MHT CET 2020 Mathematics Answer Key PDF

Question 1
Option: (A) – 8 m/s
Explanation: The velocity just before impact is $v = \sqrt{2gh} = 20$ m/s. Using the definition of coefficient of restitution, the upward velocity after the first rebound is $v' = e \cdot v = 0.4 \times 20 = 8$ m/s.

Question 2
Option: (B) – 0.58 m
Explanation: The fundamental air column length is $L_c = \frac{v}{4n} = \frac{330}{4\times375} = 0.22$ m. Subtracting this from the total tube length of 0.8 m gives the required water level height of 0.58 m from the bottom.

Question 3
Option: (C) – $R\sqrt{\rho}$
Explanation: The escape velocity is given by $V_e = \sqrt{\frac{2GM}{R}}$. Since mass M is proportional to density ρ times volume $\frac{4}{3}\pi R^3$, substituting this gives $V_e \propto \sqrt{\rho R^2} \propto R\sqrt{\rho}$.

Question 4
Option: (A) – 1 μF
Explanation: By analyzing the balanced bridge structure of the capacitors and simplifying the series and parallel combinations, the equivalent capacitance between the terminals P and Q reduces to 1 μF.

Question 5
Option: (D) – $I_c > I_b$
Explanation: In a common emitter transistor configuration, the base current I_b is extremely small compared to the collector current I_c. Hence, the current gain $\beta = \frac{I_c}{I_b}$ is always much greater than 1.

Question 6
Option: (D) – Brackett, near infrared
Explanation: The formula $\frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{n^2}\right)$ with $n \geq 5$ represents the Brackett spectral series of the hydrogen atom, which lies in the near-infrared region of the electromagnetic spectrum.

Question 7
Option: (D) – 1 kg
Explanation: Since the frequency is proportional to $\sqrt{T}$, doubling the frequency requires the tension to increase by a factor of 4. Solving $T + 3 = 4T$ yields the initial mass on the hanger as 1 kg.

Question 8
Option: (D) – $2\pi^2 f^2 L$
Explanation: The span of oscillation is L, so the amplitude is $A = L/2$. The maximum acceleration of S.H.M. at the top of the oscillation is given by $a_{\max} = \omega^2 A = (2\pi f)^2 \frac{L}{2} = 2\pi^2 f^2 L$.

Question 9
Option: (A) – $\frac{Q}{6\varepsilon_0}$ μVm, $\frac{Q}{3\varepsilon_0}$ μVm
Explanation: By Gauss's law, the total flux through the cube is $\frac{Q}{\varepsilon_0}$. Since a cube has six symmetric faces, the flux through one face is $\frac{Q}{6\varepsilon_0}$ and through two opposite faces is twice that value, namely $\frac{Q}{3\varepsilon_0}$.

Question 10
Option: (B) – 1.5 second
Explanation: The effective acceleration in an upward accelerating lift is $g' = g + a = \frac{4g}{3}$. Since $T \propto \frac{1}{\sqrt{g'}}$, the new period becomes $T' = T_0\sqrt{\frac{3}{4}} = \sqrt{3} \times \frac{\sqrt{3}}{2} = 1.5$ seconds.

Question 11
Option: (C) – $\frac{\mu_0 N^2 r^2}{2R}$
Explanation: The self-inductance of a toroid of cross-sectional radius r and mean radius R is $L = \frac{\mu_0 N^2 A}{2\pi R}$. Substituting the area of the cross-section $A = \pi r^2$ yields $L = \frac{\mu_0 N^2 r^2}{2R}$.

Question 12
Option: (A) – $\frac{\mu_w h}{C}$
Explanation: The velocity of light in water of refractive index μ_w is $v = \frac{C}{\mu_w}$. Therefore, the time taken for light to traverse a water column of height h is given by $t = \frac{h}{v} = \frac{\mu_w h}{C}$.

Question 13
Option: (C) – 24
Explanation: Using the compressibility relation $\frac{\Delta V}{V} = K \cdot \Delta P$, we compute the decrease in volume as $\Delta V = 1\ \text{L} \times (6 \times 10^{-10}\ \text{m}^2/\text{N}) \times (4 \times 10^7\ \text{N/m}^2) = 24\ \text{mL}$.

Question 14
Option: (C) – recombination of holes and electrons.
Explanation: A light-emitting diode (LED) operates under forward bias, where injected minority carriers recombine with majority carriers at the junction, releasing energy in the form of photons.

Question 15
Option: (A) – 4 m
Explanation: The shunt required is $S = \frac{G}{n-1} = \frac{45}{10-1} = 5\ \Omega$. Using the formula $S = \frac{\rho l}{A}$ with the given specific resistance and cross-sectional area yields a wire length of $l = 4$ m.

Question 16
Option: (B) – $(\hat{i}Q\cos\theta + \hat{j}Q\sin\theta)$
Explanation: Two vectors are perpendicular if their dot product is zero. Calculating the dot product of $\vec{P}$ and the vector in option 2 yields $PQ\sin\theta\cos\theta - PQ\cos\theta\sin\theta = 0$, confirming they are perpendicular.

Question 17
Option: (C) – low frequency audio signal on high frequency radio waves.
Explanation: Modulation is the process of superposing a low-frequency information signal (such as an audio signal) onto a high-frequency carrier wave (radio wave) for efficient long-distance transmission.

Question 18
Option: (D) – 1 : 4
Explanation: The velocity achieved by accelerating through potential V is proportional to $\sqrt{V}$. Since magnetic force is $F = qvB \propto \sqrt{V}$, doubling the force requires the potential to increase by a factor of 4, meaning $V_1/V_2 = 1/4$.

Question 19
Option: (D) – $3h$
Explanation: By Jurin's law, the capillary rise height is inversely proportional to the radius of the tube ($h \propto 1/r$). Reducing the tube's radius to 1/3 of its original value thus triples the height to $3h$.

Question 20
Option: (B) – 1.5 A
Explanation: Applying Kirchhoff's Current Law at the junction, the total incoming current must equal the total outgoing current: $1.2 + 1.0 = 0.2 + 0.1 + 0.4 + I$, which simplifies to $I = 1.5$ A.

Question 21
Option: (D) – would shift towards point B, would shift towards A

Explanation: Increasing the primary circuit resistance R decreases the potential gradient, shifting the null point towards B. Decreasing the secondary shunt resistance S lowers the terminal voltage, shifting the null point towards A.

Question 22
Option: (C) – $4P$
Explanation: Mixing equal volumes of two gases at pressure P in a combined volume V maintains the pressure at P at constant temperature. Halving this volume to $V/2$ then increases the pressure fourfold to $4P$ by Boyle's law.

Question 23
Option: (A) – 1.5×10^{-5} Nm
Explanation: The torque is given by $\tau = MB\sin\theta$. From the first condition, $MB = 1.732 \times 10^{-5}$ Nm. For $\theta = 60°$, the required torque is $MB\sin(60°) = 1.732\times10^{-5}\times\frac{\sqrt{3}}{2} = 1.5\times10^{-5}$ Nm.

Question 24
Option: (B) – μ_2/μ_1
Explanation: By definition, the relative refractive index of the second medium with respect to the first medium is the ratio of their absolute refractive indices, given by ${}_1\mu_2 = \mu_2/\mu_1$.

Question 25
Option: (A) – $[L^0M^{-1}T^2]$
Explanation: From the principle of homogeneity, $[c] = [t^2] = [T^2]$. Solving for the dimensions of D from $[P] = \frac{[T^2]}{[D][S]}$ and dividing $[D]$ by $[c]$ gives the dimensional formula $[L^0M^{-1}T^2]$.

Question 26
Option: (A) – $I_1t_1 = I_2t_2$
Explanation: The mass of a disc is $M = \rho\pi R^2t \implies R^2 \propto 1/t$. The moment of inertia of the disc is $I = \frac{1}{2}MR^2$, which means $I \propto 1/t$, leading directly to the relation $I_1t_1 = I_2t_2$.

Question 27
Option: (D) – $6\pi TD^2$
Explanation: The work done in blowing a soap bubble is $W = 2T\cdot\Delta A = 2T[4\pi(2D/2)^2 - 4\pi(D/2)^2]$. Simplifying the area difference yields $W = 2T[3\pi D^2] = 6\pi TD^2$.

Question 28
Option: (C) – 25 : 1
Explanation: The ratio of maximum to minimum intensities is given by $\frac{I_{\max}}{I_{\min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$. Substituting the intensity ratio of 9 : 4 gives $\left(\frac{3+2}{3-2}\right)^2 = 25:1$.

Question 29
Option: (A) – $3\vec{v}/2$
Explanation: By applying the law of conservation of linear momentum, $m(3\vec{v}) + m(0) = (m+m)\vec{v}_c$. Solving for the common velocity after the perfectly inelastic collision gives $\vec{v}_c = 3\vec{v}/2$.

Question 30
Option: (A) – 6630 Å
Explanation: The energy of the incident photon is $E = \frac{hc}{\lambda} = 6\times10^{-19}$ J. Subtracting the kinetic energy of the ejected electron (3×10^{-19} J) gives a work function of 3×10^{-19} J, which corresponds to a threshold wavelength of 6630 Å.

Question 31
Option: (A) – $\frac{E}{12\pi rm}$
Explanation: The work done by the tangential force over 3 revolutions is $W = F_t\cdot(6\pi r) = 6\pi rma_t$. Equating this to the change in kinetic energy ($2E$, as it becomes $3E$ from an initial E) yields $a_t = \frac{E}{12\pi rm}$.

Question 32
Option: (C) – $\frac{3}{4}m\ell^2$
Explanation: The two phases on the axis of rotation contribute zero moment of inertia. The third mass is at a perpendicular distance equal to the altitude of the equilateral triangle ($h = \frac{\sqrt{3}}{2}\ell$), giving $I = m\left(\frac{\sqrt{3}}{2}\ell\right)^2 = \frac{3}{4}m\ell^2$.

Question 33
Option: (B) – 2 N
Explanation: Initially, the frequency is $n = \frac{1}{2L}\sqrt{\frac{T}{m}} = \frac{v}{4L}$. When the tension is increased to $T+16$, the new frequency is the 3rd harmonic of the closed pipe, so $\sqrt{\frac{T+16}{T}} = 3 \implies T = 2$ N.

Question 34
Option: (B) – 1 : 1
Explanation: The elongation is given by $\Delta L = \frac{FL}{AY} = \frac{FL}{\pi r^2 Y}$. The ratio of elongations is $\frac{\Delta L_1}{\Delta L_2} = \frac{L_1}{L_2} \times \left(\frac{r_2}{r_1}\right)^2 = \frac{1}{2} \times (\sqrt{2})^2 = 1$, corresponding to a 1 : 1 ratio.

Question 35
Option: (D) – $\left[\frac{\rho_2-\sigma}{\rho_1-\sigma}\right] v_1$
Explanation: The terminal velocity of a sphere is directly proportional to $(\rho - \sigma)$. Taking the ratio of the terminal velocities for the two spheres of the same radius yields $v_2 = \left[\frac{\rho_2-\sigma}{\rho_1-\sigma}\right] v_1$.

Question 36
Option: (D) – diamagnetic, ferromagnetic, paramagnetic
Explanation: Diamagnetic materials have a negative magnetic susceptibility (negative slope), ferromagnetic materials have a very high positive susceptibility (steep positive slope), and paramagnetic materials have a small positive susceptibility.

Question 37
Option: (D) – 6 : 5
Explanation: By the Doppler effect, the frequency ratio is $\frac{n_{\text{approach}}}{n_{\text{recede}}} = \frac{v+v_s}{v-v_s}$. Substituting the speed of sound $v = 330$ m/s and source velocity $v_s = 30$ m/s gives $\frac{360}{300} = 6 : 5$.

Question 38
Option: (D) – 4
Explanation: The mass of a ring is proportional to its radius, so $M_A = nM_B$. The moment of inertia is $I = Mr^2 \implies I_A = M_A(nR)^2 = n^3 I_B$. Since $I_A = 64I_B$, we find $n^3 = 64 \implies n = 4$.

Question 39
Option: (D) – P
Explanation: The maximum kinetic energy of photoelectrons depends solely on the frequency of the incident light and is independent of its intensity. Therefore, the graph is a horizontal line (line P).

Question 40
Option: (A) – $\frac{E_0^2}{4R}$
Explanation: The average power is $P = \frac{E_{\text{rms}}^2 R}{Z^2}$. Since $X_L = R$, the impedance is $Z^2 = R^2 + X_L^2 = 2R^2$. Substituting this into the power formula yields $P = \frac{E_0^2 R}{2(2R^2)} = \frac{E_0^2}{4R}$.

Question 41
Option: (D) – $\frac{N_1 T_2}{N_2 T_1}$
Explanation: The activity of a radioactive sample is $A = \lambda N = \frac{\ln 2}{T} N$. Taking the ratio of activities for the two elements directly yields $\frac{A_1}{A_2} = \frac{N_1 T_2}{N_2 T_1}$.

Question 42
Option: (D) – 3 E
Explanation: The total mechanical energy of a simple pendulum is $E = \frac{1}{2}m\omega^2A^2 = \frac{1}{2}m\frac{g}{L}A^2$. Since energy is inversely proportional to length, reducing the length to 1/3 increases the total energy to $3E$.

Question 43
Option: (B) – $2\sqrt{gL}$
Explanation: Unlike a mass attached to a string, a mass attached to a rigid rod can reach the top of the vertical circle with zero velocity. By conservation of energy, the minimum velocity at the bottom is $v = \sqrt{4gL} = 2\sqrt{gL}$.

Question 44
Option: (A) – $h = R(\sqrt{3} - 1)$
Explanation: The acceleration due to gravity at height h is $g' = g\left(\frac{R}{R+h}\right)^2$. Setting $g' = g/3$ yields $\sqrt{3}R = R + h$, which simplifies to $h = R(\sqrt{3} - 1)$.

Question 45
Option: (A) – $\frac{u_0 I}{4r}$
Explanation: The magnetic field at the center of a complete circular current loop is $\frac{\mu_0 I}{2r}$. Since a semi-circular arc represents exactly half of a full circle, the field is halved to $\frac{\mu_0 I}{4r}$.

Question 46
Option: (A) – 2 f
Explanation: Cutting an equiconvex lens vertically along its axis of symmetry (line AB) produces two planoconvex lenses. Each half has half the refracting power, thereby doubling the focal length to $2f$.

Question 47
Option: (D) – 4×10^{-4} m
Explanation: The position of the 5th bright fringe is $y_5 = \frac{5\lambda D}{d}$. The separation between the two patterns on the screen is $\Delta y_5 = \frac{5D}{d}(\lambda_2 - \lambda_1) = \frac{5\times 2}{3\times 10^{-3}}(120 \times 10^{-9}) = 4 \times 10^{-4}$ m.

Question 48
Option: (C) – 90°
Explanation: Squaring both sides of the vector equation $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$ yields $A^2 + B^2 + 2\vec{A} \cdot \vec{B} = A^2 + B^2 - 2\vec{A} \cdot \vec{B}$, which simplifies to $\vec{A} \cdot \vec{B} = 0$, indicating an angle of 90°.

Question 49
Option: (D) – $E_x > E_y > E_z$
Explanation: By Wien's law, $\lambda_m T$ = constant, so lower peak wavelengths indicate higher temperatures ($T_x > T_y > T_z$). Since emissive power is $E = \sigma T^4$, it follows that $E_x > E_y > E_z$.

Question 50
Option: (B) – orbital and spin motion of electrons.
Explanation: The magnetic properties of any substance originate from the magnetic dipoles created by both the orbital motion of electrons around the nucleus and the intrinsic spin motion of the electrons.

Question 51
Option: (C) – 1° nitroalkanes
Explanation: The oxidation of aldoximes using a strong peroxy acid reagent like trifluoroperoxyacetic acid selectively yields primary (1°) nitroalkanes as the major organic product.

Question 52
Option: (C) – $Fe(NO_3)_3$
Explanation: The reaction between sodium metal and liquid ammonia to produce sodium

amide ($NaNH_2$) is catalyzed effectively by the addition of a small amount of iron(III) nitrate, $Fe(NO_3)_3$.

Question 53
Option: (D) – 30 min
Explanation: For a first-order reaction, the time required for 75% completion is exactly twice the half-life ($t_{75\%} = 2 \cdot t_{50\%}$). Thus, the time required for 50% completion is $60/2 = 30$ minutes.

Question 54
Option: (B) – Water
Explanation: This baseline substance (H_2O) coordinates to metal centers solely through one lone pair on the oxygen atom, making it a monodentate ligand, whereas oxalato and ethylenediamine are bidentate.

Question 55
Option: (A) – 154 pm
Explanation: In alkanes where all carbon atoms are sp^3 hybridized, the carbon-carbon single bond (C-C) length is a characteristic constant equal to 154 pm.

Question 56
Option: (A) – Zn (dust)
Explanation: Phenol undergoes reduction when heated with zinc dust, where the phenolic hydroxyl group is removed to produce benzene along with zinc oxide (ZnO) as a byproduct.

Question 57
Option: (C) – Zinc acetate and antimony trioxide
Explanation: Dacron (terylene) is a polyester prepared by the condensation of ethylene glycol and terephthalic acid, catalyzed by a mixture of zinc acetate and antimony trioxide.

Question 58
Option: (D) – Law of definite proportion
Explanation: The identical weight percentages of copper, carbon, and oxygen in both synthetic and natural samples of copper carbonate illustrate the Law of Definite Proportions (or Constant Composition).

Question 59
Option: (A) – glycogen
Explanation: Glycogen is a highly branched homopolypolymer of glucose, making it a natural biopolymer composed entirely of monosaccharide units, unlike silk (protein) or neoprene (synthetic).

Question 60
Option: (B) – 0.076
Explanation: For a monobasic acid, the van't Hoff factor is $i = 1 + \alpha$. Substituting $i = 1.076$ gives the degree of dissociation as $\alpha = i - 1 = 0.076$.

Question 61
Option: (A) – $H_4P_2O_7$
Explanation: Pyrophosphoric acid is formed by the elimination of one water molecule from two molecules of orthophosphoric acid, giving it the molecular formula $H_4P_2O_7$.

Question 62
Option: (D) – 7
Explanation: Butylated hydroxytoluene (BHT) contains two tert-butyl groups (each containing 3 methyls) and one methyl group attached directly to the benzene ring, totaling 7 methyl groups.

Question 63
Option: (C) – Cryolite

Explanation: Cryolite is a sodium aluminium fluoride mineral with the chemical formula Na_3AlF_6, which is famously used as a solvent in the electrolytic extraction of aluminium.

Question 64
Option: (D) – SiO_2
Explanation: In the extraction of copper, silica (SiO_2) acts as an acidic flux to combine with the iron oxide (FeO) impurity and remove it as iron silicate slag ($FeSiO_3$).

Question 65
Option: (C) – BeF_2
Explanation: Beryllium in BeF_2 is *sp* hybridized with no lone pairs on the central atom, resulting in a completely linear molecular geometry with a bond angle of 180°.

Question 66
Option: (C) – Milk
Explanation: Milk is a classic example of a liquid-in-liquid colloidal dispersion, specifically an emulsion where liquid fat globules are dispersed in an aqueous medium.

Question 67
Option: (A) – $-CO- + 4[H] \xrightarrow{\text{Zn-Hg/conc.HCl}} -CH_2- + H_2O$
Explanation: Clemmensen reduction involves the reduction of aldehydes and ketones to their corresponding hydrocarbons using zinc amalgam (Zn-Hg) and concentrated hydrochloric acid.

Question 68
Option: (C) – n-butyl bromide
Explanation: Boiling point decreases with increased branching due to a reduction in surface area and van der Waals forces. Thus, the straight-chain isomer n-butyl bromide has the highest boiling point.

Question 69
Option: (B) – Codeine
Explanation: Codeine is an opioid analgesic that acts on the central nervous system, producing depression of CNS activity, whereas paracetamol and ibuprofen are non-narcotic analgesics.

Question 70
Option: (C) – 2 and 2
Explanation: The elementary step involves 2 reactant molecules, so the molecularity is 2. The rate law is Rate $= k[O_3][O]$, which gives a reaction order of $1 + 1 = 2$.

Question 71
Option: (C) – $CH_3 - CH = CH_2 \xrightarrow{\text{(i) cold conc. } H_2SO_4, \text{(ii) } H_2O} \ldots$
Explanation: The hydration of propene with cold concentrated sulfuric acid followed by heating with water follows Markovnikov's rule to yield propan-2-ol as the major product.

Question 72
Option: (A) – 1758 kJ
Explanation: The molar mass of acetaldehyde (CH_3CHO) is 44 g/mol. Therefore, 66 g of acetaldehyde corresponds to 1.5 moles. The heat liberated is $1.5 \text{ mol} \times 1172 \text{ kJ/mol} = 1758 \text{ kJ}$.

Question 73
Option: (A) – H_2 and CO
Explanation: The oxo process (hydroformylation) converts olefins into aldehydes by reacting them with a mixture of carbon monoxide and hydrogen gas ($H_2 + CO$) in the presence of a catalyst.

Question 74
Option: (D) – CO_2
Explanation: Carbon dioxide (CO_2) is a linear symmetric molecule. The individual dipoles

of the two carbon-oxygen bonds point in opposite directions and cancel out, resulting in a net dipole moment of zero.

Question 75
Option: (A) – Benzophenone
Explanation: Benzonitrile reacts with phenylmagnesium bromide (C_6H_5MgBr) to form an imine salt intermediate, which upon subsequent acid hydrolysis yields benzophenone.

Question 76
Option: (C) – Iron
Explanation: Iron (Fe) possesses permanent unpaired electron spins that align parallel in domains, making it a classic example of a strongly magnetic, ferromagnetic substance.

Question 77
Option: (C) – Ethoxypropane
Explanation: Monohydric alcohols and ethers containing the same number of carbon atoms are functional isomers. Pentan-2-ol ($C_5H_{12}O$) is functionally isomeric with ethoxypropane ($C_5H_{12}O$).

Question 78
Option: (D) – Camphor
Explanation: Camphor is a crystalline organic solid with a highly ordered internal molecular structure, whereas rubber, butter, and tar are amorphous solids lacking long-range order.

Question 79
Option: (B) – 7.73 L
Explanation: By Boyle's law, $P_1V_1 = P_2V_2 \implies 1 \times 2.27 = 0.227 \times V_2 \implies V_2 = 10$ L. The rise in volume of the gas is $V_2 - V_1 = 10 - 2.27 = 7.73$ L.

Question 80
Option: (D) – Zn
Explanation: The electronic configuration $[Ar]3d^{10}4s^2$ corresponds to atomic number 30, which is the transition metal zinc (Zn).

Question 81
Option: (D) – $-OH$
Explanation: The hydroxyl group ($-OH$) has lone pairs of electrons on the oxygen atom, which it donates into the conjugated system, showing a $+R$ (resonance donating) effect rather than a $-R$ effect.

Question 82
Option: (C) – 6
Explanation: In the coordination complex $[CoCl_2(NH_3)_4]Cl$, the cobalt ion is directly coordinated by 2 chloride ions and 4 ammine molecules, giving a total of 6 ligands in the coordination sphere.

Question 83
Option: (D) – the solution turns green
Explanation: Sulfur dioxide acts as a reducing agent, reducing the orange dichromate ion ($Cr_2O_7^{2-}$) to the green chromium(III) ion (Cr^{3+}) while being oxidized to sulfate.

Question 84
Option: (C) – Polystyrene
Explanation: Polystyrene is a linear polymer that softens upon heating and hardens upon cooling, which is the defining characteristic of a thermoplastic polymer.

Question 85
Option: (D) – $4.0 \times 10^{-3}\ \Omega^{-1}cm^{-1}$

Explanation: Using the molar conductivity relation $\Lambda_m = \frac{1000\kappa}{M}$, we find the conductivity $\kappa = \frac{\Lambda_m \cdot M}{1000} = \frac{400.0 \times 0.01}{1000} = 4.0 \times 10^{-3}\ \Omega^{-1}\text{cm}^{-1}$.

Question 86

Option: (A) – 35.1 g mol^{-1}

Explanation: By Raoult's law for dilute solutions, $\frac{P^\circ - P}{P^\circ} = \frac{w \cdot M_{\text{solvent}}}{W \cdot M_{\text{solute}}}$. Substituting the given values and solving for the molar mass of the solute yields 35.1 g/mol.

Question 87

Option: (D) – Na/C_2H_5OH

Explanation: Mendius reduction involves the reduction of alkyl cyanides (nitriles) to primary amines using nascent hydrogen produced by sodium metal in ethanol (Na/C_2H_5OH).

Question 88

Option: (C) – $PbO_{2(s)}$ is reduced to $Pb^{2+}_{(aq.)}$

Explanation: During the discharge of a lead storage battery, the cathode reaction involves the reduction of lead dioxide (PbO_2) to lead(II) ions in the presence of sulfuric acid.

Question 89

Option: (C) – Eight

Explanation: The compound 3,4-dichloropentan-2-ol contains 3 asymmetric (chiral) carbon atoms. Since the molecule is unsymmetric, the number of stereoisomers is $2^n = 2^3 = 8$.

Question 90

Option: (D) – $\frac{\Delta T_b \times M_2 \times W_1}{W_2}$

Explanation: The elevation in boiling point is given by $\Delta T_b = \frac{K_b \times W_2 \times 1000}{M_2 \times W_1}$. Rearranging this expression to solve for the ebullioscopic constant K_b yields $\frac{\Delta T_b \times M_2 \times W_1}{1000 \times W_2}$.

Question 91

Option: (C) – $q = 500$ J, $w = 0$

Explanation: Since the gas is heated at constant volume, no pressure-volume work is done ($w = 0$). Therefore, the entire heat supplied ($q = 500$ J) goes into increasing the internal energy ($\Delta U = q = 500$ J).

Question 92

Option: (B) – 7.638×10^{-23} g

Explanation: A body-centered cubic (bcc) unit cell contains exactly 2 atoms. Since the mass of one sodium atom is 3.819×10^{-23} g, the total mass of the unit cell is $2 \times 3.819 \times 10^{-23}$ g = 7.638×10^{-23} g.

Question 93

Option: (D) – 2^n

Explanation: For an unsymmetrical organic molecule containing n asymmetric carbon atoms, the maximum number of optically active stereoisomers is given by the formula 2^n.

Question 94

Option: (A) – CO_3^{2-}

Explanation: In the carbonate ion (CO_3^{2-}), the oxidation state of carbon is +4. This is the highest possible oxidation state for carbon, compared to +2 in CO and +3 in oxalate.

Question 95

Option: (A) – 4-nitrobenzaldehyde

Explanation: Oxidation of 4-nitrotoluene with chromic oxide in acetic anhydride converts the methyl group to a gem-diacetate intermediate, which upon acid hydrolysis yields 4-nitrobenzaldehyde.

Question 96

Option: (B) – Kr

Explanation: Krypton gas is utilized in miner's cap lamps because it provides a highly efficient, bright, and stable light source under hazardous underground conditions.

Question 97
Option: (D) – Pm
Explanation: Promethium (Pm) is a lanthanide element that does not have any stable isotopes; all of its known isotopes are radioactive, making it inherently radioactive.

Question 98
Option: (D) – -3.458 kJ
Explanation: The work done in a reversible isothermal expansion is $W = -2.303nRT\log\left(\frac{V_2}{V_1}\right)$. Substituting the values gives $W = -2.303 \times 2 \times 8.314 \times 300\log\left(\frac{10}{5}\right) \approx -3.458$ kJ.

Question 99
Option: (A) – Sandmeyer reaction
Explanation: The Sandmeyer reaction is a classical synthetic transformation where a primary aromatic amino group is converted into a diazonium salt, which is then replaced by a nucleophile using copper(I) salts.

Question 100
Option: (D) – Sucrose
Explanation: Sucrose is a non-reducing disaccharide because the anomeric carbons of both glucose and fructose are involved in the glycosidic linkage, leaving no free hemiacetal or hemiketal group to reduce Tollen's reagent.

Question 101
Option: (B) – 25
Explanation: This is a binomial trial with $n = 100$. The probability of getting an even number is $p = 1/2$, so $q = 1/2$. The variance of the binomial distribution is given by $\text{Var}(X) = npq = 100 \times \frac{1}{2} \times \frac{1}{2} = 25$.

Question 102
Option: (B) – $\pi/2$
Explanation: Using the direction cosines identity $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$, we substitute $\alpha = \pi/6$ and $\beta = \pi/3$ to get $\frac{3}{4} + \frac{1}{4} + \cos^2\gamma = 1 \implies \cos^2\gamma = 0 \implies \gamma = \pi/2$.

Question 103
Option: (D) – $1/\sqrt{2}$
Explanation: Let $\tan^{-1}x = \theta \implies y = \sec\theta = \sqrt{1+x^2}$. Differentiating gives $\frac{dy}{dx} = \frac{x}{\sqrt{1+x^2}}$. Evaluating this derivative at $x = 1$ yields $\frac{1}{\sqrt{2}}$.

Question 104
Option: (B) – $-\frac{\log 2}{\log 3}$
Explanation: Since $f(x)$ is continuous at $x = 0$, $f(0) = \lim_{x\to 0}\frac{2^x-1}{1-3^x}$. Dividing both the numerator and denominator by x and taking the limit gives $\frac{\log 2}{-\log 3} = -\frac{\log 2}{\log 3}$.

Question 105
Option: (A) – $1, 2$
Explanation: Squaring both sides of the differential equation yields $(y - px)^2 = a^2p^2 + b^2$. Since the highest order derivative present is $p = \frac{dy}{dx}$, the order is 1 and its power (degree) is 2.

Question 106
Option: (C) – $x = 3 - 2\lambda, y = 4 - 5\lambda, z = -7 + 13\lambda$
Explanation: The direction vector of the line is $\vec{AB} = (1-3)\hat{i} + (-1-4)\hat{j} + (6-(-7))\hat{k} = -2\hat{i} - 5\hat{j} + 13\hat{k}$. Using point A(3, 4, -7), the parametric equations are $x = 3 - 2\lambda$, $y = 4 - 5\lambda$, and $z = -7 + 13\lambda$.

Question 107
Option: (D) – $x = n\pi \pm \frac{\pi}{3}, n \in Z$

Explanation: Using trigonometric identities, $\frac{1-\cos 2x}{1+\cos 2x} = \tan^2 x = 3 \implies \tan x = \pm\sqrt{3}$. This gives the general solution $x = n\pi \pm \frac{\pi}{3}$, where $n \in \mathbb{Z}$.

Question 108
Option: (C) – $\frac{\log 2}{(1+\log 2)}$
Explanation: Substituting $u = 1 + \log x \implies du = \frac{dx}{x}$, the definite integral transforms to $\int_1^{1+\log 2} \frac{du}{u^2} = \left[-\frac{1}{u}\right]_1^{1+\log 2} = 1 - \frac{1}{1+\log 2} = \frac{\log 2}{1+\log 2}$.

Question 109
Option: (B) – 7/6 sq. units
Explanation: The intersection of $y^2 = x$ and $x + y = 2$ in the first quadrant occurs at $y = 1$. Integrating with respect to y gives Area $= \int_0^1 ((2 - y) - y^2)dy = \left[2y - \frac{y^2}{2} - \frac{y^3}{3}\right]_0^1 = \frac{7}{6}$ square units.

Question 110
Option: (A) – 3
Explanation: Since the maximum value of $\sin^{-1}\theta$ is $\pi/2$, the sum equals $\frac{3\pi}{2}$ only when $\sin^{-1} x = \sin^{-1} y = \sin^{-1} z = \frac{\pi}{2}$, which implies $x = y = z = 1$. Thus, $x^{100} + y^{100} + z^{100} = 3$.

Question 111
Option: (A) – 75°
Explanation: Using sum-to-product formula, $\sin 15° + \sin 45° = 2\sin(30°)\cos(15°) = \cos(15°) = \sin(75°)$. Since $0° < \theta < 180°$, we find $\theta = 75°$ is a solution.

Question 112
Option: (B) – 45.46
Explanation: We use $f(x + h) \approx f(x) + h \cdot f'(x)$. Here $f(3) = 45$, $f'(3) = 23$, and $h = 0.02$. Thus, $f(3.02) \approx 45 + (0.02 \times 23) = 45.46$.

Question 113
Option: (A) – $\log y = x^2$
Explanation: The slope is $\frac{dy}{dx} = 2xy \implies \frac{dy}{y} = 2xdx$. Integrating both sides gives $\log y = x^2 + C$. Since the curve passes through $(0, 1)$, we find $C = 0$, so the equation is $\log y = x^2$.

Question 114
Option: (B) – 100 years
Explanation: For exponential growth, if the quantity doubles in 50 years, the growth factor is $2^{t/50}$. To become 4 times (2^2) its initial value, we set $2^{t/50} = 2^2 \implies t/50 = 2 \implies t =$ 100 years.

Question 115
Option: (D) – 13,695
Explanation: The general term of the series is $T_r = r(2r + 1)^2 = 4r^3 + 4r^2 + r$. Evaluating the sum $\sum_{r=1}^{10} T_r$ using standard summation formulas yields a total sum of 13,695.

Question 116
Option: (D) – 3
Explanation: Expanding the scalar triple product using vector identities, $(\vec{a} + \vec{b} + \vec{c}) \cdot [(\vec{a} \times \vec{b}) + (\vec{b} \times \vec{c}) + (\vec{c} \times \vec{a})]$ simplifies directly to $3[\vec{a}\vec{b}\vec{c}]$, hence $k = 3$.

Question 117
Option: (B) – 9/2
Explanation: Equating the general coordinates of the two lines, we obtain equations in terms of the parameters λ and μ. Solving these equations leads to the parameter values which determine $k = 9/2$.

Question 118
Option: (B) – 1

Explanation: Since $C = 90°$, $a^2+b^2 = c^2$. By the sine rule, $\frac{a^2+b^2}{a^2-b^2}\sin(A-B) = \frac{\sin^2 A+\sin^2 B}{\sin^2 A-\sin^2 B}\sin(A-B)$. Since $A+B = 90°$, this simplifies to 1.

Question 119
Option: (A) – 20/21
Explanation: Using Bayes' theorem, the probability is $P(M|G) = \frac{P(M)P(G|M)}{P(M)P(G|M)+P(F)P(G|F)}$. Substituting the values gives $\frac{0.5\times0.05}{0.5\times0.05+0.5\times0.0025} = \frac{20}{21}$.

Question 120
Option: (C) – $3x^2 - y^2 = 0$
Explanation: The lines make an angle of 30° with the Y-axis, meaning they make angles of 60° and 120° with the X-axis. Their slopes are $m = \pm\sqrt{3}$, so the joint equation is $(y-\sqrt{3}x)(y+\sqrt{3}x) = 3x^2 - y^2 = 0$.

Question 121
Option: (C) – 3
Explanation: The element in the third row and first column of A^{-1} is $\frac{C_{13}}{\det(A)}$. Computing the determinant $\det(A) = -1$ and cofactor $C_{13} = -3$ yields the inverse element value as $\frac{-3}{-1} = 3$.

Question 122
Option: (D) – $(2, 3)$
Explanation: Grouping the terms of the equation gives $9(x^2 - 4x) - 16(y^2 - 6y) = 252$. Completing the square yields $9(x-2)^2-16(y-3)^2 = 144$, identifying the centre of the hyperbola as $(2, 3)$.

Question 123
Option: (D) – 0.3 units
Explanation: The equations can be rewritten as $3x + 4y - 9 = 0$ and $3x + 4y - 7.5 = 0$. The distance between these parallel lines is given by $d = \frac{|c_1-c_2|}{\sqrt{a^2+b^2}} = \frac{|-9-(-7.5)|}{\sqrt{3^2+4^2}} = 0.3$ units.

Question 124
Option: (D) – $-25y$
Explanation: Using the double angle identity, $y = \cos^2\left(\frac{5x}{2}\right) - \sin^2\left(\frac{5x}{2}\right) = \cos(5x)$. Differentiating twice yields $\frac{d^2y}{dx^2} = -25\cos(5x) = -25y$.

Question 125
Option: (A) – $\frac{1-x}{x}$
Explanation: The infinite power tower yields $x = e^{y+x} \implies \log x = y + x$. Differentiating implicitly with respect to x gives $\frac{1}{x} = \frac{dy}{dx} + 1$, which solves to $\frac{dy}{dx} = \frac{1-x}{x}$.

Question 126
Option: (A) – π
Explanation: Using the identity $\tan^{-1}\theta+\cot^{-1}\theta = \pi/2$, the integrand simplifies to $\tan^{-1}\left(\frac{x}{x^2+1}\right)+\tan^{-1}\left(\frac{x^2+1}{x}\right) = \frac{\pi}{2}$. The definite integral is then $\int_{-1}^{3}\frac{\pi}{2}dx = \pi$.

Question 127
Option: (A) – $\frac{1}{3}(6\hat{i} + 11\hat{j} + 15\hat{k})$
Explanation: The angle bisector of A divides the opposite side BC in the ratio of the adjacent sides $AB : AC = 5 : 5 = 1 : 1$. The position vector of the midpoint is then calculated as $\frac{\vec{b}+\vec{c}}{2} = \frac{1}{3}(6\hat{i} + 11\hat{j} + 15\hat{k})$.

Question 128
Option: (A) – 1/64
Explanation: The cumulative distribution function value is $F(0.5) = \int_0^{0.5} f(x)dx = \int_0^{0.5}\frac{x}{8}dx = \left[\frac{x^2}{16}\right]_0^{0.5} = \frac{0.25}{16} = \frac{1}{64}$.

Question 129
Option: (A) – $\pi/2 - \alpha$
Explanation: Comparing with $ax^2 + 2hxy + by^2 = 0$, we have $a = 1, b = 1, h = \csc\alpha$. The angle between the lines is $\tan\theta = \frac{2\sqrt{\csc^2\alpha - 1}}{2} = \cot\alpha = \tan(\pi/2 - \alpha)$, giving $\theta = \pi/2 - \alpha$.

Question 130
Option: (A) – $4\hat{i} + 3\hat{j} + 3\hat{k}$
Explanation: The intersection of the medians is the centroid of the triangle, given by $\vec{g} = \frac{\vec{a}+\vec{b}+\vec{c}}{3} = \frac{(2+4+6)\hat{i}+(3+5+1)\hat{j}+(1+3+5)\hat{k}}{3} = 4\hat{i} + 3\hat{j} + 3\hat{k}$.

Question 131
Option: (B) – Seema is not fat or she is happy.
Explanation: The implication statement $p \to q$ is logically equivalent to the disjunction $\sim p \vee q$. Translating this back to English gives: "Seema is not fat or she is happy."

Question 132
Option: (C) – $(x + \frac{x^2}{2})\log x - (x - \frac{x^2}{4}) + C$
Explanation: Using integration by parts with $u = \log x$ and $dv = (1 + x)dx$, we get $(x + \frac{x^2}{2})\log x - \int(1 + \frac{x}{2})dx$, which evaluates to $(x + \frac{x^2}{2})\log x - (x - \frac{x^2}{4}) + C$.

Question 133
Option: (D) – $\pi/2$
Explanation: Using the definite integral symmetry property $\int_0^\pi f(x)dx = \int_0^\pi f(\pi - x)dx$ and summing the two forms, the integrand simplifies to 1, yielding a value of $I = \pi/2$.

Question 134
Option: (C) – $\vec{r} \cdot (2\hat{i} + 3\hat{j} - 4\hat{k}) = -5$
Explanation: The plane parallel to $2x+3y-4z = 17$ has the form $2x+3y-4z = d$. Substituting the point $(1, -1, 1)$ gives $2(1) + 3(-1) - 4(1) = d \implies d = -5$, which is $\vec{r} \cdot (2\hat{i} + 3\hat{j} - 4\hat{k}) = -5$.

Question 135
Option: (B) – $x = \tan(x + y) - \sec(x + y) + c$
Explanation: Substituting $u = x + y \implies \frac{du}{dx} = 1 + \frac{dy}{dx}$, the equation becomes $\frac{du}{1+\sin u} = dx$. Integrating this equation yields the solution $x = \tan(x + y) - \sec(x + y) + c$.

Question 136
Option: (B) – $-\log|x + 2| + 2\log|x + 3| + C$
Explanation: Using partial fractions, the integrand is decomposed as $\frac{x+1}{(x+2)(x+3)} = \frac{-1}{x+2} + \frac{2}{x+3}$. Integrating each term yields $-\log|x + 2| + 2\log|x + 3| + C$.

Question 137
Option: (D) – Domain $= \{1, 2, 3\}$, Range $= \{7, 5\}$
Explanation: Since $y \in \mathbb{N}$ and $x < 6$, x must be a divisor of 6, giving the domain $\{1, 2, 3\}$. Calculating the corresponding values of y yields the range $\{7, 5\}$.

Question 138
Option: (A) – $a = 1/2, b = 1/2$
Explanation: Substituting $x^2 = t$ and decomposing into partial fractions yields $\frac{2t+3}{(t-1)(t+4)} = \frac{1}{t-1} + \frac{1}{t+4}$. Integrating the terms gives $a = 1/2$ and $b = 1/2$.

Question 139
Option: (B) – $(p \vee \sim q) \wedge (\sim p \vee q)$
Explanation: The negation of $A \to B$ is $A \wedge \sim B$. Applying this to $(p \vee \sim q) \to (p \wedge \sim q)$ gives $(p \vee \sim q) \wedge (\sim p \vee q)$.

Question 140
Option: (B) – b^2
Explanation: Since $a^2 > b^2$, we can write $f(x) = a^2\cos^2 x + b^2(1 - \cos^2 x) = b^2 + (a^2 - b^2)\cos^2 x$. Because $\cos^2 x \geq 0$, the minimum value is achieved when $\cos x = 0$, which is b^2.

Question 141
Option: (A) – $2x^2 + 2y^2 + 4x - 9y - 24 = 0$
Explanation: The centres of the two circles are $C_1(1, -1.5)$ and $C_2(-3, 6)$. Using the diameter form $(x-x_1)(x-x_2)+(y-y_1)(y-y_2) = 0$ and multiplying by 2 yields $2x^2+2y^2+4x-9y-24 = 0$.

Question 142
Option: (B) – $\log y$
Explanation: The equation can be written in linear form as $\frac{dx}{dy} + \frac{x}{y \log y} = \frac{1}{y}$. The integrating factor is I.F. $= e^{\int \frac{dy}{y \log y}} = e^{\log(\log y)} = \log y$.

Question 143
Option: (A) – $3/4$
Explanation: Sum of probabilities equals 1, so $8k = 1 \implies k = 1/8$. Computing the mean $E(X) = 1.5$ and $E(X^2) = 3$, the variance is given by $\text{Var}(X) = E(X^2) - [E(X)]^2 = 3 - 2.25 = 0.75 = 3/4$.

Question 144
Option: (D) – $(4, 1)$
Explanation: Plotting the inequalities, the feasible region has corner points $(4, 1)$, $(4, 2)$, and $(3, 2)$. Evaluating the objective function $Z = 5x + 8y$ at these points shows the minimum value of 28 occurs at $(4, 1)$.

Question 145
Option: (B) – $-1/11, 2/11$
Explanation: Using $A^{-1} = \frac{1}{11}\begin{bmatrix} 1 & -2 \\ 5 & 1 \end{bmatrix}$, we set this equal to $xA + yI = \begin{bmatrix} x+y & 2x \\ -5x & x+y \end{bmatrix}$. Solving the system gives $x = -1/11$ and $y = 2/11$.

Question 146
Option: (C) – $a = 2, b = -7$
Explanation: The derivative at $(2, 3)$ is $\frac{3a(2)^2}{2(3)} = 2a$. Since the tangent line slope is 4, $2a = 4 \implies a = 2$. Substituting $(2, 3)$ into the curve's equation gives $9 = 2(8) + b \implies b = -7$.

Question 147
Option: (D) – 0
Explanation: In a cyclic quadrilateral, opposite angles sum to $180°$, so $C = 180° - A$ and $D = 180° - B$. Therefore, $\cos C = -\cos A$ and $\cos D = -\cos B$, making the total sum 0.

Question 148
Option: (A) – $f^{-1}(x) = f(x)$
Explanation: Let $y = \frac{3x+2}{5x-3} \implies 5xy - 3y = 3x + 2 \implies x = \frac{3y+2}{5y-3}$. Thus, the inverse function $f^{-1}(x)$ is identical to the original function $f(x)$.

Question 149
Option: (A) – 194
Explanation: Squaring $\tan\theta + \cot\theta = 4$ yields $\tan^2\theta + \cot^2\theta = 14$. Squaring again gives $\tan^4\theta + \cot^4\theta + 2 = 196 \implies \tan^4\theta + \cot^4\theta = 194$.

Question 150
Option: (C) – $\sin^{-1}\left(\frac{2\sqrt{2}}{3}\right)$
Explanation: The angle θ is given by $\sin\theta = \frac{\vec{b}\cdot\vec{n}}{|\vec{b}||\vec{n}|}$. Substituting the direction of the line $\vec{b} = \hat{i} - \hat{j} + \hat{k}$ and the plane normal $\vec{n} = 2\hat{i} - \hat{j} + \hat{k}$ yields $\sin\theta = \frac{4}{3\sqrt{2}} = \frac{2\sqrt{2}}{3}$.