Section-I (PHYSICS)

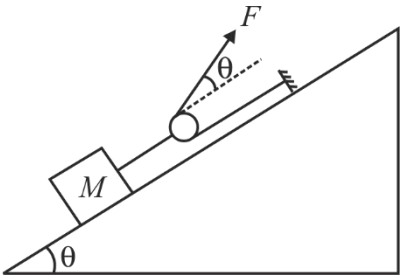
***Single Correct Type Question* (1 *to* 20)**

1. A particle of mass m is projected with a speed v at 45° with the horizontal. The magnitude of angular momentum of the projectile about the point of projection when the particle is at its maximum height h is

(1) zero (2) $\frac{mvh^2}{\sqrt{2}}$

(3) $\frac{mvh^2}{\sqrt{2}}$ (4) $\frac{mvh}{\sqrt{2}}$

2. What is the minimum value of F needed so that block begins to move upward on frictionless inclined plane as shown?



(1) $mg \tan\left(\frac{\theta}{2}\right)$ (2) $mg \cot\left(\frac{\theta}{2}\right)$

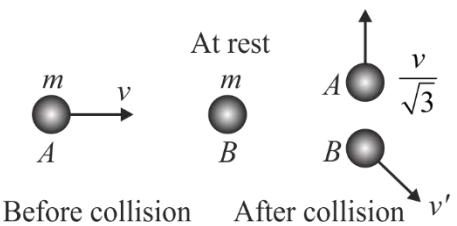
(3) $\frac{mg\sin\theta}{1+\sin\theta}$ (4) $mg \sin\left(\frac{\theta}{2}\right)$

3. The speed v reached by a car of mass m in travelling a distance x driven with constant power P, is given by:

(1) $v=\frac{3xP}{m}$ (2) $v=\left(\frac{3xP}{m}\right)^{1/2}$

(3) $v=\left(\frac{3xP}{m}\right)^{1/3}$ (4) $v=\left(\frac{3xP}{m}\right)^{2}$

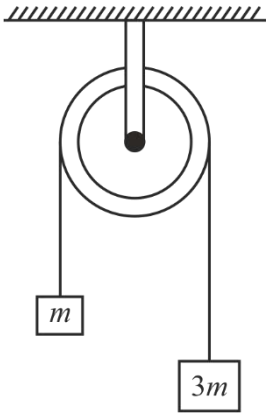
4. A mass m moves with a velocity v and collides inelastically with another identical mass. After collision, the first mass moves with velocity $v/\sqrt{3}$ in a direction perpendicular to the initial direction of motion. Find the speed of the second mass after collision.



(1) $\frac{v}{\sqrt{3}}$ (2) $2\frac{v}{\sqrt{3}}$

(3) $\sqrt{3}\,v$ (4) v

5. If the system is released, then the acceleration of the centre of mass of the system is:



(1) g/4 (2) g/2

(3) g (4) 2g

6. A wire of mass m and length l is bent in the form of a quarter circle. The moment of inertia of this wire about an axis passing through the centre of the quarter circle and perpendicular to the plane of the quarter circle is approximately:

(1) $0.6\,ml^2$ (2) ml^2

(3) $0.2\,ml^2$ (4) $0.4\,ml^2$

7. Two particles of equal mass move in a circle of radius r under the action of their mutual gravitational attraction. If the mass of each particle is M, the speed of each particle is:

(1) $\sqrt{\frac{GM}{r}}$ (2) $\sqrt{\frac{GM}{2r}}$

(3) $\sqrt{\frac{GM}{4r}}$ (4) $\sqrt{\frac{2GM}{r}}$

8. A steel wire is suspended vertically from a rigid support when loaded with a weight in air, it extends by l_a and when the weight is immersed completely in water, the extension is reduced to l_w. Then the relative density of the material of the weight is:

(1) $\frac{l_a}{l_w}$ (2) $\frac{l_a}{l_a-l_w}$

(3) $\frac{l_w}{l_a-l_w}$ (4) $\frac{l_w}{l_a}$

9. If the work done in blowing a soap bubble of volume V is W, then the work done in blowing a soap bubble of volume 2 V will be:

(1) W (2) 2W

(3) $\sqrt{2}$W (4) W$(4)^{1/3}$

10. A cylinder containing water stands on a table of height H. A small hole is punched in the side of cylinder at its base. The stream of water strikes the ground at a horizontal distance R from the table. Then, the depth of water in the cylinder is:

(1) H

(2) R

(3) $\sqrt{(RH)}$

(4) $R^2/4H$

11. A wide vessel with a small hole in the bottom is filled with water and kerosene. Neglecting viscosity, the velocity of water flow v if the thickness of water layer is h_1 and that of kerosene layer is h_2 is (density of water is ρ_1 g/cc and that of kerosene is ρ_2 gm/cc) is

(1) $v = \sqrt{2g(h_1 + h_2)}$

(2) $v = \sqrt{2g\left(h_1 + h_2\frac{\rho_2}{\rho_1}\right)}$

(3) $v = \sqrt{2g(h_1\rho_1 + h_2\rho_2)}$

(4) $v = \sqrt{2g\left(h_1\frac{\rho_1}{\rho_2} + h_2\right)}$

12. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2 R made of a material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is:

(1) $K_1 + K_2$

(2) $\frac{K_1 + 3K_2}{4}$

(3) $\frac{K_1K_2}{K_1 + K_2}$

(4) $\frac{3K_1 + K_2}{4}$

13. Internal energy of n_1 moles of hydrogen at temperature T is equal to the internal energy of n_2 mole of helium at temperature 2 T. Then the ratio n_1/n_2 is:

(1) 3/5

(2) 2/3

(3) 6/5

(4) 3/7

14. During an experiment an ideal gas is found to obey an additional law VP^2 = constant. The gas is initially at temperature T and volume V, when is expands to volume 2V, the resulting temperature is:

(1) $T/2$ (2) $2T$

(3) $\sqrt{2}T$ (4) $T/\sqrt{2}$

15. The total energy of simple harmonic motion is E. What will be the kinetic energy of the particle when displacement is half of the amplitude?

(1) 3E/4 (2) E/2

(3) E/4 (4) E/3

16. Two sinusoidal plane waves of the same frequency having intensities I_0 and 4 I_0 are travelling in the same direction. The resultant intensity at a point at which waves meet with a phase difference of zero radian is:

(1) I_0 (2) 5 I_0

(3) 9 I_0 (4) 3 I_0

17. A loaded string of length one metre and weighing 0.5 gm is hanging from a tuning fork of frequency 200 Hz and is vibrating in four loops. For the transverse arrangement, the tension is: (in dyne)

(1) 1.20×10^5

(2) 2.5×10^5

(3) 5×10^5

(4) 10×10^5

18. If during an adiabatic process the pressure of mixture of gases is found to be proportional to square of its absolute temperature. The ratio of C_p/C_v for mixture of gases is

(1) 2 (2) 1.5

(3) 1.67 (4) 2.1

19. On putting a capillary tube in a pot filled with water, the level of water rises upto a height of 4 cm in the tube. If a tube of half the diameter is used instead, the water will rise to a height of nearly

(1) 2 cm (2) 4 cm

(3) 8 cm (4) 11 cm

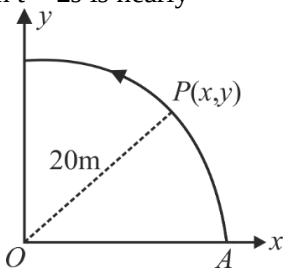
20. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at

(1) t = 2 s (2) t = 1 s

(3) t = 0.2 s (4) t = 0.25 s

***Integer Type Questions* (21 to 30):**

21. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length s = $t^3 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of 'P' (in m/s^2) when t = 2s is nearly



22. A circular platform is mounted on a vertical frictionless axle. Its radius is r = 2 m and its moment of inertia is I = 200 kg-m^2. It is initially at rest. A 70 kg man stands on the edge of the platform and begins to walk along the edge at speed v_0 = 10 m/s relative to the ground. The angular velocity (in rad/sec) of the platform is:

23. When a force is applied on a wire of uniform cross-sectional area, 3×10^{-6} m^2 and length 4 m, the increase in length is 1 mm. Energy stored (in Joule) in it will be ($Y = 2 \times 10^{11}$ N/m^2)

24. The gas in a vessel is subjected to a pressure of 20 atmosphere at a temperature 27°C. The pressure of the gas in the vessel after one half of the gas is released from the vessel and the temperature of the remainder is raised by 50°C is:

25. 200 g of ice at –20°C is mixed with 500 g of water at 20°C in an insulating vessel. Final mass of water (in g) in vessel is (specific heat of ice = 0.5 cal g^{-1} $°C^{-1}$)

26. In a medium in which a transverse progressive wave is travelling, the phase difference between two points with a separation of 1.25 cm is (π/4). If the frequency of wave is 1000 Hz, its velocity will be (in m/s):

27. When a guitar is sounded with a 440 Hz tuning fork, a beat frequency of 5 Hz is heard. If the experiment is repeated with a tuning fork of 437 Hz, the beat frequency is 8 Hz. The string frequency (in Hz) is:

28. 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 (in m):

29. Two factories are sounding their sirens at 800 Hz. A man goes from one factory to the other at a speed of 2 m/s. The velocity of the sound is 320 m/s. The number of beats (in "Hz") heard by the person will be:

30. A black body at 227°C radiates heat at the rate of 7 cal/cm^2s. At a temperature of 727°C, the rate of heat radiated in the same units will be

Section-II (CHEMISTRY)

***Single Correct Type Question* (31 *to* 50)**

31. Which has the maximum number of molecules among the following?
(1) 44 g of CO_2
(2) 48g O_2
(3) 8g H_2
(4) 64g SO_2

32. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius]

(1) $\frac{h^2}{4\pi^2 m a_0^2}$ (2) $\frac{h^2}{16\pi^2 m a_0^2}$

(3) $\frac{h^2}{32\pi^2 m a_0^2}$ (4) $\frac{h^2}{64\pi^2 m a_0^2}$

33. Screening effect is not observed in
(1) He^+
(2) Li^{2+}
(3) Be^{3+}
(4) in all the three

34. The correct sequence of decrease in the bond angles of the following hydrides is
(1) $NH_3 > PH_3 > AsH_3 > SbH_3$
(2) $NH_3 > AsH_3 > PH_3 > SbH_3$
(3) $SbH_3 > AsH_3 > PH_3 > NH_3$
(4) $PH_3 > NH_3 > AsH_3 > SbH_3$

35. The bond angle and % of d-Character in SF_6 are
(1) 120°, 20%
(2) 90°, 33%
(3) 109°, 25%
(4) 90°, 25%

36. For one mole of an ideal gas, increasing the temperature from 10°C to 20°C.
(1) increases the average kinetic energy by two times
(2) increases the rms by $\sqrt{2}$ times
(3) increases the rms by 2 times
(4) increases both the average kinetic energy and rms velocity but not significantly

37. The state of a gas can be described by quoting the relationship between …….. .

(1) pressure, volume, temperature
(2) temperature, amount, pressure
(3) amount, volume, temperature
(4) pressure, volume, temperature, amount

38. In view of the signs of $\Delta_r G°$ for the following reactions:

$$PbO_2 + Pb \rightarrow 2PbO,\ \Delta_r G^o < 0$$

$$SnO_2 + Sn \rightarrow 2SnO,\ \Delta_r G^o > 0$$

Which oxidation states are more characteristic for lead and tin?

(1) For lead + 4, for tin + 2
(2) For lead + 2, for tin + 2
(3) For lead + 4, for tin + 4
(4) For lead + 2, for tin + 4

39. If concentration of OH^- ions in the reaction

$$Fe(OH)_3(s) \rightleftharpoons Fe^{3+}(aq) + 3OH^-(aq)$$

is decreased by ¼ times, then equilibrium concentration of Fe^{3+} will increase by

(1) 8 times (2) 16 times
(3) 64 times (4) 4 times

40. The pH of a 10^{-8}M solution of HCl in water is

(1) 8
(2) – 8
(3) between 7 and 8
(4) between 6 and 7

41. In the standardization of $Na_2S_2O_3$ using $K_2Cr_2O_7$ by iodometry, the equivalent weight of $K_2Cr_2O_7$ is

(1) (molecular weight)/2
(2) (molecular weight)/6
(3) (molecular weight)/3
(4) same as molecular weight

42. The reagent commonly used to determine hardness of water titrimetrically is

(1) Oxalic acid
(2) Disodium salt of EDTA
(3) Sodium citrate
(4) Sodium thiosulphate

43. Be and Al exhibit diagonal relationship, which of the following statements about them is/are not true?

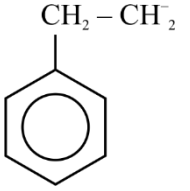
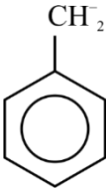
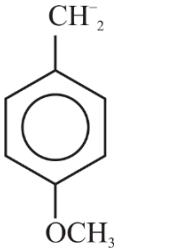
(i) Both react with HCl to liberate H_2.
(ii) They are made passive by HNO_3.
(iii) Their carbides give acetylene on treatment with water.
(iv) Their oxides are amphoteric.

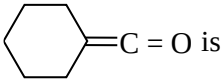
(1) iii and iv (2) i and iii
(3) i only (4) iii only

44. In which of the following silicates, cyclic structure is present?

(1) mica (2) asbestos
(3) emerald (4) talc

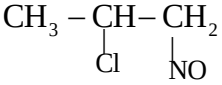
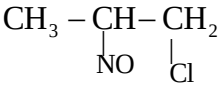
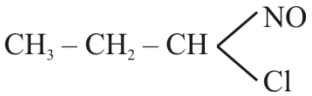
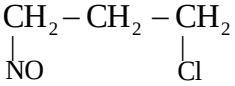
45. The most stable carbanion among the following is

(1) 
(2) 
(3) 
(4) 

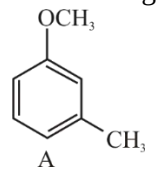
46. The IUPAC name of  is

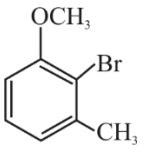
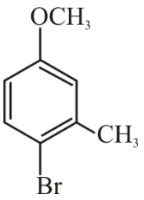
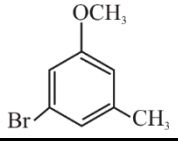
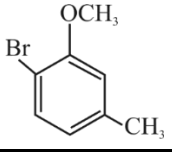
(1) Cyclohexanone
(2) Cyclohexylmethanone
(3) Oxycyclohexene
(4) Cyclohexylidenemethanone.

47. $CH_3 - CH = CH_2 + NOCl \rightarrow P.$ Identify the adduct P

(1) 
(2) 
(3) 
(4) 

48. The major product obtained on monobromination ($Br_2/FeBr_3$) of the following compound A is


A

(1) 
(2) 
(3) 
(4) 

49. Green chemistry means such reactions which
(1) produce colour during reactions
(2) reduce the use and production of hazardous chemicals
(3) are related to the depletion of ozone layer
(4) Study the reactions in plants

50. The solubility product of AgCl is 4.0×10^{-10} at 298 K. The solubility of AgCl in 0.04 m $CaCl_2$ will be
(1) 2.0×10^{-5} m
(2) 1.0×10^{-4} m
(3) 5.0×10^{-9} m
(4) 2.2×10^{-4} m

51. The number of weak electrolytes among the following is
CH_3COONa, H_2CO_3, HCOOH, $C_2H_5NH_2$, Na_2CO_3, $Ca(OH)_2$, CH_3COONH_4, HNO_2, HI and HF.

52. Equilibrium for the reaction $A_3(g) + 3B_2(g) \rightleftharpoons 3AB_2(g)$ is 64.0. Then the equilibrium constant for the reaction $\frac{1}{3}A_3(g) + B_2(g) \rightleftharpoons AB_2(g)$ will be:

53. The enthalpy of neutralization of 0.4 M H_2SO_4 will be how many times the enthalpy of neutralization of 0.1 M HCl?

54. If pressure of a gas is quadrupled and the temperature in degrees kelvin is doubled. The density of the gas will become …….. times

55. Based on VSEPR theory, the number of 90 degree F–B–F angles in BrF_5 is

56. On the Pauling scale, the electronegativity of fluorine is

57. Total number of nodes (planar and spherical) present in the 5*f*-orbital is

58. Silver (atomic weight = 108 g mol^{-1}) has a density of 10.5 g cm^{-3}. The number of silver atoms on a surface of area 10^{-12} m^2 can be expressed in scientific notation as $y \times 10^x$. The value of x is

59. The difference in the oxidation numbers of the two types of sulphur atoms in $Na_2S_4O_6$ is

60. Number of electron rich hydrides among the following are
CH_4, NH_3, PH_3, H_2O, H_2S, BH_3, HF, AlH_3, AsH_3.

Section-III (MATHEMATICS)

***Single Correct Type Question* (61 *to* 80)**

61. The angle of elevation of the top of a vertical tower from a point *P* on the horizontal ground was observed to be α. After moving a distance 2 metres from *P* towards the foot of the tower, the angle of elevation changes to β. Then the height (in metres) of the tower is:
(1) $\frac{2\sin\alpha\sin\beta}{\sin(\beta-\alpha)}$ (2) $\frac{\sin\alpha\sin\beta}{\cos(\beta-\alpha)}$
(3) $\frac{2\sin(\beta-\alpha)}{\sin\alpha\sin\beta}$ (4) $\frac{\cos(\beta-\alpha)}{\sin\alpha\sin\beta}$

62. If $\sec\theta + \tan\theta = 1$, then root of the equation $(a - 2b + c)x^2 + (b - 2c + a)x + (c - 2a + b) = 0$ is -
(1) $\sec\theta$ (2) $\tan\theta$
(3) $\sin\theta$ (4) $\cot\theta$

63. If the 7^{th} term in the binomial expansion of $\left(\frac{3}{\sqrt[3]{84}} + \sqrt{3}\ell n\, x\right)^9$, $x > 0$, is equal to 729, then *x* can be
(1) e^2 (2) e
(3) $\frac{e}{2}$ (4) $2e$

64. If $\frac{\tan\alpha - i\left(\sin\frac{\alpha}{2} + \cos\frac{\alpha}{2}\right)}{1 + 2i\sin\frac{\alpha}{2}}$ is purely, imaginary, then α is given by
(1) $n\pi + \frac{\pi}{4}$ (2) $n\pi - \frac{\pi}{4}$
(3) $(2n+1)\pi$ (4) $2n\pi + \frac{\pi}{4}$

65. The number of ways in which an examiner can assign 30 marks to 8 questions, giving not less than 2 marks to any question, is :
(1) ${}^{30}C_7$ (2) ${}^{21}C_8$
(3) ${}^{21}C_7$ (4) ${}^{30}C_8$

66. The line $ax + by + c = 0$ is normal to the circle $x^2 + y^2 + 2gx + 2fy + d = 0$ if
(1) $ag + bf + c = 0$ (2) $ag + bf - c = 0$
(3) $ag - bf + c = 0$ (4) $ag - bf - c = 0$

67. A diagonal of the rectangle formed by the lines $x^2 - 7x + 6 = 0$ and $y^2 - 14y + 40 = 0$ is
(1) $5x + 6y = 0$
(2) $5x - 6y = 0$
(3) $6x - 5y + 14 = 0$
(4) $6x - 5y - 14 = 0$

68. The range of values of m for which the $y = mx + 2$ cuts the circle $x^2 + y^2 = 1$ at distinct or coincident points, is

(1) $(-\infty, -\sqrt{3}] \cup [\sqrt{3}, \infty)$

(2) $[-\sqrt{3}, \sqrt{3}]$

(3) $[-\sqrt{3}, \infty)$

(4) $[-\sqrt{3}, 0]$

69. The value of
$({}^7C_0 + {}^7C_1) + ({}^7C_1 + {}^7C_2) + ... + ({}^7C_6 + {}^7C_7)$ is

(1) $2^8 - 2$ (2) $2^8 - 1$

(3) $2^8 + 1$ (4) 2^8

70. If a^2, b^2, c^2 are in A.P., then $b + c$, $c + a$, $a + b$ are in

(1) A.P. (2) G.P.

(3) H.P. (4) A.G.P.

71. If (a, a^2) falls inside the angle made by the lines $y = (x/2)$, $x > 0$ and $y = 3x$, $x > 0$, then a belongs to

(1) $\left(0, \frac{1}{2}\right)$ (2) $(3, \infty)$

(3) $\left(\frac{1}{2}, 3\right)$ (4) $\left(-3, -\frac{1}{2}\right)$

72. The statement $p \rightarrow (q \rightarrow p)$ is equivalent to

(1) $p \rightarrow (p \rightarrow q)$ (2) $p \rightarrow (p \vee q)$

(3) $p \rightarrow (p \wedge q)$ (4) $p \rightarrow (p \leftrightarrow q)$

73. If the mean deviation of numbers, 1, $1 + d$, $1 + 2d$, …, $1 + 100d$ from their mean is 255, then d is equal to

(1) 10.0 (2) 20.0

(3) 10.1 (4) 20.2

74. If the equation $a_1 + a_2 \cos 2x + a_3 \sin^2 x = 1$ is satisfied by every real value of x, then the number of possible values of the triplet (a_1, a_2, a_3) is

(1) 0 (2) 1

(3) 3 (4) infinite

75. In a A.P., $a_7 = 9$ if $a_1 a_2 a_7$ is least, the common difference is

(1) $\frac{13}{20}$ (2) $\frac{23}{20}$

(3) $\frac{33}{20}$ (4) $\frac{43}{20}$

76. If $\sin x + \text{cosec } x + \tan y + \cot y = 4$, where x and $y \in \left[0, \frac{\pi}{2}\right]$, then $\tan\frac{y}{2}$ is a root of the equation

(1) $\alpha^2 + 2\alpha + 1 = 0$

(2) $\alpha^2 + 2\alpha - 1 = 0$

(3) $2\alpha^2 - 2\alpha - 1 = 0$

(4) $\alpha^2 - 2\alpha - 1 = 0$

77. $\lim\limits_{x \to 1} \frac{(2x-3)(\sqrt{x}-1)}{2x^2 + x - 3} =$

(1) $-\frac{1}{10}$ (2) $\frac{1}{10}$

(3) $-\frac{1}{8}$ (4) $\frac{1}{8}$

78. The area of a triangle (in sq. unit) formed by the lines $x - y = 0$, $x + y = 0$ and any tangent to the hyperbola $x^2 - y^2 = a^2$ is -

(1) a^2 (2) $2a^2$

(3) $3a^2$ (4) $4a^2$

79. Let α, β be the roots of $x^2 + bx + 1 = 0$. Then the equation whose roots are $-\left(\alpha + \frac{1}{\beta}\right)$ and $-\left(\beta + \frac{1}{\alpha}\right)$ is

(1) $x^2 = 0$

(2) $x^2 + 2bx + 4 = 0$

(3) $x^2 - 2bx + 4 = 0$

(4) $x^2 - bx + 1 = 0$

80. Let A and B be two sets containing 2 elements and 4 elements respectively. The number of subsets of $A \times B$ having 3 or more elements is

(1) 220 (2) 219

(3) 211 (4) 256

***Integer Type Question* (81 to 90)**

81. A relation on the set $A = \{x : |x| < 3, x \in Z\}$, where Z is the set of integers is defined by $R = \{(x, y) : y = |x|, x \neq -1\}$. Then the number of elements in the power set of R is

82. If the sum $\frac{3}{1^2} + \frac{5}{1^2 + 2^2} + \frac{7}{1^2 + 2^2 + 3^2}$ + ... + upto 20 terms is equal to $\frac{k}{7}$, then k is equal to

83. If x, y, z and w are positive integers such that $x + 2y + 3z + 4w = 50$, the maximum value of $\left(\frac{x^2 y^4 z^3 w}{16}\right)^{1/10}$ is

84. If the expression

$$\cos\left(x - \frac{3\pi}{2}\right) + \sin\left(\frac{3\pi}{2} + x\right) + \sin(32\pi + x) - 18\cos(19\pi - x) + \cos(56\pi + x) - 9\sin(x + 17\pi)$$

is expressed in the form of $a \sin x + b \cos x$, then $(a + b)$ is equal to

85. Two tangents are drawn from the point $(-2, -1)$ to the parabola $y^2 = 4x$. If α is the acute angle between these tangents, then find the value of $\tan\alpha$.

86. If the equations $x^2 + bx - 1 = 0$ and $x^2 + x + b = 0$ have a common root different from -1, then b^4 is equal to

87. The line $x = c$ cuts the triangle with vertices (0, 0), (1, 1) and (9, 1) into two regions.
For the areas of the two regions to be the same, c must be equal to .....

88. A circle $x^2 + y^2 + 4x - 2\sqrt{2}y + c = 0$ is the director circle of circle S_1 and S_1 is the director circle of circle S_2 and so on. If the sum of radii of all these circles is 2, then the value of $c = k\sqrt{2}$, where value of k is

89. If $(1 + ax)^n = 1 + 8x + 24x^2 + ...$, then find the value of $a + n$.

90. How many terms are free from radical sign in the expansion of $\left(x^{1/2} + y^{1/3}\right)^{100}$.