

08/04/2026

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Memory Based Answers & Solutions

Time : 3 hrs.

for

M.M. : 300

JEE (Main)-2026 (Online) Phase-2

(Physics, Chemistry and Mathematics)

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PHYSICS

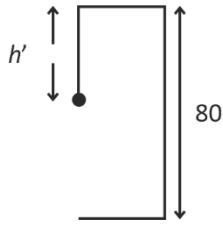
SECTION - A

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. A balloon is moving with speed 10 m/s in upward direction. At height of 75 m a stone is released. Distance travelled by stone in air
- (1) 70 m (2) 80 m
(3) 85 m (4) 90 m

Answer (3)

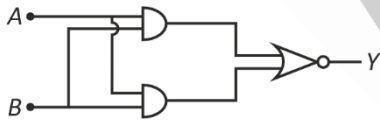


Sol.

$$h' = \frac{v^2}{2g} = \frac{10^2}{20} = 5 \text{ m}$$

$$d = 5 + 5 + 75 = 85$$

2. For the logic gate shown in the diagram find the output Y for the given input A and B



- (1) $A \cdot \bar{B}$ (2) $\bar{A} + \bar{B}$
(3) $\overline{A + B}$ (4) $\overline{A + B}$

Answer (2)

Sol. $\overline{(AB) + (A\bar{B})} = Y$

$$\Rightarrow Y = \overline{AB} = \bar{A} + \bar{B}$$

3. Two photons of wavelength λ_1 & λ_2 ($\lambda_1 = 2\lambda_2 = 2\lambda$) photoelectric effect on a metal surface emitting two photoelectrons of kinetic energies k_1 & k_2 respectively ($k_1 = 3k_2 = 3k$).

- (1) $\frac{6hc}{\lambda}$ (2) $\frac{5ch}{2\lambda}$
(3) $\frac{hc}{2\lambda}$ (4) $\frac{4hc}{3\lambda}$

Answer (2)

Sol. $\frac{hc}{\lambda_1} = k_1 + \phi \Rightarrow \frac{hc}{2\lambda} = 3k + \phi$

$$\frac{hc}{\lambda} = k + \phi$$

$$\Rightarrow k = \frac{hc}{\lambda} - \phi$$

$$\frac{hc}{2\lambda} = \frac{3hc}{\lambda} - 3\phi + \phi$$

$$\Rightarrow 2\phi = \frac{3hc}{\lambda} - \frac{hc}{2\lambda}$$

$$\phi = \frac{5hc}{2\lambda}$$

4. A block attached to a spring has natural frequency f_1 . If the spring is cut in two equal half and only one of the half spring is connected to the block then the frequency becomes f_2 . Find $\frac{f_2}{f_1}$

- (1) 2 (2) $\frac{1}{2}$
(3) $\sqrt{2}$ (4) $\frac{1}{\sqrt{2}}$

Answer (3)

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Sol. For $f_1 = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$

For half spring key = $2k$

So $f_2 = \frac{1}{2\pi} \sqrt{\frac{2k}{m}}$

$\frac{f_2}{f_1} = \sqrt{2}$

5. Two projectiles projected from ground with same speed have same range. Find their time periods are 5 s and 10 s respectively range.

- (1) 125 m (2) 250 m
(3) 100 m (4) 480 m

Answer (2)

Sol. $\frac{T_1}{T_2} = \frac{4 \sin \theta}{4 \cos \theta} = \tan \theta = \frac{1}{2}$

$\therefore \sin \theta = \frac{1}{\sqrt{5}}$

$T_1 = 5$

$\frac{24}{10} \times \frac{1}{\sqrt{5}}$

$u = 25\sqrt{5}$ m/s

$\therefore R = \frac{2u^2 \sin \theta \cos \theta}{g}$
 $= \frac{2 \times 25 \times 25 \times 25}{10} \times \frac{1}{\sqrt{5}} \times \frac{2}{\sqrt{5}}$

= 250 m

6. A new unit (α) of length is chosen such that it is equal to the distance travelled by light in vacuum in 1 second. What is the distance d between Venus and Earth in terms of this new unit, if light takes 6 minutes 40 seconds to cover the distance?

- (1) 500 unit (2) 300 unit
(3) $\frac{1}{200}$ unit (4) 400 unit

Answer (4)

Sol. $d_{(\text{in meter})} = c(360 + 40) = c \times 400$

$d_{(\text{in new unit})} = \frac{400 \times c}{c \times 1} = 400$

7. Two objects (1) & (2) travels 104 m & 120 m in 50th sec with their initial speed of 5 m/s & 12 m/s respectively.

3 kg $\bullet \rightarrow$ 5 m/s $\overline{\hspace{1cm}}$
104 m

2.5 kg $\bullet \rightarrow$ 12 m/s $\overline{\hspace{1cm}}$
120 m

Ratio of momentum of object (1) & (2) at $t = 50$ sec is nearly

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

Answer (3)

Sol. $104 = 5 + \frac{a}{2}(99)$, $a = 2$

$120 = 12 + \frac{a'}{2}(99)$, $a' = \frac{108 \times 2}{99}$

$\frac{m_1 v_1}{m_2 v_2} = \frac{3(5 + 2 \times 50)}{2.5 \left(12 + \frac{108 \times 2}{99} \times 50 \right)} \approx \frac{105 \times 3}{2.5(12 + 108)} = \frac{21}{20}$

8. Dipole moment of system, with q_1, q_2 at \vec{r}_1 and \vec{r}_2 as $3 \mu\text{C}, -9 \mu\text{C}$ and $\vec{r}_1 = 2\hat{i} + 3\hat{j} + 3\hat{k}$, $\vec{r}_2 = \hat{i} + \hat{j} + \hat{k}$ respectively is of magnitude _____.

- (1) $5\sqrt{2} \mu\text{Cm}$ (2) $10 \mu\text{Cm}$
(3) $3 \mu\text{Cm}$ (4) $12 \mu\text{Cm}$

Answer (3)

Sol. $\vec{P} = \sum q_i \vec{r}_i$
 $= (6 - 9)\hat{i} + (9 - 9)\hat{j} + (9 - 9)\hat{k}$

9. A solid cylinder has $V_{cm} = 9$ m/s & $\omega = \frac{V_{cm}}{4R}$ as shown. Find time after which it will start pure rolling $C_g = 10$ m/s²



- (1) 1 s (2) 0.9 s
(3) 2 s (4) 1.3 s

Answer (2)

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Sol. $Li = Lg$ (about point of content)

$$\Rightarrow mV_{cm}R + \frac{mR^2}{2}\omega = mV_fR + \frac{mR^2}{2}\omega_f$$

$$\Rightarrow V_{cm}R + \frac{V_{cm}}{8} = \frac{3}{2}V_fR$$

$$\Rightarrow \frac{9}{8}V_{cm} = \frac{3}{2}V_f$$

$$\Rightarrow V_f = \frac{3V_{cm}}{4}$$

$$a_{cm} = \mu g$$

$$V_f = V_{cm} - \mu g t$$

$$\Rightarrow \mu g t = \frac{V_{cm}}{4}$$

$$t = \frac{V_{cm}}{4\mu g} = 0.9 \text{ s}$$

10. Initial pressure & volume of monoatomic gas is P & V . It is expanded adiabatically to 27 times its initial volume. Find magnitude of change in internal energy.

(1) $\frac{3}{2}PV$ (2) PV

(3) $\frac{4}{3}PV$ (4) $\frac{PV}{2}$

Answer (3)

Sol. $PV^{5/3} = P_f(27V)^{5/3}$

$$P_f = \frac{P}{3^5}$$

$$\Delta U = nc_v\Delta T$$

$$\Rightarrow \Delta U = \frac{3}{2}(P_fV_f - P_iV_i)$$

$$\Rightarrow \Delta U = \frac{3}{2}\left(\frac{P}{3^5}27V - PV\right)$$

$$\Rightarrow \Delta U = \frac{3}{2}\left(\frac{PV}{9} - PV\right)$$

$$|\Delta U| = \frac{3}{2} \times \frac{8}{9}PV$$

$$= \frac{4}{3}PV$$

11. Magnetic field is represented in terms of μ_0 , ϵ_0 and electric field E as $\mu_0^x \epsilon_0^y E^z$ then $(x + y + z)$ is

- (1) 1.5 (2) 0.5
(3) 2 (4) 2.5

Answer (3)

Sol. $E = CB$

$$E = \frac{1}{\sqrt{\mu_0 \epsilon_0}} B$$

$$B = \sqrt{\mu_0 \epsilon_0} E$$

$$\Rightarrow \frac{1}{2} + \frac{1}{2} + 1 = 2$$

12. A solenoid is having 10 turns, length of 25 mm and of cross section area of 5 cm². The current in solenoid changes from 2A to 4A in 3.14 s then average EMF induced is

- (1) 0.9 mV (2) 0.35 mV
(3) 0.16 μ V (4) 0.8 μ V

Answer (3)

Sol. $\frac{\Delta Q}{\Delta t} = \frac{A\Delta B}{\Delta t} = \frac{A\Delta(\mu_0 n_i)}{\Delta t} = \frac{4\pi \times 10^{-7}}{\pi} \times \frac{10}{25 \times 10^{-3}} \times 2 \times 5 \times 10^{-4}$

$$= \frac{400}{25} \times 10^{-7-4+3}$$

$$= 16 \times 10^{-8} \text{ V}$$

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13. A car is moving with speed of 54 km/h takes a turn of radius 20 m. Angle made by bob from car ceiling with vertical is
- (1) $\tan^{-1}(0.045)$ (2) $\tan^{-1}(0.05)$
 (3) $\tan^{-1}(0.09)$ (4) $\tan^{-1}(0.6)$

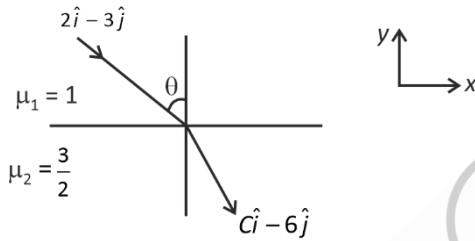
Answer (1)

Sol. $\tan\theta = \frac{v^2}{rg}$

$$\tan\theta = \frac{g}{20 \times 10}$$

$$\theta = \tan^{-1}(0.045)$$

14. The direction (vector) of incident and refracted light are shown in the diagram. Find the value of C.



- (1) $\frac{24}{\sqrt{101}}$ (2) $\frac{24}{7}$
 (3) 3 (4) $\frac{25}{\sqrt{101}}$

Answer (1)

Sol. $\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2$

$$1 \times \frac{2}{\sqrt{13}} = \frac{3}{2} \sin\theta_2$$

$$\Rightarrow (\sin\theta_2)^2 = \frac{16}{9 \times 13} = \frac{C^2}{C^2 + 36}$$

$$\Rightarrow 16C^2 + 576 = 117C^2$$

$$\Rightarrow 101C^2 = 576$$

$$\Rightarrow C = \frac{24}{\sqrt{101}} \text{ (+ve)}$$

15.
16.
17.
18.
19.
20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. A drop is falling with terminal velocity v_1 in a gas. The drop splits into 64 identical droplets. If one small droplet falls with terminal velocity v_2 , find the ratio $\frac{v_1}{v_2}$.

Answer (16)

Sol. $6\pi\eta Rv_1 = mg - F_B$

$$6\pi\eta rv_2 = \frac{mg}{64} - \frac{F_B}{64}$$

$$\Rightarrow mg - F_B = 6\pi\eta Rv_1 = 64(6\pi\eta rv_2) \quad \dots(1)$$

$$\text{Also } \frac{4}{3}\pi R^3 = 64 \times \frac{4}{3}\pi r^3$$

$$\Rightarrow R = 4r$$

$$\text{So, } 4rv_1 = 64 \cdot rv_2$$

$$\Rightarrow v_1 = 16v_2$$

$$\text{So, } \frac{v_1}{v_2} = 16$$

22.
23.
24.
25.

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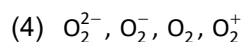
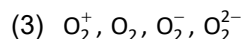
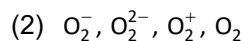
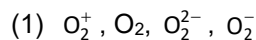
CHEMISTRY

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:

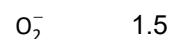
1. Increasing order of bond length from the following



Answer (3)

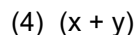
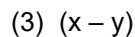
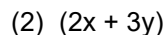
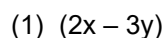
Sol. Lesser the bond order, more will be the bond length

BO



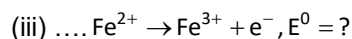
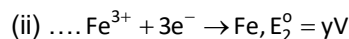
2. If $E_{Fe^{2+}/Fe}^0$ is xV and $E_{Fe^{3+}/Fe}^0$ is yV .

Then calculate $E_{Fe^{2+}/Fe^{3+}}^0$ in V .



Answer (1)

Sol. (i) $\dots Fe^{+2} + 2e^- \rightarrow Fe, E_1^0 = xV$



$$-1 \times F \times E^0 = -2 \times F \times x + 3 \times F \times y$$

$$\Rightarrow E^0 = 2x - 3y$$

3. Which of the following amino acid gives violet color complex with neutral $FeCl_3$ solution?

(1) Threonine

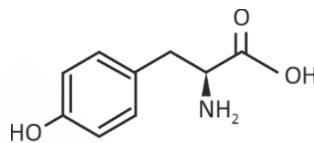
(2) Serine

(3) Tyrosine

(4) Cysteine

Answer (3)

Sol. Tyrosine contains a p-hydroxy phenyl group (a phenolic ring), Phenol on reaction with neutral $FeCl_3$ form a violet color complex



Tyrosine

4. Match List-I with List-II

| | List-I ($n = 2$) | | List-II (IE in kJ/mol) |
|-----|-----------------------|-----|---------------------------|
| (A) | ns^2 | (1) | 1402 |
| (B) | ns^2np^1 | (2) | 899 |
| (C) | ns^2np^3 | (3) | 2080 |
| (D) | ns^2np^6 | (5) | 801 |

(1) $A \rightarrow 2, B \rightarrow 4, C \rightarrow 3, D \rightarrow 1$

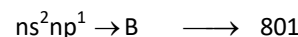
(2) $A \rightarrow 4, B \rightarrow 2, C \rightarrow 1, D \rightarrow 3$

(3) $A \rightarrow 2, B \rightarrow 4, C \rightarrow 1, D \rightarrow 3$

(4) $A \rightarrow 4, B \rightarrow 2, C \rightarrow 3, D \rightarrow 1$

Answer (3)

Sol. **IE (kJ/mol)**



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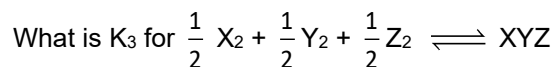
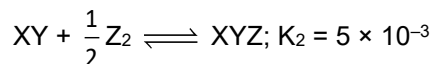
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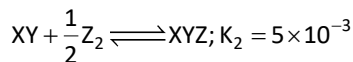
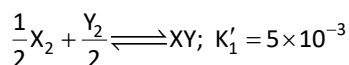


5. Consider the following

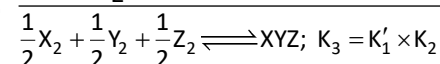


- (1) 5×10^{-4}
- (2) 2.5×10^{-5}
- (3) 1×10^4
- (4) 2.5×10^{-4}

Answer (2)



Sol.

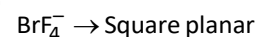
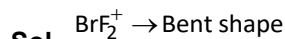


$$\begin{aligned} K_3 &= 5 \times 10^{-3} \times 5 \times 10^{-3} \\ &= 25 \times 10^{-6} \\ &= 2.5 \times 10^{-5} \end{aligned}$$

6. Bromine trifluoride auto ionises to form BrF_2^+ and BrF_4^- . The shapes of cation and anion are respectively

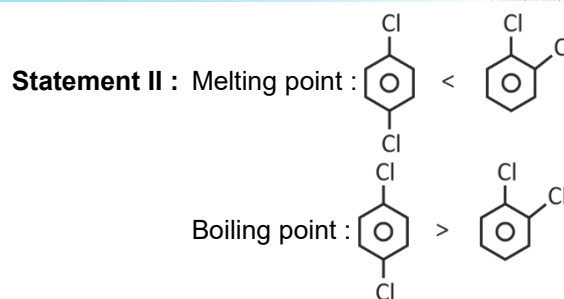
- (1) Linear, square planar
- (2) Bent, See-Saw
- (3) Bent, square planar
- (4) Linear, tetrahedral

Answer (3)



7. Given below are two statements.

Statement I : Boiling point follows the order $CH_3CH_2CH_2I > CH_3CH_2I > CHI_3$.

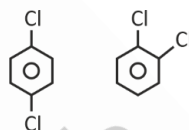


Choose the correct statements.

- (1) Both Statement I and Statement II are correct
- (2) Statement I is correct but Statement II is incorrect
- (3) Statement I is incorrect but Statement II is correct
- (4) Both Statement I and Statement II are incorrect

Answer (2)

Sol. Statement I is correct.



m.p $\Rightarrow 323 \text{ K} > 256 \text{ K}$

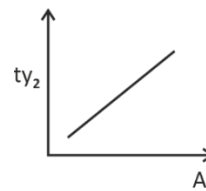
b.p $\Rightarrow 448 \text{ K} < 453 \text{ K}$

(due to symmetry \Rightarrow better packing in para)
Statement II is incorrect.

8. Given below are two statements

Statement I : Given $E_a = 12.6 \text{ K cal}$; then at room temperature, the rate constant double for a rise for a rise of 10°C

Statement II : In a first order reaction



Choose the correct option.

- (1) Both statement I and statement II are true
- (2) Statement I is false but statement II is true
- (3) Statement I is true but statement II is false
- (4) Both statement I and statement II are false

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Answer (3)

$$\text{Sol. } \log \frac{k_2}{k_1} = \frac{12600}{2.303 \times 2} \left[\frac{10}{298 \times 308} \right]$$

$$\log \frac{k_2}{k_1} = 0.3$$

$$\log \frac{k_2}{k_1} = \log 2$$

$$\frac{k_2}{k_1} = 2$$

$$k_2 = 2k_1$$

For first order reaction $t_{1/2}$ is independent of initial concentration

9. Given below are two statements

Statement I : 30% (w/w) Solution of CCl_4 in Benzene has mole fraction of CCl_4 to be 0.033.

Statement II : A mixture of CCl_4 and ethanol shows positive deviation.

In light of above statements, choose the correct option.

- (1) Both statement-I and statement-II are correct
- (2) Statement-I is correct statement-II is incorrect
- (3) Statement-I is incorrect statement-II is correct
- (4) Both statement-I and statement-II are incorrect

Answer (3)

$$\text{Sol. } \bullet \quad X_{\text{CCl}_4} = \frac{\frac{30}{154}}{\frac{30}{154} + \frac{70}{78}} = 0.178$$

- Mixture of CCl_4 and ethanol will show positive deviation

10. Match the following.

| | List-I (Mass of molecules) | | List-II (Number of molecules) |
|-----|--------------------------------|-------|----------------------------------|
| (P) | 1.8 mg H_2O | (I) | $0.5 \times 10^{-4} N_A$ |
| (Q) | 1.8 mg carbon | (II) | $1.5 \times 10^{-4} N_A$ |
| (R) | 4.9 mg H_2SO_4 | (III) | $2 \times 10^{-4} N_A$ |
| (S) | 11.7 mg NaCl | (IV) | $1 \times 10^{-4} N_A$ |

- (1) (P) \rightarrow (III), (Q) \rightarrow (IV), (R) \rightarrow (I), (S) \rightarrow (II)
- (2) (P) \rightarrow (VI), (Q) \rightarrow (II), (R) \rightarrow (I), (S) \rightarrow (III)
- (3) (P) \rightarrow (I), (Q) \rightarrow (II), (R) \rightarrow (III), (S) \rightarrow (IV)
- (4) (P) \rightarrow (II), (Q) \rightarrow (III), (R) \rightarrow (I), (S) \rightarrow (IV)

Answer (2)

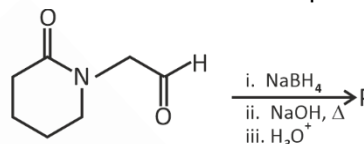
$$\text{Sol. } n_{\text{H}_2\text{O}} = \frac{1.8 \times 10^{-3}}{18} = 0.1 \times 10^{-3} N_A = 1 \times 10^{-4} N_A$$

$$n_e = \frac{1.8 \times 10^{-3}}{12} = 0.15 \times 10^{-3} N_A = 1.5 \times 10^{-4} N_A$$

$$n_{\text{H}_2\text{SO}_4} = \frac{4.9 \times 10^{-3}}{98} = \frac{1}{2} \times 10^{-4} \Rightarrow 0.5 \times 10^{-4} N_A$$

$$n_{\text{NaCl}} = \frac{11.7 \times 10^{-3}}{58.5} = 0.2 \times 10^{-3} \Rightarrow 2 \times 10^{-4} N_A$$

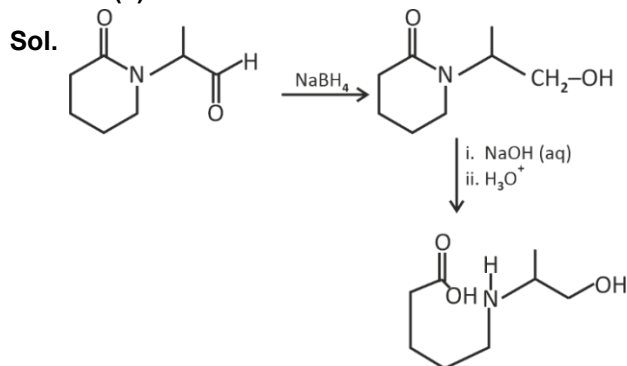
11. Consider the reaction sequence :



Identify P.

- (1)
- (2) $\text{OHC}-(\text{CH}_2)_4-\text{NH}-\text{CH}_2-\text{OH}$
- (3) $\text{HO}_2\text{C}-(\text{CH}_2)_4-\text{NH}-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{OH}$
- (4) $\text{OHC}-(\text{CH}_2)_4-\text{NH}-\underset{\text{CH}_2-\text{OH}}{\text{CH}_2}$

Answer (3)



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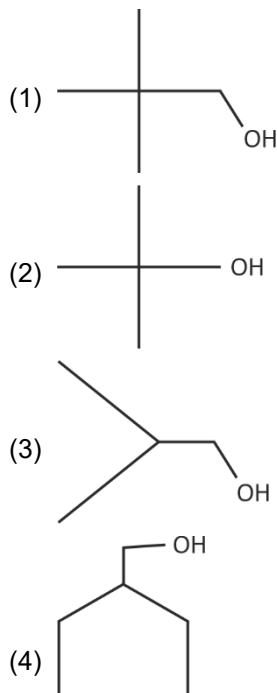
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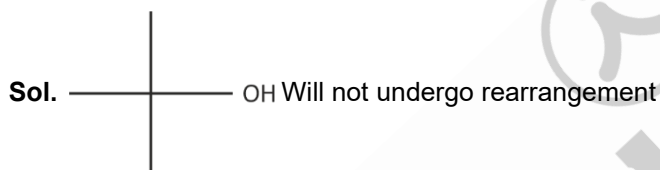
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12. Which of the following does not undergo rearrangement of carbocation



Answer (2)



13. **Statement I** : Reducing character decreases from NH_3 to BiH_3 .

Statement II : Tendency to donate a lone pair of e⁻ decreases from NH_3 to BiH_3 .

Statement III : Stability of hydrides decreases from NH_3 to BiH_3 .

Statement IV : The $\text{H}\hat{\text{E}}\text{H}$ bond angle of NH_3 is greater than SbH_3 .

Which of the following is correct statements.

- (1) S_I , S_II and S_III only
- (2) S_II and S_IV only
- (3) S_II , S_III and S_IV only
- (4) S_I and S_III only

Answer (3)

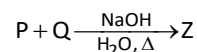
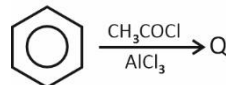
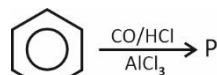
Sol. Down the group E – H bond strength decreases therefore reducing character increases.

NH_3 is strong Lewis base than BiH_3

$\text{NH}_3 \Rightarrow \text{BA} = 107.8^\circ\text{C}$

$\text{SbH}_3 \Rightarrow \text{BA} \Rightarrow 91.3^\circ$

14. Consider the following reaction

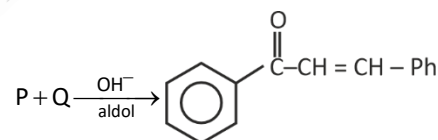
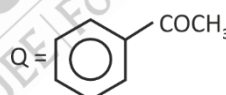


The number of π bonds in (Z) is

- (1) 8
- (2) 10
- (3) 12
- (4) 5

Answer (1)

Sol.



Number of π bonds = 3 + 3 + 2 = 8

- 15.
- 16.
- 17.
- 18.
- 19.
- 20.

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SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Given $\lambda_1 = 3000\text{\AA}$ and $\lambda_2 = 6000\text{\AA}$ then find the ratio of E_1 and E_2

Answer (2)

Sol. $E = \frac{hc}{\lambda}$

$$E_2 = \frac{hc}{\lambda_2}$$

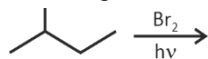
$$E_1 = \frac{hc}{\lambda_1}$$

$$\frac{E_2}{E_1} = \frac{\lambda_1}{\lambda_2}$$

$$\frac{E_2}{E_1} = \frac{3000}{6000} = \frac{1}{2}$$

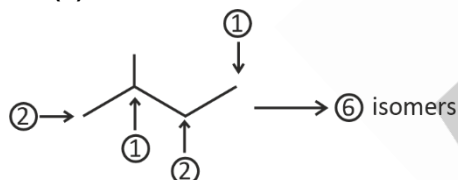
$$\frac{E_2}{E_1} = 2$$

22. The number of monobrominated products in the following reaction is (including stereoisomers)

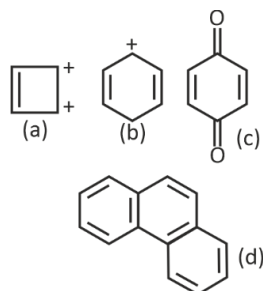


Answer (6)

Sol.



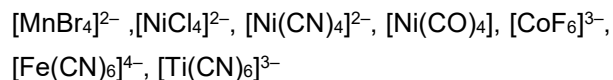
23. The number of aromatic compounds from the following is



Answer (2)

Sol. a, d are aromatic

24. Number of paramagnetic complexes among the following is



Answer (4)

Sol. $[\text{MnBr}_4]^{2-} \rightarrow \text{Br}^- \rightarrow \text{WFL} \rightarrow \text{Paramagnetic}$

$[\text{NiCl}_4]^{2-} \rightarrow \text{Cl}^- \rightarrow \text{WFL} \rightarrow \text{Para}$

$[\text{Ni}(\text{CN})_4]^{2-} \rightarrow \text{CN}^- \rightarrow \text{SFL} \rightarrow \text{Dia}$

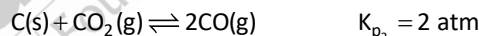
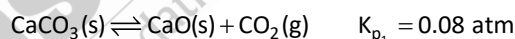
$[\text{Ni}(\text{CO})_4] \rightarrow \text{CO} \rightarrow \text{SFL} \rightarrow \text{Dia}$

$[\text{CoF}_6]^{3-} \rightarrow \text{F}^- \rightarrow \text{WFL} \rightarrow \text{Para}$

$[\text{Fe}(\text{CN})_6]^{4-} \rightarrow \text{CN}^- \rightarrow \text{SFL} \rightarrow \text{Dia}$

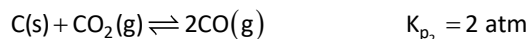
$[\text{Ti}(\text{CN})_6]^{3-} \rightarrow \text{CN}^- \rightarrow \text{SFL} \rightarrow 1 \text{ unpaired } e^- \rightarrow \text{Para}$

25. Solid C, CaO and CaCO_3 are mixed and allowed to attain equilibrium at 'T' K such that,



Partial pressure of CO at equilibrium is $x \times 10^{-1}$ atm. x is _____.

Answer (4)



$$K_{p_1} = (p_{\text{CO}_2})_e = 0.08 \text{ atm}$$

$$\text{Now, } \frac{(p_{\text{CO}})^2}{0.08} = 2$$

$$(p_{\text{CO}})^2 = 0.16 \Rightarrow p_{\text{CO}} = 0.4 \text{ atm} = 4 \times 10^{-1} \text{ atm}$$

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4. If $(x\sqrt{1-x^2})dy - (y\sqrt{1-x^2} - x^2 \cos^{-1}x)dx = 0$ and $\lim_{x \rightarrow 1^-} y(x) = 1$, then $y\left(\frac{1}{2}\right)$ is

- (1) $\frac{\pi^2}{36}$
 (2) $\frac{\pi}{36} + 1$
 (3) $\frac{\pi^2}{36} + \frac{1}{2}$
 (4) $\frac{\pi}{36}$

Answer (3)

Sol. $\frac{dy}{dx} - \frac{y}{x} = \frac{-x \cos^{-1}x}{\sqrt{1-x^2}}$
 IF $e^{-\int \frac{1}{x} dx} = \frac{1}{x}$
 $\therefore \frac{y}{x} = -\int \frac{\cos^{-1}x}{\sqrt{1-x^2}} dx$
 let $\cos^{-1}x = t$
 $\frac{-1}{\sqrt{1-x^2}} dx = dt$
 $\frac{y}{x} = \int t dt = \frac{t^2}{2} + c$
 $\frac{y}{x} = \frac{(\cos^{-1}x)^2}{2} + c$
 $\therefore \lim_{x \rightarrow 1^-} y(x) = 1 \Rightarrow \frac{1}{1} = 0 + c$
 $\Rightarrow c = 1$
 $\therefore y = \frac{x(\cos^{-1}x)^2}{2} + x$
 $y\left(\frac{1}{2}\right) = \frac{1}{2} \times \frac{\pi^2}{9 \times 4} + \frac{1}{2}$
 $y\left(\frac{1}{2}\right) = \frac{\pi^2}{36} + \frac{1}{2}$

5. Let $\frac{x^2}{f(a^2+2a+7)} + \frac{y^2}{f(3a+14)} = 1$ represents an

equation of ellipse. The major axis of given ellipse is y-axis and f is a decreasing function. If the range of a is $R - [\alpha, \beta]$ then $\alpha + \beta$ is

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

Answer (4)

Sol. $\frac{x^2}{f(a^2+2a+7)} + \frac{y^2}{f(3a+14)} = 1$
 $f(3a+14) > f(a^2+2a+7)$
 $3a+14 < a^2+2a+7$
 $a^2 - a - 7 > 0$
 $a \in \left(-\infty, \frac{1-\sqrt{29}}{2}\right) \cup \left(\frac{1+\sqrt{29}}{2}, \infty\right)$
 $a \in R - \left[\frac{1-\sqrt{29}}{2}, \frac{1+\sqrt{29}}{2}\right]$
 $\alpha + \beta = \frac{1-\sqrt{29}}{2} + \frac{1+\sqrt{29}}{2} = 1$

6. The value of $\int_0^2 \frac{\sqrt{x(x^2+x+1)}}{\sqrt{x+1}\sqrt{x^4+x^2+1}} dx$ is

- (1) $\frac{1}{3} \ln(2^{3/2}+3)$ (2) $\ln(2^{3/2}+3)$
 (3) $\ln(3^{3/2}+1)$ (4) $\frac{2}{3} \ln(2^{3/2}+3)$

Answer (4)

Sol. $\int_0^2 \frac{\sqrt{x(x^2+x+1)}}{\sqrt{x+1}\sqrt{x^4+x^2+1}} dx = \int_0^2 \frac{\sqrt{x}\sqrt{(x^2+x+1)}}{\sqrt{x+1}\sqrt{x^2+x^2+1}} dx$
 $\int_0^2 \frac{\sqrt{x}}{\sqrt{x^3+1}} dx$
 Let $x^{3/2} = \mu$
 $\frac{3}{2} x^{1/2} dx = d\mu$

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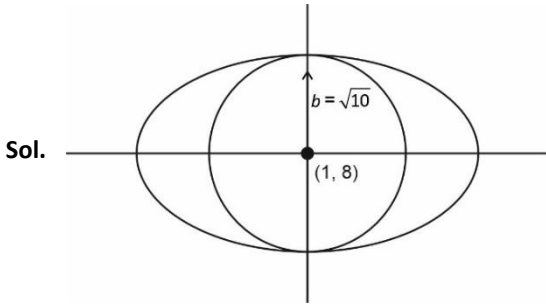
$$= \frac{2}{3} \int_0^{(2)^{3/2}} \frac{du}{\sqrt{u^2+1}} = \frac{2}{3} \ln \left[u + \sqrt{u^2+1} \right]_0^{3^2}$$

$$\frac{2}{3} \ln(2^{3/2} + 3)$$

7. The number of values of $Z \in \mathbb{C}$ satisfying the equations $|Z - (4 + 8i)| = \sqrt{10}$ and $|Z - (3 + 5i)| + |Z - (5 + 11i)| = 4\sqrt{5}$ is

- (1) 0 (2) 1
(3) 2 (4) 4

Answer (3)



$$2ae = \sqrt{4+36} = \sqrt{40}$$

$$2a = 4\sqrt{5} \Rightarrow a = 2\sqrt{5}$$

$$e = \frac{\sqrt{40}}{\sqrt{80}} = \frac{1}{\sqrt{2}}$$

$$\frac{1}{2} = 1 - \frac{b^2}{20} \Rightarrow 10 = 20 - b^2 \Rightarrow b^2 = \sqrt{10}$$

\Rightarrow Circle touches ellipse at 2 points at minor axis

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

$$\vec{b} = 10\hat{i} + 2\hat{j} - \hat{k}$$

and a vector \vec{c} be such that $2(\vec{a} \times \vec{b}) + 3(\vec{b} \times \vec{c}) = \vec{0}$. If

$\vec{a} \cdot \vec{c} = 15$, then the value of $\vec{c} \cdot (\hat{i} + \hat{j} - 3\hat{k})$ is

- (1) 5 (2) -5
(3) -3 (4) 3

Answer (2)

Sol. $2(\vec{a} \times \vec{b}) + 3(\vec{b} \times \vec{c}) = \vec{0}$

$$3(\vec{b} \times \vec{c}) = -2(\vec{a} \times \vec{b})$$

$$3(\vec{b} \times \vec{c}) = 2(\vec{b} \times \vec{a})$$

$$\vec{b} \times (3\vec{c} - 2\vec{a}) = \vec{0}$$

$\therefore \vec{b}$ & $3\vec{c} - 2\vec{a}$ are collinear

$$3\vec{c} - 2\vec{a} = \lambda \vec{b}$$

$$\vec{c} = \frac{2\vec{a} + \lambda \vec{b}}{3}$$

$$\vec{a} \cdot \vec{c} = 15$$

$$\vec{a} \cdot \left(\frac{2\vec{a} + \lambda \vec{b}}{3} \right) = 15$$

$$2|\vec{a}|^2 + \lambda(\vec{a} \cdot \vec{b}) = 45$$

$$2(26) + \lambda(35) = 45$$

$$\lambda = -\frac{1}{5}$$

$$\therefore \vec{c} = \frac{2\vec{a} - \frac{1}{5}\vec{b}}{3} = \frac{10\vec{a} - \vec{b}}{15}$$

$$\vec{c} = \frac{30\hat{i} - 12\hat{j} + 31\hat{k}}{15}$$

Let $\vec{d} = \hat{i} + \hat{j} - 3\hat{k}$

$$\vec{c} \cdot \vec{d} = \frac{1}{15}(30 - 12 - 93)$$

$$= -5$$

9. The mean and variance of x_1, x_2, x_3, x_4 be 1 and 13 respectively and the mean and variance of $y_1, y_2, y_3, \dots, y_5, y_6$ be 2 and 1 respectively, then the variance of $x_1, x_2, x_3, x_4, y_1, y_2, \dots, y_6$ will be

- (1) 6.04 (2) 6.58
(3) 5.96 (4) 6.25

Answer (1)

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Sol. $\frac{\sum_{i=1}^4 x_i}{4} = 1 \Rightarrow \sum_{i=1}^4 x_i = 4 \quad \dots(1)$

$$\frac{\sum_{i=1}^4 x_i^2}{4} - 1 = 13$$

$$\sum_{i=1}^4 x_i^2 = 56 \quad \dots(2)$$

$$\sum_{i=1}^6 \frac{y_i}{6} = 2 \Rightarrow \sum_{i=1}^6 y_i = 12 \quad \dots(3)$$

$$\frac{\sum_{i=1}^6 \frac{y_i^2}{6}}{6} - 4 = 1$$

$$\sum_{i=1}^6 y_i^2 = 30 \quad \dots(4)$$

Combine mean = $\frac{\sum_{i=1}^4 x_i^2 + \sum_{i=1}^6 y_i}{10} = \frac{4 + 12}{10} = 1.6$

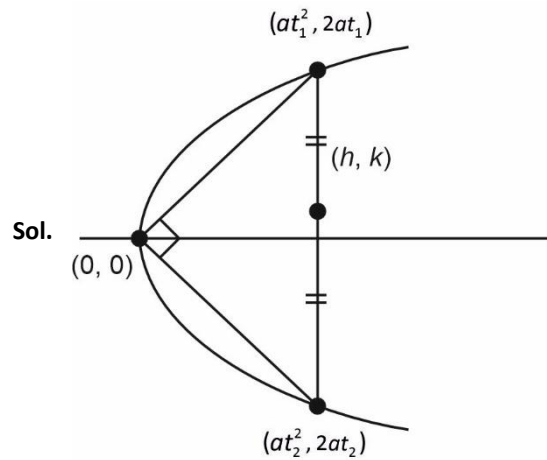
Combined variance = $\frac{\sum_{i=1}^4 x_i^2 + \sum_{i=1}^6 y_i^2}{10} - (1.6)^2$

$$= 8.6 - 2.56 = 6.04$$

10. Let O be the vertex of the parabola $y^2 = 4ax$, ($a > 0$). Let P and Q be two variable points on the parabola such that chords OP and OQ are perpendicular to each other. If the locus of mid point of segment PQ is a conic C then length of latus rectum of C is

- (1) a
- (2) $2a$
- (3) $3a$
- (4) $4a$

Answer (2)



Sol.

$$\left(\frac{2at_1}{at_1^2}\right) \times \frac{2at_2}{at_2^2} = -1 \Rightarrow \boxed{t_1 t_2 = -4}$$

$$\Rightarrow 2h = a(t_1^2 + t_2^2)$$

$$2k = 2a(t_1 + t_2)$$

$$\Rightarrow t_1 t_2 = \frac{(t_1 + t_2)^2 - (t_1^2 + t_2^2)}{2}$$

$$= \frac{\left(\frac{k}{a}\right)^2 - \frac{2h}{a}}{2} = \frac{k^2}{a^2} - \frac{\left(\frac{2h}{a}\right)(a)}{2}$$

$$\Rightarrow -4 = \frac{y^2 - 2ax}{2a^2}$$

$$\Rightarrow y^2 = 2ax - 8a^2$$

$$y^2 = 2a(x - 4a)$$

$$\Rightarrow \text{Latus rectum} = 2a$$

11. A student goes to examination center by bus, scooter or car probability of which being equally likely. Probability that he reaches late, if he takes bus, scooter or car is $\frac{1}{5}$, $\frac{1}{3}$ and $\frac{1}{4}$ respectively. Given that he reaches late, the probability he travelled by a bus is

- (1) $\frac{12}{47}$
- (2) $\frac{1}{2}$
- (3) $\frac{26}{7}$
- (4) $\frac{11}{6}$

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Answer (1)

Sol. B: Event that he goes to exam by bus

S: Event that he goes to exam by scooter

C: Event that he goes to exam by car

L: Event that he is late

$$P(B) = P(S) = P(C) = \frac{1}{3}$$

$$P\left(\frac{L}{B}\right) = \frac{1}{5}, P\left(\frac{L}{S}\right) = \frac{1}{3}, P\left(\frac{L}{C}\right) = \frac{1}{4}$$

$$P\left(\frac{B}{L}\right) = \frac{P(B \cap L)}{P(L)}$$

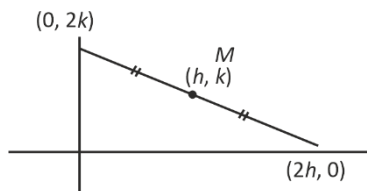
$$\begin{aligned} &= \frac{P(B)P\left(\frac{L}{B}\right)}{P(B)P\left(\frac{L}{B}\right) + P(S)P\left(\frac{L}{S}\right) + P(C)P\left(\frac{L}{C}\right)} \\ &= \frac{\frac{1}{3} \times \frac{1}{5}}{\frac{1}{3} \times \frac{1}{5} + \frac{1}{3} \times \frac{1}{3} + \frac{1}{3} \times \frac{1}{4}} = \frac{\frac{1}{15}}{\frac{47}{60}} = \frac{12}{47} \end{aligned}$$

12. The line passing through points of intersection of $3x + 4y = 1$ and $4x + 3y = 1$ intersects axes at P and Q . Then the locus of mid point of PQ is

- (1) $\frac{1}{x} + \frac{1}{y} = 14$
- (2) $\frac{3}{x} + \frac{4}{y} = 14$
- (3) $\frac{4}{x} + \frac{3}{y} = 14$
- (4) $x + y = 14$

Answer (1)

Sol.



$$\text{Locus of } M \equiv \frac{x}{2h} + \frac{y}{2k} = 1$$

The locus passes through point of intersection of lines

$$3x + 4y = 1$$

$$4x + 3y = 1$$

$$\Rightarrow x = \frac{1}{7}, y = \frac{1}{7}$$

$$\Rightarrow \frac{1}{7} \times \frac{1}{24} + \frac{1}{7} \times \frac{1}{24} = 1$$

$$\Rightarrow \boxed{\frac{1}{x} + \frac{1}{y} = 14}$$

13. Consider the relation R defined on the set $A = \{-2, -1, 0, 1, 2\}$ defined by $(a, b) \in R$ if and only if $1 + ab > 0$. Given below are two statements:

Statement I: The number of elements in R is 17.

Statement II: R is an equivalence relation in light of the above statements, choose the correct answer.

- (1) Both statement I and statement II are correct
- (2) Both statement I and statement II are incorrect
- (3) Statement I is correct but statement II is incorrect
- (4) Statement I is incorrect but statement II is correct

Answer (3)

Sol. $A = \{-2, -1, 0, 1, 2\}$

Reflexivity $(a, a) \in R$

$$\text{as } 1 + a^2 > 0$$

Symmetricity $(a, b) \in R$

$$\Rightarrow 1 + ab > 0$$

$$\Rightarrow (b, a) \in R$$

Transitive: $(-2, 0), (0, 2) \in R$

but $(-2, 2) \notin R$

$$\text{as } 1 + (-2)(2) = -3 < 0$$

$\Rightarrow R$ is not an equivalence relation

For No. of elements in R

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For $a = -2 : (-2, -2), (-2, -1), (-2, 0) \Rightarrow 3$ elements

for $a = -1 : (-1, -2), (-1, -1), (-1, 0) \Rightarrow 3$ elements

for $a = 0 : (0, -2), (0, -1), (0, 0), (0, 1), (0, 2) \Rightarrow 5$ elements

for $a = 1 : (1, 0), (1, 1), (1, 2) \Rightarrow 3$ elements

For $a = 2 : (2, 0), (2, 1), (2, 2) \Rightarrow 3$ elements

Total in R elements = 17

- 14.
- 15.
- 16.
- 17.
- 18.
- 19.
- 20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If the system of equation

$$x + y + z = 6$$

$$x + 2y + 5z = 10$$

$$2x + 3y + \lambda z = \mu$$

has infinitely many solution then $\lambda + \mu$ is equal to

Answer (22.00)

Sol. $\Delta = \begin{vmatrix} 1 & 1 & 1 \\ 1 & 2 & 5 \\ 2 & 3 & \lambda \end{vmatrix}$

for infinite solution,

$$\Delta = 0 \Rightarrow \lambda - 6 = 0 \Rightarrow \lambda = 6$$

also,

$$\Delta_2 = \begin{vmatrix} 1 & 1 & 6 \\ 1 & 2 & 10 \\ 2 & 3 & \mu \end{vmatrix}$$

$$\Delta_2 = 0 \Rightarrow \mu - 16 = 0 \Rightarrow \mu = 16$$

$$\Rightarrow \mu + \lambda = 16 + 6 = 22$$

22. Let $f(x) = \begin{cases} \frac{1}{3} & , x < \frac{\pi}{2} \\ \frac{b(1-\sin x)}{(\pi-2x)^2} & , x > \frac{\pi}{2} \end{cases}$. If f is a continuous

function at $x = \frac{\pi}{2}$, then the value of

$$\int_0^{3b-6} |x^2 + 2x - 3| dx$$
 is

Answer (4)

Sol. $\lim_{x \rightarrow \frac{\pi}{2}^-} f(x) = \lim_{x \rightarrow \frac{\pi}{2}^+} f(x)$

$$\text{LHL} = \frac{1}{3}$$

$$\text{RHL} = \lim_{x \rightarrow \frac{\pi}{2}^+} \frac{b(1-\sin x)}{(\pi-2x)^2}$$

$$= \lim_{h \rightarrow 0} \frac{b \left(1 - \sin \left(\frac{\pi}{2} + h \right) \right)}{\left(\pi - 2 \left(\frac{\pi}{2} + h \right) \right)^2}$$

$$= \lim_{h \rightarrow 0} \frac{b(1 - \cos h)}{4h^2}$$

$$= \lim_{h \rightarrow 0} \frac{b \cdot 2 \cdot \sin^2 \frac{h}{2}}{4h^2} = \frac{2b}{16} = \frac{b}{8}$$

$$\therefore \frac{1}{3} = \frac{b}{8} \Rightarrow b = \frac{8}{3}$$

$$I = \int_0^2 |x^2 + 2x - 3| dx$$

$$= \int_0^1 -(x^2 + 2x - 3) dx + \int_1^2 (x^2 + 2x - 3) dx$$

$$= \left[-\frac{x^3}{3} - \frac{2x^2}{2} + 3x \right]_0^1 + \left[\frac{x^3}{3} + \frac{2x^2}{2} - 3x \right]_1^2$$

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$$= \left(-\frac{1}{3} - 1 + 3 \right) + \left(\frac{8}{3} + 4 - 6 - \frac{1}{3} - 1 + 3 \right)$$

$$= \frac{5}{3} + \frac{7}{3} = 4$$

23. If $\int_{\frac{\pi}{6}}^{\frac{\pi}{4}} \left(\cot\left(\pi - \frac{\pi}{3}\right) \cot\left(\pi + \frac{\pi}{3}\right) + 1 \right) dx =$

$$= -\alpha \left(\ln\left(\frac{\sqrt{3}-1}{\sqrt{3}+1}\right) - \ln\left(\frac{1}{2}\right) \right)$$
 then the value of $9\alpha^2$ is

Answer (3)

Sol. $\int_{\pi/6}^{\pi/4} \left(\cot\left(x - \frac{\pi}{3}\right) \cot\left(x + \frac{\pi}{3}\right) + 1 \right) dx$

$$\because \cot(A-B) = \frac{\cot A \cot B + 1}{\cot B - \cot A}$$

$$\Rightarrow \int_{\pi/6}^{\pi/4} \cot\left(x + \frac{\pi}{3} - x + \frac{\pi}{3}\right) \left[\cot\left(x - \frac{\pi}{3}\right) - \cot\left(x + \frac{\pi}{3}\right) \right] dx$$

$$\Rightarrow \cot \frac{2\pi}{3} \int_{\pi/6}^{\pi/4} \cot\left(x - \frac{\pi}{3}\right) - \cot\left(x + \frac{\pi}{3}\right) dx$$

$$\Rightarrow -\frac{1}{\sqrt{3}} \left[\ln\left|\sin\left(x - \frac{\pi}{3}\right)\right| - \ln\left|\sin\left(x + \frac{\pi}{3}\right)\right| \right]_{\pi/6}^{\pi/4}$$

$$\Rightarrow -\frac{1}{\sqrt{3}} \left[\ln\left(\frac{\sin\left(x - \frac{\pi}{3}\right)}{\sin\left(x + \frac{\pi}{3}\right)}\right) \right]_{\pi/6}^{\pi/4}$$

$$= -\frac{1}{\sqrt{3}} \left[\ln\left(\frac{\sin\left(\frac{\pi}{12}\right)}{\sin\left(\frac{7\pi}{12}\right)}\right) - \ln\left(\frac{\sin\left(\frac{\pi}{6}\right)}{\sin\left(\frac{\pi}{2}\right)}\right) \right]$$

$$= -\frac{1}{\sqrt{3}} \left(\ln\left|\frac{\sqrt{3}-1}{\sqrt{3}+1}\right| - \ln\left(\frac{1}{2}\right) \right)$$

24. If the sum

$$26 \left(\frac{2^3}{3} \cdot {}^{12}C_2 + \frac{2^5}{5} \cdot {}^{12}C_4 + \frac{2^7}{7} \cdot {}^{12}C_6 + \dots + \frac{2^{13}}{13} \cdot {}^{12}C_{12} \right)$$

$$= 3^{13} - \alpha$$
 then α is equal to

Answer (51.00)

Sol. Notice that

$$T_r = \frac{2^{2r+1} \cdot {}^{12}C_{2r}}{(2r+1)}$$

Notice that

$${}^{12}C_0 x^0 + {}^{12}C_2 x^2 + \dots + {}^{12}C_{12} x^{12}$$

$$= \left(\frac{1}{2} \left[(1+x)^{12} + (1-x)^{12} \right] \right)$$

Integrating both sides

$$\int_0^2 \sum_{r=0}^6 ({}^{12}C_{2r} x^{2r}) = \int_0^2 \frac{1}{2} (1+x)^{12} + (1-x)^{12} dx$$

$$\sum_{r=0}^6 \int_0^2 \frac{{}^{12}C_{2r} \cdot x^{2r+1}}{2r+1} = \frac{1}{2} \left(\frac{(1+x)^{13}}{13} \right)_0^2$$

$$\sum_{r=0}^6 \frac{2^{2r+1} \cdot {}^{12}C_{2r}}{2r+1} = \frac{1}{26} [3^{13} - (-1)^{13} - (1-1)]$$

$$\frac{2 \cdot {}^{12}C_0}{1} + \sum_{r=1}^6 \frac{2^{2r+1} \cdot {}^{12}C_{2r}}{2r+1} = \frac{1}{26} (3^{13} + 1)$$

$$\Rightarrow S = \frac{1}{26} (3^{13} + 1) - 2$$

$$= \frac{3^{13} - 51}{26}$$

$$\Rightarrow 26S = 3^{13} - 51 \Rightarrow \alpha = 51$$

25. Consider a circle C defined by the equation:

$$x^2 + y^2 - 6x - 8y - 140 = 0$$

Let AB be a variable chord of this circle such that it subtends a right angle (90°) at the origin (0, 0). If the

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locus of the foot of the perpendicular drawn from the origin to the chord AB is a circle given by the equation:

$$x^2 + y^2 - \alpha x + \beta y - \gamma = 0$$

Find the value of the expression:

$$\alpha + \beta + 2\gamma$$

Answer (139)

Sol. The equation of the chord AB passing through (h, k) is:

$$y - k = -\frac{h}{k}(x - h)$$

$$hx + ky = h^2 + k^2$$

$$\frac{hx + ky}{h^2 + k^2} = 1$$

The chord AB subtends a right angle at the origin (0,0). We homogenize the circle equation

$$x^2 + y^2 - 6x - 8y - 140 = 0$$

using the line equation:

$$x^2 + y^2 - (6x + 8y)\left(\frac{hx + ky}{h^2 + k^2}\right) - 140\left(\frac{hx + ky}{h^2 + k^2}\right)^2 = 0$$

Let $S = h^2 + k^2$. The coefficient of x^2 is:

$$1 - \frac{6h}{S} - \frac{140h^2}{S^2}$$

The coefficient of y^2 is:

$$1 - \frac{8k}{S} - \frac{140k^2}{S^2}$$

Setting their sum to zero:

$$\left(1 - \frac{6h}{S} - \frac{140h^2}{S^2}\right) + \left(1 - \frac{8k}{S} - \frac{140k^2}{S^2}\right) = 0$$

$$2 - \frac{6h + 8k}{S} - \frac{140(h^2 + k^2)}{S^2} = 0$$

Since $S = h^2 + k^2$, the third term simplifies to

$$\frac{140S}{S^2} = \frac{140}{S}$$

Multiply the entire equation by S :

$$2S - (6h + 8k) - 140 = 0$$

$$2(h^2 + k^2) - 6h - 8k - 140 = 0$$

$$h^2 + k^2 - 3h - 4k - 70 = 0$$

Replacing (h, k) with (x, y), the locus is:

$$x^2 + y^2 - 3x - 4y - 70 = 0$$

$$\Rightarrow \alpha + \beta + 2\gamma = 139$$



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