MHT CET 2017 Paper 1 Mathematics Answer Key PDF

Question 1 Option: (a) – $\nu_1 - \nu_2 = \nu_3$
Explanation: The frequency of the Balmer series limit is $\nu_1 = Rc/4$ and the first line frequency is $\nu_2 = Rc(1/4 - 1/9)$. Subtracting these gives $\nu_1 - \nu_2 = Rc/9$, which corresponds exactly to the Paschen series limit frequency ν_3.

Question 2 Option: (a) – $5\,\mu$F
Explanation: Three identical capacitors in parallel yield $3C$, and when connected in series with the fourth, the equivalent capacitance is $3C/4$. Equating $3C/4 = 3.75\,\mu$F gives the individual capacitance as $C = 5\,\mu$F.

Question 3 Option: (c) – $\frac{S}{9}$
Explanation: Using a shunt of resistance $G/8$ decreases the current passing through the galvanometer to a fraction of $1/9$ of the total current. Consequently, the current sensitivity of the shunted galvanometer decreases to $S/9$.

Question 4 Option: (b) – 24
Explanation: The initial ratio of resistances is $X/Y = 40/60$, giving $Y = 1.5X$. Inserting a $30\,\Omega$ resistor in series with X shifts the null point, leading to $(X + 30)/Y = 60/40$, which yields $X = 24\,\Omega$.

Question 5 Option: (b) – 10^{-2} m
Explanation: The distance between the first minima on either side of the central maximum is the width of the central maximum, given by $2\lambda D/a$. Substituting the given values yields a width of 10^{-2} m.

Question 6 Option: (d) – 800 W
Explanation: The true power consumed in a series LCR circuit is given by $P = I_{\text{rms}}^2 R = (V_{\text{rms}}/Z)^2 R$. Substituting the given values yields $P = (220/33)^2 \times 18 = 800$ W.

Question 7 Option: (a) – $\frac{C}{2}\left[\frac{K-1}{K+1}\right]$
Explanation: The initial series capacitance is $C/2$, and after inserting the dielectric, the new capacitance is $KC/(K + 1)$. The change in capacitance is the difference of these two values, which simplifies to $\frac{C}{2}\left[\frac{K-1}{K+1}\right]$.

Question 8 Option: (b) – $\theta = \cot^{-1}\left(\frac{v}{c}\right)$
Explanation: According to Brewster's law, $\tan\theta = \mu$, where the refractive index is $\mu = c/v$. Thus, $\tan\theta = c/v$, which can be rewritten as $\cot\theta = v/c$, leading to $\theta = \cot^{-1}(v/c)$.

Question 9 Option: (b) – $\cos^2\left(\frac{\phi}{2}\right)$
Explanation: The resultant intensity of two interfering waves of equal intensity I_0 is given by $I = 4I_0\cos^2(\phi/2)$. Thus, the intensity of the resultant wave is directly proportional to $\cos^2(\phi/2)$.

Question 10 Option: (a) – 1
Explanation: For a transistor, the relation between the current gains is $\alpha = \beta/(\beta + 1)$. Rearranging this formula yields $(\beta - \alpha)/(\alpha\beta) = 1$, making the value of the expression equal to 1.

Question 11 Option: (b) – $0.5\log_e 2$
Explanation: The disintegration rate decreases to $1/4$ of its initial value in 4 minutes, which corresponds to two half-lives. Therefore, the half-life is 2 minutes, and the decay constant is $\lambda = \log_e 2/2 = 0.5\log_e 2$.

Question 12 Option: (c) – 1.286
Explanation: Since the number of waves is identical in both media, we have $\mu_g t_g = \mu_w t_w$.

Substituting the given values gives $1.5 \times 6 = \mu_w \times 7$, which yields a water refractive index of $\mu_w \approx 1.286$.

Question 13 Option: (c) – 6 V
Explanation: The energy of the transition from $n = 2$ to $n = 1$ is $13.6 \times (1 - 1/4) = 10.2\,\text{eV}$. Using the photoelectric equation with a work function of 4.2 eV yields a stopping potential of $(10.2 - 4.2) = 6\,\text{V}$.

Question 14 Option: (d) – n
Explanation: The magnetic moment of a revolving electron is $M = evr/2$. Since $v \propto 1/n$ and $r \propto n^2$ according to Bohr's model, the magnetic moment M is directly proportional to n.

Question 15 Option: (a) – which is always operated in reverse bias
Explanation: A photodiode is a semiconductor diode designed to operate in reverse bias, where the change in reverse saturation current is directly proportional to the intensity of the incident light.

Question 16 Option: (c) – $72\,\text{kg} \cdot \text{m}^2/\text{s}$
Explanation: The angular retardation is $\alpha = 60/300 = 0.2\,\text{rad/s}^2$. Three minutes before stopping (at $t = 120\,\text{s}$), the angular velocity is 36 rad/s, giving an angular momentum of $I\omega = 2 \times 36 = 72\,\text{kg} \cdot \text{m}^2/\text{s}$.

Question 17 Option: (d) – Wavelength $\lambda = 10\,\text{m}$
Explanation: Comparing the wave equation with $y = A\sin(\omega t - kx + \phi)$, we get the wave number $k = \pi/5$. Solving for wavelength using $k = 2\pi/\lambda$ yields $\lambda = 10\,\text{m}$.

Question 18 Option: (c) – $\left(\frac{T_1}{T_2}\right)^2$
Explanation: The total power radiated by a black body is $P = \sigma A T^4$. Equating the powers of both bodies yields $r_1^2 T_1^4 = r_2^2 T_2^4$, which simplifies to the ratio $r_2/r_1 = (T_1/T_2)^2$.

Question 19 Option: (c) – 17
Explanation: The difference between the fundamental frequencies of the open and closed pipes leads to a beat frequency of 17 Hz when the lengths are altered to $L/3 and 3L$, respectively.

Question 20 Option: (b) – $\left[\frac{4m(g+a)}{\pi T}\right]^{1/2}$
Explanation: The maximum tension in the rope is $m(g+a)$. Equating the maximum stress to the elastic limit $T = 4m(g+a)/(\pi d^2)$ and solving for the diameter d yields the correct formula.

Question 21 Option: (b) – $\sqrt{2.8}\,\text{m}$
Explanation: The total kinetic energy of the rolling solid sphere is $7/10\,mv^2 = 50.4\,\text{J}$. Equating this to the potential energy stored in the spring $1/2\,kx^2$ yields a maximum compression of $\sqrt{2.8}\,\text{m}$.

Question 22 Option: (d) – 96 rad
Explanation: Since the angular acceleration is constant, the average angular velocity is 12 rad/s. The total angle turned in 8 seconds is therefore $\theta = \omega_{\text{avg}} t = 12 \times 8 = 96\,\text{rad}$.

Question 23 Option: (a) – $\frac{1}{3}$
Explanation: Equating the frequency equations and substituting the relation $r_1 = 2r_2$ yields a simplified ratio of $1/(2L_1) = 3/(2L_2)$, which directly reduces to $L_1/L_2 = 1/3$.

Question 24 Option: (a) – 1.5 cm
Explanation: The upward force due to surface tension is $F = T(2\pi r)$. Substituting $F = 105\,\text{dyne}$ and $T = 70\,\text{dyne/cm}$ into this equation gives the inner circumference $2\pi r = 1.5\,\text{cm}$.

Question 25 Option: (c) – 0.2857
Explanation: For a rigid diatomic molecule, $C_p = 7/2\,R$. Substituting this into the given relation $R = nC_p$ yields $n = 2/7 \approx 0.2857$.

Question 26 Option: (a) – $\frac{pm}{KT}$
Explanation: Using the ideal gas equation $p = \frac{\rho}{m}KT$, we can solve for the density ρ, which yields the expression $\rho = pm/KT$.

Question 27 Option: (d) – $\sqrt[3]{n} : 1$
Explanation: The total surface energy of n small drops is proportional to nr^2, while that of the single big drop of radius $R = n^{1/3}r$ is proportional to $n^{2/3}r^2$, yielding a ratio of $n^{1/3} : 1$.

Question 28 Option: (a) – $\frac{2(R+h)}{R}$
Explanation: The binding energy on the surface is GMm/R and in orbit is $GMm/2(R+h)$. Dividing the two expressions yields the ratio $\frac{2(R+h)}{R}$.

Question 29 Option: (d) – $8\sqrt{2}\,\text{m}$
Explanation: The velocity equation is $v(t) = A\omega\cos(\omega t)$ with $\omega = \pi/8$. Substituting $t = 2\,\text{s}$ and $v = \pi\,\text{m/s}$ yields $\pi = A(\pi/8)\cos(\pi/4)$, which simplifies to $A = 8\sqrt{2}\,\text{m}$.

Question 30 Option: (d) – $\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$
Explanation: For a string vibrating in its third harmonic, there are three loops with antinodes (maximum amplitude) occurring at odd multiples of $L/6$, which are $L/6$, $L/2$, and $5L/6$.

Question 31 Option: (c) – $d = R\left(\frac{n-1}{n}\right)$
Explanation: The acceleration due to gravity at depth d is $g_d = g(1 - d/R)$. Equating this to g/n and solving for d yields the relation $d = R(n-1)/n$.

Question 32 Option: (d) – $\pi\,\text{rad}$
Explanation: Since displacement is $x = A\cos(\omega t)$ and acceleration is $a = -\omega^2 A\cos(\omega t) = \omega^2 A\cos(\omega t + \pi)$, the phase difference between them is exactly $\pi\,\text{rad}$.

Question 33 Option: (d) – $200, 400, 600, 800\ldots$
Explanation: An open pipe has a fundamental frequency twice that of a closed pipe of the same length ($2 \times 100 = 200\,\text{Hz}$) and generates all integer harmonics of this fundamental frequency.

Question 34 Option: (a) – is conserved
Explanation: For a particle moving in a vertical circle under the influence of gravity alone, mechanical energy is conserved at all points because gravity is a conservative force.

Question 35 Option: (a) – $\frac{MgA^2}{2L}$
Explanation: At the extreme position, the potential energy is Mgh. Approximating the height raised as $h \approx A^2/2L$ yields the potential energy expression $MgA^2/2L$.

Question 36 Option: (b) – $1.267\,\text{eV}$
Explanation: Using the photoelectric equations for both cases and solving the system with a 30% increase in frequency leads directly to a work function value of $1.267\,\text{eV}$.

Question 37 Option: (d) – 4
Explanation: In an LC parallel resonant circuit, the total current is minimum at the resonant frequency, which is correctly depicted by the parabolic curve showing a minimum in graph 4.

Question 38 Option: (b) – $\lambda_p \propto \lambda_e^2$
Explanation: The de-Broglie wavelength of an electron is $\lambda_e \propto 1/\sqrt{E}$, while the photon wavelength is $\lambda_p \propto 1/E$. Combining these relations yields $\lambda_p \propto \lambda_e^2$.

Question 39 Option: (b) – both V and E decrease
Explanation: For an isolated charged capacitor, introducing a dielectric increases the capacitance by K. This causes the potential $V = Q/C$ and energy $U = Q^2/2C$ to both decrease by a factor of K.

Question 40 Option: (b) – $10^{-2}\,\text{V/m}$
Explanation: The potential gradient is $x = I\rho/A$. Substituting $I = 0.2\,\text{A}$, $\rho = 40 \times 10^{-8}\,\Omega\cdot\text{m}$, and $A = 8 \times 10^{-6}\,\text{m}^2$ gives $x = 10^{-2}\,\text{V/m}$.

Question 41 Option: (c) – $\frac{16n}{15}$
Explanation: Applying equations of rotational motion with constant retardation shows that the ratio of total revolutions to those made until the speed drops to a quarter is 16/15, giving $16n/15$.

Question 42 Option: (d) – $\left[\frac{1}{2}\frac{I_1 I_2}{I_1+I_2}\right]\omega_1^2$
Explanation: Using conservation of angular momentum to find the common angular velocity and computing the difference between the initial and final kinetic energies yields this standard expression for energy loss.

Question 43 Option: (a) – $\frac{u^2-v^2}{\alpha+\beta}$
Explanation: Subtracting the velocity equations $u^2 = \omega^2(A^2 - x_1^2)$ and $v^2 = \omega^2(A^2 - x_2^2)$ and substituting the acceleration relations leads to the distance $d = (u^2 - v^2)/(\alpha + \beta)$.

Question 44 Option: (a) – $\frac{2nv_o}{v}$
Explanation: The apparent frequencies when moving towards and away from the source are $n(v + v_o)/v$ and $n(v - v_o)/v$. The difference between them is exactly $2nv_o/v$.

Question 45 Option: (b) – $\frac{YA\alpha T}{1+\alpha T}$
Explanation: Using the exact strain definition where the thermal expansion is normalized by the heated length $L_0(1 + \alpha T)$, the compression force is determined as $YA\alpha T/(1 + \alpha T)$.

Question 46 Option: (c) – 2.7 mWb
Explanation: The mutual inductance is $M = 15\,\text{mV}/10\,\text{A/s} = 1.5\,\text{mH}$. The flux linked with the second coil is $\phi = MI = 1.5\,\text{mH} \times 1.8\,\text{A} = 2.7\,\text{mWb}$.

Question 47 Option: (c) – $\frac{d^2}{3D}$
Explanation: The position of the second minimum is $y = 3\lambda D/2d$. Setting this equal to the half-slit distance $d/2$ and solving for λ yields $\lambda = d^2/3D$.

Question 48 Option: (c) – modulation
Explanation: Modulation is the fundamental process in communication systems where a low-frequency information signal is superimposed onto a high-frequency carrier wave for transmission.

Question 49 Option: (d) – 5×10^5 A/m
Explanation: The volume of the magnet is $V = 6 \times 10^{-6}\,\text{m}^3$. The intensity of magnetization is the magnetic moment per unit volume: $I = 3/(6 \times 10^{-6}) = 5 \times 10^5$ A/m.

Question 50 Option: (c) – 0.75 A
Explanation: The relation between flux and magnetic moment is $M = \phi L/\mu_0$. Substituting the values yields a magnetic moment of $0.75\,\text{A} \cdot \text{m}^2$.

Question 51 Option: (c) – 18.71 kJ
Explanation: The combustion of 3 moles of ethane gives $\Delta n_g = -7.5$. The work done is $W = -\Delta n_g RT = -(-7.5) \times 8.314 \times 300 \approx 18.71\,\text{kJ}$.

Question 52 Option: (c) – D-2-deoxyribose
Explanation: DNA contains D-2-deoxyribose, which is a pentose sugar lacking a hydroxyl group at the 2-position of the ribose ring.

Question 53 Option: (a) – $1.689\,\text{mol} \cdot \text{kg}^{-1}$
Explanation: The molality is calculated as moles of solute/kg of solvent = $(15.20/60)/0.150 = 1.689\,\text{mol} \cdot \text{kg}^{-1}$.

Question 54 Option: (d) – salicylic acid
Explanation: Salicylic acid (2-hydroxybenzoic acid) contains both a phenolic $-$OH group and a carboxylic acid $-$COOH group on the benzene ring.

Question 55 Option: (b) – Phosphinic acid (H_3PO_2)
Explanation: In phosphinic acid (H_3PO_2), the oxidation state of phosphorus is calculated from $3(+1) + x + 2(-2) = 0$, giving $x = +1$.

Question 56 Option: (a) – Li^+
Explanation: Lithium has the most negative standard reduction potential, meaning Li^+ has the lowest tendency to be reduced and is the weakest oxidizing agent.

Question 57 Option: (a) – lactic acid and glycolic acid
Explanation: Dextran is a biodegradable copolymer synthesized from lactic acid and glycolic acid monomers via condensation polymerization.

Question 58 Option: (a) – H_2O
Explanation: Water (H_2O) cannot act as a reducing agent because oxygen is already in its highly stable -2 oxidation state and cannot be easily oxidized under normal conditions.

Question 59 Option: (d) – Hydration
Explanation: Hydration (adding water) promotes microbial growth and spoilage, whereas food preservation techniques involve dehydration (removing water) or irradiation.

Question 60 Option: (d) – $-C_6H_5$
Explanation: The phenyl group ($-C_6H_5$) is electron-withdrawing due to its resonance effect, which decreases the electron density on the nitrogen atom of aniline, reducing its basic strength.

Question 61 Option: (d) – Specific rotation
Explanation: Enantiomers possess identical physical properties such as boiling point, density, and refractive index, but differ in the direction of their specific rotation of plane-polarized light.

Question 62 Option: (b) – Magnesite
Explanation: Magnesite is a mineral of magnesium ($MgCO_3$), whereas hematite, magnetite, and siderite are common minerals of iron.

Question 63 Option: (c) – Urotropine
Explanation: Controlled nitration of urotropine (hexamethylenetetramine) with concentrated nitric acid produces cyclonite, commonly known as the explosive RDX.

Question 64 Option: (b) – $+99\,\text{kJ}$
Explanation: The work done during irreversible compression is $W = -P_{\text{ext}}\Delta V = -100\,\text{kPa} \times (10 - 1000)\,\text{dm}^3 = 99\,\text{kJ}$.

Question 65 Option: (b) – Nitrogen
Explanation: Nitrogen can form stable $p\pi - p\pi$ multiple bonds due to its small atomic size and high electronegativity, allowing effective lateral overlap of p-orbitals.

Question 66 Option: (b) – It gives tertiary amine
Explanation: The Hofmann bromamide degradation reaction converts a primary amide into a primary amine with one fewer carbon atom, not a tertiary amine.

Question 67 Option: (d) – Both of these belong to same period of periodic table
Explanation: Zirconium (Zr) belongs to the 5th period, while Hafnium (Hf) belongs to the 6th period of the periodic table, making statement (d) incorrect.

Question 68 Option: (b) – phenylhydrazone
Explanation: Aldehydes and ketones react with phenylhydrazine ($C_6H_5NHNH_2$) via nucleophilic addition followed by elimination of water to form phenylhydrazones.

Question 69 Option: (d) – NaBr
Explanation: The solubility of sodium bromide (NaBr) in water shows a very minimal and nearly constant change with variations in temperature.

Question 70 Option: (b) – 2.0×10^{-3} kg
Explanation: Two moles of sodium (46 g) react with excess ethanol to liberate one mole of H_2 gas, which has a mass of $2.0\,\text{g} = 2.0 \times 10^{-3}\,\text{kg}$.

Question 71 Option: (c) – tert-butyl alcohol and methyl iodide
Explanation: With cold HI, tert-butyl methyl ether undergoes cleavage via an S_N1 mechanism because of the highly stable tert-butyl carbocation intermediate, yielding tert-butyl alcohol and methyl iodide.

Question 72 Option: (c) – Hoope's process
Explanation: Hoope's process is a well-known electrolytic process employed specifically for the refining and purification of aluminum metal.

Question 73 Option: (a) – green, paramagnetic
Explanation: The manganate ion (MnO_4^{2-}) is dark green in color and is paramagnetic because of the presence of one unpaired electron in its d-orbital (Mn^{6+}, d^1).

Question 74 Option: (a) – 2.40 atm
Explanation: The osmotic pressure is $\pi = CRT = (34.2/342) \times 0.082 \times 293 \approx 2.40\,\text{atm}$.

Question 75 Option: (a) – $-SO_3H$
Explanation: According to the Cahn-Ingold-Prelog (CIP) priority rules, the sulfonic acid group ($-SO_3H$) has the highest priority due to the high atomic number of sulfur.

Question 76 Option: (b) – Bithional
Explanation: Bithional is commonly added to medicated toilet soaps to impart antiseptic properties and reduce microbial growth on the skin.

Question 77 Option: (c) – Nitric oxide
Explanation: In the lead chamber process, gaseous nitric oxide (NO) serves as a homogeneous catalyst for the oxidation of sulfur dioxide to sulfur trioxide.

Question 78 Option: (b) – +3, 6
Explanation: In $K_3[Fe(CN)_6]$, the iron atom has an oxidation state of +3 and is coordinated to six cyano ligands, giving a coordination number of 6.

Question 79 Option: (a) – Inversion of cane sugar
Explanation: The acid-catalyzed inversion of cane sugar is a pseudo first-order reaction because water is present in large excess and its concentration remains virtually constant.

Question 80 Option: (a) – $C_2H_5NH_2$
Explanation: Ethylamine ($C_2H_5NH_2$) is a primary amine and reacts with Hinsberg's reagent to form a sulfonamide that dissolves in KOH but precipitates as an insoluble compound upon acidification.

Question 81 Option: (c) – $k = \frac{A}{e^{E_a/RT}}$
Explanation: The exponential form of the Arrhenius equation is $k = Ae^{-E_a/RT}$, which can be mathematically rewritten as $k = A/e^{E_a/RT}$.

Question 82 Option: (a) – Isopropyl alcohol
Explanation: Isopropyl alcohol contains the secondary methyl carbinol group ($-CH(OH)CH_3$), which is oxidized by iodine and alkali to give a positive yellow iodoform precipitate.

Question 83 Option: (a) – $q = -W$
Explanation: For an isothermal process of an ideal gas, the change in internal energy is zero ($\Delta U = 0$). By the first law of thermodynamics, $q = -W$.

Question 84 Option: (b) – Finklestein reaction
Explanation: The halogen exchange reaction of an alkyl halide with sodium iodide (NaI) in dry acetone to form an alkyl iodide is known as the Finkelstein reaction.

Question 85 Option: (c) – sp^2
Explanation: In fullerene (C_{60}), each carbon atom is bonded to three other carbon atoms via sp^2 hybridization, forming a spherical cage-like structure.

Question 86 Option: (b) – $S \cdot m^{-1}$
Explanation: The SI unit of electrical conductivity (κ) is Siemens per meter ($S \cdot m^{-1}$ or Sm^{-1}).

Question 87 Option: (a) – Alkaline $KMnO_4$
Explanation: Baeyer's reagent is a cold, dilute, alkaline solution of potassium permanganate ($KMnO_4$) used to detect unsaturation in organic compounds.

Question 88 Option: (b) – SiO_2
Explanation: Pyrex glass is a borosilicate glass whose main constituent is silica (SiO_2, approx. 80%) along with boron trioxide (B_2O_3).

Question 89 Option: (c) – Tert-butyl alcohol
Explanation: Among isomeric alcohols, tert-butyl alcohol has the most branched structure, which minimizes its surface area and weakens the intermolecular van der Waals forces, lowering its boiling point.

Question 90 Option: (c) – $\Delta H^\circ_{\text{reaction}} = \sum H^\circ_{f(\text{product bonds})} - \sum H^\circ_{f(\text{reactant bonds})}$
Explanation: The standard enthalpy of a reaction is computed using standard enthalpies of formation as $\sum \Delta H^\circ_f(\text{products}) - \sum \Delta H^\circ_f(\text{reactants})$, making statement (c) invalid.

Question 91 Option: (a) – 990 s
Explanation: The half-life of a first-order reaction is $t_{1/2} = 0.693/k$. Substituting $k = 7.0 \times 10^{-4}\ s^{-1}$ yields $t_{1/2} = 990\,s$.

Question 92 Option: (a) – bakelite
Explanation: Bakelite is a thermosetting phenol-formaldehyde polymer that is highly heat-resistant and serves as an excellent material for making handles of kitchen utensils.

Question 93 Option: (b) – Chlorine
Explanation: Chlorine has the highest negative electron gain enthalpy because fluorine's smaller size leads to strong inter-electronic repulsions that oppose the incoming electron.

Question 94 Option: (a) – $20\,cm^3$
Explanation: Since water is an incompressible liquid with a density of approximately $1\,g/cm^3$, the actual bulk volume occupied by 20 g of water is $20\,cm^3$.

Question 95 Option: (d) – $[Cu(NH_3)_4]^{2+}$
Explanation: The Effective Atomic Number (EAN) of copper in the complex is $29-2+8 = 35$, which does not equal the atomic number of the next noble gas (36), violating the EAN rule.

Question 96 Option: (d) – $Pb^{4+} \rightarrow Pb^{2+}$
Explanation: During discharging of a lead storage battery, the reduction reaction at the positive electrode (cathode) involves the conversion of lead dioxide (Pb^{4+}) to lead sulfate (Pb^{2+}).

Question 97 Option: (d) – Urea
Explanation: Urea is a non-electrolyte and does not dissociate in solution, so its Van 't Hoff factor is $i = 1$, which is the lowest compared to the ionic salts listed.

Question 98 Option: (a) – histidine
Explanation: Histidine contains an imidazole side chain, which makes it one of the basic amino acids along with lysine and arginine.

Question 99 Option: (a) – Argon
Explanation: Argon is a noble gas with a stable octet configuration and exists strictly as monoatomic molecules under standard conditions.

Question 100 Option: (d) – 24
Explanation: Stachyose is a tetrasaccharide ($C_{24}H_{42}O_{21}$) composed of two galactose units, one glucose unit, and one fructose unit, containing a total of 24 carbon atoms.

Question 101 Option: (d) – four
Explanation: For $\tan 2\theta = 1$, the angle 2θ can be $\pi/4$, $5\pi/4$, $9\pi/4$, $13\pi/4$ within $[0, 4\pi)$, yielding exactly four distinct principal solutions for θ in $[0, 2\pi)$.

Question 102 Option: (a) – on X-axis
Explanation: Evaluating the corner points of the feasible region shows that the minimum value of $z = 14$ is obtained at the vertex (3.5, 0), which lies on the X-axis.

Question 103 Option: (d) – 10
Explanation: The z-coordinates of the trisection points are $z_1 = (1(6) + 2(4))/3 = 14/3$ and $z_2 = (2(6) + 1(4))/3 = 16/3$. Their sum is $z_1 + z_2 = 10$.

Question 104 Option: (b) – $\frac{1}{e}$
Explanation: Differentiating $f(x)$ gives $f'(x) = (1 - \log x)/x^2 = 0 \implies x = e$. Since the derivative changes from positive to negative, $f(e) = 1/e$ is the maximum value.

Question 105 Option: (b) – $\frac{\pi}{4} - \frac{1}{2}$
Explanation: Using integration by parts on $\int_0^1 x \tan^{-1} x \, dx$ yields $\left[\frac{x^2}{2} \tan^{-1} x\right]_0^1 - \frac{1}{2}\int_0^1 \frac{x^2}{1+x^2} \, dx$, which evaluates to $\pi/4 - 1/2$.

Question 106 Option: (b) – $(p \vee q) \wedge \sim p$
Explanation: Applying the distributive law: $(p \vee q) \wedge \sim p \equiv (p \wedge \sim p) \vee (q \wedge \sim p) \equiv \mathrm{F} \vee (\sim p \wedge q) \equiv \sim p \wedge q$.

Question 107 Option: (a) – $1 + [g(x)]^4$
Explanation: Using the derivative of an inverse function: $g'(x) = 1/f'(g(x))$. Substituting $f'(x) = 1/(1 + x^4)$ gives $g'(x) = 1 + [g(x)]^4$.

Question 108 Option: (b) – $\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$
Explanation: The determinant of A is -3. Finding the cofactor matrix, transposing it, and dividing by $|A|$ gives the inverse matrix matching option (b).

Question 109 Option: (a) – 1
Explanation: The integral evaluates to $\frac{1}{4}\sin^{-1}(4x/3) + c$. Thus, $\alpha = 1/4$ and $\beta = 4/3$, and their sum $\alpha + 1/\beta = 1/4 + 3/4 = 1$.

Question 110 Option: (d) – $3x^2 + xy - 2y^2 = 0$
Explanation: The equation of the altitude is $x + y = 0$ and the median is $3x - 2y = 0$. Multiplying these equations yields the joint equation $3x^2 + xy - 2y^2 = 0$.

Question 111 Option: (c) – e^2
Explanation: The limit is evaluated as $\lim_{x\to 0}[(1 + \tan x)/(1 - \tan x)]^{1/x} = e^1/e^{-1} = e^2$, ensuring continuity at $x = 0$.

Question 112 Option: (c) – 10
Explanation: Using the matrix property $A(\text{adj } A) = |A|I$, and comparing it with the given diagonal matrix yields $|A| = 10$.

Question 113 Option: (b) – $\sin\left(\frac{y}{x}\right) = cx$
Explanation: Substituting $y = vx$ transforms the homogeneous differential equation into $v + x\,dv/dx = \tan v + v$. Integrating $\cot v \, dv = dx/x$ yields $\sin(y/x) = cx$.

Question 114 Option: (c) – 25
Explanation: The triangle is right-angled at C with hypotenuse $AB = 10$. The maximum area occurs when the other two sides are equal, giving an area of $c^2/4 = 25$.

Question 115 Option: (b) – $\frac{f'(t)g''(t)-g'(t)f''(t)}{[f'(t)]^3}$
Explanation: Applying the parametric differentiation formula for the second derivative $d^2y/dx^2 = \frac{d/dt(dy/dx)}{dx/dt}$ yields the quotient-rule expression in option (b).

Question 116 Option: (c) – $\frac{x+3}{-1} = \frac{y-2}{1} = \frac{z+5}{1}$
Explanation: A line equally inclined to the axes has direction ratios $(\pm1, \pm1, \pm1)$. Using the point (-3, 2, -5) gives the symmetric equation shown in option (c).

Question 117 Option: (d) – $\frac{\pi}{2}\log 2$
Explanation: Since $\log\sec x = -\log\cos x$, the integral is equal to $-\int_0^{\pi/2}\log\cos x\,dx = -(\pi/2)\log(1/2) = (\pi/2)\log 2$.

Question 118 Option: (c) – 3
Explanation: The expected gain is $E(2X) = 2E(X)$. For 3 tosses of a fair coin, the expected number of heads is $E(X) = np = 1.5$, giving an expected gain of 3.

Question 119 Option: (c) – $(q \to p) \vee (\sim p \leftrightarrow q)$
Explanation: Constructing a truth table or using logical simplification reveals that $(q \to p) \vee (\sim p \leftrightarrow q)$ evaluates to True under all truth values.

Question 120 Option: (c) – 3
Explanation: Equating the cosine of the angle $\pi/3$ to the dot product of the normals divided by their magnitudes yields the quadratic equation $(m-3)^2 = 0 \implies m = 3$.

Question 121 Option: (a) – $x - 2y + z = 0$
Explanation: The coplanarity condition of the four points with the origin requires the determinant of their coordinates to be zero, which expands to $x - 2y + z = 0$.

Question 122 Option: (a) – $pq > 0$
Explanation: For the equation $px^2 - qy^2 = 0$ to represent distinct real lines, the ratio p/q must be positive, which implies that the product $pq > 0$.

Question 123 Option: (d) – 2 MN
Explanation: Using vector addition for the midpoints M and N of PQ and RS, the sum of the vectors $\vec{PS} + \vec{QR}$ simplifies directly to $2\vec{MN}$.

Question 124 Option: (c) – 6
Explanation: The sum and product of the slopes are -5 and k. Substituting these into the difference equation $(m_1 - m_2)^2 = (m_1 + m_2)^2 - 4m_1m_2 = 1$ yields $k = 6$.

Question 125 Option: (c) – 8
Explanation: For an equally inclined vector, $l, m, n = \pm1/\sqrt{3}$. Since there are two possible signs for each of the three coordinates, there are $2^3 = 8 such vectors$.

Question 126 Option: (a) – $\frac{1}{6}$
Explanation: Using partial fractions, the integral simplifies to $\frac{1}{10}\tan^{-1}(x/2) - \frac{1}{15}\tan^{-1}(x/3) + C$. Thus, $A - B = 1/10 - (-1/15) = 1/6$.

Question 127 Option: (a) – $\frac{\pi}{2}$
Explanation: Solving the quadratic equation in $|x|$ gives $|x| = 1 \implies \alpha, \beta = \pm1$. The expression $|\tan^{-1}(1) - \tan^{-1}(-1)|$ simplifies to $\pi/4 - (-\pi/4) = \pi/2$.

Question 128 Option: (c) – $\frac{x}{y}$
Explanation: Differentiating the parametric equations gives $dx/dt = a(1 + 1/t^2)$ and $dy/dt = a(1 - 1/t^2)$. Dividing these and simplifying gives $dy/dx = x/y$.

Question 129 Option: (c) – (2, 1)
Explanation: The slope of the normal is -2, so the tangent slope is 1/2. Setting $dy/dx = 1/(2\sqrt{x-1}) = 1/2$ yields $x = 2$ and $y = 1$, giving the point (2,1).

Question 130 Option: (d) – 1
Explanation: Splitting the numerator into derivative and constant parts, the integral simplifies to $\sqrt{x^2-12x+35}+\log|x-6+\sqrt{x^2-12x+35}|$. Comparing gives $A=1$.

Question 131 Option: (b) – 55
Explanation: Solving the mean and variance equations $np=18$ and $npq=12$ gives $n=54$. Since X can take any integer value from 0 to 54, there are 55 possible values.

Question 132 Option: (d) – 8 sq unit
Explanation: The area is given by $\int_0^4[(3x+1)-(2x+1)]\,dx=\int_0^4 x\,dx=\left[x^2/2\right]_0^4=8$ square units.

Question 133 Option: (d) – $\frac{4}{3\sqrt{5}}$
Explanation: Computing the probability distribution of $X\in\{0,1,2\}$ and calculating the variance gives $\mathrm{Var}(X)=16/45$, yielding a standard deviation of $4/(3\sqrt{5})$.

Question 134 Option: (a) – $\frac{4}{3}\pi\,\mathrm{cm}^2/\mathrm{s}$
Explanation: Differentiating volume gives $dV/dt=4\pi r^2 dr/dt=4\pi$. At $V=288\pi$ (where $r=6$), $dr/dt=1/36$. Differentiating area gives $dS/dt=8\pi r(dr/dt)=4/3\,\pi$.

Question 135 Option: (c) – e
Explanation: Simplifying the expression as $x\to 0$ leads to the limit $\lim_{x\to 0}[1+\tan^2 x]^{\cot^2 x}=e$, which ensures continuity of the function at $x=0$.

Question 136 Option: (a) – $\sim p\vee(q\wedge t)$
Explanation: The dual of a logical statement is formed by replacing $\wedge$ with $\vee$, $\vee$ with $\wedge$, and the contradiction c with the tautology t.

Question 137 Option: (a) – $x\frac{d^2y}{dx^2}-\frac{dy}{dx}=0$
Explanation: The general equation of a parabola with Y-axis as its axis is $x^2=4ay$. Differentiating twice to eliminate the parameter a yields $xy''-y'=0$.

Question 138 Option: (a) – 3
Explanation: The integral of the greatest integer function is evaluated by splitting the interval: $\int_0^1 0\,dx+\int_1^2 1\,dx+\int_2^3 2\,dx=0+1+2=3$.

Question 139 Option: (c) – atleast one of the corner points
Explanation: By the fundamental theorem of linear programming, the optimal value of the objective function always occurs at one or more of the extreme corner points of the feasible region.

Question 140 Option: (d) – -2
Explanation: Since the inverse of the matrix does not exist, its determinant must be zero. Expanding the determinant of the matrix and solving for α yields $\alpha=-2$.

Question 141 Option: (a) – continuous but not differentiable
Explanation: The left-hand and right-hand limits at $x=0$ are both 0, but the left-hand derivative is 1 and the right-hand derivative is 0, making it non-differentiable.

Question 142 Option: (a) – $r\cdot(\hat{i}+\hat{j}+\hat{k})=2$
Explanation: The normal vector is $\hat{i}+\hat{j}+\hat{k}$. Using the point-normal form of the plane $\vec{r}\cdot\vec{n}=\vec{a}\cdot\vec{n}$ yields $\vec{r}\cdot(\hat{i}+\hat{j}+\hat{k})=2$.

Question 143 Option: (b) – $(0.8)^8$
Explanation: Since the trials are independent, the probability that all 8 individuals develop immunity is given by $p^n=(0.8)^8$.

Question 144 Option: (a) – $6,-\frac{17}{3}$
Explanation: Using the perpendicular distance formula of a point from a plane yields $|6\lambda-1|/7=5$. Solving the absolute value equation gives the two values of λ.

Question 145 Option: (b) – $\frac{\pi}{3}$
Explanation: Evaluating the composition of inverse trigonometric and trigonometric functions step-by-step simplifies the entire expression to $\pi/3$.

Question 146 Option: (d) – $x^2y = 4$
Explanation: Separating variables gives $dy/y + 2dx/x = 0$, which integrates to $yx^2 = c$. Using the initial conditions $x = 2, y = 1$ yields $c = 4$, so $x^2y = 4$.

Question 147 Option: (d) – $7, 10$
Explanation: The direction ratios of the median are $(\frac{\lambda-5}{2}, 1, \frac{\mu-8}{2})$. Since it is equally inclined, equating these components to 1 gives $\lambda = 7$ and $\mu = 10$.

Question 148 Option: (b) – 0.37
Explanation: For a discrete random variable, the probability $P(3 < x \leq 5) = F(5) - F(3)$. Substituting the given values $F(5) = 0.85$ and $F(3) = 0.48$ yields 0.37.

Question 149 Option: (b) – $(-2, -4, -5)$
Explanation: Equating the parametric forms of both lines and solving for the parameters yields the unique intersection point of (-2, -4, -5).

Question 150 Option: (c) – $\frac{\sec^6 x}{6} + c$
Explanation: The integral is $\int \sec^6 x \tan x \, dx = \int \sec^5 x (\sec x \tan x) \, dx$. Using substitution $u = \sec x$, the integral evaluates directly to $\sec^6 x/6 + c$.