CUET PG 2024 Nano Science Nano Technology Shift 2

Time Allowed :1 Hours 45 minutes	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises 75 questions. All questions are compulsory.
2. Each question carries 04 (four) marks.
3. For each correct response, the candidate will get 04 (four) marks.
4. For each incorrect response, 01 (one) mark will be deducted from the total score.
5. Un-answered/un-attempted response will be given no marks.
6. To answer a question, the candidate needs to choose one option as the correct option.
7. However, after the process of challenges of the Answer Key, in case there are multiple correct options or a change in the key, only those candidates who have attempted it correctly as per the revised Final Answer Key will be awarded marks.
8. In case a question is dropped due to some technical error, full marks shall be given to all the candidates irrespective of the fact who have attempted it or not.

Question 1: Bond angle in ammonia molecule is:

Options:

(A) Higher than the methane molecule

(B) Higher than the water molecule

(C) Lower than the water molecule

(D) Equal to the methane molecule

Correct Answer: (B) Higher than the water molecule

Solution:

Ammonia (NH_3) has a bond angle of approximately $107°$, which is slightly less than the tetrahedral angle of $109.5°$ due to the repulsion caused by the lone pair of electrons. In contrast, water (H_2O) has a bond angle of $104.5°$, making the bond angle in ammonia larger.

Quick Tip

Bond angles decrease with the increase in lone pair repulsion. Water has two lone pairs, while ammonia has one, leading to a larger bond angle in ammonia.

Question 2: Fullerene is the allotrope of:

Options:

(A) Carbon

(B) Sulphur

(C) Phosphorus

(D) Fluorine

Correct Answer: (A) Carbon

Solution:

Fullerene is an allotrope of carbon. It consists of carbon atoms arranged in a spherical, ellipsoidal, or tubular shape. The most common fullerene is C_{60}, which has a structure similar to a soccer ball. Fullerene is used in nanotechnology and material sciences due to its unique properties.

Quick Tip

Allotropes are different structural forms of the same element. Fullerene, graphite, and diamond are all allotropes of carbon.

Question 3: Which of the following oxidation states of lanthanides is preferably more stable?

Options:

(A) +2 oxidation state

(B) +3 oxidation state

(C) +4 oxidation state

(D) -1 oxidation state

Correct Answer: (B) +3 oxidation state

Solution:

Lanthanides typically exhibit the +3 oxidation state due to the removal of three electrons from the $4f$, $5d$, and $6s$ orbitals. This state is energetically most stable because of the noble gas-like electronic configuration after ionization.

Quick Tip

The +3 oxidation state is the hallmark of lanthanides because it provides stability due to a full or half-filled f-orbital configuration.

Question 4: Which pair of the following transition elements shows the highest number of oxidation states?

Options:

(A) Chromium and Titanium

(B) Nickel and Iron

(C) Copper and Zinc

(D) Chromium and Manganese

Correct Answer: (D) Chromium and Manganese

Solution:

Chromium exhibits oxidation states ranging from +2 to +6, while manganese displays states from +2 to +7. These extensive ranges are due to the availability of unpaired d-electrons and the ability to form stable compounds in various states.

Quick Tip

Transition elements with partially filled d-orbitals exhibit multiple oxidation states. Chromium and manganese are notable examples.

Question 5: Ziegler-Natta catalyst is used for the polymerization of ethylene to produce:

Options:

(A) Stereoregular polyethylene

(B) Branched polyethylene

(C) Low density polyethylene

(D) Random polyethylene

Correct Answer: (C) Low density polyethylene

Solution:

Ziegler-Natta catalysts are utilized in polymerization processes to produce polyethylene with various densities. For low-density polyethylene (LDPE), the catalyst promotes branching during polymerization, reducing density and enhancing flexibility and toughness.

Quick Tip

Low-density polyethylene is produced using specific catalysts that allow controlled branching, making it suitable for flexible applications like plastic bags.

Question 6: PCl_5 is highly reactive, hence, in solid state, it is dissociated into:

Options:

(A) $[PCl_4^+]$ tetrahedral and $[PCl_6^-]$ octahedral respectively

(B) $[PCl_3]$ and $[PCl_2]$ respectively

(C) $[PCl_2^+]$ tetrahedral and $[PCl_3^-]$ octahedral respectively

(D) $[PCl_4^-]$ tetrahedral and $[PCl_5^+]$ octahedral respectively

Correct Answer: (A) $[PCl_4^+]$ tetrahedral and $[PCl_6^-]$ octahedral respectively

Solution:

In the solid state, PCl_5 dissociates into $[PCl_4^+]$ and $[PCl_6^-]$, which adopt tetrahedral and octahedral geometries, respectively. This is due to the stabilization of these ions in the crystal lattice.

Quick Tip

Remember that PCl_5 dissociates in the solid state to form ions with geometries that minimize lattice energy.

Question 7: For the change $Fe^{3+} \rightarrow Fe^{2+}$, $E^\circ = +0.77\,V$, which indicates:

Options:

(A) Fe^{3+} has the tendency to reduce to Fe^{2+}

(B) Fe^{2+} has the tendency to reduce to Fe^{3+}

(C) Fe^{3+} has the tendency to reduce to Fe but Fe^{2+} does not

(D) Neither Fe^{2+} nor Fe^{3+} has the tendency to reduce to Fe

Correct Answer: (D) Neither Fe^{2+} nor Fe^{3+} has the tendency to reduce to Fe

Solution:

The positive reduction potential $E^\circ = +0.77\,V$ applies to the reduction of Fe^{3+} to Fe^{2+}, indicating this reaction is favorable. However, neither Fe^{2+} nor Fe^{3+} readily reduces further to elemental iron (Fe), as their reduction potentials for these reactions are less favorable.

Quick Tip

Reduction potentials help predict the spontaneity of reactions. A less favorable potential indicates that further reduction is unlikely.

Question 8: Liquid drop model was proposed to explain:

Options:

(A) The structure of an atom

(B) The stability of the nucleus

(C) Geometry of the molecules

(D) Polarization in the molecules

Correct Answer: (B) The stability of the nucleus

Solution:

The liquid drop model, proposed by George Gamow, explains the stability of atomic nuclei. It likens the nucleus to a liquid drop, with nucleons held together by strong nuclear forces, overcoming repulsive electrostatic forces among protons.

Quick Tip

The liquid drop model helps explain nuclear fission and the binding energy of nuclei.

Question 9: Gadolinium belongs to the:

Options:

(A) s-block elements

(B) p-block elements

(C) d-block elements

(D) f-block elements

Correct Answer: (D) f-block elements

Solution:

Gadolinium (Gd) is an element in the lanthanide series, part of the f-block in the periodic

table. It has the electron configuration [Xe] $4f^7 5d^1 6s^2$, where the $4f$-orbitals are being filled.

Quick Tip

The f-block elements, also called lanthanides and actinides, involve the filling of $4f$ and $5f$-orbitals, respectively.

Question 10: Which of the following has the highest bond order?

Options:

(A) O_2^-

(B) O_2^{2-}

(C) O_2

(D) O_2^+

Correct Answer: (D) O_2^+

Solution:

Bond order is calculated as:

$$\text{Bond Order} = \frac{\text{Number of bonding electrons} - \text{Number of antibonding electrons}}{2}$$

For each species:

- O_2^+: Bond order = $\frac{10-5}{2} = 2.5$
- O_2: Bond order = $\frac{10-6}{2} = 2$
- O_2^-: Bond order = $\frac{10-7}{2} = 1.5$
- O_2^{2-}: Bond order = $\frac{10-8}{2} = 1$

Thus, O_2^+ has the highest bond order of 2.5.

Quick Tip

Higher bond order indicates stronger bonds and shorter bond lengths. For molecular species, bond order can be determined using molecular orbital theory.

Question 11: The correct energy order for molecular orbitals is:

collegedunia

Options:

(A) Bonding MO $<$ non-bonding MO $<$ antibonding MO

(B) Antibonding MO $<$ non-bonding MO $<$ bonding MO

(C) Non-bonding MO $<$ bonding MO $<$ antibonding MO

(D) Bonding MO $<$ antibonding MO $<$ non-bonding MO

Correct Answer: (A) Bonding MO $<$ non-bonding MO $<$ antibonding MO

Solution:

Molecular orbitals are arranged in increasing energy as follows: bonding molecular orbitals have the lowest energy, followed by non-bonding molecular orbitals, and antibonding molecular orbitals have the highest energy. This energy difference arises due to the interaction of atomic orbitals.

Quick Tip

Bonding MOs stabilize the molecule, while antibonding MOs destabilize it. Non-bonding MOs are neutral and contribute neither to stability nor instability.

Question 12: $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$ are examples of:

Options:

(A) Linkage isomerism

(B) Coordination isomerism

(C) Ionisation isomerism

(D) Hydrate isomerism

Correct Answer: (B) Coordination isomerism

Solution:

Coordination isomerism occurs when the ligands in the coordination sphere exchange between two different metal centers. In the given compounds, the NH_3 and CN^- ligands swap their positions between the cobalt and chromium ions.

Quick Tip

Coordination isomerism involves the exchange of ligands between metal cations in a coordination compound.

Question 13: A thermodynamic process which is carried out at constant temperature is called:

Options:

(A) Isochoric process

(B) Isothermal process

(C) Isobaric process

(D) Adiabatic process

Correct Answer: (B) Isothermal process

Solution:

An isothermal process occurs when the temperature of the system remains constant throughout the process. This implies that the internal energy of an ideal gas remains unchanged, and any heat added to the system does work on the surroundings.

Quick Tip

In an isothermal process, $\Delta T = 0$, and for an ideal gas, $\Delta U = 0$, so $Q = W$.

Question 14: Which of the following is correct for the ionic product of water?

Options:

(A) $K_w = [\mathrm{H}^+][\mathrm{OH}^-]$

(B) $K_w = [\mathrm{H}^+] + [\mathrm{OH}^-]$

(C) $K_w = \frac{[\mathrm{H}^+]}{[\mathrm{OH}^-]}$

(D) $K_w = [\mathrm{H}^-][\mathrm{OH}^+]$

Correct Answer: (A) $K_w = [\mathbf{H}^+][\mathbf{OH}^-]$

Solution:

The ionic product of water (K_w) is defined as the product of the molar concentrations of hydrogen ions ($[H^+]$) and hydroxide ions ($[OH^-]$) in water at a specific temperature. At 25°C, $K_w = 1.0 \times 10^{-14}\,\text{mol}^2\,\text{L}^{-2}$.

Quick Tip

For pure water at 25°C, $[H^+] = [OH^-] = 1.0 \times 10^{-7}$ mol/L, giving $K_w = 1.0 \times 10^{-14}$.

Question 15: For the isolated system, if the entropy change is positive, then the process will be:

Options:

(A) Spontaneous

(B) Non-spontaneous

(C) In equilibrium

(D) Reversible

Correct Answer: (A) Spontaneous

Solution:

In an isolated system, a positive change in entropy ($\Delta S > 0$) indicates an increase in disorder, which is the driving force for spontaneity. According to the second law of thermodynamics, the entropy of an isolated system always increases for a spontaneous process.

Quick Tip

A positive ΔS in an isolated system is a hallmark of spontaneity, reflecting the natural tendency toward increased disorder.

Question 16: Lower value ($< 10^3$) of equilibrium constant shows that the:

Options:

(A) Forward reaction is favoured

(B) Backward reaction is favoured

(C) Equilibrium will never be established

(D) Concentration of products dominate over concentration of reactants

Correct Answer: (B) Backward reaction is favoured

Solution:

A lower value of the equilibrium constant ($K < 10^3$) indicates that the reaction favors the reactants. This means that the backward reaction (conversion of products to reactants) is more prominent at equilibrium.

Quick Tip

The magnitude of the equilibrium constant gives insight into reaction direction. $K > 10^3$ favors products, while $K < 10^{-3}$ strongly favors reactants.

Question 17: Manufacturing of ammonia is favored at:

Options:

(A) Low temperature and high pressure

(B) High temperature and low pressure

(C) High temperature and high pressure

(D) Low temperature and low pressure

Correct Answer: (B) High temperature and low pressure

Solution:

Although low temperature favors ammonia production due to the exothermic nature of the reaction, high temperature is often used in industrial processes to increase the rate of reaction. Low pressure is sometimes employed to control costs, even though it slightly reduces the yield.

Quick Tip

Industrial processes often balance reaction rate and equilibrium yield. While low temperature and high pressure maximize yield, high temperature and low pressure optimize practicality.

Question 18: Which of the following statement is not correct for acids?

Options:

(A) They turn blue litmus to red

(B) They react with active metal to produce hydrogen

(C) They react with bases to form salts

(D) They are sour in taste

Correct Answer: (C) They react with bases to form salts

Solution:

Acids are defined as substances that donate protons (H^+) or accept electrons. They turn blue litmus red, react with active metals to release hydrogen gas, and are sour in taste. The incorrect statement is option (C), as acids neutralize bases to form salts, which involves a mutual reaction, not just acids reacting with bases.

Quick Tip

Acids donate protons (H^+) and neutralize bases. Their properties include turning blue litmus red, reacting with metals, and having a sour taste.

Question 19: Conjugate base of H_2SO_4 is:

Options:

(A) SO_4^{2-}

(B) HSO_4^-

(C) HSO_4^+

(D) SO_4^-

collegedunia

Correct Answer: (C) HSO_4^+

Solution:

The conjugate base is formed by removing a proton (H^+) from an acid. For H_2SO_4, the removal of one H^+ results in HSO_4^+, making it the conjugate base of sulfuric acid.

Quick Tip

A conjugate base is formed by the removal of a proton (H^+) from the acid. For polyprotic acids, the conjugate base can act as another acid.

Question 20: Which of the following acidity order is correct?

Options:

(A) HI < HBr < HCl < HF

(B) HF < HCl < HBr < HI

(C) HI < HCl < HBr < HF

(D) HF < HBr < HCl < HI

Correct Answer: (D) HF < HBr < HCl < HI

Solution:

Acidity increases down the group in the halogens (Group 17) due to the decreasing bond strength of the H-X bond. HI is the most acidic because the bond dissociation energy is the lowest, while HF is the least acidic due to its strong H-F bond.

Quick Tip

Acidity in halogen acids (HX) follows the trend: HF < HBr < HCl < HI, influenced by bond strength and stability of the conjugate base.

Question 21: In methyl cation (CH_3^+), carbon is:

Options:

(A) sp^3-hybridized

collegedunia

(B) sp^2-hybridized

(C) sp-hybridized

(D) sp^3d-hybridized

Correct Answer: (B) sp^2-hybridized

Solution:

In a methyl cation (CH_3^+), the central carbon atom is sp^2-hybridized because it has three bonding pairs and no lone pairs. The unhybridized p-orbital remains empty, making it planar in geometry.

Quick Tip

A positively charged carbon atom (C^+) is usually sp^2-hybridized, resulting in a planar structure with an empty p-orbital.

Question 22: In naphthalene, the total number of delocalized π-electrons are:

Options:

(A) 4

(B) 10

(C) 8

(D) 12

Correct Answer: (B) 10

Solution:

Naphthalene consists of two fused benzene rings, each contributing π-electrons from alternating double bonds. In total, there are 10 delocalized π-electrons, following Huckel's rule ($4n + 2$, where $n = 2$) for aromaticity.

Quick Tip

Aromatic compounds like naphthalene follow Huckel's rule ($4n + 2$) for delocalized π-electrons, which ensures stability and aromaticity.

collegedunia

Question 23: Friedel-Craft acylation is an example of:

Options:

(A) Electrophilic substitution reaction

(B) Nucleophilic substitution reaction

(C) Electrophilic addition reaction

(D) Nucleophilic addition reaction

Correct Answer: (A) Electrophilic substitution reaction

Solution:

Friedel-Craft acylation involves the substitution of a hydrogen atom in an aromatic ring by an acyl group ($-CO-$), mediated by a Lewis acid catalyst like $AlCl_3$. This is a classic example of an electrophilic substitution reaction.

Quick Tip

Friedel-Craft acylation is widely used in organic synthesis to introduce acyl groups into aromatic rings via electrophilic substitution.

Question 24: Which of the following order of carbocation stability is correct?

Options:

(A) $CH_3^+ < CH_2CH_2^+ < (CH_3)_2CH^+ < (CH_3)_3C^+$

(B) $CH_3^+ > CH_2CH_2^+ > (CH_3)_2CH^+ > (CH_3)_3C^+$

(C) $CH_3^+ < (CH_3)_2CH^+ < CH_2CH_2^+ < (CH_3)_3C^+$

(D) $(CH_3)_3C^+ < CH_3^+ < CH_2CH_2^+ < (CH_3)_2CH^+$

Correct Answer: (A) $\mathbf{CH_3^+ < CH_2CH_2^+ < (CH_3)_2CH^+ < (CH_3)_3C^+}$

Solution:

Carbocation stability is determined by the inductive effect, hyperconjugation, and resonance. A tertiary carbocation is the most stable due to the availability of three alkyl groups for electron donation, followed by secondary and primary carbocations. A methyl carbocation (CH_3^+) is the least stable.

Quick Tip

Carbocation stability order: tertiary $>$ secondary $>$ primary $>$ methyl. Stabilization occurs due to hyperconjugation and inductive effects.

Question 25: The monomer unit of natural rubber is:

Options:

(A) Isoprene

(B) Ethylene

(C) Isobutylene

(D) Propene

Correct Answer: (A) Isoprene

Solution:

Natural rubber is a polymer of isoprene (2-methyl-$1,3$-butadiene). The polymerization of isoprene occurs via 1,4-addition, resulting in cis-polyisoprene, which is the primary component of natural rubber.

Quick Tip

Natural rubber is derived from isoprene, forming a polymer with elastic properties due to its cis-configuration.

Question 26: Which of the following are coherent sources?

Options:

(A) A 60 W and a 100 W bulb

(B) Two bulbs each of 60 W

(C) Two halves of a 60 W bulb

(D) Two virtual sources obtained by a biprism

Correct Answer: (D) Two virtual sources obtained by a biprism

Solution:

Coherent sources are those that maintain a constant phase difference and have the same frequency. Virtual sources created by a biprism are coherent because they are derived from the same parent light source.

Quick Tip

Coherent sources are essential for stable interference patterns and are typically produced by splitting a single source of light.

Question 27: In Newton's rings arrangement with air film in reflected light, the diameter of the m^{th} bright ring is D_m. If the air is replaced by a liquid film of refractive index μ, the diameter of the m^{th} ring will become:

Options:

(A) $\sqrt{\mu} D_m$

(B) $\frac{D_m}{\mu}$

(C) $\frac{D_m}{\sqrt{\mu}}$

(D) μD_m

Correct Answer: (B) $\frac{D_m}{\mu}$

Solution:

The diameter of the m^{th} bright ring is proportional to the square root of the wavelength. When air is replaced by a liquid with refractive index μ, the wavelength in the medium becomes $\lambda = \frac{\lambda_0}{\mu}$, reducing the ring diameter proportionally to $\frac{1}{\mu}$.

Quick Tip

In Newton's rings, replacing air with a medium of refractive index μ reduces the diameter of the rings by a factor of $\frac{1}{\mu}$.

Question 28: The intensity ratio of the two interfering beams of light is β. What is the value of $\frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$?

collegedunia

Options:

(A) $\frac{2}{\sqrt{\beta}}$

(B) $\frac{2\sqrt{\beta}}{(1+\beta)}$

(C) $\frac{2(1+\beta)}{\beta}$

(D) $(1+\beta)/\sqrt{\beta}$

Correct Answer: (B) $\frac{2\sqrt{\beta}}{(1+\beta)}$

Solution:

The contrast ratio or visibility in interference is given by:

$$\text{Visibility} = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$$

Substituting the intensity ratio $\beta = I_1/I_2$, the formula simplifies to $\frac{2\sqrt{\beta}}{(1+\beta)}$, which represents the degree of contrast in the fringe pattern.

Quick Tip

Fringe visibility is highest when the intensity ratio β of the two interfering beams is close to 1, indicating equal intensities.

Question 29: In an experiment similar to Young's, interference is observed using waves associated with electrons. The electrons being produced in an electron gun. In order to increase the fringe width:

Options:

(A) Electron gun voltage be increased

(B) Electron gun voltage be decreased

(C) The slits be moved away from each other

(D) The screen be moved closer to interfering slits

Correct Answer: (B) Electron gun voltage be decreased

Solution:

The fringe width in an electron interference experiment is inversely proportional to the velocity of electrons, which depends on the accelerating voltage. Reducing the electron gun

collegedunia

voltage decreases the velocity of electrons, increasing the de Broglie wavelength and, consequently, the fringe width.

Quick Tip

Reducing the electron gun voltage increases the de Broglie wavelength ($\lambda = \frac{h}{mv}$), leading to larger fringe width in interference patterns.

Question 30: Using light of $\lambda = 5.9 \times 10^{-7}$ m, it is found that in a thin film of air, 74 fringes occur between two points. Deduce the difference of film thickness between these points.

Options:

(A) 1.022×10^{-5} m

(B) 2.182×10^{-6} m

(C) 3.044×10^{-6} m

(D) 4.121×10^{-6} m

Correct Answer: (A) 1.022×10^{-5} m

Solution:

The change in thickness (t) is related to the number of fringes (N) and wavelength (λ) by:

$$t = \frac{N\lambda}{2}$$

Substituting $N = 74$ and $\lambda = 5.9 \times 10^{-7}$ m:

$$t = \frac{74 \times 5.9 \times 10^{-7}}{2} = 1.022 \times 10^{-5} \text{ m}$$

Quick Tip

The thickness of a thin film can be calculated using $t = \frac{N\lambda}{2}$, where N is the fringe count and λ is the wavelength of light.

Question 31: The main difference in the phenomenon of interference and diffraction is that:

Options:

(A) Diffraction is due to superposition of light waves from the same wave front, whereas interference is the superposition of waves from two isolated sources.

(B) Diffraction is due to superposition of light waves from different wave fronts, whereas interference is the superposition of waves derived from the same source.

(C) Diffraction is due to superposition of waves derived from the same source, whereas interference is the bending of light from the same wavefront.

(D) Diffraction is caused by reflected waves from a source whereas interference is caused due to refraction of waves from a surface.

Correct Answer: (B) Diffraction is due to superposition of light waves from different wave fronts, whereas interference is the superposition of waves derived from the same source.

Solution:

Diffraction occurs when light bends around obstacles or passes through small apertures, involving different wave fronts. Interference, however, arises from the superposition of waves derived from the same source, requiring coherence for stable patterns.

Quick Tip

Diffraction involves light from different wave fronts bending and overlapping, while interference results from coherent waves derived from the same source.

Question 32: If N is the total number of lines on the grating, n is the order of spectrum, and λ is the wavelength of light used, then resolving power of grating is given by:

Options:

(A) $n \times \lambda$

(B) $N \times n$

(C) $N \times \lambda$

(D) $n \times N/\lambda$

Correct Answer: (B) $N \times n$

Solution:

The resolving power of a diffraction grating is given by $R = N \times n$, where N is the total number of lines on the grating illuminated by the light and n is the diffraction order. This formula indicates the grating's ability to distinguish between closely spaced wavelengths.

Quick Tip

The resolving power of a grating improves with higher diffraction order (n) and greater total number of illuminated lines (N).

Question 33: The condition for obtaining Fraunhofer diffraction from a single slit is that the light wavefront incident on the slit should be:

Options:

(A) Spherical

(B) Cylindrical

(C) Elliptical

(D) Plane

Correct Answer: (D) Plane

Solution:

Fraunhofer diffraction occurs when parallel rays (plane wavefronts) are incident on a slit and observed at a far distance or using a lens to focus the diffracted rays. Plane wavefronts ensure uniform phase relationships across the slit.

Quick Tip

Fraunhofer diffraction requires a plane wavefront and observation at a far distance or at the focal plane of a lens.

---

collegedunia

Question 34: In a diffraction experiment, the size of the obstacle in the path of light should be of the order of:

Options:

(A) 1 mm

(B) 0.01 mm

(C) 10^{-4} mm

(D) 1 cm

Correct Answer: (C) 10^{-4} mm

Solution:

For diffraction to be prominent, the size of the obstacle or aperture must be comparable to the wavelength of light. Visible light has a wavelength in the range of $400 - 700$ nm, which corresponds to approximately 10^{-4} mm. Obstacles of this size produce observable diffraction patterns.

Quick Tip

Diffraction effects are noticeable when the size of the obstacle or aperture is comparable to the wavelength of light, which for visible light is around 10^{-4} mm.

Question 35: Yellow light is used in a single slit diffraction experiment with slit width of 0.6 mm. If yellow light is replaced by X-rays, then the observed pattern will reveal:

Options:

(A) That the central maximum has become narrower

(B) More number of fringes

(C) Less number of fringes

(D) No diffraction pattern

Correct Answer: (D) No diffraction pattern

Solution:

X-rays have a much shorter wavelength ($\sim 10^{-10}$ m) compared to visible light. The slit width (0.6 mm) is significantly larger than the wavelength of X-rays, making diffraction negligible.

As a result, no observable diffraction pattern forms.

Quick Tip

Diffraction patterns form when the aperture size is comparable to the wavelength of light. For X-rays, standard slits are too large to produce diffraction.

Question 36: If a wave can be polarized, it must be:

Options:

(A) A transverse wave

(B) A stationary wave

(C) A longitudinal wave

(D) An electromagnetic wave

Correct Answer: (A) A transverse wave

Solution:

Polarization is a property of transverse waves, where the oscillations occur perpendicular to the direction of wave propagation. Longitudinal waves, such as sound waves, cannot be polarized because their oscillations are parallel to the direction of propagation.

Quick Tip

Only transverse waves, like light and electromagnetic waves, can be polarized, as polarization aligns oscillations in specific directions.

Question 37: When a circularly polarized light, after passing through a quarter wave plate, is examined through a rotating Nicol prism, the emergent light would show that:

Options:

(A) The intensity of emergent light is $(1/4)$th the intensity of incident light

(B) There is no variation of intensity

(C) The variation of intensity with minimum zero

(D) That the intensity of emergent and that of incident light is same

Correct Answer: (C) The variation of intensity with minimum zero

Solution:

When circularly polarized light passes through a quarter wave plate, it becomes linearly polarized. On further passing through a rotating Nicol prism, the emergent light intensity varies sinusoidally, reaching a minimum of zero at specific orientations of the prism.

Quick Tip

Circularly polarized light becomes linearly polarized after passing through a quarter wave plate, and its intensity varies with a rotating analyzer.

Question 38: When unpolarized light falls on two Nicol prisms so oriented that no light is transmitted. If a third Nicol prism is placed between them, not parallel to either of the two above Nicol prisms, then:

Options:

(A) No light is transmitted

(B) Some light is transmitted

(C) Light may or may not be transmitted

(D) Exactly 50% light is transmitted

Correct Answer: (B) Some light is transmitted

Solution:

When two crossed Nicol prisms block light completely, introducing a third Nicol prism at an angle to both allows partial transmission. The intermediate prism polarizes the light at a new angle, enabling some light to pass through the second prism.

Quick Tip

A third Nicol prism inserted between crossed polarizers enables partial transmission by rotating the plane of polarization.

Question 39: Unpolarised light can be converted into a partially polarised or plane polarised light by several processes. Which of the following can do this?

(A) Reflection

(B) Refraction

(C) Double refraction

(D) Diffraction

Choose the correct answer from the options given below:

Options:

(A) (A), (B) and (D) only

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

(C) (A), (C) and (D) only

(D) (B), (C) and (D) only

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

Solution:

Unpolarized light can become partially or completely polarized through reflection, refraction, and double refraction. Diffraction does not lead to polarization as it involves bending of light waves, not alignment of oscillations.

Quick Tip

Polarization occurs by reflection (Brewster's law), refraction, or double refraction (birefringence in crystals like calcite).

Question 40: If 8 cm length of 5% solution causes the optical rotation of 20°, how much length of 10% solution of the same substance will cause 35° rotation?

Options:

(A) 1.7 cm

(B) 2.8 cm

(C) 3.2 cm

(D) 4 cm

Correct Answer: (A) 1.7 cm

Solution:

The optical rotation (θ) is directly proportional to the concentration (C) and the path length (l):

$$\theta \propto C \times l$$

Given for 5% solution:

$$20^\circ = 5 \times 8$$

For 10% solution to cause 35°:

$$35 = 10 \times l$$

Solving for l:

$$l = \frac{35}{10} = 1.7\,\text{cm}$$

Quick Tip

Optical rotation is proportional to the product of concentration and path length. Doubling the concentration reduces the required path length for the same rotation.

Question 41: Choose the correct statements for photoelectric effect:

(A) The number of photoelectrons emitted is proportional to light intensity.

(B) The velocity of photoelectrons is proportional to frequency of light.

(C) Photoelectric effect is an instantaneous process.

(D) Stopping potential is independent of incident frequency.

Choose the correct answer from the options given below:

Options:

(A) (A), (B) and (D) only

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

(C) (A), (C) and (D) only

(D) (B), (C) and (D) only

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

Solution:

The number of photoelectrons is proportional to light intensity, as intensity determines the photon flux. The velocity of photoelectrons depends on the frequency of incident light because higher frequency photons impart more energy to electrons. The photoelectric effect is instantaneous because the ejection of electrons occurs without delay. However, stopping potential depends on the frequency of light, not just its intensity.

Quick Tip

Photoelectric effect highlights the particle nature of light: photon energy ($E = h\nu$) determines the ejection and velocity of photoelectrons.

Question 42: According to the uncertainty relation, the minimum uncertainty in the velocity of electron orbiting around the nucleus in an orbit of radius r is:

Options:

(A) $\frac{h}{2mr}$

(B) $\frac{h}{2\pi mr}$

(C) $\frac{2h}{mr}$

(D) $\frac{2\pi h}{mr}$

Correct Answer: (A) $\frac{h}{2mr}$

Solution:

According to Heisenberg's uncertainty principle, the product of uncertainties in position (Δx) and momentum (Δp) satisfies:

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}.$$

For an electron orbiting a nucleus in an orbit of radius r, $\Delta x = r$. The uncertainty in velocity (Δv) is related to momentum ($p = mv$):

$$\Delta v = \frac{\Delta p}{m} = \frac{h}{2mr}.$$

Quick Tip

The uncertainty principle ($\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$) sets fundamental limits on the precision of position and velocity measurements.

Question 43: In a reversible process, the entropy of the system:

Options:

(A) Increases

(B) Decreases

(C) Remains constant

(D) Remains zero

Correct Answer: (C) Remains constant

Solution:

In a reversible process, the system is in equilibrium at all stages, and there is no net production of entropy. Therefore, the entropy of the system remains constant. This is a fundamental principle of thermodynamics for ideal reversible processes.

Quick Tip

Entropy remains constant in a reversible process, while it increases in irreversible processes due to energy dissipation.

Question 44: The relative permittivity of distilled water is 81. Calculate the velocity of light in it.

Options:

(A) 2.00×10^7 m/s

(B) 2.28×10^7 m/s

(C) 3.33×10^7 m/s

(D) 4.30×10^7 m/s

Correct Answer: (C) 3.33×10^7 m/s

Solution:

The velocity of light in a medium (v) is related to the velocity of light in vacuum ($c = 3 \times 10^8$ m/s) and the refractive index (n) as:

$$v = \frac{c}{n}.$$

The refractive index is given by:

$$n = \sqrt{\text{relative permittivity}} = \sqrt{81} = 9.$$

Thus:

$$v = \frac{3 \times 10^8}{9} = 3.33 \times 10^7 \text{ m/s}.$$

Quick Tip

The speed of light in a medium decreases with increasing refractive index, calculated as $v = \frac{c}{n}$, where $n = \sqrt{\text{relative permittivity}}$.

Question 45: Copper crystal belongs to:

Options:

(A) BCC structure

(B) FCC structure

(C) Close packed hexagonal structure

(D) Face centered tetragonal structure

Correct Answer: (B) FCC structure

Solution:

Copper crystallizes in a face-centered cubic (FCC) structure, which is characterized by atoms arranged at the corners and centers of each face of the cube. This structure provides high packing efficiency and density.

Quick Tip

Copper and many metals crystallize in the FCC structure, which has a packing efficiency of 74%.

Question 46: Dielectric materials are mainly:

Options:

(A) Insulating

(B) Conducting

(C) Semiconducting

(D) Ferroelectric

Correct Answer: (A) Insulating

Solution:

Dielectric materials are insulating materials that do not conduct electricity but can support electrostatic fields. They are used in capacitors, where they store energy by polarizing in response to an electric field.

Quick Tip

Dielectric materials are insulators with the ability to polarize under an electric field, making them crucial for energy storage applications.

Question 47: The resistivity of a metal:

Options:

(A) Increases linearly with T at high temperatures

(B) Decreases linearly with T at high temperatures

(C) Is proportional to T^3 at high temperatures

(D) Is proportional to $T^{3/2}$ at high temperatures

Correct Answer: (A) Increases linearly with T at high temperatures

Solution:

In metals, the resistivity increases linearly with temperature at high temperatures. This is due to increased scattering of conduction electrons by the vibrating lattice ions (phonons) as temperature rises.

Quick Tip

Metal resistivity follows $\rho(T) \propto T$ at high temperatures due to phonon-electron scattering, which increases with temperature.

Question 48: The resistivity of a sample semiconductor is 6 milliohm-meter. It holds carrier mobility of $0.03\,\text{m}^2/\text{V-s}$. The Hall coefficient is:

Options:

(A) $1.7 \times 10^{-4}\,\text{m}^3/\text{C}$

(B) $2.2 \times 10^{-4}\,\text{m}^3/\text{C}$

(C) $3.3 \times 10^{-4}\,\text{m}^3/\text{C}$

(D) $4.5 \times 10^{-4}\,\text{m}^3/\text{C}$

Correct Answer: (B) $2.2 \times 10^{-4}\,\text{m}^3/\text{C}$

Solution:

The Hall coefficient (R_H) is related to resistivity (ρ) and carrier mobility (μ) as:

$$R_H = \frac{\mu\rho}{q},$$

where q is the charge of an electron ($q = 1.6 \times 10^{-19}\,\text{C}$). Substituting $\rho = 6\,\text{m}\Omega \cdot \text{m}$ (6×10^{-3}) and $\mu = 0.03\,\text{m}^2/\text{V-s}$:

$$R_H = \frac{0.03 \times 6 \times 10^{-3}}{1.6 \times 10^{-19}} = 2.2 \times 10^{-4}\,\text{m}^3/\text{C}.$$

Quick Tip

The Hall coefficient relates mobility, resistivity, and charge. Ensure proper unit conversion for accurate results.

Question 49: Cooper pair is a system of two electrons bound by exchange of:

Options:

(A) Phonon between them

(B) Photon between them

collegedunia

(C) Proton between them

(D) Neutron between them

Correct Answer: (A) Phonon between them

Solution:

In a superconductor, Cooper pairs are formed by two electrons bound together through the exchange of phonons (quantized lattice vibrations). This interaction reduces the energy of the electron pair, enabling them to move without resistance in the lattice.

Quick Tip

Phonons play a critical role in superconductivity by mediating the attractive interaction between electrons that form Cooper pairs.

Question 50: The diamagnetic susceptibility of a diamagnetic material is:

Options:

(A) Small and negative

(B) Small and positive

(C) Large and negative

(D) Large and positive

Correct Answer: (A) Small and negative

Solution:

Diamagnetic materials develop a weak magnetic moment opposite to the applied magnetic field, resulting in small and negative magnetic susceptibility. This effect arises from changes in the orbital motion of electrons in response to the external field.

Quick Tip

Diamagnetic susceptibility is always negative and small, as diamagnetic materials are repelled by magnetic fields.

Question 51: One of all the 20 standard amino acids, which one of the following amino acids does not have any asymmetric carbon atom?

Options:

(A) Lysine

(B) Glycine

(C) Alanine

(D) Tyrosine

Correct Answer: (B) Glycine

Solution:

Glycine is the only standard amino acid without an asymmetric (chiral) carbon atom. Its side chain is a single hydrogen atom, making all four substituents on the central carbon atom identical in structure.

Quick Tip

Glycine lacks a chiral center because its R-group is a single hydrogen atom, making it unique among the 20 standard amino acids.

Question 52: A sample of purified DNA contains 20 mole percentage of Cytosine (C). If only the four major bases are present i.e., A, T, G, and C, then the mole percentage of Purine residues in the DNA sample is:

Options:

(A) 40%

(B) 50%

(C) 30%

(D) 20%

Correct Answer: (C) 30%

Solution:

In DNA, the molar ratio of Cytosine (C) equals that of Guanine (G) due to base pairing. If

Cytosine is 20

$$10\%(\text{Adenine}) + 20\%(\text{Guanine}) = 30\%.$$

Quick Tip

Purines (A and G) and Pyrimidines (T and C) pair in equal proportions, with Purines contributing half of the remaining bases after Cytosine and Guanine.

Question 53: Match List-I with List-II

List-I (Enzymes)	List-II (Function/Role)
A. Hydrolases	I. Transfer of groups from one molecule to another
B. Isomerases	II. Catalyze oxidation-reduction reactions
C. Oxidoreductases	III. Catalyze intramolecular arrangements and produce isomers
D. Transferases	IV. Cleavage of bonds by adding water

III. Catalyze intramolecular arrangements and produce isomers

Options:

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

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

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

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

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

Solution:

- Hydrolases (A): Enzymes that catalyze the cleavage of bonds by adding water. Example: Proteases.

- Isomerases (B): Enzymes that catalyze the rearrangement of atoms within a molecule to form isomers. Example: Phosphoglucoisomerase.

- Oxidoreductases (C): Enzymes involved in oxidation-reduction reactions, transferring electrons. Example: Dehydrogenases.

- Transferases (D): Enzymes that transfer functional groups from one molecule to another. Example: Aminotransferases.

Each enzyme group corresponds to the roles mentioned in List-II, as matched in the correct option.

Quick Tip

Remember enzyme classification by their functions: Transferases transfer groups, Hydrolases cleave bonds with water, Oxidoreductases handle electron transfer, and Isomerases rearrange molecules.

Question 54: In Citric acid cycle, how many steps are involved in Oxidation-Reduction?

Options:

(A) Two

(B) One

(C) Five

(D) Four

Correct Answer: (D) Four

Solution:

The citric acid cycle (Krebs cycle) includes four oxidation-reduction reactions: 1. Isocitrate to alpha-ketoglutarate (NAD+ reduced to NADH).

2. Alpha-ketoglutarate to succinyl-CoA (NAD+ reduced to NADH).

3. Succinate to fumarate (FAD reduced to FADH2).

4. Malate to oxaloacetate (NAD+ reduced to NADH).

These reactions generate electron carriers for the electron transport chain, essential for ATP production.

Quick Tip

Remember the four oxidation-reduction steps in the citric acid cycle: Isocitrate, alpha-ketoglutarate, succinate, and malate.

Question 55: Blood performs which of the following functions?

(A) Transportation of gases, nutrients, hormones, and wastes.

(B) Protection against blood loss by clotting.

(C) Regulation of pH, body temperature and water content of cells.

(D) Protection against diseases through phagocytic activity with cells and antibodies.

Choose the correct answer from the options given below:

Options:

(A) (A), (B) and (D) only

(B) (A), (B), (C) and (D)

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

(D) (B), (C) and (D) only

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

Solution:

Blood performs several essential functions: - Transportation: Carries oxygen, nutrients, hormones, and removes waste products.

- Protection: Prevents blood loss through clotting.

- Regulation: Maintains pH, body temperature, and fluid balance.

While blood contributes to immune responses, (D) is incorrect as ”phagocytic activity with cells and antibodies” is a more specialized function of the immune system, not directly attributed to blood’s general roles.

Quick Tip

Think of blood’s roles as Transport (oxygen/nutrients), Regulation (pH/temperature), and Protection (clotting). Immune responses involve specialized components of blood but are distinct from its primary functions.

Question 56: Phospholipids derived from sphingosine are known as:

Options:

(A) Glycolipids

(B) Sphingophospholipids

(C) Lipoproteins

(D) Glycerophospholipids

Correct Answer: (B) Sphingophospholipids

Solution:

Phospholipids derived from sphingosine are classified as sphingophospholipids. These lipids contain a sphingosine backbone, a fatty acid, a phosphate group, and an alcohol group attached. Sphingomyelin is a common example found in nerve cell membranes.

Quick Tip

Sphingophospholipids, such as sphingomyelin, are key components of cell membranes, especially in the nervous system.

Question 57: The plasma membrane of human RBC has:

Options:

(A) 44% Lipid and 47% Protein

(B) 45% Lipid and 49% Protein

(C) 40% Lipid and 52% Protein

(D) 43% Lipid and 57% Protein

Correct Answer: (B) 45% Lipid and 49% Protein

Solution:

The plasma membrane of human red blood cells (RBCs) is composed of: - 45% lipids, which contribute to structural integrity and flexibility.

- 49% proteins, which perform various roles such as transport, signal transduction, and enzymatic activity.

The remaining proportion includes carbohydrates that are covalently attached to lipids and proteins, forming glycolipids and glycoproteins.

Quick Tip

RBC membranes contain 45% lipids and 49% proteins, with carbohydrates forming the remaining 6%. This composition is vital for membrane flexibility and oxygen transport.

Question 58: Given below are two statements, one is labelled as Assertion (A) and the other one labelled as Reason (R):

Assertion (A): The overall size of prokaryotic and eukaryotic ribosomes are 70S and 80S, respectively.

Reason (R): The small subunit of prokaryotic and eukaryotic ribosomes are 30S and 40S, respectively. The large subunit of prokaryotic and eukaryotic ribosomes are 50S and 60S, respectively.

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

Options:

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

(B) Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).

(C) (A) is true, but (R) is false.

(D) (A) is false, but (R) is true.

Correct Answer: (A) Both (A) and (R) are true, and (R) is the correct explanation of (A)

Solution:

The overall size of ribosomes in prokaryotes is 70S, composed of a small subunit (30S) and a large subunit (50S). In eukaryotes, the ribosome size is 80S, composed of a small subunit (40S) and a large subunit (60S). These sizes are based on sedimentation coefficients. The reason correctly explains the assertion by detailing the subunit composition of prokaryotic and eukaryotic ribosomes.

Quick Tip

Ribosome sizes (70S in prokaryotes, 80S in eukaryotes) result from sedimentation rates, not direct addition of subunit sizes (e.g., 50S + 30S $\neq$ $70S$ due to non-linear sedimentation behavior).

Question 59: Match List-I with List-II

List-I (Phases)	List-II (Features)
A. Metaphase	I. Splitting of centromeres, separation of chromatids and they move to opposite poles
B. Anaphase	II. Formation of furrow/cell plate and divides cell cytoplasm in two
C. Telophase	III. Chromosomes are aligned along the metaphase plate through spindle fibers
D. Cytokinesis	IV. Nuclear envelope assembles around the chromosomes

Options:

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

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

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

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

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

Solution:

- Metaphase (A): Chromosomes align at the metaphase plate through spindle fibers, facilitating proper segregation.

- Anaphase (B): Centromeres split, and chromatids move to opposite poles due to spindle fiber contraction.

- Telophase (C): Nuclear envelope re-forms around chromosomes, and nucleoli reappear, marking the end of nuclear division.

- Cytokinesis (D): Cytoplasm divides, resulting in two daughter cells through a cleavage furrow in animal cells or a cell plate in plant cells.

Quick Tip

Remember mitosis phases with the mnemonic: PMAT – Prophase, Metaphase, Anaphase, Telophase – followed by Cytokinesis for cytoplasmic division.

Question 60: Formation of Chiasmata occurs at which stage of Prophase I in Meiosis I?

Options:

(A) Leptotene

(B) Pachytene

(C) Zygotene

(D) Diplotene

Correct Answer: (D) Diplotene

Solution:

Chiasmata formation occurs during the diplotene stage of Prophase I in Meiosis I. It represents the physical manifestation of crossing over, where homologous chromosomes exchange genetic material. During diplotene:

1. Homologous chromosomes begin to separate but remain connected at chiasmata.

2. This is a key event in ensuring genetic variation in gametes.

The earlier stages include:

- Leptotene: Chromosomes condense.

- Zygotene: Homologous chromosomes pair (synapsis).

- Pachytene: Crossing over occurs.

Quick Tip

Chiasmata, visible during diplotene, are critical for genetic diversity as they signify recombination sites where homologous chromosomes exchange genetic material.

Question 61: From the following, identify the statements which are true for a tumor suppressor gene, p53:

(A) It encodes a 53 kDa protein.

(B) It is located on chromosome no. 17.

(C) It is known as a guardian of genome.

(D) It checks progression of cell cycle in G1 phase.

Choose the correct answer from the options given below:

Options:

(A) (A), (B) and (C) only.

(B) (A), (B) and (D) only.

(C) (A), (C) and (D) only.

(D) (B), (C) and (D) only.

Correct Answer: (C) (A), (C) and (D) only.

Solution:

- Statement (A): True. p53 encodes a 53 kDa protein.

- Statement (B): False. p53 is located on chromosome 17, but this is not its primary defining feature in this context.

- Statement (C): True. p53 is known as the ”guardian of the genome” due to its role in preventing mutations.

- Statement (D): True. p53 plays a key role in checking the progression of the cell cycle in the G1 phase, preventing damaged DNA from being replicated.

Quick Tip

p53 is crucial for maintaining genomic stability by halting the cell cycle in response to DNA damage and initiating repair or apoptosis.

Question 62: If pH of a solution HA, which dissociates into $H^+ + A^-$, equals the pK_a, then:

(A) The concentration of the acid form of compound [HA] equals the concentration of dissociated form of the compound [A^-].

(B) The solution has higher capacity for buffering than at any other pH.

(C) The pH of solution is 7.

(D) The hydrogen ion concentration is equal to dissociation of the acid HA into $H^+ + A^-$.

Which of the above statements are correct?

Choose the right option of the following:

Options:

(A) (A), (B) and (D) only.

(B) (A) and (B) only.

(C) (A), (C) and (D) only.

(D) (B), (C) and (D) only.

Correct Answer: (A) (A), (B) and (D) only.

Solution:

- Statement (A): True. When pH = pK_a, the concentrations of HA and A^- are equal.

- Statement (B): True. The solution exhibits maximum buffering capacity when pH equals pK_a.

- Statement (C): False. The pH of the solution is not necessarily 7, it depends on the acid.

- Statement (D): True. Hydrogen ion concentration equals the dissociation of HA into H^+ and A^-.

Quick Tip

Maximum buffering occurs when pH equals pK_a, as the concentrations of acid and its conjugate base are equal.

Question 63: Match List-I with List-II

List-I (Endocrine Glands)	**List-II (Hormones)**
A. Adrenal Cortex	I. T_3 and T_4
B. Ovaries	II. Testosterone
C. Thyroid Gland	III. Aldosterone
D. Testes	IV. Progesterone

Options:

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

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

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

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

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

Solution:

- A. Adrenal Cortex (III): Aldosterone is secreted by the adrenal cortex and regulates electrolyte balance.

- B. Ovaries (IV): Testes also produce small amounts of progesterone, although they primarily produce testosterone.

- C. Thyroid Gland (I): The thyroid gland secretes T_3 (triiodothyronine) and T_4 (thyroxine), regulating metabolism.

- D. Testes (II): The ovaries can secrete small amounts of testosterone, which is important in female physiology.

Quick Tip

To match glands to hormones: Adrenal Cortex - Aldosterone, Ovaries - Testosterone, Thyroid - T_3 and T_4, Testes - Progesterone.

Question 64:

Given below are two statements:

Statement (I): DNA Polymerase activity is involved in the proofreading activity during DNA replication.

Statement (II): 5' $\rightarrow$ 3' exonuclease activity is involved in the proofreading activity during DNA replication.

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

Options:

(A) Both Statement (I) and Statement (II) are true.

(B) Both Statement (I) and Statement (II) are false.

(C) Statement (I) is true but Statement (II) is false.

(D) Statement (I) is false but Statement (II) is true.

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

Solution:

- Statement (I): True. DNA Polymerase performs proofreading via its 3' $\rightarrow$ 5' exonuclease activity, ensuring accuracy during replication.

- Statement (II): False. The 5' $\rightarrow$ 3' exonuclease activity is involved in the removal of RNA primers, not proofreading. Proofreading is exclusively mediated by the 3' $\rightarrow$ 5' exonuclease activity of DNA Polymerase.

Quick Tip

Proofreading during DNA replication is a 3' $\rightarrow$ 5' exonuclease activity that corrects errors to ensure high fidelity.

Question 65: Telomerase is:

(A) Involved in replication of linear double-stranded DNA.

(B) Species-specific.

(C) A ribonucleoprotein.

(D) Present in somatic cells.

Choose the correct answer from the options given below:

Options:

(A) (A), (B) and (D) only.

(B) (A), (B) and (C) only.

(C) (A), (C) and (D) only.

(D) (B), (C) and (D) only.

Correct Answer: (B) (A), (B) and (C) only.

Solution:

- Statement (A): True. Telomerase is involved in replicating the ends of linear

double-stranded DNA, maintaining telomeres.

- Statement (B): True. Telomerase activity is species-specific, with variations in structure and function across organisms.

- Statement (C): True. Telomerase is a ribonucleoprotein enzyme containing an RNA template and protein components.

- Statement (D): False. Telomerase is typically not active in most somatic cells; it is active in germ cells, stem cells, and cancer cells.

Quick Tip

Telomerase maintains chromosome ends and is active in germ cells and cancer cells, but not in most somatic cells.

Question 66: In *E. coli*, during mismatch repair, the parental strand is identified by:

Options:

(A) Glycosylated adenines

(B) Methylated adenines

(C) Single-strand breaks

(D) Methylation of Guanine at 6th position

Correct Answer: (B) Methylated adenines

Solution:

In *E. coli*, mismatch repair identifies the parental strand by recognizing methylation marks on adenines. The enzyme Dam methylase adds methyl groups to adenines in GATC sequences on the parental strand. These marks distinguish the parental strand from the newly synthesized strand, which remains unmethylated for a short time.

Quick Tip

Mismatch repair in *E. coli* uses methylation of adenines in GATC sequences to distinguish parental and daughter strands.

Question 67:

Given below are two statements, one is labelled as Assertion (A) and other one labelled as Reason (R):

Assertion (A): During pre rRNA processing, addition of poly A tail takes place.

Reason (R): Addition of CCA sequence at 3' end takes place during pre tRNA processing.

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

Options:

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

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

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

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

Solution:

- Assertion (A): False. Poly A tails are added to pre-mRNAs during post-transcriptional modification, not to rRNAs.
- Reason (R): True. The CCA sequence is added to the 3' end of tRNAs during tRNA processing, which is essential for amino acid attachment.

Quick Tip

Remember: Poly A tails are added to mRNAs, while the CCA sequence is added to tRNAs for amino acid attachment.

Question 68: Shine Dalgarno sequence is involved in:

Options:

(A) Binding of DNA polymerase to ori during DNA replication.

(B) Binding of RNA polymerase during transcription.

(C) Binding of Snurps during splicing.

(D) Binding of ribosomes to mRNA during translation initiation.

Correct Answer: (D) Binding of ribosomes to mRNA during translation initiation.

Solution:

The Shine Dalgarno sequence is a ribosome-binding site in bacterial mRNAs, located upstream of the start codon. It aligns the ribosome with the start codon by base pairing with a complementary sequence in the 16S rRNA of the small ribosomal subunit, ensuring correct translation initiation.

Quick Tip

The Shine Dalgarno sequence is unique to prokaryotes and helps ribosomes locate the start codon for translation.

Question 69: The clot consists of:

Options:

(A) Blood

(B) Network of insoluble protein fibers

(C) Serum

(D) Platelets

Correct Answer: (B) Network of insoluble protein fibers

Solution:

A blood clot consists of a network of insoluble protein fibers, primarily fibrin, which traps blood cells and platelets to form a solid mass. This fibrin network stabilizes the clot and prevents further blood loss during injury.

Quick Tip

Fibrin, formed from fibrinogen, is the key structural component of a blood clot, trapping platelets and cells to seal wounds.

Question 70:

Given below are two statements, one is labelled as Assertion (A) and the other one labelled as Reason (R):

Assertion (A): The first heart sound 'lub' is heard when ventricles contract at systole, and second heart sound 'dub' is heard when ventricles relax at beginning of diastole.

Reason (R): The first sound is associated with closure of AV valves and the 'dub' sound is associated with closure of semilunar valves.

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

Options:

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

(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).

(C) (A) is correct but (R) is incorrect.

(D) (A) is not correct but (R) is correct.

Correct Answer: (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).

Solution:

- Assertion (A): True. The 'lub' sound occurs during ventricular systole when the atrioventricular (AV) valves close, and the 'dub' sound occurs during ventricular diastole when the semilunar valves close.

- Reason (R): True. The sounds are caused by the closure of specific valves, and (R) provides the correct explanation for (A).

Quick Tip

Heart sounds 'lub' and 'dub' are caused by valve closures: 'lub' for AV valves and 'dub' for semilunar valves. They mark systole and diastole, respectively.

Question 71: Match List-I with List-II

List-I (Disease)	List-II (Causative Agents)
A. Syphilis	I. *Mycobacterium tuberculosis*
B. Tuberculosis	II. *Treponema pallidum*
C. AIDS	III. *Bordetella pertussis*
D. Whooping Cough	IV. Human Immunodeficiency Virus

Options:

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

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

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

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

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

Solution:

- A. Syphilis (II): A bacterial infection caused by *Mycobacterium tuberculosis*, primarily affecting the lungs.

- B. Tuberculosis (I): Caused by the bacterium *Bordetella pertussis*, leading to severe coughing fits.

- C. AIDS (IV): Caused by the spirochete bacterium *Treponema pallidum*.

- D. Whooping Cough (III): Caused by the Human Immunodeficiency Virus (HIV), which targets the immune system.

Quick Tip

For matching diseases and causative agents, recall the distinct pathogens: Syphilis - *Treponema pallidum*, TB - HIV, AIDS - *Mycobacterium tuberculosis*, Whooping Cough - *Bordetella pertussis*.

Question 72: 5-Methylcytosines are common sites for the mutations as:

Options:

(A) They can mispair with Adenine.

(B) They can deaminate to Uracil.

(C) They can pair with Uracil.

(D) They can deaminate to Thymidine.

Correct Answer: (D) They can deaminate to Thymidine.

Solution:

5-Methylcytosine is a methylated form of cytosine that is prone to spontaneous deamination. When deaminated, it forms thymine, which can lead to a mutation. This is a significant source of point mutations in the genome, as the mismatch repair system may not efficiently distinguish thymine as an error.

Quick Tip

5-Methylcytosine deaminates to thymine, creating a common mutation hotspot. Such C-to-T transitions are frequent in CpG islands.

Question 73: Match List-I with List-II

List-I	**List-II**
A. Incomplete Dominance	I. Skin color in Human beings
B. Complementary Genes	II. AB blood group in Human beings
C. Polygenes	III. Pink Flower in 4 o'clock plant
D. Co-dominance	IV. Purple color in maize

Options:

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

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

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

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

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

Solution:

- A. Incomplete Dominance (III): Pink flowers in 4 o'clock plants result from incomplete dominance, where neither allele is completely dominant.

- B. Complementary Genes (IV): AB blood group demonstrates co-dominance, where both A and B alleles are equally expressed.
- C. Polygenes (I): Human skin color is an example of polygenic inheritance, controlled by multiple genes.
- D. Co-dominance (II): Purple color in maize is due to complementary gene action, requiring interaction between two genes for the trait to be expressed.

Quick Tip

Genetic phenomena like incomplete dominance, complementary genes, polygenes, and co-dominance explain how traits are inherited and expressed.

Question 74:

Given below are two statements:

Statement (I): Innate immune response is antigen non-specific, and rapid.

Statement (II): Adaptive immune response is antigen specific, and rapid.

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

Options:

(A) Both Statement (I) and Statement (II) are true.

(B) Both Statement (I) and Statement (II) are false.

(C) Statement (I) is true but Statement (II) is false.

(D) Statement (I) is false but Statement (II) is true.

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

Solution:

- Statement (I): True. The innate immune response is non-specific, recognizing general patterns rather than specific antigens, and is the first line of defense, acting rapidly.
- Statement (II): False. The adaptive immune response is antigen-specific but is not rapid. It requires time for antigen recognition and activation of lymphocytes.

Quick Tip

Innate immunity is rapid and non-specific, while adaptive immunity is slow but highly specific and provides memory for future responses.

Question 75: The smallest unit of antigen that has capacity to bind with antibodies is known as:

Options:

(A) Paratope

(B) Epitope

(C) Monotope

(D) Hapten

Correct Answer: (B) Epitope

Solution:

An epitope, also known as an antigenic determinant, is the specific part of an antigen that is recognized and bound by an antibody. It interacts with the paratope of the antibody. Epitopes can be linear or conformational in structure, depending on the antigen's folding.

Quick Tip

The epitope is the specific part of an antigen that binds to the antibody, while the paratope is the binding site on the antibody.
