NEET 2026 SAMPLE PAPER 7

A) Total Duration: 3-hour and 20-minute (200 minutes)
B) Pattern: 180 Multiple Choice Questions (MCQs) out of a total of 200
C) Marking Scheme & Rules:

- Correct Answer: +4 marks
- Incorrect Answer: -1 mark (Negative marking)
- Unattempted Question: 0 marks
- Multiple Answers: Treated as incorrect, attracting -1 mark

Physics (Section A)

Q1. What is the ratio of the fundamental frequency of an open organ pipe to that of a closed organ pipe, assuming both have the exact same length?

A. 2:1

B. 1:2

C. 3:1

D. 1:3

Q2. If the shortest wavelength observed in the Balmer series of a hydrogen atom is denoted as λ, what will be the shortest wavelength present in the Brackett series?

A. 2λ

B. 4λ

C. 9λ

D. 16λ

Q3. The underlying operating principle of a venturi-meter is based on:

A. The principle of parallel axes

B. Huygen's principle

C. Bernoulli's principle

D. The principle of perpendicular axes

Q4. Which of the following expressions represents the average thermal energy of a monoatomic gas at absolute temperature T? (where k_B is the Boltzmann constant)

A. $\frac{1}{2}k_BT$

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

C. $\frac{5}{2}k_BT$

D. $\frac{7}{2}k_BT$

Q5. The Bohr model of the atom fails to accurately describe the atomic spectra of which of the following species?

A. Deuteron atom

B. Hydrogen atom

C. Singly ionized helium atom (He^+)

D. Singly ionized neon atom (Ne^+)

Q6. Two solid copper spheres have radii r_1 and r_2 such that $r_1 = 1.5r_2$. What is the ratio of the heat energy required to raise the temperature of both spheres by 1 K?

A. 3/2

B. 9/4

C. 27/8

D. 5/3

Q7. When a capillary tube of radius r is dipped in water, the mass of the water that rises in it is 5 g. If another capillary tube with radius $2r$ is dipped, what will be the mass of the raised water?

A. 2.5 g

B. 5.0 g

C. 10.0 g

D. 20.0 g

Q8. A massless rigid rod of length 1 m has two particles of mass 5 kg and 10 kg attached to its ends. At what distance from the 5 kg mass is the center of mass located?

A. 33 cm

B. 50 cm

C. 67 cm

D. 80 cm

Q9. An iron rod possessing a magnetic susceptibility of 599 is placed in a magnetizing field. Calculate the absolute permeability. ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})

A. $2.4\pi \times 10^{-4}$

B. $2.4\pi \times 10^{-5}$

C. $2.4\pi \times 10^{-7}$

D. 8.0×10^{-5}

Q10. Determine the density of hydrogen gas at $27°C$ and 249 kPa. $(R = 8.3)$

A. 0.02

B. 0.1

C. 0.2

D. 0.5

Q11. A solid object weighs 72 N on Earth. What will be the force at an altitude equal to half the Earth's radius?

A. 24 N

B. 30 N

C. 32 N

D. 48 N

Q12. An electron accelerated by potential V has de Broglie wavelength 1.227×10^{-2} nm. Find V.

A. 10

B. 10^2

C. 10^3

D. 10^4

Q13. Calculate electric potential at 0.6 m from a dipole making 60° with axis. Dipole moment $= 16 \times 10^{-9}$ C m.

A. Zero

B. 50 V

C. 200 V

D. 400 V

Q14. A stone is thrown downward at 20 m/s and hits ground at 80 m/s. Find height. $(g = 10)$

A. 300 m

B. 320 m

C. 340 m

D. 360 m

Q15. Mean free path formula is:

A. $\frac{1}{\sqrt{2}n\pi d}$

B. $\frac{1}{\sqrt{2}n\pi d^2}$

C. $\frac{1}{\sqrt{2}n^2\pi d^2}$

D. $\frac{1}{\sqrt{2}n^2\pi^2 d^2}$

Q16. Electric field at 15 cm from sphere of radius 10 cm with charge 3.2×10^{-7} C:

A. 1.28×10^4

B. 1.28×10^5

C. 1.28×10^6

D. 1.28×10^7

Q17. Ratio of electric to magnetic intensity contribution in EM wave:

A. 1 : 1

B. 1 : c

C. c : 1

D. 1 : c^2

Q18. In YDSE, slit distance halved and screen distance doubled. Fringe width:

A. Half

B. Same

C. Double

D. Four times

Q19. Beat frequency changes from 6 to 7 Hz. If A = 530 Hz, find B:

A. 523

B. 524

C. 536

D. 537

Q20. Depletion region increases due to:

A. Forward bias

B. Reverse bias

C. Both

D. Increase current

Q21. Dimensional formula of stress:

A. $[MLT^{-2}]$

B. $[ML^0T^{-2}]$

C. $[ML^{-1}T^{-2}]$

D. $[ML^{-2}T^{-2}]$

Q22. Young's modulus expression:

A. $\frac{MgL}{A(L_1-L)}$

B. $\frac{Mg(L_1-L)}{AL}$

C. $\frac{MgL_1}{AL}$

D. $\frac{MgL}{AL_1}$

Q23. Power factor of LCR circuit:

A. Zero

B. 0.5

C. 0.866

D. 1

Q24. Resolution of telescope:

A. 1.83×10^{-7}

B. 3.66×10^{-7}

C. 6.0×10^{-7}

D. 7.32×10^{-7}

Q25. 10^{-20} J in eV:

A. 0.006

B. 0.06

C. 0.6

D. 6

Q26. Pitch of screw gauge:

A. 0.01 mm

B. 0.25 mm

C. 0.5 mm

D. 1.0 mm

Q27. Angle of incidence in prism:

A. $A/2\mu$

B. $\mu A/2$

C. μA

D. $2\mu A$

Q28. RMS current in capacitor circuit:

A. 1.7

B. 2.05

C. 2.5

D. 25.1

Q29. Resistor value (Yellow Violet Brown Gold):

A. $470\Omega, 5\%$

B. $4.7k\Omega, 5\%$

C. $47k\Omega, 10\%$

D. $470k\Omega, 5\%$

Q30. Magnetic field in solenoid:

A. 3.14×10^{-4}

B. 6.28×10^{-4}

C. 3.14×10^{-5}

D. 6.28×10^{-5}

Q31. Potential energy change:

A. 2U

B. 4U

C. 8U

D. 16U

Q32. Temperature for 4x RMS speed:

A. $66°C$

B. 223 K

C. 3097 K

D. $3295°C$

Q33. Angular acceleration direction:

A. Tangent

B. Radius inward

C. Axis

D. Radius outward

Q34. Magnetic field amplitude:

A. 1.6×10^{-6}

B. 1.6×10^{-7}

C. 1.6×10^{-8}

D. 1.6×10^{-9}

Q35. Average speed:

A. $4v/3$

B. $3v/4$

C. $2v/3$

D. $v/3$

Physics (Section B)

Q36. Determine the magnifying power of a small telescope designed for viewing distant celestial objects if the focal lengths of its objective lens and eyepiece are 140 cm and 5.0 cm, respectively.

A. 34

B. 28

C. 17

D. 32

Q37. Consider a satellite revolving in a circular orbit extremely close to the Earth's surface with a time period T. Given the Earth's average density d and the universal gravitational constant G, what physical quantity is exactly equivalent to the expression $\frac{3\pi}{Gd}$?

A. T

B. T^2

C. T^3

D. $\sqrt{T}$

Q38. A thin convex lens and a thin concave lens, both having the identical magnitude of focal length f, are positioned in direct contact along their primary axis. What will be the effective focal length of this combined lens system?

A. Zero

B. $f/4$

C. $f/2$

D. Infinite

Q39. A block rests on the flat floor of a transporting car. If the coefficient of static friction between the block and the floor is exactly 0.15, find the maximum forward acceleration the car can possess without the block sliding backward. (Take $g = 10\,m/s^2$)

A. $1.2\,m/s^2$

B. $150\,m/s^2$

C. $1.5\,m/s^2$

D. $50\,m/s^2$

Q40. The ground state (innermost orbit) radius of a hydrogen atom is documented as $5.3 \times 10^{-11}\, m$. Based on Bohr's atomic model, calculate the radius of the third allowed orbit for this same atom.

A. $0.53\, \mathring{A}$

B. $1.06\, \mathring{A}$

C. $1.59\, \mathring{A}$

D. $4.77\, \mathring{A}$

Q41. A circuit contains 10 identical resistors, each possessing a resistance R. When connected strictly in series across a battery of emf E (with zero internal resistance), a certain current flows. If these 10 resistors are instead re-wired in a parallel combination across the exact same battery, the main current drawn from the source increases by a factor of n. Determine the value of n.

A. 10

B. 100

C. 1

D. 1000

Q42. An alternating current source operating at 210 V (rms) and 50 Hz is connected directly across a $10\,\mu F$ capacitor. Compute the approximate peak alternating current flowing through the circuit. (Use $\pi \approx 3.14$)

A. 0.58 A

B. 0.93 A

C. 1.20 A

D. 0.35 A

Q43. A straight iron bar magnet of length L possesses an initial magnetic dipole moment M. It is carefully bent at its exact midpoint so that its two halves subtend an angle of 60° between them. What is the magnetic dipole moment of the newly formed bent structure?

A. M

B. $M/2$

C. $2M$

D. $M/\sqrt{3}$

Q44. Calculate the minimum total kinetic energy necessary to launch a satellite of mass m from the Earth's surface (Mass M, Radius R) into a stable circular orbit at an altitude exactly equal to $2R$ above the surface.

A. $\frac{5GmM}{6R}$

B. $\frac{2GmM}{3R}$

C. $\frac{GmM}{2R}$

D. $\frac{GmM}{3R}$

Q45. Two electrical heating coils are rated at 1 kW and 2 kW (for the exact same operational voltage). They are first connected in series, and subsequently in parallel, across a constant voltage supply. Find the specific ratio of the total power dissipated in the series configuration to the total power dissipated in the parallel configuration.

A. 1:1

B. 2:9

C. 1:2

D. 2:3

Q46. A particle experiences a time-dependent linear force modeled by the equation $F = \alpha t^2 + \beta t$, where t denotes time and α, β are constant physical parameters. Which of the following mathematical combinations will yield a strictly dimensionless quantity?

A. $\frac{\beta t}{\alpha}$

B. $\frac{\alpha t}{\beta}$

C. $\alpha\beta t$

D. $\frac{\alpha\beta}{t}$

Q47. A straight conducting wire of length L carries a steady current I oriented strictly along the positive x-axis direction. It is placed into a uniform magnetic field region defined by the vector $\vec{B} = (2\hat{i} + 3\hat{j} - 4\hat{k})$ Tesla. What is the overall magnitude of the magnetic force exerted on this wire?

A. $3IL$

B. $\sqrt{5}IL$

C. $5IL$

D. $\sqrt{3}IL$

Q48. A high-speed bullet strikes a thick rectangular wooden block with an initial velocity u. After penetrating exactly 24 cm horizontally into the block's length, its velocity drops to $u/3$. Assuming constant internal deceleration, the bullet continues to penetrate and comes to rest precisely at the opposite edge of the block. Calculate the total horizontal length of the wooden block.

A. 27 cm

B. 24 cm

C. 28 cm

D. 30 cm

Q49. Identify the INCORRECT statement regarding the fundamental physical properties of an electromagnetic wave propagating through a vacuum:

A. They are strictly transverse in their wave nature.

B. The average energy density residing in the electric field equals the energy density in the magnetic field.

C. They are originated by charges moving with a uniform speed.

D. They traverse the vacuum with a uniform velocity equal to $1/\sqrt{\mu_0\epsilon_0}$.

Q50. An alternating LCR series circuit consists of an inductor with $L = \frac{50}{\pi}\,mH$, a resistor $R = 10\,\Omega$, and a capacitor $C = \frac{10^3}{\pi}\,\mu F$. If the entire circuit is driven by an alternating voltage source of 220 V at 50 Hz, compute the net impedance offered by the circuit.

A. $10\sqrt{2}\,\Omega$

B. 15 Ω

C. $5\sqrt{5}\,\Omega$

D. 25 Ω

Chemistry (Section A)

Q51. According to the Bohr model, how does the radius of an orbit (r) relate to the principal quantum number (n)?

A. $r \propto n$

B. $r \propto n^2$

C. $r \propto \frac{1}{n}$

D. $r \propto \frac{1}{n^2}$

Q52. Which set of quantum numbers (n, l, m_l, m_s) is strictly not permissible for an electron in an atom?

A. 3, 2, -2, +1/2

B. 4, 0, 0, -1/2

C. 2, 2, -1, +1/2

D. 5, 3, 0, -1/2

Q53. Under what conditions do real gases behave most ideally?

A. High pressure and high temperature

B. Low pressure and high temperature

C. Low pressure and low temperature

D. High pressure and low temperature

Q54. For an isothermal reversible expansion of an ideal gas, which of the following is true regarding the internal energy change (ΔU)?

A. $\Delta U > 0$

B. $\Delta U < 0$

C. $\Delta U = 0$

D. $\Delta U = q$

Q55. Hess's Law of Constant Heat Summation is a direct consequence of which thermodynamic principle?

A. Entropy maximization

B. Enthalpy being a state function

C. The Second Law of Thermodynamics

D. Heat capacity being independent of temperature

Q56. For the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, what is the relationship between K_p and K_c?

A. $K_p = K_c$

B. $K_p = K_c(RT)^2$

C. $K_p = K_c(RT)^{-2}$

D. $K_p = K_c(RT)^{-1}$

Q57. In the exothermic reaction $A(g) + B(g) \rightleftharpoons C(g)$, an increase in temperature will cause the equilibrium to shift in which direction?

A. Forward, increasing products

B. Backward, increasing reactants

C. No shift occurs

D. It will oscillate between reactants and products

Q58. Which of the following mixtures acts as a basic buffer?

A. $CH_3COOH + CH_3COONa$

B. $HCl + NaCl$

C. $NH_4OH + NH_4Cl$

D. $NaOH + NaCl$

Q59. What happens to the standard cell potential (E°) if you multiply the stoichiometry of a redox reaction by 2?

A. It doubles

B. It halves

C. It is squared

D. It remains the same

Q60. For a first-order reaction, how does the half-life ($t_{1/2}$) depend on the initial concentration ($[A]_0$)?

A. $t_{1/2} \propto [A]_0$

B. $t_{1/2}$ is independent of $[A]_0$

C. $t_{1/2} \propto \frac{1}{[A]_0}$

D. $t_{1/2} \propto [A]_0^2$

Q61. In the Arrhenius equation, $k = Ae^{-E_a/RT}$, what does the pre-exponential factor (A) represent?

A. The activation energy barrier

B. The fraction of molecules with enough energy

C. The frequency of collisions with correct orientation

D. The universal gas constant

Q62. What is the coordination number of an atom in a face-centered cubic (fcc) lattice?

A. 6

B. 8

C. 12

D. 4

Q63. Which of the following aqueous solutions will exhibit the highest boiling point elevation, assuming complete dissociation?

A. 0.1 M Glucose

B. 0.1 M NaCl

C. 0.1 M $CaCl_2$

D. 0.1 M $FeCl_3$

Q64. Which element has the highest first ionization energy?

A. Helium (He)

B. Neon (Ne)

C. Fluorine (F)

D. Hydrogen (H)

Q65. According to VSEPR theory, what is the molecular geometry of SF_4?

A. Tetrahedral

B. Square planar

C. See-saw

D. Trigonal bipyramidal

Q66. What is the hybridization of the central iodine atom in the I_3^- ion?

A. sp^3

B. sp^3d

C. sp^3d^2

D. sp

Q67. Using Molecular Orbital Theory, calculate the bond order of the O_2^- (superoxide) ion.

A. 2

B. 1.5

C. 1

D. 2.5

Q68. What is the oxidation state of Cobalt in the complex $[Co(NH_3)_4Cl_2]Cl$?

A. +2

B. +3

C. +4

D. +1

Q69. Which of the following ligands is considered a 'strong field' ligand according to the spectrochemical series?

A. I^-

B. H_2O

C. CN^-

D. Cl^-

Q70. Which s-block metal imparts an apple-green color to a Bunsen flame?

A. Sodium (Na)

B. Potassium (K)

C. Barium (Ba)

D. Calcium (Ca)

Q71. The tendency of the heavier p-block elements to exhibit an oxidation state two less than their group oxidation state is known as:

A. The shielding effect

B. The lanthanide contraction

C. The inert pair effect

D. The common ion effect

Q72. Why are most transition metal (d-block) complexes colored?

A. Due to d-d electron transitions

B. Because they emit light spontaneously

C. Due to nuclear magnetic resonance

D. Because they have full d-orbitals

Q73. What is the IUPAC name for CH_3-CH(OH)-CH_2-CHO?

A. 3-hydroxybutanal

B. 2-hydroxybutanal

C. 4-oxobutan-2-ol

D. Butan-1-al-3-ol

Q74. Which of the following compounds can exhibit optical isomerism (chirality)?

A. 1-chlorobutane

B. 2-chlorobutane

C. 1,2-dichloroethane

D. Propan-2-ol

Q75. An S_N1 reaction proceeds via the formation of which intermediate?

A. A carbanion

B. A radical

C. A pentacoordinate transition state

D. A carbocation

Q76. Which group is a meta-directing deactivator in electrophilic aromatic substitution?

A. -CH_3 (Methyl)

B. -OH (Hydroxyl)

C. -NO_2 (Nitro)

D. -Cl (Chloro)

Q77. The addition of HBr to propene in the absence of peroxides follows which rule?

A. Anti-Markovnikov's rule

B. Markovnikov's rule

C. Zaitsev's rule

D. Hund's rule

Q78. Which molecule will readily undergo an Aldol condensation when treated with dilute base?

A. Formaldehyde (HCHO)

B. Benzaldehyde (C_6H_5CHO)

C. Acetaldehyde (CH_3CHO)

D. Trichloroacetaldehyde (CCl_3CHO)

Q79. In the Cannizzaro reaction, an aldehyde with no alpha-hydrogens undergoes what kind of transformation?

A. Complete oxidation

B. Disproportionation

C. Dehydration

D. Polymerization

Q80. What is the final product when a Grignard reagent (RMgX) reacts with carbon dioxide followed by acid hydrolysis?

A. An aldehyde

B. A ketone

C. A primary alcohol

D. A carboxylic acid

Q81. Why is phenol more acidic than ethanol?

A. Due to the +I effect of the benzene ring

B. Resonance stabilization of the phenoxide ion

C. The high electronegativity of the ethyl group

D. Intramolecular hydrogen bonding in phenol

Q82. Which of the following amines is the most basic in an aqueous solution?

A. Ammonia (NH_3)

B. Primary amine (e.g., CH_3NH_2)

C. Secondary amine (e.g., $(CH_3)_2NH$)

D. Tertiary amine (e.g., $(CH_3)_3N$)

Q83. Which carbohydrate cannot be hydrolyzed into simpler sugar units?

A. Sucrose

B. Starch

C. Monosaccharide

D. Maltose

Q84. Which of the following is a condensation polymer?

A. Polyethylene

B. PVC (Polyvinyl chloride)

C. Nylon-6,6

D. Teflon

Q85. What test is commonly used to distinguish primary, secondary, and tertiary alcohols based on cloudiness appearance times?

A. Tollens' test

B. Iodoform test

C. Lucas test

D. Hinsberg test

Chemistry (Section B)

Q86. How many Faradays of electricity are required to reduce 1 mole of MnO_4^- to Mn^{2+}?

A. 1 F

B. 3 F

C. 5 F

D. 7 F

Q87. Which of the following ions is colorless in an aqueous solution?

A. Ti^{3+}

B. V^{3+}

C. Cu^{+}

D. Fe^{3+}

Q88. Which of the following alkyl halides undergoes an S_N2 reaction at the fastest rate?

A. CH_3Cl

B. CH_3Br

C. CH_3I

D. CH_3F

Q89. An aqueous solution freezes at -0.186 °C. If K_f for water is 1.86 K kg mol^{-1} and K_b is 0.512 K kg mol^{-1}, what is the boiling point of this solution?

A. 100.186 °C

B. 100.512 °C

C. 100.0512 °C

D. 101.86 °C

Q90. Which type of isomerism is shown by the complex $[Co(en)_2Cl_2]^+$?

A. Only Geometrical

B. Only Optical

C. Both Geometrical and Optical

D. Ionization

Q91. The reductive ozonolysis of an alkene yields equal molar amounts of propanone and methanal. The original alkene is:

A. 2-methylpropene

B. But-2-ene

C. 2-methylbut-2-ene

D. Pent-2-ene

Q92. A Frenkel defect is most likely to be observed in the crystal lattice of which compound?

A. NaCl

B. AgBr

C. KCl

D. CsCl

Q93. The carbylamine reaction is a characteristic chemical test used to identify which class of compounds?

A. Primary amines

B. Secondary amines

C. Tertiary amines

D. Amides

Q94. What is the expected shape of the XeF_2 molecule according to VSEPR theory?

A. Bent

B. Linear

C. V-shaped

D. Tetrahedral

Q95. For a chemical reaction to be spontaneous at all temperatures, the signs of the enthalpy change (ΔH) and entropy change (ΔS) must respectively be:

A. $\Delta H > 0$, $\Delta S > 0$

B. $\Delta H > 0$, $\Delta S < 0$

C. $\Delta H < 0$, $\Delta S > 0$

D. $\Delta H < 0$, $\Delta S < 0$

Q96. Which nitrogenous base is present in RNA but is completely absent in DNA?

A. Adenine

B. Thymine

C. Uracil

D. Cytosine

Q97. A radioactive isotope has a half-life of 10 days. If you start with a 100 g sample, how much of the isotope will remain after exactly 30 days?

A. 10 g

B. 12.5 g

C. 25 g

D. 33.3 g

Q98. Heating a dry mixture of sodium benzoate and soda lime primarily yields which organic compound?

A. Phenol

B. Benzene

C. Benzaldehyde

D. Toluene

Q99. In the extraction of copper from its sulphide ore, the final extraction of the metal involves the reduction of copper(I) oxide with:

A. Carbon monoxide

B. Copper(I) sulphide

C. Sulfur dioxide

D. Iron(II) sulfide

Q100. According to the de Broglie equation, the wavelength of a moving particle is inversely proportional to its:

A. Mass only

B. Velocity only

C. Momentum

D. Kinetic energy

Botany (Section A)

Q101. The cell wall of fungi is primarily composed of which complex polysaccharide?

A. Cellulose

B. Peptidoglycan

C. Chitin

D. Hemicellulose

Q102. In members of Rhodophyceae (red algae), the reserve food material is stored in the form of:

A. Mannitol

B. Laminarin

C. Floridean starch

D. Glycogen

Q103. Which group of plants is commonly referred to as the "amphibians of the plant kingdom" because they require water for sexual reproduction?

A. Algae

B. Bryophytes

C. Pteridophytes

D. Gymnosperms

Q104. Gymnosperms differ from angiosperms primarily in having:

A. Tracheids in their xylem

B. Naked ovules not enclosed by an ovary wall

C. Broad, parallel-veined leaves

D. Motile male gametes

Q105. Pneumatophores are specialized, negatively geotropic roots found in:

A. Epiphytes

B. Halophytes

C. Hydrophytes

D. Xerophytes

Q106. A fleshy, green, photosynthetic stem of indeterminate growth that is modified to perform the functions of a leaf is called a:

A. Phylloclade

B. Cladode

C. Phyllode

D. Tendril

Q107. Whorled phyllotaxy is characterized by more than two leaves arising at a single node. Which of the following plants exhibits this?

A. Calotropis

B. Mustard

C. China rose

D. Alstonia

Q108. In a racemose inflorescence, the main axis continues to grow, and the flowers are arranged in a(n):

A. Basipetal succession

B. Acropetal succession

C. Intercalary manner

D. Centrifugal order

Q109. Axile placentation, where the ovules are attached to a central axis in a multilocular ovary, is observed in:

A. Pea

B. Dianthus

C. Tomato

D. Sunflower

Q110. Intercalary meristems are primary meristems that are primarily responsible for:

A. Forming the vascular cambium

B. Secondary growth in dicot stems

C. Increasing the length of internodes in grasses

D. Bark formation

Q111. Companion cells are specialized parenchymatous cells that are usually absent in the phloem of:

A. Dicots

B. Monocots

C. Gymnosperms

D. Angiosperms

Q112. Casparian strips are water-impermeable, waxy bands of suberin found in the:

A. Pericycle

B. Epidermis

C. Endodermis

D. Pith

Q113. The vascular cambium in a dicot root is strictly:

A. Primary in origin

B. Secondary in origin

C. Absent throughout its life

D. Apical in origin

Q114. In chloroplasts, a structured stack of thylakoids is known as a:

A. Stroma

B. Granum

C. Matrix

D. Crista

Q115. The selectively permeable single membrane surrounding the central vacuole in plant cells is called the:

A. Plasmalemma

B. Tonoplast

C. Cell wall

D. Nuclear envelope

Q116. During which specific phase of the cell cycle does DNA replication occur?

A. G1 phase

B. S phase

C. G2 phase

D. M phase

Q117. Crossing over, the exchange of genetic material between non-sister chromatids of homologous chromosomes, occurs during which stage of Prophase I?

A. Zygotene

B. Pachytene

C. Diplotene

D. Diakinesis

Q118. By convention, the water potential of pure water at standard temperature and pressure (with no applied solute or pressure) is:

A. 100

B. 10

C. 0

D. -10

Q119. Which essential mineral element forms the central coordinating ion of the porphyrin ring in a chlorophyll molecule?

A. Iron

B. Calcium

C. Magnesium

D. Manganese

Q120. Kranz anatomy, characterized by a layer of specialized bundle sheath cells, is a defining structural feature of the leaves of:

A. C3 plants

B. C4 plants

C. CAM plants

D. Hydrophytes

Q121. The primary CO_2 acceptor in the C3 photosynthetic pathway is a:

A. 3-carbon compound

B. 4-carbon compound

C. 5-carbon compound

D. 6-carbon compound

Q122. Glycolysis, the initial stage of cellular respiration that breaks down glucose into pyruvate, occurs exclusively in the:

A. Mitochondrial matrix

B. Inner mitochondrial membrane

C. Chloroplast stroma

D. Cytoplasm

Q123. The respiratory quotient (RQ), defined as the ratio of CO_2 evolved to O_2 consumed, is typically what value for fats?

A. Less than 1

B. Equal to 1

C. Greater than 1

D. Infinity

Q124. The phenomenon of apical dominance, where the growing apical bud inhibits the growth of lateral (axillary) buds, is primarily caused by:

A. Cytokinins

B. Gibberellins

C. Auxins

D. Abscisic acid

Q125. Which plant growth regulator is unique because it is a gaseous hormone primarily involved in fruit ripening and senescence?

A. Zeatin

B. Ethylene

C. Indole-3-acetic acid

D. Kinetin

Q126. The innermost wall layer of the microsporangium, which provides essential nourishment to developing pollen grains, is the:

A. Epidermis

B. Endothecium

C. Middle layer

D. Tapetum

Q127. A typical Polygonum-type angiosperm embryo sac at maturity is:

A. 8-celled, 8-nucleate

B. 7-celled, 8-nucleate

C. 7-celled, 7-nucleate

D. 8-celled, 7-nucleate

Q128. Flowers that are specifically adapted to be pollinated by wind (anemophily) typically possess:

A. Large, colorful petals

B. Well-developed nectar glands

C. Light, non-sticky pollen grains

D. Strong, sweet fragrances

Q129. Double fertilization, involving both syngamy and triple fusion, is a unique reproductive event found exclusively in:

A. Algae

B. Bryophytes

C. Gymnosperms

D. Angiosperms

Q130. According to Mendel's laws of inheritance, the genotypic ratio of a standard monohybrid cross in the F2 generation is:

A. 3:1

B. 1:2:1

C. 9:3:3:1

D. 1:1

Q131. In Mirabilis jalapa (Four o'clock plant), crossing a pure red-flowered plant with a pure white-flowered plant produces strictly pink F1 progeny. This is a classic example of:

A. Co-dominance

B. Incomplete dominance

C. Multiple allelism

D. Epistasis

Q132. The chromosomal theory of inheritance, which linked Mendelian genetics with the movement of chromosomes during meiosis, was proposed by:

A. Gregor Mendel

B. Thomas Hunt Morgan

C. Sutton and Boveri

D. Watson and Crick

Q133. In any functional ecosystem, which of the following ecological pyramids is always upright and can never be inverted?

A. Pyramid of numbers

B. Pyramid of biomass

C. Pyramid of energy

D. Pyramid of species

Q134. The pioneer species responsible for initiating primary succession on a bare rock surface are usually:

A. Mosses

B. Lichens

C. Ferns

D. Grasses

Q135. Which of the following strategies represents an example of ex-situ (off-site) biodiversity conservation?

A. National Park

B. Biosphere Reserve

C. Wildlife Sanctuary

D. Seed Bank

Botany (Section B)

Q136. In the classic Hershey-Chase experiment proving DNA is the genetic material, which radioactive isotopes were used to label the viral DNA and protein coat, respectively?

A. ^{14}C and ^{15}N

B. ^{32}P and ^{35}S

C. ^{35}S and ^{32}P

D. ^{15}N and ^{32}P

Q137. The independent, free-living, photosynthetic gametophyte stage of a pteridophyte (like a fern) is called a:

A. Protonema

B. Sporangium

C. Prothallus

D. Strobilus

Q138. During secondary growth in dicot stems, the phellogen, phellem, and phelloderm are collectively known as the:

A. Bark

B. Periderm

C. Vascular cambium

D. Stele

Q139. In a mango, which is a fleshy fruit known as a drupe, the edible, fleshy, and juicy portion is the:

A. Epicarp

B. Endocarp

C. Mesocarp

D. Thalamus

Q140. Which of the following cell organelles is strictly NOT considered a part of the endomembrane system?

A. Endoplasmic reticulum

B. Golgi complex

C. Lysosome

D. Mitochondrion

Q141. "Uphill" transport across a cell membrane, which transports substances against their concentration gradient and requires ATP energy, is a characteristic of:

A. Simple diffusion

B. Facilitated diffusion

C. Active transport

D. Osmosis

Q142. The enzyme nitrogenase, which is highly sensitive to molecular oxygen and essential for biological nitrogen fixation, requires which metal ion as a crucial component?

A. Copper (Cu)

B. Molybdenum (Mo)

C. Zinc (Zn)

D. Boron (B)

Q143. According to the chemiosmotic hypothesis of ATP synthesis in chloroplasts, the breakdown of the proton gradient provides the energy for ATP formation. Where do these protons accumulate to create this gradient?

A. In the stroma

B. In the inner membrane space

C. In the thylakoid lumen

D. Outside the chloroplast

Q144. In the first step of the TCA cycle (Krebs cycle), the 2-carbon acetyl group combines with which 4-carbon compound to form citric acid?

A. Malic acid

B. Succinic acid

C. Alpha-ketoglutaric acid

D. Oxaloacetic acid (OAA)

Q145. Plants that require exposure to light for a period strictly shorter than their critical photoperiod to initiate flowering are classified as:

A. Long-day plants

B. Short-day plants

C. Day-neutral plants

D. Long-short day plants

Q146. To prevent autogamy (self-pollination), many flowering plants have evolved mechanisms where the pollen is released and the stigma becomes receptive at completely different times. This specific mechanism is called:

A. Dichogamy

B. Herkogamy

C. Heterostyly

D. Cleistogamy

Q147. A genetic cross between an F1 hybrid organism and its homozygous recessive parent is known as a:

A. Back cross

B. Test cross

C. Reciprocal cross

D. Dihybrid cross

Q148. In a molecular transcription unit, the promoter region—the binding site for RNA polymerase—is conventionally located at the:

A. 3' end (downstream) of the template strand

B. 5' end (upstream) of the coding strand

C. Center of the structural gene

D. 3' end of the terminator region

Q149. An ecological interaction in which one species benefits while the other species is neither harmed nor benefited is termed:

A. Mutualism

B. Parasitism

C. Commensalism

D. Amensalism

Q150. The phenomenon where the concentration of a toxic substance, such as DDT, increases at successive trophic levels in an aquatic food chain is known as:

A. Eutrophication

B. Biomagnification

C. Biofortification

D. Biochemical oxygen demand

Zoology (Section A)

Q151. Which of the following statements regarding the counter-current mechanism in the human kidney is strictly correct?

A. It helps to maintain a concentration gradient in the medullary interstitium.

B. The descending limb of the vasa recta is impermeable to water.

C. NaCl is actively transported out of the descending limb of the loop of Henle.

D. Urea is actively pumped into the thick ascending limb of the loop of Henle.

Q152. In a standard electrocardiogram (ECG), the end of the T-wave specifically marks the:

A. Beginning of ventricular systole

B. End of ventricular systole

C. Beginning of atrial diastole

D. End of atrial depolarization

Q153. Match the following reproductive structures with their exact ploidy level and select the correct option: (a) Spermatogonia, (b) Secondary spermatocyte, (c) Spermatid, (d) Primary oocyte.

A. (a)-2n, (b)-n, (c)-n, (d)-2n

B. (a)-2n, (b)-2n, (c)-n, (d)-n

C. (a)-n, (b)-n, (c)-2n, (d)-2n

D. (a)-2n, (b)-n, (c)-2n, (d)-n

Q154. According to the sliding filament theory of muscle contraction, which of the following events strictly occurs during an active contraction?

A. The A-band significantly decreases in length.

B. The I-band retains its original length.

C. The H-zone progressively disappears.

D. The Z-lines are pushed further apart.

Q155. A population of 1000 individuals is in Hardy-Weinberg equilibrium. If the frequency of the recessive allele 'a' is 0.4, what is the exact number of heterozygous individuals in this population?

A. 160

B. 360

C. 480

D. 640

Q156. Which of the following restriction endonucleases produces blunt ends in a DNA sequence?

A. EcoRI

B. BamHI

C. HindIII

D. EcoRV

Q157. In the human female menstrual cycle, the rapid surge in Luteinizing Hormone (LH) is directly responsible for:

A. Degeneration of the corpus luteum

B. Rupture of the Graafian follicle

C. Rapid proliferation of the endometrial lining

D. Suppression of FSH secretion

Q158. Which of the following correctly pairs an evolutionary concept with its corresponding anatomical example?

A. Divergent evolution - Wings of a butterfly and wings of a bird

B. Convergent evolution - Forelimbs of a whale and forelimbs of a bat

C. Adaptive radiation - Darwin's finches on the Galapagos Islands

D. Atavism - Presence of a vermiform appendix in humans

Q159. During the transmission of a nerve impulse, the repolarization phase of the action potential is primarily driven by the:

A. Rapid influx of Na^+ ions

B. Slow influx of Ca^{2+} ions

C. Rapid efflux of K^+ ions

D. Active transport of Na^+ and K^+ via the pump

Q160. Select the incorrect statement regarding the general characteristics of the phylum Chordata.

A. They possess a post-anal tail at some stage of embryonic development.

B. The central nervous system is dorsal, hollow, and single.

C. A notochord is present during the embryonic period.

D. The heart is dorsally located.

Q161. Which of the following is a classic example of an autoimmune disorder affecting the neuromuscular junction?

A. Rheumatoid arthritis

B. Multiple sclerosis

C. Myasthenia gravis

D. Muscular dystrophy

Q162. The initial clinical application of gene therapy was performed in 1990 to treat a four-year-old girl suffering from:

A. Cystic fibrosis

B. Adenosine deaminase (ADA) deficiency

C. Phenylketonuria

D. Alpha-1 antitrypsin deficiency

Q163. A patient with blood group 'O' requires an immediate blood transfusion. Which of the following blood types can be safely administered?

A. Blood group A only

B. Blood group AB only

C. Blood group O only

D. Any blood group (A, B, AB, or O)

Q164. In the process of RNA interference (RNAi), the silencing of a specific mRNA is achieved by the:

A. Binding of a complementary double-stranded DNA fragment

B. Cleavage by restriction endonucleases

C. Binding of a complementary single-stranded RNA molecule

D. Binding of a complementary double-stranded RNA molecule

Q165. Which of the following sets of hormones is exclusively secreted in women only during pregnancy?

A. hCG, hPL, and Relaxin

B. Estrogen, Progesterone, and FSH

C. hCG, hPL, and LH

D. Prolactin, Relaxin, and Oxytocin

Q166. In the human digestive system, the enzyme enterokinase directly facilitates the conversion of:

A. Pepsinogen into pepsin

B. Trypsinogen into trypsin

C. Procarboxypeptidase into carboxypeptidase

D. Chymotrypsinogen into chymotrypsin

Q167. Identify the correct sequence of the male accessory ducts starting from the testis to the urethra.

A. Rete testis → Vasa efferentia → Epididymis → Vas deferens

B. Vasa efferentia → Rete testis → Vas deferens → Epididymis

C. Rete testis → Epididymis → Vasa efferentia → Vas deferens

D. Epididymis → Vasa efferentia → Rete testis → Vas deferens

Q168. Which feature uniquely distinguishes the members of the class Mammalia from all other vertebrate classes?

A. Presence of a four-chambered heart

B. Homeothermy (warm-bloodedness)

C. Presence of a muscular diaphragm separating thorax and abdomen

D. Internal fertilization and viviparity

Q169. What is the primary function of the copper ions released by Copper-T intrauterine devices (IUDs)?

A. They inhibit the process of ovulation.

B. They suppress sperm motility and their fertilizing capacity.

C. They make the uterus unsuitable for implantation.

D. They alter the hormonal balance to prevent follicle maturation.

Q170. Which of the following respiratory volumes or capacities cannot be directly measured using a standard clinical spirometer?

A. Tidal Volume (TV)

B. Vital Capacity (VC)

C. Residual Volume (RV)

D. Inspiratory Capacity (IC)

Q171. A genetically engineered plasmid vector must contain a selectable marker. What is its primary biological purpose?

A. To facilitate the replication of the plasmid inside the host.

B. To provide restriction sites for the insertion of foreign DNA.

C. To identify and eliminate non-transformants and selectively permit the growth of transformants.

D. To enhance the expression of the recombinant protein.

Q172. Which portion of the human hindbrain is responsible for regulating cardiovascular reflexes, respiration, and gastric secretions?

A. Cerebellum

B. Hypothalamus

C. Medulla oblongata

D. Thalamus

Q173. The 'p' in the Hardy-Weinberg equation $p^2 + 2pq + q^2 = 1$ specifically represents the:

A. Frequency of the dominant phenotype in the population

B. Frequency of the heterozygous genotype

C. Frequency of the dominant allele in the gene pool

D. Frequency of the recessive allele in the gene pool

Q174. Which of the following joints is functionally classified as a 'pivot joint'?

A. The joint between the atlas and the axis vertebrae

B. The joint between the carpal and metacarpal bones of the thumb

C. The glenohumeral joint of the shoulder

D. The pubic symphysis

Q175. The hormone that actively stimulates the exocrine pancreas to release water and bicarbonate ions into the duodenum is:

A. Cholecystokinin (CCK)

B. Secretin

C. Gastrin

D. Gastric Inhibitory Peptide (GIP)

Q176. Which structural component of the human inner ear is directly responsible for maintaining dynamic balance and body posture?

A. Organ of Corti

B. Semicircular canals

C. Eustachian tube

D. Tympanic membrane

Q177. The very first cellular forms of life on Earth are generally presumed to have been:

A. Aerobic autotrophs

B. Anaerobic chemoheterotrophs

C. Aerobic photoheterotrophs

D. Anaerobic chemoautotrophs

Q178. During human spermatogenesis, the first meiotic division (Meiosis I) specifically results in the formation of:

A. Primary spermatocytes

B. Secondary spermatocytes

C. Spermatids

D. Spermatozoa

Q179. In the context of biotechnology, what is the primary role of the Taq polymerase enzyme during a PCR cycle?

A. Denaturation of double-stranded DNA

B. Annealing of primers to the template strand

C. Thermostable extension of the new DNA strand

D. Ligation of the Okazaki fragments

Q180. Which of the following white blood cells is a large agranulocyte that actively differentiates into a macrophage upon entering tissue spaces?

A. Eosinophil

B. Neutrophil

C. Monocyte

D. Lymphocyte

Q181. A decrease in the blood pressure or blood volume actively stimulates the release of which enzyme from the juxtaglomerular (JG) cells?

A. Angiotensin II

B. Aldosterone

C. Renin

D. Atrial Natriuretic Factor (ANF)

Q182. Which of the following classes of immunoglobulins is primarily responsible for mediating allergic responses?

A. IgA

B. IgG

C. IgE

D. IgM

Q183. Identify the incorrect statement regarding the structural organization of a cockroach.

A. Malpighian tubules are located at the junction of the midgut and hindgut.

B. The nervous system consists of a series of fused, segmentally arranged ganglia.

C. Hepatic caeca are present at the junction of the foregut and midgut.

D. Males possess anal styles, while females do not possess anal cerci.

Q184. In the human male, the failure of the testes to descend into the scrotum during embryonic development is clinically known as:

A. Impotence

B. Cryptorchidism

C. Castration

D. Vasectomy

Q185. Which evolutionary principle states that allele frequencies in a population remain constant from generation to generation in the absolute absence of evolutionary influences?

A. Darwin's theory of Natural Selection

B. The Founder Effect

C. The Hardy-Weinberg Principle

D. Genetic Drift

Zoology (Section B)

Q186. Evaluate the following statements regarding the hormonal regulation of kidney function and identify the correct combination: (I) Atrial Natriuretic Factor (ANF) acts as a vasodilator to decrease blood pressure. (II) Anti-diuretic Hormone (ADH) prevents diuresis by actively facilitating water reabsorption from later parts of the tubule. (III) An excessive loss of body fluid physically switches off the osmoreceptors to halt ADH secretion. (IV) ADH directly causes a significant decrease in the Glomerular Filtration Rate (GFR).

A. Statements I and II only

B. Statements II and III only

C. Statements I, III, and IV only

D. Statements II, III, and IV only

Q187. In his classic simulation of early Earth conditions, S.L. Miller successfully synthesized amino acids. Which specific combination of gases and temperature did he utilize in his closed-flask experiment?

A. CH_4, H_2, NH_3, and water vapor at $600°C$

B. CH_3, H_2, NH_3, and water vapor at $800°C$

C. CH_4, H_2, NH_3, and water vapor at $800°C$

D. CO_2, N_2, H_2, and water vapor at $800°C$

Q188. Analyze the physiological actions of the following major metabolic hormones and identify the correct statement:

A. Insulin primarily induces hyperglycemia by actively promoting glycogenolysis in the liver.

B. Glucagon acts selectively on hepatocytes to promote glycogenesis, leading to hypoglycemia.

C. Glucocorticoids actively stimulate gluconeogenesis, lipolysis, and proteolysis.

D. Insulin's cellular action is exclusively restricted to pancreatic beta cells and adipocytes.

Q189. Match the specific population characteristics with their respective ecological age pyramids: (a) Pre-reproductive individuals are the largest group, followed by reproductive and post-reproductive groups. (b) The number of pre-reproductive and reproductive individuals is almost equal. (c) The population size decreases due to fewer pre-reproductive individuals than reproductive ones.

A. (a)-Expanding pyramid, (b)-Stable pyramid, (c)-Declining pyramid

B. (a)-Stable pyramid, (b)-Expanding pyramid, (c)-Declining pyramid

C. (a)-Expanding pyramid, (b)-Declining pyramid, (c)-Stable pyramid

D. (a)-Declining pyramid, (b)-Stable pyramid, (c)-Expanding pyramid

Q190. Which of the following statements is strictly true regarding human leukocytes (white blood cells)?

A. Basophils are agranulocytes characterized by a distinct kidney-shaped nucleus.

B. Monocytes are the most abundant granulocytes and possess a multi-lobed nucleus.

C. Eosinophils are granulocytes that primarily secrete histamine, serotonin, and heparin.

D. Neutrophils are the most abundant leukocytes and exhibit highly efficient phagocytic activity.

Q191. The inactive protoxin produced by Bacillus thuringiensis is converted into a lethal, active toxin inside the insect gut strictly due to:

A. The highly acidic pH of the foregut

B. The alkaline pH of the midgut

C. The mechanical grinding action of the proventriculus

D. The extremely high body temperature of the insect vector

Q192. Read the Assertion (A) and Reason (R) carefully: Assertion (A): In human females, the second meiotic division is not completed until fertilization occurs. Reason (R): The secondary oocyte is temporarily arrested in the metaphase stage of Meiosis II.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false.

D. Both A and R are false.

Q193. The phenomenon of industrial melanism observed in the peppered moth (Biston betularia) serves as a classic evolutionary demonstration of:

A. Stabilizing natural selection

B. A random mutation directly induced by industrial smoke

C. Directional natural selection

D. Disruptive natural selection leading to speciation

Q194. Upon successfully entering the human body, the Human Immunodeficiency Virus (HIV) first replicates extensively within which specific immune cells before subsequently attacking T-helper cells?

A. B-lymphocytes

B. Macrophages

C. Cytotoxic T-cells

D. Neutrophils

Q195. In a standard dihybrid cross, if the genetic recombination frequency between two linked genes is calculated to be exactly 50

A. The genes are tightly linked and physically adjacent on the same chromosome.

B. The genes are assorting independently and are either on different chromosomes or very far apart on the same chromosome.

C. The genes exhibit complete linkage with absolutely no crossing over.

D. One of the genes is strictly lethal in the homozygous recessive condition.

Q196. Identify the animal phylum based exclusively on these features: strictly marine habitat, presence of a water vascular system, bilateral symmetry in larvae, and radial symmetry in adults.

A. Porifera

B. Ctenophora

C. Echinodermata

D. Hemichordata

Q197. During the physiological mechanism of hearing, the physical movement of the basilar membrane actively presses the stereocilia of the hair cells directly against which specific structure to generate action potentials?

A. Reissner's membrane

B. Tectorial membrane

C. Tympanic membrane

D. Macula

Q198. In the presence of a classical competitive inhibitor, how are the K_m (Michaelis constant) and V_{max} (maximum velocity) of an enzyme-catalyzed reaction mathematically affected?

A. K_m increases, and V_{max} decreases.

B. K_m remains the same, and V_{max} decreases.

C. K_m increases, and V_{max} remains exactly the same.

D. Both K_m and V_{max} increase simultaneously.

Q199. Dietary fats are fundamentally absorbed in the human small intestine packaged as chylomicrons. Which specific anatomical structures transport these large chylomicrons away from the intestinal villi?

A. Hepatic portal vein

B. Lacteals

C. Mesenteric capillaries

D. Vasa recta

Q200. A mammalian somatic cell actively undergoes the cell cycle. If the initial DNA content during the G_1 phase is designated as '2C' and the chromosome number is '2n', what will be the exact DNA content and chromosome number strictly during the G_2 phase?

A. 4C and 4n

B. 4C and 2n

C. 2C and 2n

D. 2C and 4n

Solutions

1. **(A) 2:1.** The fundamental frequency of an open pipe is $f_o = \frac{v}{2L}$ and for a closed pipe is $f_c = \frac{v}{4L}$; thus, the ratio $f_o : f_c = \frac{1}{2} : \frac{1}{4} = 2 : 1$.

2. **(B) 4λ.** Shortest wavelength $\lambda \propto n_1^2$; for Balmer $n_1 = 2$ ($\lambda \propto 4$) and for Brackett $n_1 = 4$ ($\lambda \propto 16$), making the latter four times longer.

3. **(C) Bernoulli's principle.** A venturi-meter uses the pressure difference created by varying fluid speeds in different pipe cross-sections to measure flow rate.

4. **(B)** $\frac{3}{2}k_BT$**.** According to the law of equipartition of energy, a mono-atomic gas has 3 degrees of freedom, each contributing $\frac{1}{2}k_BT$.

5. **(D) Singly ionized neon atom** (Ne^+)**.** The Bohr model applies only to hydrogen-like species (single-electron systems), but Ne^+ has 9 electrons remaining.

6. **(C) 27/8.** Heat energy $Q \propto mass$, and mass $\propto r^3$; therefore, the ratio of heat required is $(r_1/r_2)^3 = (1.5)^3 = (3/2)^3 = 27/8$.

7. **(C) 10.0 g.** Mass $m = \rho\pi r^2 h$; since height $h \propto 1/r$, the mass is directly proportional to r. Doubling r doubles the mass from 5 g to 10 g.

8. **(C) 67 cm.** Center of mass distance from the 5 kg mass is $x = \frac{m_2 L}{m_1+m_2} = \frac{10\times100}{5+10} = 66.67cm$.

9. **(A)** $2.4\pi \times 10^{-4} TmA^{-1}$**.** Absolute permeability $\mu = \mu_0(1+\chi) = 4\pi \times 10^{-7} \times (1+599) = 2400\pi \times 10^{-7} = 2.4\pi \times 10^{-4}$.

10. **(C)** $0.2kg/m^3$**.** Using density $\rho = \frac{PM}{RT} = \frac{249\times10^3\times2\times10^{-3}}{8.3\times300} = \frac{498}{2490} = 0.2kg/m^3$.

11. **(C) 32 N.** Force $F \propto \frac{1}{(R+h)^2}$; at $h = R/2$, the weight becomes $W \times \frac{R^2}{(1.5R)^2} = 72 \times \frac{1}{2.25} = 32N$.

12. **(D)** 10^4V**.** Using $\lambda = \frac{1.227}{\sqrt{V}}nm$, we get $1.227 \times 10^{-2} = \frac{1.227}{\sqrt{V}}$, so $\sqrt{V} = 100$ and $V = 10,000V$.

13. **(C) 200 V.** Potential $V = \frac{kp\cos\theta}{r^2} = \frac{9\times10^9\times16\times10^{-9}\times\cos60^\circ}{(0.6)^2} = \frac{144\times0.5}{0.36} = 200V$.

14. **(A) 300 m.** Using $v^2 - u^2 = 2gh$, we have $80^2 - 20^2 = 2(10)h$, which simplifies to $6000 = 20h$, giving $h = 300m$.

15. **(B)** $\frac{1}{\sqrt{2}n\pi d^2}$**.** The mean free path is the average distance between collisions and is inversely proportional to the number density and collision cross-section πd^2.

16. **(B)** $1.28 \times 10^5 N/C$**.** Electric field $E = \frac{kQ}{r^2} = \frac{9\times10^9\times3.2\times10^{-7}}{(0.15)^2} = \frac{2880}{0.0225} = 1.28 \times 10^5 N/C$.

17. **(A) 1 : 1.** In an electromagnetic wave, the energy is shared equally between the electric and magnetic fields, so their intensity contributions are equal.

18. **(D) Becomes four times.** Fringe width $\beta = \frac{\lambda D}{d}$; if D is doubled and d is halved, $\beta' = \frac{\lambda(2D)}{d/2} = 4\beta$.

19. **(B) 524 Hz.** Frequency $f_B = 530 \pm 6$; since decreasing tension in B (lowering f_B) increases beats to 7, B must have been lower than A $(530 - 6 = 524Hz)$.

20. **(B) Reverse biasing only.** In reverse bias, the majority carriers are pulled away from the junction, which widens the depletion layer.

21. **(C)** $[ML^{-1}T^{-2}]$**.** Stress is Force/Area, having dimensions $\frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$, which is identical to the dimensions of pressure.

22. **(A)** $\frac{MgL}{A(L_1-L)}$**.** Young's modulus $Y = \frac{Stress}{Strain} = \frac{F/A}{\Delta L/L} = \frac{Mg/A}{(L_1-L)/L}$, which simplifies to the given expression.

23. **(D) 1.0.** Since removing L or C gives the same phase shift, $X_L = X_C$; the circuit is at resonance where the power factor $\cos\phi = 1$.

24. **(B)** $3.66\times10^{-7}rad$**.** Limit of resolution $\Delta\theta = \frac{1.22\lambda}{D} = \frac{1.22\times600\times10^{-9}}{2} = 3.66\times10^{-7}rad.$

25. **(B) 0.06 eV.** Converting Joules to eV: $E = \frac{10^{-20}J}{1.6\times10^{-19}J/eV} = \frac{1}{16}eV \approx 0.06eV.$

26. **(C) 0.5 mm.** Pitch is calculated by multiplying the least count by the total number of divisions: $0.01mm \times 50 = 0.5mm.$

27. **(C)** μA**.** For a thin prism with normal emergence, $r_2 = 0$ and $r_1 = A$; using Snell's law for small angles, $i = \mu r_1 = \mu A$.

28. **(C) 2.5 A.** $X_C = \frac{1}{2\pi fC} \approx 79.6\Omega$; the RMS current $I = \frac{V}{X_C} = \frac{200}{79.6} \approx 2.51A.$

29. **(A)** $470\Omega, 5\%$**.** Colors Yellow(4), Violet(7), Brown(10^1), and Gold(5%) give $47 \times 10^1 = 470\Omega$ with 5% tolerance.

30. **(B)** $6.28 \times 10^{-4}T$**.** $B = \mu_0\frac{N}{L}I = 4\pi \times 10^{-7} \times \frac{100}{0.5} \times 2.5 = 1000\pi \times 2 \times 10^{-7} = 6.28 \times 10^{-4}T.$

31. **(D) 16 U.** Potential energy $U = \frac{1}{2}kx^2$; since extension x increases 4-fold (from 2 to 8 cm), U increases by $4^2 = 16$ times.

32. **(D)** $3295°C$**.** $v_{rms} \propto \sqrt{T}$; to increase speed by 3 times (making it 4x), T must increase 16x. $223K \times 16 = 3568K = 3295°C.$

33. **(C) Along the axis of rotation.** Angular acceleration $\vec{\alpha} = \frac{d\vec{\omega}}{dt}$ is a vector directed along the same axis as the angular velocity.

34. **(B)** $1.6 \times 10^{-7}T$**.** Amplitude $B_0 = \frac{E_0}{c} = \frac{48}{3\times10^8} = 16 \times 10^{-8} = 1.6 \times 10^{-7}T.$

35. **(A)** $4v/3$**.** For two equal halves of distance, average speed is the harmonic mean: $v_{avg} = \frac{2v_1v_2}{v_1+v_2} = \frac{2(v)(2v)}{v+2v} = \frac{4v}{3}$.

36. **(B) 28.** The magnifying power of a telescope in normal adjustment is given by $M = f_o/f_e$; substituting the given values, we get $M = 140/5.0 = 28$.

37. **(B)** T^2**.** The period $T = 2\pi\sqrt{R/g}$ and $g = \frac{4}{3}\pi GRd$ lead to $T = \sqrt{3\pi/Gd}$; squaring both sides gives $T^2 = 3\pi/Gd$.

38. **(D) Infinite.** The power of the combination is $P = P_1 + P_2 = 1/f + 1/(-f) = 0$; since focal length $F = 1/P$, the effective focal length is infinite.

39. **(C)** $1.5m/s^2$**.** To prevent sliding, the car's acceleration must not exceed the maximum frictional acceleration $a = \mu g = 0.15 \times 10 = 1.5m/s^2$.

40. **(D)** $4.77\mathring{A}$**.** According to Bohr's model, $r_n = n^2r_1$; for the third orbit ($n = 3$), the radius is $3^2 \times 0.53 \times 10^{-10}m = 4.77 \times 10^{-10}m = 4.77\mathring{A}.$

41. **(B) 100.** Series current is $I_s = E/10R$ and parallel current is $I_p = E/(R/10) = 10E/R$; the ratio I_p/I_s results in a factor of $n = 100$.

42. **(B) 0.93 A.** Peak current $I_0 = \sqrt{2}V_{rms}\omega C = \sqrt{2} \times 210 \times 2\pi \times 50 \times 10 \times 10^{-6}$; calculation yields approximately $0.93A$.

43. **(B) $M/2$.** When bent at 60° at the midpoint, the distance between the poles becomes the third side of an equilateral triangle ($L/2$); thus the new moment is $m \times (L/2) = M/2$.

44. **(A) $\frac{5GmM}{6R}$.** Total energy required is $E_{final} - E_{initial} = -\frac{GmM}{2(3R)} - (-\frac{GmM}{R}) = \frac{GmM}{R} - \frac{GmM}{6R} = \frac{5GmM}{6R}$.

45. **(B) 2:9.** $P_{series} = \frac{1\times2}{1+2} = \frac{2}{3}kW$ and $P_{parallel} = 1+2 = 3kW$; the ratio of total power dissipated is $(2/3) : 3 = 2 : 9$.

46. **(B) $\frac{\alpha t}{\beta}$.** Dimensions are $[\alpha] = [FT^{-2}]$ and $[\beta] = [FT^{-1}]$; therefore, $\frac{[FT^{-2}][T]}{[FT^{-1}]} = [M^0L^0T^0]$, making it a dimensionless quantity.

47. **(C) $5IL$.** The force vector $\vec{F} = I(\vec{L} \times \vec{B}) = I(L\hat{i} \times (2\hat{i} + 3\hat{j} - 4\hat{k})) = IL(3\hat{k} + 4\hat{j})$; the magnitude is $IL\sqrt{3^2 + 4^2} = 5IL$.

48. **(A) 27 cm.** Using $v^2 - u^2 = 2as$, we find $a = -u^2/54$; the total distance required for the bullet to stop ($v = 0$) is $s = -u^2/2a = 27cm$.

49. **(C) They are originated by charges moving with a uniform speed.** This is incorrect because electromagnetic waves are only produced by accelerating or oscillating charges.

50. **(C) $5\sqrt{5}\,\Omega$.** Reactances are $X_L = 2\pi fL = 5\,\Omega$ and $X_C = \frac{1}{2\pi fC} = 10\,\Omega$; impedance $Z = \sqrt{10^2 + (10-5)^2} = \sqrt{125} = 5\sqrt{5}\,\Omega$.

51. **(B) $r \propto n^2$.** According to Bohr's model, the radius is given by $r_n = \frac{n^2h^2\epsilon_0}{\pi mZe^2}$, meaning radius is directly proportional to the square of the principal quantum number.

52. **(C) 2, 2, -1, +1/2.** For any given principal quantum number n, the azimuthal quantum number l must be an integer ranging from 0 to $(n-1)$; here l cannot be equal to n.

53. **(B) Low pressure and high temperature.** Under these conditions, intermolecular forces become negligible and the volume of the gas molecules is insignificant compared to the total volume.

54. **(C) $\Delta U = 0$.** For an ideal gas, internal energy is a function of temperature only; since the process is isothermal ($\Delta T = 0$), the internal energy change must be zero.

55. **(B) Enthalpy being a state function.** Hess's Law states that total enthalpy change is independent of the pathway taken, which is the definition of a state function.

56. **(C) $K_p = K_c(RT)^{-2}$.** The relationship is $K_p = K_c(RT)^{\Delta n_g}$; here $\Delta n_g = 2 - (1 + 3) = -2$, resulting in the given expression.

57. **(B) Backward, increasing reactants.** According to Le Chatelier's principle, increasing the temperature of an exothermic reaction shifts the equilibrium toward the endothermic (backward) direction.

58. **(C) NH_4OH + NH_4Cl.** A basic buffer consists of a weak base (Ammonium hydroxide) and its salt with a strong acid (Ammonium chloride).

59. **(D) It remains the same.** Standard cell potential (E°) is an intensive property, meaning its value does not depend on the stoichiometry of the reaction or the amount of substance.

60. **(B) $t_{1/2}$ is independent of $[A]_0$.** For a first-order reaction, $t_{1/2} = \frac{0.693}{k}$, which shows the time required to consume half the reactant does not involve the initial concentration.

61. **(C) The frequency of collisions with correct orientation.** The pre-exponential factor A, also called the frequency factor, represents the rate at which molecules collide with the proper geometry to react.

62. **(C) 12.** In a face-centered cubic lattice, each atom is in contact with 12 nearest neighbors (4 in its own plane, 4 above, and 4 below).

63. **(D) 0.1 M $FeCl_3$.** Boiling point elevation depends on the van't Hoff factor (i); $FeCl_3$ dissociates into 4 ions ($i = 4$), giving it the highest particle concentration among the choices.

64. **(A) Helium (He).** Helium has the highest first ionization energy because its electrons are in a very stable $1s^2$ configuration and are closest to the nucleus.

65. **(C) See-saw.** SF_4 has 4 bond pairs and 1 lone pair on the sulfur atom, leading to an AX_4E geometry which is described as see-saw.

66. **(B) sp^3d.** The central iodine in I_3^- has 2 bond pairs and 3 lone pairs, totaling 5 electron pairs, which requires sp^3d hybridization and a linear molecular shape.

67. **(B) 1.5.** Using MOT, O_2^- has 10 bonding and 7 antibonding electrons; Bond Order $= (10 - 7)/2 = 1.5$.

68. **(B) +3.** In $[Co(NH_3)_4Cl_2]Cl$, the complex ion is $[Co(NH_3)_4Cl_2]^+$; let x be Cobalt's charge: $x + 4(0) + 2(-1) = +1$, so $x = +3$.

69. **(C) CN^-.** Cyanide is a strong field ligand because it causes a large splitting of the d-orbitals, often resulting in low-spin complexes.

70. **(C) Barium (Ba).** Barium ions impart a characteristic apple-green or yellowish-green color to the Bunsen flame due to electronic transitions.

71. **(C) The inert pair effect.** This effect describes the reluctance of the outermost s-electrons to participate in bonding due to poor shielding by d and f electrons in heavy p-block elements.

72. **(A) Due to d-d electron transitions.** Transition metal complexes are colored because they can absorb specific wavelengths of visible light to promote an electron from a lower energy d-orbital to a higher one.

73. **(A) 3-hydroxybutanal.** The aldehyde group takes priority as C1; the hydroxyl group is located on C3 of the four-carbon chain, making it 3-hydroxybutanal.

74. **(B) 2-chlorobutane.** This molecule has a chiral carbon at the second position (attached to H, Cl, Methyl, and Ethyl groups), allowing it to exist as two non-superimposable mirror images.

75. **(D) A carbocation.** S_N1 reactions occur in two steps: the leaving group departs first to form a planar, trivalent carbocation intermediate which is then attacked by a nucleophile.

76. **(C) -NO_2 (Nitro).** The nitro group is strongly electron-withdrawing by both inductive and resonance effects, which deactivates the ring and directs substitution to the meta position.

77. **(B) Markovnikov's rule.** This rule states that in the addition of a protic acid to an alkene, the hydrogen atom becomes attached to the carbon with the greater number of hydrogen atoms.

78. **(C) Acetaldehyde (CH_3CHO).** Aldol condensation requires the presence of α-hydrogens; acetaldehyde has three, allowing it to form an enolate ion in the presence of a base.

79. **(B) Disproportionation.** In the Cannizzaro reaction, an aldehyde without α-hydrogens simultaneously oxidizes to a carboxylic acid salt and reduces to a primary alcohol.

80. **(D) A carboxylic acid.** The Grignard reagent attacks the carbon in CO_2 to form a carboxylate salt ($RCOOMgX$), which yields a carboxylic acid upon acidic hydrolysis.

81. **(B) Resonance stabilization of the phenoxide ion.** Phenol is more acidic than alcohols because the negative charge on the resulting phenoxide ion is delocalized into the aromatic ring through resonance.

82. **(C) Secondary amine (e.g., $(CH_3)_2NH$).** In aqueous solution, the basicity of methyl-substituted amines follows the order: Secondary > Primary > Tertiary due to the balance of inductive effects and solvation.

83. **(C) Monosaccharide.** Monosaccharides are the simplest form of carbohydrates and cannot be broken down further into smaller sugar units by hydrolysis.

84. **(C) Nylon-6,6.** This is a condensation polymer formed by the reaction between adipic acid and hexamethylenediamine, involving the elimination of water molecules.

85. **(C) Lucas test.** The Lucas reagent (conc. HCl + $ZnCl_2$) distinguishes alcohols based on the rate of alkyl chloride formation: tertiary (immediate), secondary (5 min), and primary (none at room temp).

86. **(C) 5 F.** The oxidation state of Mn in MnO_4^- is +7 and in Mn^{2+} is +2; the reduction requires 5 moles of electrons, which is exactly 5 Faradays of electricity.

87. **(C) Cu^+.** Cu^+ has a completely filled $3d^{10}$ configuration; since there are no empty d-orbitals for electronic transitions, the ion appears colorless in aqueous solution.

88. **(C) CH_3I.** In S_N2 reactions, the rate is highest for the best leaving group; I^- is the most stable and weakest base among halides, making CH_3I react the fastest.

89. **(C) 100.0512 °C.** The molality is $m = \Delta T_f/K_f = 0.186/1.86 = 0.1$; thus the boiling point elevation $\Delta T_b = K_b \times m = 0.0512$, giving a boiling point of 100.0512°C.

90. **(C) Both Geometrical and Optical.** The complex exhibits *cis-trans* geometrical isomerism, and the *cis* isomer is chiral (lacks a plane of symmetry), thus exhibiting optical isomerism.

91. **(A) 2-methylpropene.** Reductive ozonolysis of 2-methylpropene ($(CH_3)_2C = CH_2$) breaks the double bond to produce propanone ($(CH_3)_2C = O$) and methanal ($HCHO$).

92. **(B) AgBr.** A Frenkel defect occurs when a smaller ion is displaced to an interstitial site; $AgBr$ is a classic example as it shows both Frenkel and Schottky defects.

93. **(A) Primary amines.** The carbylamine reaction (isocyanide test) is a specific test for primary amines, which produce a characteristic foul-smelling isocyanide when treated with chloroform and KOH.

94. **(B) Linear.** XeF_2 has a trigonal bipyramidal electron geometry with 3 lone pairs in the equatorial positions; this forces the 2 F atoms into axial positions, resulting in a linear shape.

95. **(C) $\Delta H < 0$, $\Delta S > 0$.** A reaction is spontaneous at all temperatures when the enthalpy change is negative (exothermic) and the entropy change is positive, ensuring ΔG is always negative.

96. **(C) Uracil.** RNA contains the nitrogenous bases Adenine, Guanine, Cytosine, and Uracil, whereas DNA contains Thymine instead of Uracil.

97. **(B) 12.5 g.** After 30 days (3 half-lives), the remaining mass is calculated by halving the initial 100 g three times: $100 \rightarrow 50 \rightarrow 25 \rightarrow 12.5$ g.

98. **(B) Benzene.** Heating sodium benzoate with soda lime ($NaOH + CaO$) triggers decarboxylation, which removes the $COONa$ group and leaves behind a benzene molecule.

99. **(B) Copper(I) sulphide.** In the final self-reduction step of copper extraction, copper(I) oxide reacts with copper(I) sulphide to produce pure metallic copper and sulfur dioxide gas.

100. **(C) Momentum.** According to the de Broglie hypothesis, the wavelength (λ) is related to the momentum (p) by the equation $\lambda = h/p$, showing an inverse relationship.

101. **(C) Chitin.** The fungal cell wall is made of chitin, a nitrogen-containing polysaccharide, which distinguishes fungi from plants (cellulose) and bacteria (peptidoglycan).

102. **(C) Floridean starch.** Red algae (Rhodophyceae) store food as floridean starch, which is structurally similar to amylopectin and glycogen found in animals.

103. **(B) Bryophytes.** Bryophytes are called the "amphibians of the plant kingdom" because they live on land but strictly require water for fertilization of their motile sperm.

104. **(B) Naked ovules not enclosed by an ovary wall.** In gymnosperms, the ovules remain exposed both before and after fertilization, as they lack an ovary wall that would later become a fruit.

105. **(B) Halophytes.** Pneumatophores are respiratory roots that grow vertically out of the water or mud to allow mangrove plants (halophytes) to breathe in anaerobic swamp conditions.

106. **(A) Phylloclade.** A phylloclade is a fleshy green stem of unlimited growth that has modified to perform photosynthesis, commonly seen in xerophytic plants like Opuntia.

107. **(D) Alstonia.** Whorled phyllotaxy occurs when three or more leaves arise at each node to form a circle around the stem, a characteristic feature of the Alstonia plant.

108. **(B) Acropetal succession.** In racemose inflorescences, the main axis (peduncle) grows indefinitely, and flowers are produced such that the youngest are at the apex and the oldest at the base.

109. **(C) Tomato.** Axile placentation occurs in multilocular ovaries where the placenta is formed by the fusion of margins of the carpels at the central axis, as seen in Tomato and Lemon.

110. **(C) Increasing the length of internodes in grasses.** Intercalary meristems are primary meristems located between permanent tissues that facilitate the elongation of stems and the regrowth of grass eaten by herbivores.

111. **(C) Gymnosperms.** The phloem of gymnosperms lacks specialized sieve tubes and companion cells; instead, they possess simpler sieve cells and albuminous cells.

112. **(C) Endodermis.** Casparian strips are waterproof bands of suberin found in the endodermal cell walls that regulate the flow of water and minerals into the vascular cylinder.

113. **(B) Secondary in origin.** Unlike the shoot, the vascular cambium in a dicot root is completely secondary in origin, developing from tissues located below the phloem and above the protoxylem.

114. **(B) Granum.** Thylakoids are arranged in stacks called grana within the chloroplast stroma, providing a large surface area for the light-harvesting complexes of photosynthesis.

115. **(B) Tonoplast.** The tonoplast is the single unit membrane that bounds the vacuole and contains transport proteins that maintain the vacuole's acidic pH and high solute concentration.

116. **(B) S phase.** The Synthesis (S) phase is the specific interval of the interphase during which DNA is replicated, doubling the genetic content while maintaining the chromosome number.

117. **(B) Pachytene.** Crossing over is the exchange of genetic segments between non-sister chromatids of homologous chromosomes, occurring during the pachytene stage of Prophase I.

118. **(C) 0.** By definition, pure water at standard pressure and temperature is assigned a water potential of zero; adding solutes always makes the water potential negative.

119. **(C) Magnesium.** Magnesium is the central atom in the chlorophyll porphyrin ring; a deficiency of this element leads to chlorosis, or the yellowing of leaves.

120. **(B) C4 plants.** Kranz anatomy involves a "wreath-like" arrangement of bundle sheath cells that allows C4 plants to minimize photorespiration by concentrating CO2 around Rubisco.

121. **(C) 5-carbon compound.** Ribulose-1,5-bisphosphate (RuBP) is the 5-carbon sugar that acts as the initial acceptor of atmospheric CO2 in the C3 photosynthetic pathway.

122. **(D) Cytoplasm.** Glycolysis is the anaerobic breakdown of glucose into two molecules of pyruvic acid and occurs entirely within the cytosol/cytoplasm of the cell.

123. **(A) Less than 1.** The Respiratory Quotient (RQ) for fats (like tripalmitin) is approximately 0.7 because fats are highly reduced and require more oxygen for complete oxidation.

124. **(C) Auxins.** Auxins produced in the shoot tip maintain apical dominance by inhibiting the growth of lateral buds; removing the tip allows lateral buds to grow.

125. **(B) Ethylene.** Ethylene is a gaseous phytohormone that accelerates fruit ripening and regulates abscission and senescence in various plant organs.

126. **(D) Tapetum.** The tapetum is the innermost layer of the anther wall that provides nourishment to the developing microspores and secretes precursors for the pollen wall.

127. **(B) 7-celled, 8-nucleate.** At maturity, the Polygonum-type embryo sac contains three antipodal cells, two synergids, one egg cell, and one central cell containing two polar nuclei.

128. **(C) Light, non-sticky pollen grains.** Wind-pollinated (anemophilous) flowers produce light, dry, and non-sticky pollen to ensure they can be easily transported over long distances by air.

129. **(D) Angiosperms.** Double fertilization is a unique event in flowering plants where one male gamete fertilizes the egg (syngamy) and the other fuses with two polar nuclei (triple fusion).

130. **(B) 1:2:1.** In a monohybrid cross, while the phenotypic ratio is 3:1, the genotypic ratio is 1 homozygous dominant to 2 heterozygous to 1 homozygous recessive.

131. **(B) Incomplete dominance.** In incomplete dominance, the heterozygous F1 phenotype is an intermediate blend of the parents, such as pink flowers resulting from red and white parents.

132. **(C) Sutton and Boveri.** Sutton and Boveri independently noted that the separation of pairs of chromosomes during meiosis parallels the segregation of Mendelian factors.

133. **(C) Pyramid of energy.** The pyramid of energy is always upright because only about 10% of the energy at one trophic level is transferred to the next; the rest is lost as heat.

134. **(B) Lichens.** Lichens are pioneer organisms on bare rock because they can tolerate extreme desiccation and secrete acids that dissolve rock to form the first layer of soil.

135. **(D) Seed Bank.** Seed banks are a form of ex-situ conservation where seeds are stored under ultra-low temperatures to preserve the genetic diversity of plants away from their natural habitats.

136. **(B) ^{32}P and ^{35}S.** DNA contains phosphorus but no sulfur, while proteins contain sulfur but no phosphorus, allowing Hershey and Chase to selectively label and track each molecule.

137. **(C) Prothallus.** In pteridophytes, the spores germinate to give rise to a prothallus, which is an inconspicuous, small, multicellular, and free-living photosynthetic gametophyte.

138. **(B) Periderm.** The periderm is a protective tissue of secondary origin that replaces the epidermis in stems and roots, comprising the phellogen, phellem, and phelloderm.

139. **(C) Mesocarp.** In the mango (a drupe), the fruit consists of an outer thin epicarp, a middle fleshy edible mesocarp, and an inner stony hard endocarp.

140. **(D) Mitochondrion.** The endomembrane system includes the ER, Golgi complex, lysosomes, and vacuoles; mitochondria are excluded as their functions are not coordinated with these organelles.

141. **(C) Active transport.** Active transport uses energy in the form of ATP to pump molecules "uphill" against a concentration gradient through specific carrier proteins in the membrane.

142. **(B) Molybdenum (Mo).** The enzyme nitrogenase is a Mo-Fe protein that catalyzes the conversion of atmospheric nitrogen to ammonia; molybdenum is a vital part of its catalytic site.

143. **(C) In the thylakoid lumen.** In chloroplasts, protons produced by water splitting and the cytochrome complex accumulate within the thylakoid lumen to create the gradient necessary for ATP synthesis.

144. **(D) Oxaloacetic acid (OAA).** The first reaction of the citric acid cycle is the condensation of the acetyl group from acetyl-CoA with oxaloacetic acid to yield citric acid.

145. **(B) Short-day plants.** Short-day plants require a light period less than a critical duration and a continuous dark period exceeding a critical length to induce the flowering process.

146. **(A) Dichogamy.** Dichogamy is an outbreeding device where the pollen release and stigma receptivity are not synchronized, effectively preventing autogamy within the same flower.

147. **(B) Test cross.** A test cross involves crossing an individual of unknown genotype with a homozygous recessive parent to determine the zygosity of the former based on progeny ratios.

148. **(B) 5' end (upstream) of the coding strand.** In a transcription unit, the promoter is a DNA sequence located towards the 5' end of the coding strand that serves as the binding site for RNA polymerase.

149. **(C) Commensalism.** Commensalism is an interspecific interaction where the commensal species derives benefit while the host species is neither significantly harmed nor helped.

150. **(B) Biomagnification.** Biomagnification is the cumulative increase in the concentration of persistent, non-biodegradable toxins at each successive trophic level of a food chain.

151. **(A) It helps to maintain a concentration gradient in the medullary interstitium.** The counter-current mechanism involving the loop of Henle and vasa recta creates an increasing osmolarity gradient essential for water reabsorption.

152. **(B) End of ventricular systole.** In an ECG, the T-wave represents ventricular repolarization; its conclusion marks the point where the ventricles have finished contracting.

153. **(A) (a)-2n, (b)-n, (c)-n, (d)-2n.** Spermatogonia and primary oocytes are diploid (2n), while secondary spermatocytes and spermatids are the result of meiosis I and are haploid (n).

154. **(C) The H-zone progressively disappears.** During contraction, actin filaments slide toward the center of the sarcomere, narrowing the H-zone and reducing the I-band length, while the A-band remains constant.

155. **(C) 480.** Since $q = 0.4$, $p = 0.6$. The number of heterozygotes is $2pq \times population = 2(0.6)(0.4) \times 1000 = 480$.

156. **(D) EcoRV.** EcoRV recognizes the sequence GATATC and cleaves it in the middle to produce blunt ends, unlike EcoRI, BamHI, and HindIII which produce "sticky" staggered ends.

157. **(B) Rupture of the Graafian follicle.** The LH surge mid-cycle triggers the final maturation and subsequent rupture of the follicle to release the ovum, a process known as ovulation.

158. **(C) Adaptive radiation - Darwin's finches on the Galapagos Islands.** This describes the process where a single ancestral species evolves into diverse forms to occupy different ecological niches.

159. **(C) Rapid efflux of K^+ ions.** Repolarization occurs when voltage-gated potassium channels open, allowing K^+ to move out of the cell, restoring the negative resting membrane potential.

160. **(D) The heart is dorsally located.** Chordates are characterized by a ventral heart; a dorsal heart is a characteristic found in non-chordate phyla like Arthropoda.

161. **(C) Myasthenia gravis.** This is an autoimmune disorder where antibodies block or destroy acetylcholine receptors at the neuromuscular junction, leading to skeletal muscle weakness.

162. **(B) Adenosine deaminase (ADA) deficiency.** The first clinical gene therapy was used to introduce a functional ADA gene into the lymphocytes of a patient with Severe Combined Immunodeficiency (SCID).

163. **(C) Blood group O only.** Individuals with blood group O have anti-A and anti-B antibodies in their plasma, meaning they can only safely receive blood from other O-type donors.

164. **(D) Binding of a complementary double-stranded RNA molecule.** RNAi is a biological process where double-stranded RNA (dsRNA) molecules inhibit gene expression by neutralizing specific mRNA molecules.

165. **(A) hCG, hPL, and Relaxin.** Human Chorionic Gonadotropin (hCG) and Human Placental Lactogen (hPL) are produced by the placenta, and Relaxin is secreted by the ovary late in pregnancy.

166. **(B) Trypsinogen into trypsin.** Enterokinase is an enzyme produced by the intestinal mucosa that activates the pancreatic proenzyme trypsinogen, which then activates other pancreatic enzymes.

167. **(A) Rete testis → Vasa efferentia → Epididymis → Vas deferens.** This represents the correct anatomical pathway for sperm transport from the seminiferous tubules toward the ejaculatory duct.

168. **(C) Presence of a muscular diaphragm separating thorax and abdomen.** While other features like a 4-chambered heart are shared with birds, the presence of a diaphragm is unique to the class Mammalia.

169. **(B) They suppress sperm motility and their fertilizing capacity.** Copper ions released by IUDs act as a spermicide by decreasing the movement and efficiency of sperm, preventing fertilization.

170. **(C) Residual Volume (RV).** Residual volume is the air remaining in the lungs after a maximal forced expiration; because it never leaves the lungs, it cannot be measured by simple spirometry.

171. **(C) To identify and eliminate non-transformants and selectively permit the growth of transformants.** Selectable markers, like antibiotic resistance genes, allow researchers to grow only the cells that successfully took up the plasmid.

172. **(C) Medulla oblongata.** The medulla contains vital centers that control autonomic functions including the respiratory rhythm, cardiovascular reflexes, and gastric secretions.

173. **(C) Frequency of the dominant allele in the gene pool.** In the Hardy-Weinberg equation, 'p' denotes the frequency of the dominant allele, while 'q' denotes the frequency of the recessive allele.

174. **(A) The joint between the atlas and the axis vertebrae.** This is a pivot joint that allows for the rotational movement of the head (the "no" movement).

175. **(B) Secretin.** Secretin is released by the duodenum in response to acidic chyme and stimulates the pancreas to secrete a fluid high in bicarbonate to neutralize the acid.

176. **(B) Semicircular canals.** These canals contain the crista ampullaris, which detects rotational movement and helps the brain maintain dynamic equilibrium and posture.

177. **(B) Anaerobic chemoheterotrophs.** The first cells likely lived in an oxygen-free environment and obtained energy by absorbing organic molecules from the primordial environment.

178. **(B) Secondary spermatocytes.** The first meiotic division is a reductional division that converts a single diploid primary spermatocyte into two haploid secondary spermatocytes.

179. **(C) Thermostable extension of the new DNA strand.** Taq polymerase is derived from *Thermus aquaticus* and can withstand the high temperatures of PCR required to synthesize new DNA strands.

180. **(C) Monocyte.** Monocytes are the largest type of leucocyte; they circulate in the blood and migrate into tissues to become macrophages or dendritic cells.

181. **(C) Renin.** A drop in blood pressure causes the JG cells to release renin, which initiates the RAAS pathway to increase blood volume and pressure.

182. **(C) IgE.** Immunoglobulin E (IgE) binds to mast cells and basophils, triggering the release of histamine and other mediators during an allergic reaction.

183. **(D) Males possess anal styles, while females do not possess anal cerci.** This is incorrect because anal cerci are present in both sexes; anal styles are the structures found exclusively in males.

184. **(B) Cryptorchidism.** This clinical condition occurs when one or both testes fail to move into the scrotum, which is necessary for the lower temperature required for spermatogenesis.

185. **(C) The Hardy-Weinberg Principle.** This principle states that allele and genotype frequencies remain constant (in equilibrium) in a population provided no evolutionary forces are acting upon it.

186. **(A) Statements I and II only.** ANF acts as a vasodilator to lower blood pressure, while ADH prevents diuresis by facilitating water reabsorption; statement III is false as fluid loss *switches on* osmoreceptors.

187. **(C)** CH_4, H_2, NH_3**, and water vapor at** $800°C$**.** S.L. Miller's experiment simulated primitive Earth's reducing atmosphere using these specific gases and a high-temperature spark discharge.

188. **(C) Glucocorticoids actively stimulate gluconeogenesis, lipolysis, and proteolysis.** Glucocorticoids like cortisol increase blood glucose levels and promote the breakdown of fats and proteins to provide energy during stress.

189. **(A) (a)-Expanding pyramid, (b)-Stable pyramid, (c)-Declining pyramid.** An expanding population has a broad base of young individuals, a stable one has equal young and adults, and a declining one has fewer young.

190. **(D) Neutrophils are the most abundant leukocytes and exhibit highly efficient phagocytic activity.** Neutrophils make up 60–65% of WBCs and act as the first line of defense by engulfing and destroying invading pathogens.

191. **(B) The alkaline pH of the midgut.** The crystalline protoxin from *Bacillus thuringiensis* is solubilized and activated only when it encounters the specific alkaline environment of an insect's midgut.

192. **(A) Both A and R are true, and R is the correct explanation of A.** The second meiotic division is suspended in metaphase II and is only completed when the sperm's entry triggers the completion of the cycle.

193. **(C) Directional natural selection.** Industrial melanism is directional because the environmental change (soot on trees) favored one extreme phenotype (dark moths) over the other (light moths).

194. **(B) Macrophages.** Upon entry into the body, HIV first infects macrophages, which act as an "HIV factory" by replicating the virus before it moves on to deplete T-helper cells.

195. **(B) The genes are assorting independently and are either on different chromosomes or very far apart on the same chromosome.** A recombination frequency of 50% is the maximum possible and is functionally equivalent to independent assortment.

196. **(C) Echinodermata.** Echinoderms are exclusively marine, possess a unique water vascular system, and exhibit a developmental shift from bilateral symmetry in larvae to radial symmetry in adults.

197. **(B) Tectorial membrane.** As the basilar membrane moves in response to sound waves, it causes the hair cell stereocilia to bend against the stiff tectorial membrane, generating nerve impulses.

198. **(C) K_m increases, and V_{max} remains exactly the same.** A competitive inhibitor increases the substrate concentration needed to reach half-velocity (K_m), but the maximum reaction rate (V_{max}) is still achievable.

199. **(B) Lacteals.** Chylomicrons are too large to enter blood capillaries directly and are instead absorbed into the specialized lymph vessels called lacteals located in the intestinal villi.

200. **(B) 4C and 2n.** DNA replication during the S phase doubles the DNA content from 2C to 4C, but the chromosome number remains 2n until they are separated during the M phase.