



General Instructions

- (i) The examination will be conducted in Computer-Based Test (CBT) mode.
- (ii) Each question carries +3 marks for correct answer and -1 mark for wrong answer.
- (iii) The total number of questions are 80.
- (iv) Duration of the exam is 1 hour (60 minutes).

1. In the 2024 Olympics, two runners, Noah Lyles and Kishane Thompson, finished the 100.00 m race in 9.784 s and 9.789 s respectively. Assuming that they move with constant speed throughout the race, the distance between the two runners when Noah Lyles touched the finishing line would be closest to:

- (A) 5 cm
- (B) 10 cm
- (C) 20 cm
- (D) 50 cm

2. The Balmer series of hydrogenic spectral lines refers to an electron transitioning from $n \geq 3$ to $n = 2$. A hydrogenic atom with atomic number $Z = 24$ undergoes a Balmer transition of the largest possible wavelength. The emitted photon has energy E_0 . Another hydrogenic atom with atomic number $Z = 25$ undergoes a similar Balmer transition with emitted photon energy E_1 . Then $|E_1 - E_0|$, in eV, is closest to:

- (A) 9
- (B) 27

(C) 54

(D) 90

3. Three positive and two negative charges each of magnitude q are placed at five of the six vertices of a regular hexagon of side R . The work done to bring a negative charge q from infinity to the centre of the hexagon is:

(A) $\frac{1}{4\pi\epsilon_0} \left(-\frac{q^2}{R} \right)$

(B) $\frac{1}{4\pi\epsilon_0} \left(\frac{q^2}{R} \right)$

(C) $\frac{1}{4\pi\epsilon_0} \left(-\frac{5q^2}{R} \right)$

(D) $\frac{1}{4\pi\epsilon_0} \left(\frac{q^2}{2R} \right)$

4. Consider a metal cylinder of heat capacity C , thermal conductivity K , mass m and radius r . The combination that will have the dimension of time is:

(A) $\frac{C}{Kr}$

(B) $\frac{mC}{Kr}$

(C) $\frac{Kr}{mC}$

(D) $\frac{Cr}{K}$

5. Let $\theta \neq \frac{(2n+1)\pi}{2}$, for $n \in \mathbb{Z}$. Consider the system of equations

$$x \cos \theta + y \sec \theta = 0$$

$$x \sin \theta + y \tan \theta = 0$$

This system does not have a unique solution if and only if θ belongs to:

(A) $\{n\pi : n \in \mathbb{Z}\}$

(B) $\{(2n+1)\pi : n \in \mathbb{Z}\}$

(C) $\{2n\pi : n \in \mathbb{Z}\}$

(D) $\{(4n + 1)\pi : n \in \mathbb{Z}\}$

6. Let S be the set of all rational numbers r such that if

$$r = \frac{p}{q}$$

with $p, q \in \mathbb{Z}$, $q \neq 0$, then the two roots of the quadratic equation

$$x^2 + 2px + q^2 = 0$$

are equal. Then the number of elements in S is:

- (A) 2
 - (B) 4
 - (C) 1
 - (D) Infinite
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7. Evaluate $\int_0^\pi x \sin^2(x^2) dx$

- (A) $\frac{\pi}{4}$
 - (B) π
 - (C) $\frac{\sqrt{\pi}}{4}$
 - (D) $\sqrt{\pi}$
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8. For $x \in \mathbb{R}$, define $\langle x \rangle = x - [x]$ where $[x]$ denotes the greatest integer less than or equal to x . Then for any arbitrary pair of real numbers $x, y \in \mathbb{R}$, which of the following is always true?

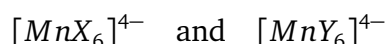
- (A) $\langle x + y \rangle \leq \langle x \rangle + \langle y \rangle$
 - (B) $\langle x + y \rangle \geq \langle x \rangle + \langle y \rangle$
 - (C) $\langle x + y \rangle = \langle x \rangle + \langle y \rangle$
 - (D) $\langle x + y \rangle \neq \langle x \rangle + \langle y \rangle$
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9. Consider the following reaction: $x\text{MnO}_4^- + y\text{I}^- + z\text{H}^+ \rightarrow p\text{Mn}^{2+} + q\text{IO}_3^- + r\text{H}_2\text{O}$. The correct

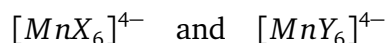
ratio $x : y$ in the balanced equation is:

- (A) 6 : 5
 - (B) 6 : 4
 - (C) 1 : 1
 - (D) 5 : 4
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10. Negatively charged monodentate strong field ligand X^- and weak field ligand Y^- form the complexes



respectively. Under certain reaction conditions, let the crystal field splitting energies for



be Δ_{o1} and Δ_{o2} , respectively. Which of the following statements is/are correct?

- (A) Electron pairing energy in $[MnX_6]^{4-}$ is smaller than Δ_{o1} .
 - (B) $[MnY_6]^{4-}$ is more stabilized than $[MnX_6]^{4-}$.
 - (C) The t_{2g} orbitals in $[MnX_6]^{4-}$ are stabilized by $2\Delta_{o1}$ as compared to degenerate d -orbitals.
 - (D) $[MnY_6]^{4-}$ is more intense in colour as compared to $[MnX_6]^{4-}$.
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11. Once upon a time there lived a population of mammals X . Due to continental drift, the population got separated into two groups and continued to live independently for a long period of time. After approximately 1 lakh years, researchers attempted to interbreed the two populations, but they were unable to produce fertile offspring. This type of speciation has probably occurred due to:

- (A) Temporal isolation
 - (B) Mechanical isolation
 - (C) Geographical isolation
 - (D) Both (B) and (C)
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12. Genomic DNA is digested with *Alu I* restriction enzyme that is a 4-base pair cutter. Assuming a random distribution of bases in the genome, what is the frequency with which it will cut the DNA?

- (A) $\frac{1}{4}$
(B) $\frac{1}{2^4}$
(C) $\frac{1}{256}$
(D) $\frac{1}{1296}$
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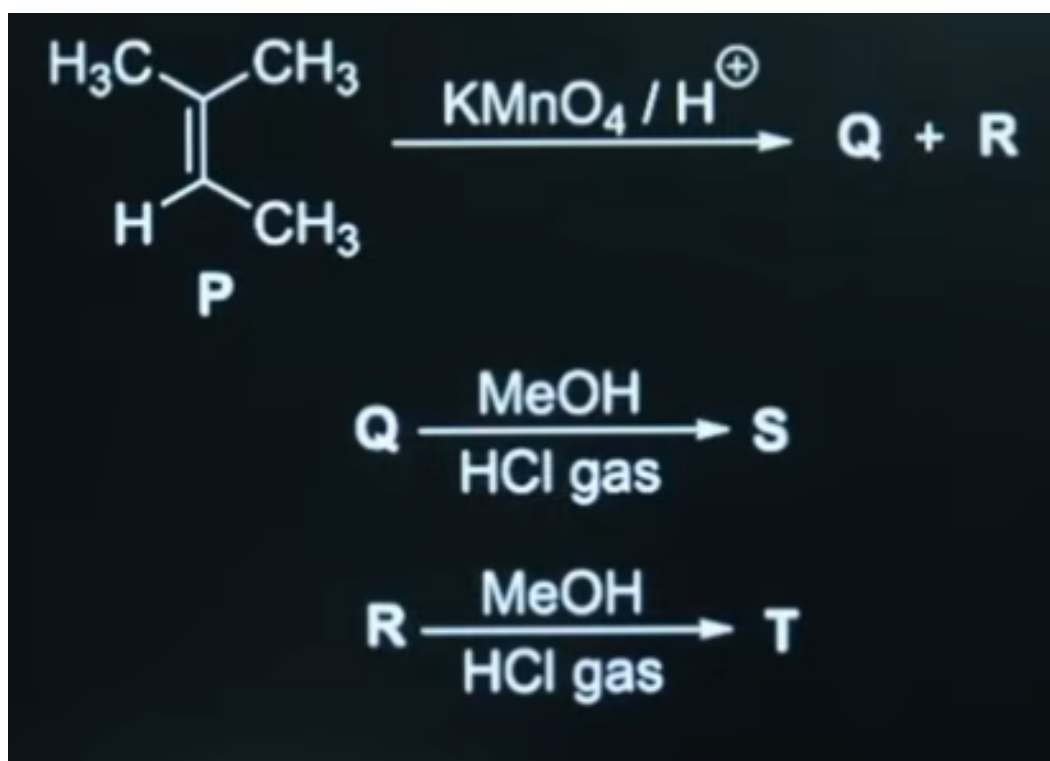
13. Which one of the following statements about DNA replication is incorrect?

- (A) During DNA replication, when adjacent bidirectional forks converge, the lagging strand will meet the leading strand of the same template strand.
(B) Mismatched nucleotide at the 3'-OH end of the primer strand triggers the 3' → 5' exonucleolytic proofreading activity.
(C) In a replication bubble moving bidirectionally, the same parental DNA strand can serve as a template for both the lagging and the leading strand synthesis.
(D) DNA replication involves RNA–DNA chimeric molecules.
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14. Covishield is a vaccine used to create immunological memory against COVID-19 infection. It is made by inserting the gene coding for the SARS-CoV-2 spike protein into an adenovirus vector. When injected into the human body, the vector releases the gene into human cells, which then produce the spike protein. However, the adenovirus vector is not able to replicate itself because:

- (A) The adenovirus only grows in bacterial populations.
(B) Genes involved in growth and replication have been replaced by the spike protein coding gene.
(C) The adenovirus has been attenuated; hence its growth is inhibited.
(D) A killed adenovirus is injected into the human body.
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15. Consider the following reaction:



In this context, the correct statement is:

- (A) Q is a ketone and T is an ether.
- (B) R is an acid and S is a ketal.
- (C) R is an aldehyde and S is an acetal.
- (D) Q is an acid and T is an ester.