FIITJEE

Solutions to JEE(Main)-2020

Test Date: 5^{th} September 2020 (Second Shift)

PHYSICS, CHEMISTRY & MATHEMATICS

Paper - 1

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

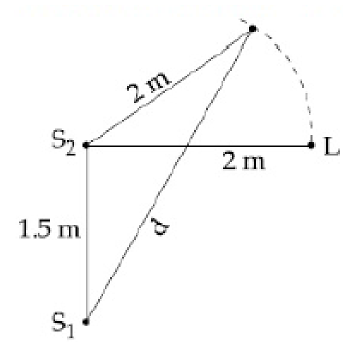
- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

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. Two coherent sources of sound, S_1 and S_2 produce source waves of the same wavelength, $\lambda = 1$ m, in phase. S_1 and S_2 are placed 1.5 m apart (see fig). A listener located at L, directly in front of S_2 finds that the intensity is at a minimum when he is 2 m away from S_2. The listener moves away from S_1, keeping his distance from S_2 fixed. The adjacent maximum of intensity is observed when the listener is at a distance d from S_1. Then, d is:

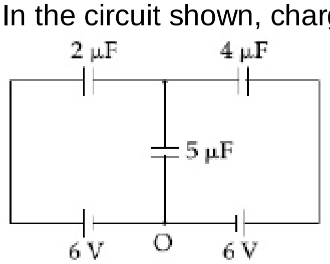


(A) 12 m (B) 3 m
(C) 5 m (D) 2 m

2. Two different wires having lengths L_1 and L_2, and respective temperature coefficient of linear 4expansion α_1 and α_2, are joined end-to-end. Then the effective temperature coefficient of linear expansion is:

(A) $\frac{\alpha_1 + \alpha_2}{2}$ (B) $2\sqrt{\alpha_1\alpha_2}$
(C) $\frac{\alpha_1 L_1 + a_2 L_2}{L_1 + L_2}$ (D) $4\frac{\alpha_1\alpha_2}{\alpha_1 + \alpha_2}\frac{L_1L_2}{\left(L_2 + L_1\right)^2}$

3. In the circuit shown, charge on the 5 μF capacitor is:

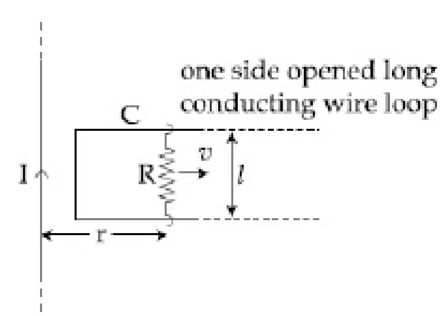


(A) 16.36 μC (B) 5.45 μC
(C) 10.90 μC (D) 18.00 μC

4. In adiabatic process, the density of a diatomic gas becomes 32 times its initial value. The final pressure of the gas is found to be n times the initial pressure. The value of n is:

(A) 128 (B) $\frac{1}{32}$
(C) 32 (D) 326

5. An infinitely long straight wire carrying current I, one side opened rectangular loop and a conductor C with a sliding connector are located in the same plane, as shown in the figure. The connector has length l and resistance R. It slides to the right with a velocity v. The resistance of the conductor and the self inductance of the loop are negligible. The induced current in the loop, as a function of separation r, between the connector and the straight wire is:



(A) $\frac{\mu_0}{2\pi}\frac{Ivl}{Rr}$ (B) $\frac{\mu_0}{\pi}\frac{Ivl}{Rr}$
(C) $\frac{2\mu_0}{2\pi}\frac{Ivl}{Rr}$ (D) $\frac{\mu_0}{4\pi}\frac{Ivl}{Rr}$

6. An iron rod of volume $10^{-3}m^3$ and relative permeability 1000 is placed as core in a solenoid with 10 turns/cm. If a current of 0.5 A is passed through the solenoid, then the magnetic moment of the rod will be:
(A) 0.5×10^2 Am^2 (B) 50×10^2 Am^2
(C) 500×10^2 Am^2 (D) 5×10^2 Am^2

7. The correct match between the entries in column I and column II are:

	I **Radiation**		II **Wavelength**
(a)	Microwave	(i)	100 m
(b)	Gamma rays	(ii)	10^{-15} m
(c)	A.M. radio waves	(iii)	10^{-10} m
(d)	X-rays	(iv)	10^{-3} m

(A) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii) (B) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)
(C) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv) (D) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

8. A radioactive nucleus decays by two difference processes. The half life for the first process is 10 s and that for the second is 100 s. The effective half life of the nucleus is closes to:
(A) 6 sec. (B) 9 sec.
(C) 12 sec. (D) 55 sec.

9. Ten charges are placed on the circumference of a circle of radius R with constant angular separation between successive charges. Alternate charges 1, 3, 5, 7, 9 have charge (+ q) each, while 2, 4, 6, 8, 10 have charge (– q) each. The potential V and the electric field E at the centre of the circle are respectively:
(Take V = 0 at infinity)
(A) $V = \frac{10q}{4\pi \in_0 R}$; $E = \frac{10q}{4\pi \in_0 R^2}$ (B) $V = 0$; $E = \frac{10q}{4\pi \in_0 R^2}$
(C) $V = 0$; $E = 0$ (D) $V = \frac{10q}{4\pi \in_0 R}$; $E = 0$

10. A driver in a car, approaching a vertical wall notices that the frequency of his car horn, has changed from 440 Hz to 480 Hz, when it gets reflected from the wall. If the speed of sound in air is 345 m/s, then the speed of the car is:
(A) 24 km/hr (B) 36 km/hr
(C) 18 km/hr (D) 54 km/hr

11. A parallel plate capacitor has plate of length 'ℓ', width 'w' and separation of plates is 'd'. It is connected to a battery of emf V. A dielectric slap of the same thickness 'd' and of dielectric constant k = 4 is being, inserted between the plates of the capacitor. At what length of the slab inside plates, will be energy stored in the capacitor be two times the initial energy stored?

(A) $2\ell/3$ (B) $\ell/2$

(C) $\ell/4$ (d) $\ell/3$

12. A spaceship in space sweeps stationary interplanetary dust. As a result, its mass increases at a rate $\frac{dM(t)}{dt} = bv^2(t)$, where v(t) its instantaneous velocity. The instantaneous acceleration of the satellite is:

(A) $-\frac{2bv^3}{M(t)}$ (B) $-\frac{bv^3}{M(t)}$

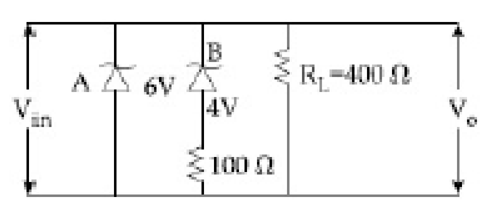
(C) – bv(t) (D) $-\frac{bv^3}{2M(t)}$

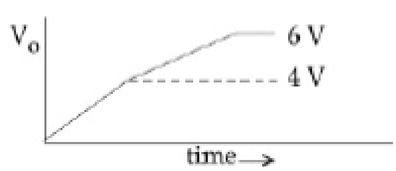
13. The acceleration due to gravity on the earth's surface at the poles is g an and angular velocity of the earth about the axis passing through the pole is ω. An object is weight at the equator and at a height h above the poles by using a spring balance. If the weights are found to be same, then h is :(h<<R, where R is the radius of the earth)

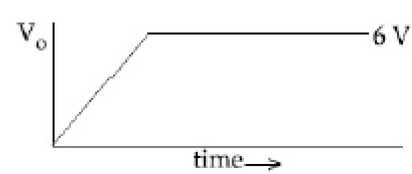
(A) $\frac{R^2\omega^2}{2g}$ (B) $\frac{R^2\omega^2}{g}$

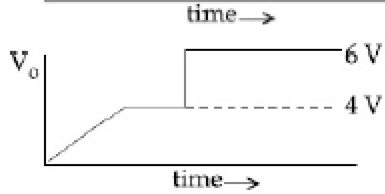
(C) $\frac{R^2\omega^2}{8g}$ (D) $\frac{R^2\omega^2}{4g}$

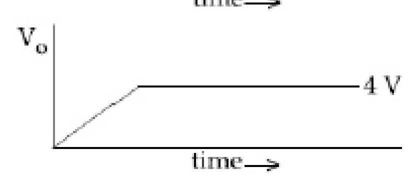
14. Two Zener diodes (A and B) having breakdown voltages of 6 V and 4 V respe4ctively, are connected as shown in the circuit below. The output voltage V_0 variation wlith input voltage linearly increasing with time, is given by: (V_{input} = 0 V at t = 0)
(figures are qualitative)



(A)


(B)


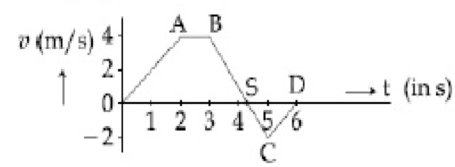
(C)


(D)


15. In an experiment to verify Stokes law, a small spherical ball of radius r and density ρ falls under gravity through a distance h in air before entering a tank of water. If the terminal velocity of the ball inside water is same as its velocity just before entering the water surface, then the value of h is proportional to: (ignore viscosity of air)
(A) r^3 (B) r^4
(C) r^2 (D) r

16. A ring is hung on a nail. It can oscillate, without slipping or sliding (i) in its plane with a time period T_1 and, T(ii) back and forth in a direction perpendicular to its plane, with a period T_2. The ratio $\frac{T_1}{T_2}$ will be:
(A) $\frac{2}{\sqrt{3}}$ (B) $\frac{3}{\sqrt{3}}$
(C) $\frac{\sqrt{2}}{3}$ (D) $\frac{2}{3}$

17. The velocity (v) and time (t) graph of a body in a straight line motion is shown in the figure. The point S is at 4.333 seconds. The total distance covered by the body in 6 s is:

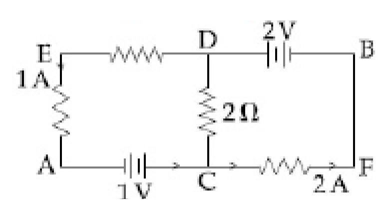


(A) 11 m (B) $\frac{37}{3}$ m
(C) 12 m (D) $\frac{49}{4}$ m

18. The quantities $x = \frac{1}{\sqrt{\mu_0 \in_0}}$, $y = \frac{E}{B}$ and $z = \frac{1}{CR}$ are defined where C-capacitance, R-Resistance, l-length, E-Electric field, B-magnetic field and $\in_0$, μ_0, - free space permittivity and permeability respectively. Then:
(A) x, y and z have the same dimension. (B) Only y and z have the same dimension.
(C) Only x and z have the same dimension (D) Only x and y have the same dimension.

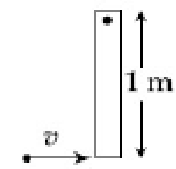
19. A galvanometer is used in laboratory for detecting the null point in electrical experiments. If, on passing a current of 6 mA it produces a deflection of 2°, its figure of merit is close to:
(A) 666° A/div. (B) 6×10^{-3} A/div.
(C) 333° A/div. (D) 3×10^{-3} A/div.

20. In the circuit, given in the figure currents in different branches and value of one resistor are shown. Then potential at point B with respect to the point A is:



(A) + 1 V (B) – 1 V
(C) + 2 V (D) – 2 V

21. A thin rod of mass 0.9 kg and length 1 m is suspended, at rest, from one end so that it can freely oscillate in the vertical plane. A particle of move 0.1 kg moving in a straight line with velocity 80 m/s hits the rod at its bottom most point and sticks to it (see figure). The angular speed (in rad/s) of the rod immediately after the collision will be __________.



22. The surface of a metal is illuminated alternately with photons of energies E_1 = 4 eV and E_2 = 2.5 eV respectively. The ratio of maximum speeds of the photoelectrons emitted in the two cases is 2. The work function of the metal in (eV) is __________.

23. A prism of angle A = 1° has a refractive index μ = 1.5. A good estimate for the minimum angle of deviation (in degrees) is close to N/10. Value of N is __________.

24. Nitrogen has is at 300° temperature. The temperature (in K) at which the rms speed of a H_2 molecule would be equal to the rms speed of a nitrogen molecule, is __________. (Molar mass of N_2 gas 28 g).

25. A body of mass 2 kg, is driven by an engine delivering, a constant power 1 J/s. the body starts from rest and moves in a straight line. After 9 seconds, the body has moved a distance (in m) __________.

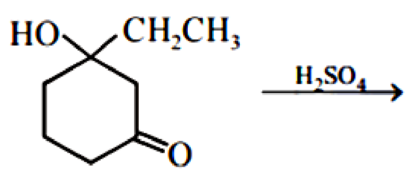
PART –B (CHEMISTRY)

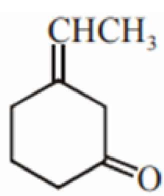
26. An element crystallises in a face-centred cubic (fcc) unit cell with cell edge a. The distance between the centres of two nearest octahedral voids in the crystal lattice is:

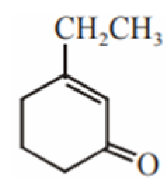
(A) $\frac{a}{2}$ (B) $\sqrt{2}a$

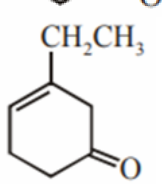
(C) a (D) $\frac{a}{\sqrt{2}}$

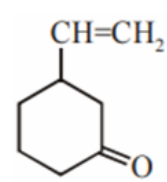
27. The major product of the following reaction is:



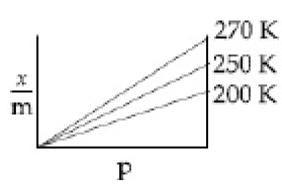
(A)


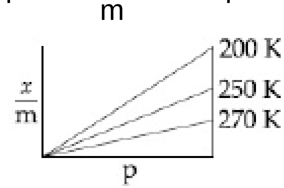
(B)


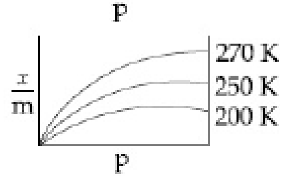
(C)


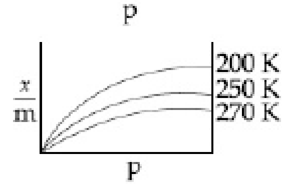
(D)


28. Adsorption of a gas follows Freundlich adsorption isotherm. If x is the mass of the gas adsorbed on mass m of the adsorbent, the correct plot of $\frac{x}{m}$ versus p is:

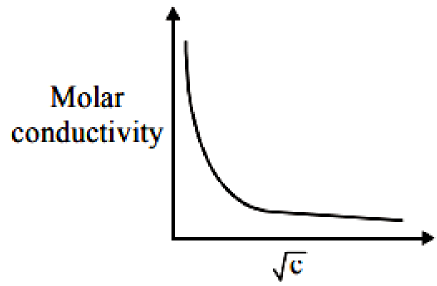
(A)


(B)


(C)


(D)


29. The variation of molar conductivity with concentration of an electrolyte (X) in aqueous solution is shown in the given figure.



(A) KNO_3 (B) CH_3COOH
(C) HCl (D) NaCl

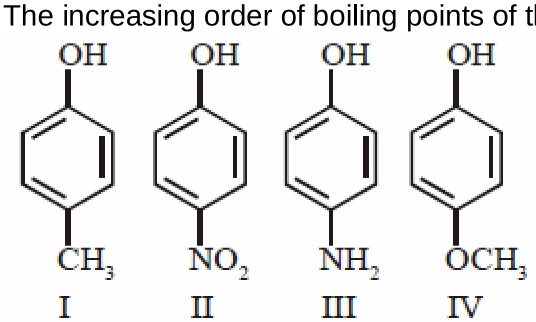
30. The compound that has the largest H – M – H bond angle (M = N, O, S, C), is
(A) H_2O (B) CH_4
(C) H_2S (D) NH_3

31. The correct order of the ionic radii of
O^{2-}, N^{3+}, F^-, Mg^{2+}, Na^+ and Al^{3+} is:
(A) $N^{3-} < O^{2-} < F^- < Na^+ < Mg^{2+} < Al^{3+}$ (B) $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$
(C) $Al^{3+} < Na^+ < Mg^{2+} < O^{2-} < F^- < N^{3-}$ (D) $N^{3-} < F^- < O^{2-} < Mg^{2+} < Na^+ < Al^{3+}$

32. Lattice enthalpy and enthalpy of solution of NaCl are 788 kJ mol^{-1} and 4 kJ mol^{-1}, respectively. The hydration enthalpy of NaCl is:
(A) 784 kJ mol^{-1} (B) –784 kJ mol^{-1}
(C) 780 kJ mol^{-1} (D) –780 kJ mol^{-1}

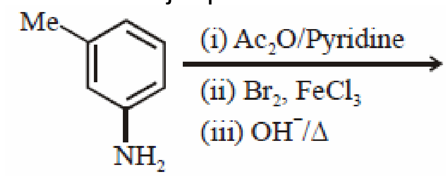
33. The correct statement about probability density (except at infinite distance from nucleus) is:
(A) It can be zero for 3p orbital (B) It can be zero for 1s orbital
(C) It can be zero for 2p orbital (D) It can be zero for 2s orbital

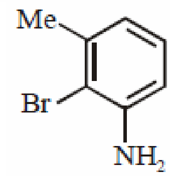
34. The increasing order of boiling points of the following compounds is:

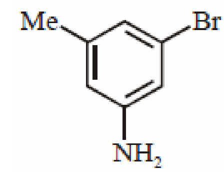


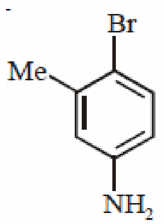
(A) I < IV < III < II (B) IV < I < II < III
(C) III < I < II < IV (D) I < III < IV < II

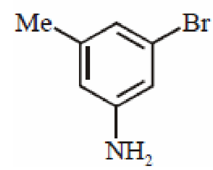
35. The final major product of the following reaction is:



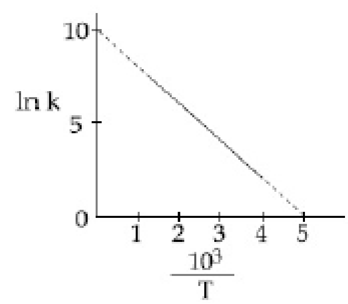
(A) 

(B) 

(C) 

(D) 

36. The rate constant (k) of a reaction is measured at different temperatures (T), and the data are plotted in the given figure. The activation energy of the reaction in kJ mol^{-1} is: (R is gas constant)



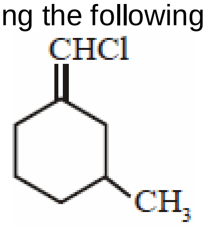
(A) 2R
(B) 2/R
(C) R
(D) 1/R

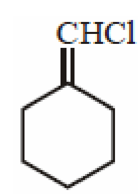
37. The major product formed in the following reaction is:

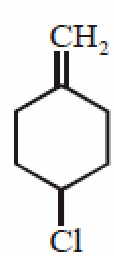
$CH_3CH = CHCH(CH_3)_2 \xrightarrow{HBr}$

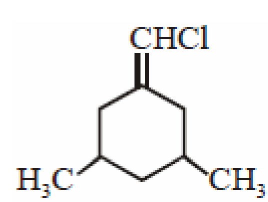
(A) $CH_3CH_2CH(Br)CH(CH_3)_2$
(B) $CH_3CH_2CH_2C(Br)(CH_3)_2$
(C) $Br(CH_2)_3CH(CH_3)_2$
(D) $CH_3CH(Br)CH_2CH(CH_3)_2$

38. Among the following compounds, geometrical isomerism is exhibited by:

(A) 

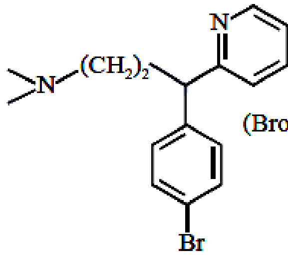
(B) 

(C) 

(D) 

39. Boron and silicon of very high purity can be obtained through:
(A) zone refining
(B) electrolytic refining
(C) liquation
(D) vapour phase refining

40. The following molecule acts as an:



(Brompheniramine)

(A) Antiseptic
(B) Anti-depressant
(C) Anti-histamine
(D) Anti-bacterial

41. Which one of the following polymers is not obtained by condensation polymerisation?
(A) Buna – N
(B) Nylon 6
(C) Nylon 6, 6
(D) Bakelite

42. Hydrogen peroxide, in the pure state, is:
(A) non-planar and blue in color
(B) planar and blue in color
(C) linear and blue in color
(D) linear and almost colorless

43. Reaction of ammonia with excel Cl_2 gives:
(A) NCl_3 and HCl
(B) NCl_3 and NH_4Cl
(C) NH_4Cl and N_2
(D) NH_4Cl and HCl

44. The one that is NOT suitable for the removal of permanent hardness of water is:
(A) Calgon's method
(B) Clark's method
(C) Treatment with sodium carbonate
(D) Ion-exchange method

45. Consider the complex ions,
$\text{trans}-\left[Co(en)_2 Cl_2\right]^+ (A)$ and
$\text{cis}-\left[Co(en)_2 Cl_2\right]^+$ (B). The correct statement regarding them is:
(A) both (A) and (B) cannot be optically active.
(B) (A) cannot be optically active, but (B) can be optically active.
(C) both (A) and (B) can be optically active.
(D) (A) can be optically active, but (B) cannot be optically active.

46. The number of chiral carbons present in sucrose is __________.

47. Considering that $\Delta_0 > P$, the magnetic moment (in BM) of $\left[Ru(H_2O)_6\right]^{2+}$ would be __________.

48. For a dimerization reaction,
$2\,A(g) \rightarrow A_2(g)$,
at 298 K, $\Delta U^{\ominus} = -20\,\text{kJ mol}^{-1}, \Delta S^{\ominus} = -30\ \text{JK}^{-1}\text{mol}^{-1}$, then the $\Delta G^{\ominus}$ will be __________ J.

49. The volume, in mL, of 0.02 M $K_2Cr_2O_7$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is __________.
(Molar mass of Fe = 56 mol^{-1})

50. For a reaction X + Y = 2Z, 1.0 mol of X, 1.5 mol of Y and 0.5 mol of Z were taken in a 1 L vessel and allowed to react. At equilibrium, the concentration of Z was 1.0 mol L^{-1}. The equilibrium constant of the reaction is __________ $\frac{x}{15}$. The value of x is __________.

PART–C (MATHEMATICS)

51. The value of $\left(\frac{-1+i\sqrt{3}}{1-i}\right)^{30}$ is:

(A) $2^{15}i$
(B) -2^{15}
(C) 6^5
(D) $-2^{15}i$

52. If the system of linear equations
$x + y + 3z = 0$
$x + 3y + k^2z = 0$
$3x + y + 3z = 0$
has a non-zero solution (x, y, z) for some $k \in R$, then $x + \left(\frac{y}{z}\right)$ is equal to:

(A) 3
(B) 9
(C) –3
(D) –9

53. $\lim_{x\to 0} \frac{x\left(e^{\left(\sqrt{1+x^2+x^4}-1\right)/x}-1\right)}{\sqrt{1+x^2+x^4}-1}$

(A) does not exist
(B) is equal to 1
(C) is equal to $\sqrt{e}$
(D) is equal to 0

54. If for some $\alpha \in R$, the lines $L_1: \frac{x+1}{2} = \frac{y-2}{-1} = \frac{z-1}{1}$ and $L_2: \frac{x+2}{\alpha} = \frac{y+1}{5-\alpha} = \frac{z+1}{1}$ are coplanar,
then the line L_2 passes through the point:

(A) (2, –10, –2)
(B) (10, –2,–2)
(C) (10, 2, 2)
(D) (–2, 10, 2)

55. Let y = y(x) be the solution of the differential equation
$\cos x \frac{dy}{dx} + 2y \sin x = \sin 2x, x \in \left(0, \frac{\pi}{2}\right)$.
If $y(\pi/3) = 0$, then $y(\pi/4)$ is equal to:

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

56. If $L = \sin^2\left(\frac{\pi}{16}\right) - \sin^2\left(\frac{\pi}{8}\right)$ and $M = \cos^2\left(\frac{\pi}{16}\right) - \sin^2\left(\frac{\pi}{8}\right)$, then:

(A) $M = \frac{1}{4\sqrt{2}} + \frac{1}{4}\cos\frac{\pi}{8}$
(B) $L = -\frac{1}{2\sqrt{2}} + \frac{1}{2}\cos\frac{\pi}{8}$
(C) $M = \frac{1}{2\sqrt{2}} + \frac{1}{2}\cos\frac{\pi}{8}$
(D) $L = \frac{1}{4\sqrt{2}} - \frac{1}{4}\cos\frac{\pi}{8}$

57. Which of the following point lies on the tangent to the curve $x^4e^y + 2\sqrt{y+1} = 3$ at the point (1, 0) ?
(A) (2, 2)
(B) (–2, 6)
(C) (–2, 4)
(D) (2, 6)

58. The derivation of $\tan^{-1}\left(\frac{\sqrt{1+x^2}-1}{x}\right)$ with respect to $\tan^{-1}\left(\frac{2x\sqrt{1-x^2}}{1-2x^2}\right)$ at $x = \frac{1}{2}$ is:
(A) $\frac{2\sqrt{3}}{3}$
(B) $\frac{\sqrt{3}}{10}$
(C) $\frac{\sqrt{3}}{12}$
(D) $\frac{2\sqrt{3}}{5}$

59. If the sum of the second, third and fourth terms of a positive term G.P. is 3 and the sum of its sixth, seventh and eights terms is 243, then the sum of the first 50 terms of this G.P. is:
(A) $\frac{1}{26}\left(3^{50}-1\right)$
(B) $\frac{1}{13}\left(3^{50}-1\right)$
(C) $\frac{2}{13}\left(3^{50}-1\right)$
(D) $\frac{1}{26}\left(3^{49}-1\right)$

60. The area (in sq. units) of the region $A = \left\{(x,y) : (x-1)[x] \le y \le 2\sqrt{x}, 0 \le x \le 2\right\}$, where [t] denotes the greatest integer function, is:
(A) $\frac{8}{3}\sqrt{2}-1$
(B) $\frac{4}{3}\sqrt{2}-\frac{1}{2}$
(C) $\frac{8}{3}\sqrt{2}-\frac{1}{2}$
(D) $\frac{4}{3}\sqrt{2}+1$

61. If $\int \frac{\cos\theta}{5+7\sin\theta-2\cos^2\theta}\,d\theta = A\log_e\left|B(\theta)\right| + C$, where C is a constant of integration, then $\frac{B(\theta)}{A}$ can be:
(A) $\frac{5(\sin\theta+3)}{2\sin\theta+1}$
(B) $\frac{5(2\sin\theta+1)}{\sin\theta+3}$
(C) $\frac{2\sin\theta+1}{5(\sin\theta+3)}$
(D) $\frac{2\sin\theta+1}{\sin\theta+3}$

62. If α and β are the roots of the equation, $7x^2-3x-2=0$, then the value of $\frac{\alpha}{1-\alpha^2}+\frac{\beta}{1-\beta^2}$ is equal to:
(A) $\frac{27}{32}$
(B) $\frac{27}{16}$
(C) $\frac{3}{8}$
(D) $\frac{1}{24}$

63. If the length of the chord of the circle, $x^2 + y^2 = r^2 \left(r > 0\right)$ along the line y – 2x = 3 is r, the r^2 is equal to:
(A) 12
(B) $\frac{12}{5}$
(C) $\frac{9}{5}$
(D) $\frac{24}{5}$

64. The statement $\left(P \to \left(q \to p\right)\right) \to \left(p \to \left(p \vee q\right)\right)$ is:
(A) a tautology
(B) equivalent to $\left(p \wedge q\right) \vee \left(\sim q\right)$
(C) equivalent to $\left(p \vee q\right) \wedge \left(\sim p\right)$
(D) a contradiction

65. There are 3 sections in a question paper and each section contains 5 questions. A candidate has to answer a total of 5 questions, choosing at least one question from each section. Then the number of ways, in which the candidate can choose the questions, is:
(A) 2255 (B) 3000 (C) 2250 (D) 1500

66. If a + x = b + y = c + z + 1, where a, b, c, x, y, x are non-zero distinct real numbers then $\begin{vmatrix} x & a+y & x+a \\ y & b+y & y+b \\ z & c+y & z+c \end{vmatrix}$ is equal to:
(A) y(a – b)
(B) y(b – a)
(C) 0
(D) y(a – c)

67. If the sum of the first 20 terms of the series $\log_{\left(7^{1/2}\right)} x + \log_{\left(7^{1/3}\right)} x + \log_{\left(7^{1/4}\right)} x + ...$ is 460, then x is equal to:
(A) 7^2
(B) $7^{46/21}$
(C) $7^{1/2}$
(D) e^2

68. If the line y = mx + c is a common tangent to the hyperbola $\frac{x^2}{100} - \frac{y^2}{64} = 1$ and the circle $x^2 + y^2 = 36$, then which one of the following is true?
(A) $4c^2 = 369$
(B) $c^2 = 369$
(C) 5m = 4
(D) 8m + 5 =0

69. If the mean and standard deviation of the data 3, 5, 7, a, b are 5 and 2 respectively, then a and b are the roots of the equation:
(A) $x^2 – 10x + 19 = 0$
(B) $x^2 – 20x + 18 = 0$
(C) $x^2 – 10x + 18 = 0$
(D) $2x^2 –20x + 19 = 0$

70. If x = 1 is a critical point of the function $f\left(x\right) = \left(3x^2 + ax - 2 - a\right)e^x$, then
(A) x = 1 is a local minima and $x = -\frac{2}{3}$.
(B) x = 1 and $x = \frac{-2}{3}$ are local minima of f.
(C) x = 1 is a local maxima and $x = -\frac{2}{3}$ is a local minima of f.
(D) x = 1 and $x = -\frac{2}{3}$ are local maxima of f.

71. Let A = (a, b, c) and B = (1, 2, 3, 4). Then the number of elements in the set $C = \{f : A \to B \mid 2 \in f(A) \text{ and f is not one} - \text{one}\}$ is __________.

72. The coefficient of x^4 in the expansion of $(1 + x + x^2 + x^3)^6$ in powers of x, is __________.

73. If the lines x + y = a and x – y = b touch the curve $y = x^2 - 3x + 2$ at the points where the curve intersects the x-axis, then $\frac{a}{b}$ is equal to __________.

74. Let the vectors $\vec{a}, \vec{b}, \vec{c}$ be such that $|\vec{a}| = 2, |\vec{b}| = 4$ and $|\vec{c}| = 4$. if the projection of $\vec{b}$ on $\vec{a}$ is equal to the projection of $\vec{c}$ on $\vec{a}$ and $\vec{b}$ is perpendicular to $\vec{c}$, then the value of $|\vec{a} + \vec{b} - \vec{c}|$ is ________.

75. In a bombing attack, there is 50% chance that a bomb will hit the target. At least two independent hits are required to destroy the target completely. Then the minimum number of bombs, that must be dropped to ensure that there is at least 99% chance of completely destroying the target, is __________.

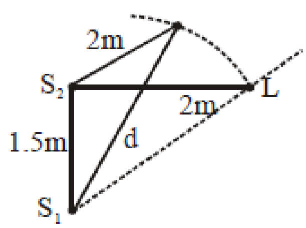
FIITJEE

Solutions to JEE (Main)-2020

PART –A (PHYSICS)

1. **B**

Sol.



Initially $S_2L = 2$ m

$S_1L = \sqrt{2^2 + (3/2)^2}$

$S_1L = \frac{5}{2} = 2.5$ m

$\Delta x = S_1L - S_2L = 0.5$ m

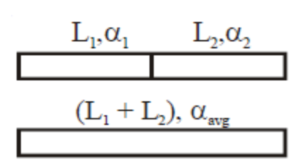
So since $\lambda = 1$ m. $\therefore \quad \Delta x = \frac{\lambda}{2}$

So white listener moves away from S_1. Then, Δx (= $S_1L - S_2L$) increases and hence, at $\Delta x = \lambda$ first maxima will appear. $\Delta x = \lambda = S_1L - S_2L$.

$1 = d - 2 \Rightarrow d = 3$ m.

2. **C**

Sol. At T°C $\quad L = L_1 + L_2$



At T + ΔT $\quad L_{eq} = L_1 + L_2$

where $L_1 = L_1(1 + \alpha_1\Delta T)$

$L_2 = L_2(1 + \alpha_2\Delta T)$

$L_{eq} = (L_1 + L_2)(1 + \alpha_{avg}\Delta T)$

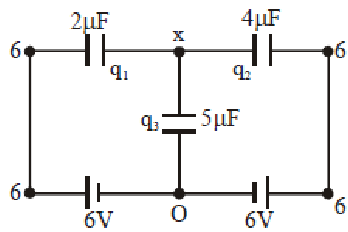
$\Rightarrow (L_1 + L_2)(1 + \alpha_{qev}\Delta T) = L_1 + L_2 + L_1\alpha_1\Delta T + L_2\Delta_2\Delta T$

$\Rightarrow (L_1 + L_2)\alpha_{avg} = L_1\alpha_1 + L_2\alpha_2$

$\Rightarrow \alpha_{avg} = \frac{L_1\alpha_1 + L_2\alpha_2}{L_1 + L_2}$

3. **A**

Sol.



Let potential of point O $v_0 = 0$

Now, using junction analysis

We can say, $q_1 + q_2 + q_3 = 0$

$2(x-6) + 4(x-6) + 5(x) = 0$

$x = \dfrac{36}{11} \qquad q_3 = \dfrac{36(5)}{11} = \dfrac{180}{11}$

$q_3 = 16.36\ \mu C$

4. **A**

Sol. In adiabatic process

PV_γ = constant

$$P\left(\frac{m}{\rho}\right)^{\gamma} = \text{constant}$$

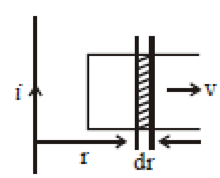
As mass is constant

$P \propto \rho\gamma$

$$\frac{P_f}{P_i} = \left(\frac{\rho_f}{\rho_i}\right)^{\gamma} = (32)^{7/5} = 2^7 = 128$$

5. **A**

Sol.



$$B = \frac{\mu_0 i}{2\pi r}$$

$$\phi = \frac{\mu_0 i}{2\pi r}\ell dr$$

$$\Rightarrow \frac{d\phi}{2t} = \frac{\mu_0 i \ell}{2\pi r}\cdot\frac{dr}{dt}$$

$$\Rightarrow e = \frac{\mu_o}{2\pi}\cdot\frac{iv\ell}{r}$$

$$i = \frac{e}{R} = \frac{\mu_0}{2\pi}\cdot\frac{iv\ell}{Rr}$$

6. **D**

Sol. $M = \mu_r NiA$

Here

μ_r = Relative permeability

N = Number of turns
i = Current
A = Area of cross section

$M = \mu_r NiA = \mu_r n\ell iA$

$M = \mu_r niV = 1000(1000)\ 0.5\ (10^{-3})$
$= 500 = 5 \times 10^2\ Am^2$

7. **A**

Sol. Energies of given Radiation can have
The following relation

$E_{\gamma\text{-Rays}} > E_{\text{X-Rays}} > E_{\text{microwave}} > E_{\text{AM Radiaowaves}}$

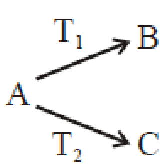
$\therefore\ \lambda_{\gamma\text{-Rays}} < \lambda_{\text{X-Rays}} < \lambda_{\text{microwave}} < \lambda_{\text{AM Radiowaves}}$

According to tres.

(a) Microwave $\rightarrow 10^{-3}$ m (iv)
(b) Gamma Rays $\rightarrow 10^{-15}$ m (ii)
(c) AM Radio wve $\rightarrow 100$ m (i)
(d) X-Rays $\rightarrow 10^{-10}$ m (iii)

8. **B**

Sol.



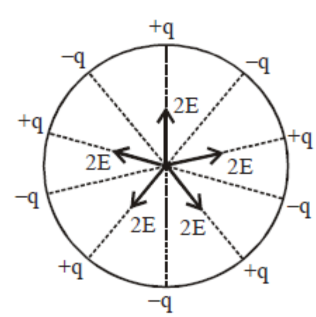
$$\frac{1}{T_{eff}} = \frac{1}{T_1} + \frac{1}{T_2}$$

$$T_{eff} = \frac{T_1T_2}{T_1 + T_2} = \frac{1000}{110} = \frac{100}{11} = 9.09$$

$$T_{eff} \cong 9$$

9. **C**

Sol. Potential of centre, = V =



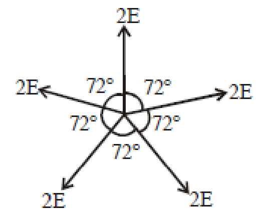
$$V_C = \frac{K(\sum q)}{R}$$

$$V_C = \frac{K(0)}{R} = 0$$

Electric field at centre $\vec{E}_B = \vec{E}_B = \sum \vec{E}$

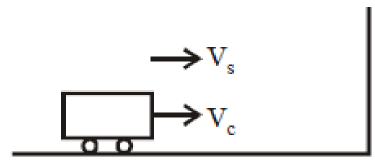
Let E be electric field produced by each charge at the centre, then resultant electric field will be

$E_C = 0$, since equal electric field vectors are acting at equal angle so their resultant is equal to zero.



10. **D**

Sol.



f_1 = frequency heard by wall = $f_s = \left(\frac{v_s}{v_s - v_e}\right)$

f_2 = frequency heard y driver after reflection from wall

$$f_2 = \left(\frac{v_s + v_c}{v_s}\right) f_1 = \left(\frac{v_s + v_e}{v_s - v_e}\right) f_0$$

$$\frac{f_2}{f_0} = \frac{v_s - v_c}{v_s + v_c}$$

$$\frac{48}{44} = \frac{v_s - v_c}{v_s + v_c}$$

$12(v_s + v_c) = 11(v_s - v_c)$

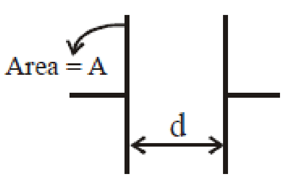
$23v_c = v_s$

$$v_c = \frac{v_s}{23} = \frac{345}{23} = 15 \text{ m/s}$$

$$= \frac{15 \times 18}{5} = 54 \text{ km/hr}$$

11. **D**

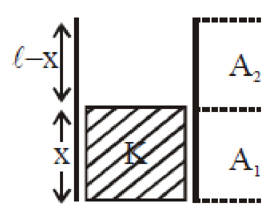
Sol.



Before inserting slab

$$C_i = \frac{\varepsilon_0 A}{d}$$

$$C_i = \frac{\varepsilon_0 \ell w}{d}$$



After inserting dielectric slab

$C_f = C_1 + C_2$

$$C_f = \frac{K\varepsilon_0 A_1}{d} + \frac{\varepsilon_0 A_2}{d}$$

$$C_f = \frac{K\varepsilon_0 wx}{d} + \frac{\varepsilon_0 w(\ell - x)}{d}$$

$$C_f = 2C_i \Rightarrow \frac{K\varepsilon_0 wx}{d} + \frac{\varepsilon_0 w(\ell - x)}{d} = \frac{2\varepsilon_0 \ell w}{d}$$

$$4x + \ell - x = 2\ell$$

$$x = \frac{\ell}{3}$$

12. **B**

Sol. $\frac{dm(t)}{dt} = bv^2$

$F_{thast} = v\frac{dm}{dt}$

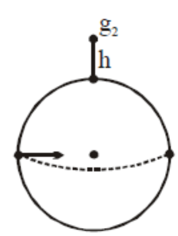
Force on satellite = $-\vec{v}\frac{dm(t)}{dt}$

M(t) a = –v (bv^2)

$a = a\frac{bv^3}{M(t)}$

13. **A**

Sol. $g_e = g - R\omega^2$



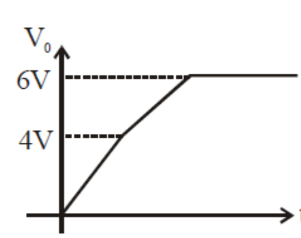
$g_2 = g - \frac{2gh}{R}$

Now $R\omega^2 = \frac{2gh}{R}$

$h = \frac{R^2\omega^2}{2g}$

14. **A**

Sol. Till input voltage reaches 4 V. No zener is in breakdown region. So $V_0 = V_i$ then now hen V_i changes between 4V to 6V one zener with 4V will breakdown are P.D. across this zener will become constant and remaining potential will drop acro resistance in series with 4V zener.

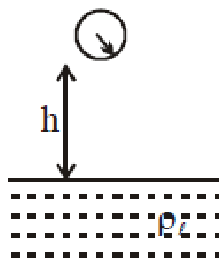


Now current in circuit increases Abruptly and

source must have an internal resistance due to which. Some potential will get drop across the source also so correct graph between V_0 and t will be
We have to assume some resistance in series with source.

15. **B**

Sol.



After falling through h, the velocity be equal to terminal velocity.

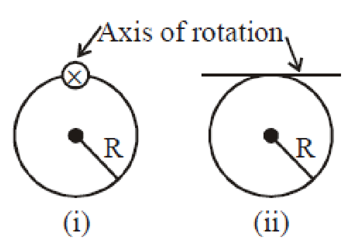
$$\sqrt{2gh} = \frac{2}{9}\frac{r^2 g}{\eta}(\rho_\ell - \rho)$$

$$\Rightarrow \quad h = \frac{2}{81}\frac{r^4 g(\rho_\ell - \rho)^2}{\eta^2}$$

$$\Rightarrow \quad h \propto r^4$$

16. **A**

Sol. Moment of inertia in case (i) is I_1



Moment of inertia in case (ii) is I_2

$I_1 = 2MR^2$

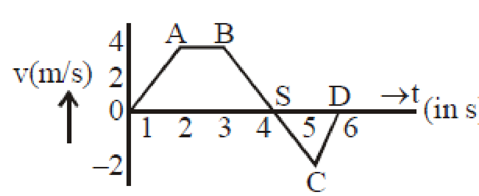
$I_2 = \frac{3}{2}MR^2$

$$T_1 = 2\pi\sqrt{\frac{I_1}{Mgd}} \quad ; \quad T_2 = 2\pi\sqrt{\frac{I_2}{Mgd}}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{2MR^2}{\frac{3}{2}MR^2}} = \frac{2}{\sqrt{3}}$$

17. **B**

Sol. $OS = 4 + \frac{1}{3} = \frac{13}{3}$



$SD = 2 - \frac{1}{3} = \frac{5}{3}$

Area of OABS is A_1

Area of SCD is A_2

Distance = $|A_1| + |A_2|$

$$A_1 = \frac{1}{2}\left[\frac{13}{3}+1\right]4 = \frac{32}{3}$$

$$A_2 = \frac{1}{2}\times\frac{5}{3}\times 2 = \frac{5}{3}$$

Distance = $|A_1| + |A_2|$

$$= \frac{32}{3}+\frac{5}{3} = \frac{37}{3}$$

18. **A**

Sol. $x = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = \text{speed} \Rightarrow [x] = [L^1T^{-1}]$

$y = \frac{E}{B} = \text{speed} \Rightarrow [y] = [L^1T^{-1}]$

$z = \frac{\ell}{RC} = \frac{\ell}{\tau} \Rightarrow [z] = [L^1T^{-1}]$

So, x, y, z all have the same dimensions.

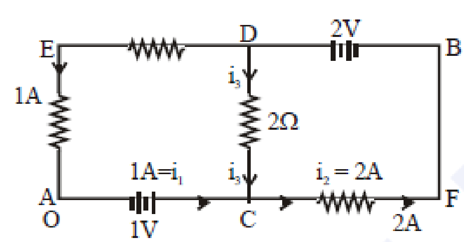
19. **D**

Sol. Figure of Merit = $C = \frac{i}{\theta}$

$= C = \frac{6\times10^{-3}}{2}$ = 3×10^{-3} Am^2

20. **A**

Sol. Let us assume the potential at A = V_A = 0.



Now at junction C, according to KCL

$i_1 + i_3 = i_2$

$1A + i_3 = 2A$

$i_3 = 2A$

Now analyse potential along ACDB

$v_A + 1 + i_3(2) - 2 = v_B$

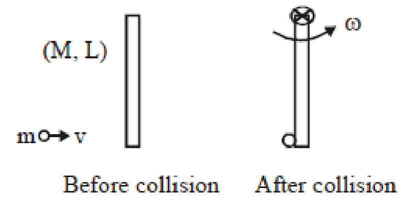
$0 + 1 + 2(1) - 2 = v_B$

$v_B = 3 - 2$

$v_B = 1$ amp.

21. **20.00**

Sol. $\vec{L}_i = \vec{L}_f$



mvL = Iω

$$mvL = \left(\frac{ML^3}{3} + mL^2\right)\omega$$

$$0.1 \times 80 \times 1 = \left(\frac{0.9 \times 1^2}{3} + 0.1 \times 1^2\right)\omega$$

$$8 = \left(\frac{3}{10} + \frac{1}{10}\right)\omega \quad ; \quad 8 = \frac{4}{10}\omega \quad ; \quad \omega = 20\,\text{rad}\frac{\text{rad}}{\text{sec}}$$

22. **2.00**

Sol. $E_1 = \phi + K_1$ ...(1)

$E_2 = \phi + K_2$ ...(2)

$E_1 - E_2 = K_1 - K_2$

Now $\frac{V_1}{V_2} = 2$

$\frac{K_1}{K_2} = 4$; $K_1 = 4K_2$

Now from equation (2)

$\Rightarrow$ $4 - 2.5 = 4K_2 - K_2$

$1.5 = 3K_2$

$K_2 = 0.5$ eV

Now putting this

Value in equation (2)

$2.5 = \phi + 0.5$ eV

$\phi = 2$ eV

23. **5.00**

Sol. $\delta_{min} = (\mu - 1)A$

$= (1.5 - 1)1$

$= 0.5$

$\delta_{min} = \frac{5}{10}$

N = 5

24. **40.93**

Sol. $V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{N_2} = V_{H_2}$

$\sqrt{\frac{3RT_{N_2}}{M_{N_2}}} = \sqrt{\frac{3RT_{H_2}}{M_{H_2}}}$

$\frac{573}{28} = \frac{T_{H_2}}{2}$

$\Rightarrow \quad T_{H_2} = 40.928$

25. **18.00**

Sol. P = constant

P = mav

$m\frac{dv}{dt}v = P$

$\int_0^v vdv = \frac{P}{m}\int_0^t dt$

$\frac{v^2}{2} = \frac{Pt}{m} \quad \Rightarrow \quad v = \left(\frac{2Pt}{m}\right)^{1/2}$

$\frac{dx}{dt} = \sqrt{\frac{2P}{m}}t^{1/2}$

$\int_0^x dx = \sqrt{\frac{2P}{m}}\int_0^t t^{1/2}dt$

$x = \sqrt{\frac{2P}{m}}\ \frac{t^{3/2}}{3/2} = \sqrt{\frac{2P}{m}} \times \frac{2}{3}t^{3/2}$

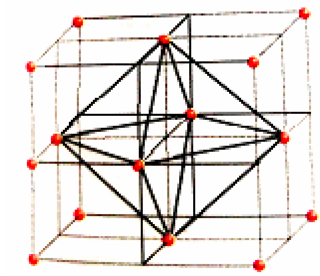
$= \sqrt{\frac{2\times 1}{2}} \times \frac{2}{3} \times 9^{3/2}$

$= \frac{2}{3} \times 27 = 18$

PART –B (CHEMISTRY)

26. D

Sol. In FCC octahedral voids are present at the edge centers and body center

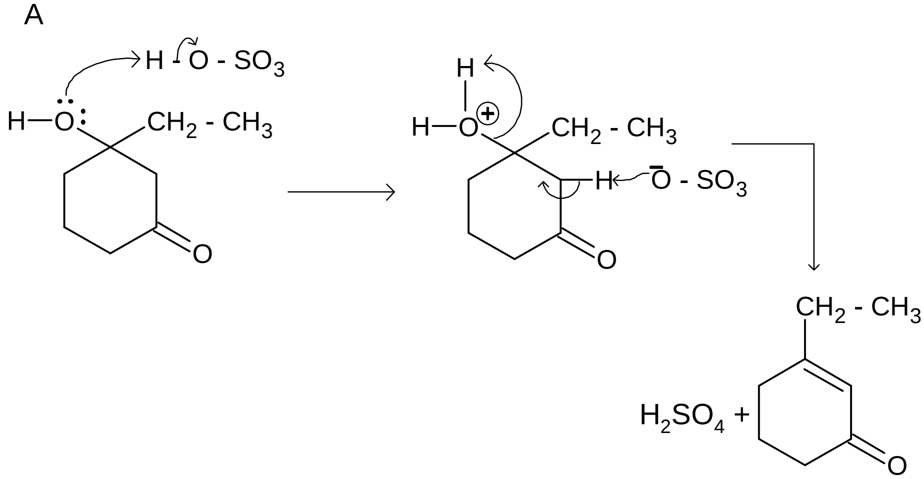


Consider a diagonal projected form edge centre passing through the body centre

Distance between octahedral voids = $\frac{\sqrt{2}a}{2} = \frac{a}{\sqrt{2}}$

27. A

Sol.



28. D

Sol. $\text{Gas} + \text{Solid} \rightleftharpoons \text{GS} \quad \Delta H = -ve$

Adsorbed gas

Adsorption of gas is an exothermic process. Increase in temperature reduces the extent of adsorption.

$\frac{x}{m} = K_P^{1/n} (n > 1)$

29. B

Sol. KNO_3, HCl and NaCl are strong electrolytes for these electrolytes of $\wedge_m$ with $\sqrt{c}$ will be liner which can be given as

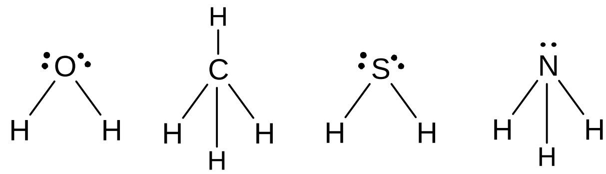
$\wedge_m = \wedge_m^0 - A\sqrt{c}$ for strong electrolyte

Since given variation is not linear it has to be a weak electrolyte

CH_3COOH is a weak electrolyte

30. B

Sol.



B.E ≈ 104^o ≈ 109^o ≈ 92^o ≈ 107^o

Using VSEPR, L.P – B.P repulsion we can safely say that CH_4 should have highest bond angle among the given

31. B

Sol. In isoelectronic species nuclear charge can be approximated as

Nuclear charge $\approx \dfrac{Z}{\text{no. of electrons}}$

	Al^{3+}	Mg^{2+}	Na^{+}	F^{-}	O^{2-}	N^{3-}
Nuclear Charge	$\frac{13}{10}$	$\frac{12}{10}$	$\frac{11}{10}$	$\frac{9}{10}$	$\frac{8}{10}$	$\frac{7}{10}$

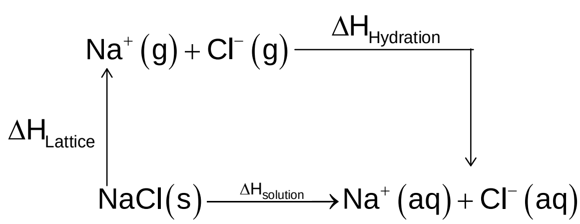
Minimum nuclear charge is in N^{3-} and maximum is in Al^{3+}

So order should be

$Al^{3+} < Mg^{2+} < Na^{+} < F^{-} < O^{2-} < N^{3-}$

32. B

Sol.



Hess's law

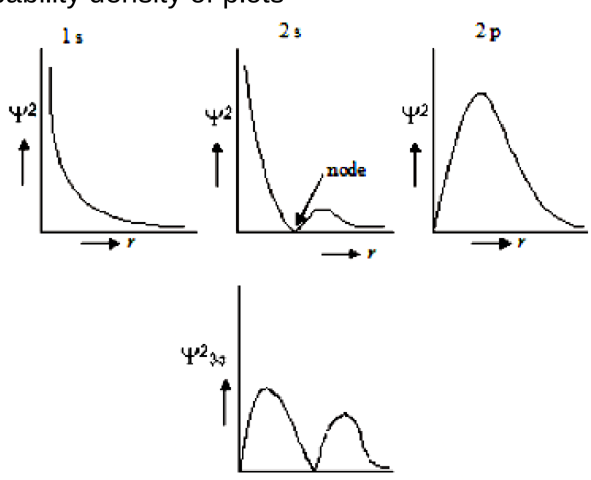
$\Delta H_{solution} = \Delta H_{lattice} + \Delta H_{hydration}$

$4 = 788 + \Delta H_{hydration}$

$\Delta H_{hydration} = -784 \text{ kJ mol}^{-1}$

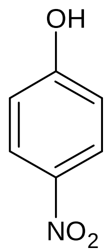
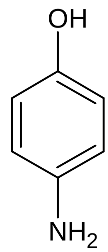
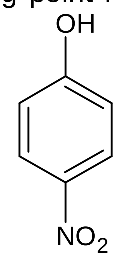
33. A

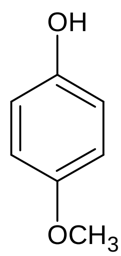
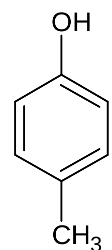
Sol. Probability density of plots



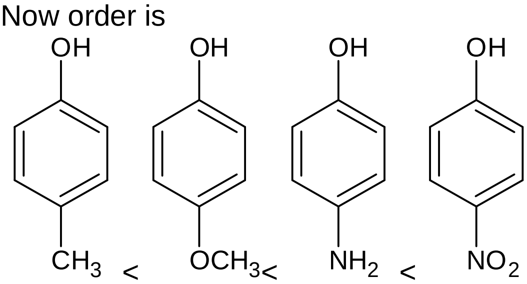
From the given graph answer is (1)

34. A

Sol. In  and  there is intermolecular hydrogen boding this hydrogen bonding will make there boiling point higher than other two. Now between these two hydrogen bonding is stronger in  (higher electronegativity of oxygen).

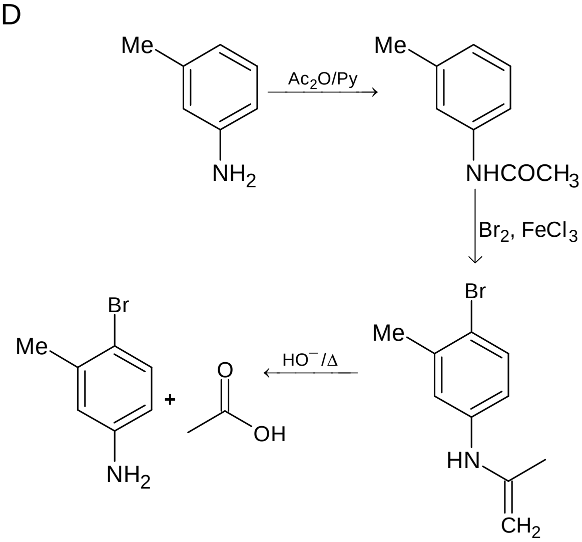
Boiling point of  will be higher than  due to higher molar mass (and dipole-dipole interaction)

Now order is



35. D

Sol.



36. A

Sol. $\ell nK = -\frac{E_a}{RT} + I$

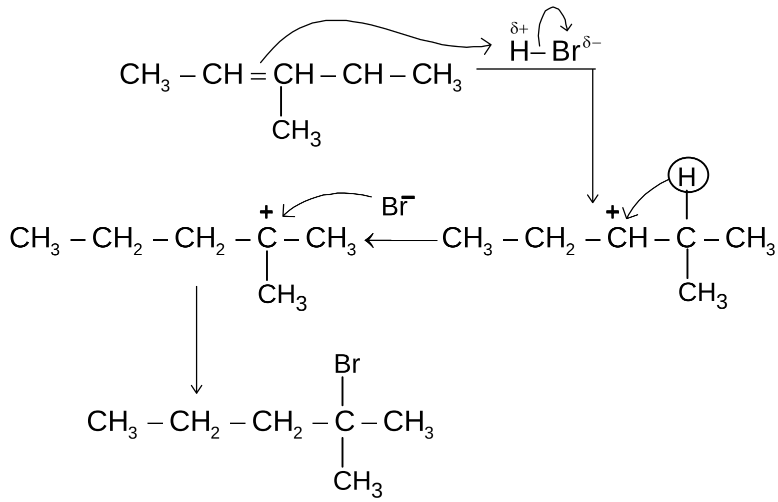
$-\frac{E_a}{R} = \text{slope}$ slope is negative

$\Rightarrow -\frac{E_a}{R} = -\frac{10-0}{5-0}$

$E_a = 2R$

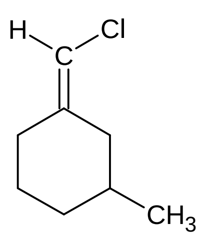
37. B

Sol.

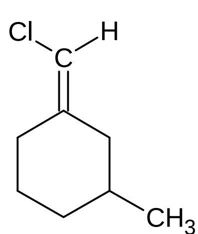


38. A

Sol.



and



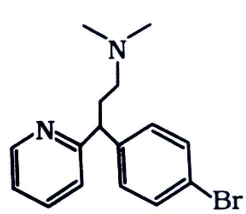
Geometrical isomers

39. A

Sol. Zone refining is used to obtain high purity elements which are used in the manufacture of semiconductors. Boron and silicon both are used in semiconductors.

40. C

Sol.



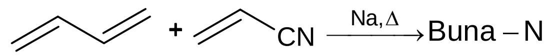
Brompheniramine
(Dimetapp, Dimetane)

Anti Histamine(Given in NCERT)

41. A

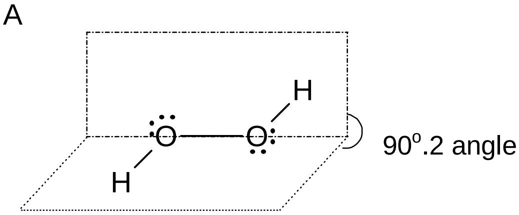
Sol. Nylon 6, Nylon 6, 6 & Bakelite are condensation polymers.

Buna – N- Addition polymerization



42. A

Sol.



Hydrogen peroxide has open book type structure. It is coloureless in free state

43. A

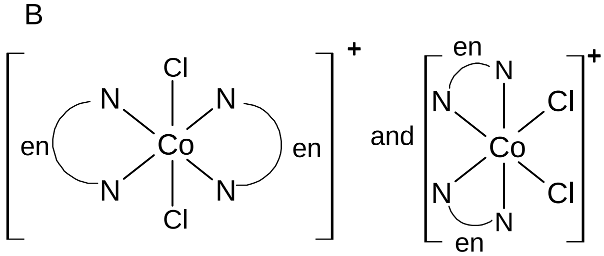
Sol. $NH_3 + \underset{(excess)}{3Cl_2} \longrightarrow NCl_3 + 3HCl$

44. B

Sol. Boiling and clark's method ($Ca(OH)_2$) are used for removing temporary hardness. Whereas, calgon, sodium carbonate ion exchange method are used for removing permanent hardness.

45. B

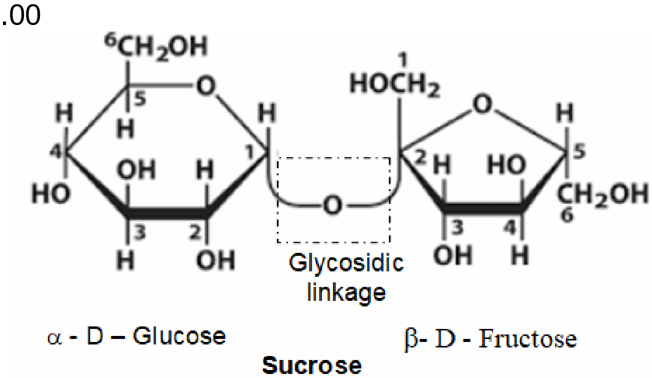
Sol.



(A) Trans	(B) Cis
Optically inactive due to presence of plane of symmetry	Optically active no plane of symmetry

46. 9.00

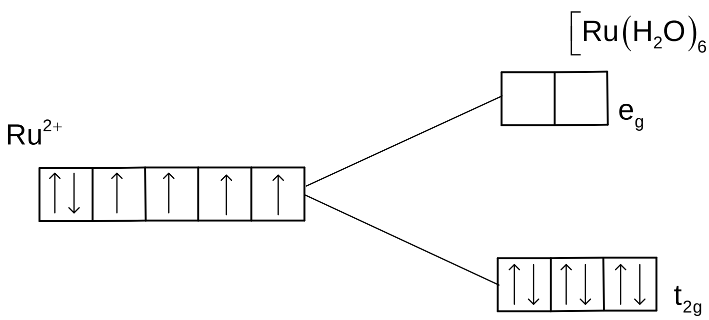
Sol.



47. 0.00

Sol. $\Delta_0 > P$

Pairing of electron will take place



Number of unpaired electron = 0

μ = 0.00

48. –13.49

Sol. $2\ A(g) \rightarrow A_2(g)$

$\Delta n_g = 1 - 2$

$\Delta n_g = 1$

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta H = -20 \times 10^3 + (-1)8.31 \times 298$

$\Delta H = -22477.572\ J\ mol^{-1}$

$\Delta G = \Delta H - T\Delta S$

$\Delta G = -22477.572 - (-30)298 = -22477.572 + 8940$

$\Delta G = -13537.57\ J\ mol^{-1}$

49. 50.00

Sol. $\underset{n_f=6}{K_2Cr_2O_7} + \underset{n_f=3}{FeC_2O_4} \longrightarrow Fe^{3+} + \underset{+H_2O}{CO_2} + Cr^{3+} + K^+$

Now apply equivalent concept

$$\underbrace{0.02 \times 6}_{\text{Normality}} \times V = \frac{0.288}{\frac{144}{3}} \times 10^3$$

$$V = \frac{0.288 \times 10^3}{48 \times 6 \times 0.02} = 50.00\ mL$$

50. 16.00

Sol. $X + Y \rightleftharpoons 2Z$

	X	Y	2Z
Initial	1.0	1.5	0.5
At equ^m	1 – x	1.5 – x	0.5 + 2x
equ^m conc	0.75	1.25	1.0

0.5 + 2x = 1

x = 0.25

$$K = \frac{1}{0.75 \times 1.25}$$

$$K = \frac{16}{15}$$

X = 16.00

PART–C (MATHEMATICS)

51. D

Sol. $$\left(\frac{-1+\sqrt{3}i}{1-i}\right)^{30} = \left(\frac{2\cos\left(\frac{2\pi}{3}\right)+i\sin\left(\frac{2\pi}{3}\right)}{\sqrt{2}\left(\cos\frac{\pi}{4}-i\sin\frac{\pi}{4}\right)}\right)^{30}$$

$$=\frac{2^{30}\left(\cos 20\pi + i\sin 20\pi\right)}{2^{15}\left(\cos\frac{15\pi}{2}-i\sin\frac{15\pi}{2}\right)}$$

$$=\frac{2^{15}\left(1+0i\right)}{\left(0+i\right)}=-2^{15}i$$

52. C

Sol. So $D = 0 \rightarrow \begin{vmatrix} 1 & 1 & 3 \\ 1 & 3 & k^2 \\ 3 & 1 & 3 \end{vmatrix} = 0 \quad \Rightarrow \qquad k^2 = 9$

$x + y + 3z = 0$ ……………..(1)

$x + 3y + 9z = 0$ ……………..(2)

$3x + y + 3z = 0$ ……………..(3)

(1) – (3)

$x = 0 \Rightarrow y + 3z = 0$

$\frac{y}{z} = -3$

So $x + \left(\frac{y}{z}\right) = -3$

53. B

Sol. $$\lim_{x\to 0}\frac{\left(e^{\frac{\sqrt{1+x^2+x^4}-1}{x}}-1\right)}{\left(\frac{\sqrt{1+x^2+x^4}-1}{x}\right)}$$

put $\frac{\sqrt{1+x^2+x^4}-1}{x} = t$

clearly $x \rightarrow 0 \Rightarrow t \rightarrow 0$

$\therefore$ given limit $= \lim_{t\to 0} \frac{e^t - 1}{t} = 1$

54. A

Sol. Line are coplanar

so $\begin{vmatrix} \alpha & 5-\alpha & 1 \\ 2 & -1 & 1 \\ +1 & +3 & 2 \end{vmatrix} =$

$-5\alpha + (\alpha - 5)3 + 7 = 0$

$-2\alpha = 8 \Rightarrow \alpha = -4$

$\Rightarrow L_2 : \frac{x+2}{-4} = \frac{y+1}{9} = \frac{z+1}{1}$

Now by cross checking option (A) is correct.

55. D

Sol. $\frac{dy}{dx} + 2\tan x.y = 2\sin x$

I.F. $= e^{\int 2\tan x\, dx} = \sec^2 x$

Solution is $y.\sec^2 x = \int 2\sin x.\sec^2 x\, dx + C$

$y\sec^2 x = 2\sec x + C$

$0 = 2.2 + c \Rightarrow c = -4$

$y\sec^2 x = 2\sec x - 4$

$y\left(\frac{\pi}{4}\right) = \sqrt{2} - 2$

56. C

Sol. $L = \sin\left(\frac{\pi}{16} + \frac{\pi}{8}\right)\sin\left(\frac{\pi}{16} - \frac{\pi}{8}\right)$

$\sin\frac{3\pi}{16}.\sin\left(-\frac{\pi}{16}\right)$

$= \frac{1}{2}\left(\cos\left(\frac{3\pi}{16} + \frac{\pi}{16}\right) - \cos\left(\frac{3\pi}{16} - \frac{\pi}{16}\right)\right) =$

$= \frac{1}{2}\left(\frac{1}{\sqrt{2}} - \cos\frac{\pi}{8}\right)$

$M = \cos\left(\frac{\pi}{16} + \frac{\pi}{8}\right)\cos\left(\frac{\pi}{16} - \frac{\pi}{8}\right)$

$\cos\frac{3\pi}{16}.\cos\left(-\frac{\pi}{16}\right)$

$$=\frac{1}{2}\left(\cos\left(\frac{3\pi}{16}+\frac{\pi}{16}\right)+\cos\left(\frac{3\pi}{16}-\frac{\pi}{16}\right)\right)$$

$$=\frac{1}{2}\left(\frac{1}{\sqrt{2}}+\cos\frac{\pi}{8}\right)$$

57. C

Sol. $e^y y' x^4 + 4x^3 e^y + 2y'\frac{1}{2\sqrt{y+1}} = 0$ at (1, 0)

$y' + 4 + y' = 0 \quad \Rightarrow \quad y' = -2$

equation of tangent at $(1,0)$ is $2x + y - 2 = 0$

So option (C) is correct.

58. B

Sol. Let $x = \tan\theta$

$$y_1 = \tan^{-1}\left(\frac{\sec\theta - 1}{\tan\theta}\right) = \tan^{-1}\left(\tan\frac{\theta}{2}\right) = \frac{\theta}{2} = \frac{1}{2}\tan^{-1}x$$

$$x = \sin\phi, y_2 = \tan^{-1}\left(\frac{2\sin\phi\cos\phi}{\cos 2\phi}\right)$$

$$= \tan^{-1}(\tan 2\phi) = 2\phi = 2\sin^{-1}x$$

$$\frac{dy_1}{dy_2} = \frac{dy_1/dx}{dy_2/dx} = \frac{\frac{1}{(1+x^2)}\cdot\frac{1}{2}}{2.\frac{1}{\sqrt{1-x^2}}}$$

$$= \frac{\sqrt{1-x^2}}{4(1+x^2)} = \frac{\sqrt{1-\frac{1}{4}}}{4\left(1+\frac{1}{4}\right)} = \frac{\sqrt{3}}{10}$$

59. A

Sol. Let $a, ar, ar^2 \ldots\ldots\ldots$ G.P.

$T_2 + T_3 + T_4 = 3 \quad \Rightarrow \quad ar(1+r+r^2) = 3 \quad \ldots\ldots\ldots$(i)

$T_6 + T_7 + T_8 = 243 \quad \Rightarrow \quad ar^5(1+r+r^2) = 243 \quad \ldots\ldots\ldots$(ii)

by (i) and (ii)

$r^4 = 81 \quad \Rightarrow \quad r = 3$

$\therefore \quad a = \frac{1}{13}$

$$S_{50} = \frac{a\left(r^{50}-1\right)}{r-1} = \frac{3^{50}-1}{26}$$

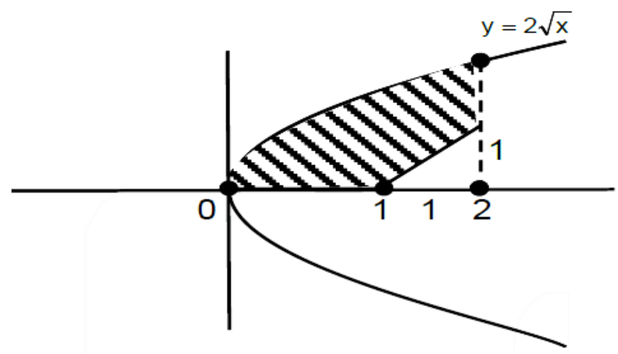
60. B

Sol. $y = [x](x-1)$

$$= \begin{cases} 0 & 0 \le x < 1 \\ x-1 & 1 \le x < 2 \end{cases}$$

$$\text{Area } = \int_0^2 2\sqrt{x}.dx - \frac{1}{2}(1)(1)$$

$$= \left(\frac{4x^{3/2}}{3}\right)_0^2 - \frac{1}{2} = \frac{8\sqrt{2}}{3} - \frac{1}{2}$$



61. B

Sol. $$I = \int \frac{\cos\theta}{2\sin^2\theta + 7\sin\theta + 3} d\theta$$

$\sin\theta = t \qquad \Rightarrow \qquad \cos\theta\, d\theta = dt$

$$= \frac{1}{2}\int \frac{1}{t^2 + \frac{7}{2}t + \frac{3}{2}} dt$$

$$= \frac{1}{2}\int \frac{1}{\left(t+\frac{7}{4}\right)^2 - \left(\frac{5}{4}\right)^2} dt$$

$$= \frac{1}{2}\ln\left|\frac{2t+1}{t+3}\right| + c$$

$$= \frac{1}{5}\ln\left|\frac{2\sin\theta+1}{\sin\theta+3}\right| + c$$

So $A = \frac{1}{5}$

$$B(\theta) = \frac{5(2\sin\theta+1)}{\sin\theta+3}$$

62. B

Sol. $\alpha + \beta = \frac{3}{7}. \alpha\beta = -\frac{2}{7}$

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

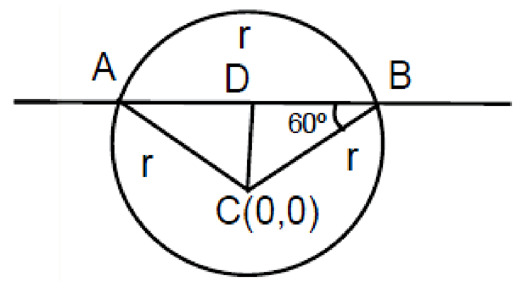
$$= \frac{(\alpha+\beta)-\alpha\beta(\alpha+\beta)}{1+(\alpha\beta)^2-(\alpha^2+\beta^2)}$$

$$\Rightarrow \frac{(\alpha+\beta)-\alpha\beta(\alpha+\beta)}{1+(\alpha\beta)^2-(\alpha+\beta)^2+2\alpha\beta}$$

$$= \frac{\frac{3}{2}+\frac{2}{7}\left(\frac{3}{7}\right)}{1+\left(\frac{2}{7}\right)^2-\left(\frac{3}{7}\right)^2-2\left(\frac{2}{7}\right)} = \frac{27}{16}$$

63. B

Sol. $AB = r,\ AD = \frac{r}{2}$



$CD = r\sin 60^o = \frac{\sqrt{3}r}{2}$

$\Rightarrow \frac{|0+0-3|}{\sqrt{1^2+2^2}} = \frac{\sqrt{3}r}{2} \Rightarrow r = 2\sqrt{\frac{3}{5}} \Rightarrow r^2 = \frac{12}{5}$

64. A

Sol.

p	q	$q \rightarrow p$	$p \vee q$	$r : p \rightarrow (q \rightarrow$	$s : p \rightarrow (p \vee$	$r \rightarrow s$
T	T	T	T	T	T	T
T	F	T	T	T	T	T
F	T	F	T	T	T	T
F	F	T	F	T	T	T

65. C

Sol. $A \rightarrow 5Q$ $\quad B \rightarrow 5Q$ $\quad C \rightarrow 5QA$

A_1, A_2, A_3, A_4, A_5 $\quad B_1, B_2, B_3, B_4, B_5$ $\quad C_1, C_2, C_3, C_4, C_5$

$A_1A_2A_3\,B_1C_1 \Rightarrow {}^3C_1 \times {}^5C_3 \times {}^5C_1 \times {}^5C_1 = 750$

$A_1A_2B_1B_2C_1 \Rightarrow {}^3C_2 \times {}^5C_2 \times {}^5C_2 \times {}^5C_1 = 1500$

$\therefore$ Total = 2250

66. A

Sol. Given $x+a=y+b+1=z+c$

Now $\begin{vmatrix} x & a+y & a+x \\ y & b+y & b+y \\ z & c+y & c+z \end{vmatrix} = \begin{vmatrix} x & a+y & a \\ y & b+y & b \\ z & c+y & c \end{vmatrix}\left(C_3 \to C_3 - C_1\right)$

$= \begin{vmatrix} x & y & a \\ y & y & b \\ z & y & c \end{vmatrix}\left(C_2 \to C_2 - C_3\right)$

$= y\begin{vmatrix} x & 1 & b \\ y & 1 & b \\ z & 1 & c \end{vmatrix}$

$R_2 \to R_2 - R_1$ and $R_3 \to R_3 - R_1$

$y.\begin{vmatrix} x & 1 & a \\ y-x & 0 & b-a \\ z-x & 0 & c-a \end{vmatrix} = y\begin{vmatrix} x & 1 & a \\ a-b & 0 & -(a-b) \\ z-x & 0 & c-a \end{vmatrix}$

$= y(a-b)\begin{vmatrix} x & 1 & a \\ 1 & 0 & -1 \\ z-x & 0 & c-a \end{vmatrix}$

$= -y(a-b)(c-a+z-x) = y(a-b)$

67. A

Sol. Given $\log_{7^{\frac{1}{2}}} x + \log_{7^{\frac{1}{3}}} x + \log_{7^{\frac{1}{4}}} x + \ldots\ldots 20$ times = 460

$\Rightarrow \quad (2+3+4.....+21)\log_7 x = 460$

$\Rightarrow \quad \frac{20}{2}(2+21)\log_7 x = 460$

$\Rightarrow \quad \log_7 x = 2$

$\Rightarrow \quad x = 49$

68. A

Sol. $c^2 = 36\left(1+m^2\right)$ ………….(1)

$c^2 = 100m^2 - 64$ ………….(2)

$100m^2 - 64 = 36 + 36m^2$

69. A

Sol. $5+3+7+a+b = 25 \Rightarrow a+b = 10$

S.D. $= \sqrt{\frac{5^2+3^2+7^2+a^2+b^2}{2} - 5^2} = 2$

$$= \frac{a^2+b^2+83}{5} - 25 = 4 \Rightarrow a^2+b^2 = 62$$

$$\Rightarrow (a+b)^2 - 2ab = 62 \Rightarrow ab = 19$$

So equation whose roots are a and b is $x^2 - 10x + 19 = 0$

70. D

Sol. $f(x) = (3x^2 + ax - 2 - a)e^x$

$f'(x) = (3x^2 + ax - 2 - a)e^x + e^x(6x + a)$

$= e^x(3x^2 + (a+6)x - 2)$

$\because$ x = 1 is a critical point

$\therefore$ $f'(1) = 0$

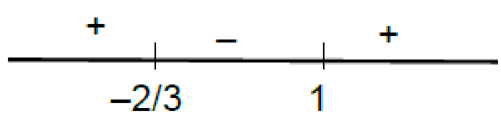
$\therefore$ $3 + a + 6 - 2 = 0$

$a = -7$

$\therefore f'(x) = e^x(3x^2 - x - 2)$

$= e^x(3x^2 - 3x + 2x - 2)$

$= e^x(3x+2)(x-1)$



$\therefore$ maxima at $x = \frac{-2}{3}$

$\therefore$ minima at x = 1

71. 19.00

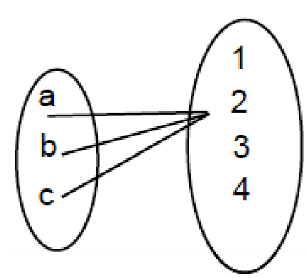
Sol. Only ‘2’ in range $\rightarrow$ 1 function

one element out of 1, 3, 4 is in range with ‘2’

number of ways $= {}^3C_1 . \frac{3!}{2!.1!} . 2! = 18$

(Select one from 1, 3, 4 and distribute among a, b, c)

Total function $= 1 + 18 = 19$



72. 120.00

Sol. $(1 + x + x^2 + x^4)^6 = (1+x)^6 . (1+x^2)^6$

Coefficient of $x^4 = {}^6C_4 . {}^6C_0 + {}^6C_2 . {}^6C_1 + {}^6C_0 . {}^6C_2$

$= 15 + 90 + 15$

$= 120$

73. 0.50

Sol. $y = x^2 - 3x + 2,\qquad x + y = a, x - y = b$

$2x_1 - 0 = 31 \qquad 2x_2 - 3 = -1$

$x_1 = 2 \qquad x_2 = 1$

$x_1 = 4 - 6 + 2 = 0 \qquad x_2 = 0$

$(2,0) \qquad (1, 0)$

$b = 2 \qquad a = 1$

$\therefore \frac{a}{b} = \frac{1}{2} = 0.5$

74. 6.00

Sol. $\vec{b}.\vec{a} = \vec{c}.\vec{a}$

$\left|\vec{a} + \vec{b} - \vec{c}\right|^2 = \left|\vec{a}\right|^2 + \left|\vec{b}\right|^2 + \left|\vec{c}\right|^2 + 2\left(\vec{a}.\vec{b} - \vec{b}.\vec{c} - \vec{a}.\vec{c}\right)$

$= 4 + 16 + 16 + 2\left(\vec{a}.b - 0 - \vec{a}.\vec{b}\right) = 36$

$\Rightarrow \left|\vec{a} + \vec{b} - \vec{c}\right| = 6$

75. 11.00

Sol. Let probability of hitting the target $= p \Rightarrow p = \frac{1}{2}$

Let n be the minimum number of bombs
According to given condition

$1 - \left({}^nC_0P^0(1-P)^n + {}^nC_1P^1(1-P)^{n-1}\right) \geq \frac{99}{100}$

$\Rightarrow \qquad 2^n \geq (n+1)100$

$n = 10 \qquad \Rightarrow \qquad 2^{10} \geq 1100$ Reject

$n = 11 \qquad \Rightarrow \qquad 2^{11} \geq 1200$ Select