

Exam Solutions Shift-01

Session-02

29 JANUARY 2024

IIT JEE

Time- 03 Hrs

M.Marks : 300

Topic Covered

Physics : Full Syllabus

Chemistry : Full Syllabus

Maths : Full Syllabus

GENERAL INSTRUCTION

1. Immediately fill in the particulars on this page of the test booklet.
2. The test is of 3 hours duration.
3. The test booklet consists of 90 questions. The maximum marks are 300.
4. There are Three Sections in the question paper, Section I, II & III consisting of Section-I (Physics), Section-II (Chemistry), Section-III (Mathematics) and having 30 questions in each part in which first 20 questions are compulsory and are of Objective Type and Last 10 questions are integers type in which you have to attempt 5 questions only.
5. There is only one correct response for each question.
6. Each correct answer will give 4 marks while 1 Mark will be deducted.
7. No student is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
8. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.



Physics

Question: A block of mass 100 kg is moved along a horizontal surface 10 m from the starting point. If coefficient of friction between ground and the block is 0.4 find work done against friction

Options:

- (a) 3.9 kJ
- (b) 4.2 kJ
- (c) 3.7 kJ
- (d) 4.1 kJ

Answer: (a)

Question: A particle is executing SHM with an amplitude A. If potential energy of the system is zero about mean position $x = 0$, Find ratio of total energy to kinetic energy at $x = A/3$

Options:

- (a) 8/9
- (b) 9/8
- (c) $3/2\sqrt{2}$
- (d) $2\sqrt{2}/3$

Answer: (b)

Question: $i = 20 + 3/2 t$ Find charge flown in 20

Options:

- (a) 1600 C
- (b) 1200 C
- (c) 1000 C
- (d) 800 C

Answer: (c)

Question: Match the following

A	$\oint \underline{B} \cdot d\underline{A} = 0$	P	Faraday & Lenz's law
B	$\oint \underline{E} \cdot d\underline{A} = \frac{Q_{in}}{\epsilon_0}$	Q	Gauss law on magnetism
C	$\oint \underline{B} \cdot d\underline{l} = \mu \cdot i_{enc}$	R	Ampere's law



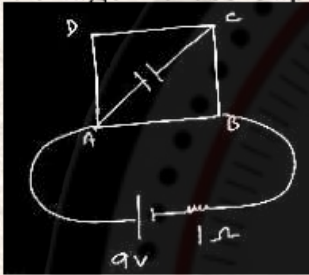
D	$\oint \underline{E} \cdot d\underline{l} = -\frac{d\phi_B}{dt}$	S	Gauss law of electrostatics
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Options:

- (a) (A-Q), (B-S), (C-R), (D-P)
- (b) (A-S), (B-Q), (C-R), (D-P)
- (c) (A-Q), (B-R), (C-S), (D-P)
- (d) (A-Q), (B-S), (C-P), (D-R)

Answer: (a)

Question: In the Following Circuit the resistance of square loop ABCD is 16 Ohm. Find the Voltage Across Capacitor in steady State



Options:

- (a) 4.5 V
- (b) 4 V
- (c) 3 V
- (d) 1 V

Answer: (a)

Question: A Square loop of side 0.1 m is in East West Plane and magnetic field is along North East of 0.2 T. If B is Removed in 10 s find EMF Induced?

Options:

- (a) 14 mV
- (b) 0.14 mV
- (c) 1 mV
- (d) 0.2 mV

Answer: (b)

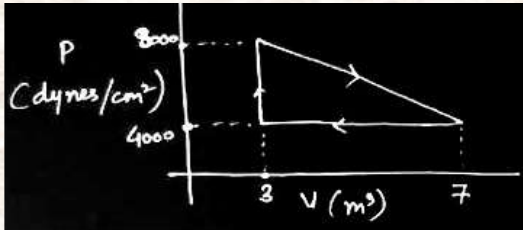
Question: If de Broglie wavelength of an electron is same as wavelength of a photon and speed of the electron is 25% of speed of EM waves in vacuum. Find ratio of kinetic energy of electron & energy of photon.

Options:

- (a) 1/8
- (b) 1/4
- (c) 1/2
- (d) 1

Answer: (a)

Question: P-V graph of a gas is given. Find the work done by the gas.



Options:

- (a) 400 J
- (b) 600 J
- (c) 800 J
- (d) 100 J

Answer: (c)

Question: A convex lens made of glass ($\mu_{\text{glass}} = 1.5$) has focal length of 20 cm in air. If this lens is put inside a fluid of refractive index 1.6. The new focal length will be

Options:

- (a) 160 cm
- (b) -160 cm
- (c) -180 cm
- (d) 80 cm

Answer: (b)

Question: If R is the radius of Earth's and Particle has Equal weight at "d" distance below the surface of Earth's and "d" distance above it, find "d"

Options:

- (a) $d = \sqrt{5} R/2$
- (b) $d = \sqrt{3} R$
- (c) $d = (\sqrt{5}-1) R/2$
- (d) $d = R$

Answer: (c)

Question: The flow speeds on upper & lower surfaces of the wings are 70 m/s & 64 m/s respectively on an airplane in a wind tunnel. What is the lift force on the wing? Area of wing is 0.2 m^2 . Given: density of air = 1.2 kg/m^3

Options:

- (a) 16
- (b) 36
- (c) 81
- (d) 144

Answer: (c)

Question: In a concave mirror of radius of curvature $R = 30 \text{ cm}$ the size of inverted image is half the size of object. Find the distance of the object from pole.

Options:

- (a) 30
- (b) 45
- (c) 60
- (d) 20

Answer: (b)



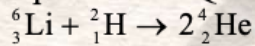
Question: A Galvanometer shows deflection corresponding to 25 division when a certain current is passed. The deflection becomes 5 divisions when galvanometer is shunted with 24Ω . Find the resistance of galvanometer

Options:

- (a) 24Ω
- (b) 48Ω
- (c) 96Ω
- (d) 120Ω

Answer: (c)

Question: In the given nuclear reaction, which of the following expression correctly represent the Q value



Given masses:

$${}^6_3\text{Li} = 6.015122 \text{ amu}, {}^4_2\text{He} = 4.002603 \text{ amu}$$

$${}^2_1\text{H} = 2.014101 \text{ amu}, 1 \text{ amu} = 931.5 \text{ MeV}$$

Options:

- (a) 22.37 MeV
- (b) 21.42 MeV
- (c) 22.02 MeV
- (d) 21.90 MeV

Answer: (a)

Question: S1: When a capillary tube is dipped in cold water and then hot water, the height of water increases

S2: When a capillary tube is dipped in hot water and then cold water, the height of water decreases

[Assume negligible change in density of water or radius of capillary]

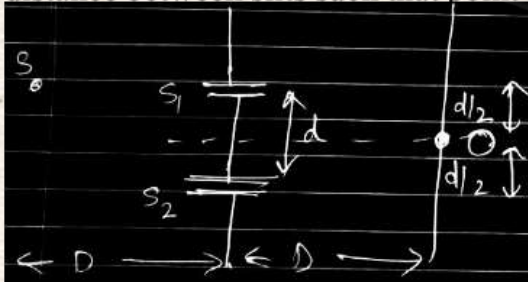
Options:

- (a) 1 true, 2 false
- (b) 1 false, 2 true
- (c) Both false
- (d) Both True

Answer: (c)

Question: In YDSE experiment source is placed exactly in front of one slit.

The distance between slits & screen is 0.2m. Wavelength used is 400 nm. Find the minimum distance between slits such that point O is dark



Options:

- (a) 0.28 mm
- (b) 0.36 mm



- (c) 0.14 mm
- (d) 0.49 mm

Answer: (a)

Question: A galvanometer with resistance $R_g = 8\Omega$ has a full scale deflection current of $I_g = 3$ mA. What is the shunt resistance required to create an ammeter of 8 ampere range?

Options:

- (a) 0.001 Ω
- (b) 0.003 Ω
- (c) 0.009 Ω
- (d) 0.01 Ω

Answer: (b)

Question: Calculate the flux passing through a sphere of radius $4a$ whose center is at the origin, if two charges $5q$ and $-2q$ are placed at $(2q, 0)$ and $(-5q, 0)$ respectively

Options:

- (a) $5q/\epsilon_0$
- (b) $-2q/\epsilon_0$
- (c) $7q/\epsilon_0$
- (d) $3q/\epsilon_0$

Answer: (a)

Question: If the magnetic potential due to a small magnetic dipole along the axis at a distance of 20 cm is $1.5 \times 10^{-5} \text{ J Am}^{-1}$ find its magnetic dipole moment

Options:

- (a) 4 Am^2
- (b) 6 Am^2
- (c) 8 Am^2
- (d) 2 A^2

Answer: (b)



Chemistry

Question: Which of the following pair will be formed by the decomposition of KMnO_4 ?

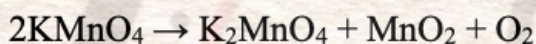
Options:

- (a) MnO_4 , MnO_2
- (b) K_2MnO_4 , MnO_2
- (c) KMnO_4 , MnO_2
- (d) MnO_2 , H_2O

Answer: (b) K_2MnO_4 , MnO_2

Solution:

Potassium permanganate forms dark purple (almost black) crystals which are isostructural with those of KClO_4 . The salt is not very soluble in water (6.4 g / 100 g of water at 293 K), but when heated it decomposes at 513 K.



Question: Interaction b/w π . Bond & lone pair l-s on adjacent atoms

Options:

- (a) Resonance
- (b) Hyper conjugation
- (c) Inductive Effect
- (d) Electronic Effect

Answer: (a) Resonance

Solution:

Question: Assertion. Electronegativity increase across a period

Reason. Effective increase in nuclear charge is more than effective shielding.

Options:

- (a) Step 1: Electronegativity increase down the group 14 is to pb
- (b) Step 2: Group 14 contains metals, non metals and also metalloids

Solution: Assertion true reason true

Step : 1 is incorrect but Step : 2 is correct

Question:

Column - I	Column - II
Ziegler Natta Catalyst	Rh
Blood Pigment	CO
Wilkinson Catalyst	Fe
Vitamin B12	Ti



Solution:

- 1 → Ti
- 2 → Fe
- 3 → Rh
- 4 → Co

Question: Appearance of Red colour on treatment with Na fusion extract of an organic compound with FeSO_4 in presence of conc. H_2SO_4 indicate element

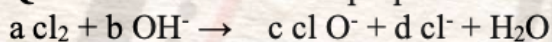
Options:

- (a) N
- (b) Br
- (c) S
- (d) N & S

Answer: (d) N & S

Solution: (d) N & S

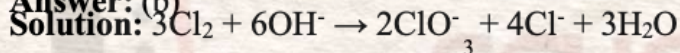
Question: Cl^- shows disproportionation in alkaline meol :



Options:

- (a) 1 1 1 3
- (b) 3 6 2 4
- (c) 1 2 1 1
- (d) 2 4 1 3

Answer: (b)



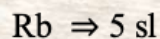
Question: The correct set of 4 Quantum numbers of Valence e^- of Rb(37)

Options:

- (a) $n = 5$., $l = 0$., $m = 1$.,
- (b) $n = 5$., $l = 0$., $m = 0$.,
- (c) $n = 5$., $l = 1$., $m = 0$.,
- (d) $n = 5$., $l = 1$., $m = 1$.,

Answer:

Solution:



↓

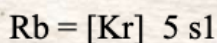
$$n = 5$$

$$l = 0$$

$$Ml = 0$$

$$Mg = +1/2 \text{ or } -1/2$$

The electronic configuration of rubidium atom ($Z = 37$) is given by



Hence, the quantum numbers for 5s1 electron is given by

$$n = 5, l = 0, m = 0, s = +1/2 \text{ or } -1/2$$

Question: Type of amino acids obtained on hydrolysis of proteins

Options:

- (a) α
- (b) β



(c) ψ

(d) δ

Answer: (a)

Solution: Alpha amino acid

Question: CO forms a bridge b/w M atoms

Options:

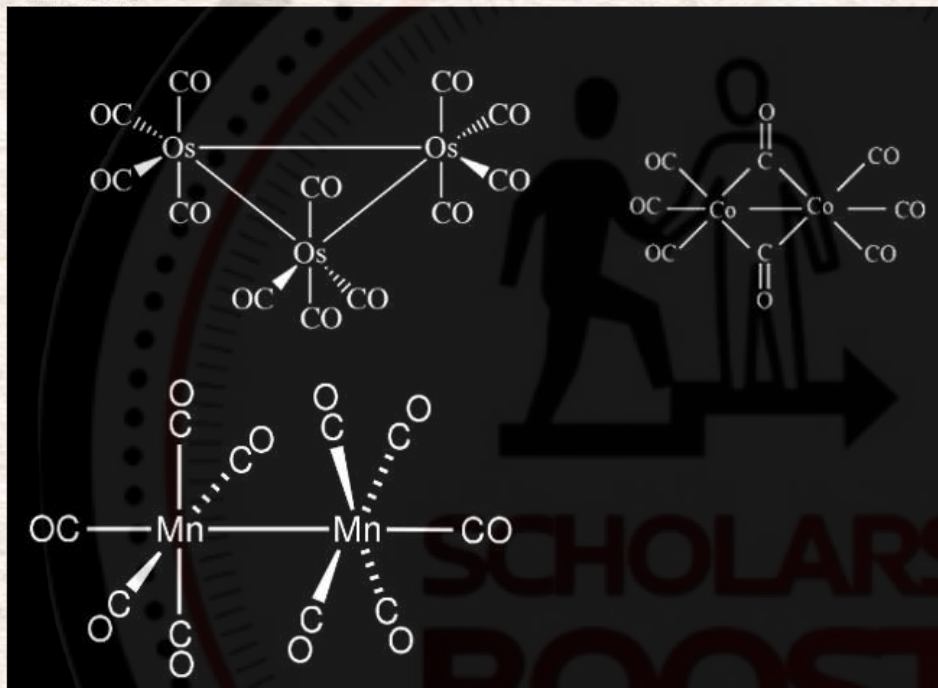
(a) $\text{Os}_3(\text{CO})_{12}$

(b) $\text{Co}_2(\text{CO})_8$

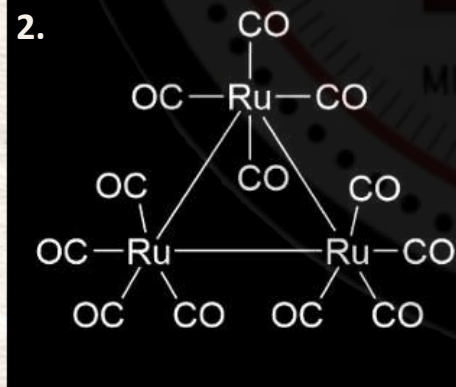
(c) $\text{Ru}_3(\text{CO})_{12}$

(d) $\text{Mn}_2(\text{CO})_{10}$

Solution:



2.



Question: Calculate the Molarity of a Solution having density = 1.25 g/ml. % (w/w) of Solute is 31.4% of H_2SO_4 solution

Options:

(a) 4

(b) 9

(c) 8

(d) 6

Answer: (a)

Solution:



Paper Solutions Shift-01

(Memory Based Solutions)



$$M = 10 \times \frac{w}{w\%} \times d$$

M_{solute}

$$M = 10 \times 31.4 \times \frac{125}{98} \times 100$$

98

$$= 4$$

Question: Find all quantum numbers $Z = 37$

Options:

(a) $n = 5$., $l = 0$., $m = 1$.,

(b) $n = 5$., $l = 0$., $m = 0$.,

(c) $n = 5$., $l = 1$., $m = 0$.,

(d) $n = 5$., $l = 1$., $m = 1$.,

Answer: (a)

Question: Among the heterocyclic compound that contain Sulphur atom is :

Options:

(a) Pyradizine

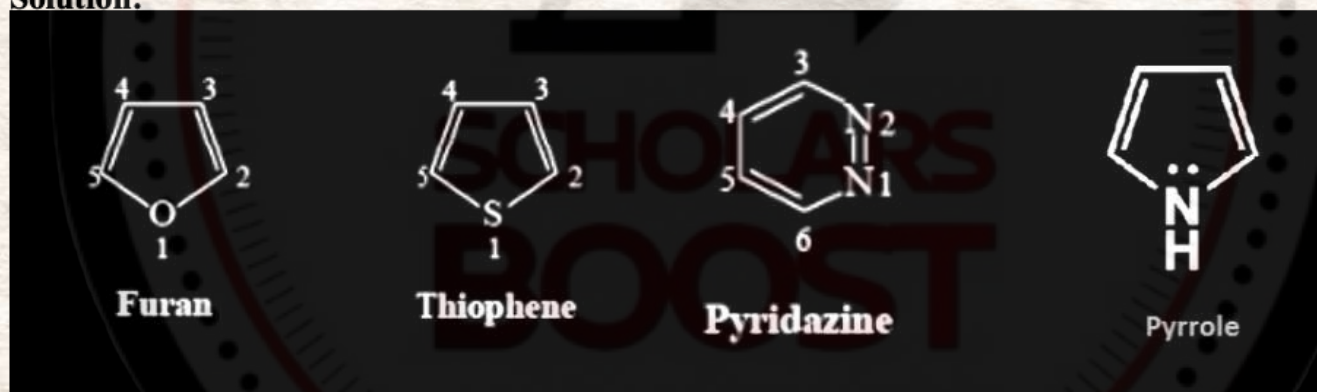
(b) Furan

(c) Thiophene

(d) Pyrrole

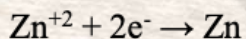
Answer: (c)

Solution:



Question: Find weight of Zinc in Zinc sulphate electrolysis $i = 0.015$ A $t = 15$ minutes

Solution:



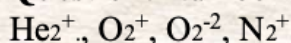
$$1 \text{ mol Zn} = 65.3 \text{ gm} = 2 \text{ F}$$

$$\text{Number of Faradays} = \frac{0.015 \times 15 \times 60}{965}$$

$$= 0.00013 \text{ g F}$$

$$= .0046$$

Question: Number of compound in which B.O = 1 and is paramagnetic



Answer: 0

Solution:

	B.O	Magnetic nature
He_2^+	0.5	Paramagnetic
O_2^+	1.5	Paramagnetic
O_2^{-2}	1	Diamagnetic



Paper Solutions **Shift-01**

(Memory Based Solutions)



N_2^+

2.5

Paramagnetic

Question: Number of compounds that gives positive fehling test Benzaldehyde, acetophenone, methanal

Answer: 1

Solution: Aliphatic aldehyde group. Aromatic aldehydes and ketones do not a give Fehling's test.



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Maths

Question: $f(x) = 2^x - x^2$ $m =$ number of solution such that $f(x)$ with x axis
 $N =$ number of solutions such that $f'(x)$ with x axis $m + n ?$

Answer: 5

Solution:

$$f(x) = 2^x - x^2$$

$$f'(x) = 2^x \ln 2 - 2x$$

$$m = 3$$

$$n = 2$$

Question: $(1 + y^2)(1 + \ln x) dx + x dy = 0$

Answer:

Question: Find $I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left(\frac{x^2 \cos x}{1 + e^x} + \frac{1 + \sin^2 x}{1 + e^{\sin(x^{2023})}} \right) dx$

Solution:

$$I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{x^2 \sin x}{1 + e^x} + \frac{1 + \cos^2 x}{1 + e^{\sin(x^{2023})}} dx$$

$$I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{x^2 \sin x}{1 + e^x} - e^x + \frac{1 + \cos^2 x}{1 + e^{\sin(x^{2023})}} dx$$

$$\alpha I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} x^2 \sin x + 1 + \cos^2 x$$

$$\alpha I = \alpha \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} x^2 \sin x + \cos^2 x dx$$

$$I = x^2 (-\cos x) + (2x)(+\sin x) + 2(\cos x) \Big|_0^{\frac{\pi}{2}} + \frac{\pi}{2} + \frac{\pi}{4}$$

$$I = \left(0 + 2 \cdot \frac{\pi}{2} \right) - (0 + 0 + 2) + \frac{3\pi}{4}$$

$$I = \frac{7\pi}{4} - 2$$



Paper Solutions Shift-01

(Memory Based Solutions)



Question: If an AP with terms $\langle a_i \rangle$, $a_6 = 2$ and a_1, a_4, a_5 is maximum. Find the common difference.

Solution:

$$a_6 = 2 \text{ \& } a_1 a_4 a_5 = \text{max. (given)}$$

$$\Rightarrow M = (a_6 - 5d)(a_6 - 2d)(a_6 - d)$$

$$= (2 - 5d)(2 - 2d)(2 - d)$$

$$M = 2(-5d^3 + 17d^2 - 16d + 4)$$

$$\frac{dM}{dQ} = 2(-15d^2 + 24d + 10d - 16) = 0$$

$$= 2(-3d(5d - 8) + 2(sd - 8)) = 0$$

$$= -2(3d - 2)(5d - 8) = 0$$

$$d = \frac{8}{5}$$

Question: $\frac{{}^{11}C_1}{2} + \frac{{}^{11}C_2}{3} + \dots + \frac{{}^{11}C_9}{9} = \frac{n}{m}$

gcd (M, n) = 1, find m + n.

Solution:

$$(1+x)^{11} = \sum_{r=0}^{11} {}^{11}C_r x^r$$

$$\int_0^1 (1+x)^{11} dx = \sum_{r=0}^{11} \frac{{}^{11}C_r x^{r+1}}{r+1} \Big|_0^1$$

$$\frac{2^{12} - 1}{12} = \sum_{r=0}^{11} \frac{{}^{11}C_r}{r+1}$$

$$= \frac{{}^{11}C_0}{1} + (5) + \frac{{}^{11}C_9}{10} + \frac{{}^{11}C_{10}}{11} + \frac{{}^{11}C_{11}}{12}$$

$$\frac{2^{12} - 1}{12} = 5 + \frac{91}{12} \Rightarrow 5 = \frac{4096 - 91}{12} = \frac{4095}{12} = \frac{1365}{4}$$

$$m + n = 1369$$

Question: $f(x) = \frac{(2^x + 2^{-x})(\tan x) \sqrt{\tan^{-1}(x^2 - x + 1)}}{(x^3 - x^2 + 1)^3}$

Find $f'(a) =$

Solution:



Paper Solutions Shift-01

(Memory Based Solutions)



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Find $f'(a) =$

Solution:



Paper Solutions Shift-01

(Memory Based Solutions)



$$f(x) = \frac{(2^x + 2^{-x}) \tan x \sqrt{\tan^{-1}(x^2 - x + 1)}}{(x^3 - x^2 + 1)^3}$$

$$f(0) = 0$$

$$f'(0) = \lim_{x \rightarrow 0} \frac{f(x)}{x} = \frac{2 \cdot 1 \cdot \sqrt{\frac{\pi}{4}}}{1} = \sqrt{\pi}$$

Question:

$$\left. \begin{aligned} x^2 + y^2 &= 46, \\ \frac{x^2}{16} + \frac{y^2}{b^2} &= 1 \end{aligned} \right\}$$

POI lies on $y^2 = 3x^2$ find $3\sqrt{3}$ times of areas of rectangle formed by POI of conic

Question:

$$\lim_{x \rightarrow \frac{\pi}{2}} \frac{1 \cdot \int_{x^3}^{\left(\frac{\pi}{2}\right)^3} \cos\left(\frac{1}{x^3}\right) dx}{\left(x - \frac{\pi}{2}\right)^2}$$

Solution:

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

Question: GTWENTY, find rank of GTWENTY

Solution:

2 4 5 1 3 4 6

G T W N T Y

$$\frac{1}{2}! \quad \frac{2}{2}! \quad 3 \quad 0 \quad 0 \quad 0 \quad 0$$

$$\text{Rank} = \frac{1}{2!} \times 6! + \frac{2}{2!} \times 5! + 3 \times 4! + 1$$

$$= 360 + 120 + 72 + 1$$

$$= 480 + 73 = 553$$

Question:

$$A \cdot A^T = I \text{ Value of } \left(\frac{1}{2}A\right) \left[(A + A^T)^2 + (A - A^T)^2 \right]$$

Options:

(a) $A^3 + AT$

(b) $(A^3 + AT)^2$

(c) $(A^3 + I)$

(d) A^3

Solution:



Paper Solutions Shift-01

(Memory Based Solutions)



$$A \cdot A^T = I$$

$$\frac{1}{2} A \left((A + A^T)^2 + (A - A^T)^2 \right)$$

$$\frac{1}{2} A \left(A^2 + (A^T)^2 + 2I + A^2 (A^T)^2 - 2I \right)$$

$$A \left(A^2 + (A^T)^2 \right) \quad A^T = A^{-1}$$

$$= A^3 + AA^T A^T$$

$$= A^3 + A^T$$

Question:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & \beta & \alpha \\ 0 & \alpha & \beta \end{bmatrix} = A \det(2A)^3 = 2^{21}$$

Find one of value of α (or β) α, β both integers.

Options:

- (a) 3
- (b) 17
- (c) 9
- (d) 6

Solution:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & \beta & \alpha \\ 0 & \alpha & \beta \end{bmatrix} = A$$

$$\det(2A)^3 = |2A|^3$$

$$= (8|A|)^3 = 2^{21}$$

$$= 2^9 \cdot |A|^3 = 2^{21}$$

$$\Rightarrow |A|^3 = 2^{12}$$

$$= \beta^2 - \alpha^2 = 2^4 = 16$$

Question:

$$f(x) = 4\sqrt{2}x^3 - 2\sqrt{2}x - 1$$

S-1 $f\left[\frac{1}{\sqrt{2}}; 1\right] \rightarrow R$; $f(x)$ intersection x axis at 1 point S-2 $f(x)$ intersection x axis at

$$x = \cos \frac{\pi}{12}$$

Solution:



Paper Solutions Shift-01

(Memory Based Solutions)



S-1

$$f(x) = 4\sqrt{2}x^3 - 2\sqrt{2}x - 1$$

$$f\left(\frac{1}{2}\right) = 4\sqrt{2} \times \frac{1}{8} - 2\sqrt{2} \times \frac{1}{2} - 1 = \sqrt{2} - \sqrt{2} - 1 = -1$$

$$f(1) = 4\sqrt{2} - 2\sqrt{2} - 1$$

$$f\left(\frac{1}{2}\right) \cdot f(1) < 0$$

$$f'(x) = 12\sqrt{2}x^2 - 2\sqrt{2} = 0$$

$$= x^2 = \frac{1}{6}$$

$$x = \pm \frac{1}{\sqrt{6}} \in \left[\frac{1}{2}, 1\right]$$

$$= 2\sqrt{2} - 1 > 0$$

S-1 is true

Question: Sum of all 64 terms is 7 (sum of terms at odd), find common ratio.

Options:

- (a) 6
- (b) 7
- (c)
- (d)

Solution:

$$\frac{a(r^{64} - 1)}{r - 1} = 7 \frac{ar(r^{64-1})}{r - 1} \Rightarrow r = \frac{1}{7}$$

Question: Event of tossing a dice and setting 2 in even no of throws.

Options:

- (a) $\frac{5}{11}$
- (b) $\frac{6}{11}$

Question: $(1 + y^2)(1 + \ln x) dx + x dy = 0$ Passes through $(1, 1)$ find $f(e) = \frac{\alpha \tan^{-1} \frac{3}{2}}{\beta + \tan^{-1} \frac{3}{2}}$.

Find $\alpha + 2\beta$

Question: $Z = \frac{1}{2} + 2i, |z+1| = \alpha z + \beta(l+i)$

Find $\alpha + 2\beta$ or $2\alpha + \beta$

Solution:



Paper Solutions Shift-01

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$$Z = \frac{1}{2} + 2i, |z+1| = \alpha z + \beta + \beta i$$

$$Z+1 = \frac{3}{2} + 2i, \sqrt{\frac{9}{4} + 4} = \alpha \left(\frac{3}{2} + 2i \right) + \beta + \beta i$$

$$\frac{3\alpha}{2} + \beta = \frac{5}{2}, 2\alpha + \beta = 0 \Rightarrow \beta = -2d$$

$$\Rightarrow 3\alpha - 4\alpha = 5 \Rightarrow \alpha = -5, \beta = -10$$

Question: (a, b) R(c, d) a, b, c, d $\in \mathbb{Z}$ ab - bd is divided by 5.

Options:

(a) S, R not T

(b) Not Transitive

Solution: Not Transitive

Question: $x^2 + y^2 = 169$, $5x - y = 13$, find area inside circle lying below the line.

Question: $4\cos\theta + 5\sin\theta = 1$, x is a solution Find $\tan x \in \left[\frac{-\pi}{2}, \frac{\pi}{2} \right]$

Question: $4 \left[\frac{1-f^2}{1+f^2} \right] + 5 \left[\frac{2f}{1+f^2} \right] = I$ when $f = \tan \frac{x}{2}$

MENTORING YOUR WAY TO SUCCESS



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Rough Work



THE END