04/04/2024
Morning

Aakash

Medical | IIT-JEE | Foundations

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Memory Based
Answers & Solutions
for
JEE (Main)-2024 (Online) Phase-2
(Physics, Chemistry and Mathematics)

Time : 3 hrs. M.M. : 300

IMPORTANT INSTRUCTIONS:

(1) The test is of 3 hours duration.

(2) This test paper consists of 90 questions. Each subject (PCM) has 30 questions. The maximum marks are 300.

(3) This question paper contains Three Parts. Part-A is Physics, Part-B is Chemistry and Part-C is Mathematics. Each part has only two sections: Section-A and Section-B.

(4) Section - A : Attempt all questions.

(5) Section - B : Attempt any 05 questions out of 10 Questions.

(6) Section - A (01 – 20) contains 20 multiple choice questions which have only one correct answer. Each question carries +4 marks for correct answer and −1 mark for wrong answer.

(7) Section - B (21 – 30) contains 10 Numerical value based questions. The answer to each question should be rounded off to the nearest integer. Each question carries +4 marks for correct answer and −1 mark for wrong answer.
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

Choose the correct answer:

1. Five identical convex lenses are placed one after the other in close contact. The power of this arrangement is 25 D. Then, power of one such lens is
   (1) 10 D
   (2) 5 D
   (3) 125 D
   (4) 20 D

Answer (2)

Sol. \(P = \sum \frac{1}{f_i}\)
   \[= 5 \times \frac{1}{f}\]
   \[\Rightarrow \frac{5}{f} = 25\]
   \[\Rightarrow P = 5 \text{ D}\]

2.

A cubical arrangement of 12 resistors each of R. Each having resistance R is shown. Find I.

3. On a given rough inclined plane, a solid sphere and a hollow cylinder are rolled one by one, with same speed. Ratio of heights attained by solid sphere and hollow cylinder is
   (1) \(\frac{9}{10}\)
   (2) \(\frac{3}{10}\)
   (3) \(\frac{7}{10}\)
   (4) \(\frac{6}{10}\)

Answer (3)

Sol. \(i = \frac{1}{8} \left(\frac{V_0}{3R/4}\right) = \frac{V_0}{6R}\)
4. A wooden block is initially at rest. Now a horizontal force is applied on the block which increases linearly with time.

The acceleration - time \((a - t)\) graph for the block would be

(1) \[ \begin{align*} a \quad t \end{align*} \]
(2) \[ \begin{align*} a \quad t \end{align*} \]
(3) \[ \begin{align*} a \quad t \end{align*} \]
(4) \[ \begin{align*} a \quad t \end{align*} \]

Answer (3)
Answer (2)

Sol. \( f \) same \( \Rightarrow \) same stopping potential

\( I_1 > I_2 \Rightarrow \) Saturation current is higher for higher intensity photons.

7. Consider the network shown:

\[
\begin{array}{c}
\text{+ 6 V} \\
15 \Omega \\
\text{10 \Omega} \\
\text{5 \Omega} \\
-8 \text{V}
\end{array}
\]

The equivalent resistance of the network is

(1) 12 \( \Omega \)  
(2) 36 \( \Omega \)  
(3) 20 \( \Omega \)  
(4) 6 \( \Omega \)

Answer (4)

Sol. One diode: short  
One diode: open

\[
R_{eq} = \frac{15 \times 10}{15 + 10} \Omega = 6 \Omega
\]

8. Instantaneous current in a circuit is

\[i(t) = \left[6 + \sqrt{54} \sin \left(2\pi t + \frac{\pi}{3}\right)\right] \text{A} \]

RMS value of current is

(1) 2\( \sqrt{6} \) A  
(2) 7 A  
(3) 3\( \sqrt{7} \) A  
(4) 6\( \sqrt{2} \) A

Answer (3)

Sol. \[i(t) = i_1 + i_2\sin(\omega t + \phi)\]

\[
\Rightarrow i_{RMS} = \sqrt{\frac{\left[\left|i_1 + i_2\sin(\omega t + \phi)\right|^2 dt\right]}{T}}
\]

\[
= \sqrt{i_1^2 + \frac{i_2^2}{2}}
\]

9. The equation of stationary wave is given as

\[y = 2A\sin\left(\frac{2\pi}{\lambda} nt\right)\cos\left(\frac{2\pi}{\lambda} x\right),\]

then which of the following is not correct.

(1) Dimension of \( x \) is \([L]\)  
(2) Dimension of \( n \) is \([LT^{-1}]\)  
(3) Dimension of \( \frac{n}{\lambda} \) is \([T]\)  
(4) Dimension of \( nt \) is \([L]\)

Answer (3)

Sol. From dimensional analyses

\[
\frac{nt}{\lambda} \Rightarrow M^0L^0T^0
\]

\[
\frac{nT}{L} = M^0L^0T^0
\]

\[n = [LT^{-1}]\]

Again \[\frac{x}{\lambda} = M^0L^0T^0\]

\[x = [L]\]
10. In magnetic field varying with \( x \)-axis as \( B(x) = (1 + 0.2x) \hat{j} \), a square loop of side 15 cm is placed such that its sides are parallel to \( x \) & \( y \) axes and one corner is at (2, 2) as shown. Net magnetic force on the loop is

\[
\begin{align*}
F_{AB} &= F_{CD} = 0 \\
F_{AD} &= i\hat{i}B_1 = (1 + 0.2 \times 2) = 1.4T \\
F_{BC} &= i\hat{i}B_2 = (1 + 0.2 \times 2.15) = 1.43T \\
|F_{net}| &= i(2B_2 - B_1) \\
&= 10 \times \frac{15}{100} \times 0.03 \\
&= \frac{4.50}{100} = 45 \text{ mN}
\end{align*}
\]

Answer (4)

11. The correct products of the reaction

\[
\begin{align*}
^{235}_{92}\text{U} + {}^1_n \rightarrow \\
\text{are}
\end{align*}
\]

(1) \( ^{141}_{56}\text{Ba} + ^{92}_{36}\text{Kr} + ^3_0\text{n} \)
(2) \( ^{141}_{56}\text{Ba} + ^{92}_{36}\text{Kr} + ^4_0\text{n} \)
(3) \( ^{20}_{10}\text{Ne} + ^{122}_{51}\text{Sb} + ^3_0\text{n} \)
(4) \( ^{20}_{10}\text{Ne} + ^{122}_{51}\text{Sb} + ^4_0\text{n} \)

Answer (1)

Sol. Conserving charge and mass, we get option (1) as correct

12. A given gas is taken through 3 different processes at 3 different densities \( \rho_1 \), \( \rho_2 \) and \( \rho_3 \). The corresponding \( P - T \) graphs are given. Then :

(1) \( \rho_3 > \rho_2 > \rho_1 \)
(2) \( \rho_3 < \rho_2 > \rho_1 \)
(3) \( \rho_3 < \rho_2 < \rho_1 \)
(4) \( \rho_3 > \rho_2 < \rho_1 \)

Answer (1)

Sol. \( PM = pRT \)

\( \Rightarrow \) Slope \( \propto \rho^1 \)

\( \Rightarrow \rho_3 > \rho_2 > \rho_1 \)
13. The graphical representation of variation of kinetic energy with radius in case of electron revolving around nucleus of atom is correctly represented by

(1) \[ K.E \] vs \( r \)

(2) \[ K.E \]

(3) \[ K.E \]

(4) \[ K.E \] vs \( r \)

Answer (4)

Sol. \[ \frac{kze^2}{r^2} = \frac{mv^2}{r} \]

\[ \frac{1}{2} \frac{mv^2}{r} = \frac{1}{2} kze^2 \]

14. In a pipe, speed of ideal liquid is \( v_1 \) at A and \( v_2 \) at B. The correct relations between \( v_1, v_2 \) and \( h \) is

\[ g \] is acceleration due to gravity and \( \rho \) is density of liquid)

(1) \[ v_2^2 = v_1^2 + 2gh \]

(2) \[ v_1 v_2 = 2gh \]

(3) \[ v_1^2 v_2 = \rho gh^2 \]

(4) \[ v_2^2 - v_1^2 + 2gh = 0 \]

Answer (1)

Sol. \[ \frac{1}{2} \rho v_1^2 + \rho gh = \frac{1}{2} \rho v_2^2 \]

\[ v_2^2 = v_1^2 + 2gh \]

15. A wire of mass \( M \) and length \( l \) bent in form of semicircle. A particle of mass \( m \) was kept at the centre of the semicircle. Find net gravitational force on particle.

(1) \[ \frac{2GMm \pi}{l^2} \]

(2) \[ \frac{2GMm}{l^2} \]

(3) \[ \frac{GMM \pi}{l^2} \]

(4) \[ \frac{3GMm \pi}{l^2} \]

Answer (1)
Sol. $R = \frac{l}{\pi}$

$E$ at centre $= \frac{2GM}{\pi R^2}$

Force on particle $= \frac{2GMm}{\pi R^2} = \frac{2GM}{\pi l^2} \times \pi^2 \cdot m$

$= \frac{2GMm\pi}{l^2}$

16. The circuit in which phase between maximum current ($I_{\text{max}}$) and maximum voltage ($V_{\text{max}}$) is $\frac{\pi}{2}$

(a) $L$-circuit
(b) $R$-circuit
(c) $C$-circuit
(d) $LC$-circuit

(1) a, b, c
(2) a, c, d
(3) b, c
(4) c, d

Answer (2)

Sol. For $L$-circuit $\rightarrow$ Phase between $I_{\text{max}}$ and $V_{\text{max}}$ is $\frac{\pi}{2}$

For $C$-circuit $\rightarrow$ Phase between $I_{\text{max}}$ and $V_{\text{max}}$ is $\frac{\pi}{2}$

For $LC$-circuit $\rightarrow$ Phase between $I_{\text{max}}$ and $V_{\text{max}}$ is $\frac{\pi}{2}$

17. For an electromagnetic wave, electric field is given as $E = 40\cos(\omega t - \frac{Z}{C})$ where $C$ is speed of light.

(symbols have their usual meanings). The variation of magnetic field is given as

(1) $\vec{B} = \frac{40}{C} \hat{j} \cos(\omega t + \frac{Z}{C})$
(2) $\vec{B} = 40\hat{j} \cos(\omega t - \frac{Z}{C})$
(3) $\vec{B} = \frac{40}{C} \hat{j} \cos(\omega t - \frac{Z}{C})$
(4) $\vec{B} = -40\hat{j} \cos(\omega t + \frac{Z}{C})$

Answer (3)

Sol.

Also $\vec{E} \times \vec{B} \uparrow \uparrow \hat{C}$

$\Rightarrow \vec{B}$ is along $+y$

18. A charged particle is moving in $x-y$ plane where its co-ordinate $(x, y)$ are varying with time $t$ is $x = 2 + 4t; y = 3t + 8t^2$. The motion of charged particle is

(1) Uniform motion
(2) Uniform accelerated motion along straight line
(3) Non uniform accelerated motion
(4) Uniform accelerated motion in a parabolic path

Answer (4)
Sol. \( \ddot{\mathbf{r}} = (2 + 4t) \hat{i} + (3t + 8t^2) \hat{j} \)
\[ \ddot{\mathbf{u}} = 4 \hat{i} + (3 + 16t) \hat{j} \]
\[ \ddot{a} = 16 \hat{j} \Rightarrow \text{Uniform accelerated} \]
At \( t = 0 \), \( \ddot{\mathbf{v}} = 4 \hat{i} + 3 \hat{j} \) is not parallel to \( \ddot{\mathbf{a}} \)
\[ \Rightarrow \text{Parabolic} \]

19. \( u \) is object distance and \( v \) is image distance formed by convex lens of focal length \( f \). The error in focal length shall be. (Error in measuring \( u \) & \( v \) are \( \Delta u \) & \( \Delta v \))

\[
\begin{align*}
(1) & \quad 2f \left( \frac{\Delta v}{v} + \frac{\Delta u}{u} \right) \\
(2) & \quad f^2 \left( \frac{\Delta v}{v^2} + \frac{\Delta u}{u^2} \right) \\
(3) & \quad f \left( \frac{\Delta v}{v} \right)^2 + \left( \frac{\Delta u}{u} \right)^2 \\
(4) & \quad \frac{\Delta v}{v} + \frac{\Delta u}{u}
\end{align*}
\]

Answer (2)

Sol. \( \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \)
\[
-\frac{1}{f^2} df = -\frac{1}{v^2} dv + \frac{1}{u^2} du
\]
\[ \Rightarrow (df) = f^2 \left[ \frac{dv}{v^2} + \frac{du}{u^2} \right] \]

20. A rubber ball fall on the floor from height \( h \) and bounces back up to height \( \frac{h}{2} \). Then percentage loss in energy and velocity of ball just before striking are respectively.

\[
\begin{align*}
(1) & \quad 50\%, \sqrt{2gh} \\
(2) & \quad 40\%, \sqrt{2gh} \\
(3) & \quad 50\%, \sqrt{gh} \\
(4) & \quad 40\%, \sqrt{gh}
\end{align*}
\]

Answer (1)

Sol. \( \Delta E = \frac{mgh}{2} \)
\[
\% \text{ change in } \Delta E = 50\%
\]
Velocity just before collision = \( \sqrt{2gh} \)

**SECTION - B**

**Numerical Value Type Questions:** This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Because of forces (separately) of 3 N and 2 N, elongations in spring are found to be ‘a’ and ‘b’ unit respectively then \( (2a - 3b) \) is

Answer (0)

Sol. \( a = \frac{3}{k} \)
\[ b = \frac{2}{k} \]
\[ \Rightarrow 2a - 3b = 0 \]
22. For a temperature change of 40°C, the corresponding temperature change in °F is

Answer (72)

Sol. \( F = 32 + \frac{9C}{5} \)

\( \Rightarrow \Delta F = \frac{9}{5}\Delta C = 72^\circ F \)

23. A particle covers 102.5 m in \( n \)th second and 115 m in \( (n + 2) \)th second. Then the acceleration of the particle is \( x \) m/s². Find 4x.

Answer (25)

Sol. \( s_n = u + \frac{a}{2}[2n - 1] \)

\( \Rightarrow 102.5 = u + \frac{a}{2}[2n - 1] \)

and \( 115 = u + \frac{a}{2}[2n + 3] \)

\( \Rightarrow 12.5 = \frac{a}{2}(4) \Rightarrow a = \frac{25}{4} \text{ m/s}^2 \)

24. The resistance of platinum wire at ice point and steam point are 10 Ω and 2 Ω respectively. After that wire is dipped in hot bath of temperature 400°C. The resistance of the wire at temperature 400°C is ______ Ω.

Answer (34)

Sol. \( \frac{R - R_{M,P}}{R_{B,P} - R_{M,P}} = \frac{T - 0}{100 - 0} \)

\( R = 34 \text{ Ω} \)

25. A soap bubble has initial radius of 3.5 cm. Work 36960 erg is done on it to blow it. Surface tension = 40 dyne/cm. The new radius is ______ cm.

Answer (7)

Sol. \( W = \Delta U = 8\pi [R^2 - r^2] \cdot S \)

\( \Rightarrow \frac{36960}{8 \times \frac{22}{7} \times 40} = R^2 - 3.5^2 \)

\( \Rightarrow R^2 = 3.5^2 + \frac{147}{4} \)

\( = \frac{49 + 147}{4} = 49 \)

\( R = 7 \text{ cm} \)

26. In an experiment to determine internal resistance of battery using potentiometer for external resistance of 10 Ω, balancing length is 50 cm and for external resistance of 1 Ω, balancing length is 40 cm then internal resistance of battery is \( x \) ohms then 7x is____

Answer (2)

Sol. \( \varepsilon - \frac{\varepsilon R}{R + r} = \frac{\varepsilon R}{R + r} = V = kl \)

\( \frac{\varepsilon R_1}{R_1 + r} = k\frac{50}{10 + r} \)

\( \frac{\varepsilon R_2}{R_2 + r} = k\frac{40}{1 + r} \)

\( \Rightarrow 5 = \frac{10}{4} \frac{1}{10 + r} \)

\( 50 + 5r = 40 + 40r \)

\( 10 = 35r \)

\( r = \frac{2}{7} \Omega \)

27.

28.

29.

30.
**CHEMISTRY**

**SECTION - A**

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

**Choose the correct answer:**

1. If EMF of Hydrogen electrode at 25°C is zero in pure water then pressure of $H_2$ in bar
   (1) $10^{-14}$  
   (2) $10^{-7}$  
   (3) 1  
   (4) 0.5

   **Answer (1)**

   **Sol.**
   \[
   E_{\text{SHE}} = -0.0591 \log \frac{P_{H_2}}{[H^+]} = 0
   \]
   \[
   \Rightarrow P_{H_2} = [H^+] \\
   P_{H_2} = (10^{-7})^2 \\
   = 10^{-14} \text{ bar}
   \]

2. For which of the following element only one oxidation state is possible
   (1) Sc  
   (2) Co  
   (3) Ni  
   (4) Fe

   **Answer (1)**

   **Sol.**
   Only $+3$ oxidation state is possible for Sc
   For other options, more than one oxidation states are possible, correct answer is (1)

3. Among the following, decreasing order of basic strength will be
   \( \text{OH}^-, \text{H}^+, \text{HCOO}^-, \text{CH}_3\text{COO}^- \), OR
   (I) II III (II) (III) (IV) (V)
   (1) II > V > III > I > IV  
   (2) II > V > I > IV > III  
   (3) III > IV > I > V > II  
   (4) V > I > IV > II > III

   **Answer (2)**

4. We are given with the following graph between $P$ and $T$

   **Choose the correct option**
   (1) $p_1 > p_2 > p_3$  
   (2) $p_1 < p_2 < p_3$  
   (3) $p_1 = p_2 = p_3$  
   (4) $p_2 > p_1 > p_3$

   **Answer (1)**

   **Sol.**
   \[
   \rho = \frac{P \times MW}{RT}
   \]
   \[
   P = \frac{\rho \cdot R \cdot T}{MW}
   \]
   \[
   P = \left( \frac{\rho \cdot R}{MW} \right) \cdot T
   \]
   \[
   \text{Slope} = \frac{\rho \cdot R}{MW}
   \]
   \[
   \text{Slope} \alpha \rho (\text{density})
   \]
   \[
   \Rightarrow \rho_1 > \rho_2 > \rho_3
   \]
   \[
   \Rightarrow \text{Option (1) is correct}
   \]

5. Which of the following have maximum dipole moment?
   (1) NH$_3$  
   (2) PF$_5$  
   (3) NF$_3$  
   (4) PCl$_5$

   **Answer (1)**

   **Sol.**
   Basic strength $\propto \frac{1}{\text{Strength of conjugate acid}}$
   Acidic strength:
   \[
   \text{HCOOH} > \text{CH}_3\text{COOH} > \text{H}_2\text{O} > \text{ROH} > \text{H}_2
   \]
   Basic strength:
   \[
   \text{HCOO}^- < \text{CH}_3\text{COO}^- < \text{OH}^- < \text{RO}^- < \text{H}^-
   \]

   **Aakashians Conquer JEE (Main) 2024**

   **Our Stars**

   - Chirag Felar
   - Tanishka Kabra
NH$_3$ has greater dipole moment than NF$_3$.

6. What is the product of the reaction shown below?

\[
\begin{align*}
\text{Zn-Hg} & \quad \text{Conc. HCl} \\
\text{Product?}
\end{align*}
\]

(1) (2) (3) (4)

Answer (2)
Sol. This is an example of Clemmensen reduction reaction. In this reaction carbonyl group is reduced to methylene group.

7. Which of the following is the correct order of first ionization enthalpy?
   (1) Be < B < O < F < N
   (2) B < Be < O < N < F
   (3) B < Be < N < F < O
   (4) Be < B < N < O < F

Answer (2)
Sol. Be has more value of first ionization enthalpy than B due to fully filled configuration and N has more value of first ionization enthalpy than O due to half filled configuration.
The correct order is B < Be < O < N < F

8. Statement-1: Aldol condensation is caused by acidity of $\alpha$ hydrogen
   Statement-2: Cross aldol is not possible between
   \[
   \begin{align*}
   &\text{C-H} \\
   &\text{and CH}_3\text{-C-H}
   \end{align*}
   \]
   (1) Both statement-1 and statement-2 are correct
   (2) Both statement-1 and statement-2 are incorrect
   (3) Statement-1 is correct but statement-2 is incorrect
   (4) Statement-1 is incorrect but statement-2 is correct

Answer (3)
Sol. Aldol reaction is given by those carbonyl compounds which have at least one $\alpha$ hydrogen atom because $\alpha$-hydrogen of carbonyl compounds is acidic. Benzaldehyde and acetaldehyde will form cross aldol because acetaldehyde has $\alpha$-hydrogen atom.

9. Select the correct structure of L-glucose.

(1) (2) (3) (4)

Answer (2)
Sol.

D-Glucose L-Glucose
10. Decreasing order of the field strength of the following ligands will be:

\[
\begin{align*}
&\text{CO, CN, Cl, H}_2\text{O} \\
&(1) \text{CO} > \text{CN} > \text{H}_2\text{O} > \text{Cl} \\
&(2) \text{CO} > \text{CN} > \text{Cl} > \text{H}_2\text{O} \\
&(3) \text{CN} > \text{CO} > \text{H}_2\text{O} > \text{Cl} \\
&(4) \text{CN} > \text{CO} > \text{Cl} > \text{H}_2\text{O}
\end{align*}
\]

Answer (1)

Sol. \(\text{CO} > \text{CN} > \text{H}_2\text{O} > \text{Cl}\)

11. Calculate the molarity of NaCl solution, if 5.85 gm of NaCl is dissolved in 500 ml of solution.

(1) 0.1 M  
(2) 0.2 M  
(3) 0.32 M  
(4) 0.4 M

Answer (2)

Sol. \[
\text{Molarity} = \frac{\text{Number of moles of solute}}{\text{Volume of solution (in L)}}
\]

\[
= \frac{5.85 \times 1000}{58.5 \times 500} = 0.1 \times 2 = 0.2 \text{ M}
\]

12. Which of the following does not give Lassaigne’s test?

(1) Urea  
(2) Azobenzene  
(3) Hydrazine  
(4) Phenylhydrazine

Answer (3)

Sol. Hydrazine \((\text{NH}_2 - \text{NH}_2)\) does not contain carbon. On fusion with sodium metal, it cannot form NaCN. So hydrazine does not show Lassaigne’s test.

13. Among the following, species that have one unpaired \(e^\oplus\)?

(1) \(\text{CN}^\ominus\)  
(2) \(\text{O}_2^\ominus\)  
(3) \(\text{O}_2^+\)  
(4) \(\text{NO}^\ominus\)

Answer (3)

Sol. Unpaired \(e^\oplus\)

\[
\begin{align*}
\text{CN}^\ominus & \rightarrow 14e^\ominus \rightarrow \text{zero} \\
\text{O}_2^+ & \rightarrow 18e^\ominus \rightarrow \text{zero} \\
\text{O}_2^- & \rightarrow 15e^\ominus \rightarrow \text{one} \\
\text{NO}^\ominus & \rightarrow 16e^\ominus \rightarrow \text{two}
\end{align*}
\]

14. For a given reaction

\[
\begin{align*}
\text{CH}_2=\text{CH}_2 & \rightarrow \text{Br} \\
\text{P} & \rightarrow \text{A} \\
\text{A} & \rightarrow \text{B}
\end{align*}
\]

Relation between the molecules P and B are:

(1) Enantiomer  
(2) Diastereomers  
(3) Positional isomers  
(4) Functional isomers

Answer (3)


15. From the given data, find enthalpy of hydrogenation of ethene in kJ/mol

(a) B.E. of \(\text{C} - \text{C}\) = 350 kJ/mol  
(b) B.E. of \(\text{C} = \text{C}\) = 600 kJ/mol  
(c) B.E. of \(\text{H} - \text{H}\) = 400 kJ/mol  
(d) B.E. of \(\text{C} - \text{H}\) = 410 kJ/mol

Answer (1)

\[
\Delta H = \Delta H(\text{C} = \text{C}) + \Delta H(\text{H} - \text{H}) - \Delta H(\text{C} - \text{C}) - 2\Delta H(\text{C} - \text{H})
\]

\[
= 600 + 400 - 350 - 2(410)
\]

\[
= -170 \text{ kJ/mol}
\]

16. Find out wavelength of a photon having frequency equal to 900 sec\(^{-1}\).

(1) \(3.33 \times 10^5 \text{ m}\)  
(2) \(3.33 \times 10^5 \text{ cm}\)  
(3) \(3.33 \times 10^7 \text{ m}\)  
(4) \(3.33 \times 10^4 \text{ m}\)

Answer (1)
13. \( \lambda = \frac{C}{\nu} \)

\( \lambda = \frac{3 \times 10^8 \text{msec}^{-1}}{900 \text{ sec}^{-1}} \)

\( \lambda = \frac{3 \times 10^6}{900} \)

\( \lambda = \frac{3 \times 10^5}{9} \)

\( \lambda = \frac{1}{3} \times 10^6 \)

\( \lambda = 0.333 \times 10^6 \)

\( \lambda = 3.33 \times 10^5 \text{ m} \)

17. Why NH₄Cl is added before NH₄OH for the ppt. of Fe³⁺ ions?

(1) To decrease OH⁻ ion concentration
(2) To increase Cl⁻ ion concentration
(3) To increase NH₄⁺ ion concentration
(4) To decrease H⁺ ion concentration

Answer (1)

Sol. \( \text{NH}_4\text{OH} \rightarrow \text{NH}_4^+ + \text{OH}^- \)

\( \text{NH}_4\text{Cl} \rightarrow \text{NH}_4^+ + \text{Cl}^- \)

Solid NH₄Cl is added to NH₄OH solution to decrease the OH⁻ ion concentration due to common ion effect.

18. Consider the following sequence of reactions and identify the unknown reagents (A) and (B) respectively.

\[ \text{CH}_3 - \text{CH}_2 - \text{CH}_2 \quad \text{(A)} \quad \text{CH}_3 - \text{CH} = \text{CH}_2 \quad \text{(B)} \]

\[ \text{CH}_3 - \text{CH} = \text{CH}_3 \quad \text{(Major)} \]

Answer (1)

Sol. \[ \text{NO}_2 + \text{R} \rightarrow \text{RNO}_2 \]

\[ \text{NH}_2 - \text{R} \quad \text{E} \quad \text{C} \quad \text{N} \]

19. Match the following

\[
\begin{array}{cccc}
\text{(i)} & \text{Nitrobenzene} & \text{(a)} & +\text{R} \\
\text{(ii)} & \text{Aniline} & \text{(b)} & -\text{R} \\
\text{(iii)} & \text{Additional reactants} & \text{(c)} & +\text{E} \\
\text{(iv)} & \text{Additional reactants} & \text{(d)} & -\text{E}
\end{array}
\]

Answer (1)

Sol. (i) \( \rightarrow \) (b), (ii) \( \rightarrow \) (a), (iii) \( \rightarrow \) (c), (iv) \( \rightarrow \) (d)

(2) (i) \( \rightarrow \) (a), (ii) \( \rightarrow \) (b), (iii) \( \rightarrow \) (c), (iv) \( \rightarrow \) (d)

(3) (i) \( \rightarrow \) (c), (ii) \( \rightarrow \) (b), (iii) \( \rightarrow \) (a), (iv) \( \rightarrow \) (d)

(4) (i) \( \rightarrow \) (d), (ii) \( \rightarrow \) (c), (iii) \( \rightarrow \) (a), (iv) \( \rightarrow \) (b)

Answer (1)

Sol. (i) \( \rightarrow \) (b), (ii) \( \rightarrow \) (a), (iii) \( \rightarrow \) (c), (iv) \( \rightarrow \) (d)

20. Which of the following is not possible major product?

(1) \[ \text{CH}_3 - \text{CH}_2 - \text{CH}_2 \text{NH}_2 + \text{H}_2 \text{O} \rightarrow \text{CH}_3 - \text{CH}_2 - \text{CH}_2 \text{NH}_2 \quad \text{(Major)} \]

(2) \[ \text{CH}_3 - \text{CH}_2 - \text{CH}_2 \text{NH}_2 + \text{H}_2 \text{O} \rightarrow \text{CH}_3 - \text{CH}_2 - \text{CH}_2 \text{NO}_2 + \text{N}_2 \]
SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. How many of the following compounds are sp³ hybridised?
   \[ \text{ClO}_3, \text{ClO}_2, \text{NH}_3, \text{NO}_2 \]

Answer (3)

Sol.

22. Total number of structural isomers possible for a compound with molecular formula \( \text{C}_7\text{H}_{16} \) are:

Answer (5)

Sol. \( \text{C}_7\text{H}_{16} \) has DoU = 0

(i) \( \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3 \)
(ii) \( \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \)

23. The de-Broglie wavelength of an electron in 4th orbit of hydrogen atom is ______ \( \pi a_0 \) (\( a_0 \) = Bohr radius).

Answer (8)

Sol. \[ \lambda_{\text{de-Broglie}} = \frac{2\pi}{n} \times 0.529 \frac{n^2}{\text{Å}} \]

or, \[ \lambda_{\text{de-Broglie}} = 2\pi \times n \times a_0 \text{ Å} \]

\[ = 2\pi \times 4 \times a_0 \text{ Å} \]

\[ = 8\pi a_0 \text{ Å} \]

24. 50 mL of KMnO₄ solution is used for titration with 20 mL of 2M oxalic acid solution in Acidic medium. The molarity of KMnO₄ solution is \( x \times 10^{-2} \) M. The value of \( x \) is

Answer (32)
27. How many of the following coordination compounds have even number of unpaired electrons?

\[ [V(H_2O)_6]^{2+}, \quad [Fe(H_2O)_6]^{2+}, \quad [Cu(H_2O)_6]^{2+}, \quad [Ni(H_2O)_6]^{2+}, \quad [Cr(H_2O)_6]^{2+} \]

**Answer (3)**

**Sol.**

\[ [V(H_2O)_6]^{2+} \quad \Rightarrow \quad \sigma^3sp^3 \quad \Rightarrow \quad n = 3 \]
\[ [Fe(H_2O)_6]^{2+} \quad \Rightarrow \quad sp^3d^6 \quad \Rightarrow \quad n = 4 \]
\[ [Cu(H_2O)_6]^{2+} \quad \Rightarrow \quad sp^3d^9 \quad \Rightarrow \quad n = 1 \]
\[ [Ni(H_2O)_6]^{2+} \quad \Rightarrow \quad sp^3d^8 \quad \Rightarrow \quad n = 2 \]
\[ [Cr(H_2O)_6]^{2+} \quad \Rightarrow \quad sp^3d^{10} \quad \Rightarrow \quad n = 4 \]

28. Consider the following reaction sequence:

\[ \text{A} \xrightarrow{k_1} \text{B} \xrightarrow{k_2} \text{C} \]

Overall, \( E_{a_3}^{\text{eff}} = 400 \text{ kJ/mole} \)

**Find out \( E_{a_3} \) (in kJ/mole)**

**Answer (100)**

**Sol.**

\( E_{a_3}^{\text{eff}} = E_{a_1} + E_{a_2} - E_{a_3} \)
\( 400 = 300 + 200 - E_{a_3} \)
\( E_{a_3} = 100 \text{ kJ/mole} \)

29. \( x \) g of ethylamine on reaction with \( \text{NaNO}_2 \) and \( \text{HCl} \), produces 2.24 L of \( \text{N}_2 \) (g) at NTP. The value of \( 2x \) will be

**Answer (9)**

**Sol.**

\[ \text{NaNO}_2 + \text{HCl} \rightarrow \text{NaCl} + \text{HNO}_2 \]
\[ \text{C}_2\text{H}_5\text{NH}_2 + \text{HNO}_2 \rightarrow \text{C}_2\text{H}_5\text{OH} + \text{N}_2 + \text{H}_2\text{O} \]

Mole of \( \text{N}_2 \) produced = \( \frac{2.24}{22.4} = 0.1 \text{ mol} \)

So, mole of \( \text{C}_2\text{H}_5\text{NH}_2 \) used = 0.1 mol

Mass of \( \text{C}_2\text{H}_5\text{NH}_2 \) = \( 45 \times 0.1 = 4.5 \text{ g} \)

So, \( 2x = 2 \times 4.5 = 9 \)

30. **
**SECTION - A**

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

Choose the correct answer:

1. If \( f(x) = \begin{cases} x-2 & 0 < x \leq 2 \\ -2 & -2 \leq x \leq 0 \end{cases} \) and
\( h(x) = f(|x|) + |f(x)| \) then
\( \int_{0}^{k} h(x) \, dx \) is equal to (\( k > 0 \))

(1) 0 (2) \( \frac{k}{2} \) (3) \( 2k \) (4) \( k \)

Answer (1)

Sol. Graph of \( f(x) \)

\[ f(|x|) \]

\[ \Rightarrow f(|x|) = \begin{cases} -2-x & x < 0 \\ x-2 & x > 0 \end{cases} \]

\[ |f(x)| = \begin{cases} 2 & x < 0 \\ 2-x & x > 0 \end{cases} \]

\[ \Rightarrow h(x) = f(|x|) + |f(x)| = \begin{cases} -x & x < 0 \\ 0 & x > 0 \end{cases} \]

\[ \Rightarrow \int_{0}^{k} h(x) \, dx = k \, dx = 0 \]

2. Let three urn A, B, C:
   - A = 7 red, 5 black
   - B = 5 red, 7 black
   - C = 6 red, 6 black

Urn is selected and black ball is taken. Then the probability that the selected urn is A is equal to

(1) \( \frac{7}{18} \) (2) \( \frac{5}{17} \) (3) \( \frac{7}{19} \) (4) \( \frac{5}{18} \)

Answer (4)

Sol. Urn A has 7 red, 5 black balls
Urn B has 5 red, 7 black balls.
Urn C has 6 red, 6 black balls

If ball drawn is black then probability that it is chosen from urn A.

\[ = \frac{1 \times 5 \times 1 \times 7 \times 1 \times 6}{3 \times 12 \times 3 \times 12 \times 3 \times 12} = \frac{5}{36} \]

\[ = \frac{5}{18} \]

3. \( \int_{-\pi/2}^{\pi/2} \frac{\sin^2 x}{1+2x} \, dx = \)

(1) \( \frac{\pi}{4} \) (2) \( \frac{\pi}{8} \) (3) \( 4\pi \) (4) \( \frac{\pi}{2} \)

Answer (1)
Sol. \( L = \int_{0}^{\pi/2} \left( \frac{\sin^2 x}{1 + 2^x} + \frac{\sin^2 (x)}{1 + 2^{-x}} \right) dx \)

\( L = \int_{0}^{\pi/2} \sin^2 x \, dx \)

\( L = \int_{0}^{\pi/2} \cos^2 x \, dx \)

\[ \Rightarrow \text{Sum of } y_{\text{max}} \text{ and } y_{\text{min}} = \frac{5}{11} + \frac{11}{5} = \frac{121 + 25}{55} = \frac{146}{55} \]

5. The coefficient of \( x^7 \) in \( (1 - x - x^2 + x^3)^6 \) equals to

(1) \( 132 \) \( \quad \) (2) \( 144 \)
(3) \( -132 \) \( \quad \) (4) \( -144 \)

Answer (4)

Sol. Coefficient of \( x^7 \) in \( (1 - x)^6 \) \( (1 - x^2)^6 \)

\[ 6C_6 - 6C_6 + 6C_6 - 6C_1 = 120 - 15 \times 20 + 6 \times 6 \]

\[ 120 - 300 + 36 = -144 \]

6. If \( (z)^2 + |z| = 0 \) and if \( \alpha \) is sum of roots and \( \beta \) is product of non-zero roots, then \( 4(\alpha^2 + \beta) \) is

(1) \( \frac{1}{4} \) \( \quad \) (2) \( 1 \)
(3) \( 4 \) \( \quad \) (4) \( 2 \)

Answer (3)

Sol. \( (z)^2 + |z| = 0 \)

Let \( z = x + iy \)

\[ \Rightarrow (x - iy)^2 + \sqrt{x^2 + y^2} = 0 \]

\[ \Rightarrow (x^2 - y^2) + \sqrt{x^2 + y^2} - 2xyi = 0 \]

\[ \Rightarrow x^2 - y^2 + \sqrt{x^2 + y^2} - 2xy = 0 \text{ and } 2xy = 0 \]

\[ \Rightarrow x = 0 \text{ and } y \neq 0 \]

Case I

\[ \Rightarrow -y^2 + |y| = 0 \Rightarrow |y| = y^2 \Rightarrow y = \pm 1 \]

Case II

\[ x \neq 0 \text{ and } y = 0 \]
\[ \Rightarrow \, x^2 + |x| = 0 \Rightarrow x = 0 \text{ only not possible} \]

\[ \Rightarrow x = 0, \, y = 0 \text{ satisfies} \]

\[ \Rightarrow z = i, \, -i, \, 0 \text{ are solution} \]

\[ \alpha = i - i = 0 \]

\[ \beta = (i) (-i) = -1 \Rightarrow 4(\alpha^2 + \beta^2) = 4 \]

7. If \( \alpha \) & \( \beta \) are roots of \( ax^2 + bx + c = 0 \) then equation whose roots are \( \frac{1}{\alpha}, \frac{1}{\beta} \) is

\[ \begin{align*}
(1) & \quad cx^2 + bx + a = 0 \\
(2) & \quad bx^2 + ax + c = 0 \\
(3) & \quad ax^2 + bx + c = 0 \\
(4) & \quad cx^2 + ax + b = 0 
\end{align*} \]

Answer (1) Sol.

\[ ax^2 + bx + c = 0 \]

\[ \alpha + \beta = \frac{-b}{a} \]

\[ \alpha \beta = \frac{c}{a} \]

Now

\[ \frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha \beta} = \frac{-b}{c} \]

\[ \frac{1}{\alpha \beta} = \frac{a}{c} \]

\[ x^2 \left( \frac{1}{\alpha} + \frac{1}{\beta} \right) x + \frac{1}{\alpha \beta} = 0 \]

\[ x^2 + \frac{b}{\alpha} x + \frac{a}{\alpha \beta} = 0 \]

\[ cx^2 + bx + a = 0 \]

8. Let \( f(x) = \begin{cases} 
\frac{1 - \cos \alpha x}{x^2} ; & x < 0 \\
2 ; & x = 0 \\
\frac{\beta \sqrt{1 - \cos x}}{x} ; & x > 0 
\end{cases} \)

is continuous at \( x = 0 \). Then \( \alpha^2 + \beta^2 \) equals to

(1) 10 \quad (2) 12 \quad (3) 13 \quad (4) 9

Answer (2)

Sol. Given \( f(x) \) is continuous at \( x = 0 \)

\[ \therefore \lim_{x \to 0^-} f(x) = \lim_{x \to 0^+} f(x) \]

When \( x < 0, \, x = 0 - h \)

\[ \lim_{h \to 0} \frac{1 - \cos(\alpha(0 - h))}{(0 - h)^2} = \lim_{h \to 0} \frac{1 - \cos(\alpha h)}{h^2} \]

\[ = \lim_{h \to 0} \left( \frac{1 - \cos(\alpha h)}{\alpha^2 h^2} \right) \]

\[ = \frac{\alpha^2}{2} \quad \ldots(1) \]

When \( x > 0, \, x = 0 + h \)

\[ \lim_{h \to 0} \frac{\beta \sqrt{1 - \cos h}}{h} = \lim_{h \to 0} \frac{\beta \sqrt{1 - \cos \alpha h}}{\alpha^2 h^2} \]

\[ \Rightarrow \beta = \frac{\beta}{\sqrt{2}} \quad \ldots(2) \]

as \( f(0) = 2 \quad \ldots(3) \)

\[ \therefore \text{From (1), (2) and (3)} \]

\[ \alpha^2 = 2, \quad \beta = 2 \sqrt{2} \]

\[ \alpha^2 + \beta^2 = 4 + 8 = 12 \]

9. If the length of focal chord of \( y^2 = 12x \) is 15 and if the distance of the focal chord from origin is \( P \) then \( 10P^2 \) is equal to

(1) 36 \quad (2) 25 \quad (3) 72 \quad (4) 144

Answer (3)
\[ y^2 = 4(3)x \]

Sol.

\[ \Rightarrow AB = 15 \]
\[
\left(3t^2 - \frac{3}{t^2}\right)^2 + \left(6t + \frac{6}{t}\right)^2 = 225
\]
\[ \Rightarrow 9\left(t^2 - \frac{1}{t^2}\right)^2 + 36\left(t + \frac{1}{t}\right)^2 = 225
\]
\[ \Rightarrow 9\left(t + \frac{1}{t}\right)^2 \left(t^2 - \frac{1}{t^2} + 4\right) = 225
\]
\[ \Rightarrow 9\left(t + \frac{1}{t}\right)^2 = 225
\]
\[ \Rightarrow t + \frac{1}{t} = \left(\frac{225}{9}\right)^{1/2} = \left(25\right)^{1/2} = \sqrt{5}
\]

Equation of \( AB = (y - 0) = \frac{2}{t - \frac{1}{t}}(x - 3) \Rightarrow t - \frac{1}{t} = 1
\]
\[ \Rightarrow y = 2x - 6 \Rightarrow y - 2x + 6 = 0
\]
Distance from origin \( P = \frac{6}{\sqrt{5}} \Rightarrow 10P^2 = \frac{10 \times 36}{5} = 72
\]

10. Numbers \(-3, 4, 7, -6, \alpha, \beta\)

Mean = 2, Variance = 23, then

Mean deviation about mean equals to

\begin{align*}
(1) & \quad \frac{13}{8} \\
(2) & \quad \frac{13}{3} \\
(3) & \quad \frac{13}{7} \\
(4) & \quad \frac{13}{9}
\end{align*}

Answer (2)

Sol. Mean = \[ \frac{-3 + 4 + 7 + (-6) + \alpha + \beta}{6} = 2 \]
\[ = 2 + \alpha + \beta = 2 \times 6
\]
\[ \Rightarrow \alpha + \beta = 10
\]
Variance = \[ \frac{\Sigma x^2}{n} - \left(\frac{\bar{x}}{n}\right)^2 = 23
\]
\[ = \frac{\Sigma x^2}{n} = 23 + 4
\]
\[ = \Sigma x^2 = 27\times6
\]
\[ = 9 + 16 + 49 + 36 + \alpha^2 + \beta^2 = 162
\]
\[ \Rightarrow \alpha^2 + \beta^2 = 52
\]
\[ \Rightarrow \text{We get } \alpha \text{ and } \beta \text{ as 4 and 6}
\]
So, mean deviation about mean
\[ = \left| -3 - 2 \right| + \left| 4 - 2 \right| + \left| 7 - 2 \right| + \left| -6 - 2 \right| + \left| 4 - 2 \right| + \left| 6 - 2 \right| \]
\[ = \frac{5 + 2 + 5 + 8 + 2}{6} = \frac{26}{6} = \frac{13}{3}
\]

11. If \[ \frac{dy}{dx} = \frac{2x^2 + 2x + 3}{x^4 + 2x^3 + 3x^2 + 2x + 2}
\] and \( y(-1) = -\frac{\pi}{4} \),
then \( y(0) \) is

\begin{align*}
(1) & \quad \frac{\pi}{3} \\
(2) & \quad \frac{\pi}{4} \\
(3) & \quad \frac{\pi}{2} \\
(4) & \quad \frac{\pi}{6}
\end{align*}

Answer (2)

Sol. \[ \int dy = \int \frac{2x^2 + 2x + 3}{x^4 + 2x^3 + 3x^2 + 2x + 2} \, dx \]
\[
\int \frac{2x^2 + 2x + 3}{(x^2 + 1)(x^2 + 2x + 2)} \, dx
\]
\[
= \int \frac{1}{x^2 + 2x + 2} \, dx + \int \frac{1}{x^2 + 1} \, dx
\]
\[
= \int \frac{1}{1 + (x + 1)^2} \, dx + \tan^{-1} x + C
\]
\[
y = \tan^{-1}(x + 1) + \tan^{-1} x + C
\]
\[
y(-1) = -\frac{\pi}{4}
\]
\[
-\frac{\pi}{4} = 0 - \frac{\pi}{4} + C
\]
\[
\Rightarrow C = 0
\]
\[
\therefore y = \tan^{-1}(x + 1) + \tan^{-1}(x)
\]
\[
\text{Now } y(0) = \tan^{-1}(1) + \tan^{-1}(0) = \frac{\pi}{4}
\]

12. If \( \mathbf{c} \) is a variable unit vector and \( \mathbf{c} \) makes angle of 45° with \( \mathbf{b} \) and 60° with \( \mathbf{a} \) with \( \mathbf{b} = \hat{i} - \hat{k} \) and \( \mathbf{a} = 2\hat{i} + 2\hat{j} - \hat{k} \) then \( |\mathbf{c} + 2\mathbf{a} - 3\mathbf{b}| \) is

(1) 19 \hspace{1cm} (2) 20 \hspace{1cm} (3) \sqrt{19} \hspace{1cm} (4) \sqrt{20}

Answer (3)

Sol. \( \mathbf{c} \) is unit vector

\[
\mathbf{b} = \hat{i} - \hat{k}
\]
\[
\mathbf{a} = 2\hat{i} + 2\hat{j} - \hat{k}
\]
\[
|\mathbf{a}| = 3, \quad |\mathbf{b}| = \sqrt{2}, \quad |\mathbf{c}| = 1
\]
\[
|\mathbf{c} + 2\mathbf{a} - 3\mathbf{b}|^2 = |\mathbf{c}|^2 + 4|\mathbf{a}|^2 + 9|\mathbf{b}|^2 + 4\mathbf{a} \cdot \mathbf{c}
\]
\[
-12\mathbf{a} \cdot \mathbf{b} - 6\mathbf{a} \cdot \mathbf{c}
\]
\[
= 1 + 36 + 18 + 4|\mathbf{a}||\mathbf{c}|\cos 60^\circ - 12|\mathbf{a}||\mathbf{c}|
\]
\[
= 55 + 12 \times \frac{1}{2} - 36 - 6\sqrt{2} \times \frac{1}{\sqrt{2}}
\]
\[
= 55 + 6 - 36 - 6
\]
\[
= 19
\]
\[
|\mathbf{c} + 2\mathbf{a} - 3\mathbf{b}| = \sqrt{19}
\]

13. If the system of equations

\[
A + \sqrt{2}\sin x \quad B + \sqrt{2}\cos x = 0
\]
\[
A + \sin x \quad B - \cos x = 0
\]
\[
A + \cos x \quad B + \sin x = 0
\]

has non-trivial solution then the value of \( x, x \in \left(0, \frac{\pi}{2}\right) \) is

(1) \( \frac{5\pi}{12} \) \hspace{1cm} (2) \( \frac{\pi}{12} \)

(3) \( \frac{5\pi}{24} \) \hspace{1cm} (4) \( \frac{\pi}{8} \)

Answer (3)

Sol. For non-trivial solution

\[
\begin{align*}
1 + \sqrt{2}\sin x & = \sqrt{2}\cos x \\
1 - \sqrt{2}\sin x & = \cos x
\end{align*}
\]
\[
\Rightarrow 1 - 1(\sqrt{2}\sin^2 x - \sqrt{2}\cos^2 x) + 1(-2\sqrt{2}\sin x \cos x) = 0
\]
\[
\Rightarrow 1 + \sqrt{2}(\cos 2x - \sin 2x) = 0
\]
\[
\Rightarrow \sqrt{2}(\cos 2x - \sin 2x) = -1
\]
\[
\Rightarrow \cos(2x + \frac{\pi}{4}) = -\frac{1}{2}
\]
\[
2x \in (0, \pi)
\]
\[
2x + \frac{\pi}{4} \in \left(\frac{\pi}{4}, \frac{5\pi}{4}\right)
\]
\[
\Rightarrow \cos\left(2x + \frac{\pi}{4}\right) = -\frac{1}{2} \Rightarrow 2x + \frac{\pi}{4} = \frac{2\pi}{3}
\]
\[
2x = \frac{2\pi}{3} - \frac{\pi}{4} = \frac{5\pi}{12}
\]
\[
\Rightarrow x = \frac{5\pi}{24}
\]
14. A line \( L_1 \) having equation \( y = x + 3 \). A square is inscribed in a circle \( x^2 + y^2 - 10x - 6y + 30 = 0 \) such that one side of square is parallel to \( L_1 \). Find \( \sum_{i=1}^{4} (x_i^2 + y_i^2) \) where \((x_i, y_i) \) \( i \in \{1, 2, 3, 4\} \) are the vertices of square.

Answer (1)

15. 152 162 172 182

16. 17. 18. 19. 20.

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. The number of rational numbers in the expansion of \( \left(2^{1/5} + 5^{1/3}\right)^{15} \) is

Answer (02)

Sol. \( T_{r+1} = {15 \choose r} \left(\frac{r}{5}\right) \cdot \left(\frac{3-r}{2}\right) \), \( r \in \{0, 1, ..., 15\} \)

For rational terms, \( \frac{r}{3} \in \text{integer and } \frac{r}{5} \in \text{integer} \)

\[ \Rightarrow 3 \text{ and } 5 \text{ divides } r \Rightarrow 15 \text{ divides } r \]

\[ \Rightarrow r = 0 \text{ and } 15 \]

\[ \Rightarrow \text{ only } 2 \text{ rational terms.} \]

22. In \( \triangle ABC \) there are 18 points, on side \( AB \) there are \( P_1, P_2, P_3, P_4, P_5 \) points, on \( BC \) there are \( P_6, P_7, ..., P_{11} \) points and on \( CA \) \( P_{12}, P_{13}, P_{14}, P_{15}, P_{16}, P_{17}, P_{18} \) points. By joining any three points from \( P_1, P_2, ..., P_{18} \) form a triangle. Then number of triangles possible are

Answer (751)

Sol. Total ways to select three points out of 18 points = \( {18 \choose 3} \)

Total ways to select 3 points from \( P_1, ..., P_5 = 5 \cdot C_3 \)

Total ways to select 3 points from \( P_6, ..., P_{11} = 6 \cdot C_3 \)

Total ways to select 3 points from \( P_{12}, ..., P_{18} = 7 \cdot C_3 \)

Total number of triangles possible

\[ = 18C_3 - 5C_3 - 6C_3 - 7C_3 \]

\[ = 751 \]
23. If \[ \lim_{x \to 1} \frac{(5x + 1)^{1/3} - (x + 5)^{1/3}}{(2x + 3)^{1/2} - (x + 4)^{1/2}} = \frac{m(5)^{1/2}}{n(2n)^{2/3}} \]

Then \( 8m + 12n \) is

Answer (100)

Sol. \[ \lim_{x \to 1} \frac{(5x + 1)^{1/3} - (x + 5)^{1/3}}{(2x + 3)^{1/2} - (x + 4)^{1/2}} \]

\[ = \frac{1}{3} \frac{(5x + 1)^{-2/3} \cdot 5 - (x + 5)^{-2/3}}{2 \cdot (2x + 3)^{-1/2} - 1} \]

\[ = \frac{1}{2} \frac{5 - 1}{(5)^{1/2}} \]

\[ = \frac{4}{2} \frac{3(6)^{2/3}}{(5)^{1/2}} \]

\[ = \frac{8(5)^{1/2}}{3(6)^{2/3}} \frac{m(5)^{1/2}}{n(2n)^{2/3}} \]

\[ \Rightarrow m = 8, n = 3 \]

\[ 8m + 12n = 64 + 36 = 100 \]

24. In a G.P. \( T_1 = 2, T_2 = P, T_3 = Q \), these are also terms of A.P (7th, 8th and 13th term).

If 5th term of G.P = \( n \)th term of A.P3. Then \( n \) is

Answer (27)

Sol. \( T_1 = 2 \)

\( T_2 = P \)

\( T_3 = Q \)

\( 2r = P \Rightarrow r = \frac{P}{2} \)

\( 2r^2 = Q \Rightarrow r^2 = \frac{Q}{2} \)

\( a' + 6d = 2 \) \( \ldots (1) \)

\( a' + 7d = P \) \( \ldots (2) \)

\( a' + 12d = Q \) \( \ldots (3) \)

\( d = 2(r - 1) \)

\[ 2r(r - 1) = 5d \]

\[ \frac{5d}{d} = -2r(r - 1) \]

\[ r = 5 \Rightarrow d = 8 \]

\[ a + 48 = 2 \]

\[ a = -46 \]

\[ 2.3^4 = -46 + (n - 1) \times 8 \]

\( n = 27 \)

25. Domain of \( \sin^{-1} \left( \frac{3x - 22}{2x - 19} \right) + \log_x \left( \frac{3x^2 - 8x + 5}{x^2 - 3x - 10} \right) \)

is \( (\alpha, \beta] \). Then \( 3\alpha + 10\beta \) equals to

Answer (97)

Sol. \( -1 \leq \frac{3x - 22}{2x - 19} \leq 1 \)

\( \frac{3x - 22 - 2x + 19}{2x - 19} \leq 0 \)

\( \frac{x - 3}{2x - 19} \leq 0 \)

\( + \quad - \quad + \)

\( \frac{3}{2} \quad \frac{19}{2} \)

\( \frac{5}{2} \quad \frac{19}{2} \)

\( \frac{41}{2} \quad \frac{19}{2} \)

Taking intersection

\( (-\infty, \frac{41}{5}) \cup (\frac{19}{2}, \infty) \)
Taking intersection of individual domains

\(-\infty, -2) \cup \left[\frac{5}{3}, 5\right) \cup (5, \infty)

\[\left(\frac{5}{3}, \frac{41}{5}\right]\]

\[3\alpha + 10\beta = 3 \times 5 + 10 \times \frac{41}{5}
= 15 + 82 = 97\]

26. If \[a = \frac{1}{2!} + \frac{2^2\alpha_2}{3!} + \frac{3^2\alpha_3}{4!} + \frac{4^2\alpha_4}{5!} + \ldots\]
\[b = \frac{1^1\alpha_0}{1!} + \frac{1\alpha_1}{1!} + \frac{2^2\alpha_2}{2!} + \frac{3\alpha_3}{3!} + \ldots\]

Then \[\frac{2b}{a}\]
equals to Answer (8)

27. If \[A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}\]
and \[\text{Det(Adj}(A - 2A^T) \text{ Adj}(2A - A^T)) = 2^8\]

Then \[A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}\]
and \[\text{Det(Adj}(A - 2A^T) \text{ Adj}(2A - A^T)) = 2^8\]

Answer (1600)

Sol. \[|\text{Adj}(A - 2A^T) \text{ Adj}(2A - A^T)| = 2^8\]
\[P = A - 2A^T\]
\[Q = 2A^T - A \Rightarrow Q^T = 2A^T - A = -P\]
\[|\text{adj}(P)| |\text{adj}(Q)| = 2^8, \Rightarrow |Q^T| = |-P| \Rightarrow |Q| = -|P|\]
\[|P|^2 |Q|^2 = 2^8 \Rightarrow |PQ| = -2^4\]
\[\Rightarrow |P|(-|P|) = -2^4 \Rightarrow |P| = 4 \text{ and } |Q| = -4\]
\[|A - 2A^T| = 4\]

28. 29. 30.