MHT CET 2024 Question Paper With Solution (April 27 - Shift 1)

Time Allowed :3 Hour	Maximum Marks :150	Total Questions :150

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question booklet contains **150 Multiple Choice Questions (MCQs)**.
2. **Section-A:** Physics & Chemistry - 50 Questions each and
   Section-B: Mathematics - 50 Questions.
3. Choice and sequence for attempting questions will be as per the convenience of the candidate.
4. Read each question carefully.
5. Determine the one correct answer out of the four available options given for each question.
6. Each question with correct response shall be awarded **one (A) mark**. There shall be no negative marking.
7. No mark shall be granted for marking two or more answers of the same question, scratching, or overwriting.
8. Duration of the paper is **3 Hours**.

Biology

1. Which hormone is responsible for regulating the basal metabolic rate (BMR) in the human body?
(1) Insulin
(2) Thyroxine (T4)
(3) Adrenaline
(4) Cortisol

Correct Answer: (2) Thyroxine (T4)
Solution:
The basal metabolic rate (BMR) is the rate at which the body uses energy to maintain vital physiological functions, such as breathing, circulation, and temperature regulation, while at rest. Thyroxine (T_4), a hormone secreted by the thyroid gland, plays a critical role in regulating BMR.
Step 1: Function of thyroxine.
Thyroxine (T_4) and triiodothyronine (T_3) are thyroid hormones that influence:

- Metabolic activity by increasing oxygen consumption,
- Energy production by promoting glucose and fat metabolism,

- Protein synthesis for tissue growth and repair.

Step 2: BMR regulation by thyroxine.
Thyroxine directly impacts the basal metabolic rate by:

- Enhancing the rate of cellular respiration,
- Stimulating mitochondrial activity for energy production.

Step 3: Comparison with other hormones.

- Insulin regulates blood sugar levels but does not control BMR.
- Adrenaline prepares the body for stress responses, not BMR.
- Cortisol manages metabolism during long-term stress but does not influence BMR directly.

Thus, the hormone primarily responsible for regulating BMR is **Thyroxine (T4)**.

Quick Tip

Thyroxine (T_4) is essential for metabolic regulation. Hypothyroidism leads to decreased BMR, while hyperthyroidism results in increased BMR.

2. Which of the following conclusions was drawn from the Avery-MacLeod-McCarty experiment related to bacterial DNA?
(1) Proteins are the genetic material in bacteria.
(2) RNA is the genetic material in bacteria.
(3) DNA is the genetic material in bacteria.
(4) Lipids are the genetic material in bacteria.

Correct Answer: (3) DNA is the genetic material in bacteria.
Solution:
The Avery-MacLeod-McCarty experiment, conducted in 1944, was pivotal in identifying DNA as the genetic material. Their work extended upon Griffith's transformation experiments.
Step 1: Key findings of Griffith's experiment.
Griffith demonstrated the phenomenon of transformation in bacteria, where non-virulent R-strain bacteria became virulent S-strain bacteria when mixed with heat-killed S-strain bacteria. However, the identity of the transforming principle was unknown.
Step 2: Avery-MacLeod-McCarty experiment.
The experiment aimed to identify the transforming principle by isolating macromolecules (DNA, RNA, and proteins) from heat-killed S-strain bacteria:

- They treated the samples with protease (to destroy proteins), RNase (to destroy RNA), and DNase (to destroy DNA).
- Transformation occurred when proteins and RNA were destroyed but was inhibited when DNA was destroyed.

Step 3: Conclusion.
The experiment concluded that DNA is the genetic material responsible for heredity and transformation in bacteria. This finding was a crucial step in molecular biology.

Thus, the correct answer is **DNA is the genetic material in bacteria**.

Quick Tip

The Avery-MacLeod-McCarty experiment demonstrated that DNA, not proteins or RNA, is the hereditary material in bacteria through transformation studies.

3. What conclusion was derived from the Hershey-Chase experiment involving bacteriophages?
(1) Proteins are the genetic material in bacteriophages.
(2) RNA is the genetic material in bacteriophages.
(3) DNA is the genetic material in bacteriophages.
(4) Lipids are the genetic material in bacteriophages.

Correct Answer: (3) DNA is the genetic material in bacteriophages.
Solution:
The Hershey-Chase experiment, conducted in 1952, confirmed that DNA is the genetic material, not protein. It used bacteriophages (viruses that infect bacteria) to demonstrate the role of DNA in heredity.
Step 1: Experimental design.
Hershey and Chase used two sets of bacteriophages labeled with radioactive isotopes:

- ^{32}P to label DNA (since phosphorus is present in DNA but not in protein),
- ^{35}S to label proteins (since sulfur is present in proteins but not in DNA).

The labeled bacteriophages were allowed to infect *E. coli* bacteria.
Step 2: Separation of viral components.
After infection:

- The bacterial cells were agitated in a blender to separate the phage protein coats from the bacterial cells.
- The mixture was centrifuged to separate the heavier bacterial cells from the lighter protein coats.

Step 3: Observations and conclusion.

- ^{32}P (DNA) was found inside the bacterial cells, indicating that DNA entered the bacteria.
- ^{35}S (protein) remained in the supernatant, indicating that proteins did not enter the bacteria.

The experiment demonstrated that DNA, not protein, is the hereditary material passed on during phage reproduction.
Thus, the correct answer is **DNA is the genetic material in bacteriophages**.

Quick Tip

The Hershey-Chase experiment used radioactive labeling to show that DNA, not protein, is the genetic material in bacteriophages, marking a critical milestone in molecular biology.

4. What is the correct sequence of ecological succession in a terrestrial ecosystem?
(1) Pioneer species → Intermediate species → Climax community
(2) Intermediate species → Pioneer species → Climax community
(3) Climax community → Pioneer species → Intermediate species
(4) Pioneer species → Climax community → Intermediate species

Correct Answer: (1) Pioneer species → Intermediate species → Climax community
Solution:
Ecological succession refers to the sequential process of change in the structure and composition of a community over time. It occurs in a predictable pattern from simpler to more complex ecosystems.
Step 1: Pioneer species.
Pioneer species are the first organisms to colonize a barren or disturbed environment. They are typically hardy and capable of surviving harsh conditions. Examples include:

- Lichens and mosses on bare rocks,
- Algae in aquatic ecosystems.

Step 2: Intermediate species.
As the pioneer species alter the environment (e.g., by breaking down rocks into soil), intermediate species such as grasses, shrubs, and small plants establish themselves. These species further modify the environment, making it suitable for more complex organisms.
Step 3: Climax community.
The final stage of succession is the climax community, characterized by a stable and mature ecosystem. In a terrestrial ecosystem, this often includes large trees, diverse plants, and animals.
The correct sequence of ecological succession is:

$$\text{Pioneer species} \rightarrow \text{Intermediate species} \rightarrow \text{Climax community}.$$

Thus, the correct answer is (**1**).

Quick Tip

Ecological succession progresses from pioneer species to intermediate species and finally to a climax community, with increasing biodiversity and ecosystem complexity.

5. Which of the following is true about the pulmonary artery in the human circulatory system?
(1) It carries oxygenated blood to the heart.
(2) It carries deoxygenated blood to the lungs.
(3) It carries oxygenated blood to the body.
(4) It carries deoxygenated blood to the heart.

Correct Answer: (2) It carries deoxygenated blood to the lungs.
Solution:
The pulmonary artery is a vital component of the human circulatory system and plays a unique role compared to other arteries in the body.
Step 1: General function of arteries.
Typically, arteries carry oxygenated blood away from the heart to various parts of the body. However, the pulmonary artery is an exception.

Step 2: Specific function of the pulmonary artery.
The pulmonary artery originates from the right ventricle of the heart and carries deoxygenated blood to the lungs for oxygenation. After receiving oxygen in the lungs, blood is transported back to the heart via the pulmonary veins.
Step 3: Comparison with other blood vessels.

- Most arteries carry oxygenated blood, but the pulmonary artery carries deoxygenated blood.
- Conversely, the pulmonary veins carry oxygenated blood, unlike other veins that carry deoxygenated blood.

Thus, the correct statement is **It carries deoxygenated blood to the lungs.**

Quick Tip

The pulmonary artery is an exception among arteries as it carries deoxygenated blood. Remember this distinction while studying the circulatory system.

6. What type of monosaccharides are fructose, glucose, and xylose? To which family do they belong based on their functional groups?
(1) Fructose is a ketose, glucose and xylose are aldoses.
(2) Fructose and xylose are ketoses, glucose is an aldose.
(3) All three are aldoses.
(4) Fructose and glucose are ketoses, xylose is an aldose.

Correct Answer: (1) Fructose is a ketose, glucose and xylose are aldoses.
Solution:
Monosaccharides are classified as aldoses or ketoses based on the functional group present:

- **Aldoses:** Contain an aldehyde group ($-CHO$).
- **Ketoses:** Contain a ketone group ($-C=O$).

Step 1: Functional group identification.

- Fructose contains a ketone group at the second carbon, making it a ketose.
- Glucose and xylose contain an aldehyde group at the first carbon, classifying them as aldoses.

Step 2: Family classification.

- **Fructose:** Ketohexose (6 carbons, ketone group).
- **Glucose:** Aldohexose (6 carbons, aldehyde group).
- **Xylose:** Aldopentose (5 carbons, aldehyde group).

Step 3: Conclusion.
Fructose is a member of the ketose family, while glucose and xylose belong to the aldose family. Thus:

Fructose is a ketose, glucose and xylose are aldoses.

The correct answer is (**1**).

Quick Tip

Monosaccharides are classified based on the presence of an aldehyde ($-CHO$) or ketone ($-C=O$) group, along with the number of carbon atoms.

7. Which of the following statements correctly differentiates reproduction in higher plants from lower plants?
(1) Higher plants reproduce only sexually, while lower plants reproduce only asexually.
(2) Lower plants reproduce through spores, while higher plants reproduce through seeds.
(3) Higher plants reproduce through fragmentation, while lower plants reproduce sexually.
(4) There is no difference in the reproduction of higher and lower plants.

Correct Answer: (2) Lower plants reproduce through spores, while higher plants reproduce through see
Solution:
Reproduction in plants varies based on their evolutionary complexity. Higher and lower plants employ different reproductive strategies.
Step 1: Reproduction in lower plants.
Lower plants, such as algae, mosses, and ferns, primarily reproduce through spores. Spores are:

- Single-celled reproductive units,
- Produced in large quantities for dispersal,
- Adapted for asexual reproduction in moist environments.

Step 2: Reproduction in higher plants.
Higher plants, such as gymnosperms and angiosperms, reproduce through seeds. Seeds are:

- Multicellular structures containing an embryo,
- Produced following sexual reproduction,
- Adapted for survival in diverse environments.

Step 3: Comparison.

- Lower plants: Spore-based reproduction (asexual).
- Higher plants: Seed-based reproduction (sexual).

Thus, the correct statement is Lower plants reproduce through spores, while higher plants reproduce through seeds.

Quick Tip

Lower plants rely on spores for reproduction, often requiring moist environments, while higher plants produce seeds, allowing them to adapt to terrestrial habitats.

Physics

1. A metallic sphere of radius R is charged to a potential V. The magnitude of the electric field at a distance $r\,(r > R)$ from the center of the sphere is:
(1) $\frac{V}{r^2}$
(2) $\frac{VR^2}{r^2}$
(3) $\frac{V}{R^2}$
(4) $\frac{V}{r}$

Correct Answer: (2) $\frac{VR^2}{r^2}$
Solution:
For a metallic sphere of radius R charged to a potential V, the electric field at a point outside the sphere $(r > R)$ behaves as if all the charge is concentrated at the center. The potential V on the surface of the sphere is given by:

$$V = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{R},$$

where:

- Q is the total charge on the sphere,
- R is the radius of the sphere,
- ϵ_0 is the permittivity of free space.

Rearranging for Q:

$$Q = 4\pi\epsilon_0 \cdot VR.$$

The electric field E at a distance $r\,(r > R)$ is given by Coulomb's law:

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{r^2}.$$

Substitute $Q = 4\pi\epsilon_0 \cdot VR$:

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{4\pi\epsilon_0 \cdot VR}{r^2}.$$

Simplify:

$$E = \frac{VR^2}{r^2}.$$

Thus, the magnitude of the electric field at a distance $r\,(r > R)$ is:

$$E = \frac{VR^2}{r^2}.$$

Quick Tip

For a metallic sphere, the electric field outside the sphere behaves as if the entire charge is concentrated at the center. Use $E = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{r^2}$ to calculate the field.

2. The coefficient of performance of a refrigerator is 5. If the temperature inside the freezer is -20°C, what is the temperature of the surroundings to which it rejects heat?
(1) 31°C
(2) 37°C
(3) 41°C
(4) 47°C

Correct Answer: (1) 31°C
Solution:
The coefficient of performance (COP) of a refrigerator is defined as:

$$\text{COP} = \frac{T_C}{T_H - T_C},$$

where:

$$T_C = \text{temperature of the freezer (cold reservoir) in Kelvin,}$$

$$T_H = \text{temperature of the surroundings (hot reservoir) in Kelvin.}$$

Step 1: Convert temperatures to Kelvin.
The given temperature inside the freezer is:

$$T_C = -20^\circ\text{C} = -20 + 273 = 253\,\text{K}.$$

The COP is provided as 5:

$$\text{COP} = 5.$$

Step 2: Rearrange the formula to solve for T_H.
Using the formula:

$$\text{COP} = \frac{T_C}{T_H - T_C}.$$

Rearranging for T_H:

$$T_H - T_C = \frac{T_C}{\text{COP}}.$$

Substitute $T_C = 253\,\text{K}$ and $\text{COP} = 5$:

$$T_H - 253 = \frac{253}{5}.$$

Simplify:

$$T_H - 253 = 50.6.$$

Add 253 to both sides:

$$T_H = 253 + 50.6 = 303.6\,\text{K}.$$

Step 3: Convert T_H back to Celsius.

$$T_H = 303.6 - 273 = 30.6^\circ\text{C}.$$

Rounding to the nearest whole number:

$$T_H = 31^\circ\text{C}.$$

Thus, the temperature of the surroundings is **31**°C.

Quick Tip

Always convert temperatures to Kelvin when applying refrigeration formulas. Use $T_H = T_C + \frac{T_C}{\text{COP}}$ to determine the surrounding temperature accurately.

3. What is the output of a NAND gate when both inputs are HIGH?
(1) HIGH
(2) LOW
(3) Alternates between HIGH and LOW
(4) Indeterminate

Correct Answer: (2) LOW
Solution:
A NAND gate (NOT AND gate) is a fundamental logic gate that gives an output opposite to the AND gate. The truth table for a NAND gate is as follows:

Input A	**Input B**	**Output Y (NAND)**
0	0	1
0	1	1
1	0	1
1	1	0

Table 1: Truth table for a NAND gate

Step 1: Analyze the given inputs.
Both inputs A and B are HIGH (1):

$$Y = \text{NOT}(A \cdot B).$$

Step 2: Apply the AND operation.

$$A \cdot B = 1 \cdot 1 = 1.$$

Step 3: Apply the NOT operation.

$$Y = \text{NOT}(1) = 0.$$

Conclusion:
The output of the NAND gate is **LOW** (0) when both inputs are HIGH.

Quick Tip

NAND gates are universal gates and can be used to construct any other logic gate. Their output is HIGH unless all inputs are HIGH.

4. What is the expression for the time period of a satellite orbiting Earth at a height h above the Earth's surface?
(1) $T = 2\pi\sqrt{\frac{R^3}{GM}}$
(2) $T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$
(3) $T = \frac{1}{2\pi}\sqrt{\frac{GM}{(R+h)^3}}$

(4) $T = 2\pi\sqrt{\frac{(R^2+h^2)}{GM}}$

Correct Answer: (2) $T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$

Solution:

The time period of a satellite is derived using Kepler's Third Law and the concept of centripetal force balancing gravitational force.

Step 1: Gravitational force provides the centripetal force.

For a satellite of mass m orbiting Earth:

$$F_{\text{gravity}} = \frac{GMm}{(R+h)^2},$$

where:

- G is the gravitational constant,
- M is the mass of Earth,
- R is the radius of Earth,
- h is the height of the satellite above Earth's surface.

This force provides the centripetal force required for circular motion:

$$F_{\text{centripetal}} = \frac{mv^2}{R+h}.$$

Equating the two forces:

$$\frac{GMm}{(R+h)^2} = \frac{mv^2}{R+h}.$$

Cancel m and simplify:

$$v^2 = \frac{GM}{R+h}.$$

Step 2: Relate orbital velocity to time period.

The orbital velocity v is given by:

$$v = \frac{2\pi(R+h)}{T}.$$

Substitute $v^2 = \frac{GM}{R+h}$:

$$\left(\frac{2\pi(R+h)}{T}\right)^2 = \frac{GM}{R+h}.$$

Simplify:

$$\frac{4\pi^2(R+h)^2}{T^2} = \frac{GM}{R+h}.$$

Rearrange for T^2:

$$T^2 = \frac{4\pi^2(R+h)^3}{GM}.$$

Take the square root:

$$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}.$$

Conclusion:
The time period of the satellite is:

$$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}.$$

Quick Tip

The time period of a satellite depends on the sum of the Earth's radius R and the satellite's height h. Use $T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$ for calculations.

5. 1. In a meter bridge experiment, a resistance of $10\,\Omega$ is balanced by a resistance X with a balance point at $40\,\text{cm}$. What is the value of X?
(1) $6.67\,\Omega$
(2) $8.00\,\Omega$
(3) $10.00\,\Omega$
(4) $15.00\,\Omega$

Correct Answer: (4) $15.00\,\Omega$
Solution:
The meter bridge is based on the principle of a balanced Wheatstone bridge, where:

$$\frac{R_1}{R_2} = \frac{l_1}{l_2},$$

where:

- $R_1 = 10\,\Omega$ is the known resistance,
- $R_2 = X\,\Omega$ is the unknown resistance,
- $l_1 = 40\,\text{cm}$ is the length of the wire on one side,
- $l_2 = 100 - l_1 = 60\,\text{cm}$ is the length of the wire on the other side.

Step 1: Use the balanced condition.
Substitute the values into the balanced condition:

$$\frac{R_1}{X} = \frac{l_1}{l_2}.$$

Rearrange for X:

$$X = R_1 \cdot \frac{l_2}{l_1}.$$

Step 2: Substitute the values.

$$X = 10 \cdot \frac{60}{40}.$$

Simplify:

$$X = 10 \cdot 1.5 = 15.00\,\Omega.$$

Conclusion:
The value of the unknown resistance X is $\mathbf{15.00\,\Omega}$.

Quick Tip

In a meter bridge, use the relation $\frac{R_1}{R_2} = \frac{l_1}{l_2}$ to calculate the unknown resistance, where l_1 and l_2 are the balancing lengths on either side. Verify that $l_1 + l_2 = 100\,\text{cm}$ for accuracy.

6. Two charges $q_1 = 2\,\mu\text{C}$ and $q_2 = -3\,\mu\text{C}$ are placed 10 cm apart in a vacuum. What is the magnitude and direction of the force between them?
(1) 5.4 N, Attractive
(2) 5.4 N, Repulsive
(3) 4.8 N, Attractive
(4) 4.8 N, Repulsive

Correct Answer: (1) 5.4 N, Attractive
Solution:
Coulomb's law states that the force between two point charges is given by:

$$F = \frac{1}{4\pi\epsilon_0} \cdot \frac{|q_1 q_2|}{r^2},$$

where:

- q_1 and q_2 are the charges,
- r is the distance between the charges,
- $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9\,\text{N}\,\text{m}^2\,\text{C}^{-2}$.

Step 1: Substitute the given values.

$$q_1 = 2 \times 10^{-6}\,\text{C},\ q_2 = -3 \times 10^{-6}\,\text{C},\ r = 10\,\text{cm} = 0.1\,\text{m}.$$

Substitute into the formula:

$$F = 9 \times 10^9 \cdot \frac{|(2 \times 10^{-6})(-3 \times 10^{-6})|}{(0.1)^2}.$$

Step 2: Simplify the calculations.

$$F = 9 \times 10^9 \cdot \frac{6 \times 10^{-12}}{0.01}.$$
$$F = 9 \cdot 6 \cdot 10^{-3} = 54 \times 10^{-3} = 5.4\,\text{N}.$$

Step 3: Determine the direction.
Since q_1 and q_2 have opposite signs (+ and −), the force is attractive.
Conclusion:
The magnitude of the force is **5.4** N and the direction is Attractive.

Quick Tip

Coulomb's law determines the force between two charges. Opposite charges attract, and like charges repel. Remember to convert distances to meters in SI units for accurate calculations.

7. Which elements have the same magnetic moment μ?
(1) Cr^{3+}, Mn^{2+}
(2) Fe^{2+}, Ni^{2+}
(3) Cu^{2+}, Zn^{2+}
(4) Mn^{2+}, Fe^{3+}

Correct Answer: (4) Mn^{2+}, Fe^{3+}
Solution:
The magnetic moment (μ) of an ion is calculated using the formula:

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

where:

- n is the number of unpaired electrons,
- μ_B is the Bohr magneton.

Step 1: Determine the electronic configuration and unpaired electrons.

- Mn^{2+}: Atomic number of Mn is 25. The configuration of Mn^{2+} is $[Ar]\,3d^5$, with $n = 5$ unpaired electrons.
- Fe^{3+}: Atomic number of Fe is 26. The configuration of Fe^{3+} is $[Ar]\,3d^5$, with $n = 5$ unpaired electrons.

Step 2: Calculate the magnetic moment. For both Mn^{2+} and Fe^{3+}:

$$\mu = \sqrt{5(5+2)} = \sqrt{35} \approx 5.92\,\mu_B.$$

Step 3: Conclusion. The elements Mn^{2+} and Fe^{3+} have the same magnetic moment of approximately $5.92\,\mu_B$.

Quick Tip

To find the magnetic moment of an ion, identify the number of unpaired electrons (n) from its electronic configuration and apply $\mu = \sqrt{n(n+2)}\,\mu_B$.

Chemistry

1. For irreversible expansion of an ideal gas under isothermal conditions, which of the following is correct?
(1) $\Delta U > 0$, $q > 0$
(2) $\Delta U = 0$, $q = -w$
(3) $\Delta U = 0$, $q = w$
(4) $\Delta U < 0$, $q < 0$

Correct Answer: (2) $\Delta U = 0$, $q = -w$
Solution:
In an isothermal process for an ideal gas, the temperature remains constant throughout the process. Therefore, the internal energy (ΔU) of the gas is zero because ΔU is a function of temperature for an ideal gas.

Step 1: First law of thermodynamics.
The first law of thermodynamics is given by:

$$\Delta U = q + w,$$

where:

- ΔU is the change in internal energy,
- q is the heat exchange,
- w is the work done by the system.

Since $\Delta U = 0$ in an isothermal process, the equation becomes:

$$0 = q + w.$$

Rearrange:

$$q = -w.$$

Step 2: Direction of heat and work.

- During expansion, work (w) is done by the gas and is positive.
- To maintain constant temperature, the system absorbs an equivalent amount of heat (q) such that $q = -w$.

Conclusion:
For irreversible isothermal expansion of an ideal gas:

$$\Delta U = 0, \quad q = -w.$$

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

Quick Tip

In isothermal processes for ideal gases, the internal energy (ΔU) does not change ($\Delta U = 0$). Heat absorbed (q) equals the negative of work done (w).

2. The atomic radius of silver (Ag) is closest to which of the following values?
(1) 144 pm
(2) 172 pm
(3) 160 pm
(4) 128 pm

Correct Answer: (1) 144 pm
Solution:
The atomic radius of an element is a measure of the size of its atoms, typically measured in picometers (pm) or angstroms (Å).
Step 1: Define the atomic radius of silver.
Silver (Ag) is a transition metal with atomic number 47. It has a single $5s^1$ electron in its outermost shell, and its atomic radius is influenced by:

- Its metallic bonding,
- The shielding effect from inner electrons.

Step 2: Reference values for atomic radius.
From experimental data and periodic trends:

$$\text{Atomic radius of Ag} = 144\,\text{pm}.$$

Step 3: Comparison with options.
The value 144 pm closely matches option (1).
Conclusion:
The atomic radius of silver (Ag) is **144** pm.

> Quick Tip
>
> The atomic radius decreases across a period and increases down a group in the periodic table. Transition metals like Ag have slightly smaller radii due to increased nuclear charge and d-orbital shielding.

3. The IUPAC name of the complex ion formed when gold dissolves in aqua regia is:
(A) Tetrachloroaurate (I)
(B) Dichloridoaurate (III)
(C) Tetrachloridoaurate (III)
(D) Tetrachloroaurate (II)

Correct Answer: (C) Tetrachloridoaurate (III)
Solution:
When gold dissolves in aqua regia (a mixture of concentrated nitric acid and hydrochloric acid), the following reactions occur:

$$\text{Au} + 4\text{HCl} + \text{HNO}_3 \rightarrow \text{H}[\text{AuCl}_4] + 2\text{H}_2\text{O} + \text{NO}.$$

The complex ion formed is $[\text{AuCl}_4]^-$, which is a coordination compound. The oxidation state of gold in this complex ion is +3.
Step 1: Identify the oxidation state of gold.
The oxidation state of gold (Au) in $[\text{AuCl}_4]^-$ can be calculated as:

$$\text{Let the oxidation state of Au be } x.$$

$$x + 4(-1) = -1 \quad \Rightarrow \quad x - 4 = -1 \quad \Rightarrow \quad x = +3.$$

Step 2: Determine the IUPAC name.
The IUPAC name of $[\text{AuCl}_4]^-$ is:

$$\text{Tetrachloridoaurate (III)}.$$

Conclusion:
The correct name of the complex ion formed is **Tetrachloridoaurate(III)**.

Quick Tip

In naming coordination compounds, use prefixes like tetra-, di-, etc., for ligands and include the oxidation state of the central metal in Roman numerals.

4. Which of the following represents the Gattermann-Koch reaction?

(A) Formylation of an aromatic ring using CO and HCl with $AlCl_3$ or CuCl.
(B) Reduction of a nitro group to an amine group.
(C) Introduction of an acyl group (-$COCH_3$) to an aromatic ring.
(D) Halogenation of an aromatic compound in the presence of a Lewis acid.

Correct Answer: (A) Formylation of an aromatic ring using CO and HCl with $AlCl_3$ or CuCl.

Solution:
The Gattermann-Koch reaction is a chemical method for introducing a formyl group ($-CHO$) into an aromatic ring. The reaction proceeds as follows:

$$\text{Aromatic compound} + CO + HCl \xrightarrow{AlCl_3 \text{ or } CuCl} \text{Aromatic aldehyde.}$$

Step 1: Reaction mechanism.
In the presence of $AlCl_3$ or CuCl, carbon monoxide (CO) reacts with hydrogen chloride (HCl) to produce the electrophilic species $COCl^+$. This electrophile attacks the aromatic ring, forming an aromatic aldehyde.
Step 2: Example reaction.
Benzene reacts with CO and HCl in the presence of $AlCl_3$ to form benzaldehyde:

$$C_6H_6 + CO + HCl \xrightarrow{AlCl_3} C_6H_5CHO.$$

Conclusion.
The Gattermann-Koch reaction specifically introduces a formyl group ($-CHO$) to an aromatic compound, which is accurately described by option (**A**).

Quick Tip

The Gattermann-Koch reaction is a formylation process requiring CO, HCl, and a Lewis acid catalyst like $AlCl_3$ or CuCl.

5. The metal that cannot be obtained by electrolysis of an aqueous solution of its salts is:
(A) Ag
(B) Ca
(C) Cu
(D) Cr

Correct Answer: (B) Ca
Solution:
The feasibility of obtaining a metal by electrolysis of its aqueous salt solution depends on its reduction potential relative to the reduction of water (H_2O).

Step 1: Compare reduction potentials.
Calcium (Ca) is an alkali earth metal with a highly negative standard reduction potential:

$$Ca^{2+} + 2e^- \rightarrow Ca,\ E^\circ = -2.87\,V.$$

Water has a less negative reduction potential:

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-,\ E^\circ = -0.83\,V.$$

Since the reduction of water (H_2O) is thermodynamically more favorable than the reduction of Ca^{2+}, calcium cannot be obtained by electrolysis of its aqueous salt solution. Instead, hydrogen gas will be liberated at the cathode.
Step 2: Other metals in the options.

- Ag and Cu have positive reduction potentials, making their reduction favorable in aqueous solutions.
- Cr can also be reduced electrochemically but requires specific conditions.

Conclusion:
The metal Ca cannot be obtained by electrolysis of its aqueous salt solution because water is preferentially reduced.

Quick Tip

Metals with highly negative reduction potentials, such as alkali and alkaline earth metals, cannot be obtained from aqueous solutions by electrolysis. Instead, molten salt electrolysis is used.

6. An example of a sigma-bonded organometallic compound is:
(A) Cobaltocene
(B) Ruthenocene
(C) Ferrocene
(D) Grignard's reagent

Correct Answer: (D) Grignard's reagent
Solution:
Organometallic compounds are those that contain a direct bond between a metal atom and a carbon atom of an organic group. These compounds can have either σ-bonds, π-bonds, or both.
Step 1: Analyze the bonding in the options.

- Cobaltocene, Ruthenocene, and Ferrocene are sandwich compounds where the metal atom forms π-bonds with aromatic cyclopentadienyl ligands.
- Grignard's reagent (RMgX) contains a metal-carbon σ-bond. This is an example of a sigma-bonded organometallic compound.

Step 2: Example of Grignard's reagent.
In a Grignard reagent such as CH_3MgBr, the magnesium atom forms a direct σ-bond with the carbon atom of the methyl group.

Conclusion:
Grignard's reagent is a classic example of a σ-bonded organometallic compound, making (**D**) the correct answer.

> Quick Tip
>
> Grignard's reagents (RMgX) are widely used in organic synthesis due to their nucleophilic carbon, which makes them versatile in forming carbon-carbon bonds.

7. The reagent used in the Etard reaction is:
(A) Chromyl chloride (CrO_2Cl_2)
(B) Potassium dichromate ($K_2Cr_2O_7$)
(C) Chromic acid (H_2CrO_4)
(D) Sodium dichromate ($Na_2Cr_2O_7$)

Correct Answer: (A) Chromyl chloride (CrO_2Cl_2)
Solution:
The Etard reaction is used to oxidize aromatic methyl groups ($-CH_3$) to aldehydes ($-CHO$) using a specific oxidizing agent.
Step 1: Key Reagent in the Etard Reaction.
The reagent used in the Etard reaction is Chromyl chloride (CrO_2Cl_2). It selectively oxidizes the methyl group of an aromatic compound, such as toluene, to form the corresponding benzaldehyde.
Step 2: Example Reaction.
When toluene reacts with chromyl chloride in carbon tetrachloride (CCl_4), the methyl group is oxidized to form benzaldehyde:

$$C_6H_5CH_3 + CrO_2Cl_2 \rightarrow C_6H_5CHO.$$

Conclusion:
The correct reagent used in the Etard reaction is Chromyl chloride ($CrO_{\mathbf{2}}Cl_{\mathbf{2}}$).

> Quick Tip
>
> The Etard reaction is useful for preparing aldehydes from methyl-substituted aromatic compounds. Chromyl chloride (CrO_2Cl_2) is the key oxidizing agent.

8. Which of the following is not a neutral ligand?
(A) H_2O
(B) NH_3
(C) ONO
(D) CO

Correct Answer: (C) ONO
Solution:
Ligands are classified as neutral or charged based on their overall charge. A neutral ligand has no net charge.
Step 1: Analyze each option.

- H_2O: Water is a neutral ligand as it has no net charge.

- NH_3: Ammonia is a neutral ligand with no net charge.
- CO: Carbon monoxide is a neutral ligand with no net charge.
- ONO: The nitrito group (ONO^-) is negatively charged, making it a non-neutral ligand.

Step 2: Identify the non-neutral ligand.
Among the given options, ONO^- is not a neutral ligand because it carries a negative charge.
Conclusion:
The ligand ONO^- is not a neutral ligand, making (**C**) the correct answer.

Quick Tip

Neutral ligands, such as H_2O, NH_3, and CO, have no net charge. Charged ligands, like ONO^-, are classified as anionic ligands.

9. Which of the following is the Reimer-Tiemann reaction?
(A) Formylation of phenols using chloroform and alkali to form ortho-hydroxybenzaldehyde.
(B) Bromination of phenols in the presence of bromine water.
(C) Oxidation of phenols to quinones using an oxidizing agent.
(D) Nitration of phenols in the presence of concentrated nitric acid.

Correct Answer: (A) Formylation of phenols using chloroform and alkali to form ortho-hydroxybenzald
Solution:
The Reimer-Tiemann reaction is a chemical reaction used to introduce a formyl group ($-CHO$) at the ortho position of a phenol. This reaction specifically occurs under basic conditions with chloroform ($CHCl_3$) as the reagent.
Step 1: Reaction mechanism.

- Chloroform reacts with a strong base (such as NaOH or KOH) to produce the electrophilic dichlorocarbene intermediate ($:CCl_2$).
- The dichlorocarbene intermediate attacks the ortho position of the phenol, leading to the formation of an intermediate compound.
- Hydrolysis of the intermediate produces ortho-hydroxybenzaldehyde.

Step 2: Example reaction. When phenol (C_6H_5OH) reacts with chloroform and alkali, the following reaction occurs:

$$C_6H_5OH + CHCl_3 + 3NaOH \rightarrow \text{o-HO-}C_6H_4CHO + 3NaCl + 2H_2O.$$

Conclusion:
The Reimer-Tiemann reaction is the formylation of phenols using chloroform and alkali to form ortho-hydroxybenzaldehyde, making (**A**) the correct answer.

Quick Tip

The Reimer-Tiemann reaction is specific for phenols and introduces a formyl group ($-CHO$) at the ortho position. Use $CHCl_3$ and NaOH to carry out this reaction.

10. How many lattice points are there in a Body-Centered Cubic (BCC) structure?
(A) 1
(B) 2
(C) 3
(D) 4

Correct Answer: (B) 2
Solution:
A Body-Centered Cubic (BCC) structure is a type of crystal lattice arrangement where atoms are positioned at specific points within a cubic unit cell.
Step 1: Lattice points in a BCC structure.

- The BCC structure has one atom at each of the eight corners of the cube.
- There is one atom at the center of the cube.

Step 2: Contribution of each lattice point.

- Each corner atom contributes $\frac{1}{8}$ to the unit cell because it is shared by 8 adjacent unit cells.
- The center atom contributes entirely (1) to the unit cell since it is not shared.

Step 3: Calculate the total number of lattice points.

$$\text{Total number of lattice points} = 8 \cdot \frac{1}{8} + 1 = 1 + 1 = 2.$$

Conclusion:
The BCC structure contains **2** lattice points per unit cell.

Quick Tip

In a BCC structure, each corner contributes $\frac{1}{8}$ of an atom, and the center contributes 1 atom. Adding these gives 2 lattice points in total.