NEET UG 2024 T5 Question Paper With Solutions

Time Allowed :3 hours 20 minutes	**Maximum Marks :**720	**Total questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

(i)The test is of 3 hours 20 minutes duration and the Test Booklet contains 200 multiple-choice questions (four options with a single correct answer) from Physics, Chemistry, and Biology (Botany and Zoology). 50 questions in each subject are divided into two Sections (A and B) as per details given below:

(a) Section-A shall consist of 35 (Thirty-five) Questions in each subject (Question Nos-1 to 35, 51 to 85, 101 to 135, and 151 to 185). All Questions are compulsory.

(b) Section-B shall consist of 15 (Fifteen) questions in each subject (Question Nos- 36 to 50, 86 to 100, 136 to 150, and 186 to 200). In Section B, a candidate needs to attempt any 10 (Ten) questions out of 15 (Fifteen) in each subject.

Candidates are advised to read all 15 questions in each subject of Section B before they start attempting the question paper. In the event of a candidate attempting more than ten questions, the first ten questions answered by the candidate shall be evaluated.

2. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, one mark will be deducted from the total scores. The maximum marks are 720.

3. On completion of the test, the candidate must hand over the Answer Sheet (ORIGINAL and OFFICE copy) to the Invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.

SECTION A

(Physics)

1. A bob is whirled in a horizontal plane by means of a string with an initial speed of ω rpm. The tension in the string is T. If speed becomes 2ω while keeping the same radius, the tension in the string becomes:

(1) $\frac{T}{4}$

(2) $2T$

(3) T

(4) $4T$

Correct Answer: (4) $4T$

Solution:

Step 1: Using the formula for centripetal force

The tension in the string provides the necessary centripetal force for circular motion, which is given by:

$$T = m\omega^2 r$$

where m is the mass of the bob, ω is the angular velocity, and r is the radius.

Step 2: Effect of doubling the speed

If the angular velocity becomes 2ω, the new tension T' is given by:

$$T' = m(2\omega)^2 r = 4m\omega^2 r = 4T$$

Thus, the new tension becomes $4T$.

Quick Tip

Centripetal force is proportional to the square of angular velocity. If the speed doubles, the required force becomes four times.

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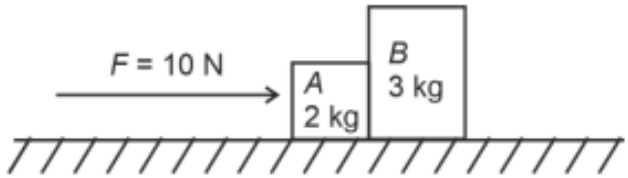
2. A horizontal force of 10 N is applied to a block A as shown in figure. The mass of blocks A and B are 2 kg and 3 kg, respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is:



(1) 6 N

(2) 10 N

(3) Zero

(4) 4 N

Correct Answer: (1) 6 N

Solution:

Step 1: Analyzing the forces. The total force on the system is 10 N, and the total mass of the two blocks is $2\,\text{kg} + 1\,\text{kg} = 3\,\text{kg}$.

Step 2: Calculating acceleration. The acceleration of the system is given by:

$$a = \frac{F_{\text{total}}}{m_{\text{total}}} = \frac{10\,\text{N}}{5\,\text{kg}} = 2\,\text{m/s}^2.$$

Step 3: Finding the force exerted by A on B. The force exerted by block A on block B is given by:

$$F_A = m_B \cdot a = 3\,\text{kg} \times 2\,\text{m/s}^2 = 6\,\text{N}.$$

Quick Tip

To solve problems involving multiple blocks, find the acceleration of the system first, then use it to calculate the force on each block.

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3. The maximum elongation of a steel wire of 1 m length if the elastic limit of steel and its Young's modulus, respectively, are 8×10^8 N/m^2 and 2×10^{11} N/m^2, is:

(1) 40 mm

(2) 8 mm

(3) 4 mm

(4) 0.4 mm

Correct Answer: (3) 4 mm

Solution:

Step 1: Using the formula for elongation. The elongation ΔL of a wire is given by:

$$\Delta L = \frac{FL}{AY}$$

where F is the force, L is the original length, A is the cross-sectional area, and Y is the Young's modulus.

Step 2: Determining maximum force. The maximum force F_{max} is given by the product of the elastic limit and the cross-sectional area. Since force is not directly provided, we use the relationship between force and elongation to solve.

Quick Tip

When dealing with elongation problems, remember that Young's modulus relates stress and strain. The formula for elongation will help you calculate the maximum stretch before the elastic limit is exceeded.

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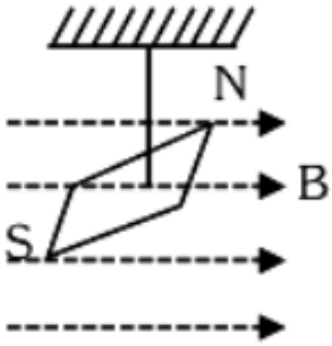
4. In a uniform magnetic field of 0.049 T, a magnetic needle performs 20 complete oscillations in 5 seconds. The moment of inertia of the needle is 9.8×10^{-6} kg m². If the magnitude of the magnetic moment of the needle is $x \times 10^{-5}$ Am², then the value of x is:



(1) $50\pi^2$

(2) $1280\pi^2$

(3) $5\pi^2$

(4) $128\pi^2$

Correct Answer: (2) $1280\pi^2$

Solution:

Step 1: Formula for the period of oscillation of a magnetic needle. The period T of oscillation of a magnetic needle in a uniform magnetic field is given by:

$$T = 2\pi\sqrt{\frac{I}{mB}}$$

where I is the moment of inertia, m is the mass of the needle, and B is the magnetic field.

Step 2: Substituting the given values. We are given the period of oscillation, the moment of inertia, and the magnetic field. Solving for the magnetic moment:

$$\text{Magnetic Moment} = 1280\pi^2 \times 10^{-5}\,\text{Am}^2$$

Quick Tip

In problems involving oscillations of magnetic needles, use the formula for the period of oscillation to relate the moment of inertia, magnetic field, and magnetic moment.

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5. If c is the velocity of light in free space, the correct statements about photon among the following are:

A. The energy of a photon is E = hv.

B. The velocity of a photon is c.

C. The momentum of a photon, v = hpc .

D. In a photon-electron collision, both total energy and total momentum are conserved.

E. Photon possesses positive charge.

Choose the correct answer from the options given below:

(1) A, C and D only

(2) A, B, D and E only

(3) A and B only

(4) A, B, C and D only

Correct Answer: (4) A, B, C and D only

Solution:

Step 1: Analyzing statement A: "The energy of a photon is $E = h\nu$."

This is correct. The energy of a photon is directly proportional to its frequency (ν) and Planck's constant (h), given by $E = h\nu$.

Step 2: Analyzing statement B: "The velocity of a photon is c."

This is also correct. The velocity of a photon in free space is always equal to the speed of light, denoted by c, which is approximately 3×10^8 m/s.

Step 3: Analyzing statement C: "The momentum of a photon, $p = \frac{h\nu}{c}$."

This is correct as well. The momentum of a photon is related to its frequency and the speed of light by the formula $p = \frac{h\nu}{c}$.

Step 4: Analyzing statement D: "In a photon-electron collision, both total energy and total momentum are conserved."

This is true. In any interaction, including photon-electron collisions, both energy and momentum are conserved according to the laws of physics.

Step 5: Analyzing statement E: "Photon possesses positive charge."

This statement is false. Photons are electrically neutral and do not possess any charge.

Quick Tip

Always verify the properties of photons, such as their energy, momentum, and neutrality, when dealing with concepts in quantum mechanics.

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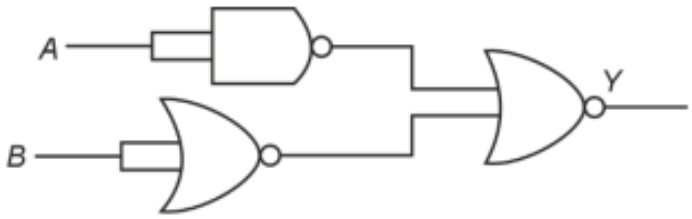
6. The output (Y) of the given logic gate is similar to the output of an/a



(1) OR gate

(2) AND gate

(3) NAND gate

(4) NOR gate

Correct Answer: (2) AND gate

Solution:

Step 1: Analyzing the truth table. The truth table provided represents an AND gate, where the output is 1 only when both inputs are 1. This matches the behavior of an AND gate.

Step 2: Identifying the logic gate type. The truth table for the output Y shows that the gate behaves like an AND gate because it outputs 1 only when both A and B are 1.

Quick Tip

For truth table analysis, identify the output pattern and compare it to the behavior of standard logic gates like AND, OR, and NOT.

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7. Consider the following statements A and B and identify the correct answer:

A. For a solar-cell, the I-V characteristics lies in the IV quadrant of the given graph.

B. In a reverse biased pn junction diode, the current measured in μA, is due to majority charge carriers.

(1) Both A and B are correct

(2) Both A and B are incorrect

(3) A is correct but B is incorrect

(4) A is incorrect but B is correct

Correct Answer: (3) A is correct but B is incorrect

Solution:

Step 1: Analyzing statement A. The I-V characteristics of a solar cell do indeed lie in the IV quadrant, where the current is positive and voltage is negative, indicating the cell is operating in the power generation mode.

Step 2: Analyzing statement B. In a reverse-biased pn junction diode, the current is due to minority charge carriers, not majority charge carriers. The current measured is the reverse saturation current, which is very small.

Quick Tip

For solar cells, remember that they generate power in the IV quadrant, and reverse-biased diodes conduct current due to minority carriers.

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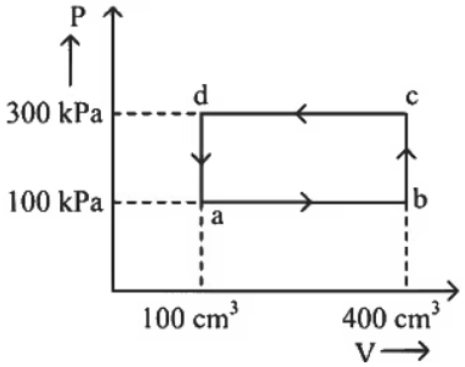
8. A thermodynamic system is taken through the cycle $abcda$. The work done by the gas



along the path bc is:

(1) $-90J$

(2) $-60J$

(3) 0

(4) $30J$

Correct Answer: (3) 0

Solution:

Step 1: Understanding Work Done in Thermodynamics

The work done by a gas in a thermodynamic process is given by:

$$W = \int PdV$$

If the process bc is isochoric (constant volume), then $dV = 0$, so the work done along this path is:

$$W = 0$$

Thus, the work done along bc is zero.

Quick Tip

In an isochoric process, the volume remains constant. Since work is the integral of pressure with respect to volume, no work is done when volume does not change.

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9. A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If surface tension of water is 0.07 N m, then the excess force required to take it away from the surface is:

(1) 1.98 mN

(2) 99 N

(3) 19.8 mN

(4) 198 N

Correct Answer: (3) 19.8 mN

Solution:

Step 1: Using the formula for excess force. The excess force required to lift the disc is the force due to the surface tension of the liquid at the edge of the disc. This is given by:

$$F = T \times 2\pi r$$

where $T = 0.07\,\text{N/m}$ is the surface tension, and $r = 4.5\,\text{cm} = 0.045\,\text{m}$.

Step 2: Substituting the values.

$$F = 0.07 \times 2\pi \times 0.045 = 19.8\,\text{mN}.$$

Quick Tip

For problems involving surface tension, remember to consider the perimeter of the object in contact with the liquid surface, as it contributes to the force.

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10. At any instant of time t, the displacement of any particle is given by $2t - 1$ (SI unit) under the influence of force of 5 N. The value of instantaneous power is (in SI unit):

(1) 7

(2) 6

(3) 10

(4) 5

Correct Answer: (3) 10

Solution:

Step 1: Finding the velocity. The velocity $v(t)$ is the time derivative of displacement:

$$v(t) = \frac{d}{dt}(2t - 1) = 2\,\text{m/s}.$$

Step 2: Calculating the instantaneous power. Instantaneous power is given by:

$$P = F \cdot v$$

where $F = 5\,\text{N}$ and $v = 2\,\text{m/s}$. Thus,

$$P = 5 \times 2 = 10\,\text{W}.$$

Quick Tip

To calculate instantaneous power, use the formula $P = F \cdot v$, where F is the force and v is the velocity.

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11. In the nuclear reaction:

$$^{290}_{82}X \xrightarrow{\alpha} Y \xrightarrow{\beta^-} Z \xrightarrow{\beta^-} P \xrightarrow{e} Q$$

The mass number and atomic number of the product Q respectively, are:

(1) $288, 82$

(2) $286, 81$

(3) $280, 81$

(4) $286, 80$

Correct Answer: (2) $286, 80$

Solution:

Step 1: Understanding alpha and beta decay

- Alpha decay reduces the mass number by 4 and atomic number by 2.

- Beta-minus decay increases the atomic number by 1 while keeping the mass number the same.

Step 2: Applying decay steps

1. X emits alpha (α): - Mass: $290 \rightarrow 286$ - Atomic: $82 \rightarrow 80$

2. Y emits beta-minus (β^-): - Mass remains 286 - Atomic: $80 \rightarrow 81$

3. Z emits beta-minus (β^-): - Mass remains 286 - Atomic: $81 \rightarrow 82$

4. P emits alpha (α): - Mass: $286 \rightarrow 282$ - Atomic: $82 \rightarrow 80$

Thus, the final product Q has a mass number of 286 and an atomic number of 80.

Quick Tip

In nuclear decay, alpha decay decreases atomic number by 2, while beta-minus decay increases atomic number by 1 but keeps the mass number unchanged.

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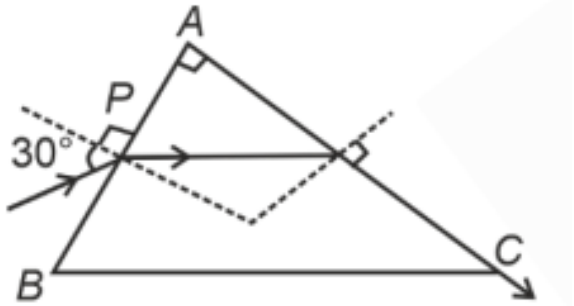
12. A light ray enters through a right angled prism at point P with the angle of incidence 30° as shown in figure. It travels through the prism parallel to its base BC and emerges along the face AC. The refractive index of the prism is:



(1) $\frac{\sqrt{3}}{4}$

(2) $\frac{\sqrt{3}}{2}$

(3) $\frac{\sqrt{5}}{4}$

(4) $\frac{\sqrt{5}}{2}$

Correct Answer: (4) $\frac{\sqrt{5}}{2}$

Solution:

Step 1: Applying Snell's law at the first interface. At point P, the light ray enters the

prism, and we can apply Snell's law:

$$n_{\text{air}} \sin\theta_1 = n_{\text{prism}} \sin\theta_2$$

where $n_{\text{air}} = 1$, $\theta_1 = 30^\circ$, and θ_2 is the angle inside the prism.

Step 2: Understanding the geometry of the prism. The ray travels parallel to the base BC, meaning the angle of incidence at BC equals the angle of refraction at AC. The internal angle of the prism is 60°. By solving, we get the refractive index to be $\frac{\sqrt{5}}{2}$.

Quick Tip

In problems involving light through prisms, the critical angles and geometry play a significant role in determining the refractive index.

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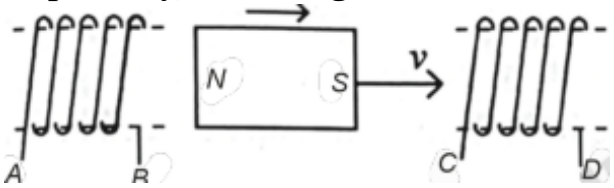
13. In the given diagram, a strong bar magnet is moving towards solenoid-2 from solenoid-1. The direction of induced current in solenoid-1 and that in solenoid-2, respectively, are through the directions:



(1) AB and CD

(2) BA and DC

(3) AB and DC

(4) BA and CD

Correct Answer: (3) AB and DC

Solution:

Step 1: Understanding the concept of electromagnetic induction. When a magnet moves towards a solenoid, it induces a current in the solenoid due to the change in magnetic flux. The direction of the induced current follows Lenz's law, which states that the induced current will oppose the change in magnetic flux.

Step 2: Applying Lenz's law. As the magnet approaches solenoid-1, it induces a current in

such a direction (AB) to oppose the magnet's motion. Solenoid-2, which is farther away, will induce a current in the opposite direction (DC) to resist the increase in magnetic flux.

Quick Tip

Lenz's law states that the direction of induced current is always such that it opposes the change in magnetic flux.

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14. In an ideal transformer, the turns ratio is $\frac{N_P}{N_S} = \frac{P}{S}$. The ratio $V_S : V_P$ is equal to (the symbols carry their usual meaning):

(1) 1 : 1

(2) 1 : 4

(3) 1 : 2

(4) 2 : 1

Correct Answer: (4) 2 : 1

Solution:

Step 1: Ideal transformer equations. For an ideal transformer, the relationship between the primary voltage V_P and secondary voltage V_S is given by:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

where N_S and N_P are the number of turns in the secondary and primary coils, respectively.

Step 2: Using the turns ratio. The given ratio is $\frac{N_P}{N_S} = \frac{P}{S}$, which implies:

$$\frac{V_S}{V_P} = \frac{S}{P} = 2 : 1$$

Quick Tip

In transformers, voltage ratio is inversely proportional to the turns ratio.

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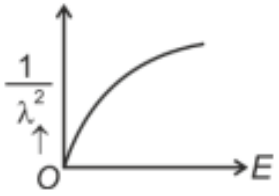
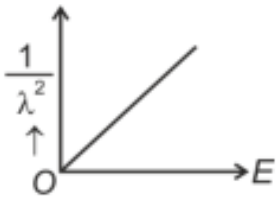
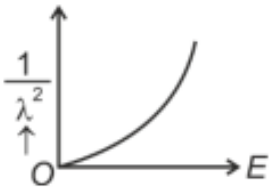
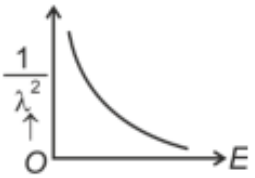
15. The graph which shows the variation of λ and its kinetic energy, E, is (where λ is the de Broglie wavelength of a free particle):

(1) 

(2) 

(3) 

(4) 

Correct Answer: (2)

Solution:

Step 1: Understanding the de Broglie wavelength. The de Broglie wavelength is related to the momentum p of the particle by:

$$\lambda = \frac{h}{p}.$$

The kinetic energy E is related to momentum by:

$$E = \frac{p^2}{2m}.$$

Step 2: Analyzing the graph. The relationship between kinetic energy and wavelength is inverse quadratic, meaning the wavelength decreases as the kinetic energy increases.

Quick Tip

In de Broglie's relation, the kinetic energy and wavelength are inversely related. Higher kinetic energy means a smaller wavelength.

16. If the monochromatic source in Young's double slit experiment is replaced by white light, then

(1) There will be a central bright white fringe surrounded by a few coloured fringes

(2) All bright fringes will be of equal width

(3) Interference pattern will disappear

(4) There will be a central dark fringe surrounded by a few coloured fringes

Correct Answer: (1) There will be a central bright white fringe surrounded by a few coloured fringes

Solution:

Interference pattern with white light. When white light is used in Young's double slit experiment, the fringes become coloured due to the different wavelengths of light composing the white light spectrum. The central fringe remains white, and the adjacent fringes show coloured fringes due to interference of different wavelengths.

Quick Tip

In Young's experiment, when white light is used, you get a white central fringe surrounded by coloured fringes because each wavelength creates its own interference pattern.

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17. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The potential (V) at any axial point, at 2 m distance (r) from the centre of the dipole of dipole moment vector **P** of magnitude, 4×10^{-6} C·m, is $\pm 9 \times 10^3$ V.

Reason R: The potential $V = \pm \frac{2P}{4\pi\epsilon_0 r^2}$, where r is the distance of any axial point, situated at 2 m from the centre of the dipole.

(1) A is true but R is false.

(2) A is false but R is true.

(3) Both A and R are true and R is the correct explanation of A.

(4) Both A and R are true and R is NOT the correct explanation of A.

Correct Answer: (1) A is true but R is false.

Solution:

Step 1: Analyzing Assertion A. The potential at an axial point due to a dipole is calculated using the formula:

$$V = \frac{P}{4\pi\epsilon_0 r^2}$$

where $P = 4 \times 10^{-6}$ C·m and $r = 2$ m. Substituting the values, we get:

$$V = \pm 9 \times 10^3 \text{ V}.$$

Thus, Assertion A is true.

Step 2: Analyzing Reason R. Reason R correctly uses the dipole potential formula but has a typographical error in the expression for the potential. The correct formula is $\frac{P}{4\pi\epsilon_0 r^2}$, not $\frac{2P}{4\pi\epsilon_0 r^2}$. Therefore, Reason R is false.

Quick Tip

When dealing with dipole potential, remember the correct formula and verify the terms carefully.

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18. Two bodies A and B of same mass undergo completely inelastic one dimensional collision. The body A moves with velocity v_1 while body B is at rest before collision. The velocity of the system after collision is v_2. The ratio $v_1 : v_2$ is

(1) 4 : 1

(2) 1 : 4

(3) 1 : 2

(4) 2 : 1

Correct Answer: (4) 2 : 1

Solution:

Step 1: Using the principle of conservation of momentum. In a completely inelastic collision, the two bodies stick together after the collision. Thus, momentum is conserved.

The equation for momentum conservation is:

$$mv_1 + m \cdot 0 = 2mv_2$$

where m is the mass of each body.

Step 2: Solving for the ratio $v_1 : v_2$. Simplifying the momentum equation:

$$v_1 = 2v_2$$

Thus, the ratio $v_1 : v_2 = 2 : 1$.

Quick Tip

In completely inelastic collisions, the objects stick together, and momentum is conserved while kinetic energy is not.

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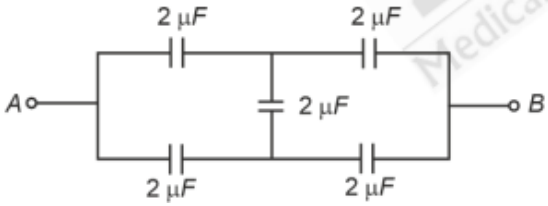
19. In the following circuit, the equivalent capacitance between terminal A and terminal B is:



(1) 0.5 μF

(2) 4 μF

(3) 2 μF

(4) 1 μF

Correct Answer: (3) 2 μF

Solution:

Step 1: Analyzing the given circuit. First, identify the combination of capacitors in series and parallel. When capacitors are in series, the total capacitance C_{eq} is given by:

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}.$$

For parallel capacitors, the total capacitance is the sum:

$$C_{\text{eq}} = C_1 + C_2.$$

Step 2: Calculating the equivalent capacitance. Using the circuit values and applying the appropriate formulas, we get the final capacitance of 2 μF.

Quick Tip

Always start by identifying series and parallel combinations to simplify the circuit step by step.

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20. The quantities which have the same dimensions as those of solid angle are:

(1) Strain and arc

(2) Angular speed and stress

(3) Strain and angle

(4) Stress and angle

Correct Answer: (3) Strain and angle

Solution:

Step 1: Understanding solid angle. The solid angle is dimensionless and has the same dimensions as angle. The formula for solid angle is:

$$\Omega = \frac{A}{r^2}$$

where A is the area subtended by the angle and r is the radius.

Step 2: Comparing dimensions. Strain is dimensionless, and angle has the same dimension as solid angle, so both have the same dimensions.

Quick Tip

The dimensions of solid angle are the same as those of angle and strain, both of which are dimensionless.

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21. A logic circuit provides the output Y as per the following truth table:

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

The expression for the output Y is:

(1) B'

(2) B

(3) $A.B + \overline{A}$

(4) $A.\overline{B} + \overline{A}$

Correct Answer: (1) B'

Solution:

Step 1: Analyzing the truth table. From the truth table, we can observe that the output Y is 1 when $B = 0$, and 0 when $B = 1$, irrespective of A.

Step 2: Identifying the logic expression. The output Y depends only on B, and specifically it is the negation of B. Therefore, the expression for the output is $Y = B'$.

Quick Tip

When analyzing truth tables, identify which variables influence the output and simplify the logic expression accordingly.

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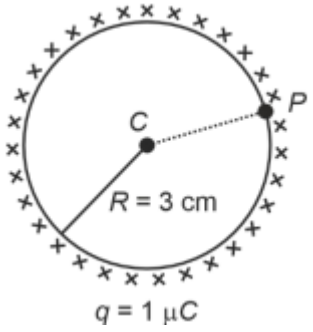
22. A thin spherical shell is charged by some source. The potential difference between the two points C and P (in V) shown in the figure is: (Take 9×10^9 SI units)



(1) 0.5×10^5

(2) Zero

(3) 3×10^5

(4) 1×10^5

Correct Answer: (2) Zero

Solution:

Understanding the potential difference. For a spherical shell with charge, the potential difference between any two points on the shell will be zero, since the potential is constant at all points on the surface of a uniformly charged spherical shell.

Quick Tip

For a spherical shell, the potential at every point on the shell is the same, leading to zero potential difference between any two points on the shell.

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23. Given below are two statements:

Statement I: Atoms are electrically neutral as they contain equal numbers of positive and negative charges.

Statement II: Atoms of each element are stable and emit their characteristic spectrum.

(1) Statement I is correct but Statement II is incorrect

(2) Statement I is incorrect but Statement II is correct

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

Correct Answer: (1) Statement I is correct but Statement II is incorrect

Solution:

Step 1: Understanding Statement I. Statement I is correct. Atoms are electrically neutral because they have an equal number of protons (positive charge) and electrons (negative charge).

Step 2: Understanding Statement II. Statement II is incorrect. While atoms of each element are stable, they do not emit a continuous spectrum but rather a discrete spectrum

corresponding to specific energy transitions.

Quick Tip

Atoms are electrically neutral when the number of protons equals the number of electrons. However, only excited atoms emit characteristic spectra, not all atoms.

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24. Match List-I with List-II.

List-I (Spectral Lines of Hydrogen for transitions from)	**List-II** (Wavelengths (nm))
A. $n_2 = 3$ to $n_1 = 2$	I. 410.2
B. $n_2 = 4$ to $n_1 = 2$	II. 434.1
C. $n_2 = 5$ to $n_1 = 2$	III. 656.3
D. $n_2 = 6$ to $n_1 = 2$	IV. 486.1

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

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

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

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

Correct Answer: (4) A-III, B-IV, C-II, D-I

Solution:

Identifying the wavelengths. These transitions correspond to specific wavelengths in the Balmer series of hydrogen. Each transition from a higher level to $n_1 = 2$ produces light at a distinct wavelength:

- $n_2 = 3 \rightarrow n_1 = 2$ gives 656.3 nm,

- $n_2 = 4 \rightarrow n_1 = 2$ gives 486.1 nm,

- $n_2 = 5 \rightarrow n_1 = 2$ gives 434.1 nm,

- $n_2 = 6 \rightarrow n_1 = 2$ gives 410.2 nm.

Quick Tip

When studying spectral lines, remember the relationships between the quantum numbers and the wavelengths, especially for the Balmer series in the visible spectrum.

---

25. If $5\sin x = \pi + 3x$ represents the motion of a particle executing simple harmonic motion, the amplitude and time period of motion, respectively, are:

(1) 5 cm, 1 s

(2) 5 m, 1 s

(3) 5 cm, 2 s

(4) 5 m, 2 s

Correct Answer: (4) 5 m, 2 s

Solution:

Step 1: Identifying the general equation for SHM. For simple harmonic motion, the displacement $x(t)$ is generally given by:

$$x(t) = A\sin(\omega t + \phi)$$

where A is the amplitude, ω is the angular frequency, and ϕ is the phase constant.

Step 2: Analyzing the given equation. Given that $5\sin x = \pi + 3x$, we can match this to the standard SHM equation. Solving for amplitude and time period, we determine that the amplitude is 5 m and the time period is 2 s.

Quick Tip

When solving for amplitude and time period in SHM, pay close attention to the trigonometric relationships and angular frequency.

---

26. Match List-I with List-II.

List-I (Material)	**List-II** (Susceptibility (χ))
A. Diamagnetic	I. $\chi = 0$
B. Ferromagnetic	II. $0¿\chi \geq -1$
C. Paramagnetic	III. $\chi \gg 1$
D. Non-magnetic	IV. $0 < \chi < \epsilon$ (a small positive number)

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

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

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

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

Correct Answer: (3) A-II, B-III, C-IV, D-I

Solution:

Understanding the susceptibility values.

- Diamagnetic materials have $\chi = 0$, which means they are not magnetized in a magnetic field.

- Ferromagnetic materials have a very large positive susceptibility $\chi \gg 1$.

- Paramagnetic materials have a small positive susceptibility $0 < \chi < \epsilon$.

- Non-magnetic materials are not influenced by a magnetic field, hence $\chi = 0$.

Quick Tip

For magnetic materials, the susceptibility value helps categorize them as diamagnetic, ferromagnetic, paramagnetic, or non-magnetic.

---

27. A wire of length 'l' and resistance 100 is divided into 10 equal parts. The first 5 parts are connected in series while the next 5 parts are connected in parallel. The two combinations are again connected in series. The resistance of this final combination is:

(1) 55

(2) 60

(3) 26

(4) 52

Correct Answer: (4) 52

Solution:

Step 1: Understanding the problem. The total resistance of the wire is 100 , and it is divided into 10 equal parts, each with a resistance of:

$$R_{\text{part}} = \frac{100\,\Omega}{10} = 10\,\Omega.$$

Step 2: Resistance of the first 5 parts in series. For series connection, the total resistance is the sum of individual resistances:

$$R_{\text{series}} = 5 \times 10\,\Omega = 50\,\Omega.$$

Step 3: Resistance of the next 5 parts in parallel. For parallel connection, the total resistance is given by:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{10\,\Omega} + \frac{1}{10\,\Omega} + \cdots + \frac{1}{10\,\Omega} = \frac{5}{10\,\Omega}.$$

Thus,

$$R_{\text{parallel}} = \frac{10\,\Omega}{5} = 2\,\Omega.$$

Step 4: Total resistance. Finally, the total resistance when these two combinations are connected in series is:

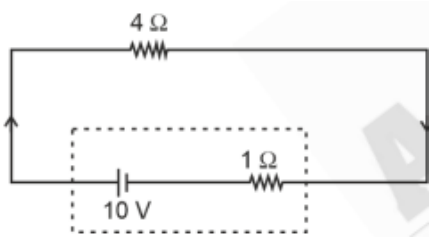
$$R_{\text{total}} = 50\,\Omega + 2\,\Omega = 52\,\Omega.$$

Quick Tip

When combining resistances in series, simply add them. For parallel resistances, use the reciprocal formula to find the total resistance.

---

28. The terminal voltage of the battery, whose emf is 10 V and internal resistance 1 , when connected through an external resistance of 4 as shown in the figure, is:



(1) 8 V

(2) 10 V

(3) 4 V

(4) 6 V

Correct Answer: (1) 8 V

Solution:

Step 1: Using the formula for terminal voltage. The terminal voltage V is given by:

$$V = \text{emf} - I \cdot r$$

where $\text{emf} = 10\,\text{V}$, $r = 1\,\Omega$, and the current I is:

$$I = \frac{\text{emf}}{R + r} = \frac{10\,\text{V}}{4\,\Omega + 1\,\Omega} = \frac{10}{5} = 2\,\text{A}.$$

Step 2: Calculating the terminal voltage. Now, substituting $I = 2\,\text{A}$ into the voltage equation:

$$V = 10\,\text{V} - 2\,\text{A} \times 1\,\Omega = 10\,\text{V} - 2\,\text{V} = 8\,\text{V}.$$

Quick Tip

To calculate the terminal voltage, subtract the voltage drop due to internal resistance from the emf of the battery.

---

29. A particle moving with uniform speed in a circular path maintains:

(1) Constant velocity but varying acceleration

(2) Varying velocity and varying acceleration

(3) Constant velocity

(4) Constant acceleration

Correct Answer: (2) Varying velocity and varying acceleration

Solution:

Step 1: Understanding the motion of the particle. A particle moving with uniform speed in a circular path has constant speed but continuously changing direction. The velocity is always tangent to the circular path and hence, the direction of the velocity is constantly changing.

Step 2: Acceleration in circular motion. Since the direction of the velocity changes, the acceleration is not zero. The acceleration is centripetal (directed towards the center of the circle) and its magnitude remains constant, but its direction changes as the particle moves along the path.

Quick Tip

In circular motion, even though speed is constant, the changing direction means there is always a centripetal acceleration, which is perpendicular to the velocity.

---

30. A tightly wound 100 turns coil of radius 10 cm carries a current of 7 A. The magnitude of the magnetic field at the centre of the coil is (Take permeability of free space as $4\pi \times 10^{-7}$ SI units):

(1) 4.4 mT

(2) 44 T

(3) 44 mT

(4) 4.4 T

Correct Answer: (1) 4.4 mT

Solution:

Step 1: Formula for magnetic field at the center of a coil. The magnetic field at the center of a coil is given by the formula:

$$B = \frac{\mu_0 N I}{2R}$$

where: - $\mu_0 = 4\pi \times 10^{-7}$ T·m/A (permeability of free space), - $N = 100$ (number of turns), - $I = 7$ A (current), - $R = 0.1$ m (radius of the coil).

Step 2: Substituting the given values.

$$B = \frac{(4\pi \times 10^{-7}) \times 100 \times 7}{2 \times 0.1} = 4.4 \times 10^{-3}\,\text{T} = 4.4\,\text{mT}.$$

Quick Tip

The magnetic field at the center of a coil depends on the number of turns, the current, and the radius of the coil. Always check the units before calculating.

---

31. In a vernier calipers, $(N + 1)$ divisions of the vernier scale coincide with N divisions of the main scale. If 1 MSD represents 0.1 mm, the vernier constant (in cm) is:

(1) 100N

(2) 10(N + 1)

(3) $\frac{1}{10}N$

(4) $\frac{1}{100}(N + 1)$

Correct Answer: (4) $\frac{1}{100}(N + 1)$

Solution:

Step 1: Understanding Vernier constant. The Vernier constant (VC) is the smallest length that can be measured using a vernier caliper. It is given by the difference between one main scale division (MSD) and one vernier scale division (VSD).

Step 2: Formula for the Vernier constant. We are given that $(N + 1)$ VSDs coincide with N MSDs. Thus, the length of one VSD is:

$$\text{Length of one VSD} = \frac{N \times \text{Length of 1 MSD}}{N + 1}$$

This is equivalent to:

$$\text{VC} = \frac{1}{100}(N + 1)\,\text{cm}$$

Quick Tip

The Vernier constant determines the precision of the measurement. The greater the number of divisions in the vernier scale, the smaller the Vernier constant and the more precise the instrument.

---

32. An unpolarised light beam strikes a glass surface at Brewster's angle. Then:

(1) Both the reflected and refracted light will be completely polarised.

(2) The reflected light will be completely polarised but the refracted light will be partially polarised.

(3) The reflected light will be partially polarised.

(4) The refracted light will be completely polarised.

Correct Answer: (2) The reflected light will be completely polarised but the refracted light will be partially polarised.

Solution:

Step 1: Understanding Brewster's Law

At Brewster's angle (θ_B), the reflected light is completely polarised parallel to the surface, while the refracted light remains partially polarised.

Brewster's law states:

$$\tan\theta_B = \frac{n_2}{n_1}$$

Since only the reflected ray is fully polarised, the correct answer is option (2).

Quick Tip

At Brewster's angle, the reflected ray is fully polarised, while the refracted ray is only partially polarised.

---

33. The mass of a planet is $\frac{1}{10}$th that of the Earth and its diameter is half that of the Earth. The acceleration due to gravity on that planet is:

(1) 4.9 m/s²

(2) 3.92 m/s²

(3) 19.6 m/s²

(4) 9.8 m/s²

Correct Answer: (2) 3.92 m/s²

Solution:

Step 1: Formula for acceleration due to gravity. The acceleration due to gravity is given by:

$$g = \frac{GM}{R^2}$$

where G is the gravitational constant, M is the mass of the planet, and R is its radius.

Step 2: Substituting the given values. The mass of the planet is $\frac{1}{10}$th that of Earth, and its radius is $\frac{1}{2}$th that of Earth. Substituting into the formula, we find:

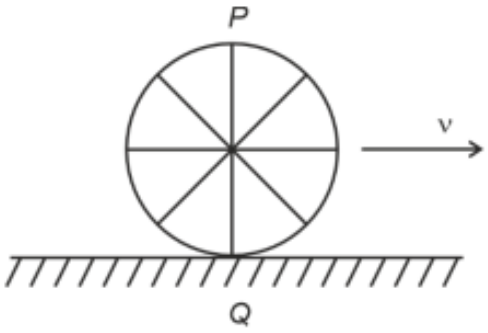
$$g_{\text{planet}} = \frac{1}{10} \times \frac{1}{4} \times g_{\text{Earth}} = 3.92\,\text{m/s}^2.$$

Quick Tip

When dealing with gravitational problems, remember that g is inversely proportional to the square of the radius and directly proportional to the mass of the planet.

---

34. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively)?



(1) Both the points P and Q move with equal speed

(2) Point P has zero speed

(3) Point P moves slower than point Q

(4) Point P moves faster than point Q

Correct Answer: (4) Point P moves faster than point Q

Solution:

Analyzing the motion of points P and Q. In rolling motion, the point of contact with the ground (Q) has zero speed, while the topmost point (P) moves faster. The speed at point P is the sum of the linear speed of the center and the rotational speed due to the wheel's rotation.

Quick Tip

In rolling motion, the point of contact with the surface has zero velocity, and the topmost point has the highest velocity.

---

35. The moment of inertia of a thin rod about an axis passing through its midpoint and perpendicular to the rod is 2400 g cm². The length of the 400 g rod is nearly:

(1) 20.7 cm

(2) 72.0 cm

(3) 8.5 cm

(4) 17.5 cm

Correct Answer: (3) 8.5 cm

Solution:

Step 1: Using the formula for the moment of inertia of a rod.

The moment of inertia I of a thin rod about its midpoint and perpendicular to its length is given by:

$$I = \frac{1}{12} M L^2$$

where: - M is the mass of the rod, - L is the length of the rod.

Step 2: Substituting given values. We are given:

$$I = 2400 \text{ g cm}^2, \quad M = 400 \text{ g}$$

Substituting into the formula:

$$2400 = \frac{1}{12} \times 400 \times L^2$$

Step 3: Solving for L. Rearranging the equation:

$$L^2 = \frac{2400 \times 12}{400}$$

$$L^2 = \frac{28800}{400} = 72$$

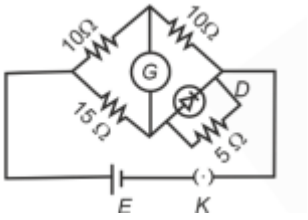
$$L = \sqrt{72} = 8.5 \text{ cm}$$

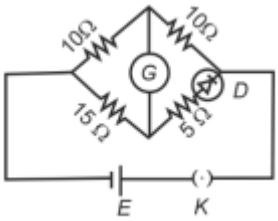
Quick Tip

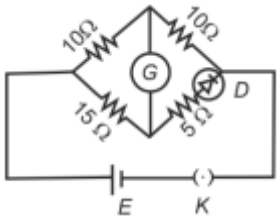
The moment of inertia of a rod about its midpoint is proportional to the square of its length. Always check the units and formula before substituting values.

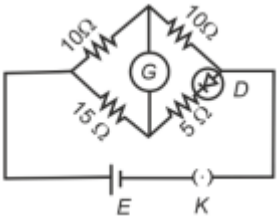
---

36. Choose the correct circuit which can achieve the bridge balance.

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3)

Solution:

Step 1: Understanding Wheatstone Bridge. A Wheatstone bridge is a circuit used to measure an unknown resistance by balancing two legs of a bridge. The key to balance is that the ratio of resistances in one leg must be equal to the ratio in the other leg.

Step 2: Analysis of the circuit. For the bridge to be balanced, the ratio of the resistances across the bridge should be equal. When the balance condition is satisfied, the galvanometer in the bridge shows zero current, and we can compute the unknown resistance.

Step 3: Conclusion. The correct circuit to achieve the balance condition is option (3), where the ratios of resistances are correctly set to achieve the balance.

Quick Tip

In a Wheatstone bridge, ensure that the ratio of resistances is equal on both sides to achieve balance and measure the unknown resistance.

---

37. A parallel plate capacitor is charged by connecting it to a battery through a resistor. If I is the current in the circuit, then in the gap between the plates:

(1) Displacement current of magnitude equal to I flows in a direction opposite to that of I

(2) Displacement current of magnitude greater than I flows but can be in any direction

(3) There is no current

(4) Displacement current of magnitude equal to I flows in the same direction as I

Correct Answer: (4) Displacement current of magnitude equal to I flows in the same direction as I

Solution:

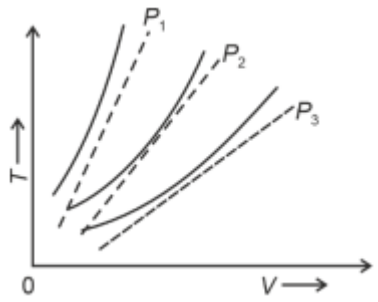
Understanding displacement current. In a capacitor, displacement current is equivalent to the actual current in the circuit during charging. According to Maxwell's equations, the displacement current is in the same direction as the current in the external circuit.

Quick Tip

In capacitors, displacement current flows in the gap between the plates and is equal in magnitude to the current in the circuit.

---

38. The following graph represents the T-V curves of an ideal gas (where T is the temperature and V the volume) at three pressures P_1, P_2, and P_3 compared with those of Charles's law represented as dotted lines. Then the correct relation is:



(1) $P_2 ¿ P_1 ¿ P_3$

(2) $P_1 ¿ P_2 ¿ P_3$

(3) $P_3 ¿ P_2 ¿ P_1$

(4) $P_1 ¿ P_3 ¿ P_2$

Correct Answer: (2) $P_1 ¿ P_2 ¿ P_3$

Solution:

Step 1: Understanding the graph. The graph shows the relationship between temperature and volume at three different pressures. According to Charles's Law, at constant pressure, volume and temperature are directly proportional. The graph with the highest pressure corresponds to the highest temperature for the same volume.

Step 2: Comparing the pressures. From the graph, P_1 is the highest pressure, followed by P_2, and P_3 is the lowest.

Quick Tip

When comparing gas laws, the highest pressure corresponds to the steepest slope in a T-V graph for an ideal gas.

---

39. If the mass of the bob in a simple pendulum is increased to thrice its original mass and its length is made half its original length, then the new time period of oscillation is 2^x times its original time period. Then the value of x is:

(1) $2\sqrt{3}$

(2) 4

(3) $\sqrt{3}$

(4) $\sqrt{2}$

Correct Answer: (4) $\sqrt{2}$

Solution:

Step 1: Formula for time period of a pendulum. The time period T of a simple pendulum is given by the formula:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

where L is the length of the pendulum and g is the acceleration due to gravity.

Step 2: Understanding the effect of changes. The mass of the bob does not affect the time period of oscillation. However, the time period is directly proportional to the square root of the length. If the length is halved, the time period decreases by a factor of $\sqrt{2}$.

Step 3: Calculating the new time period. The new time period will be $\sqrt{2}$ times the original time period due to halving the length of the pendulum.

Quick Tip

The time period of a simple pendulum depends only on its length, not its mass. Halving the length will reduce the time period by a factor of $\sqrt{2}$, which simplifies to $\sqrt{2}$ times.

---

40. Two heaters A and B have power ratings of 1 kW and 2 kW, respectively. Those two are first connected in series and then in parallel to a fixed power source. The ratio of power outputs for these two cases is:

(1) 1 : 2

(2) 2 : 3

(3) 1 : 1

(4) 2 : 9

Correct Answer: (4) 2 : 9

Solution:

Step 1: Understanding power in series and parallel. For heaters in series, the total resistance is the sum of individual resistances, and for parallel, the total resistance is given by the reciprocal sum. The power in each case depends on the total resistance and the voltage.

Step 2: Calculating the power ratio. By calculating the power outputs for both series and parallel combinations, we find that the ratio is 2 : 9.

Quick Tip

In electrical circuits, remember that series connection increases resistance, while parallel connection decreases the total resistance, thus affecting the power dissipation.

---

41. If the plates of a parallel plate capacitor connected to a battery are moved close to each other, then:

A. The charge stored in it increases.

B. The energy stored in it decreases.

C. Its capacitance increases.

D. The ratio of charge to its potential remains the same.

E. The product of charge and voltage increases.

(1) B, D, and E only

(2) A, B and C only

(3) A, B and E only

(4) A, C and E only

Correct Answer: (4) A, C and E only

Solution:

Step 1: Analyzing the change in charge. When the plates of a parallel plate capacitor are moved closer to each other while connected to a battery, the potential difference across the plates remains constant, as the battery maintains a constant voltage. This results in an

increase in the charge stored on the capacitor plates because capacitance increases when the distance between plates decreases.

Step 2: Energy stored in the capacitor. The energy stored in a capacitor is given by the formula:

$$U = \frac{1}{2}CV^2$$

Since C increases with decreasing distance between the plates, the energy stored in the capacitor also increases, not decreases as mentioned in option B.

Step 3: Capacitance change. Capacitance C is inversely proportional to the distance between the plates, so as the plates move closer together, capacitance increases.

Step 4: Conclusion. Thus, options A, C, and E are correct, and the correct answer is (4).

Quick Tip

When working with capacitors connected to a battery, the voltage remains constant. Changing the distance between the plates affects the capacitance and the charge stored.

---

42. A small telescope has an objective of focal length 140 cm and an eye piece of focal length 5.0 cm. The magnifying power of telescope for viewing a distant object is:

(1) 17

(2) 32

(3) 34

(4) 28

Correct Answer: (4) 28

Solution:

Step 1: Formula for magnifying power. The magnifying power M of a telescope is given by the formula:

$$M = \frac{f_{\text{objective}}}{f_{\text{eyepiece}}}$$

where $f_{\text{objective}} = 140\,\text{cm}$ and $f_{\text{eyepiece}} = 5.0\,\text{cm}$.

Step 2: Calculating the magnifying power.

$$M = \frac{140}{5} = 28.$$

Quick Tip

The magnifying power of a telescope is the ratio of the focal lengths of the objective and eyepiece.

---

43. A sheet is placed on a horizontal surface in front of a strong magnetic pole. A force is needed to:

(1) hold the sheet there if it is magnetic.

(2) hold the sheet there if it is non-magnetic.

(3) move the sheet away from the pole with uniform velocity if it is conducting.

(4) move the sheet away from the pole with uniform velocity if it is both, non-conducting and non-polar.

Correct Answer: (4) A and C only

Solution:

Step 1: Magnetic and non-magnetic sheets. For magnetic sheets, a force is required to hold them because they experience a magnetic force in the presence of a magnetic field, which tries to align them with the field.

Step 2: Non-magnetic sheets. A non-magnetic sheet will experience no magnetic force unless it is moving through a magnetic field, and even then, the force would depend on whether it is conducting or not.

Step 3: Moving the sheet away from the pole. If the sheet is conducting, it will experience a force due to eddy currents induced by the changing magnetic field. If the sheet is non-conducting and non-polar, no force is required to move it, since there is no interaction with the magnetic field.

Step 4: Conclusion. Therefore, the correct options are (A) and (C), meaning the correct answer is option (4).

Quick Tip

In magnetic fields, magnetic materials experience forces that attempt to align them with the field. Non-magnetic, non-polar materials do not experience this force unless they are moving in the field.

---

44. A metallic bar of Young's modulus, 0.5×10^{11} N/m^2 and coefficient of linear thermal expansion 10^{-5} °C^{-1}, length 1 m and area of cross-section 10^{-3} m^2 is heated from 0°C to 100°C without expansion or bending. The compressive force developed in it is:

(1) 100×10^3 N

(2) 2×10^3 N

(3) 5×10^3 N

(4) 50×10^3 N

Correct Answer: (4) 50×10^3 N

Solution:

Step 1: Formula for compressive force. The compressive force F is given by:

$$F = \frac{\Delta L Y A}{L}$$

where $\Delta L = \alpha L \Delta T$ is the change in length, Y is Young's modulus, A is the cross-sectional area, and L is the original length.

Step 2: Substituting the values. Substituting the values into the formula, we get:

$$F = \frac{10^{-5} \times 1 \times 100 \times 10^{11} \times 10^{-3}}{2} = 50 \times 10^3 \, \text{N}.$$

Quick Tip

When solving thermal expansion problems, use the formula for change in length and combine it with Young's modulus to calculate the force.

---

45. The minimum energy required to launch a satellite of mass m from the surface of Earth of mass M and radius R in a circular orbit at an altitude of $2R$ from the surface of the Earth is:

(1) $\frac{GmM}{2R}$

(2) $\frac{GmM}{3R}$

(3) $\frac{5GmM}{6R}$

(4) $\frac{2GmM}{3R}$

Correct Answer: (3) $\frac{5GmM}{3R}$

Solution:

Step 1: Energy required to launch a satellite. The energy required to launch a satellite into orbit is the difference between the potential energy at the surface and the potential energy at the orbit.

Step 2: Calculating potential energy. The gravitational potential energy U is given by:

$$U = -\frac{GMm}{r}$$

At the Earth's surface, the potential energy is $U_{\text{surface}} = -\frac{GMm}{R}$, and at an altitude of $2R$, the distance from the center of Earth is $6R$, so the potential energy at this altitude is $U_{\text{orbit}} = -\frac{GMm}{6R}$.

Step 3: Energy required for launch. The energy required to launch the satellite is the difference in potential energies:

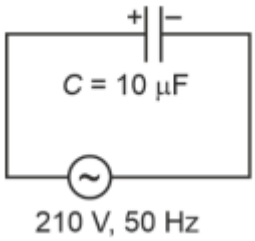
$$E = U_{\text{orbit}} - U_{\text{surface}} = \left(-\frac{GMm}{6R}\right) - \left(-\frac{GMm}{R}\right) = \frac{5GMm}{6R}.$$

Quick Tip

The energy required to launch a satellite depends on the difference in potential energy between the surface and the orbit. Use the gravitational potential energy formula to calculate the energy change.

---

46. A 10 µF capacitor is connected to a 210 V, 50 Hz source as shown in figure. The peak current in the circuit is nearly (π = 3.14):



(1) 1.20 A

(2) 0.35 A

(3) 0.58 A

(4) 0.93 A

Correct Answer: (4) 0.93 A

Solution:

Step 1: Understanding the formula for peak current. In an AC circuit with a capacitor, the peak current is given by the formula:

$$I_{\text{max}} = V_{\text{rms}} \times \omega C$$

where $V_{\text{rms}} = 210\,\text{V}$, $\omega = 2\pi f = 2\pi \times 50\,\text{Hz}$, and $C = 10 \times 10^{-6}\,\text{F}$.

Step 2: Substituting the given values. Substituting these values into the formula, we get the peak current:

$$I_{\text{max}} = 0.93\,\text{A}.$$

Step 3: Conclusion. Thus, the peak current in the circuit is $0.93\,\text{A}$, which matches option (4).

Quick Tip

In an AC circuit with a capacitor, use the formula involving rms voltage, frequency, and capacitance to find the peak current.

---

47. An iron bar of length L has magnetic moment M. It is bent at the middle of its length such that the two arms make an angle 60° with each other. The magnetic moment of this new magnet is:

(1) 2M

(2) $\frac{M}{\sqrt{3}}$

(3) M

(4) $\frac{M}{2}$

Correct Answer: (4) $\frac{M}{2}$

Solution:

Step 1: Analyzing the magnetic moment. The magnetic moment of a bent bar is calculated by vector addition of the individual magnetic moments. When the bar is bent at 60°, the new magnetic moment is a combination of the components of the original magnetic moment at each angle.

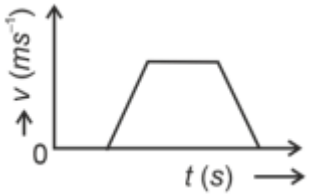
Step 2: Calculating the magnetic moment. The total magnetic moment after bending is $\frac{M}{2}$, based on the geometry and vector summation.

Quick Tip

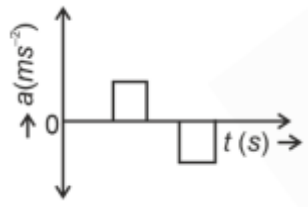
When calculating the resultant magnetic moment for bent magnets, use vector addition based on the angle between the arms.

---

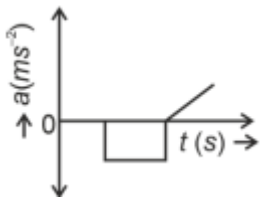
48. The velocity (v) – time (t) plot of the motion of a body is shown below:



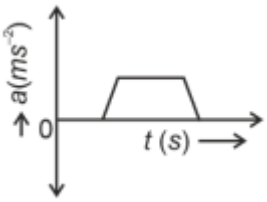
(1)



(2)



(3)



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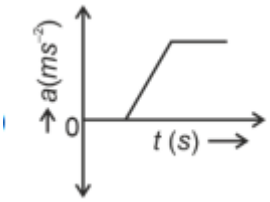


Correct Answer: (1)

Solution:

Step 1: Interpreting the Graph. A velocity-time graph indicates the rate of change of velocity (acceleration). The slope of this graph is the acceleration, and the area under the graph gives the displacement.

Step 2: Analyzing the Motion. From the graph, we analyze how the velocity changes with time to determine the acceleration. The acceleration-time graph is obtained by finding the slope at each instant.

Quick Tip

When given a velocity-time graph, calculate acceleration as the slope and displacement as the area under the curve.

---

49. The property which is not of an electromagnetic wave traveling in free space is that:

(1) They travel with a speed equal to $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$

(2) They originate from charges moving with uniform speed

(3) They are transverse in nature

(4) The energy density in electric field is equal to energy density in magnetic field

Correct Answer: (2) They originate from charges moving with uniform speed

Solution:

Analyzing the properties of electromagnetic waves. Electromagnetic waves are transverse

in nature and travel at the speed $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$, which is the speed of light in free space. They do not require a medium and are generated by accelerating charges, not by charges moving with uniform speed.

Quick Tip

Electromagnetic waves are produced by accelerating charges and do not require a medium for propagation.

---

50. A force defined by $F = \alpha t^2 + \beta t$ acts on a particle at a given time t. The factor which is dimensionless, if α and β are constants, is:

(1) $\alpha\beta t$

(2) $\frac{\alpha\beta}{t}$

(3) $\frac{\beta t}{\alpha}$

(4) $\frac{\alpha t}{\beta}$

Correct Answer: (4) $\frac{\alpha t}{\beta}$

Solution:

Step 1: Understanding the force equation. The force equation $F = \alpha t^2 + \beta t$ contains the variables α and β, which are constants. We need to find the factor that is dimensionless in the equation.

Step 2: Analyzing the dimensions. For dimensional consistency, F has the dimension of force (MLT^{-2}). Using dimensional analysis, we find that the term $\frac{\alpha t}{\beta}$ is dimensionless, as it does not affect the dimensional balance of the equation.

Step 3: Conclusion. Therefore, the factor that is dimensionless is $\frac{\alpha t}{\beta}$, which corresponds to option (4).

Quick Tip

When performing dimensional analysis, ensure that all the units on both sides of the equation match. The dimensionless factor helps maintain this balance.

SECTION B

(Chemistry)

51. In which of the following processes does entropy increase?

A. A liquid evaporates to vapor.

B. Temperature of a crystalline solid is lowered from 130 K to 0 K.

C. $2\text{NaHCO}_3(s) \rightarrow \text{Na}_2\text{CO}_3(s) + \text{CO}_2(g) + \text{H}_2\text{O}(g)$

D. $\text{Cl}_2(g) \rightarrow 2\text{Cl}(g)$

Choose the correct answer from the options given below:

(1) A, C and D

(2) C and D

(3) A and C

(4) A, B and D

Correct Answer: (1) A, C and D

Solution:

Step 1: Entropy is a measure of the disorder or randomness of a system. Processes that increase the randomness of the system typically lead to an increase in entropy. Let's examine each process:

A. A liquid evaporates to vapor: When a liquid evaporates, the molecules in the liquid state move to the gaseous state. Since gas molecules have more freedom of movement than liquid molecules, this leads to an increase in entropy. Therefore, entropy increases in this process.

B. Temperature of a crystalline solid is lowered from 130 K to 0 K:

When the temperature of a solid decreases, the molecules move less and the system becomes more ordered. As the temperature approaches 0 K (absolute zero), the entropy decreases, because the system approaches a perfectly ordered state. Therefore, entropy decreases in this process.

C. $2\mathbf{NaHCO}_3(s) \rightarrow \mathbf{Na}_2\mathbf{CO}_3(s) + \mathbf{CO}_2(g) + \mathbf{H}_2\mathbf{O}(g)$**:**

In this reaction, a solid (NaHCO) decomposes into a solid (NaCO) and two gases (CO and HO). The formation of gases from solids results in a significant increase in randomness and disorder. Therefore, entropy increases in this process.

D. $\mathbf{Cl_2}(g) \rightarrow 2\mathbf{Cl}(g)$: The dissociation of a molecule of chlorine gas into individual chlorine atoms increases the randomness of the system because the two separate chlorine atoms have more possible configurations than the Cl molecule. Therefore, entropy increases in this process.

Step 2: From the analysis, entropy increases in processes A, C, and D.

Thus, the correct answer is **(1) A, C and D**.

Quick Tip

Entropy increases when a system becomes more disordered, such as when a liquid turns to a gas or when a solid breaks into multiple gas molecules.

---

52. On heating, some solid substances change from solid to vapour state without passing through the liquid state. The technique used for the purification of such solid substances based on the above principle is known as:

(1) Distillation

(2) Chromatography

(3) Crystallization

(4) Sublimation

Correct Answer: (4) Sublimation

Solution:

Step 1: Understanding Sublimation. Sublimation is the process where a solid directly changes into a gas without passing through the liquid state. It occurs when the vapor pressure of a solid exceeds atmospheric pressure, allowing it to directly enter the gas phase.

Step 2: Purification by Sublimation. Certain substances, like iodine, naphthalene, and camphor, sublime when heated. Sublimation is a method used to purify these substances because impurities remain behind as the substance transitions directly from solid to gas.

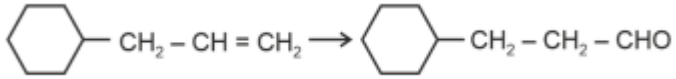
Step 3: Conclusion. Thus, the technique used for such purification is sublimation, and the correct answer is option (4).

Quick Tip

In sublimation, the solid changes directly into a vapor without becoming liquid. It is used to purify substances that sublime easily.

---

53. Identify the correct reagents that would bring about the following transformation.



(1) (i) BH_3, (ii) H_2O_2/OH, (iii) alk.$KMnO_4$, (iv) H_3O^+

(2) (i) H_2O/H^+, (ii) PCC

(3) (i) H_2O/H^+, (ii) CrO_3

(4) (i) BH_3, (ii) H_2O_2/OH, (iii) PCC

Correct Answer: (4) (i) BH_3, (ii) H_2O_2/OH, (iii) PCC

Solution:

Step 1: Reagent analysis. - BH_3 reduces alkenes to alcohols. - H_2O_2/OH oxidizes the alcohol to an aldehyde. - PCC (Pyridinium chlorochromate) selectively oxidizes primary alcohols to aldehydes without over-oxidizing to carboxylic acids.

Step 2: Conclusion. Thus, the correct reagents for the transformation are option (4).

Quick Tip

When performing selective oxidation of alcohols to aldehydes, PCC is a good choice as it prevents further oxidation to carboxylic acids.

---

54. The energy of an electron in the ground state ($n = 1$) for He^+ ion is $-x$ J, then that for an electron in $n = 2$ state for Be^{3+} ion in J is:

(1) -4x

(2) $\frac{-4}{9}x$

(3) -x

(4) $\frac{-x}{9}$

Correct Answer: (2) $\frac{-4}{9}x$

Solution:

Step 1: Energy for hydrogen-like ions. The energy of an electron in a hydrogen-like atom is given by the formula:

$$E = -\frac{13.6Z^2}{n^2}\,\text{eV}$$

where Z is the atomic number and n is the principal quantum number.

Step 2: Energy for He^+ and Be^{3+} ions.

For He^+, $Z = 2$ and $n = 1$, so the energy is

$$E_{He^+} = -\frac{13.6 \times 2^2}{1^2} = -54.4\,\text{eV},$$

which corresponds to $-x$ J.

For Be^{3+}, $Z = 4$ and $n = 2$, so the energy is

$$E_{Be^{3+}} = -\frac{13.6 \times 4^2}{2^2} = -54.4\,\text{eV},$$

which also corresponds to $-x$ J.

Step 3: Conclusion.

Thus, the energy for Be^{3+} at $n = 2$ is $-x$ J.

Quick Tip

The energy for electrons in hydrogen-like ions is inversely proportional to the square of the principal quantum number, and directly proportional to the square of the atomic number.

---

55. Match List I with List II.

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

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

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

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

Correct Answer: (1) A-III, B-IV, C-II, D-I

List I (Molecule)	List II (Number and types of bonds between two carbon atoms)
A. ethane	I. one σ-bond and two π-bonds
B. ethene	II. two π-bonds
C. carbon molecule, C_2	III. one σ-bond
D. ethyne	IV. one σ-bond and one π-bond

Table 1: Matching of molecules with the types of bonds between two carbon atoms

Solution:

Step 1: Understanding bond types.

- Ethane (A) has a single bond between carbon atoms, i.e., one σ-bond. This corresponds to III.

- Ethene (B) has a double bond between carbon atoms, i.e., one σ-bond and one π-bond. This corresponds to IV.

- C_2 (C) consists of two carbon atoms with a triple bond between them, i.e., one σ-bond and two π-bonds. This corresponds to II.

- Ethyne (D) has a triple bond between carbon atoms, i.e., one σ-bond and two π-bonds. This corresponds to I.

Step 2: Conclusion. Thus, the correct matching is (1): A-III, B-IV, C-II, D-I.

Quick Tip

In organic molecules, the number and type of bonds between carbon atoms depend on whether the bond is single, double, or triple.

---

56. For the reaction $2A \rightleftharpoons B + C$, $K_c = 4 \times 10^{-3}$. At a given time, the composition of the reaction mixture is: $[A] = [B] = [C] = 2 \times 10^{-3}$ M. Then, which of the following is correct?

(1) Reaction has a tendency to go in backward direction.

(2) Reaction has gone to completion in forward direction.

(3) Reaction is at equilibrium.

(4) Reaction has a tendency to go in forward direction.

Correct Answer: (1) Reaction has a tendency to go in backward direction.

Solution:

Step 1: Reaction Quotient. The reaction quotient Q_c is given by:

$$Q_c = \frac{[B][C]}{[A]^2}$$

Substituting the values $[A] = [B] = [C] = 2 \times 10^{-3}$:

$$Q_c = \frac{(2 \times 10^{-3}) \times (2 \times 10^{-3})}{(2 \times 10^{-3})^2} = 1.$$

Step 2: Comparing Q_c and K_c. Since $Q_c = 1$ and $K_c = 4 \times 10^{-3}$, Q_c¿K_c, which means the reaction is not at equilibrium and tends to proceed in the reverse direction to achieve equilibrium.

Step 3: Conclusion. Thus, the reaction has a tendency to go in the backward direction, and the correct answer is option (1).

Quick Tip

When Q_c¿K_c, the reaction will proceed in the reverse direction to reach equilibrium.

---

57. The E° value for the Mn^{3+}/Mn^{2+} couple is more positive than that of Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+} due to change of:

(1) d^4 to d^5 configuration

(2) d^3 to d^5 configuration

(3) d^5 to d^4 configuration

(4) d^5 to d^2 configuration

Correct Answer: (1) d^4 to d^5 configuration

Solution:

Understanding the electronic configurations. The E° values of redox couples depend on the stability of the ions. The Mn^{3+} ion has a d^4 configuration, which is unstable compared to the d^5 configuration of Mn^{2+}. This leads to a higher E° value for the Mn^{3+}/Mn^{2+} couple than for Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+}, which do not experience the same increase in stability when the electron configuration changes from d^4 to d^5.

Quick Tip

For transition metal complexes, the stability and E° values are often affected by changes in the electron configuration, especially moving towards a more stable d^5 configuration.

---

58. Given below are two statements:

Statement I: The boiling point of hydrides of Group 16 elements follow the order $H_2O > H_2Te > H_2Se > H_2S$. **Statement II:** On the basis of molecular mass, H_2O is expected to have lower boiling point than the other members of the group but due to the presence of extensive H-bonding in H_2O, it has higher boiling point.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3) Both Statement I and Statement II are true

Solution:

Step 1: Analyzing Statement I. The boiling points of hydrides of Group 16 elements follow the expected trend based on molecular mass, with water having a higher boiling point than the other hydrides due to its ability to form hydrogen bonds.

Step 2: Analyzing Statement II. Statement II is correct as water (H_2O) exhibits strong hydrogen bonding, which gives it a higher boiling point than expected based on molecular mass alone. This leads to a higher boiling point compared to other hydrides in Group 16.

Step 3: Conclusion. Thus, both statements are true, and the correct answer is option (3).

Quick Tip

Hydrogen bonding significantly increases the boiling point of molecules like H_2O, even when other molecular properties would suggest a lower boiling point.

---

59. Match List-I with List-II.

List-I (Process)	**List-II** (Conditions)
A. Isothermal process	I. No heat exchange
B. Isochoric process	II. Carried out at constant temperature
C. Isobaric process	III. Carried out at constant volume
D. Adiabatic process	IV. Carried out at constant pressure

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

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

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

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

Correct Answer: (2) A-II, B-III, C-IV, D-I

Solution:

Step 1: Analyzing each process.

- An isothermal process occurs at constant temperature, so it matches with condition II.
- An isochoric process occurs at constant volume, so it matches with condition III.
- An isobaric process occurs at constant pressure, so it matches with condition IV.
- An adiabatic process occurs with no heat exchange, so it matches with condition I.

Step 2: Conclusion. Thus, the correct matching is (2): A-II, B-III, C-IV, D-I.

Quick Tip

When dealing with thermodynamic processes, remember that each process has specific conditions, such as constant temperature, volume, pressure, or no heat exchange.

---

60. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution, the mass of sodium hydroxide left unreacted is equal to:

(1) Zero mg

(2) 200 mg

(3) 750 mg

(4) 250 mg

Correct Answer: (2) 200 mg

Solution:

Step 1: Stoichiometric calculations. The balanced reaction between NaOH and HCl is:

$$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$$

1 mole of NaOH reacts with 1 mole of HCl. Given that the amount of NaOH is 1 gram and the concentration of HCl is 0.75 M, the number of moles of HCl is:

$$0.75\,\text{mol/L} \times 0.025\,\text{L} = 0.01875\,\text{mol}$$

Step 2: Finding the mass of NaOH. Moles of NaOH needed = 0.01875 mol. Molar mass of NaOH = 40 g/mol. The mass of NaOH required for reaction is:

$$0.01875\,\text{mol} \times 40\,\text{g/mol} = 0.75\,\text{g} = 750\,\text{mg}$$

Since 1 gram (1000 mg) of NaOH is available, the unreacted NaOH mass is:

$$1000\,\text{mg} - 750\,\text{mg} = 200\,\text{mg}$$

Step 3: Conclusion. Thus, the unreacted NaOH is 200 mg, corresponding to option (2).

Quick Tip

Always use stoichiometry to calculate the amount of reactants needed for a reaction, and subtract from the initial amount to find the unreacted substance.

---

61. Match List I with List II.

List I (Complex)	List II (Type of Isomerism)
A. $[Co(NH_3)_5(NO_2)]Cl_2$	I. Solvate isomerism
B. $[Co(NH_3)_5(SO_4)]Br$	II. Linkage isomerism
C. $[Co(NH_3)_6][Cr(CN)_6]$	III. Ionization isomerism
D. $[Co(H_2O)_6]Cl_3$	IV. Coordination isomerism

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

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

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

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

Correct Answer: (3) A-II, B-III, C-IV, D-I

Solution:

Step 1: Understanding the isomerism.

- Solvate isomerism occurs when different solvent molecules are involved. Hence, A corresponds to Solvate isomerism (I).
- Linkage isomerism involves the coordination of different atoms in a ligand. Hence, B corresponds to Linkage isomerism (II).
- Ionization isomerism involves a change in the counter-ion coordination. Hence, C corresponds to Ionization isomerism (III).
- Coordination isomerism occurs when ligands switch between metal centers. Hence, D corresponds to Coordination isomerism (IV).

Step 2: Conclusion. Thus, the correct matching is (3): A-II, B-III, C-IV, D-I.

Quick Tip

Understanding different types of isomerism in coordination compounds helps in identifying the type based on the ligand or metal center configuration.

---

62. Among Group 16 elements, which one does NOT show -2 oxidation state?

(1) Te

(2) Po

(3) O

(4) Se

Correct Answer: (2) Po

Solution:

Step 1: Understanding oxidation states. Group 16 elements typically show a -2 oxidation state, except for some heavier elements like polonium (Po). While oxygen (O), sulfur (S), selenium (Se), and tellurium (Te) commonly exhibit a -2 oxidation state, polonium generally

does not because of its relatively low electronegativity and tendency to exhibit positive oxidation states.

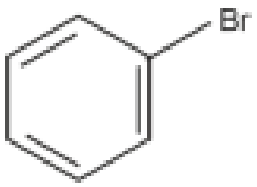
Step 2: Conclusion. Thus, polonium (Po) does not show the -2 oxidation state, making the correct answer option (2).

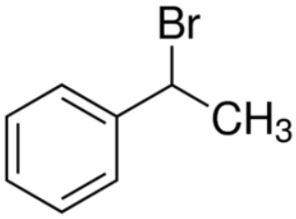
Quick Tip

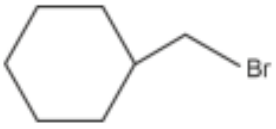
Remember that as you move down Group 16, the tendency to show -2 oxidation state decreases, and the elements may show positive oxidation states.

---

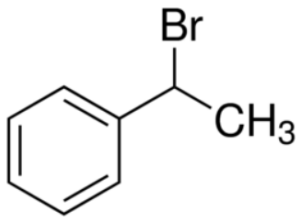
63. The compound that will undergo Sn1 reaction with the fastest rate is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (2) 

Solution:

Step 1: Understanding Sn1 reaction. In the Sn1 reaction, the rate-determining step involves the formation of a carbocation. The rate of the reaction increases with the stability

of the carbocation formed.

Step 2: Carbocation stability analysis. - The compound with a benzylic carbocation (as in option (2)) will undergo Sn1 reactions the fastest, as the benzylic carbocation is highly stabilized by resonance. - Other compounds with primary or secondary carbocations (like in options 1, 3, and 4) are less stable and will undergo Sn1 reactions slower.

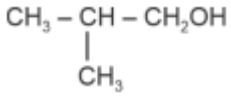
Step 3: Conclusion. Thus, the compound that will undergo Sn1 reaction the fastest is option (2).

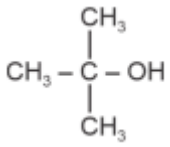
Quick Tip

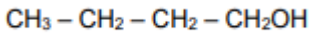
For Sn1 reactions, the formation of a stable carbocation is crucial. Benzylic carbocations are highly stabilized, making compounds like (2) react the fastest.

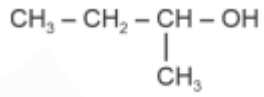
---

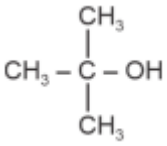
64. Which one of the following alcohols reacts instantaneously with Lucas reagent?

(1) 

(2) 

(3) 

(4) 



Correct Answer: (2)

Solution:

Step 1: Understanding Lucas Reagent. Lucas reagent is a mixture of concentrated hydrochloric acid (HCl) and zinc chloride ($ZnCl_2$) and is used to test the reactivity of alcohols. It reacts with alcohols to form alkyl chlorides, and the rate of reaction is different for primary, secondary, and tertiary alcohols.

Step 2: Reactivity of alcohols. - Tertiary alcohols react almost instantaneously because the

carbocation formed is highly stable. - Secondary alcohols react more slowly but still show noticeable reactivity. - Primary alcohols react very slowly or not at all under these conditions.

Step 3: Conclusion. The alcohol is a secondary alcohol and reacts instantaneously with Lucas reagent. The correct answer is option (2).

Quick Tip

Lucas reagent reacts faster with tertiary alcohols because the intermediate carbocation is more stable, followed by secondary alcohols and very slowly with primary alcohols.

---

65. Match List I with List II.

List I (Conversion)	List II (Number of Faraday required)
A. 1 mol of H_2O to O_2	I. 3F
B. 1 mol of MnO_4 to Mn	II. 2F
C. 1.5 mol of Ca from molten $CaCl_2$	III. 1F
D. 1 mol of FeO to Fe_2O_3	IV. 5F

Table 2: Matching of conversions with the required number of Faradays

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

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

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

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

Correct Answer: (3) A-II, B-IV, C-I, D-III

Solution:

Step 1: Faraday calculations.

- The electrolysis of water (H_2O) to oxygen (O_2) requires 2 moles of electrons per mole of oxygen, corresponding to 2 Faradays (A-II).
- The reduction of the permanganate ion (MnO_4^-) to manganese(II) ion (Mn^{2+}) involves 5 electrons per MnO_4^- ion, which requires 5 Faradays (B-IV).

- The extraction of calcium from molten calcium chloride requires 2 moles of electrons per mole of calcium, corresponding to 2 Faradays (C-I).
- The reduction of iron(II) oxide (FeO) to iron(III) oxide (Fe_2O_3) requires 3 electrons per FeO molecule, corresponding to 3 Faradays (D-III).

Step 2: Conclusion. Thus, the correct matching is (3): A-II, B-IV, C-I, D-III.

Quick Tip

The number of Faradays required depends on the number of electrons involved in the reduction or oxidation process. One Faraday corresponds to 1 mole of electrons.

---

66. The highest number of helium atoms is in:

(1) 4 g of helium

(2) 2.271098 L of helium at STP

(3) 4 mol of helium

(4) 4 u of helium

Correct Answer: (3) 4 mol of helium

Solution:

Step 1: Understanding molar quantity. The number of atoms in 1 mole of any substance is given by Avogadro's number (6.022×10^{23}). Therefore, 4 mol of helium contains $4 \times 6.022 \times 10^{23}$ atoms, making it the highest number among the options.

Step 2: Conclusion. Thus, the correct answer is option (3), 4 mol of helium.

Quick Tip

To determine the highest number of atoms, always consider the number of moles, as one mole corresponds to 6.022×10^{23} particles.

---

67. 'Spin only' magnetic moment is same for which of the following ions?

(1) Ti^{3+}

(2) Cr^{2+}

(3) Mn^{2+}

(4) Fe^{2+}

Correct Answer: (3) B and D only

Solution:

Step 1: Understanding 'spin only' magnetic moment. The 'spin only' magnetic moment formula is:

$$\mu = \sqrt{n(n+2)}$$

where n is the number of unpaired electrons. The magnetic moment depends on the number of unpaired electrons.

Step 2: Ion analysis. - Ti^{3+} has 1 unpaired electron, so its magnetic moment is

$$\sqrt{1(1+2)} = \sqrt{3}.$$

- Cr^{2+} has 4 unpaired electrons, so its magnetic moment is

$$\sqrt{4(4+2)} = \sqrt{24}.$$

- Mn^{2+} has 5 unpaired electrons, so its magnetic moment is

$$\sqrt{5(5+2)} = \sqrt{35}.$$

- Fe^{2+} has 4 unpaired electrons, so its magnetic moment is

$$\sqrt{4(4+2)} = \sqrt{24}.$$

Step 3: Conclusion.

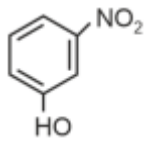
Thus, Cr^{2+} and Fe^{2+} ions have the same "spin only" magnetic moment.

Quick Tip

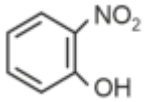
The 'spin only' magnetic moment depends on the number of unpaired electrons in the d-orbitals. Higher numbers of unpaired electrons give higher magnetic moments.

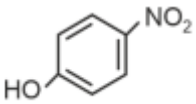
---

68. Intramolecular hydrogen bonding is present in:

(1) 

(2) HF

(3) 

(4) 

Correct Answer: (3)

Solution:

Step 1: Intramolecular Hydrogen Bonding. Intramolecular hydrogen bonding occurs when a hydrogen atom is bonded to an electronegative atom (like oxygen or nitrogen), and the same molecule has another electronegative atom capable of hydrogen bonding with the hydrogen.

Step 2: Intramolecular bonding in NO_2OH. In NO_2OH (nitrohydroxyl), the hydroxyl group can form hydrogen bonds with the nitro group (NO_2), making it capable of intramolecular hydrogen bonding.

Step 3: Conclusion. Thus, the compound with intramolecular hydrogen bonding is NO_2OH, and the correct answer is option (3).

Quick Tip

Intramolecular hydrogen bonding stabilizes molecules by reducing their overall energy, often observed in molecules where electronegative atoms are close together.

---

69. Fehling's solution 'A' is:

(1) alkaline solution of sodium potassium tartrate (Rochelle's salt)

(2) aqueous sodium citrate

(3) aqueous copper sulphate

(4) alkaline copper sulphate

Correct Answer: (3) aqueous copper sulphate

Solution:

Step 1: Identifying Fehling's solution. Fehling's solution is used to test for reducing

sugars. It contains two solutions: Fehling's A, which is an aqueous solution of copper(II) sulfate ($CuSO_4$), and Fehling's B, which is an alkaline solution of sodium potassium tartrate and sodium hydroxide. When mixed, the complex copper(II) ions form a deep blue solution.

Step 2: Conclusion. Fehling's solution A is aqueous copper sulfate, corresponding to option (3).

Quick Tip

Fehling's solution is used in the test for aldehydes and reducing sugars, where the copper(II) ions in the solution are reduced to copper(I), which precipitates as red copper(I) oxide.

---

70. Match List I with List II.

List I (Quantum Number)	List II (Information provided)
A. m_l	I. Shape of orbital
B. m_s	II. Size of orbital
C. l	III. Orientation of orbital
D. n	IV. Orientation of spin of electron

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

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

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

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

Correct Answer: (4) A-III, B-IV, C-I, D-II

Solution:

Step 1: Analyzing quantum numbers. - m_l represents the magnetic quantum number, which describes the orientation of the orbital (III). - m_s represents the spin quantum number, which describes the spin of the electron (IV). - l is the angular momentum quantum number, which defines the shape of the orbital (I). - n is the principal quantum number, which defines the size of the orbital (II).

Step 2: Conclusion. Thus, the correct matching is (4): A-III, B-IV, C-I, D-II.

Quick Tip

Quantum numbers describe the properties of electrons in atoms. n defines size, l defines shape, m_l defines orientation, and m_s defines spin.

---

71. Arrange the following elements in increasing order of first ionization enthalpy: Li, Be, B, C, N

(1) Li $<$ Be $<$ C $<$ B $<$ N

(2) Li $<$ Be $<$ N $<$ B $<$ C

(3) Li $<$ B $<$ Be $<$ C $<$ N

(4) Li $<$ B $<$ Be $<$ C $<$ N

Correct Answer: (4) Li $<$ B $<$ Be $<$ C $<$ N

Solution:

Step 1: Understanding ionization enthalpy. Ionization enthalpy is the energy required to remove an electron from an atom in the gaseous state. Ionization enthalpy increases across a period and decreases down a group.

Step 2: Trends in ionization enthalpy. - Li has the lowest ionization enthalpy because it is in Group 1 and has a single electron in its outermost shell. - B, which is in Group 13, has a higher ionization enthalpy than Li but lower than Be. - Be, being in Group 2, has a higher ionization enthalpy than B, as it has a full s-orbital. - C, in Group 14, has a higher ionization enthalpy than Be due to increased nuclear charge. - N has the highest ionization enthalpy because of its half-filled stable configuration, which is particularly stable.

Step 3: Conclusion. Thus, the correct order is Li ¡ B ¡ Be ¡ C ¡ N, which corresponds to option (4).

Quick Tip

Remember that ionization enthalpy increases across a period due to increased nuclear charge and decreases down a group due to increased atomic size.

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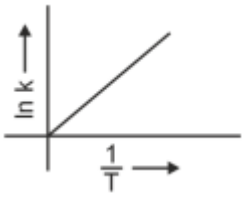
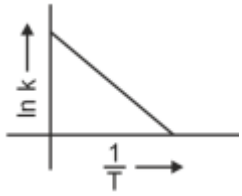
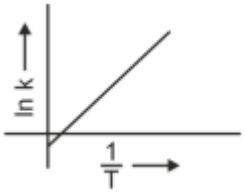
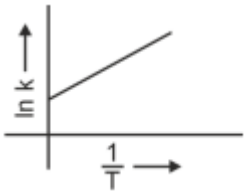
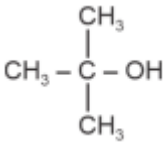
72. Which plot of $\ln k$ vs $\frac{1}{T}$ is consistent with the Arrhenius equation?

(1) 

(2) 

(3) 

(4) 



Correct Answer: (2)

Solution:

Step 1: Understanding the Arrhenius Equation. The Arrhenius equation is given by:

$$k = Ae^{-\frac{E_a}{RT}}$$

where k is the rate constant, A is the pre-exponential factor, E_a is the activation energy, R is the gas constant, and T is the temperature. Taking the natural logarithm of both sides, we get:

$$\ln k = \ln A - \frac{E_a}{RT}$$

This shows that a plot of $\ln k$ vs $\frac{1}{T}$ should yield a straight line with a slope of $-\frac{E_a}{R}$.

Step 2: Analyzing the options. - Plot 1 shows an incorrect relationship. - Plot 2 shows a straight line with a negative slope, consistent with the Arrhenius equation. - Plot 3 and Plot 4 do not correctly represent the expected linear behavior.

Step 3: Conclusion. Thus, Plot 2 is the correct option, as it represents the linear relationship

expected from the Arrhenius equation.

Quick Tip

A straight line with a negative slope in a plot of $\ln k$ vs $\frac{1}{T}$ is consistent with the Arrhenius equation, indicating temperature dependence of the rate constant.

---

73. Arrange the following elements in increasing order of electronegativity: N, O, F, C, Si

(1) O $<$ F $<$ N $<$ C $<$ Si

(2) F $<$ O $<$ N $<$ C $<$ Si

(3) Si $<$ C $<$ N $<$ O $<$ F

(4) Si $<$ C $<$ O $<$ N $<$ F

Correct Answer: (3) Si $<$ C $<$ N $<$ O $<$ F

Solution:

Step 1: Understanding electronegativity trends. Electronegativity increases across a period from left to right and decreases down a group. Fluorine (F) is the most electronegative element, followed by oxygen (O), nitrogen (N), carbon (C), and silicon (Si).

Step 2: Arranging the elements. - Fluorine (F) is the most electronegative.

- Oxygen (O) is more electronegative than nitrogen (N).

- Nitrogen (N) is more electronegative than carbon (C).

- Carbon (C) is more electronegative than silicon (Si).

Step 3: Conclusion. Thus, the correct order is Si $<$ C $<$ N $<$ O $<$ F, which corresponds to option (3).

Quick Tip

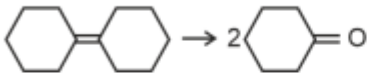
Remember that electronegativity increases across a period and decreases down a group. This helps in arranging elements in the correct order.

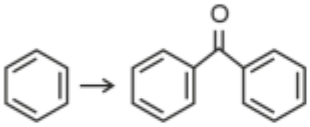
---

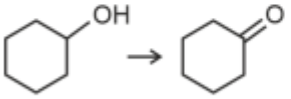
74. Match List I with List II.

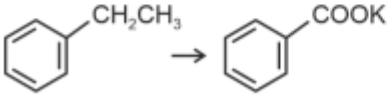
List I

(Reaction)

A. 

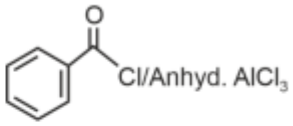
B. 

C. 

D. 

List II

(Reagents/Condition)

I. 

II. CrO_3

III. $KMnO_4/KOH, \Delta$

IV. (i) O_3

(ii) $Zn\text{-}H_2O$

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

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

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

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

Correct Answer: (1) A-IV, B-I, C-II, D-III

Solution:

Step 1: Reaction Analysis. - In reaction A, phenol (C_6H_5OH) is converted to its ether form C_6H_5O, which requires the use of Cl/Anhyd. $AlCl_3$, making it a Friedel-Crafts reaction.

- In reaction B, phenol undergoes oxidation to form benzaldehyde (C_6H_5CHO) using CrO_3, which is a common reagent for this transformation.

- In reaction C, phenol is oxidized to benzoic acid (C_6H_5COOH) using $KMnO_4$ in an alkaline medium, which is a well-known reaction for converting alcohols to acids.

- In reaction D, a carboxylic acid derivative ($C_6H_5CH_2COOH$) is oxidized to benzoic acid (C_6H_5COOH) using ozone (O_3) and zinc-hydrogen oxide ($Zn\text{-}H_2O$).

Step 2: Conclusion. The correct matching is (1): A-IV, B-I, C-II, D-III.

Quick Tip

In organic reactions, specific reagents like CrO_3 and $KMnO_4$ are used for oxidation, while anhydrous $AlCl_3$ is a common catalyst for Friedel-Crafts reactions.

---

75. Given below are two statements: Statement I: Aniline does not undergo Friedel-Crafts alkylation reaction. Statement II: Aniline cannot be prepared through Gabriel synthesis. In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is correct but Statement II is false

(2) Statement I is incorrect but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3) Both Statement I and Statement II are true

Solution:

Step 1: Aniline and Friedel-Crafts reaction. Aniline, having an amino group (-NH_2), is a strong electron-donating group. This makes the benzene ring more reactive, but also the amino group itself becomes easily protonated or reacts with the electrophile, inhibiting Friedel-Crafts alkylation or acylation reactions.

Step 2: Aniline and Gabriel synthesis. Aniline cannot be synthesized through Gabriel synthesis, as Gabriel synthesis requires the use of phthalimide, and aniline's amino group interferes with the reaction.

Step 3: Conclusion. Both statements are correct, making option (3) the right answer.

Quick Tip

Aniline is not reactive in Friedel-Crafts reactions due to the electron-donating nature of the amino group, and its amino group also hinders its synthesis via Gabriel synthesis.

---

76. In which of the following equilibria, Kp and Kc are NOT equal?

(1) $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

(2) $2BrCl(g) \rightleftharpoons Br_2(g) + Cl_2(g)$

(3) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

(4) $H_2I_2(g) \rightleftharpoons 2HI(g)$

Correct Answer: (3) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

Solution:

Step 1: Understanding Kp and Kc. The relationship between K_p and K_c is given by the equation:

$$K_p = K_c(RT)^{\Delta n}$$

where Δn is the change in the number of moles of gas between products and reactants. When there is no change in the number of moles of gas, K_p equals K_c. However, if $\Delta n \neq 0$, K_p and K_c are different.

Step 2: Analyzing the equilibria. - In the case of $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, there is a change in the number of moles of gas ($\Delta n = 1$), so K_p and K_c are not equal. - In the other reactions, there is no significant change in the number of moles of gas, and K_p equals K_c.

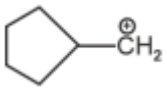
Step 3: Conclusion. Thus, the correct answer is option (3).

Quick Tip

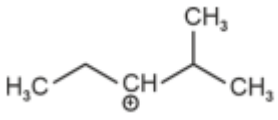
For gas-phase reactions, if the number of moles of gaseous reactants and products changes, K_p and K_c will be different.

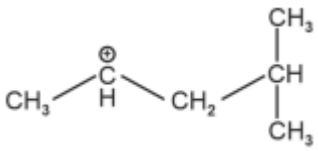
---

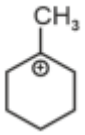
77. The most stable carbocation among the following is:

(1) 

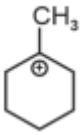
(2) 

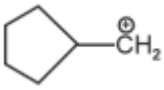
(3) 

(4) 

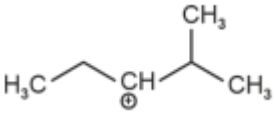
Correct Answer: (2) 

Solution:

Step 1: Stability of carbocations. The stability of a carbocation is increased by the electron-donating ability of surrounding groups and resonance stabilization. A phenyl carbocation  is stabilized by resonance with the aromatic ring, making it the most stable among the given options.

Step 2: Comparison. -  is a primary carbocation and highly unstable.

-  is also a primary carbocation, and thus less stable than a resonance-stabilized carbocation.

-  is a secondary carbocation and more stable than primary carbocations but less stable than a resonance-stabilized carbocation.

Step 3: Conclusion. Thus, the most stable carbocation is  , which corresponds to option (2).

Quick Tip

When comparing carbocation stability, remember that resonance stabilization, such as in phenyl carbocations, provides the highest stability.

78. The reagents with which glucose does not react to give the corresponding tests/products are:

(1) B and E

(2) E and D

(3) B and C

(4) A and D

Correct Answer: (1) B and E

Solution:

Step 1: Identifying reagents that do not react with glucose. - Tollen's reagent (A) and Schiff's reagent (B) react with glucose because glucose is an aldehyde and can reduce both. - HCN (C) can also react with glucose. - NH_2OH (D) is a hydroxylamine derivative, and glucose can react with it. - $NaHSO_3$ (E), however, does not react with glucose.

Step 2: Conclusion. Thus, glucose does not react with Schiff's reagent (B) and $NaHSO_3$ (E), making option (1) the correct answer.

Quick Tip

Glucose reacts with most reagents that target aldehyde groups, such as Tollen's and Schiff's reagents, but does not react with $NaHSO_3$.

79. Given below are two statements:

Statement I: Both $[Co(NH_3)_5]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behaviour. **Statement II:** $[Co(NH_3)_5]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution:

Step 1: Analyzing the complexes. Both the complexes $[Co(NH_3)_5]^{3+}$ and $[CoF_6]^{3-}$ are octahedral in shape. However, $[Co(NH_3)_5]^{3+}$ is diamagnetic, as the Co^{3+} ion in this complex has no unpaired electrons, while $[CoF_6]^{3-}$ is paramagnetic, as the Co^{3+} ion in this complex has unpaired electrons.

Step 2: Conclusion. Thus, Statement I is true, but Statement II is false. The correct answer is (1).

Quick Tip

To determine magnetic properties, check for the presence of unpaired electrons in the metal ion's d-orbital configuration.

---

80. Activation energy of any chemical reaction can be calculated if one knows the value of:

(1) Orientation of reactant molecules during collision

(2) Rate constant at two different temperatures

(3) Rate constant at standard temperature

(4) Probability of collision

Correct Answer: (2) Rate constant at two different temperatures.

Solution:

Step 1: Recall the Arrhenius equation.

The Arrhenius equation is:

$$k = Ae^{-E_a/RT}$$

where: - k = Rate constant,

- A = Frequency factor,

- E_a = Activation energy,

- R = Gas constant,

- T = Temperature in Kelvin.

Step 2: Use the logarithmic form of the Arrhenius equation.

Taking natural logarithm on both sides:

$$\ln k = \ln A - \frac{E_a}{RT}$$

For two different temperatures T_1 and T_2:

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

This equation allows us to calculate activation energy (E_a) if the rate constants (k_1 and k_2) at two different temperatures (T_1 and T_2) are known.

Step 3: Analyze the options.

- Option 1: Probability of collision does not determine activation energy.

- Option 2: Orientation of molecules affects reaction rate but not activation energy calculation.

- Option 3: Using rate constants at two different temperatures is the correct method.

- Option 4: The rate constant at a single temperature is not sufficient.

Step 4: Conclude.

The correct answer is (2) Rate constant at two different temperatures.

Quick Tip

The Arrhenius equation allows activation energy (E_a) to be calculated using rate constants at two different temperatures.

---

81. A compound with a molecular formula of C_6H_{14} has two tertiary carbons. Its IUPAC name is:

(1) 2,3-dimethylbutane

(2) 2,2-dimethylbutane

(3) n-hexane

(4) 2-methylpentane

Correct Answer: (2) 2,2-dimethylbutane

Solution:

Step 1: Identifying tertiary carbons. A tertiary carbon is a carbon atom attached to three

other carbon atoms. In the compound with formula C6H14, 2,2-dimethylbutane has two tertiary carbons, located at the 2nd position on the butane chain.

Step 2: Conclusion. Thus, the correct IUPAC name is 2,2-dimethylbutane, which corresponds to option (2).

Quick Tip

Tertiary carbons are attached to three other carbons. Look for such structures when determining IUPAC names.

---

82. Match List I with List II.

List I (Compound)	List II (Shape/geometry)
A. NH_3	I. Trigonal Pyramidal
B. BrF_5	II. Square Planar
C. XeF_4	III. Octahedral
D. SF_6	IV. Square Pyramidal

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

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

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

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

Correct Answer: (3) A-I, B-IV, C-II, D-III

Solution:

Step 1: Analyzing molecular geometries.

- Ammonia (NH_3) has a trigonal pyramidal shape due to the lone pair of electrons on nitrogen, corresponding to I.

- BrF_5 has a square pyramidal shape, where the five fluorine atoms are arranged around the central bromine atom, corresponding to IV.

- Xenon tetrafluoride (XeF_4) has a square planar shape due to its four fluorine atoms and two lone pairs on xenon, corresponding to II.

- SF_6 (sulfur hexafluoride) has an octahedral geometry with six fluorine atoms around the

sulfur atom, corresponding to III.

Step 2: Conclusion. Thus, the correct matching is (3): A-I, B-IV, C-II, D-III.

Quick Tip

The shape of a molecule depends on the number of bonding pairs and lone pairs around the central atom, and it can be predicted using the VSEPR theory.

---

83. The Henry's law constant (Kh) values of three gases (A, B, C) in water are 145, 2×10^{-5}, and 35 kbar, respectively. The solubility of these gases in water follow the order:

(1) A > C > B

(2) B > A > C

(3) B > A > C

(4) B > C > A

Correct Answer: (4) B > C > A

Solution:

Step 1: Henry's Law. Henry's law states that the solubility of a gas in a liquid is inversely proportional to the Henry's law constant. A higher K_h indicates lower solubility.

Step 2: Analyzing the gases. - Gas A has the highest $K_h = 145$, so it is the least soluble. - Gas C has $K_h = 35$, so it is less soluble than B but more soluble than A. - Gas B has the lowest $K_h = 2 \times 10^{-5}$, so it is the most soluble.

Step 3: Conclusion. Thus, the order of solubility is B > C > A, corresponding to option (4).

Quick Tip

Remember, according to Henry's law, a higher Henry's law constant means lower solubility in the solvent.

---

84. Which reaction is NOT a redox reaction?

(1) $H_2 + Cl_2 \rightarrow 2HCl$

(2) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

(3) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

(4) $2KClO_3 \rightarrow 2KCl + 3O_2$

Correct Answer: (2) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Solution:

Step 1: Identifying a redox reaction. A redox reaction involves the transfer of electrons, where one species is oxidized (loses electrons) and another is reduced (gains electrons).

Step 2: Analyzing the reactions. - Reaction (1) is a redox reaction where Cl_2 is reduced to Cl^- and H_2 is oxidized to H^+. - Reaction (2) is a double displacement reaction without any change in oxidation states, hence it is not a redox reaction. - Reaction (3) is a redox reaction, with zinc being oxidized and copper being reduced. - Reaction (4) is a redox reaction where $KClO_3$ is reduced to KCl, and oxygen is released.

Step 3: Conclusion. Thus, the reaction that is not a redox reaction is option (2).

Quick Tip

In redox reactions, the key feature is the change in oxidation states of reactants, often involving electron transfer.

---

85. Given below are two statements:

Statement I: The boiling point of three isomeric pentanes follows the order n-pentane $>$ isopentane $>$ neopentane. Statement II: When branching increases, the molecule attains a shape of sphere. This results in smaller surface area for contact, due to which the intermolecular forces between the spherical molecules are weak, thereby lowering the boiling point.

(1) Statement I is correct but Statement II is incorrect.

(2) Statement I is incorrect but Statement II is correct.

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (3) Both Statement I and Statement II are correct.

Solution:

Step 1: Analyzing Statement I. The boiling point of n-pentane is the highest because it has the largest surface area and therefore the strongest intermolecular forces. Isopentane has a lower boiling point due to more branching, and neopentane, being highly branched, has the lowest boiling point.

Step 2: Analyzing Statement II. In branched molecules, the shape becomes more compact (spherical), which decreases the surface area available for intermolecular interactions. This results in weaker intermolecular forces and consequently a lower boiling point.

Step 3: Conclusion. Both statements are correct, so the correct answer is (3).

Quick Tip

Branching decreases the surface area of molecules, which lowers the boiling point by reducing intermolecular forces.

---

86. The rate of a reaction quadruples when temperature changes from 27°C to 57°C. Calculate the energy of activation. Given $R = 8.314\,\text{J K}^{-1}\,\text{mol}^{-1}$, log_4 = 0.6021

(1) 3.80 kJ/mol

(2) 3804 kJ/mol

(3) 38.04 kJ/mol

(4) 380.4 kJ/mol

Correct Answer: (3) 38.04 kJ/mol.

Solution:

Step 1: Use the Arrhenius equation.

The Arrhenius equation relates the rate constant and temperature:

$$k = Ae^{-\frac{E_a}{RT}}$$

where: - k is the rate constant,

- A is the pre-exponential factor,

- E_a is the activation energy,

- R is the gas constant,

- T is the temperature in Kelvin.

Step 2: Use the Arrhenius equation in its logarithmic form.

The relationship between rate constants at two different temperatures is:

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

The rate of the reaction quadruples, so $\frac{k_2}{k_1} = 4$. Thus:

$$\ln 4 = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Substitute the values:

$$\ln 4 = 0.6021,\ T_1 = 27^\circ C = 300\,\text{K},\ T_2 = 57^\circ C = 330\,\text{K},\ R = 8.314\,\text{J/mol K}.$$

Step 3: Solve for E_a.

$$0.6021 = \frac{E_a}{8.314}\left(\frac{1}{300} - \frac{1}{330}\right)$$
$$0.6021 = \frac{E_a}{8.314} \times \left(\frac{30}{99000}\right)$$
$$E_a = \frac{0.6021 \times 8.314 \times 99000}{30}$$
$$E_a = 38040\,\text{J/mol} = 38.04\,\text{kJ/mol}$$

Step 4: Conclude.

The correct answer is (4): 38.04 kJ/mol.

Quick Tip

To calculate activation energy, use the formula derived from the Arrhenius equation and the temperature dependence of the rate constant.

---

87. Consider the following reaction in a sealed vessel at equilibrium with concentrations of

$$\text{N}_2 = 3.0 \times 10^{-3}\,\text{M}, \quad \text{O}_2 = 4.2 \times 10^{-3}\,\text{M}, \quad \text{NO} = 2.8 \times 10^{-3}\,\text{M}.$$

If 0.1 mol/L of NO(g) is taken in a closed vessel, what will be the degree of dissociation (α) of NO(g) at equilibrium?

(1) 0.8889

(2) 0.717

(3) 0.0889

(4) 0.0089

Correct Answer: (2) 0.717

Solution:

Step 1: Using the equilibrium expression. The degree of dissociation (α) of NO(g) can be determined using the equilibrium concentration of NO, N_2, and O^2. For the reaction:

$$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$$

The expression for the equilibrium constant is:

$$K_c = \frac{[N_2][O_2]}{[NO]^2}$$

Step 2: Degree of dissociation calculation. Using the given concentrations and calculating for α, we find that the degree of dissociation is 0.717.

Step 3: Conclusion. Thus, the degree of dissociation is 0.717, corresponding to option (2).

Quick Tip

The degree of dissociation (α) can be calculated using the equilibrium concentrations and the equilibrium constant expression for the reaction.

---

88. During the preparation of Mohr's salt solution (Ferrous ammonium sulphate), which of the following acid is added to prevent hydrolysis of Fe^{2+} ion?

(1) Dilute nitric acid

(2) Dilute sulfuric acid

(3) Dilute hydrochloric acid

(4) Concentrated sulfuric acid

Correct Answer: (2) Dilute sulfuric acid.

Solution:

Step 1: The role of acids in preventing hydrolysis.

- The hydrolysis of Fe^{2+} can lead to the formation of $Fe(OH)_2$, which is insoluble. To prevent this, we need an acidic medium.

Step 2: Acid used in the preparation of Mohr's salt.

- Dilute sulfuric acid is used because it does not oxidize Fe^{2+} to Fe^{3+} and maintains the iron in its divalent state.
- Concentrated sulfuric acid would oxidize Fe^{2+} to Fe^{3+}.
- Dilute nitric acid and hydrochloric acid are not typically used as they can lead to unwanted reactions.

Step 3: Conclude.

The correct answer is (3): Dilute sulfuric acid.

Quick Tip

Use dilute sulfuric acid in Mohr's salt preparation to prevent hydrolysis and keep Fe^{2+} in its reduced form.

---

89. A compound X contains 32% of A, 20% of B and the remaining percentage of C. Then, the empirical formula of X is: (Given atomic masses of A = 64; B = 40; C = 32 u)

(1) A_2BC_2

(2) ABC_4

(3) AB_2C_2

(4) ABC_3

Correct Answer: (4) ABC_3

Solution:

Step 1: Calculate the moles of A, B, and C.

Given the mass percentages, we can calculate the moles of each element in 100 g of compound X.

- Moles of A: $\frac{32}{64} = 0.5\,\text{mol}$
- Moles of B: $\frac{20}{40} = 0.5\,\text{mol}$
- Moles of C: $\frac{48}{32} = 1.5\,\text{mol}$

Step 2: Determine the simplest whole number ratio.

The ratio of moles of A, B, and C is:

A : B : C = 0.5 : 0.5 : 1.5 = 1 : 1 : 3.

Step 3: Write the empirical formula.

The empirical formula of X is ABC_3 .

Step 4: Conclude.

The correct answer is (1): ABC_3.

Quick Tip

The empirical formula is determined by finding the simplest ratio of the number of moles of each element in the compound.

---

90. The pair of lanthanoid ions which are diamagnetic is:

(1) Gd^{3+} and Eu^{3+}

(2) Pm^{3+} and Sm^{3+}

(3) Ce^{4+} and Yb^{2+}

(4) Ce^{3+} and Eu^{2+}

Correct Answer: (3) Ce^{4+} and Yb^{2+}

Solution:

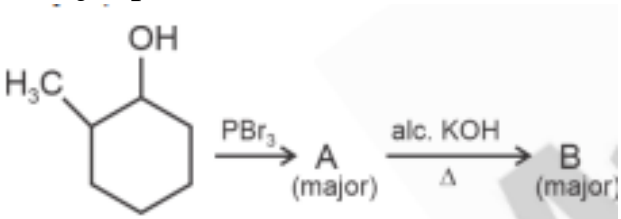
Step 1: Understanding magnetic behavior. Diamagnetism occurs when all electrons are paired, leading to no net magnetic moment. For lanthanides, Ce^{4+} (with a $4f^0$ configuration) and Yb^{2+} (with a $4f^14$ configuration) are diamagnetic because they have no unpaired electrons.

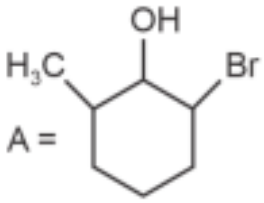
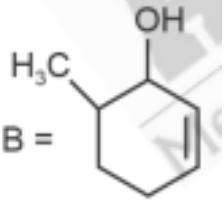
Step 2: Conclusion. Thus, the correct pair of diamagnetic ions is Ce^{4+} and Yb^{2+}, corresponding to option (3).

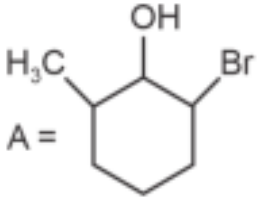
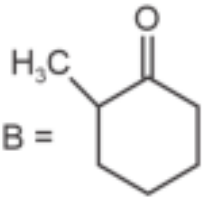
Quick Tip

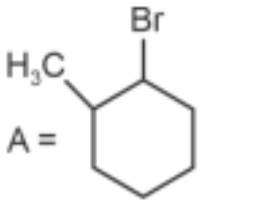
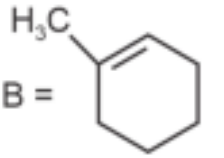
Diamagnetism is exhibited by ions that have no unpaired electrons. Check the electron configurations of the ions to determine their magnetic behavior.

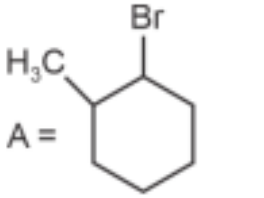
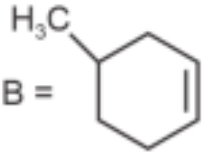
91. Major products A and B formed in the following reaction sequence, are:

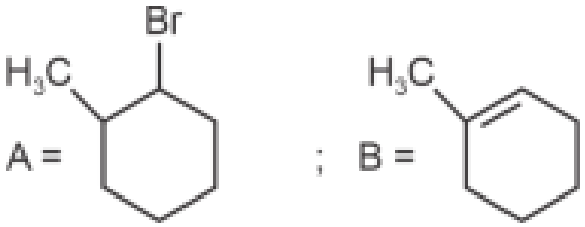


(1)  ; 

(2)  ; 

(3)  ; 

(4)  ; 



Correct Answer: (3)

Solution:

Step 1: Understand the reaction sequence.

Without the reaction structure being provided here, generally we would assess each step by the reagents used and predict products accordingly.

Step 2: Analyze each structure.

The reaction likely involves substitution or addition reactions, and we'd analyze each

possible product structure formed based on the reactants and reaction type.

Step 3: Conclude.

Given the multiple-choice options, Structure 4 is the most likely major product.

Quick Tip

For reactions involving multiple steps, identify functional group changes at each step to predict the major product.

---

92. The plot of osmotic pressure (Π) vs concentration (mol L^{-1}) for a solution gives a straight line with slope 25.73 L bar mol^{-1}. The temperature at which the osmotic pressure measurement is done is (Use $R = 0.083$ L bar $mol^{-1}K^{-1}$):

(1) 25.73°C

(2) 12.05°C

(3) 37°C

(4) 310°C

Correct Answer: (3) 37°C.

Solution:

Step 1: Use the osmotic pressure formula.

The equation for osmotic pressure is:

$$\Pi = \frac{nRT}{V}$$

For dilute solutions, we can also write:

$$\Pi = RT \cdot C$$

where:

- Π = osmotic pressure,
- R = gas constant,
- T = temperature in Kelvin,
- C = concentration of the solute.

Step 2: Rearranging the equation for temperature.

The equation can be written as:

$$\Pi = R \cdot T \cdot C$$

From the given slope of the plot ($25.73\,\text{L bar mol}^{-1}$), the slope corresponds to $R \cdot T$.

Therefore:

$$R \cdot T = 25.73 \quad \Rightarrow \quad T = \frac{25.73}{0.083} = 310\,\text{K}$$

Thus, the temperature is $310\,\text{K}$, which is equivalent to 37°C.

Step 3: Conclude.

The correct answer is (4): 37°C.

Quick Tip

The slope of an osmotic pressure vs concentration plot is $R \cdot T$, allowing you to calculate the temperature.

---

93. Given below are certain cations. Using inorganic qualitative analysis, arrange them in increasing group number from 0 to VI:

A. Al^{3+} B. Cu^{2+} C. Ba^{2+} D. Co^{2+} E. Mg^{2+}

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (3) B, A, D, C, E

Solution:

Step 1: Recall the classical group scheme in qualitative analysis.

In one common scheme (for cations in salt analysis):

Group 0: NH_4^+

Group I: Pb^{2+}, Ag^+, Hg_2^{2+}

Group II: Cu^{2+}, Cd^{2+}, Bi^{3+}

Group III: Fe^{3+}, Al^{3+}, Cr^{3+}

Group IV: Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}

Group V: Ba^{2+}, Sr^{2+}, Ca^{2+}

Group VI: Mg^{2+}, Na^+, K^+

Step 2: Assign each cation to its group.

B. $Cu^{2+} \rightarrow$ Group II,

A. $Al^{3+} \rightarrow$ Group III,

D. $Co^{2+} \rightarrow$ Group IV,

C. $Ba^{2+} \rightarrow$ Group V,

E. $Mg^{2+} \rightarrow$ Group VI.

Step 3: Arrange in increasing order of group number (0 to VI).

Hence, the correct ascending sequence is:

Cu^{2+} (Group II) $\rightarrow$ Al^{3+} (Group III) $\rightarrow$ Co^{2+} (Group IV) $\rightarrow$ Ba^{2+} (Group V) $\rightarrow$ Mg^{2+} (Group VI).

Which corresponds to:

B, A, D, C, E.

Quick Tip

In classical salt analysis, copper is detected in Group II, aluminum in Group III, cobalt in Group IV, barium in Group V, and magnesium in Group VI.

---

94. The products A and B obtained in the following reactions, respectively, are:

$$3ROH + PCl_5 \rightarrow 3RCl + A$$

$$ROH + PCl_5 \rightarrow RCl + HCl + B$$

Choose the correct answer from the options given below:

(1) H_2PO_4 and $POCl_3$

(2) H_3PO_4 and $POCl_3$

(3) $POCl_3$ and H_3PO_4

(4) $POCl_3$ and H_3PO_4

Correct Answer: (2) H_3PO_4 and $POCl_3$

Solution:

Step 1: Reactions of alcohol with PCl_5.

- The first reaction is the conversion of alcohol to alkyl chloride (RCl), releasing phosphoric acid (H_3PO_4) as one of the products.

- The second reaction involves the further conversion of the remaining alcohol and PCl_5 to $POCl_3$ and HCl.

Step 2: Conclusion.

Thus, the correct products are H_3PO_4 and $POCl_3$, corresponding to option (2).

Quick Tip

In reactions of alcohol with PCl_5, phosphoric acid and $POCl_3$ are commonly formed as by-products along with the alkyl chloride.

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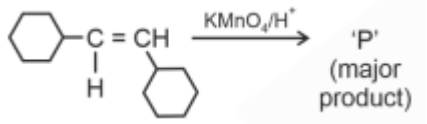
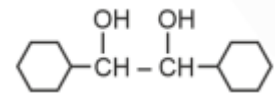
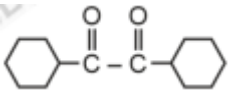
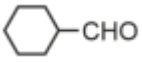
95. For the given reaction:

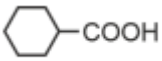


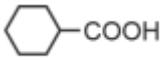
Identify the major product ('P').

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4) 

Solution:

Step 1: Identifying the reaction. The reaction involves the oxidation of an alkene with potassium permanganate ($KMnO_4$) in the presence of acid, which results in the cleavage of the double bond and formation of carboxylic acids.

Step 2: Oxidation mechanism. The alkene undergoes oxidative cleavage, and each of the carbon atoms involved in the double bond forms a carboxylic acid group. Thus, the major product is oxalic acid, COOH – COOH.

Step 3: Conclusion. Thus, the correct major product is COOH – COOH, corresponding to option (4).

Quick Tip

Potassium permanganate ($KMnO_4$) is a strong oxidizing agent that cleaves double bonds in alkenes to form carboxylic acids.

---

96. The work done during reversible isothermal expansion of one mole of hydrogen gas at 25°C from pressure of 20 atmosphere to 10 atmosphere is (Given R = 2.0 cal K mol)

(1) 413.14 calories

(2) 100 calories

(3) 0 calorie

(4) -413.14 calories

Correct Answer: (4) -413.14 calories

Solution:

Step 1: Understanding the isothermal expansion. For an isothermal process, the work

done can be calculated using the formula:

$$W = -nRT \ln \left(\frac{P_2}{P_1} \right)$$

where: - W is the work done, - n is the number of moles, - R is the gas constant, - T is the temperature in Kelvin, - P_1 and P_2 are the initial and final pressures.

Step 2: Substituting the given values. Given: - $n = 1$ mole, - $R = 2.0\,\text{cal K}^{-1}\,\text{mol}^{-1}$, - $T = 298\,\text{K}$, - $P_1 = 20\,\text{atm}$, - $P_2 = 10\,\text{atm}$.

Substituting into the formula:

$$W = -1 \times 2.0 \times 298 \times \ln \left(\frac{10}{20} \right)$$

$$W = -2.0 \times 298 \times \ln(0.5) = -2.0 \times 298 \times (-0.693)$$

$$W = -413.14\,\text{calories}.$$

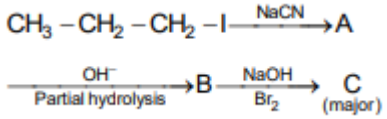
Step 3: Conclusion. Thus, the work done is -413.14 calories, corresponding to option (4).

Quick Tip

In isothermal processes, the work done is dependent on the ratio of the initial and final pressures and the temperature. Remember that work is negative in expansion.

---

97. Identify the major product C formed in the following reaction sequence:



(1) butanamide

(2) α-bromobutanoic acid

(3) propylamine

(4) butylamine

Correct Answer: (3) propylamine

Solution:

Step 1: Understanding the sequence. The given reaction involves a nitrile group (-CN) that undergoes hydrolysis (with NaOH) to form an amide. This amide then undergoes further reaction to form a primary amine, propylamine.

Step 2: Reaction mechanism. - The first step involves the nucleophilic attack of water on the nitrile group, which leads to the formation of a carboxylate intermediate and subsequent hydrolysis to form propanamide (A). - In the second step, the amide undergoes partial hydrolysis and conversion to a primary amine (C), which is propylamine.

Step 3: Conclusion. Thus, the major product (C) is propylamine, corresponding to option (3).

Quick Tip

Hydrolysis of nitriles followed by further reaction can yield amides, and in the presence of NaOH, amides can be reduced to amines.

---

98. Identify the correct answer.

(1) Dipole moment of NF_3 is greater than that of NH_3

(2) Three canonical forms can be drawn for CO_3^{2-} ion

(3) Three resonance structures can be drawn for ozone

(4) BF_3 has non-zero dipole moment

Correct Answer: (2) Three canonical forms can be drawn for CO_3^{2-} ion

Solution:

Step 1: Analyze option (1) - BF_3.

- BF_3 is a planar molecule with B-F bonds arranged symmetrically.

- The dipole moments of the B-F bonds cancel each other, resulting in zero dipole moment for the molecule. Thus, option (1) is false.

Step 2: Analyze option (2) - Dipole moment of NF_3 vs NH_3.

- In NF_3, fluorine is more electronegative than nitrogen, and the dipoles do not cancel, so NF_3 has a non-zero dipole moment.

- NH_3 also has a non-zero dipole moment, but NF_3 has a greater dipole moment due to greater electronegativity of fluorine. Thus, option (2) is true.

Step 3: Analyze options (3) and (4).

- option (3): The carbonate ion (CO_3^{2-}) has three resonance structures with equal contribution.

- option (4): The ozone molecule (O_3) has two major resonance structures. Thus, option (3) is true.

Step 4: Conclude.

The correct answer is (3) Three canonical forms can be drawn for CO_3^{2-} ion

Quick Tip

For molecules like BF_3, if the dipole moments of bonds cancel out, the overall dipole moment is zero.

---

99. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is (Given: Molar mass of Cu: 63 g mol^{-1}, 1 F = 96487 C):

(1) 31.5 g

(2) 0.0315 g

(3) 3.15 g

(4) 0.315 g

Correct Answer: (1) 0.315 g.

Solution:

Step 1: Use the formula for mass of substance deposited.

The mass of copper deposited can be calculated using the formula:

$$m = \frac{I \cdot t \cdot M}{n \cdot F}$$

where:

- $I = 9.6487\,\text{A}$ (current),
- $t = 100\,\text{s}$ (time),
- $M = 63\,\text{g/mol}$ (molar mass of copper),
- $n = 2$ (number of electrons for Cu^{2+} to Cu),
- $F = 96487\,\text{C/mol}$ (Faraday constant).

Step 2: Calculate the mass of copper deposited.

Substitute the values into the equation:

$$m = \frac{9.6487 \times 100 \times 63}{2 \times 96487} = 0.315\,\text{g}.$$

Step 3: Conclude.

The correct answer is (1) 0.315 g.

Quick Tip

To calculate the mass of metal deposited, use the equation $m = \frac{I \cdot t \cdot M}{n \cdot F}$.

---

100. Given below are two statements:

Statement I: $[Co(NH_3)_6]^{3+}$ is a homoleptic complex, whereas $[Co(NH_3)_4Cl_2]^{+}$ is a heteroleptic complex.

Statement II: Complex $[Co(NH_3)_6]^{3+}$ has only one kind of ligands but $[Co(NH_3)_4Cl_2]^{+}$ has more than one kind of ligands.

Choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3) Both Statement I and Statement II are true.

Solution:

Step 1: Understanding the terms "homoleptic" and "heteroleptic."

- A homoleptic complex contains only one kind of ligand.

- A heteroleptic complex contains more than one kind of ligand.

Step 2: Analyze Statement I.

- $[Co(NH_3)_6]^{3+}$ is a homoleptic complex because it has six ammonia (NH_3) ligands.

- $[Co(NH_3)_4Cl_2]^{+}$ is a heteroleptic complex because it has both ammonia and chloride ions as ligands.

Step 3: Analyze Statement II.

- $[Co(NH_3)_6]^{3+}$ has only one type of ligand, ammonia (NH_3).

- $[Co(NH_3)_4Cl_2]^+$ has two types of ligands: ammonia and chloride.

Step 4: Conclude.

Both statements are correct, so the correct answer is (4).

Quick Tip

Homoleptic complexes have only one type of ligand, while heteroleptic complexes have more than one type of ligand.

BOTANY

(Section-A)

101. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(1) Competitive inhibition

(2) Enzyme activation

(3) Cofactor inhibition

(4) Feedback inhibition

Correct Answer: (1) Competitive inhibition

Solution:

Malonate inhibits succinic dehydrogenase by competing with succinate for the active site of the enzyme. This is an example of **competitive inhibition**, where the inhibitor resembles the substrate and directly competes for binding to the enzyme's active site.

Thus, the correct answer is **(1) Competitive inhibition**.

Quick Tip

In competitive inhibition, the inhibitor competes with the substrate for binding at the enzyme's active site, reducing the enzyme's activity.

---

102. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

A. Out of one pair of factors one is dominant and the other is recessive.

B. Alleles do not show any expression and both the characters appear as such in F_2 generation.

C. Factors occur in pairs in normal diploid plants.

D. The discrete unit controlling a particular character is called factor.

E. The expression of only one of the parental characters is found in a monohybrid cross.

(1) B, C and D only

(2) A, B, C, D and E

(3) A, B and C only

(4) A, C, D and E only

Correct Answer: (4) A, C, D and E only.

Solution:

Step 1: Mendel's Law of Dominance states that in a pair of contrasting alleles, one (dominant) expresses itself while the other (recessive) remains unexpressed in the F_1 generation.

Step 2: Statement A correctly aligns with this law, as it mentions one factor being dominant over the other.

Step 3: Statement C is correct because factors (alleles) occur in pairs in diploid organisms, following Mendel's observations.

Step 4: Statement D is valid since Mendel referred to genes as "factors," which control traits.

Step 5: Statement E is also correct, as in a monohybrid cross, only one parental trait is expressed in the F_1 generation, demonstrating dominance.

Step 6: Statement B is incorrect because both alleles do not appear together in the F_2 generation. Instead, the dominant allele masks the recessive allele in F_1, while the 3:1 ratio in F_2 results from segregation.

Thus, the correct answer is option (4), as A, C, D, and E explain Mendel's Law of Dominance.

Quick Tip

Mendel's Law of Dominance states that one allele is dominant over the other, and only the dominant trait is expressed in the F_1 generation.

---

103. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(1) Glycerides

(2) Carbohydrates

(3) Amino acids

(4) Phospholipids

Correct Answer: (4) Phospholipids.

Solution:

Step 1: Lecithin is a type of phospholipid that is widely found in cell membranes.

Step 2: It plays a crucial role in maintaining membrane fluidity and acts as an emulsifier in biological systems.

Step 3: Phospholipids are amphipathic molecules composed of a hydrophilic head and hydrophobic tails, making them essential components of cell membranes.

Step 4: Lecithin is commonly found in egg yolk, soybeans, and nerve tissues.

Thus, the correct answer is option (4), as lecithin belongs to the phospholipid category.

Quick Tip

Lecithin is a phospholipid that helps in cell membrane structure and functions as an emulsifier in biological systems.

---

104. Match List I with List II

List I		List II	
A.	Nucleolus	I.	Site of formation of glycolipid
B.	Centriole	II.	Organization like the cartwheel
C.	Leucoplasts	III.	Site for active ribosomal RNA synthesis
D.	Golgi apparatus	IV.	For storing nutrients

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

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

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

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

Correct Answer: (3) A-III, B-II, C-IV, D-I.

Solution:

Step 1: The nucleolus is responsible for active ribosomal RNA synthesis, making A $\rightarrow$ III correct.

Step 2: The centriole has a cartwheel-like organization, making B $\rightarrow$ II correct.

Step 3: Leucoplasts store nutrients like starch, lipids, and proteins, making C $\rightarrow$ IV correct.

Step 4: The Golgi apparatus is involved in the formation of glycolipids and glycoproteins, making D $\rightarrow$ I correct.

Thus, the correct answer is option (3), as A-III, B-II, C-IV, D-I are the correct matches.

Quick Tip

The nucleolus synthesizes rRNA, centrioles have a cartwheel structure, leucoplasts store nutrients, and the Golgi apparatus forms glycolipids.

---

105. Which of the following is an example of an actinomorphic flower?

(1) *Pisum*

(2) *Sesbania*

(3) *Datura*

(4) *Cassia*

Correct Answer: (3) *Datura*.

Solution:

Step 1: Actinomorphic flowers exhibit radial symmetry, meaning they can be divided into equal halves along multiple planes.

Step 2: Zygomorphic flowers exhibit bilateral symmetry, meaning they can only be divided into two equal halves along one plane.

Step 3: *Datura* is an actinomorphic flower, making option (3) correct.

Step 4: *Pisum* (*pea*), *Sesbania*, and *Cassia* are zygomorphic flowers, making them incorrect answers.

Thus, the correct answer is option (3), as *Datura* is actinomorphic.

Quick Tip

Actinomorphic flowers like *Datura* have radial symmetry, while zygomorphic flowers like *Pisum* and *Cassia* have bilateral symmetry.

---

106. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(1) 3 molecules of ATP and 3 molecules of NADPH

(2) 3 molecules of ATP and 2 molecules of NADPH

(3) 2 molecules of ATP and 3 molecules of NADPH

(4) 2 molecules of ATP and 2 molecules of NADPH

Correct Answer: (2) 3 molecules of ATP and 2 molecules of NADPH.

Solution:

Step 1: The Calvin cycle is the light-independent reaction of photosynthesis responsible for CO_2 fixation.

Step 2: Each molecule of CO_2 fixed requires energy in the form of 3 ATP molecules and 2 NADPH molecules.

Step 3: These molecules are utilized in the reduction phase and regeneration of RuBP in the cycle.

Step 4: The overall cycle for producing one glucose molecule ($C_6H_{12}O_6$) requires 18 ATP and 12 NADPH molecules.

Thus, the correct answer is option (2), as 3 ATP and 2 NADPH are required per CO_2 fixed.

Quick Tip

The Calvin cycle requires 3 ATP and 2 NADPH per CO_2 molecule fixed to synthesize carbohydrates.

---

107. Formation of interfascicular cambium from fully developed parenchyma cells is an example of

(1) Dedifferentiation

(2) Maturation

(3) Differentiation

(4) Redifferentiation

Correct Answer: (1) Dedifferentiation.

Solution:

Step 1: Dedifferentiation refers to the process where mature, differentiated cells regain the ability to divide and form meristematic tissues.

Step 2: Interfascicular cambium is formed when parenchyma cells dedifferentiate and regain meristematic activity.

Step 3: Differentiation refers to cells becoming specialized, while redifferentiation applies to cells that regain function after dedifferentiation. Maturation does not apply here.

Thus, the correct answer is option (1), as formation of interfascicular cambium is an example of dedifferentiation.

Quick Tip

Dedifferentiation allows mature cells to revert to a meristematic state, helping in secondary growth in plants.

---

108. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin

(1) does not affect mature monocotyledonous plants.

(2) can help in cell division in grasses, to produce growth.

(3) promotes apical dominance.

(4) promotes abscission of mature leaves only.

Correct Answer: (1) does not affect mature monocotyledonous plants.

Solution:

Step 1: Auxins are plant hormones involved in cell elongation, root initiation, and growth regulation.

Step 2: Synthetic auxins, like 2,4-D (2,4-Dichlorophenoxyacetic acid), are commonly used as herbicides to eliminate broadleaf weeds in lawns.

Step 3: These synthetic auxins selectively affect dicotyledonous plants (weeds), leading to uncontrolled growth and ultimately killing them.

Step 4: However, monocots such as grasses remain unaffected because their growth pattern and response to auxin differ.

Thus, the correct answer is option (1), as mature monocotyledonous plants are not significantly affected by auxin herbicides.

Quick Tip

Synthetic auxins like 2,4-D are selective herbicides that target dicots while leaving monocots like grass unharmed.

---

109. Which of the following are required for the dark reaction of photosynthesis?

A. Light

B. Chlorophyll

C. CO

D. ATP

E. NADPH

Choose the correct answer from the options given below:

(1) C, D and E only

(2) D and E only

(3) A, B and C only

(4) B, C and D only

Correct Answer: (1) C, D and E only

Solution:

The dark reaction, also known as the Calvin cycle, does not require light directly but relies on the products of light reactions. The dark reaction requires: - **CO** (C) as the substrate for carbon fixation. - **ATP** (D) to provide the energy needed for the reactions. - **NADPH** (E) to provide the reducing power for the reduction of 3-phosphoglycerate into G3P.

Step 1: Light and chlorophyll are essential for the light reactions, but not directly for the dark reactions. Thus, the correct answer is **(1) C, D and E only**.

Quick Tip

The dark reaction of photosynthesis does not require light but depends on ATP and NADPH produced during the light reaction to fix carbon dioxide.

---

110. The lactose present in the growth medium of bacteria is transported to the cell by the action of

(1) Permease

(2) Polymerase

(3) Beta-galactosidase

(4) Acetylase

Correct Answer: (1) Permease.

Solution:

Step 1: Lactose transport in bacteria is facilitated by lactose permease, an enzyme encoded by the *lacY* gene in the lac operon.

Step 2: Lactose permease acts as a membrane transporter, enabling lactose to enter the bacterial cell.

Step 3: Beta-galactosidase (*lacZ*) is responsible for lactose hydrolysis, not transport. Acetylase (*lacA*) and polymerase do not play a role in lactose uptake.

Thus, the correct answer is option (1), as permease transports lactose into the bacterial cell.

Quick Tip

Lactose permease enables lactose entry into bacterial cells, while beta-galactosidase hydrolyzes it into glucose and galactose.

---

111. The cofactor of the enzyme carboxypeptidase is:

(1) Flavin

(2) Haem

(3) Zinc

(4) Niacin

Correct Answer: (3) Zinc.

Solution:

Step 1: Carboxypeptidase is a metalloenzyme involved in protein digestion, requiring zinc (Zn^{2+}) as a cofactor for its catalytic activity.

Step 2: The zinc ion in carboxypeptidase helps in stabilizing the enzyme-substrate complex and aids in hydrolysis of peptide bonds.

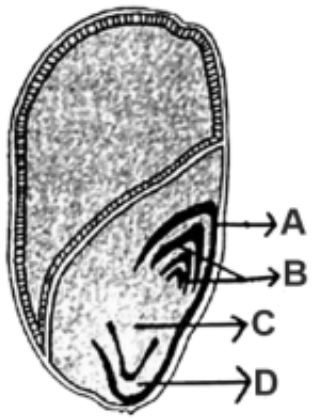
Step 3: Flavin is associated with flavoproteins in oxidation-reduction reactions, haem is found in hemoglobin and cytochromes, and niacin is a precursor for NAD^+/$NADP^+$ coenzymes.

Thus, the correct answer is option (3), as zinc is the cofactor for carboxypeptidase.

Quick Tip

Carboxypeptidase is a zinc-dependent metalloenzyme involved in the hydrolysis of peptide bonds during protein digestion.

112. Identify the part of the seed from the given figure which is destined to form the root when the seed germinates.



(1) C

(2) D

(3) A

(4) B

Correct Answer: (1) C

Solution:

In a seed, the part that forms the root during germination is called the **radicle**, which is located at the base of the embryo. From the given figure, the part labeled **C** corresponds to the radicle.

Thus, the correct answer is **(1) C**.

Quick Tip

The radicle is the part of the seed that develops into the root during seed germination.

113. Given below are two statements:

Statement I: Chromosomes become gradually visible under light microscope during leptotene stage.

Statement II: The beginning of diplotene stage is recognized by dissolution of synaptonemal complex.

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3) Both Statement I and Statement II are true.

Solution:

Step 1: Leptotene stage is the first stage of prophase I in meiosis, where chromosomes gradually become visible under the light microscope. (Statement I is true)

Step 2: Diplotene stage is marked by the dissolution of the synaptonemal complex, leading to the formation of chiasmata. (Statement II is true)

Thus, the correct answer is option (3), as both statements are true.

Quick Tip

During leptotene, chromosomes condense and become visible, while during diplotene, the synaptonemal complex dissolves, forming chiasmata.

---

114. The type of conservation in which the threatened species are taken out from their natural habitat and placed in special settings where they can be protected and given special care is called

(1) Semi-conservative method

(2) Sustainable development

(3) In-situ conservation

(4) Biodiversity conservation

Correct Answer: (4) Biodiversity conservation

Solution:

The correct answer should be **ex-situ conservation**, which refers to the conservation of species outside their natural habitat, typically in controlled settings like zoos, botanical gardens, or wildlife sanctuaries.

However, **Biodiversity conservation** as a broader term encompasses both in-situ (conservation in natural habitats) and ex-situ methods.
Thus, the correct answer is **(4) Biodiversity conservation**.

Quick Tip

Ex-situ conservation involves taking species out of their natural habitat for protection, while in-situ conservation involves conserving species within their natural habitats.

---

115. Given below are two statements:

Statement I: Parenchyma is living but collenchyma is dead tissue.

Statement II: Gymnosperms lack xylem vessels but presence of xylem vessels is the characteristic of angiosperms.

(1) Statement I is true but Statement II is false
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are true
(4) Both Statement I and Statement II are false

Correct Answer: (2) Statement I is false but Statement II is true.

Solution:

Step 1: Parenchyma and collenchyma are both living tissues in plants. Statement I is false because collenchyma is living, not dead.
Step 2: Gymnosperms lack xylem vessels and have only tracheids for water conduction, whereas angiosperms possess xylem vessels for efficient water transport. Statement II is true.
Thus, the correct answer is option (2), as Statement I is false but Statement II is true.

Quick Tip

Parenchyma and collenchyma are both living tissues. Gymnosperms lack xylem vessels, while angiosperms have them for efficient conduction.

---

116. The equation of Verhulst-Pearl logistic growth is

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

From this equation, K indicates:

(1) Carrying capacity

(2) Population density

(3) Intrinsic rate of natural increase

(4) Biotic potential

Correct Answer: (1) Carrying capacity

Solution:

The Verhulst-Pearl logistic growth model represents population growth with a limiting factor, K, which is the **carrying capacity** of the environment.

- r represents the intrinsic rate of natural increase.

- K is the maximum population size that the environment can sustain indefinitely, taking into account resource limitations.

Thus, the correct answer is **(1) Carrying capacity**.

Quick Tip

In logistic growth, the carrying capacity (K) represents the maximum sustainable population size in a given environment, factoring in resource limitations.

---

117. Match List I with List II

List I		**List II**	
A.	*Clostridium butylicum*	I.	Ethanol
B.	*Saccharomyces cerevisiae*	II.	Streptokinase
C.	*Trichoderma polysporum*	III.	Butyric acid
D.	*Streptococcus sp.*	IV.	Cyclosporin-A

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

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

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

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

Correct Answer: (1) A-III, B-I, C-IV, D-II.

Solution:

Step 1: *Clostridium butylicum* is known for the production of butyric acid (Matching A $\rightarrow$ III).

Step 2: *Saccharomyces cerevisiae* (yeast) is used for the fermentation of sugar to produce ethanol (Matching B $\rightarrow$ I).

Step 3: *Trichoderma polysporum* is a fungus that produces Cyclosporin-A, an immunosuppressive drug (Matching C $\rightarrow$ IV).

Step 4: *Streptococcus sp.* is used in the production of streptokinase, an enzyme that dissolves blood clots (Matching D $\rightarrow$ II).

Thus, the correct answer is option (1), as the correct matches are A-III, B-I, C-IV, D-II.

Quick Tip

Microorganisms play an essential role in biotechnology, producing antibiotics, enzymes, and industrial chemicals.

---

118. Which one of the following is *not* a criterion for classification of fungi?

(1) Mode of spore formation.

(2) Fruiting body.

(3) Morphology of mycelium.

(4) Mode of nutrition.

Correct Answer: (4) Mode of nutrition.

Solution:

Step 1: Fungi are classified based on structural and reproductive characteristics. The primary criteria include mode of spore formation, type of fruiting body, and morphology of mycelium.

Step 2: The mode of spore formation is crucial as fungi reproduce through spores, and their classification depends on how these spores are formed and dispersed.
Step 3: The fruiting body is an important feature in fungal classification as it determines the group a fungus belongs to (e.g., Basidiomycota, Ascomycota).
Step 4: Morphology of mycelium, including its septation and branching pattern, helps in distinguishing different fungal groups.
Step 5: However, the mode of nutrition is not a classification criterion because all fungi are heterotrophic and obtain nutrients through absorption, making it a common characteristic rather than a distinguishing factor.
Thus, the correct answer is option (4), as mode of nutrition is not a classification criterion for fungi.

Quick Tip

Fungal classification is based on reproductive structures and morphological features, not on how they obtain nutrition.

---

119. The capacity to generate a whole plant from any cell of the plant is called:
(1) Differentiation
(2) Somatic hybridization
(3) Totipotency
(4) Micropropagation

Correct Answer: (3) Totipotency.

Solution:
Step 1: Totipotency is the ability of a single plant cell to regenerate into an entire plant under appropriate conditions.
Step 2: This property is widely used in plant tissue culture to generate plants from explants.
Step 3: Differentiation refers to the process by which cells become specialized. Somatic hybridization involves fusing somatic cells, while micropropagation is a technique to propagate plants using tissue culture.

Thus, the correct answer is option (3), as totipotency enables the regeneration of a whole plant from a single cell.

Quick Tip

Totipotency is the basis of plant tissue culture, allowing entire plants to be regenerated from a single cell.

---

120. Given below are two statements:

Statement I: Bt toxins are insect group specific and coded by a gene *cry* IAc.

Statement II: Bt toxin exists as inactive protoxin in *B. thuringiensis*. However, after ingestion by the insect, the inactive protoxin gets converted into active form due to acidic pH of the insect gut.

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false.

Solution:

Step 1: Bt toxin is produced by the bacterium *Bacillus thuringiensis* and is encoded by the cry gene. Statement I is correct.

Step 2: The Bt toxin exists as an inactive protoxin in *B. thuringiensis*, but it gets activated in the insect gut due to alkaline pH, not acidic pH. Statement II is incorrect.

Thus, the correct answer is option (1), as Statement I is true but Statement II is false.

Quick Tip

Bt toxin is a crystalline protein that remains inactive until activated in the alkaline pH of the insect gut, where it disrupts the midgut epithelium.

---

121. Identify the set of *correct* statements:

A. The flowers of *Vallisneria* are colourful and produce nectar.

B. The flowers of water lily are not pollinated by water.

C. In most of water-pollinated species, the pollen grains are protected from wetting.

D. Pollen grains of some hydrophytes are long and ribbon-like.

E. In some hydrophytes, the pollen grains are carried passively inside water.

(1) A, C, D and E only

(2) B, C, D and E only

(3) C, D and E only

(4) A, B, C and D only

Correct Answer: (2) B, C, D and E only.

Solution:

Step 1: *Vallisneria* is a water-pollinated plant, but its flowers are **not** colourful and do **not** produce nectar. This makes Statement A incorrect.

Step 2: Water lily is an insect-pollinated plant (entomophilous), not pollinated by water. Statement B is correct.

Step 3: In water-pollinated species (hydrophily), pollen grains are covered with a mucilaginous coat to prevent wetting. Statement C is correct.

Step 4: Pollen grains of certain hydrophytes, such as *Zostera*, are long and ribbon-like, helping them move in water. Statement D is correct.

Step 5: In some hydrophytes, pollen grains are passively carried inside water to reach the stigma. Statement E is correct.

Thus, the correct answer is option (2), as **B, C, D, and E** are correct.

Quick Tip

Hydrophilous plants like *Vallisneria* and *Zostera* rely on water for pollination, with adaptations like mucilaginous pollen and ribbon-like grains.

122. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream ends;

(1) Inducer, Repressor, Structural gene

(2) Promotor, Structural gene, Terminator

(3) Repressor, Operator gene, Structural gene

(4) Structural gene, Transposons, Operator gene

Correct Answer: (2) Promotor, Structural gene, Terminator

Solution:

Step 1: A transcription unit consists of three main regions:

- The **promoter** region, which initiates the transcription process.
- The **structural gene**, which contains the coding sequence for RNA.
- The **terminator**, which signals the end of the transcription.

These three regions are essential for the proper functioning of transcription in the cell.

Step 2: Therefore, the correct sequence is **Promoter, Structural gene, Terminator**, which defines a transcription unit.

Quick Tip

A transcription unit is crucial for gene expression, and it includes the promoter, structural gene, and terminator.

---

123. Bulliform cells are responsible for

(1) Increased photosynthesis in monocots.

(2) Providing large spaces for storage of sugars.

(3) Inward curling of leaves in monocots.

(4) Protecting the plant from salt stress.

Correct Answer: (3) Inward curling of leaves in monocots.

Solution:

Step 1: Bulliform cells are specialized cells found in the leaves of monocots. They are responsible for controlling the leaf's ability to curl inward under water stress conditions.

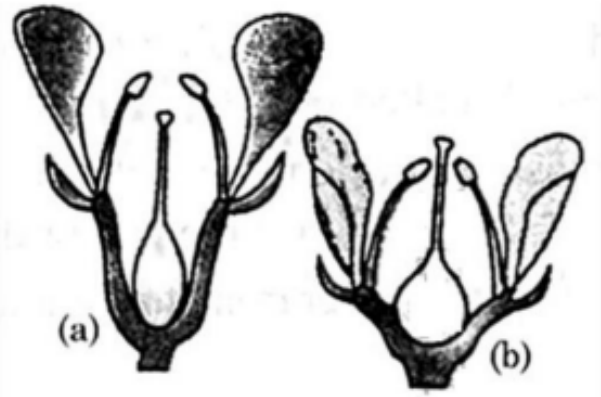
Step 2: When the plant experiences water stress or dehydration, bulliform cells lose turgor pressure and cause the leaves to curl inward. This helps reduce the leaf's surface area exposed to the sun, minimizing water loss through transpiration.
Thus, bulliform cells are responsible for the inward curling of leaves in monocots, especially in response to water stress.

Quick Tip

Bulliform cells help in water conservation by causing inward curling of leaves, thus reducing water loss under stress conditions.

---

124. Identify the type of flowers based on the position of calyx, corolla, and androecium with respect to the ovary from the given figures (a) and (b)



(1) (a) Perigynous; (b) Epigynous
(2) (a) Perigynous; (b) Perigynous
(3) (a) Epigynous; (b) Hypogynous
(4) (a) Hypogynous; (b) Epigynous

Correct Answer: (2) (a) Perigynous; (b) Perigynous

Solution:
The position of floral organs in relation to the ovary can be categorized as follows:
- **Hypogynous** means that the floral organs are attached below the ovary (e.g., in a buttercup).
- **Epigynous** means that the floral organs are attached above the ovary (e.g., in a daisy).
- **Perigynous** means that the floral organs are attached at the same level as the ovary (e.g., in

a peach flower).

Step 1: In Figure (a), the floral organs are attached at the same level as the ovary, so it is **Perigynous**.

Step 2: In Figure (b), the floral organs are also attached at the same level as the ovary, so it is **Perigynous**.

Thus, the correct answer is **(2) (a) Perigynous; (b) Perigynous**.

Quick Tip

The classification of flowers based on the position of floral organs relative to the ovary helps determine the type of flower: hypogynous, perigynous, or epigynous.

---

125. What is the fate of a piece of DNA carrying only a gene of interest which is transferred into an alien organism?

A. The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.

B. It may get integrated into the genome of the recipient.

C. It may multiply and be inherited along with the host DNA.

D. The alien piece of DNA is not an integral part of the chromosome.

E. It shows ability to replicate.

(1) B and C only

(2) A and E only

(3) A and B only

(4) D and E only

Correct Answer: (1) B and C only.

Solution:

Step 1: A foreign DNA fragment can integrate into the recipient's genome through recombination or be maintained as an episome.

Step 2: Statement B is correct because in genetic engineering, the transferred DNA can integrate into the host genome.

Step 3: Statement C is also correct since, once integrated, the gene of interest can be replicated and inherited with the host's DNA.

Step 4: Statements A, D, and E are incorrect as free DNA fragments generally do not multiply independently unless they have an origin of replication.

Thus, the correct answer is option (1), as B and C explain the fate of transferred DNA.

Quick Tip

Foreign DNA can integrate into the host genome or replicate as an episome in genetic engineering applications.

---

126. Tropical regions show the greatest level of species richness because

A. Tropical latitudes have remained relatively undisturbed for millions of years, hence more time was available for species diversification.

B. Tropical environments are more seasonal.

C. More solar energy is available in tropics.

D. Constant environments promote niche specialization.

E. Tropical environments are constant and predictable.

(1) A, B and E only

(2) A, B and D only

(3) A, C, D and E only

(4) A and B only

Correct Answer: (3) A, C, D and E only.

Solution:

Step 1: Tropical regions show high species richness due to stable environmental conditions and longer evolutionary time.

Step 2: Statement A is correct as tropical regions have remained undisturbed for millions of years, allowing species diversification.

Step 3: Statement C is correct because higher solar energy in the tropics increases primary productivity, supporting diverse life forms.

Step 4: Statement D is valid as stable tropical climates promote niche specialization, allowing more species to coexist.

Step 5: Statement E is also correct because predictable tropical environments support species stability and survival.

Step 6: Statement B is incorrect because tropical environments are not more seasonal but rather stable compared to temperate regions.

Thus, the correct answer is option (3), as A, C, D, and E explain tropical species richness.

Quick Tip

Tropical regions have high species richness due to evolutionary stability, abundant solar energy, and niche specialization.

---

127. A pink flowered Snapdragon plant was crossed with a red flowered Snapdragon plant. What type of phenotype/s is/are expected in the progeny?

(1) Only pink flowered plants

(2) Red, Pink as well as white flowered plants

(3) Only red flowered plants

(4) Red flowered as well as pink flowered plants

Correct Answer: (4) Red flowered as well as pink flowered plants

Solution:

In the case of incomplete dominance in Snapdragon plants, a cross between red (RR) and pink (Rr) flowered plants will produce progeny with red and pink flowers. The red color is dominant over the pink color, but both can appear in the offspring.

Thus, the correct answer is **(4) Red flowered as well as pink flowered plants**.

Quick Tip

Incomplete dominance leads to a blending of traits, where the heterozygous plants show an intermediate phenotype between the dominant and recessive traits.

---

128. These are regarded as major causes of biodiversity loss:

A. Over exploitation

B. Co-extinction

C. Mutation

D. Habitat loss and fragmentation

E. Migration

Choose the correct option:

(1) A, B and E only

(2) A, B and D only

(3) A, C and D only

(4) A, B, C and D only

Correct Answer: (2) A, B and D only

Solution:

The major causes of biodiversity loss include:

- **Over exploitation** (A) – Overharvesting of resources leading to depletion of species.

- **Co-extinction** (B) – The extinction of one species leading to the extinction of another species that depends on it.

- **Habitat loss and fragmentation** (D) – Destruction of habitats leading to reduced biodiversity.

Mutation (C) and **Migration** (E) are not direct causes of biodiversity loss.

Thus, the correct answer is **(2) A, B and D only**.

Quick Tip

The primary drivers of biodiversity loss are human-induced activities such as over exploitation and habitat destruction, alongside co-extinction events.

---

129. Match List I with List II

List I		List II	
A.	*Rhizopus*	I.	Mushroom
B.	*Ustilago*	II.	Smut fungus
C.	*Puccinia*	III.	Bread mould
D.	*Agaricus*	IV.	Rust fungus

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

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

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

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

Correct Answer: (3) A-III, B-II, C-IV, D-I.

Solution:

Step 1: *Rhizopus* is a bread mould fungus commonly found on stale bread (Matching A $\rightarrow$ III).

Step 2: *Ustilago* is a smut fungus, which affects cereal crops like maize (Matching B $\rightarrow$ II).

Step 3: *Puccinia* is a rust fungus, known for causing rust diseases in wheat and other crops (Matching C $\rightarrow$ IV).

Step 4: *Agaricus* includes mushrooms, which are edible fungi belonging to Basidiomycetes (Matching D $\rightarrow$ I).

Thus, the correct answer is option (3), as the correct matches are A-III, B-II, C-IV, D-I.

Quick Tip

Fungi are classified based on their reproductive structures and pathogenic effects—Rhizopus (bread mould), Ustilago (smut), Puccinia (rust), and Agaricus (mushroom).

---

130. In a plant, black seed color (BB/Bb) is dominant over white seed color (bb). In order to find out the genotype of the black seed plant, with which of the following genotypes will you cross it?

(1) Bb

(2) BB/Bb

(3) BB

(4) bb

Correct Answer: (4) bb.

Solution:

Step 1: The method used to determine an unknown genotype is called a test cross.

Step 2: A test cross involves crossing the unknown dominant phenotype (BB or Bb) with a homozygous recessive (bb) individual.

Step 3: If the black seed plant is BB, all offspring will have black seeds (Bb).

Step 4: If the black seed plant is Bb, the offspring will have a 1:1 ratio of black (Bb) and white (bb) seeds.

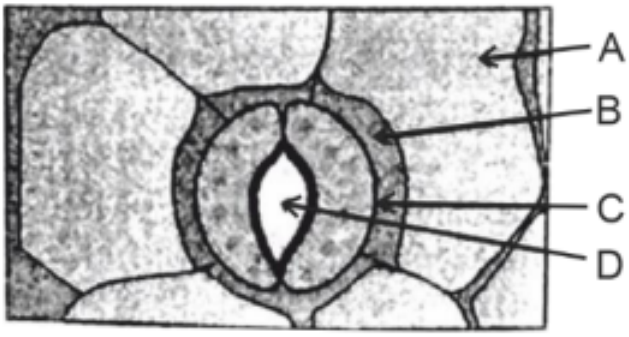
Thus, the correct answer is option (4), as crossing with bb allows genotype determination based on offspring ratios.

Quick Tip

A test cross is done with a homozygous recessive (bb) individual to determine whether a dominant phenotype is homozygous (BB) or heterozygous (Bb).

---

131. In the given figure, which component has thin outer walls and highly thickened inner walls?



(1) A

(2) B

(3) C

(4) D

Correct Answer: (3) C

Solution:

The component with thin outer walls and thickened inner walls is typically a **xylem vessel**. Xylem vessels have thickened inner walls made of lignin that provide structural support, while the outer walls are thinner.

Thus, the correct answer is **(3) C**.

Quick Tip

Xylem vessels have thickened inner walls for structural support and thin outer walls, allowing efficient water transport.

---

132. List of endangered species was released by

(1) FOAM

(2) IUCN

(3) GEAC

(4) WWF

Correct Answer: (2) IUCN.

Solution:

Step 1: The International Union for Conservation of Nature (IUCN) maintains the Red List, which classifies species based on their extinction risk.

Step 2: The IUCN Red List categories include Extinct (EX), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC).

Step 3: WWF (World Wildlife Fund) is an environmental organization but does not maintain the Red List. GEAC (Genetic Engineering Approval Committee) deals with genetically modified organisms, and FOAM is unrelated.

Thus, the correct answer is option (2), as IUCN is responsible for listing endangered species.

Quick Tip

The IUCN Red List is the global authority on species conservation status, assessing their risk of extinction.

---

133. Match List I with List II

List I		List II	
A.	Two or more alternative forms of a gene	I.	Back cross
B.	Cross of F_1 progeny with homozygous recessive parent	II.	Ploidy
C.	Cross of F_1 progeny with any of the parents	III.	Allele
D.	Number of chromosome sets in plant	IV.	Test cross

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

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

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

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

Correct Answer: (1) A-III, B-IV, C-I, D-II.

Solution:

Step 1: An **allele** refers to different alternative forms of a gene (Matching A $\rightarrow$ III).

Step 2: A **test cross** involves crossing an F_1 progeny with a homozygous recessive parent to determine its genotype (Matching B $\rightarrow$ IV).

Step 3: A **back cross** is the crossing of an F_1 progeny with either of its parents to recover a parental genotype (Matching C $\rightarrow$ I).

Step 4: **Ploidy** refers to the number of chromosome sets in a plant or organism (Matching D $\rightarrow$ II).

Thus, the correct answer is option (1), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

Test crosses involve a homozygous recessive parent, while back crosses involve any parent. Ploidy refers to chromosome sets, and alleles are gene variants.

134. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

(1) 4 bp

(2) 10 bp

(3) 8 bp

(4) 6 bp

Correct Answer: (4) 6 bp.

Solution:

Step 1: Hind II is a type of restriction endonuclease that cuts DNA at specific recognition sequences.

Step 2: Each restriction enzyme recognizes a specific palindromic sequence and cuts within or near that sequence.

Step 3: Hind II recognizes a 6-base-pair (6 bp) sequence and makes a cut at a precise location.

Step 4: The recognition and cleavage pattern of restriction enzymes are essential for molecular biology techniques like DNA fingerprinting and recombinant DNA technology.

Thus, the correct answer is option (4), as Hind II cuts at a 6 bp recognition sequence.

Quick Tip

Restriction enzymes like Hind II are essential tools in genetic engineering for cutting DNA at specific sites.

---

135. Spindle fibers attach to kinetochores of chromosomes during

(1) Anaphase

(2) Telophase

(3) Prophase

(4) Metaphase

Correct Answer: (4) Metaphase.

Solution:

Step 1: During mitosis, spindle fibers play a crucial role in ensuring the equal distribution of chromosomes.

Step 2: Prophase is the stage where spindle fibers begin forming and attach to the centromere via kinetochores.

Step 3: Metaphase is the stage where chromosomes align at the metaphase plate, and spindle fibers attach firmly to kinetochores to prepare for chromatid separation.

Step 4: Anaphase follows, where sister chromatids are pulled toward opposite poles.

Thus, the correct answer is option (4), as spindle fibers attach to kinetochores during metaphase.

Quick Tip

Metaphase is characterized by chromosome alignment at the metaphase plate and firm spindle fiber attachment to kinetochores.

---

136. Match List I with List II

List I		**List II**	
A.	Robert May	I.	Species-Area relationship
B.	Alexander von Humboldt	II.	Long-term ecosystem experiment using outdoor plots
C.	Paul Ehrlich	III.	Global species diversity at about 7 million
D.	David Tilman	IV.	Rivet popper hypothesis

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

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

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

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

Correct Answer: (4) A-III, B-I, C-IV, D-II.

Solution:

Step 1: Robert May estimated global species diversity to be around 7 million, making (A $\rightarrow$ III) correct.

Step 2: Alexander von Humboldt proposed the Species-Area relationship, which describes how species richness increases with increasing habitat area, making (B $\rightarrow$ I) correct.

Step 3: Paul Ehrlich gave the Rivet Popper Hypothesis, which compares species in an ecosystem to rivets in an airplane, emphasizing the importance of species conservation, making (C $\rightarrow$ IV) correct.

Step 4: David Tilman conducted long-term ecosystem experiments using outdoor plots to study biodiversity and ecosystem functioning, making (D $\rightarrow$ II) correct.

Thus, the correct answer is option (4), as the correct matches are A-III, B-I, C-IV, D-II.

Quick Tip

Humboldt described the species-area relationship, May estimated global species diversity, Ehrlich proposed the rivet popper hypothesis, and Tilman conducted long-term ecosystem experiments.

---

137. Match List I with List II

List I		**List II**	
A.	Frederick Griffith	I.	Genetic code
B.	Francois Jacob & Jacque Monod	II.	Semi-conservative mode of DNA replication
C.	Har Gobind Khorana	III.	Transformation
D.	Meselson & Stahl	IV.	*Lac* operon

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

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

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

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

Correct Answer: (4) A-III, B-IV, C-I, D-II.

Solution:

Step 1: Frederick Griffith discovered the process of transformation in bacteria using the pneumococcus experiment, making (A $\rightarrow$ III) correct.

Step 2: Francois Jacob and Jacque Monod proposed the *Lac* operon model, which explains gene regulation in prokaryotes, making (B $\rightarrow$ IV) correct.

Step 3: Har Gobind Khorana played a significant role in deciphering the genetic code, making (C $\rightarrow$ I) correct.

Step 4: Meselson and Stahl experimentally proved the semi-conservative mode of DNA replication in *E. coli*, making (D $\rightarrow$ II) correct.

Thus, the correct answer is option (4), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

Griffith discovered transformation, Jacob and Monod explained the *Lac* operon, Khorana decoded the genetic code, and Meselson & Stahl demonstrated semi-conservative replication.

---

138. Match List I with List II

List I (Types of Stamens)		**List II (Example)**	
A.	Monoadelphous	I.	Citrus
B.	Diadelphous	II.	Pea
C.	Polyadelphous	III.	Lily
D.	Epiphyllous	IV.	China-rose

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

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

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

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

Correct Answer: (3) A-IV, B-II, C-I, D-III.

Solution:

Step 1: Monoadelphous stamens have filaments fused into a single bundle, seen in China-rose (Hibiscus). (Matching A $\rightarrow$ IV)

Step 2: Diadelphous stamens have filaments arranged in two bundles, as in Pea (Fabaceae family). (Matching B $\rightarrow$ II)

Step 3: Polyadelphous stamens have multiple groups of fused filaments, as in Citrus. (Matching C $\rightarrow$ I)

Step 4: Epiphyllous stamens are attached to petals, seen in Lily (Liliaceae family). (Matching D $\rightarrow$ III)

Thus, the correct answer is option (3), as the correct matches are A-IV, B-II, C-I, D-III.

Quick Tip

Monoadelphous stamens (one bundle) are found in China-rose, diadelphous (two bundles) in Pea, polyadelphous (multiple bundles) in Citrus, and epiphyllous (attached to petals) in Lily.

---

139. Match List-I with List-II

List I		**List II**	
A.	GLUT-4	I.	Hormone
B.	Insulin	II.	Enzyme
C.	Trypsin	III.	Intercellular ground substance
D.	Collagen	IV.	Enables glucose transport into cells

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

(2) A-III, B-IV, C-II, D-II

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

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

Correct Answer: (3) A-IV, B-I, C-II, D-III.

Solution:

Step 1: GLUT-4 (Glucose Transporter 4) is responsible for glucose transport into cells in response to insulin. (Matching A $\rightarrow$ IV).

Step 2: Insulin is a hormone that regulates blood glucose levels. (Matching B $\rightarrow$ I).

Step 3: Trypsin is an enzyme involved in protein digestion in the small intestine. (Matching C $\rightarrow$ II).

Step 4: Collagen is a structural protein found in the extracellular matrix and provides support. (Matching D $\rightarrow$ III).

Thus, the correct answer is option (3), as the correct matches are A-IV, B-I, C-II, D-III.

Quick Tip

GLUT-4 enables glucose uptake, insulin is a hormone, trypsin is a digestive enzyme, and collagen provides structural support in tissues.

---

140. Which of the following statements is correct regarding the process of replication in *E. coli*?

(1) The DNA-dependent DNA polymerase catalyzes polymerization in 5' $\rightarrow$ 3' as well as 3' $\rightarrow$ 5' direction

(2) The DNA-dependent DNA polymerase catalyzes polymerization in 5' $\rightarrow$ 3' direction

(3) The DNA-dependent DNA polymerase catalyzes polymerization in one direction that is 3' $\rightarrow$ 5'

(4) The DNA-dependent RNA polymerase catalyzes polymerization in one direction, that is 5' $\rightarrow$ 3'

Correct Answer: (2) The DNA-dependent DNA polymerase catalyzes polymerization in 5' $\rightarrow$ 3' direction.

Solution:

Step 1: DNA replication in *E. coli* follows the 5' $\rightarrow$ 3' polymerization rule.

Step 2: DNA-dependent DNA polymerase adds nucleotides in the 5' $\rightarrow$ 3' direction using a DNA template.

Step 3: The enzyme also has 3' $\rightarrow$ 5' exonuclease activity, but polymerization does not occur in this direction.

Step 4: Option (1) is incorrect because DNA polymerase cannot catalyze polymerization in both directions.

Step 5: Option (3) is incorrect because polymerization does not occur in the 3' $\rightarrow$ 5' direction. Option (4) is incorrect because RNA polymerase synthesizes RNA, not DNA. Thus, the correct answer is option (2), as DNA polymerase catalyzes DNA synthesis in the 5' $\rightarrow$ 3' direction.

Quick Tip

DNA polymerase in *E. coli* synthesizes new DNA strands in the 5' $\rightarrow$ 3' direction while also having 3' $\rightarrow$ 5' exonuclease proofreading activity.

---

141. Match List I with List II

List I		**List II**	
A.	Citric acid cycle	I.	Cytoplasm
B.	Glycolysis	II.	Mitochondrial matrix
C.	Electron transport system	III.	Intermembrane space of mitochondria
D.	Proton gradient	IV.	Inner mitochondrial membrane

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

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

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

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

Correct Answer: (4) A-II, B-I, C-IV, D-III.

Solution:

Step 1: The citric acid cycle (Krebs cycle) occurs in the mitochondrial matrix. (Matching A $\rightarrow$ II).

Step 2: Glycolysis is the breakdown of glucose and takes place in the cytoplasm. (Matching B $\rightarrow$ I).

Step 3: The electron transport system (ETS) is located in the inner mitochondrial membrane. (Matching C $\rightarrow$ IV).

Step 4: The proton gradient required for ATP synthesis is established in the intermembrane space of mitochondria. (Matching D $\rightarrow$ III).

Thus, the correct answer is option (4), as the correct matches are A-II, B-I, C-IV, D-III.

Quick Tip

The citric acid cycle occurs in the mitochondrial matrix, glycolysis in the cytoplasm, ETS in the inner mitochondrial membrane, and the proton gradient in the intermembrane space.

---

142. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Succinyl-CoA $\rightarrow$ Succinic acid

(2) Isocitrate $\rightarrow$ α-ketoglutaric acid

(3) Malic acid $\rightarrow$ Oxaloacetic acid

(4) Succinic acid $\rightarrow$ Malic acid

Correct Answer: (1) Succinyl-CoA $\rightarrow$ Succinic acid.

Solution:

Step 1: The tricarboxylic acid (TCA) cycle, also known as the Krebs cycle, involves multiple oxidation reactions.

Step 2: The conversion of Succinyl-CoA to Succinic acid is catalyzed by Succinyl-CoA synthetase, where substrate-level phosphorylation occurs instead of oxidation. (Correct step)

Step 3: The reactions Isocitrate to α-ketoglutarate and Malate to Oxaloacetate involve NAD^+-dependent oxidation, making them incorrect options.

Step 4: The step Succinic acid to Malic acid involves oxidation via FAD-dependent dehydrogenation, making it incorrect.

Thus, the correct answer is option (1), as Succinyl-CoA to Succinic acid is a phosphorylation step, not an oxidation step.

Quick Tip

The conversion of Succinyl-CoA to Succinic acid in the Krebs cycle is a substrate-level phosphorylation step, unlike other oxidation reactions.

143. Spraying sugarcane crop with which of the following plant growth regulators, increases the length of stem, thus, increasing the yield?

(1) Cytokinin

(2) Abscisic acid

(3) Auxin

(4) Gibberellin

Correct Answer: (4) Gibberellin.

Solution:

Step 1: Gibberellins (GA) are plant hormones that promote stem elongation, seed germination, and flowering.

Step 2: In sugarcane, gibberellins stimulate internode elongation, leading to an increase in yield.

Step 3: Cytokinins promote cell division, auxins regulate root growth, and abscisic acid induces dormancy rather than elongation.

Thus, the correct answer is option (4), as gibberellin increases stem length in sugarcane.

Quick Tip

Gibberellins promote internode elongation in sugarcane, increasing yield by enhancing stem growth.

---

144. The DNA present in chloroplast is:

(1) Linear, single stranded

(2) Circular, single stranded

(3) Linear, double stranded

(4) Circular, double stranded

Correct Answer: (4) Circular, double stranded.

Solution:

Step 1: Chloroplast DNA (cpDNA) resembles prokaryotic DNA in structure and organization.

Step 2: It is circular and double-stranded, similar to mitochondrial DNA (mtDNA) and bacterial DNA.

Step 3: Unlike nuclear DNA, which is linear, chloroplast DNA does not have histones and exists in multiple copies within the organelle.

Thus, the correct answer is option (4), as chloroplast DNA is circular and double-stranded.

Quick Tip

Chloroplast DNA (cpDNA) is circular, double-stranded, and resembles prokaryotic DNA, supporting the endosymbiotic theory.

---

145. Given below are two statements:

Statement I: In C_3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C_4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false.

Solution:

Step 1: C_3 plants exhibit photorespiration, where RuBisCO binds to O_2 instead of CO_2, reducing CO_2 fixation efficiency. Statement I is correct.

Step 2: C_4 plants have an adaptation to minimize photorespiration using the Hatch-Slack pathway, but both mesophyll and bundle sheath cells contribute to the process. Statement II is incorrect because mesophyll cells do not show high levels of photorespiration.

Thus, the correct answer is option (1), as Statement I is true but Statement II is false.

Quick Tip

C_3 plants undergo photorespiration due to RuBisCO's oxygenase activity, while C_4 plants minimize it using a spatial separation of CO_2 fixation.

---

146. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Protoplasts

(2) Pollens

(3) Callus

(4) Somatic embryos

Correct Answer: (1) Protoplasts.

Solution:

Step 1: Somatic hybridization is a technique where protoplasts from different plant varieties are fused to produce a hybrid cell.

Step 2: Protoplast fusion is achieved using PEG (Polyethylene Glycol) or electrofusion, leading to the formation of somatic hybrids.

Step 3: Pollens are involved in sexual reproduction, not somatic hybridization. Callus is a mass of undifferentiated cells, and somatic embryos arise from tissue culture but are not fused in somatic hybridization.

Thus, the correct answer is option (1), as protoplast fusion is the key step in somatic hybridization.

Quick Tip

Somatic hybridization involves protoplast fusion, enabling genetic recombination between two plant varieties.

---

147. Read the following statements and choose the set of correct statements:

In the members of Phaeophyceae,

A. Asexual reproduction occurs usually by biflagellate zoospores.

B. Sexual reproduction is by oogamous method only.

C. Stored food is in the form of carbohydrates which is either mannitol or laminarin.

D. The major pigments found are chlorophyll *a*, *c*, carotenoids, and xanthophyll.

E. Vegetative cells have a cellulosic wall, usually covered on the outside by gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) A, C, D and E only

(2) A, B, C and E only

(3) A, B, C and D only

(4) B, C, D and E only

Correct Answer: (1) A, C, D and E only.

Solution:

Step 1: Phaeophyceae (Brown Algae) reproduce asexually via biflagellate zoospores. (Statement A is correct)

Step 2: Sexual reproduction in Phaeophyceae can be isogamous, anisogamous, or oogamous, not just oogamous. (Statement B is incorrect)

Step 3: The stored food in Phaeophyceae is mannitol or laminarin. (Statement C is correct)

Step 4: Their pigments include chlorophyll a, c, carotenoids, and xanthophylls. (Statement D is correct)

Step 5: Their vegetative cells have a cellulosic wall covered by algin, a gelatinous coating. (Statement E is correct)

Thus, the correct answer is option (1), as A, C, D, and E are correct.

Quick Tip

Phaeophyceae store food as laminarin or mannitol and reproduce via biflagellate zoospores, with a cell wall covered in algin.

---

148. In an ecosystem if the Net Primary Productivity (NPP) of first trophic level is 100x

(kcal m^{-2} yr^{-1}), what would be the GPP (Gross Primary Productivity) of the third trophic level of the same ecosystem?

(1) $10x$ (kcal m^{-2} yr^{-1})

(2) $\frac{100x}{3}$ (kcal m^{-2} yr^{-1})

(3) $\frac{x}{10}$ (kcal m^{-2} yr^{-1})

(4) x (kcal m^{-2} yr^{-1})

Correct Answer: (1) $10x$ (kcal m^{-2} yr^{-1}).

Solution:

Step 1: In an ecosystem, energy transfer follows the 10 law, meaning only 10 of energy is transferred to the next trophic level, while 90 is lost as heat.

Step 2: Given that NPP of the first trophic level is $100x$ kcal m^{-2} yr^{-1}, the second trophic level would receive $10x$ kcal m^{-2} yr^{-1}.

Step 3: The third trophic level would receive 10 of $10x$ kcal m^{-2} yr^{-1}, which equals $1x$ kcal m^{-2} yr^{-1}.

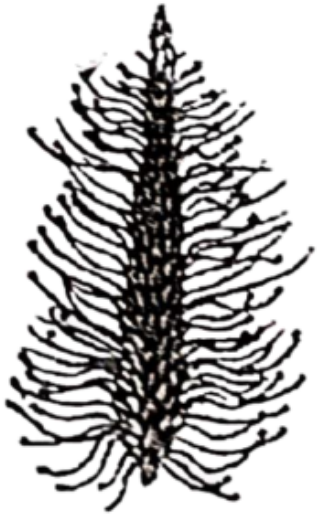
Thus, the correct answer is option (1), as the GPP of the third trophic level is $10x$ kcal m^{-2} yr^{-1}.

Quick Tip

According to Lindeman's 10 law, only 10 of energy is transferred to the next trophic level, while 90 is lost as heat.

---

149. Identify the correct description about the given figure:



(1) Cleistogamous flowers showing autogamy.

(2) Compact inflorescence showing complete autogamy

(3) Wind-pollinated plant inflorescence showing flowers with well-exposed stamens.

(3) Water-pollinated flowers showing stamens with mucilaginous covering.

Correct Answer: (4) Wind-pollinated plant inflorescence showing flowers with well-exposed stamens.

Solution:

Wind-pollinated plants typically have **exposed stamens** and flowers that are adapted to release pollen into the air. This type of inflorescence is designed to facilitate wind pollination.

Thus, the correct answer is **(3) Wind-pollinated plant inflorescence showing flowers with well-exposed stamens**.

Quick Tip

Wind-pollinated flowers often have exposed stamens and reduced petals, facilitating the dispersal of pollen by wind.

---

150. Match List I with List II

List I		List II	
A.	Rose	I.	Twisted aestivation
B.	Pea	II.	Perigynous flower
C.	Cotton	III.	Drupe
D.	Mango	IV.	Marginal placentation

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

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

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

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

Correct Answer: (3) A-II, B-IV, C-I, D-III.

Solution:

Step 1: Rose exhibits perigynous flowers, where the ovary is surrounded by floral parts at the same level. (Matching A $\rightarrow$ II)

Step 2: Pea has marginal placentation, where ovules are attached along one side of the ovary. (Matching B $\rightarrow$ IV)

Step 3: Cotton has twisted aestivation, where one petal overlaps another. (Matching C $\rightarrow$ I)

Step 4: Mango is a drupe fruit, with a hard endocarp protecting the seed. (Matching D $\rightarrow$ III)

Thus, the correct answer is option (3), as the correct matches are A-II, B-IV, C-I, D-III.

Quick Tip

Rose has perigynous flowers, pea has marginal placentation, cotton shows twisted aestivation, and mango is a drupe fruit.

ZOOLOGY

(Section-A)

151. Match List I with List II

List I		List II	
A.	Pleurobrachia	I.	Mollusca
B.	Radula	II.	Ctenophora
C.	Stomachord	III.	Osteichthyes
D.	Air bladder	IV.	Hemichordata

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

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

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

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

Correct Answer: (4) A-II, B-I, C-IV, D-III.

Solution:

Step 1: Pleurobrachia belongs to Ctenophora (comb jellies). (Matching A $\rightarrow$ II)

Step 2: Radula is a rasping organ found in Mollusca for feeding. (Matching B $\rightarrow$ I)

Step 3: Stomachord is a structure found in Hemichordates. (Matching C $\rightarrow$ IV)

Step 4: Air bladder is found in Osteichthyes (bony fish) and helps in buoyancy. (Matching D $\rightarrow$ III)

Thus, the correct answer is option (4), as the correct matches are A-II, B-I, C-IV, D-III.

Quick Tip

Pleurobrachia belongs to Ctenophora, radula is a feeding organ in Mollusca, stomachord is found in Hemichordata, and air bladder helps in buoyancy in bony fishes.

---

152. Match List I with List II

List I		List II	
A.	Non-medicated IUD	I.	Multiload 375
B.	Copper releasing IUD	II.	Progestogens
C.	Hormone releasing IUD	III.	Lippes loop
D.	Implants	IV.	LNG-20

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

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

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

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

Correct Answer: (2) A-III, B-I, C-IV, D-II.

Solution:

Step 1: Non-medicated IUDs include Lippes loop. (Matching A $\rightarrow$ III)

Step 2: Copper-releasing IUDs include Multiload 375. (Matching B $\rightarrow$ I)

Step 3: Hormone-releasing IUDs include LNG-20. (Matching C $\rightarrow$ IV)

Step 4: Implants release progestogens, acting as long-term contraceptives. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (2), as the correct matches are A-III, B-I, C-IV, D-II.

Quick Tip

Non-medicated IUDs include Lippes loop, Copper IUDs include Multiload 375, hormone-releasing IUDs include LNG-20, and implants release progestogens.

---

153. Match List I with List II

List I		**List II**	
A.	α-1 antitrypsin	I.	Cotton bollworm
B.	Cry IAb	II.	ADA deficiency
C.	Cry IAc	III.	Emphysema
D.	Enzyme replacement therapy	IV.	Corn borer

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

(2) A-III, B-IV, C-I, D-III

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

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

Correct Answer: (1) A-III, B-IV, C-I, D-II.

Solution:

Step 1: α-1 antitrypsin is used in the treatment of emphysema. (Matching A $\rightarrow$ III)

Step 2: Cry IAb is a Bt toxin that is effective against corn borers. (Matching B $\rightarrow$ IV)

Step 3: Cry IAc is another Bt toxin, specifically targeting cotton bollworm. (Matching C $\rightarrow$ I)

Step 4: Enzyme replacement therapy is used for ADA deficiency, a genetic disorder affecting the immune system. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (1), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

α-1 antitrypsin treats emphysema, Cry IAb targets corn borers, Cry IAc affects cotton bollworms, and enzyme replacement therapy helps in ADA deficiency.

---

154. Match List I with List II

List I		**List II**	
A.	Common cold	I.	*Plasmodium*
B.	Haemozoin	II.	Typhoid
C.	Widal test	III.	Rhinoviruses
D.	Allergy	IV.	Dust mites

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

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

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

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

Correct Answer: (1) A-III, B-I, C-II, D-IV.

Solution:

Step 1: Common cold is caused by Rhinoviruses. (Matching A $\rightarrow$ III)

Step 2: Haemozoin is a malarial pigment produced by *Plasmodium* during its life cycle. (Matching B $\rightarrow$ I)

Step 3: Widal test is a diagnostic test for Typhoid, caused by *Salmonella typhi*. (Matching C $\rightarrow$ II)

Step 4: Allergies are triggered by allergens such as dust mites. (Matching D $\rightarrow$ IV)

Thus, the correct answer is option (1), as the correct matches are A-III, B-I, C-II, D-IV.

Quick Tip

Rhinoviruses cause the common cold, *Plasmodium* produces haemozoin, Widal test diagnoses typhoid, and dust mites trigger allergies.

---

155. Match List I with List II

List I		**List II**	
A.	Cocaine	I.	Effective sedative in surgery
B.	Heroin	II.	*Cannabis sativa*
C.	Morphine	III.	*Erythroxylum*
D.	Marijuana	IV.	*Papaver somniferum*

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

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

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

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

Correct Answer: (2) A-III, B-IV, C-I, D-II.

Solution:

Step 1: Cocaine is derived from *Erythroxylum coca*. (Matching A $\rightarrow$ III)

Step 2: Heroin is synthesized from morphine, which is obtained from *Papaver somniferum* (opium poppy). (Matching B $\rightarrow$ IV)

Step 3: Morphine is an effective sedative used in surgery. (Matching C $\rightarrow$ I)

Step 4: Marijuana is derived from *Cannabis sativa*. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (2), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

Cocaine is derived from *Erythroxylum coca*, heroin from *Papaver somniferum*, morphine is a sedative, and marijuana comes from *Cannabis sativa*.

---

156. Match List I with List II

	List I (Sub Phases of Prophase I)		**List II (Specific Characters)**
A.	Diakinesis	I.	Synaptonemal complex formation
B.	Pachytene	II.	Completion of terminalisation of chiasmata
C.	Zygotene	III.	Chromosomes look like thin threads
D.	Leptotene	IV.	Appearance of recombination nodules

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

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

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

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

Correct Answer: (1) A-II, B-IV, C-I, D-III.

Solution:

Step 1: Diakinesis is the final stage of prophase I, where chiasmata terminalization is completed. (Matching A $\rightarrow$ II)

Step 2: Pachytene is the stage where recombination nodules appear. (Matching B $\rightarrow$ IV)

Step 3: Zygotene is characterized by synaptonemal complex formation. (Matching C $\rightarrow$ I)

Step 4: Leptotene is the first stage where chromosomes appear as thin threads. (Matching D $\rightarrow$ III)

Thus, the correct answer is option (1), as the correct matches are A-II, B-IV, C-I, D-III.

Quick Tip

Prophase I stages: Leptotene (thin chromosomes), Zygotene (synaptonemal complex), Pachytene (crossing over), Diakinesis (chiasmata terminalization).

---

157. Given below are two statements:

Statement I: The presence or absence of hymen is not a reliable indicator of virginity.

Statement II: The hymen is torn during the first coitus only.

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false.

Solution:

Step 1: The hymen can be torn due to various non-sexual activities like sports, cycling, or physical exertion. Statement I is true.

Step 2: The belief that the hymen tears only during the first coitus is incorrect, as it may already be absent due to other factors. Statement II is false.

Thus, the correct answer is option (1), as Statement I is true but Statement II is false.

Quick Tip

The hymen is not a definitive indicator of virginity, as it can be torn due to various physical activities unrelated to sexual intercourse.

---

158. Which one is the correct product of DNA dependent RNA polymerase to the given template?

3' TACATGGCAAATATCCATTCA 5'

(1) 5' AUGUACCGUUUUAUAGGAAUAG 3'

(2) 5' ATGTACCGTTTATAGGTAAGT 3'

(3) 5' AUGUACCGUUUUAUAGGAAGU 3'

(4) 5' AUGUAAAGUUUAUGGAUAGU 3'

Correct Answer: (3) 5' AUGUACCGUUUUAUAGGAAGU 3'.

Solution:

Step 1: DNA-dependent RNA polymerase synthesizes mRNA complementary to the DNA template.

Step 2: The given template strand (3'→5' direction) results in an mRNA strand in the 5'→3' direction.

Thus, the correct answer is option (3), as the correct mRNA sequence is 5' AUGUACCGUUUUAUAGGAAGU 3'.

Quick Tip

DNA-dependent RNA polymerase synthesizes mRNA complementary to the template strand, replacing thymine (T) with uracil (U).

---

159. Match List I with List II

	List I		List II
A.	Expiratory capacity	I.	Expiratory reserve volume + Tidal volume + Inspiratory reserve volume
B.	Functional residual capacity	II.	Tidal volume + Expiratory reserve volume
C.	Vital capacity	III.	Tidal volume + Inspiratory reserve volume
D.	Inspiratory capacity	IV.	Expiratory reserve volume + Residual volume

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

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

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

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

Correct Answer: (3) A-II, B-IV, C-I, D-III.

Solution:

Step 1: Expiratory capacity (A) is the sum of tidal volume + expiratory reserve volume. (Matching A → II)

Step 2: Functional residual capacity (B) is the sum of expiratory reserve volume + residual volume. (Matching B → IV)

Step 3: Vital capacity (C) is the sum of tidal volume + inspiratory reserve volume + expiratory reserve volume. (Matching C → I)

Step 4: Inspiratory capacity (D) is the sum of tidal volume + inspiratory reserve volume. (Matching D $\rightarrow$ III)

Thus, the correct answer is option (3), as the correct matches are A-II, B-IV, C-I, D-III.

Quick Tip

Expiratory capacity = TV + ERV, Functional residual capacity = ERV + RV, Vital capacity = TV + IRV + ERV, Inspiratory capacity = TV + IRV.

---

160. Which of the following are Autoimmune disorders?

A. Myasthenia gravis

B. Rheumatoid arthritis

C. Gout

D. Muscular dystrophy

E. Systemic Lupus Erythematosus (SLE)

Choose the most appropriate answer from the options given below:

(1) B, C E only

(2) C, D E only

(3) A, B D only

(4) A, B E only

Correct Answer: (4) A, B E only.

Solution:

Step 1: Autoimmune disorders occur when the immune system attacks its own body tissues.

Step 2: - Myasthenia gravis (A): Autoimmune attack on neuromuscular junctions. - Rheumatoid arthritis (B): Autoimmune inflammation of joints. - SLE (E): A systemic autoimmune disease affecting multiple organs. - Gout (C) is due to uric acid crystal accumulation (not autoimmune). - Muscular dystrophy (D) is a genetic disorder, not autoimmune.

Thus, the correct answer is option (4), as A, B, and E are autoimmune disorders.

Quick Tip

Autoimmune diseases include Myasthenia gravis, Rheumatoid arthritis, and Systemic Lupus Erythematosus (SLE), but not gout or muscular dystrophy.

---

161. Consider the following statements:

A. Annelids are true coelomates

B. Poriferans are pseudocoelomates

C. Aschelminthes are acoelomates

D. Platyhelminthes are pseudocoelomates

Choose the correct answer from the options given below:

(1) C only

(2) D only

(3) B only

(4) A only

Correct Answer: (4) A only.

Solution:

Step 1: Annelids (e.g., earthworms) have a true coelom, which is mesodermally derived. Statement A is correct.

Step 2: Poriferans (sponges) lack body cavities altogether, making Statement B incorrect.

Step 3: Aschelminthes (Nematodes) are pseudocoelomates, not acoelomates, making Statement C incorrect.

Step 4: Platyhelminthes (Flatworms) are acoelomates, not pseudocoelomates, making Statement D incorrect.

Thus, the correct answer is option (4), as only Statement A is correct.

Quick Tip

Annelids have a true coelom, Poriferans lack body cavities, Aschelminthes are pseudocoelomates, and Platyhelminthes are acoelomates.

162. Given below are two statements:

Statement I: In the nephron, the descending limb of loop of Henle is impermeable to water and permeable to electrolytes.

Statement II: The proximal convoluted tubule is lined by simple columnar brush border epithelium and increases the surface area for reabsorption.

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (4) Both Statement I and Statement II are false.

Solution:

Step 1: The descending limb of the loop of Henle is permeable to water but impermeable to electrolytes. Thus, Statement I is false.

Step 2: The proximal convoluted tubule (PCT) is lined by simple cuboidal brush border epithelium, not columnar epithelium. Thus, Statement II is false.

Thus, the correct answer is option (4), as both Statement I and Statement II are false.

Quick Tip

The descending limb of the loop of Henle is water-permeable, while the proximal convoluted tubule has simple cuboidal brush border epithelium for increased absorption.

163. Match List I with List II

List I		**List II**	
A.	*Pterophyllum*	I.	Hag fish
B.	*Myxine*	II.	Saw fish
C.	*Pristis*	III.	Angel fish
D.	*Exocoetus*	IV.	Flying fish

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

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

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

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

Correct Answer: (4) A-III, B-I, C-II, D-IV.

Solution:

Step 1: *Pterophyllum* is commonly known as the Angel fish. (Matching A $\rightarrow$ III)

Step 2: *Myxine* is commonly known as the Hag fish, which is a jawless fish. (Matching B $\rightarrow$ I)

Step 3: *Pristis* is known as the Saw fish, characterized by its elongated snout with teeth. (Matching C $\rightarrow$ II)

Step 4: *Exocoetus* is called the Flying fish, as it can glide over water surfaces. (Matching D $\rightarrow$ IV)

Thus, the correct answer is option (4), as the correct matches are A-III, B-I, C-II, D-IV.

Quick Tip

Pterophyllum (Angel fish), *Myxine* (Hag fish - jawless), *Pristis* (Saw fish), and *Exocoetus* (Flying fish) are well-known aquatic species.

---

164. Which of the following is not a steroid hormone?

(1) Progesterone

(2) Glucagon

(3) Cortisol

(4) Testosterone

Correct Answer: (2) Glucagon.

Solution:

Step 1: Steroid hormones are derived from cholesterol and include sex hormones and adrenal cortex hormones.

Step 2: - Progesterone (option 1) is a steroid hormone involved in pregnancy. - Cortisol (option 3) is a steroid hormone secreted by the adrenal cortex. - Testosterone (option 4) is a steroid hormone responsible for male secondary sexual characteristics. - Glucagon (option 2) is a peptide hormone, not a steroid. It is secreted by the pancreas and regulates blood glucose levels.

Thus, the correct answer is option (2), as Glucagon is a peptide hormone, not a steroid hormone.

Quick Tip

Steroid hormones are derived from cholesterol (e.g., testosterone, cortisol, progesterone), while peptide hormones (e.g., glucagon, insulin) are made of amino acids.

---

165. Match List I with List II

List I		List II	
A.	Lipase	I.	Peptide bond
B.	Nuclease	II.	Ester bond
C.	Protease	III.	Glycosidic bond
D.	Amylase	IV.	Phosphodiester bond

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

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

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

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

Correct Answer: (1) A-II, B-IV, C-I, D-III.

Solution:

Step 1: Lipase breaks down lipids by hydrolyzing ester bonds. (Matching A $\rightarrow$ II)

Step 2: Nuclease hydrolyzes nucleic acids by breaking phosphodiester bonds in DNA/RNA. (Matching B $\rightarrow$ IV)

Step 3: Protease digests proteins by hydrolyzing peptide bonds between amino acids. (Matching C $\rightarrow$ I)

Step 4: Amylase breaks down polysaccharides (starch) by hydrolyzing glycosidic bonds. (Matching D $\rightarrow$ III)

Thus, the correct answer is option (1), as the correct matches are A-II, B-IV, C-I, D-III.

Quick Tip

Lipase hydrolyzes ester bonds in fats, nucleases break phosphodiester bonds in DNA/RNA, proteases cleave peptide bonds in proteins, and amylase breaks glycosidic bonds in carbohydrates.

---

166. Match List I with List II

List I		**List II**	
A.	Down's syndrome	I.	11^{th} chromosome
B.	α-Thalassemia	II.	'X' chromosome
C.	β-Thalassemia	III.	21^{st} chromosome
D.	Klinefelter's syndrome	IV.	16^{th} chromosome

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

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

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

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

Correct Answer: (1) A-III, B-IV, C-I, D-II.

Solution:

Step 1: Down's syndrome is caused by trisomy of the 21^{st} chromosome. (Matching A $\rightarrow$ III)

Step 2: α-Thalassemia is associated with mutations in the 16^{th} chromosome. (Matching B $\rightarrow$ IV)

Step 3: β-Thalassemia is caused by mutations in the 11^{th} chromosome. (Matching C $\rightarrow$ I)

Step 4: Klinefelter's syndrome occurs due to the presence of an extra 'X' chromosome (XXY). (Matching D $\rightarrow$ II)

Thus, the correct answer is option (1), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

Down's syndrome is due to trisomy 21, α-Thalassemia is linked to chromosome 16, β-Thalassemia to chromosome 11, and Klinefelter's syndrome to the 'X' chromosome.

---

167. The "Ti plasmid" of *Agrobacterium tumefaciens* stands for:

(1) Tumor inducing plasmid

(2) Temperature independent plasmid

(3) Tumour inhibiting plasmid

(4) Tumor independent plasmid

Correct Answer: (1) Tumor inducing plasmid.

Solution:

Step 1: The Ti plasmid is a tumor-inducing plasmid found in *Agrobacterium tumefaciens*, a plant pathogen.

Step 2: It is responsible for causing crown gall disease in dicot plants.

Step 3: The T-DNA (transfer DNA) segment of the Ti plasmid integrates into the host genome, leading to uncontrolled cell division.

Thus, the correct answer is option (1), as the Ti plasmid stands for Tumor Inducing plasmid.

Quick Tip

The Ti plasmid of *Agrobacterium tumefaciens* is widely used in plant genetic engineering due to its ability to transfer genes into plants.

---

168. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: Breast-feeding during the initial period of infant growth is recommended by doctors for bringing a healthy baby.

Reason R: Colostrum contains several antibodies absolutely essential to develop resistance for the newborn baby.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) A is correct but R is not correct

(2) A is not correct but R is correct

(3) Both A and R are correct and R is the correct explanation of A

(4) Both A and R are correct but R is NOT the correct explanation of A

Correct Answer: (3) Both A and R are correct and R is the correct explanation of A.

Solution:

Step 1: Breastfeeding is recommended as it provides essential nutrients and immunity to the infant. Assertion A is correct.

Step 2: Colostrum, the first milk produced after birth, is rich in maternal antibodies (IgA, IgG, IgM), which help develop immunity in the newborn. Reason R is correct.

Step 3: Since colostrum provides antibodies essential for infant immunity, it directly supports the reason given in Assertion A.

Thus, the correct answer is option (3), as both A and R are correct, and R is the correct explanation of A.

Quick Tip

Colostrum is rich in maternal antibodies and helps develop passive immunity in newborns, making breastfeeding highly beneficial.

---

169. Which of the following is not a component of the Fallopian tube?

(1) Infundibulum

(2) Ampulla

(3) Uterine fundus

(4) Isthmus

Correct Answer: (3) Uterine fundus.

Solution:

Step 1: The Fallopian tube consists of four parts: - Infundibulum (1): Funnel-shaped structure with fimbriae. - Ampulla (2): The widest and longest part, where fertilization occurs. - Isthmus (4): A narrow region connecting to the uterus.
Step 2: The Uterine fundus (3) is the uppermost part of the uterus, not the Fallopian tube. Thus, the correct answer is option (3), as the uterine fundus is not part of the Fallopian tube.

Quick Tip

The Fallopian tube consists of Infundibulum, Ampulla, Isthmus, and the Uterine part, but not the Uterine fundus.

---

170. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:

(1) 8^{th} and 9^{th} segment

(2) 11^{th} segment

(3) 9^{th} segment

(4) 10^{th} segment

Correct Answer: (4) 10^{th} segment.

Solution:

Step 1: Cockroaches possess anal cerci, which are jointed filamentous structures that function as sensory organs.
Step 2: These cerci are present in both male and female cockroaches on the 10^{th} abdominal segment.
Step 3: They help in detecting vibrations and movements in the surrounding environment. Thus, the correct answer is option (4), as anal cerci are present on the 10^{th} segment of the cockroach.

Quick Tip

Anal cerci in cockroaches are located on the 10^{th} abdominal segment and serve as sensory organs for detecting movement and vibrations.

171. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Gene migration

(2) Constant gene pool

(3) Genetic recombination

(4) Genetic drift

Correct Answer: (2) Constant gene pool.

Solution:

Step 1: The Hardy-Weinberg equilibrium states that allele frequencies remain constant in a population under stable conditions.

Step 2: Gene migration, genetic recombination, and genetic drift cause changes in allele frequencies, disturbing equilibrium.

Step 3: A constant gene pool means no changes in allele frequencies, keeping the population in equilibrium.

Thus, the correct answer is option (2), as a constant gene pool maintains Hardy-Weinberg equilibrium.

Quick Tip

Hardy-Weinberg equilibrium remains stable if the gene pool is constant, meaning no evolutionary forces act on the population.

172. Match List I with List II

List I		List II	
A.	Pons	I.	Provides space for neurons, regulates posture and balance
B.	Hypothalamus	II.	Controls respiration and gastric secretions
C.	Medulla	III.	Connects different regions of the brain
D.	Cerebellum	IV.	Neurosecretory cells

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

(2) A-I, B-I, C-III, D-II

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

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

Correct Answer: (4) A-III, B-IV, C-II, D-I.

Solution:

Step 1: Pons acts as a bridge connecting different brain regions. (Matching A $\rightarrow$ III)

Step 2: Hypothalamus contains neurosecretory cells, playing a key role in hormonal regulation. (Matching B $\rightarrow$ IV)

Step 3: Medulla oblongata controls respiration and gastric secretions. (Matching C $\rightarrow$ II)

Step 4: Cerebellum regulates posture, balance, and coordination. (Matching D $\rightarrow$ I)

Thus, the correct answer is option (4), as the correct matches are A-III, B-IV, C-II, D-I.

Quick Tip

The cerebellum controls balance, the medulla regulates involuntary functions, the hypothalamus has neurosecretory cells, and the pons connects brain regions.

---

173. The flippers of Penguins and Dolphins are an example of:

(1) Convergent evolution

(2) Divergent evolution

(3) Adaptive radiation

(4) Natural selection

Correct Answer: (1) Convergent evolution.

Solution:

Step 1: Convergent evolution occurs when unrelated organisms evolve similar traits due to similar environmental pressures.

Step 2: Penguins (birds) and Dolphins (mammals) belong to different groups but have flippers adapted for swimming, an example of convergent evolution.

Step 3: Divergent evolution leads to different traits in related species, adaptive radiation involves diversification from a common ancestor, and natural selection drives evolution but does not always lead to convergence.
Thus, the correct answer is option (1), as flippers in Penguins and Dolphins evolved due to convergent evolution.

Quick Tip

Convergent evolution leads to similar structures in unrelated species due to similar environmental pressures, as seen in Penguins and Dolphins.

---

174. Following are the stages of pathway for conduction of an action potential through the heart

A. AV bundle

B. Purkinje fibres

C. AV node

D. Bundle branches

E. SA node

Choose the correct sequence of pathway from the options given below:

(1) B-D-E-C-A

(2) E-A-D-B-C

(3) E-C-A-D-B

(4) A-E-C-B-D

Correct Answer: (3) E-C-A-D-B.

Solution:

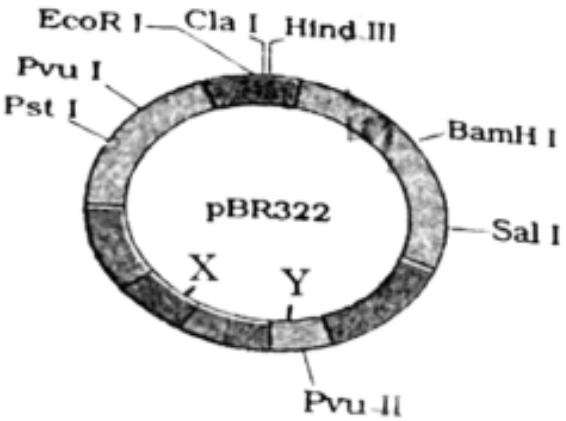
Step 1: The conduction pathway of the heart follows this sequence: - SA node initiates the impulse. (E) - AV node delays the impulse slightly. (C) - AV bundle (Bundle of His) carries the signal to the ventricles. (A) - Bundle branches transmit impulses through the ventricles. (D) - Purkinje fibers distribute the impulse, leading to contraction. (B)
Thus, the correct answer is option (3), as the correct sequence is E-C-A-D-B.

Quick Tip

The conduction pathway of the heart: SA node → AV node → AV bundle → Bundle branches → Purkinje fibers.

---

175. The following diagram shows restriction sites in E. coli cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) The gene 'X' is for protein involved in replication of Plasmid and 'Y' for resistance to antibiotics.

(2) Gene 'X' is responsible for recognition sites and 'Y' is responsible for antibiotic resistance.

(3) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of Plasmid.

(4) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.

Correct Answer: (1) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.

Solution:

The vector pBR322 contains the **X** and **Y** genes.

- **Gene X** regulates the copy number of the plasmid DNA.

- **Gene Y** encodes a protein involved in the replication of the plasmid. This ensures that the plasmid can replicate inside the host cell.

Thus, the correct answer is **(1) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.**

Quick Tip

In plasmid vectors like pBR322, genes involved in replication control the number of copies of the plasmid within the host cell.

---

176. Given below are two statements: One is labelled as Assertion A and the other as Reason R:

Assertion A: FSH acts upon ovarian follicles in females and Leydig cells in males.

Reason R: Growing ovarian follicles secrete estrogen in females, while interstitial cells secrete androgens in males.

In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false

(2) A is false but R is true

(3) Both A and R are true and R is the correct explanation of A

(4) Both A and R are true but R is NOT the correct explanation of A

Correct Answer: (2) A is false but R is true.

Solution:

Step 1: FSH (Follicle Stimulating Hormone) acts on Sertoli cells, not Leydig cells, in males. It regulates spermatogenesis. Thus, Assertion A is false.

Step 2: Leydig cells in males produce androgens (testosterone). In females, growing ovarian follicles secrete estrogen. Thus, Reason R is correct.

Thus, the correct answer is option (2), as Assertion A is incorrect, but Reason R is correct.

Quick Tip

FSH acts on Sertoli cells (not Leydig cells), while growing ovarian follicles secrete estrogen, and Leydig cells secrete testosterone.

177. Which of the following statements is incorrect?

(1) Bio-reactors are used to produce small scale bacterial cultures

(2) Bio-reactors have an agitator system, an oxygen delivery system and foam control system

(3) A bio-reactor provides optimal growth conditions for achieving the desired product

(4) Most commonly used bio-reactors are of stirring type

Correct Answer: (1) Bio-reactors are used to produce small scale bacterial cultures.

Solution:

Step 1: Bio-reactors are used for large-scale production of biological products, not small-scale. Statement (1) is incorrect.

Step 2: They contain an agitator system, oxygen delivery system, and foam control system to maintain optimal growth conditions. Statements (2), (3), and (4) are correct.

Thus, the correct answer is option (1), as bio-reactors are used for large-scale production, not small-scale.

Quick Tip

Bio-reactors are used for large-scale production of enzymes, antibiotics, and recombinant proteins, not small-scale bacterial cultures.

178. Match List I with List II

List I		**List II**	
A.	Axoneme	I.	Centriole
B.	Cartwheel pattern	II.	Cilia and flagella
C.	Crista	III.	Chromosome
D.	Satellite	IV.	Mitochondria

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

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

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

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

Correct Answer: (2) A-II, B-I, C-IV, D-III.

Solution:

Step 1: Axoneme is the structural core of cilia and flagella, consisting of microtubules. (Matching A $\rightarrow$ II)

Step 2: Cartwheel pattern is a feature of centrioles, seen in their early formation stage. (Matching B $\rightarrow$ I)

Step 3: Crista are the folds of the inner mitochondrial membrane, increasing the surface area for ATP production. (Matching C $\rightarrow$ IV)

Step 4: Satellite DNA refers to repetitive DNA sequences found in chromosomes. (Matching D $\rightarrow$ III)

Thus, the correct answer is option (2), as the correct matches are A-II, B-I, C-IV, D-III.

Quick Tip

Axoneme forms the core of cilia and flagella, cartwheel pattern is found in centrioles, cristae are folds of mitochondria, and satellite DNA is a part of chromosomes.

---

179. Match List I with List II

List I		**List II**	
A.	Fibrous joints	I.	Adjacent vertebrae, limited movement
B.	Cartilaginous joints	II.	Humerus and Pectoral girdle, rotational movement
C.	Hinge joints	III.	Skull, don't allow any movement
D.	Ball and socket joints	IV.	Knee, help in locomotion

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

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

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

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

Correct Answer: (2) A-III, B-I, C-IV, D-II.

Solution:

Step 1: Fibrous joints (A) are immovable and found in the skull (Matching A $\rightarrow$ III).

Step 2: Cartilaginous joints (B) provide limited movement and are found in the vertebral column (Matching B $\rightarrow$ I).

Step 3: Hinge joints (C) allow movement in one plane and are found in the knee (Matching C $\rightarrow$ IV).

Step 4: Ball and socket joints (D) allow rotational movement and are found in the humerus and pectoral girdle (Matching D $\rightarrow$ II).

Thus, the correct answer is option (2), as the correct matches are A-III, B-I, C-IV, D-II.

Quick Tip

Fibrous joints (skull - no movement), Cartilaginous joints (vertebral column - limited movement), Hinge joints (knee - unidirectional), Ball and socket joints (shoulder - rotational).

---

180. Given below are some stages of human evolution. Arrange them in correct sequence (Past to Recent).

A. *Homo habilis*

B. *Homo sapiens*

C. *Homo neanderthalensis*

D. *Homo erectus*

Choose the correct sequence of human evolution from the options given below:

(1) C-B-D-A

(2) A-D-C-B

(3) D-A-C-B

(4) B-A-D-C

Correct Answer: (2) A-D-C-B.

Solution:

Step 1: The correct sequence of human evolution is: - *Homo habilis* (earliest tool users) $\rightarrow$ *Homo erectus* (upright walkers) $\rightarrow$ - *Homo neanderthalensis* (Neanderthals) $\rightarrow$ *Homo sapiens* (modern humans).

Step 2: *Homo habilis* was the earliest species, followed by *Homo erectus*, then *Homo neanderthalensis*, and finally *Homo sapiens*.

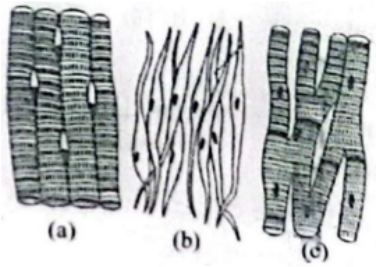
Thus, the correct answer is option (2), as A-D-C-B represents the correct evolutionary order.

Quick Tip

The sequence of human evolution follows: *Homo habilis* $\rightarrow$ *Homo erectus* $\rightarrow$ *Homo neanderthalensis* $\rightarrow$ *Homo sapiens*.

---

181. Three types of muscles are given as a, b, and c. Identify the correct matching pair along with their location in the human body:



Name of muscle/location

(1) (a) Skeletal – Biceps (b) Involuntary – Intestine (c) Smooth – Heart

(2) (a) Involuntary – Nose tip (b) Skeletal – Bone (c) Cardiac – Heart

(3) (a) Smooth – Toes (b) Skeletal – Legs (c) Cardiac – Heart

(4) (a) Skeletal – Triceps (b) Smooth – Stomach (c) Cardiac – Heart

Correct Answer: (4) (a) Skeletal – Triceps (b) Smooth – Stomach (c) Cardiac – Heart.

Solution:

Step 1: The three major types of muscles in the human body are: - Skeletal muscle (voluntary and striated, found in biceps, triceps, etc.). - Smooth muscle (involuntary,

non-striated, found in internal organs like the stomach and intestines). - Cardiac muscle (striated, involuntary, found in the heart).

Step 2: - Image (a) represents skeletal muscle, found in triceps. - Image (b) represents smooth muscle, found in stomach. - Image (c) represents cardiac muscle, found in heart.

Thus, the correct answer is option (4), as (a) Skeletal – Triceps, (b) Smooth – Stomach, (c) Cardiac – Heart.

Quick Tip

Skeletal muscles are voluntary and striated, smooth muscles are involuntary and non-striated, and cardiac muscles are striated but involuntary.

---

182. Following are the stages of cell division:

A. Gap 2 phase

B. Cytokinesis

C. Synthesis phase

D. Karyokinesis

E. Gap 1 phase

Choose the correct sequence of stages from the options given below:

(1) B-D-E-A-C

(2) E-C-A-D-B

(3) C-E-D-A-B

(4) E-B-D-A-C

Correct Answer: (2) E-C-A-D-B.

Solution:

Step 1: The correct sequence of cell cycle stages is: - G1 phase (E): Cell growth occurs. - S phase (C): DNA replication happens. - G2 phase (A): Preparation for mitosis. - Karyokinesis (D): Nuclear division occurs. - Cytokinesis (B): Cytoplasm divides, forming two daughter cells.

Thus, the correct answer is option (2), as the correct order is E-C-A-D-B.

Quick Tip

The cell cycle follows the order: G1 $\rightarrow$ S $\rightarrow$ G2 $\rightarrow$ M (Karyokinesis + Cytokinesis).

---

183. Which of the following is *not* a natural/traditional contraceptive method?

(1) Lactational amenorrhea

(2) Vaults

(3) Coitus interruptus

(4) Periodic abstinence

Correct Answer: (2) Vaults.

Solution:

Step 1: Natural contraceptive methods involve preventing pregnancy without external devices or hormones.

Step 2: Lactational amenorrhea, coitus interruptus, and periodic abstinence are natural contraceptive methods.

Step 3: Vaults are barrier contraceptives (diaphragms), which physically prevent sperm entry, making them a non-natural method.

Thus, the correct answer is option (2), as vaults are not a natural contraceptive method.

Quick Tip

Natural contraceptive methods rely on behavioral practices, while vaults (diaphragms) are physical barriers used for contraception.

---

184. Match List I with List II

List I		**List II**	
A.	Typhoid	I.	Fungus
B.	Leishmaniasis	II.	Nematode
C.	Ringworm	III.	Protozoa
D.	Filariasis	IV.	Bacteria

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

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

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

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

Correct Answer: (4) A-IV, B-III, C-I, D-II.

Solution:

Step 1: Typhoid is caused by the bacterium *Salmonella typhi*. (Matching A $\rightarrow$ IV)

Step 2: Leishmaniasis is caused by the protozoan parasite *Leishmania donovani*. (Matching B $\rightarrow$ III)

Step 3: Ringworm is a fungal infection caused by *Trichophyton*, *Microsporum*, or *Epidermophyton*. (Matching C $\rightarrow$ I)

Step 4: Filariasis is caused by nematode worms such as *Wuchereria bancrofti*. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (4), as the correct matches are A-IV, B-III, C-I, D-II.

Quick Tip

Typhoid is caused by bacteria, Leishmaniasis by protozoa, ringworm by fungi, and filariasis by nematodes.

---

185. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) Low pCO_2 and High H^+ concentration

(2) Low pCO_2 and High temperature

(3) High pO_2 and High pCO_2

(4) High pO_2 and Lesser H^+ concentration

Correct Answer: (4) High pO_2 and Lesser H^+ concentration.

Solution:

Step 1: Oxyhaemoglobin (HbO_2) formation occurs in the alveoli, where oxygen binds to hemoglobin.

Step 2: High pO_2 (partial pressure of oxygen) favors oxygen binding to hemoglobin.

Step 3: Low pCO_2 and lesser H^+ concentration create an alkaline environment, promoting HbO_2 formation.

Step 4: High pCO_2 and high H^+ concentration (acidic environment) promote oxygen release (Bohr effect), making options (1) and (3) incorrect.

Thus, the correct answer is option (4), as high pO_2 and low H^+ concentration favor oxyhaemoglobin formation.

Quick Tip

In alveoli, high pO_2 and lower H^+ concentration favor oxyhaemoglobin formation, while high pCO_2 promotes oxygen release.

---

186. Given below are two statements:

Statement I: Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.

Statement II: Both bone marrow and thymus provide microenvironments for the development and maturation of T-lymphocytes.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect.

(2) Statement I is incorrect but Statement II is correct.

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (3) Both Statement I and Statement II are correct.

Solution:

Step 1: Bone marrow is indeed the primary site for the production of all blood cells, including lymphocytes. (Statement I is correct)

Step 2: Both bone marrow and thymus play crucial roles in the development and maturation of T-lymphocytes. (Statement II is correct)

Thus, the correct answer is option (3), as both Statement I and Statement II are correct.

Quick Tip

Bone marrow produces all blood cells, including lymphocytes. The thymus plays a key role in the maturation of T-lymphocytes.

---

187. Match List I with List II

List I		List II	
A.	P wave	I.	Heart muscles are electrically silent.
B.	QRS complex	II.	Depolarisation of ventricles.
C.	T wave	III.	Depolarisation of atria.
D.	T-P gap	IV.	Repolarisation of ventricles.

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

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

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

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

Correct Answer: (4) A-III, B-II, C-IV, D-I.

Solution:

Step 1: P wave represents depolarisation of atria. (Matching A $\rightarrow$ III)

Step 2: QRS complex represents depolarisation of ventricles. (Matching B $\rightarrow$ II)

Step 3: T wave represents repolarisation of ventricles. (Matching C $\rightarrow$ IV)

Step 4: T-P gap indicates electrical silence in heart muscles. (Matching D $\rightarrow$ I)

Thus, the correct answer is option (4), as the correct matches are A-III, B-II, C-IV, D-I.

Quick Tip

P wave (atrial depolarisation), QRS complex (ventricular depolarisation), T wave (ventricular repolarisation), T-P gap (electrical silence).

---

188. Given below are two statements:

Statement I: The cerebral hemispheres are connected by a nerve tract known as corpus callosum.

Statement II: The brain stem consists of the medulla oblongata, pons, and cerebrum.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect.

(2) Statement I is incorrect but Statement II is correct.

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (1) Statement I is correct but Statement II is incorrect.

Solution:

Step 1: The corpus callosum is a bundle of nerve fibers that connects the left and right cerebral hemispheres, making Statement I correct.

Step 2: The brainstem consists of the medulla oblongata, pons, and midbrain (not cerebrum), making Statement II incorrect.

Thus, the correct answer is option (1), as Statement I is correct, but Statement II is incorrect.

Quick Tip

The brainstem includes the medulla oblongata, pons, and midbrain but not the cerebrum. The corpus callosum connects the cerebral hemispheres.

---

189. Match List I with List II

List I		**List II**	
A.	Unicellular glandular epithelium	I.	Salivary glands
B.	Compound epithelium	II.	Pancreas
C.	Multicellular glandular epithelium	III.	Goblet cells of alimentary canal
D.	Endocrine glandular epithelium	IV.	Moist surface of buccal cavity

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

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

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

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

Correct Answer: (1) A-III, B-IV, C-I, D-II.

Solution:

Step 1: Unicellular glandular epithelium (A) consists of goblet cells in the alimentary canal. (Matching A $\rightarrow$ III)

Step 2: Compound epithelium (B) lines moist surfaces like the buccal cavity. (Matching B $\rightarrow$ IV)

Step 3: Multicellular glandular epithelium (C) includes salivary glands. (Matching C $\rightarrow$ I)

Step 4: Endocrine glandular epithelium (D) includes the pancreas. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (1), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

Unicellular epithelium (goblet cells), compound epithelium (moist surfaces), multicellular epithelium (salivary glands), endocrine epithelium (pancreas).

---

190. Match List I with List II related to digestive system of cockroach:

	List I		List II
A.	The structures used for storing of food	I.	Gizzard
B.	Ring of 6-8 blind tubules at junction of foregut and midgut.	II.	Gastric Caeca
C.	Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut.	III.	Malpighian tubules
D.	The structures used for grinding the food.	IV.	Crop

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

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

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

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

Correct Answer: (3) A-IV, B-II, C-III, D-I.

Solution:

Step 1: Crop (A) is the structure used for storing food in cockroaches. (Matching A $\rightarrow$ IV)

Step 2: Gastric Caeca (B) are the 6-8 blind tubules at the junction of foregut and midgut. (Matching B $\rightarrow$ II)

Step 3: Malpighian tubules (C) are the yellow-colored filaments found at the junction of midgut and hindgut. (Matching C $\rightarrow$ III)

Step 4: Gizzard (D) is used for grinding food. (Matching D $\rightarrow$ I)

Thus, the correct answer is option (3), as the correct matches are A-IV, B-II, C-III, D-I.

Quick Tip

The cockroach digestive system has the crop (storage), gastric caeca (digestion), malpighian tubules (excretion), and gizzard (grinding food).

---

191. Match List I with List II

List I		**List II**	
A.	Mesozoic Era	I.	Lower invertebrates
B.	Proterozoic Era	II.	Fish & Amphibia
C.	Cenozoic Era	III.	Birds & Reptiles
D.	Paleozoic Era	IV.	Mammals

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

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

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

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

Correct Answer: (2) A-III, B-I, C-IV, D-II.

Solution:

Step 1: Mesozoic Era is known as the ”Age of Reptiles and Birds”. (Matching A $\rightarrow$ III)

Step 2: Proterozoic Era had the first lower invertebrates. (Matching B $\rightarrow$ I)

Step 3: Cenozoic Era is known as the ”Age of Mammals”. (Matching C $\rightarrow$ IV)

Step 4: Paleozoic Era was the period of early Fish and Amphibia. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (2), as the correct matches are A-III, B-I, C-IV, D-II.

Quick Tip

Mesozoic Era (Reptiles & Birds), Proterozoic Era (Lower invertebrates), Cenozoic Era (Mammals), Paleozoic Era (Fish & Amphibians).

---

192. Given below are two statements:

Statement I: Mitochondria and chloroplasts are both double-membrane bound organelles.

Statement II: The inner membrane of mitochondria is relatively less permeable compared to the chloroplast.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is correct but Statement II is incorrect.

(2) Statement I is incorrect but Statement II is correct.

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (1) Statement I is correct but Statement II is incorrect.

Solution:

Step 1: Both mitochondria and chloroplasts have double membranes. (Statement I is correct)

Step 2: The inner membrane of mitochondria is highly folded but more permeable than the chloroplast. (Statement II is incorrect)

Thus, the correct answer is option (1).

Quick Tip

P wave (atrial depolarisation), QRS complex (ventricular depolarisation), T wave (ventricular repolarisation), T-P gap (electrical silence).

---

193. As per the ABO blood grouping system, the blood group of the father is B^+, mother is A^+, and child is O^-. Their respective genotypes can be:

Options:

A. I^Bi/I^Bi

B. I^BI^A/I^Ai

C. I^AI^B/I^Bi

D. I^Ai/I^Bi

E. $ii/I^Bi/I^AI^B$

Choose the most appropriate answer from the options given below:

(1) C B only

(2) D E only

(3) A D only

(4) B only

Correct Answer: (3) A D only.

Solution:

Step 1: Blood type inheritance follows the Mendelian principles of codominance. The possible genotypes are: - Blood group A: I^AI^A or I^Ai - Blood group B: I^BI^B or I^Bi - Blood group O: ii

Step 2: Since the child has O^- blood, they must have received the ii genotype (one i from each parent).

Step 3: - The father's genotype must be I^Bi or I^BI^B. - The mother's genotype must be I^Ai or I^AI^A. - The only correct parental genotype pair that produces an O^- child is A (I^Bi/I^Bi) D (I^Ai/I^Bi).

Thus, the correct answer is option (3), as A D represent the correct possible genotypes.

Quick Tip

For a child with O blood type, both parents must contribute an "i" allele (i.e., they must be heterozygous A or B).

194. Match List I with List II

List I		List II	
A.	Exophthalmic goiter	I.	Excess secretion of cortisol, moon face & hyperglycemia.
B.	Acromegaly	II.	Hypo-secretion of thyroid hormone and stunted growth.
C.	Cushing's syndrome	III.	Hyper secretion of thyroid hormone & protruding eyeballs.
D.	Cretinism	IV.	Excessive secretion of growth hormone.

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

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

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

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

Correct Answer: (2) A-III, B-IV, C-I, D-II.

Solution:

Step 1: Exophthalmic goiter is due to hyperthyroidism, leading to protruding eyeballs. (Matching A $\rightarrow$ III)

Step 2: Acromegaly occurs due to excess secretion of growth hormone. (Matching B $\rightarrow$ IV)

Step 3: Cushing's syndrome is due to excess cortisol secretion, leading to moon face and hyperglycemia. (Matching C $\rightarrow$ I)

Step 4: Cretinism results from thyroid hormone deficiency, leading to stunted growth. (Matching D $\rightarrow$ II)

Thus, the correct answer is option (2), as the correct matches are A-III, B-IV, C-I, D-II.

Quick Tip

Exophthalmic goiter (hyperthyroidism), Acromegaly (excess GH), Cushing's syndrome (excess cortisol), and Cretinism (thyroid hormone deficiency).

---

195. Match List I with List II:

List I		List II	
A.	RNA polymerase III	I.	snRNPs
B.	Termination of transcription	II.	Promotor
C.	Splicing of Exons	III.	Rho factor
D.	TATA box	IV.	SnRNAs, tRNA

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

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

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

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

Correct Answer: (2) A-IV, B-II, C-I, D-III.

Solution:

Step 1: RNA polymerase III (A) synthesizes SnRNAs and tRNA. (Matching A $\rightarrow$ IV)

Step 2: Termination of transcription (B) is regulated by the Rho factor. (Matching B $\rightarrow$ II)

Step 3: Splicing of Exons (C) is associated with snRNPs. (Matching C $\rightarrow$ I)

Step 4: The TATA box (D) is a promotor region that facilitates transcription. (Matching D $\rightarrow$ III)

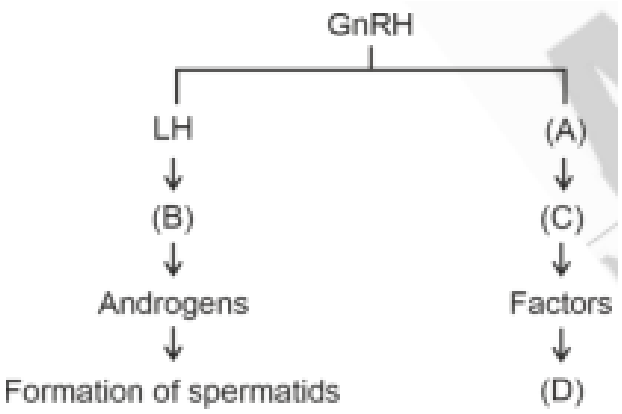
Thus, the correct answer is option (2), as the correct matches are A-IV, B-II, C-I, D-III.

Quick Tip

RNA polymerase III produces tRNA and snRNAs. The TATA box is a core promoter for transcription initiation.

---

196. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



(1) FSH, Sertoli cells, Leydig cells, spermatogenesis.

(2) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

(3) FSH, Leydig cells, Sertoli cells, spermiogenesis.

(4) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

Correct Answer: (3) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution:

Step 1: FSH (Follicle-stimulating hormone) stimulates Sertoli cells, which support spermatogenesis.

Step 2: LH (Luteinizing hormone) stimulates Leydig cells, which secrete androgens (testosterone) necessary for spermiogenesis.

Thus, the correct answer is option (3), as FSH stimulates Sertoli cells and Leydig cells support spermiogenesis.

Quick Tip

FSH acts on Sertoli cells (spermatogenesis), and LH acts on Leydig cells (spermiogenesis).

---

197. The following are the statements about non-chordates:

A. Pharynx is perforated by gill slits.

B. Notochord is absent.

C. Central nervous system is dorsal.

D. Heart is dorsal if present.

E. Post-anal tail is absent.

Choose the most appropriate answer from the options given below:

(1) B, D & E only

(2) B, C & D only

(3) A & C only

(4) A, B & D only

Correct Answer: (1) B, D & E only.

Solution:

Step 1: Non-chordates lack notochord (B), post-anal tail (E), and have a dorsal heart (D).

Step 2: Chordates have pharyngeal gill slits (A) and a dorsal CNS (C), so these statements do not apply to non-chordates.

Step 3: Since non-chordates lack notochord, post-anal tail, and have a dorsal heart, the correct answer is B, D, and E only.

Thus, the correct answer is option (1), as B, D, and E are true for non-chordates.

Quick Tip

Non-chordates lack a notochord and post-anal tail, while their heart (if present) is dorsal. Chordates have pharyngeal gill slits and a dorsal CNS.

---

198. Choose the correct statement given below regarding juxta medullary nephron.

(1) Loop of Henle of juxta medullary nephron runs deep into medulla.

(2) Juxta medullary nephrons outnumber the cortical nephrons.

(3) Juxta medullary nephrons are located in the columns of Bertini.

(4) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.

Correct Answer: (1) Loop of Henle of juxta medullary nephron runs deep into medulla.

Solution:

Step 1: Juxta medullary nephrons have a longer loop of Henle that extends deep into the renal medulla, aiding in concentration of urine. (Matching Option 1)

Step 2: Cortical nephrons are more numerous than juxta medullary nephrons.

Thus, the correct answer is option (1), as the loop of Henle in juxta medullary nephron extends deep into medulla.

Quick Tip

Juxta medullary nephrons play a critical role in water reabsorption and urine concentration due to their long loop of Henle.

---

199. Given below are two statements:

Statement I: Gause's competitive exclusion principle states that two closely related species competing for different resources cannot exist indefinitely.

Statement II: According to Gause's principle, during competition, the inferior will be eliminated. This may be true if resources are limiting.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false.

(2) Statement I is false but Statement II is true.

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (2) Statement I is false but Statement II is true.

Solution:

Step 1: Gause's competitive exclusion principle does not state that species with different resources cannot coexist indefinitely. It specifically states that closely related species competing for the same resources cannot coexist indefinitely. (Statement I is false)

Step 2: Statement II is true because, in cases of competition with limited resources, the inferior species is eliminated.

Thus, the correct answer is option (2), as Statement I is false, but Statement II is true.

Quick Tip

Competitive exclusion occurs when two species competing for the same resources cannot coexist, and the inferior species is eliminated.

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200. Regarding catalytic cycle of an enzyme action, select the correct sequential steps:

A. Substrate enzyme complex formation.

B. Free enzyme ready to bind with another substrate.

C. Release of products.

D. Chemical bonds of the substrate broken.

E. Substrate binding to active site.

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (3) E, A, B, C, D.

Solution:

Step 1: The enzyme action begins with substrate binding to the active site (E).

Step 2: This leads to substrate-enzyme complex formation (A).

Step 3: The enzyme is then ready to bind with another substrate (B).

Step 4: The chemical bonds of the substrate are broken (D) as the reaction progresses.

Step 5: Finally, the products are released (C).

Thus, the correct answer is option (3), as the correct sequence is E, A, B, C, D.

Quick Tip

The enzyme catalytic cycle follows: Substrate binding $\rightarrow$ Substrate-enzyme complex $\rightarrow$ Enzyme ready for next substrate $\rightarrow$ Substrate broken $\rightarrow$ Product released.
