NEET 2026 Official Paper (Held On: 03 May, 2026) (Previous Year Paper)

National Eligibility cum Entrance Test (NEET) • 2026 • 180 questions • 180 minutes • Answer key and solutions

Take this paper as a free timed mock test

Practise under exam conditions, then review your answers after you submit.

yourmocktest.com/pyq/neet/neet-2026-official-paper-held-on-03-may-2026-previous-year-paper

Scan the QR code or click the link to open it.

PHYSICS

Q1. A 100-turn closely wound circular coil of radius 5 cm has a magnetic field of 3.14 × 10^(-3) T at its centre. The current flowing through the coil, and the magnitude of the magnetic moment of this coil are, respectively :

(Take μ0 = 4π × 10^(-7) T m/A)

(a) 2.5 A, 2 A m²

(b) 2.5 A, 20 A m²

(c) 2 A, 4 A m²

(d) 2 A, 10 A m²

Q2. Match List I with List II :

List I	List II
A. E = hν	I. de Broglie wavelength
B. Diffraction and Interference	II. Particle nature of light
C. λ = h/p	III. Wave nature of light
D. Compton effect	IV. Energy of photon

Choose the correct answer from the options given below :

(a) A - IV, B - III, C - I, D - II

(b) A - I, B - IV, C - III, D - II

(c) A - IV, B - I, C - II, D - III

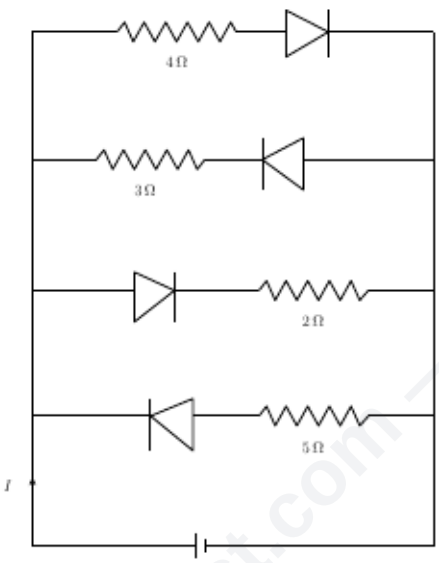
(d) A - IV, B - III, C - II, D - I

Q3. The current I in the circuit shown below is :

(All diodes are ideal and identical)

Potential difference across the circuit is 10 V.

(All diodes are ideal and identical)

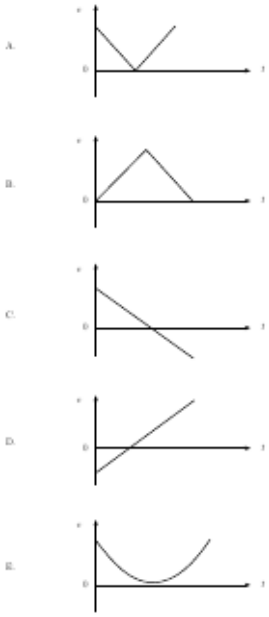


(a) 5/3 A
(b) 15/2 A
(c) 1/3 A
(d) 5/9 A

Q4. The speed of light in vacuum is taken as unity. If light takes 6 min 40 s to reach the Earth from the Sun, the distance between the Sun and the Earth in new unit is :

(a) 3 × 10^8
(b) 3 × 10^(10)
(c) 400
(d) 500

Q5. The following plots show variation of velocity (v) with time (t), of a ball thrown vertically upward, and falling back. Which of the following plots is/are correct ?



(a) C only
(b) A and E only
(c) D only
(d) B only

YourMockTest.com — Free Study Material

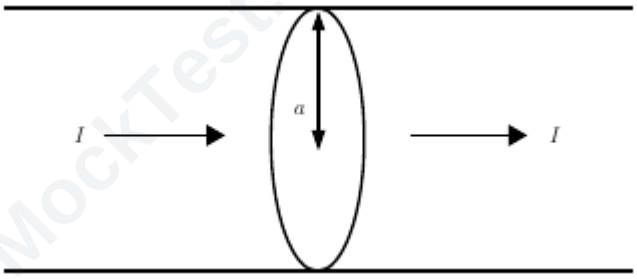
Q6. In a vernier callipers, 20 VSD coincide with 16 MSD (each division of length 1 mm). The least count of the vernier callipers is :

(a) 0.01 cm
(b) 0.1 cm
(c) 0.02 cm
(d) 0.2 cm

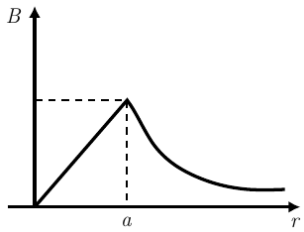
Q7. An ac circuit contains a resistance of 1 kΩ, a capacitor of 0.1 μF and an inductor of 1 mH connected in series. The resonance frequency of the circuit is approximately :

(a) 10.1 kHz
(b) 20.7 kHz
(c) 15.9 kHz
(d) 13.5 kHz

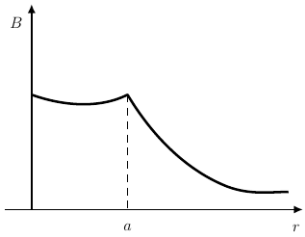
Q8. The figure given below, shows a long straight solid wire of circular cross-section of radius 'a' carrying steady current I. The current I is uniformly distributed across its cross-section. The plot which correctly represents the variation of magnetic field (B) with distance (r) from the axis of the conductor in the region is :



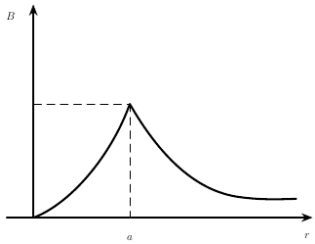
(a)



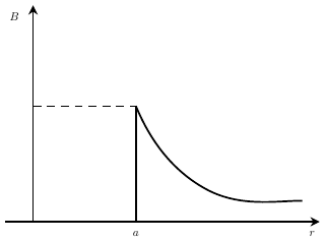
(b)



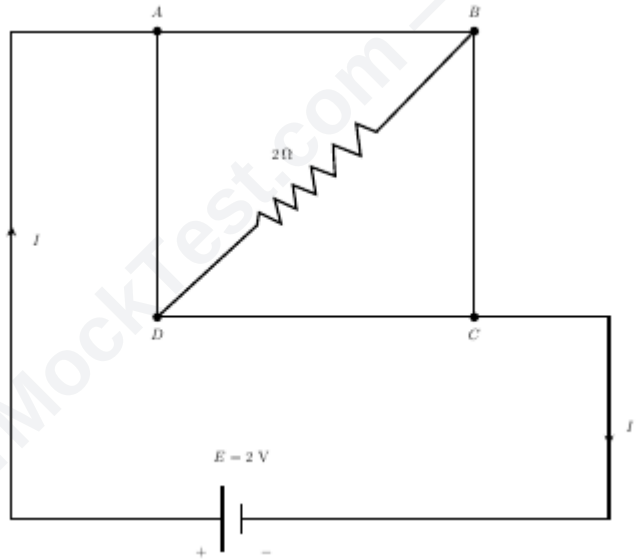
(c)



(d)



Q9. A uniform metallic wire having resistance 4 Ω is bent to form a square loop (ABCD) (see figure). A resistance of 2 Ω is connected between points B and D and a battery of 2 V is connected across points A and C as shown in the figure. Now the value of current (I) is :



(a) 2 A
(b) 4 A
(c) 8 A
(d) 4.5 A

Q10. An unknown nucleus has a nuclear density of 2.29 × 10^(17) kg/m³ and mass of 19.926 × 10^(-27) kg. Its mass number A is approximately :

(Take R0 = 1.2 × 10^(-15) m, 4π = 12.56)

(a) 12
(b) 19
(c) 20
(d) 16

Q11. A rectangular wire loop of sides 8 cm and 3 cm with a small cut, is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the plane of the loop. The emf developed across the cut, if the velocity of the loop is 2 cm s^(-1), in a direction normal to the shorter side of the loop, will be :

(a) 1.8 × 10^(-4) volt
(b) 1.2 × 10^(-4) volt
(c) 1.3 × 10^(-4) volt
(d) 4.8 × 10^(-4) volt

Q12. A galvanometer of resistance 100 Ω gives full scale deflection for a current of 1 mA. It is converted into an ammeter of range 0 - 10 A. The shunt required is :

(a) 0.01 Ω
(b) 0.10 Ω
(c) 0.001 Ω
(d) 1.0 Ω

YourMockTest.com — Free Study Material

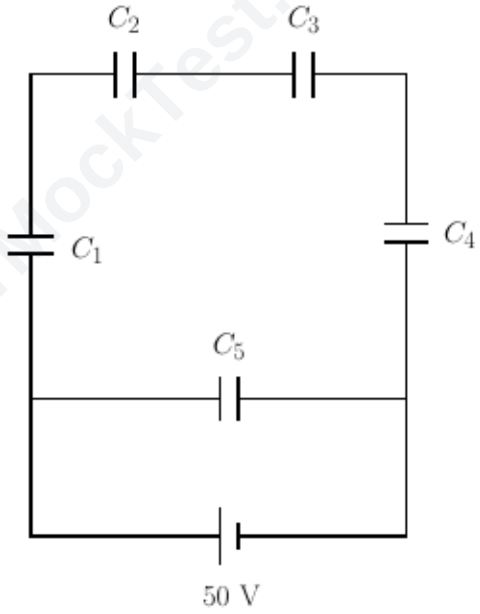
Q13. In Young's double slit experiment, using monochromatic light of wavelength λ, the intensity of light at a point on the screen where the path difference is λ is K units. The intensity of light at a point where the path difference is λ/3 will be :

(a) K/4
(b) K
(c) K/2
(d) 2 K

Q14. The magnitude and direction of the acceleration produced in a body of mass 5 kg when two mutually perpendicular forces 8 N and 6 N act on it, are respectively :

(a) 2 m s^(-2) ; tan ^(-1)(3/4) with 6 N force
(b) 2 m s^(-2) ; tan ^(-1)(4/3) with 8 N force
(c) 2 m s^(-2) ; tan ^(-1)(3/4) with 8 N force
(d) 20 m s^(-2) ; tan ^(-1)(4/3) with 8 N force

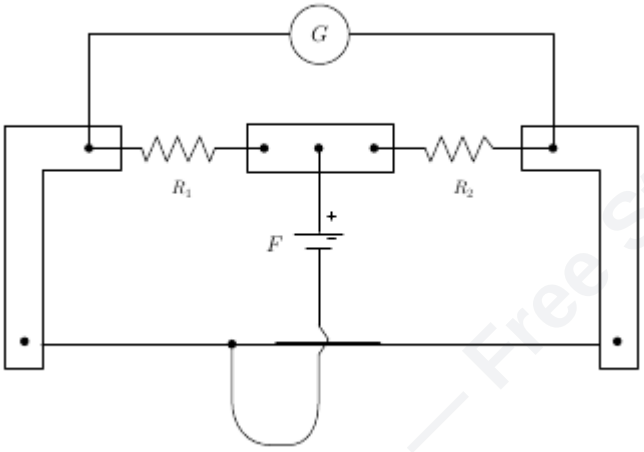
Q15. Five capacitors of capacitances C1 = C2 = C3 = C4 = 10 μF and C5 = 2.5 μF are connected as shown, along with a battery of 50 V.



The equivalent capacitance and the charges on each capacitor respectively are :

(a) 5 μF, 125 μC on all capacitors
(b) 5 μF, 250 μC on all capacitors
(c) 4 μF, 250 μC on C1 to C4 and 125 μC on C5
(d) 5 μF, 125 μC on C1 to C4 and 25 μC on C5

Q16. In a metre bridge experiment (see figure), the positions of the cell, E, and galvanometer, G, are interchanged. We shall observe in the galvanometer :



(a) Only the right-sided deflection
(b) Only the left-sided deflection
(c) There will be no deflection irrespective of the position of the jockey
(d) Both right-sided and left-sided deflection and at balance point, no deflection

Q17. The power of a crane, which lifts a mass of 1000 kg to a height of 20 m in 10 s is :
(g = 9.8 m/s²)
(a) 19.6 W
(b) 39.2 W
(c) 39.2 kW
(d) 19.6 kW

Q18. Match List I with List II :

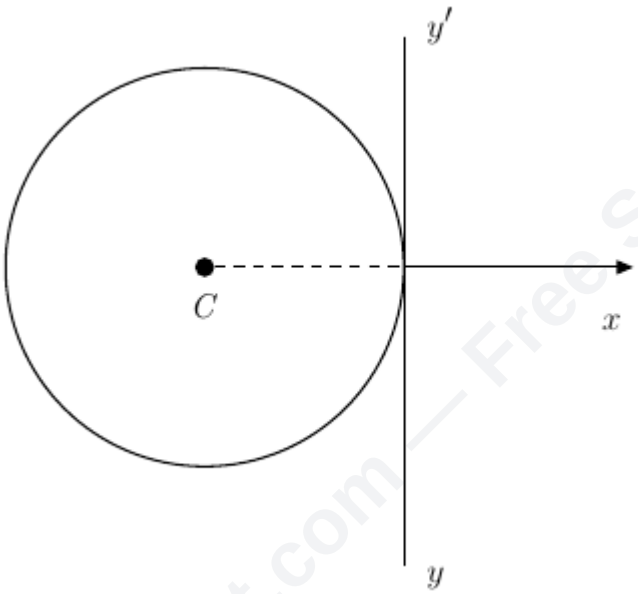
List I	List II
A. Young's Modulus	I. (Δ d)/(Δ L) (L/d)
B. Compressibility	II. FL/(A(Δ L))
C. Bulk Modulus	III. -1/(Δ P) ((Δ V)/V)
D. Poisson's Ratio	IV. -P (V/(Δ V))

Choose the correct answer from the options given below :
(a) A - I, B - IV, C - III, D - II
(b) A - IV, B - I, C - II, D - III
(c) A - III, B - II, C - I, D - IV
(d) A - II, B - III, C - IV, D - I

Q19. In a concave lens, a ray of light emanating from the object parallel to the principal axis of the lens, after refraction :
(a) emerges parallel to the principal axis.
(b) appears to diverge from the first principal focus.
(c) passes through 2F, which is the radius of curvature of the lens.
(d) passes through the second principal focus.

Q20. A thin wire of length ' L ' and linear mass density ' m ' is bent into a circular ring (in x-y plane) with centre ' C ' as shown in figure. The moment of inertia of the ring about an axis yy' will be :

YourMockTest.com — Free Study Material



(a) (3 mL³)/(8 π²)
(b) (3 mL³)/(8 π)
(c) (3 mL²)/(8 π²)
(d) (3 mL²)/(8 π)

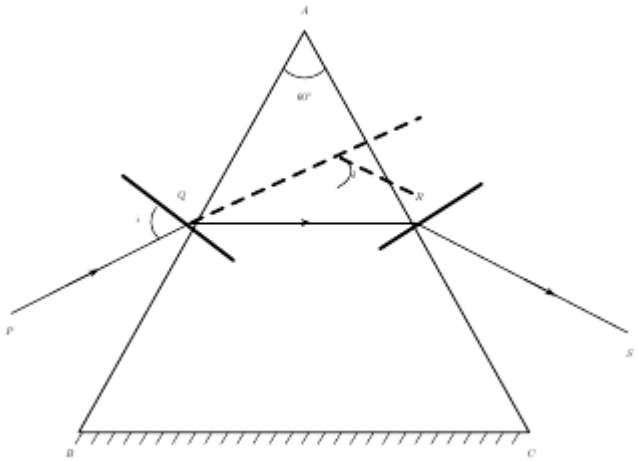
Q21. Each side of a metallic cube of mass 5.580 kg is measured to be 9.0 cm. Keeping the significant figures in view, the density of the material of the cube can be best expressed as X × 10³ kg m^(-3), where the value of X is :

(a) 7.654
(b) 7.7
(c) 7.65
(d) 7.6

Q22. For a travelling harmonic wave y(x, t) = 2 · 0 cos 2π(10 t - 0 · 0080 x + 0 · 35), where x and y are in cm and t in s. The phase difference between oscillatory motion of two points separated by a distance of 0 · 5 m is :

(a) 8 π rad
(b) 0 · 08 π rad
(c) 0 · 008 π rad
(d) 0 · 8 π rad

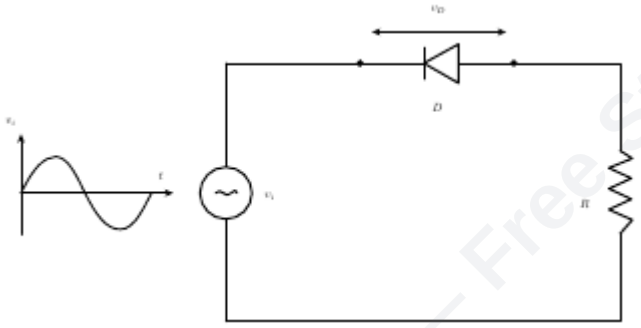
Q23. A ray of monochromatic light is passing through an equilateral prism (ABC) as shown in the figure. The refracted ray (QR) is parallel to its base (BC) and the angle of incidence (i) is 50°. Then the angle of deviation (δ) is :



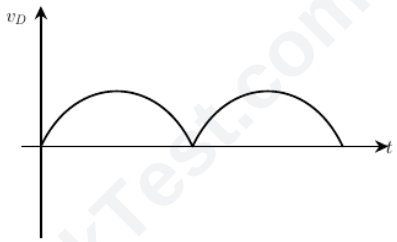
(a) 40°
(b) 45°
(c) 55°

(d) 35°

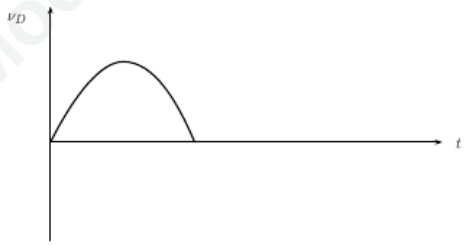
Q24. In the circuit shown below, the voltage appearing across the diode D will be of the form :



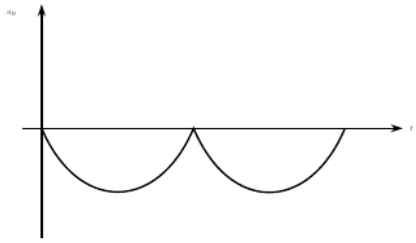
(a)



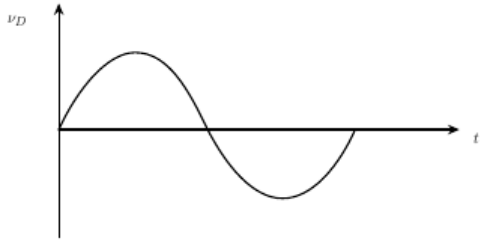
(b)



(c)



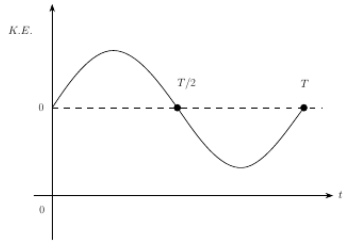
(d)



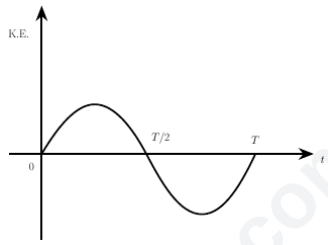
Q25. For a simple pendulum, having time period T, the variation of kinetic energy (K.E.) with time (t) is represented by :

Free Study Material — YourMockTest.com

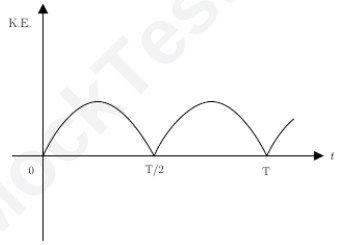
(a)



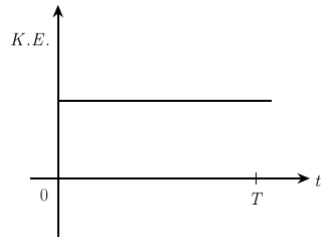
(b)



(c)



(d)



Q26. A resistor is connected to a battery of 12 V emf and internal resistance 2 Ω. If the current in the circuit is 0 · 6 A, the terminal voltage of the battery is :

(a) 10 V
(b) 10 · 8 V
(c) 12 V
(d) 1 · 2 V

Q27. The amount of work done to raise a mass ' m ' from the surface of the Earth to a height equal to the radius of the Earth ' R ', will be :

(a) 2 mg R
(b) mg R
(c) mg R/4
(d) mg R/2

Q28. An electric heater supplies heat to a system at a rate of 100 W. If the system performs work at a rate of 75 J/s, then the rate at which internal energy increases will be :

(a) 125 W
(b) 100 W
(c) 25 W
(d) 75 W

YourMockTest.com — Free Study Material

Q29. A room heater is rated 400 W, 220 V. If the supply voltage drops to 200 V, what will be the power consumed (approximately) ?

(a) 121 W
(b) 331 W
(c) 200 W
(d) 400 W

Q30. When a ruler falls vertically, 5 different persons catch it with different reaction times.

(g = 9 · 8 m s^(-2))

A. Person A has reaction time of 0 · 20 s

B. Person B has reaction time of 0 · 22 s

C. Person C has reaction time of 0 · 18 s

D. Person D has reaction time of 0 · 19 s

E. Person E has reaction time of 0 · 21 s

What is the correct order of the distance travelled by the ruler for each person ?

(a) C > D > A > B > E
(b) C > D > A > E > B
(c) B > E > A > C > D
(d) B > E > A > D > C

Q31. Consider two uncharged capacitors of equal capacitance 200 pF. One of them is charged by a 100 V supply and disconnected. Now this capacitor is connected to the uncharged capacitor. The amount of electrostatic energy lost in the process is :

(a) 1 · 0 × 10^(-6) J
(b) 0 · 5 × 10^(-6) J
(c) 0 · 5 J
(d) 1 · 0 J

Q32. Savitha, a XI standard student, while conducting an experiment to determine the effective length of a simple pendulum L, notes down the data of time taken to complete 30 oscillations as 60 s and hence calculates the length of the simple pendulum as :

(Take $\pi^2 = 9.8$ and $g = 9.8\ m/s^2$)

(a) 2 m
(b) 0.75 m
(c) 1.5 m
(d) 1 m

Q33. The peak value of an alternating current is 5 A and frequency is 60 Hz. How long will the current, starting from zero, take to reach the peak value ?

(a) 1/240 s
(b) 1/30 s
(c) 1/120 s
(d) 1/60 s

Q34. In interference and diffraction, the light energy is redistributed. If it reduces in one region, producing a dark fringe, it increases in another region, producing a bright fringe.

A. As there is no gain or loss of energy, these phenomena are consistent with the principle of conservation of energy.

B. Diffraction and interference are characteristics exhibited only by light waves.

Choose the correct answer from the options given below :

(a) A is true, but B is false
(b) A is true and B is also true
(c) A is false, but B is true
(d) Both A and B are false

YourMockTest.com — Free Study Material

Q35. A box of mass 15 kg is kept on the floor of a stationary trolley. The coefficient of static friction between the box and the trolley is 0.12. Keeping the box in stationary state over the trolley, the maximum acceleration with which the trolley can be moved horizontally in m s^(-2) is :

(g = 10 m/s²)

(a) 1.5
(b) 1.8
(c) 2.1
(d) 1.2

Q36. The sum of kinetic energy and potential energy of a simple pendulum bob is 0.02 joule. The speed of the simple pendulum bob at equilibrium position is approximately :

(Consider mass of the bob = 20 g)

(a) 1.41 m/s
(b) 14.1 m/s
(c) 0.2 m/s
(d) 2.0 m/s

Q37. Four statements are given (A is mass number) :

A. The volume of a nucleus is proportional to A^(1/3).

B. The volume of a nucleus is proportional to A.

C. The difference in mass of an atom and its nucleus is called the mass defect.

D. The difference in mass of a nucleus and its constituents is called the mass defect.

Choose the correct answer from the options given below :

(a) B and D are true, but A and C are false
(b) A and D are true, but B and C are false
(c) A and C are true, but B and D are false
(d) B and C are true, but A and D are false

Q38. The angular speed of a flywheel is increased from 600 rpm to 1200 rpm in 10 s. The number of revolutions completed by the flywheel during this time is :

(a) 600
(b) 900
(c) 300
(d) 150

Q39. A submarine is designed to withstand an absolute pressure of 100 atm. How deep can it go below the water surface ?

(Consider the density of water = 1000 kg m^(-3), 1 atm = 1 × 10^5 Pa and gravitational acceleration g = 10 m/s²)

(a) 9900 m
(b) 99 m
(c) 9000 m
(d) 990 m

Q40. Match List I with List II :

List I (Electromagnetic wave)	List II (Production)
A. Microwave	I. Electrons in atoms emit light when they move from a higher energy level to a lower energy level
B. Visible light	II. Radioactive decay of nucleus
C. Gamma rays	III. Vibration of atoms and molecules
D. Infra-red rays	IV. Klystron valve or magnetron valve

Choose the correct answer from the options given below :

(a) A - III, B - I, C - II, D - IV
(b) A - III, B - IV, C - I, D - II
(c) A - IV, B - III, C - II, D - I
(d) A - IV, B - I, C - II, D - III

Q41. Which of the following statements are correct ?

A. Inside a conductor, the electrostatic field is zero.

B. Electric field at the surface of a charged conductor does not depend on its surface charge density.

C. The interior of a charged conductor can have no excess charge in the static situation.

D. At the surface of a charged conductor, the electrostatic field must be normal to the surface at every point.

E. The electrostatic potential is zero everywhere inside a charged conductor.

Choose the correct answer from the options given below :

(a) C, D and E only
(b) A, B and D only
(c) A, C and D only
(d) A, C and E only

Q42. For a metal of work function 6.6 eV, which of the following wavelengths of incident radiation does not give rise to the photoelectric effect ?

(Take Planck's constant as 6.6 × 10^(-34) J s)

(a) 200 nm
(b) 150 nm
(c) 100 nm
(d) 50 nm

Q43. In the first excited state of hydrogen atom, the energy of its electron is -3.4 eV. The radial distance of the electron from the hydrogen nucleus in this case is approximately :

(Take 1 eV = 1.6 × 10^(-19) J, e = 1.6 × 10^(-19) C and $1/4\pi\varepsilon_0 = 9 \times 10^9$ N m²/C²)

(a) 2.1 × 10^(-8) m
(b) 2.1 × 10^(-11) m
(c) 2.1 × 10^(-9) m
(d) 2.1 × 10^(-10) m

Q44. Two statements are given below :

A. When the forward bias voltage across a p-n junction diode increases above a certain threshold voltage, the diode current increases significantly.

B. This current is called reverse saturation current.

Choose the correct answer from the options given below :

(a) Both Statements A and B are false
(b) Statement A is true, but Statement B is false
(c) Both Statements A and B are true
(d) Statement A is false, but Statement B is true

Q45. A flask contains argon and chlorine in the ratio of 2 : 1 by mass. The temperature of the mixture is 27°C. The ratio of root mean square speed of the molecules of the two gases ((v_(rms)^(Ar))/(v_(rms)^(Cl))) is :

(Atomic mass of argon = 40.0 u and molecular mass of chlorine = 70.0 u)

(a) √7/2
(b) 7/2
(c) 7/4
(d) 2/√7

YourMockTest.com — Free Study Material

CHEMISTRY

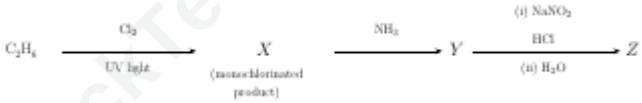
Q46. Match List I with List II :

List I	List II
A. [figure]	I. (i) (ii) NaOH (iii) H^+
B. CH3COOH → CH3CH2OH	II. (i) O2 (ii) H2OH^+
C. [figure]	III. (i) CH3OH, H^+ (ii) H2, catalyst
D. [figure]	IV. coc H2SO4 (ii) H^+, H2O

Choose the correct answer from the options given below :

(a) A - I, B - III, C - IV, D - II
(b) A - II, B - IV, C - III, D - I
(c) A - II, B - III, C - I, D - IV
(d) A - II, B - III, C - IV, D - I

Q47. The major product Z formed in the following sequence of reactions is



(a) C_(2^H5) - N = N - OH
(b) C2H5OH
(c) C2H5NO2
(d) C2H5NH2

Q48. In a qualitative analysis Bi^(3+) is detected by appearance of precipitate of BiO(OH)(s). Calculate pH when the following equilibrium exists at 298 K:

BiO(OH)(s) <=> BiO^+ (aq) + OH^- (aq),

K = 4 × 10^(-10)

(Given : log 2 = 0.3010)

(a) 4.699
(b) 8.714
(c) 9.301
(d) 5.286

Q49. When 1 dm^3 of CO2 gas is passed over hot coke. the volume of gascous mixture after complete reaction at STP becomes 1.4 dm^3. The composition of the gaseous mixture at STP is

(a) 0.6 dm^3 of CO, 0.8 dm^3 of CO2
(b) 0.8 dm3 of CO, 0.8 dm3 of CO2
(c) 0.8 dm3 of CO, 0.6 dm3 of CO2
(d) 0.6 dm3 of CO, 0.6 dm3 of CO2

Q50. Match List I with List II :

List I (Quantum Numbers)	List II (Orbital)
A. n - 2, l - 1	I. 3d
B. n - 4, l - 0	II. 2p
C. n - 5, l - 3	III. 4s
D. n - 3, l - 2	IV. 5f

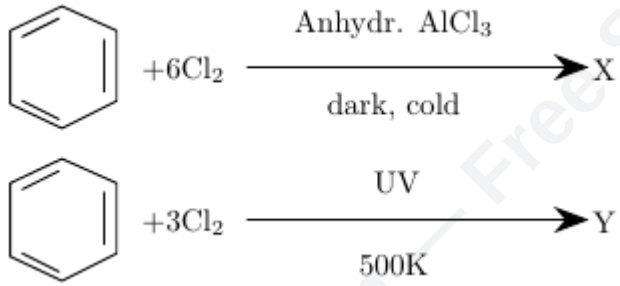
Choose the correct answer from the options given below :

(a) A - II, B - III, C - IV, D - I

YourMockTest.com — Free Study Material

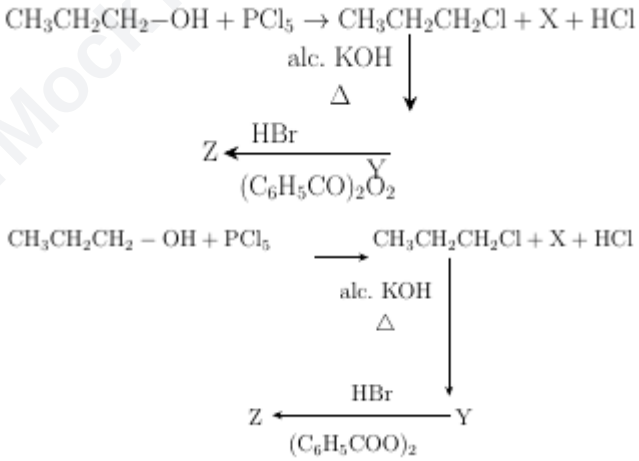
(b) A - I, B - II, C - III, D - IV
(c) A - IV, B - II, C - III, D - I
(d) A - II, B - III, C - I, D - IV

Q51. The number of chlorine atoms present in the organic products X and Y of the following reactions, respectively, are



(a) 3 and 6
(b) 6 and 6
(c) 6 and 3
(d) 3 and 3

Q52. In the following reaction sequence, X and Z, respectively are :



(a) X = POCl3; Z = CH3 - CH - CH3
(b) X = H3PO3; Z = CH3CH2CH2 - Br
(c) X = H3PO3; Z = CH3 - CH - CH3
(d) X = POCl3; Z = CH3CH2CH2 - Br

Q53. Match List I with List II :

List I	List II
(Transition metal/compound/complex)	(Catalytic Role)
A. V2O5	I. Preparation of ammonia from N2/H2 mixture
B. Fe	II. Polymerisation of alkynes
C. PdCl2	III. Preparation of H2SO4 from SO2
D. Ni complex	IV. Oxidation of ethyne to ethanal

Choose the correct answer from the options given below :

(a) A-III, B-IV, C-I, D-II
(b) A-II, B-I, C-IV, D-III
(c) A-IV, B-I, C-III, D-II
(d) A-III, B-I, C-IV, D-II

YourMockTest.com — Free Study Material

Q54. Identify the correct statement about ClF3 from the following options :

(a) It has a trigonal pyramidal geometry with two lone pairs on Cl atom.
(b) It has T-shaped geometry with two lone pairs on Cl atom.
(c) It has a planar trigonal geometry with two lone pairs on Cl atom.
(d) It has T-shaped geometry with three lone pairs on Cl atom.

Q55. Calculate emf of the half cell given below :

Pt(s) | H2(g, 2 atm) | HCl(aq, 0.02 M)
E_(H2/H^+)° = 0 V
(Given : (2.303 RT)/F = 0.059,
log 2 = 0.3010)

(a) 0.109 V
(b) 0.035 V
(c) -0.035 V
(d) -0.109 V

Q56. Match List I with List II :

List I	List II
(Order of reaction)	(Unit of rate constant)
A. Zero order	I. mol^(-1) L s^(-1)
B. First order	II. mol^(-2) L² s^(-1)
C. Second order	III. s^(-1)
D. Third order	IV. mol L^(-1) s^(-1)

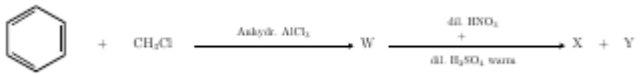
Choose the correct answer from the options given below :

(a) A-IV, B-III, C-II, D-I
(b) A-I, B-II, C-III, D-IV
(c) A-IV, B-III, C-I, D-II
(d) A-IV, B-II, C-I, D-III

Q57. The calculated 'spin-only' magnetic moment of Ti^(2+) (3d²) is :

(a) 2.84 BM
(b) 5.92 BM
(c) 4.90 BM
(d) 3.87 BM

Q58. Two products X and Y are formed in the following reaction sequence.



The suitable method that can be used for the separation of products X and Y is :

(a) Continuous extraction
(b) Differential extraction
(c) Fractional distillation
(d) Sublimation

Q59. A bulb is rated at 150 watt, converting 8% energy into light. If energy of one photon is 4.42 × 10^(-19) J, how many photons are emitted by the bulb per second ?

(a) 1.35 × 10^(19)
(b) 4.06 × 10^(19)
(c) 2.71 × 10^(19)
(d) 27.2 × 10^(19)

YourMockTest.com — Free Study Material

Q60. In a test tube containing a salt, a few drops of dilute H2SO4 was added, which gave colourless vapours having the smell of vinegar. The vapours turned the blue litmus paper red.

Identify the correct anion from the following :

(a) Acetate, CH3COO^-

(b) Carbonate, CO3^(2-)

(c) Sulphate, SO4^(2-)

(d) Sulphide, S^(2-)

Q61. Select the reagents that reduce nitriles to primary amines :

A. (i) LiAlH4 ; (ii) H2O

B. Sn + HCl

C. H2/Ni

D. Na(Hg)/C2H5OH

E. Br2/aq. NaOH

Choose the correct answer from the options given below :

(a) A, B and C only

(b) A, C and D only

(c) A, D and E only

(d) B, D and E only

Q62. Identify the incorrect statement from the following :

(a) Carbon has the ability to form pπ-pπ multiple bond with itself.

(b) ECl3 (E = B and Al) is a monomer when E = B and a dimer when E = Al.

(c) Oxygen exhibits only -2 oxidation state.

(d) The order of catenation property of Group 14 elements is C gg Si > Ge ≈ Sn.

Q63. Although +3 oxidation state is most common in lanthanoids, cerium still shows +4 oxidation state because :

(a) Its nearest inert gas is Radon.

(b) After losing one more electron, it acquires 4f^(14) electronic configuration.

(c) Its atomic number is 61.

(d) After losing one more electron, it acquires 4f^0 electronic configuration.

Q64. During Lassaigne's test, the elements present in an organic compound are converted from :

(a) covalent form to covalent form

(b) ionic form to ionic form

(c) covalent form to ionic form

(d) ionic form to covalent form

Q65. The number of hydrogen atoms present in 5.4 g of urea is :

(Given : Molar mass of urea : 60 g mol^(-1), N_A : 6.022 × 10^{23} particles mol^(-1))

(a) 2.168 × 10^{23}

(b) 2.168 × 10^{22}

(c) 1.084 × 10^{22}

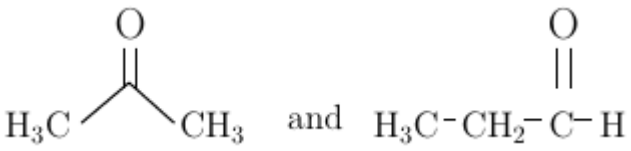
(d) 1.084 × 10^{23}

Q66. The pair of molecules that are metamers among the following is :

(a) CH3CH2CH2OH and CH3 - CH(OH) - CH3

(b) CH3OCH2CH2CH3 and CH3CH2OCH2CH3

(c)



(d) CH3CH2CH2CH2CH3 and (CH3)2CHCH2CH3

Q67. Identify the incorrect statement from the following :

(a) P(C2H5)3 and As(C6H5)3 form dπ-dπ bond with transition metals.
(b) Nitrogen can form dπ-pπ bond with oxygen.
(c) Nitrogen can form pπ-pπ multiple bonds with itself.
(d) Phosphorus, arsenic and antimony show catenation property.

Q68. Phenolphthalein is used as an indicator for the titration of sodium hydroxide solution against a standard solution of oxalic acid. The colour change that is observed at an alkaline pH close to the equivalence point during this titration is :

(a) pinkish red to yellow
(b) yellow to pinkish red
(c) colourless to pink
(d) pink to colourless

Q69. Match List I with List II :

List I	List II
A. C2H4	I. 3σ bonds, 2π bonds
B. C2H2	II. 3σ bonds, one lone pair
C. CH4	III. 4σ bonds
D. NH3	IV. 5σ bonds, 1π bond

Choose the correct answer from the options given below :

(a) A - IV, B - I, C - III, D - II
(b) A - III, B - IV, C - II, D - I
(c) A - I, B - II, C - IV, D - III
(d) A - II, B - III, C - I, D - IV

Q70. At a certain temperature, T (K), during a process, 500 J is absorbed by the system and work of 200 J is done by the system. Then change in internal energy of the system is :

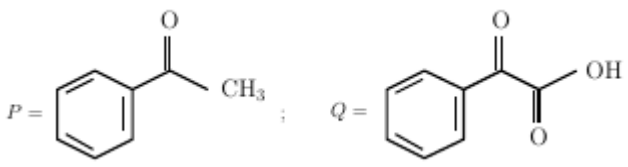
(a) 700 J
(b) 300 J
(c) 400 J
(d) 500 J

Q71. Methane reacts with steam at 1273 K in the presence of nickel catalyst to form :

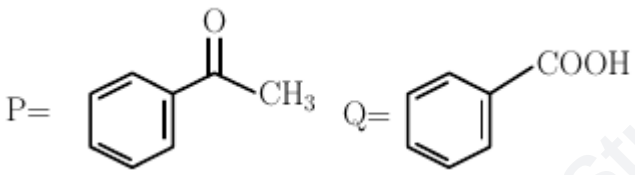
(a) CO and H2
(b) CO and H2O
(c) CO2 and H2O
(d) CO2 and H2

Q72. Compound P(C8H8O) gives a red orange precipitate with 2,4-DNP reagent and it does not reduce Fehling's reagent. On drastic oxidation with chromic acid, P gives an aromatic product Q that produces effervescence on treating with aq. NaHCO3. Compounds P and Q, respectively, are :

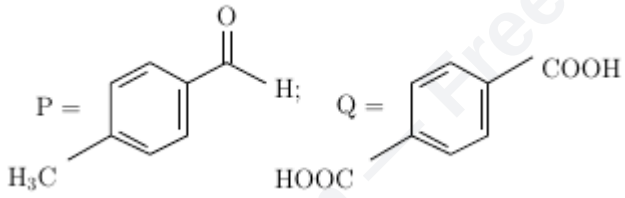
(a)



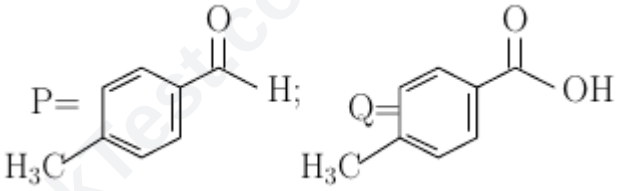
(b)



(c)



(d)



Q73. A solution of copper sulphate is electrolysed for 10 minutes with a current of 1.5 amperes. The mass of copper deposited at cathode is :

(Given : Molar mass of Cu = 63 g mol^(-1) ;

1 F = 96487 C mol^(-1))

(a) 2.4036 g
(b) 1.7018 g
(c) 0.5876 g
(d) 0.2938 g

Q74. The functional group that can be identified through phthalein dye test is :

(a) Phenolic
(b) Alcohol
(c) Aldehyde
(d) Carboxylic acid

Q75. The correct statement with regard to the secondary structure of DNA/RNA is :

(a) DNA possesses a single strand helix structure and contains uracil as one of the four bases.
(b) RNA possesses a single strand helix structure and contains thymine as one of the four bases.
(c) DNA possesses a double strand helix structure and contains thymine as one of the four bases.
(d) RNA possesses a double strand helix structure and contains uracil as one of the four bases.

Q76. Identify the correct statements :

A. The molality of 2.5 g of ethanoic acid (Molar mass : 60 g mol^(-1)) in 75 g of benzene solution is 0.556 m.

B. The molarity of a solution containing 5 g of NaOH (molar mass : 40 g mol^(-1)) in 450 mL of solution is 0.278 M at 298 K.

C. Aquatic species are more comfortable in cold water.

D. The solubility of gas increases with decrease in pressure.

E. For a binary mixture of A and B, the number of moles of A and B are n_A and n_B respectively. The mole fraction of B will be $\chi_B = n_A/(n_A + n_B)$

Choose the correct answer from the options given below :

(a) A and C only
(b) A, B and C only

(c) A, D and E only
(d) A and B only

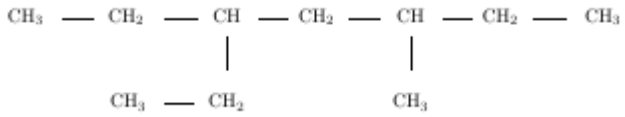
Q77. Mixture of chloroform and acetone forms a solution with negative deviation from Raoult's law due to :
(a) formation of hydrogen bonding between acetone and chloroform.
(b) increase in escaping tendency of molecules of each component.
(c) stronger intermolecular forces between chloroform molecules than those between chloroform and acetone molecules.
(d) repulsive forces.

Q78. At 298 K, a certain buffer solution contains equal concentrations of X^- and HX, K_b for X^- is 10^(-10).
What is the pH of this buffer solution ?
(a) 2
(b) 10
(c) 4
(d) 6

Q79. Identify the incorrect statement from the following :
(a) The IUPAC name of the element with atomic number 107 is Unnilseptium.
(b) The largest and the smallest species among Mg, Mg^(2+), Al and Al^(3+) are Al and Mg^(2+), respectively.
(c) The similarity in behaviour of Li with Mg is referred to as 'diagonal relationship'.
(d) The oxidation state and covalency of Al in [AlCl(H2O)5]^(2+) are 3 and 6 respectively.

Q80. The correct order of increasing metallic character of Na, Be, P, Mg and Si is :
(a) P < Si < Be < Mg < Na
(b) Be < Si < P < Mg < Na
(c) P < Si < Na < Mg < Be
(d) P < Mg < Be < Si < Na

Q81. The correct IUPAC name of the following compound is :



(a) 2,4-diethylhexane
(b) 3,5-diethylhexane
(c) 3-ethyl-5-methylheptane
(d) 3-methyl-5-ethylheptane

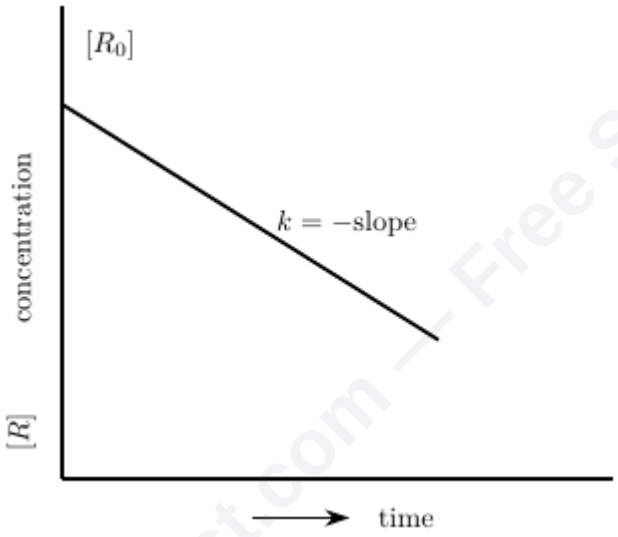
Q82. Match List I with List II

List I (Complex/ion)	List II (Shape/geometry)
A. [Pt(Cl2)(NH3)2]	I. Octahedral
B. [Co(NH3)6]Cl3	II. Trigonal bipyramidal
C. [NiCl4]^(2-)	III. Square planar
D. [Fe(CO)5]	IV. Tetrahedral

Choose the correct answer from the options given below :
(a) A - I, B - III, C - IV, D - II
(b) A - III, B - IV, C - I, D - II
(c) A - IV, B - I, C - III, D - II
(d) A - III, B - I, C - IV, D - II

YourMockTest.com — Free Study Material

Q83. For a certain reaction R → Product, the plot of concentration [R] vs time has a negative slope as shown. The order of reaction is :

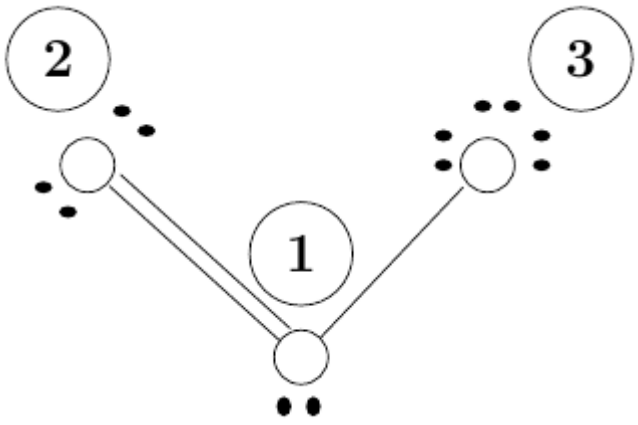


(a) 0
(b) 1
(c) 2
(d) 2.5

Q84. Which one of the following is an ambidentate ligand ?
(a) Ethylenediaminetetraacetate ion
(b) Oxalate
(c) Ethane-1,2-diamine
(d) Thiocyanate

Q85. Consider the following reaction :
2A (g) + B (g) → 2D (g)
Δ U^(-) = -10 kJ mol^(-1) and Δ S^(-) = -44 J K^(-1) at 298 K.
Identify the correct option with Δ G^(-) for the reaction and spontaneity of the reaction at 298 K.
(Given : R = 8.31 J mol^(-1) K^(-1))
(a) -1.635 kJ mol^(-1), spontaneous
(b) +0.63568 kJ mol-1, non-spontaneous
(c) -0.63568 kJ mol-1, spontaneous
(d) +1.635 kJ mol-1, non-spontaneous

Q86.



The correct formal charges on oxygen atoms numbered 2, 1 and 3 respectively are :
(a) -1, 0, +1

(b) 0, +1, -1
(c) 0, 0, 0
(d) +1, 0, -1

Q87. Given below are certain reactions. Identify the reaction for which K_p ≠ K_c.

(a) H2(g) + I2(g) <=> 2HI (g)
(b) N2 (g) + O2 (g) <=> 2NO (g)
(c) N2 (g) + 3H2 (g) <=> 2NH3 (g)
(d) H2O (g) + CO (g) <=> H2 (g) + CO2 (g)

Q88. Given below is an expression for the rate constant of a first order reaction occurring at a certain temperature, T (K).

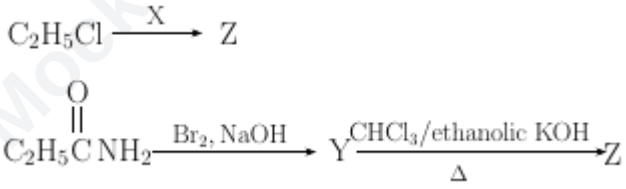
ln k = 14.34 - (1.25 × 10^4)/T

The energy of activation in kcal mol^(-1) for the reaction is :

(Given : k in s^(-1) R = 1.987 cal mol^(-1) K^(-1))

(a) 12.42
(b) 14.34
(c) 18.63
(d) 24.84

Q89. The following two reactions give the same foul smelling product Z.



X and Z, respectively, are :

(a) X = AgCN; Z = C2H5CN
(b) X = KCN; Z = C2H5CN
(c) X = KCN; Z = C2H5NC
(d) X = AgCN; Z = C2H5NC

Q90. Match List I with List II :

List I (Complex)	List II (Type of isomerism)
A. [Pt(NH3)2Cl2]	I. Optical
B. [Co(en)3]^(3+)	II. Solvate
C. [Co(NH3)5NO2]Cl2	III. Geometrical
D. [Cr(H2O)6]Cl3	IV. Linkage

Choose the correct answer from the options given below :

(a) A - III, B - I, C - II, D - IV
(b) A - I, B - III, C - II, D - IV
(c) A - III, B - I, C - IV, D - II
(d) A - II, B - IV, C - III, D - I

BIOLOGY

Q91. "The Evil Quartet" of biodiversity loss includes which of the following ?

(a) Over-exploitation; Alien species invasions; Air pollution; Co-extinctions
(b) Habitat loss and fragmentation; over-exploitation; Alien species invasions; Co-extinctions
(c) Habitat loss and fragmentation; Air pollution; Water pollution; Co-extinctions
(d) Over-exploitation; Alien species invasions; Soil pollution; Co-extinctions

YourMockTest.com — Free Study Material

Q92. Which one of the following is the site for active ribosomal RNA synthesis ?

(a) Nucleolus
(b) Chromatin
(c) Centrosome
(d) Kinetochore

Q93. Match List I with List II :

List I (Phase of cell cycle)	List II (Activity)
A. G1 phase	I. Actual cell division occurs
B. S phase	II. Cell is metabolically active and continuously grows but does not replicate its DNA
C. G2 phase	III. Synthesis of DNA occurs and the amount of DNA per cell doubles
D. M phase	IV. Proteins are synthesized while cell growth continues

Choose the correct answer from the options given below :

(a) A - II, B - III, C - IV, D - I
(b) A - III, B - IV, C - I, D - II
(c) A - I, B - II, C - III, D - IV
(d) A - IV, B - I, C - II, D - III

Q94. Match List I with List II :

List I	List II
A. Productivity	I. Gross primary productivity minus respiration losses
B. Net primary productivity	II. Rate of formation of new organic matter by consumers
C. Gross primary productivity	III. Rate of biomass production
D. Secondary productivity	IV. Rate of production of organic matter during photosynthesis

Choose the correct answer from the options given below :

(a) A - I, B - II, C - III, D - IV
(b) A - III, B - I, C - IV, D - II
(c) A - III, B - I, C - II, D - IV
(d) A - I, B - III, C - IV, D - II

Q95. Which of the following statements are correct?

A. The Amazon rainforest being cut and cleared for cultivation of soyabeans is an example of habitat loss.
B. Steller's sea cow and passenger pigeon became extinct due to over-exploitation by humans.
C. The Nile perch introduced into Lake Victoria in East Africa helped in population growth of cichlid fish in the lake.
D. Water hyacinth is an invasive species.
E. When a species becomes extinct, the plant and animal species associated with it are not affected.

Choose the correct answer from the options given below :

(a) B, C and D only
(b) A, B and D only
(c) A, B and E only
(d) C, D and E only

Q96. Identify the correct statements about biomolecules.

A. Lipids are generally water soluble.
B. Proteins are polypeptides.
C. Polysaccharides are long chains of sugars.

YourMockTest.com — Free Study Material

D. Adenine and guanine are substituted pyrimidines.

E. Almost all enzymes are proteins.

Choose the correct answer from the options given below :

(a) C, D and E only
(b) B, C and E only
(c) B, D and E only
(d) A, B and C only

Q97. How many ATP and NADPH molecules are required to make one molecule of glucose through the Calvin pathway ?

(a) 18 ATP and 12 NADPH
(b) 6 ATP and 12 NADPH
(c) 24 ATP and 18 NADPH
(d) 12 ATP and 18 NADPH

Q98. Which of the following statements are not true regarding restriction endonucleases ?

A. They are called molecular scissors.

B. These are the enzymes responsible for restricting the growth of bacteriophages in E. coli.

C. They cut the DNA only at the centre of the palindromic sites.

D. They remove nucleotides only from the ends of DNA fragments.

E. They recognise specific palindromic base-pair sequences.

Choose the answer from the options given below :

(a) A and B only
(b) D and E only
(c) C and D only
(d) A and E only

Q99. Match List I with List II :

List I	List II
A. Decomposition	I. Accumulation of dark coloured amorphous colloidal substance
B. Detritus	II. Release of inorganic nutrients by the activity of microbes in soil
C. Mineralisation	III. Breaking down of complex organic matter into inorganic substances
D. Humification	IV. Dead remains of plants and animals including fecal matter

Choose the correct answer from the options given below :

(a) A - I, B - II, C - III, D - IV
(b) A - IV, B - III, C - I, D - II
(c) A - III, B - IV, C - II, D - I
(d) A - III, B - II, C - I, D - IV

Q100. In which one of the following, the ovules are not enclosed by an ovary wall and remain exposed ?

(a) Selaginella
(b) Funaria
(c) Pinus
(d) Wolffia

Q101. Match List I with List II :

List I (Placentation)	List II (Example)
A. Marginal	I. Mustard

YourMockTest.com — Free Study Material

B. Axile	II. Pea
C. Parietal	III. Marigold
D. Basal	IV. Lemon

Choose the correct answer from the options given below :

(a) A - I, B - III, C - II, D - IV
(b) A - IV, B - II, C - I, D - III
(c) A - II, B - IV, C - I, D - III
(d) A - III, B - I, C - IV, D - II

Q102. In angiosperms, root hairs arise from which one of the following regions of the root ?

(a) The root cap zone
(b) The region of meristematic activity
(c) The region of elongation
(d) The region of maturation

Q103. Which one of the following is not a characteristic of plant cells in the phase of elongation ?

(a) Increased vacuolation
(b) Large conspicuous nuclei
(c) Cell enlargement
(d) New cell wall deposition

Q104. Which of the following statements are correct with reference to a transcription unit ?

A. A transcription unit in DNA is defined primarily by three regions : promoter, structural gene and terminator.
B. The promoter is said to be located towards the 5' -end of the structural gene.
C. The promoter is a DNA sequence that provides binding site for RNA polymerase.
D. The promoter defines the template and coding strands.
E. The terminator is located towards the 3' -end of the coding strand and it defines the end of the process of transcription.

Choose the correct answer from the options given below :

(a) A, B, C, D and E
(b) B, C, D and E only
(c) A, C, D and E only
(d) A, B, C and D only

Q105. Alpha-helix is found in which level of protein structure ?

(a) Quaternary structure
(b) Tertiary structure
(c) Primary structure
(d) Secondary structure

Q106. Which of the following statements are correct regarding amino acids ?

A. They are substituted methanes.
B. Serine is an aromatic amino acid.
C. Valine is a neutral amino acid.
D. Lysine is an acidic amino acid.

Choose the correct answer from the options given below :

(a) C and D only
(b) A and B only
(c) A and C only
(d) B and C only

YourMockTest.com — Free Study Material

Q107. The main function of bulliform cells in grasses is :

(a) to make the leaf impermeable to fungal spores.
(b) to perform photosynthesis.
(c) to minimize water loss during water stress.
(d) to transport water.

Q108. Find the incorrect statement(s) about photosynthesis from the following :

A. The water splitting complex is associated with PS I.
B. C4 plants use the C3 pathway of CO_2 fixation as the main biosynthetic pathway.
C. In C4 plants, photorespiration does not occur.
D. C3 plants exhibit 'Kranz' anatomy.
E. ATP synthesis in chloroplast occurs through chemiosmosis.
Choose the answer from the options given below :

(a) B only
(b) A and D only
(c) B and C only
(d) B and E only

Q109. Match List I with List II :

List I	List II
A. Conjunctive tissue	I. Specialised cells in the vicinity of guard cells
B. Casparian strips	II. Endodermal cells rich in starch
C. Subsidiary cells	III. Tissue between xylem and phloem
D. Starch sheath	IV. Endodermal cells with suberin deposition

Choose the correct answer from the options given below :

(a) A - IV, B - III, C - I, D - II
(b) A - III, B - IV, C - II, D - I
(c) A - III, B - IV, C - I, D - II
(d) A - IV, B - III, C - II, D - I

Q110. Match List I with List II :

List I	List II
A. Genetically modified organism	I. Agrobacterium tumefaciens
B. Thermostable DNA polymerase	II. Bt cotton
C. Ti plasmid	III. Thermus aquaticus
D. pBR322	IV. Escherichia coli

Choose the correct answer from the options given below :

(a) A - II, B - I, C - IV, D - III
(b) A - I, B - IV, C - III, D - II
(c) A - II, B - III, C - I, D - IV
(d) A - I, B - II, C - IV, D - III

Q111. Heterophyllous development in response to environment is an example of which of the following phenomena ?

(a) Dedifferentiation
(b) Elasticity
(c) Redifferentiation
(d) Plasticity

YourMockTest.com — Free Study Material

Q112. In racemose inflorescence, _____

(a) the main axis terminates in a flower
(b) the growth is limited
(c) flowers are borne in an acropetal succession
(d) flowers are solitary

Q113. Which one of the following disorders is caused by the substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule ?

(a) Haemophilia
(b) Thalassemia
(c) Sickle-cell anaemia
(d) Phenylketonuria

Q114. Match List I with List II :

List I	List II
A. Incomplete dominance	I. Human skin colour
B. Co-dominance	II. Inheritance of flower colour in Antirrhinum sp.
C. Pleiotropy	III. Phenylketonuria disease in humans
D. Polygenic inheritance	IV. ABO blood groups

Choose the correct answer from the options given below :

(a) A - II, B - IV, C - III, D - I
(b) A - I, B - III, C - II, D - IV
(c) A - II, B - I, C - III, D - IV
(d) A - I, B - IV, C - III, D - II

Q115. Arrange the following in the correct developmental sequence related to microsporogenesis :

A. Microspore tetrads
B. Sporogenous tissue
C. Pollen grains
D. Pollen mother cells

Choose the correct answer from the options given below :

(a) D, A, C, B
(b) B, D, C, A
(c) B, D, A, C
(d) A, D, C, B

Q116. Arrange the following steps of DNA fingerprinting in a correct sequence.

A. Isolation of DNA and its digestion by restriction endonucleases.
B. Hybridisation using a labelled VNTR probe.
C. Transferring of separated DNA fragments to synthetic membranes.
D. Detection of hybridised DNA fragments by autoradiography.
E. Separation of DNA fragments by electrophoresis.

Choose the correct answer from the options given below :

(a) A, E, C, B, D
(b) A, E, B, C, D
(c) A, B, D, C, E
(d) A, D, B, E, C

YourMockTest.com — Free Study Material

Q117. Exploring molecular, genetic and species-level diversity for products of economic importance is called :

(a) Biomagnification
(b) Biofortification
(c) Bioremediation
(d) Bioprospecting

Q118. Which of the following statements are true with reference to the sex-determination in honeybees ?

A. An offspring formed from the union of a sperm and an egg, develops as a female (queen or worker).
B. An unfertilized egg develops as a male by parthenogenesis.
C. A male has half the number of chromosomes than that of a female.
D. Males produce sperms by meiosis.
E. Honeybees have a haplodiploid sex-determination system.
Choose the correct answer from the options given below :

(a) B, C, D and E only
(b) A, B, C and D only
(c) A, B, D and E only
(d) A, B, C and E only

Q119. Identify the correct sequence of steps in each cycle of Polymerase Chain Reaction :

(a) Denaturation → Annealing → Extension
(b) Denaturation → Extension → Annealing
(c) Extension → Annealing → Denaturation
(d) Annealing → Denaturation → Extension

Q120. Which of the following statements are correct with respect to DNA separation, isolation and visualization ?

A. The cutting of DNA is done by molecular scissors.
B. The DNA fragments separate according to their size in an agarose gel, upon electrophoresis.
C. The separated DNA fragments can be seen without staining when exposed to UV light.
D. The separated DNA fragments, when stained with ethidium bromide, can be seen in visible light.
Choose the correct answer from the options given below :

(a) A and D only
(b) B and D only
(c) B and C only
(d) A and B only

Q121. The main criteria used for Five Kingdom Classification proposed by R.H. Whittaker (1969) included :

A. Cell structure
B. Body organization
C. Presence of flagellum
D. Reproduction
E. Phylogenetic relationships
Choose the correct answer from the options given below :

(a) A, B, D and E only
(b) A, B, C, D and E
(c) A, B and E only
(d) B, C and D only

Q122. Which one of the following is a triploid cell ?

(a) Central cell
(b) Primary endosperm cell
(c) Zygote
(d) Synergid

Q123. Which of the following statements are correct with reference to packaging of DNA helix ?

A. Histones are organized to form a unit of eight molecules called histone octamer.

B. Histones are negatively charged basic proteins.

C. Histones are rich in the basic amino acid residues - lysine and arginine.

D. The positively charged DNA is wrapped around the histone octamer to form nucleosome.

E. The packaging of chromatin at higher levels requires an additional set of proteins called non-histone chromosomal proteins.

Choose the correct answer from the options given below :

(a) A, B and D only
(b) A, C and E only
(c) C, D and E only
(d) B, D and E only

Q124. Which of the following is an in situ conservation method ?

(a) Sacred Groves
(b) Wildlife Safari Parks
(c) Botanical Gardens
(d) Seed Banks

Q125. In the lac operon, the z gene codes for :

(a) transacetylase
(b) the repressor of lac operon
(c) permease
(d) beta-galactosidase

Q126. Match List I with List II :

List I (Growth Regulator)	List II (Function/Effect)
A. 2,4-D	I. Brewing industry
B. GA3	II. Stimulation of stomatal closure
C. Kinetin	III. Herbicide
D. ABA	IV. Nutrient mobilisation

Choose the correct answer from the options given below :

(a) A - IV, B - III, C - II, D - I
(b) A - I, B - II, C - IV, D - III
(c) A - III, B - I, C - IV, D - II
(d) A - I, B - IV, C - III, D - II

Q127. Arrange the following steps of somatic hybridisation in a correct sequence.

A. Digestion of cell walls.

B. Isolation of naked protoplasts.

C. Fusion of protoplasts to get hybrid protoplast.

D. Isolation of single cells from two different varieties of plants.

E. Growing of hybrid protoplast to form a new plant.

Choose the correct answer from the options given below :

(a) E, A, B, C, D
(b) D, A, B, C, E
(c) E, B, A, D, C
(d) D, B, A, E, C

YourMockTest.com — Free Study Material

Q128. $2(C_{51}H_{98}O_6) + 145\ O_2 \rightarrow 102\ CO_2 + 98\ H_2O$ + energy

The Respiratory Quotient (RQ) of a biomolecule used for respiration, as per the above equation, would be :

(a) Less than 0.5
(b) Between 0.5 and 0.95
(c) Between 1.25 and 2
(d) 1.0

Q129. Since the origin and diversification of life on Earth, there have been five episodes of mass extinction of species. How is the sixth extinction, which is in progress, different from the previous episodes ?

(a) The current species extinction rates are far lower than those in previous episodes.
(b) The present species extinction rates are 100 to 1000 times faster than in the pre-human times.
(c) The present net species extinction rate is zero.
(d) The current species extinction rate is nearly 10 times faster than that in previous episodes.

Q130. Match List I with List II :

List I	List II
A. Trypsin	I. Intercellular ground substance
B. Morphine	II. Lectin
C. Concanavalin A	III. Enzyme
D. Collagen	IV. Alkaloid

Choose the correct answer from the options given below :

(a) A - III, B - IV, C - II, D - I
(b) A - I, B - II, C - III, D - IV
(c) A - III, B - II, C - IV, D - I
(d) A - IV, B - III, C - II, D - I

Q131. Which one of the following statements is not true about the universal rules of binomial nomenclature ?

(a) Both the words in a biological name, when handwritten, are separately underlined or printed in italics.
(b) The specific epithet in the biological name starts with a small letter.
(c) The first word in the biological name represents the specific epithet, while the second component denotes the genus.
(d) Biological names are generally in Latin.

Q132. The enzyme required for carboxylation in the Calvin cycle is :

(a) PEP carboxylase
(b) RuBP carboxylase - oxygenase
(c) Carboxypeptidase
(d) Hexokinase

Q133. Which of the following floral formula is the correct floral formula of Solanaceae family ?

(a) (+) ? K_((5)) C_((5)) A5 G_((2))
(b) (+) ? K5 C_((5)) A5 G_((2))
(c) (+) ? K_((5)) C_((5)) A5 G2
(d) (+) ? K5 C5 A5 G_((2))

Q134. Which one of the following types of pollination brings genetically different types of pollen grains to the stigma ?

(a) Geitonogamy
(b) Autogamy
(c) Xenogamy
(d) Cleistogamy

YourMockTest.com — Free Study Material

Q135. Match List I with List II :

List I (Process)	List II (Location)
A. Glycolysis	I. Inner mitochondrial membrane
B. ETS	II. Mitochondrial matrix
C. Accumulation of protons	III. Cytoplasm
D. Krebs' cycle	IV. Intermembrane space

Choose the correct answer from the options given below :

(a) A - I, B - IV, C - III, D - II
(b) A - III, B - I, C - IV, D - II
(c) A - IV, B - II, C - I, D - III
(d) A - II, B - III, C - IV, D - I

Q136. Insertion of a foreign DNA at BamHI site in an E. coli cloning vector pBR322 results in the loss of antibiotic resistance towards :

(a) Gentamycin
(b) Ampicillin and tetracycline
(c) Tetracycline
(d) Ampicillin

Q137. The sixth mutant codon of beta globin gene causing polymerization of Haemoglobin and change in RBC shape is _____

(a) CAG
(b) GUG
(c) AUG
(d) GAG

Q138. Choose the correct statement regarding GIFT to overcome infertility.

(a) Ova collected from a female donor are transferred to the uterus of an infertile female.
(b) It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce ovum but can provide suitable environment for fertilization and development.
(c) Early embryos with up to 8 blastomeres are transferred to the uterus of an infertile female.
(d) Early embryos with up to 8 blastomeres are transferred into the fallopian tube of an infertile female.

Q139. Which one of the following is an appropriate example of 'sexual deceit'?

(a) Female wasp and fig
(b) Cuckoo and crow
(c) Ophrys and bumblebee
(d) Sea anemone and clown fish

Q140. Evolution of human appears parallel to the progressive development of brain and language skills. As such, the evolution of individual species in the sequence of their appearance is :

(a) Homo habilis → Homo erectus → Ramapithecus → Neanderthal → Homo sapiens
(b) Ramapithecus → Homo habilis → Homo erectus → Neanderthal → Homo sapiens
(c) Homo sapiens → Ramapithecus → Homo habilis → Neanderthal → Homo erectus
(d) Neanderthal → Ramapithecus → Homo habilis → Homo erectus → Homo sapiens

Q141. Match List I with List II related to embryonic development at various months of pregnancy :

List I	List II
A. The foetus movement starts and hair appears on the head	I. 24 weeks of pregnancy
B. The foetus develops limbs and digits	II. 20 weeks of pregnancy

YourMockTest.com — Free Study Material

C. The foetus develops external genital organs	III. 8 weeks of pregnancy
D. The foetus body is covered with fine hair; eyelids separate and eyelashes are formed	IV. 12 weeks of pregnancy

Choose the correct answer from the options given below :

(a) A - III, B - II, C - IV, D - I
(b) A - II, B - IV, C - III, D - I
(c) A - IV, B - II, C - III, D - I
(d) A - II, B - III, C - IV, D - I

Q142. A group of researchers procured some fish-like animals and upon investigation the following characters were observed :

A. Endoskeleton was made of cartilage.

B. Ectoparasitic; as they were found attached on fish skin with their circular sucking mouth.

C. Paired fins and scales were absent, but 7 pairs of gill slits were present.

Which of the following species of animals did they consider to fit best with these characters ?

(a) Exocoetus sp.
(b) Branchiostoma sp.
(c) Petromyzon sp.
(d) Scoliodon sp.

Q143. Spermatogonia undergo a series of cell divisions to produce sperms. Select the correct statements from the following :

A. Spermatogonia always undergo meiotic cell division.

B. Primary spermatocytes divide mitotically to produce secondary spermatocytes.

C. Secondary spermatocytes, through their second meiotic division, produce haploid spermatids.

D. Spermatids produce spermatozoa through mitosis.

E. Spermatids transform into spermatozoa by spermiogenesis.

Choose the correct answer from the options given below :

(a) C and E only
(b) A, C and E only
(c) B, C and D only
(d) A and E only

Q144. What is the probability of having children with 'O' blood group, where both mother and father are heterozygous for 'A' and 'B' blood group, respectively ?

(a) 50%
(b) 0%
(c) 75%
(d) 25%

Q145. Arrange the following events occurring in Renin-Angiotensin mechanism in the correct order :

A. Increase in blood pressure and Glomerular filtration rate.

B. Reabsorption of Na^+ and water from distal parts of tubule due to Aldosterone.

C. Fall in Glomerular filtration rate.

D. Vasoconstriction by Angiotensin II and release of Aldosterone.

E. Renin converts Angiotensinogen into Angiotensin I, followed by Angiotensin II.

Choose the correct answer from the options given below :

(a) C, A, B, D, E
(b) A, D, B, E, C
(c) A, C, E, B, D
(d) C, E, D, B, A

YourMockTest.com — Free Study Material

Q146. Match List I with List II :

List I (Respiratory Volume)	List II (Capacity in mL)
A. ERV (Expiratory Reserve Volume)	I. 2500 - 3000 mL
B. RV (Residual Volume)	II. 500 mL
C. IRV (Inspiratory Reserve Volume)	III. 1000 - 1100 mL
D. TV (Tidal Volume)	IV. 1100 - 1200 mL

Choose the correct answer from the options given below :

(a) A - III, B - I, C - IV, D - II
(b) A - I, B - III, C - II, D - IV
(c) A - III, B - IV, C - I, D - II
(d) A - I, B - II, C - III, D - IV

Q147. Match List I with List II :

List I	List II
A. Progestasert	I. Barrier made of rubber used by females
B. Multiload 375	II. Oral contraceptive
C. Diaphragm	III. Hormone releasing IUD
D. Saheli	IV. Copper releasing IUD

Choose the correct answer from the options given below :

(a) A - III, B - IV, C - I, D - II
(b) A - III, B - IV, C - II, D - I
(c) A - IV, B - II, C - I, D - III
(d) A - IV, B - III, C - I, D - II

Q148. Non-membrane bound cell organelles found in both prokaryotic and eukaryotic cells are

(a) Centrosomes
(b) Ribosomes
(c) Lysosomes
(d) Mitochondria

Q149. Ecological pyramids represent the relationship between the organisms at different trophic levels and they are generally inverted for :

(a) Pyramid of energy in pond ecosystem
(b) Pyramid of biomass in sea
(c) Pyramid of number in grassland
(d) Pyramid of biomass in grassland

Q150. The flightless bird with forelimbs modified as paddle-like structures suited for swimming is known as :

(a) Struthio
(b) Psittacula
(c) Neophron
(d) Aptenodytes

Q151. Match List I with List II :

List I (Bioactive molecules)	List II (Importance)
A. Streptokinase	I. Immunosuppressive agent
B. Statins	II. Removal of clots from the blood vessels

YourMockTest.com — Free Study Material

C. Lipases	III. Blood cholesterol-lowering agent
D. Cyclosporin A	IV. Detergent formulations

Choose the correct answer from the options given below :

(a) A - II, B - III, C - IV, D - I
(b) A - IV, B - III, C - II, D - I
(c) A - II, B - III, C - I, D - IV
(d) A - III, B - II, C - I, D - I

Q152. Choose the correct statements regarding cell organelles and their inclusions.

A. The endomembrane system includes Golgi complex, endoplasmic reticulum and mitochondria.

B. Rough endoplasmic reticulum bears ribosomes on its surface.

C. Both mitochondria and plastids have circular DNA.

D. A network of microtubules, microfilaments and intermediate filaments present in the cytoplasm is called cytoskeleton.

E. Mitochondrion is a single membrane-bound structure.

Choose the correct answer from the options given below :

(a) C, D and E only
(b) A and B only
(c) A, B and C only
(d) B, C and D only

Q153. Select the set of fishes which belong to the class Osteichthyes :

(a) Devil fish, Cuttlefish and Hagfish
(b) Starfish, Hagfish and Cuttlefish
(c) Flying fish, Angel fish and Fighting fish
(d) Saw fish, Fighting fish and Dog fish

Q154. In a population of a grasshopper species, the chromosome number of some members is 23 and some other members possess 24 chromosomes. The 23 and 24 chromosome-bearing members in this species are _____.

(a) all males
(b) all females
(c) females and males, respectively
(d) males and females, respectively

Q155. The WBC count of a person's blood sample is 8000/cu.mm. How many eosinophils and lymphocytes would be in the same blood sample approximately ?

(a) 160 - 240/cu.mm and 1600 - 2000/cu.mm, respectively
(b) 100 - 120/cu.mm and 160 - 200/cu.mm, respectively
(c) 300 - 500/cu.mm and 500 - 700/cu.mm, respectively
(d) 300 - 500/cu.mm and 1200 - 1500/cu.mm, respectively

Q156. The toxin proteins isolated from Bacillus thuringiensis, coded by which of the following genes would control cotton bollworms and corn borer, respectively ?

(a) cryIAc and cryIIAb
(b) cryIAc and cyrIIAb
(c) cryIAc and cryIAb
(d) cryIIAb and cryIAc

Q157. Match List I with List II :

List I (Drug)	**List II (Effect)**
A. Nicotine	I. Causes sense of euphoria and increased energy

B. Morphine	II. Stimulates adrenal gland to release catecholamines into blood circulation
C. Heroin	III. Effective sedative and painkiller
D. Cocaine	IV. A depressant; slows down body function

Choose the correct answer from the options given below :

(a) A - III, B - II, C - IV, D - I
(b) A - II, B - III, C - IV, D - I
(c) A - II, B - III, C - I, D - IV
(d) A - III, B - II, C - I, D - IV

Q158. Match List I with List II related to muscular/skeletal system :

List I	List II
A. Tetany	I. Inflammation of joints
B. Arthritis	II. Autoimmune disorder affecting neuromuscular junction
C. Myasthenia gravis	III. Wild contraction in muscle due to low Ca^(++) in body fluid
D. Muscular dystrophy	IV. Progressive degeneration of skeletal muscle

Choose the correct answer from the options given below :

(a) A - III, B - I, C - II, D - IV
(b) A - IV, B - III, C - II, D - I
(c) A - I, B - II, C - III, D - IV
(d) A - III, B - II, C - I, D - IV

Q159. In which animal do haploid cells divide mitotically to produce gametes ?

(a) Male honeybees
(b) Male grasshoppers
(c) Male earthworms
(d) Male frogs

Q160. In humans, respiration occurs in the following steps. Arrange these steps in the correct order.

A. Diffusion of O2 and CO2 between blood and tissues
B. Diffusion of O2 and CO2 across alveolar membrane
C. Pulmonary ventilation by which atmospheric air is drawn in and CO2 rich alveolar air is released out
D. Cellular respiration
E. Transport of gases by the blood

Choose the correct answer from the options given below :

(a) A, B, C, D, E
(b) E, A, C, D, B
(c) C, A, B, E, D
(d) C, B, E, A, D

Q161. Arrange the following cell layers/structures around the female gamete, from outer to inner side :

A. Zona pellucida
B. Perivitelline space
C. Corona radiata
D. Plasma membrane of ovum

Choose the correct answer from the options given below :

(a) C, A, D, B
(b) C, A, B, D

YourMockTest.com — Free Study Material

(c) D, B, A, C
(d) A, C, B, D

Q162. The human protein named α -1-antitrypsin, obtained from transgenic animals, is used for the treatment of _____.
(a) Alzheimer's disease
(b) Emphysema
(c) Rheumatoid arthritis
(d) Cystic fibrosis

Q163. Select the correct statements regarding cell membrane in eukaryotic cell.
A. Membrane of human RBCs has approximately 52% protein.
B. Major phospholipids are arranged in a bilayer.
C. Extensions of the plasma membrane into the cell form mesosomes.
D. Tails towards the inner part of lipids are hydrophobic and thus protected from aqueous medium.
E. Glycocalyx is present on the outer surface of the plasma membrane.
Choose the correct answer from the options given below :
(a) A, C and E only
(b) B, C and E only
(c) C, D and E only
(d) A, B and D only

Q164. Male frogs can be distinguished from female frogs due to the presence of :
A. Bulging eyes
B. Vocal sacs
C. Webbed digits in feet
D. Copulatory pad on first digit of fore limbs
E. Olive green-coloured skin with dark irregular spots
Choose the correct answer from the options given below :
(a) B and D only
(b) B and C only
(c) A and B only
(d) C and E only

Q165. Which of the following equations depicts Verhulst-Pearl logistic population growth ?
(a) $dN/dt = rN ((K-N)/K)$
(b) $dN/dt = rN ((K+N)/K)$
(c) $dN/dt = rN (K/(K-N))$
(d) $dN/dt = rN ((K-N)/N)$

Q166. Choose the correct statements regarding frog's anatomy :
A. Hepatic portal system is the special venous connection between liver and intestine.
B. There are twelve pairs of cranial nerves arising from the brain.
C. The ureters and oviducts open separately into the cloaca in female frogs.
D. Hind-brain consists of cerebellum, medulla oblongata and optic lobes.
E. Sinus venosus joins the right atrium of heart.
Choose the correct answer from the options given below :
(a) B and D only
(b) A, C and E only
(c) A, B and C only
(d) B and C only

YourMockTest.com — Free Study Material

Q167. Select the incorrect statements with reference to Rh grouping.

A. Erythroblastosis foetalis is a condition observed having foetus with Rh^(-ve) blood and mother with Rh^(+ve) blood.

B. Rh antigen is observed on RBCs in the majority of human beings.

C. Before blood transfusion, Rh group should also be matched.

D. Rh incompatibility is observed when a pregnant mother is Rh^(-ve) and the foetus is Rh^(+ve).

E. Erythroblastosis foetalis can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the second child.

Choose the answer from the options given below :

(a) A and E only
(b) A and B only
(c) B and C only
(d) C and D only

Q168. Which of the following statements are correct with reference to human endoskeleton ?

A. Human skull is monocondylic.

B. The joint between any two adjoining vertebrae is a cartilaginous joint.

C. In human beings, the number of cervical vertebrae is seven.

D. All ribs except the last 2 pairs are bicephalic.

E. The occipital bone of skull is articulated with atlas vertebra.

Choose the correct answer from the options given below :

(a) A, B and D only
(b) B and E only
(c) B, C and E only
(d) C, D and E only

Q169. Match List I with List II :

List I	List II
A. Cortisol	I. Stimulates the formation of alveoli in mammary glands
B. Aldosterone	II. Produces anti-inflammatory reactions
C. Cholecystokinin	III. Stimulates reabsorption of Na^+ and water from renal tubule
D. Progesterone	IV. Stimulates secretion of pancreatic enzymes and bile juice

Choose the correct answer from the options given below :

(a) A - III, B - II, C - IV, D - I
(b) A - II, B - III, C - IV, D - I
(c) A - IV, B - II, C - I, D - III
(d) A - II, B - III, C - I, D - IV

Q170. The following are the stages of life cycle of Plasmodium. Arrange the stages in the proper order.

A. The parasites reproduce asexually in RBCs, bursting the cells.

B. The parasites reproduce asexually in liver cells, bursting the cells and releasing into blood.

C. Gametocytes develop in RBCs.

D. Sporozoites reach the liver through the blood.

E. Female mosquito injects sporozoites into humans during bite.

Choose the correct answer from the options given below :

(a) A, B, C, D, E
(b) E, D, B, A, C
(c) C, A, B, D, E

YourMockTest.com — Free Study Material

(d) E, C, D, B, A

Q171. Select the incorrect statements from the following :

A. Digestive system in Platyhelminthes is incomplete.

B. Bilateral symmetry is a characteristic feature of adult Echinoderms.

C. Pseudocoelom is possessed by Aschelminthes.

D. Notochord is persistent throughout life in the class Chondrichthyes.

E. Members of class Reptilia maintain a constant body temperature.

Choose the answer from the options given below :

(a) B and E only
(b) C and D only
(c) A and C only
(d) B and D only

Q172. The specific receptors for neurotransmitters in a synapse are present on _____.

(a) Post-synaptic membrane
(b) Pre-synaptic membrane
(c) Myelin sheath
(d) Schwann cell

Q173. Choose the correct statements regarding muscle contraction.

A. A motor neuron carries a signal sent by the Central Nervous System (CNS) to the sarcolemma of the muscle fibre.

B. The neural signal generates an action potential which causes the release of Ca^(++) into sarcoplasm.

C. Increase in Ca^(++) inactivates the actin for breaking cross bridges.

D. Actin binds to the myosin head to form a cross bridge.

E. Shortening of sarcomere takes place, by pulling actin filaments towards the centre of 'A' band.

Choose the correct answer from the options given below :

(a) A, B, D and E only
(b) C and D only
(c) C and E only
(d) A and B only

Q174. Which of the following is not an example of convergent evolution ?

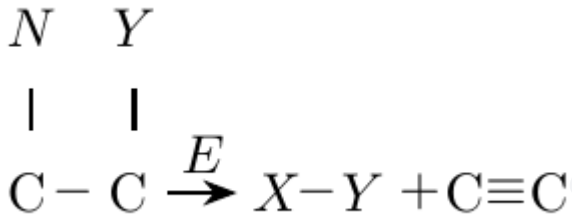
(a) Eyes of octopuses and mammals
(b) Fore limbs of whales and bats
(c) Wings of butterflies and birds
(d) Flippers of penguins and dolphins

Q175. The JGA (Juxta Glomerular Apparatus) is a special sensitive region formed by cellular modifications in _____ related to the same nephron.

(a) Distal convoluted tubule and efferent renal arteriole
(b) Proximal convoluted tubule and afferent renal arteriole
(c) Distal convoluted tubule and afferent renal arteriole
(d) Proximal convoluted tubule and efferent renal arteriole

Q176. The following reaction depicts the activity of a particular class of enzymes :

YourMockTest.com — Free Study Material



Identify the enzyme class 'E' from the following options :

(a) Ligases
(b) Lyases
(c) Isomerases
(d) Transferases

Q177. Match List I with List II :

List I	List II
A. Molluscs	I. Pulmonary respiration only
B. Reptiles	II. Branchial respiration
C. Adult amphibians	III. Cellular respiration
D. Amoeba	IV. Pulmonary and Cutaneous respiration

Choose the correct answer from the options given below :

(a) A - III, B - II, C - I, D - IV
(b) A - II, B - I, C - IV, D - III
(c) A - II, B - I, C - III, D - IV
(d) A - I, B - II, C - IV, D - III

Q178. What is the reason behind production of large holes in 'Swiss Cheese' ?

(a) The production of large amount of CO_2 by Clostridium butylicum
(b) The production of large amount of CO_2 and H_2 by Trichoderma polysporum
(c) The production of large amount of CO_2 and H_2 by lactic acid bacteria called Lactobacillus
(d) The production of large amount of CO_2 by Propionibacterium sharmanii

Q179. Match List I with List II with respect to chronology of evolution of life forms :

List I	List II
A. About 65 mya	I. Jawless fish probably evolved
B. About 500 mya	II. The dinosaurs suddenly disappeared from the earth
C. About 350 mya	III. Seaweeds and few plants probably existed
D. About 320 mya	IV. Invertebrates were formed and became active

Choose the correct answer from the options given below :

(a) A - II, B - IV, C - I, D - III
(b) A - II, B - IV, C - III, D - I
(c) A - I, B - II, C - III, D - IV
(d) A - III, B - IV, C - I, D - II

Q180. Choose the correct statements regarding population interactions between two species.

A. In both parasitism and commensalism, only one species benefits and the other species is harmed.
B. Both species benefit in mutualism.
C. Both species benefit in commensalism.

YourMockTest.com — Free Study Material

D. In parasitism, only one species benefits and the other species is harmed.

E. In amensalism, one species is harmed and the other is unaffected.

Choose the correct answer from the options given below :

(a) A and D only

(b) A and B only

(c) B and E only

(d) B, D and E only

ANSWER KEY

1	a	2	a	3	b	4	c	5	a	6	c	7	c	8	a	9	a	10	a
11	a	12	a	13	a	14	c	15	a	16	d	17	d	18	d	19	b	20	a
21	b	22	c	23	a	24	b	25	c	26	b	27	d	28	c	29	b	30	d
31	b	32	d	33	a	34	a	35	d	36	a	37	a	38	d	39	d	40	d
41	c	42	a	43	d	44	b	45	a	46	d	47	b	48	c	49	c	50	a
51	b	52	d	53	d	54	b	55	a	56	c	57	a	58	c	59	c	60	a
61	b	62	c	63	d	64	c	65	a	66	b	67	b	68	d	69	a	70	b
71	a	72	b	73	d	74	a	75	c	76	b	77	a	78	c	79	b	80	a
81	c	82	d	83	a	84	d	85	b	86	b	87	c	88	d	89	d	90	c
91	b	92	a	93	a	94	b	95	b	96	b	97	a	98	c	99	c	100	c
101	c	102	d	103	b	104	a	105	d	106	c	107	c	108	b	109	c	110	c
111	d	112	c	113	c	114	a	115	c	116	a	117	d	118	d	119	a	120	d
121	a	122	b	123	b	124	a	125	d	126	c	127	b	128	b	129	b	130	a
131	c	132	b	133	a	134	c	135	b	136	c	137	b	138	b	139	c	140	b
141	d	142	c	143	a	144	d	145	d	146	c	147	a	148	b	149	b	150	d
151	a	152	d	153	c	154	d	155	a	156	c	157	b	158	a	159	a	160	d
161	b	162	b	163	d	164	a	165	a	166	b	167	a	168	c	169	b	170	b
171	a	172	a	173	a	174	b	175	c	176	b	177	b	178	d	179	a	180	d

SOLUTIONS

Q1. Answer: (a) 2.5 A, 2 A m²

Given:

Number of turns, N = 100

Radius of coil, r = 5 cm = 0.05 m

Magnetic field at centre, B = 3.14 × 10^(-3) T

μ0 = 4π × 10^(-7) T m A^(-1)

Formula Used:

Magnetic field at centre of circular coil:

B = μ0NI / 2r

Magnetic moment:

M = NIA

Area of coil:

A = πr²

Calculation:

I = 2rB / μ0N

=> I = 2 × 0.05 × 3.14 × 10^(-3) / (4π × 10^(-7) × 100) = 3.14 × 10^(-4) / 4π × 10^(-5) = 2.5 A

Now,

$A = \pi \times (0.05)^2 = \pi \times 0.0025 \approx 0.00785\ m^2$

Magnetic moment:

$M = NIA = 100 \times 2.5 \times 0.00785$

$\Rightarrow M \approx 1.96\ A\ m^2 \approx 2\ A\ m^2$

So, current flowing through the coil, and the magnitude of the magnetic moment, respectively, are 2.5 A, 2 A m^2

Q2. Answer: (a) A - IV, B - III, C - I, D - II

Given: We need to match List I with List II.

Concept Used:

A. $E = h\nu$

This is the energy equation of photon.

$\Rightarrow$ A → IV

B. Diffraction and Interference

These phenomena prove wave nature of light.

$\Rightarrow$ B → III

C. $\lambda = h/p$

This is de Broglie wavelength relation.

$\Rightarrow$ C → I

D. Compton effect

Compton effect proves particle nature of light.

$\Rightarrow$ D → II

Final Matching: A – IV, B – III, C – I, D – II

Q3. Answer: (b) 15/2 A

Calculation

Only the 4 Ω and 2 Ω branches are forward biased and conduct current.

Equivalent resistance,

$R_{(eq)} = (4 \times 2)/(4 + 2)$

$\Rightarrow R_{(eq)} = 8/6 = 4/3\ \Omega$

Given potential difference across the circuit is 10 V

Using Ohm's law,

$I = V/(R_{(eq)})$

$\Rightarrow I = 10/(4/3)$

$\Rightarrow I = (10 \times 3)/4$

$\Rightarrow I = 15/2$ A

Hence, the correct answer is I = 15/2 A.

Q4. Answer: (c) 400

Given:

Speed of light in vacuum = 1 unit

Time taken by light = 6 min 40 s

Calculation:

6 min = 6 × 60= 360 s

$\Rightarrow$ Total time = 360 + 40 = 400 s

Distance = Speed × Time

Since speed of light = 1 unit,

$\Rightarrow$ Distance = 1 × 400 = 400

So, the distance between the Sun and the Earth in new unit is 400.

Q5. Answer: (a) C only

The correct answer is C only

Velocity-Time Graph for a Ball Thrown Vertically

YourMockTest.com — Free Study Material

• When a ball is thrown vertically upward, its velocity decreases due to the effect of gravity until it becomes zero at the highest point.

• After reaching the highest point, the ball starts falling back, and its velocity increases in the downward direction due to acceleration due to gravity.

• Correct Representation of Velocity vs Time

• In the velocity-time graph, the velocity is positive during the upward motion and negative during the downward motion.

• The graph in option C accurately shows this behavior, where the velocity decreases linearly, reaches zero at the peak, and then increases negatively (downward motion).

Q6. Answer: (c) 0.02 cm

Given:

20 VSD = 16 MSD

and, 1 MSD = 1 mm

Formula Used:

Least Count = 1 MSD − 1 VSD

Calculation:

Given:

20 VSD = 16 MSD

=> 1 VSD = 16/20 MSD = 0.8 MSD

Since 1 MSD = 1 mm

=> 1 VSD = 0.8 mm

Now, Least Count = 1 MSD − 1 VSD

=> LC = 1 − 0.8 = 0.2 mm

Convert into cm: LC = 0.02 cm

Result: Least count = 0.02 cm

Q7. Answer: (c) 15.9 kHz

Given:

Resistance, R = 1 kΩ= 1000 Ω

Capacitance, C = 0.1 μF = 0.1 × 10^(-6) F= 10^(-7) F

Inductance, L = 1 mH = 10^(-3) H

Formula Used:

Resonance frequency:

f = 1 / 2π√LC

Calculation:

LC = 10^(-3) × 10^(-7) = 10^(-10)

=> √LC = 10^(-5)

Now,

f = 1 / 2π × 10^(-5) = 1 / 6.28 × 10^(-5)

=> f ≈ 1.59 × 10^4 Hz ≈ 15.9 kHz

Final Answer: f = 15.9 kHz.

Q8. Answer: (a) [figure]

Given:

A long solid wire of radius a carries current I uniformly distributed across its cross-section.

Concept Used:

For a solid conductor carrying uniformly distributed current:

• Inside the conductor: B prop. to r

So, magnetic field increases linearly with distance from the axis.

• Outside the conductor: B prop. to 1/r

So, magnetic field decreases inversely with distance.

Explanation:

• At r = 0, B = 0

YourMockTest.com — Free Study Material

• From the centre to r = a, B increases linearly
• At r = a, magnetic field becomes maximum
• For r > a, B decreases as 1/r
The correct graph is

Q9. Answer: (a) 2 A

Given:
Total resistance of square wire = 4 Ω
Since square has 4 equal sides:
=> Resistance of each side = 4/4
Each side resistance = 1 Ω
Resistance connected between B and D = 2 Ω
Battery voltage, V = 2 V
Concept Used:
Between A and C there are two paths:
Path 1: A → B → C
=> Resistance = 1 + 1 = 2 Ω
Path 2: A → D → C
=> Resistance = 1 + 1 = 2 Ω
Also diagonal BD has 2 Ω.
Since network is symmetrical:
Potential at B = Potential at D
=> No current flows through BD resistance.
Therefore diagonal resistance can be ignored.
Calculation:
Now two 2 Ω branches are in parallel.
Equivalent resistance:
R = (2 × 2)/(2 + 2)= 4/4 = 1 Ω
Using Ohm's law:
I = V/R = 2/1 = 2 A
Result: Current I = 2 A

Q10. Answer: (a) 12

Given:
Nuclear density, ρ = 2.29 × 10^(17) kg m^(-3)
Mass of nucleus, M = 19.926 × 10^(-27) kg
R0 = 1.2 × 10^(-15) m
4π = 12.56
Formula Used:
Density of nucleus:
ρ = Mass / Volume
Volume of nucleus:
$V = (4/3)\pi R^3$
Nuclear radius:
R = R0A^(1/3)
Calculation:
$V = (4/3)\pi(R0A^{(1/3)})^3 = (4/3)\pi R0^3A$
Now, $\rho = M / [(4/3)\pi R0^3A]$
$=> A = M / [\rho \times (4/3)\pi R0^3]$
Substituting values:
$A = 19.926 \times 10^{(-27)} / [2.29 \times 10^{(17)} \times (12.56/3) \times (1.2 \times 10^{(-15)})^3]$
$=> A = 19.926 \times 10^{(-27)} / [2.29 \times 10^{(17)} \times 4.186 \times 1.728 \times 10^{(-45)}]$

YourMockTest.com — Free Study Material

=> A ≈ 19.926 × 10^(-27) / 16.56 × 10^(-28) ≈ 12

Final Answer: Mass number A = 12

Q11. Answer: (a) 1.8 × 10^(-4) volt

Given:

Length of loop = 8 cm = 0.08 m

Breadth of loop = 3 cm = 0.03 m

Magnetic field, B = 0.3 T

Velocity, v = 2 cm s^(-1) = 0.02 m s^(-1)

Formula Used:

Emf induced: e = Blv

Here, l = side perpendicular to motion

Calculation:

The loop moves in a direction normal to the shorter side.

Therefore, effective length: l = 3 cm = 0.03 m

Now, e = Blv

=> e = 0.3 × 0.03 × 0.02 = 0.00018 V = 1.8 × 10^(-4) V

Final Answer: e = 1.8 × 10^(-4) Volt.

Q12. Answer: (a) 0.01 Ω

Given:

Resistance of galvanometer, G = 100 Ω

Full scale deflection current, I_g = 1 mA = 0.001 A

Required ammeter range, I = 10 A

Formula Used:

Shunt resistance: S = (I_g × G) / (I − I_g)

Calculation:

S = (0.001 × 100) / (10 − 0.001)

=> S = 0.1 / 9.999 ≈ 0.01 Ω

Result: Required shunt resistance = 0.01 Ω

Q13. Answer: (a) K/4

Given:

• In Young's double slit experiment:

• Intensity at path difference λ = K units

• We need intensity when path difference = λ/3

Formula Used:

Intensity in YDSE:

=> I = $I_{(max)}$ cos²(φ/2)

Phase difference:

=> φ = 2π(Δx/λ)

Calculation:

For path difference Δx = λ, φ = 2π(λ/λ)

=> φ = 2π

and, I = $I_{(max)}$ cos²(π)

=> I = $I_{(max)}$

Given this intensity = K

=> $I_{(max)}$ = K

Now for path difference Δx = λ/3, φ = 2π(1/3)

=> φ = 2π/3

So, I = K cos²(π/3)

=> I = K × (1/2)² = K/4

Result: Required intensity = K/4

YourMockTest.com — Free Study Material

Q14. Answer: (c) 2 m s^(-2) ; tan ^(-1)(3/4) with 8 N force

Given:

Mass of body, m = 5 kg

Two mutually perpendicular forces: F1 = 8 N and F2 = 6 N

Formula Used:

Resultant force: F = √(F1² + F2²)

Acceleration: a = F / m

Direction: tan θ = Perpendicular / Base

Calculation:

F = √(8² + 6²) = √(64 + 36) = √100 = 10 N

Now,

=> a = 10 / 5 = 2 m s^(−2)

Direction with respect to 8 N force:

tan θ = 6 / 8 = 3 / 4

=> θ = tan^(−1)(3/4)

Result: Acceleration = 2 m s^(−2) and Direction = tan^(−1)(3/4) with 8 N force.

Q15. Answer: (a) 5 μF, 125 μC on all capacitors

Given:

• C1 = C2 = C3 = C4 = 10 μF

• C5 = 2.5 μF

• V = 50 V

Formula Used:

For series capacitors:

1/C = 1/C1 + 1/C2 + 1/C3 + 1/C4

Charge: Q = CV

Calculation:

1/C = 1/10 + 1/10 + 1/10 + 1/10

=> 1/C = 4/10 => C = 10/4 = 2.5 μF

This 2.5 μF combination is in parallel with C5 = 2.5 μF

=> Equivalent capacitance: C_(eq) = 2.5 + 2.5 = 5 μF

Now, Q = CV

=> Q = 5 × 50 = 250 μC

Charge in the series branch:

Q = 2.5 × 50 = 125 μC

In series connection, charge on each capacitor is same.

Charge on C1, C2, C3 and C4 = 125 μC each

For C5:

Q = 2.5 × 50 = 125 μC

Final Answer: Equivalent capacitance = 5 μF, and the charge on each capacitor is 125 μC.

Q16. Answer: (d) Both right-sided and left-sided deflection and at balance point, no deflection

Concept Used:

• In a metre bridge, balance condition depends on equality of potentials at two points.

• At balance point: No current flows through galvanometer.

• Therefore, interchange of cell and galvanometer does not affect the balance condition.

• This is based on the principle of reversibility of Wheatstone bridge.

Explanation:

• When the cell E and galvanometer G are interchanged:

• The bridge still works normally.

• On moving the jockey on different sides of balance point:

• Current direction through galvanometer changes.

YourMockTest.com — Free Study Material

Hence galvanometer shows deflection on both sides.

At exact balance point:

• Potential difference across galvanometer becomes zero.

• No deflection is observed.

Result:

Correct option is "Both right-sided and left-sided deflection and at balance point, no deflection".

Q17. Answer: (d) 19.6 kW

Given:

Mass, m = 1000 kg

Height, h = 20 m

Time, t = 10 s

Acceleration due to gravity, g = 9.8 m/s²

Formula Used:

Power = Work / Time

Work done against gravity: W = mgh

Calculation:

W = 1000 × 9.8 × 20 = 196000 J

=> Power = 196000 / 10 = 19600 W

=> Power = 19.6 kW

Result: Power of crane = 19.6 kW

Q18. Answer: (d) A - II, B - III, C - IV, D - I

Given:

We need to match physical quantities with their formulas.

Concept Used:

Young's Modulus:

Y = Stress / Strain

=> Y = (F/A) / (ΔL/L) = FL / A(ΔL)

So, A → II

Compressibility:

Compressibility is reciprocal of bulk modulus.

Compressibility = − (1/P)(ΔV/V)

So, B → III

Bulk Modulus:

B = − P(V/ΔV)

So, C → IV

Poisson’s Ratio:

Poisson’s Ratio = Lateral strain / Longitudinal strain

=> Δd/ΔL × L/d

So, D → I

Final Matching: A – II, B – III, C – IV, D – I

Q19. Answer: (b) appears to diverge from the first principal focus.

Given:

A ray of light is incident on a concave lens parallel to the principal axis.

Concept Used:

• A concave lens is a diverging lens.

• Rays parallel to the principal axis diverge after refraction.

• The refracted rays appear to come from the principal focus on the same side of the lens.

Explanation:

When a ray parallel to the principal axis passes through a concave lens:

• The ray bends outward.

• It does not actually pass through the focus.
• Its backward extension passes through the first principal focus.
Therefore, the refracted ray appears to diverge from the first principal focus.
So, correct option is "appears to diverge from the first principal focus".

Q20. Answer: (a) $(3\ mL^3)/(8\ \pi^2)$

Given:
• Length of wire = L
• Linear mass density = m
• Wire is bent into a circular ring.
• Axis yy′ is tangential to the ring and lies in its plane.
Formula Used:
Total mass of ring: M = mL
Circumference of ring: L = 2πR
=> R = L / 2π
Moment of inertia of a ring about diameter: $I_{(diameter)} = MR^2 / 2$
Using parallel axis theorem for tangent axis: $I_{(yy')} = I_{(diameter)} + MR^2$
Calculation:
$I_{(yy')} = MR^2/2 + MR^2$
=> $I_{(yy')} = 3MR^2/2$
Substituting M = mL and R = L/2π
$I_{(yy')} = (3/2) \times (mL) \times (L/2\pi)^2$
=> $I_{(yy')} = (3/2) \times mL \times L^2 / 4\pi^2$
=> $I_{(yy')} = 3mL^3 / 8\pi^2$
Result: Moment of inertia about yy′ = $3mL^3 / 8\pi^2$

Q21. Answer: (b) 7.7

Given:
Mass of cube, m = 5.580 kg
Side of cube, a = 9.0 cm => a = 0.09 m
Formula Used:
Density, ρ = Mass / Volume
Volume of cube = a^3
Calculation:
Volume = $(0.09)^3$
=> Volume = 0.000729 m^3
=> ρ = 5.580 / 0.000729 = 7654.32 kg m^(−3) = 7.654×10^3 kg m^(−3)
Significant Figures:
Mass has 4 significant figures.
Side length 9.0 cm has 2 significant figures.
Final answer must have 2 significant figures.
=> ρ = 7.7×10^3 kg m^(−3)
Result: X = 7.7

Q22. Answer: (c) 0 · 008 π rad

Given:
• Wave equation: y(x,t) = 2.0 cos 2π(10 t − 0.0080 x + 0.35)
• Distance between two points: Δx = 0.5 m
Formula Used:
For a travelling wave: Phase difference, Δφ = 2π × (coefficient of x) × Δx
Calculation:
Given coefficient of x = 0.0080
Δφ = 2π × 0.0080 × 0.5

=> $\Delta\varphi = 2\pi \times 0.004 = 0.008\pi$ rad

Therfore, phase difference = 0.008π rad

Q23. Answer: (a) 40°

Given:

• Equilateral prism i.e. prism angle, A = 60°

• Angle of incidence, i = 50°

• Refracted ray inside prism is parallel to base BC.

Concept Used:

In an equilateral prism:

Each angle = 60°

=> Face AB makes 60° with base BC.

Since refracted ray QR is parallel to BC:

=> Angle between refracted ray and prism face AB = 60°

Angle of refraction is measured from normal.

=> $r_1 = 90° - 60° = 30°$

Similarly at second face: $r_2 = 30°$

Using prism relation: $r_1 + r_2 = A$

=> 30° + 30° = 60°

Now for prism: Deviation, $\delta = i + e - A$

Here, symmetry gives: $e = i = 50°$

Calculation:

$\delta = 50° + 50° - 60° = 40°$

Result: Angle of deviation = 40°

Q24. Answer: (b) [figure]

CONCEPT:

Voltage Across an Ideal Diode

• An ideal diode behaves as an open circuit when it is reverse biased.

• An ideal diode behaves as a short circuit when it is forward biased.

• Therefore, the voltage across the diode is maximum when it is reverse biased, while it is approximately zero when it is forward biased.

EXPLANATION:

• During the positive half-cycle of the input voltage, the diode is reverse biased.

• No current flows through the circuit.

• Hence, there is no voltage drop across the resistor.

• The entire input voltage appears across the diode.

• Thus, V_D follows the positive half-cycle of the input.

• During the negative half-cycle, the diode becomes forward biased.

• The ideal diode conducts and behaves like a short circuit.

• Therefore, the voltage across the diode becomes approximately zero.

• Hence, the voltage across the diode consists of a positive half-sinusoidal waveform during the reverse-biased interval and remains zero during the forward-biased interval.

Therefore, the waveform across the diode is a positive half-wave followed by zero voltage.

Q25. Answer: (c) [figure]

Given:

Time period of simple pendulum = T

We need to identify the correct graph between K.E. and time.

Concept Used:

For a simple pendulum:

• Kinetic Energy is always positive or zero.

• Kinetic Energy becomes maximum at mean position.

YourMockTest.com — Free Study Material

• Kinetic Energy becomes zero at extreme positions.
• In one complete oscillation, K.E. becomes maximum two times.
Therefore, time period of K.E. = T/2
Explanation:
At t = 0, pendulum is at extreme position.
=> Velocity = 0
=> K.E. = 0
As pendulum moves toward mean position:
=> Velocity increases
=> K.E. increases
At mean position:
=> Velocity is maximum
=> K.E. is maximum
Again at next extreme position:
=> Velocity becomes zero
=> K.E. becomes zero
This process repeats after every T/2.
Hence, K.E. graph always remains positive and forms repeating arches.
Result: Correct graph is

Q26. Answer: (b) 10 · 8 V

Given:
Emf of battery, E = 12 V
Internal resistance, r = 2 Ω
Current, I = 0.6 A
Formula Used:
Terminal voltage: V = E − Ir
Calculation:
V = 12 − (0.6 × 2) = 12 − 1.2
=> V = 10.8 V
Final Answer: Terminal voltage = 10.8 V.

Q27. Answer: (d) mg R/2

Given:
Mass of body = m
Radius of Earth = R
Height raised = R
Formula Used:
Gravitational potential energy: U = -GMm / r
Calculation:
Initial distance from Earth’s center:
=> r1 = R
Final distance from Earth’s center:
=> r2 = R + R = 2R
Work done = Increase in potential energy
W = U2 − U1
=> W = [-GMm / (2R)] − [-GMm / R]
=> W = GMm / R − GMm / (2R)
=> W = GMm / (2R)
Now, g = GM / R²
=> GM = gR²
Substituting, W = (gR² × m) / (2R)

=> W = mgR / 2

Final Answer: Work done = mgR / 2

Q28. Answer: (c) 25 W

Given:

Heat supplied per second, Q = 100 W

Work done by system per second, W = 75 J/s

Formula Used:

First law of thermodynamics:

$\Delta Q = \Delta U + \Delta W$

Calculation:

$\Delta U = \Delta Q - \Delta W = 100 - 75$

=> $\Delta U = 25$ W

Final Answer: Rate of increase of internal energy = 25 W.

Q29. Answer: (b) 331 W

Given:

Rated power, P1 = 400 W

Rated voltage, V1 = 220 V

New voltage, V2 = 200 V

Formula Used:

For a heater, resistance remains constant:

$P = V^2 / R$

Therefore, P prop. to V^2

Calculation:

$P2 / P1 = (V2 / V1)^2$

=> $P2 / 400 = (200 / 220)^2 = (10 / 11)^2$

=> $P2 / 400 = 100 / 121$

=> $P2 = 400 \times 100 / 121 \approx 330.6$ W

=> $P2 \approx 331$ W

Final Answer: Power consumed ≈ 331 W.

Q30. Answer: (d) B > E > A > D > C

Concept

• When an object falls freely under gravity, the distance it travels is determined by its initial velocity, the acceleration due to gravity, and the time of fall.

• For a falling ruler being caught, the distance the ruler falls corresponds to the person's reaction time.

• Since the ruler is released from rest, the distance traveled is directly proportional to the square of the reaction time.

Formula Used

The equation of motion for a body starting from rest under gravity is:

$s = ut + 1/2gt^2$

Since the ruler falls from rest:

$u = 0$

$s = 1/2gt^2$

Since g is a constant (9.8 m/s^2), the distance s is directly proportional to the square of the reaction time t :

s prop. to t^2

Calculation

Given the reaction times for the five persons:

$t_A = 0.20$ s

$t_B = 0.22$ s

$t_C = 0.18$ s

$t_D = 0.19$ s

$t_E = 0.21$ s

YourMockTest.com — Free Study Material

Comparing these reaction times in descending order (highest to lowest):

0.22 s > 0.21 s > 0.20 s > 0.19 s > 0.18 s

This corresponds to the persons in the following order:

B > E > A > D > C

Since the distance s increases as the time t increases, the order of distances traveled by the ruler will be the same as the order of the reaction times.

Therefore, the correct order of distance traveled is:

B > E > A > D > C

Hence, the correct order is B > E > A > D > C.

Q31. Answer: (b) 0 · 5 × 10^(-6) J

Concept

• When a charged capacitor is connected to an uncharged capacitor, charge redistribution occurs until both capacitors reach a common potential.

• In this process, energy is lost, primarily in the form of heat in the connecting wires or through electromagnetic radiation.

• The total charge remains conserved, but the total electrostatic energy decreases.

Formula Used

Energy stored in a capacitor:

$U = 1/2CV^2$

Common potential after connection:

$V_c = (C1V1 + C2V2)/(C1 + C2)$

The energy lost during the process is given by:

$\Delta U = 1/2 (C1 C2)/(C1 + C2) (V1 - V2)^2$

Calculation

Given:

Capacitance of both capacitors, C1 = C2 = C = 200 pF = 200 × 10^(-12) F

Potential of the first capacitor, V1 = 100 V

Potential of the second capacitor (uncharged), V2 = 0 V

Substituting the values into the energy loss formula:

$\Delta U = 1/2 (200 \times 10^{(-12)}) \times (200 \times 10^{(-12)})/(200 \times 10^{(-12)}) + (200 \times 10^{(-12)}) (100 - 0)^2$

$\Rightarrow \Delta U = 1/2 ((200 \times 10^{(-12)})^2)/(400 \times 10^{(-12)}) \times 10000$

$\Rightarrow \Delta U = 1/2 ((40000 \times 10^{(-24)})/(400 \times 10^{(-12)})) \times 10^4$

$\Rightarrow \Delta U = 1/2 (100 \times 10^{(-12)}) \times 10^4$

$\Rightarrow \Delta U = 50 \times 10^{(-8)} J$

$\Rightarrow \Delta U = 0.5 \times 10^{(-6)} J$

Hence, the amount of electrostatic energy lost in the process is 0.5 × 10^(-6) J.

Q32. Answer: (d) 1 m

Concept

• A simple pendulum consists of a mass (bob) suspended from a fixed point that swings back and forth.

• The time period (T) is the time taken to complete one full oscillation.

• The time period depends on the effective length of the pendulum (L) and the acceleration due to gravity (g).

Formula Used

Time period of a simple pendulum:

$T = 2\pi \sqrt{(L/g)}$

Relation between total time (t), number of oscillations (n), and time period (T):

$T = t/n$

Calculation

Given:

Total time taken, t = 60 s

Number of oscillations, n = 30

Acceleration due to gravity, $g = 9.8 m/s^2$

Approximation, $\pi^2 = 9.8$

First, calculate the time period T :

T = 60/30 = 2 s

Now, substitute the values into the time period formula:

$2 = 2\pi \sqrt{(L/g)}$

Divide both sides by 2:

$1 = \pi \sqrt{(L/g)}$

Squaring both sides:

$1^2 = \pi^2 (L/g)$

$1 = \pi^2 L/g$

Rearranging for L :

$L = g/(\pi^2)$

Substituting the given values g = 9.8 and $\pi^2 = 9.8$:

L = 9.8/9.8 = 1 m

Hence, the effective length of the simple pendulum is 1 m.

Q33. Answer: (a) 1/240 s

Concept

• Alternating current (AC) varies sinusoidally with time, following the equation $I = I0 \sin (\omega t)$.

• One complete cycle corresponds to a time period T.

• Starting from zero, the current reaches its first peak value at one-fourth of the time period, i.e., t = T/4.

Formula Used

Relation between time period and frequency:

T = 1/f

Time taken to reach peak value from zero:

t = T/4 = 1/4f

Calculation

Given:

Frequency, f = 60 Hz

Peak current, I0 = 5 A

We need to find the time t to reach the peak value from zero. This occurs when the phase angle is 90° or π/2 radians.

Using the formula:

t = 1/4f

Substituting the value of f :

t = 1/(4 × 60) s

t = 1/240 s

Hence, the current will take 1/240 s to reach the peak value.

Q34. Answer: (a) A is true, but B is false

Concept

• Conservation of Energy: In wave optics, the principle of superposition leads to interference and diffraction. Energy is not lost; it is simply redistributed from regions of minimum intensity to regions of maximum intensity.

• Wave Nature: Interference and diffraction are fundamental characteristics of wave motion. Any entity that behaves as a wave will exhibit these phenomena.

Explanation

Statement A:

In the phenomena of interference and diffraction, the intensity of light at any point is given by the principle of superposition. At points of constructive interference, the intensity is greater than the sum of the individual intensities, and at points of destructive interference, it is less. However, the total energy across the entire pattern remains constant and equal to the sum of the energies of the individual waves. No energy is created or destroyed; it is merely redistributed. Therefore, these phenomena are perfectly consistent with the principle of conservation of energy. Hence, Statement A is true.

Statement B:

Interference and diffraction are not exclusive to light waves. They are general properties exhibited by all types of waves, including mechanical waves (such as sound waves and water waves), electromagnetic waves (such as radio waves and X-rays), and even matter waves (such as electrons). For example, sound waves undergo diffraction when they pass through a doorway. Hence,

YourMockTest.com — Free Study Material

Statement B is false.

Conclusion

Based on the analysis, Statement A is correct while Statement B is incorrect.

Hence, A is true, but B is false.

Q35. Answer: (d) 1.2

Concept

• For a box to remain stationary relative to an accelerating trolley, the pseudo-force acting on the box must be balanced by the force of static friction.

• The maximum acceleration occurs when the pseudo-force equals the maximum possible static friction (limiting friction).

• Static friction depends on the coefficient of friction and the normal reaction force.

Formula Used

Maximum static friction:

$f_{(s,max)} = \mu_s N$

Normal force on a horizontal surface:

$N = mg$

Newton's second law (Pseudo-force):

$F_p = ma$

Condition for no slipping:

$ma \leq \mu_s mg$

Calculation

Given:

• Mass of the box, $m = 15$ kg

• Coefficient of static friction, $\mu_s = 0.12$

• Acceleration due to gravity, $g = 10$ m/s²

To keep the box stationary over the trolley, the horizontal acceleration a must satisfy:

$ma \leq f_{(s,max)}$

$ma \leq \mu_s mg$

The mass m cancels out from both sides:

$a_{(max)} = \mu_s g$

Substituting the given values:

$a_{(max)} = 0.12 \times 10$

$a_{(max)} = 1.2$ m/s²

Hence, the maximum acceleration with which the trolley can be moved horizontally is 1.2 m/s².

Q36. Answer: (a) 1.41 m/s

Concept

• The total mechanical energy of a simple pendulum, which is the sum of its kinetic energy (KE) and potential energy (PE), remains constant during its motion (neglecting air resistance).

• At the equilibrium position (the lowest point of the swing), the potential energy is at its minimum. If we take this point as the reference level, the potential energy is zero.

• Consequently, at the equilibrium position, all the total energy of the pendulum is converted into kinetic energy.

Formula Used

Total mechanical energy (E):

$E = KE + PE$

Kinetic energy at the equilibrium position:

$KE_{(max)} = 1/2mv^2$

Where:

• m is the mass of the bob.

• v is the speed of the bob at the equilibrium position.

Calculation

Given:

Total energy, $E = 0.02$ J

Mass of the bob, m = 20 g = 0.02 kg

By the law of conservation of energy, the total energy at the equilibrium position is purely kinetic:

$E = 1/2mv^2$

Substituting the given values into the formula:

$0.02 = 1/2 \times 0.02 \times v^2$

Multiplying both sides by 2:

$0.04 = 0.02 \times v^2$

Solving for v^2 :

$v^2 = 0.04/0.02$

$v^2 = 2$

Taking the square root:

$v = \sqrt{2} \approx 1.414$ m/s

Rounding to two decimal places, we get approximately 1.41 m/s.

Hence, the speed of the simple pendulum bob at the equilibrium position is approximately 1.41 m/s.

Q37. Answer: (a) B and D are true, but A and C are false

Concept

• The radius of a nucleus R is related to its mass number A.

• The volume of a nucleus, assuming it is spherical, depends on the cube of its radius.

• The mass defect is a measure of the binding energy of the nucleus, representing the difference between the total mass of individual nucleons and the actual mass of the nucleus.

Formula Used

Nuclear radius:

R = R0 A^(1/3)

Nuclear volume:

$V = 4/3\ \pi R^3$

Mass defect (Δ m):

Δ m = [Z m_p + (A - Z) m_n] - M_(nucleus)

Explanation

For Statements A and B:

The radius of a nucleus is given by R = R0 A^(1/3). The volume V of the nucleus is:

$V = 4/3\ \pi (R0\ A^{(1/3)})^3$

$V = 4/3\ \pi R0^3\ A$

This shows that V prop. to A. Therefore, Statement A is false and Statement B is true.

For Statements C and D:

The mass defect is defined as the difference between the sum of the masses of the constituents (protons and neutrons) and the actual mass of the nucleus. The difference between the mass of an atom and its nucleus is approximately the mass of the electrons, which is not the mass defect.

Therefore, Statement C is false and Statement D is true.

Conclusion:

Statements B and D are true, while A and C are false.

Hence, B and D are true, but A and C are false.

Q38. Answer: (d) 150

Concept

• The motion of a flywheel is an example of rotational motion with constant angular acceleration.

• Angular displacement can be calculated using the average angular velocity when acceleration is uniform.

• The number of revolutions is the total angular displacement divided by 2π radians.

Formula Used

Angular speed in rad/s:

ω = (2π N)/60 (where N is in rpm)

Average angular velocity:

ω_(avg) = (ω1 + ω2)/2

Angular displacement:

$\theta = \omega_{(avg)} \times t$

Number of revolutions (n):

$n = \theta/2\pi$

Calculation

Given:

Initial speed N1 = 600 rpm

Final speed N2 = 1200 rpm

Time t = 10 s

First, calculate initial and final angular velocities in rad/s:

$\omega 1 = (2\pi \times 600)/60 = 20\pi$ rad/s

$\omega 2 = (2\pi \times 1200)/60 = 40\pi$ rad/s

Now, find the average angular velocity:

$\omega_{(avg)} = (20\pi + 40\pi)/2 = 60\pi/2 = 30\pi$ rad/s

Calculate total angular displacement (θ):

$\theta = \omega_{(avg)} \times t$

$\theta = 30\pi \times 10 = 300\pi$ rad

Finally, find the number of revolutions (n):

$n = \theta/2\pi$

$n = 300\pi/2\pi = 150$

Hence, the number of revolutions completed by the flywheel is 150.

Q39. Answer: (d) 990 m

Concept

• The absolute pressure at a depth in a fluid is the sum of the atmospheric pressure at the surface and the hydrostatic pressure exerted by the fluid column.

• Atmospheric pressure ($P_{(atm)}$) is typically 1 atm unless otherwise specified.

• Hydrostatic pressure is given by the product of depth, density, and gravitational acceleration.

Formula Used

Absolute pressure formula:

$P_{(abs)} = P_{(atm)} + \rho gh$

Where:

• $P_{(abs)}$ = Absolute pressure

• $P_{(atm)}$ = Atmospheric pressure

• ρ = Density of the fluid

• g = Acceleration due to gravity

• h = Depth below the surface

Calculation

Given:

$P_{(abs)} = 100$ atm $= 100 \times 10^5$ Pa

$P_{(atm)} = 1$ atm $= 1 \times 10^5$ Pa

$\rho = 1000$ kg/m³

g = 10 m/s²

Using the absolute pressure relation:

$P_{(abs)} = P_{(atm)} + \rho gh$

Substitute the values:

$100 \times 10^5 = 1 \times 10^5 + (1000 \times 10 \times h)$

Subtracting atmospheric pressure from both sides to find gauge pressure:

$99 \times 10^5 = 10^4 \times h$

Solving for h :

$h = (99 \times 10^5)/(10^4)$

$h = 99 \times 10$

h = 990 m

Hence, the submarine can go to a depth of 990 m below the water surface.

Q40. Answer: (d) A - IV, B - I, C - II, D - III

Concept

• Electromagnetic waves are categorized by their frequency and wavelength, and each type is produced through different physical processes.

• Microwaves are generated by oscillating currents in special vacuum tubes.

• Visible light is produced by the excitation of electrons in atoms.

• Gamma rays are of nuclear origin, produced during transitions within the atomic nucleus.

• Infrared rays are often referred to as heat waves and are produced by the thermal motion of atoms and molecules.

Explanation

• A. Microwaves: These are produced by special vacuum tubes called klystrons, magnetrons, or Gunn diodes. Thus, A matches with IV.

• B. Visible light: Visible light is emitted when electrons in atoms move from a higher energy state to a lower energy state (electronic transitions). Thus, B matches with I.

• C. Gamma rays: These high-frequency waves are produced during the radioactive decay of a nucleus or in nuclear reactions. Thus, C matches with II.

• D. Infra-red rays: These are produced by the vibration and rotation of atoms and molecules in a substance. Thus, D matches with III.

Conclusion

By matching the electromagnetic waves with their respective production methods, we get:

A - IV, B - I, C - II, D - III

Hence, the correct match is A - IV, B - I, C - II, D - III.

Q41. Answer: (c) A, C and D only

Concept

• Electrostatics of Conductors: Conductors contain mobile charge carriers (electrons) that redistribute themselves until they reach an equilibrium state.

• Internal Electric Field: In a static situation, the electric field inside a conductor is zero. If it weren't, the free charges would move.

• Charge Distribution: According to Gauss's Law, since the electric field inside is zero, the net flux through any internal surface is zero, meaning no net charge resides inside the conductor.

• Surface Field: The electric field at the surface must be perpendicular to the surface; otherwise, a tangential component would cause surface charges to move.

• Electrostatic Potential: Since the electric field inside is zero ($E = -dV/dr = 0$), the potential remains constant throughout the volume and on the surface of the conductor.

Explanation

Let us evaluate each statement:

• Statement A: Inside a conductor, the electrostatic field is zero. This is a fundamental property of conductors in electrostatic equilibrium. (Correct)

• Statement B: The electric field at the surface of a charged conductor is given by E = σ/ε0, where σ is the surface charge density. Thus, it depends on the surface charge density. (Incorrect)

• Statement C: By Gauss's law, if the electric field is zero everywhere inside, any Gaussian surface within the conductor encloses zero net charge. All excess charge resides on the surface. (Correct)

• Statement D: If the electric field were not normal to the surface, there would be a tangential component that would exert force on surface charges and cause them to move. In a static situation, the field must be normal. (Correct)

• Statement E: The electrostatic potential is constant (equipotential) throughout the volume and surface of the conductor because the field is zero. It is not necessarily zero unless the conductor is grounded. (Incorrect)

Based on the analysis, statements A, C, and D are the correct ones.

Hence, the correct answer is A, C and D only.

Q42. Answer: (a) 200 nm

Concept

• The photoelectric effect occurs only if the energy of the incident photon (E) is greater than or equal to the work function (φ) of the metal.

• Energy of a photon is inversely proportional to its wavelength (λ).

• The maximum wavelength that can cause photoelectric emission is called the threshold wavelength (λ0). If the incident wavelength is greater than the threshold wavelength (λ > λ0), no photoelectric effect occurs.

Formula Used

Energy of incident photon:

E = hc/λ

Threshold wavelength:

λ0 = hc/φ

Conversion of energy from eV to Joules:

1 eV = 1.6 × 10^(-19) J

Constants:

h = 6.6 × 10^(-34) J s

c = 3 × 10^8 m/s

Calculation

Given:

Work function, φ = 6.6 eV = 6.6 × 1.6 × 10^(-19) J

Calculating the threshold wavelength (λ0):

λ0 = hc/φ

λ0 = (6.6 × 10^(-34) × 3 × 10^8)/(6.6 × 1.6 × 10^(-19))

Canceling 6.6 from numerator and denominator:

λ0 = (3 × 10^(-26))/(1.6 × 10^(-19))

λ0 = 1.875 × 10^(-7) m

Converting to nanometers (1 nm = 10^(-9) m):

λ0 = 187.5 nm

For the photoelectric effect to not occur, the incident wavelength λ must be greater than λ0 :

λ > 187.5 nm

Comparing with the given options:

• 200 nm: 200 nm > 187.5 nm (Emission will not occur)

• 150 nm: 150 nm < 187.5 nm (Emission will occur)

• 100 nm: 100 nm < 187.5 nm (Emission will occur)

• 50 nm: 50 nm < 187.5 nm (Emission will occur)

Hence, the wavelength that does not give rise to the photoelectric effect is 200 nm.

Q43. Answer: (d) 2.1 × 10^(-10) m

Concept

• According to the Bohr model of the hydrogen atom, the total energy of an electron is equal to half of its potential energy and negative of its kinetic energy.

• The total energy of an electron in an orbit of radius r is related to the electrostatic potential energy between the electron and the nucleus.

• For a hydrogen atom Z = 1, the total energy is given by E = -(ke²)/2r, where k = 1/4πε0.

Formula Used

The total energy of an electron in a hydrogen atom is:

E = -1/4πε0(e²)/2r

Rearranging for the radial distance:

r = 1/4πε0(e²)/(2|E|)

Calculation

Given:

Energy in the first excited state, E = -3.4 eV

Converting energy into joules:

|E| = 3.4 × 1.6 × 10^(-19) J

Charge of electron:

e = 1.6 × 10^(-19) C

Coulomb constant:

$1/4\pi\varepsilon_0 = 9 \times 10^9\ N\ m^2/C^2$

Substituting the values:

$r = (9 \times 10^9 \times (1.6 \times 10^{-19})^2)/(2 \times (3.4 \times 1.6 \times 10^{-19}))$

Cancelling common terms:

$r = (9 \times 10^9 \times 1.6 \times 10^{-19})/(2 \times 3.4)$

$r = (14.4 \times 10^{-10})/6.8$

$r \approx 2.117 \times 10^{-10}\ m$

Therefore,

$r \approx 2.1 \times 10^{-10}\ m$

Hence, the radial distance of the electron from the hydrogen nucleus is approximately 2.1×10^{-10} m.

Q44. Answer: (b) Statement A is true, but Statement B is false

Concept

• In forward bias, the positive terminal of the battery is connected to the p-side and the negative terminal to the n-side of the p-n junction diode.

• Threshold voltage (also known as cut-in or knee voltage) is the minimum voltage required for the diode to conduct current significantly in forward bias.

• Reverse saturation current is the current that flows due to minority charge carriers when the diode is in reverse bias.

Formula Used

The current through a p-n junction diode is given by the diode equation:

$I = I_0 (e^{(eV/(\eta kT))} - 1)$

Where:

• I = Diode current

• I_0 = Reverse saturation current

• V = Applied voltage

• e = Charge of an electron

• k = Boltzmann constant

• T = Temperature

Explanation

Analysis of Statement A:

When a p-n junction diode is forward biased, the applied voltage opposes the internal barrier potential. As the forward voltage increases and exceeds the threshold voltage (approximately 0.7 V for Silicon and 0.3 V for Germanium), the depletion layer width decreases significantly, allowing majority charge carriers to cross the junction. This leads to an exponential increase in the diode current. Thus, Statement A is true.

Analysis of Statement B:

The significant current that flows during forward bias is called the forward current. Reverse saturation current is the very small current (in the order of microamperes or nanoamperes) that flows when the diode is reverse biased, caused by the drift of minority charge carriers across the junction. Therefore, Statement B is false.

Hence, Statement A is true, but Statement B is false.

Q45. Answer: (a) √7/2

Given:

Mass ratio of Argon : Chlorine = 2 : 1

Molar mass of Ar = 40 u

Molar mass of Cl_2 = 70 u

Temperature = 27°C

Formula Used:

For a gas,

$v_{rms}=\sqrt{(3RT/M)}$

$\Rightarrow v_{rms} \propto 1/\sqrt{M}$

Calculation:

Required ratio:

=> v_(rms)^(Ar) / v_(rms)^(Cl2) = √(M_(Cl2) / M_(Ar)) = √(70 / 40) = √(7 / 4) = √7 / 2

Final Answer: v_(rms)^(Ar) / v_(rms)^(Cl2) = √7 / 2

Q46. Answer: (d) A - II, B - III, C - IV, D - I

CONCEPT:

Conversion of Organic Compounds Using Reagents

• Different reagents are used for specific organic transformations such as oxidation, reduction, hydration, and aromatic substitution.

• Important reactions used in the question are:

• Oxidation of alkyl benzene using O2 followed by acidic hydrolysis produces phenol.

• Carboxylic acids can be reduced to alcohols using catalytic hydrogenation in acidic medium.

• Alcohols undergo dehydration in presence of concentrated H2SO4 and on subsequent hydration give alcohols according to Markovnikov's rule.

• Benzene can be converted into phenol through sulphonation using oleum followed by fusion with NaOH and acidification.

EXPLANATION:

Reaction A:

Isopropyl benzene (cumene) on oxidation with O2 followed by acidic hydrolysis forms phenol.

Hence, A matches with:

Reaction B:

Acetic acid is converted into ethanol by reduction using CH3OH, H^+ followed by catalytic hydrogenation.

Hence, B matches with:

Reaction C:

1-Propanol on dehydration using concentrated H2SO4 and heat forms propene, which on hydration gives 2-propanol.

Hence, C matches with:

Reaction D:

Benzene undergoes sulphonation with oleum, followed by fusion with NaOH and acidification to produce phenol.

Hence, D matches with:

• Therefore, the correct matching is:

Hence, the correct matching of List-I with List-II is A-II, B-III, C-IV, D-I.

Q47. Answer: (b) C2H5OH

CONCEPT:

• Reaction with AgNO2: Alkyl halides react with silver nitrite (AgNO2), which is a covalent compound, primarily to form nitroalkanes because the lone pair on the nitrogen atom acts as the nucleophilic site.

• Reduction of Nitro Groups: The nitro group (-NO2) can be reduced to a primary amino group (-NH2) using a metal and a concentrated acid, such as tin and hydrochloric acid (Sn/HCl).

• Diazotization and Decomposition: Primary aliphatic amines react with nitrous acid (HNO2, generated from NaNO2 and HCl) at low temperatures (0-5°C) to form aliphatic diazonium salts. These salts are highly unstable and decompose immediately in aqueous solutions to yield alcohols and nitrogen gas.

EXPLANATION:

• Step 1: Conversion of C2H5Br to X

Ethyl bromide reacts with AgNO2 through a nucleophilic substitution reaction to form nitroethane.

C2H5Br + AgNO2 → C2H5NO2 + AgBr

Product X is Nitroethane (C2H5NO2).

• Step 2: Conversion of X to Y

Nitroethane is reduced by the Sn/HCl mixture to form the corresponding primary amine.

C2H5NO2 + 6[H] → C2H5NH2 + 2H2O

Product Y is Ethylamine (C2H5NH2).

• Step 3: Conversion of Y to Z

Ethylamine reacts with nitrous acid (HNO2) at 0-5°C. An unstable diazonium salt is formed as an intermediate, which decomposes in the presence of water to form ethanol.

C2H5NH2 + HNO2 → [C2H5N2^+Cl^-] → C2H5OH + N2↑ + HCl

Product Z is Ethanol (C2H5OH).

Therefore, the major product Z formed in the sequence is C2H5OH.

Q48. Answer: (c) 9.301

CONCEPT:

Solubility Product (K) and pH Calculation

• For a sparingly soluble base or salt in equilibrium with its ions, the equilibrium constant (K) is determined by the concentrations of the dissolved ions.

• For the reaction: BiO(OH)(s) <=> BiO^+(aq) + OH^-(aq), the expression is:

K = [BiO^+][OH^-]

• The pOH is calculated as: pOH = -log[OH^-].

• The pH is calculated from pOH at 298 K using the relation: pH + pOH = 14.

EXPLANATION:

• The given equilibrium reaction is:

BiO(OH)(s) <=> BiO^+(aq) + OH^-(aq)

• Let the molar solubility of BiO(OH) be 's'. According to the stoichiometry:

• [BiO^+] = s

• [OH^-] = s

• Given the equilibrium constant K = 4 × 10^(-10):

• K = [BiO^+][OH^-]

• 4 × 10^(-10) = s × s

• $s^2 = 4 \times 10^{(-10)}$

• s = √(4 × 10^(-10))

• s = 2 × 10^(-5) M

• The concentration of hydroxide ions is [OH^-] = 2 × 10^(-5) M.

• Calculating pOH:

• pOH = -log[OH^-]

• pOH = -log(2 × 10^(-5))

• pOH = -(log 2 + log 10^(-5))

• pOH = -(0.3010 - 5)

• pOH = 4.699

• Calculating pH:

• pH = 14 - pOH

• pH = 14 - 4.699

• pH = 9.301

Therefore, the pH of the solution when equilibrium exists is 9.301.

Q49. Answer: (c) 0.8 dm3 of CO, 0.6 dm3 of CO2

CONCEPT:

Boudouard Reaction and Stoichiometry

• When carbon dioxide (CO2) gas is passed over red-hot coke (solid carbon), a chemical reaction occurs to form carbon monoxide (CO) gas.

• The balanced chemical equation for this reaction is:

CO2(g) + C(s) → 2CO(g)

• According to the stoichiometry of the reaction, 1 mole (or 1 volume at constant T and P) of CO2 gas reacts with solid coke to produce 2 moles (or 2 volumes) of CO gas.

• The total volume of the resulting mixture depends on the extent of the reaction and the amount of unreacted CO2 remaining.

EXPLANATION:

• Let the initial volume of CO2 gas be 1 dm^3.

• Let 'x' dm^3 be the volume of CO2 that reacts with the coke.

• Using the balanced equation: CO2(g) + C(s) → 2CO(g)

• Volume of CO2 reacted = x dm^3

• Volume of CO produced = 2x dm^3

• After the reaction is complete, the gaseous mixture consists of:

• Volume of remaining (unreacted) CO_2 = (1 - x) dm^3

• Volume of CO produced = 2x dm^3

• The total volume of the gaseous mixture is given as 1.4 dm^3. Therefore:

• Total Volume = (Volume of unreacted CO_2) + (Volume of CO produced)

• 1.4 = (1 - x) + 2x

• 1.4 = 1 + x

• x = 1.4 - 1 = 0.4 dm^3

• Now, determine the composition of the mixture by substituting the value of x:

• Volume of CO = 2x = 2 × 0.4 = 0.8 dm^3

• Volume of CO_2 = 1 - x = 1 - 0.4 = 0.6 dm^3

Therefore, the composition of the gaseous mixture at STP is 0.8 dm^3 of CO and 0.6 dm^3 of CO_2.

Q50. Answer: (a) A - II, B - III, C - IV, D - I

CONCEPT:

Quantum Numbers and Orbitals

• Principal Quantum Number (n): It designates the main energy level or shell in which the electron resides. It can have positive integer values (1, 2, 3, ...).

• Azimuthal Quantum Number (l): Also known as the orbital angular momentum quantum number, it defines the three-dimensional shape of the orbital. For a given value of n, l can have values from 0 to (n-1).

• The values of l are associated with specific subshell notations:

• l = 0 corresponds to an s orbital.

• l = 1 corresponds to a p orbital.

• l = 2 corresponds to a d orbital.

• l = 3 corresponds to an f orbital.

• An orbital is identified by writing the principal quantum number followed by the letter symbol of the subshell (e.g., for n=2 and l=1, the orbital is 2p).

EXPLANATION:

• A. n = 2, l = 1:

• The principal shell is 2.

• Since l = 1, it represents a p-subshell.

• The orbital is 2p. (Match: II)

• B. n = 4, l = 0:

• The principal shell is 4.

• Since l = 0, it represents an s-subshell.

• The orbital is 4s. (Match: III)

• C. n = 5, l = 3:

• The principal shell is 5.

• Since l = 3, it represents an f-subshell.

• The orbital is 5f. (Match: IV)

• D. n = 3, l = 2:

• The principal shell is 3.

• Since l = 2, it represents a d-subshell.

• The orbital is 3d. (Match: I)

Therefore, the correct matching is A - II, B - III, C - IV, D - I.

Q51. Answer: (b) 6 and 6

CONCEPT:

Chlorination of Benzene

• Benzene undergoes different reactions with chlorine depending upon the reaction conditions.

• In the presence of anhydrous $AlCl_3$ under dark and cold conditions, electrophilic substitution occurs forming benzene hexachloride derivative with six chlorine atoms attached.

• In the presence of UV light and high temperature, addition reaction occurs and benzene forms benzene hexachloride (BHC),

which also contains six chlorine atoms.

EXPLANATION:

• Formation of X:

• The product X contains six chlorine atoms.

• Formation of Y:

• The product Y is benzene hexachloride (BHC), which also contains six chlorine atoms.

• Therefore, the number of chlorine atoms present in X and Y are 6 and 6 respectively.

Hence, the number of chlorine atoms present in products X and Y are 6 and 6 respectively.

Q52. Answer: (d) X = $POCl_3$; Z = $CH_3CH_2CH_2$ - Br

CONCEPT:

Reaction of Alcohol with PCl_5 and Dehydrohalogenation

• Alcohols react with PCl_5 to form alkyl chlorides.

• During this reaction, phosphorus oxychloride ($POCl_3$) and HCl are formed as by-products.

• Alkyl chlorides on heating with alcoholic KOH undergo β-elimination (dehydrohalogenation) to form alkenes.

• Alkenes react with HBr in the presence of peroxide ($(C_6H_5CO)_2O_2$) through anti-Markovnikov addition, giving bromoalkanes.

EXPLANATION:

• • Hence, compound X is:

$POCl_3$

• Propyl chloride on heating with alcoholic KOH undergoes elimination reaction to form propene:

$CH_3CH_2CH_2Cl \xrightarrow{[\Delta]\text{alc. KOH}} CH_3CH=CH_2$

• The alkene formed reacts with HBr in presence of peroxide.

• Due to peroxide effect, HBr adds according to anti-Markovnikov rule:

$CH_3CH=CH_2 \xrightarrow{[(C_6H_5CO)_2O_2]HBr} CH_3CH_2CH_2Br$

• Therefore, compound Z is: $CH_3CH_2CH_2Br$

Therefore, X = $POCl_3$ and Z = $CH_3CH_2CH_2Br$.

Q53. Answer: (d) A-III, B-I, C-IV, D-II

CONCEPT:

Catalytic Properties of Transition Metals and their Compounds

• Transition metals and their compounds are known for their catalytic activity. This is attributed to their ability to adopt multiple oxidation states and their ability to form complexes.

• They provide a surface for reactants to be adsorbed, which brings the reactant molecules closer together and lowers the activation energy of the reaction.

• Specific catalysts are used for industrial processes like the Haber process, Contact process, and Wacker process.

EXPLANATION:

• A. V_2O_5 (Vanadium pentoxide):

• It is used as a catalyst in the Contact Process for the oxidation of sulphur dioxide (SO_2) to sulphur trioxide (SO_3), which is a key step in the preparation of sulphuric acid (H_2SO_4).

• Match: A - III

• B. Fe (Iron):

• Finely divided iron is used as a catalyst in the Haber Process for the industrial synthesis of ammonia from a nitrogen (N_2) and hydrogen (H_2) mixture.

• Match: B - I

• C. $PdCl_2$ (Palladium chloride):

• Palladium salts like $PdCl_2$ are used in the Wacker Process. While typically used for ethene, it is also involved in the catalytic oxidation of alkynes/alkenes to carbonyl compounds like ethanal.

• Match: C - IV

• D. Ni complex (Nickel complexes):

• Nickel complexes (such as those used in Reppe chemistry) are effective catalysts for the polymerisation of alkynes to form cyclic or linear polymers.

• Match: D - II

Therefore, the correct matching is A-III, B-I, C-IV, D-II.

Q54. Answer: (b) It has T-shaped geometry with two lone pairs on Cl atom.

CONCEPT:

Valence Shell Electron Pair Repulsion (VSEPR) Theory

• The geometry of a molecule depends on the total number of valence shell electron pairs (bond pairs and lone pairs) surrounding the central atom.

• The Steric Number (SN) is calculated as:

SN = (Number of bond pairs) + (Number of lone pairs)

• For a steric number of 5, the electron geometry is trigonal bipyramidal. If lone pairs are present, they occupy equatorial positions to minimize electronic repulsion, leading to different molecular shapes.

EXPLANATION:

• In the molecule ClF3ClF3ClF3

:

• The central atom is Chlorine (ClClCl

), which belongs to Group 17 and has 7 valence electrons.

• There are 3 Fluorine (FFF

) atoms bonded to the central Chlorine atom, forming 3 bond pairs.

• The number of remaining valence electrons on Chlorine = 7 - 3 = 4 electrons.

• These 4 electrons form 42=242=242=2

lone pairs.

• Calculation of Steric Number:

• Steric Number = 3 (bond pairs) + 2 (lone pairs) = 5.

• A steric number of 5 implies sp3dsp3dsp3d

hybridization and a trigonal bipyramidal electron geometry.

• Molecular Geometry:

• With 2 lone pairs and 3 bond pairs, the two lone pairs occupy the equatorial positions of the trigonal bipyramid to minimize repulsion (lp-lp and lp-bp).

• This arrangement results in a molecular shape known as T-shaped geometry.

Therefore, ClF3ClF3ClF3

has a T-shaped geometry with two lone pairs on the ClClCl

atom.

Q55. Answer: (a) 0.109 V

CONCEPT:

Nernst Equation for a Half-Cell

• The electrode potential of a half-cell depends on the standard electrode potential, temperature, concentration of ions, and pressure of gases involved.

• For the hydrogen electrode represented as an oxidation electrode:

H2(g) → 2H^+(aq) + 2e^-

• The electrode potential is calculated using the Nernst equation:

E = E^o - 0.059/n log ([H^+]²)/(P_(H2))

• Here,

• n = number of electrons transferred

• [H^+] = concentration of hydrogen ions

• P_(H2) = pressure of hydrogen gas

EXPLANATION:

• The given half-cell is:

Pt(s) | H2(g, 2 atm) | HCl(aq, 0.02 M)

• The oxidation reaction taking place is:

H2(g) → 2H^+(aq) + 2e^-

• Given values:

• E^o = 0 V

• P_(H2) = 2 atm

• [H^+] = 0.02 M = 2 × 10^(-2) M

• n = 2

• Using the Nernst equation:

E = 0 - 0.059/2 log ((2 × 10^(-2))²)/2

• Simplifying:

(2 × 10^(-2))² = 4 × 10^(-4)

(4 × 10^(-4))/2 = 2 × 10^(-4)

E = -0.0295 log (2 × 10^(-4))

• Using logarithmic properties:

log (2 × 10^(-4)) = log 2 + log 10^(-4)

= 0.3010 - 4

= -3.699

• Substituting:

E = -0.0295 x (-3.699)

E = 0.109 V

Therefore, the electrode potential of the given half-cell is 0.109 V.

Q56. Answer: (c) A-IV, B-III, C-I, D-II

CONCEPT:

Units of Rate Constant (k)

• The rate law for a reaction of order n is expressed as: Rate = k[Concentration]^n.

• To find the unit of the rate constant k, the formula used is:

Unit of k = (mol L^(-1))^(1-n) s^(-1)

• Alternatively, the units can be written as mol^(1-n) L^(n-1) s^(-1).

EXPLANATION:

• A. Zero order (n = 0):

• Applying the formula: Unit = (mol L^(-1))^(1-0) s^(-1)

• Unit = mol L^(-1) s^(-1)

• This matches with IV.

• B. First order (n = 1):

• Applying the formula: Unit = (mol L^(-1))^(1-1) s^(-1)

• Unit = (mol L^(-1))^0 s^(-1) = s^(-1)

• This matches with III.

• C. Second order (n = 2):

• Applying the formula: Unit = (mol L^(-1))^(1-2) s^(-1)

• Unit = (mol L^(-1))^(-1) s^(-1) = mol^(-1) L s^(-1)

• This matches with I.

• D. Third order (n = 3):

• Applying the formula: Unit = (mol L^(-1))^(1-3) s^(-1)

• Unit = (mol L^(-1))^(-2) s^(-1) = mol^(-2) L² s^(-1)

• This matches with II.

Therefore, the correct matching is A-IV, B-III, C-I, D-II.

Q57. Answer: (a) 2.84 BM

CONCEPT:

Spin-only Magnetic Moment (μ)

• The magnetic moment of transition metal ions is primarily determined by the number of unpaired electrons present in their d-orbitals.

• It can be calculated using the spin-only formula:

μ = √[n(n + 2)] BM

• Where:

• n is the number of unpaired electrons.

YourMockTest.com — Free Study Material

• BM stands for Bohr Magneton, which is the unit of magnetic moment.

EXPLANATION:

• The given ion is Ti^(2+).

• The atomic number of Titanium (Ti) is 22. Its ground state electronic configuration is:

Ti: [Ar] $3d^2$ $4s^2$

• To form the Ti^(2+) ion, two electrons are removed from the outermost 4s orbital:

Ti^(2+): [Ar] $3d^2$ 4s^0 (or simply $3d^2$)

• In the $3d^2$ configuration, there are 2 unpaired electrons (n = 2) in the d-subshell according to Hund's rule.

• Applying the spin-only magnetic moment formula:

• $\mu = \sqrt{[n(n + 2)]}$

• $\mu = \sqrt{[2(2 + 2)]}$

• $\mu = \sqrt{[2 \times 4]}$

• $\mu = \sqrt{8}$

• $\mu \approx 2.828$ BM

• Rounding to two decimal places, we get approximately 2.84 BM.

Therefore, the calculated 'spin-only' magnetic moment of Ti^(2+) is 2.84 BM.

Q58. Answer: (c) Fractional distillation

CONCEPT:

Friedel-Crafts Alkylation and Nitration of Toluene

• Benzene reacts with CH3Cl in the presence of anhydrous AlCl3 through Friedel-Crafts alkylation to form toluene.

• Toluene undergoes nitration with dilute HNO3 and dilute H2SO4 to form a mixture of ortho-nitrotoluene and para-nitrotoluene.

• Ortho and para products are liquid isomers having different boiling points.

• Such liquid mixtures are separated by fractional distillation.

EXPLANATION:

• In the first step, benzene reacts with methyl chloride in the presence of anhydrous AlCl3:

C6H6 + CH3Cl &xrightarrow{anhyd.\ AlCl_{3}} C6H5CH3

The product formed is toluene.

• T oluene undergoes nitration with dilute nitric acid and dilute sulphuric acid:

C6H5CH3 &xrightarrow[dil.\ H_{2}SO_{4}]{dil.\ HNO_{3}} o-nitrotoluene + p-nitrotoluene

• The methyl group is an electron-donating group and directs substitution mainly at the ortho and para positions.

• The products obtained are:

• Ortho-nitrotoluene (X)

• Para-nitrotoluene (Y)

• Since both compounds are liquids with different boiling points, they can be separated by:

Fractional distillation

Therefore, products X and Y can be separated using fractional distillation.

Q59. Answer: (c) 2.71 × 10^(19)

CONCEPT:

• Power and Energy: Power (P) is the rate at which energy is emitted or consumed per unit time. 1 Watt = 1 Joule per second.

• Efficiency (η): It is the ratio of useful energy output to the total energy input. In this case, the useful energy is the light energy.

• Photon Count: The total energy emitted in the form of light is the product of the number of photons (n) and the energy of a single photon (E_p).

Total Light Energy = n × E_p

EXPLANATION:

• Given data:

• Power of the bulb (P_{total}) = 150 W = 150 J/s

• Efficiency (η) = 8% = 0.08

• Energy of one photon (E_p) = 4.42 × 10^(-19) J

• Calculate the energy converted into light per second:

• Energy emitted as light per second (E_{light}) = Total Power × Efficiency

• E_(light) = 150 J/s × 0.08

• E_(light) = 12 J/s

• Calculate the number of photons emitted per second (n):

• The number of photons emitted per second is the total light energy per second divided by the energy of one photon.

• n = E_(light) / E_p

• n = 12 / (4.42 × 10^(-19))

• n = (12 / 4.42) × 10^(19)

• n ≈ 2.7149 × 10^(19)

Therefore, the number of photons emitted by the bulb per second is 2.71 × 10^(19).

Q60. Answer: (a) Acetate, CH3COO^-

CONCEPT:

Identification of Anions (Acidic Radicals)

• In qualitative inorganic analysis, dilute sulphuric acid (H2SO4) is used to detect certain anions based on the characteristics of the gases they evolve.

• Each anion reacts with the acid to produce a specific gas or vapor with unique properties such as color, odor, and its effect on indicators like litmus paper.

EXPLANATION:

• When dilute H2SO4 is added to a salt containing the acetate ion (CH3COO^-), acetic acid (CH3COOH) is formed.

2CH3COO^- + H2SO4 → 2CH3COOH + SO4^(2-)

• Vinegar Smell: The resulting acetic acid vapors have a very characteristic sharp smell, similar to vinegar.

• Litmus Test: Since acetic acid is an acid, its vapors turn moist blue litmus paper red.

• Analysis of other options:

• Carbonate (CO3^(2-)): Reacts with dilute H2SO4 to produce CO2 gas, which is colorless and odorless, and turns lime water milky.

• Sulphide (S^(2-)): Reacts with dilute H2SO4 to produce H2S gas, which has a distinct smell of rotten eggs.

• Sulphate (SO4^(2-)): Does not react with dilute H2SO4 because it is the anion of the acid itself.

Therefore, the anion that produces colorless vapors with the smell of vinegar and turns blue litmus red is Acetate (CH3COO^-).

Q61. Answer: (b) A, C and D only

CONCEPT:

Reduction of Nitriles to Primary Amines

• The reduction of nitriles (R-C≡N) involves the addition of hydrogen across the carbon-nitrogen triple bond to form primary amines (R-CH2NH2).

• This transformation can be achieved using strong reducing agents, catalytic hydrogenation, or specific chemical reduction methods like the Mendius reaction.

EXPLANATION:

• A. (i) LiAlH4; (ii) H2O: Lithium aluminium hydride is a strong nucleophilic reducing agent. It reduces nitriles to primary amines. The second step (hydrolysis) is necessary to release the final amine from its complex.

R-C≡N + [H] → R-CH2NH2

• B. Sn + HCl: This reagent combination is primarily used for the reduction of nitro groups (-NO2) into primary amines. It is not typically used to reduce nitriles to primary amines.

• C. H2/Ni: Catalytic hydrogenation using hydrogen gas in the presence of a nickel catalyst (such as Raney Nickel) is a standard method to reduce nitriles to primary amines.

• D. Na(Hg)/C2H5OH: The reduction of nitriles using sodium amalgam in ethanol is known as the Mendius reduction. It effectively produces primary amines from nitriles.

• E. Br2/aq. NaOH: These are the reagents for the Hoffmann Bromamide Degradation reaction. This reaction converts an amide into a primary amine with one fewer carbon atom and is not used for nitriles.

Comparing the given reagents, A, C, and D are the correct reagents for the conversion of nitriles to primary amines.

Therefore, the correct answer is A, C and D only.

Q62. Answer: (c) Oxygen exhibits only -2 oxidation state.

CONCEPT:

Properties of p-Block Elements

• The chemical and physical properties of p-block elements are influenced by their atomic size, electronegativity, and electronic configuration.

• Catenation: This is the property of atoms of the same element to link together to form long chains or rings. It depends on the strength of the element-element bond.

• Oxidation State: This represents the number of electrons an atom loses, gains, or appears to use when joining with other atoms in compounds.

• Multiple Bonding: Smaller atoms of the second period (like Carbon) have the ability to form stable pπ-pπ multiple bonds.

EXPLANATION:

• Carbon's Multiple Bonding: Carbon has a small atomic size and high electronegativity, allowing it to form strong pπ-pπ multiple bonds with itself (as seen in alkenes and alkynes) and with other atoms like Nitrogen or Oxygen. This statement is correct.

• Trihalides of Boron and Aluminum: BCl3 exists as a monomer because the small Boron atom cannot easily accommodate four large Chlorine atoms in a dimerized structure. AlCl3, however, exists as a dimer (Al2Cl6) in vapor and non-polar solvents to complete the octet of Aluminum. This statement is correct.

• Oxidation States of Oxygen: Oxygen typically exhibits a -2 oxidation state in most of its compounds (oxides). However, it exhibits other oxidation states as well:

• In peroxides (e.g., H2O2), the oxidation state is -1.

• In superoxides (e.g., KO2), the oxidation state is -1/2.

• In OF2, the oxidation state is +2.

• In O2F2, the oxidation state is +1.

Since Oxygen exhibits several oxidation states besides -2, the statement that it exhibits only -2 is incorrect.

• Catenation in Group 14: Catenation tendency decreases down the group as the atomic size increases and the element-element bond enthalpy decreases. The order is C gg Si > Ge ≈ Sn. This statement is correct.

Therefore, the incorrect statement is: Oxygen exhibits only -2 oxidation state.

Q63. Answer: (d) After losing one more electron, it acquires 4f^0 electronic configuration.

CONCEPT:

Oxidation States of Lanthanoids

• Lanthanoids predominantly exhibit a +3 oxidation state. However, some elements show +2 or +4 oxidation states because of the extra stability associated with attaining an empty (f^0), half-filled (f^7), or fully filled (f^(14)) f-subshell.

• Cerium (Ce) is the first element of the lanthanoid series with an atomic number of 58.

EXPLANATION:

• The electronic configuration of Cerium (Z = 58) in its ground state is:

Ce: [Xe] $4f^1$ $5d^1$ $6s^2$

• In the +3 oxidation state (Ce^(3+)), the configuration is:

Ce^(3+): [Xe] $4f^1$

• In the +4 oxidation state (Ce^(4+)), the atom loses one more electron from the 4f orbital:

Ce^(4+): [Xe] 4f^0

• The 4f^0 electronic configuration represents an empty f-subshell, which is highly stable as it achieves the noble gas configuration of Xenon ([Xe]).

• While Ce^(4+) is a strong oxidizing agent (tending to revert to the more stable +3 state in aqueous solution), the initial formation of the +4 state is facilitated by this noble gas configuration.

Therefore, Cerium shows a +4 oxidation state because after losing one more electron (from the +3 state), it acquires a 4f^0 electronic configuration.

Q64. Answer: (c) covalent form to ionic form

CONCEPT:

Lassaigne's Test (Sodium Fusion Test)

• Lassaigne's test is a qualitative analysis used to detect the presence of nitrogen, sulphur, and halogens in an organic compound.

• Organic compounds are generally covalent in nature, which means the elements are bonded covalently and do not ionize easily in water.

• To identify these elements using inorganic reagents, they must first be converted into water-soluble ionic compounds.

EXPLANATION:

• In Lassaigne's test, the organic compound is fused with a small piece of sodium metal in a fusion tube.

• Sodium metal is highly reactive and converts the elements present in the organic compound into their corresponding ionic sodium salts:

• Sodium + Carbon + Nitrogen → Sodium cyanide (NaCN)

• 2 × Sodium + Sulphur → Sodium sulphide (Na2S)

• Sodium + Halogen (X) → Sodium halide (NaX)

• In the organic compound, nitrogen, sulphur, and halogens are present in the covalent form.

• After fusion with sodium metal, these elements are converted into the ionic form (Na^+, CN^-, S^(2-), X^-).

• The resulting ionic salts are then dissolved in distilled water to prepare the Lassaigne's extract (sodium fusion extract) for further chemical tests.

Therefore, during Lassaigne's test, the elements present in an organic compound are converted from covalent form to ionic form.

Q65. Answer: (a) 2.168×10^{23}

CONCEPT:

Mole Concept and Stoichiometry

• The number of moles (n) of a substance is calculated using the formula:

n = Mass / Molar mass

• One mole of any substance contains Avogadro's number (N_A) of entities (molecules or atoms), which is approximately 6.022×10^{23}.

• To find the total number of atoms of a specific element in a sample, multiply the number of moles of the compound by Avogadro's number and then by the number of atoms of that element present in one molecule of the compound.

EXPLANATION:

• The chemical formula for urea is NH2CONH2 (or CH4N2O).

• One molecule of urea contains 4 hydrogen (H) atoms.

• Given data:

• Mass of urea = 5.4 g

• Molar mass of urea = 60 g mol^(-1)

• N_A = 6.022×10^{23} mol^(-1)

• Step 1: Calculate the number of moles of urea:

• Moles of urea = Mass / Molar mass

• Moles of urea = 5.4 / 60 = 0.09 mol

• Step 2: Calculate the number of molecules of urea:

• Number of molecules = Moles × N_A

• Number of molecules = $0.09 \times 6.022 \times 10^{23}$

• Step 3: Calculate the total number of hydrogen atoms:

• Since 1 molecule of urea has 4 H atoms,

• Total H atoms = 4 × Number of molecules

• Total H atoms = $4 \times 0.09 \times 6.022 \times 10^{23}$

• Total H atoms = $0.36 \times 6.022 \times 10^{23}$

• Total H atoms = 2.16792×10^{23}

Therefore, the number of hydrogen atoms present in 5.4 g of urea is 2.168×10^{23}.

Q66. Answer: (b) CH3OCH2CH2CH3 and CH3CH2OCH2CH3

CONCEPT:

Metamerism

• Metamerism is a type of structural isomerism shown by compounds having the same molecular formula and the same functional group but different alkyl groups on either side of a polyvalent atom such as oxygen, sulphur, or nitrogen.

• Ethers commonly show metamerism because different alkyl groups can be attached on both sides of the oxygen atom.

• For metamers:

• Molecular formula must be the same.

• Functional group must be the same.

• Distribution of carbon atoms around the functional group must be different.

EXPLANATION:

• The compounds: CH3OCH2CH2CH3 and CH3CH2OCH2CH3

are ethers having the same molecular formula: C4H10O

• In the first ether, the alkyl groups attached to oxygen are:

• Methyl group (CH3-)

• Propyl group (CH3CH2CH2-)

• In the second ether, the alkyl groups attached to oxygen are:

• Ethyl group (CH3CH2-)

• Ethyl group (CH3CH2-)

• Thus, both compounds have the same functional group but different distribution of carbon chains around the oxygen atom.

• Hence, they are metamers.

Therefore, CH3OCH2CH2CH3 and CH3CH2OCH2CH3 are metamers.

Q67. Answer: (b) Nitrogen can form dπ-pπ bond with oxygen.

CONCEPT:

Electronic Configuration and Bonding in Group 15 Elements

• Nitrogen (N): Being a second-period element, nitrogen has the valence electronic configuration $2s^2\ 2p^3$. It lacks vacant d-orbitals in its valence shell.

• Heavier Elements: Phosphorus (P), Arsenic (As), and Antimony (Sb) have vacant d-orbitals in their valence shells ($n \geq 3$), which allows them to expand their octet and participate in d-orbital bonding.

• Pi (π) Bonding: The type of π-bonding (pπ-pπ, pπ-dπ, or dπ-dπ) depends on the availability and size of the orbitals on the bonding atoms.

EXPLANATION:

• Bonding with Transition Metals: Triethylphosphine (P(C2H5)3) and Triphenylarsine (As(C6H5)3) can act as ligands that form dπ-dπ bonds. This occurs when filled d-orbitals of a transition metal overlap with the vacant d-orbitals of Phosphorus or Arsenic (back-bonding).

• Inability of Nitrogen to form dπ Bonds: Because nitrogen does not possess d-orbitals, it is physically impossible for it to form dπ-pπ bonds. In oxides of nitrogen (such as NO2 or NO3^-), any π-bonding that occurs is of the pπ-pπ type.

• Multiple Bonds in Nitrogen: Nitrogen is small enough to allow for effective lateral overlap of its p-orbitals, enabling it to form strong pπ-pπ multiple bonds with itself, as seen in the diatomic N2 molecule.

• Catenation Property: Catenation is the ability of atoms of the same element to form chains or rings. Phosphorus (P4), arsenic, and antimony show this property significantly, whereas nitrogen shows it only to a very limited extent.

Therefore, the statement that Nitrogen can form dπ-pπ bonds with oxygen is incorrect.

Q68. Answer: (d) pink to colourless

CONCEPT:

Acid-Base Indicators (Phenolphthalein)

• Indicators are chemical substances that change color depending on the pH of the medium.

• Phenolphthalein is a synthetic indicator that is widely used in acid-base titrations, especially those involving strong bases.

• It has a pH range of approximately 8.2 to 10.0:

• In acidic and neutral solutions (pH < 8.2), phenolphthalein is colorless.

• In alkaline/basic solutions (pH > 8.2), phenolphthalein turns pink or pinkish-red.

EXPLANATION:

• In the given titration:

• Sodium hydroxide (NaOH) is a strong base.

• Oxalic acid (H2C2O4) is a weak organic acid.

• The phrase 'titration of sodium hydroxide against a standard solution of oxalic acid' indicates that the sodium hydroxide solution is being analyzed (placed in the conical flask) and the oxalic acid is the titrant (placed in the burette).

• Since the sodium hydroxide solution is in the conical flask, the initial medium is alkaline.

• When phenolphthalein is added to the sodium hydroxide solution, it turns pink.

• As the standard oxalic acid is added from the burette, the hydroxide ions (OH^-) are neutralized by the hydrogen ions (H^+) from the acid.

• At the equivalence point, the base is completely neutralized. As the pH drops below the indicator's transition range (approximately 8.2), the solution becomes colorless.

• Therefore, the color change observed at the endpoint is from pink to colorless.

The correct observation for the color change during this titration is pink to colourless.

Q69. Answer: (a) A - IV, B - I, C - III, D - II

CONCEPT:

• Sigma (σ) Bond: A covalent bond formed by the head-on overlap of atomic orbitals. All single bonds are σ bonds.

• Pi (π) Bond: A covalent bond formed by the lateral overlap of atomic orbitals. A double bond contains one σ and one π bond, while a triple bond contains one σ and two π bonds.

• Lone Pair: A pair of valence electrons that are not shared with another atom in a covalent bond.

EXPLANATION:

• A. C2H4 (Ethene):

• The Lewis structure is H2C=CH2.

• There are 4 C-H single bonds (4 σ bonds) and 1 C=C double bond (1 σ and 1 π bond).

• Total: 5 σ bonds and 1 π bond. This matches with IV.

• B. C2H2 (Ethyne):

• The Lewis structure is HC≡CH.

• There are 2 C-H single bonds (2 σ bonds) and 1 C≡C triple bond (1 σ and 2 π bonds).

• Total: 3 σ bonds and 2 π bonds. This matches with I.

• C. CH4 (Methane):

• The Lewis structure consists of a central carbon atom bonded to four hydrogen atoms by single bonds.

• Total: 4 σ bonds. This matches with III.

• D. NH3 (Ammonia):

• The nitrogen atom forms three single bonds with three hydrogen atoms (3 σ bonds).

• Nitrogen has 5 valence electrons, 3 are used for bonding, leaving 2 electrons as 1 lone pair.

• Total: 3 σ bonds and 1 lone pair. This matches with II.

Matching the pairs: A-IV, B-I, C-III, D-II.

Q70. Answer: (b) 300 J

CONCEPT:

First Law of Thermodynamics

• The First Law of Thermodynamics states that the change in the internal energy (ΔU) of a system is equal to the heat (q) added to the system plus the work (w) done on the system.

• The mathematical expression is:

ΔU = q + w

• Sign Conventions:

• Heat (q): Positive (+) if heat is absorbed by the system, negative (−) if heat is released by the system.

• Work (w): Positive (+) if work is done on the system (compression), negative (−) if work is done by the system (expansion).

EXPLANATION:

• According to the problem:

• Heat absorbed by the system (q) = +500 J

• Work done by the system (w) = -200 J (Since work is done by the system, the sign is negative according to IUPAC convention).

• Using the First Law of Thermodynamics formula:

• ΔU = q + w

• ΔU = 500 J + (-200 J)

• ΔU = 500 J - 200 J

• ΔU = 300 J

Therefore, the change in internal energy of the system is 300 J.

Q71. Answer: (a) CO and H2

CONCEPT:

Steam Reforming of Methane

• Steam reforming is the process by which hydrocarbons like methane react with steam at high temperatures in the presence of a catalyst to produce dihydrogen.

• This reaction is used industrially for the large-scale production of hydrogen gas and synthesis gas (syngas).

EXPLANATION:

• The balanced chemical equation for the reaction of methane with steam is:

CH4(g) + H2O(g) → CO(g) + 3H2(g)

• Reactants: Methane (CH4) and Steam (H2O).

• Conditions: Temperature of 1273 K and a Nickel (Ni) catalyst.

• Products: Carbon monoxide (CO) and Hydrogen gas (H2).

• Methane reacts with steam at 1273 K using Nickel as a catalyst to yield a mixture of carbon monoxide and hydrogen gas.

• The resulting mixture of CO and H2 is often called synthesis gas or water gas.

Therefore, methane reacts with steam at 1273 K in the presence of nickel catalyst to form CO and H2.

Q72. Answer: (b) [figure]

CONCEPT:

Identification of Aldehyde and Ketone Compounds

• 2,4-DNP reagent gives a red-orange precipitate with aldehydes and ketones due to the presence of the carbonyl group (>C=O).

• Fehling's reagent is reduced by aliphatic aldehydes, but aromatic ketones do not reduce Fehling's solution.

• Strong oxidation of alkyl side chains attached to a benzene ring converts them into carboxylic acid groups.

• Carboxylic acids react with aqueous NaHCO3 to produce brisk effervescence due to the evolution of CO2 gas.

EXPLANATION:

• Therefore, compound P is acetophenone and compound Q is benzoic acid.

Q73. Answer: (d) 0.2938 g

CONCEPT:

Faraday's First Law of Electrolysis

• The mass (m) of a substance deposited or liberated at any electrode is directly proportional to the quantity of electricity (Q) passed through the electrolyte.

• It is mathematically expressed as:

m = Z × Q = Z × I × t

• The formula to calculate the mass of a substance deposited is:

m = (M × I × t) / (n × F)

• m = mass of the substance deposited (in grams)

• M = molar mass of the substance (in g mol^(-1))

• I = current (in amperes)

• t = time (in seconds)

• n = number of electrons involved in the redox reaction (valency)

• F = Faraday constant (approximately 96487 C mol^(-1))

EXPLANATION:

• Step 1: Identify the given values

• Current (I) = 1.5 A

• Time (t) = 10 minutes = 10 × 60 seconds = 600 s

• Molar mass of Copper (M) = 63 g mol^(-1)

• Faraday constant (F) = 96487 C mol^(-1)

• Step 2: Determine the number of electrons (n)

• The electrolysis of copper sulphate (CuSO4) involves the reduction of Cu^(2+) ions at the cathode:

• Cu^(2+)(aq) + 2e^- → Cu(s)

• Therefore, the number of electrons involved, n = 2.

• Step 3: Calculate the mass deposited

• Using the formula: m = (M × I × t) / (n × F)

• m = (63 × 1.5 × 600) / (2 × 96487)

• m = 56700 / 192974

• m ≈ 0.2938 g

Therefore, the mass of copper deposited at the cathode is 0.2938 g.

Q74. Answer: (a) Phenolic

CONCEPT:

Phthalein Dye Test

• The phthalein dye test is a qualitative chemical analysis used to identify the presence of a phenolic functional group in an organic compound.

• It involves a condensation reaction between a phenol and phthalic anhydride in the presence of a dehydrating agent.

EXPLANATION:

• When a phenolic compound is heated with phthalic anhydride and a few drops of concentrated sulfuric acid (H2SO4), it undergoes condensation to form a phthalein derivative.

• For example, when phenol itself reacts with phthalic anhydride, it forms phenolphthalein.

• The reaction can be represented as:

Phenol + Phthalic Anhydride → Phenolphthalein + H2O

• Upon adding dilute sodium hydroxide (NaOH) to the reaction product, a characteristic color is produced due to the formation of a sodium salt with a highly conjugated system.

• Phenol produces a pink/red color.

• Resorcinol produces a green fluorescence (due to the formation of fluorescein).

• Alcohols, aldehydes, and carboxylic acids do not produce these specific colored dyes when subjected to these reaction conditions.

Therefore, the functional group that can be identified through the phthalein dye test is phenolic.

Q75. Answer: (c) DNA possesses a double strand helix structure and contains thymine as one of the four bases.

CONCEPT:

Secondary Structure of Nucleic Acids

• DNA (Deoxyribonucleic Acid): The secondary structure of DNA is a double-stranded helix. Two polynucleotide chains are coiled around each other and held together by hydrogen bonds between specific base pairs. DNA contains four nitrogenous bases: Adenine (A), Guanine (G), Cytosine (C), and Thymine (T).

• RNA (Ribonucleic Acid): The secondary structure of RNA typically consists of a single polynucleotide strand (single-stranded helix). RNA contains four nitrogenous bases: Adenine (A), Guanine (G), Cytosine (C), and Uracil (U).

EXPLANATION:

• Analyzing the structural differences:

• DNA is double-stranded and contains the base thymine.

• RNA is single-stranded and contains the base uracil instead of thymine.

• Reviewing the characteristics:

• The statement that DNA possesses a double strand helix structure and contains thymine as one of the four bases is correct.

• The description of DNA as a single-stranded helix is incorrect.

• The description of RNA as having thymine is incorrect because RNA contains uracil.

• The description of RNA as a double strand helix is generally incorrect for its standard secondary structure.

Therefore, the correct statement is that DNA possesses a double strand helix structure and contains thymine as one of the four bases.

Q76. Answer: (b) A, B and C only

CONCEPT:

• Molality (m): It is defined as the number of moles of solute per kilogram (kg) of the solvent.

Molality (m) = (Mass of solute / Molar mass of solute) / Mass of solvent in kg

• Molarity (M): It is defined as the number of moles of solute per litre of the solution.

Molarity (M) = (Mass of solute / Molar mass of solute) / Volume of solution in L

• Henry Law and Gas Solubility:

• The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid. Therefore, solubility increases with an increase in pressure.

• The solubility of gases in liquids typically decreases as the temperature increases. This makes cold water richer in dissolved oxygen compared to warm water.

• Mole Fraction (χ): For a binary mixture of A and B, the mole fraction of component B is the ratio of moles of B to the total moles in the solution.

χ_B = n_B / (n_A + n_B)

EXPLANATION:

• Statement A:

• Mass of ethanoic acid = 2.5 g, Molar mass = 60 g mol^(-1)

• Moles of ethanoic acid = 2.5 / 60 = 0.04167 mol

• Mass of benzene (solvent) = 75 g = 0.075 kg

• Molality = 0.04167 mol / 0.075 kg = 0.556 m

• Therefore, statement A is correct.

• Statement B:

• Mass of NaOH = 5 g, Molar mass = 40 g mol^(-1)

• Moles of NaOH = 5 / 40 = 0.125 mol

• Volume of solution = 450 mL = 0.450 L

• Molarity = 0.125 mol / 0.450 L = 0.278 M

• Therefore, statement B is correct.

• Statement C: Solubility of oxygen in water increases as the temperature decreases. Because cold water holds more dissolved oxygen, aquatic species are more comfortable in it. Therefore, statement C is correct.

• Statement D: According to Henry Law, the solubility of a gas increases with an increase in pressure. Statement D is incorrect.

• Statement E: The mole fraction of B is χ_B = n_B / (n_A + n_B). The given formula χ_B = n_A / (n_A + n_B) actually defines the mole fraction of component A. Therefore, statement E is incorrect.

Based on the above analysis, the correct statements are A, B and C only.

Q77. Answer: (a) formation of hydrogen bonding between acetone and chloroform.

CONCEPT:

Negative Deviation from Raoult's Law

• A non-ideal solution shows a negative deviation from Raoult's law when the vapor pressure of the mixture is lower than the value calculated using Raoult's law.

• This behavior occurs when the intermolecular attractive forces between the different components (A-B interactions) are stronger than the forces between the like molecules (A-A and B-B interactions).

• Stronger A-B interactions lead to a decrease in the escaping tendency of the molecules into the vapor phase.

EXPLANATION:

• Chloroform (CHCl3) and acetone (CH3COCH3) molecules exhibit specific interactions when mixed.

• The hydrogen atom in chloroform is bonded to a carbon atom that is attached to three highly electronegative chlorine atoms. This makes the hydrogen atom electron-deficient (acidic).

• The acetone molecule contains a carbonyl oxygen (C=O) with lone pairs of electrons.

• When these two substances are mixed, a hydrogen bond is formed between the hydrogen atom of chloroform and the oxygen atom of acetone.

• The formation of this hydrogen bond represents a stronger intermolecular attraction (A-B) compared to the dipole-dipole interactions found in pure chloroform (A-A) or pure acetone (B-B).

• Because the molecules are held more strongly together in the mixture, fewer molecules escape to the vapor phase, resulting in a lower vapor pressure and thus a negative deviation from Raoult's law.

Therefore, the mixture of chloroform and acetone shows negative deviation from Raoult's law due to the formation of hydrogen bonding between acetone and chloroform.

Q78. Answer: (c) 4

CONCEPT:

Henderson-Hasselbalch Equation

• For an acidic buffer solution, the pH is calculated using the Henderson-Hasselbalch equation:

pH = pK_a + log([Conjugate Base] / [Acid])

• The relationship between the acid dissociation constant (K_a) and the base dissociation constant (K_b) for a conjugate acid-base pair is:

K_a × K_b = K_w

where K_w is the ionic product of water, which is 10^(-14) at 298 K.

EXPLANATION:

• Given data:

• K_b for X^- = 10^(-10)

• Concentration of salt [X^-] = Concentration of acid [HX]

• Temperature = 298 K

• Step 1: Find the value of K_a for HX:

• K_a = K_w / K_b
• K_a = 10^(-14) / 10^(-10)
• K_a = 10^(-4)
• Step 2: Calculate the pK_a value:
• pK_a = -log(K_a)
• pK_a = -log(10^(-4))
• pK_a = 4
• Step 3: Calculate the pH of the buffer using the Henderson-Hasselbalch equation:
• pH = pK_a + log([X^-] / [HX])
• Since [X^-] = [HX], the ratio [X^-] / [HX] = 1.
• pH = 4 + log(1)
• Since log(1) = 0:
• pH = 4 + 0
• pH = 4

Therefore, the pH of the buffer solution is 4.

Q79. Answer: (b) The largest and the smallest species among Mg, Mg^(2+), Al and Al^(3+) are Al and Mg^(2+), respectively.

CONCEPT:

• IUPAC Nomenclature of Elements: Elements with atomic numbers greater than 100 are named systematically using roots for each digit: 1 (un), 0 (nil), and 7 (sept), ending with the suffix 'ium'.
• Atomic and Ionic Radii Trends:
• In a period, the atomic radius generally decreases from left to right due to the increasing effective nuclear charge.
• For isoelectronic species (atoms or ions with the same number of electrons), the radius decreases as the atomic number increases because the nucleus exerts a stronger pull on the same number of electrons.
• Cations are always smaller than their parent neutral atoms due to the loss of an electron shell or increased effective nuclear charge.
• Diagonal Relationship: This refers to the similarity in chemical properties between certain elements of the second period and the elements of the third period placed diagonally to them, such as Lithium (Li) and Magnesium (Mg).
• Oxidation State and Covalency: The oxidation state is the charge assigned to an atom in a compound, while the covalency in coordination complexes typically refers to the coordination number (the number of ligand donor atoms bonded to the central metal).

EXPLANATION:

• Naming of Element 107: Using IUPAC roots, 1 is 'un', 0 is 'nil', and 7 is 'sept'. Combining these gives Un + nil + sept + ium = Unnilseptium. This statement is correct.
• Comparison of Sizes:
• Between Mg (Z=12) and Al (Z=13), both are in the third period. Since atomic size decreases across the period, Mg is larger than Al.
• Between Mg^(2+) and Al^(3+), both are isoelectronic with 10 electrons. Al^(3+) has a higher nuclear charge (+13) compared to Mg^(2+) (+12), making Al^(3+) the smaller ion.
• Neutral atoms are larger than their corresponding cations. Therefore, the overall size order is Mg > Al > Mg^(2+) > Al^(3+).
• The largest species is Mg and the smallest is Al^(3+). The statement identifying Al as the largest and Mg^(2+) as the smallest is incorrect.
• Diagonal Relationship: Li and Mg show similar properties such as the formation of nitrides and the thermal instability of their carbonates because they have similar ionic sizes and polarizing power. This statement is correct.
• Aluminum Complex: In [AlCl(H2O)5]^(2+) :
• The oxidation state of Al (x) is calculated as: x + (-1) + 5(0) = +2 => x = +3.
• The coordination number (covalency) is the total number of ligands, which is 1 (Cl^-) + 5 (H2O) = 6. This statement is correct.

Therefore, the incorrect statement is that the largest and smallest species among the given group are Al and Mg^(2+), respectively.

Q80. Answer: (a) P < Si < Be < Mg < Na

CONCEPT:

• Metallic Character: It refers to the ease with which an atom can lose its valence electrons to form positive ions (cations).
• Periodic Trends:

• Across a Period (Left to Right): Metallic character decreases because the effective nuclear charge increases, pulling the electrons closer to the nucleus and making them harder to remove.

• Down a Group (Top to Bottom): Metallic character increases because the atomic size increases and the valence electrons are farther from the nucleus, making them easier to remove.

EXPLANATION:

• Identify the positions of the given elements in the periodic table:

• Na (Sodium): Group 1, Period 3

• Mg (Magnesium): Group 2, Period 3

• Be (Beryllium): Group 2, Period 2

• Si (Silicon): Group 14, Period 3

• P (Phosphorus): Group 15, Period 3

• Comparing Period 3 elements (Na, Mg, Si, P):

• Metallic character decreases from Group 1 to Group 15.

• Order: Na > Mg > Si > P.

• Comparing Group 2 elements (Be, Mg):

• Metallic character increases down the group.

• Order: Mg > Be.

• Relative Metallic Nature:

• P is a non-metal (least metallic).

• Si is a metalloid (more metallic than P).

• Be is a group 2 metal. Although it is in Period 2, it is more metallic than the metalloid Si.

• Mg is below Be in Group 2, so it is more metallic than Be.

• Na is to the left of Mg in Period 3, so it is the most metallic.

• Combining the trends, the increasing order of metallic character is:

P < Si < Be < Mg < Na

Therefore, the correct order is P < Si < Be < Mg < Na.

Q81. Answer: (c) 3-ethyl-5-methylheptane

CONCEPT:

IUPAC Rules for Naming Alkanes:

• Longest Chain Rule: The parent structure is the longest continuous chain of carbon atoms.

• Lowest Locant Rule: The principal chain is numbered from the end that gives the lowest possible locants (position numbers) to the substituents.

• Alphabetical Order Rule: If two different substituents are present at equivalent positions from either end of the chain, the numbering is done such that the substituent that comes first alphabetically is assigned the lower number.

EXPLANATION:

• Identification of the longest chain:

In the given compound, if we select the horizontal chain, it contains 6 carbon atoms (hexane). However, by including the carbons of the ethyl groups, a longer chain of 7 carbon atoms (heptane) can be identified.

• Identifying substituents:

When the 7-carbon chain is selected as the parent chain, the groups remaining outside the chain are a methyl group (-CH3) and an ethyl group (-CH2CH3).

• • Assembling the name:

Combining the locants, substituent names, and the parent chain name (heptane) gives: 3-ethyl-5-methylheptane.

Therefore, the correct IUPAC name of the compound is 3-ethyl-5-methylheptane.

Q82. Answer: (d) A - III, B - I, C - IV, D - II

CONCEPT:

Coordination Polyhedron and Geometry

• The spatial arrangement of the ligand atoms which are directly attached to the central atom/ion defines a coordination polyhedron about the central atom.

• The most common coordination polyhedra are octahedral, square planar, tetrahedral, and trigonal bipyramidal.

• The geometry is determined by the coordination number (CN) and the hybridization of the central metal ion:

YourMockTest.com – Free Study Material

• CN = 4: Tetrahedral (sp^3) or Square planar (dsp^2).
• CN = 5: Trigonal bipyramidal (dsp^3).
• CN = 6: Octahedral (d^2sp^3 or sp^3d^2).
EXPLANATION:
• A. [Pt(Cl2)(NH3)2]:
• Central metal: Pt^(2+) (d^8 configuration).
• Coordination number: 4.
• For Platinum(II) complexes, the crystal field stabilization energy is very high, making 4-coordinate Pt(II) complexes almost exclusively square planar (III).
• B. [Co(NH3)6]Cl3:
• Central metal: Co^(3+) (d^6 configuration).
• Coordination number: 6.
• A coordination number of 6 corresponds to an octahedral geometry (I).
• C. [NiCl4]^(2-):
• Central metal: Ni^(2+) (d^8 configuration).
• Coordination number: 4.
• Cl^- is a weak field ligand, resulting in sp^3 hybridization and a tetrahedral geometry (IV).
• D. [Fe(CO)5]:
• Central metal: Fe^0 (d^8 configuration after electron pairing).
• Coordination number: 5.
• A coordination number of 5 for d^8 systems with strong field ligands like CO leads to a trigonal bipyramidal geometry (II).
Based on the above analysis, the correct matching is: A - III, B - I, C - IV, D - II.

Q83. Answer: (a) 0

CONCEPT:
Integrated Rate Laws
• The order of a reaction is determined by the relationship between the concentration of reactants and time.
• For a zero-order reaction, the rate of reaction is independent of the concentration of reactants. The integrated rate equation is:
[R]=−kt+[R]0[R]=−kt+[R]0[R]=−kt+[R]0
where [R][R][R]
is the concentration at time ttt
, kkk
is the rate constant, and [R]0[R]0[R]0
is the initial concentration.
• For a first-order reaction, the integrated rate equation is:
ln[R]=−kt+ln[R]0ln[R]=−kt+ln[R]0ln?[R]=−kt+ln?[R]0
EXPLANATION:
• The given plot is concentration [R][R][R]
versus time ttt
.
• From the zero-order integrated rate equation:
[R]=−kt+[R]0[R]=−kt+[R]0[R]=−kt+[R]0
• This equation is in the form of a straight line, y=mx+cy=mx+cy=mx+c
, where:
• y=[R]y=[R]y=[R]
• x=tx=tx=t
• m=−km=−km=−k
(Slope)
• c=[R]0c=[R]0c=[R]0
(Intercept)
• Since the graph of [R][R][R]
vs ttt

is a straight line with a negative slope (equal to −k−k−k

), the reaction must be of zero order.

• In contrast, for a first-order reaction, a plot of ln[R]ln[R]ln?[R]

vs ttt

would be linear, and for a second-order reaction, a plot of 1/[R]1/[R]1/[R]

vs ttt

would be linear.

Therefore, the order of the reaction is 0.

Q84. Answer: (d) Thiocyanate

CONCEPT:

Ambidentate Ligands

• Ligands that possess more than one donor atom but coordinate to the central metal atom or ion through only one of those donor atoms at a time are called ambidentate ligands.

• Common examples include the thiocyanate ion (SCN^-), the nitrite ion (NO2^-), and the cyanide ion (CN^-).

EXPLANATION:

• Thiocyanate (SCN^-): This ligand has two potential donor atoms: Sulfur (S) and Nitrogen (N). It can coordinate to the metal ion through the sulfur atom (M-SCN, known as thiocyanato) or through the nitrogen atom (M-NCS, known as isothiocyanato). Because it has two different ways to bind, it is an ambidentate ligand.

• Ethylenediaminetetraacetate ion (EDTA): This is a hexadentate ligand. It coordinates to a metal ion through six donor atoms (two nitrogen atoms and four oxygen atoms) simultaneously, forming a stable chelate complex.

• Oxalate (C2O4^(2-)): This is a bidentate ligand. it coordinates to the central metal ion through two oxygen atoms at the same time.

• Ethane-1,2-diamine (en): This is also a bidentate ligand, coordinating to the central metal ion through two nitrogen atoms simultaneously.

Therefore, Thiocyanate is an ambidentate ligand.

Q85. Answer: (b) +0.63568 kJ mol-1, non-spontaneous

CONCEPT:

• The relationship between the standard enthalpy change (ΔH°) and the standard internal energy change (ΔU°) for a gaseous reaction is given by:

ΔH° = ΔU° + Δn_gRT

• The standard Gibbs free energy change (ΔG°) is related to ΔH° and ΔS° by the Gibbs-Helmholtz equation:

ΔG° = ΔH° - TΔS°

• Spontaneity Criteria:

• If ΔG° < 0, the reaction is spontaneous.

• If ΔG° > 0, the reaction is non-spontaneous.

• If ΔG° = 0, the reaction is at equilibrium.

EXPLANATION:

• For the given reaction:

2A(g) + B(g) → 2D(g)

• Δn_g = (moles of gaseous products) - (moles of gaseous reactants)

• Δn_g = 2 - (2 + 1) = 2 - 3 = -1

• Given values:

• ΔU° = -10 kJ mol^(-1) = -10,000 J mol^(-1)

• ΔS° = -44 J K^(-1) mol^(-1)

• T = 298 K

• R = 8.31 J mol^(-1) K^(-1)

• Step 1: Calculate the standard enthalpy change (ΔH°):

ΔH° = ΔU° + Δn_gRT

ΔH° = -10,000 J mol^(-1) + [(-1) × 8.31 J mol^(-1) K^(-1) × 298 K]

ΔH° = -10,000 - 2476.38

ΔH° = -12,476.38 J mol^(-1)

• Step 2: Calculate the standard Gibbs free energy change (ΔG°):

ΔG° = ΔH° - TΔS°

ΔG° = -12,476.38 J mol^(-1) - [298 K × (-44 J K^(-1) mol^(-1))]

ΔG° = -12,476.38 + 13,112

ΔG° = +635.62 J mol^(-1)

ΔG° = +0.63562 kJ mol^(-1) ≈ +0.63568 kJ mol^(-1)

• Since ΔG° is positive (+0.63568 kJ mol^(-1)), the reaction is non-spontaneous at 298 K.

Therefore, the standard Gibbs free energy change (ΔG°) for the reaction is +0.63568 kJ mol^(-1) and the reaction is non-spontaneous.

Q86. Answer: (b) 0, +1, -1

CONCEPT:

Formal Charge

• Formal charge is the theoretical charge assigned to an atom in a molecule, assuming that electrons in all chemical bonds are shared equally between atoms, regardless of relative electronegativity.

• The formal charge (FC) of an atom in a Lewis structure can be calculated using the following formula:

FC = [V] - [L] - [B/2]

Where:

• V = Number of valence electrons of the atom in its ground state.

• L = Number of non-bonding (lone pair) electrons.

• B = Number of bonding (shared) electrons.

EXPLANATION:

• In the Lewis structure of the ozone (O3) molecule, there are three oxygen atoms. For any oxygen atom, the number of valence electrons (V) is 6.

• Based on the numbering in the structure:

• For Oxygen atom 2 (Double-bonded oxygen):

• Number of lone pair electrons (L) = 4 (2 lone pairs)

• Number of bonding electrons (B) = 4 (from 1 double bond)

• FC = 6 - 4 - (4/2) = 6 - 4 - 2 = 0

• For Oxygen atom 1 (Central oxygen):

• Number of lone pair electrons (L) = 2 (1 lone pair)

• Number of bonding electrons (B) = 6 (from 1 double bond and 1 single bond)

• FC = 6 - 2 - (6/2) = 6 - 2 - 3 = +1

• For Oxygen atom 3 (Single-bonded oxygen):

• Number of lone pair electrons (L) = 6 (3 lone pairs)

• Number of bonding electrons (B) = 2 (from 1 single bond)

• FC = 6 - 6 - (2/2) = 6 - 6 - 1 = -1

• The formal charges on atoms 2, 1, and 3 are 0, +1, and -1 respectively.

Therefore, the correct formal charges on oxygen atoms numbered 2, 1 and 3 respectively are 0, +1, -1.

Q87. Answer: (c) N2 (g) + 3H2 (g) <=> 2NH3 (g)

CONCEPT:

Relationship between K_p and K_c

• The equilibrium constant in terms of partial pressure (K_p) and the equilibrium constant in terms of molar concentration (K_c) are related by the following equation:

K_p = K_c(RT)^(Δng)

• Where:

• R is the universal gas constant.

• T is the absolute temperature (in Kelvin).

• Δn_g is the change in the number of moles of gaseous species, calculated as:

Δn_g = (Sum of stoichiometric coefficients of gaseous products) - (Sum of stoichiometric coefficients of gaseous reactants)

• From the equation, we can conclude that:

• If Δn_g = 0, then K_p = K_c.

• If Δn_g ≠ 0, then K_p ≠ K_c.

EXPLANATION:

• To identify the reaction where K_p ≠ K_c, we must calculate Δn_g for each reaction:

• For H2(g) + I2(g) <=> 2HI(g):

Δn_g = 2 - (1 + 1) = 2 - 2 = 0. Thus, K_p = K_c.

• For N2(g) + O2(g) <=> 2NO(g):

Δn_g = 2 - (1 + 1) = 2 - 2 = 0. Thus, K_p = K_c.

• For N2(g) + 3H2(g) <=> 2NH3(g):

Δn_g = 2 - (1 + 3) = 2 - 4 = -2. Since Δn_g ≠ 0, K_p ≠ K_c.

• For H2O(g) + CO(g) <=> H2(g) + CO2(g):

Δn_g = (1 + 1) - (1 + 1) = 2 - 2 = 0. Thus, K_p = K_c.

Therefore, the reaction for which K_p ≠ K_c is N2(g) + 3H2(g) <=> 2NH3(g).

Q88. Answer: (d) 24.84

CONCEPT:

Arrhenius Equation

• The temperature dependence of the rate constant (k) for a reaction is given by the Arrhenius equation:

k = A e^(−Ea/RT)

• Taking the natural logarithm (ln) on both sides of the equation, we get the linear form:

ln k = ln A − E_a / (RT)

• Where:

• k is the rate constant.

• A is the pre-exponential factor or frequency factor.

• E_a is the activation energy of the reaction.

• R is the universal gas constant (1.987 cal mol^(−1) K^(−1)).

• T is the absolute temperature in Kelvin.

EXPLANATION:

• Given the expression for the first-order reaction:

ln k = 14.34 − (1.25 × 10^4) / T

• Comparing this expression with the standard logarithmic form of the Arrhenius equation:

ln k = ln A − E_a / (RT)

• By comparing the terms that include temperature (T), we can establish the following relationship:

E_a / R = 1.25 × 10^4

• Rearranging to solve for the activation energy (E_a):

E_a = 1.25 × 10^4 × R

• Substituting the given value of R = 1.987 cal mol^(−1) K^(−1):

E_a = 1.25 × 10^4 × 1.987

E_a = 12500 × 1.987

E_a = 24837.5 cal mol^(−1)

• To find the activation energy in kcal mol^(−1), we divide the value by 1000:

E_a = 24837.5 / 1000 kcal mol^(−1)

E_a = 24.8375 kcal mol^(−1)

• Rounding the result to two decimal places, we get approximately 24.84 kcal mol^(−1).

Therefore, the energy of activation for the reaction is 24.84 kcal mol^(−1).

Q89. Answer: (d) X = AgCN; Z = C2H5NC

CONCEPT:

Formation of Cyanides and Isocyanides

• Alkyl halides react with KCN to form alkyl cyanides (R−CN).

• Alkyl halides react with AgCN to form alkyl isocyanides (R−NC).

• Isocyanides have a very unpleasant foul smell.

• Primary amines on heating with chloroform and alcoholic KOH give isocyanides through the carbylamine reaction.

YourMockTest.com – Free Study Material

EXPLANATION:

• In the first reaction:

C2H5Cl + AgCN → C2H5NC

• Silver cyanide is mainly covalent, so the nucleophilic attack occurs through nitrogen, producing an isocyanide.

• The product formed is:

C2H5NC

Ethyl isocyanide

• Therefore, reagent X is:

AgCN

• In the second reaction, propanamide undergoes Hofmann bromamide degradation:

C2H5CONH2 &xrightarrow{Br_{2}/NaOH} C2H5NH2

• The primary amine formed reacts with CHCl3 and alcoholic KOH on heating:

C2H5NH2 &xrightarrow[Δ]{CHCl_{3}/alc.\ KOH} C2H5NC

• This is the carbylamine reaction which produces foul smelling isocyanides.

• Thus, the foul smelling product Z is:

C2H5NC

Therefore, X = AgCN and Z = C2H5NC.

Q90. Answer: (c) A - III, B - I, C - IV, D - II

CONCEPT:

Isomerism in Coordination Compounds:

• Geometrical Isomerism: This type of isomerism arises in heteroleptic complexes due to different possible geometric arrangements of the ligands around the central metal atom. Common in square planar and octahedral complexes.

• Optical Isomerism: This occurs when the complex molecules are non-superimposable mirror images of each other. These are called enantiomers and are typical in octahedral complexes containing didentate ligands.

• Linkage Isomerism: This arises in coordination compounds containing ambidentate ligands (ligands that can bind through more than one donor atom, such as NO2^- or SCN^-).

• Solvate (Hydrate) Isomerism: This is a form of structural isomerism where the solvent molecule (typically water) can act as either a ligand within the coordination sphere or as a molecule of crystallization outside the sphere.

EXPLANATION:

• A. [Pt(NH3)2Cl2]:

• This is a square planar complex of the type MA2B2.

• It exhibits Geometrical isomerism as the two chlorine ligands can be adjacent to each other (cis-isomer) or opposite to each other (trans-isomer).

• Match: A - III

• B. [Co(en)3]^(3+):

• This octahedral complex contains three bidentate ethylenediamine (en) ligands.

• Due to the arrangement of the chelate rings, it lacks a plane of symmetry and forms non-superimposable mirror images (dextro and laevo forms). Thus, it exhibits Optical isomerism.

• Match: B - I

• C. [Co(NH3)5NO2]Cl2:

• The NO2^- ligand is an ambidentate ligand.

• It can bind to the cobalt atom via the nitrogen atom (-NO2, nitro) or the oxygen atom (-ONO, nitrito), leading to Linkage isomerism.

• Match: C - IV

• D. [Cr(H2O)6]Cl3:

• This complex involves water as the ligand.

• It can exhibit Solvate isomerism where water molecules can be replaced by chloride ions within the coordination sphere (e.g., [Cr(H2O)5Cl]Cl2·H2O).

• Match: D - II

By matching the lists, we get: A - III, B - I, C - IV, D - II.

YourMockTest.com — Free Study Material

Q91. Answer: (b) Habitat loss and fragmentation; over-exploitation; Alien species invasions; Co-extinctions

The correct answer is - Habitat loss and fragmentation; over-exploitation; Alien species invasions; Co-extinctions

Key Points

• Habitat loss and fragmentation

• Occurs when large natural habitats are divided into smaller fragments by human activities like urbanization and deforestation.

• Leads to the isolation of species populations, reducing their ability to survive and reproduce.

• Over-exploitation

• Involves excessive hunting, fishing, or harvesting of species, which disrupts ecological balance.

• Example: Overfishing leading to the collapse of marine ecosystems.

• Alien species invasions

• Occurs when non-native species are introduced to an area, often outcompeting native species for resources.

• Example: Invasive plants like Lantana and water hyacinth disrupt native ecosystems.

• Co-extinctions

• Happens when the extinction of one species leads to the extinction of another dependent species.

• Example: The extinction of a host plant can lead to the extinction of its pollinator species.

Additional Information

• The "Evil Quartet"

• The term was introduced by biologists to describe the four major causes of biodiversity loss.

• These factors often interact, amplifying their negative effects on ecosystems.

• Importance of biodiversity

• Biodiversity ensures ecosystem stability by supporting processes like pollination, nutrient cycling, and climate regulation.

• Loss of biodiversity can lead to ecosystem collapse and impact human survival.

• Conservation efforts

• Include habitat restoration, controlling invasive species, and enforcing laws to prevent over-exploitation.

• International agreements like the Convention on Biological Diversity (CBD) aim to protect global biodiversity.

Q92. Answer: (a) Nucleolus

The correct answer is - Nucleolus

Key Points

• Nucleolus

• The nucleolus is a specialized structure within the cell nucleus where ribosomal RNA (rRNA) is synthesized.

• It is the primary site for rRNA transcription, processing, and the initial stages of ribosome assembly.

• Contains specific regions, such as the fibrillar center, where rRNA genes are located, and the dense fibrillar component, where rRNA processing occurs.

• This structure ensures the production of rRNA, which is essential for forming functional ribosomes required for protein synthesis.

Additional Information

• Other cellular components

• Chromatin: Composed of DNA and proteins, it is involved in gene regulation but does not directly synthesize rRNA.

• Centrosome: An organelle involved in organizing microtubules during cell division, not linked to rRNA synthesis.

• Kinetochore: A protein structure on chromosomes involved in chromosome segregation during mitosis, unrelated to rRNA production.

• Significance of rRNA

• rRNA forms the structural and functional core of ribosomes, facilitating the translation of mRNA into proteins.

• rRNA contributes to the catalytic activity of ribosomes, specifically in peptide bond formation.

Q93. Answer: (a) A - II, B - III, C - IV, D - I

The correct answer is - A - II, B - III, C - IV, D - I

Key Points

• G1 phase

• During the G1 phase (Gap 1 phase), the cell is metabolically active and grows continuously.

• However, DNA replication does not occur in this phase.

• S phase

• This is the phase where DNA synthesis occurs, leading to the doubling of DNA content in the cell.

• Chromosome replication takes place, preparing the cell for mitosis.
• G2 phase
• In the G2 phase (Gap 2 phase), the cell continues to grow and synthesizes proteins required for mitosis.
• This phase ensures that the cell is fully prepared for division.
• M phase
• The M phase (Mitotic phase) is where the cell undergoes actual division to form two daughter cells.
• It consists of mitosis (nuclear division) and cytokinesis (cytoplasm division).
Additional Information
• Interphase
• The combination of G1, S, and G2 phases is referred to as interphase, during which the cell prepares for division.
• It accounts for about 90% of the cell cycle.
• Checkpoints in the cell cycle
• Specific checkpoints in the G1, G2, and M phases ensure that the cell is ready to proceed to the next stage.
• These checkpoints verify DNA integrity, proper replication, and readiness for division.
• Cell cycle regulation
• The cell cycle is tightly regulated by proteins such as cyclins and cyclin-dependent kinases (CDKs).
• These proteins ensure proper progression and prevent errors during the cycle.

Q94. Answer: (b) A - III, B - I, C - IV, D - II

The correct answer is - A - III, B - I, C - IV, D - II
Key Points
• Productivity
• Refers to the rate of biomass production in an ecosystem.
• It is categorized as primary productivity (production by autotrophs) and secondary productivity (production by heterotrophs).
• Net Primary Productivity (NPP)
• Defined as Gross Primary Productivity (GPP) minus respiration losses.
• Represents the available organic matter for consumption by herbivores and decomposers.
• Gross Primary Productivity (GPP)
• Refers to the rate of production of organic matter during photosynthesis.
• It is the total energy captured by autotrophs before losses due to respiration.
• Secondary Productivity
• Describes the rate of formation of new organic matter by consumers in an ecosystem.
• It is directly influenced by the efficiency of energy transfer from primary producers to consumers.
Additional Information
• Primary Productivity Types
• Gross Primary Productivity (GPP): The total rate at which solar energy is converted into chemical energy by autotrophs.
• Net Primary Productivity (NPP): The energy remaining after autotrophs have used a portion for respiration.
• Secondary Productivity
• Involves the production of biomass by heterotrophic organisms such as herbivores, carnivores, and decomposers.
• Depends on the energy and nutrient availability in the ecosystem.
• Importance of Productivity
• Critical for understanding energy flow and nutrient cycling in ecosystems.
• Provides insights into ecosystem efficiency and sustainability.

Q95. Answer: (b) A, B and D only

The correct answer is - A, B and D only
Key Points
• Habitat loss
• The Amazon rainforest being cut and cleared for soybean cultivation is a clear example of habitat loss.
• Deforestation disrupts ecosystems and displaces many species dependent on the forest for survival.
• Over-exploitation of species
• Steller's sea cow and passenger pigeon became extinct due to excessive hunting and exploitation by humans.

• Such practices reduce population sizes drastically, leading to extinction.
• Invasive species
• Water hyacinth is a well-known invasive aquatic species.
• It spreads rapidly, choking water bodies and disrupting aquatic ecosystems.

Additional Information

• Incorrect statements
• The Nile perch introduced into Lake Victoria actually led to a decline in cichlid fish populations due to predation, not population growth.
• When a species becomes extinct, the associated plant and animal species are often affected, contrary to statement E.
• Impact of invasive species
• Invasive species like the water hyacinth can outcompete native species for resources.
• They often cause ecological and economic harm by altering ecosystems and reducing biodiversity.
• Human activities and habitat destruction
• Human-induced activities such as deforestation, agriculture, and urbanization are major causes of habitat loss.
• Efforts like afforestation and conservation programs are crucial to mitigate habitat destruction.

Q96. Answer: (b) B, C and E only

The correct answer is - B, C and E only

Key Points

• Proteins are polypeptides
• Proteins are composed of long chains of amino acids, linked by peptide bonds.
• These amino acid chains fold into specific three-dimensional structures, giving proteins their functionality.
• Polysaccharides are long chains of sugars
• Polysaccharides are made of repeated units of monosaccharides, connected by glycosidic bonds.
• Examples include starch, cellulose, and glycogen, which serve as energy storage or structural components.
• Almost all enzymes are proteins
• Enzymes are biological catalysts primarily composed of proteins, although some RNA molecules (ribozymes) also exhibit catalytic activity.
• They accelerate chemical reactions by lowering the activation energy required.

Additional Information

• Incorrect Statements
• Statement A - Lipids are generally not water-soluble. They are hydrophobic molecules and dissolve in nonpolar solvents like chloroform or ether.
• Statement D - Adenine and guanine are purines, not pyrimidines. They are nitrogenous bases found in nucleic acids.
• Enzymes and Biomolecules
• While most enzymes are proteins, some ribozymes (RNA molecules) also act as catalysts in specific biological processes like RNA splicing.
• Proteins, polysaccharides, and lipids play distinct roles in cellular structure and metabolism.

Q97. Answer: (a) 18 ATP and 12 NADPH

The correct answer is - 18 ATP and 12 NADPH

Key Points

• Calvin Cycle
• The Calvin cycle, also known as the C3 pathway, is the process through which plants fix carbon dioxide into glucose.
• Energy Requirement
• To synthesize one molecule of glucose, the Calvin cycle requires 18 ATP and 12 NADPH molecules.
• This energy is used in the reduction phase and regeneration phase of the cycle.
• Six CO_2 Molecules
• The Calvin cycle operates six times to fix six CO_2 molecules, which are needed to produce one glucose molecule ($C_6H_{12}O_6$).

Additional Information

• Phases of the Calvin Cycle
• Carbon Fixation
• CO_2 combines with ribulose-1,5-bisphosphate (RuBP) to form 3-phosphoglycerate (3-PGA).

YourMockTest.com — Free Study Material

• Reduction
• ATP and NADPH are used to convert 3-PGA into glyceraldehyde-3-phosphate (G3P).
• Regeneration
• ATP is utilized to regenerate RuBP from G3P, allowing the cycle to continue.
• Source of ATP and NADPH
• ATP and NADPH are produced during the light-dependent reactions of photosynthesis in the thylakoid membranes.
• Importance of the Calvin Cycle
• The Calvin cycle is essential for converting inorganic carbon into organic compounds, which are used as energy sources by the plant and other organisms.

Q98. Answer: (c) C and D only

The correct answer is - C and D only

Key Points

• Restriction endonucleases
• These enzymes are often referred to as molecular scissors because they can cut DNA molecules at specific sites.
• They play a key role in restricting the growth of foreign DNA, such as bacteriophage DNA, in E. coli and other organisms by recognizing and cleaving specific sequences.
• They recognize palindromic sequences in the DNA but do not necessarily cut only at the center of these sequences. Some enzymes cut at specific points within or near the palindromic site.
• They are endonucleases, meaning they cleave DNA at internal positions, not just at the ends of DNA fragments like exonucleases.
• The statements C ("They cut the DNA only at the center of the palindromic sites") and D ("They remove nucleotides only from the ends of DNA fragments") are incorrect because:
• Restriction endonucleases cut at specific recognition sites, but not necessarily at the center of palindromic sites.
• They do not remove nucleotides from the ends of DNA fragments; this is the role of exonucleases.

Additional Information

• Recognition of palindromic sequences
• Palindromic sequences are DNA sequences that read the same in the 5’ to 3’ direction on both strands, e.g., GAATTC.
• Restriction enzymes such as EcoRI recognize and cut these sequences.
• Types of restriction endonucleases
• There are three main types of restriction enzymes: Type I, Type II, and Type III.
• Type II enzymes are widely used in molecular biology because they cut at specific recognition sites.
• Applications of restriction enzymes
• They are extensively used in genetic engineering and recombinant DNA technology.
• They help in the creation of recombinant plasmids and DNA fragment analysis for research purposes.

Q99. Answer: (c) A - III, B - IV, C - II, D - I

The correct answer is - A - III, B - IV, C - II, D - I

Key Points

• Decomposition (A - III)
• Refers to the breaking down of complex organic matter (dead plants and animals) into simpler inorganic substances.
• Decomposition is carried out by microorganisms like bacteria and fungi.
• Detritus (B - IV)
• Detritus consists of the dead remains of plants and animals, including fecal matter.
• It serves as the primary raw material for decomposition in ecosystems.
• Mineralisation (C - II)
• Mineralisation involves the release of inorganic nutrients into the soil by the activity of microbes.
• This process is essential for nutrient cycling in ecosystems.
• Humification (D - I)
• Humification leads to the accumulation of humus, a dark-colored, amorphous, colloidal organic substance in soil.
• Humus improves soil fertility and water retention capacity.

Additional Information

• Decomposition Process

• Includes two main steps: humification and mineralisation.
• Requires favorable environmental factors like temperature, moisture, and oxygen.
• Importance of Detritus
• Detritus is the starting point for the detritus food chain (DFC), where decomposers and detritivores play a key role.
• It helps in the recycling of nutrients in ecosystems.
• Role of Humus
• Humus is resistant to microbial degradation and remains in the soil for a long time.
• It acts as a reservoir of nutrients and enhances soil texture.

Q100. Answer: (c) Pinus

The correct answer is - Pinus

Key Points

• Pinus is a gymnosperm, and in gymnosperms, the ovules are not enclosed by an ovary wall.
• The ovules in gymnosperms are exposed on the surface of specialized structures called megasporophylls.
• Unlike angiosperms, which have ovules enclosed within an ovary, gymnosperms like Pinus exhibit naked ovules.
• This characteristic is one of the key differences between gymnosperms and angiosperms.

Additional Information

• Angiosperms
• In angiosperms, the ovules are enclosed within an ovary, which later develops into a fruit.
• Examples include plants like Wolffia, which is the world's smallest flowering plant.
• Gymnosperms
• Gymnosperms, such as Pinus, have naked seeds because the ovules are not enclosed by an ovary wall.
• Other examples of gymnosperms include Cycads and Ginkgo.
• Bryophytes and Pteridophytes
• Plants like Selaginella (a pteridophyte) and Funaria (a bryophyte) reproduce using spores, not seeds.
• These groups do not produce ovules or seeds, so the concept of ovary enclosure is not applicable.

Q101. Answer: (c) A - II, B - IV, C - I, D - III

The correct answer is - A - II, B - IV, C - I, D - III

Key Points

• Marginal Placentation
• In this type of placentation, the ovules are attached along the margin of the ovary.
• It is commonly observed in plants like Pea.
• Axile Placentation
• Here, the ovules are attached to a central axis, and the ovary is divided into multiple chambers by septa.
• An example of this type is Lemon.
• Parietal Placentation
• In this type, the ovules develop on the inner wall of the ovary, and there are no partitions within the ovary.
• It is typically seen in plants like Mustard.
• Basal Placentation
• The ovules are attached at the base of the ovary.
• This type of placentation is found in plants like Marigold.

Additional Information

• Placentation
• Placentation refers to the arrangement of ovules within the ovary.
• It plays a critical role in seed development and varies across plant species.
• Types of Placentation
• Free Central: Ovules are attached to a central column without septa (e.g., Dianthus).
• Superficial: Ovules develop over the entire inner surface of the ovary (e.g., Nymphaea).
• Other Examples:
• Marginal: Pea
• Axile: Tomato, Lemon

YourMockTest.com — Free Study Material

• Parietal: Mustard, Argemone

• Basal: Sunflower, Marigold

Q102. Answer: (d) The region of maturation

The correct answer is - The region of maturation

Key Points

• Root hairs are extensions of the epidermal cells, which primarily function to increase the surface area for water and nutrient absorption.

• They are formed in the region of maturation, where epidermal cells differentiate into specialized structures like root hairs.

• The region of maturation is located above the region of elongation, where cells stop elongating and begin to mature into their final functional forms.

• This region also contains fully developed vascular tissues, which help transport water and nutrients absorbed by the root hairs to the rest of the plant.

Additional Information

• Root anatomy

• The root is divided into different regions: root cap, region of meristematic activity, region of elongation, and region of maturation.

• Each region has a specific function:

• Root cap zone: Protects the meristematic tissue as the root grows through the soil.

• Region of meristematic activity: Contains actively dividing cells for root growth.

• Region of elongation: Cells elongate to increase the length of the root.

• Region of maturation: Cells differentiate into specialized types like root hairs.

• Function of root hairs

• Root hairs play a critical role in absorbing water and minerals from the soil.

• They significantly enhance the root's surface area, which is essential for efficient absorption.

Q103. Answer: (b) Large conspicuous nuclei

The correct answer is - Large conspicuous nuclei

Key Points

• Phase of elongation in plant cells

• The phase of elongation is characterized by processes such as cell enlargement, increased vacuolation, and new cell wall deposition.

• Absence of large conspicuous nuclei

• In this phase, the nuclei become less prominent as the cells focus on enlargement and vacuole formation.

• Large and conspicuous nuclei are typically observed in actively dividing cells during the meristematic phase, not the elongation phase.

Additional Information

• Processes in the phase of elongation

• Increased vacuolation: The formation of large vacuoles helps maintain turgor pressure, which is essential for cell expansion.

• Cell enlargement: Cell size increases significantly due to water uptake and expansion of the vacuole.

• New cell wall deposition: Cell walls are reinforced with new material to accommodate the increased cell size.

• Meristematic phase vs. elongation phase

• Meristematic phase: Cells have large, conspicuous nuclei and are actively dividing.

• Elongation phase: Cells grow in size, and the nuclei become less prominent as vacuolation and cell wall deposition dominate.

Q104. Answer: (a) A, B, C, D and E

The correct answer is - A, B, C, D and E

Key Points

• Promoter:

• The promoter is a specific DNA sequence located at the 5' end of the structural gene.

• It provides the binding site for RNA polymerase, which initiates transcription.

• The promoter also defines the template strand (used for transcription) and the coding strand (not transcribed).

• Structural Gene:

• The structural gene contains the sequence of nucleotides that are transcribed into RNA.

• It serves as the template for synthesizing mRNA, tRNA, or rRNA.

YourMockTest.com — Free Study Material

• Terminator:
• The terminator is located towards the 3' end of the coding strand.
• It signals the end of transcription by RNA polymerase.

Additional Information

• Transcription Unit:
• A transcription unit is defined as the region of DNA that is transcribed into RNA.
• It consists of the promoter, structural gene, and terminator.
• Template Strand:
• The strand of DNA that serves as the template for RNA synthesis is called the template strand.
• It is complementary to the RNA sequence being synthesized.
• Coding Strand:
• The coding strand has the same sequence as the RNA (except thymine is replaced by uracil).
• This strand is not used for transcription.

Q105. Answer: (d) Secondary structure

The correct answer is - Secondary structure

Key Points

• Alpha-helix is a specific structural motif found in the secondary structure of proteins.
• The secondary structure refers to the regular, repeated patterns of folding in a polypeptide chain, stabilized by hydrogen bonds.
• In the alpha-helix:
• The polypeptide chain coils into a right-handed helix.
• Hydrogen bonds form between the carbonyl oxygen of one amino acid and the amide hydrogen of another amino acid that is four residues away.
• It is a common element of secondary structure, along with the beta-sheet.

Additional Information

• Levels of protein structure:
• Primary structure: The linear sequence of amino acids in a polypeptide chain.
• Secondary structure: Local folding patterns like alpha-helices and beta-sheets, stabilized by hydrogen bonding.
• Tertiary structure: The three-dimensional shape of a single polypeptide, formed by interactions such as hydrophobic interactions, ionic bonds, and disulfide bonds.
• Quaternary structure: The assembly of multiple polypeptide chains into a functional protein complex.
• Stability of alpha-helices:
• Hydrogen bonding plays a crucial role in stabilizing the helical structure.
• Proline and glycine residues can disrupt alpha-helices due to their unique structural properties.
• Examples of proteins with alpha-helices:
• Alpha-helices are found in structural proteins like keratin and in globular proteins like hemoglobin.

Q106. Answer: (c) A and C only

The correct answer is - A and C only

Key Points

• Amino acids
• Amino acids are called substituted methanes because they have four different groups attached to a central carbon atom: an amino group (-NH2), a carboxyl group (-COOH), a hydrogen atom, and a unique side chain (R group).
• Valine
• Valine is classified as a neutral amino acid because its side chain is nonpolar and does not carry a charge at physiological pH.
• Incorrect options
• Serine is not an aromatic amino acid; it is a polar amino acid with a hydroxyl (-OH) group in its side chain.
• Lysine is not an acidic amino acid; it is a basic amino acid with an amino group in its side chain that is positively charged at physiological pH.

Additional Information

• Classification of amino acids
• Amino acids can be classified based on the properties of their side chains into nonpolar, polar, acidic, and basic categories.
• Aromatic amino acids (e.g., phenylalanine, tyrosine, tryptophan) contain a benzene ring or similar structure in their side chains.

YourMockTest.com — Free Study Material

• Acidic vs. basic amino acids

• Acidic amino acids (e.g., glutamic acid, aspartic acid) have carboxyl groups in their side chains, making them negatively charged at physiological pH.

• Basic amino acids (e.g., lysine, arginine, histidine) have amino groups in their side chains, making them positively charged at physiological pH.

• Neutral amino acids

• Neutral amino acids have side chains that are neither charged nor aromatic. Examples include valine, alanine, and leucine.

Q107. Answer: (c) to minimize water loss during water stress.

The correct answer is - To minimize water loss during water stress

Key Points

• Bulliform cells are specialized large, bubble-like epidermal cells found in grasses.

• These cells are involved in reducing water loss during periods of water stress.

• During water scarcity:

• Bulliform cells lose water and become flaccid.

• This causes the grass leaves to curl inward, reducing the exposed surface area.

• By curling, the leaves reduce transpiration, helping the plant conserve water.

Additional Information

• Structure of bulliform cells

• Located on the upper epidermis of grass leaves.

• Typically arranged in groups, aiding in leaf folding.

• Role in drought resistance

• Grass species with more bulliform cells are better adapted to arid environments.

• They help plants survive prolonged periods of water deficiency.

• Associated processes

• Leaf movement is controlled by turgor pressure in bulliform cells.

• Changes in turgor pressure directly influence leaf folding and unfolding.

Q108. Answer: (b) A and D only

The correct answer is - A and D only

Key Points

• Statement A is incorrect:

• The water splitting complex (Oxygen-Evolving Complex, OEC) is associated with PS II, not PS I.

• This complex splits water molecules into protons, electrons, and oxygen during the light reactions of photosynthesis.

• Statement D is incorrect:

• Kranz anatomy is a characteristic feature of C4 plants, not C3 plants.

• In Kranz anatomy, bundle sheath cells are arranged concentrically around vascular bundles, aiding in efficient carbon fixation and minimizing photorespiration.

Additional Information

• Statement B is correct:

• C4 plants utilize the C3 pathway (Calvin Cycle) as their main biosynthetic pathway for producing sugars.

• However, they initially fix CO2 into a 4-carbon compound in mesophyll cells, which is then transported to bundle sheath cells where the C3 pathway occurs.

• Statement C is correct:

• Photorespiration does not occur in C4 plants due to their specialized biochemical and anatomical adaptations, such as Kranz anatomy and the Hatch-Slack pathway.

• This minimizes oxygenase activity of Rubisco, enhancing photosynthetic efficiency.

• Statement E is correct:

• ATP synthesis in chloroplasts occurs via chemiosmosis, which involves the generation of a proton gradient across the thylakoid membrane during the light reactions.

• Protons flow back into the stroma through ATP synthase, driving the phosphorylation of ADP to form ATP.

YourMockTest.com — Free Study Material

Q109. Answer: (c) A - III, B - IV, C - I, D - II

The correct answer is - A - III, B - IV, C - I, D - II

Key Points

• Conjunctive tissue (A - III)

• This tissue is located between the xylem and phloem in vascular bundles.

• It plays a structural and supportive role in the plant's vascular system.

• Casparian strips (B - IV)

• Casparian strips are suberin depositions found in the radial and transverse walls of endodermal cells.

• They help regulate the movement of water and solutes into the vascular tissue, ensuring selective absorption.

• Subsidiary cells (C - I)

• These are specialized cells found around guard cells in the epidermis of leaves.

• They assist in the opening and closing of stomata by providing structural and functional support to guard cells.

• Starch sheath (D - II)

• This term refers to endodermal cells rich in starch.

• They are involved in the storage and regulation of nutrients in plants.

Additional Information

• Endodermis and Casparian Strips

• The endodermis is the innermost layer of cells in the cortex of roots and stems.

• Casparian strips act as a barrier, forcing water and solutes to pass through the protoplast of endodermal cells, ensuring selective absorption.

• Guard Cells and Stomata

• Guard cells control the opening and closing of stomata, regulating gas exchange and water loss in plants.

• Subsidiary cells provide functional support to guard cells, helping in efficient stomatal movement.

• Conjunctive Tissue

• This tissue is found in vascular bundles and provides mechanical support to xylem and phloem.

• It is typically composed of parenchyma or sclerenchyma cells, based on the plant's needs.

• Starch Sheath

• The starch sheath is important for starch storage and acts as a nutrient reservoir.

• It is typically observed in the endodermis of roots and stems.

Q110. Answer: (c) A - II, B - III, C - I, D - IV

html

The correct answer is - A - II, B - III, C - I, D - IV

Key Points

• Genetically Modified Organism (Bt cotton)

• Bt cotton is a genetically modified crop that incorporates a gene from Bacillus thuringiensis, providing resistance to pests like the cotton bollworm.

• Thermostable DNA Polymerase (Thermus aquaticus)

• Thermus aquaticus is a thermophilic bacterium from which the thermostable Taq polymerase is derived, commonly used in Polymerase Chain Reaction (PCR).

• Ti Plasmid (Agrobacterium tumefaciens)

• Ti plasmid is a tumor-inducing plasmid found in Agrobacterium tumefaciens, used as a vector for genetic engineering in plants.

• pBR322 (Escherichia coli)

• pBR322 is a widely used cloning vector that replicates within Escherichia coli.

Additional Information

• Bacillus thuringiensis (Bt)

• The Bt gene encodes for proteins that are toxic to specific insect pests, but safe for humans, animals, and beneficial insects.

• Bt crops like cotton and corn are widely used in agriculture to reduce pesticide use.

• Thermus aquaticus

• The Taq polymerase derived from this bacterium is heat-resistant and functions at high temperatures, essential for PCR cycles.

• Agrobacterium tumefaciens

• It is a soil bacterium that naturally transfers DNA into plant cells, making it a valuable tool in genetic engineering.

• pBR322

• This plasmid contains genes for ampicillin and tetracycline resistance, making it a selectable marker in genetic experiments.

Q111. Answer: (d) Plasticity

The correct answer is - Plasticity

Key Points

• Plasticity

• Plasticity refers to the ability of an organism to change its morphology or function in response to environmental conditions.

• Heterophyllous development is an excellent example of plasticity, as plants produce different types of leaves based on environmental factors like water availability, temperature, and light intensity.

• This phenomenon is observed in plants like cotton, coriander, and larkspur, where the development of distinct leaf forms is triggered by external stimuli.

• It demonstrates how plants can adapt to changing environments for survival and growth.

Additional Information

• Types of Heterophylly

• Environmental heterophylly: Occurs when plants produce different leaf forms in response to environmental factors, e.g., cotton.

• Habitual heterophylly: Occurs naturally due to the plant's genetic makeup, e.g., coriander.

• Developmental heterophylly: Different types of leaves arise at different stages of development, e.g., larkspur.

• Other Phenomena

• Dedifferentiation: Refers to the reversion of specialized cells to their meristematic state.

• Redifferentiation: Refers to the maturation of dedifferentiated cells into specialized structures.

• Elasticity: Relates to the ability to regain original form after deformation, more relevant to mechanical properties.

Q112. Answer: (c) flowers are borne in an acropetal succession

The correct answer is - flowers are borne in an acropetal succession

Key Points

• Racemose inflorescence

• It is a type of inflorescence where the main axis continues to grow indefinitely.

• In this arrangement, the flowers are borne laterally in a specific order.

• Acropetal succession

• Flowers are arranged in such a way that the older flowers are at the base and younger flowers are towards the apex.

• This pattern is referred to as acropetal, meaning the development proceeds from the bottom towards the top.

• The key feature of racemose inflorescence is uninterrupted growth of the main axis and sequential flowering from base to apex.

Additional Information

• Types of Racemose Inflorescence

• Simple Raceme: Flowers are borne on pedicels of equal length along the main axis, e.g., Mustard.

• Spike: Flowers are sessile (without pedicels) and arranged along the main axis, e.g., Achyranthes.

• Catkin: A pendulous spike with unisexual flowers, e.g., Mulberry.

• Spadix: A fleshy axis with unisexual flowers, often surrounded by a bract called spathe, e.g., Banana.

• Corymb: Pedicels of flowers arise at different levels but bring all flowers to the same height, e.g., Cauliflower.

• Umbel: Pedicels of flowers arise from the same point on the main axis, e.g., Coriander.

• Contrast with Cymose Inflorescence

• In cymose inflorescence, the main axis terminates in a flower, limiting its growth.

• Flowers are arranged in a basipetal succession, meaning older flowers are towards the apex and younger ones towards the base.

Q113. Answer: (c) Sickle-cell anaemia

The correct answer is - Sickle-cell anaemia

Key Points

• Sickle-cell anaemia

• It is caused by the substitution of Glutamic acid (Glu) with Valine (Val) at the sixth position in the beta globin chain of the haemoglobin molecule.

• This substitution results from a single-point mutation in the HBB gene on chromosome 11.

• The altered haemoglobin is referred to as HbS, which leads to the distortion of red blood cells into a sickle shape.

• Sickle-shaped red blood cells have a reduced ability to carry oxygen and tend to block blood flow in small vessels, causing pain and organ damage.

Additional Information

• Genetic basis of Sickle-cell anaemia

• Sickle-cell anaemia is an autosomal recessive disorder, meaning an individual must inherit two copies of the mutated gene (one from each parent) to exhibit symptoms.

• Carriers (heterozygous individuals) have one normal allele and one mutated allele, resulting in the sickle-cell trait, which generally does not manifest severe symptoms.

• Symptoms of Sickle-cell anaemia

• Common symptoms include episodes of pain (sickle-cell crises), anaemia, fatigue, swelling in hands and feet, and frequent infections.

• Complications may include stroke, pulmonary hypertension, and damage to organs such as the spleen and liver.

• Diagnosis and Treatment

• Diagnosis is typically performed using a blood test to detect abnormal haemoglobin or genetic testing for the HBB mutation.

• Treatment options include blood transfusions, medications like hydroxyurea, and in some cases, bone marrow transplantation.

Q114. Answer: (a) A - II, B - IV, C - III, D - I

The correct answer is - A - II, B - IV, C - III, D - I

Key Points

• Incomplete dominance (A - II)

• Incomplete dominance occurs when neither allele is completely dominant, resulting in an intermediate phenotype in heterozygotes.

• An example is the inheritance of flower color in Antirrhinum sp., where crossing red and white flowers produces pink flowers.

• Co-dominance (B - IV)

• In co-dominance, both alleles in a heterozygote are fully expressed without blending.

• The ABO blood group system in humans is an example, where IA and IB alleles are co-dominant, resulting in blood group AB.

• Pleiotropy (C - III)

• Pleiotropy occurs when a single gene influences multiple, seemingly unrelated phenotypic traits.

• An example is Phenylketonuria (PKU), where a single gene mutation affects multiple traits like mental retardation, reduced hair pigmentation, and more.

• Polygenic inheritance (D - I)

• Polygenic inheritance involves multiple genes contributing to a single trait, resulting in a continuous range of phenotypes.

• An example is human skin color, which is determined by the interaction of multiple genes.

Additional Information

• Incomplete Dominance

• In incomplete dominance, the F1 generation shows an intermediate phenotype, and the F2 generation exhibits a phenotypic ratio of 1:2:1.

• Co-dominance

• Co-dominance differs from incomplete dominance as both alleles are fully expressed, not blended.

• Pleiotropy

• Pleiotropic genes often underlie genetic disorders, as a mutation in one gene can disrupt multiple biological pathways.

• Polygenic Inheritance

• Traits like height, eye color, and intelligence are influenced by polygenic inheritance.

• Environmental factors can also interact with polygenic traits, further influencing the phenotype.

Q115. Answer: (c) B, D, A, C

The correct answer is - B, D, A, C

Key Points

• Microsporogenesis is the process of formation of microspores from the sporogenous tissue through meiotic division.

• The correct developmental sequence is as follows:

• Sporogenous tissue (B): This is the initial stage where the cells are capable of undergoing meiotic division to form microspores.

• Pollen mother cells (D): These are the diploid cells derived from sporogenous tissue that undergo meiosis.

YourMockTest.com — Free Study Material

• Microspore tetrads (A): The pollen mother cells divide meiotically to form four haploid microspores arranged in a tetrad structure.
• Pollen grains (C): The microspores separate and develop into mature pollen grains, which are the male gametophytes.
• Thus, the correct sequence is B (Sporogenous tissue), D (Pollen mother cells), A (Microspore tetrads), and C (Pollen grains).

Additional Information

• Microsporogenesis process:
• The process occurs inside the anther, which is the male reproductive structure of flowering plants.
• Each anther contains microsporangia, where microsporogenesis takes place.
• Pollen mother cells:
• These are diploid cells that undergo meiosis to form haploid microspores.
• The meiotic division consists of two stages: meiosis I and meiosis II.
• Pollen grains:
• These are the male gametophytes of seed plants and are responsible for fertilization.
• Pollen grains have a protective outer layer called the exine, which helps them survive harsh environmental conditions.

Q116. Answer: (a) A, E, C, B, D

The correct answer is - A, E, C, B, D

Key Points

• Step A: Isolation of DNA and its digestion by restriction endonucleases
• DNA is extracted from the cells and cut into fragments using restriction enzymes.
• This is the first step in preparing DNA for fingerprinting.
• Step E: Separation of DNA fragments by electrophoresis
• DNA fragments are separated based on their size through agarose gel electrophoresis.
• Smaller fragments move faster through the gel, while larger ones move slower.
• Step C: Transferring separated DNA fragments to synthetic membranes
• The separated DNA fragments are transferred to a nylon or nitrocellulose membrane.
• This step is called Southern blotting, which makes the DNA accessible for hybridization.
• Step B: Hybridisation using a labelled VNTR probe
• A radioactive or fluorescent VNTR (Variable Number of Tandem Repeats) probe is used to bind to complementary DNA sequences on the membrane.
• VNTRs are specific regions of repetitive sequences unique to individuals.
• Step D: Detection of hybridised DNA fragments by autoradiography
• The hybridized DNA is visualized using autoradiography, producing a pattern of bands unique to each individual.
• This pattern is the DNA fingerprint.

Additional Information

• DNA fingerprinting
• It is a technique used to identify individuals based on their unique DNA sequence.
• Primarily used in forensic science, paternity testing, and genetic studies.
• VNTRs (Variable Number of Tandem Repeats)
• VNTRs are short, repetitive sequences of DNA that vary greatly between individuals.
• They are the key to making DNA fingerprints unique.
• Restriction enzymes
• Also known as molecular scissors, these enzymes cut DNA at specific sequences.
• They are essential for fragmenting DNA in the first step of DNA fingerprinting.

Q117. Answer: (d) Bioprospecting

The correct answer is - Bioprospecting

Key Points

• Bioprospecting
• It refers to the exploration of biological resources, such as plants, animals, and microorganisms, to identify and develop products of economic importance.
• This process involves studying molecular, genetic, and species-level diversity for applications in areas like medicine, agriculture, and biotechnology.
• Bioprospecting often leads to the discovery of new drugs, bioactive compounds, or genetic materials that can be

commercialized.

• It is a sustainable approach to utilizing biodiversity while ensuring conservation and equitable sharing of benefits derived from its use.

Additional Information

• Related Concepts

• Biomagnification

• Refers to the increase in concentration of toxic substances, like pesticides or heavy metals, as they move up the food chain.

• It is unrelated to the exploration of biological diversity for economic use.

• Biofortification

• Involves increasing the nutritional value of crops through techniques like genetic modification or conventional breeding.

• Its primary focus is on addressing malnutrition, not resource discovery.

• Bioremediation

• Refers to the use of microorganisms or biological agents to clean up polluted environments, such as oil spills or contaminated soil.

• This is distinct from the exploration of biodiversity for economic purposes.

• Applications of Bioprospecting

• Discovery of antibiotics, enzymes, and natural products for pharmaceutical use.

• Development of bio-based agricultural inputs, such as biopesticides and biofertilizers.

• Identification of genetic resources for improving crop varieties and livestock breeds.

Q118. Answer: (d) A, B, C and E only

The correct answer is - A, B, C and E only

Key Points

• Haplodiploid sex-determination system

• Honeybees follow a haplodiploid sex-determination system, where the sex of the offspring depends on the ploidy (number of chromosome sets).

• Females (queen or worker bees) are diploid with two sets of chromosomes, while males (drones) are haploid with only one set of chromosomes.

• An offspring from a sperm and egg union develops as a female

• Females result from the fertilization of an egg by a sperm, leading to a diploid individual.

• This includes both queen bees and worker bees.

• Unfertilized eggs develop as males

• In honeybees, males are produced by parthenogenesis, where an unfertilized egg develops directly into a haploid male.

• Males have half the chromosomes of females

• Since males are haploid, they inherit only one set of chromosomes, while females inherit two sets (diploid).

Additional Information

• Role of meiosis in males

• Males in honeybees do not produce sperm through meiosis since they are haploid.

• Their sperm are produced via mitosis, as meiosis requires a diploid set of chromosomes.

• Queen determination

• Whether a female becomes a queen or a worker depends not on genetics but on diet during larval development.

• Larvae fed exclusively on royal jelly develop into queens, while others become worker bees.

• Parthenogenesis in other species

• Parthenogenesis is not unique to honeybees; it is also observed in some reptiles, amphibians, and other insects.

Q119. Answer: (a) Denaturation → Annealing → Extension

The correct answer is - Denaturation → Annealing → Extension

Key Points

• Denaturation

• Occurs at a high temperature (typically around 94–98°C).

• Breaks the hydrogen bonds between double-stranded DNA, resulting in single-stranded DNA templates.

• Annealing

• Occurs at a lower temperature (typically 50–65°C).

YourMockTest.com — Free Study Material

• Facilitates the binding of specific primers to their complementary sequences on the single-stranded DNA.
• Extension
• Occurs at an optimal temperature for Taq polymerase activity (usually 72°C).
• Taq polymerase synthesizes a new DNA strand by adding nucleotides to the primer-bound template strand.
Additional Information
• Polymerase Chain Reaction (PCR)
• Developed by Kary Mullis in 1983.
• Used to amplify specific DNA sequences exponentially by repeating cycles of denaturation, annealing, and extension.
• Essential in applications such as genetic testing, forensic science, and molecular diagnostics.
• Taq Polymerase
• Heat-stable enzyme isolated from Thermus aquaticus, a thermophilic bacterium.
• Enables DNA synthesis during the extension step at high temperatures.
• Primers
• Short, single-stranded DNA sequences that are complementary to the target DNA regions.
• Provide the starting point for Taq polymerase to synthesize new DNA strands.
• Cycling Conditions
• Optimized cycling temperatures and times are critical for ensuring specificity and efficiency of DNA amplification.
• Typically includes 20–40 cycles to achieve sufficient DNA amplification.

Q120. Answer: (d) A and B only

The correct answer is - A and B only
Key Points
• Molecular scissors
• The process of cutting DNA involves restriction enzymes, which act as molecular scissors.
• These enzymes recognize specific DNA sequences and cut at precise locations, enabling manipulation of DNA fragments.
• DNA separation
• During electrophoresis, DNA fragments are separated based on their size.
• Smaller fragments move faster through the agarose gel, while larger fragments move slower.
• Incorrect visualization claim
• DNA fragments cannot be seen without staining under UV light.
• Staining with ethidium bromide or other dyes is essential for visualization.
Additional Information
• Electrophoresis process
• DNA is loaded into wells of an agarose gel and subjected to an electric field.
• DNA, being negatively charged, migrates towards the positive electrode.
• Role of ethidium bromide
• Ethidium bromide binds to DNA and fluoresces under UV light, making the fragments visible.
• This dye is essential for visualizing DNA after electrophoresis.
• Visualization techniques
• Modern alternatives like SYBR Green and GelRed are less toxic and are used for DNA staining.
• They also provide high sensitivity for DNA detection.

Q121. Answer: (a) A, B, D and E only

The correct answer is - A, B, D, and E only
Key Points
• Cell structure
• Refers to the type of cell (prokaryotic or eukaryotic) present in the organism.
• Prokaryotes are placed in Kingdom Monera, while eukaryotes are distributed among the other kingdoms.
• Body organization
• Describes the level of complexity in the organism's structure, such as unicellular or multicellular.
• Multicellular organisms with distinct tissues are classified into higher kingdoms like Plantae and Animalia.
• Reproduction

YourMockTest.com — Free Study Material

• Includes sexual and asexual modes, which are considered for classification.
• Organisms exhibiting complex reproduction mechanisms are placed in higher kingdoms.
• Phylogenetic relationships
• Refers to evolutionary relationships among organisms based on common ancestry.
• This criterion is crucial for grouping organisms into kingdoms that reflect their evolutionary lineage.

Additional Information
• Five Kingdom Classification
• Proposed by R.H. Whittaker in 1969.
• Divides organisms into five kingdoms: Monera, Protista, Fungi, Plantae, and Animalia.
• Kingdom Monera
• Includes prokaryotic unicellular organisms such as bacteria.
• Kingdom Protista
• Comprises eukaryotic unicellular organisms like protozoa and algae.
• Criteria not included
• Presence of flagellum is not a primary criterion for classification.
• Flagella are present in various organisms across different kingdoms and do not define kingdom-level classification.

Q122. Answer: (b) Primary endosperm cell

The correct answer is - Primary endosperm cell

Key Points
• Primary endosperm cell
• The primary endosperm cell is formed as a result of the fusion of one sperm nucleus with the two polar nuclei in the central cell of the embryo sac during fertilization.
• This fusion results in a triploid (3n) cell because it involves the combination of three haploid nuclei.
• The primary endosperm cell divides and develops into the endosperm, which provides nutrition to the developing embryo.

Additional Information
• Central cell
• The central cell in the embryo sac contains two haploid polar nuclei before fertilization.
• After fertilization, the fusion of these polar nuclei with one sperm nucleus forms the triploid primary endosperm cell.
• Zygote
• The zygote is a diploid (2n) cell formed by the fusion of one sperm nucleus with the egg cell nucleus.
• It develops into the embryo but is not triploid.
• Synergids
• Synergids are haploid cells located in the embryo sac near the egg cell.
• They play a role in guiding the pollen tube for fertilization but do not undergo fertilization themselves.

Q123. Answer: (b) A, C and E only

The correct answer is - A, C, and E only

Key Points
• Histone octamer
• Histones are organized to form a unit of eight molecules, called the histone octamer.
• This octamer serves as the core structure around which DNA is wrapped.
• Basic amino acid residues
• Histones are rich in lysine and arginine, which are basic amino acids.
• The abundance of these residues contributes to the interaction between histones and the negatively charged DNA.
• Non-histone chromosomal proteins
• For higher-level chromatin packaging, additional proteins known as non-histone chromosomal proteins are required.
• These proteins help in organizing chromatin into higher-order structures.

Additional Information
• Nucleosome structure
• A nucleosome is formed when negatively charged DNA is wrapped around a histone octamer.
• This structure is the fundamental unit of chromatin organization and provides stability to the DNA molecule.

YourMockTest.com — Free Study Material

• Charge properties of histones
• Histones are not negatively charged; they are positively charged due to the presence of lysine and arginine.
• The positive charge facilitates binding to the negatively charged phosphate backbone of DNA.
• Role in gene regulation
• Chromatin packaging regulates gene expression by controlling the accessibility of DNA to transcription factors.
• Highly compact chromatin (heterochromatin) is transcriptionally inactive, while loosely packed chromatin (euchromatin) is active.

Q124. Answer: (a) Sacred Groves

The correct answer is - Sacred Groves

Key Points

• In situ conservation
• This refers to the conservation of species in their natural habitats.
• It involves protecting the ecosystem and maintaining the conditions necessary for the survival and reproduction of species.
• Sacred Groves
• Sacred groves are small patches of forests or natural vegetation that are protected by communities due to religious or cultural beliefs.
• They are examples of in situ conservation because they preserve the plants, animals, and other biodiversity within their natural habitats.
• These areas often serve as refugia for rare and endangered species, contributing to biodiversity conservation.

Additional Information

• Ex situ conservation
• In contrast to in situ conservation, ex situ conservation involves conserving species outside their natural habitats.
• Examples include:
• Botanical gardens: These are areas where plants are grown and maintained for research, conservation, and education.
• Seed banks: Facilities that store seeds under controlled conditions to preserve genetic diversity.
• Wildlife safari parks: Parks that house animals in controlled environments for conservation and public awareness.
• Importance of Sacred Groves
• They act as a gene pool for various flora and fauna.
• Provide ecosystem services such as water conservation and soil fertility enhancement.
• They hold cultural and religious significance, which encourages local communities to actively protect them.

Q125. Answer: (d) beta-galactosidase

The correct answer is - beta-galactosidase

Key Points

• Beta-galactosidase
• The z gene in the lac operon codes for the enzyme beta-galactosidase.
• This enzyme is responsible for hydrolyzing lactose into its monosaccharide components: glucose and galactose.
• Beta-galactosidase plays a critical role in lactose metabolism, allowing E. coli to utilize lactose as an energy source when glucose is unavailable.
• Induction of z gene
• The production of beta-galactosidase is regulated by the presence or absence of lactose in the environment.
• When lactose is available, it binds to the repressor protein, allowing transcription of the z gene to proceed.

Additional Information

• Lac operon
• The lac operon is a gene system in E. coli that regulates the metabolism of lactose.
• It consists of three structural genes: z, y, and a, which code for beta-galactosidase, permease, and transacetylase, respectively.
• Regulation of the lac operon
• In the absence of lactose, the repressor protein binds to the operator region, preventing transcription of the operon.
• When lactose is present, it acts as an inducer, binding to the repressor and inactivating it, allowing transcription of the operon to occur.
• Other enzymes in the lac operon
• The y gene codes for permease, which facilitates the transport of lactose into the cell.
• The a gene codes for transacetylase, whose exact role is less well-understood but is believed to be involved in detoxification.

YourMockTest.com — Free Study Material

Q126. Answer: (c) A - III, B - I, C - IV, D - II

The correct answer is - A - III, B - I, C - IV, D - II

Key Points

• 2,4-D

• 2,4-D is a selective herbicide used to control weeds by disrupting their growth processes.

• It is widely used in agriculture to target broadleaf weeds without harming grasses.

• GA3

• Gibberellic acid (GA3) is employed in the brewing industry to stimulate barley germination for malt production.

• It enhances enzyme production, improving starch conversion during brewing.

• Kinetin

• Kinetin is a type of cytokinin, which facilitates nutrient mobilization and promotes cell division and growth.

• It plays a role in the development of shoots and leaves.

• ABA (Abscisic Acid)

• ABA is involved in stimulation of stomatal closure during water stress conditions.

• It helps plants conserve water by reducing transpiration.

Additional Information

• Plant Growth Regulators

• Plant growth regulators are chemical substances that influence physiological processes like cell division, elongation, and differentiation.

• They are classified into five main groups: Auxins, Gibberellins, Cytokinins, Abscisic Acid (ABA), and Ethylene.

• Herbicides

• Herbicides like 2,4-D are chemicals used to control unwanted plants (weeds) in agriculture.

• Selective herbicides target specific types of plants while leaving others unaffected.

• Stress Responses in Plants

• ABA plays a significant role in drought resistance by inducing stomatal closure.

• It is also involved in seed dormancy and germination regulation.

Q127. Answer: (b) D, A, B, C, E

The correct answer is - D, A, B, C, E

Key Points

• Somatic hybridisation involves the fusion of protoplasts from two different plant varieties to create a hybrid plant.

• The correct sequence of steps includes:

• Isolation of single cells: Cells are extracted from two different plant varieties.

• Digestion of cell walls: Cell walls are enzymatically digested to release protoplasts.

• Isolation of naked protoplasts: Protoplasts (cells without walls) are separated after digestion.

• Fusion of protoplasts: Protoplasts are fused to form hybrid protoplasts.

• Growing hybrid protoplasts: Hybrid protoplasts are cultured to regenerate into a new hybrid plant.

• This process is used in plant biotechnology for crop improvement.

Additional Information

• Protoplast fusion techniques:

• Fusion is induced chemically using agents like polyethylene glycol (PEG) or electrically (electrofusion).

• These techniques ensure proper fusion and compatibility between protoplasts of different species.

• Applications of somatic hybridisation:

• Development of hybrid plants with desirable traits such as disease resistance and improved yield.

• Used in combining genomes of distantly related species, which is not possible through conventional breeding.

• Limitations:

• Regeneration of hybrid plants can be complex and time-consuming.

• Not all combinations of protoplasts result in viable hybrids.

Q128. Answer: (b) Between 0.5 and 0.95

The correct answer is - Between 0.5 and 0.95

Key Points

• Respiratory Quotient (RQ)

• The Respiratory Quotient (RQ) is the ratio of the volume of CO2 produced to the volume of O2 consumed during respiration.

• It is expressed as:

RQ = (Volume of CO2 produced) / (Volume of O2 consumed)

• Given Equation Analysis

• From the given equation:

2(C51H98O6)+145 O2→102 CO2+98 H2O+energy2(C51H98O6)+145 O2→102 CO2+98 H2O+energy2(C51H98O6)+145 O2→102 CO2+98 H2O+energy

• Volume of CO2 produced = 102102102

• Volume of O2 consumed = 145145145

• Thus, RQ=102145≈0.703RQ=102145≈0.703RQ=102145≈0.703

• This value falls between 0.5 and 0.95.

• Conclusion

• The Respiratory Quotient for the given biomolecule is between 0.5 and 0.95.

Additional Information

• RQ values for different biomolecules

• For carbohydrates, RQ = 1.0 (e.g., glucose oxidation).

• For proteins, RQ = ~0.8.

• For lipids (fats), RQ = ~0.7.

• For anaerobic respiration, RQ > 1.0.

• Significance of RQ

• RQ provides insights into the type of substrate being metabolized.

• A lower RQ (e.g., ~0.7) indicates fat metabolism, while a higher RQ (e.g., 1.0) indicates carbohydrate metabolism.

• Practical Applications

• Used in metabolic studies to determine energy production and substrate utilization.

• Helps in understanding energy requirements during exercise or other physiological conditions.

Q129. Answer: (b) The present species extinction rates are 100 to 1000 times faster than in the pre-human times.

The correct answer is - The present species extinction rates are 100 to 1000 times faster than in the pre-human times

Key Points

• Sixth mass extinction

• The ongoing extinction event is termed the sixth mass extinction, primarily driven by human activities.

• Unlike previous mass extinctions caused by natural events like asteroid impacts or volcanic eruptions, the current crisis is a result of anthropogenic (human-induced) factors.

• Current extinction rates

• Modern species are vanishing at rates that are 100 to 1000 times faster than the natural, pre-human background extinction rate.

• This unprecedented acceleration is attributed to factors such as habitat destruction, climate change, pollution, overexploitation, and the introduction of invasive species.

• Biological impact

• The loss of biodiversity disrupts ecosystems, impacting food chains, ecological balance, and the availability of ecosystem services like pollination and water purification.

• Many species are unable to adapt to the rapid pace of environmental changes caused by human activities.

Additional Information

• Previous mass extinctions

• There have been five previous mass extinctions, such as the Permian-Triassic extinction (250 million years ago) and the Cretaceous-Paleogene extinction (66 million years ago).

• These events were triggered by natural catastrophic events like massive volcanic activity or asteroid impacts.

• Role of humans

• Humans are the primary drivers of the sixth extinction through activities such as deforestation, overfishing, and the emission of greenhouse gases.

• Conservation efforts, such as the establishment of protected areas and wildlife corridors, aim to mitigate the loss of species.

• Key global initiatives

• Organizations like the International Union for Conservation of Nature (IUCN) and the Convention on Biological Diversity (CBD)

YourMockTest.com — Free Study Material

are working to address biodiversity loss.

• Global frameworks such as the United Nations Sustainable Development Goals emphasize the importance of protecting life on Earth.

Q130. Answer: (a) A - III, B - IV, C - II, D - I

The correct answer is - A - III, B - IV, C - II, D - I

Key Points

• Trypsin - Enzyme (III)

• Trypsin is a digestive enzyme produced in the pancreas.

• It helps in the breakdown of proteins into smaller peptides in the small intestine.

• It belongs to the class of proteolytic enzymes.

• Morphine - Alkaloid (IV)

• Morphine is a naturally occurring alkaloid derived from the opium poppy plant.

• It is used as a painkiller due to its analgesic properties.

• It acts on the central nervous system to relieve pain and induce euphoria.

• Concanavalin A - Lectin (II)

• Concanavalin A is a lectin (carbohydrate-binding protein) derived from jack beans.

• It is widely used in biochemical research for studying glycoproteins and carbohydrates.

• Collagen - Intercellular Ground Substance (I)

• Collagen is the most abundant protein in the extracellular matrix of connective tissues.

• It provides structural support and helps maintain tissue integrity.

• It is crucial for skin, tendons, and cartilage.

Additional Information

• Proteolytic Enzymes

• These are enzymes that break down proteins into amino acids or smaller peptides.

• Examples include trypsin, pepsin, and chymotrypsin.

• Lectins

• These are carbohydrate-binding proteins that play a role in cell recognition and signaling.

• They are used in various biological and biochemical applications.

• Alkaloids

• These are naturally occurring compounds containing basic nitrogen atoms.

• They often have pharmacological effects (e.g., morphine for pain relief, quinine for malaria treatment).

• Collagen Functions

• Helps in tissue repair and regeneration.

• Provides tensile strength to connective tissues like skin and cartilage.

Q131. Answer: (c) The first word in the biological name represents the specific epithet, while the second component denotes t...

The correct answer is - The first word in the biological name represents the specific epithet, while the second component denotes the genus

Key Points

• Binomial nomenclature

• It is a system of naming organisms using two components: the genus name and the specific epithet.

• The genus name always comes first and starts with a capital letter.

• The specific epithet comes second and starts with a small letter.

• Both components together form a unique name for each species.

• Incorrect statement explanation

• In the given incorrect statement, the terms "specific epithet" and "genus" are reversed.

• The first word in the biological name represents the genus, not the specific epithet.

• The second word represents the specific epithet, describing the species within the genus.

Additional Information

• Universal rules of binomial nomenclature

• Both words are either italicized (if printed) or underlined separately (if handwritten).

• The names are generally derived from Latin or are Latinized.
• The system was developed by Carl Linnaeus, regarded as the father of modern taxonomy.
• Purpose of binomial nomenclature
• It ensures a standardized way to name species globally, avoiding confusion caused by local names.
• The system provides a clear indication of the taxonomic hierarchy, starting with the genus.

Q132. Answer: (b) RuBP carboxylase - oxygenase

The correct answer is - RuBP carboxylase-oxygenase

Key Points

• RuBP carboxylase-oxygenase
• Also known as Ribulose-1,5-bisphosphate carboxylase/oxygenase, or Rubisco.
• It is the primary enzyme responsible for the carboxylation step in the Calvin cycle, a crucial part of the photosynthetic process.
• Rubisco catalyzes the reaction between CO2 and RuBP (Ribulose-1,5-bisphosphate), forming two molecules of 3-phosphoglycerate.
• This reaction is essential for the fixation of atmospheric carbon dioxide into an organic form that can be used by plants to synthesize sugars.

Additional Information

• Importance of the Calvin Cycle
• The Calvin cycle occurs in the stroma of chloroplasts and is a key part of the light-independent reactions of photosynthesis.
• It converts ATP and NADPH, generated in the light-dependent reactions, into chemical energy in the form of glucose.
• Properties of Rubisco
• Rubisco is one of the most abundant enzymes on Earth due to its central role in photosynthesis.
• It has a dual activity: carboxylase activity for the Calvin cycle and oxygenase activity, which leads to photorespiration.
• Photorespiration
• When Rubisco binds to O2 instead of CO2, it initiates a wasteful process called photorespiration.
• Photorespiration reduces the efficiency of photosynthesis by consuming energy without producing sugars.

Q133. Answer: (a) (+) ? K_((5)) C_((5)) A5 G_((2))

The correct answer is - (+) ? K(5) C(5) A5 G−−(2)(+) ? K(5) C(5) A5 G_(2)

Key Points

• Floral formula represents the structure of a flower using symbols and numbers for various floral parts.
• The floral formula of the Solanaceae family is:
• (+)(+)

indicates actinomorphic symmetry (radial symmetry).

• ??

signifies bisexual flowers.

• K(5)K(5)

represents a calyx with 5 sepals fused together.

• C(5)C(5)

shows a corolla with 5 petals fused together.

• A5A5

indicates 5 stamens (androecium).

• G−−(2)G_(2)

denotes a bicarpellary gynoecium with fused carpels and a superior ovary.

• Option 1 matches the correct floral formula for the Solanaceae family.

Additional Information

• Examples of Solanaceae family
• Common plants include tomato (Solanum lycopersicum), potato (Solanum tuberosum), brinjal (Solanum melongena), and chili (Capsicum).
• Distinctive features of Solanaceae flowers
• They are typically pentamerous (floral parts in multiples of 5).
• The ovary is superior with axial placentation.
• Economic significance

YourMockTest.com — Free Study Material

• Includes food crops, medicinal plants, and ornamental plants.
• Examples: Capsicum (spices), Atropa belladonna (medicinal), Petunia (ornamental).

Q134. Answer: (c) Xenogamy

The correct answer is - Xenogamy

Key Points

• Xenogamy
• Xenogamy refers to the transfer of genetically distinct pollen grains from the anther of one plant to the stigma of a different plant of the same species.
• This type of pollination ensures genetic diversity in the offspring, which can increase adaptability and survival.
• It is achieved through external agents like insects, wind, or water.

Additional Information

• Other types of pollination
• Geitonogamy: Transfer of pollen grains from the anther to the stigma of a different flower on the same plant. It does not introduce genetic variation as the genetic material is the same.
• Autogamy: Self-pollination where pollen grains are transferred from the anther to the stigma of the same flower. This leads to no genetic diversity.
• Cleistogamy: Pollination occurs within closed flowers, ensuring self-pollination and no genetic variation.
• Importance of genetic diversity
• Genetic diversity enhances the adaptability of plants to changing environmental conditions.
• It reduces the risk of extinction due to susceptibility to diseases or pests.

Q135. Answer: (b) A - III, B - I, C - IV, D - II

The correct answer is - A - III, B - I, C - IV, D - II

Key Points

• Glycolysis
• Occurs in the cytoplasm of the cell.
• This process breaks down glucose into pyruvate, generating ATP and NADH.
• Electron Transport System (ETS)
• Occurs in the inner mitochondrial membrane.
• It involves a series of protein complexes that transfer electrons to produce a proton gradient, which drives ATP synthesis.
• Accumulation of protons
• Occurs in the intermembrane space of the mitochondria.
• Protons are pumped from the mitochondrial matrix to the intermembrane space during ETS, creating a proton gradient.
• Krebs' Cycle
• Occurs in the mitochondrial matrix.
• This cycle generates NADH, FADH2, and ATP by oxidizing acetyl-CoA derived from carbohydrates, fats, and proteins.

Additional Information

• Glycolysis
• It is the first step of cellular respiration and is anaerobic (does not require oxygen).
• End products are 2 pyruvate, 2 ATP, and 2 NADH molecules per glucose molecule.
• Electron Transport System (ETS)
• The final step of aerobic respiration where oxygen acts as the final electron acceptor, forming water.
• Produces the majority of the ATP in cellular respiration through oxidative phosphorylation.
• Proton Gradient
• The gradient created across the inner mitochondrial membrane is utilized by ATP synthase to produce ATP.
• This is a critical component of the chemiosmotic theory.
• Krebs' Cycle
• Also called the citric acid cycle or TCA cycle.
• Produces 3 NADH, 1 FADH2, and 1 ATP per acetyl-CoA molecule.
• It is an aerobic process as it indirectly depends on oxygen for regeneration of NAD^+ and FAD.

YourMockTest.com — Free Study Material

Q136. Answer: (c) Tetracycline

The correct answer is - Tetracycline

Key Points

• pBR322 Cloning Vector

• pBR322 is a widely used cloning vector in molecular biology.

• It contains two antibiotic resistance genes: Ampicillin resistance (amp^r) and Tetracycline resistance (tet^r).

• BamHI Restriction Site

• BamHI is a restriction enzyme that cuts DNA at specific sequences.

• In pBR322, the BamHI site is located within the tetracycline resistance (tet^r) gene.

• Insertion of Foreign DNA

• When foreign DNA is inserted at the BamHI site, it disrupts the coding sequence of the tetracycline resistance gene.

• This results in the loss of tetracycline resistance, while ampicillin resistance remains unaffected.

Additional Information

• Selectable Markers in pBR322

• Selectable markers like amp^r and tet^r allow researchers to identify bacterial cells that have successfully taken up the vector.

• Cells with disrupted tet^r are sensitive to tetracycline but remain resistant to ampicillin.

• Applications of pBR322

• pBR322 is used extensively in recombinant DNA technology to clone and express foreign genes.

• Its multiple cloning sites (MCS) and selectable markers make it a versatile tool in genetic engineering.

• Antibiotic Resistance in Cloning

• Antibiotic resistance genes in vectors help ensure that only transformed cells grow on selective media.

• Insertional inactivation of these genes is a common strategy for identifying successful cloning events.

Q137. Answer: (b) GUG

The correct answer is - GUG

Key Points

• GUG

• The sixth codon in the beta globin gene undergoes a mutation from GAG (Glutamic acid) to GUG (Valine).

• This mutation leads to the production of an abnormal Haemoglobin S, which causes polymerization under low oxygen conditions.

• Polymerization of haemoglobin alters the shape of red blood cells (RBCs), transforming them into a sickle shape.

• The sickle-shaped RBCs are less efficient in transporting oxygen and have a shorter lifespan, leading to clinical symptoms of Sickle Cell Anaemia.

Additional Information

• Beta Globin Gene Mutation

• Located on chromosome 11, the beta globin gene encodes a critical protein in adult haemoglobin.

• Any mutation in this gene can result in haemoglobin disorders like Sickle Cell Anaemia or Beta Thalassemia.

• Effects of Sickle Cell Mutation

• Altered RBCs can block blood vessels, leading to tissue ischemia and pain episodes (crises).

• Reduced oxygen-carrying capacity results in anaemia and fatigue.

• Inheritance Pattern

• Sickle Cell Anaemia follows an autosomal recessive inheritance pattern.

• Individuals with one mutated gene are carriers, while those with two mutated genes exhibit disease symptoms.

Q138. Answer: (b) It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot p...

The correct answer is - It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce ovum but can provide suitable environment for fertilization and development.

Key Points

• Gamete Intrafallopian Transfer (GIFT)

• GIFT is a reproductive technology used to assist infertile females who can provide a suitable environment for fertilization but cannot produce ova.

• It involves transferring the donor ovum directly into the fallopian tube of the recipient female.

• This method mimics natural fertilization within the fallopian tube, allowing fertilization to occur naturally within the recipient's

YourMockTest.com — Free Study Material

body.

• It is suitable for females who have functional fallopian tubes but face ovulation issues.

• Procedure

• Ova are collected from a healthy donor.

• These ova are placed into the recipient's fallopian tube along with sperm for natural fertilization.

Additional Information

• Difference between GIFT and other reproductive technologies

• In IVF (In Vitro Fertilization), fertilization occurs outside the body in a lab setting, and embryos are transferred to the uterus.

• In ZIFT (Zygote Intrafallopian Transfer), fertilization is performed externally, and early embryos (zygotes) are transferred into the fallopian tube.

• GIFT, unlike IVF or ZIFT, allows fertilization to occur naturally within the fallopian tube.

• Applications of GIFT

• GIFT is recommended for couples with unexplained infertility or low sperm motility.

• It is only effective if the recipient has functional fallopian tubes.

• Limitations

• Not suitable for females with damaged or blocked fallopian tubes.

• Requires surgical intervention for ova and sperm placement into the fallopian tube.

Q139. Answer: (c) Ophrys and bumblebee

The correct answer is - Ophrys and bumblebee

Key Points

• Sexual deceit

• Refers to the manipulation of reproductive behavior by one organism to attract another for reproduction-related purposes without offering any genuine reward.

• In the case of Ophrys (a genus of orchids) and bumblebee, the orchid flower mimics the appearance and scent of a female bumblebee.

• This trickery lures male bumblebees into attempting to mate with the flower, facilitating pollination as the bumblebee transfers pollen to other orchids.

• This interaction is a classic example of sexual deceit in nature.

Additional Information

• Pollination strategies in plants

• Plants use various strategies to attract pollinators, including visual cues, scents, and nectar rewards.

• Some species, like Ophrys, use deceptive strategies such as mimicking pollinator species to ensure pollination.

• Examples of mutualism and deceit

• Mutualism: The relationship between sea anemones and clownfish, where both benefit.

• Deceptive interactions: The mimicry employed by Ophrys orchids to trick bumblebees for pollination.

• Other forms of deceit in nature

• Examples include brood parasitism, such as the interaction between cuckoos and crows, where cuckoos lay eggs in crow nests.

• These strategies demonstrate how organisms manipulate others to enhance their survival or reproduction.

Q140. Answer: (b) Ramapithecus → Homo habilis → Homo erectus → Neanderthal → Homo sapiens

The correct answer is - Ramapithecus → Homo habilis → Homo erectus → Neanderthal → Homo sapiens

Key Points

• Ramapithecus

• One of the earliest ancestors of humans, believed to have existed around 14-8 million years ago.

• Considered a transitional form between apes and early humans.

• Homo habilis

• Known as the "handy man," this species existed approximately 2.4 to 1.5 million years ago.

• Notable for its use of basic stone tools, marking the beginning of technological evolution.

• Homo erectus

• Existed around 1.9 million to 110,000 years ago, with advanced tool use and the ability to control fire.

• Spread across Africa, Asia, and Europe, showing significant geographical adaptability.

• Neanderthal

• Lived approximately 400,000 to 40,000 years ago.
• Exhibited advanced hunting techniques and social behaviors, and had a brain size comparable to modern humans.
• Homo sapiens
• The modern human species, emerging around 300,000 years ago.
• Characterized by advanced cognitive abilities, language development, and cultural evolution.

Additional Information

• Progressive Brain Development
• The evolution of human species is closely linked to the increase in brain size and complexity.
• From approximately 400 cm^3 in early hominins to around 1,350 cm^3 in Homo sapiens.
• Language Skills
• The ability to communicate through language evolved significantly in Homo erectus and Homo sapiens.
• Critical for the development of culture, social structures, and technological advancements.
• Tool Use
• Homo habilis is the first species credited with creating and using tools.
• Homo erectus refined tool-making with more complex designs, aiding survival and adaptation.

Q141. Answer: (d) A - II, B - III, C - IV, D - I

The correct answer is - A - II, B - III, C - IV, D - I

Key Points

• A - II: The foetus movement starts and hair appears on the head occurs at 20 weeks of pregnancy.
• By the 20th week, the foetus begins to show noticeable movement, commonly referred to as "quickening."
• Hair (lanugo) begins to form on the head during this stage.
• B - III: The foetus develops limbs and digits happens by 8 weeks of pregnancy.
• By the end of the embryonic period (8 weeks), limb buds have developed into fully formed limbs with distinct digits.
• C - IV: The foetus develops external genital organs is seen at 12 weeks of pregnancy.
• By the 12th week, external genitalia are sufficiently developed to differentiate male from female.
• D - I: The foetus body is covered with fine hair; eyelids separate, and eyelashes are formed by 24 weeks of pregnancy.
• At this stage, the foetus is covered in fine hair (lanugo), and eyelashes and eyebrows are visible.
• The eyelids, which were previously fused, begin to open.

Additional Information

• Foetal Development Highlights by Trimester
• First Trimester (0–12 weeks): Key developments include the formation of the heart, brain, spinal cord, limbs, and external genitalia.
• Second Trimester (13–26 weeks): Movements become noticeable, fine hair covers the foetus, and functional organs (e.g., kidneys) mature.
• Third Trimester (27–40 weeks): The foetus gains weight, organs mature further, and it prepares for birth.
• Lanugo and Vernix Caseosa
• Lanugo is the fine hair covering the foetus, which helps in binding the vernix caseosa (a protective waxy coating).
• Both lanugo and vernix caseosa protect the foetus's skin during its development in amniotic fluid.
• Significance of Quickening
• Quickening, the first perception of foetal movement, is considered an important milestone in pregnancy, typically occurring around the 18th to 20th week.
• It helps confirm the health and development of the foetus.

Q142. Answer: (c) Petromyzon sp.

The correct answer is - Petromyzon sp.

Key Points

• Petromyzon, commonly known as the lamprey, belongs to the class Cyclostomata.
• It has an endoskeleton made of cartilage, a characteristic feature of the group.
• These organisms are ectoparasitic and attach to other fish using their circular sucking mouth.
• They lack paired fins and scales, which differentiates them from most fish species.
• The presence of 7 pairs of gill slits aligns with the structural features of lampreys.

Additional Information

• Comparison with other options:

• Exocoetus sp.: Known as flying fish, it belongs to class Actinopterygii and has paired fins and scales, which are absent in Petromyzon.

• Branchiostoma sp.: A cephalochordate with a notochord and lacks a cartilaginous endoskeleton or sucking mouth.

• Scoliodon sp.: A cartilaginous fish (shark) with paired fins and scales, which contrasts with Petromyzon's characteristics.

• Cyclostomata:

• This class includes jawless vertebrates like lampreys and hagfishes.

• They are primitive chordates with a circular mouth, which is adapted for parasitic feeding in some species.

• These organisms are agnathans (lack jaws), distinguishing them from higher vertebrates.

Q143. Answer: (a) C and E only

The correct answer is - C and E only

Key Points

• Secondary spermatocytes undergo meiotic division:

• Secondary spermatocytes undergo their second meiotic division to produce haploid spermatids.

• This process ensures that the spermatids have a haploid number of chromosomes, which is essential for fertilization.

• Spermatids transform into spermatozoa via spermiogenesis:

• Spermatids undergo spermiogenesis, a process of morphological transformation where they develop into mature spermatozoa.

• This transformation includes the development of the acrosome, condensation of the nucleus, and formation of the tail for motility.

Additional Information

• Spermatogenesis overview:

• Spermatogenesis is the process of sperm production that occurs in the seminiferous tubules of the testes.

• It involves three key stages: mitotic division of spermatogonia, meiotic division to produce haploid cells, and spermiogenesis for sperm maturation.

• Role of spermatogonia:

• Spermatogonia are the diploid stem cells of spermatogenesis. They initially divide by mitosis to produce primary spermatocytes.

• Primary spermatocytes undergo the first meiotic division to produce secondary spermatocytes.

• Key differences between spermatids and spermatozoa:

• Spermatids are immature cells and lack the structural features necessary for fertilization.

• Spermatozoa are fully mature, motile cells capable of fertilizing the ovum.

Q144. Answer: (d) 25%

The correct answer is - 25%

Key Points

• Inheritance of Blood Groups

• Blood group inheritance follows the Mendelian principles of genetics, where each parent contributes one allele for the ABO blood group.

• The A and B alleles are codominant, while O is recessive.

• Parental Genotypes

• The mother is heterozygous for blood group A, meaning her genotype is AO.

• The father is heterozygous for blood group B, meaning his genotype is BO.

• Possible Offspring Genotypes

• Using a Punnett square, the following combinations are possible:

• AB (A from mother, B from father)

• A (A from mother, O from father)

• B (B from father, O from mother)

• O (O from both parents)

• The probability of the child having genotype OO (blood group O) is 25%.

Additional Information

• Punnett Square Explanation

• The Punnett square for this case is:

	A (Mother)	**O (Mother)**

B (Father)	AB	B
O (Father)	A	O

• The probability of each genotype is:
• AB: 25%
• A: 25%
• B: 25%
• O: 25%
• Blood Group Characteristics
• A: Has A antigen on red blood cells and anti-B antibodies in plasma.
• B: Has B antigen on red blood cells and anti-A antibodies in plasma.
• AB: Has both A and B antigens on red blood cells and no antibodies in plasma.
• O: Has no antigens on red blood cells but both anti-A and anti-B antibodies in plasma.

Q145. Answer: (d) C, E, D, B, A

The correct answer is - C, E, D, B, A

Key Points

• Renin-Angiotensin Mechanism
• The process begins with a fall in Glomerular filtration rate (GFR), which triggers the release of Renin from the juxtaglomerular cells in the kidneys (Step C).
• Renin converts Angiotensinogen (produced by the liver) into Angiotensin I, which is further converted into Angiotensin II by the enzyme ACE (Step E).
• Angiotensin II causes vasoconstriction (narrowing of blood vessels) and stimulates the release of Aldosterone from the adrenal glands (Step D).
• Aldosterone increases reabsorption of sodium (Na^+) and water in the distal tubules of the nephron, helping restore blood volume and pressure (Step B).
• The combined effects of vasoconstriction and water reabsorption lead to an increase in blood pressure and restoration of GFR (Step A).

Additional Information

• Importance of Renin-Angiotensin Mechanism
• This mechanism is crucial for maintaining blood pressure homeostasis and ensuring adequate kidney filtration.
• It plays a vital role during conditions like hypovolemia (low blood volume), dehydration, or blood loss.
• Regulation of Aldosterone
• Aldosterone is part of the Renin-Angiotensin-Aldosterone System (RAAS), which regulates electrolyte balance and blood pressure.
• Its release is triggered by Angiotensin II and high potassium levels.
• Clinical Relevance
• RAAS dysregulation is associated with conditions like hypertension, heart failure, and chronic kidney disease.
• Drugs like ACE inhibitors and Angiotensin II receptor blockers (ARBs) target this system to manage these conditions.

Q146. Answer: (c) A - III, B - IV, C - I, D - II

The correct answer is - A - III, B - IV, C - I, D - II

Key Points

• Expiratory Reserve Volume (ERV)
• The volume of air that can be exhaled forcefully after normal expiration.
• Capacity: 1000 - 1100 mL.
• Residual Volume (RV)
• The volume of air remaining in the lungs even after a forceful expiration.
• Capacity: 1100 - 1200 mL.
• Inspiratory Reserve Volume (IRV)
• The maximum volume of air that can be inhaled after a normal inspiration.
• Capacity: 2500 - 3000 mL.
• Tidal Volume (TV)

YourMockTest.com – Free Study Material

• The volume of air inhaled or exhaled during normal, quiet breathing.
• Capacity: 500 mL.
Additional Information
• Types of Respiratory Volumes
• Inspiratory Capacity (IC): The total volume of air that can be inspired after a normal expiration (TV + IRV).
• Functional Residual Capacity (FRC): The volume of air remaining in the lungs after normal expiration (ERV + RV).
• Vital Capacity (VC): The maximum volume of air that can be exhaled after a maximum inhalation (TV + IRV + ERV).
• Total Lung Capacity (TLC): The total volume of air in the lungs after maximum inspiration (TV + IRV + ERV + RV).
• Significance of Respiratory Volumes
• Respiratory volumes are crucial for diagnosing lung and respiratory conditions such as asthma, COPD, and restrictive lung diseases.
• They are measured using a device called a spirometer.

Q147. Answer: (a) A - III, B - IV, C - I, D - II

The correct answer is - A - III, B - IV, C - I, D - II
Key Points
• Progestasert
• Progestasert is a hormone-releasing intrauterine device (IUD).
• It releases progesterone to prevent pregnancy.
• This device works by creating a hostile environment in the uterus, reducing sperm motility and preventing fertilization.
• Multiload 375
• Multiload 375 is a copper-releasing IUD.
• Copper ions released by the device inhibit sperm mobility and viability, thereby preventing fertilization.
• It is a long-term contraceptive option with efficacy lasting up to 5 years.
• Diaphragm
• The diaphragm is a barrier contraceptive device made of rubber or silicone.
• It is placed over the cervix to block sperm entry into the uterus.
• It is used in combination with spermicide for increased effectiveness.
• Saheli
• Saheli is a non-hormonal oral contraceptive pill.
• Its active ingredient is Centchroman, which prevents implantation of the fertilized egg.
• It is taken weekly, offering a safe and convenient option for contraception.
Additional Information
• Intrauterine Devices (IUDs)
• These are small, T-shaped devices inserted into the uterus to prevent pregnancy.
• They come in two types: Copper-releasing IUDs (e.g., Multiload 375) and hormone-releasing IUDs (e.g., Progestasert).
• IUDs are long-term, reversible, and highly effective contraceptive methods.
• Barrier Methods
• Barrier methods physically block sperm from entering the uterus.
• Examples include diaphragms, cervical caps, and condoms.
• They are often used with spermicide to enhance contraceptive effectiveness.
• Oral Contraceptives
• Oral contraceptives can be hormonal or non-hormonal.
• Hormonal pills contain estrogen and/or progesterone to prevent ovulation.
• Non-hormonal pills like Saheli work by altering the uterine environment to inhibit implantation.

Q148. Answer: (b) Ribosomes

The correct answer is - Ribosomes
Key Points
• Ribosomes are non-membrane-bound organelles found in both prokaryotic and eukaryotic cells.
• They are composed of ribosomal RNA (rRNA) and proteins.
• They function as the site of protein synthesis in cells.

• Unlike other organelles such as mitochondria or lysosomes, ribosomes do not have a surrounding membrane.
• In prokaryotic cells, ribosomes are of the 70S type, whereas in eukaryotic cells, they are of the 80S type.
• They can be found freely in the cytoplasm or attached to the endoplasmic reticulum in eukaryotic cells.

Additional Information

• Centrosomes
• These are membrane-bound organelles found only in eukaryotic cells.
• They play a role in cell division by organizing microtubules.
• Lysosomes
• These are membrane-bound organelles present only in eukaryotic cells.
• They contain digestive enzymes for breaking down macromolecules.
• Mitochondria
• Known as the powerhouse of the cell, they are membrane-bound organelles found only in eukaryotic cells.
• They are responsible for cellular respiration and energy production (ATP).

Q149. Answer: (b) Pyramid of biomass in sea

The correct answer is - Pyramid of biomass in sea

Key Points

• Pyramid of biomass in sea
• In marine ecosystems, the pyramid of biomass is generally inverted due to the fact that phytoplankton, which are the primary producers, have a small biomass but high reproduction rates.
• Despite their small biomass, phytoplankton can support larger biomass of primary consumers (zooplankton) and higher trophic levels such as fish.
• Phytoplankton are rapidly consumed and replaced, which leads to the inverted biomass pyramid characteristic of aquatic ecosystems.

Additional Information

• Ecological pyramids
• Ecological pyramids are graphical representations showing the relationship between different trophic levels in terms of energy, biomass, or number.
• They can be upright, inverted, or spindle-shaped depending on the ecosystem and the factor being represented.
• Types of ecological pyramids
• Pyramid of energy: Always upright, as energy decreases with each successive trophic level.
• Pyramid of biomass: Upright in terrestrial ecosystems but inverted in aquatic ecosystems due to the rapid turnover of phytoplankton.
• Pyramid of numbers: Can be upright, inverted, or spindle-shaped depending on the number of organisms at each trophic level.
• Marine ecosystem dynamics
• Marine ecosystems are characterized by small-sized primary producers (phytoplankton) that reproduce quickly.
• This allows them to sustain larger biomass at higher trophic levels, leading to the inverted biomass pyramid.

Q150. Answer: (d) Aptenodytes

The correct answer is - Aptenodytes

Key Points

• Aptenodytes
• It refers to a genus of flightless birds commonly known as penguins.
• Penguins have forelimbs modified into paddle-like flippers, making them highly adapted for swimming.
• They are known for their aquatic lifestyle and are primarily found in the Southern Hemisphere, especially in Antarctica.
• Examples of species within this genus include the Emperor Penguin (Aptenodytes forsteri) and King Penguin (Aptenodytes patagonicus).

Additional Information

• Adaptations of Penguins
• Penguins have a streamlined body shape to reduce water resistance during swimming.
• They possess dense feathers coated with oil for waterproofing and insulation in cold environments.
• Their bones are solid rather than hollow, aiding in diving by reducing buoyancy.
• Flightlessness in Birds

• Flightless birds, such as penguins, have evolved due to adaptations for other specialized functions, such as swimming or running.
• Other examples of flightless birds include the Ostrich (Struthio), the Kiwi, and the Rhea.

Q151. Answer: (a) A - II, B - III, C - IV, D - I

The correct answer is - A - II, B - III, C - IV, D - I

Key Points

• Streptokinase
• Importance: It is used for the removal of clots from blood vessels.
• Mechanism: Streptokinase activates plasminogen to form plasmin, which dissolves fibrin clots.
• Statins
• Importance: These are effective blood cholesterol-lowering agents.
• Mechanism: Statins inhibit HMG-CoA reductase, an enzyme involved in cholesterol synthesis.
• Lipases
• Importance: They are widely used in detergent formulations.
• Function: Lipases break down fats into glycerol and fatty acids, aiding in cleaning greasy stains.
• Cyclosporin A
• Importance: It acts as an immunosuppressive agent.
• Application: Used in organ transplantation to prevent rejection by suppressing immune responses.

Additional Information

• Streptokinase in clinical use:
• Used for thrombolytic therapy: Effective in treating myocardial infarction and pulmonary embolism.
• Precaution: Overuse can lead to bleeding complications.
• Statins and cardiovascular health:
• Primary benefit: Reduces LDL ("bad cholesterol") levels.
• Secondary effects: Improves endothelial function and reduces inflammation.
• Lipases in biotechnology:
• Industrial applications: Used in food processing, biodiesel production, and pharmaceuticals.
• Environmental benefits: Lipases help in biodegradable cleaning solutions.
• Cyclosporin A and immunosuppression:
• Mechanism: Inhibits calcineurin, preventing the activation of T-cells.
• Side effects: Can cause nephrotoxicity and hypertension if not monitored carefully.

Q152. Answer: (d) B, C and D only

The correct answer is - B, C, and D only

Key Points

• Rough endoplasmic reticulum (RER)
• The RER has ribosomes attached to its surface, which are responsible for protein synthesis.
• These ribosomes give the RER its characteristic "rough" appearance under a microscope.
• Mitochondria and plastids
• Both mitochondria and plastids contain circular DNA and ribosomes, enabling them to synthesize some of their own proteins.
• These organelles are considered semi-autonomous due to their genetic material and protein synthesis machinery.
• Cytoskeleton
• The cytoskeleton is a network of microtubules, microfilaments, and intermediate filaments present in the cytoplasm.
• It provides structural support, facilitates intracellular transport, and aids in cell division.

Additional Information

• Endomembrane system
• The endomembrane system includes the Golgi complex, endoplasmic reticulum (ER), lysosomes, and vacuoles, but not mitochondria.
• Mitochondria are distinct from this system due to their double membrane and role in energy production.
• Mitochondria
• Mitochondria are double membrane-bound structures, with the inner membrane forming cristae to increase the surface area for energy production.

YourMockTest.com – Free Study Material

• They are involved in cellular respiration, producing ATP through oxidative phosphorylation.
• Plastids
• Plastids are double membrane-bound organelles found in plants and algae, with types including chloroplasts, chromoplasts, and leucoplasts.
• Chloroplasts contain chlorophyll and are responsible for photosynthesis.

Q153. Answer: (c) Flying fish, Angel fish and Fighting fish

The correct answer is - Flying fish, Angel fish and Fighting fish

Key Points

• Class Osteichthyes
• Osteichthyes are commonly known as bony fishes.
• This class includes fishes that have a skeleton primarily made of bone tissue, unlike cartilaginous fishes.
• Examples include Flying fish, Angel fish, and Fighting fish.
• Key Characteristics
• They have a swim bladder for buoyancy control.
• Most of them have scales, which are dermal in origin.
• They possess gills covered by an operculum for respiration.

Additional Information

• Comparison with Other Classes
• Devil fish, Cuttlefish, and Hagfish belong to different classes. For example:
• Devil fish is a type of octopus (class Cephalopoda).
• Cuttlefish also belongs to class Cephalopoda.
• Hagfish belongs to class Myxini (jawless fishes).
• Starfish is not a fish; it belongs to phylum Echinodermata.
• Saw fish and Dog fish are cartilaginous fishes (class Chondrichthyes).
• Significance of Osteichthyes
• Osteichthyes make up the largest group of vertebrates.
• They are found in freshwater and marine environments.

Q154. Answer: (d) males and females, respectively

The correct answer is - males and females, respectively

Key Points

• Chromosome number variation
• In this species of grasshopper, chromosome number differences between individuals are linked to sex determination.
• Males typically have one less chromosome compared to females due to the presence of an unpaired sex chromosome.
• Males and females
• Males of this species possess 23 chromosomes, as they are XO (only one sex chromosome).
• Females possess 24 chromosomes, as they are XX (two sex chromosomes).
• Sex determination system
• This species follows the XO/XX sex determination system, which is common in insects like grasshoppers.
• The absence of a second sex chromosome in males results in the difference in chromosome number between sexes.

Additional Information

• XO/XX sex determination system
• In the XO system, males have one X chromosome (XO), while females have two X chromosomes (XX).
• There is no Y chromosome in this system, unlike the XY system found in humans.
• Chromosome pairing in meiosis
• In males, the unpaired X chromosome results in haploid gametes that determine the sex of the offspring.
• Females, with two X chromosomes, produce diploid gametes.
• Examples of organisms
• The XO/XX system is found in grasshoppers, crickets, and some other insects.
• This system allows for simple genetic determination of sex without the need for complex mechanisms.

YourMockTest.com - Free Study Material

Q155. Answer: (a) 160 - 240/cu.mm and 1600 - 2000/cu.mm, respectively

The correct answer is - 160 - 240/cu.mm and 1600 - 2000/cu.mm, respectively

Key Points

• Eosinophils and lymphocytes are types of white blood cells (WBCs).
• Eosinophils typically make up 2-3% of the total WBC count.
• Lymphocytes typically account for 20-25% of the total WBC count.
• For a WBC count of 8000/cu.mm:
• Eosinophils would be approximately 160 - 240/cu.mm (2-3% of 8000).
• Lymphocytes would be approximately 1600 - 2000/cu.mm (20-25% of 8000).

Additional Information

• White blood cells (WBCs) are a crucial part of the immune system.
• They help fight infections, remove damaged cells, and protect the body against foreign invaders.
• The normal WBC count ranges between 4000 and 11000/cu.mm.
• Types of WBCs include:
• Neutrophils: The most abundant type, comprising 55-70% of total WBCs.
• Lymphocytes: Comprise 20-25%, crucial for producing antibodies.
• Monocytes: Constitute 3-8%, involved in phagocytosis and immune response regulation.
• Eosinophils: Make up 2-3%, play a role in combating parasites and allergic reactions.
• Basophils: Account for 0.5-1%, involved in inflammatory and allergic responses.
• Clinical relevance:
• Abnormal WBC counts can indicate infection, inflammation, or immune system disorders.
• Specific WBC types are analyzed to diagnose conditions like allergies, parasitic infections, or leukemia.

Q156. Answer: (c) cryIAc and cryIAb

The correct answer is - cryIAc and cryIAb

Key Points

• Bacillus thuringiensis
• It produces crystal proteins, also known as cry proteins, which are toxic to specific insect pests.
• These proteins are encoded by cry genes, and they provide effective pest control.
• CryIAc and CryIAb
• CryIAc and CryIAb genes specifically control pests such as cotton bollworms and corn borers.
• These toxins bind to the midgut receptors of the target insects, causing cell lysis and ultimately killing the pests.
• Application in Genetically Modified Crops
• Genetically modified crops like Bt cotton and Bt maize are developed using these cry genes to confer pest resistance.
• This reduces the reliance on chemical pesticides and promotes sustainable agriculture.

Additional Information

• Mode of Action of Cry Proteins
• Cry proteins work by binding to specific receptors in the insect's gut.
• This leads to the formation of pores in the gut cell membranes, disrupting ion flow and causing cell death.
• Specificity of Cry Genes
• Different cry genes target different insect species. For example:
• CryIAc targets cotton bollworms.
• CryIAb targets corn borers.
• This specificity minimizes harm to non-target organisms.
• Environmental Benefits
• Bt crops reduce the need for chemical pesticides, which can harm the environment and human health.
• They also help in preserving beneficial insects in the ecosystem.

Q157. Answer: (b) A - II, B - III, C - IV, D - I

The correct answer is - A - II, B - III, C - IV, D - I

Key Points

• Nicotine - Stimulates adrenal gland to release catecholamines (A - II)

YourMockTest.com – Free Study Material

• Nicotine is a stimulant that acts on the adrenal glands, causing the release of catecholamines like adrenaline and noradrenaline.
• This leads to increased heart rate, blood pressure, and a sense of alertness.
• Morphine - Effective sedative and painkiller (B - III)
• Morphine is an opioid analgesic widely used for its pain-relieving and sedative properties.
• It works by binding to opioid receptors in the brain, reducing the sensation of pain.
• Heroin - A depressant; slows down body functions (C - IV)
• Heroin, an opioid, acts as a depressant that reduces central nervous system activity.
• It slows down breathing, heart rate, and overall body functions.
• Cocaine - Causes sense of euphoria and increased energy (D - I)
• Cocaine is a powerful stimulant that induces a sense of euphoria, increased energy, and heightened alertness.
• It works by increasing levels of dopamine in the brain.
Additional Information
• Nicotine
• Nicotine is found in tobacco products like cigarettes and is highly addictive.
• Its stimulation of catecholamine release can lead to temporary alertness but also long-term health issues like hypertension.
• Morphine
• It is often used in palliative care to relieve severe pain, especially in cancer patients.
• Overuse can lead to tolerance and dependence.
• Heroin
• It is an illegal drug derived from morphine and has no accepted medical use in many countries.
• Prolonged use can cause physical and psychological dependence.
• Cocaine
• It can cause serious cardiovascular issues such as heart attacks and strokes due to its stimulant effects.
• Chronic use can lead to addiction, paranoia, and other mental health disorders.

Q158. Answer: (a) A - III, B - I, C - II, D - IV

The correct answer is - A - III, B - I, C - II, D - IV
Key Points
• Tetany (A - III)
• Tetany refers to wild contractions or spasms in muscles.
• Caused by low calcium ion concentration (Ca++Ca++
) in body fluids, leading to increased nerve excitability.
• Arthritis (B - I)
• Arthritis is characterized by inflammation of joints, resulting in pain and stiffness.
• Common types include osteoarthritis and rheumatoid arthritis.
• Myasthenia gravis (C - II)
• An autoimmune disorder affecting the neuromuscular junction.
• Results in muscle weakness due to impaired signal transmission between nerves and muscles.
• Muscular dystrophy (D - IV)
• A group of genetic disorders causing progressive degeneration of skeletal muscle.
• Symptoms include muscle weakness and loss of muscle mass.
Additional Information
• Calcium deficiency and tetany
• Low calcium levels can affect nerve and muscle function, leading to spasms.
• Common in conditions like hypoparathyroidism.
• Types of arthritis
• Osteoarthritis: Caused by wear and tear of cartilage.
• Rheumatoid arthritis: An autoimmune disorder targeting joint tissues.
• Myasthenia gravis pathophysiology
• Caused by autoantibodies blocking or destroying acetylcholine receptors.
• Results in impaired communication between nerves and muscles.
• Muscular dystrophy genetic basis

• Most types are linked to mutations in genes responsible for muscle proteins.
• Duchenne muscular dystrophy is the most common and severe form.

Q159. Answer: (a) Male honeybees

The correct answer is - Male honeybees

Key Points

• Haploid cells
• Male honeybees, also known as drones, are haploid, meaning they have a single set of chromosomes (n).
• They develop from unfertilized eggs through a process called parthenogenesis.
• Mitotic division in haploid cells
• In male honeybees, the haploid cells divide mitotically to produce sperm cells.
• This is a unique process because most animals produce gametes through meiosis, not mitosis.
• Gamete production
• The sperm produced by male honeybees is haploid, and it fuses with the egg of a queen bee (diploid) to form a diploid zygote, which will develop into a female worker or queen.

Additional Information

• Parthenogenesis
• This is a form of asexual reproduction where offspring develop from unfertilized eggs.
• In honeybees, parthenogenesis results in male drones, which are haploid.
• Diploid organisms
• Most animals, including humans, are diploid, meaning their cells contain two sets of chromosomes (2n).
• In these organisms, gametes (sperm and egg) are produced through meiosis, reducing the chromosome number by half.
• Reproductive roles in honeybees
• Male drones exist solely to fertilize the queen's eggs and do not participate in tasks such as foraging or hive maintenance.
• Female worker bees and queens are diploid and arise from fertilized eggs.

Q160. Answer: (d) C, B, E, A, D

The correct answer is - C, B, E, A, D

Key Points

• Step-by-step process of respiration in humans:
• Pulmonary ventilation (Step C): This is the first step where atmospheric air is drawn into the lungs, and carbon dioxide-rich air is expelled out.
• Diffusion across alveolar membrane (Step B): Oxygen from the alveolar air diffuses into the blood, and carbon dioxide from the blood diffuses into the alveolar air.
• Transport of gases (Step E): Oxygen and carbon dioxide are transported by the blood to different parts of the body.
• Diffusion between blood and tissues (Step A): Oxygen diffuses from the blood into the tissues, and carbon dioxide diffuses from the tissues into the blood.
• Cellular respiration (Step D): This is the final step where cells utilize oxygen to produce energy, and carbon dioxide is released as a byproduct.
• Thus, the correct order is C → B → E → A → D.

Additional Information

• Alveolar membrane:
• The alveolar membrane is extremely thin and highly permeable, allowing efficient gas exchange.
• It consists of alveolar epithelium, a basement membrane, and capillary endothelium.
• Oxygen transport:
• Most oxygen is transported in the blood bound to hemoglobin in red blood cells.
• A small fraction is dissolved in the plasma.
• Cellular respiration:
• This process occurs in the mitochondria, where glucose is broken down in the presence of oxygen to generate ATP (energy).
• Carbon dioxide is a byproduct and is expelled from the body during exhalation.

Q161. Answer: (b) C, A, B, D

The correct answer is - Corona radiata, Zona pellucida, Perivitelline space, Plasma membrane of ovum

Key Points

YourMockTest.com — Free Study Material

• Corona radiata:
• This is the outermost layer surrounding the ovum.
• It consists of several layers of granulosa cells that provide nutrients and protection to the ovum.
• Zona pellucida:
• This is a glycoprotein-rich layer that lies beneath the corona radiata.
• It plays a crucial role in sperm binding and initiating acrosomal reactions during fertilization.
• Perivitelline space:
• This is the fluid-filled space between the zona pellucida and the plasma membrane of the ovum.
• It contains the polar bodies, which are byproducts of meiosis.
• Plasma membrane of ovum:
• This is the innermost layer that directly encloses the cytoplasm of the ovum.
• It is involved in fusion with the sperm cell membrane during fertilization.

Additional Information

• Functions of the layers:
• Corona radiata: Provides physical protection and nourishment to the ovum.
• Zona pellucida: Acts as a selective barrier for sperm entry and prevents polyspermy after fertilization.
• Perivitelline space: Contains polar bodies and helps in meiotic division regulation.
• Plasma membrane: Facilitates sperm-egg fusion and ensures proper zygote formation.
• Relevance during fertilization:
• The sperm must penetrate the corona radiata and bind to the zona pellucida to initiate fertilization.
• Once inside the perivitelline space, the sperm fuses with the plasma membrane of the ovum to form a zygote.
• Structure importance:
• Each layer has a specific role in ensuring only one sperm fertilizes the ovum, preventing issues like polyspermy.

Q162. Answer: (b) Emphysema

The correct answer is - Emphysema

Key Points

• α-1-Antitrypsin (AAT)
• It is a protein primarily produced in the liver and plays a critical role in protecting lung tissues.
• AAT inhibits the enzyme neutrophil elastase, which, if uncontrolled, can damage lung tissues.
• Emphysema
• Emphysema is a chronic pulmonary condition that damages the air sacs (alveoli) in the lungs, leading to breathing difficulties.
• A deficiency in α-1-Antitrypsin can result in unchecked enzymatic activity, causing lung tissue damage and contributing to emphysema.
• Transgenic animals
• Transgenic animals, such as sheep or goats, are genetically engineered to produce human proteins like AAT in their milk.
• The extracted AAT protein is purified and used for therapeutic applications.

Additional Information

• Applications of α-1-Antitrypsin
• AAT is used in replacement therapy for individuals with AAT deficiency to prevent further lung damage.
• It is administered via intravenous infusion in patients diagnosed with AAT-deficiency-related emphysema.
• Genetic basis of AAT deficiency
• AAT deficiency is caused by mutations in the SERPINA1 gene.
• It is an inherited disorder following an autosomal codominant pattern, meaning both alleles contribute to the phenotype.
• Other therapeutic proteins from transgenic animals
• Examples include antithrombin for blood clot prevention and growth hormones for treating growth deficiencies.
• This technology demonstrates the potential of biopharming in medical advancements.

Q163. Answer: (d) A, B and D only

The correct answer is - A, B and D only

Key Points

• Membrane composition of human RBCs

• The plasma membrane of human red blood cells (RBCs) contains approximately 52% protein and 40% lipids, confirming statement A.

• Phospholipid bilayer arrangement

• Phospholipids in the cell membrane are arranged in a bilayer with hydrophobic tails facing inward and hydrophilic heads facing outward, as stated in B.

• Hydrophobic nature of lipid tails

• The lipid tails in the bilayer are hydrophobic and are oriented towards the inner region of the membrane to avoid contact with the aqueous medium, as mentioned in D.

Additional Information

• Glycocalyx

• The glycocalyx is a layer of carbohydrates present on the outer surface of the plasma membrane, contributing to cell recognition and adhesion. However, this is not relevant to the correct answer.

• Mesosomes

• Mesosomes are intracellular extensions of the plasma membrane in prokaryotic cells. They are not found in eukaryotic cells, invalidating statement C.

• Function of cell membranes

• The eukaryotic cell membrane regulates the entry and exit of substances, maintains cell shape, and facilitates cell signaling and communication through embedded proteins.

Q164. Answer: (a) B and D only

The correct answer is - B and D only

Key Points

• Vocal sacs

• Male frogs have specialized structures called vocal sacs, which are used to produce mating calls and attract females during the breeding season.

• These sacs are generally absent in female frogs.

• Copulatory pad on the first digit of forelimbs

• Another distinguishing feature of male frogs is the presence of a copulatory pad on the first digit of their forelimbs.

• This structure helps males grip females during amplexus (the mating position in frogs).

• It is absent in female frogs.

Additional Information

• Sexual dimorphism in frogs

• Sexual dimorphism refers to the physical differences between males and females of the same species.

• In frogs, this is evident through features like vocal sacs and copulatory pads, which are specific to males.

• Function of vocal sacs

• Vocal sacs amplify the sound of mating calls, making them audible over long distances.

• This helps male frogs compete for the attention of females during the breeding season.

• Other features in frogs

• Bulging eyes, webbed digits, and olive green-colored skin are common features in both male and female frogs and do not help in distinguishing between sexes.

Q165. Answer: (a) dN/dt = rN ((K-N)/K)

The correct answer is - dNdt=rN(K−NK)dNdt=rN(K−NK)

Key Points

• Verhulst-Pearl logistic population growth equation

• This equation models population growth considering environmental carrying capacity (K).

• The term rNrN

represents exponential growth rate, where rr

is the intrinsic growth rate and NN

is the population size.

• (K−NK)(K−NK)

accounts for the density-dependent regulation, slowing growth as the population approaches KK

.

• The equation ensures that growth decreases when NN

approaches KK

, simulating realistic population dynamics.

Additional Information

• Carrying Capacity (K)

• KK

is the maximum population size that the environment can sustain indefinitely without degradation.

• Factors influencing KK

include resource availability, space, and competition.

• Logistic Growth vs. Exponential Growth

• Exponential growth assumes unlimited resources, leading to indefinite population growth.

• Logistic growth incorporates resource limitations, slowing growth as the population nears KK

.

• Applications of Logistic Growth

• Used in ecology to model population dynamics of species.

• Applicable in economics to study market saturation and growth trends.

Q166. Answer: (b) A, C and E only

The correct answer is - A, B, and E only

Key Points

• Hepatic portal system

• The hepatic portal system is a special venous connection between the liver and the intestine.

• It ensures that nutrients absorbed from the intestine are transported to the liver for processing before being circulated to the rest of the body.

• Cranial nerves in frogs

• Frogs have ten pairs of cranial nerves, not twelve.

• This statement is incorrect, thus not part of the correct answer.

• Ureters and oviducts in female frogs

• In female frogs, the ureters and oviducts open separately into the cloaca.

• This is part of the correct answer as it accurately describes their anatomy.

• Hindbrain components

• The hindbrain in frogs consists of the cerebellum and medulla oblongata, but not optic lobes (which are part of the midbrain).

• This makes the statement regarding the hindbrain incorrect.

• Sinus venosus

• The sinus venosus is a chamber that collects deoxygenated blood and delivers it to the right atrium of the heart.

• This is a correct statement and part of the answer.

Additional Information

• Frog heart structure

• The frog's heart is three-chambered, consisting of two atria and one ventricle.

• The sinus venosus is a thin-walled sac located at the posterior end of the heart, collecting deoxygenated blood.

• Cloaca

• The cloaca is a common chamber into which the digestive, excretory, and reproductive systems open.

• In female frogs, the oviducts and ureters open into the cloaca separately, facilitating reproduction and excretion.

• Hindbrain functions

• The cerebellum is responsible for maintaining balance and coordination in frogs.

• The medulla oblongata controls vital functions such as respiration and heart rate.

• However, optic lobes are part of the midbrain, not the hindbrain.

Q167. Answer: (a) A and E only

The correct answer is - A and E only

Key Points

• Statement A: Incorrect

• Erythroblastosis foetalis occurs when the mother is Rh-negative and the foetus is Rh-positive, not the other way around as mentioned in the statement.

• This condition arises due to the mother's immune system producing antibodies against the Rh antigen of the foetus, leading to hemolysis of foetal RBCs.
• Statement B: Incorrect
• The Rh antigen is found on the RBCs of approximately 85% of the human population, not the majority as stated.
• The remaining 15% are Rh-negative.
Additional Information
• Statement C: Correct
• Matching the Rh factor is crucial during blood transfusion to prevent adverse immune reactions such as hemolysis.
• Statement D: Correct
• Rh incompatibility occurs when the mother is Rh-negative, and the foetus is Rh-positive, leading to potential immune responses.
• Statement E: Correct
• Anti-Rh antibodies (Rho(D) immune globulin) administered immediately after the first delivery prevent sensitization of the mother's immune system, thus avoiding erythroblastosis foetalis in subsequent pregnancies.

Q168. Answer: (c) B, C and E only

The correct answer is - B, C and E only
Key Points
• B. The joint between any two adjoining vertebrae is a cartilaginous joint.
• Cartilaginous joints provide limited movement and are primarily designed for stability and shock absorption.
• These joints are formed by intervertebral discs, which are fibrocartilaginous structures.
• C. In human beings, the number of cervical vertebrae is seven.
• Humans, like most mammals, have seven cervical vertebrae
• These vertebrae are labeled as C1 to C7, with C1 being the atlas and C2 being the axis.
• E. The occipital bone of the skull is articulated with the atlas vertebra.
• The occipital condyles of the skull connect with the atlas vertebra to form the atlanto-occipital joint.
• This joint allows nodding movements of the head.
Additional Information
• A. Human skull is monocondylic.
• This statement is incorrect as the human skull is dicondylic, meaning it has two occipital condyles.
• Dicondylic skulls allow better articulation and movement with the atlas vertebra.
• D. All ribs except the last 2 pairs are bicephalic.
• This statement is incorrect because all ribs, including the last 2 pairs, are bicephalic.
• Bicephalic ribs have two articulation points (heads) connecting to the thoracic vertebrae.
• Vertebral column and joints
• The vertebral column consists of 33 vertebrae divided into cervical, thoracic, lumbar, sacral, and coccygeal regions.
• Cartilaginous joints between vertebrae provide flexibility and absorb mechanical forces during movement.

Q169. Answer: (b) A - II, B - III, C - IV, D - I

The correct answer is - A - II, B - III, C - IV, D - I
Key Points
• Cortisol (A - II)
• Functions: Cortisol is a glucocorticoid hormone secreted by the adrenal cortex.
• It produces anti-inflammatory reactions by inhibiting the release of inflammatory mediators and reducing immune responses.
• Aldosterone (B - III)
• Functions: Aldosterone is a mineralocorticoid hormone secreted by the adrenal cortex.
• It stimulates reabsorption of sodium (Na^+) and water from the renal tubule into the bloodstream, maintaining blood pressure and fluid balance.
• Cholecystokinin (CCK) (C - IV)
• Functions: CCK is a peptide hormone secreted by the intestinal mucosa.
• It stimulates the secretion of pancreatic enzymes and bile juice, aiding in the digestion of fats and proteins.
• Progesterone (D - I)
• Functions: Progesterone is a steroid hormone secreted by the corpus luteum and placenta.
• It stimulates the formation of alveoli in mammary glands, preparing them for milk production during pregnancy.

Additional Information
• Other Roles of Cortisol
• Regulates metabolism by increasing glucose synthesis and fat breakdown.
• Helps the body respond to stress by increasing energy availability.
• Other Roles of Aldosterone
• Promotes excretion of potassium (K^+) in the urine.
• Its secretion is regulated by the renin-angiotensin-aldosterone system (RAAS).
• Functions of Bile Juice
• Emulsifies fats, breaking them into smaller droplets for easier digestion.
• Neutralizes acidic chyme entering the duodenum from the stomach.
• Progesterone in Pregnancy
• Maintains the uterine lining for implantation of the fertilized egg.
• Prevents uterine contractions, ensuring a stable environment for fetal development.

Q170. Answer: (b) E, D, B, A, C

The correct answer is - E, D, B, A, C
Key Points
• Stage-wise life cycle of Plasmodium
• Female mosquito injects sporozoites into the human bloodstream during a bite (Stage E).
• Sporozoites travel to the liver via blood circulation (Stage D).
• Asexual reproduction occurs in liver cells, causing them to burst and releasing merozoites into the blood (Stage B).
• Asexual reproduction continues in RBCs, leading to the bursting of infected cells and further spread (Stage A).
• Gametocytes develop in RBCs, which are later picked up by a mosquito during its next bite (Stage C).
• Importance of sequence
• Understanding the sequence is crucial for studying the pathogenesis and transmission of malaria.
• The order reflects the parasite's progression within human hosts and vectors.
Additional Information
• Plasmodium life cycle stages
• Sporozoites: Infective form injected by the mosquito.
• Merozoites: Released from liver cells, infect RBCs.
• Gametocytes: Sexual forms developed in RBCs, taken up by mosquitoes.
• Vector biology
• Anopheles mosquito is the primary vector for Plasmodium.
• Lifecycle completion occurs in both humans (asexual stages) and mosquitoes (sexual reproduction).
• Clinical implications
• The bursting of RBCs leads to symptoms like fever and chills.
• Understanding the lifecycle aids in designing antimalarial drugs targeting specific stages.

Q171. Answer: (a) B and E only

The correct answer is - B and E only
Key Points
• Bilateral symmetry in Echinoderms
• Adult Echinoderms exhibit radial symmetry, not bilateral symmetry.
• Bilateral symmetry is seen in their larval stage, but they transition to radial symmetry during adulthood.
• Reptilia and body temperature
• Reptiles are poikilothermic (cold-blooded), meaning they cannot maintain a constant body temperature.
• They rely on external heat sources to regulate their body temperature.
Additional Information
• Digestive system in Platyhelminthes
• Platyhelminthes have an incomplete digestive system, meaning they lack an anus.
• Digestion occurs through a single opening that serves as both mouth and exit for waste.
• Pseudocoelom in Aschelminthes

• Aschelminthes (e.g., roundworms) possess a pseudocoelom, which is a body cavity not fully lined by mesoderm.
• Notochord in Chondrichthyes
• Chondrichthyes (e.g., sharks) retain their notochord throughout life, which provides structural support.

Q172. Answer: (a) Post-synaptic membrane

The correct answer is - Post-synaptic membrane

Key Points

• Receptors for neurotransmitters are specialized proteins located on the post-synaptic membrane.
• These receptors bind specifically to neurotransmitters released from the pre-synaptic neuron.
• The binding of neurotransmitters to these receptors triggers a response in the post-synaptic neuron, such as initiating an electrical signal.
• Signal transmission in a synapse occurs in a one-way direction:
• From the pre-synaptic neuron (which releases neurotransmitters) to the post-synaptic neuron (which has the receptors).
• The specificity of these receptors ensures that only the correct neurotransmitter can elicit a response.

Additional Information

• Pre-synaptic membrane
• Contains vesicles filled with neurotransmitters that are released into the synaptic cleft during signal transmission.
• Does not have receptors for neurotransmitters, as its primary role is to release them.
• Myelin sheath
• A fatty layer that insulates axons, facilitating faster transmission of electrical signals.
• It does not play a direct role in synaptic signaling or neurotransmitter binding.
• Schwann cells
• Specialized glial cells that produce the myelin sheath in the peripheral nervous system.
• They are not involved in receptor-mediated neurotransmitter binding at synapses.

Q173. Answer: (a) A, B, D and E only

The correct answer is - A, B, D and E only

Key Points

• Motor Neuron Signal Transmission
• A motor neuron carries signals from the Central Nervous System (CNS) to the sarcolemma of muscle fibers, initiating muscle contraction.
• Action Potential and Calcium Release
• The neural signal generates an action potential, leading to the release of Ca++Ca++
ions into the sarcoplasm.
• These ions play a critical role in muscle contraction by enabling interaction between actin and myosin filaments.
• Cross Bridge Formation
• Actin binds to the myosin head, forming a cross bridge, which is essential for muscle contraction.
• Sarcomere Shortening
• The sarcomere shortens as actin filaments are pulled towards the center of the 'A' band, resulting in muscle contraction.

Additional Information

• Role of Calcium Ions
• Ca++Ca++
ions bind to troponin, causing a conformational change in tropomyosin and exposing active sites on actin for cross-bridge formation.
• Calcium does not inactivate actin; instead, it facilitates the interaction between actin and myosin.
• Sliding Filament Theory
• Muscle contraction is explained by the sliding filament theory, where actin and myosin filaments slide past each other.
• ATP is required for the detachment of myosin heads and their reattachment during the contraction cycle.
• Structure of Sarcomere
• The 'A' band contains overlapping actin and myosin filaments, while the 'I' band contains only actin filaments.
• During contraction, the 'I' band shortens, but the 'A' band remains unchanged.

YourMockTest.com — Free Study Material

Q174. Answer: (b) Fore limbs of whales and bats

The correct answer is - Fore limbs of whales and bats

Key Points

• Convergent evolution

• Occurs when unrelated species evolve similar traits due to similar environmental pressures or ecological niches.

• Examples include wings in birds and butterflies or eyes in octopuses and mammals.

• Fore limbs of whales and bats

• Represent divergent evolution, not convergent evolution.

• Both species share a common ancestor, and their fore limbs have evolved differently to adapt to different ecological functions (swimming for whales and flying for bats).

• This trait is an example of homologous structures, not analogous structures.

Additional Information

• Homologous structures

• Structures that share a common evolutionary origin but may have different functions.

• Examples: Fore limbs of whales, bats, humans, and other tetrapods.

• Analogous structures

• Structures that have similar functions but different evolutionary origins.

• Examples: Wings of butterflies and birds, flippers of penguins and dolphins.

• Divergent evolution

• Occurs when species with a common ancestor evolve different traits due to adaptation to different environments.

• Leads to homologous structures.

• Convergent evolution

• Leads to analogous structures due to similar selection pressures.

• Examples include streamlined body shapes in sharks and dolphins.

Q175. Answer: (c) Distal convoluted tubule and afferent renal arteriole

The correct answer is - Distal convoluted tubule and afferent renal arteriole

Key Points

• Juxta Glomerular Apparatus (JGA)

• JGA is a specialized structure located in the nephron, responsible for regulating kidney function.

• It is formed by cellular modifications in the distal convoluted tubule and the afferent renal arteriole, which are closely associated with the same nephron.

• JGA plays a key role in the regulation of blood pressure and filtration rate by controlling the secretion of renin.

• Renin Secretion

• The macula densa cells in the distal convoluted tubule detect changes in sodium chloride (NaCl) concentration.

• The juxtaglomerular cells in the afferent arteriole respond to these signals by releasing renin, which triggers the renin-angiotensin system.

Additional Information

• Components of JGA

• The macula densa cells are located in the distal convoluted tubule and are sensitive to changes in the concentration of sodium and chloride ions.

• The juxtaglomerular cells, found in the walls of the afferent arteriole, secrete renin in response to signals from the macula densa.

• Extraglomerular mesangial cells help in communication between macula densa and juxtaglomerular cells.

• Functions of JGA

• Maintains blood pressure through activation of the renin-angiotensin-aldosterone system (RAAS).

• Regulates glomerular filtration rate (GFR) based on feedback from the macula densa cells.

• Clinical Relevance

• Dysfunction of JGA can lead to hypertension or impaired renal function due to altered renin secretion.

• Conditions like renovascular hypertension are associated with excessive renin production.

Q176. Answer: (b) Lyases

The correct answer is - Lyases

Key Points

• Lyases are a class of enzymes that catalyze the cleavage of bonds (such as C-C, C-O, C-N, etc.) by means other than hydrolysis or oxidation.
• They often generate a double bond or a new ring structure in the resulting product.
• The reaction in question likely involves the breaking of a bond without the addition of water (non-hydrolytic) or electron transfer (non-oxidative), which aligns with the activity of lyases.
• Examples of lyase enzymes include decarboxylases, aldolases, and lyases acting on phosphate groups.

Additional Information

• Classification of Enzymes
• Enzymes are classified into six major classes: Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, and Ligases.
• Each class is defined based on the type of reaction they catalyze.
• Difference between Lyases and Other Classes
• Lyases differ from Hydrolases because they do not involve water in bond cleavage.
• Unlike Oxidoreductases, lyases do not involve electron transfer in the reaction mechanism.
• Examples of Reactions Catalyzed by Lyases
• The conversion of pyruvate to acetaldehyde by pyruvate decarboxylase.
• The cleavage of fructose 1,6-bisphosphate into glyceraldehyde-3-phosphate and dihydroxyacetone phosphate by aldolase.

Q177. Answer: (b) A - II, B - I, C - IV, D - III

The correct answer is - A - II, B - I, C - IV, D - III

Key Points

• Molluscs
• Most molluscs, such as aquatic species, use branchial respiration, meaning they breathe through gills.
• Reptiles
• Reptiles rely on pulmonary respiration only, breathing exclusively through lungs.
• Adult amphibians
• Adult amphibians use both pulmonary respiration (lungs) and cutaneous respiration (through skin) for breathing.
• Amoeba
• Amoebas rely on cellular respiration, where oxygen diffuses directly through their cell membrane and is used in metabolic processes.

Additional Information

• Respiration Types
• Branchial respiration: Involves the use of gills in aquatic organisms, like molluscs and fish.
• Pulmonary respiration: Involves lungs as the primary organ for breathing, seen in reptiles, mammals, and birds.
• Cutaneous respiration: Involves gas exchange directly through the skin, primarily seen in amphibians.
• Cellular respiration: Happens at the cellular level, where oxygen is utilized to produce energy through metabolic pathways like glycolysis and the Krebs cycle.
• Amphibians' Dual Respiration
• Amphibians like frogs can breathe through their lungs when on land and through their skin while underwater.
• This adaptation allows them to survive in both terrestrial and aquatic environments.
• Single-celled Organisms
• Organisms like amoebas depend entirely on simple diffusion for oxygen intake and waste removal.
• They lack specialized respiratory structures due to their microscopic size.

Q178. Answer: (d) The production of large amount of CO2 by Propionibacterium sharmanii

The correct answer is - The production of large amount of CO2CO2

by Propionibacterium sharmanii

Key Points

• Swiss Cheese production
• The characteristic large holes in Swiss cheese are formed due to the release of CO2CO2

(carbon dioxide).

• This CO2CO2

is produced during the fermentation process by the bacterium Propionibacterium sharmanii.
• As the cheese matures, the CO2CO2

accumulates and creates the iconic holes or "eyes."
• Role of Propionibacterium sharmanii
• This bacterium is added during the cheese-making process.
• It ferments lactic acid into propionic acid, acetic acid, and CO2CO2
, which also contribute to the unique flavor of Swiss cheese.
Additional Information
• Key microorganisms in cheese production
• Lactic acid bacteria (e.g., Lactobacillus, Streptococcus) are responsible for primary fermentation, converting lactose into lactic acid.
• Propionibacterium sharmanii is specific to Swiss cheese and is responsible for the secondary fermentation that produces CO2CO2
.
• Other types of cheese holes
• Some cheeses, like Emmental, also have holes due to the same bacterial CO2CO2
production.
• However, cheeses such as Cheddar do not have holes because they are not fermented with gas-producing bacteria.
• Importance of controlled fermentation
• The size and distribution of holes depend on factors like temperature, humidity, and the amount of bacteria added.
• Careful monitoring ensures consistent quality and appearance of the Swiss cheese.

Q179. Answer: (a) A - II, B - IV, C - I, D - III

The correct answer is - A - II, B - IV, C - I, D - III
Key Points
• A - II (About 65 mya - The dinosaurs suddenly disappeared from the earth)
• Dinosaurs went extinct approximately 65 million years ago, marking the end of the Cretaceous period.
• This extinction event is believed to have been caused by a massive asteroid impact or volcanic activity.
• B - IV (About 500 mya - Invertebrates were formed and became active)
• During this time, the Cambrian Explosion occurred, leading to the rapid diversification of invertebrates.
• Key invertebrate groups such as arthropods and mollusks emerged during this period.
• C - III (About 350 mya - Seaweeds and few plants probably existed)
• Fossil evidence suggests that simple plants like seaweeds and early land plants existed around this time.
• This marks an important step in the evolution of terrestrial ecosystems.
• D - I (About 320 mya - Jawless fish probably evolved)
• Jawless fish, one of the earliest vertebrates, evolved approximately 320 million years ago.
• These fish are represented today by species such as lampreys and hagfish.
Additional Information
• Mass Extinction Events
• There have been five major mass extinction events in Earth's history, including the one that wiped out the dinosaurs 65 mya.
• The most significant extinction event was the Permian-Triassic extinction, which occurred about 252 mya.
• Evolutionary Timeline of Life
• The first life forms appeared approximately 3.5 billion years ago, starting with simple, single-celled organisms.
• Multicellular organisms evolved around 600 mya, leading to the Cambrian Explosion.
• Vertebrates like jawless fish emerged after invertebrates, marking a major evolutionary milestone.
• Fossil Evidence
• Fossils provide crucial evidence for understanding the timeline of evolutionary events.
• They help scientists date the appearance of major life forms such as plants, fish, and invertebrates.

Q180. Answer: (d) B, D and E only

The correct answer is - B, D, and E only
Key Points
• Mutualism
• In mutualism, both species benefit from the interaction.
• Examples include pollination, where plants gain reproductive success and pollinators receive nectar.

YourMockTest.com — Free Study Material

• Parasitism
• In parasitism, one species benefits while the other species is harmed.
• Parasites depend on the host for survival, often causing harm or disease to the host.
• Amensalism
• In amensalism, one species is harmed while the other species remains unaffected.
• An example is the release of toxins by certain plants, such as black walnut, which inhibits the growth of nearby plants.
Additional Information
• Commensalism
• In commensalism, one species benefits while the other is neither harmed nor benefited.
• An example is barnacles attaching to whales; barnacles gain mobility, while whales remain unaffected.
• Competition
• In competition, both species are harmed as they compete for limited resources.
• This occurs in scenarios such as food scarcity or habitat overlap.
• Predation
• In predation, one species benefits (predator) while the other species is harmed (prey).
• Examples include lions hunting zebras or birds feeding on insects.

More previous year papers and mock tests: **www.yourmocktest.com/pyq**

YourMockTest.com — Free Study Material