28/01/2026
Morning

Aakash
Medical | IIT-JEE | Foundations

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Memory Based
Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2026 (Online) Phase-1

(Physics, Chemistry and Mathematics)

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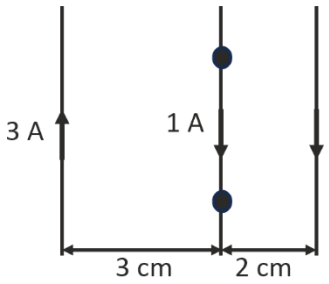
PHYSICS

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. There are three long parallel wires in a plane as shown. Find force on 15 cm of length of middle wire.



(1) 5 μN

(2) 7 μN

(3) 6 μN

(4) 1 μN

Answer (3)

Sol. $B = B_1 + B_2 = \frac{\mu_0(3)}{2(3\times10^{-2})\pi} + \frac{\mu_0(2)}{2(2\times10^{-2})\pi} = \frac{\mu_0\times10^2}{\pi}$

$F = 15\times10^{-2}\times1\times10^{-7}\times10^2\times2 = 6\times10^{-6}$

2. Equation of an EMW in a medium is given by $E = 2\sin(2\times10^{15}t - 10^7 x)$. Find refractive index of the medium.

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

(2) 2

(3) $\frac{5}{3}$

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

Answer (1)

Sol. $v = \frac{2\times10^{15}}{10^7} = 2\times10^8$

$\mu = \frac{c}{v} = 1.5$

3. For a circular coil of radius R, magnetic field at center is B_0 = 16 μT. What will be the magnetic field on axis at a distance $x = \sqrt{3}R$ from center

(1) $\frac{1}{4}$ μT (2) $\frac{1}{2}$ μT

(3) 4 μT (4) 2 μT

Answer (4)

Sol. $B_{(x)} = \frac{\mu_0}{4\pi}\cdot\frac{I\,2\pi R^2}{(x^2+R^2)^{3/2}}$

$\Rightarrow \left(B_{(x)}\right) = \frac{\mu_0}{2}\frac{IR^2}{8R^3} = \frac{\mu_0 I}{16R}$

Given $B_0 = \frac{\mu_0 I}{2R} = 16$ μT

So $B = \frac{1}{8}\cdot 16\ \mu T = 2\ \mu T$

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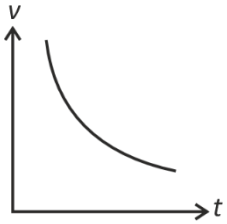
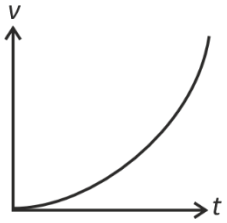
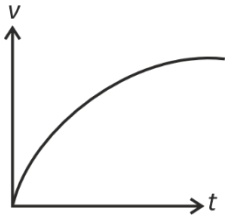
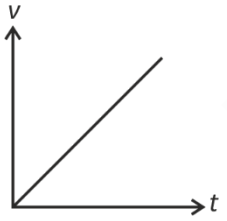
4. An object is being dropped from height h above the ground. Apart from force of gravity additional drag force, $F = -kv$ acts on the object. Find the grph of v v/s t.

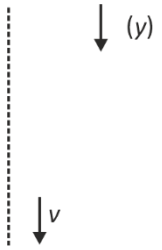
(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. 

$$m\frac{dv}{dt} = (mg - kv)$$

$$\Rightarrow \frac{dv}{dt} = \left(g - \frac{kv}{m}\right)$$

$$\int_0^v \frac{d_v}{g - \frac{kv}{m}} = \int_0^t dt$$

$$\Rightarrow -\frac{m}{k}\ln\left(g - \frac{kv}{m}\right)\Big|_0^v = t\Big|_0^t$$

$$\Rightarrow \ln\left(\frac{g - \frac{kv}{m}}{g}\right) = -\frac{tk}{m}$$

$$\Rightarrow \left(g - \frac{kv}{m}\right) = ge^{-\frac{kt}{m}}$$

$$\Rightarrow g\left(1 - e^{-\frac{kt}{m}}\right) = \frac{kv}{m}$$

$$\Rightarrow v = \frac{mg}{k}\left(1 - e^{-\frac{kt}{m}}\right)$$

5. Electric current in a circuit is given by $i = i_0\left(\frac{t}{T}\right)$. Find rms current for the period $t = 0$ to $t = T$.

(1) $\frac{i_0}{\sqrt{5}}$ (2) $\frac{i_0}{\sqrt{2}}$

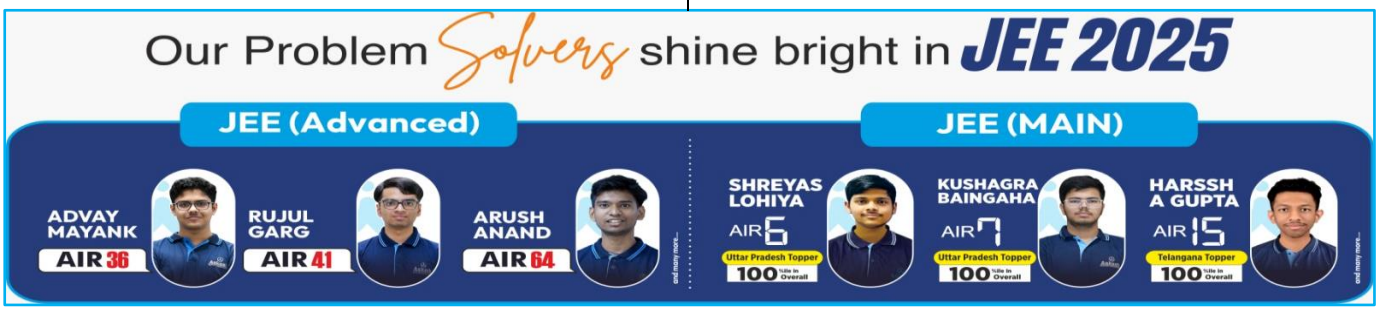
(3) $\frac{i_0}{2}$ (4) $\frac{i_0}{\sqrt{3}}$

Answer (4)

Sol. $$I_{rms}^2 = \frac{\int_0^T \frac{I_0^2 t^2}{T^2} dt}{T}$$

$$= \frac{i_0^2 \cdot \frac{T}{3}}{T} = \frac{i_0^2}{3}$$

$$I_{rms} = \frac{i_0}{\sqrt{3}}$$



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6. Position of a particle is given by $x = A\sin(\omega t)$ potential energy is minimum at $t = \frac{T}{2\beta}$ where T is time period. Find maximum value of β.

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

(3) $\frac{1}{3}$ (4) $\frac{1}{6}$

Answer (2)

Sol. At $t = \frac{T}{2}, T, \frac{3T}{2}, 2T, \ldots$

Potential energy is minimum.

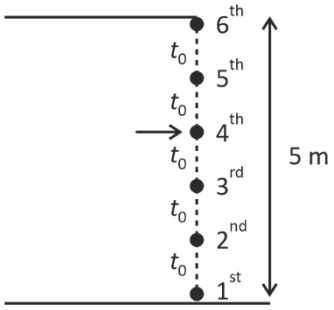
7. A tap is at a height of 5 m from ground. Water drops are falling from it at regular interval. When 1st drop hits the ground 6th droplet is just about to fall. Find the height of 4th droplet from ground when 1st droplet hits the ground.

(1) 4.2 m (2) 3.2 m

(3) 4 m (4) 3 m

Answer (1)

Sol.



$\Rightarrow \frac{1}{2}g(25t_0^2) = 5$

$\Rightarrow gt_0^2 = \frac{2}{5}$

Also $t_1 = 5\,t_0$

$S_4 = \frac{1}{2} \times g \cdot 4\,t_0^2 = 2gt_0^2$

$S_4 = 2 \times \frac{2}{5} = \frac{4}{5}$ m

So, $S_1 - S_4 = 5 - \frac{4}{5} = \frac{21}{5} = 4.2$ m

8. If 10 kg of ice at –10°C is mixed with 100 kg of with at 25°C, then resultant temperature in equilibrium for mixture shall be

$\left(S_i = \frac{1}{2}\text{ cal/gm} - °\text{C}, S_w = 1\text{ cal/gm} - °\text{C}, Lf = 80\text{ cal/gm}\right)$

(1) 0°C (2) 15°C

(3) 12.5° (4) 5°C

Answer (2)

Sol. 10 × 10 × 500 + 10 × 80 × 1000

= 10 kg of water of 0°

10^4 {5 + 80} = 85 × 10^4 cal

100 × 1000 × 1 × 25 = 25 × 10^5 cal

Heat budget

Reserved heat = 25 × 10^5 –85 × 10^4

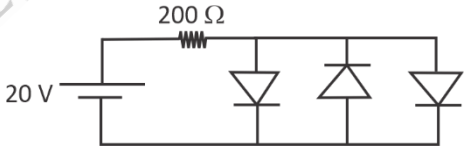
= 10^4(250 – 85)

= 165 × 10^4 Cal

Mass 110 kg of water at 0°C.

$\Delta T = \frac{165 \times 10^4}{110 \times 10^3} = \frac{165\,\phi}{11\,\phi} = 15°$

9. The threshold voltage for the diodes is 0.7 volt. Then current through diodes (from left to right) in given circuit is



(1) Zero, Zero, Zero

(2) 32.23 mA, 32.23 mA, 32.23 mA

(3) 48.25 mA, zero, 48.25 mA

(4) 50 mA, Zero, 50 mA

Answer (3)

Sol. $i = \frac{20 - 0.7}{200} = \frac{19.3}{200} = 96.5$ mA

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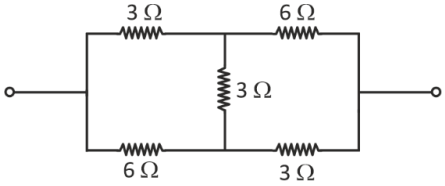
10. Find equivalent resistance of the given circuit.

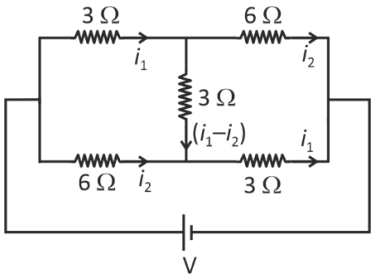


(1) 6.4 Ω (2) 4.2 Ω

(3) 7 Ω (4) 5 Ω

Answer (2)

Sol.



$-3i_1-3(i_1-i_2)+6i_2=0 \quad \ldots(1)$

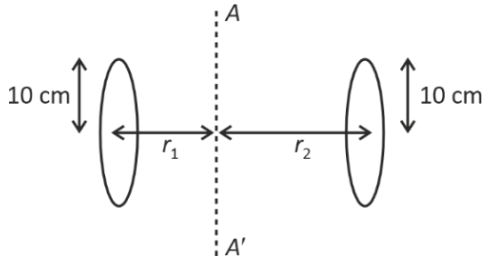
$-3i_1-6i_2+V=0$

$i_1=\frac{V}{7} \quad i_2=\frac{2V}{21}$

$I=i_1+i_2=\frac{5V}{21}$

$R_{eq}=\frac{V}{I}=\frac{21}{5}=4.2\,\Omega$

11. For the given situation shown in figure two disks each of mass m = 600 grams are rotating about a fixed axis AA'. Radius of each disk is r_0 = 10 cm and they are at distance r_1 = 10 cm and r_2 = 20 cm from the axis AA'. Torque acting about the axis is 45 × 10^5 dyne-cm. Find angular acceleration in rad/sec^2.



(1) $\frac{170}{11}$ rad/sec^2 (2) $\frac{140}{9}$ rad/sec^2

(3) $\frac{150}{11}$ rad/sec^2 (4) $\frac{160}{9}$ rad/sec^2

Answer (3)

Sol. $I=\frac{mr_0^2}{4}+mr_2^2+\frac{mr_0^2}{4}+mr_1^2$

$I=\frac{mr_0^2}{2}+m\left(r_1^2+r_2^2\right)$

$I=m\left[\frac{1}{2\times100}+\frac{1}{100}+\frac{4}{100}\right]=\frac{6}{10}\left[\frac{11}{2}\right]\times\frac{1}{100}$

Also $\tau = 45 \times 10^5$ dyne-cm = 45×10^{-2} N.m

So, $\propto=\frac{45\times100\times2\times10}{100\times6\times11}=\frac{150}{11}$ rad/s^2

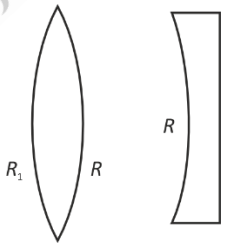
12. A bi-convex lens of refractive index 1.5 and planoconcave lens of refractive index 1.7 have same power. If 2nd radius of curvature of convex lens is equal to radius of curvature of planoconcave less. Find ratio of 1st radius of curvature to 2nd radius of curvature of bi-convex lens.

(1) $\frac{3}{2}$ (2) $\frac{5}{2}$

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

Answer (2)

Sol.



$(1.5-1)\left(\frac{1}{R_1}+\frac{1}{R}\right)=\left|(1.7-1)\left(-\frac{1}{R}-\frac{1}{\infty}\right)\right|$

$\frac{1}{2R_1}+\frac{1}{2R}=\frac{7}{10R}$

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$$\frac{1}{2R_1}=\frac{2}{10R}$$

$$\frac{R_1}{R}=\frac{5}{2}$$

13. Find the ratio of de-Broglie wavelength associated with deuteron with kinetic energy of K and α-particle with kinetic energy of $2K$.

(1) 2 : 1 (2) $2\sqrt{2}:1$

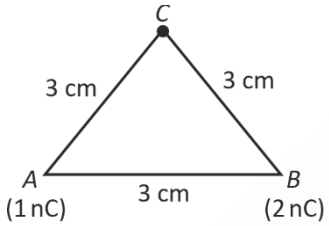
(3) $1:\sqrt{2}$ (4) $\sqrt{2}:1$

Answer (1)

Sol. $\lambda\propto\frac{1}{P}\propto\frac{1}{\sqrt{mK}}$

$$\frac{\lambda_1}{\lambda_2}=\frac{\sqrt{4\times2K}}{\sqrt{2\times K}}=2$$

14. Find the work done by external agent in moving a 3nC charge from a large separation to point C.



(1) 8.1 μJ (2) 12 μJ

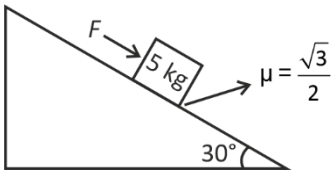
(3) 2.7 μJ (4) 9 μJ

Answer (3)

Sol. $w=\frac{9\times10^9\times1\times10^{-9}\times3\times10^{-9}}{3\times10^{-2}}+\frac{9\times10^9\times2\times10^{-9}\times3\times10^{-9}}{3\times10^{-2}}$

$w = 27\times10^{-7}$ J = 2.7 μJ

15. A block of mass 5 kg is placed on wedge of inclination 30°. Find force applied to move the block downwards with constant speed.



(1) $(\sqrt{3}-1)\frac{25}{2}$ (2) 12.5 N

(3) Zero (4) 25 N

Answer (2)

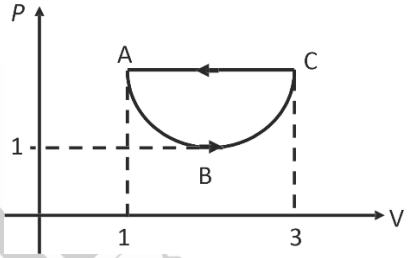
Sol. $F = \mu mg\cos30° - mg\sin30°$

$$=\frac{\sqrt{3}}{2}mg\cdot\frac{\sqrt{3}}{2}-\frac{mg}{2}$$

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

F = 12.5 N

16. Process ABC represents a parabolic section given by $(v-2)^2 = 4(P-1)$ in given cyclic process then work done by gas in process is

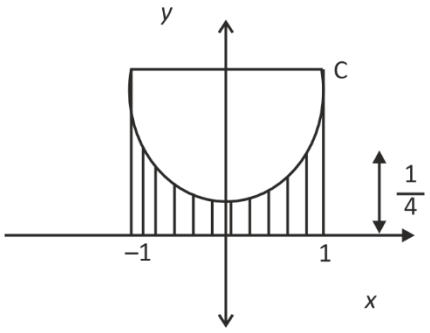


(1) $-\frac{1}{3}$ units (2) $-\frac{1}{6}$ units

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

Answer (1)

Sol. $x^2 = 4y$



Area = $2\int_0^1\frac{x^2}{4}dx = 2\times\frac{1}{12}\times1=\frac{1}{6}$

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Required area = rectangle = Shaded area

$= \frac{1}{4} \times 2 - \frac{1}{6}$

$= \frac{1}{3}$ J

17. **Statement-I:** When a planar wavefront passes through a prism then its wavefront doesn't change, but when planar wavefront passes through a smaller slit wavefront becomes cylindrical.

Statement-II: If distance between slits is decreased and screen distance is increased then fringe width increases.

(1) S-I & S-II are both correct

(2) S-I & S-II are both incorrect

(3) S-I is correct & S-II is incorrect

(4) S-I is incorrect & S-II is correct

Answer (1)

Sol. $\beta = \frac{\lambda D}{d}$

18. In a vernier callipers when nothing is placed between the jaws zero of vernier scale is ahead of zero of main scale and 4^{th} division of vernier scale consider with one of the main scale. Now when a thin cylindrical wire is kept in the gaps then main scale reading is 15 and 5^{th} vernier division matches with one of the main scale marking. Find the diameter of wire.

(Main scale marking = 1 mm & LC = 0.1 mm)

(1) 15.9 mm (2) 14.9 mm

(3) 15.8 mm (4) 15.1 mm

Answer (4)

Sol. Zero error = (+0.4 mm)

Reading = (15 + 0.5) mm

So diameter = 15 + 0.5 – 0.4 = 15.1 mm

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. Two identical cells with same emf Σ and internal resistance *r* respectively are given. When cells are connected in series and when they are in parallel in both cases they drive equal current '*I*' in external resistance of 6 Ω. Find the value of internal resistance *r*.

Answer (6)

Sol. $\frac{2\Sigma}{6+2r} = i$

And $\frac{\Sigma}{\frac{r}{2}+6} = i$

So, $6 + 2r = r + 12 \Rightarrow r = 6\ \Omega$

22. In a potentiometer, when a battery is connected with ext. resistance $R_1 = 4\ \Omega$, the balancing length is found to be 120 cm. Now when R_1 is removed and another ext. resistance $R_2 = 12\ \Omega$ is connected then the balancing length is found to be 180 cm. Find internal resistance (in Ω) of the battery.

Answer (4)

Sol. $\left(\frac{V_0}{l_0}\right) \times 120 = \left(\frac{E}{r+4}\right) 4 \quad \ldots(1)$

And $\frac{V_0}{l_0} \times 180 = \left(\frac{E}{r+12}\right) 12 \quad \ldots(2)$

So, $\frac{12}{18} = \frac{4(r+12)}{(r+4)\times 12} \Rightarrow \frac{2}{3} = \frac{(r+12)}{(r+4)3}$

$\Rightarrow 2r + 8 = r + 12$

$\Rightarrow r = 4\ \Omega$

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. In Carius method of estimation of bromine, 1.53 g of an organic compound gave 1 g AgBr. The % of bromine in organic compound is, (Atomic mass of Ag, Br = 108, 80 u respectively)

(1) 35.23 (2) 43.53

(3) 27.81 (4) 22.71

Answer (3)

Sol. $$\% \text{ of Br} = \frac{\frac{1}{188}\times 80}{1.53}\times 100$$

= 27.81%

2. In period 4 of the periodic table which elements have the highest and lowest atomic radii respectively

(1) K and Br (2) Na and Cl

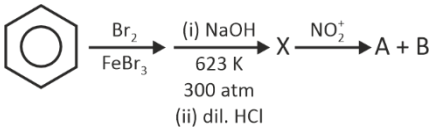
(3) K and Se (4) Rb and Br

Answer (1)

Sol. Atomic size generally decreases from left to right in the period.

(Not including noble gases)

3. Consider the following reaction sequence :



The organic product 'A' and 'B' can be separated by

(1) Steam distillation

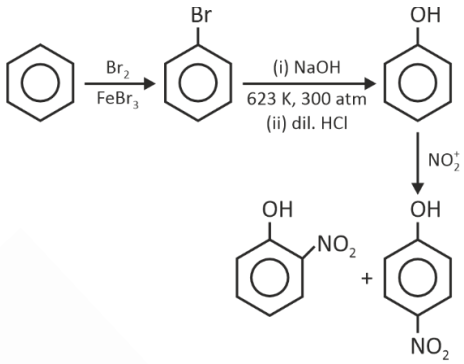
(2) Fractional distillation

(3) Distillation under reduced pressure

(4) Azeotropic distillation

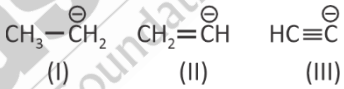
Answer (1)

Sol.



o-nitrophenol is steam volatile due to intramolecular hydrogen bonding.

4. Consider following ions



Stability of ions is in order

(1) III > II > I (2) II > III > I

(3) I > II > III (4) I > III > II

Answer (1)

Sol. More is electronegativity of carbon more is stability of carbanion.

5. For equivalence point X ml of 0.02 M HCl is treated with 5 mL of 0.02 M of a weak base. The pK_b of weak base is 5.69 and the pH of the resulting solution is Y at half of the equivalence point. The value of (x + y) is:

(1) 5 (2) 8.81

(3) 13.31 (4) 3.81

Answer (3)

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Sol. At equivalence point: 0.02 x = 0.02 × 5

x = 5 mL.

For basic buffer: (at half of equivalence point)

$$pOH = pK_b + \log\frac{[\text{Conj. acid}]}{[\text{Weak base}]}$$

so, 14 – y = 5.69 + log 1

y = 8.31

x + y = 5 + 8.31 = 13.31

6. For a first order reaction, X → Y + Z, time required for decomposition of $\frac{1}{8}$th and $\frac{1}{10}$th of its initial conc. is $t_{1/8}$ and $t_{1/10}$.

The value of $\left(\frac{t_{1/8}}{t_{1/10}}\right)\times 10 = ?$

Take : log8 = 0.90, log7 = 0.84, log9 = 0.95

(1) 9 (2) 10

(3) 12 (4) 8

Answer (3)

Sol. $t_{1/8} = \frac{2.303}{k}\log\frac{1}{1-\frac{1}{8}} = \frac{2.303}{k}\log\frac{8}{7}$

$$= \frac{2.303}{k}(0.06)$$

$$t_{1/10} = \frac{2.303}{k}\log\frac{1}{1-\frac{1}{10}} = \frac{2.303}{k}\log\frac{10}{9}$$

$$= \frac{2.303}{k}(0.05)$$

$$\frac{t_{1/8}}{t_{1/10}} = \frac{\left(\frac{2.303}{k}\right)(0.06)}{\left(\frac{2.303}{k}\right)(0.05)} = \frac{6}{5} = 1.2$$

7. Choose the correct statements in respect of hydrides of Group-15.

A. Reducing power increasing down the group.

B. Basic nature increases down the group.

C. Stability decreases down the group.

D. Boiling point decreases regularly down the group.

(1) A, B and C only (2) A, B and D only

(3) A and C only (4) B, C and D only

Answer (3)

Sol. A. Down the group bond energy decreases, so release of hydrogen becomes easier and reducing power increases.

B. Basic nature decreases down the group due to decrease of electron density on central atom.

C. Stability decreases down the group due to decrease of bond strength.

D.

Hydrides →	NH_3	PH_3	AsH_3	SbH_3	BiH_3
B.P. (K) →	238	185	210	254	290

Increasing from PH_3 to BiH_3.

8. Which is correct option.

(A) $[Ni(CN)_4]^{2-}$ is paramagnetic while $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ are diamagnetic.

(B) $[Ni(CN)_4[^{2-}$ and $[Ni(CO)_4]$ are diamagnetic while $[NiCl_4]^{2-}$ is paramagnetic.

(C) $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ are paramagnetic while $[Ni(CN)_4]^{2-}$ is diamagnetic.

(D) $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are paramagnetic while $[Ni(CO)_4]$ is diamagnetic.

(1) A (2) B

(3) C (4) D

Answer (2)

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Sol. $[Ni(CN)_4]^{2-}$

$\Rightarrow Ni^{2+} \Rightarrow 3d^8$

$\Rightarrow CN^-$ is SFL

$\Rightarrow dsp^2$ and diamagnetic (n = 0)

$[NiCl_4]^{2-}$

$\Rightarrow Ni^{2+} \Rightarrow Cl^-$ is WFL ($3d^8$)

$\Rightarrow sp^3$ hybridised and paramagnetic (n = 2)

$[Ni(CO)_4] \Rightarrow Ni \Rightarrow 3d^{10}$

$\Rightarrow sp^3$ hybridised

$\Rightarrow$ diamagnetic (n = 0)

9. The wave number of three spectral lines of H-atom are given. Identify the correct set of spectral lines belonging to Balmer series

(1) $\frac{5R}{36}, \frac{3R}{16}, \frac{21R}{100}$ (2) $\frac{3R}{4}, \frac{3R}{16}, \frac{7R}{144}$

(3) $\frac{7R}{144}, \frac{3R}{16}, \frac{16R}{255}$ (4) $\frac{5R}{36}, \frac{3R}{16}, \frac{21R}{24}$

Answer (1)

Sol. For 1st line $\bar{\nu} = R\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5R}{36}$

2nd line $\bar{\nu} = R\left(\frac{1}{4} - \frac{1}{16}\right) = \frac{3R}{16}$

3rd line $\bar{\nu} = R\left(\frac{1}{4} - \frac{1}{25}\right) = \frac{21R}{100}$

10. Given below are two statements

Statement I : Among XeF_4, BF_4^- and SF_4, the species having equal M-X bond lengths are XeF_4 and BF_4^-. (M = central atom).

Statement II : Among O_2^{2-}, O_2^-, F_2 and O_2^+, the highest bond order is for F_2 and O_2^{2-}

In the light of the above statements, choose the most appropriate option.

(1) Both statement-I and statement-II are correct

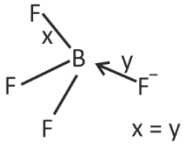
(2) Both statement-I and statement-II are incorrect

(3) Statement-I is correct but statement-II is incorrect

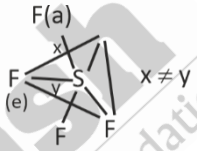
(4) Statement-I is incorrect but statement-II is correct.

Answer (3)

Sol.



(x, y are bond lengths)



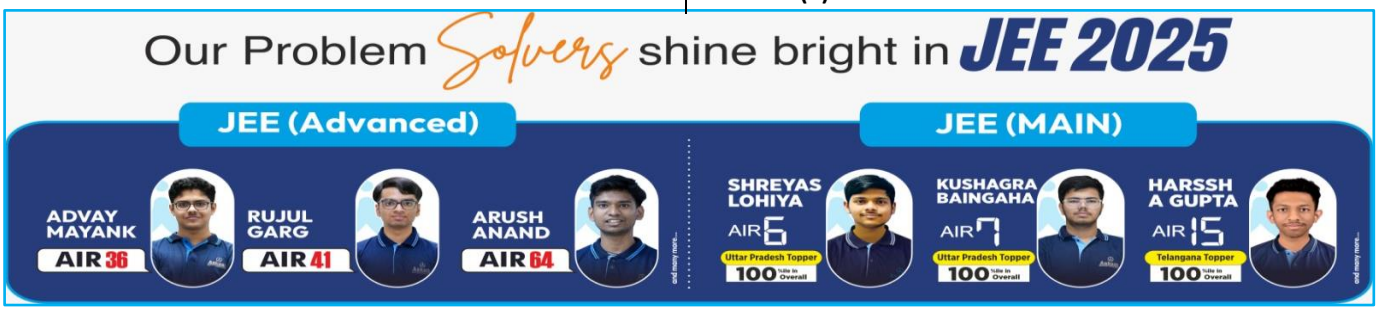
Species	B.O.
O_2	2.0.
O_2^-	1.5.
O_2^+	2.5.
O_2^{2-}	1.0
F_2	1.0

11. Among the following pairs, coloured ions are

(1) Ti^{3+} and V^{3+} (2) Ti^{3+} and Sc^{3+}

(3) Ti^{4+} and V^{3+} (4) V^{2+} and Sc^{3+}

Answer (1)



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Sol.

Ion	Number of unpaired electrons	Colour
Ti^{3+}	1	Purple
V^{3+}	2	Green
Sc^{3+}	0	Colourless
Ti^{4+}	0	
V^{2+}	3	Violet

12. At T(K), 2 moles of liquid A and 3 moles of liquid B are mixed. The vapour pressure of ideal solution so formed is 320 mm Hg. At this stage one mole of A are mixed further, the vapour pressure is found to be 340 mm Hg. The vapour pressure of pure A and B are respectively

(1) 200 mm Hg
400 mm Hg

(2) 440 mm Hg
240 mm Hg

(3) 300 mm Hg
400 mm Hg

(4) 240 mm Hg
440 mm Hg

Answer (2)

Sol. $P_S = X_A P_A^o + X_B P_B^o$

$$320 = \frac{P_A^o \times 2}{5} + \frac{P_B^o \times 3}{5}$$

$$1600 = 2P_A^o + 3P_B^o \quad \ldots(1)$$

After adding 1 mole of A

$$340 = \frac{3P_A^o}{6} + \frac{3P_A^o}{6}$$

$$680 = P_A^o + P_B^o \quad \ldots(2)$$

$3 \times (2) - (1)$

$$\boxed{240 \text{ mm Hg} = P_B^o}$$

$$\boxed{440 \text{ mm Hg} = P_A^o}$$

13. Observe the following reaction:

$$C_3H_6Cl_2 \xrightarrow[NaNH_2]{\text{excess}} (X) \xrightarrow[H_2O]{Hg^{2+}, H^+} (Y)$$

The product (Y) gives which of the following test?

(1) Tollen's test (2) Lucas test

(3) Iodoform test (4) Fehling's test

Answer (3)

Sol. $CH_3-CH_2-CHCl_2 \xrightarrow[NaNH_2]{\text{excess}} \underset{(X)}{CH_3-C\equiv CH} \xrightarrow[H_2O]{Hg^{2+}, H^+} \underset{(Y)}{CH_3-\overset{O}{\overset{\|}{C}}-CH_3}$

(Y) gives iodoform test.

14. $X \xrightarrow[H_3O^+]{\text{(i) } CO_2,\ 500 \text{ atm}} Y$

X react with $FeCl_3$

X contain C = 76.57% H = 6.43% O = 17%

V.D. of X = 47

Incorrect statement among following

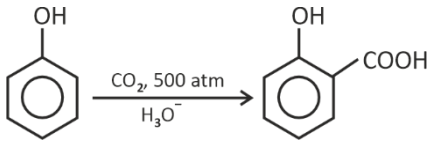
(1) X reacts with $NaHCO_3$

(2) X is more acidic than Y

(3) Y is salicylic acid

(4) Y is product of Kolbe's reaction

Answer (2)

Sol. 

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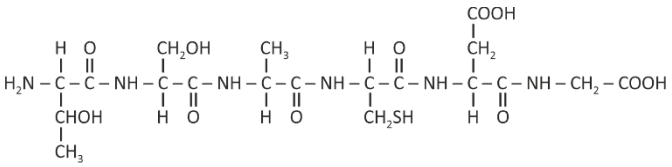
15. Consider the following polypeptide :



In the given polypeptide, Y is the essential amino acid present. The correct representation of Y and the name of amino acids in the correct sequence in polypeptide is

(1)

Y	Polypeptide (name of amino acid)
Thr	Thr-Ser-Ala-Cys-Asp-Gly

(2)

Y	Polypeptide (name of amino acid)
Ser	Ser-Ala-Thr-Cys-Asp-Gly

(3)

Y	Polypeptide (name of amino acid)
Thr	Thr-Ser-Cys-Asp-Ala-Gly

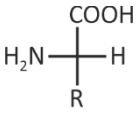
(4)

Y	Polypeptide (name of amino acid)
Ser	Thr-Ser-Ala-Asp-Cys-Gly

Answer (1)

Sol. Threonine is essential amino acid.

$\therefore$ Natural amino acids general form



$\therefore$ R $\Rightarrow$ H_3C – CHOH – (Threonine) (essential Amino acid)

R $\Rightarrow$ HO – CH_2 – (Serine)

R $\Rightarrow$ CH_3 – (Alanine)

R $\Rightarrow$ HS – CH_2 – (Cysteine)

R $\Rightarrow$ HOOC – CH_2 – (Aspartic acid)

R $\Rightarrow$ H – (Glycine)

16. Which of the following reaction is correctly matched with the product formed?

(1) $CH_3-\overset{O}{\overset{\|}{C}}-NH_2 + Br_2 + KOH \longrightarrow CH_3NH_2$

(2) $CH_3-\overset{O}{\overset{\|}{C}}-NH_2 + Br_2 + KOH \longrightarrow CH_3-CH_2-NH_2$

(3) $CH_3-CN \xrightarrow{LiAlH_4} CH_3-NH_2$

(4) $CH_3-NC \xrightarrow{LiAlH_4} CH_3-CH_2-NH_2$

Answer (1)

Sol. $CH_3-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[KOH]{Br_2} CH_3-NH_2$

$CH_3-CN \xrightarrow{LAH} CH_3-CH_2-NH_2$

$CH_3-NC \xrightarrow{LAH} CH_3-NH-CH_3$

17. Match the column-I showing compounds with column-II showing suitable test for that compound

	Column-I		**Column-II**
(P)	$C_6H_5COCH_2CH_3$	a	Iodoform test
(Q)	C_6H_5CHO	b	2, 4-DNP test
(R)	$C_6H_5CH_2CHO$	c	Tollens test
(S)	$C_6H_5COCH_3$	d	Fehling test

(1) P – b

Q – b, c

R – b, c, d,

S – a, b

(2) P – b

Q – b, c, d

R – b, c, d

S – a, b, c

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(3) P – a, b

Q – b, c, d

R – b, c, d

S – a, b, d

(4) P – b

Q – b, c, d

R – b, c

S – a, b

Answer (1)

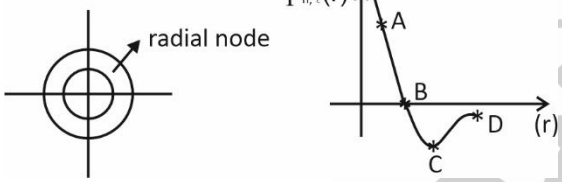
Sol. a. Iodoform test is given by aldehydes and ketones having CH_3CO – group

b. 2, 4-DNP test is given by aldehydes and ketones.

c. Tollen test is given by aldehydes, but not ketones.

d. Fehling test is given by only aliphatic aldehydes.

18. Consider the diagram



Radial node is shown by

(1) A

(2) B

(3) C

(4) D

Answer (2)

Sol. At radial node, $\psi(r)$ vs r curve touches r-axis.

19. In reversible isothermal process at 600 K, pressure changes from 0.5 MPa to 0.2 MPa, then find ΔU, w and q. Given moles of gas in container is 1 mol. ($R = 8.3\ JK^{-1}\ mol^{-1}$)

(1) $\Delta U = 0$

$q = -4.587$ kJ

$w = +4.587$ kJ

(2) $\Delta U = 0$

$q = 0$

$w = 0$

(3) $\Delta U = 0$

$q = 0$

$w = -4.587$ kJ

(4) $\Delta U = 0$

$q = +4.587$ kJ

$w = -4.587$

Answer (4)

Sol. For reversible isothermal process,

$$w = -nRT\ln\frac{V_2}{V_1}$$

$$w = nRT\ln\frac{P_2}{P_1}$$

$$= 1\times 8.3\times 2.303\times 600\log\frac{0.2}{0.5}$$

$= -4.587$ kJ

For isothermal process, $\Delta U = 0$

20.

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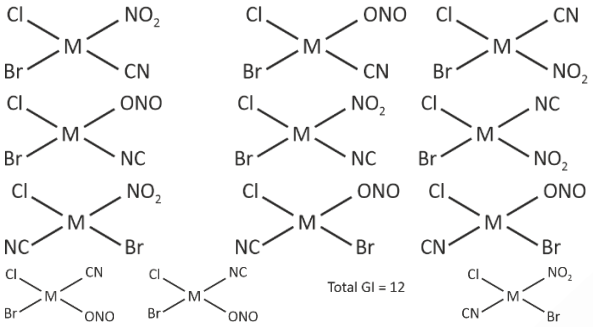
SECTION - B

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

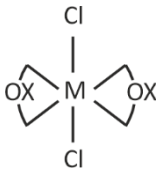
21. Calculate the sum of number of geometrical isomers of [MCl BrNO$_2$CN], number of optically inactive isomers of [M(OX)$_2$Cl$_2$] and number of geometrical isomers of [MCl$_3$Br$_3$]

Answer (15)

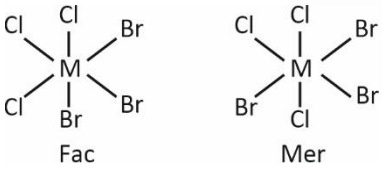
Sol. [M Cl BrNO$_2$CN]



[M(OX)$_2$Cl$_2$]



Total optically inactive isomer = 1



Total GI = 2

Sum = 15

22. Find out the ratio of de Broglie wavelengths of deuteron with kinetic energy E and α particle having kinetic energy 2E.

Answer (2)

Sol. $\lambda = \dfrac{h}{\sqrt{2.m.KE}}$

$$\frac{\lambda_D}{\lambda_\alpha} = \left(\frac{m_\alpha \times (KE)_\alpha}{m_D \times (KE)_D}\right)^{1/2}$$

$$= \left(\frac{2m_D \times 2E}{m_D \times E}\right)^{1/2} = 2$$

23. Consider a galvanic cell reaction :

$$3BH_4^-(aq) + 4ClO_3^-(aq) \xrightarrow{H^+} 4Cl^- + 3H_2BO_3^-(aq) + 3H_2O$$

EMF of cell is given by,

$$E_{cell} = E^o_{cell} - \frac{RT}{nF}\ln[Q]$$

Here 'Q' is reaction quotient for the given cell reaction. Find 'n'.

Answer (24)

Sol. $\overset{+5}{ClO_3^-} \longrightarrow \overset{-1}{Cl^-}$ ΔOxidation number = 6 units

$$3BH_4^- + 4ClO_3^- \longrightarrow 4Cl^- + 3H_2BO_3^- + 3H_2O$$

Number of electrons exchanged in balanced reaction = (5 –(–1)) × 4 = 24

24. 500 ml of 1.2 M KI solution is reacting with 500 ml of 0.2 M KMnO$_4$ solution in acidic medium, and product iodine is further reacting with 0.1 M Na$_2$S$_2$O$_3$ solution. The volume of Na$_2$S$_2$O$_3$ solution required for complete reaction is ____ ml.

Answer (5000)

Sol. $KI + KMnO_4 \rightarrow I_2 + Mn^{2+}$

m equivalent of KI = 500 × 1.2 × 1 = 600

m equivalent of KMnO$_4$ = 500 × 0.2 × 5 = 500 (limiting reagent)

So, m equivalent of I$_2$ formed = 500,

$$\text{m mol of } I_2 = \frac{500}{2} = 250$$

Now, $I_2 + Na_2S_2O_3 \rightarrow NaI + Na_2S_4O_6$

m equivalent of I$_2$ = 250 × 2 = 500,

so, m equivalent of Na$_2$S$_2$O$_3$ $\Rightarrow$ 500 = 0.1 × V

V = 5000 ml

25.

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MATHEMATICS

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. Consider the 10 observations 2, 3, 5, 10, 11, 13, 15, 21, a and b such that mean of observations in 9 and variance is 34.2 . Then the mean deviation about median is

(1) 3 (2) 5

(3) 6 (4) 7

Answer (2)

Sol. Mean = $\frac{80+9+6}{10}=9 \Rightarrow a+b=100$

Also,

Variance = $[(2-9)^2+(3-9)^2+(5-9)^2+(10-9)^2+(11-9)^2+(13-9)^2+(15-9)^2+(21-9)^2+(a-9)^2+(b-a)^2]/10 = 34.2$

$\Rightarrow$ Solving for a and b,

we get $a = 3$ or 7

$b = 7$ or 3

Deviation about median = $\frac{10+7}{2}=8.5$

$$=\frac{\Sigma|x_i-8.5|}{10}=5$$

2. If α, β are roots of quadratic equation $\lambda x^2-(\lambda+3)x+3=0$ and $\alpha<\beta$ such that $\frac{1}{\alpha}-\frac{1}{\beta}=\frac{1}{3}$, then find sum of all possible values of λ.

(1) 3 (2) 2

(3) 4 (4) 6

Answer (4)

Sol. $\because \frac{1}{\alpha}-\frac{1}{\beta}=\frac{1}{3}$

$\therefore 9(\alpha-\beta)^2=\alpha^2\beta^2$ ...(1)

$\because \alpha+\beta=\frac{\lambda+3}{\lambda}$ and $\alpha\cdot\beta=\frac{3}{5}$

From eq. (1)

$$9\left\{\left(\frac{\lambda+3}{\lambda}\right)^2-\frac{12}{\lambda}\right\}=\frac{9}{\lambda^2}$$

$\therefore (\lambda+3)^2-12\lambda=1$

or $\lambda^2-6\lambda+8=0$

Sum of all values of $\lambda = 6$

3. If 3 balls are taken from the box without replacement and found to be all black. If all configuration of red balls and black balls are equally likely then the probability that box contained 1 red and 9 black ball is $\frac{p}{q}$ for some coprime natural number p and q then, $p+q$ is

(1) 59 (2) 69

(3) 57 (4) 79

Answer (2)

Sol. $P\left(\frac{1R+9B}{BBB}\right)=\frac{P(1R+9B)P\left(\frac{BBB}{1R+9B}\right)}{P(BBB)}$

$$=\frac{\left(\frac{1}{10}\right)\cdot\frac{{}^9C_3}{{}^{10}C_3}}{\sum_{k=0}^{10}P\left(\frac{BBB}{kR+(10-k)B}\right)\cdot P(kR+(10-k)B)}$$

$$=\frac{\frac{1}{10}\cdot\frac{{}^9C_3}{{}^{10}C_3}}{\frac{1}{10}\sum_{k=0}^{10}\frac{{}^{10-k}C_3}{{}^{10}C_3}}=\frac{{}^9C_3}{\sum_{k=0}^{10}{}^{10-k}C_3}$$

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$$= \frac{{}^9C_3}{{}^{10}C_3 + {}^9C_3 + ... + {}^3C_3} = \frac{{}^9C_3}{{}^{11}C_4} = \frac{14}{55}$$

$\Rightarrow \boxed{69}$

4. Find the value of $\sum_{K=1}^{\infty} \frac{(-1)^{K+1} K(K+1)}{K!}$

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

(3) $\frac{1}{e}$ (4) e

Answer (3)

Sol. $\because \sum_{K=1}^{\infty} \frac{(-1)^{K+1} K(K+1)}{K!}$

$$= \sum_{K=1}^{\infty} \frac{(-1)^{K+1}((K+1)+2)}{(K!)!}$$

$$= \sum_{K=1}^{\infty} \frac{(-1)^{K+1}}{(K-2)!} + \frac{2.(-1)^{K+1}}{(K-1)!}$$

$$= \left(-1 + \frac{1}{1!} - \frac{1}{2!} + \frac{1}{3!} - \frac{1}{4!} + ...\right) + 2\left(1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + ...\infty\right)$$

$$= -e^{-1} + 2e^{-1} = \frac{1}{e}$$

5. If f be a real valued function such that $f(x^2 + 1) = x^4 + 5x^2 + 2$, then $\int_0^3 f(x)dx$ is equal to

(1) 16 (2) $\frac{31}{2}$

(3) $\frac{33}{2}$ (4) 14

Answer (3)

Sol. If $f(x^2 + 1) = x^4 + 5x^2 + 2$

Let $x^2 + 1 = t$

$\Rightarrow$ $f(t) = (t - 1)^2 + 5(t - 1) + 2$

$= t^2 - 2t + 1 + 5t - 3$

$= t^2 + 3t - 2$

$$\Rightarrow \int_0^3 f(x)dx = \frac{x^3}{3} + \frac{3x^2}{2} - 2x\Big|_0^3$$

$$= \frac{27}{3} + \frac{27}{2} - 6 = 3 + \frac{27}{2} = \frac{33}{2}$$

6. $\lim_{x \to 0} \frac{\ln\left(\sec(ex)\sec\left(e^2x\right)\sec\left(e^3x\right)...\sec\left(e^{10}x\right)\right)}{e^2 - e^2\cos x}$

(1) $\frac{e^{18} - 1}{e^2 - 1}$ (2) $\frac{e^{20} - 1}{e^2 - 1}$

(3) $\frac{e^{16} - 1}{e^2 - 1}$ (4) $\frac{e^{22} - 1}{e^2 - 1}$

Answer (2)

Sol. $\lim_{x \to 0} \frac{\ln(\sec(ex)) + \ln(\sec(e^2x)) + \ln(\sec(e^3x)) + ... + \ln(\sec(e^{10}x))}{e^2(1 - \cos x)}$

$$\lim_{x \to 0} \frac{e\tan(ex) + e^2\tan(e^2x) + e^3\tan(e^3x) + ... + e\tan(e^{10}x)}{\left(\frac{e^2 \sin x}{x}\right)x}$$

$$\Rightarrow \frac{1}{e^2}[e^2 + e^4 + e^6 + e^8 + ... + e^{20}]$$

$1 + e^2 + e^4 + ... + e^{18}$

$$\frac{e^{2\times 10} - 1}{e^2 - 1} = \frac{e^{20} - 1}{e^2 - 1}$$

7. Consider a circle C_1 passing through origin and lying in region $x \geq 0$ only, with diameter 10. Consider a chord PQ of C_1 with equation $x = y$ and another circle C_2 which has PQ as diameter. A chord is drawn to C_2 passing through (2, 3) such that distance of chord from centre of C_2 is maximum has equation $x + ay + b = 0$ then $(b - a)$ is equal to

(1) 4 (2) 2

(3) 3 (4) 5

Answer (2)

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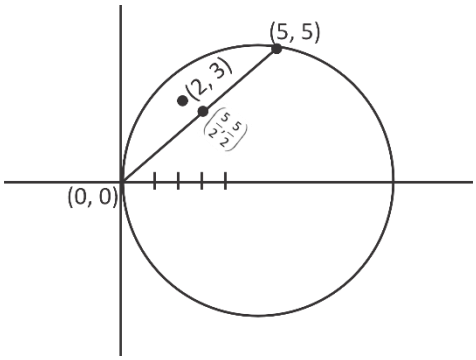
Sol. $X \geq 0$ and touching at x (0, 0)

$C_1 : (x-5)^2 + y^2 = 25$



$C_2 = (x-5)(x) + y(y-5) = 0$

Since the distance of chord is maximum from centre $\left(\frac{5}{2}, \frac{5}{2}\right)$

$\Rightarrow (y-3) = (1)(x-2)$

$\Rightarrow (y-3) = (1)(x-2) = x-2$

$\Rightarrow x - y + 1 = 0$

a = – 1

b = 1

b – a = 2

8. If $y = f(x)$ satisfies the differential equation $x\frac{dy}{dx} - \sin^2 y = x^3 \cos^2 y$ and $y(1) = \frac{\pi}{4}$, then $y\left(\frac{\pi}{3}\right)$ is

(1) 1 (2) $\tan^{-1}\left(\frac{\pi}{4}\right)$

(3) $\tan^{-1}\left(\frac{\pi^3}{27}\right)$ (4) Zero

Answer (3)

Sol. $x\frac{dy}{dx} - \sin 2y = x^3 \cos^2 y$

$\frac{dy}{dx} - \frac{\sin 2y}{x} = x^2 \cos^2 y$

$\sec^2 y \frac{dy}{dx} - \frac{2\sin y \cos y}{x \cos^2 y} = x^2$

$\sec^2 y \frac{dy}{dx} - \frac{2}{x}\tan xy = x^2$

Let $\tan y = t$

$\sec^2 y \frac{dy}{dx} - \frac{dt}{dx}$

$\frac{dt}{dx} - \frac{2}{x}t = x^2$

If $= e^{-\int \frac{2}{x}dx} = e^{-2\ln x} = \frac{1}{x^2}$

$\frac{t}{y^2} = \int 1 dx$

$\frac{\tan y}{x^2} = x + c$

$\tan y = x^3 + x^2 c$

$\because y(1) = \frac{\pi}{4}$

$\Rightarrow c = 0$

$\Rightarrow \tan y = x^3$

Now $y\left(\frac{\pi}{3}\right) = \tan^{-1}\left(\frac{\pi^3}{27}\right)$

9. Let z be a complex number lying in the first quadrant such that $|z-6| = 5$ and $|z-3i+5| = 7$, then $z^3 - 7z^2 + 25z + 16$ is equal to

(1) 45 (2) 55

(3) 35 (4) 25

Answer (2)

Sol. $|z-6| = 5$ and $|z+5-3i| = 7$

$\Rightarrow (x-6)^2 + y^2 = 25$

$(x+5)^2 + (y-3)^2 = 49$

$\Rightarrow x^2 + y^2 - 12x + 11 = 0$

$x^2 + y^2 + 10x - 6y - 15 = 0$

$\Rightarrow -22x + 6y + 26 = 0$

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Solving we get $x = 2$, $y = 3$ (in Ist quadrant)

$z = 2 + 3i$

$(z-2) = 3i \Rightarrow z^2 - 4z + 13 = 0$

$z^3 - 7z^2 + 25z - 39 = 0$

10. Consider polynomial functions $f(x)$ and $g(x)$ such that $g(x) = 3x^2 + 2x - 3$, $f(0) = -3$ such that $4g(f(x)) = 3x^2 - 32x + 72$ then $f(g(2))$ is equal to

(1) $-\frac{25}{6}$ (2) $\frac{25}{6}$

(3) $-\frac{7}{2}$ (4) $\frac{7}{2}$

Answer (4)

Sol. $g(f(x)) = 3\left(\frac{x}{2}\right)^2 - 8x + 18$

Notice that $g(x)$ is Quadratic, hence $f(x)$ has to be linear with leading coefficient $\frac{1}{2}$

$\Rightarrow f(x) = \frac{x}{2} + c$

$\because f(0) = -3 \Rightarrow f(x) = \frac{x-6}{2}$

Verify :

$g(f(x)) = 3\left(\frac{x-6}{2}\right)^2 + 2\left(\frac{x-6}{2}\right) - 3$

$= \frac{1}{4}\left[3x^2 - 36x + 108 + 4x - 24 - 12\right]$

$= \frac{1}{4}(3x^2 - 32x + 72)$

Now, $f(g(2)) = f(13) = \frac{7}{2}$

11. Let three unit vectors are $\vec{a}$, $\vec{b}$ and $\vec{c}$ such that $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 9$ then the value of natural number k such that $|2\vec{a} + k\vec{b} + k\vec{c}|^2 = 9$ is

(1) 9 (2) 6

(3) 3 (4) 5

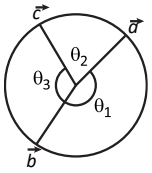
Answer (4)

Sol. $|\vec{a}| = 1 = |\vec{b}| = |\vec{c}|$

$|\vec{a} - \vec{b}|^2 = (\vec{a} - \vec{b}) \cdot (\vec{a} - \vec{b})$

$= 2 - 2\vec{a} \cdot \vec{b}$

$\Rightarrow \sum 2 - 2\vec{a} \cdot \vec{b} = 9$



$\Rightarrow \cos\theta_1 + \cos\theta_2 + \cos\theta_3 = -\frac{3}{2}$

$\Rightarrow \theta_1 = \theta_2 = \theta_3 = \frac{2\pi}{3}$

$\Rightarrow \vec{a} \cdot \vec{b} = -\frac{1}{2},\ \vec{b} \cdot \vec{c} = -\frac{1}{2},\ \vec{c} \cdot \vec{a} = -\frac{1}{2}$

$|2\vec{a} + k\vec{b} + k\vec{c}|^2$

$= 4 + k^2 + k^2 + 2(2k + 2k + k^2)\left(-\frac{1}{2}\right)$

$= 2k^2 - 4k + 4 = (k-2)^2 = 9$

$\Rightarrow k = 5$

12. Let $A = \begin{bmatrix} 12 & -5 \\ 10 & 6 \end{bmatrix}$, $B = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 12 \\ -6 \end{bmatrix}$ such that $B = (I + A)^{-1}$, then $x_1 - x_2$ is equal to

(1) 27 (2) 108

(3) 21 (4) 54

Answer (2)

Sol. $B = (I + A)^{-1}$

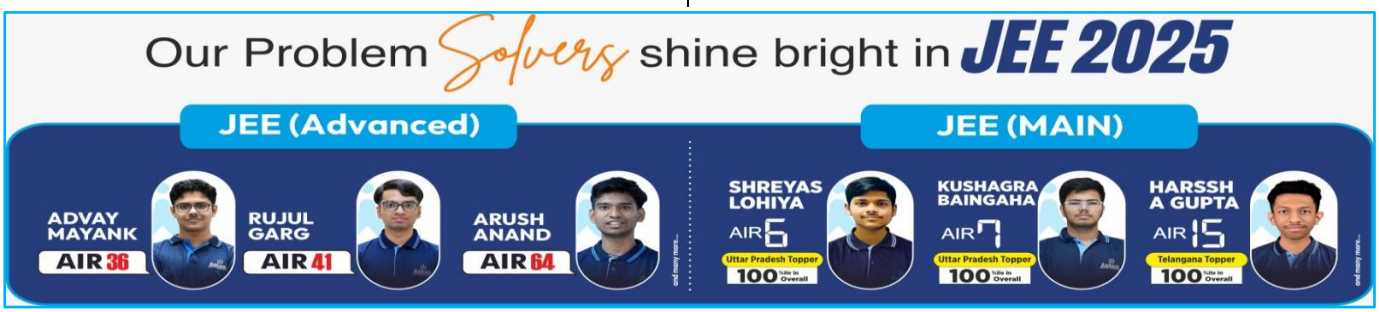
$\Rightarrow (I + A)^{-1}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 12 \\ -6 \end{bmatrix}$

$\Rightarrow \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 12 \\ -6 \end{bmatrix}\left(\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + \begin{bmatrix} 12 & -5 \\ 10 & 6 \end{bmatrix}\right)$

$= \begin{bmatrix} 12 \\ -6 \end{bmatrix} = \begin{bmatrix} 13 & -5 \\ 10 & 7 \end{bmatrix}$

$= \begin{bmatrix} 186 \\ 78 \end{bmatrix}$

$\Rightarrow x_1 - x_2 = 108$



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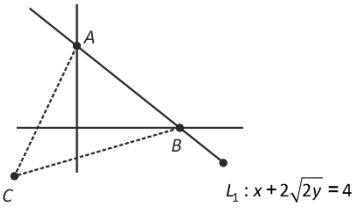
13. Let a line $L: x+2\sqrt{2}y-4=0$ cuts x-axis and y-axis at A and B respectively. Consider an equilateral triangle ABC, such that (0, 0) is the orthocentre of ΔABC. If $C \equiv (\alpha, \beta)$ then $\left|\alpha+\sqrt{2}\beta\right|$ is

(1) 4 (2) 6

(3) 2 (4) 4

Answer (2)

Sol.



$A\left(0,\sqrt{2}\right)$ $B(4, 0)$

ABC is an equilateral Δ

$\Rightarrow$ orthocentre = centroid

$\Rightarrow C(\alpha, \beta) \equiv \left(-4,-\sqrt{2}\right)$

$\Rightarrow \alpha = -4, \beta = -\sqrt{2}$

$\left|\alpha+\sqrt{2}\beta\right| = \left|-4-2\right| = 6$

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. Let $k = \tan\left(\frac{\pi}{4}+\frac{1}{2}\cos^{-1}\frac{2}{3}\right)+\tan^{-1}\left(\frac{1}{2}\sin^{-1}\frac{2}{3}\right)$. Then number of solutions of the equation $\sin^{-1}(kx - 1) = \sin^{-1}x - \cos^{-1}x$ is

Answer (1)

Sol. $K = \tan\left(\frac{\pi}{4}+\frac{1}{2}\cos^{-1}\frac{2}{3}\right)+\tan\left(\frac{1}{2}\sin^{-1}\frac{2}{3}\right)$

$= \tan\left(\frac{\pi}{4}+\frac{1}{2}\cos^{-1}\frac{2}{3}\right)+\tan\left(\frac{1}{2}\left(\frac{\pi}{2}-\cos^{-1}\frac{2}{3}\right)\right)$

$= \tan\left(\frac{\pi}{4}+\frac{1}{2}\cos^{-1}\frac{2}{3}\right)+\tan\left(\frac{\pi}{4}-\frac{1}{2}\cos^{-1}\frac{2}{3}\right)$

Let $\frac{1}{2}\cos^{-1}\frac{2}{3}=\theta$

$= \tan\left(\frac{\pi}{4}+\theta\right)+\tan\left(\frac{\pi}{4}-\theta\right)$

$= \frac{1+\tan\theta}{1-\tan\theta}+\frac{1-\tan\theta}{1+\tan\theta}$

$= \frac{2(1+\tan^2\theta)}{1-\tan^2\theta} = \frac{2}{\cos^2\theta}$

$= \frac{2}{2/3}=3$

Now $\sin^{-1}(kx-1)=\sin^{-1}x-\cos^{-1}x$

$\sin^{-1}(3x-1)=\sin^{-1}x-\frac{\pi}{2}+\sin^{-1}x$

$\sin^{-1}(3x-1)+\frac{\pi}{2}=2\sin^{-1}x$

$\therefore$ only positive value g x is zero

$\therefore$ No. of solution = 1

22. Product of first three term of G.P is 27, then the range of sum of these terms is $R - (a, b)$ then $a^2 + b^2$ is

Answer (90)

Sol. Let first three terms be $\frac{a}{r}, a, ar$

$\frac{a}{r}\cdot a\cdot ar = 27$

$a^3 = 27$

$a = 3$

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Now $S=\frac{a}{r}+a+ar$

$\Rightarrow S=\frac{3}{r}+3+3r$

If $r>0\Rightarrow r+\frac{1}{r}\geq 2$

$r<0\Rightarrow r+\frac{1}{r}\leq -2$

Case I:

If $r>0$

$S=3\left[r+\frac{1}{r}+1\right]$

$S\geq 9$

Case II

If $r<0$

$S=3\left(r+\frac{1}{r}+1\right)$

$S\leq -3$

$S\in(-\infty,-3]\cup[9,\infty)$

$S\in R-(-3,9)$

$a=-3 \quad b=9$

$a^2+b^2=90$

23. The common difference of AP a_1, a_2, a_3.....a_m is 13 times the common difference of AP b_1, b_2, b_3....b_n. Also a_{78} = 327, b_{43} = –385, b_{31} = –277, then a_1 is equal to

Answer (9336)

Sol. Let common difference be d_1 for

a_1, a_2,.....a_m

let common difference be d_2 for

b_1, b_2,.....b_n

Now $d_1 = 13d_2$

$a_{78} = a_1 + 77d_1 = 327$

$b_{43} = b_1 + 42d_2 = -385$

$b_{31} = b_1 + 30d_2 = -277 \Rightarrow b_1 = -7,\ d_2 = -9$

$\because\ d_2 = -9$

$\Rightarrow d_1 = -13 \times 9 = -117$

$a_1 + 77(-117) = 327$

$\Rightarrow a_1 = 9336$

24.

25.

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