SAMPLE PAPERS

JEE Advanced

PAPER – 1

Maximum Marks: 180

Physics : Simple Harmonic Motion, Waves & Sound, Modern Physics & Communication Systems.

Chemistry: Chemical Kinetics, States of matter, Environmental Chemistry, Hydrogen & Compounds, Alcohol Phenol & Ethers, Carbonyl Compounds, Carboxylic Acid, Nitrogen Compounds, Biomolecules & Polymers

Mathematics: Circles, Parabola, Ellipse, Hyperbola, Areas, Differential Equation, Probability, Linear Programming

Important Instruction

A. General:

1. This booklet is your Question Paper.
2. Blank papers, clipboards, log tables, slide rules, calculators, cameras, cellular phones, pagers and electronic gadgets are NOT allowed inside the examination hall.
3. Using a black ball point pen to darken the bubbles.

B. Question Paper Format:

The question paper consists of three parts (Physics, Chemistry and Mathematics). Each part consists of two sections.

4. Section 1 contains 10 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE THAN ONE** are correct.
5. Section 2 contains 10 questions. The answer to each of the questions is a **SINGLE DIGIT INTEGER**, ranging from 0 to 9 (both inclusive).

C. Marking Scheme:

6. For each question in Section 1, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
7. For each question in Section 2, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

PART – A (PHYSICS)

SECTION – 1 (Multiple Choice Questions) ONE OR MORE THAN ONE CORRECT

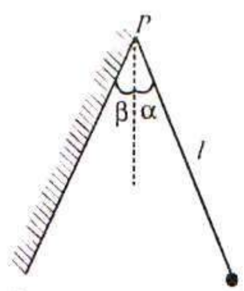
1. A simple pendulum of string length l and bob of mass m is displaced from its equilibrium position O to a position P so that the height of P above O is h. It is then released. What is the tension in the string when the bob passes through the equilibrium position O? Neglect friction. V is the velocity of the bob at O.

(a) $m\left(g+\frac{V^2}{l}\right)$ (b) $\frac{2mgh}{l}$ (c) $mg\left(1+\frac{h}{l}\right)$ (d) $mg\left(1+\frac{2h}{l}\right)$

2. A wave pulse moving to the right along the x-axis is represented by the wave function $y(x, t) = \frac{2.0}{(x-3.0t)^2+1}$, where x and y are in centimeters and t is in seconds. (The maximum pulse height is defined as maximum displacement along y-axis). Then

(a) The maximum pulse height is decreasing with time
(b) The maximum pulse height is constant with time
(c) The speed of the pulse is 3.0 cm/s
(d) The speed of the pulse is 0.33 m/s

3. A ball is hung vertically by a thread of length 'ℓ' from a point P of an inclined wall that makes an angle β with the vertical. The thread with the ball is then deviated through a small angle α $(\alpha > \beta)$ and set free. Assuming the wall to be perfectly elastic, the period of such pendulum is



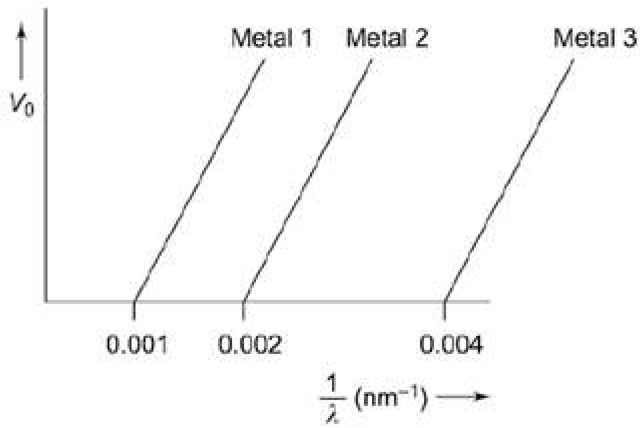
(a) $2\sqrt{\frac{\ell}{g}}\left[\frac{\pi}{2}+\sin^{-1}\left(\frac{\beta}{\alpha}\right)\right]$ (b) $\sqrt{\frac{\ell}{g}}\left[\sin^{-1}\left(\frac{\beta}{\alpha}\right)\right]$

(c) $2\sqrt{\frac{\ell}{g}}\left[\cos^{-1}\left(\frac{\alpha}{\beta}\right)\right]$ (d) $\sqrt{\frac{\ell}{g}}\left[\cos^{-1}\left(-\frac{\beta}{\alpha}\right)\right]$

4. Fig. shows graphs between cut-off voltage V_0 and $\frac{1}{\lambda}$ for three metals 1, 2 and 3, where λ is the wavelength of the incident radiation in nm.

If W_1, W_2 and W_3 are the work functions of metals 1, 2 and 3 respectively, then

(a) $W_1 : W_2 : W_3 = 1 : 2 : 4$
(b) $W_1 : W_2 : W_3 = 4 : 2 : 1$
(c) The graphs for metals 1, 2 and 3 are parallel to each other and the slope of each graph is hc/e, where h = Planck's constant, c = speed of light and e = charge of an electron
(d) Ultraviolet light will eject photoelectrons from metals 1 and 2 and not from metal 3.



5. Two identical straight wires are stretched so as to produce 6 beats per second when vibrating simultaneously. On changing the tension slightly in one of them, the beat frequency remains unchanged. Denoting by T_1, T_2 the higher and the lower initial tension in the strings, then it could be said that while making the above changes in tension.
(a) T_2 is decreased (b) T_2 was increased (c) T_1 was decreased (d) T_1 was increased

6. The displacement x of a particle varies with time t as

$$x = A \sin^2 \omega t + B \cos^2 \omega t + C \sin \omega t \cos \omega t$$

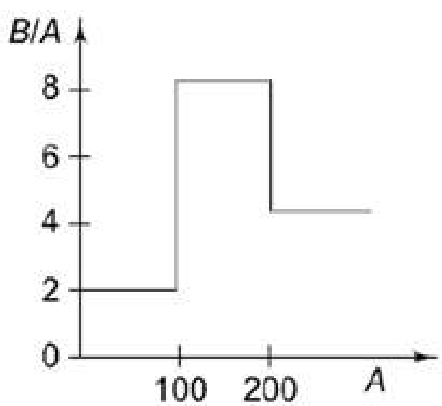
For what values of A, B and C is the motion simple harmonic?
(a) All values of A, B and C with $C \neq 0$ (b) $A = B$, $C = 2B$ (c) $A = -B$, $C = 2B$ (d) $A = B$, $C = 0$

7. The equation of a wave travelling on a string stretched along x -axis is given by $\left(y = Ae^{-\left(\frac{x}{a}+\frac{t}{T}\right)^2} \right)$

Where is the maximum of pulse located at $t = T$?

(a) $x = \frac{1}{a}$ (b) $x = \frac{-1}{a}$ (c) $x = a$ (d) $x = -a$

8. Assume that the nuclear binding energy per nucleon (B/A) versus mass number is as shown in the figure. Use this plot to choose the correct choice(s) given below.



(a) Fusion of two nuclei with mass numbers lying in the range of 1 < A < 50 will release energy
(b) Fusion of two nuclei with mass numbers lying in the range of 51 < A < 100 will release energy
(c) Fission of a nucleus lying in the mass number range of 100 < A < 200 will release energy when broken into equal fragments
(d) Fission of a nucleus lying in the mass number range of 200 < A < 260 will release energy when broken into equal fragments

9. A solid sphere of density ρ and radius R is floating in a liquid of density σ with half its volume submerged. When the sphere pressed down slightly and released, it executes simple harmonic motion of time period T. If viscous effect is ignored, then

(a) σ = 2ρ (b) ρ = 2σ (c) $T = 2\pi\sqrt{\frac{2R}{3g}}$ (d) $T = 2\pi\sqrt{\frac{3R}{2g}}$

10. In a resonance – column experiment to measure the velocity of sound, the first resonance is obtained at a length ℓ_1 and the second resonance at a length ℓ_2. Then which of the following is (are) incorrect.
(a) $\ell_2 > 3\ell_1$ (b) $\ell_2 = 3\ell_1$ (c) $\ell_2 < 3\ell_1$
(d) May be any of the above, depending on the frequency of the tuning fork used

SECTION – 2 (INTEGER TYPE QUESTIONS)

11. Difference between n^{th} and $(n + 1)^{th}$ Bohr's radius of 'H' atom is equal to it's $(n – 1)^{th}$ Bohr's radius. The value of n is approximately __________.

12. A block is kept on a horizontal table. The table is undergoing simple harmonic motion of frequency 3 Hz in a horizontal plane. The coefficient of static friction between the block and the table is 0.72. Find the maximum amplitude in cm of the table for which the block does not slip on the surface of the table. Take g = 10 ms^{-2} .

13. A steel wire of length 1 m, mass 0.1 kg and uniform cross-sectional area 10^{-7} m^2 is rigidly fixed at both ends. The temperature of the wire is decreased by 80/3°C. If transverse waves are set up in the wire, find the frequency in Hz. The Young's modulus of steel = 2×10^{11} Nm^{-2} and coefficient of linear expansion of steel
= 1.2×10^{-5} per° C.

14. A simple pendulum has time period T_1. The point of suspension is now moved upward according to the relation $y = kt^2$ (k = 1 m/s^2), where y is the vertical displacement. The time period now becomes T_2. The ratio of $\frac{T_1^2}{T_2^2}$ is considered to be x. Then the value of 5x is _____ . (Take g = 10 m/s^2)

15. The ratio of molecular mass of two radioactive substance is $\frac{4}{3}$. IF the ratio of their initial activity per mole is considered as x, find 3x.

16. A 20 cm long string, having a mass of 1.0 g, is fixed at both the ends. The tension in the string is 0.5 N. The string is set into vibrations using an external vibrator of frequency 100 Hz. Find the separation (in cm) between the successive nodes on the string.

17. A particle is moving on x-axis has potential energy $U = 2 – 20x + 5x^2$ joules along x-axis. The particle is released at x = – 3. If the mass of the particle is 0.1 kg and the maximum velocity of the particle (in m/s) is 10x, find the value of x.

18. For a certain organ pipe three successive resonance frequencies are observed at 425 Hz, 595 Hz and 765 Hz respectively. If the speed of sound in air is 340 m/s, then the length of the pipe is ______m.

19. Two radioactive materials X_1 and X_2 have decay constants 10 λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time $\frac{1}{x\lambda}$, find the value of x.

20. Two sound waves move in the same direction. If the average power transmitted across a cross-section by them are equal while their wavelengths are in the ratio of 1 : 2. Their pressure amplitudes would be in the ratio of _______.

PART – B (CHEMISTRY)

SECTION – 1 (Multiple Choice Questions) ONE OR MORE THAN ONE CORRECT

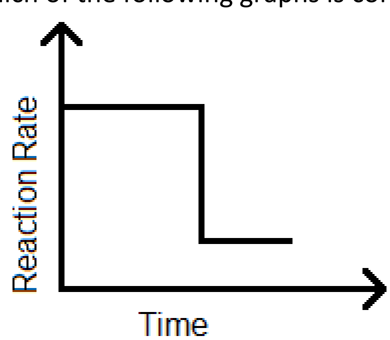
21. Which of the following changes decrease the vapour pressure of water kept in a sealed vessel?
(a) Decreasing the quantity of water
(b) Adding salt to water
(c) Decreasing the volume of the vessel to one half
(d) Decreasing the temperature of water.

22. Boyle's law may be expressed as
(a) $\left(\frac{dp}{dV}\right)_T = \frac{K}{V}$ (b) $\left(\frac{dp}{dV}\right)_T = -\frac{K}{V^2}$ (c) $\left(\frac{dp}{dV}\right)_T = \frac{K^2}{V}$ (d) $V \propto \frac{1}{p}$

23. A new carbon-carbon bond formation is possible in
(a) Cannizzaro's reaction (b) Friedel Crafts reaction
(c) Clemmensen's reduction (d) Reimer-Tiemann reaction

24. Non-degradable solid pollutants are
(a) domestic waste (b) DDT (c) Plastics (d) Cow dung

25. Which of the following graphs is correct for a zero order reaction?

(a)


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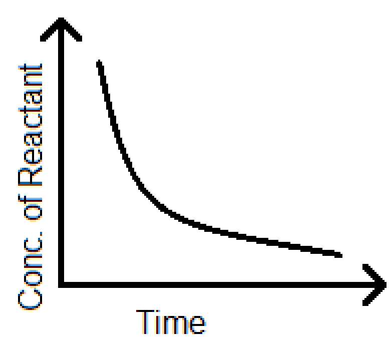
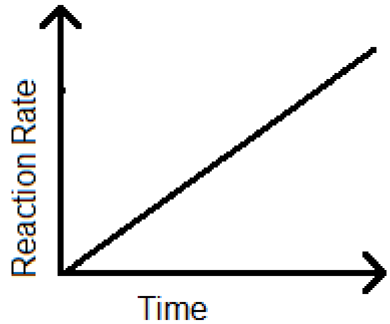
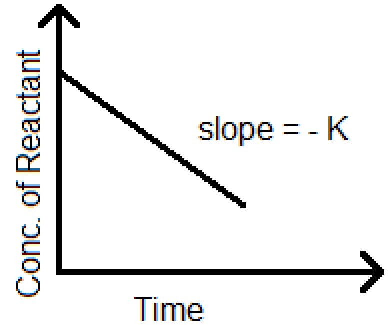


(c) 

(d) 

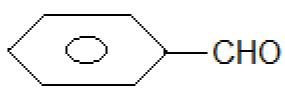
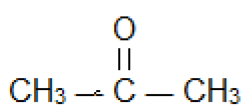
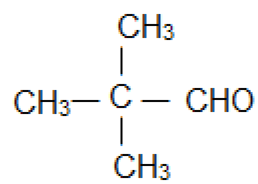
26. Which of the following polymers are thermoplastics?
(a) Teflon (b) Natural rubber (c) Neoprene (d) Polystyrene

27. In fibrous proteins, polypepetide chains are held together by
(a) Vander Waals forces (b) Disulphide linkage
(c) Electrostatic forces of attraction (d) Hydrogen bonds

28. Which of the following carbohydrates are branched polymer of glucose?
(a) Amylase (b) Amylopectin (c) Cellulose (d) Glycogen

29. Which of the following are used to convert RCHO into RCH_2OH?
(a) H_2/Bd (b) $NaBH_4$ (c) $LiAlH_4$ (d) Reaction with RMgX followed by hydrolysis

30. Which of the following compounds do not undergo aldol condensation?

(a) CH_3CHO **(b)**  **(c)**  **(d)** 

SECTION – 2 (INTEGER TYPE QUESTIONS)

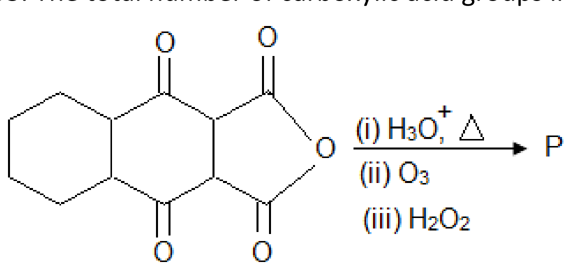
31. A closed vessel with rigid walls contains 1mole of ${}^{238}_{92}U$ and 1 mole of air at 298 K. Considering complete decay of ${}^{238}_{92}U$ to ${}^{206}_{82}Pb$, the ratio of the final pressure to the initial pressure of the system at 298 K is

32. The concentration of R in the reaction R → P was measured as a function of time and the following data is obtained.

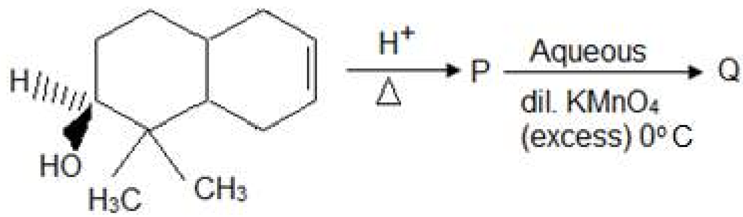
[R](molar)	1.0	0.75	0.40	0.10
t (min)	0.0	0.05	0.12	0.18

The order of the reaction is

33. The total number of carboxylic acid groups in the product ‘p’ is

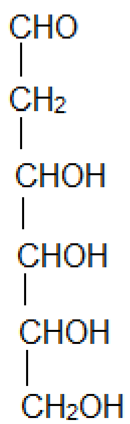


34. The number of hydroxyl group(s) is Q is

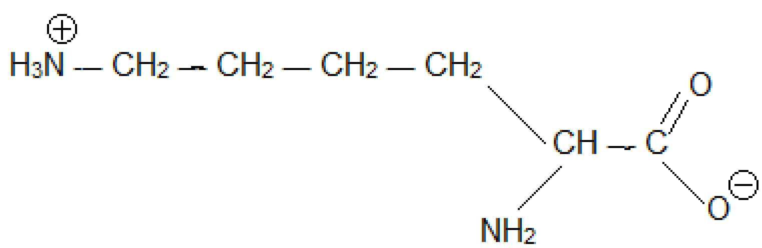


35. A tetrapepetide has – COOH on Alanine. This produces glycine(Gly), Valine(Val), Phenyl alanine(Phe) and Alanine(Ala, on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary sturctures) with – NH_2 group attached to a chiral centre is

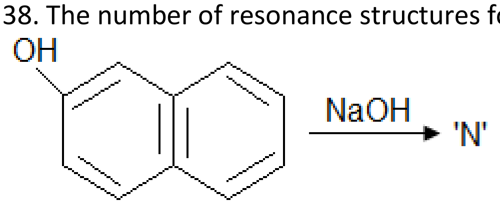
36. When the following aldohexose exists in its D-configuration, the total number of number of stereoisomers in its pyranose form is



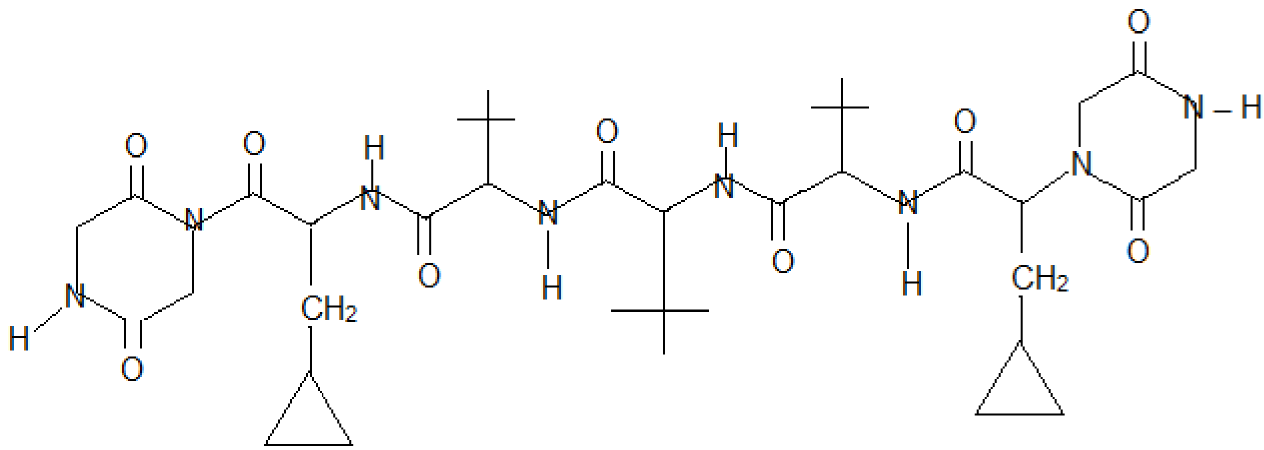
37. The total number of basic groups in the following form of lysine is



38. The number of resonance structures for 'N' is



39. The total number of distinct naturally occurring amino acids obtained by complete acidic hydrolysis of the peptide shown below is



40. If the value of Avogadro number is 6.023×10^{23} mol $^{-1}$ and the value of Boltzman constant is 1.380×10^{-23} J K $^{-}$ then the number of significant digits in the calculated value of the universal gas constant is

PART – C (MATHEMATICS)

SECTION – 1 (Multiple Choice Questions) ONE OR MORE THAN ONE CORRECT

41. If the normal's at $(x_i, y_i)$where i= 1, 2, 3, 4 to the rectangular hyperbola xy = 2 meet at the point (3, 4), then
(a) $x_1 + x_2 + x_3 + x_4 = 3$
(b) $y_1 + y_2 + y_3 + y_4 = 4$
(c) $x_1x_2x_3x_4 = -4$
(d) $y_1 y_2 y_3 y_4 = 4$

42. An urn contains fair tickets with numbers 112, 121, 211, 222 and one ticket is drawn. Let A_i (I = 1, 2,3) be the event that the ith digit of the number of ticket drawn is 1 then
(a) $P(A_1) = P(A_2) = P(A_3) = \frac{1}{2}$
(b) $P(A_1 \cap A_2) = P(A_1) P(A_2)$
(c) A_1, A_2, A_3 are pair wise independent events
(d) $P(A_1 \cap A_2 \cap A_3) \neq P(A_1) P(A_2) P(A_3)$

43. If the normal at any given point P on ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ meets its auxiliary circle at Q and R such that $\angle QOR = 90°$, where O is centre of ellipse, then
(a) $2(a^2 - b^2) = a^4 \sec^2 \theta + a^2b^2 \operatorname{cosec}^2 \theta$
(b) $a^4 + 5a^2 b^2 + 2b^4 = a^4 \tan^2 \theta + a^2b^2 \cot^2 \theta$
(c) $a^4 + 5b^2 a^2 + 2b^4 \geq 2a^3b$
(d) $a^4 + 2b^2 \geq 5a^2b^2 + 2a^3b$

44. Given the family of lines, a (3x + 4y + 6) + b(x + y + 2) = 0. The line of the family situated at the greatest distance from the point P(2, 3) has equation:
(a) 4x + 3y + 8 = 0
(b) 5x + 3y + 10 = 0
(c) 15x + 8y + 30 = 0
(d) None

45. For a given parabola $y^2 = 4ax$, two variable chords PQ and RS at right angles are drawn through the fixed point $A(x_1, y_1)$ inside the parabola, making variable angles θ and α with x-axis. If r_1, r_2, r_3, r_4 are distances of P, Q, R and S from A, then the value of $\frac{1}{r_1r_2} + \frac{1}{r_3r_4}$
(a) independent of θ
(b) independent of α
(c) depends upon θ and α
(d) is a constant

46. For different values of k, the circle $x^2 + y^2 + (8 + k)x + (8 + k)y + (16 + 12k) = 0$, always passes through two fixed point P and Q. For $k = k_1$, the tangents at P and Q intersect at the origin. Which of the following is/are correct?

(a) the mid-point of P and Q is (–6, –6)
(b) the sum of ordinates of P and Q is –12
(c) k_1 may be equal to $-\frac{32}{9}$
(d) k_1 may be equal to $\frac{8}{3}$

47. If a function y = f(x) is such that f'(x) is continuous function and satisfies
$(f(x))^2 = K + \int_0^x \left((f(t))^2 + (f'(t))^2\right) dt$, $K \in R^+$, then

(a) f(x) is increasing function $\forall$ x ∈ R
(b) f(x) is bounded function
(c) f(x) is neither even nor odd
(d) if k = 100 then f(0) = 10

48. A circle has the same centre as an ellipse and passes through the foci F_1 and F_2 of the ellipse the two curves intersect in four points. Let P be any point of intersection. If the major axis of the ellipse is 15 and the area of ΔPF_1F_2 is 26, then the distance between foci is

(a) 11
(b) 9
(c) 10
(d) 15

49. The equation $\left|\sqrt{x^2 + (y-1)^2} - \sqrt{x^2 + (y+1)^2}\right| = k$ will represent a hyperbola for

(a) k ∈ (0, 2)
(b) k ∈ (0, 1)
(c) k ∈ (1, ∞)
(d) k ∈ (0,)∞

50. C_1, C_2 are two circles of radii $a, b (a < b)$ touching both the coordinate axes and have their centres in the first quadrant. Then the true statements among the following are

(a) If C_1, C_2 touch each other then $\frac{b}{a} = 3 + 2\sqrt{2}$

(b) If C_1, C_2 are orthogonal then $\frac{b}{a} = 2 + \sqrt{3}$

(c) If C_1, C_2 intersect in such a way that their common chord has maximum length then $\frac{b}{a} = 3$

(d) If C_2 passes through centre of C_1 then $\frac{b}{a} = 2 + \sqrt{2}$

SECTION – 2 (INTEGER TYPE QUESTIONS)

51. n biased coins, with m^{th} coin having probability of throwing head equal to $\frac{1}{(2m+1)}$ (m = 1, 2, ... n), are tossed once. The probability of getting an odd numbers of heads, if result for each coin are independent, is $\frac{\alpha n}{\beta n + \gamma}$ then $\alpha + \beta + \gamma$ is equal to ______

52. Consider the parabola $y = ax - bx^2$. If the least positive value of a for which there exist $\alpha, \beta \in R - \{0\}$ such that both the point (α, β) and (β, α) lies on the given parabola is k then [k] is equal to _______

53. Differential equation, having $y = \left(\sin^{-1} x\right)^2 + A\left(\cos^{-1} x\right) + B$ where A and B are arbitary constants is

$$\left(p - x^2\right)\frac{d^2y}{dx^2} - \frac{x\,dy}{dx} = q \quad \text{then} \quad p + q = \_\_$$

54. The tangents drawn from the origin to the circle $x^2 + y^2 - 2rx - 2hy + h^2 = 0$ are perpendicular then sum of all possible values of $\frac{h}{r}$ is ___

55. If the area bounded by the curves $y = -x^2 + 6x - 5$, $y = -x^2 + 4x - 3$ and the line $y = 3x - 15$ is $\frac{73}{\lambda}$, then the value of λ is

56. From a point perpendicular tangents are drawn to ellipse $x^2 + 2y^2 = 2$. The chord of contact touches a circle which is concentric with given ellipse. Then find the ratio of maximum and minimum area of circle

57. Let R = {x, y : $x^2 + y^2 \le 144$ and $\sin(x + y) \ge 0$}. And S be the area of region given by R, then find $S/9\pi$.

58. The minimum area bounded by the function y= f(x) and $y = \alpha x + 9$ ($\alpha \in R$) where f satisfies the relation $f(x + y) = f(x) + f(y) + y\sqrt{f(x)}$ $\forall x,y \in R$ and $f'(0) = 0$ is 9A, value of A is

59. A game is played with a special fair cubic die which has one red side, two blue sides, and three green sides. The result is the colour of the top side after the die has been rolled. If the die is rolled repeatedly, the probability that the second blue result occurs on or before the tenth roll, can be expressed in the form $\frac{3^p - 2^q}{3^r}$ where p, q, r are positive integers, If $p^2 + q^2 + r^2 .= 280 + x$. Find x

60. Let P, Q be two points on the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ whose eccentric angles differ by a right angle. Tangents are drawn at P and Q to meet at R. If the chord PQ divides the joint of C and R in the ratio m : n (C being centre of ellipse), then find m+n(m:n is in simplified form).