

PART : MATHEMATICS

1 Let α be a root of the equation $1 + x^2 + x^4 = 0$.
Then the value of $\alpha^{1011} + \alpha^{2022} - \alpha^{3033}$ is equal to:
(A) 1 (B) α (C) $1 + \alpha$ (D) $1 + 2\alpha$

NTA Ans. (A)

Reso Ans. (A)

Sol. $x^4 + x^2 + 1 = 0$

α is a root $\therefore \alpha^4 + \alpha^2 + 1 = 0$

$\Rightarrow \alpha^2 = \omega$ or ω^2

Now $\alpha^{1011} + \alpha^{2022} - \alpha^{3033}$

$= \alpha \cdot (\alpha^2)^{505} + (\alpha^2)^{1011} - \alpha \cdot (\alpha^2)^{1516}$

$= \alpha \cdot \omega^{505} + \omega^{1011} - \alpha \cdot \omega^{1516}$

$= \alpha\omega + 1 - \alpha\omega$

$= 1$

2 Let $\arg(z)$ represent the principal argument of the complex number z .
Then, $|z| = 3$ and $\arg(z - 1) - \arg(z + 1) = \frac{\pi}{4}$ intersect

- (A) exactly at one point. (B) exactly at two points.
(C) nowhere. (D) at infinitely many points.

NTA Ans. (C)

Reso Ans. (C)

3 Let $A = \begin{pmatrix} 2 & -1 \\ 0 & 2 \end{pmatrix}$. If $B = I - {}^5C_1(\text{adj}A) + {}^5C_2(\text{adj}A)^2 - \dots - {}^5C_5(\text{adj}A)^5$, then the sum of all elements of the matrix B is

- (A) -5 (B) -6 (C) -7 (D) -8

NTA Ans. (C)

Reso Ans. (C)

Sol.

$B = (I - (\text{adj} A))^5 = \left(\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - \begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix} \right)^5 = \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix}^5 = C^5$

$C^2 = \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$

$C^4 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 4 \\ 0 & 1 \end{bmatrix}$

$B = C^4 C = \begin{bmatrix} 1 & 4 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} -1 & -5 \\ 0 & -1 \end{bmatrix}$

Sum of elements = $(-1) + (-5) + (-1) = -7$

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4

The sum of the infinite series $1 + \frac{5}{6} + \frac{12}{6^2} + \frac{22}{6^3} + \frac{35}{6^4} + \frac{51}{6^5} + \frac{70}{6^6} + \dots$

Question: is equal to:

A $\frac{425}{216}$

B $\frac{429}{216}$

C $\frac{288}{125}$

D $\frac{280}{125}$

NTA Ans. (C)

Reso Ans. (C)

Sol.

$$\text{Let } S = 1 + \frac{5}{6} + \frac{12}{6^2} + \frac{22}{6^3} + \dots \quad (1)$$

$$\frac{S}{6} = \frac{1}{6} + \frac{5}{6^2} + \frac{12}{6^3} + \dots \quad (2)$$

Equation (1) - (2)

$$\frac{5S}{6} = 1 + \frac{4}{6} + \frac{7}{6^2} + \frac{10}{6^3} + \dots \quad (3)$$

$$\frac{5S}{36} = \frac{1}{6} + \frac{4}{6^2} + \frac{7}{6^3} + \dots \quad (4)$$

Equation (3) - (4)

$$\frac{25S}{36} = 1 + \frac{3}{6} + \frac{3}{6^2} + \frac{3}{6^3} + \dots$$

$$= 1 + \frac{\frac{3}{6}}{1 - \frac{1}{6}} = 1 + \frac{3}{5}$$



$$\frac{25S}{36} = \frac{8}{5} \Rightarrow S = \frac{288}{125}$$

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5

The value of $\lim_{x \rightarrow 1} \frac{(x^2 - 1) \sin^2(\pi x)}{x^4 - 2x^3 + 2x - 1}$

Question: is equal to:

- A $\frac{\pi^2}{6}$
- B $\frac{\pi^2}{3}$
- C $\frac{\pi^2}{2}$
- D π^2

NTA Ans. (D)

Reso Ans. (D)

Sol. Given

$$\begin{aligned} & \lim_{x \rightarrow 1} \frac{(x^2 - 1) \sin^2 \pi x}{x^4 - 2x^3 + 2x - 1} \\ &= \lim_{x \rightarrow 1} \frac{(x - 1)(x + 1) \sin^2 \pi x}{(x - 1)^3(x + 1)} \\ & \quad \text{Put } x = 1 + h \\ &= \lim_{h \rightarrow 0} \frac{\sin^2 \pi(1 + h)}{(1 + h - 1)^2} \\ &= \lim_{h \rightarrow 0} \pi^2 \frac{\sin^2 \pi h}{\pi^2 h^2} = \pi^2 \end{aligned}$$

6

Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a function defined by $f(x) = (x - 3)^{n_1} (x - 5)^{n_2}$, $n_1, n_2 \in \mathbb{N}$

Question: Then, which of the following is NOT true?

- A For $n_1 = 3, n_2 = 4$, there exists $\alpha \in (3, 5)$ where f attains local maxima.
- B For $n_1 = 4, n_2 = 3$, there exists $\alpha \in (3, 5)$ where f attains local minima.
- C For $n_1 = 3, n_2 = 5$, there exists $\alpha \in (3, 5)$ where f attains local maxima.
- D For $n_1 = 4, n_2 = 6$, there exists $\alpha \in (3, 5)$ where f attains local maxima.

NTA Ans. (C)






Reso Ans. (C)

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7

Let f be a real valued continuous function on $[0, 1]$ and

$$f(x) = x + \int_0^1 (x-t)f(t)dt.$$

Question: Then, which of the following points (x, y) lies on the curve $y = f(x)$?

A (2, 4)

B (1, 2)

C (4, 17)

D (6, 8)

NTA Ans. (D)

Reso Ans. (D)

8

$$\text{If } \int_0^2 (\sqrt{2x} - \sqrt{2x-x^2}) dx = \int_0^1 (1 - \sqrt{1-y^2} - \frac{y^2}{2}) dy + \int_1^2 (2 - \frac{y^2}{2}) dy + I$$

Question: then I equals

A $\int_0^1 (1 + \sqrt{1-y^2}) dy$

B $\int_0^1 (\frac{y^2}{2} - \sqrt{1-y^2} + 1) dy$

C $\int_0^1 (1 - \sqrt{1-y^2}) dy$

D $\int_0^1 (\frac{y^2}{2} + \sqrt{1-y^2} + 1) dy$

NTA Ans. (C)

Reso Ans. (C)

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9

If $y = y(x)$ is the solution of the differential equation $(1 + e^{2x}) \frac{dy}{dx} + 2(1 + y^2)e^x = 0$ and $y(0) = 0$, then $6 \left(y'(0) + \left(y(\log_e \sqrt{3}) \right)^2 \right)$ is equal to

Question:

- A 2
- B -2
- C -4
- D -1

NTA Ans. (C)

Reso Ans. (C)

10

Let $P : y^2 = 4ax, a > 0$ be a parabola with focus S. Let the tangents to the parabola P make an angle of $\frac{\pi}{4}$ with the line $y = 3x + 5$ touch the parabola P at A and B.

Question: Then the value of a for which A, B and S are collinear is

- A 8 only
- B 2 only
- C $\frac{1}{4}$ only
- D any $a > 0$

NTA Ans. (D)

Reso Ans. (D)

11

Let a triangle ABC be inscribed in the circle $x^2 - \sqrt{2}(x + y) + y^2 = 0$ such that

Question: $\angle BAC = \frac{\pi}{2}$. If the length of side AB is $\sqrt{2}$, then the area of the ΔABC is equal to :

- A $(\sqrt{2} + \sqrt{6})/3$
- B $(\sqrt{6} + \sqrt{3})/2$
- C $(3 + \sqrt{3})/4$
- D $(\sqrt{6} + 2\sqrt{3})/4$

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NTA Ans. Bonus

Reso Ans. Bonus

12 Let $\frac{x-2}{3} = \frac{y+1}{-2} = \frac{z+3}{-1}$ lie on the plane $px - qy + z = 5$, for some $p, q \in \mathbb{R}$. The

Question: shortest distance of the plane from the origin is:

A $\sqrt{\frac{3}{109}}$

B $\sqrt{\frac{5}{142}}$

C $\frac{5}{\sqrt{71}}$

D $\frac{1}{\sqrt{142}}$

NTA Ans. (B)

Reso Ans. (B)

13 The distance of the origin from the centroid of the triangle whose two sides have the equations

$x - 2y + 1 = 0$ and $2x - y - 1 = 0$ and whose orthocenter is $\left(\frac{7}{3}, \frac{7}{3}\right)$ is:

Question:

A $\sqrt{2}$

B 2

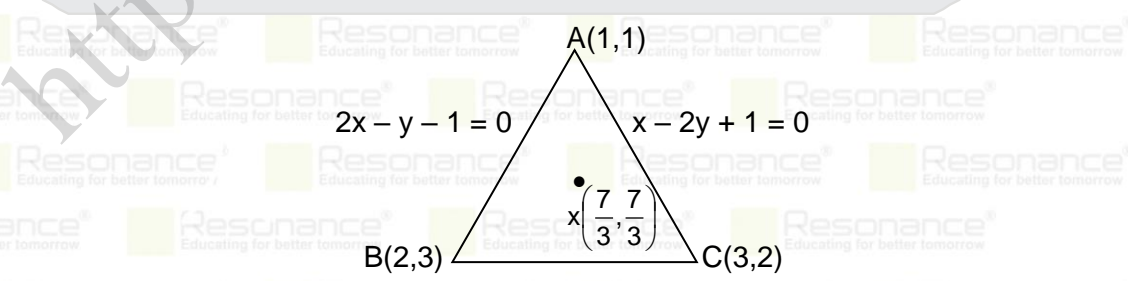
C $2\sqrt{2}$

D 4

NTA Ans. (C)

Reso Ans. (C)

Sol.



altitude through B is $2x + y + \lambda = 0$

$$\Rightarrow \frac{14}{3} + \frac{7}{3} + \lambda = 0$$

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$\lambda = -7$
 \therefore altitude is $2x + y - 7 = 0$
 equation of AB is $2x - y - 1 = 0$
 \therefore B (2, 3), similarly C(3,2)
 \therefore centroid G (2,2)
 \therefore OG = $\sqrt{4+4} = 2\sqrt{2}$

14

Let Q be the mirror image of the point P(1, 2, 1) with respect to the plane $x + 2y + 2z = 16$. Let T be a plane passing through the point Q and contains the line $\vec{r} = -\hat{k} + \lambda(\hat{i} + \hat{j} + 2\hat{k}), \lambda \in \mathbb{R}$. Then, which of the following points lies on T?

Question:

- A (2, 1, 0)
- B (1, 2, 1)
- C (1, 2, 2)
- D (1, 3, 2)

NTA Ans. (B)

Reso Ans. (B)

15

Let A, B, C be three points whose position vectors respectively are

$$\vec{a} = \hat{i} + 4\hat{j} + 3\hat{k}$$

$$\vec{b} = 2\hat{i} + \alpha\hat{j} + 4\hat{k}, \alpha \in \mathbb{R}$$

$$\vec{c} = 3\hat{i} - 2\hat{j} + 5\hat{k}$$

If α is the smallest positive integer for which $\vec{a}, \vec{b}, \vec{c}$ are noncollinear, then the

Question: length of the median, in ΔABC , through A is :

- A $\frac{\sqrt{82}}{2}$
- B $\frac{\sqrt{62}}{2}$
- C $\frac{\sqrt{69}}{2}$
- D $\frac{\sqrt{66}}{2}$

NTA Ans. (A)

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Reso Ans. (A)

16

The probability that a relation R from $\{x, y\}$ to $\{x, y\}$ is both symmetric and transitive, is equal to

A $\frac{5}{16}$

B $\frac{9}{16}$

C $\frac{11}{16}$

D $\frac{13}{16}$

NTA Ans. (A)

Reso Ans. (A)

17

The number of values of $a \in \mathbb{N}$ such that the variance of 3, 7, 12, a, $43 - a$ is a

Question: natural number is:

A 0

B 2

C 5

D infinite

NTA Ans. (A)

Reso Ans. (A)

18

From the base of a pole of height 20 meter, the angle of elevation of the top of a tower is 60° . The pole subtends an angle 30° at the top of the tower. Then the height of the tower is:

Question:

A $15\sqrt{3}$

B $20\sqrt{3}$

C $20 + 10\sqrt{3}$

D 30

NTA Ans. (D)

Reso Ans. (D)

Sol.

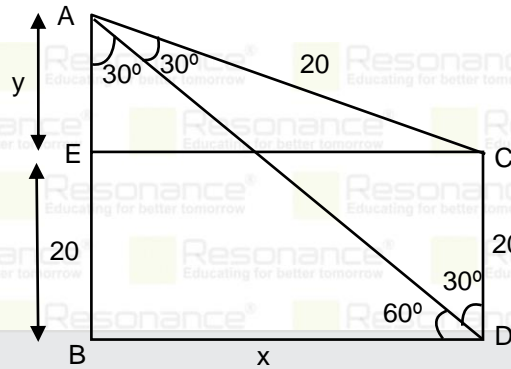
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In $\triangle ABD$

$$\tan 60^\circ = \frac{20 + y}{x} \dots\dots(1)$$

In $\triangle AEC$

$$\cos 60^\circ = \frac{y}{20} = \frac{1}{2} \Rightarrow y = 10 \dots\dots(2)$$

height of tower = $20 + y = 30\text{m}$

19

Question: Negation of the Boolean statement $(p \vee q) \Rightarrow ((\sim r) \vee p)$ is equivalent to

A $p \wedge (\sim q) \wedge r$

B $(\sim p) \wedge (\sim q) \wedge r$

C $(\sim p) \wedge q \wedge r$

D $p \wedge q \wedge (\sim r)$

NTA Ans. (C)

Reso Ans. (C)

Sol. Given $(p \vee q) \Rightarrow (\sim r) \vee p$

\therefore Negation is $(p \vee q) \wedge \sim(\sim r \vee p)$

$= (p \vee q) \wedge (r \wedge \sim p)$

$= (q \wedge \sim p) \wedge r$

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20

Let $n \geq 5$ be an integer. If $9^n - 8n - 1 = 64\alpha$ and $6^n - 5n - 1 = 25\beta$, then $\alpha - \beta$ is

Question: equal to

- A $1 + {}^nC_2(8-5) + {}^nC_3(8^2-5^2) + \dots + {}^nC_n(8^{n-1}-5^{n-1})$
- B $1 + {}^nC_3(8-5) + {}^nC_4(8^2-5^2) + \dots + {}^nC_n(8^{n-2}-5^{n-2})$
- C ${}^nC_3(8-5) + {}^nC_4(8^2-5^2) + \dots + {}^nC_n(8^{n-2}-5^{n-2})$
- D ${}^nC_4(8-5) + {}^nC_5(8^2-5^2) + \dots + {}^nC_n(8^{n-3}-5^{n-3})$

NTA Ans. (C)

Reso Ans. (C)

21

Let $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = \hat{i} + \hat{j} + \hat{k}$ and \vec{c} be a vector such that $\vec{a} + (\vec{b} \times \vec{c}) = \vec{0}$ and

$\vec{b} \cdot \vec{c} = 5$. Then, the value of $3(\vec{c} \cdot \vec{a})$ is equal to ____.

NTA Ans. 10

Reso Ans. 10

22

Let $y = y(x)$, $x > 1$, be the solution of the differential equation

$$(x-1) \frac{dy}{dx} + 2xy = \frac{1}{x-1}, \text{ with } y(2) = \frac{1+e^4}{2e^4}. \text{ If } y(3) = \frac{e^\alpha + 1}{\beta e^\alpha}, \text{ then the value of}$$

$\alpha + \beta$ is equal to ____.

NTA Ans. 14

Reso Ans. 14

23

Let 3, 6, 9, 12, ... upto 78 terms and 5, 9, 13, 17, ... upto 59 terms be two series. Then, the sum of the terms common to both the series is equal to ____.

NTA Ans. 2223

Reso Ans. 2223

Sol.

3, 6, 9 upto 78th term

$$t_{78} = 3 + (78 - 1) 3 = 234$$

5, 9, 13, 17 upto 59th term

$$T_{59} = 5 + (59 - 1) 4 = 237$$

Now series of common term is

9, 21, 33,

$$t_n = 9 + (n-1) 12 \leq 234$$

$$12n \leq 237$$

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$$n \leq 19.75 \Rightarrow n = 19$$

$$\therefore S_{19} = \frac{19}{2} [18 + (19-1)12] = 19 \times 117 = 2223$$

24 The number of solutions of the equation $\sin x = \cos^2 x$ in the interval $(0, 10)$ is ____.

NTA Ans. 4

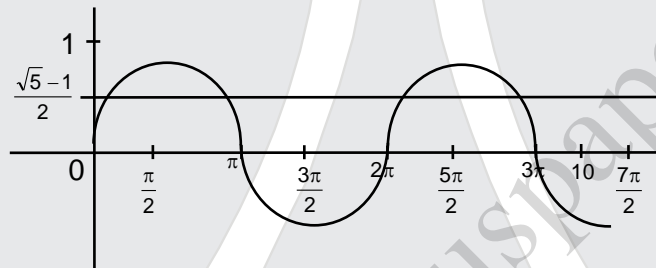
Reso Ans. 4

Sol. Given equation $\sin x = \cos^2 x$

$$\Rightarrow \sin^2 x + \sin x - 1 = 0$$

$$\Rightarrow \sin x = \frac{-1 \pm \sqrt{5}}{2}$$

$$\Rightarrow \sin x = \frac{\sqrt{5} - 1}{2}$$



\therefore Number of solution = 4

25 For real numbers a, b ($a > b > 0$), let

$$\text{Area} \left\{ (x, y) : x^2 + y^2 \leq a^2 \text{ and } \frac{x^2}{a^2} + \frac{y^2}{b^2} \geq 1 \right\} = 30\pi$$

and

$$\text{Area} \left\{ (x, y) : x^2 + y^2 \geq b^2 \text{ and } \frac{x^2}{a^2} + \frac{y^2}{b^2} \leq 1 \right\} = 18\pi$$

\therefore Then the value of $(a - b)^2$ is equal to ____.

NTA Ans. 12

Reso Ans. 12

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26 Let f and g be twice differentiable even functions on $(-2, 2)$ such that $f\left(\frac{1}{4}\right) = 0, f\left(\frac{1}{2}\right) = 0, f(1) = 1$ and $g\left(\frac{3}{4}\right) = 0, g(1) = 2$. Then, the minimum number of solutions of $f(x)g''(x) + f'(x)g'(x) = 0$ in $(-2, 2)$ is equal to ____.

NTA Ans. 4

Reso Ans. 4

27 Let the coefficients of x^{-1} and x^{-3} in the expansion of $\left(2x^{\frac{1}{5}} - \frac{1}{x^{\frac{1}{5}}}\right)^{15}, x > 0$, be m and n respectively. If r is a positive integer such that $mn^2 = {}^{15}C_r \cdot 2^r$, then the value of r is equal to ____.

NTA Ans. 5

Reso Ans. 5

28 The total number of four digit numbers such that each of first three digits is divisible by the last digit, is equal to ____.

NTA Ans. 1086

Reso Ans. 1086

29 Let $M = \begin{bmatrix} 0 & -\alpha \\ \alpha & 0 \end{bmatrix}$, where α is a non-zero real number and $N = \sum_{k=1}^{49} M^{2k}$. If $(I - M^2)N = -2I$, then the positive integral value of α is ____.

NTA Ans. 1

Reso Ans. 1

30 Let $f(x)$ and $g(x)$ be two real polynomials of degree 2 and 1 respectively. If $f(g(x)) = 8x^2 - 2x$, and $g(f(x)) = 4x^2 + 6x + 1$, then the value of $f(2) + g(2)$ is ____.

NTA Ans. 18

Reso Ans. 18

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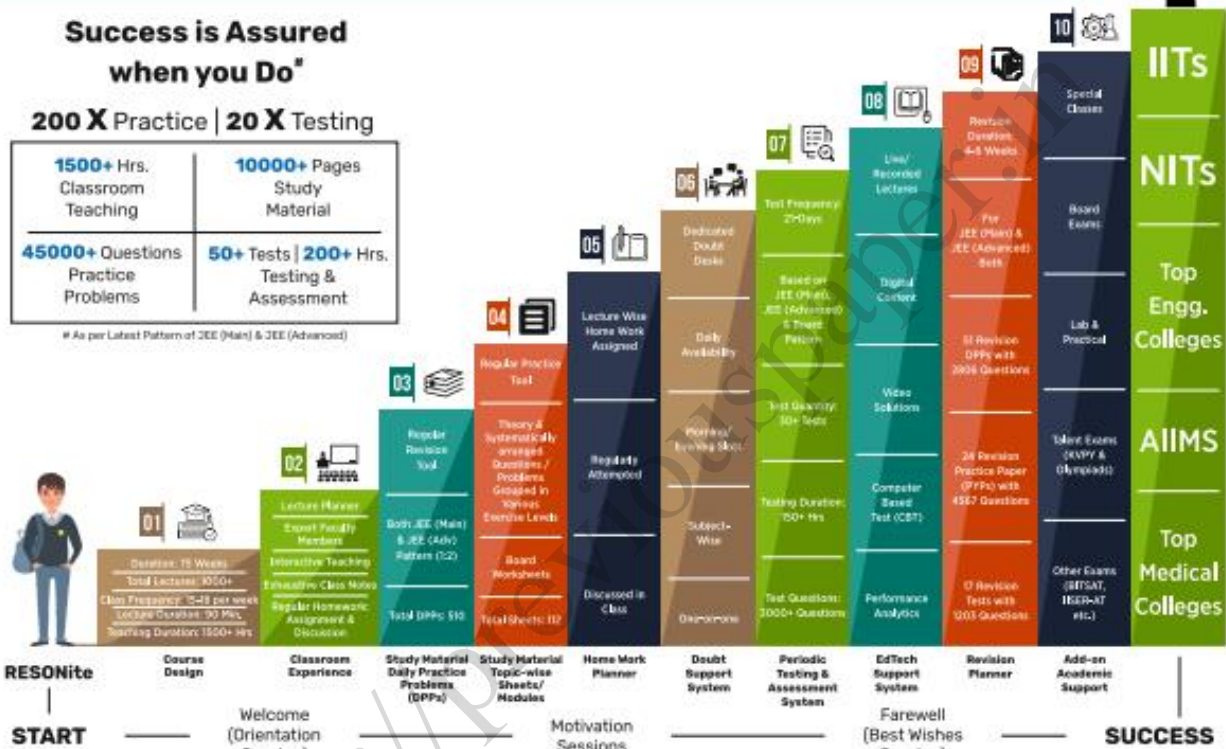
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2022

COMPUTER BASED TEST (CBT) Questions & Solutions

Date: 29 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300






SUBJECT: CHEMISTRY

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PART : CHEMISTRY

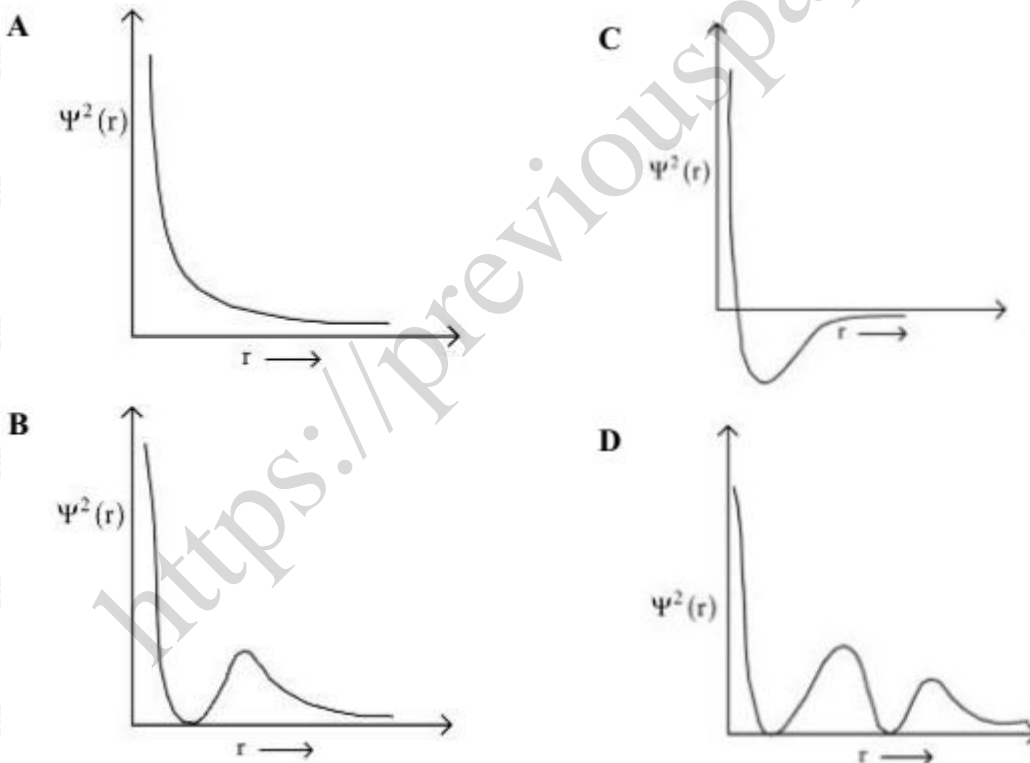
1 Using the rules for significant figures, the correct answer for the expression $\frac{0.02858 \times 0.112}{0.5702}$ will be

- A 0.005613
- B 0.00561
- C 0.0056
- D 0.006

Ans (B)

Sol. $\frac{0.00285 \times 0.112}{0.5702} = \frac{0.0003200}{0.5702} = 0.000561$

2 Which of the following is the correct plot for the probability density $\Psi^2(r)$ as a function of distance 'r' of the electron from the nucleus for 2s orbital?



Ans (B)

Sol. 2S orbital has one radial node ($n - l - 1 = 2 - 0 - 1 = 1$). ($\Psi^2(r) = 0$) at one point.

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3 Consider the species CH_4 , NH_4^+ and BH_4^- . Choose the correct option with respect to the three species.

A They are isoelectronic and only two have tetrahedral structures.

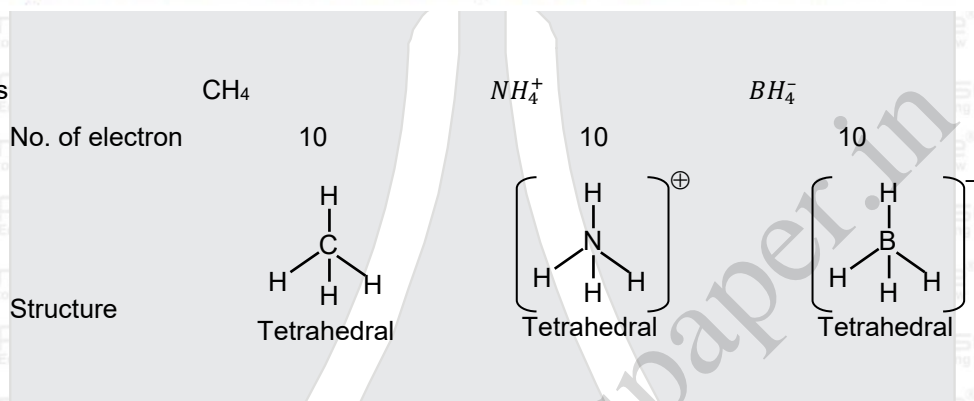
B They are isoelectronic and all have tetrahedral structures.

C Only two are isoelectronic and all have tetrahedral structures.

D Only two are isoelectronic and only two have tetrahedral structures.

Ans (B)

Sol. Species



4 4.0 moles of argon and 5.0 moles of PCl_5 are introduced into an evacuated flask of 100 litre capacity at 610 K. The system is allowed to equilibrate. At equilibrium, the total pressure of mixture was found to be 6.0 atm. The K_p for the reaction is [Given: $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$]

A 2.25

B 6.24

C 12.13

D 15.24

Ans (A)

Sol. $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$

5 mole 0 0

(5 - x) x x

Total moles at equilibrium = $(5 + x) + n_{\text{Ar}} = (5 + x) + 4 = (9 + x)$

$n_{\text{total}} = \frac{PV}{RT} = \frac{6 \times 100}{0.082 \times 610} = 11.995 = 12 \text{ moles}$

$9 + x = 12 \text{ moles}$





$x = 3 \text{ moles}$

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$$\text{Pressure of } (\text{PCl}_5 + \text{PCl}_3 + \text{Cl}_2) = \frac{8}{12} \times 6 = 4 \text{ atm}$$

$$K_P = \frac{P_{\text{PCl}_3} \times P_{\text{Cl}_2}}{P_{\text{PCl}_5}} = \frac{\left(\frac{3}{8} \times 4\right) \left(\frac{3}{8} \times 4\right)}{\left(\frac{2}{8} \times 4\right)} = \left(\frac{3}{2}\right) \left(\frac{3}{2}\right) = \left(\frac{9}{4}\right) = 2.25$$

- 5 A 42.12% (w/v) solution of NaCl causes precipitation of a certain sol in 10 hours. The coagulating value of NaCl for the sol is
 [Given: Molar mass : Na = 23.0 g mol⁻¹ ; Cl = 35.5 g mol⁻¹]

- A 36 mmol L⁻¹
 B 36 mol L⁻¹
 C 1440 mol L⁻¹
 D 1440 mmol L⁻¹

Ans (D)

Sol. Coagulation value = $\frac{\text{millimoles of electrolyte}}{\text{Volume of solution in L}}$

$$\text{Molarity of NaCl} = \frac{\% (w/v) \times 10}{\text{GMM}} = \left[\frac{42.14 \times 10}{58.5} \right] = 7.2 \text{ M}$$

$$\text{millimole of NaCl electrolyte} = 7.2 \text{ mole} = 72000 \text{ millimole}$$

$$\text{Coagulation value for 10 hours} = \frac{\text{millimoles of electrolyte}}{\text{Volume of solution in L}} = 72000$$

$$\text{For 2 hours Coagulation value} = \left(\frac{72000 \times 2}{10} \right) = 1440 \text{ millimole}$$

- 6 Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: The first ionization enthalpy for oxygen is lower than that of nitrogen.

Reason R: The four electrons in 2p orbitals of oxygen experience more electron-electron repulsion.






In the light of the above statements, choose the *correct* answer from the options given below.

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- A Both A and R are correct and R is the correct explanation of A.
 B Both A and R are correct but R is NOT the correct explanation of A.
 C A is correct but R is not correct.
 D A is not correct but R is correct.

Ans (A)

Sol. Resonance is (B) NTA answer is (A)

7 Match List I with List II.

List I Ore	List II Composition
A. Siderite	I. FeCO_3
B. Malachite	II. $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$
C. Sphalerite	III. ZnS
D. Calamine	IV. ZnCO_3

Choose the correct answer from the options given below:

- A A-I, B-II, C-III, D-IV
 B A-III, B-IV, C-II, D-I
 C A-IV, B-III, C-I, D-II
 D A-I, B-II, C-IV, D-III

Ans (A)






Sol. Siderite $\Rightarrow \text{FeCO}_3$
 Malachite $\Rightarrow \text{CuCO}_3 \cdot \text{Cu(OH)}_2$
 Carnallite $\Rightarrow \text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
 Calamine $\Rightarrow \text{ZnCO}_3$

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8

Given below are two statements.

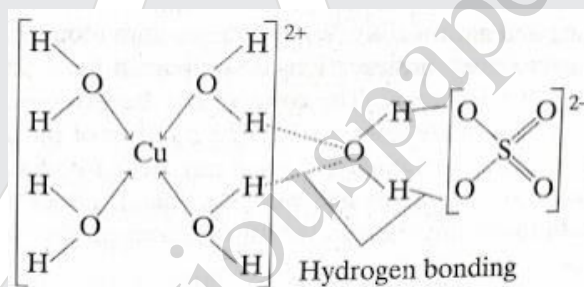
- Statement I: In $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, Cu-O bonds are present.
- Statement II: In $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, ligands coordinating with Cu(II) ion are O- and S-based ligands.

In the light of the above statements, choose the *correct* answer from the options given below.

- A Both Statement I and Statement II are correct.
- B Both Statement I and Statement II are incorrect.
- C Statement I is correct but Statement II is incorrect.
- D Statement I is incorrect but Statement II is correct.

Ans (C)

Sol. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} \Rightarrow [\text{Cu}(\text{H}_2\text{O})_4]\text{SO}_4 \cdot \text{H}_2\text{O}$



9 Amongst baking soda, caustic soda and washing soda, carbonate anion is present in

- A washing soda only.
- B washing soda and caustic soda only.
- C washing soda and baking soda only.
- D baking soda, caustic soda and washing soda.

Ans (A)






Sol.	Compound	Formula
	(1) Baking soda	NaHCO_3
	(2) Washing soda	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
	(3) Caustic soda	NaOH

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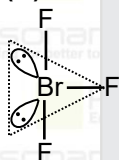
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- 10 Number of lone pair(s) of electrons on central atom and the shape of BrF_3 molecule respectively, are
- A 0, triangular planar.
- B 1, pyramidal.
- C 2, bent T-shape.
- D 1, bent T-shape.

Ans (C)

Sol.



Bent T-shape with Two unpaired electron.

- 11 Aqueous solution of which of the following boron compounds will be strongly basic in nature?
- A NaBH_4
- B LiBH_4
- C B_2H_6
- D $\text{Na}_2\text{B}_4\text{O}_7$

Ans (D)

Sol. $\text{Na}_2\text{B}_4\text{O}_7$ on reaction with water gives NaOH and H_3BO_3

- 12 Sulphur dioxide is one of the components of polluted air. SO_2 is also a major contributor to acid rain. The correct and complete reaction to represent acid rain caused by SO_2 is
- A $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$
- B $\text{SO}_2 + \text{O}_3 \rightarrow \text{SO}_3 + \text{O}_2$
- C $\text{SO}_2 + \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{SO}_4$
- D $2\text{SO}_2 + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4$

Ans (D)

Sol. It is fact

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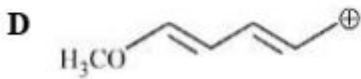
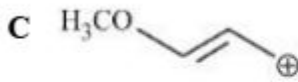
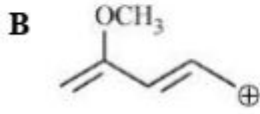
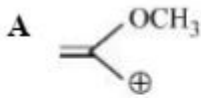
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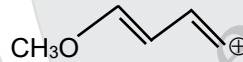
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13 Which of the following carbocations is most stable?

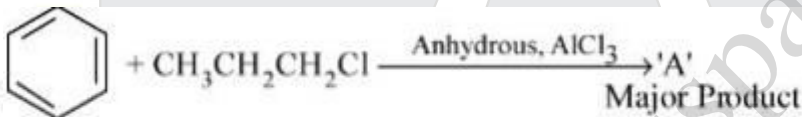


Ans (D)

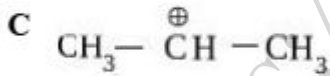
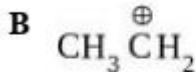
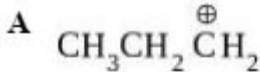
Sol. Due to extend conjugation most stable carbocation is



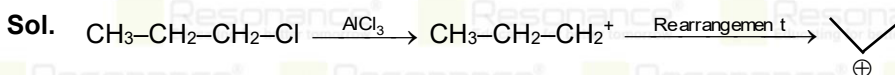
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The stable carbocation formed in the above reaction is



Ans (C)




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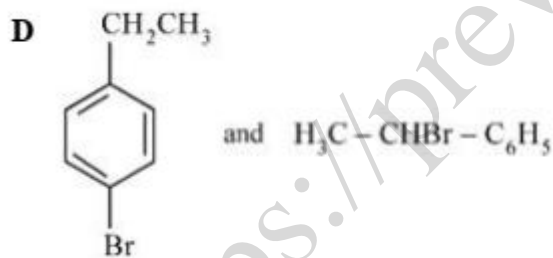
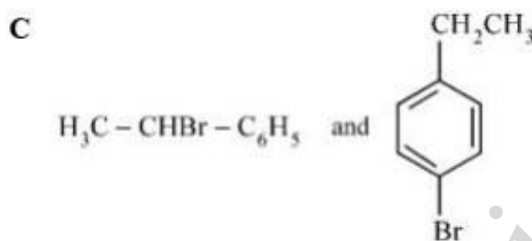
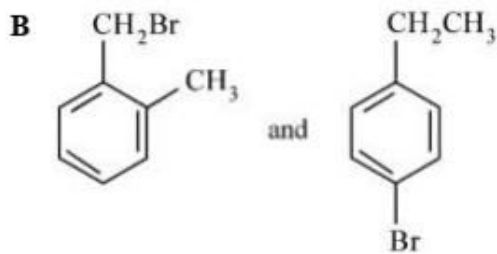
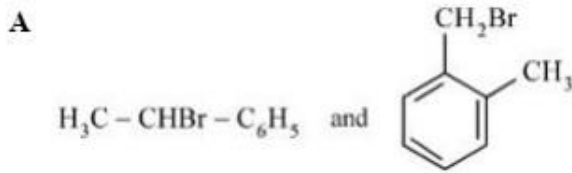
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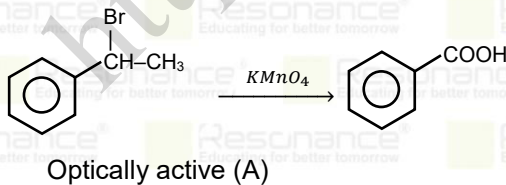
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- 15 Two isomers (A) and (B) with Molar mass 184 g/mol and elemental composition C, 52.2% ; H, 4.9 % and Br 42.9% gave benzoic acid and p-bromobenzoic acid, respectively on oxidation with $KMnO_4$. Isomer 'A' is optically active and gives a pale yellow precipitate when warmed with alcoholic $AgNO_3$. Isomer 'A' and 'B' are, respectively



Ans (C)

Sol.




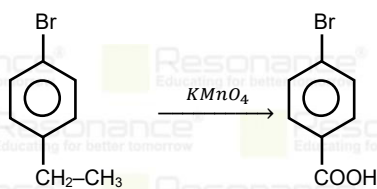
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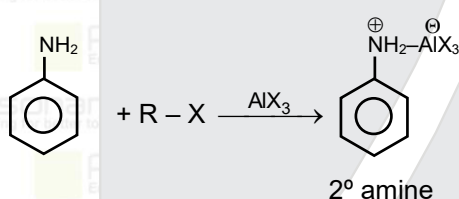
(B)

16 In Friedel-Crafts alkylation of aniline, one gets

- A alkylated product with ortho and para substitution.
- B secondary amine after acidic treatment.
- C an amide product.
- D positively charged nitrogen at benzene ring.

Ans (D)

Sol.



17 Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: Dacron is an example of polyester polymer.

Reason R: Dacron is made up of ethylene glycol and terephthalic acid monomers.

In the light of the above statements, choose the *most appropriate* answer from the options given below.

- A Both A and R are correct and R is the correct explanation of A.
- B Both A and R are correct but R is NOT the correct explanation of A.
- C A is correct but R is not correct.
- D A is not correct but R is correct.

Ans (A)

Sol. It is fact.

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18 The structure of protein that is unaffected by heating is

- A secondary structure
- B tertiary structure
- C primary structure
- D quaternary structure

Ans (C)

Sol. During denaturation of protein 2 and 3 structure are destroyed but 1° structure remain intact.

19 The mixture of chloroxylenol and terpineol is an example of

- A antiseptic
- B pesticide
- C disinfectant
- D narcotic analgesic

Ans (A)

Sol. Commonly used antiseptic Dettol is a mixture of chloroxylenol and terpineol.

20 A white precipitate was formed when BaCl_2 was added to water extract of an inorganic salt. Further, a gas 'X' with characteristic odour was released when the formed white precipitate was dissolved in dilute HCl. The anion present in the inorganic salt is

- A I^-
- B SO_3^{2-}
- C S^{2-}
- D NO_2^-

Ans (B)






Sol. $\text{SO}_3^{2-} + \text{Ba}^{2+} \longrightarrow \text{BaSO}_3 \downarrow$ (White ppt) $\xrightarrow{\text{dil HCl}}$ $\text{SO}_2(\text{g}) \uparrow$ (Burning sulphur like smell)
 $\text{S}^{2-} + \text{Ba}^{2+} \longrightarrow \text{No ppt}$

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- 21 A box contains 0.90 g of liquid water in equilibrium with water vapour at 27°C. The equilibrium vapour pressure of water at 27°C is 32.0 Torr. When the volume of the box is increased, some of the liquid water evaporates to maintain the equilibrium pressure. If all the liquid water evaporates, then the volume of the box must be ____ litre. [nearest integer]
 (Given: $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$)
 (Ignore the volume of the liquid water and assume water vapours behave as an ideal gas.)

Ans 29

Sol. $PV = nRT$

$$\frac{32}{760} \times V = \frac{0.9}{18} \times 0.082 \times 300$$

$$V = 29.12 \text{ Liter} \approx 29$$

- 22 2.2 g of nitrous oxide (N_2O) gas is cooled at a constant pressure of 1 atm from 310 K to 270 K causing the compression of the gas from 217.1 mL to 167.75 mL. The change in internal energy of the process, ΔU is '-x' J. The value of 'x' is ____.
 [nearest integer]

(Given: atomic mass of N = 14 g mol^{-1} and of O = 16 g mol^{-1} .
 Molar heat capacity of N_2O is 100 $\text{J K}^{-1} \text{ mol}^{-1}$)

Ans 195

Sol. Mass of nitrous oxide (N_2O) = 2.2 gram

Pressure constant = (1 atm)

$$T_1 = 310 \text{ K} \quad V_1 = 217.1 \text{ ml}$$

$$T_2 = 270 \text{ K} \quad V_2 = 167.75 \text{ ml}$$

$$\text{Molar heat capacity of } \text{N}_2\text{O} = 100 \frac{\text{J}}{\text{K} \times \text{mole}}$$

$$q = nC_m \Delta T$$

$$\text{No. of mole} = \frac{2.2}{44} = 0.05$$

$$q = -0.05 \times 100 \times 40$$

$$= -200 \frac{\text{J}}{\text{K} \times \text{mole}}$$

$$W = -P\Delta V$$

$$= 1 \times [167.75 - 217.1] \times 10^{-3}$$

$$= 49.35 \times 10^{-3} \text{ atm} \times \text{litre}$$

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$$= 49.35 \times 10^{-3} \times 101.325 \text{ J}$$

$$= 5 \text{ J}$$

$$\Delta U = q + w$$

$$= -200 + 5$$

$$= -195 \text{ J}$$

- 23 Elevation in boiling point for 1.5 molal solution of glucose in water is 4 K. The depression in freezing point for 4.5 molal solution of glucose in water is 4 K. The ratio of molal elevation constant to molal depression constant (K_b/K_f) is ____.

Ans 3

Sol. $\Delta T_b = K_b \times m_1$

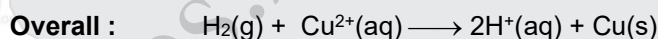
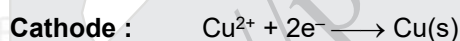
$$\Delta T_f = K_f \times m_2$$

$$\Rightarrow \frac{\Delta T_b}{\Delta T_f} = \frac{K_b \times 1.5}{K_f \times 4.5} = \frac{4 \text{ K}}{4 \text{ K}}$$

$$\frac{K_b}{K_f} = 3$$

- 24 The cell potential for the given cell at 298 K
 $\text{Pt} | \text{H}_2 (\text{g}, 1 \text{ bar}) | \text{H}^+ (\text{aq}) || \text{Cu}^{2+} (\text{aq}) | \text{Cu} (\text{s})$
 is 0.31V. The pH of the acidic solution is found to be 3, whereas the concentration of Cu^{2+} is 10^{-x} M. The value of x is ____.
 (Given: $E^\ominus_{\text{Cu}^{2+}/\text{Cu}} = 0.34 \text{ V}$ and $\frac{2.303RT}{F} = 0.06 \text{ V}$)

Ans 7



$$E_{\text{cell}} = E^\ominus_{\text{cell}} - \frac{0.059}{2} \log \frac{[\text{H}^+]^2}{[\text{Cu}^{2+}]}$$

$$0.31 = 0.34 - \frac{0.06}{2} \log \left(\frac{[\text{H}^+]^2}{[\text{Cu}^{2+}]} \right)$$

$$0.31 = 0.34 + 0.03 [-\log [\text{H}^+]^2 + \log [\text{Cu}^{2+}]]$$

$$0.31 = 0.34 + 0.03 [2\text{pH} + \log [\text{Cu}^{2+}]]$$

$$-0.03 = 0.03 [2\text{pH} + \log [\text{Cu}^{2+}]]$$

$$-1 = 6 + \log [\text{Cu}^{2+}]$$

$$-7 = \log [\text{Cu}^{2+}]$$

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$$\log [\text{Cu}^{2+}] = \log 10^{-7}$$

$$[\text{Cu}^{2+}] = 10^{-7}$$

$$x = 7$$

25 The equation

$$k = (6.5 \times 10^{12} \text{ s}^{-1}) e^{-26000\text{K}/T}$$

is followed for the decomposition of compound A. The activation energy for the reaction is ___ kJ mol^{-1} . [nearest integer]

(Given: $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

Ans 216

Sol. $k = A e^{-\frac{E_a}{R}T}$

$$k = 6.5 \times 10^{12} e^{-26000\text{K}/T}$$

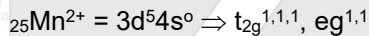
$$\frac{E_a}{R} = 26000 = 26 \times 10^3$$

$$E_a = 26 \times 10^3 \times 8.314 = 216.164 \times 10^3 \text{ J} = 216.164 \text{ KJ}$$

26 Spin only magnetic moment of $[\text{MnBr}_6]^{4-}$ is ___ B.M. (round off to the closest integer)

Ans 6

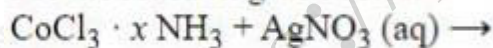
Sol. $[\text{MnBr}_6]^{4-}$



number of unpaired electrons = 5

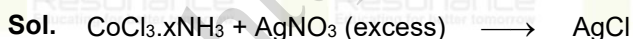
$$\mu(\text{spin only}) = \sqrt{n(n+2)} \text{ BM} = \sqrt{5(5+2)} \text{ BM} = \sqrt{35} \text{ BM} = 5.916 \text{ BM} \approx 6 \text{ BM}$$

27 For the reaction given below :



If two equivalents of AgCl precipitate out, then the value of x will be _____.

Ans 5



1 mole

2 moles

It means 2 Cl are outside the co-ordinations sphere & co-ordination number of Co is 6

So possible complex is $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$

so x = 5

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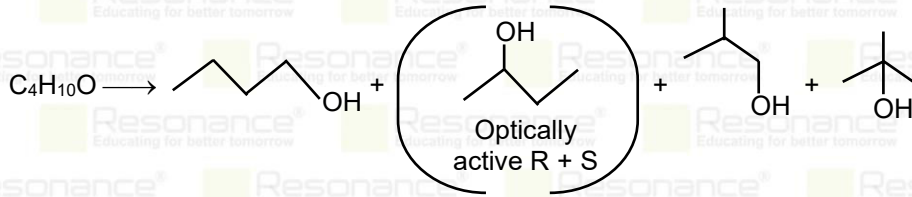
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28 The number of chiral alcohol(s) with molecular formula $C_4H_{10}O$ is _____.

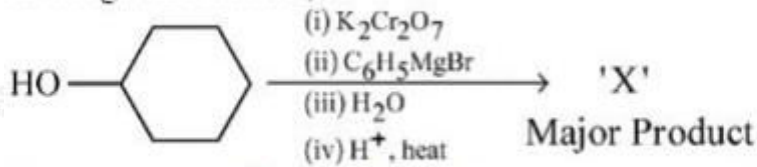
Ans (2)

Sol.



Only 2-Butanol is chiral with R or S configuration.

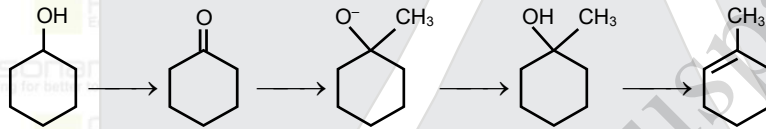
29 In the given reaction,



the number of sp^2 hybridised carbon(s) in compound 'X' is _____.

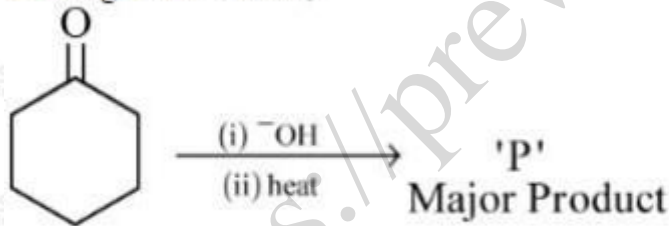
Ans (8)

Sol.



No. of sp^2 carbon are 2 in final product.

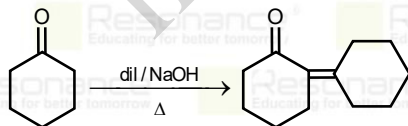
30 In the given reaction,



The number of π electrons present in the product 'P' is _____.

Ans (4)

Sol.




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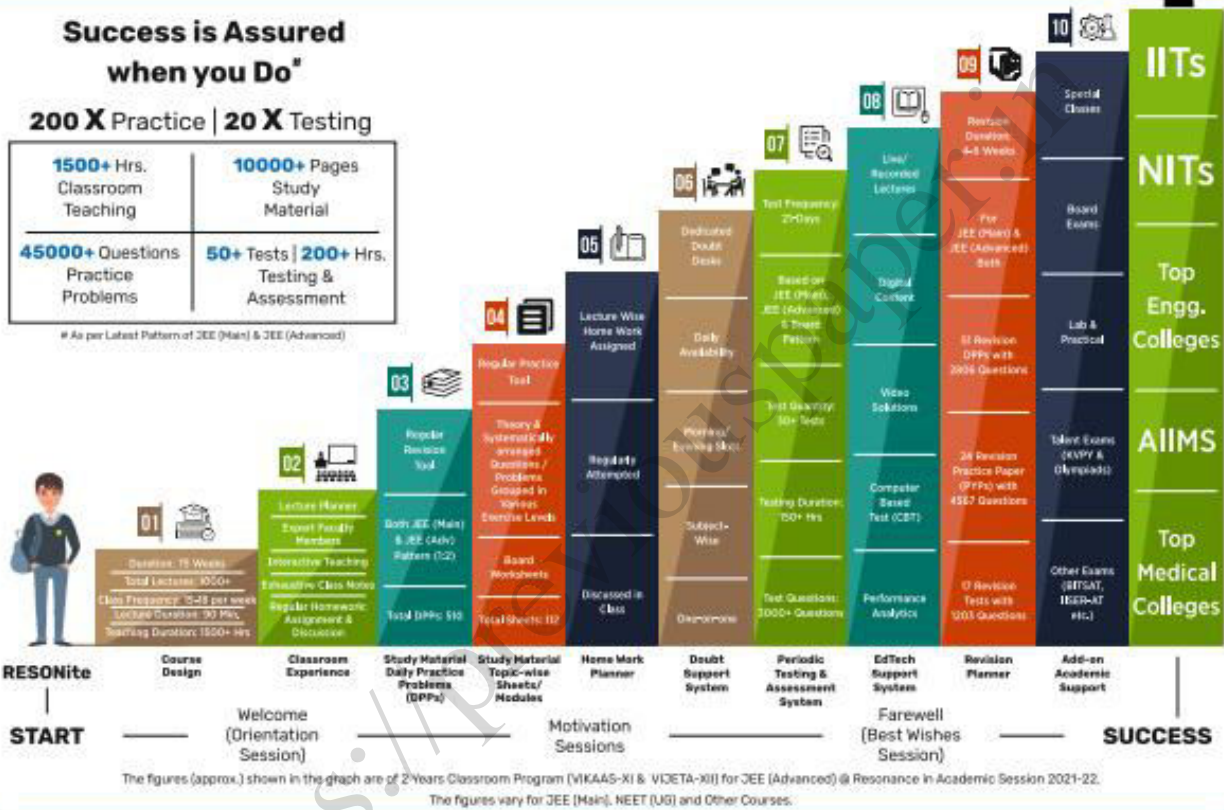
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Duration: 3 Hours | Max. Marks: 300



SUBJECT: PHYSICS

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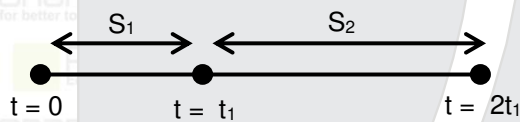
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PART : PHYSICS

- 1 A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in t s, the distance travelled by the toy in the next t s will be :

- A 10m
 B 20m
 C 30m
 D 40m

Ans. (C)



$$S_1 = \frac{1}{2} a t_1^2$$

$$\Rightarrow S_1 + S_2 = \frac{1}{2} a (2t_1)^2 = \frac{1}{2} a 4t_1^2$$

$$\Rightarrow S_1 : S_1 + S_2 = 1 : 4$$

$$\Rightarrow S_1 : S_2 = 1 : 3$$

Here $S_1 = 10$ m

So, $S_2 = 30$ m

2. At what temperature a gold ring of diameter 6.230 cm be heated so that it can be fitted on a wooden bangle of diameter 6.241 cm ? Both the diameters have been measured at room temperature (27°C).

Question: (Given: coefficient of linear thermal expansion of gold $\alpha_L = 1.4 \times 10^{-5} \text{ K}^{-1}$)

- A 125.7°C
 B 91.7°C
 C 425.7°C
 D 152.7°C






Ans. (D)

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Sol. To fit gold ring of diameter 5.230 cm over wooden bangle of diameter 6.241 cm gold ring expansion is required.

$$l = l_0 [1 + \alpha \Delta T]$$

$$6.241 = 5.230 [1 + 1.4 \times 10^{-5} (T - 27)]$$

$$\frac{6.241}{5.230} - 1 = 1.4 \times 10^{-5} (T - 27)$$

$$T = 152.7^\circ\text{C}$$

3. Two point charges Q each are placed at a distance d apart. A third point charge q is placed at a distance x from mid-point on the perpendicular bisector. The value of x

Question: at which charge q will experience the maximum Coulomb's force is:

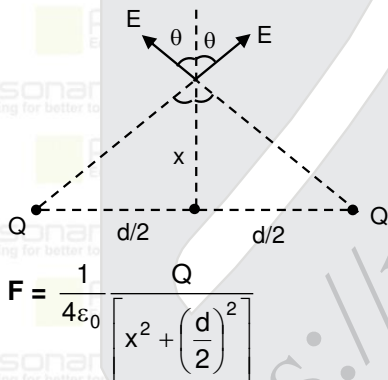
A $x = d$

B $x = \frac{d}{2}$

C $x = \frac{d}{\sqrt{2}}$

D $x = \frac{d}{2\sqrt{2}}$

Ans. (D)



$$F = \frac{1}{4\epsilon_0} \left[\frac{2Qq}{x^2 + \left(\frac{d}{2}\right)^2} \right]$$

$$E_{\text{net}} = 2E \cos \theta$$

$$= \frac{2Q}{4\pi\epsilon_0} \frac{x}{\left[x^2 + \left(\frac{d}{2}\right)^2 \right]^{3/2}}$$

$$F = qE_{\text{net}}$$

$$F = \frac{2Q}{4\pi\epsilon_0} \frac{x}{\left[x^2 + \left(\frac{d}{2}\right)^2 \right]^{3/2}}$$

For maximise of F $\frac{dF}{dx} = 0$; $x = \frac{d}{2\sqrt{2}}$

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4 The speed of light in media 'A' and 'B' are $2.0 \times 10^{10} \text{ cm/s}$ and $1.5 \times 10^{10} \text{ cm/s}$ respectively. A ray of light enters from the medium B to A at an incident angle ' θ '. If the ray suffers total internal reflection, then

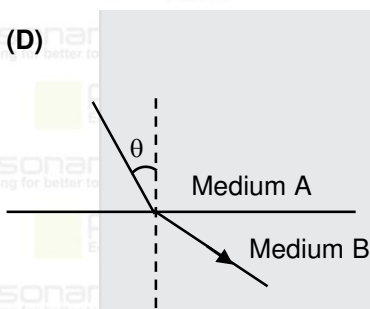
A $\theta = \sin^{-1}\left(\frac{3}{4}\right)$

B $\theta > \sin^{-1}\left(\frac{2}{3}\right)$

C $\theta < \sin^{-1}\left(\frac{3}{4}\right)$

D $\theta > \sin^{-1}\left(\frac{3}{4}\right)$

Ans. (D)
Sol.



Speed of light in A = V_A

Speed of light in B = V_B

$$\frac{V_A}{V_B} = \frac{\mu_B}{\mu_A}$$

$$\frac{2 \times 10^{10}}{1.5 \times 10^{10}} = \frac{\mu_B}{\mu_A}$$

$$\frac{\mu_A}{\mu_B} = \frac{3}{4}$$

$$\text{Critical angle} = \theta_c = \sin^{-1} \frac{\mu_A}{\mu_B} = \sin^{-1} \frac{3}{4}$$

When $\theta > \theta_c$ i.e. $\theta > \sin^{-1} \frac{3}{4}$ TIR take place

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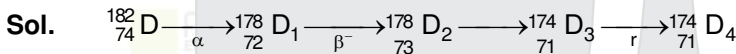
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5. In the following nuclear reaction,
 $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta^-} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\gamma} D_4$
 Mass number of D is 182 and atomic number is 74. Mass number and atomic number of D_4 respectively will be ____

- Question:
- A 174 and 71
 - B 174 and 69
 - C 172 and 69

Ans. (A)



6. The electric field at a point associated with a light wave is given by
 $E = 200 [\sin(6 \times 10^{15})t + \sin(9 \times 10^{15})t] \text{Vm}^{-1}$

Given : $h = 4.14 \times 10^{-15} \text{ eVs}$

If this light falls on a metal surface having a work function of 2.50 eV , the maximum kinetic energy of the photoelectrons will be

- Question:
- A 1.90 eV
 - B 3.27 eV
 - C 3.60 eV
 - D 3.42 eV

Ans. (D)

Sol. $KE_{\text{max.}} = E - \phi$

$$= \frac{h\nu}{2\pi} - \phi$$

$$= \frac{4.14 \times 10^{-15} \times 9 \times 10^{15}}{2 \times 3.14} - 2.5 = 5.9 - 2.5 = 3.4 \text{ eV}$$

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7. A capacitor is discharging through a resistor R . Consider in time t_1 , the energy stored in the capacitor reduces to half of its initial value and in time t_2 , the charge stored reduces to one eighth of its initial value. The ratio t_1/t_2 will be

Question:

- A 1/2
- B 1/3
- C 1/4
- D 1/6

Ans. (D)

Sol. $q = Qe^{-\frac{t}{\tau}}$ $U = \frac{q^2}{2C}$

$$\frac{Q}{\sqrt{2}} = Qe^{-\frac{t_1}{\tau}}$$

$$t_1 = \tau \ln \sqrt{2}$$

$$\frac{Q}{8} = Qe^{-\frac{t_2}{\tau}}$$

$$t_2 = \tau \ln 8$$

$$\frac{t_1}{t_2} = \frac{\tau \ln \sqrt{2}}{\tau \ln 8} = \frac{\frac{1}{2} \tau \ln 2}{3 \tau \ln 2} = \frac{1}{6}$$

8. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal, W_2 , if the process is purely adiabatic and W_3 if the process is purely

Question: isobaric. Then, choose the correct option

- A $W_1 < W_2 < W_3$
- B $W_2 < W_3 < W_1$
- C $W_3 < W_1 < W_2$
- D $W_2 < W_1 < W_3$

Ans. (D)

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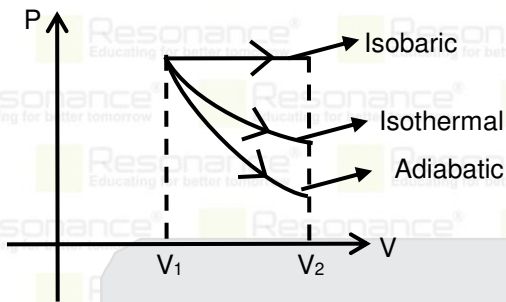
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Sol. $W =$ area under P-V curve

so according to graph



$$W_3 > W_1 > W_2$$

$V_1 \rightarrow V_2$ in three different ways

$W_1 \rightarrow$ Isothermal $W_2 \rightarrow$ Adiabatic

$W_3 \rightarrow$ Isobaric

$$W_2 < W_1 < W_3$$

9 Question:

Two long current carrying conductors are placed parallel to each other at a distance of 8 cm between them. The magnitude of magnetic field produced at mid-point between the two conductors due to current flowing in them is $300 \mu T$. The equal current flowing in the two conductors is :

- A 30A in the same direction.
- B 30A in the opposite direction.
- C 60A in the opposite direction.
- D 300A in the opposite direction.

Ans. (B)

Sol. Current is opposite direction

$$B = \frac{2\mu_0 i}{2\pi 4\text{cm}} \Rightarrow 300 \times 10^{-6} = \frac{2 \times 2 \times 10^{-7} \times i}{4 \times 10^{-2}} \Rightarrow i = 30 \text{ Amp.}$$

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10. The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to three times its previous value, then approximate

Question: new time period of the satellite will be

- A 40 hours
- B 36 hours
- C 30 hours
- D 25 hours

Ans. (B)

Sol. $T^2 \propto r^3$

$$\frac{7^2}{T^2} = \left(\frac{R}{3R}\right)^3$$

$$\frac{49}{T^2} = \frac{1}{27}$$

$$T^2 = 49 \times 27$$

$$T = 7 \times 3\sqrt{3} = 21 \times 1.732$$

$$= 35.7$$

11. The TV transmission tower at a particular station has a height of 125 m. For doubling the coverage of its range, the height of the tower should be increased by

- A 125 m
- B 250 m
- C 375 m
- D 500 m

Ans. (D)

Sol. $d = \sqrt{2hR}$

$$2d = \sqrt{2h'R}$$

$$h' = 4h = 4 \times 125 = 500 \text{ m}$$

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12. The motion of a simple pendulum executing S.H.M. is represented by the following equation.

$$y = A \sin(\pi t + \phi), \text{ where time is measured in second.}$$

Question: The length of pendulum is

- A 97.23 cm
 B 25.3 cm
 C 99.4 cm
 D 406.1 cm

Ans. (C)

Sol. $\omega = \pi$

$$\sqrt{\frac{g}{l}} = \pi$$

$$g = \pi^2 l$$

$$l = \frac{g}{\pi^2} = 1 \text{ m}$$

13. A vessel contains 16g of hydrogen and 128 g of oxygen at standard temperature and pressure. The volume of the vessel in cm^3 is :

- A 72×10^5
 B 32×10^5
 C 27×10^4
 D 54×10^4

Ans. (C)

Sol. Number of moles of Hydrogen (H_2) = $\frac{m}{M} = \frac{16}{2} = 8$

$$\text{Number of moles of } \text{O}_2 = \frac{128}{32} = 4$$

$$PV = nRT$$

$$\text{where pressure } P = 1 \text{ atm} = 1.01 \times 10^5 \text{ Pa (STP)}$$

$$T = 0^\circ\text{C} = 273 \text{ K (STP)}$$

$$1.01 \times 10^5 V = (8 + 4) \times 8.314 \times 273$$

$$V = \frac{12 \times 8.314 \times 273}{1.01 \times 10^5} \text{ m}^3$$






$$= 0.27 \times 10^6 \text{ cm}^3 = 27 \times 10^4 \text{ cm}^3$$

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14.

Given below are two statements :

Statement I: The electric force changes the speed of the charged particle and hence changes its kinetic energy; whereas the magnetic force does not change the kinetic energy of the charged particle.

Statement II: The electric force accelerates the positively charged particle perpendicular to the direction of electric field. The magnetic force accelerates the moving charged particle along the direction of magnetic field.

In the light of the above statements, choose the *most appropriate* answer from the

Question: options given below :

- A Both Statement I and Statement II are correct.
- B Both Statement I and Statement II are incorrect.
- C Statement I is correct but Statement II is incorrect.
- D Statement I is incorrect but Statement II is correct.

Ans. (C)

15.

A block of mass 40 kg slides over a surface, when a mass of 4 kg is suspended through an inextensible massless string passing over frictionless pulley as shown below.

The coefficient of kinetic friction between the surface and block is 0.02. The acceleration of block is. (Given $g = 10 \text{ ms}^{-2}$.)



Question:






- A 1 ms^{-2}
- B $1/5 \text{ ms}^{-2}$
- C $4/5 \text{ ms}^{-2}$
- D $8/11 \text{ ms}^{-2}$

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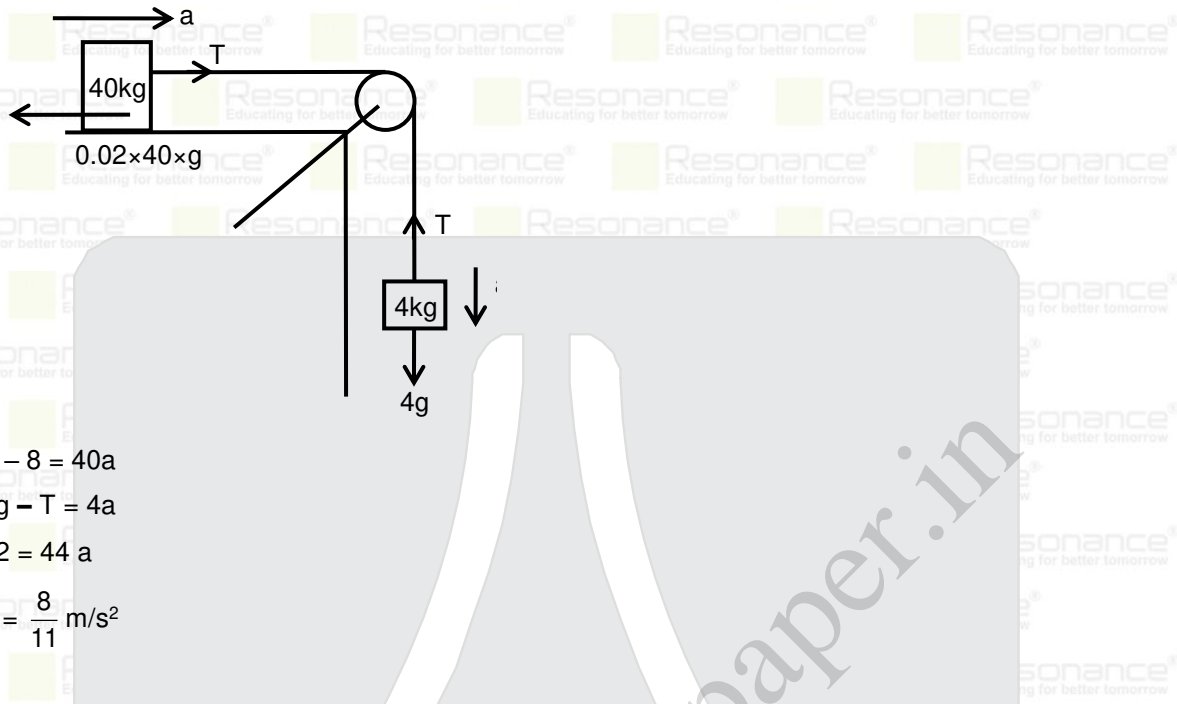
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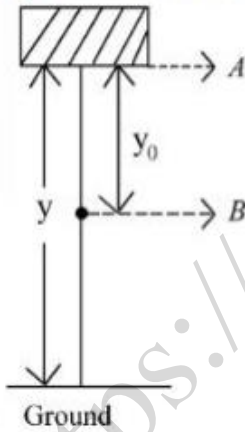
Ans. (D)

Sol.



16.

In the given figure, the block of mass m is dropped from the point 'A'. The expression for kinetic energy of block when it reaches point 'B' is



Question:

A $\frac{1}{2} mgy_0^2$

B $\frac{1}{2} mgy^2$

C $mg(y - y_0)$

D mgy_0

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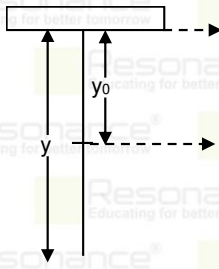
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Ans. (D)

Sol.



Work done by $mg = \Delta KE$

$$mgy_0 = \frac{1}{2}mv^2$$

$$KE_{\text{final}} = mgy_0$$

17.

A block of mass M placed inside a box descends vertically with acceleration. The block exerts a force equal to one-fourth of its weight on the floor of the

Question: The value of 'a' will be

A $\frac{g}{4}$

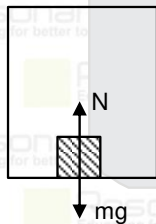
B $\frac{g}{2}$

C $\frac{3g}{4}$

D g

Ans. (C)

Sol.



$$N - mg = ma$$

according to question $N = \frac{mg}{4}$

$$\frac{mg}{4} - mg = ma$$

$$a = \frac{-3g}{4}$$

\therefore Box is accelerating downward with $\frac{3g}{4}$

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18. If the electric potential at any point (x, y, z) m in space is given by $V = 3x^2$ volt.

Question: The electric field at the point $(1, 0, 3)$ m will be :

- A 3 Vm^{-1} , directed along positive x-axis.
- B 3 Vm^{-1} , directed along negative x-axis.
- C 6 Vm^{-1} , directed along positive x-axis.
- D 6 Vm^{-1} , directed along negative x-axis.

Ans. (D)

Sol. We know that

$$E = - \frac{dv}{dx}$$

$$\Rightarrow E = - \frac{d}{dx} (3x^2) = -6x$$

at $(1, 0, 3)$, $E = -6$

19. The combination of two identical cells, whether connected in series or parallel combination provides the same current through an external resistance of 2Ω . The

Question: value of internal resistance of each cell is

- A 2Ω
- B 4Ω
- C 6Ω
- D 8Ω

Ans. (A)

Sol. $\frac{2\varepsilon}{R+2r} = \frac{\varepsilon}{R+\frac{r}{2}}$

$$\Rightarrow 2R + r = R + 2r$$

$$\Rightarrow r = R$$

$$r = R$$

$$r = R = 2\Omega$$

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20

A person can throw a ball upto a maximum range of 100 m. How high above the ground he can throw the same ball?

- Question: **g**
- A 25 m
 B 50 m
 C 100 m
 D 200 m

Ans. (B)

Sol. $R_{\max} = u^2/g = 100 \text{ m}$

$H_{\max} = u^2/2g = 50 \text{ m}$

21.

The Vernier constant of Vernier callipers is 0.1 mm and it has zero error of (-0.05 cm) . While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5. The corrected diameter will be _____ ×

Sol.

V.C = 0.1 mm = 0.01 cm

zero error = -0.05 cm

\therefore correction = 0.05 cm

M.S.R. = 1.7 cm

V.S.R. = $5 \times \text{V.C.} = 5 \times 0.01 = 0.05 \text{ cm}$

diameter = MSR + VSR + correction

$1.7 + 0.05 + 0.05 = 1.8 \text{ cm}$

$= 180 \times 10^{-2} \text{ cm}$

Ans. 180

22.

A small spherical ball of radius 0.1 mm and density 10^4 kg m^{-3} falls freely under gravity through a distance h before entering a tank of water. If, after entering the water the velocity of ball does not change and it continue to fall with same constant velocity inside water, then the value of h will be _____ m
 (. Given $g = 10 \text{ ms}^{-2}$, viscosity of water = $1.0 \times 10^{-5} \text{ N-sm}^{-2}$).






Ans. 20

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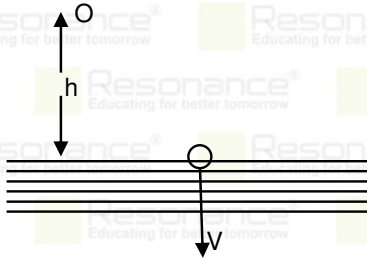
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Sol.

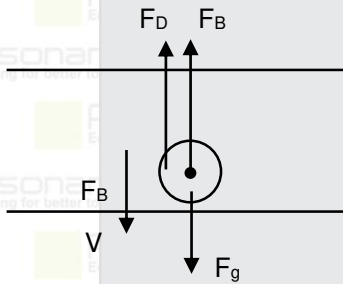


$$V^2 = U^2 + 2as$$

$$V^2 = 0 + 2(-g)(-h)$$

$$V^2 = 2gh$$

$$V = \sqrt{2gh} = \sqrt{20h}$$



As ball move with constant velocity 'v' so its acceleration is zero $\therefore F_{net} = 0$

$$F_D + F_B - F_g = 0$$

$$6 \eta r v = \frac{4}{3} g r^3 [P - \rho_w]$$

$$6 \times 10^{-5} V = \frac{4}{3} \times 10 \times (0.1 \times 10^{-3})^2 [10^4 - 10^3]$$

$$6 \times 10^{-5} V = \frac{4}{3} \times 10 \times 10^{-8} \times 10^3 [10^{-1}]$$

$$6 \times 10^{-5} V = \frac{4}{3} \times 10^{-4} \times 9$$

$$\sqrt{20h} = 2 \times 10$$

$$20h = 400 \quad \therefore h = 20 \text{ m}$$

23. In an experiment to determine the velocity of sound in air at room temperature using a resonance tube, the first resonance is observed when the air column has a length of 20.0 cm for a tuning fork of frequency 400 Hz is used. The velocity of the sound at room temperature is 336 ms^{-1} . The third resonance is observed when the air column has a length of _____ cm

Ans. 104

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Sol. Wavelength of wave $\Rightarrow \lambda = \frac{V}{f} = \frac{336}{400} = 84 \text{ cm}$

At first resonance

$$\frac{\lambda}{4} = l + e \Rightarrow \frac{84}{4} = 20 + e$$

$$\Rightarrow e = 1$$

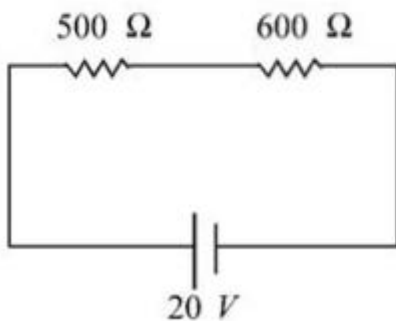
So third resonance length

$$5 \frac{\lambda}{4} = l_2 + e$$

$$5(21) = l_2 + 1$$

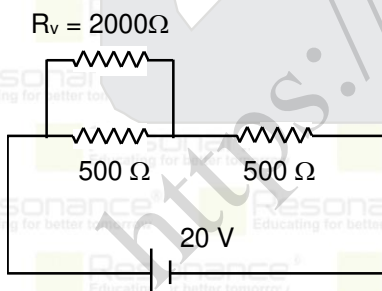
$$l_2 = 104 \text{ cm}$$

24. Two resistors are connected in series across a battery as shown in figure. If a voltmeter of resistance 2000Ω is used to measure the potential difference across 500Ω resistor, the reading of the voltmeter will be _____ V



Ans. 8

Sol.



Parallel equivalent of $2000, 500 \Rightarrow \frac{2000 \times 500}{2000 + 500} = 400 \Omega$

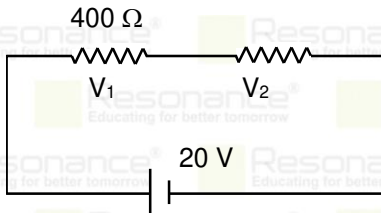
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Reading of $V = V_1$

$$V_1 = \frac{400}{400 + 600} \times 20$$

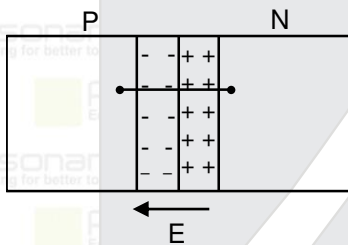
$$\frac{400}{1000} \times 20 \Rightarrow \frac{400 \times 20}{1000} = 8V$$

25. A potential barrier of 0.4 V exists across a p-n junction. An electron enters the junction from the n-side with a speed of $6.0 \times 10^5 \text{ ms}^{-1}$. The speed with which electron enters the p side will be $\frac{x}{3} \times 10^5 \text{ ms}^{-1}$ the value of x is _____.

:(Given mass of electron = $9 \times 10^{-31} \text{ kg}$, charge on electron = $1.6 \times 10^{-19} \text{ C}$.)

Ans. 14

Sol.



$$-e \times V_N + \frac{1}{2} m v_i^2 = -e V_P + \frac{1}{2} m v_f^2$$

we know $V_N - V_P = \text{potential barrier} = 0.4 \text{ V}$

$$-e (V_N - V_P) + \frac{1}{2} m v_i^2 = \frac{1}{2} m v_f^2$$

$$-1.6 \times 10^{-19} \times 0.4 + \frac{1}{2} \times 9 \times 10^{-31} \times 36 \times 10^{10} = \frac{1}{2} \times 9 \times 10^{-31} v_f^2$$

$$-0.64 \times 10^{-19} + 1.62 \times 10^{-19} = \frac{1}{2} \times 9 \times 10^{-31} v_f^2$$

$$0.98 \times 10^{-19} = 4.5 \times 10^{-31} v_f^2$$

$$\frac{0.98 \times 10^{12}}{4.5} = v_f^2$$

$$v_f = 0.466666 \times 10^6$$

$$= 4.6666 \times 10^5 \text{ m/s} = \frac{14}{3} \times 10^5 \text{ m/s}$$

Ans. 14

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26. The displacement current of $4.425 \mu\text{A}$ is developed in the space between the plates of parallel plate capacitor when voltage is changing at a rate of 10^6Vs^{-1} . The area of each plate of the capacitor is 40cm^2 . The distance between each plate of the capacitor is $x \times 10^{-3} \text{m}$. The value of x is ,
 ∴ (Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{C}^2 \text{N}^{-1} \text{m}^{-2}$) _____

Ans. 8

Sol.

$$i_d = \text{displacement current} = \frac{\epsilon_0 d\phi_E}{dt}$$

$$i_d = \frac{\epsilon_0 d}{dt} (EA)$$

$$\text{where } E = \frac{q}{A\epsilon_0}$$

$$i_d = \epsilon_0 \frac{d}{dt} \left(\frac{qA}{A\epsilon_0} \right) = \frac{dq}{dt} = \frac{d}{dt} (CV)$$

$$i_d = C \frac{dv}{dt}$$

$$i_d = \frac{\epsilon_0 A}{d} \frac{dv}{dt}$$

$$4.425 \times 10^{-6} = \frac{8.85 \times 10^{-12} \times 40 \times 10^{-4} \times 10^6}{d}$$

$$d = 2 \times 10^{-6} \times 10^{-4} \times 10^6 \times 40$$

$$d = 80 \times 10^{-4} = 8 \times 10^{-3} \text{ m}$$

27. The moment of inertia of a uniform thin rod about a perpendicular axis passing through one end is I_1 . The same rod is bent into a ring and its moment of inertia about a diameter is I_2 . If $\frac{I_1}{I_2}$ is $\frac{x\pi^2}{3}$, then the value of x will be _____.

Ans. 8

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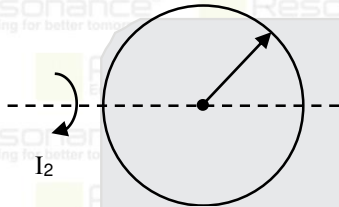
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Sol.



$$2\pi r = \ell$$

$$r = \frac{\ell}{2\pi}$$

$$I_2 = \frac{mr^2}{2} = \frac{m}{2} \left(\frac{\ell}{2\pi} \right)^2$$

$$\frac{I_1}{I_2} = \frac{8}{3} \pi^2$$

28. The half life of a radioactive substance is 5 years. After x years a given sample of the radioactive substance gets reduced to 6.25% of its initial value. The value of x is _____

Ans. 20

Sol. Time taken in 50% is T_H

Time taken in 25% is $2T_H$

Time taken in 12.5% is $3T_H$

Time taken in 6.25% is $4T_H$

So $4T_H = 4 \times 5 = 20$ years

29. In a double slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-3} cm. If the distance between the slits is 1 mm, then the wavelength of the light will be _____

Ans. 600

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Sol. $\beta = \frac{\lambda D}{d}$ where $d = 1\text{ mm}$

$$\beta' = \frac{\lambda D'}{d}$$

As screen is shifted toward slit by $5 \times 10^{-2}\text{ m}$

$$\therefore D - D' = 5 \times 10^{-2}\text{ m} = 5 \times 10^{-2} \times 1000 = 50\text{ mm}$$

fringe width get change by $3 \times 10^{-3}\text{ cm}$

$$\therefore \beta - \beta' = 3 \times 10^{-3}\text{ cm} = 3 \times 10^{-2}\text{ mm}$$

$$\beta - \beta' = \frac{\lambda}{d}(D - D')$$

$$\lambda = \frac{[\beta - \beta']d}{[D - D']} = \frac{3 \times 10^{-2} \times 1}{50} = 0.6 \times 10^{-3}\text{ mm} = 6 \times 10^{-4}\text{ mm} = 600\text{ nm}$$

Ans. 600

30. An inductor of 0.5 mH , a capacitor of $200\text{ }\mu\text{F}$ and a resistor of $2\text{ }\Omega$ are connected in series with a 220 V ac source. If the current is in phase with the emf, the frequency of ac source will be $\times 10^2\text{ Hz}$.

Ans. 5

$$L = 0.5 \times 10^{-3}\text{ H} \quad C = 200 \times 10^{-6}\text{ F} \quad R = 2\Omega.$$

If current is in phase with energy so this is the condition of resonance.

$$f = f_R = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2 \times 3.14\sqrt{LC}}$$

$$f = \frac{1}{6.28\sqrt{0.5 \times 10^{-3} \times 200 \times 10^{-6}}} = 503.55\text{ Hz} = 5.03 \times 10^2\text{ Hz}$$






Ans. 5

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Numbers that Inspire Students to **EXCEL**

Trust of 9,50,000+ STUDENTS*	Total Selections 1,78,546 <small>JEE (Adv.) + Eligibility for JEE (Main) + NEET (UG)</small>	AIRs in TOP-100 350 <small>JEE (Adv.) + JEE (Main) + NEET (UG)</small>	Pool of 800+ FACULTY	Study Centres in 70+ CITIES
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* Since 2001 | ** Students Qualified from JEE (Main) to JEE (Advanced) since 2012 | Top 50 (lectures & AIRs in TOP-100 mentioned are in JEE (Adv.) | JEE (Main) since 2002, JEE (Main) / APJEE (since 2009), NEET (UG) / APJEE (since 2012) | APJEE (Jala Patk)

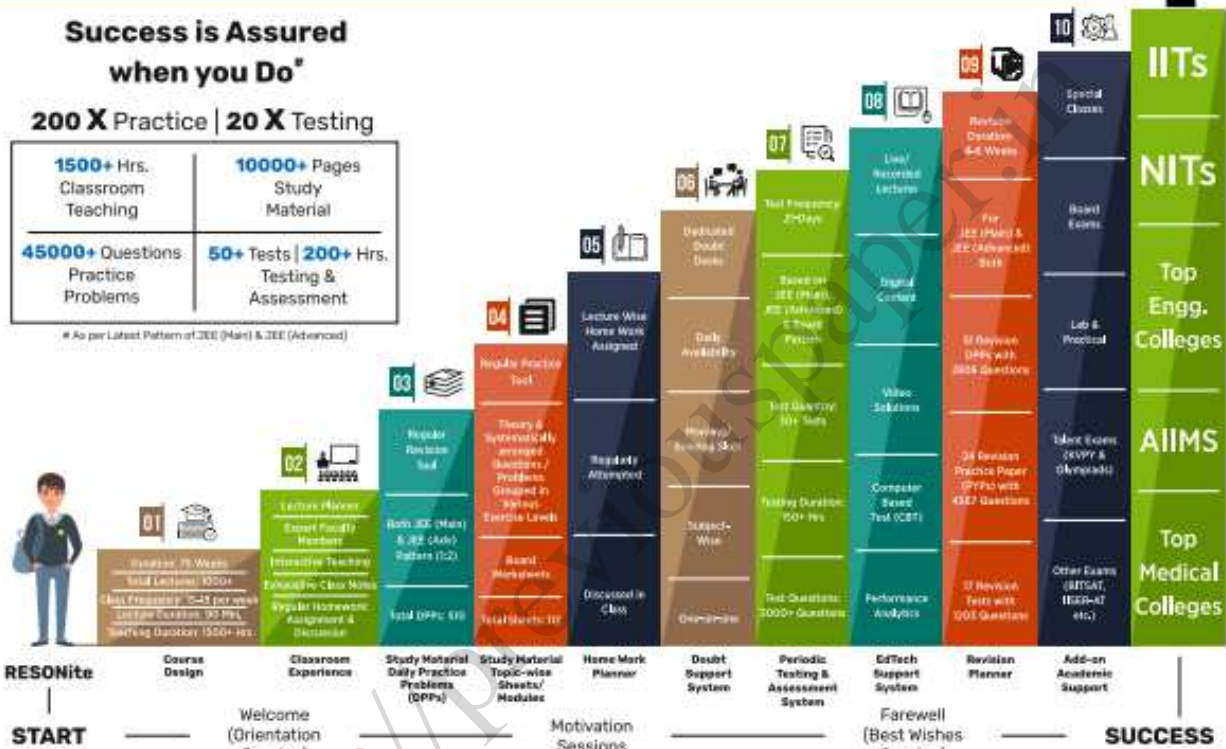
The 10-Building Blocks of **Proven & Trusted Teaching Methodology @ Resonance**

**Success is Assured
when you Do***

200 X Practice | 20 X Testing

1500+ Hrs. Classroom Teaching	10000+ Pages Study Material
45000+ Questions Practice Problems	50+ Tests 200+ Hrs. Testing & Assessment

* As per Latest Pattern of JEE (Main) & JEE (Advanced)



The figures (approx.) shown in the graph are of 2 Years Classroom Program (VIKAAS-XI & VIETA-XII) for JEE (Advanced) @ Resonance in Academic Session 2021-22. The figures vary for JEE (Main), NEET (UG) and Other Courses.

The Strong Faculty Team at Resonance Kota to deliver this successful Teaching Methodology



Photo Taken on 20th June 2022 | Some Faculty Members were not present in the Photo Session.

SCHOLARSHIP UPTO

100%

Based on JEE (Main) 2022 NTA Score (Percentile) & Scholarship Test (ResoNET)

Admission Announcement: 2022-23 Class: 5 to 12 & 12+

ResoNET 3rd & 10th July

Target: JEE (Advanced) | JEE (Main) | NEET (UG) Pre-Foundation (V to X) | Board

Polish your subject knowledge to Shine in JEE (Advanced) 2022 with the guidance of HODs & Top Notch Sr. Faculty of Resonance

SPARK 7 WEEKS COMPACT COURSE OFFLINE/ONLINE

from 4th July 2022

Scholarship upto 90%