JEE MAIN 2026

Sample Paper – 3

Time Allowed: 3 hours **Maximum Marks:** 300

General Instructions:

1. The test consists of total **75 questions.**

2. Each subject **(PCM)** has **25 questions.**

3. Each subject divided into two sections. **Section A** consists of 20 multiple-choice questions & **Section B** consists of 5 numerical value-type questions.

4. Marking Scheme:

- **Section A (MCQs):** +4 marks for each correct answer, –1 mark for each incorrect answer, 0 marks for unattempted.
- **Section B (Numerical):** +4 marks for each correct answer, 0 marks for incorrect or unattempted.

5. Any textual, printed, or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.

6. All calculations/written work should be done in the rough sheet is provided with the Question Paper.

Physics

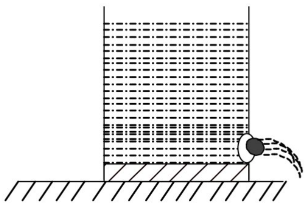
PART – A

SECTION – A

(Single Choice Answer Type)

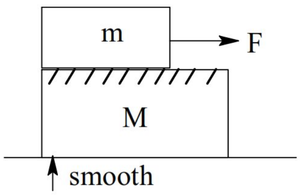
This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Liquid of density ρ is filled in the container of negligible mass having area A. Area of hole 'a' is very small (a << A). Co-efficient of friction between container and surface is equal to $\left(\frac{a}{A}\right)$. As liquid is coming out of vessel, instantaneous acceleration of the container.



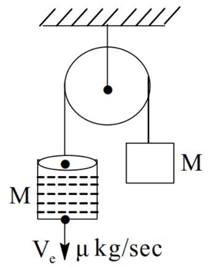
(A) $\left(\frac{A}{a}g\right)$
(B) $\frac{3g}{2}$
(C) $\left(\frac{ag}{A}\right)$
(D) zero

2. A plank having mass M is placed on smooth horizontal surface. Block of mass m is placed on it coefficient of friction between block and plank is $\mu_0 + kx$, where k is constant and x is relative displacement between block and plank. A force F is applied on block where F = at, where a = 10; t is in second. Find t_0 when relative motion will occur between block and plank



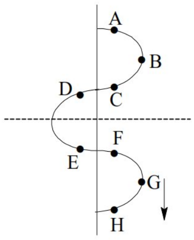
(A) $\mu_0 M + \frac{\mu_0 M^2}{m}$
(B) $\mu_0 m + \frac{\mu_0 M^2}{m}$
(C) $\mu_0 m + \frac{\mu_0 m^2}{M}$
(D) $\mu_0 M + \frac{\mu_0 m^2}{M}$

3. Velocity of water flow in downward direction relative to cylindrical tank is V_e acceleration at any time t will be



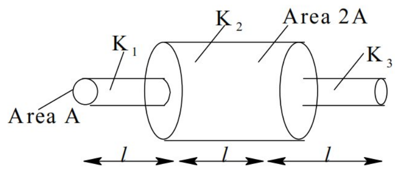
(A) $\frac{\mu(v_e + gt)}{(2M - \mu t)}$
(B) $\frac{\mu v_e}{(2M - \mu t)}$
(C) $\frac{\mu gt}{(2M - \mu t)}$
(D) None of these

4. A transverse wave travelling along negative y-axis its snap shot is given at any instant of time t. Points which is having velocity in negative x-direction.



(A) A,E,F
(B) C,D,H
(C) B,G,H
(D) A,H

5. Equivalent thermal conductivity of figure given below will be? Given that length of each cylinder is l and area of cylinder having thermal conductivity $K_1 \& K_3$ is A while middle cylinder is having K_2.



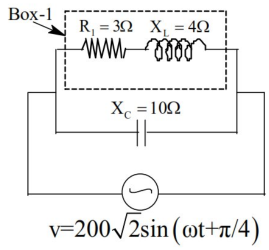
(A) $\dfrac{5}{2\left[\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right]}$

(B) $\dfrac{1}{\left(\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right)}$

(C) $\dfrac{2}{5\left[\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right]}$

(D) None of these

6. As shown in figure , Instantaneous current in branch having capacitor C will be :(given $\tan^{-1}$ (4/3) = 53°)



(A) $20\sqrt{2}\sin(\omega t+3\pi/4)$

(B) $40\sqrt{2}\sin(\omega t+\pi/4)$

(C) $60\sqrt{2}\sin(\omega t-\pi/4)$

(D) None of above

7. A thermodynamic process obeys the following relation $2dQ = dU + 2dW$ where dQ, dU, dW has usual meaning. Then heat capacity for the process is:
[Given di-atomic gas; R = gas constant]

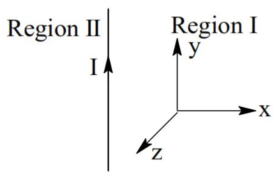
(A) $\dfrac{5R}{2}$

(B) $\dfrac{7R}{2}$

(C) $\dfrac{3R}{5}$

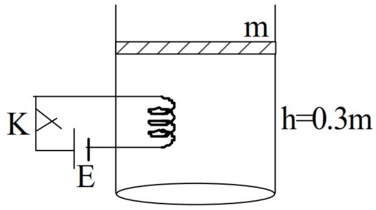
(D) infinite

8. A infinite length current carrying wire is placed in x, y plane parallel to y axis as shown in figure. (All charges are projected in region I)



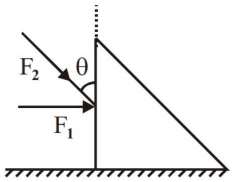
(A) A positively charged particle projected along y axis will get deflected along z axis
(B) A positively charged particle projected along x axis will get deflected along y axis
(C) A negatively charged particle is projected along x axis will get deflected along +y axis
(D) A negatively charge particle is projected along x axis will get deflected along +z axis

9. An insulated cylinder contains nitrogen gas which is sealed on the top by a heavy metal piston of mass m. Piston is free to move with negligible friction. Initial height of the piston is 0.3 m at temperature 27°C when it is given some heat with the help of an electrical circuit piston slowly rises to height 0.5 m above the bottom of the cylinder. During expansion of the gas, net heat absorbed by the nitrogen gas:



(A) Equal to work done by nitrogen gas on the piston
(B) Greater to work done by nitrogen gas on the piston
(C) Less to work done by nitrogen gas on the piston
(D) Will be always twice of the work done by the gas on the piston

10. A wedge of mass m, lying on a rough horizontal plane, is acted upon by a horizontal force F_1 and another force F_2, inclined at an angle θ to the vertical. The block is in equilibrium, then minimum coefficient of friction between it and the surface is



(A) $(F_2\sin\theta)/(mg+F_2\cos\theta)$ (B) $(F_1\cos\theta+F_2)/(mg-F_2\sin\theta)$

(C) $(F_1+F_2\sin\theta)/(mg+F_2\cos\theta)$ (D) $(F_1\sin\theta-F_2)/(mg-F_2\cos\theta)$

11. A charge particle is projected in a region of magnetic field and electric field. If mass of charged particle is m and its speed changes from V_0 to $2V_0$ [W_E = work done by electric field; W_B = work done by magnetic field]. Which statement is incorrect?

(A) $W_B = \frac{1}{2}mv_0^2$ (B) $W_B + W_E = \frac{3}{2}mv_0^2$

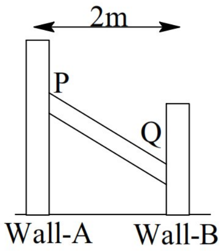
(C) $W_E = \frac{3}{2}mv_0^2$ (D) $W_E - W_B = \frac{3}{2}mv_0^2$

12. De-Broglie wavelength of the particle increases by 75% then kinetic energy of particle becomes

(A) $\frac{16}{49}$ times (B) $\frac{9}{16}$ times

(C) $\frac{16}{25}$ times (D) $\frac{4}{9}$ times

13. Two vertical walls are separated by a distance of 2 metres. Wall 'A' is smooth while wall B is rough with a coefficient of friction μ = 0.5. A uniform rod is propped between them. The length of the longest rod that can be probed between the walls is equal to :

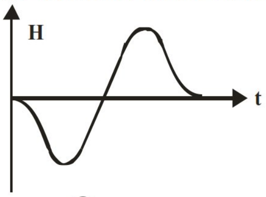


(A) 2 metres (B) $2\sqrt{2}$ metres

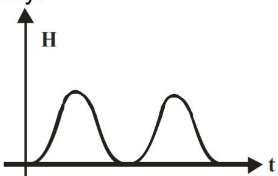
(C) $\sqrt{5}$ metres (D) $\frac{\sqrt{17}}{2}$ metres

14. A bar magnet is pulled along axis of a coil with uniform velocity with South Pole entering into the coil. The sketch of Joule's heat with time is represented by:

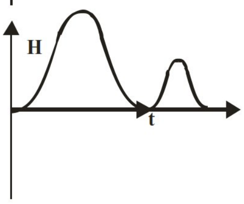
(A)



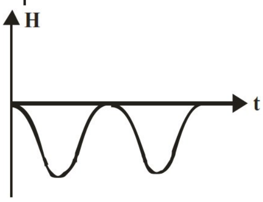
(B)



(C)



(D)



15. A parent radioactive nucleus A (decay constant λ_a) converts into a radio-active nucleus B of decay constant λ_b, initially, number of atoms of B is zero. At any time N_a, N_b are number of atoms of nuclei A and B respectively then maximum value of N_b.

(A) $\frac{\lambda_a N_a}{\lambda_b}$
(B) $\frac{\lambda_b N_a}{\lambda_a}$
(C) $\frac{(\lambda_a + \lambda_b) N_a}{\lambda_b}$
(D) $\frac{\lambda_b}{(\lambda_a + \lambda_b)} N_a$

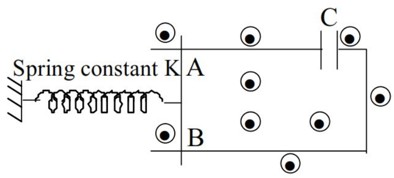
16. Fundamental note of a closed pipe of length l is f_0 at 0°C. First overtone of the same pipe at 273°C is (assume there is no effect of temperature on the dimension of the pipe).

(A) $3f_0$
(B) f_0
(C) $\left(3\sqrt{2}\right) f_0$
(D) $3/\sqrt{2}\, f_0$

17. A satellite is revolving round the earth at a height (R/2) from surface of earth in circular orbit. The change in speed required for the satellite to escape to infinity for the satellite to escape to infinity is: [Take R as radius of earth; and M as mass of earth]

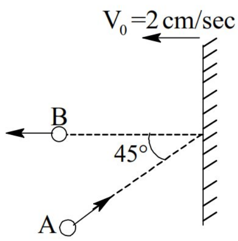
(A) $\sqrt{\frac{2GM}{3R}}$
(B) $\sqrt{\frac{GM}{3R}}\left(2-\sqrt{2}\right)$
(C) $\sqrt{\frac{GM}{3R}}\left(\sqrt{2}-1\right)$
(D) $\sqrt{\frac{4GM}{3R}}$

18. In the arrangement shown in the figure, uniform magnetic field B is upward to the plane of paper. Connecter AB is smooth and conducting, having mass m and length l. Initially spring has extension X_0. Spring is non-conducting (neglect induction in spring). Connector is released at t = 0. Maximum charge on the capacitor is:



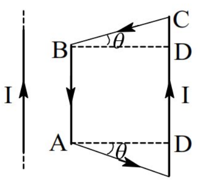
(A) $X_0\sqrt{\frac{KC}{1+\frac{B^2 l^2 C}{m}}}$
(B) $X_0\sqrt{\frac{KC}{1+\frac{m}{B^2 l^2 C}}}$
(C) $\sqrt{\frac{KC}{2+\frac{B^2 l^2 C}{m}}}$
(D) $\sqrt{\frac{4KC}{1+\frac{B^2 l^2 C}{2m}}}$

19. Mirror is moving towards the particle with speed 2 cm/sec. Speed of A and B are $10\sqrt{2}$ and 5 cm/sec respectively in the direction shown in figure. Magnitude of velocity of image of the particle B with respect to image of A.



(A) $\sqrt{325}$ cm/sec
(B) 15 cm/sec
(C) 13 cm/sec
(D) $\sqrt{269}$ cm/sec

20. Loop ABCD and long straight wire are in the same plane. Side CD = 2AB. Distance between long straight wire and AB is equal to distance BD. Net force on the loop is:



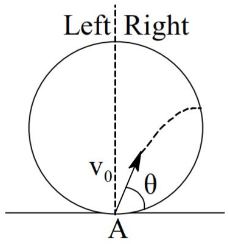
(A) Towards the long straight wire
(B) Away from the long straight wire
(C) Parallel to the long straight wire
(D) Net force on the loop will be zero

SECTION – B

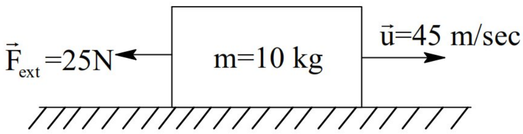
(Numerical Answer Type)

This section contains **5** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

21. A hollow sphere of mass m and radius R is placed on smooth ground. A particle of mass m is projected with velocity v_0 and angle θ from lowest point A inside the sphere as shown in diagram. If particle strikes the sphere at a point which is on horizontal level of centre and at that moment particle is at highest point. The collision between particle and sphere is elastic. The value of v_0 is $\frac{\sqrt{kRg}}{\sin\theta}$. Find the value of 'k'

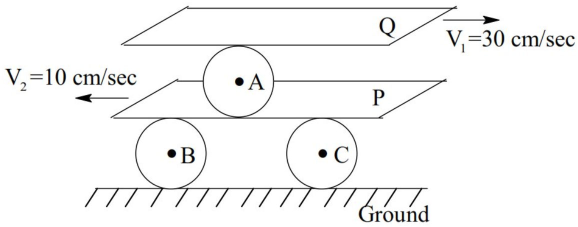


22. Initial velocity of the block $\vec{u} = 45\hat{i}$ while external force on it is $\vec{F} = 25(-\hat{i})$. It coefficient of static and kinetic friction are 0.3 and 0.2 respectively then distance traveled by the block in 12 second is $25x$ m, then find the value of 'x' ($g = 10\ m/s^2$) :

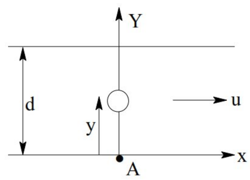


23. Calculate the time (in hrs) in which a layer of ice of thickness 10 cm will increase by 5 cm on the surface of a pond when temperature of the surrounding is –10°C. Coefficient of thermal conductivity of ice $K = 0.005\left(\frac{Cal}{cm-sec-^{o}C}\right)$ and density $\rho = 0.9\,gram/cm^3$. (L = 80 cal/g)

24. All three spheres are identical having radius 10 cm. There is no slipping at any point of contact. Plank P and Q are moving in opposite direction with speed 10 and 30 cm/sec. Find the height of instantaneous axis of rotation of sphere A from the ground (in cm) :



25. A river of width d is flowing with a velocity u. A person starts from point A. He always try to keep himself along y axis. Speed of man w.r.t. to river at any position is given by $v = k\sqrt{y}$ (k → +ve constant). Time taken by man to cross the river is $\frac{x\sqrt{d}}{4k}$, then find the value of ____.
(Assume that at t = 0, y = 0)



Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

26. In the following statement, which combination of true (T) and false (F) options in correct?

(A) Ionic mobility is highest for I^- in water as compared to other halides.

(B) IF_5 is square pyramidal and IF_7 is pentagonal bipyramidal in shape

(C) Reactivity order is $F_2 < Cl_2 < Br_2 < I_2$

(D) Oxidising power order is $F_2 < Cl_2 < Br_2 < I_2$

(A) TFTF (B) TTFT

(C) TTTT (D) TTFF

27. According to VSEPR model, the shape of $[XeOF_5]^-$ is

(A) Octahedral (B) Triagonal bipyramidal

(C) Square pyramidal (D) Pentagonal monopyramidal

28. Identify the statement(s) which is not correct with respect to surface phenomenon.

(A) If on adding electrolyte in an emulsion, the conductivity increases then it will be oil in water type emulsion.

(B) Tyndall effect is observed when refractive indices of dispersed phase and dispersion medium differ largely.

(C) Macromolecular colloids are generally lyophobic in nature

(D) Gases which can react with adsorbents are generally chemisorbed

29. Xenon fluorides are very good oxidising and fluorinating agents. They also act as F^- donors and acceptors. When XeF_4 donates its fluoride to SbF_5, then the states of hybridisation of central atom of cationic part and anionic part of product are:

(A) sp^3d, sp^3d^2 (B) sp^3d^2, sp^3d

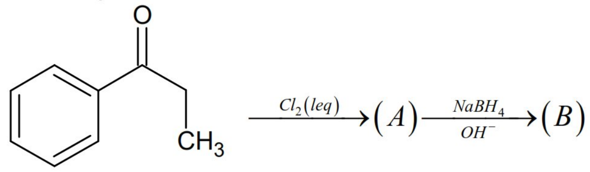
(C) sp^3d^2, sp^3d^2 (D) dsp^2, sp^3

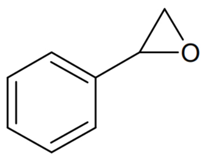
30. Correct order of bond angle is

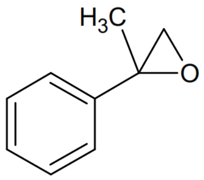
(A) $(\bullet CH_3) > (\bullet CF_3)$ (B) $CH_3^- > CH_3^+$

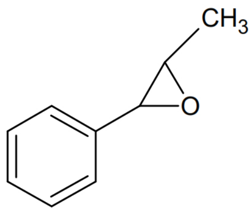
(C) $CH_4 > CF_4$ (D) $CH_4 > (\bullet CH_3)$

31. The end product of the reaction is:

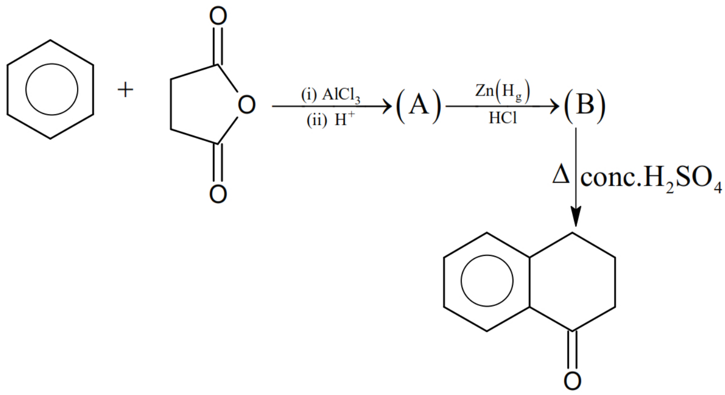


(A) 

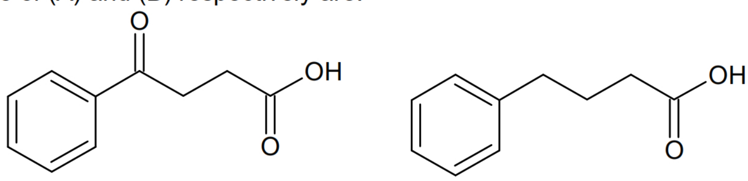
(B) 

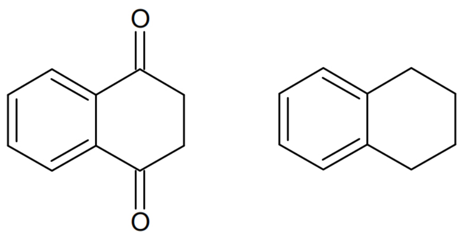
(C) 

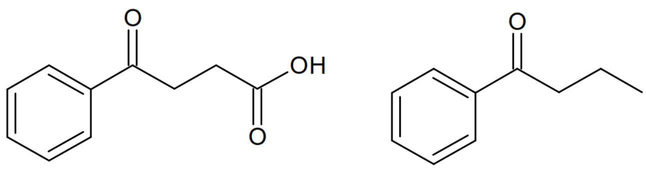
(D) None of these

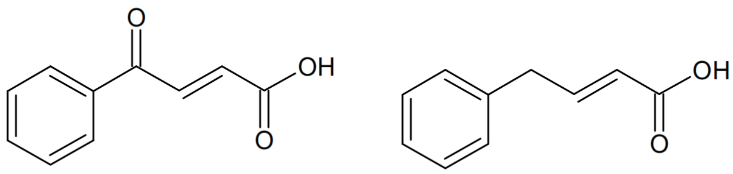
32. 

Structure of (A) and (B) respectively are:

(A) 

(B) 

(C) 

(D) 

33. An aqueous solution of a metal ion (A) on reaction with KI gives a black brownish ppt (B) and this aqueous suspension on treatment with excess KI gives orange yellowish solution. Then A is

(A) pb^{2+} (B) Bi^{3+}

(C) Hg_2^{2+} (D) Hg^{2+}

34. Which of the following compounds consist of a P – P linkage?

(A) Hypo phosphoric acid (B) Pyrophosphorous acid

(C) Dipolyphosphoric acid (D) Metaphosphoric acid

35. Which of the following elements of lanthanide series have highest tendency to show $+2$ oxidation state?

(A) Eu (B) Gd

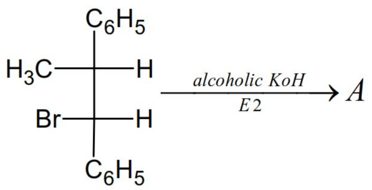
(C) Tb (D) None of these

36. The specific conductance of a saturated solution of silver bromide is $K\ Scm^{-1}$. The limiting ionic conductivity of Ag^{+} and Br^{-} ions are x and y respectively. The solubility of silver bromide in g/L is (molar mass of $AgBr = 188$)

(A) $\dfrac{K\times1000}{x-y}$ (B) $\dfrac{K}{x+y}\times188$

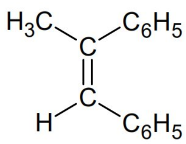
(C) $\dfrac{K\times1000\times188}{x+y}$ (D) $\dfrac{x+y}{k}\times\dfrac{1000}{188}$

37.

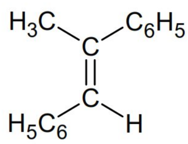


A is

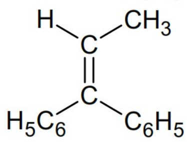
(A)



(B)

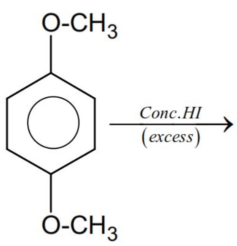


(C)

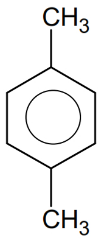


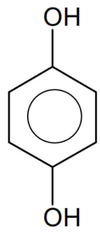
(D) None of these

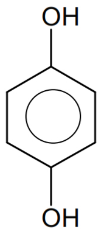
38.

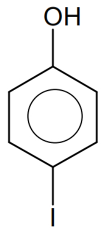


Products, Products of reaction are

(A)  $+2CH_3I$

(B)  $+2CH_3OH$

(C)  $+2CH_3I$

(D)  $+2CH_3I$

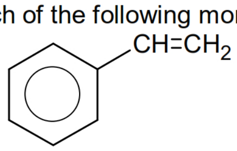
39. The activation energies of two reactions are E_1 & E_2 with $E_1 > E_2$. If temperature of reacting system is increased from T_1 (rate constant are k_1 and k_2) to T_2 (rate constant are k_1^1 and k_2^1) predict which of the following alternative is correct.

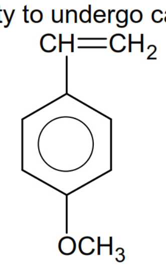
(A) $\frac{k_1^1}{k_1} = \frac{k_2^1}{k_2}$
(B) $\frac{k_1^1}{k_1} > \frac{k_2^1}{k_2}$
(C) $\frac{k_1^1}{k_1} < \frac{k_2^1}{k_2}$
(D) $k_1^1 < k_2^1$

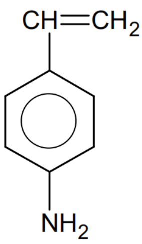
40. The wavelength of the first Lyman lines of hydrogen, He^+ and Li^{2+} ions and λ_1, λ_2 & λ_3. The ration of these wavelengths is

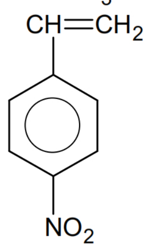
(A) $1:4:9$
(B) $9:4:1$
(C) $36:9:4$
(D) $6:3:2$

41. Which of the following monomers has greatest ability to undergo cationic polymerisation?

(A) 

(B) 

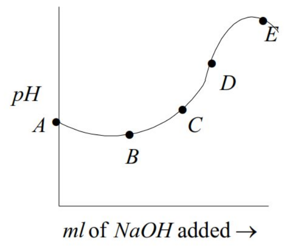
(C) 

(D) 

42. Two system $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ and $COCl(g) \rightleftharpoons CO(g) + Cl_2(g)$ are simultaneously in equilibrium in a vessel at constant volume. If some CO is introduced in the vessel, then at new equilibrium, the modes of

(A) PCl_5 increase
(B) PCl_5 remain unchanged
(C) PCl_5 decrease
(D) Cl_2 increase

43. The curve in the figure shows the variation of pH during the course of titration of weak acid HA with a strong base NaOH. At which point in the titration curve is the concentration of acid equal to that of its conjugate base.



(A) Point D
(B) Point E
(C) Point C
(D) Point B

44. The minimum mass of NaBr which should be added in 200 ml of 0.0004 $M - AgNO_3$ solution just to start precipitation of $AgBr. K_{sp}$ of $AgBr = 4 \times 10^{-13}$. (Br = 80)

(A) $1.0 \times 10^{-9}\, g$
(B) $2 \times 10^{-10}\, g$
(C) $2.06 \times 10^{-8}\, g$
(D) $1.03 \times 10^{-7}\, g$

45. In which of the following cases is the value of x maximum?

(A) $CaSO_4 \bullet xH_2O$
(B) $BaSO_4 \bullet xH_2O$
(C) $MgSO_4 \bullet xH_2O$
(D) All have same values of x as all metal ions belong to same group

SECTION – B

(Numerical Answer Type)

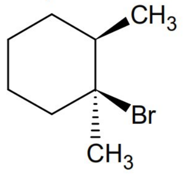
This section contains **5** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

46. The number of incorrect statements of the following statements is:

(i) H^+ is the smallest size cation in the periodic table
(ii) Van der Waals radius of chlorine is more than covalent radius
(iii) Ionic mobility of hydrated Li^+ is greater than that of hydrated Na^+
(iv) He atom has the highest ionisation enthalpy in the periodic table

47. How many dichloride cyclopentanes (including stereoisomers) are obtained when cyclopentane reacts with excess chlorine at high temperature?

48. The number of alpha hydrogen's present in major product obtained when following substrate is subjected to $E2$ reaction will be:



49. The number of paramagnetic complexes from given compounds:

(i) $\left(Ni(CN)_4\right)^{2-}$

(ii) $\left(NiCl_4\right)^{2-}$

(iii) $\left(CoCl_4\right)^{2-}$

(iv) $\left(CoF_6\right)^{2-}$

50. A certain amount of reducing agent reduces x mole of $KMnO_4$ & y mole of $K_2Cr_2O_7$ in different experiments in acidic medium. If the change in oxidation state of reducing agent is same in both experiments then $(x-y)$ is__ .

Mathematics

PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

51. If $a\alpha^2 + b\alpha + c = 3\alpha^2 - 4\alpha + 1, a\beta^2 + b\beta + c = 3\beta^2 - 4\beta + 1$ and $a\gamma^2 + b\gamma + c = 3\gamma^2 - 4\gamma + 1$ (where $\alpha, \beta, \gamma \in R$ and distinct) these sum of root of the equation $3ax^2 + 9bx + 7c = 0$.

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

52. If k denotes the sum of the imaginary parts of the roots of the equation $z^2 - 8(1-i)z + 63 - 16i = 0$ then k is

(A) 6
(B) -6
(C) 8
(D) -8

53. The sum $\sum_{k=0}^{49} (-1)^k \, {}^{99}C_{2k}$ equals

(A) -2^{98}
(B) 2^{98}
(C) -2^{49}
(D) 2^{49}

54. For differential equation $(x^4y^2 - y)dx + (x^2y^4 - x)dy = 0$

(A) $(x^3 - y^3) + \frac{3}{xy} = c$
(B) $x^3 - y^3 + \frac{1}{xy} = c$
(C) $x^3 + y^3 + \frac{3}{xy} = c$
(D) $x^3 + y^3 + \frac{1}{xy} = c$

55. Sum of roots of the equation $2^{333x-2} + 2^{111x+1} = 2^{222x+2} + 1$ is.

(A) $\frac{111}{2}$
(B) $\frac{2}{111}$
(C) 2
(D) 111

56. $\int \frac{e^{\tan^{-1}x}}{(1+x^2)}\left(\left(\sec^{-1}\sqrt{1+x}\right)^2 + \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)\right)dx$ is $(x > 0)$

(A) $e^{\tan^{-1}x} \cdot \tan^{-1}x + c$
(B) $e^{\tan^{-1}x} \cdot \frac{(\tan^{-1}x)^2}{2} + c$
(C) $e^{\tan^{-1}x}\left(\sec^{-1}\sqrt{1+x^2}\right)^2 + c$
(D) $e^{\tan^{-1}x}\left(\operatorname{cosec}^{-1}\sqrt{1+x^2}\right)^2 + c$

57. If $(x-2y-4)^2 = 24x+12y$ then length of latus rectum is

(A) $\frac{5}{\sqrt{12}}$

(B) $\frac{\sqrt{5}}{12}$

(C) $\frac{12}{\sqrt{5}}$

(D) None of these

58. IF $P(a\sec\theta, b\tan\theta), Q(a\sec\phi, b\tan\phi)$ are the ends of a focal chord of $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ then $\tan\frac{\theta}{2}\tan\frac{\phi}{2}$ can be

(A) $\frac{e-1}{e+1}$

(B) $\frac{e+1}{e-1}$

(C) $\frac{1+e}{1-e}$

(D) None of thee

59. Consider the function $f(x)=\frac{\sqrt{1+\cos x}+\sqrt{1-\cos x}}{\sqrt{1+\cos x}-\sqrt{1-\cos x}}(x\in(x,2\pi))$ then $f(x)$ is

(A) $\cot\left(\frac{\pi}{4}+\frac{x}{2}\right)$

(B) $\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)$

(C) $\cot\left(\frac{\pi}{4}-\frac{x}{2}\right)$

(D) None of these

60. In $\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$ the equation $\log_{\sin\theta}\cos 2\theta = 2$ has

(A) No solution

(B) One solution

(C) 2 solutions

(D) None of these

61. Let $f(x)=\cos x, g(x)=\left[\begin{matrix} \min\{f(t):0\le t\le x\} & x\in[0,\pi] \\ \sin x-1 & x>\pi \end{matrix}\right.$ then

(A) $g(x)$ is discontinuous at $x=\pi$

(B) $g(x)$ is continuous for $x\in[0,\infty)$

(C) $g(x)$ is differentiable at $x=\pi$

(D) $g(x)$ differentiable for $x\ge 0$

62. If $f(x)\, and\, g(x)$ are two functions such that $f(x)=[x]+[-x]\, and\, g(x)=\{x\}\,\forall x\in R\, and$ $h(x)=f(g(x))$ these incorrect statement is($[.]$ is G.I.F and $\{.\}$ is F Part of x)

(A) $f(x)\, and\, g(x)$ are identical function

(B) $f(x)=g(x)$ has no solution

(C) $f(x)+h(x)>0$ has no solution

(D) $f(x)-h(x)$ is periodic function

63. Let $f(x)$ be a polynomial $f:R\to R$ such that $f(2x)=f'(2x)f''(x)$ these $f(x)$ is

(A) One – One onto

(B) One – One into

(C) Many One – Onto

(D) Many – One into

64. Consider three planes $2x+py+6z=8, x+2y+qz=5 \, and \, x+y+3z=4$ then 3 planes intersect at a point if

(A) $p=2, q\neq 3$
(B) $p\neq 2, q\neq 3$
(C) $p\neq 2, q=3$
(D) None of these

65. If a^2, b^2, c^2 are in AP then $\cot A, \cot B \, and \, \cot C$ in

(A) GP
(B) AP
(C) HP
(D) None of these

66. R is relation over the set of integers and it is given by $(x,y)\in R \Leftrightarrow |x-y|\leq 1$. Then R is

(A) Reflective and transitive
(B) Reflective and symmetric
(C) Symmetric and transitive
(D) An equivalence relation

67. If $A=\begin{bmatrix} a & b & c \\ c & a & b \\ b & c & a \end{bmatrix}$ and a,b,c are roots of the equation $x^3+x^2-4=0$ then $A \; A^T$ is

(A) I
(B) $I+A$
(C) A^2
(D) $A-I$

68. If $a>b>c$ and the system of equations $ax+by+cz=0, bx+cy+az=0, cx+ay+bz=0$ has a non-trivial solution these both the roots of equation $at^2+bt+c=0$ are

(A) Cereal
(B) Negative
(C) Positive
(D) None of these

69. If A and B are non-zero square metrics of order 3 there incorrect statement is

(A) $adj(AB)=adjA.adjB$
(B) $(AB)^{-1}=B^{-1}.A^{-1}$
(C) $(AB)^T=B^T \, A^T$
(D) $AB=0 \Rightarrow |A|=0 \; and \; |B|=0$

70. The only statement among the following that is tautology is

(A) $A\cap(A\cup B)$
(B) $A\cup(A\cap B)$
(C) $[A\cap(A\to B)]\to B$
(D) $B\to[A\cap(A\to B)]$

SECTION – B

(Numerical Answer Type)

This section contains **5** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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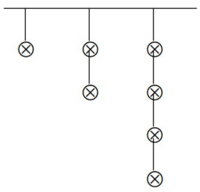
71. $\int_0^{\frac{\pi}{2}} \frac{1-\sin 2x}{(1+\sin 2x)^2} dx = \frac{a}{b}$ (a & b are coprime) these $a+b+ab$ is ____.

72. 7 clay balls (shown as $\otimes$). If N be the number of different ways these can be shot (lone at a time). If no ball can be shot unit the ball (s) below it, have been shot, then N is _____.



73. A regular pyramid on a square base has an edge 150m long and the length of the side of its base is 200m. Then height of pyramid is ______

74. 20 teachers of a school either teach maths or physics 12 of them teach maths while 4 teach both the subjects then the no. of teachers teaching only physics is ______

75. If $a_r = (\cos 2r\pi + \sin 2r\pi)^{1/9}$ then $\Delta = \begin{vmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{vmatrix}$ is _____.

SOLUTIONS

Physics

PART – A

SECTION – A

1. C

Sol. At any time

$$F_{thrust} - F_{friction} = ma$$

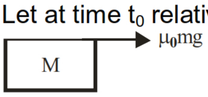
$$\rho a v^2 - \mu m g = ma$$

$$\rho a(2gh) - \left(\frac{a}{A}\right)(\rho A h) g = (\rho A h) a'$$

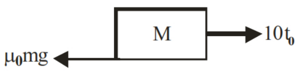
$$2\rho a g h - \rho a g h = \rho A h a' \; ; \; \frac{a}{A} g = a'$$

2. C

Sol. Let at time t_0 relative motion will occur



$$\mu_0 mg = Ma \quad ..... (1)$$



$$10t_0 - \mu_0 mg = ma \quad ..... (2)$$

From (1) and (2) ;

$$t_0 = \mu_0 m + \frac{\mu_0 m^2}{M}$$

3. A

Sol. $Mg - T = M\dfrac{dv}{dt}$ ..... (1)

$T + \mu v_e - (M_0 - \mu t)g = \left(M_0 - \mu t\right)\dfrac{dV}{dt}$ ..... (2)

From (1) and (2), we get

$Mg + \mu V_e - (M - \mu t)g = (2M - \mu t)\dfrac{dv}{dt}$ ..... (3)

$\left(\mu v_e + \mu g t\right) = \left(2M - \mu t\right)\dfrac{dv}{dt}$ ..... (4)

$\dfrac{dv}{dt} = \dfrac{\mu(v_e + gt)}{(2M - \mu t)}$

$\therefore \quad \dfrac{dv}{dt} = \dfrac{\mu(v_e + gt)}{(2M - \mu t)}$

So, correct answer is (A)

4. A

5. A

Sol. $\dfrac{l}{K_1A} + \dfrac{l}{2K_2A} + \dfrac{l}{K_3A} = \dfrac{l}{KA} + \dfrac{l}{2K_A} + \dfrac{l}{KA}$

$\dfrac{5}{2K} = \left(\dfrac{1}{K_1} + \dfrac{1}{2K_2} + \dfrac{1}{K_3}\right)$

$K_{eq} = \dfrac{5}{2\left(\dfrac{1}{K_1} + \dfrac{1}{2K_2} + \dfrac{1}{K_3}\right)}$

6. A

Sol. Voltage across capacitor will lag current by 90° ;

$\therefore \quad i_C = \dfrac{200\sqrt{2}}{10}\sin\left(\omega t + \dfrac{\pi}{4} + \dfrac{\pi}{2}\right)$

$i = 20\sqrt{2}\sin\left(\omega t + \dfrac{3\pi}{4}\right)$

$\therefore$ Correct answer is (A)

7. D

Sol. 2dQ = dU + 2dW

dQ = dU + dW

dQ = dW

$\Rightarrow$ dU = 0

Process is isothermal.

8. B

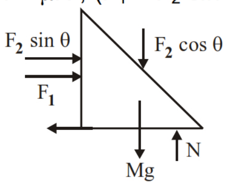
Sol. F = q v × B

= q v_0i × B (–k) = qv_0 B j

9. B

10. C

Sol. $f = \mu N$; $(F_1 + F_2 \sin\theta) = \mu (mg + F_2 \cos\theta)$



$$\mu = \frac{F_1 + F_2 \sin\theta}{mg + F_2 \cos\theta}$$

11. C

Sol. $W_B = 0$

$W_E = \Delta KE$; $W_B + W_E = \Delta KE$

12. A

Sol. K.E. = $p^2/2m$ and $p = h/\lambda$

13. D

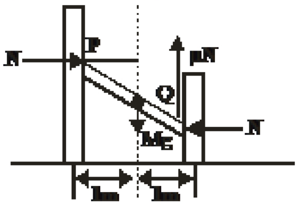
Sol. Drawing F.B.D. of rod PQ

$\Sigma Fx = 0$

$\Sigma Fy = 0 \Rightarrow \mu N = mg$ ..... (1)

$\Sigma\tau$ about centre of mass = 0

$$\left[N \times \frac{l}{2}\sin\theta\right][2] = \mu N \times \frac{l}{2}\cos\theta \Rightarrow \tan\theta = \frac{\mu}{2}$$



Hence $\sec\theta = \left(\sqrt{\mu^2 + 4}\right)/2$

Thus, $\left(\frac{l/2}{1}\right) = \frac{\sqrt{\mu^2+4}}{2} \Rightarrow l = \sqrt{\mu^2 + 4}$

$\Rightarrow \; l = \sqrt{0.25 + 4} = \frac{\sqrt{17}}{2}$ metres

14. B

Sol. $e = -\frac{d\phi}{dt}$

$i = \frac{e}{R}$ where R is resistance

$H = i^2Rt$

The emf will induce from zero to some maximum value and then from maximum to zero.

15. A

Sol. N_b reaches maximum when activity of A will be equal to activity of B.

i.e., $\lambda_a N_a = \lambda_b N_b \Rightarrow N_b = \dfrac{\lambda_a N_a}{\lambda_b}$

16. C

Sol. $f_0 = \dfrac{c}{\lambda} = \dfrac{c}{4(l+e)}$ and $\dfrac{c}{c_0} = \sqrt{\dfrac{273+\theta}{273}}$

$\therefore\ f_0' = \dfrac{c_0}{4(l+e)}\sqrt{1+\dfrac{\theta}{273}}$

If temperature is same, first overtone will be $3f_0$

$\therefore$ at 273°C first overtone is $3\sqrt{2}\,f_0$.

17. B

Sol. $V_0 = \sqrt{\dfrac{GM}{3R/2}} = \sqrt{\dfrac{2GM}{3R}}$

In order to escape to infinity let $(V - V_0)$ is the speed change required. Thus,

$$\frac{-GMm}{(3R/2)} + \frac{1}{2}m(v)^2 = 0$$

Thus, $v = \sqrt{\dfrac{4GM}{3R}}$

Thus speed change required = $v - v_0$

$$\Delta V = \sqrt{\frac{4GM}{3R}} - \sqrt{\frac{2GM}{3R}}\ ;\ \Delta V = \sqrt{\frac{GM}{3R}}\left(2-\sqrt{2}\right)$$

18. B

Sol. At any time

$Kx - IlB = ma$ ..... (1)

$\dfrac{q}{C} = Bvl$

$I = BlCa$ ..... (2)

From (1) and (2)

$kx = a(B^2l^2C + m)$

$a = \left(\dfrac{K}{B^2l^2C+m}\right)x$ ..... (3)

Since motion of connector will be opposite to the displacement from equilibrium. Therefore equation (3) represents S.H.M.

$$\omega = \sqrt{\frac{K}{B^2l^2C+m}}$$

$$V_{max} = X_0\omega$$

$$\therefore\quad q_{max} = BlCV_{max}$$

$$q_{max} = BlCX_0\omega$$

$$X_0\sqrt{\frac{KC}{1+\frac{m}{B^2 l^2 C}}}$$

19. A

Sol. Velocity of image of particle B

$$\bar{v}_B = 5(\hat{i}) + 4(-\hat{i}) = \hat{i}$$

velocity of image of particle A

$$v_A = 10(-\hat{i}) + 4(-\hat{i}) - 10\hat{j}$$

$$= 14(-\hat{i}) - 10\,j$$

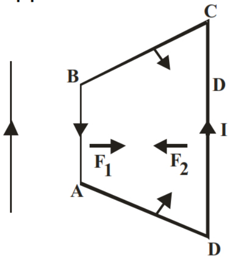
Relative velocity of image

$$\bar{V}_{BA} = \bar{V}_B - \bar{V}_A \;= \hat{i} - \left[14(-\hat{i}) - 10\hat{j}\right] = 15\hat{i} + 10\,\hat{j}$$

$$|\bar{V}_{BA}| = \sqrt{325}\,\text{cm/sec}$$

20. B

Sol. Magnitude of force on AB (F_1) and magnitude of force on CD (F_2) will be equal in magnitude and opposite in direction.



Hence $\bar{F}_1 + \bar{F}_2 = 0$ resultant of $\bar{F}_3 + \bar{F}_4$ will be away from the long straight wire.

SECTION – B

21. 2

Sol. Conservation of energy

$$\frac{1}{2}mv_0^2 = mgR + \frac{1}{2}mv^2, v = v_0\cos\theta$$

$$\frac{1}{2}v_0^2 = gR + \frac{v_0^2\cos^2\theta}{2}$$

$$v_0^2\left[1-\cos^2\theta\right] = gR$$

$$v_0 = \frac{\sqrt{2gR}}{\sin\theta}$$

22. 9

Sol. Net retardation $a = \dfrac{F_{ext} + \mu_k mg}{m} = 4.5$

If body stop at time t, then

$V = u + at$

$0 = 45 - 4.5t \quad \Rightarrow t = 10\,\text{sec}$

When block stops, F_{ext} will try to bring the block back ward while frictional force will oppose its motion, since block is stationary therefore at this moment, frictional force will be static. Whose maximum value will be $\mu_s mg = 30N$. Since static frictional force is self adjusting therefore it will be 25 N and block will not move after t = 10 sec.

$$S = \frac{u^2}{2a} = 225\,m$$

23. 25

Sol. Time taken by the layer of ice to increase its thickness by $x = x_2 - x_1$

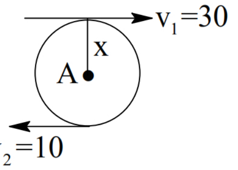
$$t = \frac{\rho L}{2K\theta}(x_2^2 - x_1^2) = \frac{.9 \times 80}{2 \times .005 \times 10}\left[(15)^2 - (10)^2\right]$$

$t = 9 \times 10^4\,\text{sec}$; t = 25 Hours

24. 25

Sol. Let x be the distance of axis of rotation from the top of sphere A (downward). Since angular velocity of the top and bottom point of sphere A will be same, therefore,

$$\omega = \frac{30}{x} = \frac{10}{(2R - x)}$$



$$\frac{30}{x} = \frac{10}{20 - x}$$

$\Rightarrow$ x = 15

$\therefore$ Distance from ground

= 2R + (2R – x)

= 20 + 5 = 25 cm

25. 8

Sol. $t = \int \frac{dy}{V_y} = \int_0^d \frac{dy}{Ky^{1/2}} = \frac{2\sqrt{d}}{k}$.

PART – B

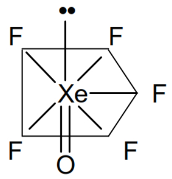
SECTION – A

26. D

Sol. Fluorine is most reactive amongst halides and has highest oxidising power

27. D

Sol.



Hybridisation $-sp^3d^3$

Shape – pentagonal monopyramidal

28. C

Sol. Macromolecular colloids like starch, gelatin are generally lyophilic.

29. A

Sol.

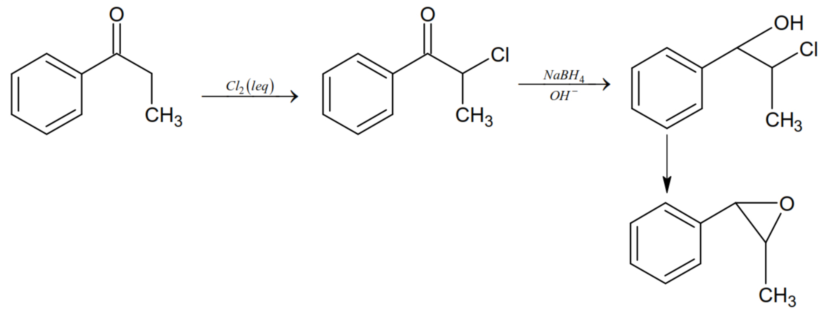
$$\underset{sp^3d}{\underset{\downarrow}{[XeF_3]^+}}\ \underset{sp^3d^2}{\underset{\downarrow}{[SbF_6]^-}}$$

30. A

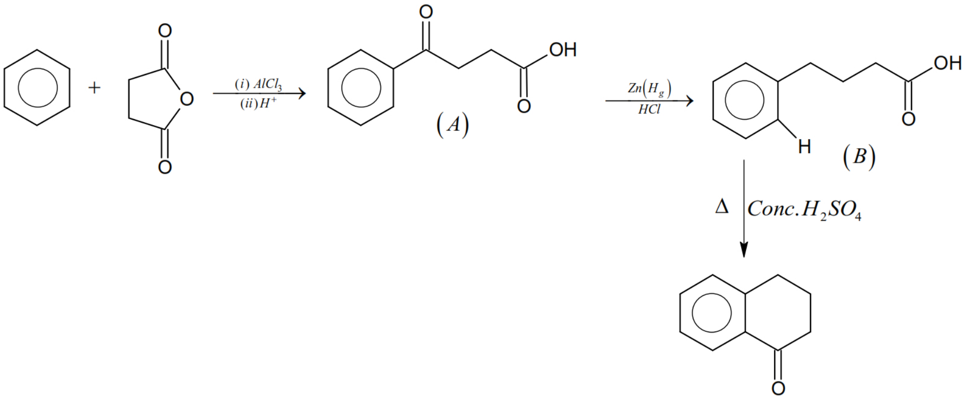
Sol. In $(\bullet CF_3)$, % p-character because of which bond angle decreases

31. C

Sol.



32. A
Sol.

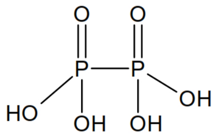


33. B
Sol.

$$\underset{(A)}{Bi^{3+}} \xrightarrow{KI} \underset{(B)}{BiI_3} \xrightarrow[KI]{excess} \left[BiI_4\right]^-$$

Black ppt yellow brown solution

34. A
Sol.



$H_4P_2O_6$

35. A
Sol. Because of stability of half filled f-subshell configuration.

36. C
Sol.

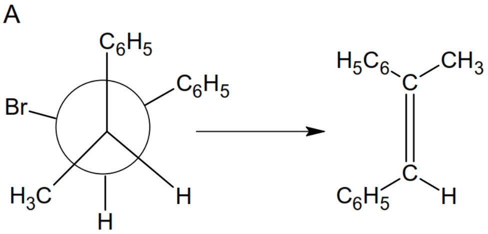
$AgBr = x + y$

$$AgBr = \frac{K \times 1000}{M}$$

M – molarity of $AgBr$ solution

8 (solubility in g/L) = $\frac{K \times 1000}{(x+y)} \times 188$

37. A
Sol.



$+ HBr$

38. C
Sol. $-OH$ group of phenol cannot be replaced by iodine as it does not undergo nucleophilic substitution reaction under normal conditions.

39. B
Sol. Greater the activation energy of a reaction, greater is the temperature dependence of rate constant of reaction.

40. C

Sol. $\frac{1}{\lambda} = RZ^2\left(1-\frac{1}{4}\right)$ for lyman line

41. C

Sol. Methoxy group stabilises the cationic intermediate by $+M$ effect

42. C

Sol. Cl_2 is present simultaneously in two equilibria. Decrease in its concentration shift both equilibria forward.

43. D

Sol. Point B represents exactly half neutralisation of acid. At this point concentration acid left and its conjugate base are equal.

44. C

Sol. $\left[Br^-\right] = \frac{4\times10^{-13}}{4\times10^{-4}} = 10^{-9}M$

Mass of $NaBr$ added of $200\,ml = 103\times\frac{10^{-9}}{1000}\times200$

$= 2.06\times10^{-8}\,g$

45. C

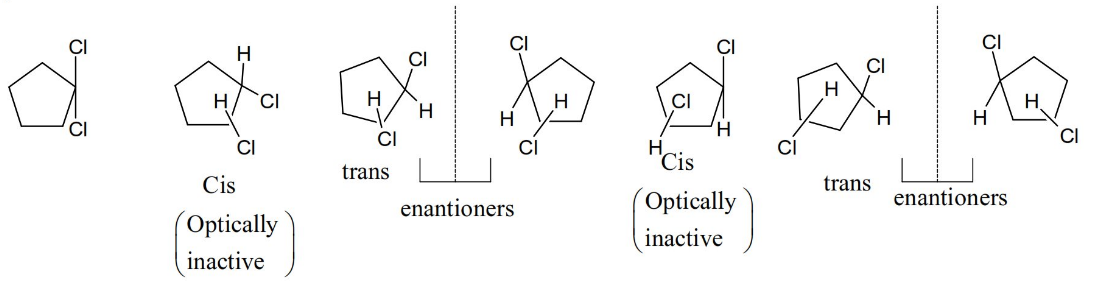
Sol. Greater the charge density, greater is hydration.

SECTION – B

46. 1

47. 7

Sol.



Total isomers = 7

48. 10

49. 3

Sol. $\left(\mathrm{Ni}\left(\mathrm{CN}\right)_4\right)^{2-}$ is dsp^2 hybridised and diamagnetic

50. 1

Sol. Equivalents of $KMnO_4 = 5x$

Equivalents of $K_2Cr_2O_7 = 6y$

Equivalents of oxidising agent must be same $5x = 6y$

$x - y = 6 - 5 \Rightarrow 1$

PART – C

SECTION – A

51. D

Sol. $a=3, b=-4, c=1$

52. D

53. C

Sol. Put $x=i$ and equate the real part

54. C

Sol. $x^2dx+y^2dy=\frac{d(xy)}{(xy)^2}$

55. B

Sol. Let $x=\frac{\log_2 y}{111}$ these $y^3-16y^2+8y-4=0$

56. C

Sol. $\sec^{-1}\sqrt{1+x^2}=\tan^{-1}x, \cos^{-1}\frac{1-x^2}{1+x^2}=2\tan^{-1}x$

57. C

Sol. $\left(\frac{x-2y-4}{\sqrt{5}}\right)^2=\frac{12}{\sqrt{5}}\left(\frac{2x+y}{\sqrt{5}}\right)$ (if is parabola)

58. C

Sol. $\tan\frac{\theta}{2}\tan\frac{\theta}{2}=\frac{1+e}{1-e}$ if focus is $(-ae,\theta)$

59. D

Sol. $f(x)=\tan\left(\frac{\pi}{4}-\frac{x}{2}\right)$

60. B

61. B

62. D

63. C

64. B

65. B

Sol. $b^2+c^2-a^2, c^2+a^2-b^2, a^2+b^2-c^2$ are in AP.

66. B

67. A

68. D

Sol, Both the roots opposite in sign

69. A

Sol. $adj(AB) = adjB.adjA$

70. C

SECTION – B

71. 7

Sol. $\int_0^{\frac{\pi}{2}} \frac{(1-\tan x)^2}{(1+\tan x)^4} \sec^2 x\, dx = \frac{1}{3}$

72. 105

Sol. $\frac{\lfloor 7}{\lfloor 4 \lfloor 2} = 105$

73. 50

Sol. $OM = \sqrt{\left(50\sqrt{5}\right)^2 - (100)^2} = 50m$

74. 8

75. 0

Sol. $\Delta = 0$