NTA
JEE-MAIN

15
Mock Tests

Physics | Chemistry | Mathematics

Includes

2 Solved Papers 2019

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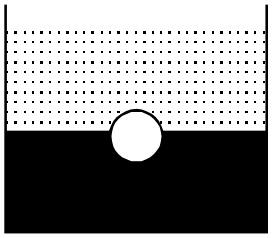
MOCK TEST – 1

PHYSICS (SECTION – A)

1. A solid uniform ball of volume V floats on the interface of two immiscible liquids (see the figure). The specific gravity of the upper liquid is ρ_1 and that of lower one is ρ_2 and the specific gravity of ball is $\rho(\rho_1 < \rho < \rho_2)$. The fraction of the volume of the ball in the upper liquid is



(a) $\frac{\rho_2}{\rho_1}$ (b) $\frac{\rho_2 - \rho}{\rho_2 - \rho_1}$

(c) $\frac{\rho - \rho_1}{\rho_2 - \rho_1}$ (d) $\frac{\rho_1}{\rho_2}$

2. A water drop is divided into 8 equal droplets. The pressure difference between inner and outer sides of the big drop

(a) will be the same as for smaller droplet

(b) will be half of that for smaller droplet

(c) will be one-fourth of that for smaller droplet

(d) will be twice of that for smaller droplet

3. A rod of length *l* and cross-sectional area A has a variable conductivity given by $x = \alpha T$, where α is a positive constant and T is temperatures in kelvin. Two ends of the rod are maintained at temperatures T_1 and $T_2(T_1 > T_2)$. Heat current flowing through the rod will be

(a) $\frac{A\alpha(T_1^2 - T_2^2)}{l}$ (b) $\frac{A\alpha(T_1^2 + T_2^2)}{l}$

(c) $\frac{A\alpha(T_1^2 + T_2^2)}{3l}$ (d) $\frac{A\alpha(T_1^2 - T_2^2)}{2l}$

4. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio C_p/C_v for the gas is

(a) $\frac{3}{2}$ (b) $\frac{4}{3}$

(c) 2 (d) $\frac{5}{3}$

5. A stretched rope having linear mass density 5×10^{-2} kg/m is under a tension of 80 N. The power that has to be supplied to the rope to generate harmonic waves at a frequency of 60 Hz and an amplitude of $\frac{2\sqrt{2}}{15\pi}$m is

(a) 215 W (b) 251 W

(c) 512 W (d) 521 W

6. A source of sound of frequency 256 Hz is moving rapidly towards a wall with a velocity of 5 m/s. If sound travels at a speed of 330 m/s, then number of beats per second heard by an observer between the wall and the source is

(a) 7.7 Hz (b) 9 Hz

(c) 4 Hz (d) none of these

7. Two strings A and B, made of same material, are stretched by same tension. The radius of string A is double of the radius of B. A transverse wave travels on A with speed v_A and on B with speed v_B. The ratio v_A/v_B is

(a) 1/2 (b) 2

(c) 1/4 (d) 4

8. In YDSE of equal width slits, if intensity at the center of screen is I_0, then intensity at a distance of $\beta/4$ from the central maxima is

(a) I_0 (b) $\frac{I_0}{2}$

(c) $\frac{I_0}{4}$ (d) $\frac{I_0}{3}$

9. When resonance is produced in a series L-C-R circuit, then which of the following is not correct?

(a) Inductive and capacitive reactance are equal

(b) If R is reduced, the voltage across capacitor will increase

(c) Current in the circuit is in phase with the applied voltage.

(d) Impedance of the circuit is maximum.

10. When the current changes from +2 A to –2 A in 0.05 s, an emf of 8 V is induced in the coil. The self-induction of the coil is_____

11. A letter A (in capital letters) is constructed of a uniform wire with resistance $1\,\Omega - cm^{-1}$. The sides of the letter are 20 cm each and the cross piece in the middle is 10 cm long. The apex angle is 60°, the resistance between the ends of the legs is approximately_____

12. A uniform electric field **E** exists between the plates of a charged condenser. A charged particle enters the space between the plates and perpendicular to **E**. The path of the particle between the plates is

(a) straight line (b) parabola

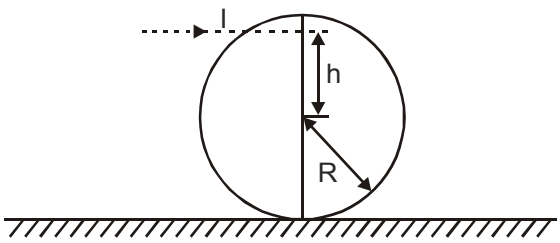
(c) circle (d) hyperbola

13. A smooth sphere is moving on a horizontal surface with velocity vector $2\hat{i}+2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ vector and the coefficient of restitution between the sphere and the wall is e = 1/2. The velocity vector of the sphere after it hits the wall is

(a) $\hat{i}-\hat{j}$ (b) $-\hat{i}+2\hat{j}$

(c) $-\hat{i}-\hat{j}$ (d) $2\hat{i}-\hat{j}$

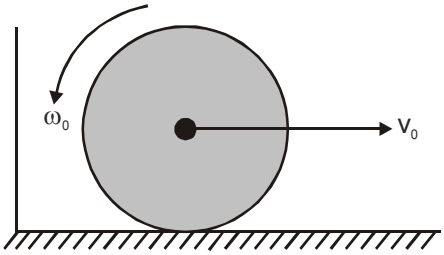
14. A solid sphere rests on a horizontal surface. A horizontal impulse is applied at height h from centre. The sphere starts rotating just after the application of impulse. The ratio h/r will be



(a) $\frac{1}{2}$ (b) $\frac{2}{5}$

(c) $\frac{1}{5}$ (d) $\frac{2}{3}$

15. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The disc comes to rest after moving some distance to the right. It follows that



(a) $3v_0 = 2\omega_0 r$ (b) $2v_0 = \omega_0 r$

(c) $v_0 = \omega_0 r$ (d) $2v_0 = 3\omega_0 r$

16. The radii of two plantes are respectively R_1 and R_2 and and their densities are respectively ρ_1 and ρ_2. The ratio of the acceleration due to gravity at their surfaces is

(a) $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$

(b) $g_1 : g_2 = R_1R_2 : \rho_1\rho_2$

(c) $g_1 : g_2 = R_1\rho_2 : R_2\rho_1$

(d) $g_1 : g_2 = R_1\rho_1 : R_2\rho_2$

17. A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of 0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncentainty of 0.01 mm. Take g = 9.8 m/s^2 (exact). The Young's modulus obtained from the reading is

(a) $(2.0 \pm 0.3)\times 10^{11}$ Nm^{-2}

(b) $(2.0 \pm 0.2)\times 10^{11}$ Nm^{-2}

(c) $(2.0 \pm 0.1)\times 10^{11}$ Nm^{-2}

(d) $(2.0 \pm 0.05)\times 10^{11}$ Nm^{-2}

18. A proton and an α-particle enters a uniform magnetic field perpendicularly with the same speed. If proton takes 25μ s to make 5 revolutions, then the periodic time for the α-particle would be _____

19. A magnetic needle is kept in a non-uniform magnetic field. It experiences

(a) a torque but not a force

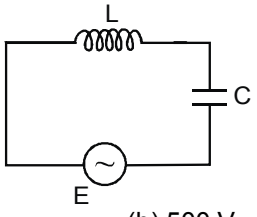
(b) neither a force nor a torque

(c) a force and a torque

(d) a force but not a torque

20. A coil of inductance 300 mH and resistance 2Ω is connected to a source of voltage 2 V. The current reaches half of its steady state value in _____

21. In the circuit shown here, the voltage across L and C are respectively 300 V and 400 V. The voltage E of the AC source is

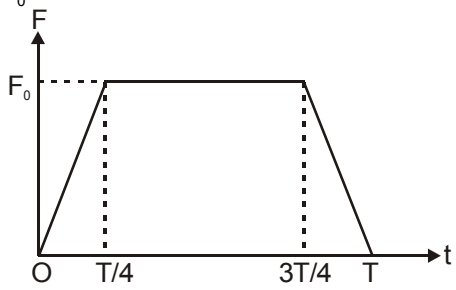


(a) 400 V (b) 500 V

(c) 100 V (d) 700 V

22. In a meter bridge experiment, null point is obtained at 40 cm from one end of the wire when resistance X is balanced against another resistance Y. If X < Y, then the new position of the null points from the same end, if one decides to balance a resistance of 3X against Y, will be close to _____

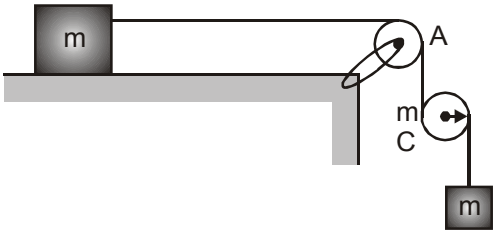
23. A particle of mass m moving with a velocity v makes a head-on elastic one dimensional collision with a stationary particle of mass m establishing a contact with it for extremely small time T. Their force of contact increases from zero to F_0 linearly in time T/4, remains constant for a further time T/2 and decreases linearly from F_0 to zero in further time T/4 as shown in figure. The magnitude possessed by F_0 is



(a) $\frac{mu}{T}$ (b) $\frac{2mu}{T}$

(c) $\frac{4mu}{3T}$ (d) $\frac{3mu}{4T}$

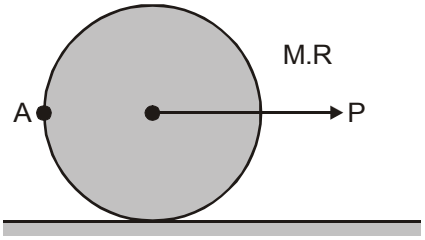
24. Angular acceleration of the cylinder C (mass m, radius R) shown in figure is (all strings and pulley are ideal):



(a) $\frac{2g}{3R}$ (b) $\frac{2g}{5R}$

(c) $\frac{2g}{R}$ (d) $\frac{g}{2R}$

25. A solid cylinder of mass M and radius R is being pulled along a horizontal surface on which it performs pure rolling, by a horizontal force P applied at its centre. For this situation, mark the correct statement(s).



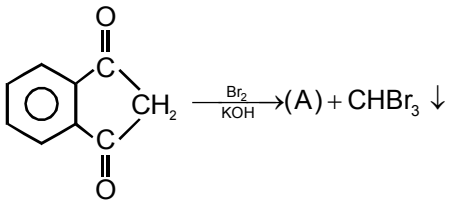
(a) The surface should be rough.

(b) After 3s of motion the velocity of point A is $\frac{2\sqrt{2}P}{M}$

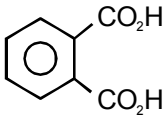
(c) Acceleration of the centre of mass is constant and is equal to $\frac{2P}{3M}$

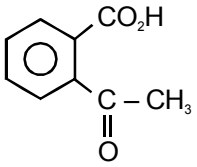
(d) All of the above

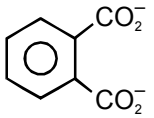
CHEMISTRY (SECTION – B)

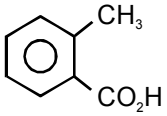
26. 

Product (A) of the reaction is:

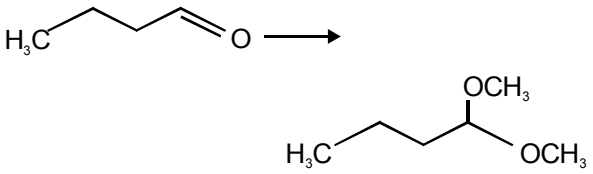
(a) 

(b) 

(c) 

(d) 

27. Give the best conditions for this transformation



(a) CH_3OH, H^+(cat), heat

(b) H_2O, H^+(cat.), heat

(c) Mg, ether, CH_3OH

(d) $SOCl_2$, CH_3OH

28. Which are not cleaved by HIO_4?

I : glycerol

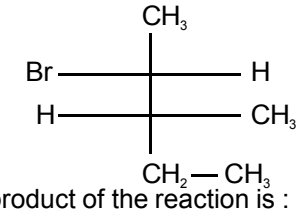
II : ethylene glycol

III : 1, 3-propanediol

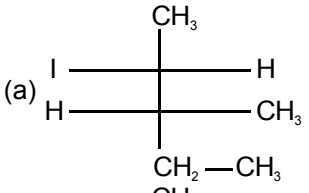
IV : 2-methoxy propanol

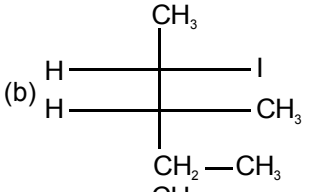
(a) 1, II, III, IV (b) I, II

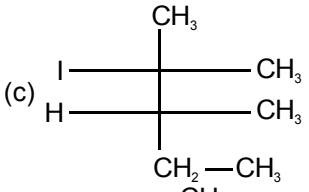
(c) II, III (d) III, IV

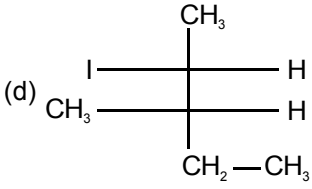
29.  + NaI → product; S_N2

product of the reaction is :

(a) 

(b) 

(c) 

(d) 

30. Number of moles of MnO_4^- needed to react with 7.5 moles of SO_3^{2-} in the acidic medium is _____

31. Correct order of basic strengths of given amines is:

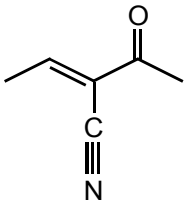
(a) $\underset{2°}{Me_2NH} > \underset{1°}{MeNH_2} > \underset{3°}{Me_3N} > NH_3$ (Protic solvent)

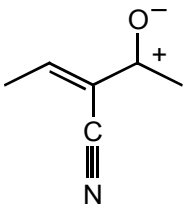
(b) $\underset{2°}{Et_2NH} > \underset{3°}{Et_3H} > \underset{1°}{EtNH_2} > NH_3$ (Protic solvent)

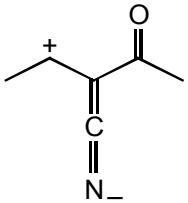
(c) $Me_3N > Me_2NH > Me - NH_2 > NH_3$ (Gas phase)

(d) All are correct.

32. Compare relative stability of following resonating structure.

(i) 

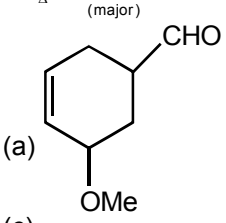
(ii) 

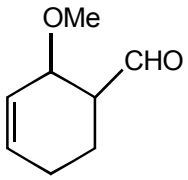
(iii) 

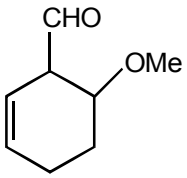
(a) (i) > (ii) > (iii) (b) (ii) > (i) > (iii)

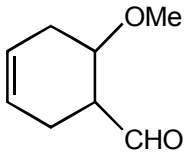
(c) (i) > (iii) > (ii) (d) (ii) > (iii) > (i)

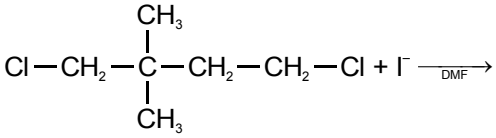
33. $H_2C = CH - CH = CH - OMe + H_2C = CH - CHO \xrightarrow[\Delta]{} \underset{\text{(major)}}{(A)}$

(a) 

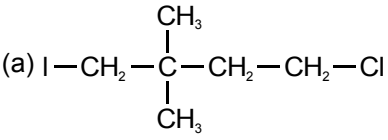
(b) 

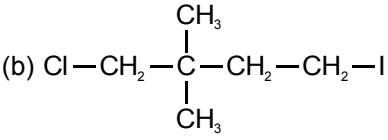
(c) 

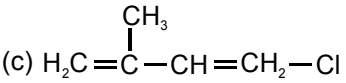
(d) 

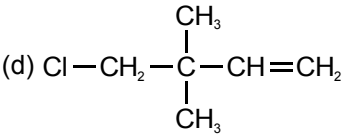
34. 

product; Major product of this reaction is :

(a) 

(b) 

(c) 

(d) 

35. The gas absorbs 100 J heat and is simultaneously compressed by a constant external pressure of 1.50 atm from 8 litres to 2 litre. Hence E will be_____

36. A 100 watt, 110 volt lamp is connected in series with an electrolytic cell containing cadmium sulphate solution. What mass of cadmium will be deposited by the current flowing for 10 hours? (Given, Atomic mass of Cd = 112.4)_____

37. Standard electrode potential (E°) for OCl^-/Cl^- and Cl^-/Cl_2 are respectively 0.94 V and –1.36 V. The E° value for OCl^-/Cl_2 will be

(a) – 0.42 V (b) –2.20 V

(c) 0.52 V (d) 1.04 V

38. In the reaction, $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ at t°C., the ratio of number of moles of SO_2, O_2 and SO_3 in the equilibrium mixture is 2 : 3 : 5. If the equilibrium pressure be 3 atms., then K_p is _____

39. For the reaction : $2A(g) + B(g) \rightleftharpoons 3C(g) + D(g)$ two mole each of A and B were taken into a flask. The following must always be true when the system attained equilibrium:

(a) [A] = [B] (b) [A] < [B]

(c) [B] = [C] (d) [A] > [B]

40. The degree of dissociation of PCl_5 at one atmosphere is 0.3. The pressure at which PCl_5 is dissociated to 50% is

(a) 2.73 atm (b) 0.3 atm

(c) 0.05 atm (d) 1.67 atm

41. 2 moles of a perfect gas at 27°C is compressed reversibly and isothermally from a pressure of $1.01 \times 10^5 Nm^{-2}$ to $5.05 \times 10^6 Nm^{-2}$. Maximum work done on the gas in this process is [log 5 = 0.6990]

(a) -1.95×10^4 Joule (b) $+1.95 \times 10^4$ Joule

(c) -1.95×10^3 Joule (d) $+1.95 \times 10^3$ Joule

42. $\Delta S°$ will be the highest for the reaction

(a) $Ca(s) + \frac{1}{2}O_2(g) \longrightarrow CaO(s)$

(b) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

(c) $C(s) + O_2(g) \longrightarrow CO_2(g)$

(d) $N_2(g) + O_2(g) \longrightarrow 2NO(g)$

43. The work function of a metal is 4.2 eV. If the radiation of 2000 Å falls on the metal, then kinetic energy of the fastest photoelectron is

(a) 1.66×10^{-19} J (b) 3.22×10^{-19} J

(c) 1.66×10^{-20} J (d) 3.22×10^{-18} J

44. Among NO_3^-, AsO_3^{3-}, CO_3^{2-}, ClO_3^-, SO_3^{2-}, and BO_3^{3-} ions, the non-planar species are

(a) AsO_3^{3-}, SO_3^{2-} and ClO_3^-

(b) NO_3^-, SO_3^{2-} and ClO_3^-

(c) CO_3^{2-}, AsO_3^{3-} and SO_3^{2-}

(d) NO_3^-, CO_3^{2-} and ClO_3^-

45. $MeMgBr + D_2O \longrightarrow$?

Which of the following is product of the above reaction?

(a) CH_3OD (b) CH_3D

(c) CH_2D_2 (d) CH_4

46. When $Cr_2O_7^{2-}$ is heated with Cl^- and conc. H_2SO_4 deep red vapours of chromyl chloride are formed deep red vapours have formula:

(a) $CrOCl_2$ (b) $(CrO)_2Cl_2$

(c) CrO_2Cl_2 (d) CrO_3Cl

47. The true statement for the acids of phosphorus H_3PO_2, H_3PO_3 and H_3PO_4 is

(a) Their acidic nature $H_3PO_4 < H_3PO_3 < H_3PO_2$

(b) All of them are tribasic acids

(c) The geometry of phosphorus is tetrahedral in all the three acids

(d) None of these

48. When light of frequency 3.2×10^{16} Hz is used to irradiate a metal surface, the maximum kinetic energy of the emitted photoelectron is $\frac{3}{4}$ of the energy of irradiating photon, then the threshold frequency of the metal would be

(a) 2.4×10^{25} Hz (b) 2.4×10^{16} Hz

(c) 1.6×10^{15} Hz (d) 8×10^{15} Hz

48. At pH = $pK_{In} + 1$ (where K_{In} = dissociation constant for indicator) the ratio of $[In^-]/[HIn]$ in the solution is $\left(\frac{10}{1}\right)$ for this pH the % dissociation of the indicator is _____

50. For a mixture of two volatile component A and B, vapour pressure of solution (in mm Hg) is $P_S = 210 - 120\,X_A$ where X_A = mole fraction of A in liquid mixture. Hence, P_A° and P_B° (in mm Hg) should be

(a) 210, 120 (b) 90, 210

(c) 110, 210 (d) 120, 210

MATHEMATICS (SECTION – C)

51. Let $f(x) = 3x^2 - 7x + a$, $x > \frac{7}{6}$, the value of a such that f(x) touches its inverse $f^{-1}(x)$ is

(a) 3 (b) – 3

(c) $\frac{16}{3}$ (d) $\frac{49}{12}$

52. If $2f(xy) = (f(x))^y + (f(y))^x$ for all $x, y \in R$ and f(1) = 3, then the value of $\sum_{r=1}^{10} f(r)$

(a) $\frac{3}{2}(3^{10} - 1)$ (b) $\frac{3}{2}(3^9 - 1)$

(c) $\frac{3^{10} - 1}{2}$ (d) None of these

53. The fundamental period of the function f(x) = [x] + $\left[x+\frac{1}{3}\right]+\left[x+\frac{2}{3}\right]-3x+\sin 3\pi x-1$ is:

(a) $\frac{1}{3}$ (b) $\frac{2}{3}$

(c) $\frac{4}{3}$ (d) None of these

54. If $\lim_{x\to 1}\left(\frac{x^n-1}{n(x-1)}\right)^{\frac{1}{x-1}}=e^p$, then p is equal to

(a) $\frac{n-1}{2}$ (b) $\frac{n+1}{2}$

(c) $\frac{n+3}{2}$ (d) $\frac{n-3}{2}$

55. $\lim_{x\to\infty}\left(\frac{\pi}{2}-\tan^{-1}x\right)^{1/x}$ is equal to

(a) 0 (b) 1

(c) – 1 (d) 2

56. Number of solutions to x + y + z = 10 where $1 \le x, y, z \le 6$ & $x, y, z \in N$ _____

57. If f(x) is a continuous function and attains only rational values, also f(0) = 3,
then roots of equation $f(1)x^2 + f(3)x + f(5) = 0$ are

(a) imaginary (b) rational

(c) irrational (d) real and equal

58. Let $\theta_1, \theta_2, \theta_3, \ldots$ be a sequence with $\theta_1 = \frac{\pi}{3}$ and $\sec\theta_n = \sec\theta_{n-1} + 2\cos\theta_{n-1}$, $n \ge 2$. Then $4 < |\sec\theta_n| < 6$, if value of n is

(a) 13, 14 (b) 4, 5

(c) 15, 16 (d) 26, 27

59. The value of the expression
$\sin^{-1}\left(\sin\frac{22\pi}{7}\right)+\cos^{-1}\left(\cos\frac{5\pi}{3}\right)+\tan^{-1}\left(\tan\frac{5\pi}{7}\right)+$ $\sin^{-1}(\cos 2)$ is

(a) $\frac{17\pi}{42}-2$ (b) – 2

(c) $\frac{-\pi}{21}-2$ (d) none of these

60. If $f(x)=\begin{cases}[x]+\sqrt{\{x\}} & x<1\\ \frac{1}{[x]+\{x\}^2} & x\ge 1\end{cases}$; then {where [.] and { . } represents greatest integer part and fractional part respectively.]

(a) f(x) is continuous at x = 1 but not differentiable

(b) f(x) is not continuous at x = 1

(c) f(x) is differentiable at x = 1

(d) $\lim_{x\to 1^+}$ f(x) does not exist

61. $\int\frac{1}{\sin^4 x+\cos^4 x}dx =$

(a) $\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{\tan^2 x-1}{\tan x}\right)+c$

(b) $\tan^{-1}\left(\frac{\tan^2 x-1}{\sqrt{2}\tan x}\right)+c$

(c) $\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{\tan^2 x-1}{2\tan x}\right)+c$

(d) $\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{\tan^2 x-1}{\sqrt{2}\tan x}\right)+c$

62. If A = {a, b, c, d} and B = {1, 2, 3}, then the number of on-to function possible from A to B satisfying $f(a) = 1$ is _____

63. The value of 'a' if the line 3x + 4y + a = 0 is a tangent to the circle $x^2 + y^2 – 4x + 6y + 9 = 0$ is

(a) 4 (b) –16

(c) 16 (d) $\frac{5}{2}$

64. If eccentricity of a given hyperbola is $\frac{3}{2}$, then then eccentricity of its conjugate hyperbola is

(a) $\frac{4}{3}$ (b) $\sqrt{3}$

(c) $\frac{3}{\sqrt{5}}$ (d) $\sqrt{2}$

65. If the equation of a given hyperbola is xy – 3x + 4y – 6 = 0, then the equation of its conjugate hyperbola is

(a) xy – 3x + 4y – 18 = 0

(b) xy – 3x + 4y = 0

(c) xy – 3x + 4y + 6 = 0

(d) xy – 3y + 4y – 12 = 0

66. The system of equation |x – 1| + 3y = 4, x – |y – 1| = 2 has

(a) no solution

(b) a unique solution

(c) two solution

(d) more than two solutions

67. The 1025^{th} term in the sequence 1, 22, 4444, 88888888, ... is

(a) 2^9 (b) 2^{10}

(c) 2^{11} (d) 2^{12}

68. If $a_1, a_2, ..., a_n$ are positive real numbers whose product is a fixed number c, then the minimum value of $a_1 + a_2 + ... + a_{n-1} + 2a_n$ is

(a) $n(2c)^{1/n}$

(b) $(n + 1)c^{1/n}$

(c) $2nc^{1/n}$

(d) $(n + 1)(2c)^{1/n}$

69. The remainder obtained, when 1! + 2! + 3! + ... + 175! is divided by 15 is _____

70. Let A = $\{x_1, x_2, x_3, x_4, x_5, x_6\}$, B = $\{y_1, y_2, y_3, y_4, y_5, y_6\}$. Then the number of one-one mappings from A to B such that $f(x_i) \neq y_i$, i = 1, 2, 3, 4, 5, 6 is_____

71. Sum to infinite terms of the series

$$\cot^{-1}\left(1^2+\frac{3}{4}\right)+\cot^{-1}\left(2^2+\frac{3}{4}\right)+\cot^{-1}\left(3^2+\frac{3}{4}\right)+....$$

is

(a) $\frac{\pi}{4}$ (b) $\tan^{-1}2$

(c) $\tan^{-1}3$ (d) $\cot^{-1}3$

72. Equation of angle bisector of the lines $3x-4y+1=0$ and $12x+5y-3=0$ containing the point (1, 2) is

(a) $3x+11y-4=0$ (b) $99x-27y-2=0$

(c) $3x+11y+4=0$ (d) $99x+27y-2=0$

73. If a tangent of slope 2 of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is normal to the circle $x^2+y^2+4x+1=0$ then the maximum value of ab is _____

74. The sequence a_1, a_2, a_3 , ... satisfies a_1 = 19, a_9 = 99, and for all $n \geq 3$, a_n is the arithmetic mean of the first $n-1$ terms. Then a_2 is equal to

(a) 179 (b) 99

(c) 79 (d) 59

75. If $p \Rightarrow (\sim p \vee q)$ is false, the truth values of p & q are respectively:

(a) F, T (b) F, F

(c) T, T (d) T, F

ANSWERS

1. (b)	**2.** (b)	**3.** (d)	**4.** (a)	**5.** (c)	**6.** (d)	**7.** (a)	**8.** (b)	**9.** (d)	**10.** (0.1H)
11. (26.7Ω)	**12.** (b)	**13.** (b)	**14.** (b)	**15.** (b)	**16.** (d)	**17.** (b)	**18.** (10μs)	**19.** (c)	**20.** (0.1 s)
21. (c)	**22.** (67 cm)	**23.** (c)	**24.** (b)	**25.** (d)	**26.** (c)	**27.** (a)	**28.** (d)	**29.** (b)	**30.** (3)
31. (d)	**32.** (a)	**33.** (d)	**34.** (b)	**35.** (1011J)	**36.** (19g)	**37.** (c)	**38.** (6.94)	**39.** (b)	**40.** (b)
41. (b)	**42.** (b)	**43.** (b)	**44.** (a)	**45.** (b)	**46.** (c)	**47.** (c)	**48.** (d)	**49.** (91)	**50.** (b)
51. (c)	**52.** (a)	**53.** (b)	**54.** (a)	**55.** (b)	**56.** (27)	**57.** (a)	**58.** (b)	**59.** (a)	**60.** (c)
61. (d)	**62.** (12)	**63.** (c)	**64.** (c)	**65.** (a)	**66.** (c)	**67.** (b)	**68.** (a)	**69.** (3)	**70.** (265)
71. (b)	**72.** (b)	**73.** (4)	**74.** (a)	**75.** (T, F)					

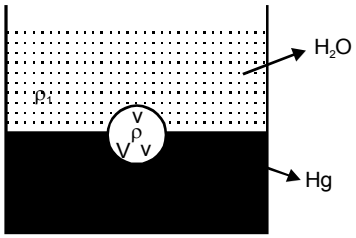
EXPLANATIONS

1. Let V be the total volume of the ball and v be the volume of ball in upper liquid. Then V – v is the volume of lower liquid displaced.

Using law of floatation, we have

$V\rho g = v\rho_1 g + (V - v)\rho_2 g$

$V\rho = v\rho_1 + v\rho_2 - v\rho_2$



or $V(\rho - \rho_2) = v(\rho_1 - \rho_2)$

$\frac{v}{V} = \frac{\rho - \rho_2}{\rho_1 - \rho_2} = \frac{\rho_2 - \rho}{\rho_2 - \rho_1}$

2. Suppose, R = radius of water drop

andr = radius of droplets

$\therefore \quad \frac{4}{3}\pi R^3 = 8 \times \frac{4}{3}\pi r^3$

(Since, volume remains constant)

$\therefore \quad r = \frac{R}{2}$

Since, excess pressure inside drop $= \frac{2T}{R}$

(T-Surface tension, R-radius)

$\therefore$ Pressure difference between inner and outer surface of big drop will be half of that for smaller droplet.

3. Heat current:

$i = -kA\frac{dT}{dx}, \quad idx = -kAdT$

$i\int_0^l dx = -A\alpha\int_{T_1}^{T_2} TdT$

$il = -A\alpha\frac{(T_2^2 - T_1^2)}{2}$

$i = \frac{A\alpha(T_1^2 - T_2^2)}{2l}$

4. Given $P \propto T^3$. But for adiabatic process $P \propto T^{\gamma/\gamma-1}$.

So, $\frac{\gamma}{\gamma - 1} = 3 \Rightarrow \gamma = \frac{3}{2} \Rightarrow \frac{C_p}{C_v} = \frac{3}{2}$

5. $P = \frac{1}{2}\mu\omega^2 A^2 v$ where $v = \sqrt{\frac{T}{\mu}}$

6. For a stationary observer between wall and source, frequency from direct source is

$\left(\frac{v}{v - v_s}\right)f_0$

Frequency from reflected sound is

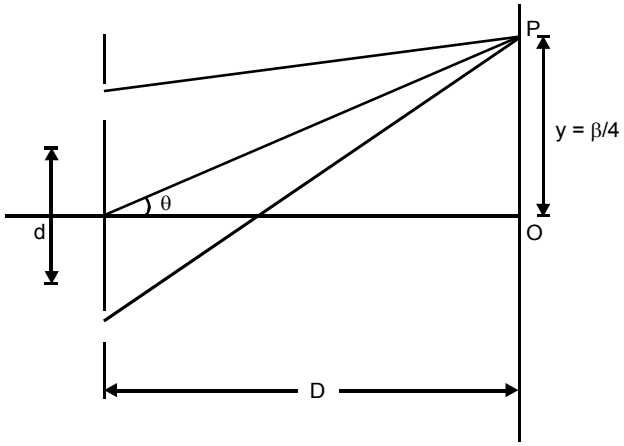
$\left(\frac{v}{v - v_s}\right)f_0$

So no beats will be heard.

7. $\frac{v_A}{v_B} = \frac{D_B}{D_A} = \frac{1}{2}$

8. Let the intensity of individual waves be I.

Then



$I_0 = 4I \Rightarrow I = \frac{I_0}{4}$

At P, $\Delta x = d \sin\theta$

$\Rightarrow \Delta x = d \sin\theta = \frac{dy}{D} \Rightarrow \Delta x = \frac{d}{D} \times \frac{\beta}{4} = \frac{d}{D} \times \frac{\lambda D}{4d} = \frac{\lambda}{4}$

$\therefore \quad \Delta\phi = \frac{2\pi}{\lambda} \times \frac{\pi}{4} = \frac{\pi}{2} \qquad [\Delta\phi = k\,\Delta x]$

$I' = I + I + 2\sqrt{I^2}\cos\frac{\pi}{2} = 2I = \frac{I_0}{2}$

9. For L-C-R circuit, the current

$i = \frac{E_0}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}\sin(\omega t + \phi)$

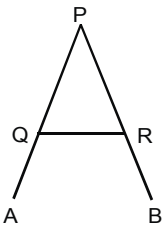
At resonance, impedance, $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

is minimum $\phi = 0$

Also reducing R, will increase the current in the circuit, which thereby increases the voltage across the capacitor.

10. $L = \left|\frac{\xi}{\Delta i/\Delta t}\right| = 0.1\,H$

11.



PQ, PR, QR, AQ and BR are all of 10Ω each. Further, PQ and PR are in series, whose combination is in parallel with QR. Finally the three resistors are in series across A-B. Hence, equivalent resistance across A-B is 26.7Ω

12. The motion is two dimensional, with constant velocity along one direction and constant acceleration along the other direction. Hence, path is parabolic.

13. $\hat{j}$ component, i.e., component of velocity parallel to wall remains unchanged while $\hat{i}$ component will become $\frac{-1}{2}(2\hat{i})$ or $\hat{j}$. Therefore, velocity vector of the sphere after it hits the wall is $-\hat{i}+2\hat{j}$.

14. $J = mv$ ...(i)

$Jh = I\omega$ ...(ii)

$\frac{h}{R} = \frac{2}{5}$

15. Since the disc comes to rest, it stops rotating and translating simultaneously v = 0 and $\omega = 0$.

That means, the angular momentum about the instantaneous point of contact just after the time of stopping is zero. We know that the angular momentum of the disc about P remains constant because frictional force f N and mg pass through point p and thus produce no torque about this point

$\Rightarrow L_{initial} - L_{final} \Rightarrow mvr - I_0\omega_0 = 0$

$\Rightarrow mvr = \frac{1}{2}mr^2\omega_0 \Rightarrow 2v_0 = \omega_0 r$

16. $g \propto R\rho$

17. We know that $Y = \frac{mg}{\pi\frac{D^2}{4}} \times \frac{L}{l}$

$\frac{\Delta Y}{Y} = \frac{2\Delta D}{D} + \frac{\Delta l}{l}$

[$\because$ the values of m, g and L are exact]

$= 2\frac{0.01}{0.4} + \frac{0.05}{0.8} = 2\times 0.025 + 0.0625$

= 0.05 + 0.0625 = 0.1125

$\Delta Y = 2 \times 10^{11} \times 0.1125 = 0.225 \times 10^{11}$

[$\because$ The value of $Y = 2 \times 10^{11}$ in all the four options]

18. $5 = \frac{2\pi m_p}{q_p B}$ & $T_\alpha = \frac{2\pi m_\alpha}{q_\alpha B} = \frac{2\pi(4m_p)}{(2q_p)B} = 2\times 5 = 10\mu s$

19. In a non-uniform magnetic field both Force and Torque are non-zero

20. Use $i = i_o\left(1-e^{-(Rt/L)}\right) \Rightarrow \frac{i_o}{2} = i_o\left(1-e^{-(Rt/L)}\right)$

$\Rightarrow e^{-(Rt/L)} = \frac{1}{2} \Rightarrow t = \frac{L}{R}\ln 2 = 0.1s$

21. The potential difference across inductor and capacitor have a phase difference of 180°. Hence, E_{source} = 400 – 300 = 100 V

22. At 1st null point: $\frac{x}{y} = \frac{40}{100-40} = \frac{2}{3}$.....(1)

At 2nd null point:

$\frac{3x}{y} = \frac{l}{100-l} \Rightarrow 2 = \frac{l}{100-l} \Rightarrow l = \frac{200}{3} \approx 67cm$

23. Impulse = area of trapezium

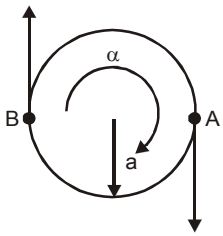
$= \frac{1}{2}\left(T+\frac{T}{2}\right)F_0 = \frac{3TF_0}{4}$

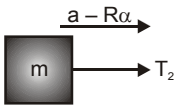
According to impuse-momentum theorem.

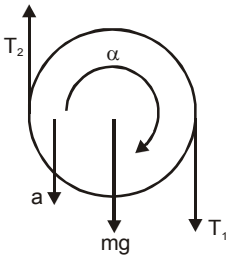
Impulse = Change in momentum

$\Rightarrow \frac{3TF_0}{4} = mu \Rightarrow F_0 = \frac{4mu}{3T}$

24. $\vec{a}_A = \vec{a}_{trans} + \vec{a}_{rot}$







$|\vec{a}_A| = a + R\alpha$

$|\vec{a}_B| = a - R\alpha$

$mg - T_1 = m(a + R\alpha)$ (i)

$T_1 + mg - T_2 = ma$ (ii)

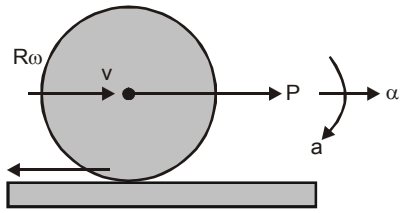
$T_2 = m(a - R\alpha)$ (iii)

$T_1R + T_2R = \frac{mR^2}{2}\alpha$ (iv)

On solving these equations, we get

$a = \frac{2g}{3}, \alpha = \frac{2g}{5R}$

25. If the surface is smooth, then rolling would not be possible without friction. There would not be any force which would produce some rotational effect. So, surface should be rough.



As cylinder is performing pure rolling motion, friction is static in nature.

The equation of motion is given as

$P - f = Ma$

$fR = I\alpha$

$a = R\alpha$

$a = \frac{P}{I/R^2 + M}$ which is a constant.

After 3s,

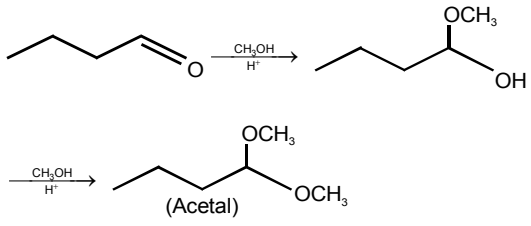
$3\omega = \alpha \times t = \alpha \times 3 = 3\left[\frac{P}{I/R^2 + M}\right] \times \frac{1}{R}$

$v = at = 3\left[\frac{P}{I/R^2 + M}\right]$

So, net velocity of point A

$|\vec{v}_A| = \sqrt{v^2 + (R\omega)^2} = \frac{3\sqrt{2}P}{I/R^2 + M}$

27.



28. HIO_4 will not oxidize diol from 1, 3 atom & not used for cleavage of ether.

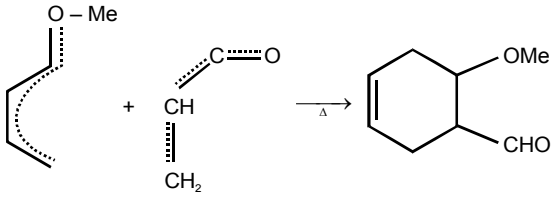
29. Inversion of configuration takes place.

32. (1) Neutral R.S. are most stable.

(2) With the increase in charge separation stability of R.S. decreases, so stability order is

i > ii > iii

33.



34. S_N^2 reaction is favourable at least crowded site.

35. ΔQ_{absorb} = 100 J

$\Delta H = +\Delta Q_{absorb}$ = 100 J

P_{ext} = 1.50 atm

V_1 = 8

V_2 = 2

$\Delta E = \Delta H + P\Delta V$

= 100 + 1.50 (8 – 2) = 109

36. P = 100 watt

V = 110 volt

Time = 10 hrs = $10 \times 60 \times 60 = 3.6 \times 10^4$ sec

$P = V \times I$

$i = \frac{P}{V} = \frac{100}{110}$

$W = Zit = \frac{Eit}{96500} = \frac{112.4}{2} \times \frac{100}{110} \times \frac{3.6 \times 10^4}{96500}$ = 19.05 gm

Approx = 19 gm

37. $2e^- + OCl^- \longrightarrow Cl^-$ $E_1^0 = 0.9$ V

$Cl^- + e^- = -1.36$ V

$e^- + OC^-$ Cl_2

$\Delta G_3^0 = \Delta G_1^0 + \Delta G_2^0$

$-1 \times F \times = -2 \times F \times 0.94 + -1 \times F (-1.36)$

$E_3^0 = 2 \times 0.94 - 1.36 = 0.52$ V

38. $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

2 3 5

$P_{SO_2} = 3 \times \frac{2}{10} = 0.6$

$P_{O_2} = 3 \times \frac{3}{10} = 0.9$

$P_{SO_3} = 3 \times \frac{5}{10} = 1.5$

$K_P = \frac{P_{SO_3}^2}{P_{SO_2}^2 \times P_{O_2}} = \frac{(1.5)^2}{(0.6)^2 \times 0.9}$ = 6.94

39. $2A(g) + B(g) \rightleftharpoons 3C(g) + D(g)$

2 –2x 2 – x 3x x

$K_C = \frac{(3x)^3 \times x}{(2 - 2x)^2 \times (2 - x)}$

[A] < [B] at equilibrium

40. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

1	0	0
$(1-\alpha)$	α	α

$$K_p = \left(\frac{\alpha}{1+\alpha}\right)^2 P^2 \times \frac{(1+\alpha)}{(1-\alpha)P} = \frac{\alpha^2 P}{(1-\alpha^2)}$$

since α = 0.3 at 1 atm pressure

$$K_p = \frac{0.3 \times 0.3 \times 1}{1-0.09} = \frac{0.09}{0.91} = \frac{9\times10^{-2}}{91\times10^{-2}} \simeq \frac{9}{91}$$

$$K_p = \frac{9}{91}$$

when α = 50% = 0.5, the pressure can be calculated as follows

$$K_p = \frac{\alpha^2 P}{(1-\alpha^2)}$$

$$\frac{9}{91} = \frac{0.5 \times 0.5 \times P}{(1-0.5^2)} = \frac{0.5 \times 0.5\,P}{0.75}$$

or $P = \frac{9 \times 0.75}{91 \times 0.5 \times 0.5} = 0.297 = 0.3$ atm

41. For an isothermal reversible process involving a perfect gas, work done on the system is a +ve quantity.

$w = 2.303 \times nRT \log \frac{5.05\times10^6}{1.01\times10^5}$

$= 2.303 \times 2 \times 300 \times 8.314 \log 50$

$= 2.303 \times 2 \times 300 \times 8.314 \times 1.6990$

$= 4.606 \times 2494.2 \times 1.6990$

$= +1.95 \times 10^4$ Joules

42. solid $\longrightarrow$ solid + gas has the maximum $\Delta S°$.

43. Work function of a metal = 4.2 eV

$E_0 = 4.2 \times 1.6 \times 10^{-19}$ J

$= 6.72 \times 10^{-19}$ J

Energy absorbed by the electron:

$E = h\nu = \frac{hc}{\lambda}$, $E = \frac{6.63\times10^{-34}\times3\times10^8}{2000\times10^{-10}}$

$= \frac{6.63\times3\times10^{-26}}{2\times10^{-7}}$

$E = 9.94 \times 10^{-19}$ J

Kinetic energy of the photoelectron emitted $= E - E_0$

$= (9.94 - 6.72) \times 10^{-19}$ J

$= 3.22 \times 10^{-19}$ J

44. AsO_3^{3-} – tetrahederal; SO_3^{2-} – tetrahederal

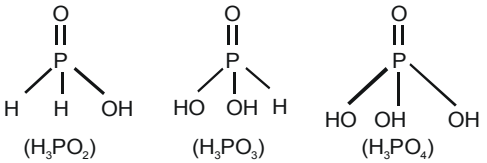
ClO_3^- – tetrahederal; CO_3^{2-} – trigonal planar

NO_3^- – trigonal planar; BO_3^{3-} – trigonal planar

45. $CH_3MgBr + D_2O \longrightarrow CH_3D +$ Mg(OD)(Br)

46. CrO_2Cl_2 (chromyl chloride)

47.



(H_3PO_2) (H_3PO_3) (H_3PO_4)

48. $E = E_0 + \frac{3}{4}E$

$E_0 = \frac{1}{4}E$ or $\nu_0 = \frac{1}{4}\nu$

$\nu_0 = \frac{1}{4} \times 3.2 \times 10^{16} = 8 \times 10^{15}$

50. $P_s = P_B^o + \left(P_A^o - P_B^o\right)X_A$

Comparing it with given equation, we get

$P_B^o = 210$ and $P_A^o = 90$

51. $f(x) = 3x^2 - 7x + a$, $x > \frac{7}{6}$

f(x) is invertible in its domain, and it is increasing in $x > \frac{7}{6}$. Since f(x) touches its inverse, it means f(x) touches y = x line.

$\Rightarrow$ $3x^2 - 7x + a = x$ has only one root

$3x^2 - 8x + a = 0$

D = 0

$64 - 12a = 0$

$\therefore$ $a = \frac{16}{3}$

52. From given functional equation 2f(xy)

$= (f(x))^y + (f(y))^x$, $\forall$ x, y $\in$ R

putting y = 1

$2f(x) = f(x) + (f(1))^x$

$f(x) = 3^x$

$\therefore$ $\sum_{r=1}^{10} f(r) = \sum_{r=1}^{10} 3^r = \frac{3(3^{10}-1)}{3-1} = \frac{3}{2}(3^{10}-1)$

53. $f(x) = [x] + \left[x + \frac{1}{3}\right] + \left[x + \frac{2}{3}\right] - 3x + \sin 3\pi x - 1$

$= x - \{x\} + x + \frac{1}{3} - \left\{x + \frac{1}{3}\right\} + x + \frac{2}{3} - \left\{x + \frac{2}{3}\right\} - 3x + \sin 3\pi x - 1$

$= \sin 3\pi x - \left(\{x\} + \left\{x + \frac{1}{3}\right\} + \left\{x + \frac{2}{3}\right\}\right)$

sin $3\pi x$ is periodic with period $\frac{2}{3}$

$\{x\}+\left\{x+\frac{1}{3}\right\}+\left\{x+\frac{2}{3}\right\}$ is periodic with period $\frac{1}{3}$

$\therefore$ Period of f(x) = LCM $\left(\frac{2}{3},\frac{1}{3}\right)=\frac{2}{3}$

54. $\lim\limits_{x\to1}\left(\frac{(x-1)(x^{n-1}+x^{n-2}+....+1)}{n(x-1)}\right)^{\frac{1}{x-1}}$ (1^∞ form)

$=e^{\lim\limits_{x\to1}\left(\frac{x^n-1}{n(x-1)}-1\right)^{\frac{1}{x-1}}}=e^{\lim\limits_{x\to1}\left(\frac{x^{n-1}+x^{n-2}+....+1-n}{n(x-1)}\right)}=e^{\lim\limits_{x\to1}\left(\frac{x^{n-1}-1}{x-1}+\frac{x^{n-2}-1}{x-1}+\frac{x-1}{x-1}+\frac{1-1}{x-1}\right)\frac{1}{n}}$

$=e^{((n-1)+(n-2)+(n-3)+....+2+1)\frac{1}{n}}=e^{\frac{n-1}{2}}$

55. Let $y=\lim\limits_{x\to\infty}\left(\frac{\pi}{2}-\tan^{-1}x\right)^{\frac{1}{x}}$

$=\lim\limits_{x\to\infty}(\cot^{-1}x)^{\frac{1}{x}}$ (0° form)

$\ln y=\lim\limits_{x\to\infty}\frac{\ln\cot^{-1}x}{x}$ $\left(\frac{\infty}{\infty}\text{ form}\right)$

$=\lim\limits_{x\to\infty}-\frac{1}{(1+x^2)\cot^{-1}x}$

$=-\lim\limits_{x\to\infty}\frac{(1+x^2)^{-1}}{\cot^{-1}x}$ $\left(\frac{0}{0}\text{ form}\right)$

$=-\lim\limits_{x\to\infty}\frac{\frac{-2x}{(1+x^2)^2}}{-\frac{1}{1+x^2}}=-2\lim\limits_{x\to\infty}\frac{x}{1+x^2}$

$=-2\lim\limits_{x\to\infty}\frac{1}{2x}=0$

$y = e^\circ = 1$

56. $x + y + z = 10$

number of solution is equal to coefficient of x^{10} in expression

$\Rightarrow (x + x^2 .....x^6)^3 = x^3(1 - x^6)^3(1 - x)^{-3}$

Coeff. of x^7 in $(1 - x^6)^3 (1 - x)^{-3}$

Coeff. of x^7 in $(1 - 3x^6)(1 - x)^{-3}$

$= {}^{7+3-1}C_7' - 3^{1+3-1}C_1 = {}^9C_2 - 9 = 27$

57. f(x) is a constant function so

$f(1) = f(3) = f(5) = f(0) = 3$

Now $3x^2 + 3x + 3 = 0 \Rightarrow x^2 + x + 1 = 0$

This equation has imaginary roots.

58. $\sec^2\theta_n=\sec 2\,\theta_{n-1}+4+4\cos^2\theta_{n-1}$

$0<4\cos^2\theta_{n-1}<4$

$4+\sec^2\theta_{n-1}<\sec^2\theta_n<8+\sec^2\theta_{n-1}$

$4n<\sec^2\theta_n<8n-4$

$2\sqrt{n}<|\sec\theta_n|<\sqrt{8n-4}$

$n=4\quad 4<|\sec\theta_4|<2\sqrt{7}<6$

$n=5\quad 2\sqrt{5}<|\sec\theta_5|<6$

59. $3\pi-\frac{22\pi}{7}+\left(2\pi-\frac{5\pi}{3}\right)+\left(\frac{5\pi}{7}-\pi\right)+\frac{\pi}{2}-2$

$-\frac{3\pi}{7}+\frac{5\pi}{6}-2=\frac{-18+35}{42}-2=\frac{17\pi}{42}-2$

60. $f(x)=\begin{cases}[x]+\sqrt{\{x\}} & x<1\\ \frac{1}{[x]+\{x\}^2} & x\ge1\end{cases}$

Consider the function f(x) in the interval (0, 2)

$f(x)=\begin{cases}\sqrt{x} & \\ \frac{1}{1+(x-1)^2} & \begin{matrix}0<x<1\\ 1\le x<2\end{matrix}\end{cases}$

$f(1) = 1$ $\lim\limits_{x\to1}f(x)=1$

continuous at x = 1

61. $\int\frac{1}{\sin^4x+\cos^4x}dx=\int\frac{\sec^4x}{\tan^4x+1}dx$

Let $\tan x = t$

$\int\frac{\left(1+t^2\right)dt}{t^4+1}=\int\frac{1+\frac{1}{t^2}}{t^2+\frac{1}{t^2}}dt$

Let $t-\frac{1}{t}=z\Rightarrow\int\frac{dt}{t^2+2}=\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{z}{\sqrt{2}}\right)+c$

$=\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{t^2-1}{\sqrt{2}t}\right)+c$

62. No of function = $3^3-{}^2C_1\cdot2^3+{}^2C_2\cdot1^3=12$

63. Distance from centre to the line should be equal to radius

$\therefore d=\frac{|6-12+a|}{5}=2\Rightarrow a-6=\pm10\Rightarrow a=6\pm10$

$\Rightarrow a=16\text{ or }-4$

64. $\frac{1}{e_1^2}+\frac{1}{e_2^2}=1\Rightarrow\frac{4}{9}+\frac{1}{e_2^2}=1\Rightarrow e_2^2=\frac{9}{5}\Rightarrow e_2=\frac{3}{\sqrt{5}}$

65. Equation of pair of asymptops is given by

$s + l = 0$

$\Rightarrow xy-3x+4y-18=0$

for the above equation to represent a pair of lines l = –6

$\therefore$ equation of conjugate hyperbola is

$s + 2l = 0$

$xy – 3x + 4y – 18 = 0$

66. The given equations are

$|x - 1| + 3y = 4$

$\Rightarrow \begin{cases} x + 3y = 5, x \geq 1 & ...(i) \\ -x + 3y = 3, x < 1 & ...(ii) \end{cases}$

and$x - |y - 1| = 2$

$\Rightarrow \begin{cases} x - y = 1, y \geq 1 & ...(iii) \\ x + y = 3, y < 1 & ...(iv) \end{cases}$

Solving Eqs. (i) and (iii), we get

$x = 2, y = 1$

no solution

Solving Eqs. (i) and (iv), we get ($\because$ $x \geq 1, y < 1$)

$x = 2, y = 1$

no solution

Solving Eqs. (ii) and (iii), we get

$x = 3, y = 2$ no solution ($\because$ $x < 1, y \geq 1$)

Solving Eqs. (ii) and (iv), we get

$x = 5/2, y = 3/2$ ($\because$ $x < 1, y < 1$)

no solution

Hence, solution is $x = 2, y = 1$ (a unique solution)

67. The number of digits in each term of the sequence are 1, 2, 4, 8, ...

Which are in GP

Let 1025th term is 2^n.

Then $1 + 2 + 4 + 8 + ... + 2^{n-1} < 1025 \leq 1 + 2 + 4 + 8 + ... + 2^n$

$\Rightarrow 1.\frac{(2^n - 1)}{(2 - 1)} < 1025 \leq 1.\frac{(2^{n+1} - 1)}{(2 - 1)}$

$\Rightarrow 2^n - 1 < 1025 \leq 2^{n+1} - 1$

$\Rightarrow 2^n < 1026 \leq 2^{n+1}$

or $2^{n+1} \geq 1026 > 1024$

$\Rightarrow 2^{n+1} > 2^{10}$

or $n + 1 > 10$

$\therefore$ $n > 9$

$\therefore$ $n = 10$ (which is always satisfy Eq. (i)),

$\therefore$ 1025th term is 2^{10}.

68. Given $a_1\, a_2\, a_3 ... a_{n-1}\, a_n = c$

$\because$ AM $\geq$ GM

$\Rightarrow \frac{a_1 + a_2 + ... + a_{n-1} + 2a_n}{n} \geq (a_1\, a_2 ... a_{n-1}\, 2a_n)^{1/n}$

$= (2c)^{1/n}$[from Eq. (i)]

$\therefore$ $a_1 + a_2 + ... + a_{n-1} + 2a_n \geq n(2c)^{1/2}$

Hence, minimum value of $a_1 + a_2 + ... + a_{n-1} + 2a_n$ is $n(2c)^{1/n}$.

69. $\because$ $\underline{|5}, \underline{|6}, \underline{|7}, \underline{|8}, ..., \underline{|175}$ each multiple of 15

and $\underline{|1} + \underline{|2} + \underline{|3} + \underline{|4} = 33$

Hence, required remainder = 3.

70. $\because$ $f(x_i) \neq y_i$

ie, no object goes to its scheduled place. Then number of one-one mappings

$= \underline{|6}\left(1 - \frac{1}{\underline{|1}} + \frac{1}{\underline{|2}} - \frac{1}{\underline{|3}} + \frac{1}{\underline{|4}} - \frac{1}{\underline{|5}} + \frac{1}{\underline{|6}}\right)$

$= \underline{|6}\left(\frac{1}{\underline{|2}} - \frac{1}{\underline{|3}} + \frac{1}{\underline{|4}} - \frac{1}{\underline{|5}} + \frac{1}{\underline{|6}}\right)$

$= 360 - 120 + 30 - 6 + 1$

$= 265$

71. $T_n = \cot^{-1}\left(n^2 + \frac{3}{4}\right) = \tan^{-1}\left(\frac{1}{n^2 + \frac{3}{4}}\right)$

$= \tan^{-1}\left(n + \frac{1}{2}\right) - \tan^{-1}\left(n - \frac{1}{2}\right)$

$S_n = \sum_{n=1}^{n} t_n = \tan^{-1}\left(n + \frac{1}{2}\right) - \tan^{-1}\frac{1}{2}$

$\Rightarrow \quad S_\infty = \frac{\pi}{2} - \tan^{-1}\frac{1}{2} = \cot^{-1}\frac{1}{2} = \tan^{-1}2$

72. Since $3 \times 1 - 4 \times 2 + 1$ and $12 \times 1 + 5 \times 2 - 3$ are of the opposite sign, so required angle bisector is given by

$\frac{3x - 4y + 1}{5} = -\left(\frac{12 + 5y - 3}{13}\right)$

73. A tangent of slope 2 is $y = 2x \pm \sqrt{4a^2 + b^2}$ this is normal to $x^2 + y^2 + 4x + 1 = 0$ then

$0 = -4 \pm \sqrt{4a^2 + b^2} \Rightarrow 4a^2 + b^2 = 16$

using Am $\geq$ GM $ab \leq 4$

74. $n \geq 3$, a_3 = ...(1)

$a_4 = = \Rightarrow a_4 = a_3$

$a_5 = = a_4$

$a_3 = a_4 = a_5 = ... = a_9 = 99$

put in equation (1)

$99 = \Rightarrow a_2 = 179$

75. $p \Rightarrow (\sim p \vee q)$ is the false means p is true & $\sim p \vee q$ is false

$\Rightarrow$ p is true & both ~ p & q are false $\Rightarrow$ p is true & q is flase