = \frac{4\times 10^9}{8\times 10^{10}} = \frac{1}{20}$$

$V = \ell^3$

$dV = 3\ell^2\, d\ell$

$$\frac{dV}{V} = \frac{3\ell^2}{\ell^3}d\ell = \frac{3d\ell}{\ell}$$

$$\frac{\Delta V}{V} = \frac{3\Delta\ell}{\ell} \quad ; \quad \frac{\Delta\ell}{\ell^2} = \frac{\Delta V}{3V} = \frac{1}{60}$$

$$\%\ \frac{\Delta\ell}{\ell} = \frac{100}{60} = 1.67\%$$

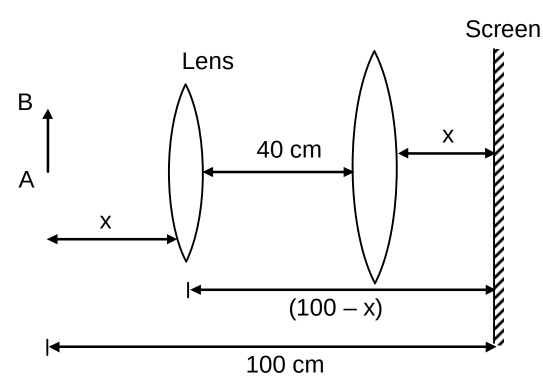
21. **20.00**

Sol. Distance moved = Area under curve

$$= \frac{1}{2}\times 8\times 5 = 20$$

22. **476**

Sol.



$P = \dfrac{1}{f} = \left(\dfrac{N}{100}\right)D$

2x + 40 = 100
x = 30 cm
100 – x = 70 cm

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{70} - \frac{1}{-30} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{1}{70} + \frac{1}{30} = \frac{3+7}{210} = \frac{1}{21}$$

f = 21 cm = 0.21 M

Power = $\dfrac{1}{f} = \dfrac{1}{0.21}$; $D = \left(\dfrac{100}{21}\right)D$

$$\frac{N}{100}D = \frac{100}{21}D$$

$N = \frac{10000}{21} = 476.19$

$N \simeq 476$

23. **150**

Sol. T = constant

PV = nRT

PdV + vdP = 0

$dV = (-)\frac{vd\rho}{P}$

$|\Delta V| = V\frac{\Delta P}{P}$

$V\frac{\Delta P}{P} = \frac{nR\Delta T}{P}$

$\Delta T = \frac{V}{nR}\Delta P$

$C = \frac{V}{nR} = \frac{T}{P} = \frac{300}{p} = 150$

P = constant

PdV = nRdT

$\Delta v = \frac{nR\Delta T}{P}$

24. **2.00**

Sol. $i_1 = \frac{40}{100} = \frac{2}{5}$

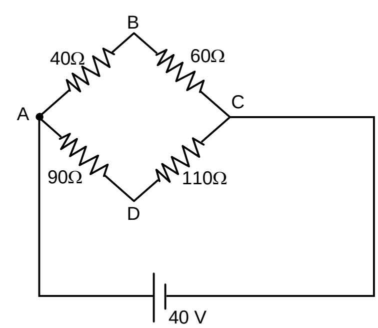
$i_2 = \frac{40}{200} = \frac{1}{5}$

$V_A - V_B = 40\ i_1 = 40 \times \frac{2}{5}$

$V_A - B_B = 16$

$V_A - V_D = 90I_2 = \frac{90}{5} = 18$

$V_B - V_D = 18 - 16 = 2$ volt



25. **200.00**

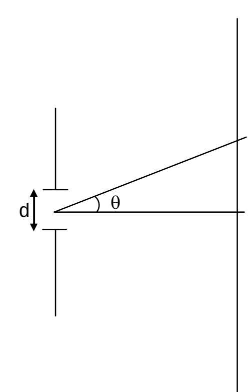
Sol. $\lambda = 6 \times 10^{-7}$ M

$d = 6 \times 10^{-5}$ M

$I = I_o\left\{\frac{\sin(B)}{\beta}\right\}^2$; $\beta = \frac{\pi d\sin\theta}{\lambda}$

$\theta = \frac{\pi}{2}$; $\beta = \frac{\pi d}{\lambda}$

$= \frac{\pi\, 6\times10^{-5}}{6\times10^{-7}} = 100\ \pi$



So at ∞ also minima will form total number of minima = 2 × 100 = 200

PART –B (CHEMISTRY)

26. D

Sol. $[Co(H_2O)_3F_3]$ $Co^{3+} = 3d^6 4s^0 \Rightarrow t_{2g}^{2,1,1}, e_g^{1,1}$

CFSE = $[-0.4n t_{2g} + 0.6 n_{eg}]\Delta_0 + n(P)$

$= [-0.4 \times 4 + 0.6 \times 2]\Delta_0 + 0 = -0.4\,\Delta_0$

27. C

Sol. In Calcination and roasting CO_2 and SO_2 are released which are responsible for Global warning and acid rain.

28. C

Sol. Charge(q) = $\frac{it}{96500}F = \frac{1\times15\times60}{96500} = \frac{900}{96500} = \frac{9}{965}F = 0.0093F$

No. of moles of Au^+ = 0.025 & No. of moles of Ag^+ = 0.025

Species with higher value of SRP will get deposited first at cathode.

(i) $Au^+(aqs) + e^- \longrightarrow Au(s)$

0.025 0.0093 mole

So only Au will get deposited

29. B

Sol. Due to resonance C-Cl bond in option B is shortest.

30. A

Sol. H can easily gain electron to form its anion.

31. A

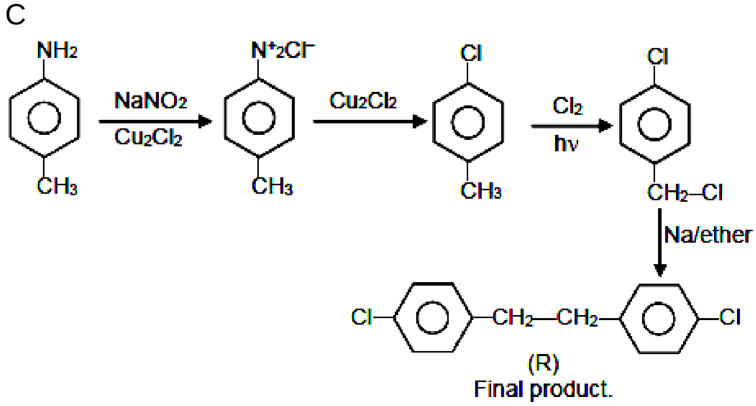
Sol. On adding reaction equilibrium constant will get multiplied.

32. C

Sol. S_N1 reaction depends on carbocation stability and cation form in 3 will be most stable.

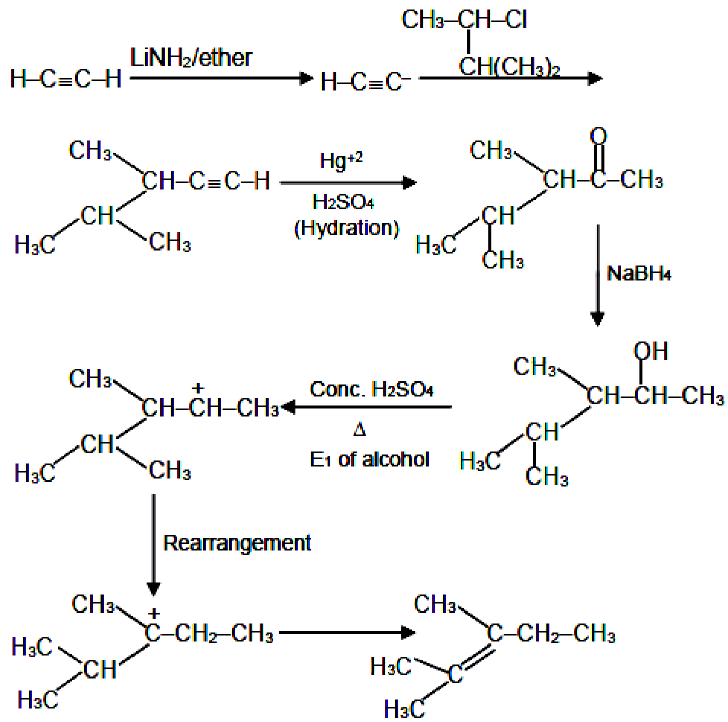
33. C

Sol.



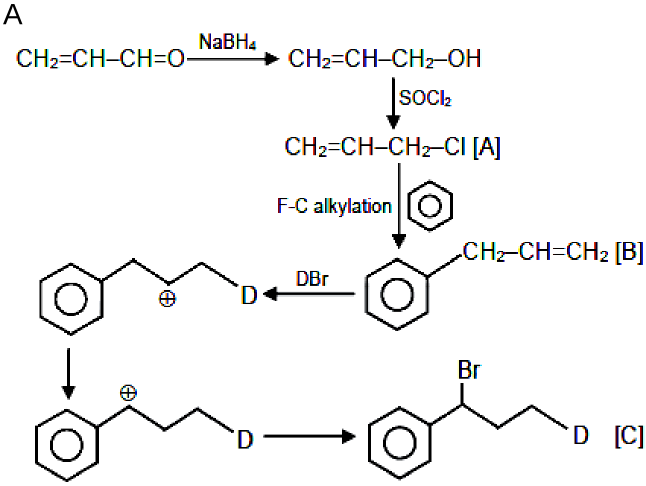
34. D

Sol.



35. A

Sol.



36. A

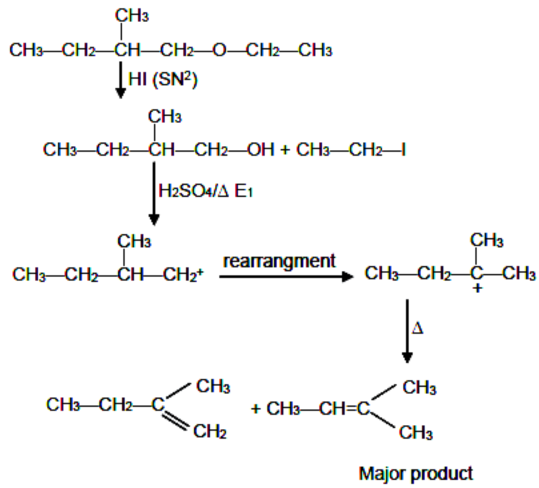
Sol. Egg white will stabilize blue ink easily.

37. B

Sol. Cobalt has 2 unpaired electron

38. B

Sol.



39. A

Sol. Terfenadine act as antihistamine.

40. B

Sol. BeO is hexagonal wurtzite type structure.

41. C

Sol. $KMnO_4$ oxidise HCl to Cl_2.

42. C

Sol. In $[Ni(CN)_4]^{2-}$ hybridization is dsp^2 remaining are SP^3d^2

43. A

Sol.

$$\underset{sp^3d^2}{XeF_4} + SbF_5 \longrightarrow \underset{sp^3d}{[XeF_3]^+}[SbF_6]^-$$

44. C

Sol.

For hydrogen atom :

For Lyman series $n_1 = 1$ & $n_2 = \infty$

$$\frac{1}{\lambda_H} = R_H\left[\frac{1}{1} - \frac{1}{\infty}\right] \qquad \text{So,} \qquad \lambda = \frac{1}{R_H}$$

For He^+ ion

Balmer series $n_1 = 2$ & $n_2 = 3$

$$\frac{1}{\lambda_{He^+}} = R_H \times Z^2\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$\frac{1}{\lambda_{He^+}} = R_H \times 4 \times \frac{5}{36}$$

$$\frac{1}{\lambda_{He^+}} = \frac{5}{9}R_H = \left(\frac{5}{9}\right)\frac{1}{\lambda}$$

$$(\lambda_{He^+}) = \frac{9}{5}\lambda$$

45. C
Sol. P_{ext} is zero so W = zero

46. 84297 J
Sol. $k = Ae^{-\frac{Ea}{RT}}$

$$\ln\left(\frac{K_2}{K_1}\right) = \frac{Ea}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\ln(5) = \frac{Ea}{8.314}\left[\frac{1}{300} - \frac{1}{315}\right]$$

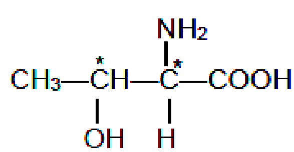
$$1.6094 = \frac{Ea}{8.314}\left[\frac{15}{300 \times 315}\right]$$

$$Ea = 84297J$$

47. 19
Sol. (i) $2Fe^{2+} + H_2O_2 \longrightarrow 2Fe^{3+} + 2OH^-$

(ii) $2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$

So sum of $(x + y + x^1 + y^1 + z^1) = 2 + 2 + 2 + 5 + 8 = 19$

48. 2
Sol.


Threonine have two chiral carbon atom.

49. 10
Sol. Equivalent of solute = 0.1 × 0.1

Mole of solute ($Na_2CO_3.xH_2O$) = $[0.1 \times 0.1]\frac{1}{2}$

Mass of $Na_2CO_3.xH_2O$ = $[0.1 \times 0.1]\frac{1}{2} \times [106 + 18x] = 1.43$

$\Rightarrow$ [106 + 18x = 286

18x = 180

x = 10

50. 167

Sol.

$$\Pi = i\,CRT = i\left[\frac{n}{V}\right]RT$$

$$\Pi_{\text{final}} = \frac{(\pi_1 V_1) + (\pi_2 V_2)}{V_1 + V_2}$$

$$\Pi_{\text{final}} = \frac{(0.1 \times 1) + (0.2 \times 2)}{3}$$

$$= \frac{(0.1 + 0.4)}{3} = \frac{0.5}{3} = \frac{500}{3} \times 10^{-3}\ \text{atm}$$

so X = 167

PART–C (MATHEMATICS)

51. A

Sol. $(2+\alpha)^4 = \left(\frac{3}{2}+i\frac{\sqrt{3}}{2}\right)^4$

$= \left[\sqrt{3}e^{i\left(\frac{\pi}{6}\right)}\right]^4$

$= 9\left(\cos\frac{2\pi}{3}+i\sin\frac{2\pi}{3}\right)$

$= \frac{-9}{2}+\frac{9\sqrt{3}i}{2}$

$\Rightarrow 0+9\left(\frac{-1+i\sqrt{3}}{2}\right)$

$\therefore a=0, b=9$

Answer A

52. C

Sol. Contrapositive of $p \to q$ is $\sim q \to \sim p$.

53. D

Sol. ${}^{N+5}C_{R-1} : {}^{N+5}C_R : {}^{N+5}C_{R+1}$

$= 5 \quad : \quad 10 \quad : \quad 4$

$2\left({}^{N+5}C_{R-1}\right) = {}^{N+5}C_R \Rightarrow 3R = N+6$

$7\left({}^{N+5}C_R\right) = 5\left({}^{N+5}C_{R+1}\right) \Rightarrow 12R = 18+5N$

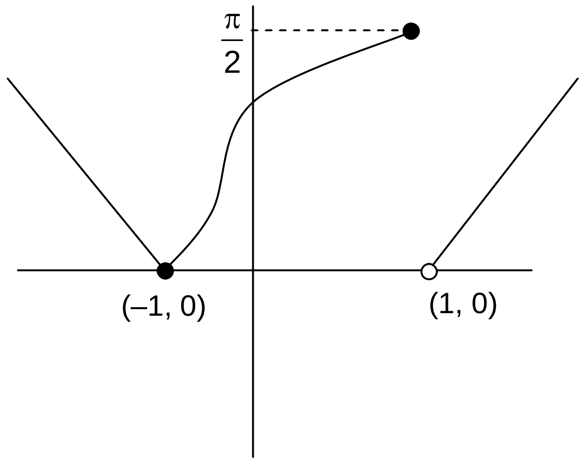
Solving: $N=6,\ R=4$

$\therefore$ Largest coefficient is ${}^{N+5}C_{R+1} = {}^{11}C_5 = 462$

Answer is Option D.

54. C

Sol. Graph of f(x) is



Option C is correct.

55. B

Sol. Here, $\begin{vmatrix} 1 & 1 & 1 \\ 2 & 4 & -1 \\ 3 & 2 & \lambda \end{vmatrix} = 0 \Rightarrow \lambda = \frac{9}{2}$

Also, $\begin{vmatrix} 1 & 1 & 2 \\ 2 & 4 & 6 \\ 3 & 2 & \mu \end{vmatrix} = 0 \Rightarrow \mu = 5$

$\therefore$ Option B is correct.

56. A

Sol. Given: $3\alpha^2 - 10\alpha + 27\lambda = 0$ ....(i)

$3\alpha^2 - 3\alpha + 6\lambda = 0$ ....(ii)

Subtract $-7\alpha + 21\lambda = 0$

$3\lambda = 0$

By (ii) $9\lambda^2 - 3\lambda + 2\lambda = 0$

$\Rightarrow \lambda = 0, \frac{1}{9}$

$\therefore \alpha = \frac{1}{3}, \beta = \frac{2}{3}, \alpha = \frac{1}{3}, \gamma = 3$

$\therefore \frac{\beta\gamma}{\lambda} = \frac{\frac{2}{3}.3}{\frac{1}{9}} = 18$

57. B

Sol. By family of circle, passing through intersection of given circle will be member of $S + \lambda S_1 = 0$ family $(\lambda \neq 1)$

$$\left(x^2+y^2-6x\right)+\lambda\left(x^2+y^2-4y\right)=0$$
$$(\lambda+1)x^2+(\lambda+1)y^2-6x-4\lambda y=0$$
$$x^2+y^2-\frac{6}{\lambda+1}\times-\frac{4\lambda}{\lambda+1}y=0$$
Centre $\left(\frac{3}{\lambda+1},\frac{2\lambda}{\lambda+1}\right)$

Centre lies on i $2x-3y+12=0$
$$2\left(\frac{3}{\lambda+1}\right)-3\left(\frac{2\lambda}{\lambda+1}\right)+12=0$$
$$6\lambda+18=0$$
$$\lambda=-3$$
Circle $x^2+y^2-3x-6y=0$

58. A

Sol. $$\int_{\pi/6}^{\pi/3}\left(\frac{\frac{d}{dx}\left(\tan^4 x\right)}{2}.\sin'3x+\tan'x.\frac{\frac{d}{dx}\left(\sin^4 3x\right)}{2}\right)$$
$$=\frac{1}{2}\int_{\pi/6}^{\pi/3}\frac{d}{dx}\left(\tan^4 x.\sin^4 3x\right)dx$$
$$=\frac{1}{2}\left[\tan^4 x.\sin^4 3x\right]_{\pi/6}^{\pi/3}$$
$$=\frac{1}{2}\left[\left(\sqrt{3}\right)^4.O-\frac{1}{\left(\sqrt{3}\right)^4}\right]$$
$$=-\frac{1}{18}$$

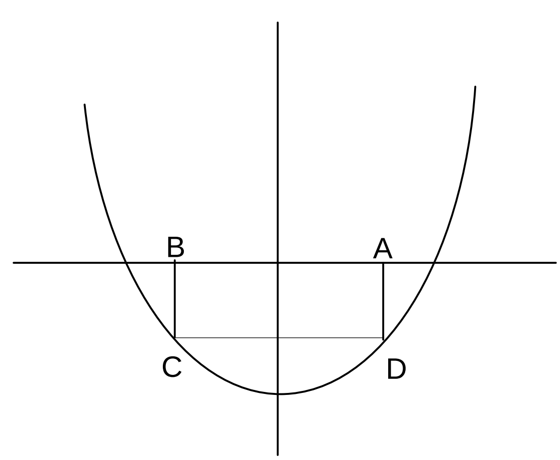
59. A

Sol. $A(\alpha,0),B(-\beta,0)$

$\Rightarrow D\left(\alpha,\alpha^2-1\right)$

Area (ABCD) = (AB) (AD)

$\Rightarrow S=(2\alpha)\left(1-\alpha^2\right)=2\alpha-2\alpha^2$
$$\frac{ds}{d\alpha}=2-6\alpha^2$$
$$=0\Rightarrow a^2$$
$$=\frac{1}{3}$$



$$\Rightarrow \alpha = \frac{1}{\sqrt{3}}$$

$$\text{Area} = 2\alpha - 2\alpha^2 = \frac{2}{\sqrt{3}} - \frac{2}{3\sqrt{3}}$$

$$= \frac{4}{3\sqrt{3}}$$

60. C

Sol. Let $A = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}$

$Ax_1 = B_1$

$a_1 + a_2 + a_3 = 1$

$b_1 + b_2 + b_3 = 0$

$c_1 + c_2 + c_3 = 0$

Similar $2a_3 + a_3 = 0$ and $a_3 = 0$

$2b_2 + b_3 = 2 \qquad b_3 = 0$

$2c_2 + c_3 = 0 \qquad c_3 = 2$

$\therefore a_2 = 0, b_2 = 1, c_2 = -1,$

$a_1 = 1, b_1 = -1, c_1 = -1$

$$A = \begin{bmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \\ -1 & -1 & 2 \end{bmatrix} \therefore |A| = 2$$

61. B

Sol. $\frac{dy}{dx} - \frac{y-3x}{\ln(y-3x)} + 3 = 0$

$$\frac{dy}{dx} + 3 = \frac{y+3x}{\ln(y+3x)}$$

$$\frac{d}{dx}(y+3x) = \frac{y+3x}{\ln(y+3x)}$$

$$\int \frac{\ell n(y+3x)}{(y+3x)} d(y+3x) = \int dx$$

Let $\ell n(y+3x) - t$

$$\frac{1}{(y+3x)} d(y+3x) = dt$$

$$\int t\, dt = \int dx$$

$$\frac{t^2}{2} = x + c$$

$$\frac{\left(\ell n(y+3x)\right)^2}{2} = x + c$$

62. D

Sol. Since AM two positive quantities $\geq$ their G.M.

$$\frac{2^{\sin x} + 2^{\cos x}}{2} \geq \sqrt{2^{\sin x}.2^{\cos x}}$$

$$= \sqrt{2^{\sin x + \cos x}} = \sqrt{2^{\sqrt{2}\cos\left(x - \frac{\pi}{4}\right)}}$$

$$\geq \sqrt{2^{-\sqrt{2}}} \Rightarrow 2^{\sin x} + 2^{\cos x} \geq 2.2^{1//\sqrt{2}} = 2^{1-1/\sqrt{2}}$$

63. B

Sol Applying L – Hospital Rule

$$\lim_{t \to x} \frac{2t f^2(x) - x^2\left(2f(t)f'(t)\right)}{1}$$

$$\therefore 2 \times f^2(x) - x^2\left(2f(x)f'(x)\right) = 0$$

$$\Rightarrow f(x) - x f'(x) = 0$$

$$\Rightarrow \frac{f('x)}{f(x)} = \frac{1}{x} \Rightarrow \ell n f(x) = \ell n x + C$$

At $x = 1, c = 1$

$$\therefore \ell n f(x) = \ell n x + 1$$

when $f(x) = 1$

then $\ell n x = -1$

$$x = \frac{1}{e}$$

64. D

Sol. Equation PQ

$$\frac{x-1}{2} = \frac{y+2}{3} = \frac{z-3}{-6} = \lambda$$

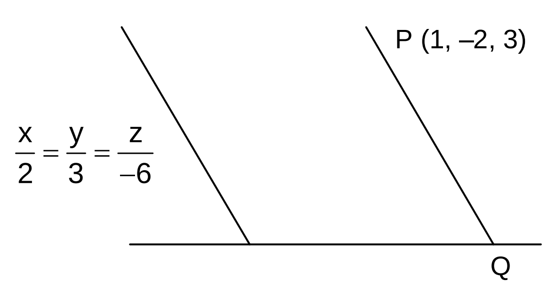
Let $Q = (2\lambda + 1, 3\lambda - 2, -6\lambda + 3)$

Q lies on $x - y + z = 5$

$$= (2\lambda + 1) - (3\lambda - 2) + (-6\lambda + 3) = 5$$

$$\Rightarrow \lambda = -\frac{1}{7}$$

$$Q = \left(\frac{5}{7}, \frac{-17}{7}, \frac{15}{7}\right)$$



$$\therefore PQ = \sqrt{\left(\frac{2}{7}\right)^2 + \left(\frac{3}{7}\right)^2 + \left(\frac{6}{7}\right)^2}$$

$PQ = 1$

65. C

Sol. sum 6 $\rightarrow$ (1, 5), (5, 1), (3, 3), (2, 4), (4, 2)

sum 7 $\rightarrow$ (1, 6), (6, 1), (5, 2), (2, 5), (3, 4), (4, 3)

$= P(A) + P(\overline{A}).P(\overline{B}).P(A) + P(\overline{A})P(\overline{B})P(\overline{A}).P(\overline{B}).P(A) + ...$

This is infinite G.P. with common ratio $P(\overline{A}) \times P(\overline{B})$

Probability of A wins $= \dfrac{P(A)}{1 - P(\overline{A})P(\overline{B})}$

$$= \frac{\frac{5}{36}}{1 - \frac{31}{36}.\frac{30}{36}} = \frac{30}{61}$$

66. C

Sol. $\tan 30^o = \dfrac{x}{y} = \dfrac{1}{\sqrt{3}} \Rightarrow y = \sqrt{3}x$ ……….(i)

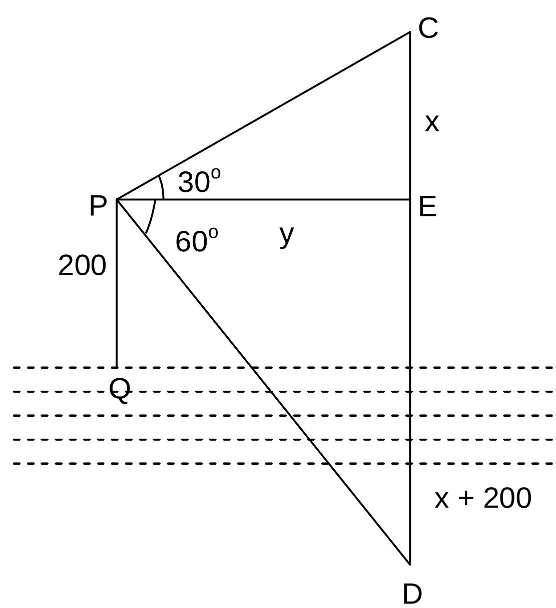
and $\tan 60^o = \dfrac{x+400}{y} \Rightarrow \sqrt{3}y$

$= x + 400$ ……….(ii)

Solving (i) and (ii), we get

$2x = 400,\ x = 200$

$\sin 30^o = \dfrac{x}{PC} = \dfrac{200}{PC} \Rightarrow PC = 400$



67. A

Sol. Given : $\dfrac{a}{e} = 4$ and $\dfrac{1}{4} = 1 - \dfrac{b^2}{a^2}$

Solving : $a = 2, b = \sqrt{3}$

Parametric co – ordinates are

$\left(2\cos\theta, \sqrt{3}\sin\theta\right) = (1, \beta)$

$\therefore \theta = 60^o$

$\therefore$ Equation of normal is $ax\sec\theta - by\operatorname{cosec}\theta = a^2 - b^2$

$\Rightarrow \quad 4x - 2y = 1$

68. B

Sol. Let number of elements in T is R.

$\therefore 20R = 500 \Rightarrow R = 25$

and $6R = 5N \Rightarrow N = 30$

69. C

Sol. Any point (x, y) on perpendicular bisector equidistant from p and q

$\therefore (x-1)^2 + (y-4)^2 = (x-k)^2 + (y-3)^2$

At $x = 0,\ y = -4$

$\therefore\ 1 + 64 = k^2 + 49$

$k^2 = 16$

70. A

Sol. Given,

$300 = 1 + (N-1)d$

$\Rightarrow (N-1)d = 299$

$\therefore (N, d) = (24, 13)$ is the only possible pair

$\therefore a_{20} = 1 + 19(13) = 248$ and, $S_{20} = \frac{1+248}{2} \times 20$

$= 2490$

71. 18

Sol. Let $\vec{a} = x\hat{i} + y\hat{j} + z\hat{k}$

$\hat{i} \times (\vec{a} \times \hat{i}) = (\hat{i}.\hat{i})\vec{a} - (\vec{a}.\hat{i}) = y\hat{j} + z\hat{k}$

Similarly $\hat{j} \times (\vec{a} \times \hat{j}) = x\hat{i} + z\hat{k}$ and $\hat{k} \times (\vec{a} \times \hat{k}) = x\hat{i} + y\hat{k}$

$\left|\hat{i} \times (\vec{a} \times \hat{i})\right|^2 + \left|\hat{j} \times (\vec{a} \times \hat{j})\right|^2 + \left|\hat{k} \times (\vec{a} \times \hat{k})\right|^2$

$= \left|y\hat{j} + z\hat{k}\right|^2 + \left|x\hat{i} + z\hat{k}\right|^2 + \left|x\hat{i} + y\hat{j}\right|^2 = 2|a|^2 = 2(9) = 18$

72. 135

Sol. Ways of selecting correct questions $= {}^6C_4 = 15$

Ways of doing them correct = 1

Ways of doing remaining 2 questions incorrect $= 3^2 = 9$

$\therefore$ No. Of ways $= 15 \times 1 \times 9 = 135$

73. 2

Sol. Let $P(2\cos\theta, 2\sin\theta)$

$\therefore Q(-2\cos\theta, -2\sin\theta)$

Given line $x + y - 2 = 0$

$$\therefore \alpha = \frac{|2\cos\theta + 2\sin\theta - 2|}{\sqrt{2}}$$

$$\beta = \frac{|-2\cos\theta - 2\sin\theta - 2|}{\sqrt{2}}$$

$$\therefore \alpha\beta = \sqrt{2}(\cos\theta + \sin\theta - 1).\sqrt{2}(\cos\theta + \sin\theta + 1)$$

$$= 2\left|\cos^2\theta + \sin^2\theta + 2\sin\theta\cos\theta - 1\right| = 2|\sin 2\theta|$$

Max $|\sin\theta| = 1$

$\therefore$ maximum $\alpha\beta = 2$.

74. 4

Sol.

xi	5	15	25
fi	2	x	2

$$\bar{x} = \frac{\sum f_i x_i}{\sum f_i} = \frac{10 + 15x + 50}{4 + x}$$

$$= \frac{60 + 15x}{4 + x} = 15$$

$$\sigma^2 = 50 = \frac{\sum f_i x_i^2}{\sum f_i} - \left(\bar{x}\right)^2$$

$$50 = \frac{50 + 225x + 1250}{4 + x}(15)^2$$

$$50 = \frac{1300 + 225x}{4 + x} - 225$$

$$\Rightarrow 275(4 + x) - 1300 + 225x$$

$$\Rightarrow 50x = 200x \Rightarrow x = 4$$

$$50 = \frac{225x + 1250}{4 + x}(15)^2$$

$$50 = \frac{1300 + 225x}{4 + x} - 225$$

$$\Rightarrow 275(4 + x) = 1300 + 225x$$

$$\Rightarrow 50x = 200 \Rightarrow x = 4$$

75. 21

Sol. Clearly, $\int_0^n \{x\}\,dx = \frac{n}{2}$

$$\int_0^n [x]\,dx = 1 + 2 + 3.....n - 1$$

$$= \frac{n(n-1)}{2}$$

$$\therefore \left(\frac{n(n-1)}{2}\right)^2 = \frac{n}{2}\{10n(n-1)\}$$

Solving, n = 21