# BITSAT 2026 May 27 Shift 1

## Question Paper (Memory-Based) with Solutions

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### General Instructions

(i) **Duration:** The total duration of the examination is 3 hours (180 minutes).

(ii) **Total Marks:** The complete paper carries a maximum of 390 marks.

(iii) **Structure:** The paper has 4 Sections:

- **Part 1:** 30 Multiple Choice Questions (Physics).
- **Part 2:** 30 Multiple Choice Questions (Chemistry).
- **Part 3:** 10 Multiple Choice Questions (English Proficiency), 20 Multiple Choice Questions (Logical Reasoning)
- **Part 4:** 40 Multiple Choice Questions (Mathematics/Biology)

(iv) **Compulsory Questions:** All 130 questions are compulsory,and +12 Questions(Optional Extra Questions)

(v) Each question has four options. Only **one** option is correct.

(vi) **Correct Answer:** +3 marks.

(vii) **Incorrect Answer:** −1 (Negative marking).

(viii) **Unanswered/Marked for Review:** 0 marks.

## PHYSICS

**1. A body of mass $m$ is dropped from a height $h$. What is its kinetic energy just before it hits the ground?**

(A) $mgh$

(B) $\frac{1}{2}mgh$

(C) $2mgh$

(D) $mgh^2$

**Correct Answer:** (A) $mgh$

**Solution:**

**Concept:** According to the Law of Conservation of Mechanical Energy, the total mechanical energy in a closed system remains constant if only conservative forces (like gravity) are acting on the body.

**Step 1:** Analyze the initial energy of the system. When the body is at height $h$, its velocity is zero (it is "dropped"). Therefore, its initial kinetic energy $(KE_i)$ is 0, and its initial potential energy $(PE_i)$ is $mgh$.

$$E_{\text{total}} = PE_i + KE_i = mgh + 0 = mgh$$

**Step 2:** Analyze the energy just before impact. Just before the body hits the ground, its height is 0, meaning the potential energy $(PE_f)$ is 0. All the initial potential energy has been converted into kinetic energy $(KE_f)$.

$$E_{\text{total}} = PE_f + KE_f = 0 + KE_f$$

**Step 3:** Equate energies and solve. Since the total energy must remain constant:

$$mgh = 0 + KE_f \implies KE_f = mgh$$

**Quick Tip:** For objects in free fall, the potential energy lost equals the kinetic energy gained.

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**2. Two charges $q_1$ and $q_2$ are placed at a distance $r$. If the distance between them is doubled, the electrostatic force between them becomes:**

(A) One-fourth of the original force

(B) Half of the original force

(C) Four times the original force

 

(D) Twice the original force

**Correct Answer:** (A) One-fourth of the original force

**Solution:**

**Concept:** Coulomb's Law describes the electrostatic force ($F$) between two point charges:

$$F = k\frac{q_1 q_2}{r^2}$$

where $k$ is Coulomb's constant, $q_1, q_2$ are the magnitudes of the charges, and $r$ is the distance between them.

**Step 1:** Identify the relationship between Force and Distance. From the formula, $F$ is inversely proportional to the square of the distance between the charges:

$$F \propto \frac{1}{r^2}$$

**Step 2:** Calculate the effect of doubling the distance. Let the original force be $F_1 = \frac{kq_1q_2}{r^2}$. When the distance is doubled, $r' = 2r$. The new force $F_2$ is:

$$F_2 = \frac{kq_1q_2}{(2r)^2} = \frac{kq_1q_2}{4r^2}$$

**Step 3:** Compare the new force to the original.

$$F_2 = \frac{1}{4}\left(\frac{kq_1q_2}{r^2}\right) = \frac{1}{4}F_1$$

**Quick Tip:** In inverse-square laws (like gravity or electrostatics), doubling the distance reduces the force by a factor of 4.

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**3. A light ray enters a glass slab of refractive index $\mu = 1.5$ from air. What is the speed of light inside the glass slab? (Speed of light in air $c = 3 \times 10^8$ m/s)**

(A) $2 \times 10^8$ m/s

 

(B) $4.5 \times 10^8$ m/s

(C) $3 \times 10^8$ m/s

(D) $1.5 \times 10^8$ m/s

**Correct Answer:** (A) $2 \times 10^8$ m/s

**Solution:**

**Concept:** The refractive index ($\mu$) of a medium is defined as the ratio of the speed of light in vacuum ($c$) to the speed of light in that medium ($v$):

$$\mu = \frac{c}{v}$$

**Step 1:** Rearrange the formula to solve for velocity. Given $\mu = 1.5$ and $c = 3 \times 10^8$ m/s:

$$v = \frac{c}{\mu}$$

**Step 2:** Substitute the values.

$$v = \frac{3 \times 10^8}{1.5}$$

**Step 3:** Calculate the result.

$$v = 2 \times 10^8 \text{ m/s}$$

**Quick Tip:** A higher refractive index means light travels slower in that medium compared to vacuum.

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**4. A gas undergoes an adiabatic process. During this process:**

(A) No heat is exchanged with the surroundings

(B) The temperature of the gas remains constant

(C) The pressure of the gas remains constant

(D) The volume of the gas remains constant

**Correct Answer:** (A) No heat is exchanged with the surroundings

 

**Solution:**

**Concept:** Thermodynamic processes are classified based on the constraints on heat exchange, temperature, pressure, or volume. An adiabatic process is specifically defined by the lack of thermal energy transfer.

**Step 1:** Define the adiabatic condition. In thermodynamics, a process is adiabatic if the heat exchanged with the surroundings, $dQ$, is equal to zero.

**Step 2:** Evaluate the options based on the definition. (A) True: Adiabatic implies $dQ = 0$.

(B) False: This describes an isothermal process.

(C) False: This describes an isobaric process.

(D) False: This describes an isochoric (or isometric) process.

**Quick Tip:** Adiabatic processes often occur so quickly that the system does not have time to exchange heat with its surroundings.

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## CHEMISTRY

**5. Using the standard electrode potential, find out the pair between which redox reaction is not feasible. $E^{\ominus}$ values: $Fe^{3+}/Fe^{2+} = +0.77V$; $I_2/I^- = +0.54V$; $Cu^{2+}/Cu = +0.34V$; $Ag^+/Ag = +0.80V$.**

(A) $Fe^{3+}$ and $I^-$

(B) $Ag^+$ and Cu

(C) $Fe^{3+}$ and Cu

(D) Ag and $Fe^{3+}$

**Correct Answer:** (D) Ag and $Fe^{3+}$

**Solution:**

**Concept:** A redox reaction is spontaneous and feasible only if the standard Gibbs free energy change $\Delta G^\ominus$ is negative. This corresponds to a positive standard cell potential $E^\ominus_{\text{cell}}$.

$$E^\ominus_{\text{cell}} = E^\ominus_{\text{cathode}} - E^\ominus_{\text{anode}}$$

For a reaction to occur, the species with the higher standard reduction potential must act as the cathode (undergoing reduction), while the species with the lower reduction potential must act as the anode (undergoing oxidation).

**Step 1:** Analyze the fundamental condition for non-feasibility. A reaction is **not feasible** if the calculated $E^\ominus_{\text{cell}}$ is negative. This occurs when an attempt is made to force the species with a higher reduction potential to undergo oxidation. If $E^\ominus_{\text{cathode}} < E^\ominus_{\text{anode}}$, then $E^\ominus_{\text{cell}} < 0$, rendering the reaction non-spontaneous.

**Step 2:** Evaluate each option based on the provided $E^\ominus$ values.

- **Option (1):** $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$
  $E^\ominus_{\text{cell}} = E^\ominus_{Fe^{3+}/Fe^{2+}} - E^\ominus_{I_2/I^-} = 0.77 - 0.54 = +0.23\text{V}$. Since it is positive, the reaction is **feasible**.

- **Option (2):** $2Ag^+ + Cu \rightarrow 2Ag + Cu^{2+}$
  $E^\ominus_{\text{cell}} = E^\ominus_{Ag^+/Ag} - E^\ominus_{Cu^{2+}/Cu} = 0.80 - 0.34 = +0.46\text{V}$. Since it is positive, the reaction is **feasible**.

- **Option (3):** $2Fe^{3+} + Cu \rightarrow 2Fe^{2+} + Cu^{2+}$
  $E^\ominus_{\text{cell}} = E^\ominus_{Fe^{3+}/Fe^{2+}} - E^\ominus_{Cu^{2+}/Cu} = 0.77 - 0.34 = +0.43\text{V}$. Since it is positive, the reaction is **feasible**.

- **Option (4):** $Ag + Fe^{3+} \rightarrow Ag^+ + Fe^{2+}$
  Here, Ag is intended to act as the anode (oxidation, $E^\ominus = 0.80\text{V}$) and $Fe^{3+}$ as the cathode (reduction, $E^\ominus = 0.77\text{V}$).
  $E^\ominus_{\text{cell}} = 0.77 - 0.80 = -0.03\text{V}$. Because the potential is negative, the reaction is **not feasible**.

**Quick Tip:** A simple rule of thumb: A metal with a higher (more positive) reduction potential cannot be oxidized by a species with a lower (less positive) reduction potential. Always check if the oxidizing agent has a higher reduction potential than the reducing agent.

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**6. The reaction $A(g) \rightarrow P(g) + Q(g) + R(g)$ follows first-order kinetics with a half-life of 69.3 s at 500°C. Starting with pure $A$ in a container at 500°C and a pressure of 0.4 atm, what will be the total pressure of the system after 230 s?**

(A) 1.15 atm

(B) 1.32 atm

(C) 1.22 atm

(D) 1.12 atm

**Correct Answer:** (D) 1.12 atm

**Solution:**

**Concept:** For a first-order gas-phase reaction, the rate constant $k$ is related to the half-life $t_{1/2}$ as:

$$k = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$$

The progress of the reaction can be tracked using the pressure changes of the reactants and products.

**Step 1:** Calculate the rate constant $k$. Given $t_{1/2} = 69.3$ s:

$$k = \frac{0.693}{69.3} = 0.01 \text{ s}^{-1}$$

**Step 2:** Determine the pressure of reactant A remaining after 230 s. Using the first-order integrated rate law:

$$P_A = P_0 e^{-kt}$$

$$P_A = 0.4 \times e^{-0.01 \times 230} = 0.4 \times e^{-2.3}$$

Since $e^{-2.3} \approx 0.1$:

$$P_A = 0.4 \times 0.1 = 0.04 \text{ atm}$$

**Step 3:** Calculate the total pressure at time $t = 230$ s. Let $x$ be the decrease in pressure of $A$.

$$A(g) \rightarrow P(g) + Q(g) + R(g)$$

Initial pressure: 0.4 0 0 0 At $t = 230$: $(0.4 - x)$ $x$ $x$ $x$ Since $P_A = 0.4 - x = 0.04$, it follows that $x = 0.36$ atm.

The total pressure $P_T$ is the sum of all partial pressures:

$$P_T = (0.4 - x) + x + x + x = 0.4 + 2x$$

$$P_T = 0.4 + 2(0.36) = 0.4 + 0.72 = 1.12 \text{ atm}$$

**Quick Tip:** For reactions where stoichiometry is $A \rightarrow n_1 P + n_2 Q + \ldots$, the total pressure at any time $t$ is $P_T = P_0 + (\sum n_i - 1)x$, where $x = P_0 - P_A$.

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**7. Electron affinity is positive, when:**

(A) $O^- \rightarrow O^-$

(B) $O^- \rightarrow O^{2-}$

(C) $O \rightarrow O^+$

(D) $O \rightarrow O^{2+}$

**Correct Answer:** (B) $O^- \rightarrow O^{2-}$

**Solution:**

**Concept:** Electron affinity is the energy released when an electron is added to a neutral gaseous atom. Generally, the first electron addition is exothermic (negative value). However, when adding an electron to an already negatively charged ion, a strong electrostatic repulsion exists between the incoming electron and the existing negative charge.

**Step 1:** Understanding the energetics of ion formation. Adding an electron to a neutral atom (like O) is typically exothermic because the nucleus attracts the incoming electron. The reaction is:

$$O(g) + e^- \rightarrow O^-(g) \quad (\Delta H < 0)$$

 

This process releases energy.

**Step 2:** Analyzing the second electron addition. To form the oxide ion ($O^{2-}$), an additional electron must be forced into the already negative $O^-$ ion. The incoming electron faces significant electronic repulsion from the electron cloud of the $O^-$ ion.

$$O^-(g) + e^- \rightarrow O^{2-}(g) \quad (\Delta H > 0)$$

Because work must be done to overcome this repulsion, energy is absorbed, making the electron affinity value **positive**.

**Step 3:** Conclusion. Among the choices provided, the process where an electron is added to an anion ($O^-$ changing into $O^{2-}$) is the only one that represents a second electron affinity, which is always endothermic (positive).

**Quick Tip:** Remember: First electron affinity is usually negative (energy released), while subsequent electron affinities (for anions) are always positive (energy required) due to inter-electronic repulsion.

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**8. The ionic radii in Å of $N^{3-}$, $O^{2-}$, and $F^-$ are respectively:**

(A) $1.71, 1.40$ and $1.36$

(B) $1.71, 1.36$ and $1.40$

(C) $1.36, 1.40$ and $1.71$

(D) $1.36, 1.71$ and $1.40$

**Correct Answer:** (A) $1.71, 1.40$ and $1.36$

**Solution:**

**Concept:** The given species $N^{3-}$, $O^{2-}$, and $F^-$ are **isoelectronic species**, meaning they all possess the same number of electrons (10 electrons each).

**Step 1:** Understanding the relationship between nuclear charge and ionic radius. For isoelectronic species, the number of electrons is constant, but the number of protons (nuclear charge) increases as we move from Nitrogen ($Z = 7$) to Oxygen ($Z = 8$) to Fluorine ($Z = 9$).

**Step 2:** Applying the principle of effective nuclear charge. As the atomic number ($Z$) increases, the nucleus exerts a stronger attractive force on the same number of electrons, pulling the electron cloud closer to the nucleus. Therefore, the ionic radius decreases as the nuclear charge increases.

$$Z(\text{N}) = 7, Z(\text{O}) = 8, Z(\text{F}) = 9$$

Since $Z(\text{N}) < Z(\text{O}) < Z(\text{F})$, the ionic radii follow the order:

$$\text{N}^{3-} > \text{O}^{2-} > \text{F}^{-}$$

**Step 3:** Matching the given values. Based on the trend, the radius should be largest for $\text{N}^{3-}$ (1.71Å) and smallest for $\text{F}^{-}$ (1.36Å). The correct sequence is: $\text{N}^{3-} = 1.71\text{Å}$ $\text{O}^{2-} = 1.40\text{Å}$ $\text{F}^{-} = 1.36\text{Å}$

**Quick Tip:** For isoelectronic ions, remember: As the negative charge decreases (or positive charge increases), the ionic radius decreases.

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## MATHEMATICS

**9. Find the sum of the series $\left(x + \frac{1}{x}\right)^2 + \left(x^2 + \frac{1}{x^2}\right)^2 + \left(x^3 + \frac{1}{x^3}\right)^2 + \cdots$ up to $n$ terms.**

(A) $\frac{x^{2n}-1}{x^2-1} \times \frac{x^{2n+2}+1}{x^{2n}} + 2n$

(B) $\frac{x^{2n}+1}{x^2+1} \times \frac{x^{2n+2}-1}{x^{2n}} - 2n$

(C) $\frac{x^{2n}-1}{x^2-1} \times \frac{x^{2n}-1}{x^{2n}} - 2n$

(D) None of these

**Correct Answer:** (A) $\frac{x^{2n}-1}{x^2-1} \times \frac{x^{2n+2}+1}{x^{2n}} + 2n$

**Solution:**

**Concept:** The general term of the series can be written as:

$$T_r = \left(x^r + \frac{1}{x^r}\right)^2 = (x^r)^2 + \frac{1}{(x^r)^2} + 2(x^r)\left(\frac{1}{x^r}\right) = x^{2r} + \frac{1}{x^{2r}} + 2$$

 

**Step 1:** Form the sum of $n$ terms. The sum $S_n$ is:

$$S_n = \sum_{r=1}^{n} \left( x^{2r} + \frac{1}{x^{2r}} + 2 \right)$$

$$S_n = \sum_{r=1}^{n} x^{2r} + \sum_{r=1}^{n} \frac{1}{x^{2r}} + \sum_{r=1}^{n} 2$$

**Step 2:** Evaluate the individual summations. 1. The first term is a geometric progression (G.P.) with first term $a = x^2$ and common ratio $r = x^2$:

$$\sum_{r=1}^{n} x^{2r} = x^2 \frac{(x^2)^n - 1}{x^2 - 1} = \frac{x^2(x^{2n} - 1)}{x^2 - 1}$$

2. The second term is a G.P. with $a = \frac{1}{x^2}$ and common ratio $r = \frac{1}{x^2}$:

$$\sum_{r=1}^{n} \frac{1}{x^{2r}} = \frac{1}{x^2} \frac{1 - (\frac{1}{x^2})^n}{1 - \frac{1}{x^2}} = \frac{1}{x^2} \frac{\frac{x^{2n}-1}{x^{2n}}}{\frac{x^2-1}{x^2}} = \frac{x^{2n} - 1}{x^{2n}(x^2 - 1)}$$

3. The third term is simply: $\sum_{r=1}^{n} 2 = 2n$.

**Step 3:** Combine the results.

$$S_n = \frac{x^2(x^{2n} - 1)}{x^2 - 1} + \frac{x^{2n} - 1}{x^{2n}(x^2 - 1)} + 2n$$

Factor out $\frac{x^{2n}-1}{x^2-1}$:

$$S_n = \frac{x^{2n} - 1}{x^2 - 1} \left( x^2 + \frac{1}{x^{2n}} \right) + 2n = \frac{x^{2n} - 1}{x^2 - 1} \left( \frac{x^{2n+2} + 1}{x^{2n}} \right) + 2n$$

**Quick Tip:** Expand the square first to simplify the expression into separate geometric series that are easier to sum.

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**10. A person invites 10 friends to dinner and places them such that 4 are at one round table and 6 are at another round table. The total number of ways in which he can arrange the guests is:**

(A) 10!/6!

 

(B) $10!/24$

(C) $9!/24$

(D) None of these

**Correct Answer:** (B) $10!/24$

**Solution:**

**Concept:** The number of ways to arrange $n$ distinct objects in a circle is $(n-1)!$. When we need to partition a group into smaller sets and arrange them at separate tables, we must consider both the selection of guests for each table and the circular arrangement at each table.

**Step 1:** Select the guests for each table. We need to choose 4 friends out of 10 to sit at the first table, and the remaining 6 will sit at the second table. The number of ways to do this is:

$$\binom{10}{4} = \frac{10!}{4! \times 6!}$$

**Step 2:** Arrange the guests at the round tables. 1. The 4 friends at the first table can be arranged in $(4-1)! = 3! = 6$ ways. 2. The 6 friends at the second table can be arranged in $(6-1)! = 5! = 120$ ways.

**Step 3:** Calculate the total number of ways. Total ways = (Ways to select) × (Ways to arrange at Table 1) × (Ways to arrange at Table 2)

$$\text{Total} = \binom{10}{4} \times 3! \times 5!$$

$$\text{Total} = \frac{10!}{4! \times 6!} \times 3! \times 5!$$

$$\text{Total} = \frac{10!}{(4 \times 3!) \times 6} \times 3! \times 120 = \frac{10!}{4 \times 6 \times 6} \times 6 \times 120 = \frac{10!}{24} \times \frac{120}{6} = \frac{10!}{24} \times 20$$

Actually, simplifying directly:

$$\frac{10!}{4! \times 6!} \times 3! \times 5! = \frac{10!}{(4 \times 3!) \times 6} \times 3! \times 5! = \frac{10! \times 3! \times 5!}{24 \times 6 \times 5!} = \frac{10! \times 6}{24 \times 6} = \frac{10!}{24}$$

Since $10!/24$ is mathematically correct and appears to be Option (2), the answer is (2).

 

**Quick Tip:** Always remember to partition (choose) the groups first before applying circular permutation formulas to each subset.

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**11. If $z_1, z_2, \ldots, z_n$ are complex numbers such that $|z_1| = |z_2| = \ldots = |z_n| = 1$, then $|z_1 + z_2 + \ldots + z_n|$ is equal to:**

(A) $|z_1 z_2 z_3 \ldots z_n|$

(B) $|z_1| + |z_2| + \ldots + |z_n|$

(C) $\left|\frac{1}{z_1} + \frac{1}{z_2} + \ldots + \frac{1}{z_n}\right|$

(D) $n$

**Correct Answer:** (C) $\left|\frac{1}{z_1} + \frac{1}{z_2} + \ldots + \frac{1}{z_n}\right|$

**Solution:**

**Concept:** For any complex number $z$ such that $|z| = 1$, a fundamental property is that the conjugate $\bar{z}$ is equal to the reciprocal $\frac{1}{z}$. This follows from the definition $|z|^2 = z\bar{z} = 1$.

**Step 1:** Use the property of complex numbers on the unit circle. Since $|z_k| = 1$ for all $k = 1, 2, \ldots, n$, we know that:

$$z_k \bar{z}_k = |z_k|^2 = 1 \implies \bar{z}_k = \frac{1}{z_k}$$

**Step 2:** Transform the given expression. We want to evaluate $|z_1 + z_2 + \ldots + z_n|$. Using the property that the modulus of a complex number is equal to the modulus of its conjugate (i.e., $|z| = |\bar{z}|$):

$$|z_1 + z_2 + \ldots + z_n| = |\overline{z_1 + z_2 + \ldots + z_n}|$$

$$= |\bar{z}_1 + \bar{z}_2 + \ldots + \bar{z}_n|$$

**Step 3:** Substitute the reciprocal property. Substitute $\bar{z}_k = \frac{1}{z_k}$ back into the expression:

$$|\bar{z}_1 + \bar{z}_2 + \ldots + \bar{z}_n| = \left|\frac{1}{z_1} + \frac{1}{z_2} + \ldots + \frac{1}{z_n}\right|$$

Thus, $|z_1 + z_2 + \ldots + z_n| = \left|\frac{1}{z_1} + \frac{1}{z_2} + \ldots + \frac{1}{z_n}\right|$.

 

**Quick Tip:** Always look for symmetry in complex number problems involving the unit circle. The identity $z^{-1} = \bar{z}$ is a powerful tool for simplifying sums of complex numbers.

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**12. Evaluate the definite integral: $\int_0^{\pi/2} \sin^2(x)\,dx$.**

(A) $\frac{\pi}{4}$

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

(C) 1

(D) 0

**Correct Answer:** (A) $\frac{\pi}{4}$

**Solution:**

**Concept:** To integrate $\sin^2(x)$, we use the trigonometric power-reduction identity:

$$\sin^2(x) = \frac{1 - \cos(2x)}{2}$$

**Step 1:** Substitute the identity into the integral.

$$\int_0^{\pi/2} \sin^2(x)\,dx = \int_0^{\pi/2} \frac{1 - \cos(2x)}{2}\,dx$$

$$= \frac{1}{2}\int_0^{\pi/2} (1 - \cos(2x))\,dx$$

**Step 2:** Perform the integration.

$$= \frac{1}{2}\left[x - \frac{\sin(2x)}{2}\right]_0^{\pi/2}$$

**Step 3:** Evaluate at the bounds. At upper bound $x = \pi/2$: $\frac{\pi}{2} - \frac{\sin(\pi)}{2} = \frac{\pi}{2} - 0 = \frac{\pi}{2}$

At lower bound $x = 0$: $0 - \frac{\sin(0)}{2} = 0 - 0 = 0$

Total: $\frac{1}{2}\left(\frac{\pi}{2} - 0\right) = \frac{\pi}{4}$

 

**Quick Tip:** Whenever you encounter powers of trigonometric functions, power-reduction identities are usually the most efficient path to simplification.

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