

OJEE B Pharm Sample Paper 01

A) Mode and Time: The exam is a Computer Based Test (CBT) lasting 120 minutes.

B) Total Questions: The exam contains 120 questions.

C) Marking Scheme & Rules:

- The question paper is divided into four sections, Physics - 40, Chemistry - 40, Mathematics - 40, and Biology - 40 questions. The candidates must attempt either PCB or PCM as per their choice.
- +4 marks for correct answers and -1 for incorrect ones.

Physics

Q1. The dimensions of $\frac{1}{\mu_0 \epsilon_0}$ are:

- A. $[LT^{-1}]$
- B. $[L^2T^{-2}]$
- C. $[L^{-1}T]$
- D. $[L^{-2}T^2]$

Q2. A projectile is fired with a velocity u making an angle θ with the horizontal. Its trajectory is a parabola. The radius of curvature at the highest point is:

- A. $\frac{u^2 \cos^2 \theta}{g}$
- B. $\frac{u^2 \sin^2 \theta}{g}$
- C. $\frac{u^2 \cos \theta}{g}$
- D. $\frac{u^2}{g}$

Q3. Two masses m_1 and m_2 ($m_1 > m_2$) are connected by a massless string over a frictionless pulley. The acceleration of the system is:

- A. $\frac{m_1 - m_2}{m_1 + m_2} g$
- B. $\frac{m_1 + m_2}{m_1 - m_2} g$
- C. $\frac{2m_1 m_2}{m_1 + m_2} g$
- D. $\frac{m_1 - m_2}{2m_1 m_2} g$

Q4. The work done by a conservative force along a closed path is:

- A. Positive
- B. Negative
- C. Zero
- D. Infinite

Q5. A solid sphere and a solid cylinder of the same mass and radius roll down an inclined plane from the same height. Which reaches the bottom first?

- A. Solid cylinder
- B. Solid sphere
- C. Both simultaneously
- D. Depends on the material

Q6. The escape velocity on the surface of the Earth is v_e . If a body is projected with a velocity $2v_e$, its velocity at infinite distance from the Earth is:

- A. v_e
- B. $\sqrt{2}v_e$
- C. $\sqrt{3}v_e$
- D. $2v_e$

Q7. The Young's modulus of a perfectly rigid body is:

- A. Zero
- B. 1
- C. Infinite
- D. Depends on its density

Q8. According to Bernoulli's theorem, for a steady flow of an ideal liquid, which of the following is constant?

- A. $P + \frac{1}{2}\rho v^2 + \rho gh$
- B. $P - \frac{1}{2}\rho v^2 + \rho gh$
- C. $P + \frac{1}{2}\rho v^2 - \rho gh$
- D. $P + \rho v^2 + gh$

Q9. An ideal gas goes from state A to state B via three different processes. The heat supplied is Q_1, Q_2, Q_3 and work done is W_1, W_2, W_3 respectively. Which is true?

- A. $Q_1 = Q_2 = Q_3$
- B. $W_1 = W_2 = W_3$
- C. $Q_1 - W_1 = Q_2 - W_2 = Q_3 - W_3$
- D. $Q_1 + W_1 = Q_2 + W_2$

Q10. The efficiency of a Carnot engine working between 27°C and 327°C is:

- A. 20%
- B. 50%
- C. 75%
- D. 100%

Q11. For a simple pendulum undergoing SHM, the kinetic energy is maximum at:

- A. Extreme positions
- B. Mean position
- C. Half the amplitude
- D. Independent of position

Q12. Two waves of same frequency and same amplitude 'a' are superposed. If the resultant amplitude is 'a', the phase difference between them is:

- A. $\pi/4$
- B. $\pi/3$
- C. $\pi/2$
- D. $2\pi/3$

Q13. The electric potential V at any point (x, y, z) is $V = 4x^2$ volts. The electric field at $(1, 0, 2)$ in V/m is:

- A. 8 along negative X-axis
- B. 8 along positive X-axis
- C. 16 along negative X-axis
- D. 16 along positive Z-axis

Q14. A capacitor of capacitance C is charged to a potential V and then connected in parallel to an identical uncharged capacitor. The total energy of the system becomes:

- A. CV^2
- B. $\frac{1}{2}CV^2$
- C. $\frac{1}{4}CV^2$
- D. $\frac{1}{8}CV^2$

Q15. The resistance of a wire is R . If it is stretched to double its length, its new resistance is:

- A. $R/2$
- B. $2R$
- C. $4R$
- D. $R/4$

Q16. Kirchhoff's first and second laws for electrical circuits are consequences of:

- A. Conservation of energy and charge respectively
- B. Conservation of charge and energy respectively
- C. Conservation of momentum and energy
- D. Conservation of mass and charge

Q17. A charged particle moves through a magnetic field perpendicular to its velocity. Which of the following changes?

- A. Speed
- B. Kinetic energy
- C. Momentum
- D. Mass

Q18. The magnetic susceptibility of a diamagnetic substance is:

- A. Small and positive
- B. Small and negative
- C. Large and positive
- D. Large and negative

Q19. Magnetic flux ϕ through a coil is $5t^2 - 4t + 1$ Weber. The induced emf at $t = 2$ s is:

- A. 16 V
- B. -16 V
- C. 21 V
- D. -21 V

Q20. In an LCR series circuit, at resonance, the phase difference between current and voltage is:

- A. $\pi/2$
- B. $\pi/4$
- C. Zero
- D. π

Q21. The ratio of the speed of light in a vacuum to the speed of light in a medium is:

- A. Permittivity
- B. Permeability
- C. Refractive index
- D. Polarization constant

Q22. Two coherent light sources have intensities I_1 and I_2 . The ratio of maximum to minimum intensity in the interference pattern is:

- A. $\frac{(\sqrt{I_1} + \sqrt{I_2})^2}{(\sqrt{I_1} - \sqrt{I_2})^2}$
- B. $\frac{I_1 + I_2}{I_1 - I_2}$
- C. $\frac{I_1^2 + I_2^2}{I_1^2 - I_2^2}$
- D. $\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}$

Q23. The de Broglie wavelength of an electron accelerated through a potential difference of V volts is proportional to:

- A. V
- B. $\sqrt{V}$
- C. $1/V$
- D. $1/\sqrt{V}$

Q24. According to Bohr's model, the radius of the n -th orbit is proportional to:

- A. n
- B. n^2
- C. $1/n$
- D. $1/n^2$

Q25. The binding energy per nucleon is maximum for:

- A. ${}^4\text{He}$
- B. ${}^{56}\text{Fe}$
- C. ${}^{100}\text{Mo}$
- D. ${}^{235}\text{U}$

Q26. In a p-n junction diode, the depletion region is formed due to:

- A. Diffusion of majority carriers
- B. Drift of minority carriers
- C. Injection of electrons
- D. Recombination of electrons and holes at the contacts

Q27. Which logic gate is called the universal gate?

- A. AND
- B. OR
- C. NAND
- D. XOR

Q28. If the distance between two masses is doubled, the gravitational force between them becomes:

- A. Doubled
- B. Halved
- C. One-fourth
- D. Four times

Q29. A block of mass m is moving on a rough horizontal surface with velocity v . The coefficient of kinetic friction is μ_k . The distance it travels before stopping is:

- A. $\frac{v^2}{2\mu_k g}$

B. $\frac{v^2}{\mu_k g}$

C. $\frac{v}{\mu_k g}$

D. $\frac{v^2}{4\mu_k g}$

Q30. The moment of inertia of a uniform circular disc of radius R and mass M about its diameter is:

A. $MR^2/2$

B. $MR^2/4$

C. MR^2

D. $2MR^2/5$

Q31. An ideal gas undergoes an adiabatic expansion. Its temperature:

A. Increases

B. Decreases

C. Remains constant

D. Cannot be determined

Q32. The r.m.s. velocity of gas molecules is proportional to:

A. T

B. T^2

C. $\sqrt{T}$

D. $1/\sqrt{T}$

Q33. A lens of power +2.0 D is immersed in a liquid of refractive index equal to that of the lens. The new power is:

A. +2.0 D

B. -2.0 D

C. Zero

D. Infinite

Q34. In Young's double slit experiment, if the slit width ratio is 1:9, the ratio of maximum to minimum intensity is:

A. 4:1

- B. 9:1
- C. 16:1
- D. 25:1

Q35. The stopping potential in the photoelectric effect depends upon:

- A. Intensity of incident light
- B. Frequency of incident light
- C. Angle of incidence
- D. Time of illumination

Q36. Half-life of a radioactive substance is 20 minutes. The fraction of the substance that decays in 60 minutes is:

- A. $1/8$
- B. $7/8$
- C. $1/4$
- D. $3/4$

Q37. In an n-type semiconductor, the majority charge carriers are:

- A. Holes
- B. Electrons
- C. Protons
- D. Neutrons

Q38. A wire of resistance $10\ \Omega$ is bent to form a complete circle. The resistance between two diametrically opposite points is:

- A. $10\ \Omega$
- B. $5\ \Omega$
- C. $2.5\ \Omega$
- D. $20\ \Omega$

Q39. The unit of self-inductance is:

- A. Weber
- B. Henry

C. Tesla

D. Farad

Q40. Electromagnetic waves are:

A. Longitudinal

B. Transverse

C. Both A and B

D. Neither A nor B

Chemistry

Q41. The number of moles of water in 180 g of water is:

A. 1

B. 10

C. 18

D. 100

Q42. The maximum number of electrons in a subshell is given by the expression:

A. $4l - 2$

B. $4l + 2$

C. $2l + 1$

D. $2n^2$

Q43. The element with the highest electron affinity among the halogens is:

A. F

B. Cl

C. Br

D. I

Q44. The hybridization of phosphorus in PCl_5 is:

A. sp^3

B. sp^3d

C. sp^3d^2

D. dsp^3

Q45. According to the kinetic theory of gases, the collision between molecules is:

- A. Perfectly inelastic
- B. Perfectly elastic
- C. Partially elastic
- D. Sticky

Q46. For the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, the unit of K_c is:

- A. mol L^{-1}
- B. L mol^{-1}
- C. $\text{mol}^{-2}\text{L}^2$
- D. Unitless

Q47. The pH of a 10^{-8} M HCl solution is approximately:

- A. 8.0
- B. 6.98
- C. 7.0
- D. 6.0

Q48. In a galvanic cell, oxidation takes place at the:

- A. Anode
- B. Cathode
- C. Salt bridge
- D. Electrolyte

Q49. The order of a reaction for which the rate constant has units s^{-1} is:

- A. Zero
- B. First
- C. Second
- D. Third

Q50. Lyophilic sols are:

- A. Irreversible
- B. Reversible
- C. Unstable
- D. Easily coagulated

Q51. The ore of Aluminium is:

- A. Hematite
- B. Bauxite
- C. Magnetite
- D. Galena

Q52. Which of the following is laughing gas?

- A. NO
- B. NO_2
- C. N_2O
- D. N_2O_5

Q53. The oxidation state of Os in OsO_4 is:

- A. +4
- B. +6
- C. +8
- D. -8

Q54. The coordination number of Co in $[Co(en)_3]^{3+}$ is:

- A. 3
- B. 4
- C. 6
- D. 8

Q55. IUPAC name of $CH_3 - CH(OH) - CH_2 - COOH$ is:

- A. 3-Hydroxybutanoic acid
- B. 2-Hydroxybutanoic acid

C. 4-Hydroxybutanoic acid

D. Butan-3-ol-1-oic acid

Q56. Which of the following shows geometrical isomerism?

A. But-1-ene

B. But-2-ene

C. Propene

D. 2-Methylpropene

Q57. Benzene reacts with CH_3Cl in the presence of anhydrous $AlCl_3$ to form:

A. Chlorobenzene

B. Toluene

C. Xylene

D. Benzyl chloride

Q58. S_N2 reaction is fastest in:

A. Primary alkyl halide

B. Secondary alkyl halide

C. Tertiary alkyl halide

D. Vinyl halide

Q59. Ethanol and Dimethyl ether are:

A. Position isomers

B. Chain isomers

C. Functional isomers

D. Metamers

Q60. Phenol is treated with chloroform and aqueous NaOH to give salicylaldehyde. The reaction is:

A. Reimer-Tiemann

B. Kolbe

C. Friedel-Crafts

D. Wurtz

Q61. Aldehydes can be distinguished from ketones by using:

- A. Tollen's reagent
- B. Grignard reagent
- C. Lucas reagent
- D. Hinsberg reagent

Q62. The most basic amine in an aqueous solution among the following is:

- A. NH_3
- B. CH_3NH_2
- C. $(CH_3)_2NH$
- D. $(CH_3)_3N$

Q63. The sugar present in DNA is:

- A. Glucose
- B. Fructose
- C. Ribose
- D. 2-Deoxyribose

Q64. Which of the following is a condensation polymer?

- A. Teflon
- B. Polyethene
- C. PVC
- D. Nylon-6,6

Q65. Aspirin is chemically:

- A. Methyl salicylate
- B. Acetyl salicylic acid
- C. Salicylic acid
- D. Phenyl salicylate

Q66. In the face-centered cubic lattice, the fraction of the total volume occupied by the atoms is:

- A. 0.52
- B. 0.68
- C. 0.74
- D. 0.80

Q67. The elevation in boiling point for 1 M NaCl solution is twice that of 1 M Glucose solution because:

- A. NaCl is a strong electrolyte
- B. Glucose is a strong electrolyte
- C. NaCl undergoes association
- D. NaCl undergoes dissociation

Q68. Nernst equation describes the relationship between:

- A. Rate and concentration
- B. Electrode potential and concentration
- C. Pressure and volume
- D. Temperature and free energy

Q69. A catalyst alters the:

- A. Enthalpy of reaction
- B. Entropy of reaction
- C. Activation energy
- D. Equilibrium constant

Q70. The Tyndall effect is associated with:

- A. True solutions
- B. Suspensions
- C. Colloids
- D. Emulsions

Q71. The general electronic configuration of transition elements is:

- A. $(n-1)d^{1-10}ns^{1-2}$
- B. $(n-1)d^{10}ns^2$

C. $nd^{1-10}ns^2$

D. $(n-1)d^{1-5}ns^1$

Q72. The shape of XeF_4 molecule is:

- A. Tetrahedral
- B. Square planar
- C. Octahedral
- D. Linear

Q73. Which of the following is an ambidentate ligand?

- A. NH_3
- B. H_2O
- C. CN^-
- D. Cl^-

Q74. The major product of dehydrohalogenation of 2-bromobutane is:

- A. But-1-ene
- B. But-2-ene
- C. Isobutene
- D. Butyne

Q75. Which of the following alcohols yields a ketone on oxidation?

- A. Primary alcohol
- B. Secondary alcohol
- C. Tertiary alcohol
- D. Phenol

Q76. Cannizzaro reaction is not given by:

- A. Formaldehyde
- B. Benzaldehyde
- C. Acetaldehyde
- D. Trichloroacetaldehyde

Q77. Hinsberg's reagent is:

- A. Benzenesulfonyl chloride
- B. p-Toluenesulfonyl chloride
- C. Benzoyl chloride
- D. Acetyl chloride

Q78. The sequence of amino acids in a protein represents its:

- A. Primary structure
- B. Secondary structure
- C. Tertiary structure
- D. Quaternary structure

Q79. Natural rubber is a polymer of:

- A. Neoprene
- B. Isoprene
- C. Chloroprene
- D. Styrene

Q80. Artificial sweetening agent used only in cold food and drinks is:

- A. Saccharin
- B. Sucralose
- C. Aspartame
- D. Alitame

Mathematics

Q81. If A and B are two sets such that $n(A) = 15$, $n(B) = 20$, and $n(A \cap B) = 5$, then $n(A \cup B)$ is:

- A. 30
- B. 35
- C. 40
- D. 25

Q82. The domain of the function $f(x) = \sqrt{4 - x^2}$ is:

- A. $(-\infty, -2] \cup [2, \infty)$
- B. $[-2, 2]$
- C. $(-2, 2)$
- D. $[0, 2]$

Q83. If $z = 3 - 4i$, the modulus of z is:

- A. 3
- B. 4
- C. 5
- D. 25

Q84. The roots of the equation $x^2 - 5x + 6 = 0$ are:

- A. 2, 3
- B. -2, -3
- C. 1, 6
- D. -1, -6

Q85. The number of ways a committee of 3 can be chosen from 5 people is:

- A. 15
- B. 10
- C. 20
- D. 60

Q86. In the expansion of $(x + y)^{10}$, the number of terms is:

- A. 9
- B. 10
- C. 11
- D. 12

Q87. The sum of the infinite geometric series $1 + \frac{1}{2} + \frac{1}{4} + \dots$ is:

- A. 1

- B. 2
- C. 3
- D. Infinite

Q88. The slope of the line passing through $(2, 3)$ and $(4, 7)$ is:

- A. 2
- B. $1/2$
- C. -2
- D. 4

Q89. The eccentricity of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ is:

- A. $3/5$
- B. $4/5$
- C. $5/3$
- D. $2/5$

Q90. The value of $\lim_{x \rightarrow 0} \frac{\tan 3x}{x}$ is:

- A. 1
- B. 3
- C. $1/3$
- D. 0

Q91. The derivative of $\ln(\cos x)$ with respect to x is:

- A. $\tan x$
- B. $-\tan x$
- C. $\cot x$
- D. $-\cot x$

Q92. The maximum value of $\sin x \cos x$ is:

- A. 1
- B. $1/2$
- C. $\sqrt{2}$

D. 2

Q93. The integral $\int xe^x dx$ equals:

A. $xe^x - e^x + C$

B. $xe^x + e^x + C$

C. $e^x - xe^x + C$

D. $\frac{x^2}{2}e^x + C$

Q94. The area bounded by the curve $y = x^2$ and the line $y = 4$ is:

A. $32/3$

B. $16/3$

C. $8/3$

D. 32

Q95. The integrating factor for the differential equation $\frac{dy}{dx} + y = e^{-x}$ is:

A. e^{-x}

B. e^x

C. x

D. $1/x$

Q96. The dot product of vectors $\mathbf{a} = \mathbf{i} + 2\mathbf{j} - \mathbf{k}$ and $\mathbf{b} = 2\mathbf{i} - \mathbf{j} + 3\mathbf{k}$ is:

A. 0

B. -3

C. -1

D. 3

Q97. The distance of the point $(1, -2, 3)$ from the plane $x - y + z = 5$ is:

A. $\frac{1}{\sqrt{3}}$

B. $\frac{2}{\sqrt{3}}$

C. $\sqrt{3}$

D. $\frac{1}{3}$

Q98. Two dice are thrown. The probability of getting a sum of 7 is:

- A. $1/6$
- B. $1/12$
- C. $1/36$
- D. $1/4$

Q99. A die is tossed thrice. The probability of getting an odd number at least once is:

- A. $1/8$
- B. $7/8$
- C. $3/8$
- D. $5/8$

Q100. If A is a square matrix of order 3 and $|A| = 4$, then $|\text{adj}A|$ is:

- A. 4
- B. 16
- C. 64
- D. 12

Q101. Let R be a relation on N defined by $x + 2y = 8$. The domain of R is:

- A. $\{2, 4, 8\}$
- B. $\{2, 4, 6, 8\}$
- C. $\{2, 4, 6\}$
- D. $\{1, 2, 3, 4\}$

Q102. The value of $\cos^{-1}(\cos \frac{7\pi}{6})$ is:

- A. $7\pi/6$
- B. $5\pi/6$
- C. $\pi/6$
- D. $-\pi/6$

Q103. If ω is a complex cube root of unity, then $1 + \omega + \omega^2$ is:

- A. 1
- B. -1

C. 0

D. ω

Q104. How many 4-digit numbers can be formed using 1, 2, 3, 4, 5 without repetition?

A. 120

B. 24

C. 256

D. 625

Q105. The sum of the first n odd natural numbers is:

A. n^2

B. $n(n+1)/2$

C. $n(n+1)$

D. n^3

Q106. The radius of the circle $x^2 + y^2 - 4x + 6y - 12 = 0$ is:

A. 3

B. 4

C. 5

D. 25

Q107. If $y = \sqrt{\sin x + \sqrt{\sin x + \dots \infty}}$, then dy/dx is:

A. $\frac{\cos x}{2y-1}$

B. $\frac{\cos x}{1-2y}$

C. $\frac{\sin x}{2y-1}$

D. $\frac{\sin x}{1-2y}$

Q108. The function $f(x) = x^3 - 3x^2 + 3x - 100$ is:

A. Strictly increasing

B. Strictly decreasing

C. Neither

D. Constant

Q109. Evaluate $\int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x} dx$:

- A. $\pi/2$
- B. $\pi/4$
- C. $\pi/8$
- D. 1

Q110. The degree of the differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^3 + y = 0$ is:

- A. 1
- B. 2
- C. 3
- D. Not defined

Q111. The cross product of vectors **i** and **j** is:

- A. **i**
- B. **j**
- C. **k**
- D. 0

Q112. The shortest distance between two parallel lines is:

- A. Along the normal to both
- B. Zero
- C. Infinite
- D. Variable

Q113. A coin is tossed 3 times. The variance of the number of heads is:

- A. $3/2$
- B. $3/4$
- C. 3
- D. $1/4$

Q114. The median of the data 3, 5, 1, 4, 7, 9 is:

- A. 4

B. 4.5

C. 5

D. 5.5

Q115. $\lim_{x \rightarrow \infty} (1 + \frac{1}{x})^x$ equals:

A. 0

B. 1

C. e D. ∞ **Q116.** $\int \frac{1}{x^2+a^2} dx$ is:A. $\frac{1}{a} \tan^{-1} \frac{x}{a} + C$ B. $\tan^{-1} \frac{x}{a} + C$ C. $\frac{1}{2a} \ln \left| \frac{x-a}{x+a} \right| + C$ D. $\ln |x + \sqrt{x^2 + a^2}|$ **Q117.** If $y = a^x$, then y' is:A. a^x B. xa^{x-1} C. $a^x \ln a$ D. $\frac{a^x}{\ln a}$ **Q118.** The focus of the parabola $y^2 = 8x$ is:

A. (2, 0)

B. (0, 2)

C. (-2, 0)

D. (0, -2)

Q119. If $A = \begin{pmatrix} 2 & 0 \\ 0 & 3 \end{pmatrix}$, then A^{-1} is:A. $\begin{pmatrix} 1/2 & 0 \\ 0 & 1/3 \end{pmatrix}$

B. $\begin{pmatrix} 3 & 0 \\ 0 & 2 \end{pmatrix}$

C. $\begin{pmatrix} -2 & 0 \\ 0 & -3 \end{pmatrix}$

D. $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

Q120. The value of $\sin 15^\circ$ is:

A. $\frac{\sqrt{3}-1}{2\sqrt{2}}$

B. $\frac{\sqrt{3}+1}{2\sqrt{2}}$

C. $\frac{\sqrt{3}}{2}$

D. $\frac{1}{\sqrt{2}}$

Biology

Q121. The basic unit of classification is:

- A. Genus
- B. Species
- C. Order
- D. Family

Q122. Five-kingdom classification was proposed by:

- A. Linnaeus
- B. Whittaker
- C. Darwin
- D. Haeckel

Q123. Fungi differ from plants in that they:

- A. Are heterotrophic
- B. Lack a cell wall
- C. Are prokaryotic
- D. Have chlorophyll

Q124. The xylem in plants is responsible for:

- A. Transport of food
- B. Transport of water
- C. Photosynthesis
- D. Respiration

Q125. The fluid mosaic model of the plasma membrane was proposed by:

- A. Schleiden and Schwann
- B. Singer and Nicolson
- C. Robert Hooke
- D. Camillo Golgi

Q126. During which phase of the cell cycle does DNA replication occur?

- A. G1 phase
- B. S phase
- C. G2 phase
- D. M phase

Q127. The end product of glycolysis is:

- A. Acetyl CoA
- B. Pyruvic acid
- C. Lactic acid
- D. Citric acid

Q128. The light-dependent reactions of photosynthesis take place in the:

- A. Stroma
- B. Thylakoids
- C. Matrix
- D. Cytoplasm

Q129. The human stomach secretes an enzyme called:

- A. Trypsin

- B. Amylase
- C. Pepsin
- D. Lipase

Q130. The respiratory rhythm center in humans is located in the:

- A. Cerebrum
- B. Cerebellum
- C. Medulla oblongata
- D. Hypothalamus

Q131. The pacemaker of the human heart is the:

- A. AV node
- B. SA node
- C. Bundle of His
- D. Purkinje fibers

Q132. The functional unit of the human kidney is the:

- A. Neuron
- B. Nephron
- C. Alveolus
- D. Glomerulus

Q133. Which part of the brain controls voluntary muscle movements and balance?

- A. Cerebrum
- B. Cerebellum
- C. Medulla
- D. Pons

Q134. The hormone responsible for the fight-or-flight response is:

- A. Insulin
- B. Adrenaline
- C. Thyroxine

D. Glucagon

Q135. Double fertilization is a characteristic feature of:

- A. Algae
- B. Fungi
- C. Gymnosperms
- D. Angiosperms

Q136. The male reproductive part of a flower is the:

- A. Carpel
- B. Pistil
- C. Stamen
- D. Stigma

Q137. Leydig cells in the human testes secrete:

- A. Estrogen
- B. Progesterone
- C. Testosterone
- D. FSH

Q138. The site of fertilization in the human female reproductive system is the:

- A. Ovary
- B. Uterus
- C. Fallopian tube
- D. Cervix

Q139. Mendel's law of independent assortment is based on:

- A. Monohybrid cross
- B. Dihybrid cross
- C. Test cross
- D. Back cross

Q140. A person with blood group AB has:

- A. Antigen A and B, no antibodies
- B. Antibody a and b, no antigens
- C. Antigen A and antibody b
- D. Antigen B and antibody a

Q141. The genetic material of the Tobacco Mosaic Virus (TMV) is:

- A. Double-stranded DNA
- B. Single-stranded DNA
- C. Single-stranded RNA
- D. Double-stranded RNA

Q142. The process of synthesis of mRNA from DNA is called:

- A. Replication
- B. Transcription
- C. Translation
- D. Mutation

Q143. The start codon for translation is usually:

- A. UAA
- B. UAG
- C. UGA
- D. AUG

Q144. The book "Origin of Species" was written by:

- A. Lamarck
- B. Darwin
- C. Wallace
- D. Mendel

Q145. Homologous organs indicate:

- A. Convergent evolution
- B. Divergent evolution

C. Parallel evolution

D. Natural selection

Q146. The disease malaria is caused by:

A. Bacteria

B. Virus

C. Protozoan

D. Fungi

Q147. Antibodies are chemically:

A. Carbohydrates

B. Lipids

C. Proteins

D. Nucleic acids

Q148. The widely used restriction endonuclease EcoRI is obtained from:

A. Agrobacterium

B. E. coli

C. Bacillus thuringiensis

D. Thermus aquaticus

Q149. Golden rice is genetically modified to be rich in:

A. Vitamin A

B. Vitamin B

C. Vitamin C

D. Vitamin D

Q150. The interaction where one species benefits and the other is neither harmed nor benefited is:

A. Mutualism

B. Commensalism

C. Parasitism

D. Amensalism

Q151. A graphical representation of the trophic structure of an ecosystem is called:

- A. Food chain
- B. Food web
- C. Ecological pyramid
- D. Biome

Q152. The major contributor to the greenhouse effect is:

- A. SO_2
- B. CO_2
- C. NO_2
- D. CFCs

Q153. Kyoto Protocol is related to:

- A. Ozone depletion
- B. Greenhouse gas emissions
- C. Water pollution
- D. Conservation of biodiversity

Q154. A competitive inhibitor of an enzyme binds to the:

- A. Active site
- B. Allosteric site
- C. Substrate
- D. Coenzyme

Q155. Kranz anatomy is found in the leaves of:

- A. C_3 plants
- B. C_4 plants
- C. CAM plants
- D. All angiosperms

Q156. In humans, the number of floating ribs is:

- A. 2 pairs

- B. 3 pairs
- C. 4 pairs
- D. 5 pairs

Q157. The largest gland in the human body is the:

- A. Pancreas
- B. Thyroid
- C. Liver
- D. Pituitary

Q158. Crossing over occurs during which stage of meiosis?

- A. Leptotene
- B. Zygotene
- C. Pachytene
- D. Diplotene

Q159. Plasmids are found in:

- A. Viruses
- B. Bacteria
- C. Fungi
- D. Protozoa

Q160. The Earth Summit held in Rio de Janeiro in 1992 was for:

- A. Assessing greenhouse gases
- B. Conservation of biodiversity
- C. Controlling ozone depletion
- D. Limiting population growth

Solutions

1. B

Explanation: The quantity $1/(\mu_0\epsilon_0)$ represents the square of the speed of light in a vacuum (c^2). Therefore, its dimensional formula is the square of velocity, which is $[L^2T^{-2}]$.

2. A

Explanation: At the highest point of a projectile's trajectory, the velocity is purely horizontal ($u \cos \theta$) and the only acceleration is due to gravity (g). The radius of curvature is given by $R = v^2/a_{\perp}$, which yields $(u \cos \theta)^2/g$.

3. A

Explanation: In an Atwood machine setup, the net driving force is $(m_1 - m_2)g$ and the total mass being accelerated is $(m_1 + m_2)$. Applying Newton's second law gives the acceleration as $a = \frac{m_1 - m_2}{m_1 + m_2}g$.

4. C

Explanation: A conservative force (like gravity or electrostatic force) is defined by the property that the total work done moving a particle between two points is independent of the path taken. Consequently, work done around any closed path is zero.

5. B

Explanation: The acceleration of a rolling body down an incline depends on its moment of inertia fraction k^2/R^2 . A solid sphere has a smaller factor ($2/5$) compared to a solid cylinder ($1/2$), meaning it accelerates faster and reaches the bottom first.

6. C

Explanation: Using the conservation of energy, the total energy at the surface equals the total energy at infinity: $\frac{1}{2}m(2v_e)^2 - \frac{GmM}{R} = \frac{1}{2}mv'^2$. Since $v_e^2 = \frac{2GM}{R}$, substituting yields the final velocity at infinity as $v' = \sqrt{3}v_e$.

7. C

Explanation: A perfectly rigid body does not undergo any change in its dimensions (zero strain) regardless of the applied stress. Since Young's modulus is the ratio of stress to longitudinal strain, dividing by zero gives an infinite modulus.

8. A

Explanation: Bernoulli's theorem states that for the streamline flow of an ideal, incompressible fluid, the sum of pressure energy, kinetic energy per unit volume, and potential energy per unit volume remains constant ($P + \frac{1}{2}\rho v^2 + \rho gh = \text{const}$).

9. C

Explanation: The change in internal energy (ΔU) of an ideal gas is a state function and depends only on the initial and final states, not the path. According to the first law of thermodynamics ($\Delta U = Q - W$), $Q_1 - W_1 = Q_2 - W_2 = Q_3 - W_3$.

10. B

Explanation: The efficiency of a Carnot engine is $\eta = 1 - (T_2/T_1)$, where temperatures must be in Kelvin. Here, $T_1 = 327^\circ\text{C} = 600\text{ K}$ and $T_2 = 27^\circ\text{C} = 300\text{ K}$, giving an efficiency of $1 - (300/600) = 0.5$ or 50%.

11. B

Explanation: In simple harmonic motion, a particle's velocity is maximum when it passes through the equilibrium (mean) position. Since kinetic energy is proportional to the square of velocity, it attains its maximum value at the mean position.

12. D

Explanation: The resultant amplitude is $A = \sqrt{a^2 + a^2 + 2a^2 \cos \phi}$. If $A = a$, then $a^2 = 2a^2(1 + \cos \phi)$, which simplifies to $\cos \phi = -1/2$. This corresponds to a phase difference of $2\pi/3$ radians (120°).

13. A

Explanation: The electric field is the negative gradient of the potential, $\mathbf{E} = -\nabla V$. For $V = 4x^2$, the field is $E_x = -8x$. At the point $(1, 0, 2)$, $x = 1$, making the field -8 V/m, which is 8 V/m along the negative X-axis.

14. C

Explanation: When a charged capacitor ($Q = CV$) connects to an identical uncharged one, the charge is shared equally, resulting in a common potential $V' = V/2$. The new total energy is $E = \frac{1}{2}(2C)(V/2)^2 = \frac{1}{4}CV^2$.

15. C

Explanation: When a wire is stretched, its volume remains constant. If the length is doubled ($l' = 2l$), the cross-sectional area halves ($A' = A/2$). Since resistance $R = \rho \frac{l}{A}$, the new resistance becomes $4R$.

16. B

Explanation: Kirchhoff's Current Law (first law) is based on the conservation of charge at a junction. Kirchhoff's Voltage Law (second law) is based on the conservation of energy around a closed loop in a circuit.

17. C

Explanation: A magnetic field exerts a force perpendicular to the velocity, changing the particle's direction but not its speed. Since direction changes, the velocity vector and therefore the momentum vector change, while kinetic energy remains constant.

18. B

Explanation: Diamagnetic materials develop a weak induced magnetization in a direction opposite to the applied external magnetic field. Consequently, their magnetic susceptibility is always small and negative.

19. B

Explanation: By Faraday's law of induction, the induced emf is given by $\epsilon = -d\phi/dt$. Differentiating $\phi = 5t^2 - 4t + 1$ yields $10t - 4$. At $t = 2$ s, $\epsilon = -(10(2) - 4) = -16$ V.

20. C

Explanation: At resonance in an LCR series circuit, the inductive reactance equals the capacitive reactance ($X_L = X_C$), canceling each other out. The circuit behaves purely resistively, making the phase difference between voltage and current zero.

21. C

Explanation: The absolute refractive index of a medium is defined physically as the ratio of the speed of light in a vacuum (c) to the speed of light in that specific

medium (v), denoted as $n = c/v$.

22. A

Explanation: In an interference pattern, the maximum intensity occurs when waves interfere constructively $((\sqrt{I_1} + \sqrt{I_2})^2)$, and minimum when they interfere destructively $((\sqrt{I_1} - \sqrt{I_2})^2)$. The ratio of these gives the correct expression.

23. D

Explanation: An electron accelerated through a potential V gains kinetic energy $E = eV$. Its de Broglie wavelength is $\lambda = h/p = h/\sqrt{2mE} = h/\sqrt{2meV}$. Thus, λ is inversely proportional to the square root of V .

24. B

Explanation: According to Bohr's theory for hydrogen-like atoms, the radius of an electron's orbit is given by $r_n = \frac{n^2 h^2 \epsilon_0}{\pi m e^2 Z}$. Therefore, the radius is directly proportional to the square of the principal quantum number, n^2 .

25. B

Explanation: The binding energy per nucleon curve peaks around mass number 56. Iron-56 (^{56}Fe) represents the most tightly bound nucleus in nature, meaning it requires the most energy per nucleon to disassemble.

26. A

Explanation: When a p-n junction is formed, holes from the p-side and electrons from the n-side (majority carriers) diffuse across the junction due to the concentration gradient. Their recombination leaves behind uncompensated ions, forming the depletion region.

27. C

Explanation: A universal logic gate is one that can be used to implement any other Boolean function (such as AND, OR, NOT) entirely on its own. Both NAND and NOR gates are universal gates.

28. C

Explanation: Newton's law of universal gravitation states that the force is inversely proportional to the square of the distance between the masses ($F \propto 1/r^2$). If distance is doubled, the force becomes $1/2^2 = 1/4$ of the original.

29. A

Explanation: The deceleration due to kinetic friction is $a = \mu_k g$. Using the kinematic equation $v^2 = u^2 - 2as$ with final velocity $v = 0$ and initial velocity $u = v$, the stopping distance s is $v^2/(2\mu_k g)$.

30. B

Explanation: The moment of inertia of a uniform disc about an axis passing through its center and perpendicular to its plane is $MR^2/2$. By the perpendicular axes theorem, $I_z = I_x + I_y$, so the moment about a diameter is half of that, yielding $MR^2/4$.

31. B

Explanation: In an adiabatic expansion, the gas does work on its surroundings without exchanging heat ($Q = 0$). According to the first law of thermodynamics, this work is done at the expense of its internal energy, causing a decrease in temperature.

32. C

Explanation: The root mean square (r.m.s.) velocity of gas molecules is derived from kinetic theory as $v_{rms} = \sqrt{3RT/M}$. Therefore, v_{rms} is directly proportional to the square root of the absolute temperature T .

33. C

Explanation: According to the Lens Maker's Formula, if the refractive index of the surrounding liquid matches the refractive index of the lens, the focal length becomes infinite. Consequently, the power ($P = 1/f$) becomes zero.

34. A

Explanation: The intensity ratio is $I_1/I_2 = 1/9$, meaning the amplitude ratio is $a_1/a_2 = 1/3$. The ratio $I_{max}/I_{min} = (a_1 + a_2)^2/(a_2 - a_1)^2 = (3 + 1)^2/(3 - 1)^2 = 16/4 = 4 : 1$.

35. B

Explanation: According to Einstein's photoelectric equation ($eV_0 = h\nu - \Phi$), the stopping potential V_0 is linearly dependent on the frequency of the incident light (ν), independent of its intensity.

36. B

Explanation: Sixty minutes corresponds to 3 half-lives ($60/20$). The fraction of the substance remaining undecayed is $(1/2)^3 = 1/8$. Therefore, the fraction that has decayed is $1 - 1/8 = 7/8$.

37. B

Explanation: In an n-type semiconductor, doping with pentavalent impurities introduces extra conduction electrons. Therefore, electrons are the majority charge carriers, while holes are the minority carriers.

38. C

Explanation: Bending the wire into a circle and taking diametrically opposite points creates two parallel resistors, each half the total resistance ($5\ \Omega$ each). Their equivalent parallel resistance is $(5 \times 5)/(5 + 5) = 2.5\ \Omega$.

39. B

Explanation: Self-inductance measures the ability of a coil to oppose changes in current by inducing an emf. The SI unit for self-inductance is the Henry (H), equivalent to Weber per Ampere.

40. B

Explanation: Electromagnetic waves consist of oscillating electric and magnetic fields that are mutually perpendicular and perpendicular to the direction of propagation. This makes them purely transverse waves.

41. B

Explanation: The number of moles is calculated by dividing the given mass by the molar mass of the substance. For water (H_2O), the molar mass is 18 g/mol , so 180 g corresponds to $180/18 = 10$ moles.

42. B

Explanation: A subshell with an azimuthal quantum number l contains $(2l + 1)$ orbitals. Since Pauli's exclusion principle allows 2 electrons per orbital, the maximum number of electrons is $2(2l + 1) = 4l + 2$.

43. B

Explanation: While fluorine is the most electronegative, chlorine has the highest electron affinity. Fluorine's small size leads to significant electron-electron repulsion, making the addition of an electron energetically less favorable than in chlorine.

44. B

Explanation: Phosphorus in PCl_5 has 5 valence electrons and forms 5 single bonds with chlorine, resulting in 5 bond pairs and 0 lone pairs. This steric number of 5 corresponds to an sp^3d hybridization and trigonal bipyramidal geometry.

45. B

Explanation: A fundamental postulate of the kinetic theory of ideal gases is that intermolecular collisions, as well as collisions with the container walls, are perfectly elastic, meaning there is no net loss of kinetic energy.

46. C

Explanation: For the Haber process, the change in the number of moles of gas is $\Delta n = 2 - (1 + 3) = -2$. The unit of the equilibrium constant K_c is $(\text{mol L}^{-1})^{\Delta n} = (\text{mol L}^{-1})^{-2} = \text{L}^2 \text{mol}^{-2}$.

47. B

Explanation: In very dilute solutions of acids (10^{-8} M), the contribution of H^+ ions from the autoionization of water (10^{-7} M) cannot be ignored. The total $[H^+]$ is slightly greater than 10^{-7} , yielding a pH slightly below 7 (approx 6.98).

48. A

Explanation: By convention in any electrochemical cell, oxidation (loss of electrons) always occurs at the anode, while reduction (gain of electrons) occurs at the cathode.

49. B

Explanation: The general unit for a rate constant k is $(\text{mol L}^{-1})^{1-n} \text{s}^{-1}$, where n is the order of the reaction. For $n = 1$, the concentration terms cancel out, leaving the unit simply as s^{-1} .

50. B

Explanation: Lyophilic (liquid-loving) sols are highly stable due to strong solvent-particle interactions. If the dispersion medium is removed, they can be easily reconstituted by simply mixing them back with the solvent, making them reversible.

51. B

Explanation: Bauxite ($Al_2O_3 \cdot 2H_2O$) is the principal commercial ore of aluminum. Hematite and magnetite are ores of iron, while galena is an ore of lead.

52. C

Explanation: Nitrous oxide (N_2O) is commonly known as laughing gas due to the euphoric effects it produces when inhaled. It is frequently used in dentistry as a mild anesthetic and analgesic.

53. C

Explanation: In osmium tetroxide (OsO_4), oxygen typically exhibits an oxidation state of -2. For the molecule to be neutral, osmium must have an oxidation state of +8, one of the highest known oxidation states for any element.

54. C

Explanation: Ethylenediamine (en) is a bidentate ligand, meaning each molecule forms two coordinate bonds with the central metal ion. With three such ligands, the total number of coordinate bonds (coordination number) is $3 \times 2 = 6$.

55. A

Explanation: Numbering the principal carbon chain starts from the carboxylic acid carbon (C1) to give the lowest locant to substituents. A 4-carbon chain is a butanoic acid, and an -OH group on the third carbon makes it 3-hydroxybutanoic acid.

56. B

Explanation: Geometrical (cis-trans) isomerism requires restricted rotation around a double bond and two different groups attached to each carbon atom of the double bond. But-2-ene ($CH_3 - CH = CH - CH_3$) satisfies these conditions.

57. B

Explanation: This is a Friedel-Crafts alkylation. Benzene reacts with methyl chloride in the presence of a Lewis acid catalyst ($AlCl_3$) to substitute a hydrogen atom with a methyl group, forming toluene (methylbenzene).

58. A

Explanation: The S_N2 (bimolecular nucleophilic substitution) mechanism proceeds via a single-step concerted process. It is highly sensitive to steric hindrance, thus making primary alkyl halides the most reactive substrates.

59. C

Explanation: Ethanol (CH_3CH_2OH) is an alcohol, whereas dimethyl ether (CH_3OCH_3) is an ether. Both share the same molecular formula (C_2H_6O) but possess completely different functional groups, making them functional isomers.

60. A

Explanation: The reaction of phenol with chloroform in an alkaline medium yields ortho-hydroxybenzaldehyde (salicylaldehyde) as the major product. This specific formylation of a phenol ring is called the Reimer-Tiemann reaction.

61. A

Explanation: Tollen's reagent (ammoniacal silver nitrate) is a mild oxidizing agent that can oxidize aldehydes to carboxylic acids, forming a silver mirror. Ketones cannot be oxidized by Tollen's reagent.

62. C

Explanation: In aqueous solution, secondary amines like dimethylamine are most basic because of an optimal balance between the inductive (+I) effect of alkyl groups and the hydrogen-bonding stabilization of the conjugate acid (solvation).

63. D

Explanation: The sugar backbone of Deoxyribonucleic Acid (DNA) consists of 2-deoxyribose, which differs from the ribose found in RNA by lacking an oxygen atom on the second carbon ring position.

64. D

Explanation: Nylon-6,6 is a condensation polymer formed by the step-growth polymerization of hexamethylenediamine and adipic acid, during which small molecules (like water) are eliminated. The others listed are addition polymers.

65. B

Explanation: Aspirin is synthesized by the acetylation of salicylic acid. Its formal chemical name is acetylsalicylic acid, where an acetyl group is attached to the hydroxyl oxygen of salicylic acid.

66. C

Explanation: In a face-centered cubic (FCC) lattice, atoms are located at the corners and face centers, leading to an efficient packing. The packing efficiency represents 74% of the total volume, giving a fraction of 0.74.

67. A

Explanation: Elevation in boiling point is a colligative property dependent on the number of solute particles. NaCl completely dissociates into two ions (Na^+ and Cl^-) per formula unit (van't Hoff factor $i = 2$), unlike the non-electrolyte glucose ($i = 1$).

68. B

Explanation: The Nernst equation allows the calculation of the cell potential (electrode potential) under non-standard conditions. It links the potential to standard electrode potential, temperature, and the reaction quotient (concentration).

69. C

Explanation: A catalyst provides an alternative reaction pathway with a lower activation energy barrier. It does not alter the thermodynamics of the reaction, meaning enthalpy change (ΔH) and equilibrium constant remain unchanged.

70. C

Explanation: The Tyndall effect is the scattering of light by suspended particles in a medium. It is an optical characteristic uniquely observed in colloidal dispersions because the particle size is comparable to the wavelength of light.

71. A

Explanation: Transition elements involve the progressive filling of the $(n-1)d$ orbitals. Their general outer electronic configuration is $(n-1)d^{1-10}ns^{1-2}$, reflecting exceptions like chromium and copper.

72. B

Explanation: Xenon in XeF_4 has 8 valence electrons. With 4 fluorine atoms, it forms 4 single bonds and retains 2 lone pairs. This sp^3d^2 hybridization with two lone pairs on opposite axial positions results in a square planar shape.

73. C

Explanation: An ambidentate ligand contains more than one potential coordinating atom, but binds through only one at a time. The cyanide ion (CN^-) can bond to a metal center either through the carbon atom or the nitrogen atom.

74. B

Explanation: Dehydrohalogenation of 2-bromobutane follows Zaitsev's rule, which states that the most highly substituted alkene is the major product. Thus, elimination of a proton from C3 forms But-2-ene as the major product.

75. B

Explanation: Oxidation of primary alcohols produces aldehydes (and further, carboxylic acids). Secondary alcohols are oxidized to yield ketones, which are generally

resistant to further oxidation under mild conditions.

76. C

Explanation: The Cannizzaro reaction is a disproportionation reaction undergone only by aldehydes that lack α -hydrogen atoms. Acetaldehyde (CH_3CHO) possesses three α -hydrogens and instead undergoes an aldol condensation.

77. A

Explanation: Hinsberg's reagent is benzenesulfonyl chloride ($C_6H_5SO_2Cl$). It reacts differently with primary, secondary, and tertiary amines, making it a classic chemical test to distinguish between these classes of amines.

78. A

Explanation: The primary structure of a protein is the linear sequence of amino acids linked together by peptide bonds. Secondary, tertiary, and quaternary structures describe spatial folding and multi-subunit associations.

79. B

Explanation: Natural rubber is an addition polymer formed by the linkage of isoprene (2-methyl-1,3-butadiene) monomer units. It consists of long chains of cis-1,4-polyisoprene.

80. C

Explanation: Aspartame decomposes at baking or cooking temperatures, making it unsuitable for hot foods. Therefore, its use as an artificial sweetener is strictly limited to cold foods and soft drinks.

81. A

Explanation: Using the principle of inclusion-exclusion for sets, $n(A \cup B) = n(A) + n(B) - n(A \cap B)$. Substituting the given values yields $15 + 20 - 5 = 30$.

82. B

Explanation: For the square root function to be defined in the real numbers, the expression inside must be non-negative. Hence, $4 - x^2 \geq 0$, which factors to $(2 - x)(2 + x) \geq 0$, resulting in the domain $[-2, 2]$.

83. C

Explanation: The modulus of a complex number $z = a + bi$ is defined as $|z| = \sqrt{a^2 + b^2}$. For $z = 3 - 4i$, the modulus is $\sqrt{3^2 + (-4)^2} = \sqrt{9 + 16} = \sqrt{25} = 5$.

84. A

Explanation: The quadratic equation $x^2 - 5x + 6 = 0$ can be factored as $(x - 2)(x - 3) = 0$. Therefore, the roots are $x = 2$ and $x = 3$.

85. B

Explanation: Choosing a committee involves combinations because the order of selection doesn't matter. The number of ways to choose 3 people from 5 is given by $\binom{5}{3} = \frac{5!}{3!2!} = 10$.

86. C

Explanation: For any binomial expansion of the form $(x + y)^n$, the total number of terms produced is $n + 1$. For $n = 10$, there are $10 + 1 = 11$ terms.

87. B

Explanation: This is an infinite geometric series with the first term $a = 1$ and

common ratio $r = 1/2$. Since $|r| < 1$, the sum converges to $S = \frac{a}{1-r} = \frac{1}{1-0.5} = 2$.

88. A

Explanation: The slope m of a line passing through two points (x_1, y_1) and (x_2, y_2) is given by $m = \frac{y_2 - y_1}{x_2 - x_1}$. Substituting the points yields $\frac{7-3}{4-2} = \frac{4}{2} = 2$.

89. A

Explanation: For the standard ellipse equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, where $a > b$, eccentricity is $e = \sqrt{1 - \frac{b^2}{a^2}}$. Here, $e = \sqrt{1 - \frac{16}{25}} = \sqrt{\frac{9}{25}} = \frac{3}{5}$.

90. B

Explanation: To evaluate the limit, we multiply and divide by 3 to use standard limit forms: $\lim_{x \rightarrow 0} 3 \times \frac{\tan 3x}{3x}$. Since $\lim_{u \rightarrow 0} \frac{\tan u}{u} = 1$, the result is $3 \times 1 = 3$.

91. B

Explanation: Using the chain rule, $\frac{d}{dx} [\ln(\cos x)] = \frac{1}{\cos x} \cdot \frac{d}{dx} (\cos x)$. Since the derivative of $\cos x$ is $-\sin x$, the final result is $\frac{-\sin x}{\cos x} = -\tan x$.

92. B

Explanation: The expression can be rewritten using double angle formulas: $\sin x \cos x = \frac{1}{2} \sin(2x)$. The maximum value of the sine function is 1, making the maximum value of the entire expression $1/2$.

93. A

Explanation: Using integration by parts ($\int u dv = uv - \int v du$), let $u = x$ and $dv = e^x dx$. Then $du = dx$ and $v = e^x$. The integral becomes $xe^x - \int e^x dx = xe^x - e^x + C$.

94. A

Explanation: The intersections are at $x = -2, 2$. Area = $\int_{-2}^2 (\text{upper} - \text{lower}) dx = \int_{-2}^2 (4 - x^2) dx$. Evaluating this yields $[4x - \frac{x^3}{3}]_{-2}^2 = (8 - \frac{8}{3}) - (-8 + \frac{8}{3}) = \frac{32}{3}$.

95. B

Explanation: This is a linear first-order differential equation of the form $y' + P(x)y = Q(x)$ where $P(x) = 1$. The integrating factor is $IF = e^{\int P(x) dx} = e^{\int 1 dx} = e^x$.

96. B

Explanation: The dot product is the sum of the products of corresponding components: $\mathbf{a} \cdot \mathbf{b} = (1)(2) + (2)(-1) + (-1)(3) = 2 - 2 - 3 = -3$.

97. A

Explanation: The perpendicular distance from a point (x_1, y_1, z_1) to a plane $Ax + By + Cz + D = 0$ is $\frac{|Ax_1 + By_1 + Cz_1 + D|}{\sqrt{A^2 + B^2 + C^2}}$. Substituting values gives $\frac{|1 - (-2) + 3 - 5|}{\sqrt{1^2 + (-1)^2 + 1^2}} = \frac{1}{\sqrt{3}}$.

98. A

Explanation: There are 36 possible outcomes for two dice. The pairs that sum to 7 are (1,6), (2,5), (3,4), (4,3), (5,2), and (6,1). There are 6 favorable outcomes, so the probability is $6/36 = 1/6$.

99. B

Explanation: The easiest approach is using the complement rule: $P(\text{at least one odd}) = 1 - P(\text{all even})$. $P(\text{all even})$ is $(1/2)^3 = 1/8$. Thus, $P(\text{at least one odd}) =$

$$1 - 1/8 = 7/8.$$

100. B

Explanation: For any $n \times n$ square matrix A , the determinant of its adjoint is given by $|\text{adj}A| = |A|^{n-1}$. Here $n = 3$ and $|A| = 4$, so the determinant is $4^{3-1} = 4^2 = 16$.

101. C

Explanation: The relation is $x = 8 - 2y$. For x and y to belong to the set of natural numbers (N), y can only be 1, 2, or 3 (if $y \geq 4$, x is not a natural number). The corresponding x values (the domain) are $\{6, 4, 2\}$.

102. B

Explanation: The principal value branch of $\cos^{-1}$ is $[0, \pi]$. $\cos(7\pi/6) = \cos(2\pi - 5\pi/6) = \cos(5\pi/6)$. Since $5\pi/6$ lies within the principal range, $\cos^{-1}(\cos(7\pi/6)) = 5\pi/6$.

103. C

Explanation: A fundamental property of the complex cube roots of unity ($1, \omega, \omega^2$) is that their sum always equals zero: $1 + \omega + \omega^2 = 0$.

104. A

Explanation: Selecting 4 digits from 5 without repetition implies calculating permutations: ${}^5P_4 = \frac{5!}{(5-4)!} = 5 \times 4 \times 3 \times 2 = 120$.

105. A

Explanation: The sequence of odd numbers forms an arithmetic progression: 1, 3, 5... The sum of the first n terms of an AP is $\frac{n}{2}(2a + (n-1)d)$. With $a = 1, d = 2$, this simplifies perfectly to n^2 .

106. C

Explanation: A circle equation $x^2 + y^2 + 2gx + 2fy + c = 0$ has radius $\sqrt{g^2 + f^2 - c}$. Here, $g = -2$, $f = 3$, and $c = -12$. The radius is $\sqrt{(-2)^2 + 3^2 - (-12)} = \sqrt{4 + 9 + 12} = 5$.

107. A

Explanation: We can write the infinite nested series as $y = \sqrt{\sin x + y}$. Squaring both sides gives $y^2 = \sin x + y$. Differentiating implicitly gives $2yy' = \cos x + y'$, which rearranges to $y' = \frac{\cos x}{2y-1}$.

108. A

Explanation: Find the derivative: $f'(x) = 3x^2 - 6x + 3 = 3(x-1)^2$. Since a perfect square is always non-negative, $f'(x) \geq 0$ for all real x . Hence, the function is strictly increasing.

109. B

Explanation: Using the definite integral property $\int_0^a f(x)dx = \int_0^a f(a-x)dx$, let I be the integral. Adding the original integral to the transformed one (sin becomes cos) yields $2I = \int_0^{\pi/2} 1dx = \pi/2$, so $I = \pi/4$.

110. A

Explanation: The degree of a differential equation is the power to which the highest order derivative is raised, provided it's a polynomial in derivatives. The highest order derivative here is $\frac{d^2y}{dx^2}$, which has a power of 1.

111. C

Explanation: In the right-handed Cartesian coordinate system, the cross product of the mutually perpendicular basis vectors follows a cyclic rule. Thus, $\mathbf{i} \times \mathbf{j} = \mathbf{k}$.

112. A

Explanation: By geometric definition, the shortest distance between any two parallel lines (or planes) is the perpendicular distance connecting them, which naturally lies along the normal to both lines.

113. B

Explanation: This follows a binomial distribution where $n = 3$, probability of success $p = 1/2$, and probability of failure $q = 1/2$. The variance is defined as $\text{Var}(X) = npq = 3 \times \frac{1}{2} \times \frac{1}{2} = \frac{3}{4}$.

114. B

Explanation: To find the median, first sort the data in ascending order: 1, 3, 4, 5, 7, 9. Since there is an even number of observations (6), the median is the average of the two middle terms: $(4 + 5)/2 = 4.5$.

115. C

Explanation: The expression $\lim_{x \rightarrow \infty} (1 + \frac{1}{x})^x$ is the standard definition of the mathematical constant e (Euler's number), which is approximately 2.718.

116. A

Explanation: This is a standard trigonometric substitution integral. Substituting $x = a \tan \theta$ allows the integrand to be simplified, leading directly to the established formula $\frac{1}{a} \tan^{-1} \frac{x}{a} + C$.

117. C

Explanation: Taking the natural logarithm on both sides yields $\ln y = x \ln a$. Differentiating implicitly with respect to x gives $\frac{1}{y} y' = \ln a$, which simplifies to $y' = y \ln a = a^x \ln a$.

118. A

Explanation: The given equation $y^2 = 8x$ is of the standard form $y^2 = 4ax$. Comparing coefficients gives $4a = 8$, so $a = 2$. The focus of this right-opening parabola is at $(a, 0)$, which is $(2, 0)$.

119. A

Explanation: For a diagonal matrix, the inverse is simply obtained by taking the reciprocals of the diagonal elements, leaving the off-diagonal elements as zero. Thus, the 2 becomes $1/2$ and the 3 becomes $1/3$.

120. A

Explanation: Using the difference formula $\sin(45^\circ - 30^\circ) = \sin 45^\circ \cos 30^\circ - \cos 45^\circ \sin 30^\circ$. Plugging in known values: $(\frac{1}{\sqrt{2}})(\frac{\sqrt{3}}{2}) - (\frac{1}{\sqrt{2}})(\frac{1}{2}) = \frac{\sqrt{3}-1}{2\sqrt{2}}$.

121. B

Explanation: The species is the fundamental, lowest, and most basic taxonomic rank in the biological classification system, representing a group of organisms capable of interbreeding and producing fertile offspring.

122. B

Explanation: R.H. Whittaker (1969) proposed the widely accepted five-kingdom classification system consisting of Monera, Protista, Fungi, Plantae, and Animalia, based on cell structure, body organization, and mode of nutrition.

123. A

Explanation: Unlike autotrophic plants that produce their own food via photosynthesis using chlorophyll, fungi are heterotrophic (specifically saprophytic or parasitic), meaning they must obtain preformed organic nutrients from their environment.

124. B

Explanation: Xylem is the specialized vascular tissue responsible for the unidirectional conduction of water and dissolved mineral nutrients from the roots upward to the stems and leaves.

125. B

Explanation: S.J. Singer and G.L. Nicolson proposed the fluid mosaic model in 1972, depicting the plasma membrane as a dynamic, fluid phospholipid bilayer with various proteins embedded throughout like a mosaic.

126. B

Explanation: The S (Synthesis) phase of the interphase is the specific period during the cell cycle when chromosomal DNA undergoes replication, effectively doubling the genetic content of the cell.

127. B

Explanation: Glycolysis is a ten-step anaerobic metabolic pathway that breaks down one molecule of glucose (a 6-carbon sugar) into two molecules of pyruvic acid (a 3-carbon compound), yielding a net gain of ATP and NADH.

128. B

Explanation: The light-dependent reactions require photosynthetic pigments (like chlorophyll), which are embedded in the membranes of the thylakoids within the chloroplasts, where ATP and NADPH are generated.

129. C

Explanation: The chief cells (peptic cells) in the gastric glands of the stomach secrete pepsinogen, which is activated by hydrochloric acid into the active proteolytic enzyme pepsin to digest proteins.

130. C

Explanation: The primary respiratory rhythm center, which continuously regulates the rate and depth of autonomous breathing, is located in the medulla oblongata of the brainstem.

131. B

Explanation: The Sinoatrial (SA) node, located in the upper wall of the right atrium, is called the natural pacemaker because it possesses the highest inherent rate of depolarization, initiating the cardiac cycle.

132. B

Explanation: The nephron is the microscopic structural and functional unit of the kidney, responsible for filtering blood, reabsorbing necessary substances, and excreting waste products as urine.

133. B

Explanation: The cerebellum, located at the back of the brain, is primarily responsible for coordinating voluntary muscular movements, maintaining posture,

and ensuring physical balance.

134. B

Explanation: Adrenaline (epinephrine), secreted by the adrenal medulla during stress or emergencies, rapidly prepares the body for a "fight or flight" response by increasing heart rate, blood pressure, and glucose mobilization.

135. D

Explanation: Double fertilization is unique to angiosperms (flowering plants). One male gamete fuses with the egg cell to form the zygote, while the other fuses with two polar nuclei to form the triploid primary endosperm nucleus.

136. C

Explanation: The stamen is the male reproductive organ of a flower, consisting of a slender stalk called the filament and an anther at the tip, which produces the pollen grains.

137. C

Explanation: Leydig cells (interstitial cells) are located in the connective tissue between the seminiferous tubules of the testes. They are responsible for synthesizing and secreting male sex hormones, primarily testosterone.

138. C

Explanation: In human females, the fusion of the sperm and the ovum (fertilization) typically occurs in the ampullary region of the fallopian tube (oviduct).

139. B

Explanation: Mendel formulated the law of independent assortment based on his observations from dihybrid crosses (tracking two traits simultaneously), concluding that alleles for different traits segregate independently during gamete formation.

140. A

Explanation: Individuals with the AB blood group are universal recipients. Their red blood cells express both A and B antigens on the surface, but their blood plasma lacks naturally occurring anti-A and anti-B antibodies.

141. C

Explanation: The Tobacco Mosaic Virus (TMV) is a well-studied plant virus. Its genome consists of a single-stranded positive-sense RNA molecule enclosed within a helical protein capsid.

142. B

Explanation: Transcription is the biological process where the genetic information encoded in a specific segment of double-stranded DNA is copied into a complementary single-stranded messenger RNA (mRNA) molecule.

143. D

Explanation: The codon AUG on the mRNA strand serves a dual function: it codes for the amino acid methionine (formylmethionine in prokaryotes) and also universally acts as the initiation (start) codon for protein synthesis.

144. B

Explanation: "On the Origin of Species" is a seminal work in scientific literature authored by Charles Darwin, published in 1859, wherein he introduced the scientific theory that populations evolve over generations through natural selection.

145. B

Explanation: Homologous organs share a common fundamental anatomical plan and embryonic origin but perform different functions (e.g., human arm and bat wing), serving as strong evidence for divergent evolution from a common ancestor.

146. C

Explanation: Malaria is an infectious disease caused by parasitic protozoans belonging to the genus *Plasmodium* (such as *P. falciparum* or *P. vivax*), which are transmitted via the bites of infected female *Anopheles* mosquitoes.

147. C

Explanation: Antibodies, also known as immunoglobulins (Ig), are large, Y-shaped glycoproteins produced by plasma cells (derived from B lymphocytes) in response to specific antigens.

148. B

Explanation: EcoRI is a widely utilized restriction enzyme in molecular biology. The name indicates it was isolated from the bacterium *Escherichia coli* (*E. coli*), specifically from the strain RY13, as the first discovered enzyme of its type.

149. A

Explanation: Golden rice is a genetically engineered variety of rice (*Oryza sativa*) designed to synthesize beta-carotene, a precursor to Vitamin A, in the edible parts of rice to combat Vitamin A deficiency.

150. B

Explanation: Commensalism is an ecological relationship between two organisms where one benefits (the commensal) while the other (the host) derives neither benefit nor harm from the association.

151. C

Explanation: An ecological pyramid is a graphical representation designed to show the biomass, bio-productivity, or number of organisms at each successive trophic level within a given ecosystem.

152. B

Explanation: While multiple gases contribute to the greenhouse effect, Carbon dioxide (CO_2) is the most significant anthropogenic greenhouse gas due to its massive abundance from fossil fuel combustion and deforestation.

153. B

Explanation: The Kyoto Protocol is an international treaty extending the 1992 UNFCCC, committing state parties to reduce greenhouse gas emissions based on the scientific consensus that global warming is occurring.

154. A

Explanation: A competitive inhibitor structurally resembles the natural substrate and competes directly for binding at the active site of the enzyme, temporarily preventing the substrate from binding and halting catalysis.

155. B

Explanation: Kranz anatomy is a specialized leaf structure found in C₄ plants (like maize and sugarcane). It features an inner ring of bundle sheath cells and an outer ring of mesophyll cells, adapting the plant to minimize photorespiration.

156. A

Explanation: Humans typically have 12 pairs of ribs. The last two pairs (11th and 12th) are called floating ribs because they are attached only to the vertebrae in the back and have no anterior cartilaginous connection to the sternum.

157. C

Explanation: The liver is the largest internal organ and the largest exocrine gland in the human body, performing vital metabolic, detoxification, and digestive functions (such as bile production).

158. C

Explanation: Crossing over, the physical exchange of genetic material between non-sister chromatids of homologous chromosomes, occurs specifically during the pachytene stage of Prophase I in meiosis.

159. B

Explanation: Plasmids are small, circular, double-stranded, extrachromosomal DNA molecules that replicate independently of the chromosomal DNA. They are found naturally in bacteria and some archaea and eukaryotes.

160. B

Explanation: The United Nations Conference on Environment and Development (UNCED), also known as the Rio Earth Summit, culminated in major agreements including the Convention on Biological Diversity (CBD) focused on conservation and sustainable use.