

MHT CET 2021 Mathematics Answer Key PDF

Answer Key

Question 1 -Option- (4) No real solution

Explanation: The maximum value of $4 \sin^2 x + 6 \cos^2 x$ is $4 + 6 = 10$. Since $10 < 12$, the equation has no real solution.

Question 2 -Option- (2) s^{-1}

Explanation: For a first-order reaction, the rate constant unit is determined from $k = \text{Rate}/[A]$. Dividing $(\text{mol L}^{-1} \text{s}^{-1})$ by (mol L^{-1}) yields s^{-1} .

Question 3 -Option- (1) $\frac{|(\vec{a}-\vec{d}) \times \vec{b}|}{|\vec{b}|}$

Explanation: The perpendicular distance from a point to a line is the magnitude of the projection of the vector $(\vec{a} - \vec{d})$ orthogonal to the line's direction vector $\vec{b}$.

Question 4 -Option- (3) ZnS

Explanation: Frenkel defects are typically exhibited by ionic crystals like ZnS and silver halides where there is a large difference in size between the cations and anions.

Question 5 -Option- (2) $-x \cot(x/2) + C$

Explanation: Resolving the standard integral $\int \frac{x - \sin x}{1 - \cos x} dx$ (corrected for typographical error in the numerator) using integration by parts yields $-x \cot(x/2) + C$.

Question 6 -Option- (1) $\frac{\sqrt{5}-1}{4}$

Explanation: The exact trigonometric value of $\sin 18^\circ$ is mathematically derived using multiple-angle formulas to be $\frac{\sqrt{5}-1}{4}$.

Question 7 -Option- (3) $x \log(\sec x + \tan x) - \int x \sec x dx$

Explanation: Integrating by parts with $u = \log(\sec x + \tan x)$ and $dv = dx$ gives $du = \sec x dx$ and $v = x$, yielding $x \log(\sec x + \tan x) - \int x \sec x dx$.

Question 8 -Option- (2) Palladium (Pd)

Explanation: Palladium ($Z = 46$) has an exceptional ground-state configuration of $[\text{Kr}]4d^{10}5s^0$, meaning it possesses a completely filled $4d$ orbital.

Question 9 -Option- (3) $\Delta V = 0$

Explanation: An isochoric thermodynamic process is characterized by constant volume, which means the change in volume (ΔV) is zero.

Question 10 -Option- (3) Silica

Explanation: Diamond, graphite, and fullerene are pure allotropic forms of carbon, whereas silica (SiO_2) is a compound of silicon and oxygen containing no carbon.

Question 11 -Option- (3) Lactose

Explanation: Lactose, a disaccharide sugar composed of glucose and galactose subunits, is the primary sugar present in milk.

Question 12 -Option- (3) $5/2$

Explanation: Rationalizing the limit as $x \rightarrow \infty$ yields $\lim_{x \rightarrow \infty} \frac{5x-7}{\sqrt{x^2+5x-7}+x}$. Dividing through by x gives the limit value $\frac{5}{1+1} = 5/2$.

Question 13 -Option- (2) 11

Explanation: Undecane is a saturated alkane with the chemical formula $C_{11}H_{24}$, containing exactly 11 carbon atoms in its chain.

Question 14 -Option- (2) $\frac{n^2-1}{12}$

Explanation: Adding a constant to every observation in a dataset does not change its dispersion. Thus, the variance remains equal to the original variance of $\frac{n^2-1}{12}$.

Question 15 -Option- (3) Bromine

Explanation: Bromine is the only halogen, and one of only two elements in the periodic table, that exists in the liquid state at standard room temperature.

Question 16 -Option- (2) Oil seals and tank linings

Explanation: Buna-N (nitrile rubber) is highly resistant to oils, fuel, and other chemicals, making it exceptionally suited for manufacturing industrial oil seals and tank linings.

Question 17 -Option- (2) Polyacrylamide

Explanation: Polyacrylamide gels are widely used as the standard porous supporting medium in gel electrophoresis (PAGE) to separate proteins and nucleic acids.

Question 18 -Option- (4) PVC

Explanation: Due to its polymer properties and ease of blending, plasticized PVC and modified vinyl formulations are widely used as adhesives in commercial tiles and pipes.

Question 19 -Option- (3) 128 pm

Explanation: The resonance hybrid structure of the ozone (O_3) molecule results in equalized O-O bonds with a measured average bond length of 128 pm.

Question 20 -Option- (2) Gold sol

Explanation: Lyophobic sols like gold sol and sulfur sol are formed by the aggregation of a large number of atoms or small molecules, classifying them as multimolecular wastes.

Question 21 -Option- (2) 120°

Explanation: Since the magnitudes satisfy $|\vec{e}_1| = |\vec{e}_2| = |\vec{e}_1 + \vec{e}_2| = 1$, they form the sides of an equilateral triangle, meaning the angle between the two unit vectors is 120° .

Question 22 -Option- (3) 119°

Explanation: Due to the presence of one lone pair on the sulfur atom exerting repulsion on the bond pairs, the bond angle in SO_2 is reduced from 120° to approximately 119° .

Question 23 -Option- (2) First order

Explanation: All natural and artificial radioactive decay processes follow spontaneous first-order nuclear reaction kinetics.

Question 24 -Option- (3) KCl

Explanation: Potassium chloride (KCl) solutions of highly precise concentrations are standardly used to calibrate and determine the cell constant of a conductivity cell.

Question 25 -Option- (2) AC to DC

Explanation: A rectifier is an electrical device designed specifically to convert alternating current (AC), which periodically reverses direction, into direct current (DC).

Question 26 -Option- (2) $4\sqrt{2}/5$

Explanation: $\cos x = 24/25 \implies \sin x = 7/25$. Expanding $(\sin(x/2) + \cos(x/2))^2 = 1 + \sin x = 32/25$ yields the positive root value of $4\sqrt{2}/5$.

Question 27 -Option- (1) Hexanal

Explanation: Boiling points of aldehydes increase with increasing molecular mass and surface area due to stronger London dispersion forces. Hexanal has the longest chain here.

Question 28 -Option- (3) Clay sol

Explanation: Metal hydroxides form positively charged sols, whereas metal sols, starch, and clay sols carry a net negative charge.

Question 29 -Option- (1) Cellulose nitrate

Explanation: Cellulose nitrate (celluloid) was the historical and primary thermoplastic polymer used specifically in the manufacture of photographic and cinema films.

Question 30 -Option- (1) Conditional identities

Explanation: Mathematical identities that hold true only under specific, predefined constraints (such as $A + B + C = \pi$ in a triangle) are conditional identities.

Question 31 -Option- (1) (0, 5)

Explanation: Evaluating $Z = 10x + 25y$ at feasible region corners (0, 0), (5, 0), and (0, 5) reveals that the maximum value of 125 is achieved at (0, 5).

Question 32 -Option- (3) Scalar triple product

Explanation: The standard formula for the shortest distance between skew lines features the scalar triple product $[(\vec{a}_2 - \vec{a}_1) \cdot \vec{b}_1 \times \vec{b}_2]$ in the numerator.

Question 33 -Option- (1) $\sqrt{61}$

Explanation: With intercepts $A(2, 0, 0)$, $B(0, 3, 0)$, and $C(0, 0, 4)$, the area of $\triangle ABC$ is $\frac{1}{2}\sqrt{(ab)^2 + (bc)^2 + (ca)^2} = \sqrt{61}$.

Question 34 -Option- (1) $\vec{r} \cdot (2\hat{i} + 3\hat{j} - \hat{k}) = 5$

Explanation: The Cartesian plane equation $2x + 3y - z = 5$ converts directly to the vector format $\vec{r} \cdot (2\hat{i} + 3\hat{j} - \hat{k}) = 5$.

Question 35 -Option- (1) $9/8$

Explanation: Let the slopes be $m, 2m$. From $3m = -2h/b$ and $2m^2 = a/b$, we eliminate m to obtain the ratio $h^2/ab = 9/8$.

Question 36 -Option- (1) 11

Explanation: The number of diagonals of an n -sided polygon is $\frac{n(n-3)}{2} = 44 \implies n^2 - 3n - 88 = 0 \implies n = 11$.

Question 37 -Option- (1) $\frac{x^2}{4} + \frac{\pi x}{4} + C$

Explanation: Since the argument simplifies to $\tan(\pi/4 + x/2)$, the integral reduces to $\int (\pi/4 + x/2)dx = \frac{\pi x}{4} + \frac{x^2}{4} + C$.

Question 38 -Option- (1) $-\frac{a(1-t^2)}{2t}$

Explanation: Differentiating x and y with respect to t and evaluating the derivative ratio yields $\frac{dy}{dx} = -\frac{a(1-t^2)}{2t}$.

Question 39 -Option- (3) $-\cot(x + y) = x + C$

Explanation: Using the substitution $u = x + y$ simplifies the variables to $\int \frac{du}{1+\sin u} = \int dx$, giving the general solution.

Question 40 -Option- (2) 0

Explanation: A square matrix is singular (having no inverse) if and only if its determinant is exactly equal to zero.

Question 41 -Option- (2) $-1/2$

Explanation: Since $|A| = 1(4) - 2(3) = -2$, the determinant of its inverse is $|A^{-1}| = 1/|A| = -1/2$.

Question 42 -Option- (2) 0

Explanation: Expressing the integrand as $\tan^{-1}(1-x) - \tan^{-1}x$ and applying the definite integral properties shows the integral evaluates to zero.

Question 43 -Option- (4) $14/25$

Explanation: Summing the probabilities for the given range in the distribution table yields the total probability of $14/25$.

Question 44 -Option- (2) 46.66

Explanation: Multiplying each observation by a constant k scales the standard deviation by $|k|$. Thus, the new SD is $2 \times 23.33 = 46.66$.

Question 45 -Option- (2) $3/4$

Explanation: The outcomes with a difference of 1 between heads and tails are 3H,1T and 1H,2T, which occur in $3 + 3 = 6$ out of 8 cases, giving a probability of $3/4$.

Question 46 -Option- (1) 54

Explanation: For a binomial distribution, mean $np = 18$ and variance $npq = 12 \implies q = 2/3 \implies p = 1/3$. Thus, $n = 18 \times 3 = 54$.

Question 47 -Option- (4) $LHL = RHL = f(a)$

Explanation: A function is continuous at a point $x = a$ if and only if its left-hand limit, right-hand limit, and functional value at that point are all equal.

Question 48 -Option- (2) Until the indeterminacy is removed

Explanation: L'Hospital's rule is applied successively by differentiating the numerator and denominator until the $0/0$ or ∞/∞ indeterminate form is resolved.

Question 49 -Option- (2) $2ab$

Explanation: The maximum area of a rectangle inscribed in an ellipse with semi-axes a and b is a standard coordinate geometry result equal to $2ab$.

Question 50 -Option- (1) $16+14i$

Explanation: Since $x = 1 + i \implies x^2 = 2i$ and $x^3 = -2 + 2i$. Substituting these values into the polynomial yields $13 + 15i$, which is closest to option (1).

Question 51 -Option- (3) Lu Explanation: Lutetium (Lu, $Z = 71$ $Z=71$) represents the final lanthanoid element where the $4f$ subshell is completely filled. code Code

Question 52 -Option- (4) 1.59g

Explanation: Copper reduction requires 2 Faradays per mole. Mass of Cu produced is $0.05 F \times \frac{63.5}{2} \text{ g/F} = 1.59 \text{ g}$.

Question 53 -Option- (1) $NaClO_3, NaCl, H_2O$

Explanation: The disproportionation reaction of chlorine gas with hot, concentrated sodium hydroxide yields sodium chlorate and sodium chloride.

Question 54 -Option- (3) Be

Explanation: Beryllium (Be) is highly resistant to water even at elevated temperatures due to the formation of a protective oxide layer.

Question 55 -Option- (3) d^2sp^3

Explanation: Cobalt(III) in $[Co(NH_3)_6]^{3+}$ is a d^6 ion under strong-field ammonia ligands, forcing pairing to undergo inner orbital d^2sp^3 hybridization.

Question 56 -Option- (4) 5.48×10^{-4}

Explanation: By Henry's Law, Solubility $S = K_H \cdot P = 6.85 \times 10^{-4} \times 0.8 = 5.48 \times 10^{-4}$.

Question 57 -Option- (4) -273.15°C

Explanation: Absolute zero is defined as the fundamental lower limit of temperature, which is exactly -273.15°C .

Question 58 -Option- (3) Gatterman-Koch : $CrO_3/(CH_3CO)_2O$

Explanation: This is incorrect because the Gatterman-Koch reaction uses CO and HCl in the presence of anhydrous $AlCl_3$.

Question 59 -Option- (1) Iodobenzene

Explanation: Iodobenzene is prepared directly by warming a diazonium salt with potassium iodide (KI), not by the standard Sandmeyer reaction.

Question 60 -Option- (1) n-butyl bromide

Explanation: Since S_N2 reactivity increases with less steric hindrance, the primary alkyl halide (n-butyl bromide) undergoes S_N2 fastest.

Question 61 -Option- (4) HF

Explanation: Fluorine has the highest electronegativity, giving the H-F bond the strongest dipole moment and highest dipole-dipole interactions.

Question 62 -Option- (2) 68%

Explanation: The packing efficiency of a body-centered cubic (BCC) unit cell is a standard value of 68%.

Question 63 -Option- (1) Magnesium

Explanation: Grignard reagents are organomagnesium halides synthesized by reacting an organic halide with magnesium metal in dry ether.

Question 64 -Option- (2) All are non-radioactive

Explanation: This statement is incorrect because Promethium (Pm, $Z = 61$) is a highly radioactive synthetic lanthanoid element.

Question 65 -Option- (1) BCl_3

Explanation: Boron trichloride (BCl_3) is a Lewis acid due to an electron-deficient boron atom, but is not a Brønsted-Lowry acid as it lacks protons.

Question 66 -Option- (2) Na_2CO_3

Explanation: Sodium carbonate (Na_2CO_3) is a salt of a strong base and a weak acid, which undergoes hydrolysis to yield a highly basic solution.

Question 67 -Option- (3) Potassium salt of higher fatty acid

Explanation: Soaps are systematically defined as the sodium or potassium salts of long-chain fatty acids.

Question 68 -Option- (3) 965 s

Explanation: Moles of Ag = $5.4/108 = 0.05$. By Faraday's Law, $t = \frac{nF}{I} = \frac{0.05 \times 96500}{5} = 965$ s.

Question 69 -Option- (2) Dry cell

Explanation: A dry cell (Leclanché cell) is a non-rechargeable primary cell, whereas lead storage and Ni-Cd are secondary cells.

Question 70 -Option- (3) Zero

Explanation: In $[Co(NH_3)_6]^{3+}$, Co^{3+} has a d^6 configuration. Strong-field NH_3 ligands pair all electrons, leaving zero unpaired.

Question 71 -Option- (3) 19.93 g/cm^3

Explanation: Density $\rho = \frac{z \cdot M}{N_A \cdot V} = \frac{4 \times 192}{6.022 \times 10^{23} \times (64 \times 10^{-24})} \approx 19.93 \text{ g/cm}^3$.

Question 72 -Option- (2) -404 J

Explanation: Work done $W = -P_{\text{ext}} \Delta V = -2.02 \text{ bar} \times (7-5) \text{ dm}^3 = -4.04 \text{ dm}^3 \cdot \text{bar} = -404 \text{ J}$.

Question 73 -Option- (1) Urea/Formaldehyde

Explanation: Urea-formaldehyde resin is a thermosetting aminoplast polymer, whereas others yield standard polyamide polymers.

Question 74 -Option- (2) Bulk

Explanation: Adsorption is strictly a surface phenomenon, unlike absorption which is a bulk phenomenon.

Question 75 -Option- (2) 7.7×10^{-5}

Explanation: For first-order, $k = \frac{0.693}{t_{1/2}} = \frac{0.693}{2.5 \times 3600 \text{ s}} \approx 7.7 \times 10^{-5} \text{ s}^{-1}$.

Question 76 -Option- (3) 1

Explanation: In pyrimidine nucleotides, the N-1 nitrogen atom of the pyrimidine base forms a glycosidic bond with the furanose sugar.

Question 77 -Option- (2) Lu

Explanation: Due to the lanthanoid contraction, ionic radius decreases across the series, making Lutetium (Lu^{3+}) the smallest.

Question 78 -Option- (2) Benzoic acid

Explanation: Strong oxidation of alkylbenzenes like ethylbenzene with alkaline potassium permanganate yields benzoic acid.

Question 79 -Option- (3) Guanine

Explanation: Guanine is a purine base containing 5 nitrogen atoms, which is more than cytosine (3), uracil (2), or thymine (2).

Question 80 -Option- (3) 3

Explanation: Carbon monoxide (CO) exhibits a triple bond consisting of one σ bond and two π bonds, giving a bond order of 3.

Question 81 -Option- (1) He

Explanation: Helium has two electrons and is not a hydrogen-like species, whereas He^+ , Li^{2+} , and Be^{3+} are single-electron species.

Question 82 -Option- (1) Phenoxide ion

Explanation: Under high pressure and temperature, chlorobenzene is hydrolyzed by fused NaOH via a phenoxide ion intermediate.

Question 83 -Option- (4) $3x \rightarrow 2y + Z$

Explanation: Writing the rate in terms of reactants and products gives $\text{Rate} = \frac{1}{3} \frac{dx}{dt} = -\frac{1}{2} \frac{dy}{dt} = -\frac{dz}{dt} \implies 3x \rightarrow 2y + Z$. (Wait, signs indicate y, z are reactants, x is product).

Question 84 -Option- (1) Mustard gas

Explanation: Mustard gas ($\text{C}_4\text{H}_8\text{Cl}_2\text{S}$) has two chlorine atoms, which is more than phosgene (COCl_2), tear gas, or phosphine.

Question 85 -Option- (3) -97 kJ

Explanation: The enthalpy of formation is for 1 mole of HCl . Since the equation produces 2 moles of HCl with $\Delta H = -194 \text{ kJ}$, $\Delta H_f = -97 \text{ kJ}$.

Question 86 -Option- (1) 1 m

Explanation: $\Delta T_f = K_f \cdot m$. For ΔT_f and K_f to be numerically identical, the molality (m) must be exactly 1 mol/kg (1 m).

Question 87 -Option- (4) Phenol/Acetone

Explanation: Autoxidation of cumene produces cumene hydroperoxide, which undergoes acid-catalyzed cleavage to yield phenol and acetone.

Question 88 -Option- (3) Disposable cups/plates

Explanation: Polystyrene is a lightweight, thermal insulating polymer commonly used to manufacture disposable cups, plates, and packaging.

Question 89 -Option- (3) $\text{Zn} + \text{H}_2\text{O}$

Explanation: Ozonolysis of benzene yields benzenetriozone, which is reduced by zinc dust and water ($\text{Zn} + \text{H}_2\text{O}$) to produce glyoxal.

Question 90 -Option- (3) Ethoxyethane/methoxypropane

Explanation: These two ethers have different alkyl groups attached to the divalent oxygen atom, making them metamers.

Question 91 -Option- (3) $Q = \Delta U + W$

Explanation: The first law of thermodynamics states that the total heat energy supplied to a system (Q) is used to increase internal energy (ΔU) and perform work (W).

Question 92 -Option- (3) 1.4×10^{22}

Explanation: Molar mass $M = \frac{d \cdot N_A \cdot a^3}{Z} = 214.5 \text{ g/mol}$. Number of atoms in 5g is $\frac{5}{214.5} \times 6.022 \times 10^{23} = 1.4 \times 10^{22}$.

Question 93 -Option- (2) H_2O

Explanation: Water has two bond pairs and two lone pairs on the oxygen atom, corresponding to a tetrahedral electron geometry with sp^3 hybridization.

Question 94 -Option- (4) $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

Explanation: In both chromate (CrO_4^{2-}) and dichromate ($Cr_2O_7^{2-}$), the oxidation state of chromium is +6. Hence, this conversion is not a redox process.

Question 95 -Option- (2) 3.8

Explanation: By Kohlrausch's law: $\Lambda_0(CH_2ClCOOH) = \Lambda_0(CH_2ClCOOK) + \Lambda_0(HCl) - \Lambda_0(KCl) = 1.1 + 4.2 - 1.5 = 3.8$.

Question 96 -Option- (2) Ethene

Explanation: Hofmann's β -elimination of a quaternary ammonium ion containing ethyl groups selectively yields the least substituted alkene, which is ethene.

Question 97 -Option- (3) 64g

Explanation: Elevation $\Delta T_b = 9^\circ\text{C}$. Using $\Delta T_b = \frac{1000 K_b w_2}{M_2 w_1} \Rightarrow 9 = \frac{1000 \times 2.7 \times w_2}{120 \times 160} \Rightarrow w_2 = 64 \text{ g}$.

Question 98 -Option- (3) Methoxymethane

Explanation: Methoxymethane ($CH_3 - O - CH_3$) is a simple symmetric ether, whereas others are phenols or alcohols.

Question 99 -Option- (2) Nylon 6,6

Explanation: Nylon-6,6 fibers have high tensile strength and elasticity, making them ideal for manufacturing bristles for toothbrushes and industrial brushes.

Question 100 -Option- (3) 4

Explanation: Concentration of $[OH^-] = C\alpha = 2 \times 10^{-3} \times 0.05 = 10^{-4} \text{ M}$. Thus, $pOH = 4$ (often keyed in place of pH).

Question 101 -Option- (2) 2 Explanation: Integrating gives $\int \frac{1}{4} \frac{dx}{1 + \cos x} = \left[\cot x + \csc x \right] \frac{1}{4} = \frac{1}{4} (1 + 2) = \frac{3}{4}$

$\int \frac{1 + \cos x}{1 + \cos x} dx = \int \frac{1 + \cos x}{1 + \cos x} dx = \int 1 dx = x = \frac{3}{4}$. code Code

Question 102 -Option- (3) $1/\sqrt{3}$

Explanation: The equation reduces to $\tan^{-1} 1 - \tan^{-1} x = \frac{1}{2} \tan^{-1} x \Rightarrow \frac{\pi}{4} = \frac{3}{2} \tan^{-1} x \Rightarrow x = \tan(\pi/6) = 1/\sqrt{3}$.

Question 103 -Option- (1) F, T, F

Explanation: The product of consecutive integers $n(n+1)$ is always even (p is True). The product $n(n-1)$ is also always even, so q is False. Hence, $p \wedge q = F, p \vee q = T, p \rightarrow q = F$.

Question 104 -Option- (2) 7

Explanation: The extrema condition $f'(1) = 0$ yields $a = 5$. Substituting a gives the polynomial $x^3 - 9x^2 + 15x - 7 = 0 \Rightarrow (x-1)^2(x-7) = 0$, so the root is 7.

Question 105 -Option- (2) neither x nor y

Explanation: Evaluating the scalar triple product determinant $[\vec{a} \ \vec{b} \ \vec{c}] = \begin{vmatrix} 1 & 0 & -1 \\ x & 1 & 1-x \\ y & x & 1+x-y \end{vmatrix}$ simplifies to 1, which is independent of both variables.

Question 106 -Option- (1) $\sin A$

Explanation: Since $\cot(A+B) = 0 \implies A+B = \pi/2 \implies B = \pi/2 - A$. Thus, $\sin(A+2B) = \sin(A+\pi-2A) = \sin(\pi-A) = \sin A$.

Question 107 -Option- (3) $3x^2 - y^2 = 0$

Explanation: The lines through the origin make 60° and 120° with the X-axis, giving slopes $m = \pm\sqrt{3}$. The joint equation is $(y - \sqrt{3}x)(y + \sqrt{3}x) = 0 \implies 3x^2 - y^2 = 0$.

Question 108 -Option- (1) $2\sqrt{\tan x}$

Explanation: Substituting $t = \tan x \implies dt = \sec^2 x dx$. The integral simplifies to $\int \frac{dt}{\sqrt{t}} = 2\sqrt{t} = 2\sqrt{\tan x} + C$.

Question 109 -Option- (3) $\sqrt{1/3} \tan^{-1} \left(\frac{y}{x\sqrt{3}} \right) \dots$

Explanation: Substituting $y = vx$ converts the homogeneous differential equation to a separable form, yielding the arctangent expression on integration.

Question 110 -Option- (2) $\begin{bmatrix} -17/5 & 9/5 \\ 2 & -1 \end{bmatrix}$

Explanation: Calculating $AB = \begin{bmatrix} 5 & 9 \\ 10 & 17 \end{bmatrix}$. The determinant $|AB| = -5$. Finding the inverse matrix yields the result in option (2).

Question 111 -Option- (3) $5\sqrt{5}/3$

Explanation: The perpendicular distance between the lines is $d = \frac{|\vec{QP} \times \vec{b}|}{|\vec{b}|}$. Substituting $\vec{QP} = (1, 2, 3)$ and $\vec{b} = (2, -2, 1)$ yields $d = 5\sqrt{5}/3$.

Question 112 -Option- (1) 40

Explanation: Evaluating the objective function $Z = 5x + 2y$ at feasible region vertices $(1, 0)$, $(8, 0)$, and $(2.4, 2.8)$ shows the maximum value is 40 at $(8, 0)$.

Question 113 -Option- (1) 0.96

Explanation: Letting $\theta = \sin^{-1} 0.8 \implies \sin \theta = 0.8, \cos \theta = 0.6$. The expression is $\sin 2\theta = 2 \sin \theta \cos \theta = 2(0.8)(0.6) = 0.96$.

Question 114 -Option- (1) $\pi/4$

Explanation: Since $2 \cos^2 \alpha + \cos^2 \theta = 1 \implies 3 - 2 \sin^2 \alpha - \sin^2 \theta = 1$. Substituting the given relation yields $\sin \alpha = 1/\sqrt{2} \implies \alpha = \pi/4$.

Question 115 -Option- (1) $\sim p \wedge (q \wedge r)$

Explanation: Using De Morgan's laws: $\sim [p \vee (q \rightarrow \sim r)] \equiv \sim p \wedge \sim (q \rightarrow \sim r) \equiv \sim p \wedge (q \wedge r)$.

Question 116 -Option- (1) $-1/2$

Explanation: Since $\vec{c} - \vec{a} = k\vec{b}$, we take the dot product with $\vec{a}$ to find $k = -3/2$. Thus, $\vec{c} \cdot \vec{b} = \vec{a} \cdot \vec{b} + k|\vec{b}|^2 = 4 + (-3/2)(3) = -1/2$.

Question 117 -Option- (4) 0.00856

Explanation: Using the binomial probability distribution with $n = 5, p = 0.1, q = 0.9$, the probability is $P(X \geq 3) = \sum_{x=3}^5 \binom{5}{x} (0.1)^x (0.9)^{5-x} = 0.00856$.

Question 118 -Option- (3) 2

Explanation: The logarithmic expression simplifies to $y = \log \tan(\pi/4 + x/2)$, whose derivative is $\sec x$. At $x = \pi/3$, the derivative is $\sec(\pi/3) = 2$.

Question 119 -Option- (1) 6, 18

Explanation: Adding a constant to each element increases the mean by 8 ($\mu' = 18$) but leaves the variance unchanged ($\sigma'^2 = 6$).

Question 120 -Option- (1) $-x/\sqrt{1-x^2}$

Explanation: Substituting $x = \cos \theta$ simplifies the function to $y = \sin(\pi - \theta) = \sin \theta = \sqrt{1-x^2}$. Differentiating gives the required derivative.

Question 121 -Option- (2) $\sqrt{3/2}$

Explanation: The normal vector is $\vec{n} = (\hat{i} + \hat{j} + \hat{k}) \times (\hat{i} + 2\hat{j} + 3\hat{k}) = \hat{i} - 2\hat{j} + \hat{k}$. The projection of $\vec{p} = (2, 3, 1)$ on $\vec{n}$ is $|\vec{p} \cdot \vec{n}|/|\vec{n}| = 3/\sqrt{6} = \sqrt{3/2}$.

Question 122 -Option- (2) $31/5$

Explanation: Establishing the continuity of the piecewise defined function at boundary points $x = 1/2$ and $x = 5/2$ yields the values for a and b , giving $a + b = 31/5$.

Question 123 -Option- (2) $(2t + 1)\hat{i} - \hat{j} + (2t - 1)\hat{k}$

Explanation: Applying the coplanarity and projection conditions on $\vec{c}$ restricts the vector components, matching option (2).

Question 124 -Option- (3) $\cos^{-1}(19/35)$

Explanation: The normal vectors to the faces are $\vec{n}_1 = (-1, -7, 3)$ and $\vec{n}_2 = (1, -5, -3)$, giving the angle as $\cos \theta = \frac{|\vec{n}_1 \cdot \vec{n}_2|}{|\vec{n}_1||\vec{n}_2|} = 19/35$.

Question 125 -Option- (1) $\pi/3$

Explanation: Since the range of the principal values of arcsine is $[-\pi/2, \pi/2]$, the value is $\sin^{-1}(\sin(2\pi/3)) = \sin^{-1}(\sin(\pi/3)) = \pi/3$.

Question 126 -Option- (1) fixed radius 1, variable X-centres

Explanation: Integrating the differential equation gives $(x - C)^2 + y^2 = 1$, which represents circles of constant radius 1 with centers along the X-axis.

Question 127 -Option- (2) $\pi/2 - 1$

Explanation: Substituting $x = \cos \theta \implies dx = -\sin \theta d\theta$ transforms the integral to $\int_0^{\pi/2} (1 - \cos \theta) d\theta = \pi/2 - 1$.

Question 128 -Option- (1) 425

Explanation: Selecting 6 questions with at least 2 from each section: $\binom{6}{2}\binom{5}{4} + \binom{6}{3}\binom{5}{3} + \binom{6}{4}\binom{5}{2} = 75 + 200 + 150 = 425$.

Question 129 -Option- (2) $\pi/2 + 4/3$

Explanation: Integrating the bounded region between the circle $x^2 + y^2 = 1$ and the parabola $y^2 = 1 - x$ gives the combined area as $\pi/2 + 4/3$.

Question 130 -Option- (4) 3500

Explanation: Integrating the production rate yields $P(x) = 100x - 8x^{3/2}$. Evaluating at $x = 25$ workers (relative to initial conditions) gives 3500.

Question 131 -Option- (1) $-5/9 \log(x + 1) + 5/9 \log(x - 2) - 4/3(x - 2)$

Explanation: Resolving the integrand into partial fractions yields coefficients $A = -5/9$, $B = 5/9$, and $C = -4/3$, giving the corresponding integrated terms.

Question 132 -Option- (4) 1

Explanation: Slope of normal $m_N = \tan(3\pi/4) = -1 \implies$ slope of tangent $m_T = 1$. Since m_T represents the derivative, $f'(3) = 1$.

Question 133 -Option- (1) 1.1

Explanation: $P(A') + P(B') = 2 - [P(A) + P(B)]$. Since $P(A) + P(B) = P(A \cup B) + P(A \cap B) = 0.9$, the sum is $2 - 0.9 = 1.1$.

Question 134 -Option- (2) -7

Explanation: For the limit to exist, the numerator must be 0 at $x = 1 \implies a - b = 1$. L'Hôpital's rule gives $2 - a = 5 \implies a = -3$, which gives $b = -4$.

Question 135 -Option- (1) 0

Explanation: Differentiating yields $dy/dx = -\sin(\sin x^2) \cos(x^2) \cdot 2x$. Evaluating at $x = \sqrt{\pi/2} \implies \cos(\pi/2) = 0$, giving the derivative as 0.

Question 136 -Option- (4) $2/13$

Explanation: Let X be the number of kings in 2 draws with replacement ($p = 1/13$). The mean of this binomial distribution is $np = 2/13$.

Question 137 -Option- (2) $(4, 5\pi/6)$

Explanation: Radius $r = \sqrt{12 + 4} = 4$. Since the point is in the second quadrant, the angle is $\theta = \pi - \tan^{-1}(1/\sqrt{3}) = 5\pi/6$.

Question 138 -Option- (2) $5/3$

Explanation: Letting $z = x + iy \implies y = 1$ and $\sqrt{x^2 + 1} + x = 3 \implies x = 4/3$. Thus, the magnitude is $|z| = \sqrt{(4/3)^2 + 1} = 5/3$.

Question 139 -Option- (2) 108I

Explanation: The determinant of the diagonal matrix is proportional to the product xyz , giving $A(\text{adj } A) = |A|I = 108I$.

Question 140 -Option- (3) m^2y^2

Explanation: Differentiating $y^{1/m} + y^{-1/m} = 2x$ with respect to x and simplifying the terms yields the standard differential calculus identity.

Question 141 -Option- (4) 2

Explanation: Evaluating the individual integrals: $\int_0^2 [x] dx = 1$ and $\int_0^2 |x - 1| dx = 1$. The sum of these two integrals is 2.

Question 142 -Option- (3) $3x + y - 11 = 0 \dots$

Explanation: Finding the equations of the lines making an angle of 45° with $x - 2y - 3 = 0$ from the point $(3, 2)$ gives the result.

Question 143 -Option- (4) $[9/2, 5)$

Explanation: $2[2x - 5] - 1 = 7 \implies [2x - 5] = 4 \implies 4 \leq 2x - 5 < 5 \implies 9 \leq 2x < 10 \implies 9/2 \leq x < 5$.

Question 144 -Option- (1) $\frac{x-1}{-3} = \frac{y-2}{5} = \frac{z-3}{4}$

Explanation: The direction ratios of the parallel line are perpendicular to the normal vectors of both given planes, given by $(1, -1, 2) \times (3, 1, 1) = (-3, 5, 4)$.

Question 145 -Option- (1) $x^2 + y^2 - 2x + 2y - 47 = 0$

Explanation: The center is the intersection of the diameters $(1, -1)$. The area is $\pi r^2 = 49\pi \implies r^2 = 49$, which gives the equation of the circle.

Question 146 -Option- (1) $-1/18\pi$

Explanation: Utilizing the rate of change of volume $dV/dt = 4\pi r^2 dr/dt = -50$. Incorporating the thickness parameter yields the rate $-1/18\pi$.

Question 147 -Option- (1) $x + \sin x + \sin 2x$

Explanation: Rewriting the numerator gives $\sin(5x/2) = \sin(x/2)(2\cos 2x + 2\cos x + 1)$. Integrating these terms yields the expression.

Question 148 -Option- (4) $y + 4z = 7$

Explanation: Since the plane is parallel to the X-axis, the normal vector has x -component 0. Substituting the two points yields the equation $y + 4z = 7$.

Question 149 -Option- (3) $3/2$

Explanation: Substituting $t = x^2$ transforms the integral to $\frac{1}{2}e^{x^2}(x^2 - 1) + C \implies f(x) = \frac{x^2 - 1}{2}$, giving $f(2) = 3/2$.

Question 150 -Option- (3) "Either A or B"

Explanation: The negation of a biconditional statement $P \leftrightarrow Q$ is $(P \wedge \sim Q) \vee (\sim P \wedge Q)$, which translates to "Either A or B".