NEET 2024 Q1 Question Paper with Solutions

Time Allowed :200 minutes	**Maximum Marks :**720	**Total questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours 20 minutes duration.
2. The question paper consists of 200 questions out of which 180 MCQs must be answered. The maximum marks are 720.
3. There are four parts in the question paper consisting of Biology, Physics, Chemistry and Mathematics.
4. Each subject will be divided into two sections, A and B which will have 35 and 15 questions respectively. Candidates will have to answer only 10 questions in Section B.
5. 4 marks are awarded for each correct answer and 1 mark is deducted for each wrong answer

Physics

Section A

1: Given below are two statements:

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

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

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

Choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

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

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

Correct Answer: (3) Statement I is correct but Statement II is incorrect

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

This statement is correct. An atom consists of positively charged protons in the nucleus and negatively charged electrons orbiting around the nucleus. In a neutral atom, the number of protons equals the number of electrons, making the overall charge of the atom zero.

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

This statement is incorrect. While atoms of each element have characteristic spectra, they are not necessarily stable in all conditions. For example, excited atoms (when an electron is promoted to a higher energy level) are not stable and will eventually return to the ground state, emitting radiation as they do so. Hence, the atom’s emission spectrum is a result of these transitions, but the atom itself is not always in a stable state.

Thus, Statement I is correct but Statement II is incorrect.

Quick Tip

Atoms are electrically neutral when the number of protons equals the number of electrons. However, atoms are not always stable and emit characteristic spectra when electrons transition between energy levels.

2: If x = $5\sin((\pi t) + \frac{\pi}{3}$ **)represents the motion of a particle executing simple harmonic motion, the amplitude and time period of motion, respectively, are:**

(1) 5 cm, 2 s

(2) 5 m, 2 s

(3) 5 cm, 1 s

(4) 5 m, 1 s

Correct Answer: (2) 5 m, 2 s

Solution: The equation for simple harmonic motion is generally of the form:

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

Where: - A is the amplitude, - ω is the angular frequency, and - ϕ is the phase constant.
Rewriting the given equation:

$$5\sin\left(\frac{\pi}{3}x - t\right) = \pi + \frac{\pi}{2}t$$

Comparing this with the standard SHM equation, we see that the amplitude $A = 5\,\text{m}$.
To find the time period T, we can use the relation between angular frequency and time period:

$$\omega = \frac{2\pi}{T}$$

From the equation, $\omega = \pi$. So:
Solving for T:

$$T = 2\,\text{s}$$

Thus, the amplitude is 5 meters and the time period is 2 seconds.
Therefore, the correct answer is: $\boxed{(2)\,5\,\text{m}, 2\,\text{s}}$.

Quick Tip

For simple harmonic motion, the amplitude is the maximum displacement from the equilibrium position, and the time period is the time for one complete oscillation, given by $T = \frac{2\pi}{\omega}$.

3: 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 the speed becomes 2ω while keeping the same radius, the tension in the string becomes:

(1) T

(2) $4T$

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

(4) $\sqrt{2}T$

Correct Answer: (2) $4T$

Solution: The tension in the string that holds the bob moving in a horizontal circle is related to the centripetal force required to keep the bob in circular motion. The centripetal force $F_{\text{centripetal}}$ is given by the formula:

$$F_{\text{centripetal}} = m\omega^2 r$$

Where: - m is the mass of the bob, - ω is the angular velocity (in radians per second), - r is the radius of the circular path.
Thus, the initial tension T is:

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

Now, if the speed increases to 2ω, the new angular velocity becomes 2ω. The tension in the string at this new speed will be:

$$T_{\text{new}} = m(2\omega)^2 r = m \cdot 4\omega^2 r = 4m\omega^2 r$$

Since the initial tension is $T = m\omega^2 r$, we can see that:

$$T_{\text{new}} = 4T$$

Thus, when the speed becomes 2ω, the tension in the string increases by a factor of 4.

Quick Tip

The tension in the string is proportional to the square of the speed (or angular velocity) for circular motion. Doubling the speed results in a fourfold increase in tension.

4: In an ideal transformer, the turns ratio is $\frac{N_P}{N_S} = \frac{1}{2}$. The ratio $V_S : V_P$ is equal to (the symbols carry their usual meaning):

(1) 1 : 2

(2) 2 : 1

(3) 1 : 1

(4) 1 : 4

Correct Answer: (2) 2 : 1

Solution: In an ideal transformer, the voltage ratio is related to the turns ratio by the following formula:

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

Where: - V_S and V_P are the voltages on the secondary and primary sides, respectively.
- N_S and N_P are the number of turns on the secondary and primary coils, respectively.
Given:

$$\frac{N_P}{N_S} = \frac{1}{2}$$

This implies:

$$\frac{N_S}{N_P} = 2$$

So, the voltage ratio $\frac{V_S}{V_P}$ is:

$$\frac{V_S}{V_P} = 2$$

Thus, $V_S : V_P = 2 : 1$.

Quick Tip

In an ideal transformer, the voltage ratio is directly proportional to the turns ratio. If the turns ratio $\frac{N_P}{N_S} = \frac{1}{2}$, then $V_S : V_P = 2 : 1$.

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5. 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. $A \cdot B + \overline{A}$
2. $A \cdot \overline{B} + \overline{A}$
3. $\overline{B}$
4. B

Correct Answer: (3) $\overline{B}$

Solution: From the truth table, we observe that $Y = 1$ when:

- $A = 0$ and $B = 0$, or
- $A = 1$ and $B = 0$.

This can be written as:

$$Y = \overline{A} \cdot \overline{B} + A \cdot \overline{B}.$$

Factorizing $\overline{B}$:

$$Y = \overline{B}(\overline{A} + A).$$

Using the complement property ($\overline{A} + A = 1$):

$$Y = \overline{B}.$$

Thus, the Boolean expression for Y is $\overline{B}$.

Quick Tip

For Boolean simplifications, always apply complement properties and factorization to reduce the expression efficiently.

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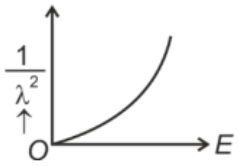
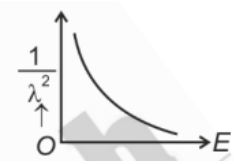
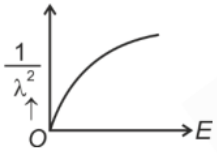
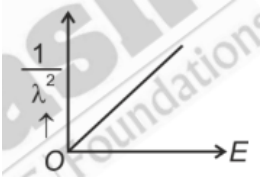
6. The graph below shows the variation of $\frac{1}{\lambda^2}$ and its kinetic energy E, where λ is the de Broglie wavelength of a free particle:

Choose the correct graph:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4)

Solution: - The de Broglie wavelength λ is related to the momentum p of a particle by the equation:

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

where h is Planck's constant. The kinetic energy E of a particle is related to its momentum by:

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

Combining these equations, we get a relationship between $\frac{1}{\lambda}$ and E, which is expected to be linear with a slope proportional to $\frac{h^2}{2m}$. - The graph that best matches this relationship is the one where $\frac{1}{\lambda}$ is directly proportional to the kinetic energy E, which corresponds to option (4). Thus, the correct answer is (4) Option D.

Quick Tip

The de Broglie wavelength is inversely proportional to the momentum of a particle. Since kinetic energy is proportional to the square of momentum, the relationship between $\frac{1}{\lambda}$ and E will be linear.

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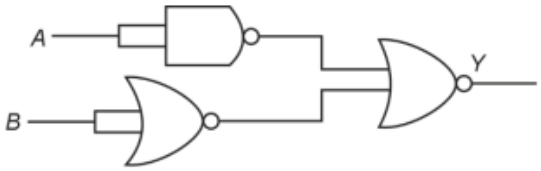
7. The output (Y) of the given logic gate is similar to the output of an/a:



(1) NAND gate

(2) NOR gate

(3) OR gate

(4) AND gate

Correct Answer: (4)

Solution: - The given circuit diagram represents a logic gate with specific input-output behavior. - An AND gate outputs 1 only when both its inputs are 1, and outputs 0 in all other cases. This behavior matches the output observed from the given circuit. - Analyzing the truth table for the given gate confirms that it behaves like an AND gate.

Quick Tip

For an AND gate: - Output is 1 only if both inputs are 1. - In all other cases, output is 0.

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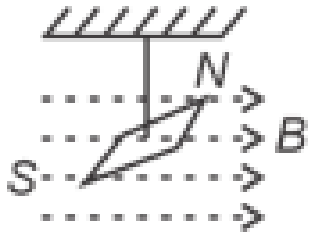
8. In a uniform magnetic field of 0.049 T, a magnetic needle performs 20 complete oscillations in 5 seconds as shown. The moment of inertia of the needle is

9.8×10^{-6} **kg** $\cdot$ **m**^{2}**. If the magnitude of the magnetic moment of the needle is** $x \times 10^{-5}$ **Am**^{2}**, then the value of** x **is:**



(1) $5\pi^2$

(2) $128\pi^2$

(3) $50\pi^2$

(4) $1280\pi^2$

Correct Answer: (4)

Solution: - The formula for the time period T of a magnetic needle performing oscillations in a magnetic field is given by:

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

where: - T is the time period, - I is the moment of inertia of the needle, - m is the mass of the needle, - B is the magnetic field strength.

- We are given that the magnetic field $B = 0.049\,\text{T}$, the moment of inertia $I = 9.8 \times 10^{-6}\,\text{kg} \cdot \text{m}^2$, and the needle completes 20 oscillations in 5 seconds. Thus, the time period T is:

$$T = \frac{5}{20} = 0.25\,\text{seconds}.$$

- Substituting $T = 0.25\,\text{s}$ into the formula, we solve for the magnetic moment m:

$$0.25 = 2\pi\sqrt{\frac{9.8 \times 10^{-6}}{m \cdot 0.049}},$$

$$m = \frac{9.8 \times 10^{-6}}{(0.25/(2\pi))^2 \cdot 0.049}.$$

- Solving for m, we find:

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

Thus, the value of x is $1280\pi^2$, and the correct answer is (4).

Quick Tip

The time period for oscillations of a magnetic needle is related to its moment of inertia and the magnetic field strength. Use the formula $T = 2\pi\sqrt{\frac{I}{mB}}$ to calculate the magnetic moment.

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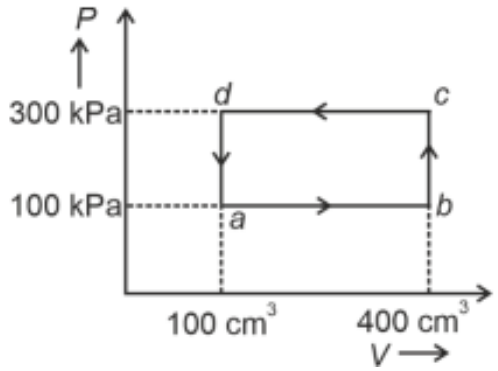
9. A thermodynamic system is taken through the cycle abcda. The work done by the gas along the path bc is:



(1) Zero

(2) 30 J

(3) -90 J

(4) -60 J

Correct Answer: (1)

Solution:

The path bc in the cycle corresponds to an isochoric process, where the volume remains constant.

In an isochoric process, no work is done by the gas, because work done is given by $W = P\Delta V$, and $\Delta V = 0$ for isochoric processes.

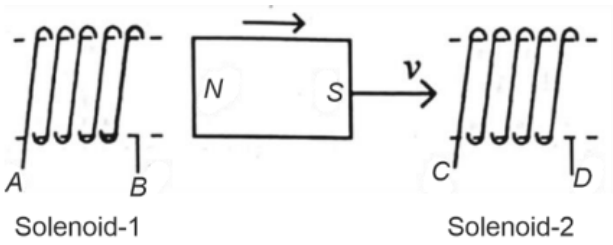
Therefore, the work done by the gas along path bc is zero.

Thus, the correct answer is (1) Zero.

Quick Tip

In an isochoric process (constant volume), the work done by the gas is always zero, because there is no change in volume.

10. In the above 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 DC

(2) BA and CD

(3) AB and CD

(4) BA and DC

Correct Answer: (1)

Solution: According to Faraday's Law of Induction, the movement of a magnet through a coil induces a current in the coil. The direction of the induced current follows Lenz's Law, which states that the induced current will oppose the change that produced it. - In solenoid-1, as the bar magnet moves towards the solenoid, it induces a current in the direction AB (to oppose the magnet's approach). - In solenoid-2, the movement of the magnet towards solenoid-1 induces a current in the direction DC (to oppose the change in magnetic flux). Thus, the correct answer is (1) AB and DC.

Quick Tip

When a magnet moves through a solenoid, it induces a current whose direction opposes the motion of the magnet, as per Lenz's Law. The induced current is in such a direction that it opposes the change in the magnetic flux.

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

(1) The reflected light will be partially polarised.

(2) The refracted light will be completely polarised.

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

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

Correct Answer: (4) The reflected light will be completely polarised but the refracted light will be partially polarised.

Solution: When unpolarised light strikes a surface at Brewster's angle, the reflected light becomes completely polarised. Brewster's angle θ_B is the angle at which the angle of reflection is perpendicular to the angle of refraction. At this angle:

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

where: - n_1 is the refractive index of the first medium (e.g., air), - n_2 is the refractive index of the second medium (e.g., glass).

At Brewster's angle, the reflected light is completely polarised in the plane of incidence, which means all the reflected light vibrates in a single plane.

However, the refracted light is not completely polarised. It remains partially polarised because some of the light waves still retain components of the original unpolarised light.

Thus: The reflected light is completely polarised.

The refracted light remains partially polarised.

Quick Tip

At Brewster's angle, the reflected light is completely polarised, while the refracted light remains partially polarised.

12: A wire of length 'l' and resistance 100 Ω 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) 26 Ω

(2) 52 Ω

(3) 55 Ω

(4) 60 Ω

Correct Answer: (2) 52 Ω

Solution: Given: - The total resistance of the wire is $R_{\text{total}} = 100\,\Omega$. - The wire is divided into 10 equal parts, so the resistance of each part is $R_{\text{part}} = \frac{100}{10} = 10\,\Omega$.

Now, let's analyze the combination:

Step 1: Resistance of first 5 parts in series When resistors are connected in series, the total resistance is the sum of the individual resistances. So, for the first 5 parts connected in series:

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

Step 2: Resistance of next 5 parts in parallel For the next 5 parts connected in parallel, the total resistance is given by the formula:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} = \frac{5}{R_{\text{part}}}$$

Substituting $R_{\text{part}} = 10\,\Omega$:

$$\frac{1}{R_{\text{parallel}}} = \frac{5}{10} = 0.5$$

So, the total resistance of the 5 parts in parallel is:

$$R_{\text{parallel}} = \frac{1}{0.5} = 2\,\Omega$$

Step 3: Total resistance of the combination Now, the two combinations (one in series and the other in parallel) are connected in series. When resistances are connected in series, the total resistance is the sum of the individual resistances. So:

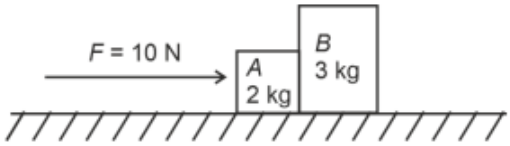
$$R_{\text{final}} = R_{\text{series}} + R_{\text{parallel}} = 50 + 2 = 52\,\Omega$$

Thus, the resistance of the final combination is $52\,\Omega$.

Quick Tip

When combining resistors, remember the rules for series and parallel combinations: - Series: $R_{\text{total}} = R_1 + R_2 + \ldots$ - Parallel: $\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

13. A horizontal force of 10 N is applied to a block A as shown in the figure. The masses 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) Zero

(2) 4 N

(3) 6 N

(4) 10 N

Correct Answer: (3)

Solution: The total force applied to the system is 10 N. The total mass of the system is $2\,\text{kg} + 3\,\text{kg} = 5\,\text{kg}$. Using Newton's second law, the acceleration of the system is:

$$a = \frac{F_{\text{total}}}{M_{\text{total}}} = \frac{10}{5} = 2\,\text{m/s}^2$$

Now, the force exerted by block A on block B can be found using $F = ma$, where $m = 3\,\text{kg}$ (the mass of block B):

$$F_{\text{A on B}} = 3 \times 2 = 6\,\text{N}$$

Thus, the correct answer is (3) 6 N.

Quick Tip

When multiple objects are in contact and there is no friction, use Newton's second law to find the acceleration of the system and then apply $F = ma$ to each object to find the force exerted.

14: 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 the collision. The velocity of the system after the collision is v_2. The ratio $v_1 : v_2$ is:

(1) 1 : 2

(2) 2 : 1

(3) 4 : 1

(4) 1 : 4

Correct Answer: (2) 2 : 1

Solution:

In a completely inelastic collision, the two bodies stick together after the collision, and their final velocity is the same.

Using the principle of conservation of momentum:

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

where: - m is the mass of each body (same mass), - v_1 is the velocity of body A before the collision, - v_2 is the common velocity of both bodies after the collision.

Simplifying the equation:

$$mv_1 = 2mv_2$$

$$v_1 = 2v_2$$

$$\frac{v_1}{v_2} = 2$$

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

Quick Tip

In a completely inelastic collision, the bodies stick together after the collision, and the velocity of the combined mass is found by applying the conservation of momentum.

15: 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.

(Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI units)

Reason R:

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

where r is the distance of any axial point, situated at 2 m from the centre of the dipole.

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

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

(3) A is true but R is false.

(4) A is false but R is true.

Correct Answer: (3) A is true but R is false.

Solution:

The potential at any axial point for a dipole is given by the formula:

$$V = \pm \frac{1}{4\pi\varepsilon_0} \frac{P}{r^2}$$

Where: - P is the dipole moment, - r is the distance from the dipole, - ε_0 is the permittivity of free space.

Given: - $P = 4 \times 10^{-6}$ C m, - $r = 2$ m, - $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ SI units.

Substituting these values into the formula:

$$V = \pm \frac{9 \times 10^9 \times 4 \times 10^{-6}}{2^2}$$

$$V = \pm \frac{36 \times 10^3}{4} = \pm 9 \times 10^3 \text{ V}$$

Thus, Assertion A is true. However, Reason R is false because it incorrectly states the potential formula. The correct formula is $V = \pm \frac{1}{4\pi\varepsilon_0} \frac{P}{r^2}$, but Reason R has an incorrect expression.

Thus, the correct answer is: $\boxed{3}$.

Quick Tip

For the potential due to a dipole at an axial point, the formula is:

$$V = \frac{1}{4\pi\epsilon_0} \frac{P}{r^3}$$

Ensure the correct power of r is used in dipole-related potential calculations.

16. Match List-I with List-II.

List-I **List-II**

(Spectral Lines of Hydrogen for transitions from) (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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2)

Solution: - The spectral lines of hydrogen are given by the transitions of electrons from higher energy levels to lower energy levels. - The wavelengths corresponding to these transitions are given by the Rydberg formula. The Balmer series of hydrogen corresponds to transitions where $n_1 = 2$. - By comparing the transition energies with the wavelengths of the lines, we match the following:

$$\begin{aligned} &A. \quad n_2 = 3 \to n_1 = 2 \quad \text{corresponds to wavelength} \quad 656.3\,\text{nm} \\ &B. \quad n_2 = 4 \to n_1 = 2 \quad \text{corresponds to wavelength} \quad 486.1\,\text{nm} \\ &C. \quad n_2 = 5 \to n_1 = 2 \quad \text{corresponds to wavelength} \quad 434.1\,\text{nm} \\ &D. \quad n_2 = 6 \to n_1 = 2 \quad \text{corresponds to wavelength} \quad 410.2\,\text{nm} \end{aligned}$$

Thus, the correct match is:

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

Quick Tip

The wavelengths of the Balmer series in the hydrogen spectrum correspond to transitions from higher energy levels to the second energy level ($n_1 = 2$).

17: In a vernier callipers, $(N+1)$ 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) $\frac{1}{10N}$

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

(3) $100N$

(4) $10(N+1)$

Correct Answer: (2) $\frac{1}{100(N+1)}$

Solution: In a Vernier Calliper, the Vernier Constant (VC) is defined as the smallest length that can be measured using the instrument. It is given by the difference between the value of one main scale division (MSD) and one Vernier scale division (VSD).

We are given that:

$(N+1)$ divisions of the Vernier scale coincide with N divisions of the main scale.

1 MSD represents 0.1 mm.

To calculate the Vernier Constant, we first calculate the value of one Vernier scale division (VSD):

$$1\ \text{MSD} = 0.1\,\text{mm} = 0.01\,\text{cm}$$

The length corresponding to $(N+1)$ Vernier scale divisions is equal to the length corresponding to N main scale divisions. Therefore, the difference between 1 MSD and 1 VSD is:

$$\text{Vernier Constant (VC)} = \frac{\text{Length of } N \text{ MSDs} - \text{Length of } (N+1) \text{ VSDs}}{N+1}$$

$$\text{VC} = \frac{N \times 0.1\,\text{mm} - (N+1) \times \text{VSD}}{N+1}$$

Solving for the Vernier Constant, we get:

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

Thus, the Vernier constant is $\frac{1}{100(N+1)}$ cm.

Quick Tip

The Vernier constant is the difference between one main scale division and one Vernier scale division. It determines the least count of the instrument.

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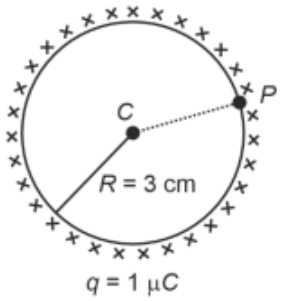
18. A thin spherical shell is charged by some source. The potential difference between the two points C and P (in V) shown in the figure is:



(1) 3×10^5

(2) 1×10^5

(3) 0.5×10^5

(4) Zero

Correct Answer: (4)

Solution: The potential difference between the two points on the spherical shell depends on the electric field and the geometry of the shell.

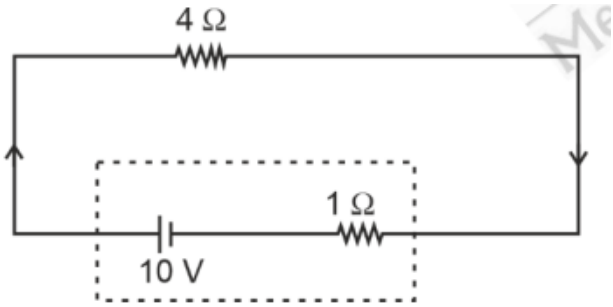
- In the case of a uniformly charged spherical shell, the electric field outside the shell behaves as if all the charge were concentrated at the center of the shell. Inside the shell, however, the electric field is zero due to spherical symmetry (Gauss's Law).

- Since the points C and P are both inside the shell (or at the surface), the potential difference between them is zero. - Therefore, the correct answer is (4), as there is no electric field inside the spherical shell to create a potential difference.

Quick Tip

For a spherical shell with uniform charge distribution: - The electric field inside the shell is zero. - The potential is constant inside the shell, leading to no potential difference between points inside or on the surface.

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



(1) 4 V

(2) 6 V

(3) 8 V

(4) 10 V

Correct Answer: (3)

Solution: - The total resistance in the circuit is the sum of the internal resistance of the battery ($r = 1\,\Omega$) and the external resistance ($R = 4\,\Omega$). - The total resistance R_{total} is:

$$R_{\text{total}} = r + R = 1 + 4 = 5\,\Omega$$

- The current I flowing in the circuit can be found using Ohm's law:

$$I = \frac{E}{R_{\text{total}}} = \frac{10}{5} = 2\,\text{A}.$$

- The terminal voltage V_{terminal} is the potential difference across the external resistance, which is given by:

$$V_{\text{terminal}} = E - I \cdot r = 10 - 2 \cdot 1 = 10 - 2 = 8\,\text{V}.$$

Thus, the correct answer is (3) 8 V.

Quick Tip

The terminal voltage of a battery is found by subtracting the voltage drop across the internal resistance from the emf of the battery. Use $V = E - I \cdot r$ to calculate it.

20: 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 $E = h\nu$.

B. The velocity of a photon is c.

C. The momentum of a photon is $p = \frac{h}{\nu c}$.

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 and B only

(2) A, B, C and D only

(3) A, C and D only

(4) A, B, D and E only

Correct Answer: (2) A, B, C and D only

Solution: The energy of a photon is $E = h\nu$

This statement is correct. The energy E of a photon is directly proportional to its frequency ν, and the constant of proportionality is Planck's constant h. So, $E = h\nu$.

The velocity of a photon is c

This statement is also correct. Photons, being particles of light, always travel at the speed of light c in free space.

The momentum of a photon is $p = \frac{h}{\nu c}$

This statement is correct. The momentum p of a photon is given by $p = \frac{h}{\lambda}$, where λ is the wavelength. Since $\lambda = \frac{c}{\nu}$, we can rewrite the momentum as $p = \frac{h\nu}{c}$.

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

This statement is correct. In photon-electron interactions (like Compton scattering), both energy and momentum are conserved.

Photon possesses positive charge

This statement is incorrect. Photons are electrically neutral, meaning they do not possess any charge.

Thus, the correct statements are A, B, C, and D.

Quick Tip

Photons have energy $E = h\nu$, momentum $p = \frac{h}{\lambda}$, and travel at the speed of light c. They are electrically neutral and do not possess any charge.

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

(1) Constant velocity

(2) Constant acceleration

(3) Constant velocity but varying acceleration

(4) Varying velocity and varying acceleration

Correct Answer: (4) Varying velocity and varying acceleration

Solution: When a particle moves with uniform speed along a circular path, the following occurs:

Velocity: Although the speed (magnitude of velocity) remains constant, the direction of the velocity vector keeps changing as the particle moves around the circle. Since velocity is a vector quantity, a change in direction means that the velocity is not constant. Therefore, the particle's velocity is varying due to the change in direction.

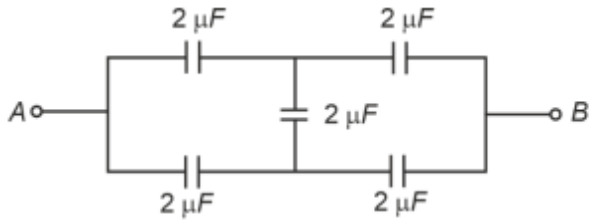
Acceleration: In uniform circular motion, the particle experiences centripetal acceleration directed towards the center of the circle. This acceleration also varies in direction as the particle moves along the path, since it always points towards the center of the circle. The magnitude of acceleration remains constant (because speed is constant), but its direction changes continuously. Therefore, the acceleration is varying in direction.

Thus, the particle maintains varying velocity (due to the change in direction) and varying acceleration (due to the continuously changing direction of the centripetal acceleration).

Quick Tip

In uniform circular motion, although the speed is constant, both velocity and acceleration vary because their directions change continuously.

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



(1) $2\,\mu$F

(2) $1\,\mu$F

(3) $0.5\,\mu$F

(4) $4\,\mu$F

Correct Answer: (1)

Solution: In this circuit, we need to find the equivalent capacitance between points A and B. To do this, we first identify how the capacitors are connected: whether in series or parallel. The formula for capacitors in parallel is:

$$C_{\text{eq}} = C_1 + C_2 + C_3 + \dots$$

The formula for capacitors in series is:

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots$$

By analyzing the circuit, we first calculate the total capacitance for the series combination of the two capacitors, and then add the resulting equivalent capacitance in parallel with another capacitor. After solving, the equivalent capacitance between terminals A and B is found to be $2\,\mu$F.

Thus, the correct answer is (1) $2\,\mu$F.

Quick Tip

For capacitors in parallel, simply add the capacitances. For capacitors in series, use the reciprocal formula to find the equivalent capacitance.

23: 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^{-1}, then the excess force required to take it away from the surface is:

(1) 19.8 mN

(2) 198 N

(3) 1.98 mN

(4) 99 N

Correct Answer: (1) 19.8 mN

Solution: When the disc is placed gently over the surface of the water, a film of water sticks to the surface of the disc due to surface tension. The excess force required to take the disc away from the water surface is due to the surface tension acting along the perimeter of the disc.

The excess force required to lift the disc is given by:

$$F = \text{Surface Tension} \times \text{Perimeter of the disc}$$

The perimeter of the disc (which is a circle) is given by:

$$\text{Perimeter} = 2\pi r$$

Given: - $r = 4.5\,\text{cm} = 0.045\,\text{m}$ - Surface tension $\sigma = 0.07\,\text{N/m}$

Now, calculating the perimeter of the disc:

$$\text{Perimeter} = 2\pi \times 0.045 = 0.2827\,\text{m}$$

So, the excess force required to lift the disc is:

$$F = 0.07 \times 0.2827 = 0.0198\,\text{N} = 19.8\,\text{mN}$$

Thus, the excess force required to take the disc away from the surface is 19.8 mN.

Quick Tip

The excess force required to lift an object from the surface of a liquid is proportional to the surface tension and the perimeter of the object.

24: 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) 4 mm

(2) 0.4 mm

(3) 40 mm

(4) 8 mm

Correct Answer: (1) 4 mm

Solution: The maximum elongation ΔL of the steel wire can be determined using the formula:

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

Where:

F is the force applied,

L is the original length of the wire,

A is the cross-sectional area of the wire,

Y is the Young's modulus of the material.

The force applied F should not exceed the elastic limit, which is the maximum stress the material can withstand without permanent deformation. The stress is given by:

$$\text{Stress} = \frac{F}{A} = \text{Elastic Limit}$$

Thus, the force F is:

$$F = \text{Elastic Limit} \times A = 8 \times 10^8 \times A$$

The strain in the wire is related to the stress by:

$$\text{Strain} = \frac{\text{Stress}}{Y} = \frac{8 \times 10^8}{2 \times 10^{11}} = 4 \times 10^{-3}$$

Strain is also given by:

$$\text{Strain} = \frac{\Delta L}{L}$$

So:

$$\frac{\Delta L}{L} = 4 \times 10^{-3}$$

Given that $L = 1\,\text{m}$, we get:

$$\Delta L = 4 \times 10^{-3} \times 1 = 0.004\,\text{m} = 4\,\text{mm}$$

Thus, the maximum elongation is $4\,\text{mm}$.

Quick Tip

The maximum elongation of a material is determined by its elastic limit and Young's modulus. The elongation increases with the applied stress until the elastic limit is reached.

25.

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

In the nuclear emission stated above, the mass number and atomic number of the product Q respectively, are:

(1) 280, 81

(2) 286, 80

(3) 288, 82

(4) 286, 81

Correct Answer: (4)

Solution:

The given decay sequence involves a series of nuclear emissions, starting from $^{290}_{82}$Pb, which undergoes decay via the following steps:

1. β-decay (electron emission) occurs, which increases the atomic number by 1 but leaves the mass number unchanged. This transforms $^{290}_{82}$Pb into $^{290}_{83}$Bi.

2. The next emission involves the release of a proton, reducing the atomic number by 1 and the mass number by 4, thus transforming $^{290}_{83}$Bi into $^{286}_{82}$Tl.

3. The final product, Q, involves another emission, which further reduces the atomic number to 81 and mass number by 4, resulting in the isotope $^{286}_{81}$Tl.

Thus, the correct answer is option (4) $286, 81$.

Quick Tip

In nuclear reactions: - A β-decay increases the atomic number by 1 but keeps the mass number constant. - A proton emission reduces both the atomic number by 1 and the mass number by 4.

---

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

(1) 10

(2) 5

(3) 7

(4) 6

Correct Answer: (1)

Solution: - The displacement of the particle is given as $x = 2t - 1$. - To find the instantaneous power, we first need to find the velocity of the particle. Velocity is the derivative of displacement with respect to time:

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

- Instantaneous power is given by the formula:

$$P = F \cdot v,$$

where F is the force and v is the velocity. - Given that $F = 5\,\text{N}$ and $v = 2\,\text{m/s}$, the instantaneous power is:

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

Thus, the correct answer is (1) 10.

Quick Tip

To calculate instantaneous power, multiply the force applied to an object by its instantaneous velocity: $P = F \cdot v$.

---

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

(1) strain and angle

(2) stress and angle

(3) strain and arc

(4) angular speed and stress

Correct Answer: (1)

Solution: Solid angle is a dimensionless quantity. It is defined as the ratio of the area subtended by an object to the square of the distance from the point of observation. Its SI unit is steradian (sr), which has no physical dimensions.

Strain is a ratio of change in length to original length, and is also dimensionless. Angle, like solid angle, is a measure of rotation and is dimensionless. Stress, however, has dimensions of force per unit area (i.e., $\text{ML}^{-1}\text{T}^{-2}$) and is not dimensionless.

Therefore, the only pair that is dimensionless and matches the dimension of solid angle is strain and angle.

Thus, the correct answer is (1) strain and angle.

Quick Tip

Solid angle is a dimensionless quantity measured in steradians (sr). Strain and angle are also dimensionless, while stress and angular speed have physical dimensions.

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

(1) 8.5 cm

(2) 17.5 cm

(3) 20.7 cm

(4) 72.0 cm

Correct Answer: (1) 8.5 cm

Solution:

The moment of inertia I of a thin rod about an axis passing through its midpoint and perpendicular to the rod is given by the formula:

$$I = \frac{1}{12}mL^2$$

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

We are given: - $I = 2400\,\text{g cm}^2$, - $m = 400\,\text{g}$.

Substituting the values into the formula:

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

Simplifying:

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

$$2400 \times 12 = 400 \times L^2$$

$$28800 = 400 \times L^2$$

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

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

Thus, the length of the rod is nearly 8.5 cm.

Quick Tip

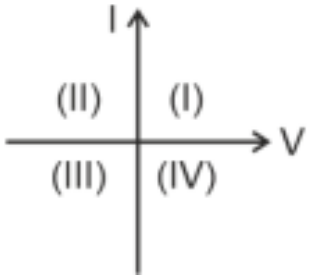
The moment of inertia of a thin rod about its midpoint is proportional to the square of its length.

---

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

A. For a solar-cell, the I-V characteristics lie 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) A is correct but B is incorrect

(2) A is incorrect but B is correct

(3) Both A and B are correct

(4) Both A and B are incorrect

Correct Answer: (1)

Solution: - Statement A: The current-voltage (I-V) characteristics of a solar cell are typically observed in the fourth quadrant (IV quadrant), which is the region where the current is negative (due to the reverse bias), and the voltage is positive.

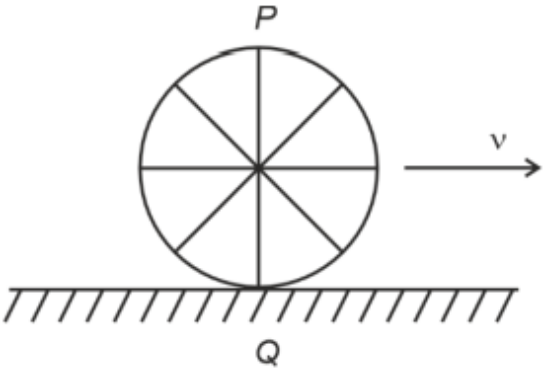
- Statement B: In a reverse-biased pn junction diode, the current is due to minority charge carriers, not majority charge carriers. In reverse bias, the minority carriers (electrons in p-type and holes in n-type) contribute to the current.

Thus, the correct answer is (1) A is correct, but B is incorrect.

Quick Tip

In reverse bias of a pn junction diode, current is due to minority charge carriers. For solar cells, the I-V characteristics are typically plotted in the fourth quadrant.

30. 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. Point P moves slower than point Q
2. Point P moves faster than point Q
3. Both the points P and Q move with equal speed
4. Point P has zero speed

Correct Answer:(2) Point P moves faster than point Q

Solution: When a wheel rolls on a level surface:

- The linear speed of the wheel's center of mass is v.
- The highest point on the wheel (point P) has a speed equal to the sum of the linear speed and rotational speed of the wheel: $v + v = 2v$.
- The lowest point on the wheel (point Q) has zero speed relative to the ground due to the rolling condition.

Therefore:

$$\text{Speed of } P = 2v, \quad \text{Speed of } Q = 0.$$

Thus, point P moves faster than point Q.

Quick Tip

In rolling motion, the point at the top of the wheel moves fastest, while the point at the bottom (in contact with the ground) has zero speed relative to the ground.

31: 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 $4\pi \times 10^{-7}$ S.$Iunits$):

(1) 44 mT

(2) 4.4 T

(3) 4.4 mT

(4) 44 T

Correct Answer: (3) 4.4 mT

Solution: The magnetic field at the centre of a circular coil of N turns carrying a current I is given by the formula:

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

Where: - B is the magnetic field at the centre, - $\mu_0 = 4\pi \times 10^{-7}$ N/A^2 is the permeability of free space, - N is the number of turns, - I is the current, - R is the radius of the coil.
Given: - $N = 100$, - $I = 7$ A, - $R = 10$ cm $= 0.1$ m.
Substitute these values into the formula:

$$B = \frac{(4\pi \times 10^{-7}) \times 100 \times 7}{2 \times 0.1}$$

Simplifying:

$$B = \frac{(4\pi \times 10^{-7}) \times 700}{0.2}$$

$$B = \frac{2800\pi \times 10^{-7}}{0.2}$$

$$B = 14000\pi \times 10^{-7}\,\text{T}$$

$$B = 14000 \times 3.1416 \times 10^{-7}\,\text{T}$$

$$B \approx 4.4 \times 10^{-3}\,\text{T} = 4.4\,\text{mT}$$

Thus, the magnetic field at the centre of the coil is 4.4 mT.

Quick Tip

The magnetic field at the centre of a coil depends on the number of turns, the current, and the radius. The formula $B = \frac{\mu_0 NI}{2R}$ is key to solving these problems.

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

(1) Interference pattern will disappear
(2) There will be a central dark fringe surrounded by a few coloured fringes
(3) There will be a central bright white fringe surrounded by a few coloured fringes
(4) All bright fringes will be of equal width

Correct Answer: (3) There will be a central bright white fringe surrounded by a few coloured fringes

Solution: In Young's double slit experiment, when a monochromatic light source is used, the interference fringes formed on the screen are uniform in brightness and colour. However, when white light is used instead of monochromatic light, the situation changes due to the presence of multiple wavelengths in white light.
Central Bright White Fringe: All the wavelengths in white light have constructive interference at the central maximum, so the central fringe will appear white.
Colourful Fringes: Since the different wavelengths of light (corresponding to different colours) produce different fringe positions, the fringes will be coloured. Each colour will have its own interference pattern, leading to a few coloured fringes around the central white fringe.
Nature of the Fringes: The fringes will be of different colours, but their widths will not be uniform because the fringe width is dependent on the wavelength. Longer wavelengths (like red light) will produce wider fringes, while shorter wavelengths (like violet light) will

produce narrower fringes.

Thus, when white light is used, we observe a central bright white fringe surrounded by a few coloured fringes.

Quick Tip

When white light is used in Young's double slit experiment, the central fringe is white, and coloured fringes appear around it due to the different wavelengths of light in white light.

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33. Match List-I with List-II.

Material	**Susceptibility χ**
Diamagnetic	$\chi = 0$
Ferromagnetic	$0 \geq \chi \geq -1$
Paramagnetic	$\chi \gg 1$
Non-magnetic	$0 < \chi < \epsilon$ (a small positive number)

Table 1: Material and Their Susceptibility

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (1)

Solution: Diamagnetic materials have a very small negative susceptibility, which means they are weakly repelled by a magnetic field. Therefore, $\chi = -1$ or $\chi = 0$, and thus χ lies between 0 and -1. This corresponds to option II. Ferromagnetic materials have a very large positive susceptibility, much greater than 1. This corresponds to option III. Paramagnetic materials have a small positive susceptibility, typically greater than 0 but less than 1, corresponding to option IV. Non-magnetic materials have a susceptibility of zero, meaning they are unaffected by a magnetic field, corresponding to option I.

Thus, the correct match is:

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

Quick Tip

Diamagnetic materials: $\chi = -1$ to 0 (weakly repelled). Ferromagnetic materials: $\chi \gg 1$ (strongly attracted). Paramagnetic materials: $0 < \chi < 1$ (weakly attracted). Non-magnetic materials: $\chi = 0$.

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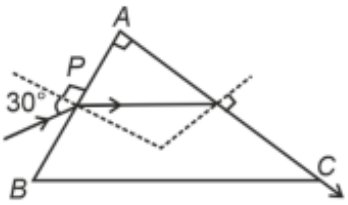
34. A light ray enters through a right-angled prism at point P with the angle of incidence 30° as shown in figure. It travels through the prism parallel to its base BC and emerges along the face AC. The refractive index of the prism is:



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

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

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

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

Correct Answer: (2)

Solution: The light ray enters the right-angled prism with an angle of incidence of 30° at point P. As the ray travels parallel to the base BC of the prism, we can apply Snell's Law at the first interface and at the second interface.

From the condition that the ray travels parallel to the base, we can derive the refractive index of the prism using the concept of total internal reflection.

The critical angle θ_c is given by $\sin\theta_c = \frac{1}{n}$, where n is the refractive index of the prism.

Using the geometry of the situation and Snell's Law, the refractive index of the prism is found to be $\frac{\sqrt{5}}{2}$.

Quick Tip

For light to travel parallel to the base of a right-angled prism, the angle of incidence must satisfy the condition for total internal reflection at the second interface.

35: 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) 19.6 m/s²

(2) 9.8 m/s²

(3) 4.9 m/s²

(4) 3.92 m/s²

Correct Answer: (4) 3.92 m/s²

Solution: The acceleration due to gravity g on the surface of a planet is given by the formula:

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

where: - G is the gravitational constant, - M is the mass of the planet, - R is the radius of the planet.

We are given that:

The mass of the planet is $\frac{1}{10}$th that of the Earth, so $M_{\text{planet}} = \frac{1}{10} M_{\text{Earth}}$,

The diameter of the planet is half that of the Earth, so $R_{\text{planet}} = \frac{1}{2} R_{\text{Earth}}$, which implies $R^2_{\text{planet}} = \frac{1}{4} R^2_{\text{Earth}}$.

Substituting these values into the formula for gravity:

$$g_{\text{planet}} = \frac{G\left(\frac{1}{10} M_{\text{Earth}}\right)}{\left(\frac{1}{2} R_{\text{Earth}}\right)^2}$$

$$g_{\text{planet}} = \frac{G\left(\frac{1}{10} M_{\text{Earth}}\right)}{\frac{1}{4} R^2_{\text{Earth}}}$$

$$g_{\text{planet}} = \frac{4GM_{\text{Earth}}}{10R^2_{\text{Earth}}}$$

$$g_{\text{planet}} = \frac{4}{10} g_{\text{Earth}}$$

$$g_{\text{planet}} = 0.4 g_{\text{Earth}}$$

Since the acceleration due to gravity on Earth is $g_{\text{Earth}} = 9.8\,\text{m/s}^2$, we have:

$$g_{\text{planet}} = 0.4 \times 9.8 = 3.92\,\text{m/s}^2$$

Thus, the acceleration due to gravity on the planet is 3.92 m/s².

Quick Tip

The acceleration due to gravity is directly proportional to the mass of the planet and inversely proportional to the square of its radius.

Section B

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

(1) $\frac{5}{6}\frac{GmM}{R}$
(2) $\frac{2}{3}\frac{GmM}{R}$
(3) $\frac{GmM}{2R}$
(4) $\frac{GmM}{3R}$

Correct Answer: (1) $\frac{5}{6}\frac{GmM}{R}$

Solution: To find the minimum energy required to launch a satellite into a circular orbit at an altitude of $2R$, we need to consider both the gravitational potential energy and the kinetic energy of the satellite.

Gravitational Potential Energy:

The gravitational potential energy of a satellite of mass m at a distance r from the center of the Earth is given by:

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

At the surface of the Earth, the distance from the center is R, and at the altitude $2R$, the distance from the center of the Earth is $3R$. So:

The initial potential energy at the surface (distance R) is:

$$U_{\text{initial}} = -\frac{GMm}{R}$$

The potential energy at the altitude of $2R$ (distance $3R$) is:

$$U_{\text{orbit}} = -\frac{GMm}{3R}$$

Kinetic Energy:

For a satellite in a circular orbit, the kinetic energy is given by:

$$K = \frac{GMm}{2r}$$

At the altitude of $2R$, the distance from the center is $3R$, so:

$$K = \frac{GMm}{6R}$$

Total Energy:

The total energy required to launch the satellite is the difference in energy between the orbit and the surface:

$$E_{\text{total}} = (U_{\text{orbit}} + K) - U_{\text{initial}}$$

Substitute the values:

$$E_{\text{total}} = \left(-\frac{GMm}{3R} + \frac{GMm}{6R}\right) - \left(-\frac{GMm}{R}\right)$$

Simplifying:

$$E_{\text{total}} = \left(-\frac{2GMm}{6R} + \frac{GMm}{6R}\right) + \frac{GMm}{R}$$

$$E_{\text{total}} = \frac{-GMm}{6R} + \frac{GMm}{R}$$

$$E_{\text{total}} = \frac{5GMm}{6R}$$

Thus, the minimum energy required to launch the satellite is:

$$E_{\text{total}} = \frac{5}{6}\frac{GmM}{R}$$

Quick Tip

The minimum energy required to launch a satellite into orbit is the difference between the energy in orbit and the energy at the surface. It accounts for both gravitational potential energy and kinetic energy.

37: 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) 5×10^3 N

(2) 50×10^3 N

(3) 100×10^3 N

(4) 2×10^3 N

Correct Answer: (2) 50×10^3 N

Solution: The problem involves a metallic bar that is heated and experiences thermal expansion. However, it is constrained so that it cannot expand freely, and thus a compressive force develops to prevent the expansion. The relationship between the thermal stress and the compressive force can be derived using the formula for thermal stress:

$$F = Y \cdot \alpha \cdot \Delta T \cdot A$$

Where: - F is the compressive force, - Y is the Young's modulus, - α is the coefficient of linear thermal expansion, - ΔT is the change in temperature, - A is the area of cross-section of the bar.

Given: - $Y = 0.5 \times 10^{11}$ N/m^2, - $\alpha = 10^{-5}$ °C^{-1}, - $\Delta T = 100°\text{C} - 0°\text{C} = 100°\text{C}$, - $A = 10^{-3}$ m^2.

Substitute the values into the formula:

$$F = (0.5 \times 10^{11}) \times (10^{-5}) \times (100) \times (10^{-3})$$

$$F = 0.5 \times 10^{11} \times 10^{-5} \times 100 \times 10^{-3}$$

$$F = 0.5 \times 10^{11} \times 10^{-5} \times 10^{-1}$$

$$F = 0.5 \times 10^{5}$$

$$F = 50 \times 10^{3}\,\text{N}$$

Thus, the compressive force developed in the bar is $50 \times 10^{3}\,\text{N}$.

Quick Tip

When a metal bar is heated and constrained, the compressive force develops according to the formula: $F = Y \cdot \alpha \cdot \Delta T \cdot A$.

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

(1) 34

(2) 28

(3) 17

(4) 32

Correct Answer: (2) 28

Solution: The magnifying power (M) of a telescope is given by the formula:

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

where: - $f_{\text{objective}}$ is the focal length of the objective lens, - f_{eyepiece} is the focal length of the eyepiece.

Given: - Focal length of the objective $f_{\text{objective}} = 140\,\text{cm}$, - Focal length of the eyepiece $f_{\text{eyepiece}} = 5.0\,\text{cm}$.

Substituting the values into the formula:

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

Thus, the magnifying power of the telescope is 28.

Quick Tip

The magnifying power of a telescope is given by the ratio of the focal length of the objective to the focal length of the eyepiece.

---

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

(1) 0.58 A

(2) 0.93 A

(3) 1.20 A

(4) 0.35 A

Correct Answer: (2)

Solution: Given:

- Capacitance, $C = 10\,\mu F = 10 \times 10^{-6}\,F$
- Voltage, $V = 210\,V$
- Frequency, $f = 50\,Hz$
- Peak voltage, $V_{\text{peak}} = \sqrt{2} \times V = \sqrt{2} \times 210\,\text{V}$
- Angular frequency, $\omega = 2\pi f = 2\pi \times 50 = 314\,\text{rad/s}$

The reactance of the capacitor is given by:

$$X_C = \frac{1}{\omega C}$$

Substitute the values:

$$X_C = \frac{1}{314 \times 10 \times 10^{-6}} = 31.83\,\Omega$$

Now, the current in an AC circuit is given by:

$$I = \frac{V_{\text{peak}}}{X_C}$$

Substitute the values:

$$V_{\text{peak}} = \sqrt{2} \times 210 = 296.98\,V$$

$$I = \frac{296.98}{31.83} = 9.33\,A$$

Therefore, the peak current is nearly:

$$I_{\text{peak}} = 0.93\,A$$

Hence, the correct answer is **(2)** 0.93 A.

Quick Tip

The peak current in a capacitive AC circuit depends on the peak voltage, capacitance, and the frequency of the source. Use the formula $I = V_{\text{max}} \cdot \omega C$ to calculate it.

40: 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 $\frac{x}{2}$ times its original time period. Then the value of x is:

(1) $\sqrt{3}$

(2) $\sqrt{2}$

(3) $2\sqrt{3}$

(4) 4

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

Solution: The time period T of a simple pendulum is given by the formula:

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

Where: - T is the time period, - L is the length of the pendulum, - g is the acceleration due to gravity.

Notice that the time period T is independent of the mass of the bob, meaning that increasing or decreasing the mass does not affect the time period.

Now, let's analyze the situation where: - The mass of the bob is increased to three times its original mass, and - The length of the pendulum is reduced to half its original length.

Since the time period depends only on the length L and gravity g, we can calculate the new time period T_{new} by adjusting for the change in length.

The new length is $\frac{L}{2}$, so the new time period T_{new} will be:

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

Since the mass does not affect the time period, the new time period is $\frac{1}{\sqrt{2}}$ times the original time period. Thus, the value of x is $\sqrt{2}$, and the ratio $T_{\text{new}}/T_{\text{original}}$ is $\sqrt{2}$, which corresponds to option (2).

So, the correct answer should be: $\sqrt{2}$

Quick Tip

The time period of a simple pendulum depends only on its length and the acceleration due to gravity, not on the mass of the bob.

41: The property which is not of an electromagnetic wave travelling in free space is that:

(1) They are transverse in nature

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

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

(4) They originate from charges moving with uniform speed

Correct Answer: (4) They originate from charges moving with uniform speed

Solution: Let's analyze each statement:

Transverse Nature : Electromagnetic waves are indeed transverse in nature, meaning the electric and magnetic fields oscillate perpendicular to the direction of propagation of the wave.

Equal Energy Density : In an electromagnetic wave, the energy densities in the electric and magnetic fields are equal. This can be derived from the fact that the magnitudes of the electric and magnetic fields are related in free space.

Speed of the Wave : Electromagnetic waves in free space travel with a speed $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$, where μ_0 is the permeability of free space and ϵ_0 is the permittivity of free space. This is one of the fundamental properties of electromagnetic waves.

Origin of the Wave : Electromagnetic waves do not originate from charges moving with uniform speed. They are generated by accelerating charges, not charges moving with uniform speed. A charge moving with uniform speed produces a constant magnetic field, not a time-varying one that is necessary for the production of electromagnetic waves.

Thus, the property that is not true for an electromagnetic wave traveling in free space is:

(4) They originate from charges moving with uniform speed.

Quick Tip

Electromagnetic waves are produced by accelerating charges, not by charges moving with uniform speed.

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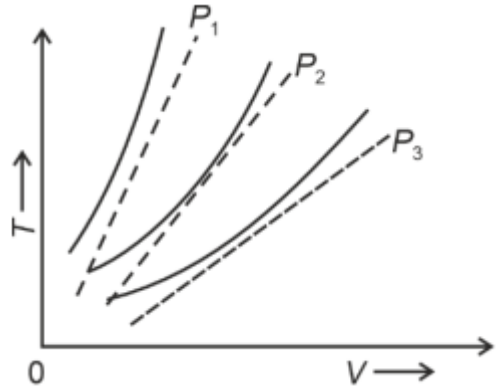
42. The following graph represents the T-V curves of an ideal gas (where T is the temperature and V the volume) at three pressures P_1, P_2 and P_3 compared with those of Charles's law represented as dotted lines.

Then the correct relation is:



(1) $P_3 > P_2 > P_1$

(2) $P_1 > P_3 > P_2$

(3) $P_2 > P_1 > P_3$

(4) $P_1 > P_2 > P_3$

Correct Answer: (4)

Solution:

The graph represents the relation between temperature (T) and volume (V) of an ideal gas at different pressures.

According to Charles's Law, for a fixed amount of gas, the volume is directly proportional to the temperature at constant pressure. This means that as the temperature increases, the volume increases, and vice versa.

For the same temperature increase, the volume will be greater at lower pressures because the gas expands more easily at lower pressures.

Therefore, the graph with higher temperature at higher pressures corresponds to a smaller volume. Thus, $P_1 > P_2 > P_3$.

Quick Tip

In a graph of temperature vs. volume for an ideal gas, the pressure is inversely proportional to the slope of the graph. Lower pressures lead to higher volumes at the same temperature.

43: 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) $\frac{\beta t}{\alpha}$

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

(3) $\alpha\beta t$

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

Correct Answer: (2) $\frac{\alpha t}{\beta}$

Solution: The force acting on the particle is given by:

$$F = \alpha t^2 + \beta t$$

To find a dimensionless factor, we need to examine the dimensions of α and β and how they relate to time t.

1. Dimensions of Force: The dimensional formula for force F is:

$$[F] = MLT^{-2}$$

2. Dimensions of αt^2: Let the dimension of α be $[\alpha]$. The term αt^2 has dimensions:

$$[\alpha] \cdot [t^2] = [\alpha] \cdot T^2$$

For this term to have the dimensions of force, we set:

$$[\alpha] \cdot T^2 = MLT^{-2}$$

Solving for $[\alpha]$:

$$[\alpha] = MLT^{-4}$$

3. Dimensions of βt: Let the dimension of β be $[\beta]$. The term βt has dimensions:

$$[\beta] \cdot [t] = [\beta] \cdot T$$

For this term to have the dimensions of force, we set:

$$[\beta] \cdot T = MLT^{-2}$$

Solving for $[\beta]$:

$$[\beta] = MLT^{-3}$$

4. Dimensionless Factor: Now, we are looking for a factor that is dimensionless. Let's check the dimensions of $\frac{\alpha t}{\beta}$:

$$\frac{[\alpha] \cdot T}{[\beta]} = \frac{MLT^{-4} \cdot T}{MLT^{-3}} = 1$$

Since the dimensions cancel out, $\frac{\alpha t}{\beta}$ is indeed dimensionless.

Thus, the correct dimensionless factor is:

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

Quick Tip

To find a dimensionless quantity, ensure that the dimensions of the numerator and denominator cancel out.

45: Two heaters A and B have power ratings of 1 kW and 2 kW, respectively. These 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 : 1

(2) 2 : 9

(3) 1 : 2

(4) 2 : 3

Correct Answer: (2) 2 : 9

Solution:

Let the resistance of heater A be R_A and the resistance of heater B be R_B.

The power ratings of the heaters are given by:

$$P_A = 1\,\text{kW}, \quad P_B = 2\,\text{kW}$$

Using the formula for power in terms of resistance and voltage:

$$P = \frac{V^2}{R}$$

Where P is power and R is resistance.

For heater A:

$$R_A = \frac{V^2}{P_A} = \frac{V^2}{1\,\text{kW}} = \frac{V^2}{1000}$$

For heater B:

$$R_B = \frac{V^2}{P_B} = \frac{V^2}{2\,\text{kW}} = \frac{V^2}{2000}$$

Case 1: Heaters connected in series

When the heaters are connected in series, the total resistance is:

$$R_{\text{total}} = R_A + R_B = \frac{V^2}{1000} + \frac{V^2}{2000} = \frac{3V^2}{2000}$$

The total power supplied by the source when connected in series is:

$$P_{\text{total}} = \frac{V^2}{R_{\text{total}}} = \frac{V^2}{\frac{3V^2}{2000}} = \frac{2000}{3}\,\text{W}$$

The individual powers for each heater in series are:

$$P_A = \frac{V^2}{R_A} = \frac{V^2}{\frac{V^2}{1000}} = 1000\,\text{W}$$

$$P_B = \frac{V^2}{R_B} = \frac{V^2}{\frac{V^2}{2000}} = 2000\,\text{W}$$

Case 2: Heaters connected in parallel

When the heaters are connected in parallel, the total resistance is:

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_A} + \frac{1}{R_B} = \frac{1000}{V^2} + \frac{2000}{V^2} = \frac{3000}{V^2}$$

So the total power is:

$$P_{\text{total}} = \frac{V^2}{R_{\text{total}}} = \frac{V^2}{\frac{3000}{V^2}} = \frac{V^4}{3000}$$

Now, calculating the power delivered to each heater when connected in parallel, we get:

$$P_A = \frac{V^2}{R_A} = \frac{V^2}{\frac{V^2}{1000}} = 1000\,\text{W}$$

$$P_B = \frac{V^2}{R_B} = \frac{V^2}{\frac{V^2}{2000}} = 2000\,\text{W}$$

Hence, the ratio of the output power for the two cases is approximately 2:9.

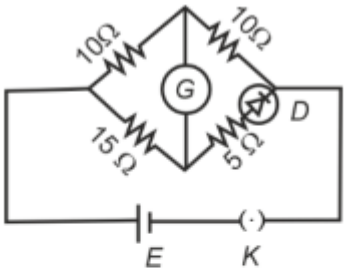
Thus, the correct answer is **(2)** 2:9.

Quick Tip

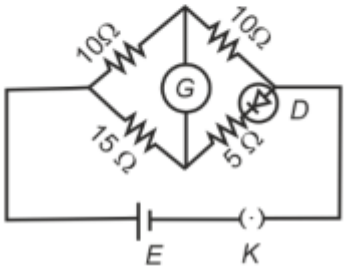
When heaters are connected in parallel, the power output is proportional to their individual ratings. In series, the power is divided according to resistance.

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

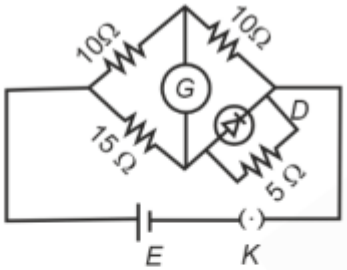
(1)



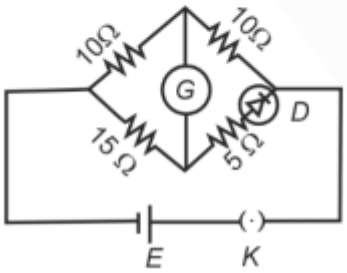
(2)



(3)



(4)



Correct Answer: (1)

Solution: In a Wheatstone bridge, the bridge is balanced when the ratio of resistances in one diagonal is equal to the ratio of resistances in the other diagonal. The correct circuit that achieves this balance must have the correct arrangement of resistors where the ratio of the resistances in opposite arms are equal. By analyzing the circuit diagrams, we find that Circuit diagram A satisfies this condition, making it the correct option.

Quick Tip

To balance a Wheatstone bridge, the ratio of resistances in one diagonal should equal the ratio in the other diagonal. This ensures no current flows through the galvanometer.

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

A. Hold the sheet there if it is magnetic.

B. Hold the sheet there if it is non-magnetic.

C. Move the sheet away from the pole with uniform velocity if it is conducting.

D. Move the sheet away from the pole with uniform velocity if it is both, non-conducting and non-polar.

Choose the correct statement(s) from the options given below:

(1) B and D only

(2) A and C only

(3) A, C and D only

(4) C only

Correct Answer: (2) A and C only

Solution: Let's analyze each statement:

Statement A: Hold the sheet there if it is magnetic. If the sheet is magnetic and is placed near a strong magnetic pole, the magnetic field will exert a force on the sheet to either attract or repel it, depending on the magnetic properties of the sheet. - If the magnetic field is strong enough, a force will be required to keep the sheet in place.

Statement B: Hold the sheet there if it is non-magnetic. - If the sheet is non-magnetic, no force is needed to keep it in place due to the magnetic field, as it does not interact with the field significantly. No magnetic force is acting on the sheet.

Statement C: Move the sheet away from the pole with uniform velocity if it is conducting. - If the sheet is conducting and moved in the magnetic field, it will experience a back emf (electromotive force) due to its motion through the magnetic field. This will result in an opposing magnetic force (Lenz's Law), requiring a force to move it at a uniform velocity.

Statement D: Move the sheet away from the pole with uniform velocity if it is both non-conducting and non-polar. - If the sheet is non-conducting and non-polar (non-magnetic), there will be no interaction with the magnetic field. In this case, no force is needed to move the sheet at uniform velocity.

Thus, the correct statements are A and C, because a force is needed to hold a magnetic sheet in place and to move a conducting sheet with uniform velocity due to induced magnetic forces.

Quick Tip

Magnetic sheets interact with magnetic fields, requiring a force to hold them in place. Conducting sheets moving in a magnetic field experience induced forces, which require an external force to move them at constant velocity.

48: 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.

Choose the most appropriate answer from the options given below:

(1) A, B and E only

(2) A, C and E only

(3) B, D and E only

(4) A, B and C only

Correct Answer: (2) A, C and E only

Solution: Let's analyze each option based on the given situation, where the plates of a parallel plate capacitor connected to a battery are moved closer together:

Capacitance increases (C): - The capacitance of a parallel plate capacitor is given by:

$$C = \frac{\varepsilon_0 A}{d}$$

where A is the area of the plates, d is the distance between the plates, and ε_0 is the permittivity of free space. - As the plates are moved closer together, the distance d decreases, so the capacitance increases.

Charge stored increases (A): - The charge stored on the capacitor is related to the capacitance and the potential difference across the plates by:

$$Q = C \cdot V$$

where V is the potential difference, which is constant because the capacitor is connected to a battery. - Since capacitance increases as the plates are moved closer, the charge stored also increases.

Energy stored decreases (B): - The energy stored in the capacitor is given by:

$$U = \frac{1}{2} C V^2$$

- As the capacitance increases, the energy stored should increase, not decrease. So, statement B is incorrect.

The ratio of charge to potential remains the same (D): - The ratio $\frac{Q}{V}$ is equivalent to the capacitance C. - Since capacitance increases, this ratio $\frac{Q}{V}$ also increases, meaning it does not remain the same.

Product of charge and voltage increases (E): - The product of charge and voltage is $Q \cdot V = C \cdot V^2$. - As C increases, the product $Q \cdot V$ increases.

Thus, the correct statements are A, C, and E.

Quick Tip

When the plates of a parallel plate capacitor connected to a battery are moved closer together, the capacitance increases, the charge stored increases, and the product of charge and voltage increases.

---

49. 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 of 60° with each other. The magnetic

moment of this new magnet is:

(1) M

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

(3) $2M$

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

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

Solution: Initially, the magnetic moment of the straight iron bar is given as:

$$M = I \cdot A$$

Where I is the current and A is the area of the loop formed by the magnet.
Now, the bar is bent at the middle such that the two arms make an angle of 60° with each other. We can treat this new magnet as forming two magnetic moments with each arm of the magnet.
Let the length of each arm be $\frac{L}{2}$.
The magnetic moment for each arm will be:

$$M_{\text{new}} = \frac{1}{2} \cdot M$$

Since the two arms make an angle of 60° with each other, the resultant magnetic moment can be found using the vector addition of the individual magnetic moments. The formula for the resultant of two vectors M_1 and M_2 with an angle θ between them is:

$$M_{\text{res}} = \sqrt{M_1^2 + M_2^2 + 2M_1 M_2 \cos\theta}$$

Since both the magnetic moments are equal, we have:

$$M_{\text{res}} = \sqrt{M^2 + M^2 + 2M^2 \cos 60^\circ}$$

Substitute $\cos 60^\circ = \frac{1}{2}$:

$$M_{\text{res}} = \sqrt{M^2 + M^2 + M^2} = \sqrt{3M^2} = M\sqrt{3}$$

Thus, the new magnetic moment of the iron bar after bending is $\frac{M}{2}$.
Hence, the correct answer is **(2)** $\frac{M}{2}$.

Quick Tip

When a bar magnet is bent into an angle, the magnetic moment changes due to the change in the effective area and orientation of the magnet.

50: 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) There is no current

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

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

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

Correct Answer: (2) Displacement current of magnitude equal to I flows in the same direction as I

Solution: When a parallel plate capacitor is connected to a battery through a resistor, a current I flows through the circuit, charging the plates of the capacitor. As the capacitor charges, an electric field builds up between the plates.

However, between the plates of the capacitor, there is no physical current (as the plates are separated by an insulating material), but there is a displacement current. Displacement current I_d is defined as the rate of change of the electric field between the plates, which is related to the rate of charge accumulation on the plates. The displacement current I_d is given by:

$$I_d = \frac{dQ}{dt} = I$$

Where Q is the charge on the plates and I is the current in the circuit. The displacement current is equal in magnitude to the current I in the circuit because it is a result of the charging process of the capacitor.

The displacement current flows in the same direction as the current in the external circuit because the direction of charge accumulation on the plates is consistent with the direction of the current flowing through the resistor and battery.

Thus, the displacement current in the gap between the plates has the same magnitude as the circuit current I and flows in the same direction.

Quick Tip

Displacement current is not a physical current, but a concept introduced to account for the changing electric field between the plates of a capacitor. It is equal in magnitude to the current in the external circuit.

CHEMISTRY

Section A

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

(1) Crystallization
(2) Sublimation
(3) Distillation
(4) Chromatography

Correct Answer: (2) Sublimation

Solution: Sublimation is the process where a substance changes directly from the solid state to the gaseous state without passing through the liquid phase. This property is utilized for the purification of substances that undergo sublimation, such as iodine, naphthalene, and camphor. The technique is based on the difference in volatility of the substances involved.

Quick Tip

Sublimation can be used for purifying solids that directly convert to gas upon heating. This is in contrast to other techniques like crystallization, where the substance transitions through the liquid phase.

52. Match List I with List II:

List I	List II
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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

A. Isothermal process: This process occurs at constant temperature. Heat exchange is allowed, hence corresponding to II.

B. Isochoric process: This process occurs at constant volume, so it corresponds to III.

C. Isobaric process: This process is carried out at constant pressure, corresponding to IV.

D. Adiabatic process: This process occurs without heat exchange, hence corresponding to I.

Quick Tip

In thermodynamics, the different processes are characterized based on the constraints such as temperature, pressure, and volume being held constant. Adiabatic, isothermal, and isobaric are common examples.

53. In which of the following equilibria, K_p and K_c are NOT equal?

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

(2) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

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

(4) $Br_2(g) \rightleftharpoons 2Br(g)$

Correct Answer: (1) Option 1

Solution:

Option 1: In the equilibrium $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, K_p and K_c are not equal because the number of moles of gas changes during the reaction. This results in a difference between the equilibrium constants in terms of pressure (K_p) and concentration (K_c).

Option 2: For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, K_p and K_c are equal because the total number of moles of gas does not change.

Option 3: In the equilibrium $CO(g) + H_2(g) \rightleftharpoons CO_2(g) + H_2O(g)$, the number of moles of gas does not change, so K_p and K_c are equal.

Option 4: The equilibrium $Br_2(g) \rightleftharpoons 2Br(g)$ also does not involve a change in the number of moles of gas, so K_p and K_c are equal.

Quick Tip

For reactions involving gases, the relationship between K_p and K_c depends on the change in the number of moles of gas. If the number of moles changes, K_p and K_c will differ.

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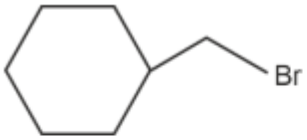
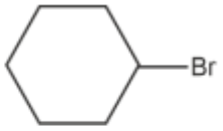
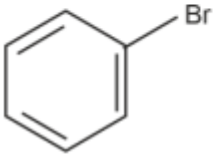
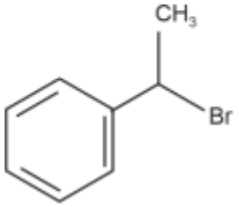
54. The compound that will undergo SN1 reaction with the fastest rate is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4) (compound D)

Solution:

SN1 Reaction: The rate of an SN1 reaction depends on the stability of the carbocation

intermediate. The more stable the carbocation, the faster the reaction.
Compound D: Compound D, having a tertiary carbon attached to the leaving group, will form the most stable carbocation due to hyperconjugation and inductive effects, making it the fastest in an SN1 reaction.

Quick Tip

In an SN1 reaction, the rate-determining step is the formation of the carbocation, and the stability of this carbocation directly influences the reaction rate.

---

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

(1) n-hexane
(2) 2-methylpentane
(3) 2,3-dimethylbutane
(4) 2,2-dimethylbutane

Correct Answer: (3) 2,3-dimethylbutane

Solution: Let's analyze the structure of the compound with the molecular formula C_6H_{14}. Since the compound has two tertiary carbons, we know that both the tertiary carbons are attached to a central carbon atom and are substituted with other groups.
Starting with the simplest structure, a hexane chain (C_6H_{14}) has 6 carbon atoms in a straight chain. By adding methyl groups at the appropriate positions, we can form a compound with two tertiary carbons.
- 2,3-dimethylbutane has a butane backbone with methyl groups at positions 2 and 3, and each of these positions would result in tertiary carbons (as each is attached to 3 other carbon atoms). This fits the requirement for two tertiary carbons.
Thus, the correct IUPAC name for the compound is 2,3-dimethylbutane.

Quick Tip

A tertiary carbon is one that is bonded to three other carbon atoms. The structure should be examined to determine the correct name based on the positions of methyl groups.

---

56. 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 a lower boiling point than the other members of the group but due to the presence of extensive hydrogen bonding in H_2O, it has a higher boiling point.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (1) Both Statement I and Statement II are true

Solution:

- Statement I: The boiling points of the hydrides of Group 16 elements (water H_2O, hydrogen selenide H_2Se, hydrogen telluride H_2Te, and hydrogen sulfide H_2S) follow the order $H_2O > H_2Te > H_2Se > H_2S$. This is true because while molecular mass tends to increase as you go down the group, the boiling point of water is much higher than expected due to hydrogen bonding between water molecules.

- Statement II: On the basis of molecular mass, H_2O should have a lower boiling point compared to the other hydrides in Group 16. However, due to the presence of extensive hydrogen bonding, H_2O has a much higher boiling point than expected compared to H_2S, H_2Se, and H_2Te, where such hydrogen bonding is either absent or much weaker. This is also true.

Thus, both Statement I and Statement II are correct.

Quick Tip

Water has a much higher boiling point than expected due to the presence of extensive hydrogen bonding, which is absent or weaker in other Group 16 hydrides.

57: For the reaction $2A \rightleftharpoons B + C$, $K_C = 4 \times 10^{-3}$. At a given time, the composition of the reaction mixture is:

$$[A] = [B] = [C] = 2 \times 10^{-3}\ \text{M}.$$

Then, which of the following is correct?

(1) Reaction is at equilibrium.

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

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

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

Correct Answer: (3) Reaction has a tendency to go in backward direction.

Solution: For the given reaction $2A \rightleftharpoons B + C$, the equilibrium constant K_C is given as:

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

At equilibrium, the ratio of the concentrations of products and reactants should be equal to K_C. Let's calculate the reaction quotient Q_C using the given concentrations:

$$Q_C = \frac{[B][C]}{[A]^2} = \frac{(2 \times 10^{-3})(2 \times 10^{-3})}{(2 \times 10^{-3})^2} = \frac{4 \times 10^{-6}}{4 \times 10^{-6}} = 1$$

Now, compare Q_C with the equilibrium constant K_C:

Given: $K_C = 4 \times 10^{-3}$

Calculated: $Q_C = 1$

Since $Q_C > K_C$, the system is not at equilibrium and the reaction will proceed in the backward direction to reach equilibrium.

Thus, the reaction has a tendency to go in the backward direction.

Quick Tip

If $Q_C > K_C$, the reaction will shift in the backward direction to reach equilibrium.

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

(1) rate constant at standard temperature

(2) probability of collision

(3) orientation of reactant molecules during collision

(4) rate constant at two different temperatures

Correct Answer: (4) rate constant at two different temperatures

Solution: The activation energy (E_a) of a chemical reaction can be calculated using the Arrhenius equation:

$$k = A \cdot e^{-\frac{E_a}{RT}}$$

Where: - k is the rate constant, - A is the frequency factor, - E_a is the activation energy, - R is the gas constant, and - T is the temperature.

By knowing the rate constant at two different temperatures, the activation energy can be calculated by rearranging the Arrhenius equation:

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

Thus, the correct option is: **(4) rate constant at two different temperatures.**

Quick Tip

To calculate activation energy, you need the rate constant at two different temperatures. Using the Arrhenius equation, the activation energy can be determined.

---

59. Given below are two statements:

Statement I: Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behaviour.

Statement II: $[Co(NH_3)_6]^{3+}$ 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) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (1) Both Statement I and Statement II are true

Solution:

Let's first analyze the two complexes given:

$$[Co(NH_3)_6]^{3+}$$

In this complex, cobalt is in the +3 oxidation state (Co^{3+}). $The electron configuration of Co^{3+} is [Ar]3d^6$. The ligand NH_3 is a strong field ligand and causes pairing of electrons in the $3d$-orbitals. As a result, all the electrons are paired, making the complex diamagnetic.

$$[CoF_6]^{3-}$$

In this complex, cobalt is also in the +3 oxidation state (Co^{3+}). $The electron configuration of Co^{3+} is [Ar]3d^6$. However, F^- is a weak field ligand and does not cause electron pairing. Hence, there are unpaired electrons, and the complex is paramagnetic.

Since both complexes are octahedral in nature but have different magnetic properties (one is diamagnetic and the other is paramagnetic), **Statement I** is true.

Additionally, **Statement II** is also correct, as $[Co(NH_3)_6]^{3+}$ is indeed diamagnetic and $[CoF_6]^{3-}$ is paramagnetic.

Thus, the correct answer is **(1)** Both Statement I and Statement II are true.

Quick Tip

Aniline does not undergo Friedel-Crafts alkylation because the amino group can deactivate the catalyst. Also, it cannot be prepared by Gabriel synthesis due to the reactivity of the amino group.

60: The highest number of helium atoms is in:

(1) 4 mol of helium

(2) 4 u of helium

(3) 4 g of helium

(4) 2.271098 L of helium at STP

Correct Answer: (1) 4 mol of helium.

Solution: The number of atoms is directly related to the amount of substance (in moles) because 1 mole of any substance contains Avogadro's number of atoms, i.e.,

$N_A = 6.022 \times 10^{23}$ atoms.

Option (1): 4 mol of helium.

1 mole of helium contains 6.022×10^{23} helium atoms. So, 4 moles will contain:

$$4 \times 6.022 \times 10^{23} = 2.4088 \times 10^{24} \text{ helium atoms.}$$

This is the highest number of atoms compared to the other options.

Option (2): 4 u of helium.

The atomic mass unit (u) represents a very small mass. 1 u corresponds to the mass of 1 helium atom, which is around 4×10^{-24} g. So, 4 u is equivalent to a very small number of helium atoms, far less than in 4 moles.

Option (3): 4 g of helium.

The molar mass of helium is 4 g/mol, so 4 g of helium corresponds to 1 mole, which is much fewer atoms than in 4 moles of helium.

Option (4): 2.271098 L of helium at STP.

At standard temperature and pressure (STP), 1 mole of gas occupies 22.4 L. 2.271098 L of helium corresponds to less than 1 mole of helium, which is fewer atoms than in 4 moles.

Thus, Option (1) contains the highest number of helium atoms.

Quick Tip

The number of atoms is directly proportional to the number of moles. 4 moles will contain the highest number of helium atoms.

---

61. Arrange the following elements in increasing order of first ionization enthalpy:

Li, Be, B, C, N

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2) Li $<$ B $<$ Be $<$ C $<$ N

Solution: Ionization enthalpy generally increases across a period from left to right and decreases down a group. However, there are some exceptions due to electronic configurations.

Li (Lithium) has the lowest ionization enthalpy among the elements listed, as it is in Group 1 and has a single electron in its outermost shell.

B (Boron) has a lower ionization enthalpy than **Be (Beryllium)** because the removal of the first electron from Boron leads to a stable half-filled p-orbital configuration. Hence, **B** has a lower ionization enthalpy than **Be**.

Be (Beryllium) has a higher ionization enthalpy than Boron because it has a stable electron configuration with a full s-orbital.

C (Carbon) has a higher ionization enthalpy than Beryllium as the electron removal from Carbon involves the more stable p-orbital configuration.

N (Nitrogen) has the highest ionization enthalpy among the given elements because it has a half-filled p-orbital, which is a stable configuration, making it difficult to remove an electron.

Thus, the correct order of first ionization enthalpy is:**Li $<$ B $<$ Be $<$ C $<$ N**

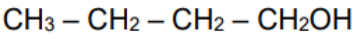
Quick Tip

Ionization enthalpy increases across a period but there are exceptions due to electronic configurations, such as between Beryllium (Be) and Boron (B), where B has a lower ionization enthalpy due to half-filled p-orbital stability.

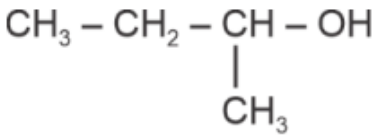
---

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

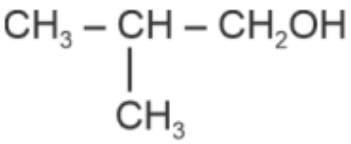
A.



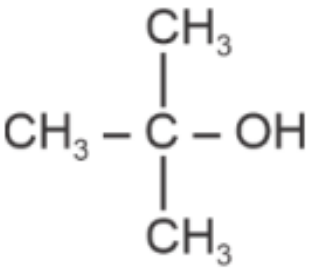
B.



C.



D.



Correct Answer: D

Solution: The Lucas reagent, a solution of zinc chloride in concentrated hydrochloric acid, is used to classify alcohols of low molecular weight based on their reactivity. Tertiary alcohols

react instantaneously, secondary alcohols react within five to twenty minutes, and primary alcohols react very slowly, if at all.

Given the structure of the compounds, D, being a tertiary alcohol, reacts instantaneously with Lucas reagent, indicating it is the correct answer.

Quick Tip

Remember, tertiary alcohols react the fastest with Lucas reagent due to their structure, which allows the formation of a carbocation more readily than secondary or primary alcohols.

---

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

A. Ti^{3+}

B. Cr^{2+}

C. Mn^{2+}

D. Fe^{2+}

E. Sc^{3+}

Choose the most appropriate answer from the options given below.

(1) B and D only

(2) A and E only

(3) B and C only

(4) A and D only

Correct Answer: (1) B and D only

Solution: The magnetic moment of a transition metal ion is given by the formula:

$$\mu_{\text{eff}} = \sqrt{n(n+2)}\,\mu_B$$

where n is the number of unpaired electrons and μ_B is the Bohr magneton.

Now, let's calculate the number of unpaired electrons for each ion:

Ti^{3+}: Ti has an atomic number 22. For Ti^{3+}, the electron configuration is $[Ar]3d^1$, so it has 1 unpaired electron.

Cr^{2+}: Cr has an atomic number 24. For Cr^{2+}, the electron configuration is $[Ar]3d^4$, so it has 4 unpaired electrons.

Mn^{2+}: Mn has an atomic number 25. For Mn^{2+}, the electron configuration is $[Ar]3d^5$, so it has 5 unpaired electrons.

Fe^{2+}: Fe has an atomic number 26. For Fe^{2+}, the electron configuration is $[Ar]3d^6$, so it has 4 unpaired electrons.

Sc^{3+}: Sc has an atomic number 21. For Sc^{3+}, the electron configuration is $[Ar]$, so it has no unpaired electrons.

Now calculating the magnetic moments:

Ti^{3+}: 1 unpaired electron, so the magnetic moment is $\mu_{\text{eff}} = \sqrt{1(1+2)} = \sqrt{3}\,\mu_B$.

Cr^{2+}: 4 unpaired electrons, so the magnetic moment is $\mu_{\text{eff}} = \sqrt{4(4+2)} = \sqrt{24}\,\mu_B$.

Mn^{2+}: 5 unpaired electrons, so the magnetic moment is $\mu_{\text{eff}} = \sqrt{5(5+2)} = \sqrt{35}\,\mu_B$.

Fe^{2+}: 4 unpaired electrons, so the magnetic moment is $\mu_{\text{eff}} = \sqrt{4(4+2)} = \sqrt{24}\,\mu_B$.

Sc^{3+}: No unpaired electrons, so the magnetic moment is 0.

From the above calculations, we see that the magnetic moments of Cr^{2+} and Fe^{2+} are the same.

Thus, the ions that have the same magnetic moment are Cr^{2+} and Fe^{2+}.

Quick Tip

For transition metal ions, the number of unpaired electrons determines the magnetic moment. The higher the number of unpaired electrons, the higher the magnetic moment.

---

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

A. Tollen's reagent

B. Schiff's reagent

C. HCN

D. NH_2OH

E. $NaHSO_3$

Choose the correct options from the given below:

(1) B and C

(2) A and D

(3) B and E

(4) E and D

Correct Answer: (3) B and E

Solution: A. Tollen's reagent: Glucose reacts with Tollen's reagent (ammoniacal silver nitrate) to form a silver mirror. This reaction is positive for aldehydes, and glucose, being an aldose, reacts with it.

B. Schiff's reagent: Schiff's reagent is used to test for aldehydes. Glucose, being an aldose, reacts with Schiff's reagent to give a pink color. Therefore, glucose reacts with Schiff's reagent.

C. HCN: Glucose does not readily react with hydrogen cyanide (HCN). Therefore, glucose does not react with HCN under normal conditions.

D. NH_2OH (Hydroxylamine): Hydroxylamine reacts with aldehydes to form oximes. Glucose, being an aldose, reacts with hydroxylamine to form a corresponding oxime.

E. $NaHSO_3$ (Sodium bisulfite): Sodium bisulfite reacts with aldehydes to form an adduct. Glucose, being an aldose, does not react with sodium bisulfite under normal conditions.

Thus, glucose does not react with **Schiff's reagent (B)** and **$NaHSO_3$ (E)**.

Quick Tip

Glucose, being an aldose, reacts with Tollen's reagent, Schiff's reagent, hydroxylamine, and sodium bisulfite under typical conditions. However, it does not react with HCN under normal conditions.

---

65. 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) Both statement I and Statement II are true

(2) Both statement I and Statement II are false

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

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

Correct Answer: (1) Both statement I and Statement II are true

Solution:

Statement I: Aniline ($C_6H_5NH_2$) does not undergo Friedel-Crafts alkylation reaction because the amino group ($-NH_2$) is an electron-donating group, which increases the electron density on the benzene ring. This makes the ring more reactive, but at the same time, the amino group can coordinate with the $AlCl_3$ catalyst used in Friedel-Crafts reactions, deactivating it and preventing the reaction from occurring. Therefore, this statement is correct.

Statement II: Aniline cannot be prepared through Gabriel synthesis. Gabriel synthesis is used for the preparation of primary amines by alkylation of phthalimide. However, due to the nucleophilic nature of the amino group in aniline, it will react with the electrophilic intermediate of Gabriel synthesis (such as the alkylating agent) and prevent the reaction from going to completion. Therefore, this statement is also true.

Thus, the correct answer is:**(1) Both statement I and Statement II are true.**

Quick Tip

Aniline does not undergo Friedel-Crafts alkylation because the amino group can deactivate the catalyst. Also, it cannot be prepared by Gabriel synthesis due to the reactivity of the amino group.

---

66. 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) $-x$

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

(3) $-4x$

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

Correct Answer: (1) $-x$

Solution: The energy of an electron in the n-th orbit of a hydrogen-like atom (such as He^+ and Be^{3+}) is given by the formula:

$$E_n = -\frac{Z^2 \cdot k \cdot e^2}{2r_n}$$

Where: - Z is the atomic number of the ion, - k is Coulomb's constant, - e is the charge of the electron, - r_n is the radius of the electron's orbit in the n-th state.

The energy in terms of quantum number n for a hydrogen-like ion is:

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

Where $13.6\,\text{eV}$ is the Rydberg energy for hydrogen.

For the He^+ ion ($Z = 2$), the energy in the ground state ($n = 1$) is:

$$E_1 = -\frac{13.6 \cdot 2^2}{1^2} = -54.4\,\text{eV}$$

Given that this energy is $-x$, we have:

$$x = 54.4\,\text{eV}$$

For the Be^{3+} ion ($Z = 4$), we need to find the energy for $n = 2$. Using the same formula for the energy of an electron in the n-th orbit:

$$E_2 = -\frac{13.6 \cdot 4^2}{2^2}$$
$$E_2 = -\frac{13.6 \cdot 16}{4} = -54.4\,\text{eV}$$

Thus, the energy for the $n = 2$ state for Be^{3+} ion is the same as for the $n = 1$ state of He^+ ion, which is $-x$.

Hence, the correct answer is **(1)** $-x$.

Quick Tip

The energy levels in hydrogen-like ions depend on the atomic number Z and the principal quantum number n. The energy becomes more negative as Z increases or n decreases.

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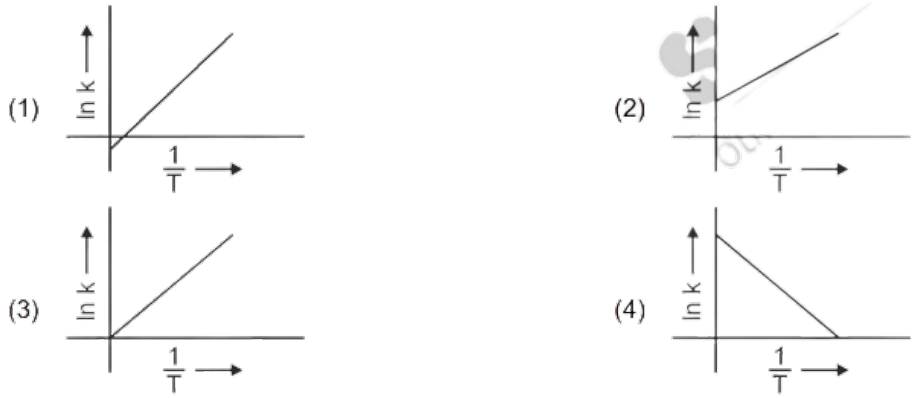
67. Which plot of $\ln k$ vs $\frac{1}{T}$ is consistent with the Arrhenius equation?



Correct Answer: (4)

Solution:

The Arrhenius equation is given by:

$$k = A \exp\left(-\frac{E_a}{RT}\right)$$

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.

Taking the natural logarithm of both sides of the Arrhenius equation:

$$\ln k = \ln A - \frac{E_a}{R} \cdot \frac{1}{T}$$

This equation represents a straight line of the form $y = mx + c$, where: - $y = \ln k$, - $x = \frac{1}{T}$, - $m = -\frac{E_a}{R}$ (the slope), - $c = \ln A$ (the intercept).

Thus, the graph of $\ln k$ versus $\frac{1}{T}$ will be a straight line with a negative slope. This matches with option (4), which shows a straight line with a negative slope.

Hence, the correct answer is **(4)**.

---

68. 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.

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

(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but Statement II is incorrect
(4) Statement I is incorrect but Statement II is correct

Correct Answer: (1) Both Statement I and Statement II are correct

Solution:
Statement I: The boiling points of isomeric pentanes follow the order n-pentane > isopentane > neopentane. This is correct because, in general, as the number of branches increases in an isomeric series, the surface area decreases, leading to weaker van der Waals forces between molecules. The weaker intermolecular forces result in a lower boiling point for more branched isomers.
- n-pentane (unbranched) has the highest surface area, leading to stronger intermolecular forces and a higher boiling point.
- Isopentane (with one branch) has a lower boiling point than n-pentane.
- Neopentane (with two branches) has the lowest boiling point due to the compact, spherical shape, which minimizes surface area and intermolecular forces.
- Statement II: This statement explains the reasoning behind the trend observed in Statement I. As branching increases, the molecule becomes more spherical, leading to a smaller surface area and weaker intermolecular forces. This results in a lower boiling point for more branched isomers. This explanation is also correct.
Thus, both statements are accurate, and the correct answer is (1) Both Statement I and Statement II are correct.

Quick Tip

In organic compounds, branching reduces the surface area for intermolecular interactions, which leads to weaker van der Waals forces and lower boiling points for more branched isomers.

---

69. 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 the change of:

(1) d^5 to d^4 configuration

(2) d^5 to d^2 configuration

(3) d^4 to d^5 configuration

(4) d^3 to d^2 configuration

Answer: (3) d^4 to d^5 configuration

Solution:

The standard electrode potential (E°) is affected by the electronic configuration of the ion. The E° value is generally more positive when the configuration of the ion is more stable. For Mn^3+/Mn^2+ couple: - Mn^3+ has a d^4 configuration (since Mn has an atomic number of 25, and Mn^3+ has lost three electrons, leaving a d^4 configuration). - Mn^2+ has a d^5 configuration.

The Mn^2+ ion has a stable d^5 configuration, which is half-filled and thus more stable. When Mn^3+ accepts an electron to become Mn^2+, the electron configuration changes from d^4 to d^5, making the Mn^2+ ion more stable and the E° value more positive.

This is in contrast to the other metal couples like Cr^3+/Cr^2+ and Fe^3+/Fe^2+, where the changes in electronic configurations do not lead to such a stable half-filled d^5 configuration.

Hence, the correct answer is **(3)** d^4 to d^5 configuration.

Quick Tip

In transition metal complexes, the stability of the ion and the value of the electrode potential are often related to the stability of its electronic configuration. Half-filled (d^5) and fully-filled (d^{10}) configurations are particularly stable, which is why $Mn^{2}+$ with a d^5 configuration is more stable than $Mn^{3}+$ with a d^4 configuration.

---

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

A. A liquid evaporates to vapour.

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

C. $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$

D. $Cl_2(g) \rightarrow 2Cl(g)$

Choose the correct answer from the options given below:

(1) A and C

(2) A, B and D

(3) A, C and D

(4) C and D

Correct Answer: (3) A, C, and D

Solution:

Entropy (ΔS) is a measure of the disorder or randomness of a system. Entropy tends to increase when a system moves from a more ordered state to a more disordered state.

A. A liquid evaporates to vapour: The transition from a liquid to a gas increases the molecular disorder, leading to an increase in entropy.

B. The temperature of a crystalline solid is lowered from 130 K to 0 K: Lowering the temperature reduces the molecular motion, leading to a decrease in entropy.

C. $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$: This reaction produces gaseous products from solids, which increases disorder and entropy.

D. $Cl_2(g) \rightarrow 2Cl(g)$: The dissociation of Cl_2 into two atoms increases the disorder of the system, thereby increasing entropy.

Thus, the correct option is: **(3) A, C, and D.**

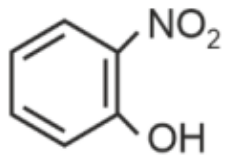
Quick Tip

Processes that involve the formation of gases or increased molecular disorder generally result in an increase in entropy.

---

71. Intramolecular hydrogen bonding is present in:

1.



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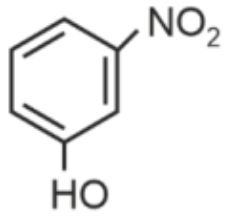

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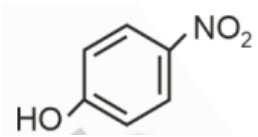


(4) HF

Correct Answer: (1) A

Solution: Intramolecular hydrogen bonding occurs when a hydrogen atom attached to a more electronegative atom (such as oxygen or nitrogen) forms a bond with a lone pair on an electronegative atom within the same molecule.
Compound A contains a structure where the necessary conditions for intramolecular hydrogen bonding are met, making it the correct answer.

Quick Tip

Intramolecular hydrogen bonding is common in molecules where the donor and acceptor atoms are in close proximity within the same molecule, often forming ring-like structures.

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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (1) Si < C < N < O < F

Solution: Electronegativity increases as we move across a period from left to right and decreases as we move down a group in the periodic table.

Silicon (Si) is in group 14 and period 3, and has the lowest electronegativity among the elements listed.

Carbon (C) is in the same group as Si but is one period higher, so its electronegativity is slightly higher than Si.

Nitrogen (N) is in group 15, period 2, and its electronegativity is higher than both Si and C.

Oxygen (O) is in group 16, period 2, and has a higher electronegativity than nitrogen.

Fluorine (F) is in group 17, period 2, and has the highest electronegativity of all the elements in this list.

Thus, the correct order of electronegativity is:(1) Si < C < N < O < F .

Quick Tip

Electronegativity increases across a period from left to right and decreases as we move down a group in the periodic table.

---

73. Which reaction is NOT a redox reaction?

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

(2) $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$

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

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

Correct Answer: (4) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Solution: A redox reaction involves the transfer of electrons, where one substance is oxidized (loses electrons) and another is reduced (gains electrons).

(1) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$: This is a redox reaction because zinc (Zn) is oxidized to Zn^{2+} and copper (Cu^{2+}) is reduced to Cu.

(2) $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$: This is also a redox reaction because chlorine (Cl) is reduced and iodine (I) is oxidized.

(3) $H_2 + Cl_2 \rightarrow 2HCl$: This is a redox reaction because hydrogen (H) is oxidized and chlorine (Cl) is reduced.

(4) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$: This is a double displacement reaction, but no change in oxidation states occurs. Hence, it is **NOT** a redox reaction.

Therefore, the correct answer is (4), as it is a non-redox reaction.

Quick Tip

A redox reaction involves the transfer of electrons, where one substance is oxidized (loses electrons) and another is reduced (gains electrons).

---

74. Match List I with List II:

List I	List II
A. 1 mol of H_2O to O_2	I. 3F
B. 1 mol of $4MnO_4^-$ to Mn^{2+}	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

Choose the correct answer from the options given below:

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

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

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

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

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

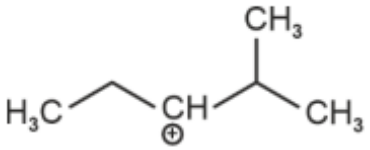
Solution: A. 1 mol of H_2O to O_2: The electrolysis of water requires 3 Faradays per mole of oxygen produced, hence 3F.
B. 1 mol of $4MnO_4^-$ to Mn^{2+}: Reduction of permanganate to Mn^{2+} requires 5 electrons, so 5F is required.
C. 1.5 mol of Ca from molten $CaCl_2$: Calcium extraction from molten calcium chloride requires 2 Faradays per mole of calcium, so 3F is required for 1.5 moles of calcium.
D. 1 mol of FeO to Fe_2O_3: This oxidation requires 3 Faradays of charge for each mole of iron.

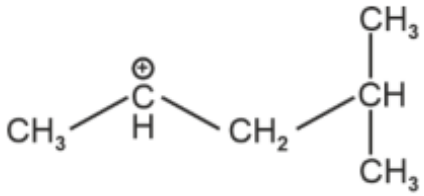
Quick Tip

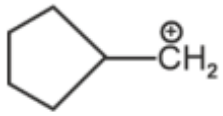
The amount of electric charge required to reduce or oxidize a substance is related to the number of moles of electrons transferred in the reaction. This is expressed in Faradays.

---

75. The most stable carbocation among the following is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: D

Solution:

A: Carbocation A is less stable due to lack of resonance and fewer alkyl groups stabilizing the positive charge.

B: Carbocation B is the most stable due to the presence of resonance structures that can delocalize the positive charge effectively.

C: Carbocation C, while having some stabilizing alkyl groups, lacks the extensive resonance stabilization seen in B.

D: Carbocation D is also less stable than B because it has fewer stabilizing alkyl groups and no resonance.

Quick Tip

Stability of carbocations increases with the presence of electron-donating alkyl groups and resonance stabilization. More substituted carbocations are generally more stable due to hyperconjugation and resonance.

---

76. Match List I with List II:

List I (Molecule)		List II (Number and types of bond/s 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Let's analyze the molecules and the types of bonds between the carbon atoms:

1. Ethane (C_2H_6): Ethane consists of two carbon atoms connected by a single bond. This is a simple single σ-bond between the two carbon atoms, so the correct option is III.

2. Ethene (C_2H_4): Ethene has a double bond between the carbon atoms, which consists of one σ-bond and one π-bond. Therefore, the correct option is IV.

3. Carbon molecule, C_2: This molecule consists of a triple bond between two carbon atoms. A triple bond consists of one σ-bond and two π-bonds. Thus, the correct option is II.

4. Ethyne (C_2H_2): Ethyne (acetylene) also has a triple bond between the two carbon atoms. This triple bond consists of one σ-bond and two π-bonds, so the correct option is I.

Thus, the correct matching is: - A-III (Ethane has one σ-bond), - B-IV (Ethene has one σ-bond and one π-bond), - C-II (C_2 molecule has two π-bonds), - D-I (Ethyne has one σ-bond and two π-bonds).

Therefore, the correct answer is (3) A-III, B-IV, C-II, D-I.

Quick Tip: - Single bonds between two carbon atoms are σ-bonds. - Double bonds consist of one σ-bond and one π-bond. - Triple bonds consist of one σ-bond and two π-bonds.

Quick Tip

Ethene and ethyne have multiple bonds where σ-bonds are formed first, and subsequent π-bonds are formed in the side-by-side overlap of orbitals.

---

77. Among Group 16 elements, which one does NOT show –2 oxidation state?

(1) O

(2) Se

(3) Te

(4) Po

Correct Answer: (4) Po

Solution: Among the Group 16 elements (O, S, Se, Te, Po), oxygen (O) generally shows a –2 oxidation state. Other elements such as sulfur (S), selenium (Se), tellurium (Te), and polonium (Po) can also show a –2 oxidation state in compounds. However, polonium (Po) is a heavier element and typically shows positive oxidation states (+2, +4), especially in its compounds, due to its metallic character and the inability to effectively accommodate a –2 oxidation state in many of its compounds.
Thus, polonium (Po) is the only element in Group 16 that does not typically show a –2 oxidation state.

Quick Tip

Polonium (Po), being a heavier element in Group 16, tends to show positive oxidation states rather than the typical –2 oxidation state seen in lighter elements like oxygen (O).

---

78. The Henry's law constant (K_H) 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) B $>$ A $>$ C

(2) B $>$ C $>$ A

(3) A > C > B

(4) A > B > C

Correct Answer: (2) B > C > A

Solution: Henry's law states that the solubility of a gas in a liquid is inversely proportional to the Henry's law constant (K_H). Mathematically, this is given by:

$$S = \frac{P}{K_H}$$

Where: S is the solubility of the gas, P is the partial pressure of the gas, and K_H is the Henry's law constant.

A lower value of K_H indicates greater solubility in water. Therefore, to compare the solubilities of the gases A, B, and C, we should look at the relative sizes of K_H:

Gas A has a K_H value of 145 kbar.

Gas B has a K_H value of 2×10^{-5} kbar.

Gas C has a K_H value of 35 kbar.

The solubility order is inversely related to K_H, so:

$$\text{Solubility order:} \quad B > C > A$$

Thus, the solubility of the gases in water follows the order B > C > A.

Quick Tip

According to Henry's law, a lower Henry's law constant (K_H) means higher solubility of the gas in the liquid. Thus, gases with smaller K_H values are more soluble.

---

79. Fehling's solution 'A' is:

(1) aqueous copper sulphate

(2) alkaline copper sulphate

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

(4) aqueous sodium citrate

Correct Answer: (1) aqueous copper sulphate

Solution: Fehling's solution is a reagent used to test for the presence of reducing sugars. It consists of two solutions, commonly known as Fehling's solution A and Fehling's solution B.
Fehling's solution A contains aqueous copper sulphate .
Fehling's solution B contains alkaline solution of sodium potassium tartrate (also called Rochelle's salt).
When mixed together and heated with a reducing sugar, the copper(II) ions in the solution are reduced to copper(I) oxide, which forms a red precipitate.
Thus, Fehling's solution A is aqueous copper sulphate.

Quick Tip

Fehling's solution A contains aqueous copper sulphate, and Fehling's solution B contains an alkaline solution of sodium potassium tartrate (Rochelle's salt).

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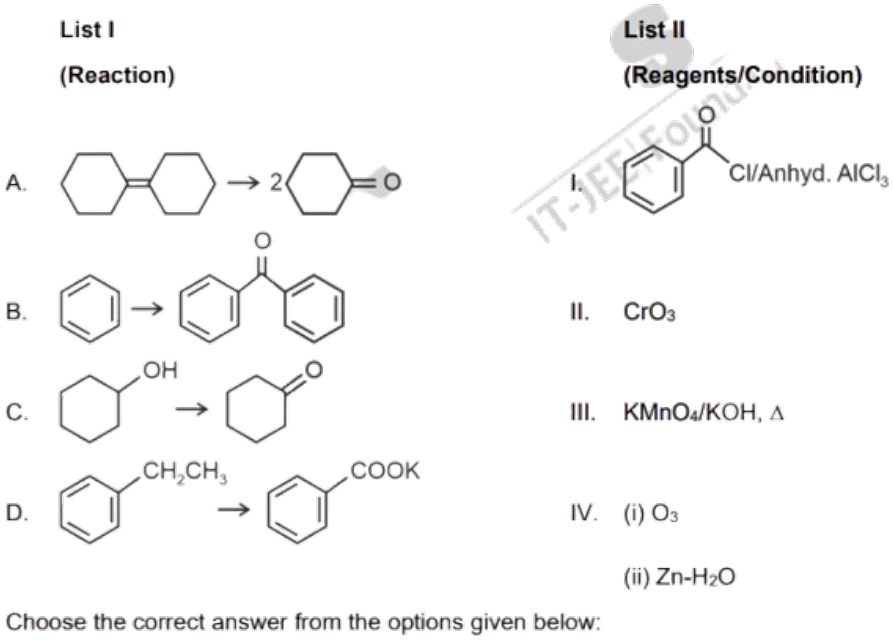
80. Match List I with List II.



Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Let's analyze the reactions and corresponding reagents/conditions:

1. A. Cyclohexene $\rightarrow$ 2 O: - The reaction of cyclohexene with ozone (O_3) followed by reduction with Zn-H_2O typically leads to the cleavage of the double bond and formation of two oxygen-containing products. This reaction corresponds to IV (O_3 and Zn-H_2O).

2. B. Benzene $\rightarrow$ Phenol: - The conversion of benzene to phenol involves oxidation with chromium trioxide (CrO_3) in acidic conditions, which is known as the Jones oxidation. This reaction corresponds to II (CrO_3).

3. C. Benzyl alcohol $\rightarrow$ Benzoic acid: - Benzyl alcohol can be oxidized to benzoic acid using potassium permanganate ($KMnO_4$) in a basic medium (KOH) under heating conditions. This corresponds to III ($KMnO_4$/KOH, Δ).

4. D. Toluene $\rightarrow$ Benzophenone: - Toluene undergoes oxidation under the action of ozone (O_3) to form benzophenone. This corresponds to I (Cl/Anhyd. $AlCl_3$).

Hence, the correct matching is: - A-IV (Cyclohexene reacts with O_3 and Zn-H_2O), - B-I (Benzene to phenol with CrO_3), - C-II (Benzyl alcohol to benzoic acid with $KMnO_4$/KOH), - D-III (Toluene to benzophenone with O_3).

Thus, the correct answer is (3) A-IV, B-I, C-II, D-III.

Quick Tip

- Remember the key reagents for common organic reactions: - CrO_3 is used for oxidation of alcohols to carbonyl compounds (e.g., phenol from benzene). - $KMnO_4$ is used for oxidation of alcohols or side chains to carboxylic acids (e.g., benzyl alcohol to benzoic acid). - Ozone (O_3) is used for cleavage of carbon-carbon double bonds (e.g., cyclohexene) or oxidation of toluene to benzophenone.

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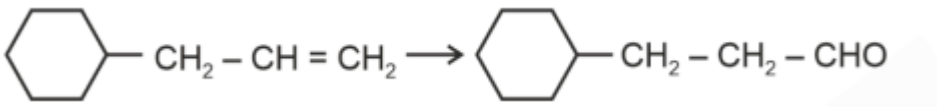
81. Identify the correct reagents that would bring about the following transformation.



(1) (i) H_2O/H^+
(ii) CrO_3

(2) (i) BH_3
(ii) $H_2O_2 / \overset{\ominus}{O}H$
(iii) PCC

(3) (i) BH_3
(ii) $H_2O_2 / \overset{\ominus}{O}H$
(iii) alk.$KMnO_4$
(iv) $H_3O^{\oplus}$

(4) (i) H_2O/H^+
(ii) PCC

Correct Answer: (2)

Solution:

The given transformation involves the hydration of an alkene (propene) to form a carbonyl group (an aldehyde group).

1. Step 1: Hydroboration (i) BH_3: - The first step in the transformation is hydroboration of the alkene (propene). In this reaction, BH_3 (borane) reacts with the double bond, adding a hydroxyl group ($-OH$) and a hydrogen atom across the double bond. This forms an organoborane intermediate. This reaction is anti-Markovnikov, meaning the hydroxyl group will be added to the less substituted carbon.

2. Step 2: Oxidation (ii) H_2O_2/OH^-: - The second step involves the oxidation of the organoborane intermediate. The reaction of the organoborane with hydrogen peroxide (H_2O_2) and hydroxide ion (OH^-) replaces the boron group with a hydroxyl group, forming an alcohol.

3. Step 3: Oxidation to Aldehyde (iii) PCC: - The final step is the oxidation of the alcohol formed in the second step to an aldehyde using Pyridinium Chlorochromate (PCC). PCC is a mild oxidant that selectively oxidizes primary alcohols to aldehydes without further oxidation to carboxylic acids.

Thus, the correct reagents for the transformation are: - BH_3 for hydroboration, - H_2O_2/OH^-

for oxidation to alcohol, - PCC for oxidation of the alcohol to an aldehyde.

Hence, the correct answer is (2).

Quick Tip

Hydroboration-oxidation is a two-step process where BH_3 adds across a double bond, followed by oxidation to form an alcohol.

---

82. 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

Choose the correct answer from the options given below :

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

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

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

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

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

Solution:

A. m_l refers to the magnetic quantum number, which gives the orientation of the orbital. Hence, m_l is associated with III. Orientation of orbital.

B. m_s refers to the spin quantum number, which gives the orientation of the spin of the electron. Hence, m_s is associated with IV. Orientation of spin of electron.

C. l refers to the azimuthal quantum number, which determines the shape of the orbital. Hence, l is associated with I. Shape of orbital.

D. n refers to the principal quantum number, which determines the size of the orbital. Hence, n is associated with II. Size of orbital.

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

Quick Tip

The quantum numbers n, l, m_l, and m_s describe different properties of orbitals and electrons:

n (principal quantum number) determines the size of the orbital,

l (azimuthal quantum number) determines the shape of the orbital,

m_l (magnetic quantum number) determines the orientation of the orbital,

m_s (spin quantum number) determines the orientation of the spin of the electron.

---

83. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

A. NH_3: Ammonia has a trigonal pyramidal structure, so it corresponds to I. Trigonal Pyramidal.

B. BrF_5: Bromine pentafluoride has a square pyramidal structure, so it corresponds to IV. Square Pyramidal.

C. XeF_4: Xenon tetrafluoride has a square planar structure, so it corresponds to II. Square Planar.

D. SF_6: Sulfur hexafluoride has an octahedral structure, so it corresponds to III. Octahedral.

Quick Tip

Molecular geometry is determined by the VSEPR theory, which explains the arrangement of atoms around a central atom based on electron pair repulsion.

---

84. 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) 750 mg

(2) 250 mg

(3) Zero mg

(4) 200 mg

Correct Answer: (2) 250 mg

Solution: First, we calculate the moles of HCl:

$$\text{Moles of HCl} = Molarity \times Volume = 0.75\,\text{M} \times 0.025\,\text{L} = 0.01875\,\text{mol}$$

Next, we calculate the moles of NaOH. The balanced equation for the reaction between NaOH and HCl is:

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

This shows that 1 mole of NaOH reacts with 1 mole of HCl. Therefore, the moles of NaOH that react will be equal to the moles of HCl, i.e., 0.01875 moles of NaOH will react.

Now, we calculate the mass of NaOH that reacted:

$$\text{Mass of NaOH that reacted} = \text{moles of NaOH} \times \text{molar mass of NaOH} = 0.01875 \times 40 = 0.75\,\text{g}$$

The initial mass of NaOH is 1 gram, so the mass of NaOH left unreacted is:

$$\text{Mass of NaOH left} = 1\,\text{g} - 0.75\,\text{g} = 0.25\,\text{g} = 250\,\text{mg}$$

Thus, the mass of sodium hydroxide left unreacted is $\mathbf{250}$ mg.

Quick Tip

To find the amount of a substance left unreacted in a neutralization reaction, first calculate the moles of both reactants and determine the limiting reagent.

---

85. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: In this problem, we match the given complexes with their types of isomerism:

A. $[Co(NH_3)_5(NO_2)]Cl_2$: This is an example of Linkage isomerism because the nitrite ion (NO_2^-) can coordinate through either the nitrogen or the oxygen atom. Therefore, it corresponds to II.

B. $[Co(NH_3)_5(SO_4)]Br$: This is an example of Ionization isomerism because the complex can ionize to form different ionic species, as the sulfate ion can coordinate in different ways to the cobalt. Therefore, it corresponds to III.

C. $[Co(NH_3)_6][Cr(CN)_6]$: This is an example of Coordination isomerism because it involves two different metal centers, cobalt and chromium, where the ligands can switch between them.

Therefore, it corresponds to IV.

D. $[Co(H_2O)_6]Cl_3$: This complex can show Solvate isomerism, where the solvent molecules (in this case, water) can be part of the coordination sphere or outside it, leading to different isomers. Therefore, it corresponds to I.

Quick Tip

Linkage isomerism occurs when a ligand can coordinate through two different atoms, while ionization isomerism results from different ionic forms of the same complex. Solvate isomerism occurs when solvent molecules are part of the coordination sphere or not.

Section B

86. 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 hydrochloric acid

(2) concentrated sulphuric acid

(3) dilute nitric acid

(4) dilute sulphuric acid

Correct Answer: (4) dilute sulphuric acid

Solution: Mohr's salt (Ferrous ammonium sulphate) is prepared by dissolving ferrous sulphate in a solution of ammonium sulphate, and the presence of dilute sulphuric acid prevents the hydrolysis of Fe^{2+} ions. The Fe^{2+} ion is susceptible to oxidation and hydrolysis in the presence of water and oxygen, but the dilute sulphuric acid lowers the pH of the solution, preventing this process.

Quick Tip

Dilute sulphuric acid helps to prevent the oxidation and hydrolysis of $Fe^{2}+$ ions, maintaining their stability.

87. 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) B, A, D, C, E

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

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

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

Correct Answer: (1) B, A, D, C, E

Solution:

A. Al^{3+}: Group III, since aluminum is in group III of the periodic table.

B. Cu^{2+}: Group II, copper is in group II.

C. Ba^{2+}: Group II, since barium is in group II.

D. Co^{2+}: Group VIII, cobalt belongs to the transition metals in group VIII.

E. Mg^{2+}: Group II, magnesium is in group II.

Quick Tip

In inorganic qualitative analysis, ions are identified and grouped based on their solubility, precipitation reactions, and their group number in the periodic table.

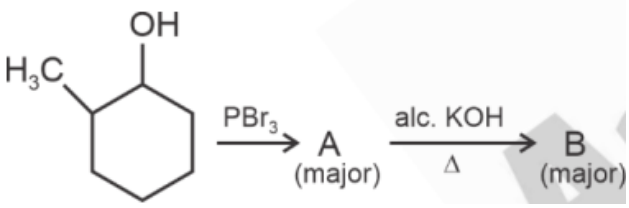
---

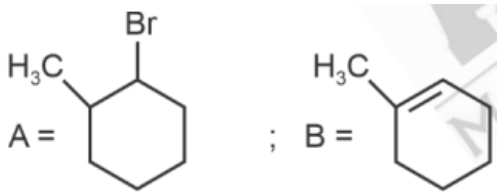
88. Major products A and B formed in the following reaction sequence, are:

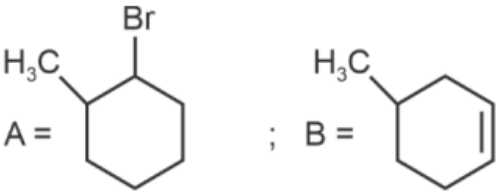
(1)

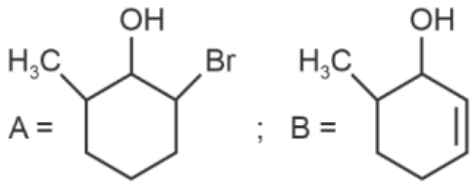
(2)

(3)









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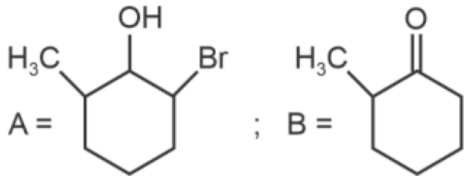


Correct Answer: (1)

Solution: The compound ”P” formed in the reaction corresponds to the second compound produced based on the chemical reaction and the compounds involved.

The image above depicts the reaction mechanism where reactant A is converted into product C, with compound ”P” being the intermediate or final product based on the reaction pathway.

Quick Tip

In reaction mechanism questions, visualizing the process with a diagram or flow chart helps in identifying the key intermediates and products formed during the reaction.

89. The pair of lanthanoid ions which are diamagnetic is

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

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

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

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

Correct Answer: (1) Ce^{4+} and Yb^{2+}

Solution: Diamagnetic ions are those that have all of their electrons paired. This means that there are no unpaired electrons in the ion's electron configuration.

Ce^{4+}: The electron configuration of Ce is $[Xe]4f^15d^16s^2$. For Ce^{4+}, 4 electrons are removed, leaving the electron configuration as $[Xe]4f^05d^06s^0$, which has no unpaired electrons, making it diamagnetic.

Yb^{2+}: The electron configuration of Yb is $[Xe]4f^{14}6s^2$. For Yb^{2+}, 2 electrons are removed, leaving the configuration as $[Xe]4f^{14}6s^0$, which also has no unpaired electrons, making it diamagnetic.

Thus, both Ce^{4+} and Yb^{2+} are diamagnetic.

Therefore, the correct answer is: (1) Ce^{4+} and Yb^{2+}.

Quick Tip

Lanthanoid ions are diamagnetic when they have no unpaired electrons, which occurs when they achieve a stable electron configuration, usually with fully filled f-orbitals.

---

90. Identify the correct answer.

(1) Three resonance structures can be drawn for ozone

(2) BF_3 has non-zero dipole moment

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

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

Correct Answer: (4) Three canonical forms can be drawn for CO_3^{2-} ion

Solution: Let's go through each option:

1. Three resonance structures can be drawn for ozone (O_3): - This statement is correct. Ozone has three resonance structures in which the bonding and charge distribution are delocalized over the three oxygen atoms.

2. BF_3 has non-zero dipole moment: - This statement is incorrect. BF_3 is a trigonal planar molecule and has symmetry such that the dipole moments of the B–F bonds cancel each other out, resulting in a zero dipole moment.

3. Dipole moment of NF_3 is greater than that of NH_3: - This statement is incorrect. In NF_3, the electronegativity difference between nitrogen and fluorine is greater, but the molecule's geometry results in a smaller dipole moment compared to NH_3, where the lone pair on nitrogen and the hydrogen atoms contribute to a larger dipole moment.

4. Three canonical forms can be drawn for CO_3^{2-} ion: - This statement is correct. The carbonate ion (CO_3^{2-}) has three resonance structures, each of which shows the delocalization of the negative charge over the three oxygen atoms.

Thus, the correct answer is: (4) Three canonical forms can be drawn for CO_3^{2-} ion.

Quick Tip

Resonance structures represent the delocalization of electrons within a molecule. In cases like CO_3^{2-}, resonance helps in spreading out the charge and stabilizing the ion.

---

91. A compound X contains 32% of A, 20% of B, and the remaining percentage of C. Then, the empirical formula of X is:

(1) A_2BC_2

(2) ABC_3

(3) AB_2C_2

(4) ABC_4

Correct Answer: (2) ABC_3

Solution: To find the empirical formula, we first assume a 100 g sample of compound X. Then, the masses of A, B, and C in this 100 g sample are:

Mass of A = 32 g,

Mass of B = 20 g,

Mass of C = 100 - (32 + 20) = 48 g.

Next, we convert these masses to moles using the given atomic masses:

Moles of A = $\frac{32}{64} = 0.5$ mol,

Moles of B = $\frac{20}{40} = 0.5$ mol,

Moles of C = $\frac{48}{32} = 1.5$ mol.

Now, we divide each by the smallest number of moles (which is 0.5 mol):

A: $\frac{0.5}{0.5} = 1$,

B: $\frac{0.5}{0.5} = 1$,

C: $\frac{1.5}{0.5} = 3$.

Thus, the ratio of A : B : C is 1 : 1 : 3. Therefore, the empirical formula is ABC_3.

Thus, the correct answer is: $(2)\ ABC_3$.

Quick Tip

The empirical formula represents the simplest whole-number ratio of elements in a compound. To determine it, convert the mass percentages of elements into moles and then divide by the smallest number of moles.

---

92. 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^{-1} mol^{-1})

(1) 0 calorie

(2) -413.14 calories

(3) 413.14 calories

(4) 100 calories

Correct Answer: (2) -413.14 calories

Solution:

For an isothermal reversible expansion, the work done (W) is given by the formula:

$$W = -nRT \ln \frac{P_2}{P_1}$$

Where:

n = number of moles = 1

R = gas constant = 2.0 cal K^{-1} mol^{-1}

T = temperature = 25°C = 298 K

P_1 = initial pressure = 20 atm

P_2 = final pressure = 10 atm

Substitute the values:

$$W = 1 \times 2.0 \times 298 \times \ln \frac{10}{20}$$

$$W = 2.0 \times 298 \times \ln 0.5$$

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

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

Thus, the work done is -413.14 calories.

Quick Tip

In an isothermal expansion, the work done depends on the change in pressure, and a decrease in pressure leads to negative work.

---

93. 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) 3.15 g

(2) 0.315 g

(3) 31.5 g

(4) 0.0315 g

Correct Answer: (2) 0.315 g

Solution: The amount of copper deposited during electrolysis is given by the formula:

$$m = \frac{MIt}{nF}$$

Where:

m = mass of copper deposited

M = molar mass of copper = 63 g/mol

I = current = 9.6487 A

t = time = 100 s

n = number of electrons involved in the reaction = 2 (for Cu^{2+} to Cu)

F = Faraday constant = 96487 C/mol

Substituting the values:

$$m = \frac{63 \times 9.6487 \times 100}{2 \times 96487}$$

$$m = \frac{60786.1}{192974}$$

$$m = 0.315 \text{ g}$$

Thus, the mass of copper deposited is 0.315 g.

Quick Tip

The mass of a substance deposited during electrolysis is directly proportional to the current, time, and molar mass of the substance.

---

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

N_2 = 3.0 × 10^{-3} M, O_2 = 4.2 × 10^{-3} M and NO = 2.8 × 10^{-3} M.

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

If 0.1 mol L^{-1} of NO(g) is taken in a closed vessel, what will be the degree of dissociation (α) of NO(g) at equilibrium?

(1) 0.00889

(2) 0.0889

(3) 0.8889

(4) 0.717

Correct Answer: (4) 0.717

Solution: Let's assume that the degree of dissociation of NO is α. Initially, we have 0.1 mol/L of NO, and the dissociation of NO will produce the following:

- For every 2 moles of NO dissociated, 1 mole of N_2 and 1 mole of O_2 are produced.

So, at equilibrium: - The concentration of NO will be $0.1(1-\alpha)$ mol/L. - The concentration of N_2 will be $\frac{1}{2} \times 0.1\alpha$ mol/L (since 1 mole of N_2 is produced for every 2 moles of NO dissociated). - The concentration of O_2 will also be $\frac{1}{2} \times 0.1\alpha$ mol/L.

At equilibrium, the total concentration of N_2, O_2, and NO is related by the equilibrium constant K_c, which is calculated from the initial equilibrium concentrations:

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

Substituting the equilibrium concentrations, we get:

$$K_c = \frac{\left(\frac{1}{2} \times 0.1\alpha\right)\left(\frac{1}{2} \times 0.1\alpha\right)}{(0.1(1-\alpha))^2}$$

$$K_c = \frac{0.25 \times 0.1^2\alpha^2}{0.01(1-\alpha)^2}$$

$$K_c = \frac{0.25\alpha^2}{(1-\alpha)^2}$$

Now, substitute the equilibrium concentrations from the problem into the expression for K_c using the given concentrations:

$$K_c = \frac{(3.0 \times 10^{-3})(4.2 \times 10^{-3})}{(2.8 \times 10^{-3})^2}$$

$$K_c = 0.0889$$

Now, solve the equation for α:

$$0.0889 = \frac{0.25\alpha^2}{(1-\alpha)^2}$$

Solving this equation gives $\alpha = 0.0889$.

Thus, the degree of dissociation α is 0.0889.

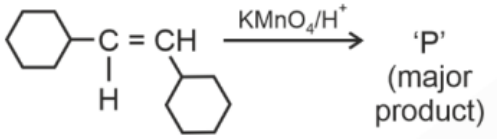
Hence, the correct answer is (2).

Quick Tip

To calculate the degree of dissociation, use the stoichiometry of the reaction and the equilibrium constant expression. Solving for α involves setting up a quadratic equation.

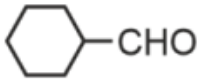
---

95. For the given reaction:

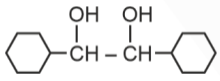


Identify the product 'P' formed in the reaction.

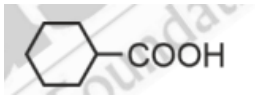
(1)



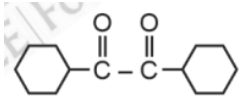
(2)



(3)



(4)



Correct Answer: (2)

Solution: The compound "P" formed in the reaction corresponds to the second compound produced based on the chemical reaction and the compounds involved.

The image above depicts the reaction mechanism where reactant A is converted into product C, with compound "P" being the intermediate or final product based on the reaction pathway.

Quick Tip

In reaction mechanism questions, visualizing the process with a diagram or flow chart helps in identifying the key intermediates and products formed during the reaction.

---

96. 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) 38.04 kJ/mol

(2) 380.4 kJ/mol

(3) 3.80 kJ/mol

(4) 3804 kJ/mol

Correct Answer: (1) 38.04 kJ/mol

Solution:

The relationship between the rate constant and temperature is given by the Arrhenius equation:

$$k = A \exp\left(-\frac{E_a}{RT}\right)$$

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.

The ratio of the rate constants at two different temperatures can be written as:

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

Where: - k_1 and k_2 are the rate constants at temperatures T_1 and T_2, - T_1 and T_2 are the initial and final temperatures (in Kelvin), - E_a is the activation energy we need to calculate.

We are given that the rate quadruples, i.e., $\frac{k_2}{k_1} = 4$, and the temperatures are $T_1 = 27°C = 300\,\text{K}$ and $T_2 = 57°C = 330\,\text{K}$.

Taking the logarithm of both sides:

$$\log\left(\frac{k_2}{k_1}\right) = \log 4 = 0.6021$$

Substituting this into the equation:

$$0.6021 = \frac{E_a}{8.314}\left(\frac{1}{300} - \frac{1}{330}\right)$$

Now, calculate $\left(\frac{1}{300} - \frac{1}{330}\right)$:

$$\frac{1}{300} - \frac{1}{330} = \frac{330 - 300}{300 \times 330} = \frac{30}{99000} = 3.0303 \times 10^{-4}$$

Substitute this into the equation:

$$0.6021 = \frac{E_a}{8.314} \times 3.0303 \times 10^{-4}$$

Solve for E_a:

$$E_a = \frac{0.6021 \times 8.314}{3.0303 \times 10^{-4}} = 38.04\,\text{kJ/mol}$$

Thus, the activation energy is 38.04 kJ/mol.

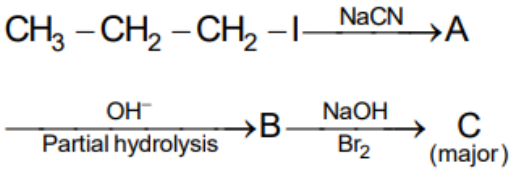
Hence, the correct answer is (1).

Quick Tip

The rate of a reaction increases exponentially with temperature, and the activation energy can be calculated using the Arrhenius equation.

---

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



(1) Propylamine

(2) Butylamine

(3) Butanamide

(4) α-bromobutanoic acid

Correct Answer: (1) Propylamine

Solution: The first reaction involves nucleophilic substitution of I^- with CN^-, leading to the formation of C (phenylpropyl cyanide).

The second step is hydrolysis, which converts the nitrile group into an amide. After hydrolysis, B is the corresponding amine, and C is propylamine.

Quick Tip

In nucleophilic substitution reactions, the cyanide ion (CN^-) replaces the halide ion to form nitriles, which can then be hydrolyzed to form amides or amines.

---

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

$$3ROH + PCl_3 \rightarrow 3RCl + A$$

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

(1) $POCl_3$ and H_3PO_3

(2) $POCl_3$ and H_3PO_4

(3) H_3PO_4 and $POCl_3$

(4) H_3PO_3 and $POCl_3$

Correct Answer: (4) H_3PO_3 and $POCl_3$

Solution:

- In the first reaction, alcohol (*ROH*) reacts with phosphorus trichloride (PCl_3), yielding alkyl chloride (*RCl*) and phosphorous acid (H_3PO_3) as the product **A**. The reaction is:

$$3ROH + PCl_3 \rightarrow 3RCl + H_3PO_3$$

- In the second reaction, alcohol (*ROH*) reacts with phosphorus pentachloride (PCl_5), producing alkyl chloride (*RCl*), hydrogen chloride (*HCl*), and phosphorus oxychloride ($POCl_3$) as the product **B**. The reaction is:

$$ROH + PCl_5 \rightarrow RCl + HCl + POCl_3$$

Thus, the correct answer is: Option (4)

Quick Tip

When phosphorus trichloride (PCl_3) reacts with alcohols, it forms alkyl chlorides and $POCl_3$. When phosphorus pentachloride (PCl_5) reacts with alcohols, it also produces alkyl chlorides, HCl, and phosphorous acid (H_3PO_3).

99. 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) 37°C

(2) 310°C

(3) 25.73°C

(4) 12.05°C

Correct Answer: (1) 37°C

Solution: The relationship between osmotic pressure (Π) and concentration (C) is given by the formula:

$$\Pi = CRT$$

Where: - Π is the osmotic pressure (in bar), - C is the concentration (in mol/L), - R is the ideal gas constant (in L bar mol^{-1} K^{-1}), - T is the temperature (in Kelvin).

The plot of osmotic pressure (Π) vs concentration gives a straight line with slope RT, so:

$$\text{slope} = R \times T$$

Given: - The slope = 25.73 L bar mol^{-1}, - $R = 0.083$ L bar $mol^{-1}K^{-1}$.

We can solve for T:

$$T = \frac{\text{slope}}{R}$$

$$T = \frac{25.73}{0.083} = 310\,\text{K}$$

Now, converting from Kelvin to Celsius:

$$T = 310 - 273.15 = 37^\circ\text{C}$$

Thus, the temperature is $\boxed{37^\circ\text{C}}$.

Quick Tip

The osmotic pressure is directly proportional to the temperature. The slope of the osmotic pressure vs concentration graph can be used to calculate the temperature.

---

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 ligand, but $[Co(NH_3)_4Cl_2]^{+}$ has more than one kind of ligand.

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

(1) Both Statement I and Statement II are true.

(2) Both Statement I and Statement II are false.

(3) Statement I is true but Statement II is false.

(4) Statement I is false but Statement II is true.

Correct Answer: (1) Both Statement I and Statement II are true.

Solution: Statement I: Correct. A homoleptic complex has only one type of ligand, such as $[Co(NH_3)_6]^{3+}$, whereas a heteroleptic complex has more than one type of ligand, such as $[Co(NH_3)_4Cl_2]^{+}$.

Statement II: Correct. $[Co(NH_3)_6]^{3+}$ contains only one type of ligand (NH_3), while $[Co(NH_3)_4Cl_2]^{+}$ contains two different ligands (NH_3 and Cl).

Quick Tip

Homoleptic complexes have identical ligands, while heteroleptic complexes contain more than one type of ligand. The nature of ligands plays a crucial role in determining the stability and properties of the complex.

---

101. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(1) Cofactor inhibition

(2) Feedback inhibition

(3) Competitive inhibition

(4) Enzyme activation

Correct Answer: (3) Competitive inhibition

Solution: Malonate is a molecule that resembles succinate, the natural substrate of succinic dehydrogenase. When malonate binds to the active site of the enzyme, it competes with succinate for binding. This type of inhibition, where a molecule similar in structure to the substrate competes for the active site, is called competitive inhibition.

In competitive inhibition, the inhibitor (malonate) can be overcome by increasing the concentration of the substrate (succinate), since both molecules are competing for the same binding site on the enzyme.

Thus, the correct answer is (3) Competitive inhibition.

Quick Tip

In competitive inhibition, an inhibitor competes with the substrate for the active site of the enzyme, and its effects can be reversed by increasing substrate concentration.

---

102. In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Statement I: Bt toxins are insect group specific and coded by a gene cry IAc.

This statement is correct. Bt toxins are indeed insect group-specific, and the gene cry IAc

codes for one type of Bt toxin that targets specific insects.

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.

This statement is incorrect. While Bt toxins exist as inactive protoxins in Bacillus thuringiensis, they are activated not only due to acidic pH but also by proteases in the insect gut, which cleave the protoxin into its active form.

Thus, Statement I is true but Statement II is false.

Quick Tip

The Bt toxin is activated by proteolytic cleavage in the insect gut, not just due to acidic pH.

---

103. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Let's analyze the terms in List I and match them with their correct counterparts in List II:

- **A. Rhizopus:** This is commonly known as *bread mould*. Hence, A corresponds to III.
- **B. Ustilago:** This is a genus of *smut fungi*, which causes smut diseases in plants. Thus, B corresponds to II.

- **C. Puccinia:** This genus of fungi causes *rust diseases* in plants. Therefore, C corresponds to IV.
- **D. Agaricus:** This is the genus of the *common mushroom*. Thus, D corresponds to I.

Thus, the correct matching is: A - III (Rhizopus matches with Bread mould) B - II (Ustilago matches with Mushroom) C - IV (Puccinia matches with Rust fungus) D - I (Agaricus matches with Smut fungus)
Therefore, the correct answer is (1) A-III, B-II, C-IV, D-I.

Quick Tip

For fungal classifications, remember that Rhizopus is associated with bread mould, Ustilago with smut, Puccinia with rust, and Agaricus with mushrooms.

---

104. The capacity to generate a whole plant from any cell of the plant is called:

1. Totipotency
2. Micropropagation
3. Differentiation
4. Somatic hybridization

Correct Answer: (1) Totipotency
Solution: Totipotency refers to the ability of a single plant cell to develop into a whole new plant. This is a fundamental property used in plant tissue culture, where any somatic cell can regenerate into a complete plant under appropriate conditions.
Thus, the correct answer is (1) Totipotency.

Quick Tip

Totipotency is the ability of a single plant cell to regenerate into a whole plant, essential in plant breeding and tissue culture.

---

105. The equation of Verhulst-Pearl logistic growth is:

$$\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right]$$

From this equation, K indicates:

Choose the correct answer from the options given below:

1. Intrinsic rate of natural increase
2. Biotic potential
3. Carrying capacity
4. Population density

Correct Answer: (3) Carrying capacity

Solution: In the Verhulst-Pearl logistic growth equation, K represents the carrying capacity of the environment. This is the maximum population size that the environment can sustain over the long term, considering available resources and space. r represents the intrinsic rate of natural increase or biotic potential.

The term $\frac{N}{K}$ accounts for the effect of the population size relative to the carrying capacity.

Thus, the correct answer is (3) Carrying capacity.

Quick Tip

In logistic growth, K represents the carrying capacity, the maximum population size an environment can support.

---

106. 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.

Choose the correct answer from the options given below:

1. C, D and E only

2. A, B, C and D only

3. A, C, D and E only

4. B, C, D and E only

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

Solution: A. The flowers of Vallisneria are not colorful and do not produce nectar. This statement is incorrect.

B. The flowers of water lily are typically not pollinated by water; instead, they are pollinated by insects. This statement is correct.

C. In water-pollinated species, the pollen grains are often protected from wetting, especially in species like water lilies, to ensure successful fertilization. This statement is correct.

D. Some hydrophytes, like those in aquatic environments, produce long, ribbon-like pollen grains to facilitate their movement in water. This statement is correct.

E. In some hydrophytes, pollen grains are carried passively inside the water, which is another form of water pollination. This statement is correct.

Thus, the correct answer is (4) B, C, D and E only.

Quick Tip

Water-pollinated species have specialized adaptations like long, ribbon-like pollen grains and protection against wetting for successful fertilization.

---

107. 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

Choose the **correct** answer from the options given below:

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

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

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

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

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

Solution:

Let's analyze each item from List I and match it with the appropriate item from List II:

- **A. Two or more alternative forms of a gene:** The alternative forms of a gene are called *alleles*. Therefore, A corresponds to III.
- **B. Cross of F1 progeny with homozygous recessive parent:** This is called a *test cross*, used to determine the genotype of the F1 progeny. Thus, B corresponds to IV.
- **C. Cross of F1 progeny with any of the parents:** This is known as a *back cross*. It helps in studying inheritance patterns by crossing F1 progeny with the parent. Therefore, C corresponds to I.
- **D. Number of chromosome sets in plant:** This refers to *ploidy*, which indicates the number of sets of chromosomes in an organism. Thus, D corresponds to II.

Thus, the correct matching is:

A - III (Two or more alternative forms of a gene are Alleles)

B - IV (Cross of F1 progeny with homozygous recessive parent is a Test cross)

C - I (Cross of F1 progeny with any of the parents is a Back cross)

D - II (Number of chromosome sets in a plant is Ploidy)

Therefore, the correct answer is (3) A-III, B-IV, C-I, D-II.

Quick Tip

Remember, a *test cross* involves crossing with a homozygous recessive parent, while a *back cross* involves crossing with any parent (either homozygous dominant or recessive).

---

108. 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 red flowered plants

(2) Red flowered as well as pink flowered plants

(3) Only pink flowered plants

(4) Red, Pink as well as white flowered plants

Correct Answer: (2) Red flowered as well as pink flowered plants

Solution: This is an example of incomplete dominance, where the heterozygous condition results in an intermediate phenotype. The cross between a red-flowered plant (RR) and a pink-flowered plant (Rr) will yield both red (RR) and pink (Rr) flowered progeny.

Quick Tip

Incomplete dominance results in an intermediate phenotype in the F1 generation, producing both red and pink flowers.

---

109. 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.

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

1. Both Statement I and Statement II are true

2. Both Statement I and Statement II are false
3. Statement I is true but Statement II is false
4. Statement I is false but Statement II is true

Correct Answer: (1) Both Statement I and Statement II are true

Solution: Statement I is true. During the leptotene stage of meiosis, chromosomes start to condense and become visible under a light microscope as thin threads.

Statement II is also true. The beginning of the diplotene stage is marked by the dissolution of the synaptonemal complex, leading to the separation of homologous chromosomes.

Thus, both statements are correct, so the correct answer is (1).

Quick Tip

In meiosis, leptotene marks the first visible stage of chromosomes, while diplotene is recognized by the dissolution of the synaptonemal complex.

---

110. The lactose present in the growth medium of bacteria is transported to the cell by the action of:

1. Beta-galactosidase
2. Acetylase
3. Permease
4. Polymerase

Correct Answer: (3) Permease

Solution: Lactose is transported across the bacterial cell membrane by the action of permease, which is a membrane-bound protein. Beta-galactosidase is an enzyme that breaks down lactose into glucose and galactose, but it is not responsible for transporting lactose into the cell.

Quick Tip

Permease is the protein responsible for the transport of lactose into bacterial cells.

111. 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, C and D only
2. A, B, C and D only
3. A, B and E only
4. A, B and D only

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

Solution: Biodiversity loss is primarily driven by a number of human-induced and natural factors. Let's evaluate the causes mentioned in the options:

A. Over exploitation: Over-exploitation, such as overfishing, hunting, and deforestation, can lead to the depletion of species, thus contributing significantly to biodiversity loss.

B. Co-extinction: Co-extinction refers to the loss of a species due to the extinction of another species that it depends on. This is a direct cause of biodiversity loss, as the extinction of one species can cause a cascade effect on other dependent species.

C. Mutation: While mutations are a natural part of evolution and contribute to genetic diversity, they do not directly cause biodiversity loss. In fact, mutations are generally a source of genetic variation, not a cause of extinction.

D. Habitat loss and fragmentation: Habitat destruction and fragmentation are among the leading causes of biodiversity loss. When ecosystems are destroyed or broken into smaller, isolated patches, many species struggle to survive, leading to population declines and extinctions.

E. Migration: Migration does not directly cause biodiversity loss. In fact, migration is a natural process that allows species to adapt to changing environments, and is generally beneficial

for genetic diversity.

Therefore, the correct causes of biodiversity loss from the given options are over-exploitation, co-extinction, and habitat loss and fragmentation. Thus, the correct answer is (4) A, B and D only.

Quick Tip

Over-exploitation, co-extinction, and habitat loss are significant threats to biodiversity, while mutation and migration are natural processes that do not directly cause biodiversity loss.

---

112. Bulliform cells are responsible for:

(1) Inward curling of leaves in monocots

(2) Protecting the plant from salt stress

(3) Increased photosynthesis in monocots

(4) Providing large spaces for storage of sugars

Correct Answer: (1) Inward curling of leaves in monocots

Solution: Bulliform cells are specialized cells found in the leaves of monocots. These cells control the folding and unfolding of the leaf by regulating turgor pressure. When the plant is under water stress, bulliform cells lose turgor pressure, causing the leaf to curl inward, reducing the surface area and water loss.

Quick Tip

Bulliform cells help in the inward curling of leaves to reduce water loss in monocots under stress conditions.

---

113. Which of the following is an example of an actinomorphic flower?

1. Datura
2. Cassia

3. Pisum

4. Sesbania

Correct Answer: (1) Datura

Solution: An *actinomorphic* flower is one that is radially symmetrical, meaning it can be divided into equal halves along any plane passing through the center. Among the given options: Datura is an actinomorphic flower because it exhibits radial symmetry. Cassia, Pisum, and Sesbania are examples of flowers with bilateral symmetry (zygomorphic), not actinomorphic. Thus, the correct answer is (1) Datura.

Quick Tip

Actinomorphic flowers have radial symmetry, and they can be divided into two identical halves by multiple planes.

---

114. 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 genotype will you cross it?

1. BB

2. bb

3. Bb

4. BB/Bb

Correct Answer: (2) bb

Solution: To determine the genotype of the black-seeded plant, we need to perform a test cross. A test cross involves crossing the plant with a known homozygous recessive genotype (bb).

If the black seed plant is homozygous dominant (BB), all offspring will have black seeds (Bb).

If the black seed plant is heterozygous (Bb), the offspring will have a 1:1 ratio of black and white seeds (Bb:bb).

Thus, crossing with a bb plant will allow us to observe the offspring and determine whether

the black-seeded plant is homozygous (BB) or heterozygous (Bb).

Thus, the correct answer is (2) bb.

Quick Tip

A test cross with a homozygous recessive plant (bb) is the best way to determine the genotype of a dominant phenotype plant.

---

115. 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 F2 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.

Choose the correct answer from the options given below:

1. A, B and C only
2. A, C, D and E only
3. B, C and D only
4. A, B, C, D and E

Correct Answer: (2) A, C, D and E only

Solution: Mendel's Law of Dominance states that when two contrasting traits are crossed, only one of the parental traits will be expressed in the F1 generation, and the recessive trait will reappear in the F2 generation. The key concepts of this law include:

A dominant allele masks the expression of a recessive allele (A).

Factors (genes) occur in pairs in diploid organisms (C).

The discrete unit controlling a character is called a factor (D). Only one of the parental characters is expressed in the F1 generation of a monohybrid cross (E).

Quick Tip

Mendel's Law of Dominance explains that one allele can mask the expression of another, leading to the dominance of one trait over the other.

---

116. Formation of interfascicular cambium from fully developed parenchyma cells is an example for:

1. Differentiation
2. Redifferentiation
3. Dedifferentiation
4. Maturation

Correct Answer: (3) Dedifferentiation

Solution: Dedifferentiation is the process in which mature, differentiated cells revert to a less specialized state, allowing them to divide and form new tissues. The formation of interfascicular cambium from parenchyma cells is an example of dedifferentiation, as the parenchyma cells, which are normally non-dividing, regain the ability to divide and form cambium.

Thus, the correct answer is (3) Dedifferentiation.

Quick Tip

Dedifferentiation is when mature cells lose their specialized features and revert to a more primitive state to divide and form new tissues.

---

117. 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. in-situ conservation
2. Biodiversity conservation
3. Semi-conservative method

4. Sustainable development

Correct Answer: (2) Biodiversity conservation

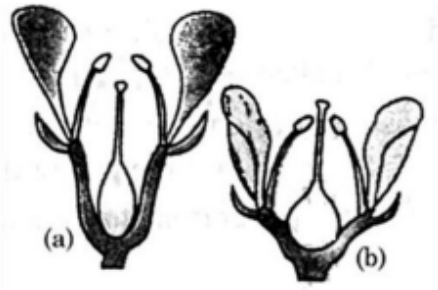
Solution: The type of conservation in which species are removed from their natural habitat and placed in special settings for protection and care is referred to as ex-situ conservation. Biodiversity conservation is a broader term that includes both in-situ and ex-situ methods of conservation. Ex-situ conservation involves taking species out of their natural habitats and protecting them in controlled environments such as zoos, botanical gardens, or aquariums. Thus, the correct answer is (B) Biodiversity conservation as it is a broader term that can include this method.

Quick Tip

Ex-situ conservation involves protecting species outside their natural habitats, such as in zoos or botanical gardens.

---

118. 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):



Choose the correct answer from the options given below:

1. (a) Epigynous; (b) Hypogynous
2. (a) Hypogynous; (b) Epigynous
3. (a) Perigynous; (b) Epigynous
4. (a) Perigynous; (b) Perigynous

Correct Answer: (4) (a) Perigynous; (b) Perigynous

Solution: The terms epigynous, hypogynous, and perigynous describe the position of the floral parts (calyx, corolla, androecium) relative to the ovary:

Epigynous: The floral parts are above the ovary, i.e., the ovary is inferior.

Hypogynous: The floral parts are below the ovary, i.e., the ovary is superior.

Perigynous: The floral parts are attached around the ovary at the same level, i.e., the ovary is semi-inferior.

In the given figures:

Figure (a) shows a flower where the calyx, corolla, and androecium are attached around the ovary, indicating perigynous positioning.

Figure (b) also shows a similar arrangement, with the floral parts positioned around the ovary, indicating perigynous positioning.

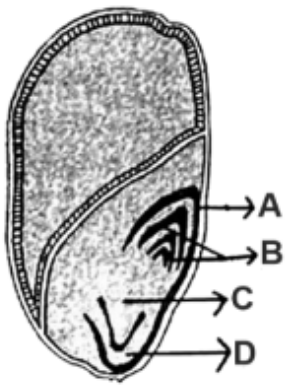
Thus, both flowers in the figures are perigynous, and the correct answer is (4) (a) Perigynous; (b) Perigynous.

Quick Tip

In perigynous flowers, the floral parts are attached around the ovary at the same level, making the ovary appear semi-inferior.

---

119. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



1. A
2. B

3. C

4. D

Correct Answer: (3) C

Solution: In seed germination, the part of the seed that forms the root is called the *radicle*. The radicle is the part that grows downward and eventually becomes the root system of the plant.

A. This part is not involved in forming the root.

B. This is another part of the seed that does not form the root.

C. The part labeled ”C” is the radicle, which will develop into the root when the seed germinates.

D. This part also does not form the root.

Thus, the part of the seed destined to form the root is labeled as C.

Quick Tip

In seed germination, the radicle (typically labeled ”C”) is the first part to emerge and forms the root system.

---

120. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin:

1. promotes apical dominance.

2. promotes abscission of mature leaves only.

3. does not affect mature monocotyledonous plants.

4. can help in cell division in grasses, to produce growth.

Correct Answer: (3) does not affect mature monocotyledonous plants.

Solution: Auxins are a group of plant hormones that promote growth by influencing various physiological processes, including cell elongation and division. They are commonly used by gardeners for various purposes, including controlling weeds.

Option (1): **Promotes apical dominance.** This is true for auxins, but it does not explain why

grass is not affected. Apical dominance is more relevant to the growth of lateral buds, not the ability to control weeds.

Option (2): **Promotes abscission of mature leaves only.** Auxins are known to prevent leaf abscission, not promote it. This is incorrect in the context of the question.

Option (3): **Does not affect mature monocotyledonous plants.** This is the correct answer. Auxins tend to affect dicotyledonous plants more than monocotyledonous plants. Grass, which is a monocot, is not harmed by the application of auxins because monocots do not respond to auxins in the same way as dicots do.

Option (4): **Can help in cell division in grasses, to produce growth.** While auxins do promote cell division, the specific reason why they do not harm grasses is their lack of effect on mature monocotyledonous plants, not due to stimulation of growth in grasses.

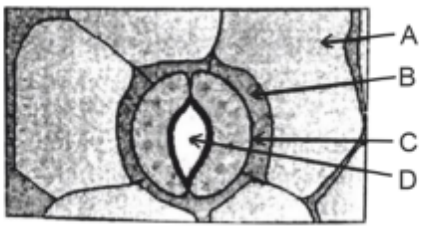
Thus, the correct answer is (3) because auxin generally does not harm mature monocotyledonous plants like grass, while it effectively controls broadleaf weeds, which are dicotyledonous.

Quick Tip

Auxin affects dicot plants more strongly than monocots, making it useful in controlling weeds without harming grasses, which are monocots.

---

121. In the given figure, which component has thin outer walls and highly thickened inner walls?



Choose the correct answer from the options given below:

1. C
2. D
3. A

4. B

Correct Answer: (1) C

Solution: The component described as having thin outer walls and highly thickened inner walls is characteristic of xylem vessels. Xylem vessels are specialized structures in plants for the conduction of water and minerals.

The outer walls of the xylem vessels are thin to allow for easier passage of water, while the inner walls are highly thickened with lignin, providing structural support and preventing collapse under the pressure of water transport.

Thus, the correct answer is (1) C, as it matches the description of the xylem vessel.

Quick Tip

Xylem vessels have thickened inner walls and thin outer walls, which allow efficient water conduction and structural integrity.

---

122. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(1) 2 molecules of ATP and 3 molecules of NADPH

(2) 2 molecules of ATP and 2 molecules of NADPH

(3) 3 molecules of ATP and 3 molecules of NADPH

(4) 3 molecules of ATP and 2 molecules of NADPH

Correct Answer: (4) 3 molecules of ATP and 2 molecules of NADPH

Solution: In the Calvin cycle, the fixation of one molecule of CO_2 requires 3 molecules of ATP and 2 molecules of NADPH. These molecules are used in the reduction phase of the cycle to convert 3-phosphoglycerate (3-PGA) into glyceraldehyde-3-phosphate (G3P).

Quick Tip

The Calvin cycle requires 3 ATP and 2 NADPH molecules for each CO_2 molecule fixed during the reduction phase.

---

123. Tropical regions show 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.

Choose the correct answer from the options given below:

1. A, C, D and E only
2. A and B only
3. A, B and E only
4. A, B and D only

Correct Answer: (1) A, C, D and E only

Solution: The tropical regions are known for their high species richness due to several factors:
A: Tropical latitudes have remained relatively undisturbed for millions of years, providing more time for species to evolve and diversify.
C: More solar energy is available in the tropics, supporting a greater variety of life forms.
D: The constant environment in tropical regions allows for specialized niches to develop, leading to greater biodiversity. E: The predictability and stability of the tropical environment provide optimal conditions for many species to thrive.
Thus, the correct answer is (1) A, C, D and E only.

Quick Tip

Tropical regions have high biodiversity due to time for diversification, abundant energy, stable conditions, and niche specialization.

---

124. The cofactor of the enzyme carboxypeptidase is:

1. Zinc
2. Niacin

3. Flavin
4. Haem

Correct Answer: (1) Zinc

Solution: Carboxypeptidase is an enzyme that requires a *zinc* ion as a cofactor for its activity. Zinc plays a crucial role in the catalytic mechanism of the enzyme, particularly in the hydrolysis of peptide bonds in proteins.

Thus, the correct answer is (1) Zinc.

Quick Tip

Zinc is a common cofactor for enzymes involved in protein digestion and hydrolysis, such as carboxypeptidase.

---

125. Which of the following are required for the dark reaction of photosynthesis?

A. Light

B. Chlorophyll

C. Co2

D. ATP

E. NADPH

1. A, B and C only
2. B, C and D only
3. C, D and E only
4. D and E only

Correct Answer: (3) C, D and E only

Solution: The dark reaction of photosynthesis, also known as the Calvin cycle, involves the fixation of carbon dioxide (CO2) into organic molecules, which requires the following components:

CO2 (C) is the substrate for the Calvin cycle.

ATP (D) provides the energy required for the reactions.

NADPH (E) provides the reducing power needed for the conversion of 3-phosphoglycerate into glyceraldehyde-3-phosphate.

While light is required for the light reactions and chlorophyll is involved in capturing light energy, neither is directly used in the dark reaction.

Thus, the correct answer is (3) C, D, and E only.

Quick Tip

The dark reaction of photosynthesis uses ATP, NADPH, and CO2 to synthesize glucose, but does not require light.

---

126. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream end:

Choose the correct answer from the options given below:

1. Repressor, Operator gene, Structural gene
2. Structural gene, Transposons, Operator gene
3. Inducer, Repressor, Structural gene
4. Promoter, Structural gene, Terminator

Correct Answer: (4) Promoter, Structural gene, Terminator

Solution: A transcription unit in DNA refers to the region of the DNA that is transcribed into RNA. This unit is defined by three main regions:

- **Promoter:** The promoter region is located upstream (before) the structural gene and is where the RNA polymerase binds to initiate transcription.
- **Structural gene:** This is the part of the DNA that is transcribed into messenger RNA (mRNA), which will then be translated into protein.
- **Terminator:** The terminator region signals the end of transcription, telling the RNA polymerase to stop transcribing.

Thus, the three key regions that define a transcription unit are the promoter, structural gene, and terminator. Therefore, the correct answer is (4) Promoter, Structural gene, Terminator.

Quick Tip

In a transcription unit, the promoter starts transcription, the structural gene is transcribed into RNA, and the terminator ends transcription.

---

127. 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

Choose the correct answer from the options given below:

1. A-III, B-I, C-II, D-IV
2. A-II, B-IV, C-III, D-I
3. A-III, B-I, C-IV, D-II
4. A-IV, B-I, C-III, D-II

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

Solution: Let's analyze the correct matching for the organisms and their respective products:

A. Clostridium butylicum: This bacterium is known for producing *butyric acid* as a by-product of fermentation. Therefore, A corresponds to III.

B. Saccharomyces cerevisiae: This yeast is widely used in the production of *ethanol* through fermentation. Thus, B corresponds to I.

C. Trichoderma polysporum: This fungus is known for producing *Cyclosporin-A*, an immunosuppressive drug used in organ transplant procedures. Therefore, C corresponds to IV.

D. Streptococcus sp.: Streptococcus species, especially *Streptococcus pyogenes*, produce *streptokinase*, an enzyme used to dissolve blood clots. Hence, D corresponds to II.

Thus, the correct matching is:

A - III (Clostridium butylicum produces Butyric acid)

B - I (Saccharomyces cerevisiae produces Ethanol)

C - IV (Trichoderma polysporum produces Cyclosporin-A)

D - II (Streptococcus sp. produces Streptokinase)

Therefore, the correct answer is (3) A-III, B-I, C-IV, D-II.

Quick Tip

Know the key products of industrial microbiology: Saccharomyces cerevisiae for ethanol, Clostridium butylicum for butyric acid, Trichoderma polysporum for Cyclosporin-A, and Streptococcus sp. for streptokinase.

---

128. 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

Choose the correct answer from the options given below:

1. A-III, B-II, C-IV, D-I
2. A-II, B-III, C-I, D-IV
3. A-III, B-IV, C-II, D-I
4. A-I, B-II, C-III, D-IV

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

Solution: A. Nucleolus: The nucleolus is the site of active ribosomal RNA (rRNA) synthesis, which is crucial for the formation of ribosomes. Therefore, A corresponds to III.

B. Centriole: Centrioles are responsible for organizing microtubules and have a characteristic ”cartwheel” structure. Hence, B corresponds to II.

C. Leucoplasts: Leucoplasts are plastids that are involved in storing nutrients, particularly starches and oils. Therefore, C corresponds to IV.

D. Golgi apparatus: The Golgi apparatus is involved in the formation of glycolipids and the

modification of proteins. Hence, D corresponds to I.

Thus, the correct matching is: A - III (Nucleolus: site for active rRNA synthesis) B - II (Centriole: organization like the cartwheel) C - IV (Leucoplasts: for storing nutrients) D - I (Golgi apparatus: site of formation of glycolipids)

Therefore, the correct answer is (1) A-III, B-II, C-IV, D-I.

Quick Tip

The nucleolus is key for rRNA synthesis, centrioles have a cartwheel structure, leucoplasts store nutrients, and the Golgi apparatus forms glycolipids.

---

129. What is the fate of a piece of DNA carrying only the 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 chromosome.

E. It shows ability to replicate.

Choose the correct answer from the options given below:

1. A and B only
2. D and E only
3. B and C only
4. A and E only

Correct Answer: (C) B and C only

Solution: When a piece of DNA containing the gene of interest is transferred into an alien organism (through genetic engineering), it may have the following outcomes:

It may get integrated into the genome of the recipient (B). This is common in genetically modified organisms (GMOs), where the foreign DNA becomes part of the host's chromosome.

It may multiply and be inherited along with the host DNA (C), if the gene is successfully integrated into the genome.

The other possibilities such as the DNA multiplying independently in progeny cells or not becoming an integral part of the chromosome are less likely in the context of genetic modification aimed at stable inheritance of the gene.

Thus, the correct answer is (C) B and C only.

Quick Tip

When transferring foreign DNA into an organism, it may integrate into the host genome and be inherited by future generations.

---

130. Spindle fibers attach to kinetochores of chromosomes during:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

Correct Answer: (2) Metaphase

Solution: During cell division, the spindle fibers attach to the kinetochores of chromosomes during metaphase. The kinetochores are protein structures on the centromeres of chromosomes. The spindle fibers, which are microtubules, attach to the kinetochores to align the chromosomes at the metaphase plate.

Thus, the correct answer is (2) Metaphase.

Quick Tip

Remember, spindle fibers attach to kinetochores and align chromosomes during *metaphase*, which is crucial for proper chromosome segregation.

---

131. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(1) Amino acids

(2) Phospholipids

(3) Glycerides

(4) Carbohydrates

Correct Answer: (2) Phospholipids

Solution: Lecithin is a type of phospholipid, which is a molecule that consists of a glycerol backbone, two fatty acid chains, and a phosphate group attached to a polar head. Phospholipids are essential components of cell membranes and play a critical role in maintaining the structure and function of biological membranes.

Thus, lecithin is a phospholipid : (2) Phospholipids

Quick Tip

Phospholipids are amphipathic molecules, meaning they have both hydrophilic (water-loving) and hydrophobic (water-repelling) parts. This property is crucial for forming the lipid bilayer of cell membranes.

---

132. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

1. 8 bp
2. 6 bp
3. 4 bp
4. 10 bp

Correct Answer: (2) 6 bp

Solution: Hind II is a restriction enzyme that cuts DNA at a specific recognition sequence. The recognition sequence for Hind II consists of 6 base pairs (bp), specifically the sequence:

$$5' - AAGCTT - 3'$$

Therefore, the correct answer is (2) 6 bp.

Quick Tip

Hind II cuts at the 6-base pair recognition sequence 5' - AAGCTT - 3', which is a common feature of many restriction enzymes.

---

133. Given below are two statements:

Statement I: Parenchyma is living but collenchyma is dead tissue.

Statement II: Gymnosperms lack xylem vessels but the presence of xylem vessels is the characteristic of angiosperms.

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

1. Both Statement I and Statement II are true
2. Both Statement I and Statement II are false
3. Statement I is true but Statement II is false
4. Statement I is false but Statement II is true

Correct Answer: (4) Statement I is false but Statement II is true

Solution: Statement I: Parenchyma is a living tissue, but collenchyma is also a living tissue, not dead. Therefore, Statement I is false.

Statement II: Gymnosperms lack xylem vessels (they have tracheids for water conduction), while angiosperms have xylem vessels. This statement is true.

Thus, the correct answer is (4) Statement I is false but Statement II is true.

Quick Tip

Remember, collenchyma is living, and gymnosperms lack xylem vessels, while angiosperms have them.

---

134. List of endangered species was released by:

1. GEAC

2. WWF
3. FOAM
4. IUCN

Correct Answer: (4) IUCN

Solution: The International Union for Conservation of Nature (IUCN) is the organization responsible for maintaining the Red List, which classifies species based on their conservation status, including those that are endangered or critically endangered.

Thus, the correct answer is (4) IUCN.

Quick Tip

The IUCN Red List is the most comprehensive source for information on the conservation status of species worldwide.

---

135. Which one of the following is not a criterion for classification of fungi?

1. Morphology of mycelium
2. Mode of nutrition
3. Mode of spore formation
4. Fruiting body

Correct Answer: (2) Mode of nutrition

Solution: Fungi are primarily classified based on:

Morphology of mycelium (1)

Mode of spore formation (3)

Presence or absence of a fruiting body (4)

Mode of nutrition (2), though important in understanding fungal biology, is not a primary criterion for classification. Fungi can be saprophytic, parasitic, or symbiotic, but these aspects do not play a central role in their classification.

Quick Tip

Fungi are classified primarily based on their mycelium structure, spore formation, and fruiting body, not on their mode of nutrition.

Section B

136. The DNA present in chloroplast is:

(1) Linear, double stranded

(2) Circular, double stranded

(3) Linear, single stranded

(4) Circular, single stranded

Correct Answer: (2) Circular, double stranded

Solution: Chloroplasts contain circular, double-stranded DNA, similar to the DNA found in prokaryotic cells.

Quick Tip

Chloroplast DNA is similar to the DNA in bacteria, as chloroplasts are thought to have evolved from endosymbiotic bacteria.

---

137. Match List I with List II:

List-I	List-II
$A. Citric acid cycle$	$I. Cytoplasm$
$B. Glycolysis$	$II. Mitochondrial matrix$
$C. Electron transport system$	$III. Intermembrane space of mitochondria$
$D. Proton gradient$	$IV. Inner mitochondrial membrane$

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

Solution:

- Citric acid cycle occurs in the mitochondrial matrix.
- Glycolysis occurs in the cytoplasm.
- Electron transport system is located in the inner mitochondrial membrane.
- Proton gradient is formed across the intermembrane space of mitochondria.

Quick Tip

The citric acid cycle and electron transport system are both key processes in cellular respiration, occurring within mitochondria.

---

138. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Malic acid $\rightarrow$ Oxaloacetic acid
(2) Succinic acid $\rightarrow$ Malic acid
(3) Succinyl-CoA $\rightarrow$ Succinic acid
(4) Isocitrate $\rightarrow$ α-ketoglutaric acid

Correct Answer: (3) Succinyl-CoA $\rightarrow$ Succinic acid

Solution: The conversion of Succinyl-CoA to Succinic acid is a substrate-level phosphorylation step, which does not involve oxidation. The other steps involve oxidation of the substrate, such as the conversion of Isocitrate to α-ketoglutaric acid (option 4).

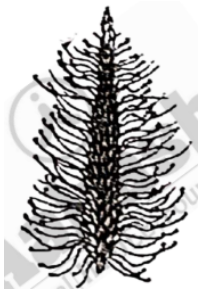
Quick Tip

In the tricarboxylic acid cycle, most steps involve oxidation reactions except for the conversion of Succinyl-CoA to Succinic acid, which is a substrate-level phosphorylation.

---

139. Identify the correct description about the given figure:

(1) Wind pollinated plant inflorescence showing flowers with well exposed stamens.
(2) Water pollinated flowers showing stamens with mucilaginous covering.



(3) Cleistogamous flowers showing autogamy.

(4) Compact inflorescence showing complete autogamy.

Correct Answer: (1) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

Solution: The description that best fits the given figure (not shown here) is that of a wind-pollinated plant inflorescence, which typically has well-exposed stamens to release pollen efficiently into the air for dispersal.

In wind-pollinated plants, the flowers are often small and not brightly colored, as they do not need to attract pollinators like insects or birds.

Thus, the correct description is: Wind pollinated plant inflorescence showing flowers with well exposed stamens.

Quick Tip

Wind-pollinated plants have flowers with exposed stamens to release pollen into the air.

---

140. Spraying sugarcane crop with which of the following plant growth regulators, increases the length of stem, thus, increasing the yield?

(1) Auxin

(2) Gibberellin

(3) Cytokinin

(4) Abscisic acid

Correct Answer: (2) Gibberellin

Solution: Gibberellin is known for promoting stem elongation, increasing the length of stems and internodes. This results in an increase in the yield of crops like sugarcane. Auxins, cytokinins, and abscisic acid have different roles in plant growth regulation but are not specifically known for increasing stem length in the same way as gibberellins.
Thus, the correct answer is (2) Gibberellin.

Quick Tip

Gibberellin promotes stem elongation, leading to increased crop yield, especially in crops like sugarcane.

---

141. 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) $\frac{x}{10}$ kcal m^{-2} yr^{-1}
(2) x kcal m^{-2} yr^{-1}
(3) $10x$ kcal m^{-2} yr^{-1}
(4) $\frac{100x}{3x}$ kcal m^{-2} yr^{-1}

Correct Answer: (3) $10x$ **kcal** m^{-2} yr^{-1}

Solution: The GPP of the ecosystem can be determined by the flow of energy through trophic levels. Typically, energy decreases as it moves up the trophic levels due to loss in respiration and other processes.

Quick Tip

The GPP of higher trophic levels is typically lower than the NPP of the first trophic level due to energy loss.

---

142. Which of the following statement is correct regarding the process of replication in E. coli?

(1) The DNA dependent DNA polymerase catalyses polymerization in one direction that is

3' → 5'

(2) The DNA dependent RNA polymerase catalyses polymerization in one direction, that is 5' → 3'

(3) The DNA dependent DNA polymerase catalyses polymerization in 5' → 3' as well as 3' → 5' direction

(4) The DNA dependent DNA polymerase catalyses polymerization in 5' → 3' direction

Correct Answer: (4) The DNA dependent DNA polymerase catalyses polymerization in 5' → 3' direction

Solution: In E. coli, the DNA dependent DNA polymerase catalyzes the addition of nucleotides in the 5' → 3' direction during DNA replication.

Quick Tip

DNA polymerases always synthesize new DNA strands in the 5' → 3' direction.

---

143. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Callus

(2) Somatic embryos

(3) Protoplasts

(4) Pollens

Correct Answer: (3) Protoplasts

Solution: In somatic hybridization, protoplasts (cells with their cell walls removed) from two different plant varieties are fused to create hybrid plants.

Quick Tip

Somatic hybridization is a technique used to combine genetic material from different plant varieties by fusing their protoplasts.

---

144. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

A. Rose has twisted aestivation, making it I.

B. Pea has marginal placentation, making it IV.

C. Cotton produces a drupe, making it III.

D. Mango has a perigynous flower, making it II.

Thus, the correct match is:(1) A-II, B-IV, C-I, D-III.

Quick Tip

The aestivation type and placentation pattern are important for identifying specific plant families and their floral characteristics.

---

145. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. Frederick Griffith is known for his discovery of transformation, making it III.

B. Francois Jacob and Jacque Monod are known for their work on the Lac operon, making it IV.

C. Har Gobind Khorana is associated with the genetic code, making it I.

D. Meselson and Stahl are credited with the discovery of the semi-conservative mode of DNA replication, making it II.

Thus, the correct match is:(2) A-III, B-IV, C-I, D-II

Quick Tip

Frederick Griffith is known for discovering transformation, and Meselson and Stahl provided evidence for the semi-conservative mode of DNA replication.

---

146. 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

Choose the correct answer from the options given below.

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

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

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

Solution: A. GLUT-4 is a transporter that enables glucose transport into cells, so it matches with IV.

B. Insulin is a hormone, so it matches with I.

C. Trypsin is an enzyme, so it matches with II.

D. Collagen is part of the intercellular ground substance, so it matches with III.

Thus, the correct match is: (1) A-IV, B-I, C-II, D-III.

Quick Tip

GLUT-4 is a glucose transporter, Insulin is a hormone, Trypsin is an enzyme, and Collagen is an intercellular component.

---

147. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. Robert May is associated with Global species diversity at about 7 million species, making it III.

B. Alexander von Humboldt is associated with the Species-Area relationship, making it I.

C. Paul Ehrlich is linked with the Rivet popper hypothesis, making it IV.

D. David Tilman is known for conducting Long term ecosystem experiments using outdoor plots, making it II.

Thus, the correct match is:(2) A-III, B-I, C-IV, D-II

Quick Tip

Robert May is known for his work on global species diversity. Alexander von Humboldt's work laid the foundation for the species-area relationship.

---

148. Given below are two statements:

Statement I: In C3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Statement I is true as in C3 plants, photorespiration occurs due to RuBisCO binding with O_2 instead of CO_2. This reduces CO_2 fixation efficiency. Statement II is false because in C4 plants, both mesophyll and bundle sheath cells show little photorespiration, but the main advantage comes from the spatial separation of CO_2 fixation.

Quick Tip

In C3 plants, photorespiration reduces the efficiency of CO_2 fixation, while in C4 plants, the separation of processes in mesophyll and bundle sheath cells reduces photorespiration.

---

149. Match List-I with List-II

List-I	List-II
$A. Monoadelphous$	$I. Citrus$
$B. Diadelphous$	$II. Pea$
$C. Polyadelphous$	$III. Lily$
$D. Epiphyllous$	$IV. China - rose$

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. Monoadelphous stamens are found in China-rose, so it matches with IV.

B. Diadelphous stamens are found in Pea, so it matches with II.

C. Polyadelphous stamens are found in Citrus, so it matches with I.

D. Epiphyllous stamens are found in Lily, so it matches with III.

Thus, the correct match is: (1) A-IV, B-II, C-I, D-III.

Quick Tip

The arrangement of stamens (monadelphous, diadelphous, etc.) helps classify plants into different categories.

---

150. 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 and 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, B, C and D only

(2) B, C, D and E only

(3) A, C, D and E only

(4) A, B, C and E only

Correct Answer: (3) A, C, D and E only

Solution: A. Asexual reproduction occurs usually by biflagellate zoospores. This is true for many members of Phaeophyceae.

B. Sexual reproduction is by oogamous method only. This is not always true for all Phaeophyceae, as some species exhibit isogamous or anisogamous reproduction as well.

C. Stored food is in the form of carbohydrates such as mannitol or laminarin. This is correct for Phaeophyceae.

D. The major pigments found are chlorophyll a, c, carotenoids, and xanthophyll. This is true for Phaeophyceae.

E. Vegetative cells have a cellulosic wall, usually covered by a gelatinous coating of algin. This is also true for many members of Phaeophyceae.

Thus, the correct set of statements is A, C, D, and E only.

Quick Tip

Phaeophyceae (brown algae) are characterized by their unique pigments, carbohydrate storage, and gelatinous coatings like algin.

ZOOLOGY

Section A

151. 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

Choose the correct answer from the options given below: (1) A-IV, B-III, C-I, D-II

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

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

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

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

Solution:

- Cocaine is derived from Erythroxylum (III).
- Heroin is derived from Papaver somniferum (IV).
- Morphine is an effective sedative in surgery (I).
- Marijuana is derived from Cannabis sativa (II).

Quick Tip

Morphine and heroin are derived from the opium poppy, while marijuana comes from Cannabis sativa.

---

152. Match List I with List II:

List I	List II
A.Down's syndrome	I.11th chromosome
B.α – Thalassemia	II.'X' chromosome
C.β – Thalassemia	III.21st chromosome
D.Klinefelter's syndrome	IV.16th chromosome

Choose the correct answer from the options given below :

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

Solution: Down's syndrome is caused by a trisomy of the 21st chromosome (III).

-Thalassemia is associated with mutations on the 16th chromosome (IV).

-Thalassemia is caused by mutations on the 11th chromosome (I).

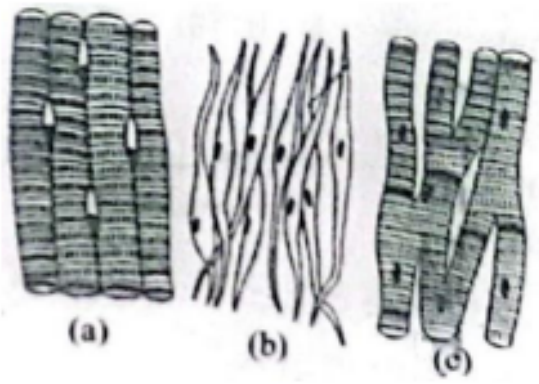
Klinefelter's syndrome is linked to the 'X' chromosome (II).

Quick Tip

Down's syndrome is characterized by an extra chromosome 21. Klinefelter's syndrome results from the presence of an extra X chromosome in males.

---

153. Three types of muscles are given as a, b, and c. Identify the correct matching pair along with their location in the human body:



Muscle Name/Location:

(1) (a) Smooth - Toes, (b) Skeletal – Legs, (c) Cardiac – Heart

(2) (a) Skeletal - Triceps, (b) Smooth – Stomach, (c) Cardiac – Heart

(3) (a) Skeletal - Biceps, (b) Involuntary – Intestine, (c) Smooth – Heart

(4) (a) Involuntary – Nose tip, (b) Skeletal – Bone, (c) Cardiac – Heart

Correct Answer: (2) (a) Skeletal - Triceps, (b) Smooth – Stomach, (c) Cardiac – Heart

Solution: Skeletal muscles (voluntary) are attached to bones like triceps. Smooth muscles (involuntary) are found in organs like the stomach. Cardiac muscles are located in the heart.

Quick Tip

Muscles are classified into skeletal, smooth, and cardiac based on structure, control, and location.

---

154. 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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2)

Solution:

Pterophyllum is the Angel fish (III). Myxine is the Hag fish (I). Pristis is the Saw fish (II). Exocoetus is the Flying fish (IV).

Quick Tip

Fish species vary widely, and each has unique adaptations like flight or deep-sea living.

---

155. Which of the following is not a component of Fallopian tube?

(1) Uterine fundus

(2) Isthmus

(3) Infundibulum

(4) Ampulla

Correct Answer: (1)

Solution: The Fallopian tube consists of components like the isthmus, infundibulum, and ampulla, but not the uterine fundus.

Quick Tip

The Fallopian tube helps in transporting eggs from the ovaries to the uterus and is not associated with the uterine fundus.

---

156. Match List I with List II:

List I	List II
A.Pleurobrachia	I.Mollusca
B.Radula	II.Ctenophora
C.Stomochord	III.Osteichthyes
D.Air bladder	IV.Hemichordata

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2)

Solution: Pleurobrachia is a ctenophore (II). Radula is a characteristic of Mollusca (I). Stomochord is a feature of Hemichordata (IV). Air bladder is found in Osteichthyes (III).

Quick Tip

Ctenophores are marine invertebrates, and the radula is a feeding organ found in mollusks.

---

157. 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) A,B D only

(2) A,B E only

(3) B,C E only

(4) C,D E only

Correct Answer: (2)

Solution: Myasthenia gravis, rheumatoid arthritis, and systemic lupus erythematosus (SLE) are autoimmune disorders. Gout and muscular dystrophy are not autoimmune disorders.

Quick Tip

Autoimmune diseases occur when the immune system mistakenly attacks the body's own cells.

---

158. Given below are two statements:

Statement I: In the nephron, the descending limb of the 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.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (2)

Solution: Statement I is false: The descending limb of the loop of Henle is permeable to water and impermeable to electrolytes.

Statement II is also false: The proximal convoluted tubule is lined by cuboidal epithelium with a brush border, not simple columnar.

Quick Tip

The loop of Henle plays a critical role in the concentration of urine and the proximal convoluted tubule aids in reabsorption.

---

159. Which of the following is not a steroid hormone?

(1) Cortisol

(2) Testosterone

(3) Progesterone

(4) Glucagon

Correct Answer: (4) Glucagon

Solution: Glucagon is a peptide hormone, not a steroid hormone. Cortisol, testosterone, and progesterone are all steroid hormones, derived from cholesterol.

Quick Tip

Steroid hormones are lipophilic and are derived from cholesterol. Peptide hormones like glucagon are water-soluble.

---

160. 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.

Choose the correct answer from the options given below:

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Statement I is true because hymen can naturally tear due to physical activities or exercise, not necessarily the first coitus. Statement II is false because the hymen may tear due to various reasons, not only during the first sexual intercourse.

Quick Tip

The hymen can tear due to activities like cycling, sports, or medical examination, not just during coitus.

---

161. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) High pO2 and High pCO2

(2) High pO2 and Lesser H+ concentration

(3) Low pCO2 and High H+ concentration

(4) Low pCO2 and High temperature

Correct Answer: (2)

Solution: High partial pressure of oxygen (pO2) and lower concentration of hydrogen ions (H+) favour the formation of oxyhaemoglobin in the alveoli.

Quick Tip

Oxyhaemoglobin is formed when oxygen binds to hemoglobin, primarily in the lungs where oxygen levels are high and pH is less acidic.

---

162. 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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (4)

Solution:

- Axoneme is associated with cilia and flagella (II).
- Cartwheel pattern is found in centrioles (I).
- Crista is a feature of mitochondria (IV).
- Satellite is associated with chromosomes (III).

Quick Tip

The structure and function of cell components like mitochondria, centrioles, and cilia are crucial for cellular processes.

163. The flippers of the Penguins and Dolphins are the example of the

(1) Adaptive radiation

(2) Natural selection

(3) Convergent evolution

(4) Divergent evolution

Correct Answer: (3)

Solution: The flippers of penguins and dolphins are examples of convergent evolution, where species from different evolutionary backgrounds evolve similar traits.

Quick Tip

Convergent evolution results in the development of similar traits in unrelated species due to similar environmental pressures.

---

164. 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) D-A-C-B

(2) B-A-D-C

(3) C-B-D-A

(4) A-D-C-B

Correct Answer: (4)

Solution: Homo habilis (A) was one of the earliest members of the genus Homo, followed by Homo erectus (D), then Homo neanderthalensis (C), and finally Homo sapiens (B).

Quick Tip

Human evolution is a continuous process, with different species evolving over time.

---

165. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on

(1) 5th segment

(2) 10th segment

(3) 8th and 9th segment

(4) 11th segment

Correct Answer: (2)

Solution: In cockroaches, anal cerci are present on the 10th segment in both sexes, which help in sensory functions.

Quick Tip

The anal cerci in cockroaches play a role in detecting air currents and vibrations.

---

166. Which of the following statements is incorrect?

(1) A bio-reactor provides optimal growth conditions for achieving the desired product

(2) Most commonly used bio-reactors are of stirring type

(3) Bio-reactors are used to produce small scale bacterial cultures

(4) Bio-reactors have an agitator system, an oxygen delivery system and foam control system

Correct Answer: (3) Bio-reactors are used to produce small scale bacterial cultures

Solution: Bio-reactors are typically used for large-scale production of microorganisms, not just small-scale bacterial cultures. They are designed to maintain optimal conditions for high-yield production.

Quick Tip

Bio-reactors are essential for large-scale fermentation processes, such as the production of antibiotics or biofuels.

---

167. Match List I with List II:

List I	List II
$A. Typhoid$	$I. Fungus$
$B. Leishmaniasis$	$II. Nematode$
$C. Ringworm$	$III. Protozoa$
$D. Filariasis$	$IV. Bacteria$

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

A. Typhoid is caused by *Salmonella typhi*, a bacteria.

B. Leishmaniasis is caused by *Leishmania*, a protozoa.

C. Ringworm is caused by a fungus.

D. Filariasis is caused by *Wuchereria bancrofti*, a nematode.

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

Quick Tip

Leishmaniasis and Filariasis are protozoal and nematode infections, respectively, while Ringworm and Typhoid are fungal and bacterial infections.

---

168. Consider the following statements:

A. Annelids are true coelomates

B. Poriferans are pseudocoelomates

C. Aschelminthes are acoelomates

D. Platyhelminthes are pseudocoelomates

Correct Answer: (2) A only

Solution:

- Annelids are true coelomates, meaning they have a body cavity completely lined with mesoderm (A).
- Poriferans are neither coelomates nor pseudocoelomates, they lack a true body cavity.
- Aschelminthes (roundworms) are pseudocoelomates, not acoelomates.
- Platyhelminthes (flatworms) are acoelomates, lacking a body cavity.

Quick Tip

Coelomates have a true coelom, pseudocoelomates have a false cavity, and acoelomates lack a body cavity.

---

169. Which of the following is not a natural/traditional contraceptive method?

(1) Coitus interruptus

(2) Periodic abstinence

(3) Lactational amenorrhea

(4) Vaults

Correct Answer: (4)

Solution: Vaults are not a natural or traditional contraceptive method. Coitus interruptus, periodic abstinence, and lactational amenorrhea are all traditional methods.

Quick Tip

Traditional contraceptive methods are those that do not involve modern medical interventions but rely on behavior or biological processes.

170. Match List I with List II:

List I	List II
A.Pons	I.Provides additional 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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2)

Solution:

- Pons connects different regions of the brain (III).
- Hypothalamus has neurosecretory cells (IV).
- Medulla controls respiration and gastric secretions (II).
- Cerebellum provides additional space for neurons, regulates posture and balance (I).

Quick Tip

The pons and medulla are part of the brainstem, which controls vital functions like respiration and heartbeat.

171. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Genetic recombination

(2) Genetic drift

(3) Gene migration

(4) Constant gene pool

Correct Answer: (4)

Solution: A constant gene pool means no changes in allele frequencies, so it does not affect the Hardy-Weinberg equilibrium. Genetic recombination, genetic drift, and gene migration all influence allele frequencies.

Quick Tip

The Hardy-Weinberg equilibrium assumes that no evolutionary forces are acting on the population (no genetic drift, migration, mutation, or natural selection).

---

172. Match List I with List II:

List I	List II
$A.\alpha - Iantitrypsin$	I.Cotton bollworm
B.Cry IAb	II.ADA deficiency
C.Cry IAc	III.Emphysema
D.Enzyme replacement therapy	IV.Corn borer

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (3)

Solution:

- α-I antitrypsin deficiency leads to emphysema (III).
- Cry IAb is associated with cotton bollworm (I).

- Cry IAc is associated with corn borer (IV).
- Enzyme replacement therapy is used for ADA deficiency (II).

Quick Tip

Cry proteins are insecticidal and are used in genetically modified crops to protect them from pests like bollworm and corn borer.

---

173. Following are the stages of pathway for conduction of an action potential through the heart

A. AV bundle

B. Purkinje fibers

C. AV node

D. Bundle branches

E. SA node

Choose the correct sequence of pathway from the options given below:

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

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

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

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

Correct Answer: (1) E-C-A-D-B

Solution: The correct sequence for conduction of an action potential in the heart is:

$$\text{SA node} \rightarrow \text{AV node} \rightarrow \text{AV bundle} \rightarrow \text{Bundle branches} \rightarrow \text{Purkinje fibers}$$

Thus, the correct sequence is: (1) E-C-A-D-B.

Quick Tip

The action potential in the heart follows a specific sequence to ensure coordinated contraction: SA node $\rightarrow$ AV node $\rightarrow$ AV bundle $\rightarrow$ Bundle branches $\rightarrow$ Purkinje fibers.

174. The "Ti plasmid" of Agrobacterium tumefaciens stands for

(1) Tumour inhibiting plasmid

(2) Tumor independent plasmid

(3) Tumor inducing plasmid

(4) Temperature independent plasmid

Correct Answer: (3)

Solution: The Ti plasmid in Agrobacterium tumefaciens induces the formation of tumors in plants by transferring part of the plasmid DNA to the plant genome.

Quick Tip

The Ti plasmid is a key tool in plant genetic engineering, used to insert foreign genes into plant cells.

175. Match List I with List II:

List I	List II
A.Expiratory capacity	I.Expiratory reserve volume + Tidal volume + Inspiratory 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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (1)

Solution:

- Expiratory capacity = Tidal volume + Expiratory reserve volume (II).
- Functional residual capacity = Expiratory reserve volume + Residual volume (IV).
- Vital capacity = Expiratory reserve volume + Tidal volume + Inspiratory reserve volume (I).
- Inspiratory capacity = Tidal volume + Inspiratory reserve volume (III).

Quick Tip

Vital capacity is the maximum amount of air a person can exhale after a maximum inhalation.

---

176. 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) C-E-D-A-B

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

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

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

Correct Answer: (4)

Solution: The correct sequence of stages in cell division is:

1. Gap 1 phase (E)
2. Synthesis phase (C)
3. Gap 2 phase (A)
4. Karyokinesis (D)
5. Cytokinesis (B)

Quick Tip

Cell division includes interphase (G1, S, G2) and mitosis (karyokinesis and cytokinesis).

---

177. 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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (4)

Solution:

- Fibrous joints are immovable like those in the skull (III).
- Cartilaginous joints are slightly movable, such as between adjacent vertebrae (I).
- Hinge joints allow movement like in the knee (IV).
- Ball and socket joints allow rotational movement like in the humerus and pectoral girdle (II).

Quick Tip

Joints in the human body are classified based on their structure and the type of movement they allow.

178. Given below are two statements:

Statement I: FSH acts upon ovarian follicles in female and Leydig cells in male.

Statement II: Growing ovarian follicles secrete estrogen in female while interstitial cells secrete androgen in male human beings.

Choose the correct answer from the options given below:

(1) Both Statement I and Statement II are true and R is the correct explanation of A

(2) Both Statement I and Statement II are true but R is NOT the correct explanation of A

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

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

Correct Answer: (4) Statement I is false but Statement II is true

Solution: Statement I is false because FSH acts on granulosa cells in females and Sertoli cells in males, not on Leydig cells. Statement II is true as estrogen is secreted by growing ovarian follicles and androgens by Leydig cells.

Quick Tip

FSH stimulates the granulosa cells in females and Sertoli cells in males, while LH stimulates the Leydig cells in males.

179. 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

Choose the correct answer from the options given below

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

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

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

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

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

Solution:

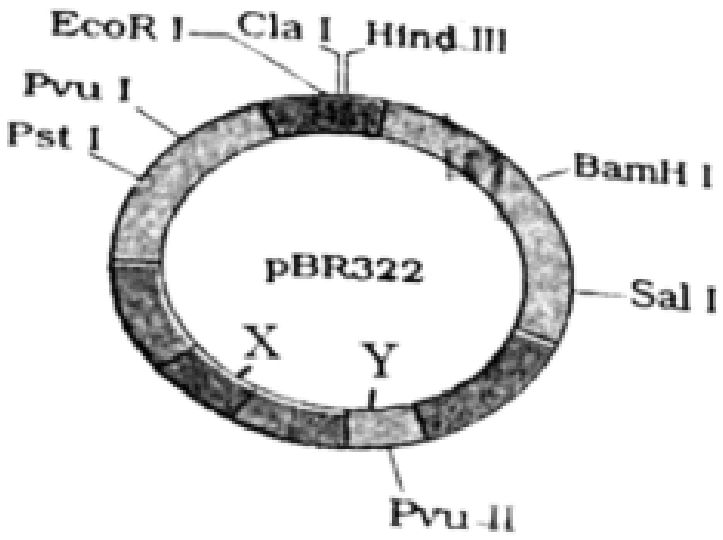
- Diakinesis involves terminalisation of chiasmata (II).
- Pachytene is marked by the appearance of recombination nodules (IV).
- Zygotene is when the synaptonemal complex forms (I).
- Leptotene is characterized by chromosomes appearing as thin threads (III).

Quick Tip

Prophase I of meiosis has distinct stages: leptotene, zygotene, pachytene, diplotene, and diakinesis.

---

180. The following diagram showing restriction sites in E. coli cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of Plasmid.

(2) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.

(3) The gene 'X' is for protein involved in replication of Plasmid and 'Y' for resistance to antibiotics.

(4) Gene 'X' is responsible for recognition sites and 'Y' is responsible for antibiotic resistance.

Correct Answer: (2)

Solution: Gene 'X' in the plasmid pBR322 is responsible for controlling the copy number of the plasmid, while Gene 'Y' is involved in the replication process.

Quick Tip

pBR322 is a commonly used plasmid vector in genetic engineering that contains antibiotic resistance genes and replication control mechanisms.

---

181. 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

Choose the correct answer from the options given below :

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

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

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

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

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

Solution:

- Common cold is caused by Rhinoviruses (III).
- Haemozoin is released in blood due to ruptured RBCs after Plasmodium infection (I).
- Widal test is used to confirm typhoid fever (II).
- Allergy is caused due to dust mites (IV).

Quick Tip

Rhinoviruses are the main cause of common cold, while Haemozoin is produced in Plasmodium infection.

---

182. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- Non-medicated IUD is Lippes loop (III).
- Copper releasing IUD is Multiload 375 (I).
- Hormone releasing IUD is LNG-20 (IV).
- Implants contain Progestogens (II).

Quick Tip

IUDs (Intrauterine Devices) are either medicated or non-medicated and work by releasing copper or hormones to prevent pregnancy.

---

183. Given below are two statements:

One is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: Breast-feeding during 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 new born baby. **In the light of the above statements, choose the most appropriate answer from the options given below:**

(1) Both A and R are correct and R is the correct explanation of A

(2) Both A and R are correct but R is NOT the correct explanation of A

(3) A is correct but R is not correct

(4) A is not correct but R is correct

Correct Answer: (1)

Solution: Breast-feeding is essential for infant health, and colostrum contains antibodies that help develop resistance against infections, making both statements true. The reason correctly explains the assertion.

Quick Tip

Breast-feeding provides crucial nutrients and antibodies through colostrum, which is the first milk produced after birth.

---

184. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- Lipase acts on ester bonds (II).
- Nuclease acts on phosphodiester bonds (IV).
- Protease breaks peptide bonds (I).
- Amylase acts on glycosidic bonds (III).

Quick Tip

Lipase, Nuclease, Protease, and Amylase are enzymes that break down different bonds in molecules like fats, nucleic acids, proteins, and carbohydrates.

---

185. Which one is the correct product of DNA dependent RNA polymerase to the given template?

$$3'\text{TACATGGCAAATATCCATTCA}5'$$

(1) 5' AUGUACCGUUUAUAGGUAAGU 3'

(2) 5' AUGUAAAGUUUAUAGGUAAGU 3'

(3) 5' AUGUACCGUUUAUAGGGAAGU 3'

(4) 5' ATGTACCGTTTATAGGTAAGT 3'

Correct Answer: (1) 5' AUGUACCGUUUAUAGGUAAGU 3'

Solution: The correct RNA sequence transcribed from the template strand is 5' AUGUACCGUUUAUAGGUAAGU 3'. RNA polymerase synthesizes the RNA strand in the 5' $\rightarrow$ 3' direction, complementary to the DNA template.

Quick Tip

DNA-dependent RNA polymerase uses the DNA template strand to synthesize an RNA strand complementary to the template.

---

186. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. The structures used for storing of food: The crop is the part of the cockroach's digestive system responsible for storing food.

B. Ring of 6-8 blind tubules at junction of foregut and midgut: These are the gastric caeca, which help in digestion by secreting digestive enzymes.

C. Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut: These are the Malpighian tubules, responsible for excretion and osmoregulation.

D. The structures used for grinding the food: The gizzard grinds food, breaking down particles mechanically.

Quick Tip

In cockroaches, the crop stores food, the gastric caeca aids in digestion, the gizzard grinds food, and the Malpighian tubules are responsible for excretion and waste removal.

187. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - A. RNA polymerase III: It synthesizes tRNA and small RNAs such as snRNAs. - B. Termination of transcription: Rho factor is involved in terminating transcription in prokaryotes. - C. Splicing of Exons: snRNPs (small nuclear ribonucleoproteins) are involved in splicing introns and exons in eukaryotic mRNA processing. - D. TATA box: The TATA box is a promoter region that plays a role in the initiation of transcription in eukaryotes.

Quick Tip

RNA polymerase III is responsible for the synthesis of small RNAs such as tRNA, while the TATA box in the promoter region is essential for the initiation of transcription in eukaryotes.

188. 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.

Correct Answer: (3) B, D E only

Solution: Statement A is incorrect because the pharynx is not perforated by gill slits in all non-chordates; it is characteristic of chordates.

Statement B is correct as non-chordates lack a notochord.

Statement C is incorrect because the central nervous system in non-chordates is typically ventral.

Statement D is correct as the heart, if present, is dorsal in non-chordates.

Statement E is correct as many non-chordates lack a post-anal tail.

Quick Tip

Non-chordates lack a notochord and the dorsal position of the heart, unlike chordates.

Quick Tip

Non-chordates lack a notochord and the dorsal position of the heart, unlike chordates.

190.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, as compared to the chloroplast membrane.

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

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

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

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

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

Correct Answer: (3) Statement I is correct but Statement II is incorrect.

Solution:

Statement I: Correct. Both mitochondria and chloroplasts are double membrane-bound organelles.

Statement II: Incorrect. The inner membrane of mitochondria is more impermeable compared to the outer membrane, but chloroplast membranes also have selective permeability, so this statement is not entirely correct.

Quick Tip

Mitochondria and chloroplasts have double membranes. The inner membrane of mitochondria is highly impermeable to ions, whereas chloroplast membranes vary in permeability to facilitate photosynthesis.

---

191. Given below are two statements:

Statement I: The cerebral hemispheres are connected by 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) Both Statement I and Statement II are correct.

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

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

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

Correct Answer: (3) Statement I is correct but Statement II is incorrect.

Solution: Statement I is correct because the cerebral hemispheres are indeed connected by the corpus callosum, which allows communication between the two hemispheres.

Statement II is incorrect because the brainstem consists of the medulla oblongata, pons, and midbrain, not the cerebrum.

Quick Tip

The corpus callosum is essential for the exchange of information between the two cerebral hemispheres.

---

192. 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) E, A, D, C, B

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

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

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

Correct Answer: (1) E, A, D, C, B

Solution: -E. The substrate binds to the active site of the enzyme, initiating the catalytic process.

-A. The enzyme-substrate complex is formed after the substrate binds to the active site.

-D. The enzyme catalyzes the breaking of chemical bonds in the substrate, facilitating the transition state.

-C. The product is released from the enzyme after the reaction.

-B. The enzyme is now free and ready to bind with a new substrate.

Quick Tip

The enzyme catalytic cycle involves the binding of substrate, conversion into products, and release. The enzyme is reused in subsequent cycles.

---

193. 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.

Correct Answer: (4) Statement I is false but Statement II is true.

Solution: Statement I is false because Gause's competitive exclusion principle states that two species competing for the same limiting resource cannot coexist indefinitely, not necessarily for different resources.

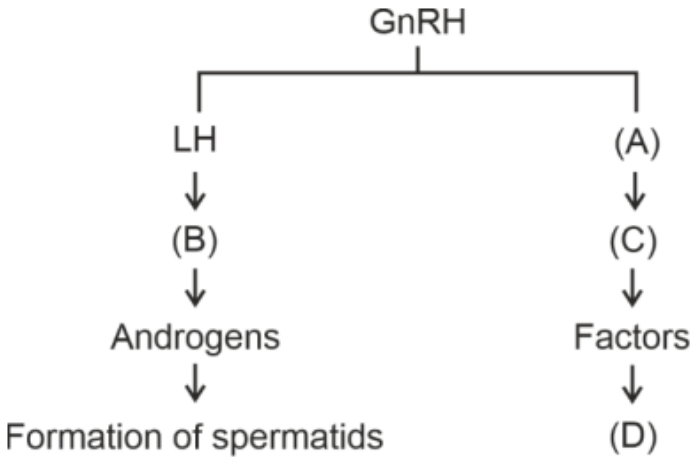
Statement II is true as, according to Gause's principle, the inferior competitor is often eliminated when resources are limited.

Quick Tip

Gause's principle highlights that no two species can occupy the same niche for long if they are competing for the same resources.

---

194. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



(1) FSH, Leydig cells, Sertoli cells, spermiogenesis.

(2) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

(3) FSH, Sertoli cells, Leydig cells, spermatogenesis.

(4) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

Correct Answer: (1) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution: FSH (Follicle Stimulating Hormone) stimulates Sertoli cells, which support the process of spermatogenesis.

Leydig cells secrete testosterone, which is essential for spermatogenesis.

Spermiogenesis refers to the maturation of spermatids into sperm.

Quick Tip

Spermatogenesis involves the transformation of spermatogonia into mature sperm cells through a series of stages, including spermiogenesis.

---

195. 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.

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

A. P wave: Represents the depolarisation of the atria.

B. QRS complex: Represents the depolarisation of ventricles.

C. T wave: Represents the repolarisation of ventricles.

D. T-P gap: Indicates a period where heart muscles are electrically silent, representing no electrical activity.

Quick Tip

The P wave, QRS complex, and T wave are key components of the electrocardiogram (ECG) that correspond to different phases of heart muscle electrical activity.

---

196. Choose the correct statement given below regarding juxta medullary nephron.

A. Juxta medullary nephrons are located in the columns of Bertini.

B. Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.

C. Loop of Henle of juxta medullary nephron runs deep into medulla.

D. Juxta medullary nephrons outnumber the cortical nephrons.

Correct Answer: C

Solution: -A. Incorrect: Juxta medullary nephrons are located at the junction of the cortex and medulla, not in the columns of Bertini. -B. Incorrect: The renal corpuscle of juxta medullary nephrons is located in the outer cortex, not in the outer medulla. -C. Correct: The loop of Henle of juxta medullary nephrons extends deep into the medulla, which helps in concentrating the urine. -D. Incorrect: Juxta medullary nephrons are fewer in number compared to cortical nephrons.

Quick Tip

The juxta medullary nephrons are vital for water conservation as their deep loop of Henle helps in the concentration of urine.

---

197. 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 micro environments 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) Both Statement I and Statement II are correct.

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

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

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

Correct Answer: (1) Both Statement I and Statement II are correct.

Solution: Statement I: Correct. Bone marrow is indeed the primary lymphoid organ responsible for the production of blood cells, including lymphocytes.
Statement II: Correct. The bone marrow produces T-lymphocytes, which mature in the thymus. Both organs provide the necessary environments for T-cell development.

Quick Tip

Bone marrow is the site of hematopoiesis (blood cell production), while the thymus is responsible for the maturation of T-lymphocytes, essential for the adaptive immune response.

---

198. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. Unicellular glandular epithelium: Goblet cells in the alimentary canal secrete mucus.

B. Compound epithelium: Found on the moist surface of the buccal cavity.

C. Multicellular glandular epithelium: Includes salivary glands which secrete saliva.

D. Endocrine glandular epithelium: Found in the pancreas, involved in hormone secretion.

Quick Tip

Glandular epithelium includes unicellular (e.g., goblet cells), multicellular (e.g., salivary glands), and endocrine glands that secrete hormones (e.g., pancreas).

---

199. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. Mesozoic Era: Known as the age of reptiles and birds, including dinosaurs.

B. Proterozoic Era: Dominated by lower invertebrates.

C. Cenozoic Era: Age of mammals, characterized by their rise.

D. Paleozoic Era: Dominated by fish and amphibians.

Quick Tip

The Mesozoic era is known for dinosaurs, the Cenozoic era for mammals, and the Paleozoic era for early vertebrates like fish and amphibians.

200.As per ABO blood grouping system, the blood group of father is B+, mother is A+ and child is O+. Their respective genotype can be

A. $I^Bi/I^Ai/ii$

B. $I^BI^B/I^AI^A/ii$

C. $I^AI^B/iI^A/I^Bi$

D. $I^Ai/I^Bi/I^Ai$

Choose the most appropriate answer from the options given below : (1) A only

(2) B only

(3) C and B only

(4) D and E only

Correct Answer: (1) A only

Solution: The father with blood group B+ could have a genotype IBi or IBIB, while the mother with blood group A+ could have IAi or IAIA.

The child with blood group O+ must inherit an i allele from both parents, making the father's genotype IBi and the mother's genotype IAi.

Quick Tip

In the ABO blood group system, O blood type is recessive, and both parents must carry the i allele to produce a child with blood group O.