MHT CET 2020 Mathematics Answer Key PDF

Question 1
Option (B) – G_1 is more sensitive than G_2.
Explanation: Current sensitivity is inversely proportional to the current required for full-scale deflection ($I_s \propto 1/I$). Since G_1 requires less current (2 mA) than G_2 (3 mA) for the same deflection, G_1 is more sensitive.

Question 2
Option (C) – $\frac{\lambda_1 E_1 - \lambda_2 E_2}{\lambda_2 - \lambda_1}$.
Explanation: Using Einstein's photoelectric equation, $E_1 = hc/\lambda_1 - \phi$ and $E_2 = hc/\lambda_2 - \phi$. Eliminating hc from these equations yields the work function $\phi = \frac{\lambda_1 E_1 - \lambda_2 E_2}{\lambda_2 - \lambda_1}$.

Question 3
Option (A) – 9Ω.
Explanation: Initially, $R_1/R_2 = 20/80 = 1/4 \implies R_2 = 4R_1$. When $15\,\Omega$ is connected in series with the smaller resistance, $(R_1 + 15)/4R_1 = 40/60 = 2/3$, which solves to $R_1 = 9\,\Omega$.

Question 4
Option (A) – remains the same.
Explanation: The root mean square velocity of gas molecules is given by $v_{\text{rms}} = \sqrt{3RT/M}$. Since the compression is isothermal, the temperature remains constant, and thus the r.m.s. velocity remains unchanged.

Question 5
Option (B) – $4/\pi$.
Explanation: For a wire of length L, the radius of the circular loop is $R = L/(2\pi)$ and the side of the square is $a = L/4$. The ratio of their magnetic moments is $M_c/M_s = I(\pi R^2)/I(a^2) = 4/\pi$.

Question 6
Option (D) – be zero.
Explanation: The initial frequency is $2\nu_0$. When reduced to 1/3rd, the new frequency is $\frac{2}{3}\nu_0$, which is below the threshold frequency ν_0. Consequently, no photoelectric emission occurs, and the current becomes zero.

Question 7
Option (C) – $\theta = \cot^{-1}(V/c)$.
Explanation: According to Brewster's law, $\tan\theta = \mu = c/V$. This can be rewritten as $\cot\theta = V/c$, which gives the polarizing angle relation $\theta = \cot^{-1}(V/c)$.

Question 8
Option (A) – very high, empty.
Explanation: In insulators, the energy band gap between the valence band and the conduction band is very high (> 3 eV), preventing electrons from transitioning, which leaves the conduction band empty.

Question 9
Option (A) – $T/12$.
Explanation: For $e = e_0 \sin\omega t$ to reach half its maximum value, we have $\sin\omega t = 1/2 \implies \omega t = \pi/6$. Substituting $\omega = 2\pi/T$ yields $t = T/12$.

Question 10
Option (C) – 3 units.
Explanation: When 27 identical drops of radius r combine, the radius of the larger drop is $R = 3r$. Since excess pressure is $P \propto 1/R$, the new pressure is $9/3 = 3$ units.

Question 11
Option (A) – 7/8.

Explanation: The frequency of the 3rd overtone of a closed pipe is $7v/(4L_c)$ and for an open pipe is $2v/L_o$. Equating them in unison gives the ratio $L_c/L_o = 7/8$.

Question 12

Option (B) – 7.91×10^{-4} rad/s.

Explanation: The effective acceleration due to gravity at the equator is $g' = g - R\omega^2$. Setting $g' = \frac{3}{5}g$ gives $\omega = \sqrt{\frac{2g}{5R}}$, which evaluates to 7.91×10^{-4} rad/s.

Question 13

Option (B) – $\frac{KV}{K+1}$.

Explanation: Inserting a dielectric K into one capacitor of a series combination modifies the charge distribution. Solving the network equations shows the potential across the other capacitor becomes $KV/(K+1)$.

Question 14

Option (D) – $13MR^2/32$.

Explanation: The moment of inertia of the remaining portion is calculated by subtracting the moment of inertia of the removed cavity (using parallel axis theorem) from that of the complete disc.

Question 15

Option (A) – 22 cm.

Explanation: By using the Lens Maker's Formula $1/f = (\mu - 1)(2/R)$ for an equiconvex lens, substituting $f = 20$ cm and $\mu = 1.55$ gives the radius of curvature $R = 22$ cm.

Question 16

Option (D) – $\sqrt{2}d$.

Explanation: The line-of-sight propagation distance is given by $d \approx \sqrt{2Rh}$. Doubling the height h of the antenna increases the range by a factor of $\sqrt{2}$.

Question 17

Option (B) – $\frac{T}{V^2\rho}$.

Explanation: The speed of a transverse wave is $V = \sqrt{T/\mu}$ where $\mu = A\rho$ is the mass per unit length. Rearranging this relation yields the cross-sectional area $A = T/(V^2\rho)$.

Question 18

Option (C) – 2×10^{-2} J/T.

Explanation: The net magnetic dipole moment is $M \times V$. With volume $V = \pi r^2 L = \frac{22}{7} \times (0.005)^2 \times 0.05$ m^3 and $M = 5 \times 10^3$ A/m, the result is approximately 2×10^{-2} J/T.

Question 19

Option (A) – $\frac{\pi m\ell}{12P}$.

Explanation: The angular impulse about the center of mass is $P(\ell/2) = I\omega$, giving $\omega = 6P/(m\ell)$. The time taken to rotate through a right angle $(\pi/2)$ is $t = \theta/\omega = \pi m\ell/(12P)$.

Question 20

Option (C) – $E_n \propto \frac{1}{L_n^2}$.

Explanation: In Bohr's atomic model, total energy is $E_n \propto 1/n^2$ and angular momentum is $L_n \propto n$. Combining these relations directly yields $E_n \propto 1/L_n^2$.

Question 21

Option (D) – $30°$.

Explanation: For an equilateral prism, $A = 60°$ and $i = e = \frac{3}{4}A = 45°$. The angle of deviation is calculated as $\delta = i + e - A = 45° + 45° - 60° = 30°$.

Question 22

Option (A) – 8 gram.

Explanation: Resolving the resonance between the second harmonic of the string and the fundamental frequency of the closed organ pipe allows calculating the linear mass density and mass of the string.

Question 23

Option (D) – which is always operated in reverse bias.

Explanation: A photodiode is designed to operate in reverse bias because the change in reverse saturation current is highly sensitive to the intensity of incident light.

Question 24

Option (D) – $m_1 r_1 : m_2 r_2$.

Explanation: Since both cars complete circles in the same time, their angular speed ω is the same. The ratio of their centripetal forces is $F_1/F_2 = (m_1 r_1 \omega^2)/(m_2 r_2 \omega^2) = m_1 r_1 / m_2 r_2$.

Question 25

Option (B) – $R\sqrt{3}$.

Explanation: Using the axial magnetic field formula $B = B_0 R^3/(R^2 + x^2)^{3/2}$ and setting $B = B_0/8$ leads to the equation $(R^2 + x^2)^{3/2} = 8R^3$, solving to $x = R\sqrt{3}$.

Question 26

Option (A) – $T \sin\theta$.

Explanation: In a conical pendulum, the horizontal component of the tension $T \sin\theta$ provides the centripetal force, which balances the centrifugal force in the rotating frame.

Question 27

Option (A) – $\frac{2}{d}\sqrt{\frac{E}{m}}$.

Explanation: The moment of inertia of the diatomic molecule is $I = md^2/2$. The average rotational kinetic energy is $E = \frac{1}{2} I\omega^2 = md^2\omega^2/4$, which gives $\omega = \frac{2}{d}\sqrt{\frac{E}{m}}$.

Question 28

Option (B) – $\frac{Mg\sigma}{\pi r Y}$.

Explanation: Poisson's ratio is $\sigma = (\Delta r/r)/(\Delta L/L)$. Since Young's modulus is $Y = MgL/(\pi r^2 \Delta L)$, substituting $\Delta L/L$ yields the decrease in radius $\Delta r = \frac{Mg\sigma}{\pi r Y}$.

Question 29

Option (C) – 0.9%.

Explanation: Using $g = 4\pi^2 L/T^2$, the percentage error in g is $\Delta g/g \times 100 = \Delta L/L \times 100 + 2(\Delta T/T \times 100) = 0.5\% + 2(0.2\%) = 0.9\%$.

Question 30

Option (C) – stationary charge.

Explanation: A stationary charge produces only an electrostatic field and does not create any magnetic field or current, and thus has no magnetic dipole moment.

Question 31

Option (A) – 9 cm.

Explanation: According to Jurin's law, $h \propto 1/r$. Since the cross-sectional area is reduced to 1/9, the radius is reduced to 1/3, meaning the water level will rise to 3 times the initial height.

Question 32

Option (D) – 1 : 3.

Explanation: For a potentiometer, the potential difference is directly proportional to the balancing length ($V \propto l$). Therefore, the ratio of potentials is $E_2/E_1 = 0.3/0.9 = 1/3$.

Question 33

Option (B) – $\lambda_1 = 0.09\lambda_2$.

Explanation: The Balmer series limit is $1/\lambda_1 = R/4$, and the Brackett longest wavelength is $1/\lambda_2 = 9R/400$. Taking their ratio gives $\lambda_1/\lambda_2 = 36/400 = 0.09 \implies \lambda_1 = 0.09\lambda_2$.

Question 34
Option (B) – $CV/2$.
Explanation: The parallel combination of C and $2C$ gives $3C$, which in series with $3C$ yields an equivalent capacitance of $1.5C$. The charge is divided equally across the parallel branches, giving $CV/2$.

Question 35
Option (B) – 45 m.
Explanation: Under constant braking deceleration, the stopping distance is proportional to the square of initial velocity ($s \propto u^2$). Tripling the speed from 15 to 45 km/hr increases the distance by 9 times.

Question 36
Option (B) – 200 V.
Explanation: The peak induced e.m.f. is given by $E_0 = MI_0\omega = MI_0(2\pi f)$. Substituting $M = 1$ H, $I_0 = 2/\pi$ A, and $f = 50$ Hz gives $E_0 = 200$ V.

Question 37
Option (A) – $\frac{BIL^2}{4\pi n}$.
Explanation: The radius of the n-turn coil is $r = L/(2\pi n)$ and the area is $A = L^2/(4\pi n^2)$. The maximum torque is $\tau_{\max} = nIAB = \frac{BIL^2}{4\pi n}$.

Question 38
Option (C) – 21/25.
Explanation: For a rigid diatomic gas $\gamma_d = 7/5$, and for monoatomic gas $\gamma_m = 5/3$. The ratio of their specific heats is $\gamma_d/\gamma_m = (7/5)/(5/3) = 21/25$.

Question 39
Option (C) – $[4M(g+a)/\pi S]^{1/2}$.
Explanation: The tension in the rope is $T = M(g+a)$. Since the maximum stress is $S = T/A = 4T/(\pi d^2)$, solving for the minimum diameter d gives $[4M(g+a)/\pi S]^{1/2}$.

Question 40
Option (D) – $mg(1+\mu_k^2)^{1/2}$.
Explanation: The surface exerts two perpendicular forces: the normal force $N = mg$ and kinetic friction $f_k = \mu_k mg$. The net contact force is $\sqrt{N^2 + f_k^2} = mg(1+\mu_k^2)^{1/2}$.

Question 41
Option (D) – increase the length four times.
Explanation: The time period of a simple pendulum is $T = 2\pi\sqrt{l/g}$. To double the time period ($T \to 2T$), the length of the pendulum must be increased by a factor of 4.

Question 42
Option (C) – 36 J.
Explanation: The displacement vector is $\vec{d} = \vec{r}_2 - \vec{r}_1 = 3\hat{i} - 3\hat{j} + 5\hat{k}$. The work done is calculated as the dot product $W = \vec{F} \cdot \vec{d} = (5)(3) + (-2)(-3) + (3)(5) = 36$ J.

Question 43
Option (D) – $\frac{a_1}{b_2} = -\frac{a_2}{b_1}$.
Explanation: Since the two vectors are perpendicular, their dot product is zero: $a_1b_1 + a_2b_2 = 0$. Rearranging this equation gives the relation $\frac{a_1}{b_2} = -\frac{a_2}{b_1}$.

Question 44
Option (B) – $\frac{1}{2}\sqrt{\frac{g}{2h}}$.
Explanation: The time of fall is $t = \sqrt{2h/g}$. For a perfectly elastic collision, the time period of motion is $T = 2t = 2\sqrt{2h/g}$, giving a frequency $f = 1/T = \frac{1}{2}\sqrt{g/2h}$.

Question 45
Option (A) – 10/11.
Explanation: The position of the 5th bright band is $5\lambda_1 D/d$ and the 6th dark band is $5.5\lambda_2 D/d$. Equating these two expressions gives the ratio $\lambda_2/\lambda_1 = 10/11$.

Question 46
Option (C) – $2\pi^2 mA^2/T^2$.
Explanation: The total energy of a particle in S.H.M. is $E = \frac{1}{2}m\omega^2 A^2$. Substituting the angular frequency $\omega = 2\pi/T$ yields $E = 2\pi^2 mA^2/T^2$.

Question 47
Option (C) – $I/2$.
Explanation: A path difference of λ corresponds to a phase difference of 2π, while $\lambda/4$ corresponds to $\pi/2$. Using the intensity formula $I = I_{\max}\cos^2(\phi/2)$, we find the new intensity is $I/2$.

Question 48
Option (B) – m^2/kg.
Explanation: The SI unit of G is $\mathrm{m^3\,kg^{-1}\,s^{-2}}$ and that of g is $\mathrm{m\,s^{-2}}$. Dividing these units gives the unit of G/g as $\mathrm{m^2/kg}$.

Question 49
Option (B) – 1.
Explanation: For a perfectly elastic collision, there is no kinetic energy loss, and the relative velocity of separation equals the relative velocity of approach, making the coefficient of restitution $e = 1$.

Question 50
Option (D) – $\pi A/2$.
Explanation: Maximum particle velocity is $v_p = 2\pi nA$ and wave velocity is $v_w = n\lambda$. Setting $v_p = 4v_w$ gives $2\pi nA = 4n\lambda$, which simplifies to $\lambda = \pi A/2$.

Question 51
Option (C) – $Ag_2O/H_2O, \Delta$.
Explanation: Hoffmann elimination reaction of quaternary ammonium hydroxides (formed by treating quaternary ammonium halides with moist silver oxide, $\mathrm{Ag_2O/H_2O}$) undergoes thermal elimination to give alkenes.

Question 52
Option (D) – 67.2 L.
Explanation: Based on the stoichiometry of the reaction $\mathrm{2KClO_3 \rightarrow 2KCl + 3O_2}$, 2 moles of reactant yield 3 moles of $\mathrm{O_2}$. At S.T.P., 3 moles of gas occupy $3 \times 22.4 = 67.2$ L.

Question 53
Option (C) – CH_3OH.
Explanation: Methanol is more acidic than other primary, secondary, and tertiary alcohols because the $+I$ (inductive) effect of the methyl group is lower than that of larger alkyl groups, stabilizing the methoxide ion.

Question 54
Option (D) – $Mg < Ca < Sr < Ba$.
Explanation: The chemical reactivity of alkaline earth metals with water increases down the group as the ionization enthalpy decreases and electropositive character increases.

Question 55
Option (C) – $TiCl_4$ along with $Al(C_2H_5)_3$.
Explanation: High-density polyethylene (HDPE) is manufactured using Ziegler-Natta catalyst, which is a coordination complex of titanium tetrachloride ($\mathrm{TiCl_4}$) and triethylaluminium ($\mathrm{Al(C_2H_5)_3}$).

Question 56
Option (B) – $-k/2.303$.
Explanation: The integrated rate law for a first-order reaction can be expressed as $\log_{10}[A]_t = -\frac{k}{2.303}t + \log_{10}[A]_0$. The slope of the plot of $\log_{10}[A]_t$ vs. t is $-k/2.303$.

Question 57
Option (D) – +2.
Explanation: In the coordination complex $[Ru(NH_3)_5H_2O]Cl_2$, both NH_3 and H_2O are neutral ligands. To balance the -2 charge of the two chloride ions, the ruthenium atom must be in the +2 oxidation state.

Question 58
Option (A) – Cl^-.
Explanation: According to the Hardy-Schulze rule, the coagulating (precipitating) power of an active ion is directly proportional to its valency. Thus, monovalent chloride ion (Cl^-) has the least precipitating power.

Question 59
Option (D) – Nylon-2-nylon-6.
Explanation: Dextron, PHBV, and Dacron are polyesters and contain ester linkages. In contrast, Nylon-2-nylon-6 is a polyamide copolymer and contains amide linkages (-CO-NH-) instead of ester linkages.

Question 60
Option (D) – $Ba[CuCl_4]$.
Explanation: Barium acts as the counter-cation (Ba^{2+}) and tetrachlorocuprate(II) is a coordination anion with formula $[CuCl_4]^{2-}$, resulting in the neutral complex $Ba[CuCl_4]$.

Question 61
Option (C) – 1.5.
Explanation: The thermal decomposition of gaseous acetaldehyde ($CH_3CHO \rightarrow CH_4 + CO$) is a classical example of a fractional-order reaction, having an experimental order of 1.5.

Question 62
Option (A) – P.
Explanation: Salvarsan (arsphenamine) is a well-known organoarsenic drug that contains arsenic, nitrogen, and oxygen. It does not contain phosphorus in its structure.

Question 63
Option (A) – anhydrous $ZnCl_2$.
Explanation: The reaction of ethyl alcohol with HCl to form ethyl chloride is carried out in the presence of anhydrous zinc chloride ($ZnCl_2$) as a catalyst, known as Groves' process.

Question 64
Option (C) – +5.
Explanation: Chloric acid is $HClO_3$. Setting the oxidation state of chlorine to x, we have $+1 + x + 3(-2) = 0 \implies x = +5$.

Question 65
Option (A) – Insulin.
Explanation: Globular proteins are folded into compact spherical shapes and are water-soluble. Insulin is a globular protein, whereas myosin, collagen, and fibroin are fibrous proteins.

Question 66
Option (D) – $CH_3 - CH(OH) - CH_3$.
Explanation: Treating 1-propanol with PCl_3 gives 1-chloropropane (X), which undergoes dehydrohalogenation to form propene (Y). Hydration of propene via Markovnikov's addition yields 2-propanol (Z).

Question 67
Option (D) – 2-Methyl-1,3-butadiene.
Explanation: Natural rubber is a linear polymer of isoprene, whose systematic IUPAC name is 2-methyl-1,3-butadiene.

Question 68
Option (A) – 1° amine.
Explanation: The reduction of a ketoxime ($R_2C{=}NOH$) with sodium and ethanol (Mendius reaction) yields a primary amine ($R_2CH\text{-}NH_2$).

Question 69
Option (A) – Vitamin C.
Explanation: Vitamin C (ascorbic acid) is derived from aliphatic monosaccharides and has an open/lactone aliphatic structure, unlike other vitamins that feature aromatic or complex steroid-like rings.

Question 70
Option (C) – AB forms electrovalent bond.
Explanation: A chemical bond formed by the complete transfer of one or more electrons from one atom to another is called an ionic or electrovalent bond.

Question 71
Option (D) – 5.8 kJ.
Explanation: Using the First Law of Thermodynamics, $\Delta U = q - w$. Since the system absorbs 8 kJ ($q = +8$) and does 2.2 kJ of work on the surroundings ($w = +2.2$), $\Delta U = 8 - 2.2 = 5.8$ kJ.

Question 72
Option (C) – molecular solid.
Explanation: Dry ice is solid carbon dioxide (CO_2), in which individual non-polar molecules are held together by weak London dispersion forces, characterizing it as a molecular solid.

Question 73
Option (B) – Argon.
Explanation: In gas chromatography, inert gases such as helium, nitrogen, argon, and hydrogen are utilized as the mobile phase (carrier gas).

Question 74
Option (B) – 120°.
Explanation: Phosphorus pentachloride (PCl_5) has a trigonal bipyramidal geometry. The three equatorial Cl-P-Cl bonds lie in the same plane with bond angles of 120°.

Question 75
Option (C) – 1.
Explanation: In the complex $[Cu(H_2O)_4]^{2+}SO_4^{2-} \cdot H_2O$, four water molecules are directly coordinated to the copper ion, while only one water molecule is held in the crystal lattice through hydrogen bonding.

Question 76
Option (D) – Van Arkel method.
Explanation: The Van Arkel method is a vapor-phase refining process used to obtain ultra-pure zirconium (Zr) and titanium (Ti) by thermal decomposition of their volatile iodides.

Question 77
Option (B) – $Na_{(s)}$.
Explanation: The number of atoms in a given mass is inversely proportional to the academic mass. Since sodium (Na, 23 g/mol) has the lowest atomic weight among the options, 1 g of Na contains the highest number of atoms.

Question 78
Option (C) – Ammonium chloride.
Explanation: Semipermeable membranes must be insoluble barriers with sub-microscopic pores. Ammonium chloride is a highly soluble ionic salt and cannot act as a membrane.

Question 79
Option (A) – Germanium.
Explanation: Zone refining is widely used for purifying semiconductors such as silicon, germanium, and gallium to a very high level of purity.

Question 80
Option (C) – Undecane.
Explanation: Undecane ($C_{11}H_{24}$) is an alkane secreted as a sex pheromone by female cockroaches to attract mates of the same species.

Question 81
Option (B) – 0.800 V.
Explanation: The standard cell potential is $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$. Therefore, $0.463\ \text{V} = E^\circ_{\text{Ag}^+/\text{Ag}} - 0.337\ \text{V}$, which gives $E^\circ_{\text{Ag}^+/\text{Ag}} = 0.800\ \text{V}$.

Question 82
Option (B) – Benzaldehyde.
Explanation: The iodoform test requires a methyl carbonyl (CH_3CO-) or a methyl carbinol ($CH_3CH(OH)$-) group. Benzaldehyde (C_6H_5CHO) lacks this structure and does not form a yellow precipitate.

Question 83
Option (B) – 3.87 BM.
Explanation: Chromium ($Z = 24$) in +3 oxidation state (Cr^{3+}) has a $3d^3$ configuration with 3 unpaired electrons. The spin-only magnetic moment is $\mu = \sqrt{3(3+2)} = \sqrt{15} \approx 3.87$ BM.

Question 84
Option (A) – Babbitt metal.
Explanation: Babbitt metal is a tin-based bearing alloy that typically consists of approximately 89% tin, 9% antimony, and 2% copper.

Question 85
Option (D) – $T^\circ = \Delta T_f + T$.
Explanation: The depression in freezing point is given by $\Delta T_f = T^\circ - T$, where T° is the freezing point of the pure solvent. Rearranging this yields $T^\circ = \Delta T_f + T$.

Question 86
Option (D) – +6.
Explanation: In $K_2Cr_2O_7$, setting the oxidation state of Cr to x, we have $2(+1) + 2x + 7(-2) = 0 \implies 2x = 12 \implies x = +6$.

Question 87
Option (A) – −231.6 kJ.
Explanation: Standard free energy is $\Delta G^\circ = -nFE^\circ_{\text{cell}}$. For $n = 2$, $\Delta G^\circ = -2 \times 96500 \times 1.20 = -231600\ \text{J} = -231.6\ \text{kJ}$.

Question 88
Option (D) – $C_6H_{12}O_6$.
Explanation: Calculating the molar ratio of the elements gives an empirical formula of CH_2O (mass = 30). With a molar mass of 180, the molecular formula is $(CH_2O)_6 = C_6H_{12}O_6$.

Question 89
Option (A) – Ethyl magnesium bromide.

Explanation: Ethanol reacts with $NaBr+H_2SO_4$ to form ethyl bromide (A), which on subsequent treatment with magnesium metal in dry ether yields ethyl magnesium bromide (B).

Question 90
Option (A) – Resorcinol.
Explanation: Dihydric phenols contain two hydroxyl groups attached to the benzene ring. Resorcinol is benzene-1,3-diol, which is a dihydric phenol.

Question 91
Option (C) – Novestrol.
Explanation: Novestrol (ethinylestradiol) is a highly potent synthetic estrogen derivative used widely in oral contraceptive formulations.

Question 92
Option (C) – 8.
Explanation: A cubic void in a crystal structure is formed at the center of a cube by 8 touching spheres, giving any cation occupying it a coordination number of 8.

Question 93
Option (D) – $CH_3 - CH_2 - C(= O) - CH_3$.
Explanation: The alkaline hydrolysis of a gem-dihalide yields an unstable gem-diol which undergoes dehydration to form a ketone.

Question 94
Option (C) – $CH_3 - CO - Cl$.
Explanation: Reaction of acetyl chloride (CH_3COCl) with benzyl cadmium yields methyl benzyl ketone and cadmium chloride, identifying reactant A as acetyl chloride.

Question 95
Option (D) – Dimethylamine.
Explanation: The carbylamine reaction is a diagnostic test only for primary amines. Dimethylamine is a secondary amine and therefore does not give this test.

Question 96
Option (C) – 12.
Explanation: In a cubic close-packed (ccp) structure, the coordination number of each sphere is 12, as it is in contact with 6 spheres in its own plane, 3 above, and 3 below.

Question 97
Option (B) – 31.1°C.
Explanation: Carbon dioxide gas can only be liquefied below its critical temperature of 31.1°C. Above this temperature, it remains gaseous and obeys Boyle's law.

Question 98
Option (C) – NO_2.
Explanation: Nitrogen dioxide (NO_2) is a characteristic reddish-brown paramagnetic gas, whereas other listed nitrogen oxides are colorless.

Question 99
Option (A) – $(CH_3)_3C - CH_2 - CH_2 - Cl$.
Explanation: Neohexyl chloride is the common name for 1-chloro-3,3-dimethylbutane, represented by the structural formula $(CH_3)_3C\text{-}CH_2\text{-}CH_2\text{-}Cl$.

Question 100
Option (A) – $-9 \times 10^2 J$.
Explanation: Work done during irreversible gas expansion is $W = -P_{ext}\Delta V = -(10^5)(10^{-2} - 10^{-3}) = -900 \text{ J} = -9 \times 10^2 \text{ J}$.

Question 101
Option (A) – $1/\sqrt{2}$.

Explanation: Let $u = f(\tan x)$ and $v = g(\sec x)$. Differentiating both with respect to x and taking their ratio at $x = \pi/4$ yields $\frac{du}{dv} = \frac{f'(1)\sec^2(\pi/4)}{g'(\sqrt{2})\sec(\pi/4)\tan(\pi/4)} = 1/\sqrt{2}$.

Question 102

Option (A) – $53/54$.

Explanation: The total number of outcomes when throwing three dice is 216. The outcomes resulting in a sum less than 5 are $(1,1,1)$, $(1,1,2)$, $(1,2,1)$, and $(2,1,1)$ (4 ways). Thus, the probability of sum ≥ 5 is $1 - 4/216 = 53/54$.

Question 103

Option (D) – 4.24%.

Explanation: For first-order radioactive decay with a half-life of 1600 years, the decay constant is $\lambda = \frac{\ln 2}{1600}$. In 100 years, the percentage of radium decayed is $(1 - e^{-100\lambda}) \times 100\% = 4.24\%$.

Question 104

Option (B) – $3e^{6y} = 2e^{9x+6} + e^6$.

Explanation: Rewriting the differential equation as $e^{6y}dy = e^{9x+6}dx$ and integrating yields $\frac{e^{6y}}{6} = \frac{e^{9x+6}}{9} + C$. Applying the initial condition $y(0) = 1$ gives the final solution $3e^{6y} = 2e^{9x+6} + e^6$.

Question 105

Option (D) – 3.

Explanation: Using the given values $f(0) = 3 \implies c = 3$ and $f(2) = 1 \implies b = -5$, we get $f(x) = 2x^2 - 5x + 3$. Evaluating the composition, $f(1) = 0$, so $(f \circ f)(1) = f(0) = 3$.

Question 106

Option (B) – -1.

Explanation: Since $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$, we can use the identity $\cos 2\theta = 2\cos^2\theta - 1$ to get $\cos 2\alpha + \cos 2\beta + \cos 2\gamma = 2(1) - 3 = -1$.

Question 107

Option (C) – $1/\sqrt{1-x^2}$.

Explanation: Substituting $x = \sin\theta$ simplifies the expression inside $\tan^{-1}$ to $\tan(\theta - \pi/4)$, leading to $y = \sin^{-1}x - \pi/4$. Differentiating with respect to x gives $dy/dx = 1/\sqrt{1-x^2}$.

Question 108

Option (B) – 2.

Explanation: The equation simplifies to $2\sin^2 x + \sin x - 1 = 0 \implies \sin x = 1/2$ or $\sin x = -1$. Excluding $\sin x = -1$ where $\tan x$ is undefined, we get exactly 2 valid solutions in $[0, 2\pi]$ at $x = \pi/6, 5\pi/6$.

Question 109

Option (B) – $a^2 + b^2$.

Explanation: For any pair of semi-conjugate diameters CP and CD of an ellipse, the sum of the squares of their lengths is constant and equal to $a^2 + b^2$.

Question 110

Option (1) – $e^x(1/(1+x^2)) + C$.

Explanation: Simplifying the integrand gives $\int e^x[\frac{1}{1+x^2} - \frac{2x}{(1+x^2)^2}]dx$. Using the standard integral form $\int e^x[f(x) + f'(x)]dx = e^x f(x) + C$, we get $e^x/(1+x^2) + C$.

Question 111

Option (1) – $2\cos\theta$.

Explanation: Simplifying from inside out: $\sqrt{2 + 2\cos 4\theta} = \sqrt{4\cos^2 2\theta} = 2\cos 2\theta$. Then, the complete expression becomes $\sqrt{2 + 2\cos 2\theta} = \sqrt{4\cos^2\theta} = 2\cos\theta$.

Question 112

Option (D) – 9.6.

Explanation: Let $f(x) = x^3 + 5x^2 - 7x + 10 \implies f'(x) = 3x^2 + 10x - 7$. Using differentials, $f(1.1) \approx f(1) + (0.1)f'(1) = 9 + (0.1)(6) = 9.6$.

Question 113
Option (A) – -2.
Explanation: For the pair of lines $Ax^2 + 2Hxy + By^2 = 0$, the sum of slopes is $-2H/B = 2h/7$ and the product of slopes is $A/B = -4/7$. Equating them gives $2h = -4 \implies h = -2$.

Question 114
Option (B) – $(1/5)[5\ \ -5;\ \ -4\ \ -5]$.
Explanation: Computing the matrix product $AB = \begin{pmatrix} 1 & 4 \\ 2 & 5 \end{pmatrix}$, its inverse is $(AB)^{-1} = \frac{1}{-3}\begin{pmatrix} 5 & -4 \\ -2 & 1 \end{pmatrix}$, which corresponds to the normalized matrix format in Option 4.

Question 115
Option (B) – $2\tan y = \tan x + \tan z$.
Explanation: Applying the arithmetic progression condition $2\sin(z + x - y) = \sin(y + z - x) + \sin(x+y-z)$ and expanding with trigonometric sum-to-product formulas leads to $\tan x, \tan y, \tan z$ being in A.P.

Question 116
Option (D) – 2.2475.
Explanation: Calculating the expectation $E[X] = -0.05$ and $E[X^2] = 2.25$, the variance is given by $\text{Var}(X) = E[X^2] - (E[X])^2 = 2.25 - 0.0025 = 2.2475$.

Question 117
Option (A) – 300.
Explanation: By De Morgan's Law, $n(A' \cap B') = n(X) - n(A \cup B)$. Since $n(A \cup B) = n(A) + n(B) - n(A \cap B) = 200 + 300 - 100 = 400$, the required value is $700 - 400 = 300$.

Question 118
Option (D) – $7^{7^{7^x}}/(\log 7)^3 + C$.
Explanation: Using the substitution $t = 7^{7^{7^x}}$, we find $dt = 7^{7^{7^x}} 7^{7^x} 7^x (\ln 7)^3 dx$. Thus, the integral evaluates directly to $7^{7^{7^x}}/(\ln 7)^3 + C$.

Question 119
Option (D) – $x = 1, y = 2$.
Explanation: Evaluating the objective function $Z = 8x + 3y$ at the corner points $(0, 0)$, $(0, 3)$, $(1.5, 0)$, and $(1, 2)$ of the feasible region shows the maximum value $Z = 14$ occurs at $(1, 2)$.

Question 120
Option (D) – 11/3 units.
Explanation: The perpendicular distance from $(2, -1, 0)$ to the plane is given by $d = \frac{|2(2)+1(-1)+2(0)+8|}{\sqrt{2^2+1^2+2^2}} = \frac{11}{3}$ units.

Question 121
Option (A) – e^8.
Explanation: The limit is evaluated as $\lim_{x\to 0}\left(\frac{1+4x}{1-4x}\right)^{1/x} = \frac{\lim_{x\to 0}(1+4x)^{1/x}}{\lim_{x\to 0}(1-4x)^{1/x}} = \frac{e^4}{e^{-4}} = e^8$.

Question 122
Option (A) – 1.
Explanation: For $A+B+C = 180°$, applying the tangent half-angle identity yields the standard trigonometric relation $\sum \tan(A/2)\tan(B/2) = 1$.

Question 123
Option (A) – $\cos^{-1}(4/9)$.
Explanation: The direction ratios of the two lines are $\vec{u} = (1, 2, 2)$ and $\vec{v} = (2, 2, -1)$. The angle between them is $\cos\theta = \frac{\vec{u}\cdot\vec{v}}{|\vec{u}||\vec{v}|} = \frac{2+4-2}{3\times 3} = \frac{4}{9}$.

Question 124
Option (B) – $e^{\tan^{-1} x} + c$.

Explanation: Using substitution $t = \tan^{-1} x$, the integral transforms into the standard form $\int e^t(f(t) + f'(t))dt = e^t f(t) + C$, which simplifies back to $e^{\tan^{-1} x} + C$.

Question 125

Option (1) – (1, 4).

Explanation: The coordinates of the mid-point of the chord are found by finding the projection of the circle's center $C(3, -1)$ onto the line $2x - 5y + 18 = 0$, yielding $(1, 4)$.

Question 126

Option (4) – $d^2y/dx^2 - 2(dy/dx) + 2y = 0$.

Explanation: Differentiating the given family of curves $y = e^x(A\cos x + B\sin x)$ twice and eliminating the arbitrary constants A and B yields the second-order linear differential equation.

Question 127

Option (B) – 10/3 sq. units.

Explanation: The area is given by the definite integral $\int_1^2 (x^2+1)dx = \left[\frac{x^3}{3} + x\right]_1^2 = \frac{14}{3} - \frac{4}{3} = 10/3$ sq. units.

Question 128

Option (D) – 1/2.

Explanation: Since the tangent is parallel to the X-axis, the derivative is zero: $\frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{2t-1}{2t} = 0 \implies t = 1/2$.

Question 129

Option (A) – 1/2.

Explanation: Differentiating $f(g(x)) = x$ gives $f'(g(x)) \cdot g'(x) = 1$. Substituting $x = a$ with $g(a) = b$ and $g'(a) = 2$ gives $f'(b) = 1/2$.

Question 130

Option (C) – 1/16.

Explanation: Since the sum of probabilities for a p.m.f. is 1, we have $\sum_{x=0}^{4} kC(4, x) = 1 \implies k(2^4) = 1 \implies k = 1/16$.

Question 131

Option (D) – $x^2 - 2px + q^2 = 0$.

Explanation: If the roots are α, β, then $\alpha + \beta = 2p$ and $\alpha\beta = q^2$. The corresponding quadratic equation is $x^2 - (\alpha + \beta)x + \alpha\beta = 0 \implies x^2 - 2px + q^2 = 0$.

Question 132

Option (C) – -7.

Explanation: By the Cayley-Hamilton theorem, $A^2 - \text{tr}(A)A + \det(A)I = 0 \implies A^2 = 8A - 7I$. Comparing this to $A^2 = 8A + kI$ gives $k = -7$.

Question 133

Option (4) – $3e^4$.

Explanation: The differential equation is $f'(x)/f(x) = 2 \implies f(x) = Ce^{2x}$. Using $f(0) = 3$ gives $f(x) = 3e^{2x}$, which at $x = 2$ evaluates to $f(2) = 3e^4$.

Question 134

Option (2) – $\sqrt{3}(x^2 + y^2) - 4xy = 0$.

Explanation: The two lines trisecting the angle in the first quadrant have slopes $m_1 = \tan 30° = 1/\sqrt{3}$ and $m_2 = \tan 60° = \sqrt{3}$. Their joint equation is $(x - \sqrt{3}y)(\sqrt{3}x - y) = 0 \implies \sqrt{3}(x^2 + y^2) - 4xy = 0$.

Question 135

Option (4) – $\pi/4$.

Explanation: Using the standard definite integral property, $\int_0^{\pi/2} \sin^2 x dx = \int_0^{\pi/2} \frac{1-\cos 2x}{2} dx = \left[\frac{x}{2} - \frac{\sin 2x}{4}\right]_0^{\pi/2} = \pi/4$.

Question 136
Option (C) – 1.
Explanation: From $\sin x + \sin^2 x = 1 \implies \sin x = \cos^2 x$. Substituting this into the given expression yields $(\cos^4 x + \cos^2 x)^2 = (\sin^2 x + \sin x)^2 = 1^2 = 1$.

Question 137
Option (B) – $(15 + \sqrt{157})$ units.
Explanation: Calculating the side lengths using the distance formula gives $AB = 6$, $BC = \sqrt{157}$, and $CA = 9$. Thus, the perimeter of the triangle is $15 + \sqrt{157}$ units.

Question 138
Option (D) – 0.
Explanation: Since $f(x) = \log(\frac{8-x}{8+x})$ is an odd function, its definite integral over the symmetric interval $[-4, 4]$ is identically zero.

Question 139
Option (4) – $x^2 + 3x = 4$.
Explanation: The coplanarity condition requires the scalar triple product to be zero, which solves to $\lambda = -4$. This value satisfies the quadratic equation $x^2 + 3x = 4$.

Question 140
Option (D) – (d).
Explanation: Following standard logical distribution laws, we get $(\sim p \vee \sim q) \vee (p \vee \sim q) \equiv \sim q \vee (\sim p \vee p) \equiv \sim q \vee \mathrm{T} \equiv \mathrm{T}$, showing it is a tautology.

Question 141
Option (C) – 93 / 256
Explanation: In 8 coin tosses, the probability of getting more heads than tails corresponds to getting 5, 6, 7, or 8 heads, which is $\frac{1}{2^8}[C(8,5) + C(8,6) + C(8,7) + C(8,8)] = 93/256$.

Question 142
Option (D) – 7 units
Explanation: Writing the line equation in parametric form and finding its intersection point $Q(4, -1, 0)$ with the plane, the distance from $P(7, 5, 2)$ to Q is computed as 7 units.

Question 143
Option (D) – 30°
Explanation: Finding the slopes of the two lines and applying the tangent formula for the angle between two lines yields $\tan\theta = 1/\sqrt{3}$, or 30°.

Question 144
Option (B) – $\pi/12$
Explanation: Completing the square in the denominator and integrating using the arctangent formula over the definite limits $[-1, 2]$ yields exactly $\pi/12$.

Question 145
Option (B) – 16 / 3 cu. units
Explanation: The volume of a tetrahedron is given by one-sixth of the scalar triple product of its coterminous edge vectors, which evaluates to 16/3.

Question 146
Option (D) – $\sqrt{2}r$ units, $\sqrt{2}r$ units
Explanation: For a rectangle inscribed in a circle of radius r to have maximum area, it must be a square. Using optimization, the side dimensions are $\sqrt{2}r$ units by $\sqrt{2}r$ units.

Question 147
Option (C) – 15 / 2
Explanation: Using the section formula, the ratio in which the y-coordinate becomes 2 is found, which is then used to compute the corresponding z-coordinate as 15/2.

Question 148

Option (C) – F T T T

Explanation: The truth values for $p \wedge q$ are T, F, F, F. Negating these values gives the final column entries as F, T, T, T.

Question 149

Option (B) – $\tan 2A \tan 2B \tan 2C$

Explanation: Since $2A + 2B + 2C = 360°$, we have $\tan(2A + 2B) = -\tan 2C$. Expanding and rearranging this relation yields $\tan 2A + \tan 2B + \tan 2C = \tan 2A \tan 2B \tan 2C$.

Question 150

Option (B) – $50\left(\frac{\log 3}{\log 2}\right)$ yrs

Explanation: Using the population growth model $P(t) = P_0 e^{kt}$, the doubling time gives $k = \frac{\ln 2}{50}$. To triple, $3 = e^{kt} \implies t = 50\frac{\ln 3}{\ln 2}$ years.