MHT CET 2024 April 29 Shift 1 Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks :**200	**Total Questions :**150

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The Duration of test is 3 Hours.
2. This paper consists of 150 Questions.
3. There are three parts in the paper consisting of Physics, Chemistry and Mathematics having 50 questions in each part of equal weightage..
4. Section-A: Physics and Chemistry - 50 Questions each.
5. Section-B: Mathematics - 50 Questions
6. Choice and sequence for attempting questions will be as per the convenience of the candidate.
7. Determine the one correct answer out of the four available options given for each question.
8. Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.
9. No mark shall be granted for marking two or more answers of same question, scratching or overwriting

Biology Questions

1. Which part of a plant is grafted onto a stock that is rooted?

1. Root
2. Scion
3. Stem
4. Leaf

Correct Answer: (B) Scion

Solution: In grafting, a rooted stock provides the root system, and a scion is grafted onto it. The scion is the upper part of the plant that bears flowers and fruits. The grafting process involves:

1. Selecting a compatible stock and scion.
2. Joining the vascular tissues of both parts to ensure nutrient and water transport.

This technique is used widely in horticulture to enhance plant yield and quality.

Final Answer:

$$\boxed{\text{Scion}}$$

Quick Tip

In grafting, the scion is the shoot system, and the stock is the root system. Compatibility is crucial for successful grafting.

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2. Which are the pioneer species in aquatic habitats?

1. Fungi
2. Algae
3. Bryophytes
4. Lichens

Correct Answer: (B) Algae

Solution: Pioneer species are the first organisms to colonize barren environments. In aquatic habitats:

- Algae, particularly cyanobacteria, are primary colonizers. They perform photosynthesis and survive in harsh conditions.
- They contribute to soil formation by releasing organic material and oxygen, making the environment suitable for other organisms.

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Final Answer:

$$\boxed{\text{Algae}}$$

Quick Tip

In aquatic habitats, algae act as pioneer species, while lichens play the same role in terrestrial environments.

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3. How many heartbeats does a person have in 1 minute on average?

1. 50
2. 72
3. 100
4. 120

Correct Answer: (B) 72

Solution: The average heart rate of a healthy adult is about 72 beats per minute. It depends on:

- Physical activity: Increases during exercise or stress.
- Age: Young children have faster heart rates compared to adults.

- Health status: Bradycardia and tachycardia are conditions of abnormally slow or fast heart rates.

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Final Answer:

$$\boxed{72 \text{ beats per minute}}$$

Quick Tip

The normal heart rate can vary between 60-100 beats per minute depending on individual health and activity level.

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4. What is the role of heme in hemoglobin?

1. Transport of oxygen
2. Transport of carbon dioxide
3. Structural stability
4. Enzyme activity

Correct Answer: (A) Transport of oxygen

Solution: Heme is a prosthetic group in hemoglobin, composed of an iron atom bound to a porphyrin ring. Its function includes:

- Binding oxygen molecules in the lungs.
- Releasing oxygen in tissues where it is needed for cellular respiration.

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Final Answer:

$$\boxed{\text{Transport of oxygen}}$$

Quick Tip

Heme binds oxygen in the lungs and delivers it to tissues, enabling cellular respiration.

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5. How much ATP is produced by aerobic respiration?

1. 2 ATP
2. 32 ATP
3. 36 ATP
4. 38 ATP

Correct Answer: (C) 36 ATP

Solution: Aerobic respiration involves the complete oxidation of glucose in the presence of oxygen. It includes:

1. Glycolysis: Produces 2 ATP.
2. Krebs cycle: Produces 2 ATP.
3. Electron transport chain: Produces 32 ATP.

Total ATP yield:

$$2 + 2 + 32 = 36\,\text{ATP}.$$

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Final Answer:

$$\boxed{36\,\text{ATP}}$$

Quick Tip

Aerobic respiration yields 36 ATP per glucose molecule, significantly more than anaerobic respiration.

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6. Statement 1: Avery, McLeod, and McCarty discovered the semi-conservative nature of DNA.
Statement 2: Meselson and Stahl used E. coli to demonstrate the semi-conservative nature of DNA.

1. Statement 1 is correct, Statement 2 is incorrect
2. Statement 2 is correct, Statement 1 is incorrect

3. Both statements are correct
4. Both statements are incorrect

Correct Answer: (B) Statement 2 is correct, Statement 1 is incorrect

Solution: Avery, McLeod, and McCarty demonstrated that DNA is the genetic material but did not discover its semi-conservative nature. Meselson and Stahl, through their experiment with E. coli and N^{15}-labeled DNA, provided conclusive evidence for the semi-conservative replication of DNA.

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Final Answer:

$$\boxed{\text{Statement 2 is correct, Statement 1 is incorrect}}$$

Quick Tip

Avery et al. established DNA as genetic material, while Meselson and Stahl demonstrated its semi-conservative replication.

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7. A Thermal Cycler/Stabilizer is used for ____?

1. Maintaining temperature
2. DNA amplification (PCR)
3. Protein synthesis
4. RNA transcription

Correct Answer: (B) DNA amplification (PCR)

Solution: A thermal cycler, also known as a PCR machine, is widely used in molecular biology for DNA amplification through the Polymerase Chain Reaction (PCR). It involves:

- **Denaturation:** Heating the DNA to $94 - 96^{\circ}$C to separate the strands.
- **Annealing:** Cooling to $50 - 65^{\circ}$C to allow primers to bind to specific sequences.
- **Extension:** Raising the temperature to 72°C for DNA polymerase to synthesize new DNA strands.

These cycles are repeated to exponentially amplify the DNA.

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Final Answer:

DNA amplification (PCR)

Quick Tip

Thermal cyclers are essential for PCR, which is a fundamental technique in genetics, forensics, and diagnostics.

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8. What are some archaeological sites where Neanderthal remains and artifacts have been discovered?

1. Lascaux Cave, France
2. Altamira Cave, Spain
3. Shanidar Cave, Iraq
4. All of the above

Correct Answer: (D) All of the above

Solution: Neanderthal remains and artifacts have been discovered in various archaeological sites, indicating their distribution and lifestyle:

- **Lascaux Cave, France:** Known for cave paintings, though Neanderthal presence is debated.
- **Altamira Cave, Spain:** Famous for prehistoric art and possible artifacts.
- **Shanidar Cave, Iraq:** Contains Neanderthal skeletal remains and evidence of burial practices.

These sites provide insight into the Neanderthal way of life and their evolutionary history.

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Final Answer:

All of the above

Quick Tip

Archaeological sites like Shanidar Cave give valuable evidence of Neanderthal behavior, including burial rituals.

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9. Which hormone is used to increase the size of fruit?

1. Auxin
2. Gibberellin
3. Cytokinin
4. Ethylene

Correct Answer: (B) Gibberellin

Solution: Gibberellins are plant hormones that promote cell elongation and division, thereby increasing fruit size. Common uses include:

- Enhancing the size of grapes and apples.
- Promoting stem elongation and seed germination.

Auxins and cytokinins are also involved in plant growth but are not specifically used for fruit size enhancement.

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Final Answer:

$$\boxed{\text{Gibberellin}}$$

Quick Tip

Gibberellins are critical for improving fruit yield and size. They are widely used in agriculture to enhance crop quality.

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10. ____ can't be further hydrolyzed.

1. Polysaccharides

2. Disaccharides
3. Monosaccharides
4. Oligosaccharides

Correct Answer: (C) Monosaccharides

Solution: Monosaccharides are the simplest carbohydrates and cannot be hydrolyzed further. Examples:

- Glucose
- Fructose
- Galactose

In contrast:

- Polysaccharides (e.g., starch) and disaccharides (e.g., sucrose) can be hydrolyzed into smaller sugar units.
- Oligosaccharides consist of a few monosaccharide units.

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Final Answer:

$$\boxed{\text{Monosaccharides}}$$

Quick Tip

Monosaccharides are directly absorbed in the digestive system and serve as primary energy sources.

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11. Which of the following uses plasma membrane for respiration?

1. Prokaryotes
2. Eukaryotes
3. Viruses

4. Fungi

Correct Answer: (A) Prokaryotes

Solution: Prokaryotes, such as bacteria, lack membrane-bound organelles like mitochondria. Instead, they use their plasma membrane for:

- Hosting enzymes for the electron transport chain.
- Carrying out ATP production via oxidative phosphorylation.

Eukaryotes perform respiration in mitochondria, while viruses lack metabolic processes.

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Final Answer:

$$\boxed{\text{Prokaryotes}}$$

Quick Tip

In prokaryotes, the plasma membrane functions as the site for ATP production, similar to mitochondria in eukaryotes.

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12. 0.16 seconds is a time interval for which event in the ECG system?

1. P wave
2. QRS complex
3. PR interval
4. T wave

Correct Answer: (C) PR interval

Solution: The PR interval in an ECG represents the time taken for the electrical impulse to travel from the sinoatrial (SA) node through the atria, AV node, and into the ventricles. This interval lasts approximately $0.12 - 0.20\,\text{s}$. Functions:

- Reflects conduction through the AV node.
- Indicates the delay that allows the ventricles to fill with blood.

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Final Answer:

$$\boxed{\text{PR interval}}$$

Quick Tip

Understanding ECG intervals, like the PR interval, helps diagnose cardiac conduction abnormalities.

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13. Which hormone is used to increase the size of fruit?

1. Auxin
2. Gibberellin
3. Cytokinin
4. Ethylene

Correct Answer: (B) Gibberellin

Solution: Gibberellins are plant hormones that promote cell elongation and division, enhancing fruit size. Uses include:

- Increasing the size of grapes and apples.
- Stimulating seed germination and stem elongation.

Auxins and cytokinins are involved in growth but are less specific to fruit enlargement.

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Final Answer:

$$\boxed{\text{Gibberellin}}$$

Quick Tip

Gibberellins are widely used in agriculture to improve fruit quality and yield.

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14. Question related to urinary bladder layers.

Solution: The urinary bladder is composed of the following layers:

- **Mucosa:** Made up of transitional epithelium and lamina propria, allowing distension.
- **Submucosa:** Provides structural support.
- **Muscularis:** Composed of detrusor muscle, facilitating contraction and relaxation.
- **Serosa/Adventitia:** Outermost layer providing protection.

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Quick Tip

Quick Tip

Understanding the layers of the urinary bladder helps in studying its function and disorders like overactive bladder.

Physics Questions

15. What is the fundamental frequency of an open organ pipe with length L and speed of sound v?

1. $\frac{v}{2L}$
2. $\frac{v}{L}$
3. $\frac{2v}{L}$
4. $\frac{vL}{2}$

Correct Answer: (A) $\frac{v}{2L}$

Solution: The fundamental frequency of an open organ pipe is determined by the formula:

$$f = \frac{v}{\lambda},$$

where v is the speed of sound and λ is the wavelength. For the fundamental mode of an open pipe:

$$\lambda = 2L \quad \text{(since the pipe supports a full wave).}$$

Substituting $\lambda = 2L$:

$$f = \frac{v}{2L}.$$

Explanation:

- In an open pipe, standing waves are formed with antinodes at both open ends.
- For the fundamental frequency, there is one node in the middle and two antinodes at the ends.

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Quick Tip

For an open pipe, the frequency increases with decreasing pipe length. The fundamental frequency is the lowest frequency.

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16. What is the angular frequency ω of a simple harmonic oscillator with mass m and spring constant k?

1. $\sqrt{\frac{k}{m}}$
2. $\sqrt{\frac{m}{k}}$
3. $\frac{k}{m}$
4. $\frac{m}{k}$

Correct Answer: (A) $\sqrt{\frac{k}{m}}$

Solution: The angular frequency of a simple harmonic oscillator is:

$$\omega = \sqrt{\frac{k}{m}},$$

where:

- k is the spring constant, which represents the stiffness of the spring.
- m is the mass of the oscillator.

Derivation:

- The restoring force in SHM is $F = -kx$, where x is displacement.
- Using Newton's second law $F = ma$, where $a = \ddot{x}$:

$$m\ddot{x} + kx = 0.$$

- This is a second-order differential equation whose solution gives $\omega = \sqrt{\frac{k}{m}}$.

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Quick Tip

Remember, the time period T is related to angular frequency as $T = \frac{2\pi}{\omega}$.

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17. Rate of cooling of a body is 0.2°C/min when excess temperature is 20°C. The proportionality constant k is:

1. $0.005\,\text{min}^{-1}$
2. $0.01\,\text{min}^{-1}$
3. $0.05\,\text{min}^{-1}$
4. $0.2\,\text{min}^{-1}$

Correct Answer: (B) $0.01\,\text{min}^{-1}$

Solution: Newton's Law of Cooling states:

$$\text{Rate of cooling} = k(\Delta T),$$

where k is the proportionality constant and ΔT is the excess temperature. Given:

$$\text{Rate of cooling} = 0.2\,^\circ\text{C/min}, \quad \Delta T = 20^\circ\text{C}.$$

Solving for k:

$$k = \frac{\text{Rate of cooling}}{\Delta T} = \frac{0.2}{20} = 0.01\,\text{min}^{-1}.$$

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Quick Tip

Newton's Law of Cooling is valid for small temperature differences between the body and its surroundings.

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18. A wheel of diameter 20 cm is rotating at 600 rpm. The linear velocity of a particle at its rim is:

1. $6.28\,\text{m/s}$
2. $12.56\,\text{m/s}$
3. $18.84\,\text{m/s}$
4. $3.14\,\text{m/s}$

Correct Answer: (A) $6.28\,\text{m/s}$

Solution: The linear velocity v is given by:

$$v = r \cdot \omega,$$

where r is the radius and ω is the angular velocity. Given:

$$\text{Diameter} = 20\,\text{cm} \Rightarrow r = \frac{20}{2} = 10\,\text{cm} = 0.1\,\text{m}.$$

The angular velocity ω is:

$$\omega = 2\pi f, \quad f = \frac{\text{rpm}}{60} = \frac{600}{60} = 10\,\text{rps}.$$

Substituting values:

$$v = 0.1 \cdot (2\pi \cdot 10) = 0.1 \cdot 20\pi \approx 6.28\,\text{m/s}.$$

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Quick Tip

Always convert rpm to radians per second (ω) when calculating linear velocity.

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19. If a copper rod carries a direct current, the magnetic field associated with the current will be?

1. Parallel to the rod
2. Perpendicular to the rod
3. Circular around the rod
4. No magnetic field

Correct Answer: (C) Circular around the rod

Solution: When a current flows through a straight conductor, such as a copper rod, a magnetic field is produced around it. This is described by Ampere's Circuital Law, which states:

$$\oint B \cdot dl = \mu_0 I,$$

where:

- B is the magnetic field,
- μ_0 is the permeability of free space,
- I is the current flowing through the conductor.

The field lines form concentric circles around the conductor, with the direction given by the **right-hand rule**:

- Point your thumb in the direction of the current.
- The curl of your fingers gives the direction of the magnetic field.

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Quick Tip

Use the right-hand rule to determine the direction of the magnetic field around current-carrying conductors.

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20. A pendulum having a negatively charged metal knob is oscillating on a positively charged surface. The time of the pendulum will be:

1. Increase

2. Decrease

3. Will remain the same

4. Will increase and then decrease

Correct Answer: (B) Decrease

Solution: When a charged pendulum oscillates over a charged surface, the force of attraction between the oppositely charged surfaces increases the effective restoring force. This leads to:

- A higher restoring force, which increases the angular frequency $\omega = \sqrt{\frac{g}{L}}$,
- A decrease in the time period $T = \frac{2\pi}{\omega}$.

Thus, the pendulum oscillates faster, resulting in a shorter time period.

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Quick Tip

External forces, such as electric or magnetic forces, can alter the oscillation characteristics of a pendulum.

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21. Find the ratio of K.E. and P.E. when a particle performs SHM and is at $\frac{1}{n}$ times its amplitude from the mean position.

1. $n^2 - 1 : 1$

2. $1 : n^2 - 1$

3. $1 : n$

4. $n : 1$

Correct Answer: (A) $n^2 - 1 : 1$

Solution: The total energy in SHM is given by:

$$E = K.E. + P.E.,$$

where $K.E.$ (kinetic energy) and $P.E.$ (potential energy) are related to the displacement x. Let A be the amplitude, and $x = \frac{A}{n}$. Then:

$$P.E. = \frac{1}{2}kx^2, \quad K.E. = E - P.E. = \frac{1}{2}kA^2 - \frac{1}{2}kx^2.$$

Simplify:

$$K.E. = \frac{1}{2}k(A^2 - x^2).$$

Substitute $x = \frac{A}{n}$:

$$P.E. = \frac{1}{2}k\left(\frac{A}{n}\right)^2 = \frac{1}{2}k\frac{A^2}{n^2},$$

$$K.E. = \frac{1}{2}k\left(A^2 - \frac{A^2}{n^2}\right) = \frac{1}{2}kA^2\left(1 - \frac{1}{n^2}\right).$$

The ratio $\frac{K.E.}{P.E.}$ is:

$$\frac{K.E.}{P.E.} = \frac{1 - \frac{1}{n^2}}{\frac{1}{n^2}} = n^2 - 1 : 1.$$

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Quick Tip

The kinetic and potential energy in SHM are always complementary and their sum remains constant.

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22. Which of the following correctly represents the AND logic gate?

1. Output = 1 if at least one input is 1
2. Output = 1 only if all inputs are 1
3. Output = 0 if all inputs are 0
4. Output = 1 if all inputs are 0

Correct Answer: (B) Output = 1 only if all inputs are 1

Solution: The AND gate performs a logical multiplication. The output Y of an AND gate is:

$$Y = A \cdot B,$$

where A and B are the inputs. Truth table:

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

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Quick Tip

AND gates are used in digital circuits where all conditions must be true for the output to be true.

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23. What is the working principle of a cyclotron?

1. Conservation of energy
2. Lorentz force
3. Electromagnetic induction
4. Coulomb's law

Correct Answer: (B) Lorentz force

Solution: A cyclotron accelerates charged particles using a perpendicular magnetic field and an alternating electric field. The principle involves the Lorentz force:

$$F = q(v \times B),$$

where:

- q is the charge of the particle,
- v is the velocity,
- B is the magnetic field.

The magnetic field forces the charged particles into a circular trajectory, while the electric field accelerates them each time they cross the gap between the dees.

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Quick Tip

Cyclotrons are used in nuclear physics to accelerate particles for experiments and medical applications.

Chemistry Questions

24. What is the polymer of elastomer?

1. Neoprene
2. Polyvinyl chloride
3. Nylon-6
4. Teflon

Correct Answer: (A) Neoprene

Solution: Elastomers are polymers with elastic properties. Neoprene is a type of elastomer formed by polymerizing chloroprene. It has:

- High elasticity,
- Resistance to weathering and ozone,
- Applications in wetsuits and industrial belts.

Other options like polyvinyl chloride and nylon-6 are not elastomers but thermoplastics or fibers.

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Quick Tip

Elastomers are primarily used for applications requiring flexibility and durability.

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25. Which one of the following is vinyl alcohol?

1. But-2-en-2-ol
2. Prop-2-en-1-ol
3. Ethanol
4. Methanol

Correct Answer: (B) Prop-2-en-1-ol

Solution: Vinyl alcohol ($CH_2 = CH - OH$) is an unstable tautomer of acetaldehyde. It is represented by the IUPAC name Prop-2-en-1-ol:

$$CH_3 - CHOH - CH_2 \rightarrow CH_2 = CH - OH.$$

Explanation:

- But-2-en-2-ol does not match the structure of vinyl alcohol.
- Prop-2-en-1-ol matches the structural and chemical characteristics of vinyl alcohol.

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Quick Tip

Vinyl alcohol is rarely found in isolation due to its instability but is important in industrial polymer applications.

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26. Which of the following does not obey the octet rule?

1. SF_6
2. H_2O
3. CO_2
4. CH_4

Correct Answer: (A) SF_6

Solution: The octet rule states that atoms tend to gain, lose, or share electrons to have a full valence shell (8 electrons). In SF_6, sulfur forms six bonds, expanding its valence shell to 12 electrons:

$$\text{Valence electrons of S} = 6 + 6(1) = 12.$$

Explanation:

- H_2O, CO_2, and CH_4 all obey the octet rule.
- SF_6 does not obey the octet rule due to its expanded valence shell.

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Quick Tip

Elements in Period 3 or higher can exceed the octet rule by utilizing their d-orbitals.

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27. Alkyl halide and aryl halide react in the presence of sodium metal and dry ether. The name of the reaction is?

1. Wurtz Reaction
2. Wurtz-Fittig Reaction
3. Fittig Reaction
4. Williamson Ether Synthesis

Correct Answer: (B) Wurtz-Fittig Reaction

Solution: In the Wurtz-Fittig reaction, alkyl halides and aryl halides react in the presence of sodium metal in dry ether to form alkyl aryl compounds:

$$C_6H_5Cl + CH_3Cl + 2Na \xrightarrow{\text{Dry Ether}} C_6H_5CH_3 + 2NaCl.$$

Explanation:

- Wurtz Reaction involves only alkyl halides.
- Fittig Reaction involves only aryl halides.

- Williamson Ether Synthesis is unrelated to this reaction.

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Quick Tip

The Wurtz-Fittig Reaction is useful for synthesizing aromatic compounds with alkyl groups.

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28. Which element has the highest oxidizing potential?

1. Li
2. Cu
3. Al
4. Mg

Correct Answer: (A) Li

Solution: Lithium (Li) has the highest standard reduction potential, making it the strongest oxidizing agent:

$$E^{\circ}_{\text{Li}} = -3.04\,\text{V}.$$

Explanation:

- Li easily loses its single valence electron, making it highly reactive.
- Other elements like Cu, Al, and Mg have lower oxidizing potentials.

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Quick Tip

The more negative the reduction potential, the stronger the oxidizing ability of the element.

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29. Which of the following has the lowest boiling point?

1. He
2. Ne
3. O
4. F

Correct Answer: (A) He

Solution: Helium (He) has the lowest boiling point among all elements, at -269°C or $4\,$K. This is due to:

- Its very weak intermolecular forces (London dispersion forces).
- Its noble gas configuration, which makes it chemically inert.

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Quick Tip

Noble gases have low boiling points due to weak Van der Waals forces.

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30. What is the chemical formula of glycerol?

1. $C_3H_8O_3$
2. $C_2H_6O_2$
3. $C_3H_6O_2$
4. $C_4H_10O_3$

Correct Answer: (A) $C_3H_8O_3$

Solution: Glycerol (also known as glycerine) is a simple polyol compound with the chemical formula:

$$C_3H_8O_3.$$

It has:

- Three carbon atoms,

- Three hydroxyl (-OH) groups, making it highly hydrophilic and soluble in water.

Structure:

$$CH_2OH - CHOH - CH_2OH.$$

Applications:

- Used as a sweetener in food,
- An important ingredient in pharmaceutical formulations.

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Quick Tip

Glycerol is widely used as a humectant due to its ability to retain moisture.

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31. Which of the following ligands has two donor atoms?

1. Cl^-
2. I^-
3. Oxalate ($C_2O_4^{2-}$)
4. H_2O

Correct Answer: (C) Oxalate ($C_2O_4^{2-}$)

Solution: Oxalate ($C_2O_4^{2-}$) is a bidentate ligand, meaning it has two donor atoms that can simultaneously coordinate with a metal ion. These donor atoms are the oxygen atoms in the carboxylate groups (-COO). Structure:

$$[O\text{-}C{=}O] - [O\text{-}C{=}O].$$

Explanation:

- Cl^- and I^- are monodentate ligands with one donor atom.
- H_2O is also a monodentate ligand with a single oxygen atom as the donor.

Applications:

- Oxalate is commonly found in complexes such as potassium ferrioxalate ($K_3[Fe(C_2O_4)_3]$).

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Quick Tip

Bidentate ligands form more stable complexes than monodentate ligands due to the chelate effect.
