MHT CET 2020 Mathematics Answer Key PDF

Question 1 Option (D) – 2
Explanation: The moment of inertia of a ring is given by $I = MR^2$. Since mass per unit length λ is constant, the mass is proportional to the radius ($M \propto R$), which implies $I \propto R^3$. Taking the ratio gives $I_1/I_2 = (R/nR)^3 = 1/n^3 = 1/8$, which simplifies to $n = 2$.

Question 2 Option (A) – 4/3
Explanation: Elongation is expressed as $\Delta L = \frac{FL}{AY}$. Expressing the cross-sectional area in terms of mass, length, and density yields $A = m/(\rho L)$, which rewrites the elongation formula as $\Delta L = \frac{FL^2\rho}{mY}$. For identical force, length, and material, elongation is inversely proportional to mass ($\Delta L \propto 1/m$), giving a ratio of 4/3.

Question 3 Option (B) – $\frac{n_1 n_2}{n_1+n_2}$
Explanation: When two open organ pipes are joined in series, their combined structural length equals the sum of individual lengths ($L = L_1 + L_2$). Since the fundamental frequency of an open pipe is given by $n = v/2L$, rewriting this for length gives $L = v/2n$. Substituting this into the length equation yields $1/n = 1/n_1 + 1/n_2$, which simplifies to the given fraction.

Question 4 Option (B) – no force.
Explanation: The magnetic field generated along the central axis of a circular current loop is parallel to that axis. An electron projected directly along this axis moves parallel to the magnetic field vector, causing the angle θ to be $0°$ or $180°$. According to the Lorentz force equation, $\vec{F} = q(\vec{v} \times \vec{B}) = qvB\sin\theta = 0$.

Question 5 Option (A) – AND
Explanation: By operational definition, the output of a digital AND logic gate reaches a high level (logic 1) if and only if all of its input lines are simultaneously set to a high level. For any other input combinations where at least one input is low, the output remains low (logic 0).

Question 6 Option (D) – r^2/R
Explanation: The primary magnetic field produced at the center of the outer coil is given by $B = \mu_0 I/2R$. The resulting magnetic flux passing through the smaller inner coil area is $\phi = B \cdot A = (\mu_0 I/2R) \cdot \pi r^2$. Since mutual inductance is defined as $M = \phi/I$, it evaluates to $\frac{\mu_0 \pi r^2}{2R}$, establishing the proportionality $M \propto r^2/R$.

Question 7 Option (C) – $xyz = 1$
Explanation: The relationship between relative refractive indices across multiple consecutive media boundaries satisfies the cyclic product rule ${}_a\mu_w \cdot_w \mu_g \cdot_g \mu_a = 1$. Substituting the given variable definitions x, y, and z directly into this continuous chain identity yields the product equation $xyz = 1$.

Question 8 Option (D) – go on decreasing.
Explanation: The magnetic field strength of a short bar magnet at a distance r on the axial line is $B_{\text{axial}} = \frac{\mu_0 2M}{4\pi r^3}$, whereas at the equatorial line it is $B_{\text{equatorial}} = \frac{\mu_0 M}{4\pi r^3}$. Moving along a circular path from the axis to the equator keeps r constant while the field transitions from B_{axial} to its half-value $B_{\text{equatorial}}$, causing a continuous decrease.

Question 9 Option (B) – 3
Explanation: Equating the centripetal forces of the two bodies gives the relation $\frac{m_1 v_1^2}{r_1} = \frac{m_2 v_2^2}{r_2}$. Substituting the given parameters yields $\frac{(3m)v^2}{(r/n)} = \frac{m(nv)^2}{r}$, which simplifies algebraically to $3n \cdot v^2 = n^2 \cdot v^2$. Canceling identical variables results in $3n = n^2$, solving to $n = 3$.

Question 10 Option (C) – 400Ω
Explanation: The initial voltmeter conversion is represented by $V = I_g(G + 2000)$, and tripling the range gives $3V = I_g(G + 2000 + 4400)$. Solving $3(G + 2000) = G + 6400$ simplifies to $3G + 6000 = G + 6400 \implies 2G = 400$, which solves to $G = 400\Omega$.

Question 11 Option (B) – 4/7 s
Explanation: Comparing the given displacement function $x = 0.25\sin(11t + 0.5)$ with the standard harmonic equation $x = A\sin(\omega t + \phi)$ identifies the angular frequency as $\omega = 11$ rad/s. The total time period of the SHM is calculated using $T = 2\pi/\omega$, which yields $2\times(22/7)/11 = 4/7$ s.

Question 12 Option (D) – $[L^0M^0T^1]$
Explanation: The ratio of inductance L to electrical resistance R defines the native inductive time constant ($\tau = L/R$) of an LR circuit. Since this structural parameter directly dictates the rate of current growth or decay in seconds, its dimensional formula matches that of time, which is $[L^0M^0T^1]$.

Question 13 Option (A) – $8\pi^2/3$
Explanation: The moment of inertia of a uniform rod is $I = ML^2/3$. When this rod is bent into a circle, its length matches the circumference ($2\pi R = L \implies R = L/2\pi$), and the moment of inertia of this ring about its diameter is $I_1 = \frac{1}{2}MR^2 = \frac{ML^2}{8\pi^2}$. Dividing I by I_1 cancels M and L^2, yielding the ratio $8\pi^2/3$.

Question 14 Option (B) – 7 : 5 : 2
Explanation: For a rigid diatomic gas molecule, the molar heat capacities are defined as $C_p = \frac{7}{2}R$ and $C_v = \frac{5}{2}R$. The continuous ratio of heat supplied, change in internal energy, and work done at constant pressure is expressed as $\Delta Q : \Delta U : \Delta W = nC_p\Delta T : nC_v\Delta T : nR\Delta T$, which simplifies to 7 : 5 : 2.

Question 15 Option (D) – 3/22
Explanation: Analyzing the potential divider networks and bridge paths of this capacitive circuit allows for systematic series-parallel reductions. Computing the relative charge distribution among the branches shows that the ratio of the charges accumulated on C_2 and C_1 reduces cleanly to the fraction 3/22.

Question 16 Option (B) – (A) (Linear with positive intercept)
Explanation: Einstein's photoelectric equation is expressed linearly as $K.E. = h\nu - \phi$. Comparing this with the slope-intercept form $y = mx + c$ indicates that a plot of kinetic energy against frequency forms a straight line with a positive threshold frequency intercept ($\nu_0 = \phi/h$) on the horizontal axis.

Question 17 Option (D) – $F^2t^2/2m$
Explanation: According to Newton's second law, a constant force F acting on a mass m initially at rest for a duration t imparts a linear momentum of $p = Ft$. Substituting this momentum value into the standard kinetic energy relationship $K.E. = p^2/2m$ directly yields the expression $F^2t^2/2m$.

Question 18 Option (B) – 5 A
Explanation: Because the two voltage sources are connected in opposition, the net electromotive force acting in the circuit loop is $E_{\text{net}} = 200 \text{ V} - 10 \text{ V} = 190 \text{ V}$. Applying Ohm's law ($I = E_{\text{net}}/R$), the steady-state current is calculated as $190 \text{ V}/38\,\Omega = 5$ A.

Question 19 Option (C) – 1 : 10
Explanation: Conservation of total liquid volume during coalescence requires $1000 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \implies R = 10r$. The surface energy is proportional to the surface area ($E \propto A$), so the ratio of the final consolidated surface area to the total initial surface area is $4\pi(10r)^2/(1000\times 4\pi r^2) = 100/1000 = 1/10$.

Question 20 Option (A) – $\sqrt{2}$
Explanation: According to the kinetic theory of gases, the root-mean-square velocity of molecules is directly proportional to the square root of the absolute temperature ($v_{\text{rms}} \propto \sqrt{T}$). Converting the temperatures to Kelvin gives $T_1 = 300$ K and $T_2 = 600$ K, yielding the velocity ratio $\sqrt{600/300} = \sqrt{2}$.

Question 21 Option (D) – real and virtual.
Explanation: By optical convention, real images are formed by the actual convergence of reflected light rays on the same side of the mirror as the object. Conversely, virtual images are formed by diverging rays that appear to intersect behind the reflecting surface on the opposite side of the mirror.

Question 22 Option (B) – area.
Explanation: In Cauchy's dispersion equation $\mu = A + B/\lambda^2$, the refractive index μ and the constant A are dimensionless quantities. By the principle of dimensional homogeneity, the term B/λ^2 must also be dimensionless, meaning the dimensions of B must match λ^2, which corresponds to area ($[L^2]$).

Question 23 Option (D) – 3 : 1
Explanation: Using the sum and difference configurations on a potentiometer wire gives the proportionalities $E_1 + E_2 \propto 64$ and $E_1 - E_2 \propto 32$. Dividing these expressions yields $\frac{E_1+E_2}{E_1-E_2} = \frac{64}{32} = 2$. Cross-multiplying and rearranging gives $E_1 + E_2 = 2E_1 - 2E_2 \implies E_1 = 3E_2$, which dictates the ratio 3 : 1.

Question 24 Option (A) – λ^{-2}
Explanation: The total power radiated by a thin linear antenna of physical length l is mathematically modeled to be proportional to the square of its electrical length, $P \propto (l/\lambda)^2$. Keeping the antenna length constant, the radiated power is inversely proportional to the square of the wavelength, meaning $P \propto \lambda^{-2}$.

Question 25 Option (D) – 1 : 8
Explanation: The internal excess pressure of a soap bubble is $\Delta P = 4T/R$, which means $R \propto 1/\Delta P$. Given $\Delta P_1 = 2\Delta P_2$, the radii are related by $R_2 = 2R_1$. Since the volume of a sphere scales with the cube of its radius ($V \propto R^3$), the volume ratio is $V_1/V_2 = (R_1/2R_1)^3 = 1/8$.

Question 26 Option (B) – 6.3×10^{-4} m
Explanation: When submerged in water, the wavelength decreases to $\lambda' = \lambda/\mu$, which directly scales the fringe width down to $\beta = \frac{\lambda D}{\mu d}$. Substituting the values gives $\beta = \frac{6300\times10^{-10}\times1.33}{1.33\times10^{-3}} = 6.3 \times 10^{-4}$ m, as the refractive index and distance parameters cancel out.

Question 27 Option (A) – $\cos^{-1}(-7/8)$
Explanation: Applying the law of vector addition for two equal forces R yielding a resultant of $R/2$ gives the equation $(R/2)^2 = R^2 + R^2 + 2R^2 \cos\theta$. Simplifying this expression algebraically leads to $R^2/4 = 2R^2(1 + \cos\theta) \implies 1/8 = 1 + \cos\theta$, which solves to $\cos\theta = -7/8$.

Question 28 Option (A) – 1 : 3
Explanation: Equating the frequency conditions gives $2 \times n_1 = 3 \times n_2 \implies 2(v_1/2L_1) = 3(v_2/2L_2)$. Since string velocity is inversely proportional to radius ($v \propto 1/r$), substituting $r_1 = 2r_2 \implies v_2 = 2v_1$ transforms the equation into $\frac{2v_1}{2L_1} = \frac{6v_1}{2L_2}$, which reduces to $L_1/L_2 = 1/3$.

Question 29 Option (D) – decreases.
Explanation: The electrical resistance of a galvanometer coil is directly proportional to the total length of the conducting wire wound inside it ($R \propto L$). Reducing the number of turns decreases the total wire length needed to form the coil, thereby reducing its net electrical resistance.

Question 30 Option (B) – 1 : 2
Explanation: The radius of gyration of a uniform rod of length L about an axis through its center is $k_1 = L/\sqrt{12}$, and about an axis through its end is $k_2 = L/\sqrt{3}$. Computing their ratio gives $k_1/k_2 = \sqrt{3/12} = \sqrt{1/4} = 1/2$.

Question 31 Option (A) – 0.616 cm^{-1}
Explanation: The cell constant (G^*) of an electrolytic cell is defined by the relationship $G^* = \kappa \times R$, where κ represents the specific conductivity and R is the measured resistance. Substituting the given operational parameters yields $G^* = 0.0112\,\Omega^{-1}\text{cm}^{-1} \times 55.0\,\Omega = 0.616\ \text{cm}^{-1}$.

Question 32 Option (B) – $[Co(NH_3)_4Cl_2]Cl$
Explanation: A coordination complex is heteroleptic if it contains more than one type of ligand species, and cationic if the coordination sphere carries a net positive charge. $[Co(NH_3)_4Cl_2]Cl$ dissociates into a complex cation $[Co(NH_3)_4Cl_2]^+$ containing two different ligands (NH_3 and Cl^-).

Question 33 Option (D) – 273.15°C
Explanation: According to Charles's law, the volume of an ideal gas is directly proportional to its absolute temperature in Kelvin ($V \propto T$). Doubling the volume requires doubling the absolute temperature from its initial STP value of 273.15 K to 546.30 K, which converts to 273.15°C.

Question 34 Option (B) – $sp^3 - s$
Explanation: The central oxygen atom in a water molecule undergoes sp^3 hybridization to accommodate its two bonding pairs and two lone pairs in a tetrahedral arrangement. Each covalent $\mathrm{O-H}$ σ-bond is formed by the axial overlap between an oxygen sp^3 hybrid orbital and a spherical hydrogen $1s$ atomic orbital.

Question 35 Option (A) – phenelzine
Explanation: Phenelzine is a clinically recognized monoamine oxidase inhibitor (MAOI) that serves as a potent antidepressant. It functions by inhibiting the enzymatic breakdown of monoamine neurotransmitters, thereby elevating their concentrations within the central nervous system.

Question 36 Option (A) – 60 % conc. H_2SO_4 and 373 K
Explanation: Butan-2-ol is a secondary alcohol. Acid-catalyzed dehydration of secondary alcohols proceeds more readily than primary alcohols, requiring moderately concentrated acid conditions (such as 60% H_2SO_4) at a temperature of 373 K to effectively drive the elimination reaction.

Question 37 Option (C) – Ce ¿ Pm ¿ Sm ¿ Gd
Explanation: Due to the phenomenon of lanthanoid contraction, there is a steady and regular decrease in the ionic radii of lanthanoid elements with increasing atomic number. Consequently, the elements are correctly arranged in decreasing order of their size as Ce ($Z = 58$) > Pm ($Z = 61$) > Sm ($Z = 62$) > Gd ($Z = 64$).

Question 38 Option (C) – Hydroxylamine
Explanation: Glucose features an open-chain form with a terminal aldehyde functional group. It reacts readily with hydroxylamine (NH_2OH) via a nucleophilic addition-elimination condensation reaction to form glucose oxime (glucoxime), chemically confirming the presence of a carbonyl group.

Question 39 Option (D) – 1.0
Explanation: Isopropyl bromide is a secondary alkyl halide. In standard comparative chemical kinetics tables for nucleophilic solvolysis proceeding via the S_N1 pathway, its relative rate of reaction is assigned as the baseline reference value of exactly 1.0.

Question 40 Option (C) – 4-Methylpent-3-en-2-one
Explanation: Mesityl oxide is a well-known α, β-unsaturated aliphatic ketone with the structural formula $(CH_3)_2C = CHCOCH_3$. Following systematic IUPAC rules, the longest continuous carbon chain containing the carbonyl group has five carbons, yielding the name 4-methylpent-3-en-2-one.

Question 41 Option (A) – Sodium meta aluminate
Explanation: During the industrial purification of bauxite ore using Bayer's process, the amphoteric aluminium oxide content is selectively leached by hot, concentrated sodium hydroxide solution. This chemical treatment converts the alumina into soluble sodium meta aluminate while leaving insoluble iron oxide impurities behind.

Question 42 Option (C) – Uuh
Explanation: According to the systematic IUPAC rules for naming superheavy elements with atomic numbers $Z > 100$, the roots for the digits 1, 1, and 6 are un, un, and hex respectively. This constructs the placeholder name Ununhexium, which is assigned the temporary three-letter symbol Uuh.

Question 43 Option (B) – n-butylamine
Explanation: Primary aliphatic amines, such as n-butylamine, possess two hydrogen atoms directly bonded to a highly electronegative nitrogen atom. This structural feature allows them to form an extensive network of intermolecular hydrogen bonds, resulting in a higher boiling point than isomeric secondary or tertiary amines.

Question 44 Option (C) – sp^3
Explanation: A symmetric, regular tetrahedral molecular geometry around a central atom arises when that atom undergoes sp^3 hybridization. This mathematical mixing creates four equivalent hybrid orbitals directed toward the corners of a tetrahedron with ideal bond angles of $109.5°$.

Question 45 Option (D) – Ethanamine
Explanation: Free-radical vapor-phase nitration of ethane yields nitroethane (A). Subsequent chemical reduction of this nitroalkane using a powerful reducing agent like lithium aluminium hydride $(LiAlH_4)$ converts the nitro group into an amino group, producing the primary amine ethanamine (B).

Question 46 Option (C) – 261.0
Explanation: According to Kohlrausch's law of independent migration of ions, the limiting molar conductivity of a strong electrolyte is the sum of its ionic components $(\Lambda_m^0 = \lambda^0(Ca^{2+}) + 2\lambda^0(Cl^-))$. Substituting the given values yields $\Lambda_m^0 = 119 + 2(71) = 261.0$.

Question 47 Option (A) – 151.98 pm
Explanation: In a body-centered cubic (BCC) crystalline lattice unit cell, the atomic radius r is geometrically related to the cell edge length a by the expression $r = \frac{\sqrt{3}}{4}a$. Substituting the edge length value of 351 pm yields $r = \frac{1.732}{4} \times 351 \approx 151.98$ pm.

Question 48 Option (A) – Melamine
Explanation: Melamine reacts with formaldehyde to produce a highly cross-linked, durable, and heat-resistant thermosetting polymer. Due to its excellent structural stability and shatterproof qualities, this resin is extensively used to manufacture break-resistant plastic dinnerware.

Question 49 Option (C) – m-Nitrobenzoic acid
Explanation: The electron-withdrawing carboxylic acid group $(-COOH)$ attached to a benzene ring exerts a powerful deactivating and meta-directing effect. Consequently, electrophilic aromatic nitration of benzoic acid selectively directs the incoming nitro group to form m-nitrobenzoic acid.

Question 50 Option (C) – Serine
Explanation: Serine is classified as a polar, uncharged amino acid. Its specific chemical identity is defined by its unique polar side chain (R-group), which consists of a hydroxymethyl group $(-CH_2OH)$ attached directly to the central α-carbon atom.

Question 51 Option (D) – 5.4×10^{-3}
Explanation: Based on the balanced reaction stoichiometry, the relative chemical reaction rates are linked by the expression $-\frac{1}{4}\frac{d[NH_3]}{dt} = \frac{1}{6}\frac{d[H_2O]}{dt}$. Solving for the rate of water formation yields $\frac{6}{4} \times (3.6 \times 10^{-3}) = 5.4 \times 10^{-3}$.

Question 52 Option (C) – 24.6 atm
Explanation: The osmotic pressure of a dilute solution is calculated using the van 't Hoff equation $\pi = CRT$. Substituting the given values $C = 1$ M, $R = 0.082$ L atm mol^{-1}K^{-1}, and $T = 300$ K directly evaluates to $\pi = 1 \times 0.082 \times 300 = 24.6$ atm.

Question 53 Option (A) – +3
Explanation: In the coordination complex $K_3[Cr(C_2O_4)_3]$, the counter potassium ions carry a +1 charge and each bidentate oxalate ligand carries a −2 charge. Setting up the algebraic neutrality equation $3(+1) + x + 3(-2) = 0$ simplifies to $x = +3$, which is the oxidation state of Chromium.

Question 54 Option (C) – Catechol
Explanation: Dihydric phenols are aromatic compounds that contain exactly two hydroxyl groups bound directly to a benzene ring. Catechol is the common name for benzene-1,2-diol, where the two −OH groups are on adjacent carbons, satisfying this definition.

Question 55 Option (D) – F
Explanation: Fluorine belongs to the second period of the periodic table and entirely lacks vacant low-energy d-orbitals in its valence shell. This electronic limitation prevents it from expanding its coordination octet, making it incapable of forming stable polyhalide ions like F_3^-.

Question 56 Option (B) – 1 sq. units
Explanation: The bounded area under the curve is evaluated by the definite integral $\int_1^e \ln x\, dx$. Applying integration by parts yields the antiderivative $[x \ln x - x]_1^e$, which evaluates at the upper and lower boundaries to $(e \ln e - e) - (1 \ln 1 - 1) = (e - e) - (0 - 1) = 1$ square unit.

Question 57 Option (D) – 30°
Explanation: For a joint second-degree homogeneous line equation $ax^2 + 2hxy + by^2 = 0$, the acute angle is given by $\tan\theta = \frac{2\sqrt{h^2-ab}}{|a+b|}$. Substituting $a = 3$, $b = 3$, and $h = -2\sqrt{3}$ gives $\tan\theta = \frac{2\sqrt{12-9}}{6} = \frac{2\sqrt{3}}{6} = \frac{1}{\sqrt{3}}$, which solves to $\theta = 30°$.

Question 58 Option (C) – $(14)3^{n-1}$
Explanation: The n-th term of a sequence is calculated from its sum by the relationship $t_n = s_n - s_{n-1}$. Substituting the given formula yields $t_n = 7(3^n - 1) - 7(3_{n-1} - 1) = 7(3^n - 3^{n-1}) = 7 \cdot 3^{n-1}(3 - 1) = 14 \cdot 3^{n-1}$.

Question 59 Option (C) – 1/2
Explanation: For a continuous random variable with a known cumulative distribution function $F(x)$, the probability is given by $P[X > 1] = 1 - F(1)$. Substituting $x = 1$ into the given equation $F(x) = \sqrt{x}/2$ yields $F(1) = 1/2$, resulting in a final probability of $1 - 1/2 = 1/2$.

Question 60 Option (A) – $\log_e e$
Explanation: Using the substitution $u = x^x$, its differential is $du = x^x(1 + \ln x)dx$. The integral simplifies to $\int 1\, du = x^x + c$. Comparing this result with the expression $kx^x + c$ shows that $k = 1$, which can be written in logarithmic form as $\log_e e$.

Question 61 Option (C) – 27 units
Explanation: Differentiating position gives velocity $v = 3t^2 - 12t + 9$, and differentiating again gives acceleration $a = 6t - 12$. Setting acceleration to zero gives $t = 2$ s. Substituting $t = 2$ back into the original displacement equation yields $s(2) = 8 - 24 + 18 + 25 = 27$ units.

Question 62 Option (A) – 8.64 years
Explanation: Integrating the population growth rate equation $dP/dt = 0.08P$ yields the solution $t = \frac{\ln 2}{0.08}$ to double the population. Substituting the mathematical approximation $\ln 2 \approx 0.6912$ simplifies to $t = 0.6912/0.08 = 8.64$ years.

Question 63 Option (D) – an odd function
Explanation: Computing the composite function $f(f(x))$ arithmetic steps simplify it to the identity function $g(x) = x$. Since this resulting function satisfies the mathematical definition of asymmetry $g(-x) = -g(x)$, it is classified as an odd function.

Question 64 Option (D) – -1/6
Explanation: Evaluating the definite integral gives the expression $\left[\frac{5}{3}x^3 - \frac{3}{2}x^2 + kx\right]_0^1 = 0$. Substituting the upper limit yields $\frac{5}{3} - \frac{3}{2} + k = 0 \implies \frac{1}{6} + k = 0$, which solves to $k = -1/6$.

Question 65 Option (B) – $2\sqrt{x}e^x + c$
Explanation: This integral matches the standard template $\int e^x(f(x) + f'(x))\,dx = e^x f(x) + c$. Defining $f(x) = 2\sqrt{x}$, its derivative is $f'(x) = 1/\sqrt{x}$, which matches the integrand perfectly and evaluates to $2\sqrt{x}e^x + c$.

Question 66 Option (A) – $-\sqrt{2}\cos x$
Explanation: Applying standard trigonometric sum-to-product or expansion identities, the expression simplifies to $\cos(3\pi/4)\cos x - \sin(3\pi/4)\sin x - [\sin(\pi/4)\cos x - \cos(\pi/4)\sin x]$. Substituting values gives $-\frac{1}{\sqrt{2}}\cos x - \frac{1}{\sqrt{2}}\sin x - \frac{1}{\sqrt{2}}\cos x + \frac{1}{\sqrt{2}}\sin x = -\sqrt{2}\cos x$.

Question 67 Option (B) – 0
Explanation: The integrand $f(x) = \frac{2x}{1+\cos^2 x}$ is an odd function because it satisfies $f(-x) = -f(x)$ due to the linear x term in the numerator. By definite integration properties, the integral of any odd function evaluated over symmetric boundaries $[-\pi, \pi]$ is zero.

Question 68 Option (B) – $[2, 4)$
Explanation: Factoring the quadratic equation in terms of the floor function gives $([x]-2)([x]-3) = 0$, which yields the solutions $[x] = 2$ or $[x] = 3$. Based on the definition of the greatest integer function, $[x] = 2 \implies x \in [2, 3)$ and $[x] = 3 \implies x \in [3, 4)$, combining to $[2, 4)$.

Question 69 Option (A) – $x^4(y')^2 + xy' - y = 0$
Explanation: Differentiating the general solution with respect to x gives $y' = -c/x^2 \implies c = -x^2y'$. Substituting this expression for the arbitrary constant c back into the original general solution equation successfully eliminates the parameter, constructing the active differential equation.

Question 70 Option (1) – $-\sqrt{\frac{1-y^2}{1-x^2}}$
Explanation: Making the trigonometric substitutions $x = \sin\alpha$ and $y = \sin\beta$ simplifies the original algebraic constraint equation directly to $\alpha + \beta = \pi/2 \implies \sin^{-1} x + \sin^{-1} y = \pi/2$. Differentiating implicitly with respect to x yields $\frac{1}{\sqrt{1-x^2}} + \frac{1}{\sqrt{1-y^2}}\frac{dy}{dx} = 0$, solving to the given derivative.

Question 71 Option (A) – 5/2
Explanation: For two vectors to be collinear, their corresponding directional components must be strictly proportional. Setting up the scalar ratios gives the equality $2/4 = -q/-5 = 3/6$, which reduces to $1/2 = q/5$, solving directly to $q = 5/2$.

Question 72 Option (C) – 9
Explanation: Expanding the scalar triple product in the numerator using distributive and determinant properties simplifies it to $9[\vec{a}\,\vec{b}\,\vec{c}]$. Dividing this term by the identical scalar triple product in the denominator cancels the vector components, leaving the integer value 9.

Question 73 Option (A) – $\pi/4$
Explanation: In a right-angled triangle where $\angle C = 90^\circ$, the sides satisfy $c^2 = a^2 + b^2$. Substituting this geometric constraint into the inverse tangent addition identity simplifies the expression to $\tan^{-1}(1)$, which corresponds to the principal angle of $\pi/4$.

Question 74 Option (D) – p
Explanation: Applying distributive laws to simplify the logical statement results in $[p \wedge (q \vee r)] \vee [p \wedge \sim (q \vee r)]$. Factoring out the common proposition p compresses the statement to $p \wedge [(q \vee r) \vee \sim (q \vee r)] \equiv p \wedge \mathrm{T} \equiv p$.

Question 75 Option (D) – -2/3
Explanation: Since the two intersecting lines are perpendicular, the dot product of their respective direction vectors must equal zero. Computing the scalar components gives $1(2) + 2(1) + m(6) = 0 \implies 4 + 6m = 0$, which solves to $m = -2/3$.

Question 76 Option (A) – 16/3 cu. units
Explanation: The volume of a tetrahedron defined by vertices is given by $\frac{1}{6}|[\vec{AB}\ \vec{AC}\ \vec{AD}]|$. Computing the vectors from the given coordinates yields the determinant value of 32, which results in a volume of $32/6 = 16/3$ cubic units.

Question 77 Option (C) – 5/13
Explanation: Utilizing the fundamental trigonometric identity $\csc^2\theta - \cot^2\theta = 1$, we can factor it to find $\csc\theta - \cot\theta = 1/5$. Adding this to the given equation cancels the cotangent terms, giving $2\csc\theta = 26/5 \implies \csc\theta = 13/5$, which means $\sin\theta = 5/13$.

Question 78 Option (B) – 27 m, 27 m
Explanation: By geometric optimization principles, for a fixed perimeter, the rectangle that encloses the maximum possible area is a square. Dividing the total perimeter parameter equally among the four sides yields the dimensions $x = y = 108/4 = 27$ m.

Question 79 Option (A) – $\sqrt{19}/3$
Explanation: Grouping the variables and completing the square transforms the equation into the standard hyperbola form $\frac{(x-1)^2}{3} - \frac{(y+2)^2}{16} = 1$. The eccentricity is calculated using $e = \sqrt{1 + b^2/a^2} = \sqrt{1 + 16/3} = \sqrt{19/3}$.

Question 80 Option (A) – 1/4
Explanation: Simplifying the expressions using substitution methods transforms the variables to $u = \frac{1}{2}\tan^{-1}x$ and $v = 2\tan^{-1}x$. Differentiating u with respect to v cancels the derivative of the inverse tangent function, yielding $du/dv = (1/2)/2 = 1/4$.

Question 81 Option (B) – $\pm 1/2, 0, \sqrt{3}/2$
Explanation: Since the line lies entirely within the ZOX plane, its projection on the Y-axis is zero, meaning $m = \cos\beta = 0$. Given it makes an angle of 30° with the Z-axis, $n = \cos 30^\circ = \sqrt{3}/2$. Using $l^2 + m^2 + n^2 = 1$ gives $l^2 = 1 - 3/4 = 1/4 \implies l = \pm 1/2$.

Question 82 Option (C) – $y = 2 + 4x + e^x - \sin x$
Explanation: Integrating the second-order differential equation y'' twice introduces two constants of integration. Evaluating these constants using the initial boundary conditions $y(0) = 3$ and $y'(0) = 4$ yields the particular solution.

Question 83 Option (B) – $x = n(\pi/3) + \pi/12$
Explanation: The standard general solution to the trigonometric equation $\tan 3x = 1$ is expressed as $3x = n\pi + \pi/4$, where $n \in \mathbb{Z}$. Dividing the entire solution sequence by 3 isolates the variable as $x = n(\pi/3) + \pi/12$.

Question 84 Option (D) – 26
Explanation: According to matrix algebra theorems, the sum of the products of the elements of any row or column with their corresponding cofactors is always equal to the determinant of that matrix. Computing the determinant value $|A|$ directly evaluates to 26.

Question 85 Option (B) – $\pi/2 - \log 2$
Explanation: Substituting the identity $2\tan^{-1}x$ allows the definite integral to be solved using integration by parts. This evaluates to $[2x\tan^{-1}x]_0^1 - \int_0^1 \frac{2x}{1+x^2}\,dx = 2(1)(\pi/4) - [\log(1+x^2)]_0^1 = \pi/2 - \log 2$.

Question 86 Option (D) – 8 hours
Explanation: Since the population exhibits exponential growth and doubles its size every 4 hours, reaching $4N$ from an initial value of N requires exactly two successive doubling cycles. The total required duration is therefore calculated as $2 \times 4 = 8$ hours.

Question 87 Option (B) – $|\frac{ab}{\sqrt{a^2+b^2}}|$
Explanation: Writing the intercept equation of the line in standard form gives $bx + ay - ab = 0$. Applying the perpendicular distance formula from the point (a, b) yields the expression $\frac{|b(a)+a(b)-ab|}{\sqrt{a^2+b^2}} = \frac{|ab|}{\sqrt{a^2+b^2}}$.

Question 88 Option (A) – 3
Explanation: For continuity to hold at the boundary $x = 0$, the limit of the rational function as $x \to 0$ must equal the function value $f(0) = 2$. Applying L'Hôpital's rule simplifies the limit statement to $\ln 9/\ln k = 2 \implies \ln k^2 = \ln 9$, solving to $k = 3$.

Question 89 Option (A) – $\pi/12$
Explanation: Applying standard compound angle identities reduces the trigonometric equation directly to the form $\tan(\pi/4-\theta) = \tan(\pi/6)$. Equating the arguments gives $\pi/4-\theta = \pi/6 \implies \theta = \pi/4 - \pi/6 = \pi/12$.

Question 90 Option (D) – A^{-1} does not exist
Explanation: Evaluating the determinant of the matrix constructed from the reciprocal cube roots of unity shows that its rows or columns are linearly dependent, causing the determinant to equal zero. Because the matrix is singular, its inverse does not exist.

Question 91 Option (B) – π
Explanation: Evaluating each inverse trigonometric term using its standard principal value branch yields $\sin^{-1}(1/2) = \pi/6$, $\cos^{-1}(\sqrt{3}/2) = \pi/6$, and $\cot^{-1}(-1/\sqrt{3}) = 2\pi/3$. Summing these values gives $\pi/6 + \pi/6 + 2\pi/3 = \pi$.

Question 92 Option (A) – $\log|x + 1| + \frac{4}{x+2} + c$
Explanation: Resolving the rational integrand into partial fractions decomposes it into $\frac{1}{x+1} - \frac{4}{(x+2)^2}$. Integrating each term independently yields the logarithmic and rational terms $\log|x + 1| + \frac{4}{x+2} + c$.

Question 93 Option (C) – 2
Explanation: A line is parallel to a plane if its direction vector $\vec{v} = (2, 1, 2)$ is perpendicular to the plane's normal vector $\vec{n} = (3, -2, -m)$. Setting their dot product to zero gives $2(3) + 1(-2) + 2(-m) = 0 \implies 4 - 2m = 0 \implies m = 2$.

Question 94 Option (B) – 5
Explanation: The net standard deviation of a binomial distribution is given by $\sigma = \sqrt{npq}$. Substituting the parameters $n = 100$, $p = 1/2$, and $q = 1/2$ into the formula evaluates to $\sqrt{100 \times 1/4} = \sqrt{25} = 5$.

Question 95 Option (C) – 72
Explanation: Evaluating the objective function $Z = 3x + 5y$ at each of the corner points of the bounded feasible region reveals that the values are $Z(0, 4) = 20$, $Z(8, 4) = 44$, and $Z(24, 0) = 72$. The maximum value is 72.

Question 96 Option (D) – 17/20
Explanation: Using the probability addition theorem, $P(A \cap B) = P(A) + P(B) - P(A \cup B) = 2/5+1/4-1/2 = 3/20$. According to De Morgan's laws, $P(A' \cup B') = 1-P(A \cap B) = 1-3/20 = 17/20$.

Question 97 Option (2) – -1/4
Explanation: Using half-angle identities, the expression simplifies to $y = \tan^{-1}(\cot(x/4)) = \tan^{-1}(\tan(\pi/2 - x/4)) = \pi/2 - x/4$. Differentiating this linear equation with respect to x directly yields the constant derivative $y' = -1/4$.

Question 98 Option (A) – $a - b = 0$
Explanation: Integrating the uniform probability density function yields $a = \int_0^{1/2} 1/2\, dx = 1/4$

and $b = \int_{3/2}^{2} 1/2\,dx = 1/4$. Since both calculated probabilities are identical, they satisfy the relation $a - b = 0$.

Question 99 Option (C) – $y + \sin^{-1} x = c$
Explanation: Separating the variables in the differential equation results in $dy + \frac{1}{\sqrt{1-x^2}}\,dx = 0$. Integrating both terms directly constructs the general solution $y + \sin^{-1} x = c$.

Question 100 Option (A) – 9/2
Explanation: For two lines to intersect, they must be coplanar. Setting the coplanarity condition determinant to zero and expanding it leads to a linear equation in k, which solves to $k = 9/2$.

Question 101 Option (B) – If Raju doesn't join Army, then he is not courageous.
Explanation: The contrapositive of a conditional proposition $p \to q$ is logically defined as $\sim q \to \sim p$. This translates to "If Raju does not join the Indian Army, then he is not courageous."

Question 102 Option (A) – 1, 84, 800
Explanation: Differentiating area gives $dA/dt = 2\pi r(dr/dt)$. At $t = 600$ s, the radius reaches $r = 4200$ cm. Substituting these values yields $2 \times (22/7) \times 4200 \times 7 = 1,84,800\ \text{cm}^2/\text{s}$.

Question 103 Option (B) – 2
Explanation: The absolute difference between the slopes of lines represented by a joint equation is given by $|m_1 - m_2| = \frac{2\sqrt{h^2-ab}}{|b|}$. Substituting the given coefficients simplifies the radical to exactly 2.

Question 104 Option (D) – 3
Explanation: For two planes to be parallel, the coefficients of their respective normal vectors must be proportional: $2/2\lambda = -5/-15 = 1/\lambda$. This simplifies to $1/\lambda = 1/3 \implies \lambda = 3$.

Question 105 Option (B) – (0,0) and 4a units
Explanation: Squaring and adding the parametric equations eliminates the parameter θ, yielding $x^2 + y^2 = (4a)^2(\cos^2\theta + \sin^2\theta) = (4a)^2$. This is the standard equation of a circle centered at the origin with a radius of $4a$.

Question 106 Option (A) – increase
Explanation: The potential gradient along the potentiometer wire is given by $k = V/L$. Increasing the length L while keeping the driving potential V constant decreases k, which consequently increases the required balancing length $l = e/k$ for a given test cell.

Question 107 Option (C) – 10^{-3}
Explanation: The magnetic induction matches $B = \phi/A = (6 \times 10^{-4}\,\text{Wb})/(3 \times 10^{-4}\,\text{m}^2) = 2\,\text{T}$. Using the standard constitutive relationship $\mu = B/H$ with a magnetic intensity of $H = 2000\,\text{A/m}$ evaluates to the permeability value $2/2000 = 10^{-3}\,\text{Wb/A}\cdot\text{m}$.

Question 108 Option (B) – 200 V
Explanation: The peak secondary electromotive force is modeled as $e_0 = MI_0\omega = MI_0(2\pi f)$. Substituting the parameters $M = 1\,\text{H}$, $I_0 = 2/\pi\,\text{A}$, and $f = 50\,\text{Hz}$ yields a peak amplitude value of $1 \times (2/\pi) \times 100\pi = 200\,\text{V}$.

Question 109 Option (C) – $\frac{\lambda'}{3}\sqrt{\frac{m}{M}}$
Explanation: The de-Broglie wavelength of a particle scales inversely with its kinetic momentum, expressed as $\lambda = h/\sqrt{2mqV}$. Comparing the relative ratios for an electron and a proton under a potential difference of $V_p = 9V_e$ yields $\lambda_p = \frac{\lambda'}{3}\sqrt{\frac{m}{M}}$.

Question 110 Option (C) – 6I
Explanation: The coherent resultant intensity formula is $I_{\text{res}} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi = 10I + 6I\cos\phi$. Computing individual outputs at phase angles $\phi_P = \pi/2$ and $\phi_Q = \pi$ gives $I_P = 10I$ and $I_Q = 4I$, yielding a net variation of $6I$.

Question 111 Option (A) – depends on wavelength and is different for different colours
Explanation: According to Brewster's law, the polarization angle matches the medium interface

properties via $\tan i_p = \mu$. Since the optical refractive index μ of a dispersive medium varies as a function of wavelength, the value of i_p changes dynamically for different colors.

Question 112 Option (D) – $\left[\frac{r_1}{r_2}\right]^2$
Explanation: The orbital radius of a charged particle moving inside a magnetic field is $r = \frac{\sqrt{2mVq}}{qB}$. Given that potential, charge, and field are kept constant, the radius is proportional to the square root of mass ($r \propto \sqrt{m}$), establishing $m \propto r^2$.

Question 113 Option (B) – does not radiate light and velocity remains unchanged
Explanation: Based on Bohr's first atomic postulate, electrons revolving around a nucleus are restricted to stable, non-radiating stationary orbits. As long as the electron remains inside a given orbit, it does not release electromagnetic energy, and its speed is conserved.

Question 114 Option (D) – $\mu_0 nI(1+\chi)$
Explanation: The internal magnetic field setup inside a core-filled solenoid is modeled using $B = \mu_0\mu_r nI$. Substituting the macro relative permeability parameter in terms of its native material susceptibility ($\mu_r = 1+\chi$) constructs the updated field expression $B = \mu_0 nI(1+\chi)$.

Question 115 Option (A) – 1 A
Explanation: Under the balanced bridge condition, the left and right gap ratios give $X/6 = 2/3 \implies X = 4\,\Omega$. The combined equivalent parallel loop resistance across the wire setup evaluates to $5\,\Omega$, drawing a net current of $5\,\text{V}/5\,\Omega = 1\,\text{A}$ from the source.

Question 116 Option (B) – $\frac{11\epsilon_0 A}{18d}$
Explanation: For a parallel array of structural capacitors, the net equivalent capacity is the direct sum $C_{\text{eq}} = C_1 + C_2 + C_3$. Accumulating the separate sub-capacitance values with discrete plates and split areas yields $\epsilon_0(A/3)[1/d + 1/2d + 1/3d] = 11\epsilon_0 A/18d$.

Question 117 Option (C) – 1
Explanation: The Barkhausen criterion dictates the exact conditions required to produce stable, sustained oscillations inside a feedback loop circuit. It mandates that the net loop gain magnitude must equal unity ($|A\beta| = 1$), while the loop phase shift must be 0 or a multiple of 2π.

Question 118 Option (A) – increase
Explanation: Reducing the incident wavelength drives up the quantum energy of incoming photons ($E = hc/\lambda$). Because the work function threshold of the metal is a fixed material parameter, the peak kinetic energy increases, which directly raises the stopping potential.

Question 119 Option (B) – $\frac{i}{5}$
Explanation: A 20% decrease in wave velocity yields a refractive index value of $\mu = 1/0.8 = 1.25 = 5/4$. For thin prisms or small angles of incidence, the angle of optical deviation simplifies using the approximation $\delta \approx i(1 - 1/\mu) = i(1 - 4/5) = i/5$.

Question 120 Option (C) – $g\sqrt{N}$
Explanation: The peak ionospheric critical frequency for wireless radio propagation is bounded by the empirical relation $f_c \approx 9\sqrt{N}$, where N represents the local maximum electron density. Representing the structural coefficient constant symbolically as g yields $g\sqrt{N}$.

Question 121 Option (A) – 186 Hz
Explanation: The fundamental frequency of a vibrating string scales with the square root of its structural tension ($n \propto \sqrt{T}$). Constructing the algebraic ratio for the two tensions gives $15/16 = (N-6)/(N+6)$, which evaluates to a tuning fork frequency of $N = 186\,\text{Hz}$.

Question 122 Option (B) – $\left[\frac{2}{3}\right]$rd kinetic energy per unit volume of a gas
Explanation: Based on the kinetic theory of gases, the mechanical pressure statement is modeled as $P = \frac{1}{3}\rho v_{\text{rms}}^2$. Multiplying and dividing by 2 isolates the internal kinetic energy density component, transforming the relationship into the standard form $P = \frac{2}{3}\left(\frac{1}{2}\rho v_{\text{rms}}^2\right)$.

Question 123 Option (A) – $\left[\frac{m_1}{m_1+m_2}\right]^{1/2}$
Explanation: Linear momentum is conserved during the collision at the equilibrium position, shifting the velocity to $v' = \frac{m_1}{m_1+m_2}v$. Equating the peak structural velocities in terms of their harmonic parameters yields the new amplitude ratio $A'/A = \sqrt{m_1/(m_1+m_2)}$.

Question 124 Option (A) – $\frac{v^2}{8\pi r}$
Explanation: Applying the linear kinematic relationship $v^2 = u^2 + 2a_t s$ with an initial velocity of $u = 0$ models the system. Substituting the angular track distance covered over two complete cycles ($s = 4\pi r$) yields $v^2 = 8\pi r a_t$, solving to $a_t = v^2/8\pi r$.

Question 125 Option (B) – $\frac{1}{2}$
Explanation: The velocity of a transverse wave string is $v = \sqrt{T/m} \propto 1/r$ under identical density and tension. Since the wire radius of string A is double that of string B, its wave speed is cut in half, establishing the ratio $V_A/V_B = 1/2$.

Question 126 Option (C) – Initial phase
Explanation: Viscous damping continuously robs an oscillator of its total mechanical energy, causing a steady decay in amplitude and a slight shift in the time period. The initial phase parameter, however, is a static boundary condition locked at $t = 0$, remaining completely unaffected.

Question 127 Option (B) – $\frac{2}{3}$ cm
Explanation: The combined double end correction for an open organ pipe is expressed as $2e = 1.2r$. Equating this to the given empirical tracking value of $0.8\,\text{cm}$ sets up the linear equation $1.2r = 0.8$, solving to an inner radius of $r = 2/3\,\text{cm}$.

Question 128 Option (C) – $\frac{\pi}{8}$ cm
Explanation: Comparing the wave function gives a spatial wave number of $k = 4\,\text{rad/cm}$. Applying the phase-to-path relationship $\Delta\phi = k\Delta x$ with a phase difference of $\pi/2$ yields the structural path difference $\Delta x = \pi/(2 \times 4) = \pi/8\,\text{cm}$.

Question 129 Option (C) – $-\frac{16\text{Gm}}{r}$
Explanation: The field null point is located at a distance of $x = r/4$ from the single mass m. Accumulating the scalar gravitational potentials from both masses at this point gives $V = -\frac{Gm}{r/4} - \frac{9Gm}{3r/4} = -4Gm/r - 12Gm/r = -16Gm/r$.

Question 130 Option (D) – $\frac{16\text{E}}{9}$
Explanation: Emissive power is modeled using $E = \sigma A T^4 \propto L^2 T^4$. Reducing the linear parameters to $1/3$ cuts the area down to $A/9$, while doubling the temperature increases the radiation factor by $2^4 = 16$, yielding the combined output $\frac{16}{9}E$.

Question 131 Option (A) – rigid diatomic
Explanation: Rearranging the thermal capacity relationship gives $\gamma - 1 = R/C_v = 0.4$, which sets the adiabatic index to $\gamma = 1.4$. This value matches the thermodynamic behavior of a diatomic gas composed of rigid molecules possessing five degrees of freedom.

Question 132 Option (D) – 0.2
Explanation: The critical velocities required at the peak and base of a vertical circle are $\sqrt{gR}$ and $\sqrt{5gR}$ respectively. Since kinetic energy scales with the square of velocity, the ratio of their energies matches their squared velocities, evaluating to $1/5 = 0.2$.

Question 133 Option (D) – 81 : 1
Explanation: Stored elastic strain energy density is $u = \frac{\text{Stress}^2}{2Y} \propto 1/d^4$. Given that the smaller wire has one-third the diameter of the larger wire, the ratio of their internal strain energies scales inversely with the fourth power, evaluating to $(3/1)^4 = 81 : 1$.

Question 134 Option (A) – 3 J
Explanation: Total rolling kinetic energy is $K = \frac{1}{2}mv^2(1 + K^2/R^2)$. For a thin ring, $K^2/R^2 =$

$1 \implies mv^2 = 4\,\mathrm{J}$. For a uniform disc, $K^2/R^2 = 0.5$, transforming the total rolling kinetic energy expression into $\frac{3}{4}mv^2 = \frac{3}{4}(4\,\mathrm{J}) = 3\,\mathrm{J}$.

Question 135 Option (B) – 3
Explanation: The shifted apparent frequencies are $F_1 = n(V+V_1)/V$ and $F_2 = n(V-V_1)/V$. Setting their relative ratio to 2 gives the equation $(V+V_1)/(V-V_1) = 2$, which simplifies to $V + V_1 = 2V - 2V_1 \implies V = 3V_1$, establishing the tracking ratio 3.

Question 136 Option (C) – 8E
Explanation: Splitting a single large fluid drop of radius R into 512 identical droplets shrinks the individual droplet radius to $r = R/8$. The new collective surface area increases by a factor of $512 \times (1/8)^2 = 8$, scaling the surface energy to $8E$.

Question 137 Option (B) – $\frac{1}{2}$
Explanation: The structural moments of inertia are $I_1 = ML^2/12$ and $I_2 = ML^2/3$, defining the native radii of gyration as $k_1 = L/\sqrt{12}$ and $k_2 = L/\sqrt{3}$. Computing the ratio of these values yields $k_1/k_2 = \sqrt{3/12} = \sqrt{1/4} = 1/2$.

Question 138 Option (C) – $mgl(1-\cos\theta)$
Explanation: By the law of conservation of mechanical energy, the peak kinetic energy achieved at the base of the swing matches the gravitational potential energy lost from the peak angle, which is modeled using $mgh = mgl(1-\cos\theta)$.

Question 139 Option (C) – $\frac{1}{120}$
Explanation: The hour hand of a standard clock sweeps out an angular displacement of $360°$ over a 12-hour cycle. Its steady angular speed in degrees per second is calculated as $\omega = 360°/(12 \times 3600\,\mathrm{s}) = 360/43200 = 1/120\,\mathrm{degree/s}$.

Question 140 Option (A) – $h = R$
Explanation: The acceleration due to gravity at an altitude h follows the relationship $g_h = g[R/(R+h)]^2$. Setting the local gravity value to one-quarter of its surface value gives $[R/(R+h)]^2 = 1/4 \implies R/(R+h) = 1/2$, solving to $h = R$.

Question 141 Option (B) – Diode with outward arrows
Explanation: A light-emitting diode (LED) is represented schematically by a standard p-n junction diode symbol. It includes two distinct outward-pointing arrows on the anode side to signify the physical emission of light photons during forward-bias recombination.

Question 142 Option (D) – 1.67 W
Explanation: Stored potential work matches the difference in energy states: $W_1 = W = \frac{1}{2}C(10^2 - 5^2) = 37.5\,C$. The second step requires an energy shift of $W_2 = \frac{1}{2}C(15^2 - 10^2) = 62.5\,C$. Taking the ratio gives $W_2 = (62.5/37.5)W = 1.67W$.

Question 143 Option (C) – 0.5
Explanation: The net change in magnetic flux is calculated from the percentage drop as $\Delta\phi = 0.90 \times (4 \times 10^{-4}\,\mathrm{Wb}) = 3.6 \times 10^{-4}\,\mathrm{Wb}$. Applying Faraday's law ($e = \Delta\phi/t$) with $e = 0.72\,\mathrm{mV}$ evaluates to a time duration of $t = 3.6/7.2 = 0.5\,\mathrm{s}$.

Question 144 Option (A) – wavelength of light decreases
Explanation: The spatial resolving power of an astronomical telescope objective is governed by the relation R.P. $= D/(1.22\lambda)$. Reducing the wavelength λ of the incident light minimizes the diffraction disc, thereby increasing the resolving power of the optical system.

Question 145 Option (D) – 5λ
Explanation: Modeling the system using the photoelectric equation gives $eV = hc/\lambda - hc/\lambda_0$ and $eV/6 = hc/3\lambda - hc/\lambda_0$. Multiplying the second equation by 6 and equating both expressions isolates the threshold wavelength as $5hc/\lambda_0 = hc/\lambda \implies \lambda_0 = 5\lambda$.

Question 146 Option (A) – $T_1 = 3T$
Explanation: The buoyant upward force inside water lowers the effective acceleration to $g' =$

$g(1-\sigma/\rho) = g(1-1000/1125) = g/9$. Since the pendulum time period scales inversely with the square root of gravity ($T \propto 1/\sqrt{g}$), the new period scales up to $T\sqrt{9} = 3T$.

Question 147 Option (C) – $\frac{2\mathrm{T}}{(\mathrm{R}-\mathrm{r})\rho\mathrm{g}}$
Explanation: Equating the net upward vertical surface tension force $T \cdot 2\pi(R+r)$ to the downward gravitational weight of the liquid column trapped in the annular gap $\pi(R^2-r^2)h\rho g$ balances the system, solving to a capillary height of $h = 2T/[(R-r)\rho g]$.

Question 148 Option (D) – 300 Hz
Explanation: Using the harmonic frequency relationship $f_{c,3} - f_{o,2} = 150\,\text{Hz}$ models the system. Writing out the boundary conditions gives $7(v/4L) - 3(v/2L) = 150 \implies 3.5n_o - 3n_o = 150$, which solves to an open fundamental frequency of $n_o = 300\,\text{Hz}$.

Question 149 Option (A) – $\frac{I}{5}$
Explanation: Equating the structural volumes during the metal recasting process dictates the new radius as $R_s = R/2$. The initial moment of inertia is $I = \frac{1}{2}MR^2$, and for the newly formed solid sphere, it evaluates to $I_s = \frac{2}{5}MR_s^2 = \frac{1}{10}MR^2 = I/5$.

Question 150 Option (B) – $\frac{\mathrm{Wl}^3}{4\mathrm{bd}^3\mathrm{Y}}$
Explanation: According to the mechanical elastic theory of bending beams, the central downward vertical deflection (sag) produced at the midpoint of a rectangular beam supporting a central load W is given by the standard structural formula $\delta = Wl^3/(4Ybd^3)$.