MHT CET 2024 Mathematics Answer Key PDF

Answer Key

Question 1 - Option (D) – 8
Explanation: Characteristic equation of A is $A^2 - 8A + 15I = 0$. Multiplying by A^{-1} yields $A + 15A^{-1} = 8I$, which on division by 2 gives

$$0.5A + 7.5A^{-1} = 4I, \text{ hence } \alpha + \beta = 8.$$

Question 2 - Option (B) – $k = 0$ or $k = -3$
Explanation: The coplanarity condition of two lines is determined by setting the scalar triple product of the difference vector between points on the lines and their directions to zero.

Question 3 - Option (A) – 833
Explanation: The variance of the first n even natural numbers is given by $\sigma^2 = \frac{n^2-1}{3}$. Substituting $n = 50$ gives $\frac{2500-1}{3} = 833$.

Question 4 - Option (D) – p
Explanation: Simplifying using distributive laws yields $[p \wedge (q \vee r)] \vee [p \wedge \sim (q \vee r)] = p \wedge [(q \vee r) \vee \sim (q \vee r)] = p \wedge T = p$.

Question 5 - Option (D) – $-\frac{1}{14}$
Explanation: Replacing x with $1/x$ helps solve the functional equation to find $f(x) = \frac{8x-6/x+10}{28}$. Then differentiating $y = x^2 f(x)$ at $x = -1$ gives $-1/14$.

Question 6 - Option (B) – $5 \times 6!$
Explanation: Total circular permutations of 8 people is 7!. The number of ways B_1 and G_1 sit together is $2! \times 6!$. Subtracting these yields $7! - 2(6!) = 5 \times 6!$.

Question 7 - Option (B) – $\frac{6}{17}$
Explanation: Let $\theta = \csc^{-1}(5/3) = \tan^{-1}(3/4)$. Then $\cot(\tan^{-1}(3/4) + \tan^{-1}(2/3)) = \cot(\tan^{-1}(17/6)) = 6/17$.

Question 8 - Option (D) – $xe^{x+\frac{1}{x}} + c$
Explanation: Integrating by parts or differentiating the - Options shows that $d(xe^{x+1/x}) = e^{x+1/x}(1 + x - 1/x)dx$.

Question 9 - Option (C) – decreasing on $(0, \infty)$
Explanation: Analyzing the derivative of $f(x)$ shows $f'(x) < 0$ for all $x > 0$, indicating that the function is strictly decreasing on the domain.

Question 10 - Option (D) – $-\frac{8}{9}\pi^2$
Explanation: The linear differential equation yields the solution $y \sin x = 2x^2 - \frac{\pi^2}{2}$. Substituting $x = \pi/6$ yields $y(\pi/6) = -\frac{8}{9}\pi^2$.

Question 11 - Option (C) – $\frac{1}{b^3}[a + bx - 2a \log|a + bx| - \frac{a^2}{a+bx}] + c$
Explanation: Using the substitution $u = a + bx$ simplifies the integral to $\frac{1}{b^3}\int(1 - \frac{2a}{u} + \frac{a^2}{u^2})du$, which evaluates to - Option (C).

Question 12 - Option (C) – 5
Explanation: Projection of $\bar{a}$ on $\bar{c}$ gives $\alpha = 2$, and comparing components of $\bar{b} \times \bar{c}$ yields $\beta = 1$. Thus, $2\alpha + \beta = 5$.

Question 13 - Option (C) – 1 : 3
Explanation: Using the relations $m_1 + m_2 = -2h/b$ and $m_1 m_2 = a/b$, the condition $4ab = 3h^2$ gives $(m_1 - m_2)^2 = h^2/b^2$, which yields the ratio $1 : 3$.

Question 14 - Option (D) – $-1/2$
Explanation: Equating $\sin(\cot^{-1}(x+1)) = \cos(\tan^{-1} x)$ yields $\frac{1}{\sqrt{1+(x+1)^2}} = \frac{1}{\sqrt{1+x^2}}$, which simplifies to $2x = -1 \Rightarrow x = -1/2$.

Question 15 - Option (A) – 1/10
Explanation: The sum of probabilities $\sum P(X = x) = 1$ gives $10p^2 + 9p - 1 = 0$. Since $p > 0$, the only valid solution is $p = 1/10$.

Question 16 - Option (A) – 0.1
Explanation: $P(\text{exactly one}) = P(A \cup B) - P(A \cap B)$. Therefore, $P(A \cap B) = 0.5 - 0.4 = 0.1$.

Question 17 - Option (D) – 91
Explanation: Expanding $(-2 - i/3)^3$ gives $\frac{-198-107i}{27}$, so $x = -198$ and $y = -107$. Thus $y - x = 91$.

Question 18 - Option (A) – $x + 2y \leq 6, 5x + 3y \geq 15, x \leq 7, y \leq 6, y \geq 0$
Explanation: The shaded region in the standard LPP plot is bounded below by the line $5x+3y = 15$ and above by $x + 2y = 6$.

Question 19 - Option (A) – $9p^2 = 4q^2$
Explanation: The dot product of the internal and external division vectors $\bar{r} = \frac{3\bar{p}+2\bar{q}}{5}$ and $\bar{s} = 3\bar{p} - 2\bar{q}$ being zero yields $9p^2 = 4q^2$.

Question 20 - Option (B) – $1/\sqrt{3}$
Explanation: The volume determinant evaluates to $V = a^3 - a + 1$. Minimizing V by setting $dV/da = 3a^2 - 1 = 0$ gives $a = 1/\sqrt{3}$.

Question 21 - Option (B) – 3.0009
Explanation: Using the linear approximation $f(x) \approx f(x_0) + f'(x_0)\Delta x$ with $x_0 = 1000$ and $f(x) = \log_{10} x$ gives $3 + \frac{2\log_{10} e}{1000} \approx 3.0009$.

Question 22 - Option (A) – a
Explanation: The equation of the tangent at any point (x_1, y_1) on $\sqrt{x} + \sqrt{y} = \sqrt{a}$ yields axes intercepts whose sum is $(\sqrt{x_1} + \sqrt{y_1})^2 = a$.

Question 23 - Option (B) – $\sqrt{3} : (2 + \sqrt{3})$
Explanation: The angles are $120°, 30°, 30°$. By the sine rule, the sides are proportional to $\sqrt{3} : 1 : 1$, giving the ratio $\frac{\sqrt{3}}{\sqrt{3}+2}$.

Question 24 - Option (D) – is a singleton set
Explanation: Solving the equation $\tan^{-1}(2x) + \tan^{-1}(3x) = \pi/4$ yields $6x^2 + 5x - 1 = 0$, giving $x = 1/6$ as the only valid positive solution.

Question 25 - Option (D) – $23/\sqrt{17}$
Explanation: Substituting $(13, 32)$ into $x/c + y/3 = 1$ yields the parameters, from which the perpendicular distance between the parallel lines is computed.

Question 26 - Option (A) – $-1/2$
Explanation: The logarithmic term is odd, integrating to zero. The greatest integer function $[x]$ integrates to $-1/2$ on the interval $[-1/2, 1/2]$.

Question 27 - Option (C) – 2
Explanation: For $g(x) = f^{-1}(x)$, we have $g'(1) = 1/f'(g(1))$. Since $f(0) = 1$, we get $g(1) = 0$. Differentiating gives $f'(0) = 1/2$, so $g'(1) = 2$.

Question 28 - Option (C) – $x = 2r$
Explanation: Minimizing the combined area $A = x^2 + \pi r^2$ subject to the constraint $4x + 2\pi r = 2$ using calculus yields the relation $x = 2r$.

Question 29 - Option (B) – $\frac{-\hat{i}-7\hat{j}+5\hat{k}}{5\sqrt{3}}$
Explanation: The cross product of the direction vectors $(3, 1, 2) \times (1, 2, 3)$ gives $-\hat{i} - 7\hat{j} + 5\hat{k}$, which is then normalized.

Question 30 - Option (A) – 88
Explanation: Finding the midpoint of the point and its image on the line, and applying perpendicularity conditions yields $a = -56$ and $b = -32$, so $|a + b| = 88$.

Question 31 - Option (B) – 23/36
Explanation: Summing the probabilities to 1 yields $k = 1/6$. Thus, $P(X > 2) = P(3) + P(4) + P(5) = 3k + 5k^2 = 23/36$.

Question 32 - Option (C) – two
Explanation: The coplanarity determinant simplifies to $-\lambda^6 + 3\lambda^2 + 2 = 0$. Solving for real values of λ yields $\lambda = \pm\sqrt{2}$, which are two real solutions.

Question 33 - Option (D) – $2f(x)$
Explanation: Substituting $\frac{2x}{1+x^2}$ into $f(x)$ yields $\log_e\left(\frac{1-2x/(1+x^2)}{1+2x/(1+x^2)}\right) = \log_e\left(\frac{1-x}{1+x}\right)^2 = 2f(x)$.

Question 34 - Option (A) – 0
Explanation: Since the cross product of the normal vectors of the two planes is zero, the normal vectors are parallel, which means the angle between the planes is 0.

Question 35 - Option (C) – $e^{\sin\theta}(\log\sin\theta - \csc\theta) + c$
Explanation: Using the substitution $t = \sin\theta$, the integral takes the form $\int e^t(f(t) + f'(t))dt$ where $f(t) = \log t - 1/t$.

Question 36 - Option (A) – $x^2 + y^2 - 6x - 8y + 9 = 0$
Explanation: The perpendicular distance from $(3, 4)$ to $5x + 12y - 11 = 0$ is $R = 4$. The circle equation is $(x - 3)^2 + (y - 4)^2 = 16$.

Question 37 - Option (D) – $2\sqrt{2}$ units
Explanation: The plane has normal vector $(1, 1, 0)$ and passes through $(1, -2, 1)$, which yields $x + y + 1 = 0$. The distance from $(1, 2, 2)$ is $4/\sqrt{2} = 2\sqrt{2}$.

Question 38 - Option (C) – 4
Explanation: $\frac{\sqrt{3}\cos 20^\circ - \sin 20^\circ}{\sin 20^\circ \cos 20^\circ} = \frac{2\sin(60^\circ - 20^\circ)}{\frac{1}{2}\sin 40^\circ} = 4$.

Question 39 - Option (A) – $\pi/6$
Explanation: Applying vector triple product expansion to $\bar{a} \times (\bar{a} \times \bar{c}) + \bar{b} = 0$ and matching magnitudes yields $\bar{a} \cdot \bar{c} = \sqrt{3}$, so $\theta = \pi/6$.

Question 40 - Option (A) – $1/\sqrt{3}$
Explanation: The bounded area is given by $\frac{1}{3a^2} = 1$. Since $a > 0$, this yields $a = 1/\sqrt{3}$.

Question 41 - Option (B) – $\frac{1}{3}(\tan x - \cot x)^3 + c$
Explanation: Let $u = \tan x - \cot x$, which simplifies the integral through substitution of the trigonometric derivatives.

Question 42 - Option (B) – 4
Explanation: Maximizing $P = xy^2 = (3 - y)y^2$ with $dP/dy = 6y - 3y^2 = 0$ gives $y = 2$, which yields the maximum value $P = 4$.

Question 43 - Option (C) – $x \log |y| = 2(x-1)$
Explanation: Integrating the differential equation yields $\log |y| = -2/x + c$. Substituting the center $(1,1)$ gives $c = 2$, which simplifies to $x \log |y| = 2(x-1)$.

Question 44 - Option (B) – $\frac{n(n+1)(2n+1)}{6}$
Explanation: Taking the logarithm and differentiating at $x = 0$ yields a sum of squares of integers, leading directly to the standard formula.

Question 45 - Option (D) – $11/3^5$
Explanation: Using binomial probability, the probability of getting 4 or 5 correct answers is ${}^5C_4(1/3)^4(2/3) + {}^5C_5(1/3)^5 = 11/3^5$.

Question 46 - Option (A) – $\frac{2\log 10}{\log 2}$
Explanation: The decay equation is $x = x_0(1/2)^t$. Setting $x = 0.01x_0$ yields $t = \frac{\log(100)}{\log 2} = \frac{2\log 10}{\log 2}$.

Question 47 - Option (A) – 2
Explanation: Simplifying the limit using standard trigonometric approximations as $x \to 0$ leads directly to a value of 2.

Question 48 - Option (C) – $(\sqrt{2}, 1-\sqrt{3})$
Explanation: Continuity at $x = 1$ and $x = \sqrt{2}$ yields two equations in a and b, which solve to give $a = \sqrt{2}$ and $b = 1 - \sqrt{3}$.

Question 49 - Option (C) – T, F, T
Explanation: For the implication $A \to B$ to be false, the antecedent $A = (p \wedge \sim q) \wedge (p \wedge r)$ must be true and the consequent $B = \sim p \vee q$ must be false. This dictates $p = T, q = F, r = T$.

Question 50 - Option (C) – $7/\sqrt{3}$
Explanation: Using cosine rule $a = \sqrt{b^2 + c^2 - 2bc\cos A} = 7$. Thus the circumradius $R = \frac{a}{2\sin A} = \frac{7}{\sqrt{3}}$.

Question 51 - Option (C) – 868 nm
Explanation: Wavelength is the reciprocal of the wave number. $\lambda = \frac{1}{11516}$ cm $\approx 8.68 \times 10^{-5}$ cm = 868 nm.

Question 52 - Option (A) – 1/8
Explanation: The fraction remaining after n half-lives is $(1/2)^n$. For 3 half-lives, $(1/2)^3 = 1/8$.

Question 53 - Option (D) – p-Benzoquinone
Explanation: Chromic acid (CrO_3) oxidizes phenol to the conjugated diketone para-benzoquinone.

Question 54 - Option (C) – 534 mm Hg
Explanation: By Raoult's law, $P_{total} = x_A P_A^\circ + x_B P_B^\circ = (0.4)(420) + (0.6)(610) = 534$ mm Hg.

Question 55 - Option (A) – Copolymer
Explanation: Neoprene is a homopolymer made by the polymerization of chloroprene monomer units.

Question 56 - Option (C) – Diamminedichloroplatinum(II)
Explanation: $[Pt(NH_3)_2Cl_2]$ has no net charge, making it a neutral coordination sphere complex.

Question 57 - Option (A) – 2 COOH, 4 OH
Explanation: Saccharic acid (glucaric acid) contains carboxylic acid groups at both ends of a 4-carbon tetrahydroxy chain.

Question 58 - Option (C) – CrO_2
Explanation: Chromium dioxide (CrO_2) is a well-known ferromagnetic transition metal oxide used in magnetic recording tapes.

Question 59 - Option (B) – Glucose
Explanation: The Drath-Frost pathway uses genetically engineered microbes to convert glucose into adipic acid enzymatically.

Question 60 - Option (C) – Ethoxyethane and Methoxypropane
Explanation: These two ethers have the same molecular formula ($C_4H_{10}O$) but different alkyl distribution around the oxygen atom, exhibiting metamerism.

Question 61 - Option (B) – Calamine
Explanation: Calamine consists primarily of zinc carbonate ($ZnCO_3$), making it a classic zinc mineral.

Question 62 - Option (A) – Po
Explanation: Ionization enthalpy decreases down a group in the periodic table, so Polonium (Po) has the lowest value in Group 16.

Question 63 - Option (C) – 88.25
Explanation: Utilizing the density formula $d = \frac{z \cdot M}{N_A \cdot a^3}$ for a bcc lattice ($z = 2$) allows calculation of the molar mass.

Question 64 - Option (A) – $NH_4OH + NH_4Cl$
Explanation: A basic buffer consists of a weak base (NH_4OH) and its conjugate salt containing a strong acid anion (NH_4Cl).

Question 65 - Option (D) – BF_3
Explanation: Boron in BF_3 has three valence electrons, all used in bonding with fluorine, leaving no lone pairs on the central atom.

Question 66 - Option (B) – 60
Explanation: Utilizing the depression of freezing point relation $\Delta T_f = K_f \cdot \frac{w \cdot 1000}{M \cdot W}$ yields $M = 60$.

Question 67 - Option (D) – Coagulation by adding small electrolyte
Explanation: Lyophilic colloids are highly stable and require large amounts of electrolytes to undergo coagulation.

Question 68 – 4.86
- Option (C)
Explanation: Using Henderson-Hasselbalch equation, $pH = pK_a + \log\left(\frac{[salt]}{[acid]}\right) = 4.56 + \log\left(\frac{0.70}{0.35}\right) = 4.86$.

Question 69 - Option (A) – But-1-ene
Explanation: Since one of the doubly bonded carbon atoms in but-1-ene holds two identical hydrogen atoms, it cannot exhibit cis-trans isomerism.

Question 70 - Option (A) – $PbSO_4 + 2e \rightarrow \ldots$
Explanation: During discharge of a lead storage cell, lead ions combine with sulfate ions on both electrodes to yield insoluble lead sulfate.

Question 71 - Option (D) – Oxonium salts
Explanation: Ethers act as Lewis bases and react with strong concentrated acids to form stable protonated oxonium salts.

Question 72 - Option (C) – 2-Iodo-3-methylbutane
Explanation: This molecule contains a chiral carbon atom bonded to four distinct groups, allowing it to exhibit optical activity.

Question 73 - Option (D) – KIO_4
Explanation: In potassium periodate (KIO_4), the oxidation state of iodine is +7, which is its highest possible oxidation state.

Question 74 - Option (C) – Three
Explanation: The secondary amine isomers of formula $C_4H_{11}N$ are diethylamine, methylpropylamine, and methylisopropylamine.

Question 75 - Option (D) – $III > II > I$
Explanation: Allylic or tertiary halides undergo much faster $C - Cl$ bond cleavage due to the stabilization of the resulting carbocation.

Question 76 - Option (B) – $R - CN \rightarrow CHO$
Explanation: The Stephen reduction converts alkyl nitriles to aldehydes using tin(II) chloride and hydrochloric acid.

Question 77 - Option (A) – 2
Explanation: Nitrogen possesses two naturally occurring stable isotopes, Nitrogen-14 and Nitrogen-15.

Question 78 - Option (C) – Deep blue
Explanation: Solvated electrons formed when alkali metals dissolve in liquid ammonia absorb light in the red region, imparting a deep blue color.

Question 79 - Option (B) – Prop-2-enoic acid
Explanation: Acrylic acid ($CH_2 = CH - COOH$) has a three-carbon chain containing a carboxylic acid and a double bond starting at C-2.

Question 80 - Option (B) – Different elements
Explanation: Isobars are atoms of different chemical elements that share the same mass number but have different atomic numbers.

Question 81 - Option (B) – 20 mL
Explanation: Applying Boyle's Law ($P_1V_1 = P_2V_2$) yields $(1.25 \text{ atm})V_1 = (1.0 \text{ atm})(25 \text{ mL}) \Rightarrow V_1 = 20 \text{ mL}$.

Question 82 - Option (A) – $\log_{10} A$
Explanation: The logarithmic Arrhenius equation is $\log_{10} k = \log_{10} A - \frac{E_a}{2.303RT}$. The intercept of the linear plot is $\log_{10} A$.

Question 83 - Option (B) – Ethanal
Explanation: Ethanal is an aldehyde, which readily reduces Tollens' reagent to form a reflective silver mirror on the tube walls.

Question 84 - Option (C) – Nylon-6
Explanation: Nylon-6 is synthesized via ring-opening condensation polymerization of caprolactam rather than addition polymerization.

Question 85 - Option (D) – ΔU
Explanation: By the first law of thermodynamics, heat exchanged at constant volume (q_v) is directly equal to the change in internal energy (ΔU).

Question 86 - Option (C) – 0.066
Explanation: The stoichiometry dictates that consumption of I^- is 1.5 times the formation rate of SO_4^{2-}. Hence, $1.5 \times 0.044 = 0.066$.

Question 87 - Option (D) – Nitrito
Explanation: Nitrito (NO_2^-) is an ambidentate ligand that has two potential donor atoms (N and O) but coordinates through only one at a time.

Question 88 - Option (C) – 0.1M $BaCl_2$
Explanation: Boiling point elevation depends on the van 't Hoff factor i. $BaCl_2$ dissociates into 3 ions, providing the highest effective concentration.

Question 89 - Option (B) – 0.293
Explanation: Standard thermodynamic calculations for the phase change of ice at 273 K yield this entropy value.

Question 90 - Option (B) – Mn and Cr
Explanation: Both elements stabilize their valence shells with half-filled d-orbitals (Mn: $[Ar]3d^5 4s^2$, Cr: $[Ar]3d^5 4s^1$).

Question 91 - Option (A) – 229.5
Explanation: In a body-centered cubic unit cell, the atomic radius is given by $r = \frac{\sqrt{3}}{4}a$. Substituting $a = 530$ pm yields 229.5 pm.

Question 92 - Option (B) – 0.02 M
Explanation: Using Ostwald's dilution law relations for weak acids, the molar concentration is determined directly from the dissociation constant.

Question 93 - Option (B) – $CH_2 = CH - CH(OH) - CH_3$
Explanation: This compound contains a hydroxyl group attached to a sp3 hybridized carbon adjacent to a carbon-carbon double bond.

Question 94 - Option (B) – $q = \Delta U = 500, w = 0$
Explanation: Heating at constant volume implies no work is done ($w = 0$), meaning all supplied heat goes directly into increasing the internal energy.

Question 95 - Option (A) – 121.4
Explanation: Standard electrolytic parameters and equations yield this conductivity value for the given dilution.

Question 96 - Option (B) – $CHBr_3 > CH_2Br_2 > CH_3Br > CH_3Cl$
Explanation: Boiling point increases with molecular mass and stronger dispersion forces, making bromoform the highest and methyl chloride the lowest.

Question 97 - Option (B) – 3.5
Explanation: On the Pauling scale, oxygen is highly electronegative and has a designated value of 3.5.

Question 98 - Option (C) – N-Ethyl-N-methylpropan-2-amine
Explanation: The longest carbon chain has three carbons (propane) with the nitrogen attached at C-2, bearing ethyl and methyl substituents.

Question 99 - Option (B) – 38600 C
Explanation: The reduction of MnO_4^- to Mn^{2+} requires 5 electrons. Charge required is $0.08 \text{ mol} \times 5 \times 96500 \text{ C/mol} = 38600$ C.

Question 100 - Option (A) – D
Explanation: The standard one-letter abbreviation representing the acidic amino acid aspartic acid is D.

Question 101 - Option (A) – 9/2 R
Explanation: For a diatomic gas with active vibrational modes, the degrees of freedom increase, giving a higher molar heat capacity at constant pressure.

Question 102 - Option (C) – 40.5 pF
Explanation: Using the series dielectric slab formula $C = \frac{\epsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2}}$ yields 4.5 times the initial capacitance.

Question 103 - Option (D) – 0.02 mA
Explanation: Standard transistor active bias formulas relate the collector current, base current, and β to yield this current.

Question 104 - Option (D) – 88
Explanation: Rewriting the SHM equation gives $\omega = 0.5$. Calculating the period $T = 4\pi = 88/7$, comparison yields $x = 88$.

Question 105 - Option (D) – $\tan^{-1}(4)$
Explanation: Equating $H_{max} = R$ gives $\frac{u^2 \sin^2\theta}{2g} = \frac{u^2 \sin 2\theta}{g}$, which simplifies directly to $\tan\theta = 4$.

Question 106 - Option (A) – i_a never greater than i_b
Explanation: Circuit analysis under standard phase conditions dictates that branch current i_a remains strictly bounded by i_b.

Question 107 - Option (A) – 1:2
Explanation: Applying parallel-axis theorem to a disc and ring about their respective tangent axes yields this ratio.

Question 108 - Option (B) – $3/\pi$
Explanation: The frequencies are $f_1 = \frac{316}{2\pi}$ and $f_2 = \frac{310}{2\pi}$. The beat frequency is $f_1 - f_2 = \frac{6}{2\pi} = \frac{3}{\pi}$.

Question 109 - Option (B) – 2 Ω
Explanation: Balancing conditions of a wheatstone bridge are used to compute the required shunt resistance across the arm.

Question 110 - Option (A) – $(1 - d/R)^{-1}$
Explanation: Variation in acceleration due to gravity at depth d affects the capillary rise height inversely as $(1 - d/R)$.

Question 111 - Option (B) – 40
Explanation: Standard refraction formulas for an equilateral prism yield this angle of minimum deviation for the given incidence angle.

Question 112 - Option (A) – L/4
Explanation: Combining $E = \frac{1}{2}L\omega$, if E is halved and ω is doubled, the new angular momentum must be $L/4$.

Question 113 - Option (A) – 1.8 km/s
Explanation: The phase difference equation yields a wavelength of 3.6 m. Using $v = f\lambda$, we obtain 1.8 km/s.

Question 114 - Option (A) – 2.5×10^{-3} J
Explanation: The work done or energy changes in pulling the loop are calculated using Faraday's laws and mechanical power balances.

Question 115 - Option (D) – λ/ϵ_0
Explanation: Integrating the electrostatic contributions of the concentric semi-circular geometries yields the potential expression.

Question 116 - Option (C) – Constant velocity bus driver
Explanation: An inertial frame is unaccelerated, which corresponds to a reference frame moving at a constant velocity.

Question 117 - Option (D) – $q^2r^2B^2/2V$
Explanation: Using $r = \frac{mv}{qB}$ and kinetic energy $K = qV = \frac{1}{2}mv^2$ yields $m = \frac{q^2r^2B^2}{2V}$.

Question 118 - Option (C) – $\sqrt{T_1^2 - T_2^2}$
Explanation: Since $T \propto \sqrt{l}$, the difference in length $l_1 - l_2$ leads to a combined period expression of this radical form.

Question 119 - Option (C) – 10 mA
Explanation: Calculating voltage drops across R_s and R_L under Zener regulation yields the current flowing through the Zener diode.

Question 120 - Option (C) – $3g/4\pi RG$
Explanation: From $g = \frac{GM}{R^2} = \frac{G(4/3\pi R^3\rho)}{R^2}$, we solve to get the density $\rho = \frac{3g}{4\pi RG}$.

Question 121 - Option (D) – decreases then increases
Explanation: Impedance in a series LCR circuit is minimum at resonance, so it decreases as frequency approaches resonance and increases afterward.

Question 122 - Option (D) – 5 Ω
Explanation: The potential gradient along the wire dictates the required series resistance to balance the target EMF.

Question 123 - Option (D) – 600 K
Explanation: Efficiency relations of Carnot engines operating with common sink temperatures yield this source temperature.

Question 124 - Option (B) – increase refractive index
Explanation: Resolving power is proportional to the refractive index of the medium, so introducing oil immersion increases it.

Question 125 - Option (B) – 3 s
Explanation: Series versus parallel configurations of thermal conductors alter the equivalent thermal resistance, scaling the transfer time.

Question 126 - Option (D) – D
Explanation: Transient current rise curves indicate that the curve reaching maximum current slowest has the largest time constant, hence smallest inductance.

Question 127 - Option (B) – $mV^2/3R$
Explanation: Conservation of energy during expansion of the monatomic gas converts bulk kinetic energy into thermal energy.

Question 128 – 8 cm
- Option (B)
Explanation: Refraction principles and apparent depth/thickness relations scale the physical path to this value.

Question 129 - Option (D) – $4N_aI_a = N_bI_b$
Explanation: Magnetic moment is given by $M = NIA = NI(\pi r^2)$. Using $r_b = 2r_a$ yields the ratio condition.

Question 130 - Option (D) – 3.06 m
Explanation: The length of a terrestrial/astronomical telescope under normal adjustment is given by the sum of focal lengths $f_o + f_e$.

Question 131 - Option (A) – 2
Explanation: Flow rate balances using the equation of continuity determine the parameter x governing efflux.

Question 132 - Option (A) – first
Explanation: Comparing standard harmonic frequencies of strings under varying boundary conditions yields this fundamental match.

Question 133 - Option (A) – 500
Explanation: Using the resonance condition $f = \frac{1}{2\pi\sqrt{LC}}$, solving for C with the given values yields approximately 500 pF.

Question 134 - Option (B) – $3I_0/16$
Explanation: Applying Malus's Law successively through the polaroids yields this fractional output intensity.

Question 135 - Option (B) – p-n junction
Explanation: Under reverse bias conditions beyond a threshold, a p-n junction exhibits sharp current shifts and cutoff features.

Question 136 - Option (D) – 3:2
Explanation: Rotational kinetic energy $K = \frac{1}{2}I\omega^2$ compared for the two geometries under specified frequencies gives this ratio.

Question 137 - Option (A) – $N^2A^2B^2\omega^2/2R$
Explanation: Induced EMF in a rotating coil yields an average power dissipation given by the formula in - Option (A).

Question 138 - Option (D) – 1:64
Explanation: Standard mass and pressure relationships for spherical bubbles scaling with radius yield this cubic ratio.

Question 139 - Option (C) – 10/3 ϵ_0 F
Explanation: Calculating the equivalent capacitance with the inserted dielectric slab of specified thickness yields this value.

Question 140 - Option (B) – $(\sqrt{3}-1)R$
Explanation: Setting $g_h = g/3 = g(1+h/R)^{-2}$ yields $1+h/R = \sqrt{3} \Rightarrow h = (\sqrt{3}-1)R$.

Question 141 - Option (D) – $(\gamma-1)/\gamma$
Explanation: The ratio of work done to heat supplied in an isobaric process is $\frac{W}{Q} = \frac{nR\Delta T}{nC_p\Delta T} = \frac{R}{C_p} = \frac{\gamma-1}{\gamma}$.

Question 142 - Option (D) – 1/2
Explanation: From $K_{max} = h(f-f_0)$, we get $K_1 = hf_0$ and $K_2 = 4hf_0$. The velocity ratio is $\sqrt{K_1/K_2} = 1/2$.

Question 143 - Option (B) – $2R$
Explanation: The path radius $r = mv/qB$ scales linearly with velocity, so doubling speed doubles the radius.

Question 144 - Option (C) – MgR/LB
Explanation: Balancing the gravitational torque against the magnetic torque acting on the current loop yields this balance expression.

Question 145 - Option (A) – 3/16 R
Explanation: Applying Stefan's law of radiation or Newton's law of cooling for the specified temperatures yields this ratio.

Question 146 - Option (B) – 0.21 m
Explanation: Relating the spatial phase difference to the wavelength of the progressive wave yields this distance.

Question 147 - Option (C) – $\sqrt{K_1/K_2}$
Explanation: Equating maximum velocities $v_{max} = A\omega$ and utilizing $\omega = \sqrt{K/m}$ yields the radical ratio.

Question 148 - Option (C) – 27
Explanation: Spectral transition wave numbers for hydrogen atoms under Rydberg formulas yield this integer ratio.

Question 149 - Option (D) – 1:1
Explanation: Charge redistributes until potentials equalize. Identical spheres will share charge equally, giving a 1:1 ratio.

Question 150 - Option (D) – $hc/(W_0+eV)$
Explanation: Einstein's equation $\frac{hc}{\lambda} = W_0 + eV$ solved directly for wavelength gives $\lambda = \frac{hc}{W_0+eV}$.