JEE MAIN 2026

Sample Paper – 7

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

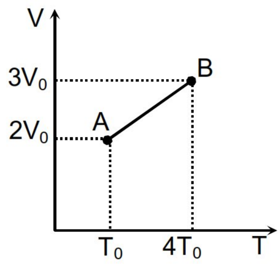
(Single Choice Answer Type)

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. An ice block at 0°C is dropped from height 'h' above the ground. What should be the value of 'h' so that it melts completely by the time it reaches the bottom assuming the loss of whole gravitational potential energy is used as heat by the ice? [Given: L_f = 80 cal/gm and g = 10 m/s^2]
(A) 33.6 m
(B) 33.6 km
(C) 8 m
(D) 8 km

2. A Solid floats with 2/3 of its volume immersed in a liquid and with 3/4 of its volume immersed in another liquid. What fraction of its volume will be immersed if it floats in a homogenous mixture formed of equal volumes of the liquids?
(A) $\frac{6}{11}$
(B) $\frac{8}{11}$
(C) $\frac{11}{16}$
(D) $\frac{12}{17}$

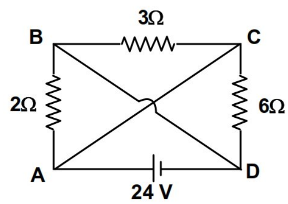
3. One mole of ideal gas undergoes an expansion from state A to state B as shown in the V-T diagram. The pressure of gas:
(A) remains constant during the process.
(B) increases from A to B, $\frac{8}{3}$ times
(C) is same at A and B, but increases in between
(D) decreases from A to B, $\frac{3}{8}$ times



4. To increase the resonant frequency in series L-C-R circuit,
(A) source frequency should be increased
(B) another resistance should be added in series with the first resistance
(C) another capacitor should be added in series with the first capacitor
(D) the source frequency should be decreased

5. Time taken by light to travel in two different materials A and B of refractive indices μ_A and μ_B of same thickness is t_1 and t_2, respectively. If $t_2 - t_1 = 5 \times 10^{-10}$ s and the ratio of μ_A to μ_B is 1:2. Then, the thickness of material in metre is (Given, V_A and V_B are velocities of light in A and B materials, respectively.)
(A) $(5\times10^{-10}\times v_A)$ m
(B) (5×10^{-10}) m
(C) (1.5×10^{-10}) m
(D) $(5\times10^{-10}\times v_B)$ m

6. Current flowing between points A and C is
(A) zero
(B) 4A
(C) 8A
(D) 12A



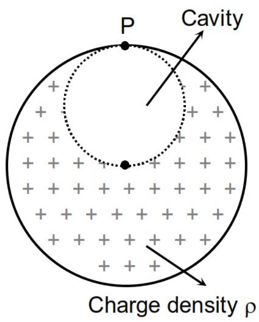
7. If frequency of incident light in a photoelectric cell is doubled, then stopping potential increases by
(A) 50%
(B) 100%
(C) more than 100%
(D) any amount depending on work function of metal

8. A charged particle enters in a region of a uniform magnetic field making 45° with direction of field. If P and R represent pitch and radius of helical path followed by particle, then $\frac{P}{R}$ equals to

(A) π (B) 2π

(C) 1 (D) $\sqrt{\pi^2+1}$

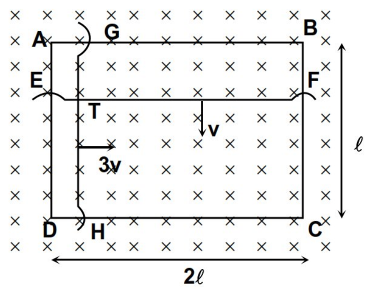
9. A sphere of diameter d is removed from a uniform non-conducting sphere of charge density p and radius R thereby creating a cavity as shown. An electron (of charge - e and mass m) is released at top point P of this cavity. Time after which the electron strikes the surface of the cavity is (Take, d = R and gravity is absent)



(A) $\sqrt{\frac{12\varepsilon_0 m}{\rho e}}$ (B) $\frac{1}{2}\sqrt{\frac{\rho e}{3\varepsilon_0 m}}$

(C) $\sqrt{\frac{2\varepsilon_0 m}{\rho e}}$ (D) $\sqrt{\frac{\varepsilon_0 m}{2\rho e}}$

10. The figure here shows a fixed rectangular conducting frame ABCD of side ℓ and 2ℓ in a region of transverse uniform magnetic field B_0. Two straight conducting sliders EF and GH are moving with respective speeds v and 3v as shown in figure. Initially, EF and GH are located very near to sides AB and AD respectively. Intersection contact of the sliders is represented by T. Emf induced in the loop ETHD when it is a square, is

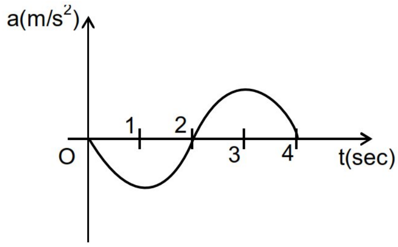


(A) $2B_0v\ell$ (B) $1.5B_0v\ell$

(C) $B_0v\ell$ (D) $0.5\ B_0v\ell$

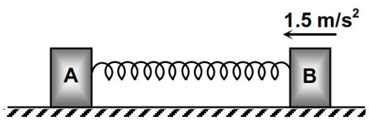
11. A particle experiences a force $\vec{F} = Ar^2\hat{r}$, where $\hat{r}$ is the unit vector along position vector $\vec{r}$. The dimensional formula of A is:
(A) $[MLT^{-2}]$ (B) $[ML^{-2}T^{-2}]$
(C) $[ML^{-2}T^{-1}]$ (D) $[ML^{-1}T^{-2}]$

12. Acceleration (a)-time (t) graph for a particle starting from rest at t = 0 is as given aside. The particle has maximum speed at:



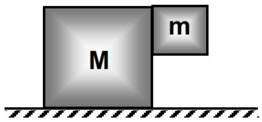
(A) 1s (B) 2 s
(C) 3 s (D) 4 s

13. Two blocks A and B with mass 4 kg and 6 kg respectively are connected by a stretched spring of negligible mass as shown in figure. When the two blocks are released simultaneously the initial acceleration of B is 1.5 m/s^2 westward. The acceleration of A is



(A) 1 m/s^2 westward
(B) 2.25 m/s^2 eastward
(C) 1 m/s^2 eastward
(D) 2.75 m/s^2 westward

14. With what minimum acceleration, mass M must be moved on frictionless surface so that m remains stick to it as shown? The coefficient of friction between M and m is μ.

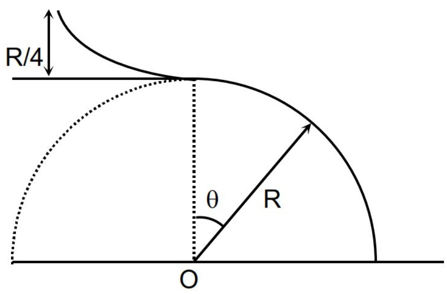


(A) μg
(B) $\frac{g}{\mu}$
(C) $\frac{\mu mg}{M+m}$
(D) $\frac{\mu mg}{M}$

15. In a circular motion of a particle, the tangential acceleration of the particle is given by $a_t = 9$ m/s^2. The radius of the circle is 4 m. The particle was initially at rest. Time after which total acceleration of the particle makes an angle of 45° with the radial acceleration is

(A) $\frac{1}{3}$ sec
(B) $\frac{2}{3}$ sec
(C) 1 sec
(D) $\frac{4}{3}$ sec

16. A skier plans to ski a smooth fixed hemisphere of radius R. He starts from rest from a curved smooth surface of height (R/4). The angle θ at which he leaves the hemisphere is:

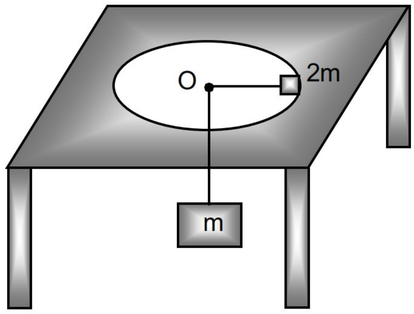


(A) $\cos^{-1}\left(\frac{2}{3}\right)$
(B) $\cos^{-1}\left(\frac{5}{\sqrt{3}}\right)$
(C) $\cos^{-1}\left(\frac{5}{6}\right)$
(D) $\cos^{-1}\left(\frac{5}{2\sqrt{3}}\right)$

17. Sachin (55 kg) and Kapil (65 kg) are sitting at the two ends of a boat at rest in still water. The boat weighs 100 kg and is 3.0 m long. Sachin walks down to Kapil and shakes hand. The boat gets displaced by:

(A) zero m
(B) 0.75 m
(C) 3.0 m
(D) 2.3 mm

18. A mass 2m rotating freely in a horizontal circle of radius 1m on a frictionless smooth table supports a stationary mass m, attached to the other end of the string passing through smooth hole O in table, hanging vertically. Find the angular velocity of rotation. (Given g = 10 m/s^2)



(A) $\sqrt{5}$ rad/s

(B) $2\sqrt{5}$ rad/s

(C) $\sqrt{10}$ rad/s

(D) $\frac{\sqrt{5}}{2}$ rad/s

19. A bowling ball of mass m, which can be treated as a uniform rigid sphere, is rolling without slipping on a horizontal surface. The coefficient of static friction between the ball and the surface is μ_S, the coefficient of kinetic friction is μ_K, and the acceleration due to gravity is g. What is the force of friction acting on the ball?

(A) zero
(B) $\mu_S mg$
(C) $\mu_k mg$
(D) $\frac{2}{5}\mu_S mg$

20. A disc of radius R and mass M is pivoted at the rim and is set for small oscillations in vertical plane (in its plane). If simple pendulum has to have the same period as that of the disc, the length of the simple pendulum should be :

(A) $\left(\frac{5}{4}\right)R$
(B) $\left(\frac{2}{3}\right)R$
(C) $\left(\frac{3}{4}\right)R$
(D) $\left(\frac{3}{2}\right)R$

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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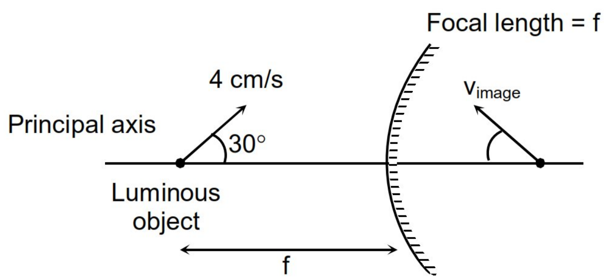
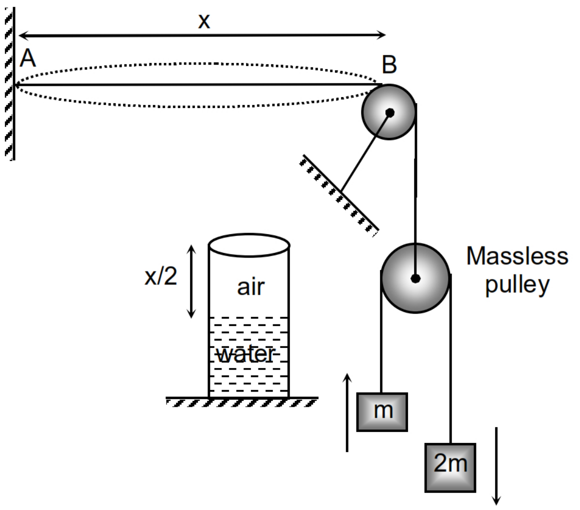
21. A point charge of $\frac{1}{4\pi}$ coulomb is placed in front of an infinite imaginary plane. Electric flux through the plane is 4.5×10^b N-m^2/C. Find b.

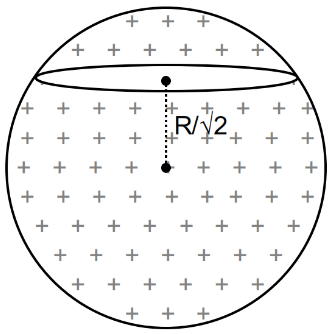
22. The speed of image of the object moving on axis of the mirror as shown is $\frac{\sqrt{7}}{k}$ cm/s. Find the value of k.



23. Consider the arrangement shown in the figure. A uniform wire (linear mass density 0.2 g/m) vibrating in its fundamental mode is in resonance with air column in a resonance tube vibrating in 1st overtone. The value of m is $\frac{54}{k}$ kg. Find the value of k. (Given that speed of sound in air is 400 m/s and g =10 m/s^2)



24. Consider the shown section at a perpendicular distance $\frac{R}{\sqrt{2}}$ from centre of the shown uniform solid sphere. Electric flux through the section is $\frac{Q}{k\sqrt{2}\varepsilon_0}$. Find the value of k.



Uniform solid sphere
(Total charge = Q, Radius = R)

25. Average life time of a hydrogen atom excited to n = 2 state is 10^{-8} s. The number of revolutions made by the electron on the average before it jumps to ground state is close to 8×10^x. Find x. (Take radius of first Bohr's orbit r_0 = 0.53 Å and speed of electron in first Bohr's orbit 2.2×10^6 m/s)

Chemistry

PART – B

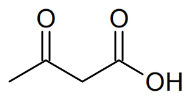
SECTION – A

(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. The correct order of decreasing acidity for following compound is

O_2NCH_2COOH, (1) CCl_3COOH, (2) $(F_3C)_3COH$, (3)



4

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

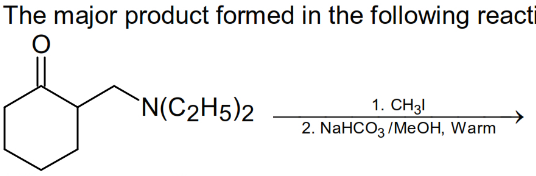
27. The major product obtained in the following reaction, is

$$H-C\equiv C-CH_2OH \xrightarrow[\substack{2.\ C_2H_5Br(1\text{ equiv.}) \\ 3.\ H_3O^+}]{1.\ LiNH_2(2\text{ equiv.})/\text{liq. }NH_3}$$

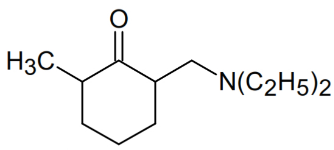
(A) $CH_3CH_2-C\equiv C-CH_2OH$
(B) $H-C\equiv C-CH_2OCH_2CH_3$
(C) $CH_3CH_2-C\equiv C-CH_2NH_2$
(D) $H-C\equiv C-CH_2NH-CH_2CH_3$

28. The reaction of P_2O_5 with HNO_3 and $HClO_4$, respectively, gives
(A) NO_2 and ClO_2
(B) N_2O_5 and Cl_2O_6
(C) N_2O_3 and Cl_2O_7
(D) N_2O_5 and Cl_2O_7

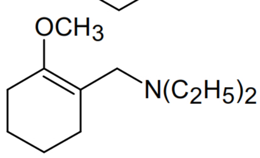
29. The major product formed in the following reaction, is



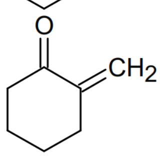
(A)

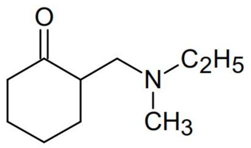


(B)



(C)



(D) 

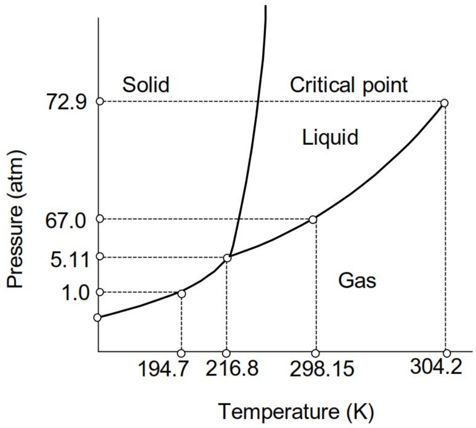
30. Select the correct statement(s) about drugs:
(A) Chlordiazepoxide is suitable for relieving tension.
(B) Barbiturates are sleep producing agents.
(C) Cimetidine prevent the interaction of histamine with the receptors present in stomach wall.
(D) All of the above are correct statements.

31. The correct electronic configuration and spin only magnetic moment Gd^{3+} (at. no. 64) are
(A) $[Xe]4f^7$ and 7.9BM
(B) $[Xe]4f^7$ and 8.9BM
(C) $[Xe]4f^6 5d^1$ and 7.9BM
(D) $[Rn]5f^7$ and 7.9BM

32. Among the following octahedral complexes, the one that has the highest enthalpy of hydration is
(A) $[Ca(H_2O)_6]^{2+}$
(B) $[Mn(H_2O)_6]^{2+}$
(C) $[V(H_2O)_6]^{2+}$
(D) $[Cr(H_2O)_6]^{2+}$

33. The Lewis acidity of BF_3 is less than BCl_3 even though fluorine is more electronegative than chlorine. It is due to
(A) stronger 2p(B)-2p(F) σ – bonding
(B) stronger 2p(B)-2p(F) π – bonding
(C) stronger 2p(B)-3p(Cl) σ – bonding
(D) stronger 2p(B)-3p(Cl) π – bonding

34. Consider the following phase diagram of CO_2 (not to scale). At equilibrium, the INCORRECT statement is:



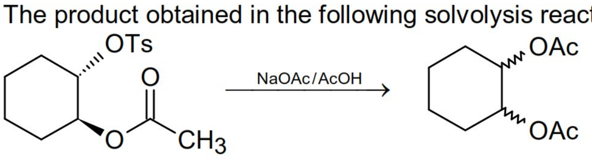
(A) At 200 K, on increasing the pressure from 1 to 50 atm, CO_2 gas condenses to liquid.
(B) It is not possible to obtain liquid CO_2 from gaseous CO_2 below 5.11 atm.
(C) Both liquid and gas phase CO_2 coexist at 29.15 K and 67 atm.
(D) With increasing pressure, the melting point of solid CO_2 increases.

35. Among the following species, the one that has pentagonal shape is:
(Given: atomic numbers of O, F, S, I and Xe are 8, 9, 16, 53 and 54, respectively)
(A) $XeOF_4$
(B) IF_5
(C) $[SF_5]^-$
(D) $[XeF_5]^-$

36. Which of the following is a viable particulate
(A) Smoke
(B) Algae
(C) Mists
(D) Dust

37. The number of unit cells in 117 g of NaCl is approximately
(A) 6×10^{20}
(B) 3×10^{23}
(C) 6×10^{23}
(D) 0.5×10^{24}

38. The product obtained in the following solvolysis reaction is



enantiomerically
pure compound

(A) a racemic mixture of *trans* 1,2-diacetoxycyclohexane
(B) enantiomerically pure *trans* 1,2-diacetoxycyclohexane
(C) racemic *cis* 1,2-diacetoxycyclohexane
(D) a mixture of *cis* and *trans* 1,2-diacetoxycyclohexane

39. A 0.1 M solution of $\left[Cu(NH_3)_4\right]^+$ is stirred with an excess of potassium cyanide sufficient to convert all the ammonium complex to the corresponding cuprocyanide complex $\left[Cu(CN)_4\right]^{-3}$ and in addition to provide the solution with an excess of CN^- equal to 0.2 M. Calculate the maximum pH of the solution when the final solution is treated with hydrogen sulphide to maintain $[H_2S] = 0.1$ M and the precipitation of cuprous sulphide is prevented. The instability constant for $\left[Cu(CN)_4\right]^{-3}$ is 6.4×10^{-15}, $K_{a,\,overall}$ of $H_2S = 1.6 \times 10^{-21}$, K_{sp} of $Cu_2S = 2.56 \times 10^{-27}$.
(A) 4.0
(B) 10.0
(C) 10.8
(D) 3.2

40. The compound which don't liberate coloured gas with conc. H_2SO_4 is
(A) $KCl + K_2Cr_2O_7$
(B) KCl
(C) KNO_2
(D) KBr

41. Suppose the mass of electron is decreased by 25%. How will it affect the Rydberg constant?
(A) It remains unchanged.
(B) It becomes one-fourth.
(C) It reduces to 75% of its original value.
(D) It is doubled.

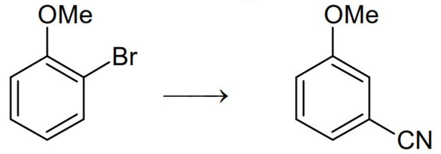
42. At moderate pressure, the compressibility factor for a gas is given as $Z = 1 + 0.35P - \frac{168}{T}.P$, where P is in bar and T is in Kelvin. What is the Boyle's temperature of the gas?

(A) 168 K
(B) 480 K
(C) 58.8 K
(D) 575 K

43. Graph between $\log\left(\frac{x}{m}\right)$ and log P is a straight line at an angle 45° with intercept on y-axis, 0.3010. The amount (in g) of the gas absorbed per g of the adsorbent when pressure is 0.2 atm is (assume that the adsorption obey Freundlich isotherm)

(A) 0.4
(B) 0.6
(C) 0.8
(D) 0.2

44. The correct set of reagents for the following conversion is



(A) (i) $NaNH_2$ / liq. NH_3; (ii) $NaNO_2$ / dil. HCl; (iii) CuCN, heat

(B) (i) HNO_3 / H_2SO_4; (ii) ZnHCl; (iii) $NaNO_2$ / dil. HCl; (iv) CuCN, heat

(C) (i) Mg / ether, H_2O^+; (ii) $(EtO)_2$ CO; (iii) NH_4OH; (iv) PCl_5

(D) (i) Mg / ether, H_2O^+; (ii) HNO_3 / H_2SO_4; (iii) $NaNO_2$ / dil. HCl; (iv) CuCN, heat

45. Phenol on reacting with Hinsberg's reagent gives:

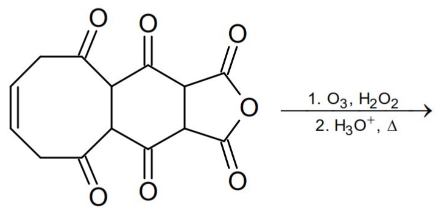
(A) Sulphone
(B) Sulphanilic
(C) Sulphonic ester
(D) Sulphonal

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. Number of carbonyl groups present in the final product of the following reaction sequence is................



47. The rate constant of a first order reaction, $X \rightarrow Y$, is $1.6 \times 10^{-3}\ s^{-1}$ at 300 K. Given that the activation energy of the reaction is 28 kJ mol^{-1} and assuming Arrhenius behaviour for the temperature dependence, the total time required to obtain 90% of Y at 350 K is ____________s. (Use R = 8.31 J K^{-1} mol^{-1})

48. The Latimer diagram of oxygen is given below. The value of 100x is________V.

$$\begin{tikzcd} O_2 \arrow[r, "+0.70\ V"] \arrow[rr, bend right, "xV"'] & H_2O_2 \arrow[r, "+1.76\ V"] & H_2O \end{tikzcd}$$

49. On heating a sample of 25 g hydrated compound (molecular weight = 250 g/mol) in thermogravimetric analysis, 16 g of dehydrated compound remains. The number of water molecules lost per molecule of hydrated compound is________.

50. The entropy change for the melting of 'x' moles of ice (heat of fusion is 80 cal g^{-1}) at 273 K and 1 atm pressure is 28.80 cal K^{-1}. The value of '50x' is__________
(Molecular weight of water = 8 g/mol)

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 P is any point on ellipse with foci S_1 and S_2 and eccentricity is $\frac{1}{2}$ such that $\angle PS_1S_2 = \alpha$, $\angle PS_2S_1 = \beta$, $\angle S_1PS_2 = \gamma$, then $\cot\left(\frac{\alpha}{2}\right), \cot\left(\frac{\gamma}{2}\right), \cot\left(\frac{\beta}{2}\right)$ are in

(A) A.P.
(B) G.P.
(C) H.P.
(D) not A.P., G.P. and H.P.

52. For each positive integer n, consider the point P with abscissa n on the curve $y^2 - x^2 = 1$. If d_n represents the shortest distance from the point P to the line y = x, then $\lim\limits_{n\to\infty}(n \cdot d_n)$ is

(A) $\frac{1}{2\sqrt{2}}$
(B) $\frac{1}{2}$
(C) $\frac{1}{\sqrt{2}}$
(D) 0

53. Latus-rectum of the conic satisfying the differential equation xdy + ydx = 0 and passing through the point (2, 8) is

(A) $4\sqrt{2}$
(B) 8
(C) $8\sqrt{2}$
(D) 16

54. Let a and b be real numbers and let $f(x) = a\sin x + b\sqrt[3]{x} + 4$, $\forall\ x \in R$. If $f(\log_{10}(\log_3 10)) = 5$, then $f(\log_{10}(\log_{10} 3))$ is

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

55. Suppose f is an even periodic function with period 2, and that f(x) = x for all x in the interval [0, 1]. The value of f(3.14) is

(A) 3.14
(B) 0.86
(C) 1.57
(D) 1.3

56. $\int (x^2+1)\left((x+1)e^x\right)^2 dx = A\left(f(x)\right)^2 + C$ where C is constant of integration and $f(-1) = \frac{2}{e}$, then 2A + f(0) is

(A) 3
(B) 2
(C) 1
(D) 0

57. If $\sum_{i=1}^{6}\left(\sin^{-1}(x_i) + \cos^{-1}(y_i)\right) = 9\pi$, then $\int_{\sum_{i=1}^{6} x_i}^{\sum_{i=1}^{6} y_i} x\ln(1+x^2)\left(\frac{e^x}{1+e^{2x}}\right)dx$ is equal to

(A) 0
(B) $e^6 + e^{-6}$
(C) $\ln\left(\frac{37}{12}\right)$
(D) $e^6 - e^{-6}$

58. Area bounded by $y = \frac{1}{x^2 - 2x + 2}$ and x-axis is

(A) 2π sq. units
(B) $\frac{\pi}{2}$ sq. units
(C) 2 sq. units
(D) π sq. units

59. Let f(x) = $\frac{\sin(\pi x^4) + (x+2)^n \frac{\tan(\pi x)}{(x+1)}}{1 + (x+2)^n - x^4}$, then $\lim_{x \to -1} f(x)$ is

(A) π
(B) $\frac{22}{7}$
(C) 1
(D) $-\pi$

60. If $f(x) = \frac{\sqrt{x^2 + kx + 1}}{x^2 - k}$, the interval(s) of all possible values of k for which f is continuous for every $x \in R$, is

(A) $(-\infty, -2]$
(B) $[-2, 0)$
(C) $R - (-2, 2)$
(D) $(-2, 2)$

61. Number of complex numbers satisfying the relation $|z + \bar{z}| + |z - \bar{z}| = 2$ and $|z + i| + |z - i| = 2$ is

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

62. If A = $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ and $\det(A^n - I) = 1 - \lambda^n$, $n \in N$, then the value of λ is

(A) 2
(B) –2
(C) 3
(D) 4

63. The matrix A = $\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 1 \\ 2 & 2 & 1 \end{bmatrix}$ be a zero divisor of the polynomial $f(x) = x^2 - 4x - 5$, then the trace of matrix A^3, is

(A) 213
(B) 123
(C) 203
(D) 201

64. The relation R = {(1, 1), (2, 2), (3, 3), (1, 2), (2, 3), (1, 3)} on the set A = {1, 2, 3} is

(A) reflexive but not symmetric
(B) reflexive but not transitive
(C) symmetric and transitive
(D) neither symmetric nor transitive

65. A tower subtends angles d, 2α, 3α respectively at points A, B and C all lying on a horizontal line through the foot of the tower, then $\frac{AB}{BC}$ is equal to

(A) $\frac{\sin(3\alpha)}{\sin(2\alpha)}$
(B) $1 + 2\cos(2\alpha)$
(C) $2\cos(2\alpha)$
(D) $\frac{\sin(2\alpha)}{\sin\alpha}$

66. The sum of squares of deviations for 10 observations taken from mean 50 is 250. The coefficient of variation is

(A) 10% (B) 40%
(C) 50% (D) none of these

67. If p and q be two statements, then $(\sim p \vee q) \wedge (\sim p \wedge \sim q)$ is a

(A) tautology (B) contradiction
(C) neither tautology nor contradiction (D) either tautology or contradiction

68. Let $y = \tan^{-1}\left(\frac{4x}{1+5x^2}\right) + \tan^{-1}\left(\frac{2+3x}{3-2x}\right)$ where $x \in \left(0, \frac{2}{3}\right)$. If $\frac{dy}{dx} = \frac{\alpha}{1+25x^2}$, then the value of α is

(A) 3 (B) 4
(C) 5 (D) 6

69. $I = \int_{e^{\pi/6}}^{e^{\pi/2}} \frac{\sin(\ln(\sin(\ln x)))\cdot\cos(\ln x)}{x\sin(\ln x)}dx$, then $\cos^{-1}(I + 1)$ is

(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{3}$
(C) ln2 (D) 2ln2

70. The largest value of $\frac{y}{x}$, where (x, y) is real number pair satisfying $(x - 3)^2 + (y - 3)^2 = 6$, is

(A) $2\sqrt{3}$ (B) $2+\sqrt{3}$
(C) $3+2\sqrt{2}$ (D) $6+2\sqrt{3}$

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. If $f(\theta) = \frac{1}{1+(\cot\theta)^x}$ and $s = \sum_{\theta=1^\circ}^{89^\circ} f(\theta)$, then [s] is (where [.] denotes G.I.F)

72. Let $\vec{v}_1$ and $\vec{v}_2$ are two vectors such that $\vec{v}_1 = 2(\sin\alpha + \cos\alpha)\hat{i} + \hat{j}$ and $\vec{v}_2 = (\sin\beta)\hat{i} + (\cos\beta)\hat{j}$ where α and β satisfy the reaction $2(\sin\alpha + \cos\alpha)\sin\beta = 3 - \cos\beta$, then the value of $3\tan^2\alpha + 4\tan^2\beta$ is

73. The line which contains all points (x, y, z) which are of the form $(x, y, z) = (2, -2, 5) + \lambda(1, -3, 2)$ intersects the plane $2x - 3y + 4z = 163$ at P and intersects the YZ plane at Q. If the distance PQ is $a\sqrt{b}$, where $a, b \in N$ and $a > 3$ then $(a + b)$ is

74. If A and B are two events with P(A) = 0.5 and $P(A \cup B) = 0.8$. If P(B) = p and A and B are mutually exclusive and P(B) = q, if A and B are independent then $\left|\frac{q}{p}\right|$ is

75. If x > 0 and y > 0 and $x^2y^3 = 6$. If m be the least value of 3x + 4y, then m is

SOLUTIONS

Physics

PART – A

SECTION – A

1. B

Sol. Applying energy conservation:

$mgh = mL_f$

$$h = \frac{L_f}{g} = \frac{80\ \text{cal/gm}}{10\ \text{m/s}^2}$$

$$= \frac{80 \times 42 \times 1000\ \text{J/kg}}{10\ \text{m/s}^2} = \left(\frac{336 \times 10^3}{10}\right)\frac{N - s^2}{kg} = 33.6\ \text{km}$$

2. D

Sol.

$$\frac{2}{3}v\rho_1 g = v\rho g$$

$$\frac{3}{4}v\rho_2 g = v\rho g$$

$$v\rho_1 + v\rho_2 = 2v\rho_m$$

$$\frac{\rho_1 + \rho_2}{2} = \rho_m$$

$$v'\left(\frac{\rho_1 + \rho_2}{2}\right)g = v\rho g$$

$$\frac{v'}{2}\left(\frac{3\rho g}{2} + \frac{4\rho g}{3}\right) = v\rho g$$

$$v' = \frac{12}{17}v$$

3. B

Sol. As $P = nR\frac{T}{V}$ so $P_A = nR\frac{T_0}{2V_0}$

and $P_B = nR\frac{4T_0}{3V_0}$

$\Rightarrow \frac{P_B}{P_A} = \frac{8}{3}$

4. C

Sol. Resonant frequency of an L-C-R circuit is given by

$\omega_r = \frac{1}{\sqrt{LC}}$

So, resonance frequency does not depend on resistance of circuit and frequency of supply. To increase resonance frequency, we have to reduce inductance or capacitance of circuit. As capacitance reduces when capacitors are connected in series

(i.e. $\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2}$), another capacitor in series to increase resonant frequency.

5. A

Sol. As, refractive index,

$\mu = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$

So, speed of light in a medium

$v = \frac{c}{\mu}$

Hence, for medium A and B,

$v_A = \frac{c}{\mu_A}$ and $v_B = \frac{c}{\mu_B}$

Time taken by light to cross some

thickness x is $\left(\text{speed} = \frac{\text{distance}}{\text{time}}\right)$

$t_1 = \frac{x}{(c/\mu_A)}$ and $t_2 = \frac{x}{(c/\mu_B)}$

Hence, $t_2 - t_1 = \frac{\mu_B \cdot x}{c} - \frac{\mu_A \cdot x}{c}$

$\Rightarrow t_2 - t_1 = \frac{x}{c}(\mu_B - \mu_A)$

Now, given, $\frac{\mu_A}{\mu_B} = \frac{1}{2}$

$\Rightarrow \mu_B = 2\mu_A$

and $t_2 - t_1 = 5 \times 10^{-10}$ s

substituting these values, we get

$5 \times 10^{-10} = \frac{x}{c}(2\mu_A - \mu_A)$

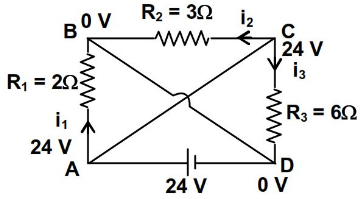
$\Rightarrow x = 5 \times 10^{-10} \times \frac{c}{\mu_A}$

But $\frac{c}{\mu_A} = v_A$

$\therefore\ x = (5 \times 10^{-10} \times v_A)m$

6. D

Sol. Assume potential at point D is equal to zero. As we know potential of all points on a plane wire are equal, so potential at B will also be equal to 0 V. Also potential difference across cell is 24 V, so potential at A will be 24 V. Similarly, potential at C is also 24V.



Assume potential

Using Ohm's law for branch AB,

$$i_1 = \frac{V_A - V_B}{R_1} = \frac{24-0}{2} = 12\text{ A}$$

For branch CB,

$$i_2 = \frac{V_C - V_B}{R_2} = \frac{24-0}{3} = 8\text{A}$$

For branch CD,

$$i_3 = \frac{V_C - V_D}{R_3} = \frac{24-0}{6} = 4\text{A}$$

By KCL for junction C,

$i = i_2 + i_3 = 8 + 4 = 12$ A

7. C

Sol. As per Einstein's photoelectric equation

$$v_S = \frac{hf}{e} - \frac{\phi}{e} \quad \text{...(i)}$$

If f is doubled, new stopping potential,

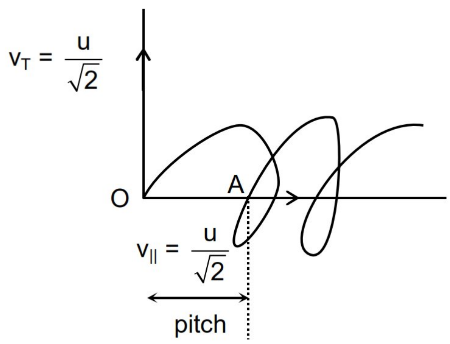
$$V_S' = \frac{2hf}{e} - \frac{\phi}{e}$$

$$= 2\left(\frac{hf}{e} - \frac{\phi}{e}\right) + \frac{\phi}{e} = 2V_S + \frac{\phi}{e} \quad \text{[from equation (i)]}$$

Which is more than double or an increase of more than 100%

8. B

Sol. When a charged particle enters a region of a uniform magnetic field, such that the angle it makes with the direction of B ≠ 90°, then it follows a helical path as shown below



Radius of helix,

$$R = \frac{mv_\perp}{qB} = \frac{mu}{\sqrt{2}qB} \quad \text{...(i)}$$

Where, $v_\perp$ = Component of velocity perpendicular to field.

Also, pitch, P = Displacement along field in one revolution (OA)

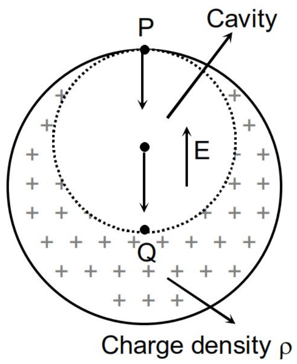
$= v_{||} \times T = \frac{u}{\sqrt{2}} \times \frac{2\pi m}{qB}$ (ii)

Dividing equation (ii) by equation (i), $\frac{P}{R} = 2\pi$

9. A

Sol. Field inside spherical cavity in a sphere = $\frac{\rho a}{3\varepsilon_0}$

Where a = distance between centres of sphere and cavity. Direction of field is along line joining centres as shown in figure.



So, field inside cavity will be $E = \frac{\rho\left(\frac{R}{2}\right)}{3\varepsilon_0} = \frac{\rho R}{6\varepsilon_0}$ (as shown)

Under influence of field, electron will accelerate down with acceleration,

$a = \frac{eE}{m} = \frac{\rho Re}{6\varepsilon_0 m}$ ...(i)

As electrons move from P to Q, striking the cavity at Q, its displacement will be equal to PQ = R= s ...(ii)

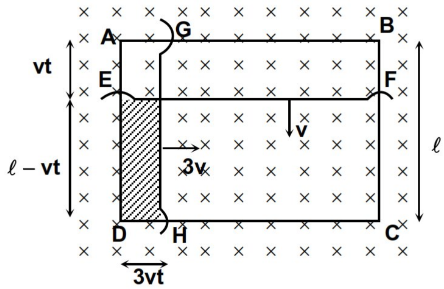
So, by using, $s = ut + \frac{1}{2}at^2$, we get

$R = 0 + \frac{1}{2}\frac{\rho Re}{6\varepsilon_0 m}t^2$ [using equation (i) and (ii)]

$\Rightarrow t = \sqrt{\frac{12\varepsilon_0 m}{\rho e}}$

10. B

Sol. At time t, distances moved by sliders GH and EF will be 3vt and vt respectively as shown.



Therefore, area of loop ETHD will be

$A = 3vt(\ell - vt) = 3v\ell t - 3v^2t^2$

$\Rightarrow \frac{dA}{dt} = 3v\ell - 6v^2t$ ...(i)

At the instant, the loop is square, its two sides will be equal. Therefore,

$3vt = \ell - vt \Rightarrow t = \frac{\ell}{4v}$

...(ii)

By Faraday's law, emf induced in the loop

$\varepsilon = \frac{d\phi}{dt} = \frac{d(B_0 \cdot A)}{dt} = B_0\frac{dA}{dt}$

$= B_0(3v\ell - 6v^2t)$ using equation (i)

$= B_0\left[3v\ell - 6v^2\left(\frac{\ell}{4v}\right)\right]$ using equation (ii)

$= \frac{3B_0v\ell}{2} = 1.5\ B_0v\ell$

11. D

Sol. $[\vec{F}] = [Ar^2\hat{r}] = [Ar^2]$

$$[A] = \frac{[\vec{F}]}{[r^2]} = \frac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$$

12. B

Sol. Between t = 0 and t = 2, acceleration has same sign which increases speed. At t = 2 sec. Direction of acceleration is reversed and speed starts decreasing.

13. B

Sol. $T = M_B \times a_B$ but T is also equal to $M_A a_A$

$\therefore M_B a_B = M_A a_A$

$\Rightarrow 6 \times 1.5 = 4 \times a_A$

$\Rightarrow a_A = 2.25\ m/s^2$

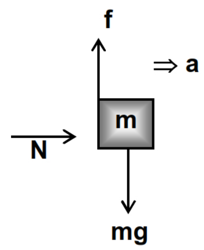
14. B

Sol. f = mg and N = mA

So, $\mu N = mg$

$\mu mA = mg$ (For A_{min}, f is max)

$$\Rightarrow A = \frac{g}{\mu}$$



15. B

Sol. At 45°, $a_t = a_r = 9$

$$\frac{v^2}{r} = \frac{v^2}{4} = 9$$

v = 6 m/s

Now, 6 = 0 + 9t

$$t = \frac{2}{3} \text{ sec}$$

16. C

Sol. Conserving energy between points A and B,

$$mg\left[\frac{R}{4} + R(1-\cos\theta)\right] = \frac{1}{2}mv^2$$

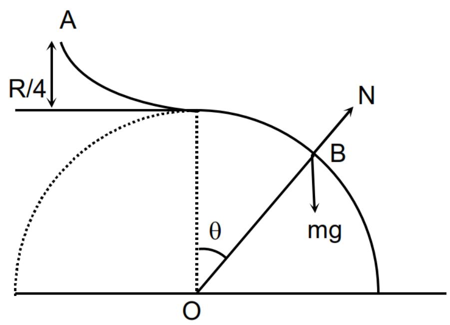
Also at point B, N = 0

$$\text{So, } mg\cos\theta = \frac{mv^2}{R}$$

$$\frac{1}{4} + (1-\cos\theta) = \frac{1}{2}\cos\theta$$

$$\frac{5}{4} = \frac{3}{2}\cos\theta$$

$$\cos\theta = \frac{5}{6}$$



17. B

Sol. Kapil and the boat can be considered as one body of mass m_b = (65 + 100) = 165 kg. Note that the centre of mass of the system remains unchanged since no external force acts on the system. Let m_S be the mass of Sachin and Δx_b and Δx_S be the displacements of the combined body of mass m_b and Sachin respectively with reference to the centre of mass. Then use the equation $m_S \Delta x_S + m_b \Delta x_b = 0$, to get the answer.

18. A

Sol. $T = (2m)\ell\omega^2 = mg$

$$\omega = \sqrt{\frac{g}{2}} = \sqrt{5} \text{ rad/s}$$

19. A

Sol. If friction acts backwards then ω will increase and v_{cm} will decrease hence violating pure rolling condition and if friction acts in forward direction the ω will decrease and v_{cm} will increase again violating pure rolling condition hence no friction acts.

20. D

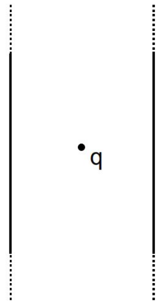
Sol. $$2\pi\sqrt{\frac{\frac{3}{2}MR^2}{MgR}} = 2\pi\sqrt{\frac{\ell}{g}}$$

SECTION – B

21. 9

Sol. To find through infinite plane-1, let us construct an infinite plane-2 at same distance from q on other side. If electric flux through plane-1 is ϕ, then flux through plane-2 will be also ϕ.

By Gauss's Law



$$\phi_{total} = 2\phi = \frac{q}{\varepsilon_0}$$

$$\phi = \frac{q}{2\varepsilon_0} = \frac{1}{8\pi\varepsilon_0} = \frac{9\times10^9}{2} = 4.5\times10^9$$

b = 9

22. 2

Sol. Magnification of the object

$$m = \frac{f}{f-u} = \frac{f}{f-(-f)} = \frac{1}{2}$$

As velocity component of image along axis is given by

$$v_i = -m^2 v_0$$

$$\Rightarrow v_i = -\left(\frac{1}{2}\right)^2 4\cos30° = -\frac{\sqrt{3}}{2} \text{ cm/s}$$

Also velocity component of image perpendicular to axis is given by

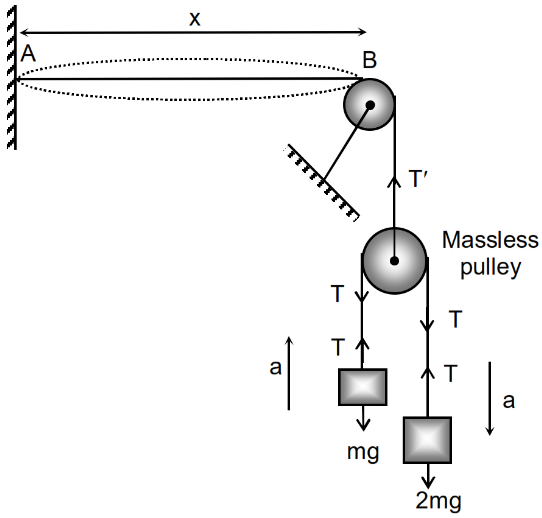
$$v_i' = mv_0 = \frac{1}{2}\cdot 4\sin30° = 1 \text{ cm/s}$$

Therefore, net velocity of image is

$$v_{net}' = \sqrt{v_i^2 + v_i'^2} = \sqrt{\frac{3}{4}+1} = \frac{\sqrt{7}}{2} \text{ cm/s}$$

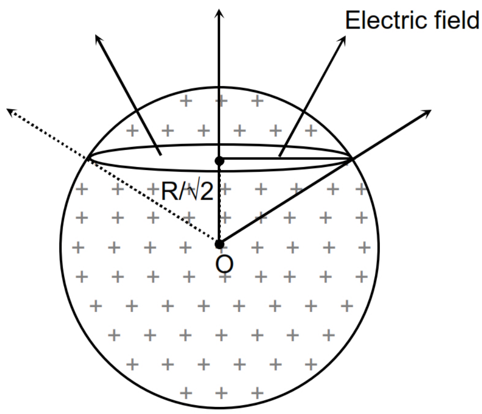
23. 5

Sol. Consider FBD of blocks.
For mass m, using F = ma, we get
$T - mg = ma$ ...(i)
Similarly for mass 2m, we get
$2mg - T = 2ma$ ...(ii)
From Equation (i) and (ii),
$T = \frac{4mg}{3}$ ...(iii)
From FBD of pulley,
$T' = 2T = \frac{8mg}{3}$
Therefore, frequency of vibration of wire in fundamental mode,
$f_1 = \frac{1}{2\ell}\sqrt{\frac{T'}{\mu}} = \frac{1}{2x}\sqrt{\frac{8mg}{3\mu}}$
Also, frequency of vibration of air in 1st overtone (3rd harmonic)
$f_2 = \frac{3v}{4\ell} = \frac{3v}{\frac{4x}{2}} = \frac{3v}{2x}$
As, resonance implies frequencies are equal
i.e., $f_1 = f_2 \Rightarrow \frac{1}{2x}\sqrt{\frac{8mg}{3\mu}} = \frac{3v}{2x}$ [using Eq. (v) and (vi)]
$\Rightarrow m = \frac{27\mu v^2}{8g} = \frac{27(0.2\times10^{-3})(400)^2}{8\times10} = \frac{54}{5}$ kg



24. 8

Sol. Lets construct a cone as shown. By field picture, ϕ through lateral surface is zero.
$\Rightarrow \phi_{section} = \phi_{cone} = \frac{q_{inside}}{\varepsilon_0}$
$= \frac{\rho\cdot\frac{1}{3}\pi\left(\frac{R}{\sqrt{2}}\right)^2\left(\frac{R}{\sqrt{2}}\right)}{\varepsilon_0}$
$= \frac{\left(\frac{Q}{\frac{4}{3}\pi R^3}\right)\cdot\left(\frac{1}{3}\pi\frac{R^3}{2\sqrt{2}}\right)}{\varepsilon_0} = \frac{Q}{8\sqrt{2}\varepsilon_0}$



25. 6

Sol. Frequency of revolution of electron,

$$f = \frac{v}{2\pi r} = \frac{v_0 \frac{Z}{n}}{2\pi r_0 \frac{n^2}{z}} = \frac{v_0 z^2}{2\pi r_0 n^3}$$

Number of revolutions in time t will be

$$N = ft = \frac{v_0 z^2 t}{2\pi r_0 n^3}$$

As we know, Bohr's radius

$r_0 = 0.53$ Å $= 0.53 \times 10^{-10}$ m

v_0 = Bohr's speed = 2.2×10^6 m/s

Putting these values in Eq. (ii), we get

$$N = \frac{2.2 \times 10^6 \times 1^2 \times 10^{-8}}{2 \times 3.14 \times 0.53 \times 10^{-10} \times 2^3} \approx 8 \times 10^6$$

Comparing with given value, we get x = 6

PART – B

SECTION – A

26. C

Sol. Carboxylic acids are more acidic than alcohol. Electronic effects also influence acidity.

27. A

Sol.

$$H-C\equiv C-CH_2OH \xrightarrow{LiNH_2} H-C\equiv C-CH_2-O^{\ominus} \xrightarrow{LiNH_2} {}^{\ominus}C-C\equiv C-CH_2-O^{\ominus}$$

$$\xrightarrow{C_2H_5Br} CH_3CH_2-C\equiv C-CH_2-O^{\ominus} \xrightarrow{H_3O^+} CH_3CH_2-C\equiv C-CH_2-CH_2OH$$

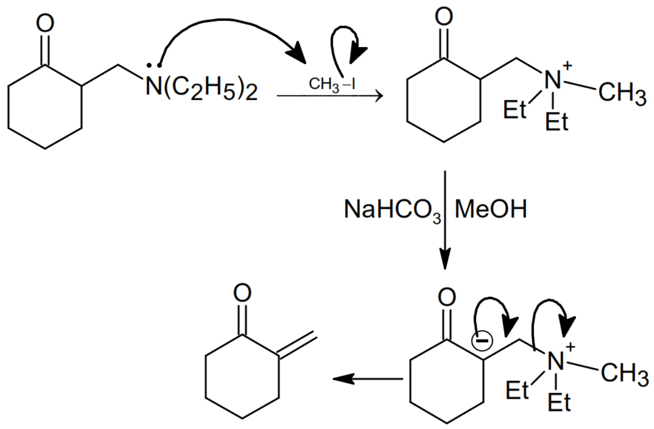
28. D

Sol. $P_2O_5 + 2HNO_3 \longrightarrow N_2O_5 + 2HPO_3$

$P_2O_5 + 2HClO_4 \longrightarrow Cl_2O_7 + 2HPO_3$

29. C

Sol.



30. D

Sol. Fact

31. A

Sol. $Gd = [Xe]4f^7 5d^1 6s^2$

$Gd^{3+} = [Xe]4f^7$

$\mu = \sqrt{n(n+2)} = \sqrt{7(7+2)} = 7.9$ BM

32. C

Sol. Highest the CFSE of compound, highest is the enthalpy of hydration.

33. B

Sol. Smaller the size of orbital extent of back bonding is more.

34. A

Sol. On increasing pressure CO_2 gas condeses to liquid.

35. D

Sol. $[XeF_5]^-$ is sp^3d^3 hybridized.

36. B

Sol. Viable particualte are minute living organisms that are dispersed in the atmosphere.

37. B

Sol. Molar mass of NaCl = 58.5 g

Moles of NaCl $\frac{117}{58.5} = 2$

In a unit cell = 4 NaCl

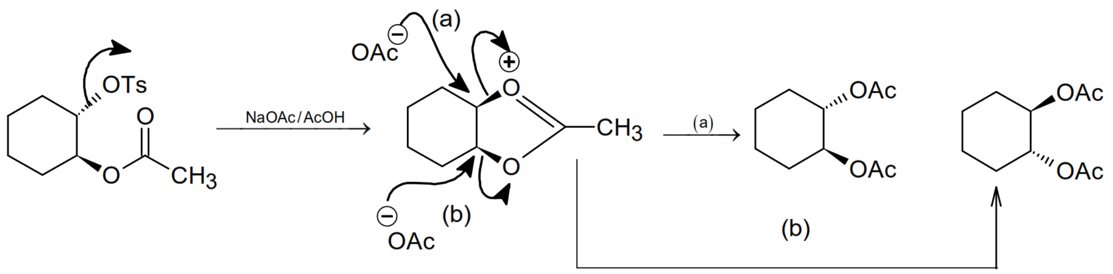
Total number unit cell $= \frac{1}{4} \times \text{Number of NaCl}$

$= \frac{1}{4} \times 2 \times 6.02 \times 10^{23}$

$= 3 \times 10^{23}$

38. A

Sol.



39. B

Sol. From the question,

$\left[Cu(CN)_4^{3-}\right] = 0.1 \text{ M and } \left[\left[CN^-\right]\right] = 0.2 \text{ M}$

$\therefore \left[Cu^+\right] = \frac{K_{instab} \cdot \left[Cu(CN)_4^{3-}\right]}{\left[CN^-\right]^4} = \frac{6.4 \times 10^{-15} \times 0.1}{(0.2)^4}$

$= 4 \times 10^{-13} \text{ M}$

Now, $\left[S^{2-}\right] = \frac{K_{SP}(Cu_2S)}{\left[Cu^+\right]^2} = \frac{2.56 \times 10^{-27}}{\left(4 \times 10^{-13}\right)^2}$

$= 1.6 \times 10^{-2} \text{ M}$

$\therefore \left[H^+\right] = \sqrt{\frac{K_a \times [H_2S]}{\left[S^{2-}\right]}} = \sqrt{\frac{1.6 \times 10^{-21} \times 0.1}{1.6 \times 10^{-2}}} = 10^{-10} \text{ M}$

and pH = 10.0.

40. B

Sol. $Cl^- + H_2SO_4 \longrightarrow HCl\uparrow (\text{Colourless}) + HSO_4^-$

41. C

Sol. $R = \dfrac{2\pi^2 me^4}{(4\pi\varepsilon_0)^2 h^3 c}$

$\Rightarrow R \propto m$

Here, m becomes $\left(m - \dfrac{m}{4} = \dfrac{3m}{4}\right)$, then R becomes $\dfrac{3}{4}R$.

42. B

Sol. At Boyle's temperature, $\dfrac{dz}{dp} = 0 \Rightarrow T = \dfrac{168}{0.35} = 480\ K$.

43. A

Sol. $\dfrac{x}{m} = K.P^{\frac{1}{n}} \Rightarrow \log\dfrac{x}{m} = \log K + \dfrac{1}{n}.\log P$

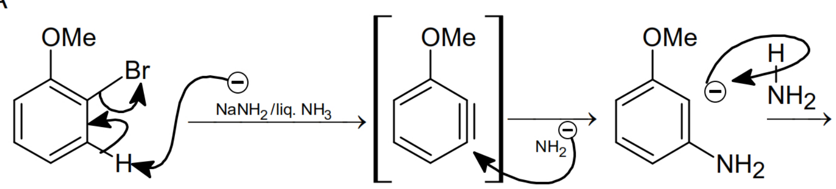
From question, $\log K = 0.3010 = \log 2 \Rightarrow K = 2$

And $\dfrac{1}{n} = \tan 45^o = 1 \Rightarrow n = 1$

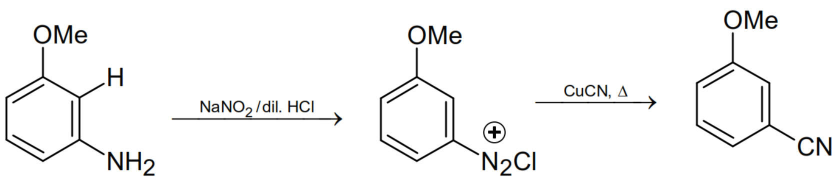
$\therefore \dfrac{x}{m} = 2 \times P = 2 \times 0.2 = 0.4$

44. A

Sol.

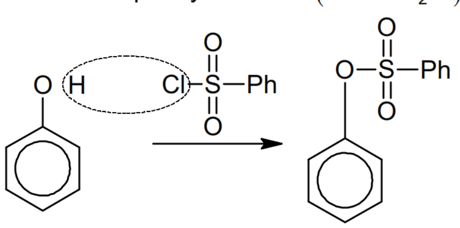


Benzyne intermediate



45. C

Sol. Benzene sulphonyl chloride $(Ph - SO_2Cl)$ is known as Hinsberg reagent.

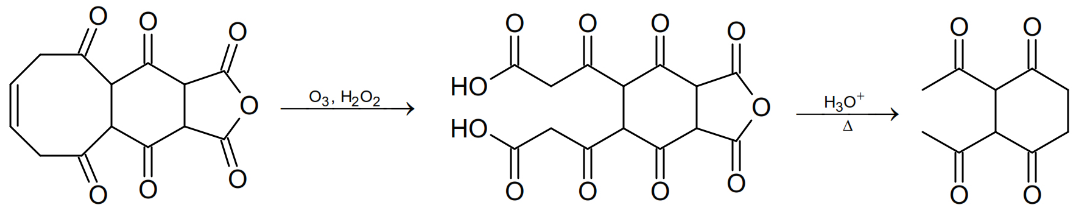


Sulphonic ester

SECTION – B

46. 4

Sol.



47. 289

Sol. $\log\frac{K_2}{K_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$T_1 = 300$ K $\quad K_1 = 1.6\times10^{-3}$, $\quad T_2 = 350$ K

$t_{90\%} = \frac{2.303}{K_2}\log\frac{100}{10}$

= 289 s.

48. 123

Sol. $2H^+ + O_2 + 2e^- \longrightarrow H_2O_2 \qquad \Delta G_1^o$

$2e^- + 2H^+ + H_2O_2 \longrightarrow 2H_2O \qquad \Delta G_2^o$

$4H^+ + O_2 + 4e^- \longrightarrow 2H_2O \qquad \Delta G_3^o$

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

$(-2\times0.70) + (-2\times1.76) = -4\times x$

$E_3^o = 1.23$

100x = 100 × 1.23 = 123

49. 5

Sol. $A.xH_2O \longrightarrow A + xH_2O$

$\frac{25}{250} \qquad \frac{16}{M}$

$\frac{25}{250} = \frac{16}{M}$

M = 160

x = 5.

50. 273

Sol. $\Delta S_{fusion} = \frac{\Delta H_{fusion}}{T} = \frac{80\times18\times x}{273}$

x = 5.46 mole

50x = 273

Mathematics

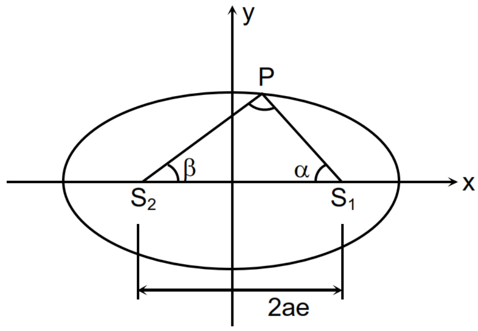
PART – C

SECTION – A

51. A

Sol. $\frac{2ae}{\sin(\alpha+\beta)} = \frac{S_1P}{\sin\beta} = \frac{S_2P}{\sin\alpha} = \frac{2a}{\sin\alpha+\sin\beta}$

$e = \frac{\sin(\alpha+\beta)}{\sin\alpha+\sin\beta}$



$\frac{1-e}{1+e} = \tan\left(\frac{\alpha}{2}\right)\tan\left(\frac{\beta}{2}\right) = \frac{1-\frac{1}{2}}{1+\frac{1}{2}} = \frac{1}{3}$

Also $\cot\left(\frac{\alpha}{2}\right) + \cot\left(\frac{\beta}{2}\right) + \cot\left(\frac{\gamma}{2}\right)$

$= \cot\left(\frac{\alpha}{2}\right)\cot\left(\frac{\beta}{2}\right)\cot\left(\frac{\gamma}{2}\right) = 3\cot\left(\frac{\gamma}{2}\right)$

$\cot\left(\frac{\alpha}{2}\right) + \cot\left(\frac{\beta}{2}\right) = 2\cot\left(\frac{\gamma}{2}\right)$

52. A

Sol. $d_n = \left|\frac{n-\sqrt{n^2+1}}{\sqrt{2}}\right|$

$\lim_{n\to\infty}(n \cdot d_n) = \frac{n}{\sqrt{2}\left(n+\sqrt{n^2+1}\right)} = \frac{1}{2\sqrt{2}}$

53. C

Sol. $\frac{dy}{y} + \frac{dx}{x} = 0 \Rightarrow xy = c$

c = 16

xy = 16

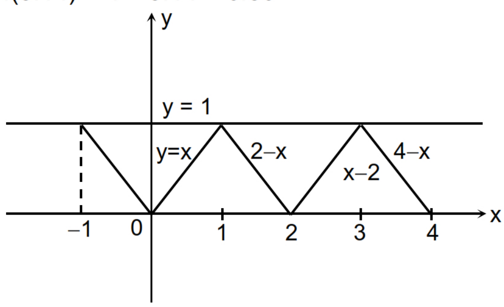
L.R. = $8\sqrt{2}$

54. C

Sol. f(x) + f(–x) = 8

55. B

Sol. f(3.14) = 4 – 3.14 = 0.86



56. B

Sol. $(x^2 + 1)\, e^x = y \Rightarrow (x + 1)^2\, exdx = dy$

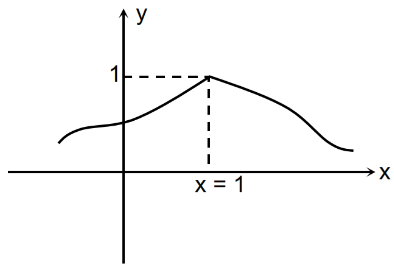
57. A

Sol. $x_i = 1 \Rightarrow \sum_{i=1}^{6} x_i = 6$

$y_i = -1 \Rightarrow \sum_{i=1}^{6} y_i = -6$

58. D

Sol. Req. area = $2\int_1^{\infty} \frac{dx}{(x-1)^2+1} = \pi$ sq. units



59. A

Sol. $\lim_{x\to -1} f(x) = \pi$

60. B

Sol. $x^2 - k \neq 0$

$k < 0$

$x^2 + x + 1 \geq 0$

61. B

Sol. Number of solutions 2

62. A

Sol. $A^n = \begin{bmatrix} 2^{n-1} & 2^{n-1} \\ 2^{n-1} & 2^{n-1} \end{bmatrix}$

$\det(A^n - I) = (2^{n-1} - 1)^2 - (2^{n-1})^2 = 1 - 2^n$

63. B

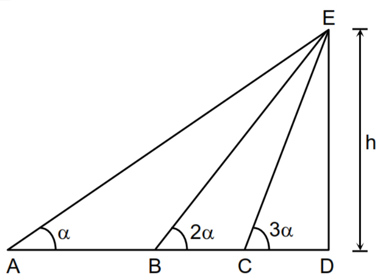
Sol. Trace $(A^3) = 123$

64. A

Sol. Reflexive, transitive but not symmetric

65. B

Sol.



66. A

Sol. $\sum (x_i - \bar{x})^2 = 250$

$\sigma^2 = \frac{250}{10} = 25$

Co-efficient of variation is = $\frac{6}{\bar{x}} \times 100 = \frac{5}{50} \times 100 = 10\%$

67. C

68. C

Sol. $y = (\tan^{-1}(5x) - \tan^{-1}(x)) + (\tan^{-1}x + \tan^{-1}(2/3))$

$\frac{dy}{dx} = \frac{5}{1+25x^2}$

69. C

Sol. $I = \int_{-\ln 2}^{0} \sin t dt = \cos(\ln 2) - 1$

70. C

Sol. $y = mx$

$\left| \frac{3m-3}{\sqrt{m^2+1}} \right| = \sqrt{6}$

$m = 3 \pm 2\sqrt{2}$

SECTION – B

71. 44

Sol. $f(\theta) = \frac{(\sin\theta)^x}{(\sin\theta)^x + (\cos\theta)^x}$

$\sum_{\theta=1^\circ}^{89^\circ} f(\theta) = \frac{89}{2}$

72. 35

Sol. $\vec{v}_1 \cdot \vec{v}_2 = 3 \Rightarrow \cos^2\theta = \frac{9}{5+\sin 2\alpha} \le 1$

$\alpha = \frac{\pi}{4}$

$\theta = 0$

$\Rightarrow \vec{v}_1$ and $\vec{v}_2$ are collinear

$\therefore \frac{2(\sin\alpha + \cos\alpha)}{\sin\beta} = \frac{1}{\cos\beta}$

$\tan\beta = 2\sqrt{2}$

$3\tan^2\alpha + 4\tan^2\beta = 3 + 4(8) = 35$

73. 23

Sol. $(\lambda + 2, -(3\lambda + 2), 2\lambda + 5)$ lies on $2x - 3y + 4z = 16 \Rightarrow \lambda = 7$

$P = (9, -23, 19)$

For Q : $x = 0$

$\lambda + 2 = 0$

$\therefore Q = (0, 4, 1)$

$PQ = 9\sqrt{14}$

74. 2

Sol. $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$0.8 = 0.5 + p - 0 \Rightarrow p = 0.3 = \frac{3}{10}$

$P(A \cap B) = P(A).P(B)$

$0.8 = 0.5 + 9 - 0.59$

$0.3 = 0.5q \Rightarrow q = \frac{3}{5}$

$\frac{q}{p} = 2$

75. 10

Sol. $3x + 4y = \frac{3x}{2} + \frac{3x}{2} + \frac{4y}{3} + \frac{4y}{3} + \frac{4y}{3}$

$AM \geq GM$

$\Rightarrow \frac{3x + 4y}{5} \geq 2$